Maintenance Manual

MONOGRAM SERIES

EDACS® Trunking Portable 800 MHz

ERICSSON

NOTICE!

This manual covers Ericsson and General Electric products manufactured and sold by Ericsson Inc.

NOTICE!

Repairs to this equipment should be made only by an authorized service technician or facility designated by the supplier. Any repairs, alterations or substitution of recommended parts made by the user to this equipment not approved by the manufacturer could void the user's authority to operate the equipment in addition to the manufacturer's warranty.

NOTICE!

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SPECIFICATIONS

Input Voltage:	7.5 VDC (Nominal)
Dimensions (Typical) (HxWxD):	Less Antenna 7" x 2.5" x 1.5" (17.78 x 6.35 x 3.81 cm)
Weight	
Radio with Medium Capacity Battery:	23.03 oz (653 g)
Ambient Temperature Range:	-22°F to +140°F (-30°C to +60°C)
Relative Humidity:	95% at 122°F (50°C)
Altitude:	
Operational:	15,000 ft (4,572 m)
In Transit:	55,000 ft (16,764 m)
Display:	7 Character Alphanumeric
Memory Levels:	16, 128 EDACS Systems/Groups 9 Areas/9 Groups GE•MARC V
Programming:	PC, IBM®, or IBM compatible

TRANSMITTER

Frequency Range (MHz):	806-824 851-869 Talk Around
Frequency Separation (MHz)	
(No Degradation)	18
RF Power (Watts):	2 (±10%)
Modulation Limiting (kHz):	5 max
FM Hum And Noise (dB):	-40 (companion Rx)
Conducted Spurious (dB):	-65 (-30 dbm)
Frequency Stability (PPM):	≤ 1.5
Channel Spacing (kHz):	25 / 12.5 (NPSPAC)
Audio Response:	EIA
Audio Distortion:	≤ 5%

RECEIVER

Frequency Range (MHz):	851-869
Frequency Separation (MHz):	18
Sensitivity (12 dB SINAD) (dBM):	-116 (0.35μV)
Selectivity	
@ 25 kHz (dB):	-65
@ 12.5 kHz (dB) NPSPAC:	-20
Intermodulation (dB):	-65
Spurious Response Image Rejection: (dBc)	-65
Frequency Stability (PPM):	≤ 1.5
Channel Spacing (kHz):	25 / 12.5 (NPSPAC)
Audio Output (mW):	400
Distortion (at Rated Audio):	≤ 10%

ENVIRONMENTAL SPECIFICATIONS

Standard	U.S. Military Spec 810C Methods & Procedures	U.S. Military Spec 810D Methods & Procedures
Low Pressure	500.1/1	500.2/1,2
High Temperature	501.1/1	501.2/1,2
Low Temperature	502.1/1	502.2/2
Temperature Shock	503.1/1	503.2/1
Solar Radiation	505.1/1	505.2/2
Humidity	507.1/2	507.2/2
Blowing Dust	510.1/1	510.2/1
Vibration	514.2/8,10	514.3/1
Shock	516.2/1,2, & 5	516.3/1,4

REGULATORY DATA

Frequency Range (MHz)	806-870
FCC Type Acceptance	F3JETP4800
RF Output	2 Watts
FCC Rules	22, 90
DOC Type Number	287 195 105A

INTRODUCTION

The EDACS Monogram Portable Radio is a rugged, lightweight unit which is housed in a molded Lexan front assembly and an aluminum rear casting. The radio provides reliable service in the 800 MHz band and contains new Dual Format technology that enables the radio to operate within a GE-MARC trunked system and an EDACS trunked system. The radio normally transmits in the 806-824 MHz band and receives from 851-869 MHz. The radio is able to transmit from 851-869 MHz for Talk-Around in the GE-MARC system.

The Dual Format EDACS Monogram radio is offered with several packages available with respect to the number of systems/groups programmed and the EDACS feature set allowed. The radio is also capable of Conventional operation. The Radio is programmed using a Personal Computer and an Interface Box connected to the UDC connector on the top panel of the radio. This allows the radio to be tailored to meet the requirements of the individual user and of the System(s) it is operating within.

Figure 1 - Portable Radio

STANDARD RADIO FEATURES

Carrier Control Timer (CCT)

The CCT is programmable on a per channel basis and prevents unnecessary channel traffic and radio damage if the transmit timer is exceeded. If the programmed timer times out during a transmission, the radio will beep and stop transmitting. The beeping tone will continue until the operator releases the PTT button.

Audio Alert Beeps

The radio generates a number of alert tones to indicate various events.

Low Battery Alert

When the battery is low and needs to be recharged, the will displayed and a low pitch tone will sound every 130 seconds.

Power Up Self Test

Each time the radio is turned on it will perform a power-up self test. After successful completion of the test, an optional tone will sound and the current System and Group/Channel will be displayed. If the unit does not pass the self test, an error message will be displayed.

CONVENTIONAL FEATURES

Channel Guard provides a means of restricting calls to specific radios through the use of a Continuous Tone Coded Squelch System. (CTCSS), or a multi-code Digital Squelch System (DCG). Tone frequencies range from 67 Hz to 210.7 Hz. There are 83 standard programmable digital codes. Refer to Table 1 and Table 2.

Manual DTMF Operation

Telephone interconnect calls can be made using the 12-button keypad. This keypad is enabled when a DTMF programmed channel is selected and PTT button is pressed.

Table 1 - Standard Tone Frequencies (Hz)

67.0	71.9	74.4	77.0	79.7	82.5	85.4	88.5	91.5	94.8	97.4
100.0	103.5	107.2	110.9	114.8	118.8	123.0	127.3	131.8	136.5	141.3
146.2	151.4	156.7	162.2	167.9	173.8	179.9	186.2	192.8	203.5	210.7

1. Do not use 179.9 Hz or 118.8 Hz in areas served by 60 Hz power distribution systems (or 100.0 Hz or 151.4 Hz in areas supplied with 50Hz power). Hum modulation of co-channel stations may "false" Channel Guard decoders.

2. Do not use adjacent Channel Guard tone frequencies in systems employing multiple Channel Guard tones. Avoid same-areas co-channel use of adjacent Channel Guard tones whenever possible. As stated in EIA Standard RS-220, there is a possibility of decoder falsing.

3. To minimize receiver turn-on time delay, especially in system using Channel Guard repeaters or receiver voting, choose the highest usable Channel Guard tone frequency. Do not use tones below 100 Hz when it is necessary to meet the receiver response time requirements of EIA Standard RS-220.

