MOBILE RADIO

GE-MARC™ V•E TMX-8615 & TMX-8630

TRUNKED MOBILE RADIO

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TMX-8615

MICROPHONE

800 MHz
15-WATT &
30-WATT

TWO-WAY FM
TRUNKED RADIO
COMBINATION

TMX-8630

GENERAL ELECTRIC

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ILLUSTRATIONS

CAUTION

Although the highest DC voltage in this mobile equipment is supplied by the vehicle battery, high currents may be drawn under short circuit conditions. These currents can possibly heat objects such as tools, rings, watchbands, etc., enough to cause burns. Be careful when working near energized circuits!

High-level RF energy in the transmitter Power Amplifier assembly can cause RF burns upon contact. Keep away from these circuits when the transmitter is energized!

NOTE

This equipment has been tested and found to comply with the technical specifications in Part 15, Subpart J of FCC rules for a Class A and Class B computing device.

SPECIFICATIONS*

SYSTEM

Frequency Range	
Transmitter	806.0125 MHz - 824.9875 MHz
Receiver	851.0125 MHz - 869.9875 MHz
Battery Drain	
Receiver @ 13.8 VDC	
Squelched	1.0 Amperes
Unsquelched	1.5 Amperes
Transmitter @ 13.6 VDC	
TMX-8615	7.0 Amperes (15-Watts)
TMX-8630	11.0 Amperes (30-Watts)
Frequency Stability	0.00025%
Channel Spacing	25 kHz @ 12.5 kHz increments
Frequency Capacity	120 Channels (typical)
Maximum Frequency Separation	19 MHz
Temperature Range	-30°C (-22°F) to +60°C (140°F)
Duty Cycle (Simplex)	100% Receive, 20% Transmit
Dimension, Less Accessories (H X W X D)	6.9 cm x 19 cm x 24 cm (2.7 x 7.5 x 9.5 inches)
Weight, Less Accessories	2.73 Kg (6.0 pounds)

RECEIVER

Audio Output (to 4-ohm speaker)	3 Watts (less than 5% distortion) (EIA)
Sensitivity	
12 dB SINAD (EIA Method)	0.3 uV
20 dB (Quieting Method)	0.4 uV
Selectivity	
EIA Two-Signal Method	-70 dB ±25 kHz
Spurious Response	-70 dB
Intermodulation	-68 dB
Modulation Acceptance	±7 kHz
Frequency Response	Within +1 dB and -8 dB of a standard 6 dB per octave de-emphasis curve from 300 Hz to 2000 Hz EIA
RF Input Impedance	50 ohms
Receiver Attack Time	100 ms (max)
Receiver Recovery Time	100 ms (max)