Table 2 - Digital Channel Guard Tones

PRIMARY CODE	EQUIVALENT CODE	PRIMARY CODE	EQUIVALENT CODE	PRIMARY CODE	EQUIVALENT CODE
023	340 766	251	236 704 742	632	123 657
025		261	227 567	565	307 362
026	566	263	213 736	654	163 460 607
031	374 643	265	171 426	662	363 436 443 444
032		271	427 510 762	664	344 471 715
043	355	306	147 303 761	703	150 256
047	375 707	311	330 456 561	712	136 502
051	520 771	315	321 673	723	235 611 671
054	405 675	331	372 507	731	447 473 474 744
065	301	343	324 570	732	164 207
071	603 717 746	346	616 635 724	734	066
072	470 701	351	353 435	743	312 515 663
073	640	364	130 641	754	076 203
074	360 721	365	107	**036**	137
114	327 615	371	217 453 530	**053**	
115	534 674	411	117 756	**122**	535
116	060 737	412	127 441 711	**145**	525
125	173	413	133 620	**212**	253
131	572 702	423	234 563 621 713	**225**	536
132	605 634 714	431	262 316 730	**246**	542 653
134	273	432	276 326	**252**	661
143	333	445	222 457 575	**255**	425
152	366 415	464	237 642 772	**266**	655
155	233 660	465	056 656	**274**	652
156	517 741	466	144 666	**325**	550 626
162	416 553	503	157 322	**332**	433 552
165	354	506	224 313 574	**356**	521
172	057	516	067 720	**446**	467 511 672
174	142 270	532	161 345	**452**	524 765
205	135 610	546	317 614 751	**454**	513 545 564
223	350 475 750	606	153 630	**455**	533 551
226	104 557	612	254 314 706	**462**	472 623 725
243	267 342	624	075 501	**523**	647 726
244	176 417	627	037 560	**526**	562 645
245	370 554	631	231 504 636 745		

NOTE: Primary codes in bold are unique Ericsson codes.

TRUNKED FEATURES (EDACS/GEMARC)

Preprogrammed DIG/DTMF Numbers

During the PC programming of the radio, the special call list may be programmed with up to 96 numbers for EDACS and 96 numbers for GE-MARC, depending upon available personality space. Using the SPC key, the numbers can be recalled to initiate the special call.

HOME

The radio will automatically select a desired Group and/or System by depressing a single key.

Keypad Lock

To prevent undesired key presses, the keypad can be locked at any time by depressing the LOCK key (shift RCL).

Power Up System/Group

The unit can be PC programmed to automatically select a desired Group and/or System on power up.

Manual Individual Calls

The radio is capable of making Individual Calls which are not programmed into your radio. The Individual Calls are made by manually entering the ID number (EDACS) or Tone Set (GE-MARC) from the radio keypad.

Manual Interconnect

The radio is capable of making Interconnect Calls which are not programmed into your radio. The Interconnect Calls are made by manually entering the telephone number from the radio keypad.

Store

Individual and Interconnect numbers may be recalled from a memory location and initiated using the Special Call Key and RCL key.

Recall Last Number Send

When entering the Special Call mode the radio will display the number (0-9) of the last accessed Special Call number.

EDACS (ONLY) FEATURES

Group Scan

The radio monitors the control channel and responds to all group channel assignments associated with the "scan" list. The "Priority" group is dictated by the group currently selected. If a call occurs on the "Priority" group while monitoring one of the scan groups, the radio will immediately enter into the "Priority" group.

Automatic Login

The radio automatically transmits the "Login" message when the radio roams into a new system, when changing the group selector and when the radio is tuned on. The "Login" message includes the Logical ID and the Group ID for the radio.

System/Group Selections

The standard EDACS feature set allows up to 16 groups total, independent of number of systems programmed.

Optionally, the radio can be configured to provide 128 or more EDACS groups.

Conventional Failsoft

In the unlikely event of a trunking failure, communications may take place in the Conventional Failsoft mode. The radio will automatically be directed and will switch to a communication channel set up for this purpose.

SCAT

The radio will operate in a Single Channel Autonomous Trunking (SCAT) system.

Base/Mobile Operation

This pre-programmed option is used in some fleets so units can only hear and talk to a base dispatch unit, not to other radios in the group.

Priority System Scan (Optional)

A priority or "home" system is pre-programmed into the radio. The radio unit continually searches (scans) for its priority system and if found, locks onto it. This improves network efficiency by preventing unnecessary multi sited calls.

Emergency (Optional)

An "Emergency" message is initiated by the caller and automatically transmitted by the radio on the control channel. The system automatically assigns the highest priority to the talk group.

Wide Area Scan (Optional)

When the radio unit loses the control channel of the current system, the radio automatically begins searching for a new control channel. The intelligent search algorithm uses a pre-programmed map of adjacent systems to ensure minimum transition time.

Dynamic Regrouping (Optional)

The unit is capable of being reprogrammed over the air while the radio is still active. Multiple talk groups can be added to a radio unit or optionally, the radio can be forced to communicate on designated talk groups.

GE-MARC (ONLY) FEATURES

Talk-Around (Direct Mode)

The radio is capable of direct unit-to-unit short range communication link. It is intended to maintain communications outside the coverage area.

SYSTEM DESCRIPTION

EDACS

The radio operates in either EDACS (digital) mode, or in GE-MARC (tone) mode, providing customers another dimension of flexibility in operation. Both modes provide opportunities to increase RF channel utilization through faster channel access and the privacy inherent with selective signalling.

The EDACS system uses 9600 baud, high speed, digital signalling to identify individual units, user groups, fleets, and agencies. Agencies contain multiple fleets and fleets contain multiple user groups (sub-fleets). By using this addressing scheme, large user groups can be accessed simultaneously all the way down to individual users. The programming to determine transmit encoded groups and decoded received groups is contained in the personality EEPROM of the mobile. This information is individually programmed to suit each users needs via the PC programmer for the radio.

The typical system configuration consists of at least 2 repeater stations (with a maximum number of 25) and the associated mobiles and portables. One repeater always is a control channel dedicated to sending out continuous control data and also to receive channel request data from the mobiles and portables. When a radio is first turned on, it scans the available list of frequencies programmed in the personality EEPROM for a control channel. When a control channel is found, the radio locks on to the frequency and monitors the data for a channel assignment (incoming call).

When receiving a channel assignment (incoming call), the monitoring radio immediately switches over to the assigned voice channel and waits for a high speed data confirmation message. Upon receipt of this message, the voice paths are unmuted and the user can hear the call.

While on the voice channel, the radio also continuously monitors the low speed, 150 baud (subaudible) data and carrier noise squelch to ensure consistent operation. Upon loss of subaudible data reception (i.e., deep fade, or out-of-range), the radio returns to the control channel frequency.

To initiate a call, the user keys the radio (which is locked to the control channel), and a 30 millisecond high speed data slotted channel request is transmitted to the control channel receiver. The control channel processes the request from the radio and transmits back a voice channel assignment on an unused channel.

When all available voice channels are in use, the control channel places the radio into a queue, transmits a queue message back to the radio, and will give a channel assignment to the requesting radio as soon as a voice channel is free. If the system is busy and the station queue is filled to capacity, a system busy message is returned to the requesting radio and an alert signal is given to the user.

After the initiating radio receives a channel assignment from the control station, it immediately switches frequency over to the assigned voice channel and sends a burst of 9600 baud dotting. The microphone voice paths are then unmuted and the transmission begins. The transmitting radio also continuously sends out a subaudible tone (along with voice) for system reliability. If the station loses this signalling, the voice channel is muted and all receiving radios are sent back to the control channel.

In normal operation, the transmitting radio sends a high speed data burst to indicate that the user has unkeyed, causing all listening radio to switch back to the control channel.

CONVENTIONAL MODE

In conventional mode (not trunked) the radio can operate either with tone Channel Guard, digital Channel Guard, or carrier squelch, depending on personality programming. Tone Channel Guard range is 67.0 to 210.7 Hz. Squelch Tail Elimination (STE) is used with Channel Guard to eliminate squelch tails at the receiving radio by phase shifting the transmitted Channel Guard tone when the PTT is released.

Direct mode works identically to conventional mode except that the transmit frequency band is changed to 851 to 870 MHz to permit direct radio -to- radio communications.

GE-MARC

The **GE-MARC** trunked radio system consists of a repeater for each channel and the users' radio units. The system uses tone signalling with each radio being assigned two and/or four tone group tone sequences. Groups of radios are assigned the same tones so that any unit can talk to all other units in the same group. A block diagram of the **GE-MARC** is shown in Figure 2.

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

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

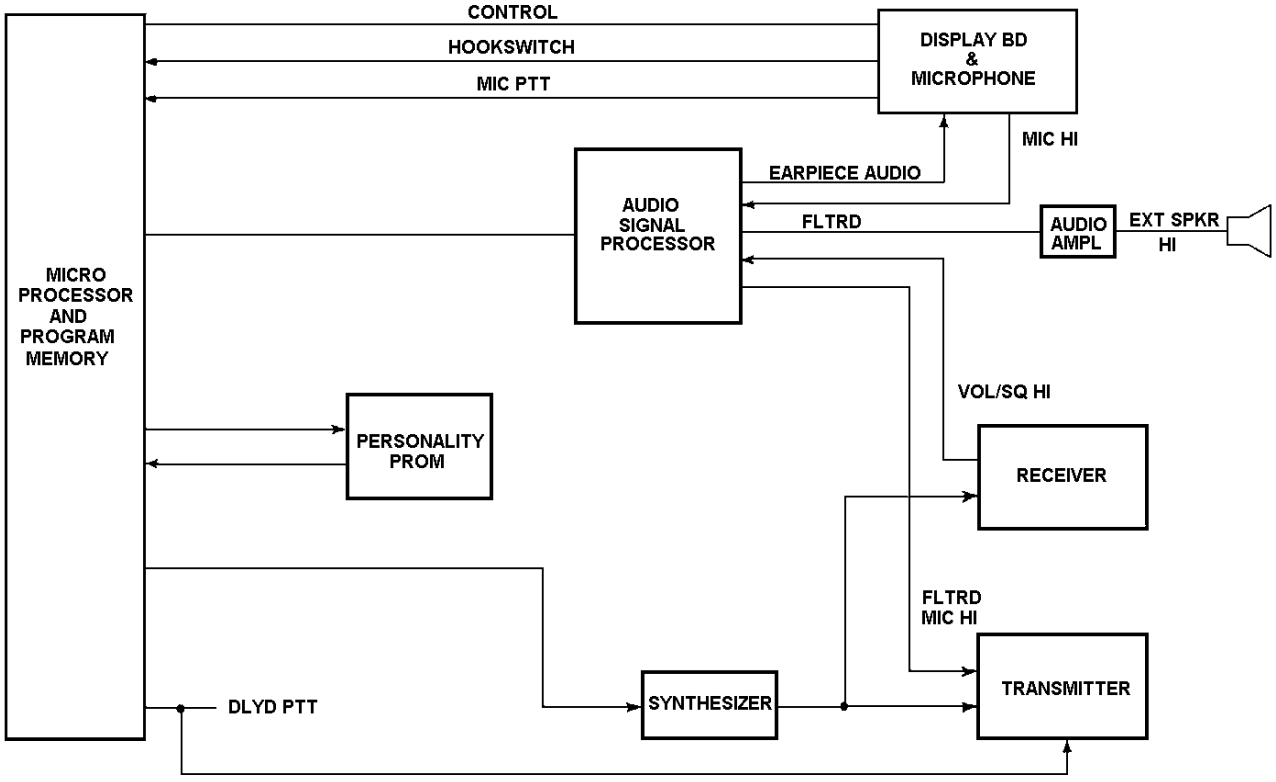


Figure 2 - GE-MARC Block Diagram

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 3.

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 signal timing diagram is shown in Figure 4.

Idle Mode

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. Upon receipt of a collect tone, the radio looks for a short interval for the group or individual tones providing that their collect tones are the same. 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, the radio then looks for busy tone for a 90 millisecond period. If four tones are properly decoded, the radio will then look for busy tone for 270 milliseconds.

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

Pressing the PTT switch will cause the radio to enter the Wait mode.

Wait Mode

When the user enters the Wait mode, the display group is checked to make sure it is a valid call-originate group. If it is not valid, a low-frequency tone is heard for one second. 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, if programmed for this option, will activate the Call Retry state and display "**RETRYNG**" in the display. Retrying will cause the radio to revert to the Idle mode and scan for an incoming call while trying to acquire a free repeater approximately every 5 seconds for a 2 minute period. If the Retry option is not enabled, the radio will sound the low-frequency tone and then return to the Idle mode and display "**BUSY**".

If a channel with no busy tone is found, the radio 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 radio proceeds to transmit the group tones (either two or four tones). If a four-tone sequence is sent, the radio 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

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 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.

NOTE

If a call is initiated and a sequence of five beeps is sounded, the user cannot access the radio system because the radio is out of receive range or is inoperative. Any subsequent call will be ignored for 20 seconds.