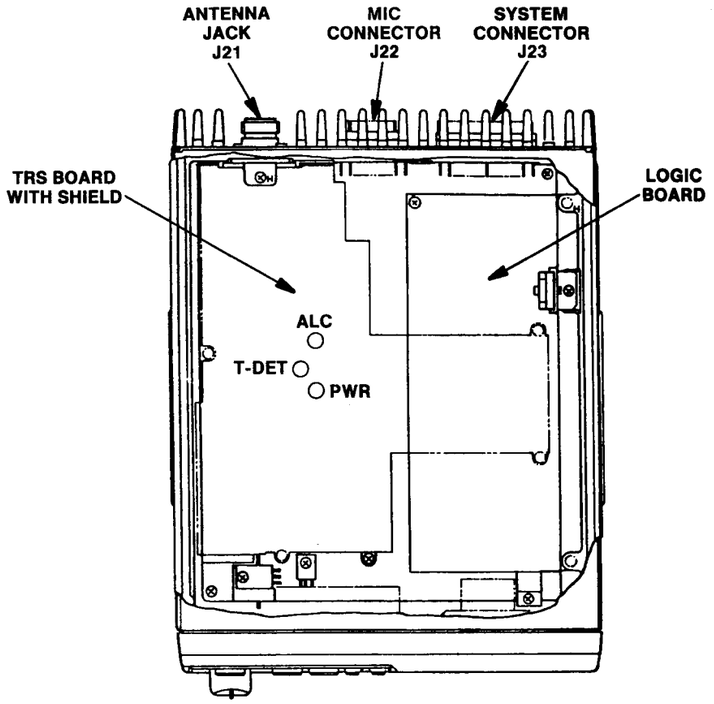
TRANSMITTER

Power Output	
TMX-8615	15 Watts
TMX-8630	30 Watts
Conducted Spurious	Meets FCC
Modulation	±4.5 kHz
Audio Sensitivity	55 to 120 millivolts
Audio Frequency Characteristics (Per RS-152B)	Within +1 dB to -5 dB of a 6 dB/ octave pre-emphasis from 300 Hz to 2500 Hz per EIA standard and +1 dB to -6 dB from 2500 Hz to 3000 Hz.
Distortion	Less than 3% (1000 Hz) Less than 5% (300 Hz to 3000 Hz)
Deviation Symmetry	0.5 kHz maximum
RF Output Impedance	50 ohms
Carrier Attack Time	30 ms (max)
Audio Attack Time	50 ms (max)

* These specifications are intended primarily for use of the serviceman. Refer to the appropriate Specifications Sheet for the complete specifications.

COMBINATION NOMENCLATURE

Digits 1&2	Digit 3	Digit 4	Digit 5	Digits 6&7
Product Code	Radio Type	Frequency	Features	Power Output
TM	**X** Wide Band	**8** 800 MHz	**6** Full Feature	**15** 15 Watts
				30 30 Watts



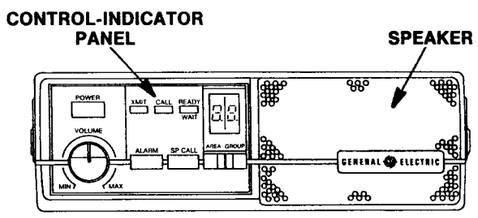


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Figure 1 - Mobile Layout Diagram

GENERAL DESCRIPTION

The GE-MARC™ V•E TMX-86 Series radios are synthesized, wide-band radios, utilizing microcomputer technology and integrated circuits to provide high performance, high reliability operation in trunked radio systems.

These trunked mobile radios can be programmed for operation in up to five groups and nine areas with up to 20 frequencies in each area. The frequencies are independently programmable, and can be programmed to operate in both GE-MARC V and GE-MARC V•E systems. The radio has a typical channel capacity of 120 synthesized channels that are field programmable.

Universal Radio Programmer TQ2310 is used to program or re-program the radio. Programming is accomplished by inserting the radio personality EEPROM into the I/O module of the programmer and then replacing the programmed EEPROM into the appropriate socket on the logic board.

A temperature-compensated oscillator module provides ±0.00025% (2.5 PPM) oscillator stability. Digital signal processing (audio and tone) provides improved audio quality and tone detection capability.

The radio circuitry consists of a transmitter/receiver/synthesizer (TRS) board, a logic board, and a control panel.

The TRS board is mounted on the bottom of the chassis, and includes the synthesizer, exciter, driver and PA module, and the receiver circuitry. The logic board mounts on the top section of the chassis over the TRS board. The control panel mounts on the front of the radio and houses the speaker, controls and indicators. Refer to Figure 1 for the Mobile Layout Diagram.

NOTE

In this preliminary manual, all figures called for in the text are located at the back of the manual.

No power supply is required since the highest supply voltage used in the radio is provided by the vehicle battery. The radio is designed for operation in 12 Volt, negative ground vehicle systems or as AC mobiles.

NOTE

AC MOBILES - The AC mobile is a conventional mobile radio used in a fixed location and utilizing an AC power supply as its DC power source. It performs all the functions a standard mobile radio. It also has the capability of operating as a control station.

Access to the TRS board and logic board is easily obtained by removing the two screws in the rear of the top cover and removing the cover. All modules and tuning controls are accessible with the top cover removed. However, it may be necessary to remove the logic board to gain access to all controls on the TRS board.

Access to the control and indicator circuitry can be obtained by removing the four screws securing the front panel to the chassis.

TRS BOARD

Transmitter

The transmitter consists of an audio processor, synthesizer, exciter and a broadband, fixed-tuned driver module and power amplifier. In the receive mode, the exciter output also serves as the receiver first mixer injection.

The RF power output level is internally adjustable for rated power. Once the level is set, a sensing control circuit holds the power constant over temperature and/or voltage variations within specified limits.

Drive for the transmitter and the receiver 1st mixer injection are derived from a phase lock loop (PLL) circuit.

Frequency stability for both the transmitter and receiver is maintained by compensation network in the oscillator module (TCXO), and a compensated reference oscillator in the synthesizer.