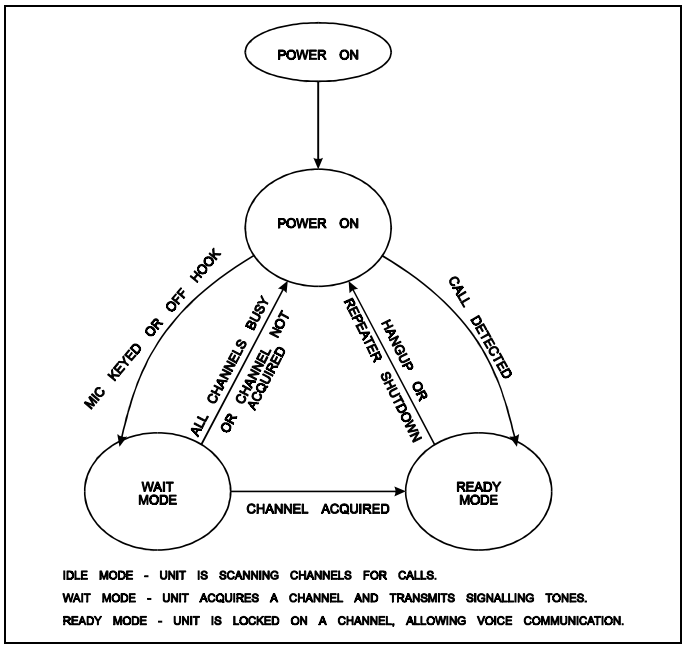


Figure 3 - GE-MARC Operation Modes

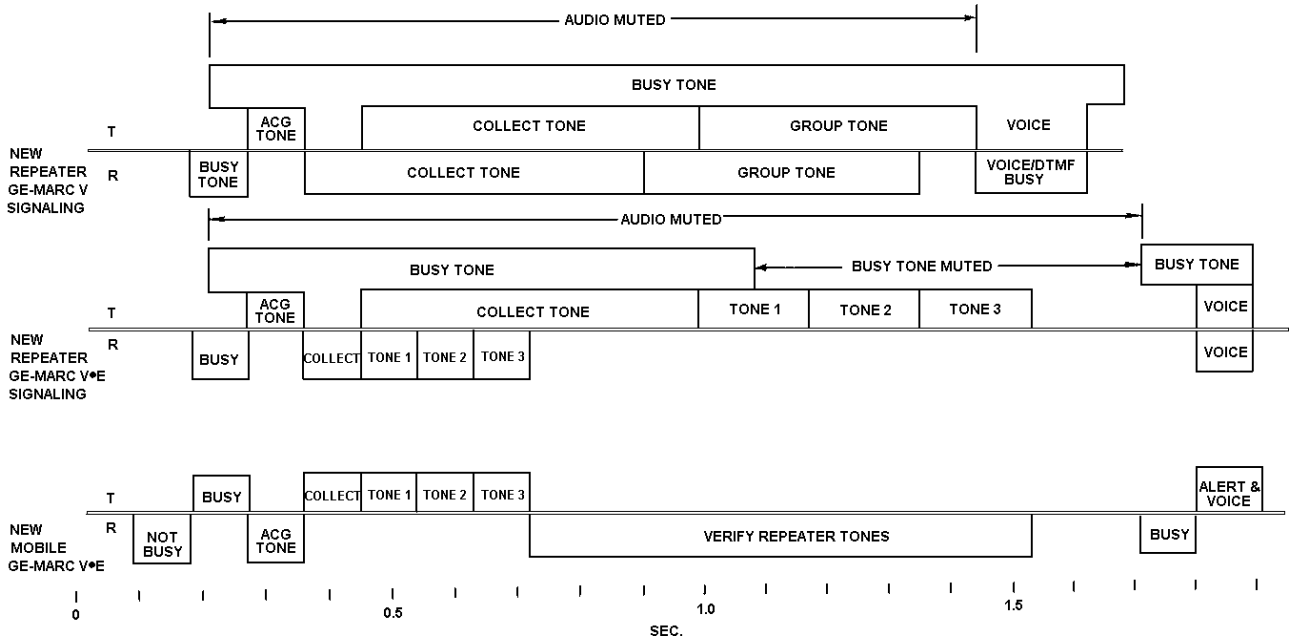


Figure 4 - Signal Timing

GLOSSARY OF GE-MARC TERMS

Idle Mode

In the "standby" condition, the mobile is inactive but prepared to call or be called. The trunked radios are IDLE until they are turned off.

Wait Mode

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

Ready Mode

In 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 the loss of received Busy Tone from the repeater. This normally occurs when the repeater shuts down after communication is completed.

Busy Tone

A "Voice-plus" tone of 3051.9 Hz is the standard busy tone. The 2918 Hz is the alternate busy tone. The busy tone modulates radio and repeater transmitters at a low level of 1 kHz deviation continuously. This tone is filtered out of the received audio and is used to hold the communication channel active. It also excludes other radios from using the channel when a call is active.

Acquisition Tone

A 1962.9 Hz tone sent at full deviation for 50 milliseconds from the repeater is used as acknowledgment from the repeater that a busy tone was sent and signals the radio that signalling tones can now be sent.

Collect Tone

A tone chosen from 34 standardized frequencies, ranging from 508.6 Hz to 2792.4 Hz, is used as the first tone in the group tone sequence. The collect tone is used to gather all radios 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 radio and/or repeater.

In a two-tone call, the radio sends the collected tone for a programmable duration. In the four-tone call, the radio always sends a 90-millisecond collect tone which the repeater regenerates and sends for the correct duration.

Group/Individual Tones

Group/Individual Tones chosen from the 34 standard frequencies 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 radio and 180 milliseconds from the repeater.

RADIO OPERATION

A complete set of operating instructions for EDACS Monogram Portable Radio are provided in AE/LZT 123 1875 and are provided with each radio.

This radio is flexible in operation and can be used in any of three operating modes: Conventional radio system, Enhanced Digital Access Communications (EDACS) system, or GE-MARC (tone controlled) system. Either of the latter two systems provide trunked channel selection for increased channel utilization.

In an EDACS trunked environment, the user selects a communications system and group. In this mode, audio channel selection is transparent to the user and is controlled via digital communication with the system controller. This mode incorporates advanced programmable features and fast access to communication channels.

In a GE-MARC trunked environment, the user selects a communications area and group. In this mode, audio channel selection is also transparent to the user and is controlled via tone signalling.

In Conventional mode, the user selects a channel and communicates on that channel. In this mode, a system refers to a set of channels and a channel is a transmit/receive radio frequency pair.

The exact operation of any radio depends upon the operating mode, the programming of the radio and the particular radio system. Most features described in these operating instructions can be enabled or disabled through programming. Both of these important factors must be considered.

USER INTERFACE

Operating controls are located on the radio top and front panel and microphone.

The front panel LCD provides radio status and communication control information to the operator. The keypad is used for manual number entry for individual calls access to a telephone interconnect system and activation of various EDACS, GE-MARC, and conventional features.

Turning The Radio ON/OFF

The radio is turned on by rotating the ON/OFF/VOLUME control clockwise from the OFF detent position. After the radio has passed the power-up self test, an optional tone will sound and the current System and Group will be displayed. If the unit does not pass the test, an error message will be displayed (**see ERROR MESSAGES** section) or the display will be blank.

ALERT TONES

The radio generates a set of unique alert tones to indicate operating status. The following section identifies and describes the alert tones for Conventional, GE-MARC, and EDACS applications.

EDACS APPLICATIONS

CALL ORIGINATE ALERT	If programmed, a short tone is sounded whenever the Push-To-Talk key is pressed and the radio has acquired a channel. This tone indicates the user can begin communications.
CALL QUEUED	If one short, high-pitched tone sounds after the transmitter is keyed, this indicates that the system has placed the request in a queue. This tone sounds at both the transmitting unit and the receiving unit(s) indicating to the user on the receiving end that a call is being directed to them. If the PTT is unkeyed while in the queue, the radio autokeys (automatically keys) Push-To-Talk when a channel becomes available (see AUTOKEY).
AUTOKEY	When the PTT is keyed to place a call on the system, but the PTT is released before getting to the channel (e.g. a queued call), the radio automatically keys on the channel when it gets the assignment. The radio generates a long beep and holds the transmitter keyed for two seconds. Pressing the PTT button keeps the channel and sends the message before this two second time-out has expired.

SYSTEM BUSY	If you press the PTT key and hear three short, medium-pitched tones, this indicates that the receiving party is already on the system or the system is busy and its queue is full. You must rekey later to access the system.
CALL DENIED	A single, low-pitched beep sounds when the PTT key is pressed and the request is denied by the system. This happens if the unit is an invalid user or if the unit is requesting an unavailable service.
OUT-OF-RANGE/ SYSTEM INOPERATIVE	A single, low-pitched tone sounds immediately after the PTT key is pressed indicating the radio is out of range of the repeater. The radio tries to place the call for a short period (3 seconds) after the initial attempt. The radio generates a second low-pitched tone when it gives up trying to place the call. These tones are also heard if the system is off the air or the radio needs servicing (even when the radio is within calling range of the repeater).

GE-MARC APPLICATIONS

CALL RECEIVED ALERT	If programmed, a single alert tone sounds when a group call is received and a two-tone alert (one high followed by one low tone) sounds for an individual call.
CALL ORIGINATE ALERT	**WAIT** momentarily displays when a call is being placed. Then a three-tone alert is sounded to indicate the call origination is complete. This indicates a channel was acquired and is ready for normal conversation.
INVALID CALL ORIGINATE ALERT	A low-frequency tone is sounded for one second immediately after pressing PTT and the display does not show **WAIT**. This indicates a call was attempted within a group that is not enabled for call originate or an invalid dispatch overdial call was attempted.
SYSTEM TONES	A low-frequency tone is sounded for one second after attempting to place a trunked call and **BUSY** is displayed. This indicates that the GE-MARC system is busy. If the "Call Retry" option has been enabled through programming, the radio retries at 5 second intervals up to 15 times unless END is pressed, a channel is acquired, or an out-of-range condition occurs.
OUT-OF-RANGE ALERT	If **NO SVC** is displayed and five beeps are sounded after attempting to place a trunked call, the radio is out of range of the GE-MARC system. If the beeps sound when the radio is within known range of the system, the radio may need servicing. If the "Call Retry" is active, the radio tries the channel at twenty second intervals for five minutes.
CARRIER CONTROL TIMER	(GE-MARC and Conventional operation.) A pulsed-tone signal is sounded for a pre-programmed time after PTT is pressed. After nine seconds of pulsing the alert tone, the radio unkeys the transmitter and communications are interrupted. While the tone is pulsing, the user can release and press PTT again to reset the timer and resume the conversation. In the conventional mode, the radio unkeys and beeps until PTT is released.
SYSTEM TONES	The GE MARC radio may generate other system tones to alert the user of custom programmed events. Contact the GE-MARC system operator for details about these alert tones.

ERROR MESSAGES

SYN LOC: if at anytime the Synthesizer is unable to load and lock on the channel property, a **SYN LOC** message will be displayed. If the **SYN LOC** message is displayed on all systems, the radio has failed or has not been programmed properly. The radio's buttons and keys will still operate with a **SYN LOC** message displayed.

PRS ERR: message indicates the personality has not bee programmed into the radio.

KEYPAD LOCK

The keypad can be locked at any time to prevent undesired key presses. To lock the keypad when it is in the unlocked state, press and release the **LOCK** (shifted RCL) key. All buttons and keys except the PTT, HOME, **SHIFT/CLR/MONITOR** and **LOCK** (shifted RCL) will not be inhibited. If the Emergency function of the HOME key is disabled, the HOME key will also be inhibited. If the key is programmed for **Emergency** or **Emergency/Home**, then the key is not inhibited and an emergency can still be declared on the Home System/Group or the current System/Group (however programmed). To unlock the keypad when it is in the locked state, press and release the LOCK (Shifted RCL) key.

RF BOARD THEORY OF OPERATION 650-020-0002

DESCRIPTION

RF Board 650-020-0002 consists of a receiver, transmitter, synthesizer circuitry, VCO module, and a TCXO module. The RF Board mounts to the bottom of the radio's chassis. Connectors on the board interconnect the RF Board to the Digital Board. The RF Board contains the following major components:

- 1.1 GHz PLL Frequency Synthesizer
- GE-MARC Busy Tone Detect Frequency Synthesizer
- 805-870 MHz 2-watt Power Amplifier
- Antenna Switch
- Low Power Narrow Band FM IF Chip
- 12.8 MHz +/- 1.5 ppm TCXO Module
- 805-870 MHz VCO Module

CIRCUIT ANALYSIS

RECEIVER SECTION

The radio receiver section consists of a double conversion super-heterodyne type receiver which uses a 1st IF frequency of 45.3 MHz and a 2nd IF frequency of 455 kHz. The features of the receiver are as follows:

- Non-tuneable pre-selector and post-selector.
- 4-pole crystal filters in the 1st IF gives increased suppression of spurious received signals such as first and second IF images.
- Two 4-pole Gaussian filters in the second IF for improved data recovery.