Receiver

The dual conversion receiver consists of a 800 MHz front end section and two mixer/IF sections operating at 800 MHz/45 MHz and 45.455 MHz/455 kHz or 44.545 MHz/455 kHz respectively. The receiver also contains a squelch and audio section. The audio section provides a 3-Watt audio output into a 4-ohm load.

Frequency Synthesizer

The synthesizer consists of a synthesizer chip, dual modulus counter, a reference oscillator, and a voltage controlled oscillator (VCO). The synthesized frequency is controlled by the personality EEPROM and applied to the transmit/receive board.

LOGIC BOARD

The logic controls the operation of the radio and consists of the microprocessor with EPROM for microprocessor code, personality EEPROM, digital signal processor and watchdog timer. The A/D, D/A coverters (CODEC), analog filtering and the modulation adjust control (R52) are also located on the logic board.

MICROPHONE

The mobile radio uses a dynamic microphone with a built-in transistorized pre-amplifier. The microphone is housed in a sturdy case, and the extendable coiled cord plugs into a jack at the back of the radio. The microphone is secured to the radio by means of a strain relief hook on the microphone cable.

HOOKSWITCH

A hookswitch is provided for holding the microphone. Removing the microphone from the hookswitch switches the radio from the idle mode to the wait mode, and lights the flashing WAIT indicator light. The hookswitch is connected to pins 8 and 9 of the systems cable plug P23.

EXTERNAL ALARM RELAY (Optional)

The optional relay kit contains a relay which can be mounted in the vehicle. Connections from the relay are made to the systems jack at the rear of the radio.

CONTROL PANEL

The control panel mounts on the front of the radio, and contains the radio controls and indicators as well as the speaker and the indicator circuit board. The controls and indicators are listed below:

Controls

The radio controls are as follows:

- POWER On pushbutton
- External ALARM pushbutton
- SP CALL (special call) pushbutton
- Rotary VOLUME control
- AREA and GROUP select pushbuttons

Indicators

Indicators lights mounted on the radio are:

- Red XMIT (transmit) light
- Green WAIT-READY light
- Green CALL light
- Green AREA and GROUP display that also serve as a power-on indicator

EXTERNAL SPEAKER (Optional)

An optional 3-watt, 4-ohm speaker is available for use with the radio. The speaker is supplied with a mounting bracket and mounting hardware. The speaker leads connect to a jack on the back of the radio.

AC POWER SUPPLY (Optional)

An optional 121 VAC power supply is available to permit the mobile unit to be used as a control station. The power supply is equipped with an eight-foot power cable to permit the power supply to be located away from the radio.

SYSTEM DESCRIPTION

The GE-MARC VoE trunked mobile 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 trunked mobile radio system consists of a repeater for each channel and the users' mobile radio units. The system uses tone signalling with each mobile being assigned two and/or four tone group tone sequences. Groups of mobiles are assigned the same tones, so that any unit can talk to all other units in the same group.

When originating a call, the mobile identifies an idle repeater channel and interrogates it with a single burst of "busy" tone. Upon receipt of the busy tone, the repeater keys its transmitter and sends a burst of "acquisition" tone back to the mobile unit. When the interrogating mobile detects the acquisition tone, it then transmits its collect and group tones, which the repeater regenerates for all idle mobile units in the system.

The idle mobiles, which continually scan all channels, will stop on the active channel if any of the programmed collect tones are detected and wait for group tone(s).

If the correct tone sequence is detected, the mobiles will alert the operator of an incoming call and open their audio circuits. If the correct sequence is not detected, the idle mobiles will resume scanning the channels. Once the mobile is "locked" on a channel, it will remain there until the repeater times out or the operator terminates the call.

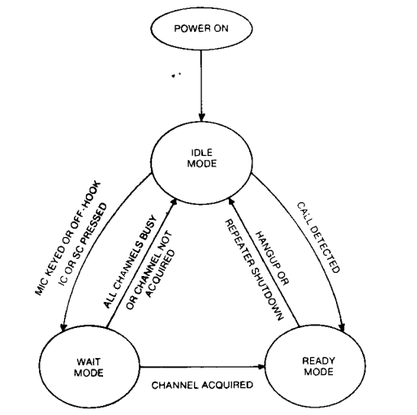
OPERATIONAL MODES

The radio will always be in one of three operational modes: idle, wait, or ready. The three operational modes and the conditions that cause the radio to switch from one mode to another are shown in Figure 2.

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 if no channel is available. The ready or conversation mode is indicated by an alert tone and the mode indicator on the control panel.

A tone signaling Timing Diagram is shown in Figure 3.

Sequence Flow Charts for each operational mode are shown in Figures 4 through 6.



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-5175

Figure 2 - Operational Modes

IDLE MODE (Figure 4)

When the radio is in the Idle mode, the audio is muted and all channels programmed for call decode are sequentially scanned for an incoming call. An incoming call is identified by detecting one of the collect tones programmed in the area. The TMX series mobile allows from one to five collect tones in each area that is scanned. Up to four collects are allowed in the group tone list and one additional is allowed for the individual decode sequence.

NOTE

If numerous collect tones are used, the mobile will stop scanning each time it sees any of the collect tones, increasing the probability of missing a call.

Upon receipt of a collect tone, the mobile looks for a short interval for any of one to five group tones depending on the number of groups in the area. When no valid tone is found, the mobile will resume scanning the channels for an incoming call.

If a group (or individual decode) tone is detected and the duration matches that of a two tone call, the mobile then looks for busy tone for a 90-millisecond period. If the duration of the tone matches the four tone call, the mobile will look for up to five group tones in the third slot of the four tone call. When a valid tone is found, the mobile will look for the last tone of any remaining valid groups. If four tones are properly decoded, the mobile will then look for busy tone for 270 milliseconds.

When no valid tones are found in any of the time slots, the mobile will resume scanning for a call with the next channel. When a busy tone is found, the mobile will enter the Ready mode. If busy tone is not detected, the mobile remains in the Idle mode and continues scanning channels looking for an incoming call.

Removing the microphone from the hanger or pressing the PTT switch will cause the radio to enter the Wait mode.

WAIT MODE (Figure 5)

When the user enters the Wait mode, the group tone is checked to make sure it is a valid call-originate group. If it