RF Amplifier and 1st Mixer

The received signal from the antenna is passed through the antenna switching module, U102, to the receiver circuitry when 0 Vdc is applied to U102 pin 4. This signal is then applied to F101. This bandpass filter prevents undesired signals from passing through the front-end of the receiver because it is centered at 860 MHz and has a passband 20 MHz wide. Any signal passing F101 will be amplified by approximately 12 dB by Q101and pass through F102. This is to decrease the 1st IF image and to prevent saturation of the mixer, Q103, by signals other than the preferred frequency. In addition, F101 and F102 minimize 1st L.O. leakage radiation through the antenna.

Q102 is a current source that supplies Q101 with 4 mA. Any signal that passes F102 is applied to the base of Q103. The signal is mixed with the 1st L.O. signal to generate the first IF frequency of 45.3 MHz. The 1st L.O. signal is applied to Q103's emitter through C133. The strip line connected to Q103's emitter maintains high impedance in order to impedance match into the mixer.

1st IF Filter and Amplifier

The signal that has been converted to the 1st IF frequency of 45.3 MHz by the mixer is impedance matched through L101, C107, and C108. This signal is applied to the 3rd overtone crystal filter (F103, F104) that has a center frequency of 45.3 MHz. The bandwidth of this filter is +/- 7.5 kHz. This will reduce the image of the 2nd IF and other undesired signals. The signal is impedance matched out of the crystal filter through L103, C110, C111 and applied to the 1st IF amplifier (Q104). Q104 will amplify the first IF signal by approximately 20 dB.

2nd Mixer and Detector

The received IF signal of 45.3 MHz is supplied to the 2nd mixer via U101 pin 16. Here it is mixed with the 2nd L.O. signal of 45.755 MHz and converted to the 2nd IF frequency of 455kHz. This 2nd IF frequency is passed through ceramic filters F105, F106 where it is limited and passed to the quad detector. The recovered audio signal is then present on U101 pin 9. This audio is buffered by the emitter-follower stage Q106 and sent to the Digital Board for further processing. The second L.O. signal is generated by crystal X101. This crystal is a 45.755 MHz, 3rd overtone, series mode crystal.

TRANSMITTER SECTION

Synthesizer Switching and Buffering

The VCO output signal is amplified and buffered by Q108 and switched between the TX or RX path by D101. When in TX, 7.5 Vdc (TX Power), is applied to R136. This turns D101 on and allows the signal to pass to amplifier Q110 and on to power module U103. The input level to U103 is 0 dBm.

Power Module and Antenna Switching Module

When the radio is in the TX mode, 7.5 Vdc (TX Power) is applied to power module U103 pin 2.

The signal from the VCO output is amplified by approximately 33 dB, and is supplied to U102 antenna switching module through the forward power detector. TX Power is also applied to U102 pin 4 causing the path from the antenna connector to the RX circuit to be disconnected, and the TX power path from U103 to the antenna to be connected.

Forward Power Detector and APC

The radio maintains stable output power of 2.0 watts by forward power detection and APC circuitry. The forward power is detected from R149, R150, and a strip line. This is rectified by D102 and filtered by C148. The filtered voltage will be directly related to forward power and is applied to the non-inverting input of U104.B. The DC voltage is doubled in this stage and then compared to a preset DAC value by U104.A. The output form U104.A is applied to the Class A stage of U103 pin 1. The voltage on this pin is directly proportional to the RF output power of amplifier U103. This completes a negative feedback loop which results in a constant RF output power over power supply voltage range and temperature variances. The preset DAC value is set for an RF output level of approximately 1.5 watts at the time of manufacture.

PLL CIRCUIT DESCRIPTION

VCO and Buffer Amplifier

The VCO generates frequencies of 806-824 MHz in normal RX and TX trunking modes and 851-869 MHz in talk-around mode. The VCO is a major block of the phase lock loop and is controlled by PLL IC U105 to maintain a stable frequency.

Q302 is the active device of the Colpitts type VCO. Fixed capacitors C307, C308, and C309 provide the feedback required to sustain oscillation. Ceramic resonator CF301 is a low characteristic impedance transmission line shorted at one end. Due to its electrical length and its termination, CF301 acts as a high Q inductor for the VCO resonant circuit. CR301, in series with padding capacitor C305, varies the circuit capacitance and tunes the oscillator to the desired frequency. The varactor (CR301) is DC controlled from the PD (phase detector) output of the synthesizer. TC301 is a tuning voltage adjustment that compensates for slight differences in circuit capacitance.

CR302, in series with C304, is the modulation circuit of the VCO. The audio modulation signal is applied to voltage divider R304-R305 to control the amplitude. The attenuator audio is applies via R403 to the varactor cathode.

R308 samples a small portion of the VCO RF and couples it through C310 to the base of Q303. Q303 is the input section of a cascode amplifier stage. The main purpose of a cascode amplifier is to provide isolation. The cascode output section (Q108) is located on the RF board. This RF from Q108 is applied to the synthesizer for phase locking and to the RX-TX switching circuit for use as L.O. injection or transmitter drive. The VCO output level of -12 dBm is applied to Q108, is amplified to +3 dBm at Q109 and applied to the PLL IC through C141 for phase locking.

In normal RX-TX trunking, C303 is part of the resonant circuit tuning. For trunking frequencies, the T/A (talk-around) pin is high turning on Q301. In turn PIN diode D301 is forward biased by R302 and this effectively AC grounds C303. When T/A is logic low, PIN diode D301 is off and C303 is removed from the circuit so the VCO can run at the higher transmit talk-around frequencies.

PLL IC (U105) AND LOOP FILTER

The frequency synthesizer consists of a single loop phase locking circuit with a reference frequency of 12.5 kHz. The phase-locked loop operates as follows. The MC145190 has on-board 64/65 prescalers that divide the VCO frequency to a useable value. In addition the '190 has 3 counter registers that are controlled by the microprocessor via U105 pins 17-20. These registers are the R,N, and A registers. To obtain the 12.5 kHz reference frequency, 1024 must be loaded from the microprocessor to the R-register. This is the TCXO frequency (12.8 MHz) divided by the reference frequency (12.5 kHz).

The frequency correction signal is determined by the PLL IC in the following manner. The divide ratio of the prescaler is initially 65 and the A and N registers are set to a start value. The Synthesizer chip will count the cycles given by the prescaler by decrementing the value in the A and N registers by one for each cycle. When the A register equals zero, the prescalers divide ratio changes to 64. The MC145190 will continue to count until the N register is zero, then the A and N registers are reloaded with their starting values. This process is then repeated. The total divide ratio of the prescaler and the A and N registers can be expressed by K={128 (N-A)}+129A. This can be simplified to K=128N + A. After the VCO frequency is divided by the total divide ratio (K), it is compared with the reference frequency and a phase error signal is generated. To determine the VCO frequency, multiply the reference by the divide ratio. FVCO= FREF x K.