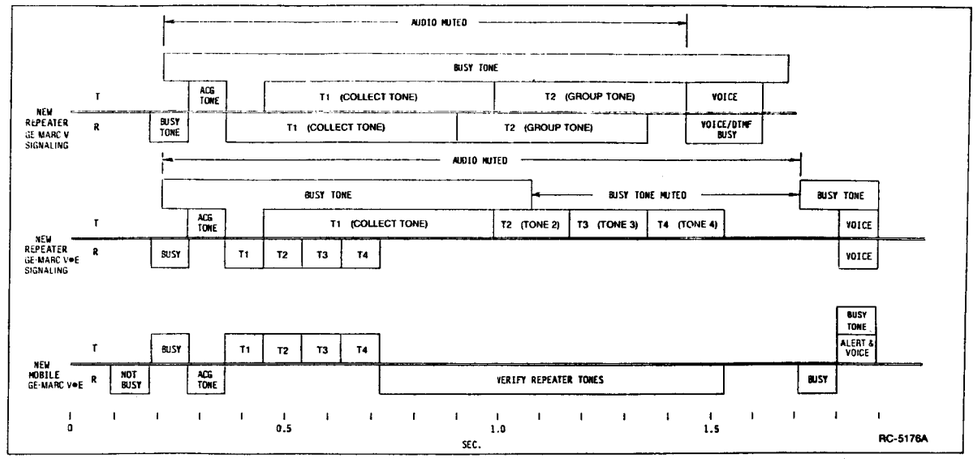


Figure 3 - Tone Signal Timing

IDLE MODE

Figure 4 - Idle Mode

WAIT MODE

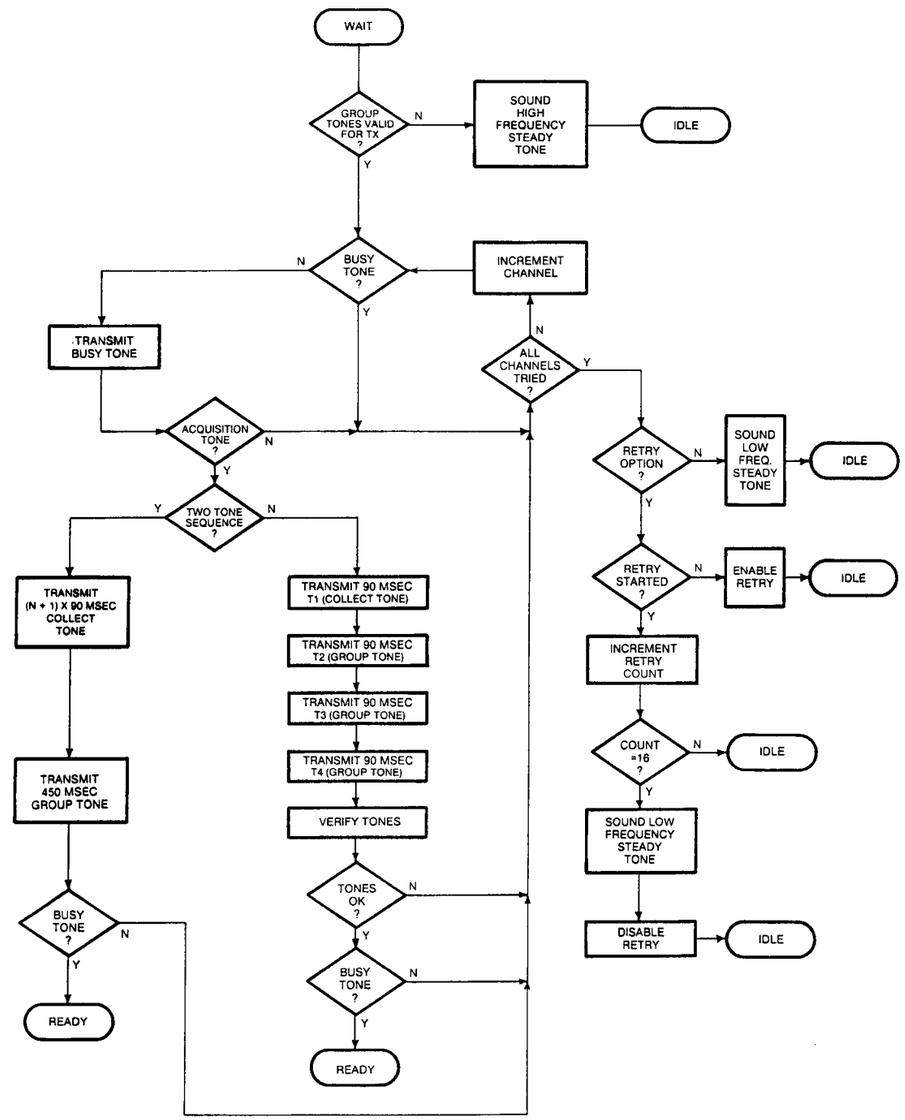


Figure 5 - Wait Mode

is not valid, a high-frequency, steady tone is heard in GE-MARC™ V●E systems only. If valid, the radio will scan the call-originate frequencies for brief intervals until it finds one with no busy tone on it. If no channel is free, the radio will activate the Call Retry state if programmed for this option. This causes the radio to revert to the Idle mode and scan for a call while trying the Wait mode approximately every 20 seconds for five minutes. If no channel is available at the end of the 5 minute period or the Retry option is not programmed, the mobile will sound a low-frequency tone, and then return to the Idle mode.

If a channel with no busy tone is found, the mobile transmits a burst of busy tone to acquire the repeater. The repeater then responds with a burst of acquisition tone. Upon receipt of the acquisition tone, the mobile proceeds to transmit the group tones (either two or four tones). If a four tone sequence is sent, the mobile must detect all four tones and busy tone before entering the Ready mode. If a two tone sequence is sent, the busy tone must be present within 90 milliseconds of the last tone in order for the radio to enter the Ready mode. If no busy tone is present, or if the four tone sequence isn't valid, the mobile will jump to the next channel in the call originate set and check for busy tone as described above.

READY MODE (Figure 6)

When an incoming call has been detected, or an idle channel has been acquired, the mobile enters the Ready mode. In this mode, 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 with the radio remaining on the channel until the operator hangs up or the repeater drops the busy tone, causing the unit to revert to Idle mode.

OPERATION

Complete operating instructions for the two-way radio are provided in the separate OPERATOR'S MANUAL. The basic procedure for receiving and transmitting messages is as follows:

TO RECEIVE A MESSAGE

1. Turn the radio on by pressing in the POWER switch. The POWER ON indicator will light.
2. Adjust VOLUME control one fourth turn clockwise from full counterclockwise position. It may be necessary to re-adjust the VOLUME for the desired listening level upon receipt of the first message.

NOTE

An audible alert tone normally precedes each incoming message.