The phase error signal, output at U106 pin 6 (PDOUT), is converted from PDOUT current to a correction voltage by the loop filter. This filter has a low-pass response with a cutoff frequency of approximately 194 Hz. The filter consists of C128, C154, C155, C156, and R128, R157. The first section of the loop filter (C155, C156, and R157) determine the transient response of the filter, convert PDOUT current into a corretion voltage, and have a large impact on reference sideband levels. The saturation capacitor (C154) is responsible for keeping transient voltages on PDOUT within linear operating range of the charge pump and for additional sideband suppression. The final section (R128 and C128) is used for extra sideband filtering without affecting the transient response of the filter.

Lock Detector

When the synthesizer is locked, the output at U106 pin 2 is essentially at a high level with narrow low-going pulses. This signal is filtered by C158, C159, and R158.

When the synthesizer is unlocked, the output at U105 pin 2 is essentially at a low level. When the PLL Synthesizer is in the unlock state, the microprocessor performs an unlock recover routine. If the recovery fails, all operations of the radio stop and "SYNLOC" is shown on the LCD.

Power Switching and Voltage Regulator

U109 and U110 provide a regulated +5Vdc to the RF Board. U110 provides power to the receiver section of the board. U109 supplies power to the rest of the board including the synthesizer chip, the VCO module, and the TCXO module. The use of two regulators provides protection from interference between the receiver and the other circuitry.

DIGITAL BOARD THEORY OF OPERATION 650-010-0003

Digital Board 650-010-0003 contains microprocessor circuitry used to control the radio's RF circuits and display board circuits. In addition this board provides dual mode trunking control and performs transmit-receive signal processing. Physically the Digital Board mounts on the top of the frame assembly. Connectors on the board interconnect the RF board and the display board. The Digital Board contains the following major components.

- 8- bit micro controller
- 128k x 8-bit operational software memory (flash EEPROM)
- 4800/9600 baud modem
- serial number memory (ROM)
- audio signal processor, busy tone notch filter
- 8K x 8-bit CMOS static RAM
- 5-Volt regulator, and Audio Power Amplifier

CIRCUIT ANALYSIS

MICRO CONTROLLER U701

Micro controller U701 controls the operation of the radio. This integrated Circuit is an Intel 83C51 8-bit micro controller with extensive I/O (input/output) interface and controlling capabilities. The micro controller performs the following radio functions.

- EDACS trunking functions

- GE-MARC trunking functions
- conventional portable radio functions
- synthesizer loading and lock monitoring
- squelch control
- transmit control
- high-speed data decoding and encoding through the modem
- low-speed data channel guard decoding and encoding
- alert tone generation
- DTMF generation through the DTMF generator
- audio path enable/mute control
- transmit and receive level adjust
- GE-MARC standard/alternate busy tone notch selection
- operational radio code flash programming
- personality programming
- clock oscillator shift control

Operating Program

The radio's operating program is stored in the 128k x 8-bit flash EEPROM U703. Micro controller U701 executes this program during normal radio operations. During flash programming, U701 runs a masked program stored in itself to transfer the new data arriving from the flash programming equipment into U703.

See section entitled “FLASH EEPROM U703" for additional details on U703.

Clock Circuitry

An 11.0592 MHz clock for U701 is generated from a clock oscillator circuit in modem U702 using crystal X701. This clock signal is applied to U701 pin 52 and sets the ALE (Address Latch Enable) output pulse frequency on U701 pin 55 to 1.8432 MHz (0.54 microsecond period). The PSEN (Program Store Enable) output at U701 pin 54 also runs continuously at 1.8432 MHz except when U701 accesses external memory.

Display Interfacing

Interfacing between micro controller U701 and the display board is accomplished via JP1. Key presses are indicated by a low bit in the 16-bit serial data stream that feeds U701 pin 16. Each time "KYPD LOAD" (U701 pin 17) transitions form low to high a new 16-bit data stream is read to U701 pin 16.

Three keys (SPC CALL, CH. UP, and CH. DWN) are tied directly to micro controller U701 on pins 46, 48, and 49 respectively. A low level signal at these pins indicate that key has been pressed.

LCD display control is through U701 pins 5 and 6 to drive JP1 pins 9 and 10 (I**C CLK and I**C DATA). These lines also control reading and writing to the personality EEPROM and the DTMF generator.

RF Board Interfacing

Micro controller U701 loads the synthesizer circuits on the RF Board serially using the Syn Data (P108 Pin 5), Syn Clk. (P108 Pin 8), Syn. Enable (P108 Pin 9) lines. U701 monitors synthesizer lock status via P108 Pin 10 from the RF Board. This line is high when synthesizer is locked.

Audio Signal Processor Control

Micro controller U701 controls ASP (Audio Signal Processor) U804 using the ASP DATA (U701 pin 10), ASP STB (U701 pin 11), and ASP EN (U701 pin 12) lines. These Logic lines from U701 load registers inside the ASP that control its internal audio paths and level control circuitry. ASP DATA is the data line, ASP STB is the strobe (clock) line, and ASP EN is the enable. See the section entitled “AUDIO SIGNAL PROCESSOR U804” for detailed information an the audio signal paths and interfacing of the ASP.

Address Demultiplexing

The upper address byte is applied directly to the memory chips via U701's eight outputs, A8-A15. The lower address byte is multiplexed with data on the 8-bit wide address/data bus. This bus transfers both the lower address byte and the 8-bit bi-directional data. Before the micro controller can read or write data, the lower address byte must first be externally latched and applied to the memory chips. Modem U702 contains an 8-bit latch which provides this demultiplexing function for U701.

The ALE output line from U701 is applied to U702 pin 12. The lower address byte (A0-A7) is latched when the ALE line transitions from high to low. The latched byte is applied to U703 and U707 via the eight outputs (A0-A7) from U702.

Address Decoding and Processor Control Outputs

This memory-mapped system uses a decoder in modem U702 to provide address decoding (chip selection) for the modem and RAM. Four active low outputs from U702 (Q0-Q3) are applied to the RAM (Q0 at pin 30) and the modem chip (Q3 on pin 27).

Micro controller U701 generates the active low write (WR) and read (RD) pulses for the external memory-mapped devices at U701 pins 37 and 38, respectively. U701 reads the external EEPROM when the program store enable (PSEN) line from U701 pin 54 is low.

The micro controller addresses the upper 64K of memory in the 128K flash EEPROM U703 using the output on U701 pin 21. This line is connected to U703's A16 address input.