The radio is now ready to receive messages from other radios in the system.

TO TRANSMIT A MESSAGE

1. Turn the radio on and adjust the VOLUME control as directed above.
2. Select the desired group.
3. Select the appropriate area.
4. Select the desired mode of operation (SP CALL or regular call).
5. Remove the microphone from the hookswitch. When a channel is acquired, press the Push-To-Talk (PTT) switch on the microphone and send the message.

NOTE

When a channel is acquired, the Ready mode indicator will light and an alert tone will be sounded.

3. To clear the radio and return to the Idle mode, replace the microphone in the hookswitch hanger.

CHANNEL DISCONNECT

The repeater continually looks for a busy tone from the mobile or station, to determine if the channel is busy or idle. If a busy tone is not received for approximately five seconds, the repeater assumes the channel is idle and disconnects. If communications were not completed, the call must be placed again. It is suggested that a procedure be established that designates the originator of a call as the one to re-establish communications.

NOTE

It's possible for two or more operators originating a call simultaneously to come up on two different channels. Communications under these conditions are impossible.

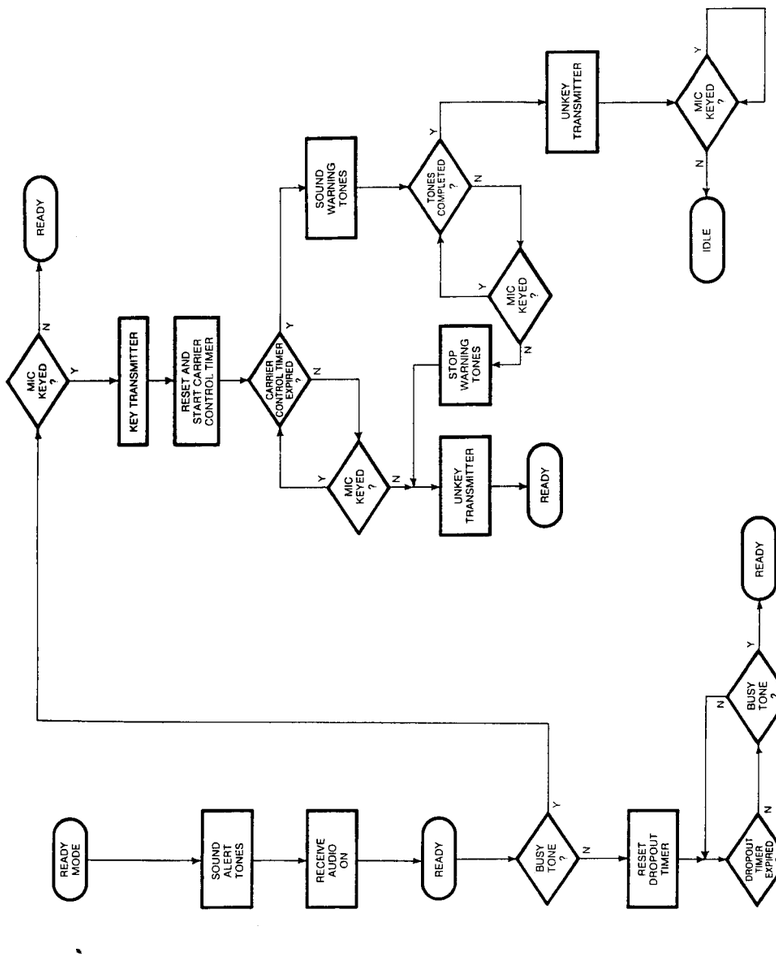


Figure 6 - Ready Mode

PROGRAMMABLE OPTIONS

The following options are provided as standard equipment. These options are controlled by the microprocessor with the different tone and frequency codes stored in the personality EEPROM on the logic board. Any changes to the options require that the EEPROM be re-programmed. The options include:

- Carrier Control Timer
- Area Select
- Group Select
- Special Call
- Receive Alert Tone Disable
- Wait Mode Re-try
- Alternate Busy Tone
- Individual Call Decode

Carrier Control Timer (CCT) - A CCT option is provided to limit the amount of continuous transmit time. The timer is programmable in 30 second increments from 30 seconds to 7.5 minutes. The timer can also be disabled.

Area Select - Permits operation on up to nine different trunked systems.

Group Select - Selected encode tones that are programmed for decoding by a selected group of mobiles.

Special Call - Special Call allows the mobile to selectively signal the control station or another mobile by adding another encode tone combination.

Alert Tone Disable - Enables the alert tone to be disabled on selected channels.

Call Retry - Enables automatic retry of "Wait" mode upon failure to get a channel. Retries channel 15 times at approximately 20 second intervals and sounds All Channel Busy tone if channels are still busy after all attempts are made. Pressing the PTT switch will override the feature and will reset the retry count.

Alternate Busy Tone - Prevents radio communications interferences between mobiles operating in adjacent areas when using the same RF frequency.

Individual Call Decode - Allows the mobile to be signalled individually by the control station or another mobile with Special Call option.

AUDIBLE "ALERT" TONES

Call Received Alert Tones

The "Call Received" indicator consists of a one or two tone alert sequence. If the received call is a two tone sequence, the single tone alert is sounded. If the received call is a four tone sequence, the two tone alert is sounded.

Call Originate Alert Tones

When initiating a two tone call a single tone alert is sounded when the channel is ready for normal conversation. When a four tone sequence is used, a three tone alert is sounded.

Carrier Control Timer

The Carrier Control Timer alert is a pulsed tone that is sounded when the mic has been keyed continuously for the pre-programmed time (0.5 minutes to 7.5 minutes). After approximately 20 seconds of pulsing, the transmitter is turned off and the mobile resumes scanning channels in the Idle mode after the user releases PTT. When the tones are pulsing, the user can unkey and key again in order to resume normal conversation.

Channel Busy/No Channel Available

The Channel "Busy"/No Channel Available tone is a one second low frequency tone which occurs at the end of the Wait mode when no channel is found.

Out-Of-Range/Receiver Inoperative Alarm

If a call is initiated and a sequence of five beeps is sounded, the user cannot access the radio system due to being out-of-range or having a defective receiver in the mobile radio. Any call initiate request at this time will be ignored for 20 seconds to prevent the system repeaters from being locked up by the receiver.

If you are within repeater range and your receiver is OK, then no apparent change in radio operation will be seen.

INDICATOR LIGHTS

XMIT - Indicates the message is being transmitted.

READY-WAIT - When flashing, indicates that the mobile radio is searching for an available channel. When lighted continuously, indicates that the radio is ready to transmit, or that an incoming call is being received.

CALL - Indicates that the radio was called.

GLOSSARY OF SYSTEM TERMS

Idle Mode

The "standby" condition for a mobile, inactive, but prepared to call or be called. Trunked radios are IDLE until they enter another mode or are turned off.

Wait Mode

The "attempting origination" condition. Wait mode is entered from Idle mode (only) as the user presses the PTT switch on the microphone, or comes "off-hook" (removes microphone from hookswitch). If successful, the unit becomes READY. Otherwise, the unit is IDLE or IDLE/WAIT after all channels are tried.

Ready Mode

The "operating" condition. Ready is entered from Idle mode via Wait mode when calling, or directly from Idle when called. Ready mode ends (the radio reverts to Idle) when the user disconnects or with loss of received Busy Tone from the repeater. This normally occurs when the repeater shuts down after communication is complete.

Busy Tone

A "voice-plus" tone (3051.9 Hz standard, 2918 Hz alternate) which modulates mobile and repeater transmitters at low level (±1 kHz deviation) continuously. This tone is filtered from received audio and is used to hold the communication channel active. It also excludes other mobiles from using the channel when a call is active.

Acquisition Tone

A tone (1962.9 Hz) sent at full deviation for 50 milliseconds from repeater. It is used as acknowledgement from the repeater of a busy tone that was sent and signals the mobile that signalling tones can now be sent.

Collection Tone

A tone chosen from 38 standardized frequencies ranging from 508.6 Hz to 2792.4 Hz used as the first tone in the group tone sequence. The collect tone is used to gather all mobiles with the same collect tone for decoding a call. The duration of the tone varies as a function of the number of channels which are programmed into the mobile and/or repeater. In a two-tone call, the mobile sends the collect for a programmable duration. In the four-tone call, the mobile always sends a 90-millisecond collect tone which the repeater regenerates and sends for the correct duration.

Group/Individual Tones

Tones chosen from the 34 standard frequencies which follow the collect tone. In a two-tone call, the second tone is sent for 450 milliseconds. In a four tone call, the second, third, and fourth tones are sent for 90 milliseconds from the mobile, and 180 milliseconds from the repeater.

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