FLASH EEPROM U703

The radio's operating program is stored in 128K x 8-bit flash EEPROM U703. Micro controller U701 executes this program during normal radio operations.

EEPROM U703 can be "flashed" to upgrade the operating program. This process allows easy reprogramming of the radio's firmware for upgrades and when additional features are added. During flash programming operations, micro controller U701 runs a simple masked program stored in itself to transfer the new data arriving from the flash programming equipment into U703. This provides easy reprogramming without the need to disassemble the radio. Flash programming equipment is connected to J104 and it uses the same interface circuitry that is used to program the personality into EEPROM U104.

The micro controller is placed in the flash program execution mode by the presence of 12V dc on the 7.5V dc line. The flash program is then executed by sending a proprietary protocol on the RX DATAand PTT/TX DATA (J107 pin 7 and J108 pin 6 respectively) lines. With 12 Vdc applied to the 7.5 Vdc line, transistors Q801 and Q802 turn on. The collector of Q802 applies 12 Vdc to the VPP input of U703 and voltage divider R726 and R727. The voltage divider pulls EA/VPP input at U701 pin 56 high (5 volts) to enable the flash programming mode.

The micro controller uses the A15 ENBL line (U701 pin 36) during flash programming to isolate writes to U703. In normal radio operation, this line is always high to enable the A15 address line from U701 pin 64 to arrive at U703 pin 11 via Q701. The address bank select line, U701 pin 21, is used to switch the flash memory bank from the lower 64K bank (when U701 pin 21 is low) to the higher 64K bank (when U701 pin 21 is high) of the 128K x 8-bit total flash memory. R779 and C756 provide a delay of this bank select line to synchronize to the other address lines.

NOTE

The flash memory requires a precise voltage of 11.5 to 12.5 VDC for proper programming. This voltage is applied at the radios battery port. Damage to the flash memory and other devices will result if the flash voltage exceeds 12.5 VDC.

RAM U707

Integrated circuit U707 is an 8192 x 8-bit high-speed static RAM that provides temporary storage for micro controller U701. Thirteen address lines are applied to the RAM. The lower eight lines (A0-A7) are applied to it from the 8-bit demultiplexer address latch inside modem U702. The five higher address lines (A8-A12) are applied directly from U701.

RAM chip selection is accomplished with the active-low chip select pulse (U707 pin 20) from the modem. Read/write control is achieved with the output enable input (OE at U707 pin 22) and the active low write enable input (U707 pin 27) from U701.

MODEM U702

Modem U702 performs several important functions for the Digital board. These functions include:

- high-speed data parallel-to-serial and serial-to-parallel conversions.
- address demultiplexing for the micro controller's lower address byte(A0-A7) from the address/data bus.
- address decoding (chip selection) for itself and the other memory-mapped integrated circuits.
- reset logic for the micro controller and the ASP.

- 11.0592 MHz clock generation for itself, the micro controller and the ASP.

High-Speed Data Conversions

Modem U702 converts high-speed EDACS data between parallel and serial formats. The high-speed rate is 9600 baud for the 800 MHz radio.

When the radio is receiving high-speed data, U702 converts this serial data to parallel data that can be handled by the micro controller. Limited high-speed data from the ASP (Audio Signal Processor) U804 feeds U702 pin 23.

When the radio is transmitting high-speed data, the modem converts the parallel data from the micro controller to serial high-speed data the can modulate the transmitter. This data is routed to the transmit audio portion of the ASP via U702 pin 26.

An interrupt output from U702 pin 32 signals U701 pin 34 that the modem is ready for the next transmit or receive byte.

Address Demultiplexing

The micro controller has a multiplexed 8-bit wide address/data bus that transfers both the lower eight address lines and the 8-bit bi-directional data. Before the micro controller can read or write data, the lower address byte must first be externally latched and applied to the memory chips. Modem U702 contains an 8-bit latch which provides this demultiplexing function.

The micro controller's ALE output line is applied to U702 pin 12. The lower address byte (A0-A7) is latched when the ALE line transitions from high to low. The latched byte is applied to U703 and U707 via the eight outputs(A0-A7) from U702.

Address Decoding

Another function of the modem is to provide address decoding (chip selection) for itself, and the RAM. Four active low outputs from U702 (combined on Q0 pin 30) are applied to the RAM (CSI pin 20) and the modem chip itself (Q3 on pin 27).

Reset Logic

A reset pulse from U702 pin 43 is applied to the micro controller and the ASP at the following states:

- at power-up
- if the watchdog timer circuit in U702 times out
- if the +5Vdc regulated supply from U801 falls out of regulation.

This active-high reset pulse is inverted by Q703 and applied to the active-low reset inputs of the micro controller (U701 pin 30) and the ASP (U804 pin 9).

A watchdog timer inside the modem must be serviced by the micro controller at least every two seconds or a 50 microsecond wide reset pulse will be sent to the micro controller and the ASP. This will occur if a hardware or software failure develops.

The modem receives a reset signal generated by +5Vdc regulator U801 when the radio is powered-up and if the +5Vdc supply falls out of regulation. Transistor Q804 inverts the reset line from U801. This reset input to the modem on U702 pin 33 (RESIN) is low during normal radio operation. At power-up, U801 and Q804 pull U702 pin 33 low after the +5Vdc supply becomes stable. U702 then brings its reset output on pin 43 low and the micro controller and the ASP begin to operate. If the +5Vdc supply falls out of regulation (less than 4.75 Vdc), U801 will pull U702 pin 33 high (via Q804) and U702 will then reset the micro controller and the ASP by pulling its reset output (U702 pin 43) high.

Clock Circuitry

A clock oscillator in U702 generates an 11.0592 MHz clock for the micro controller and the ASP. Crystal X701 is the frequency reference component. The buffered clock signal at U702 pin 15 is sent to the micro controller and the ASP.

This 11.0592 MHz clock frequency can be slightly shifted if a clock harmonic or interfering signal ("birdie") falls on the current receive frequency. This oscillator shift function is enabled with the PC programmer on a per channel basis. When the shift is enabled on the current receive frequency, the micro controller turns Q702 on via an output from the ASP (U804 pin 15). With Q702 on, additional capacitive loading is applied to the crystal via C735.

SERIAL NUMBER ROM U706

The serial number ROM (Read Only Memory) U706 contains a unique 48-bit number which is read by the micro controller at power-up. A single pin on the device provides serial communication with the micro as well as +5Vdc power through pull-up resistor R728.

For proper radio operation, the unique serial number must match the personality information in EEPROM U104. Replacing either device may disable operation on all programmed EDACS systems. Conventional and GE-MARC systems will continue to function normally. To restore EDACS operations the radio must be reprogrammed based upon the serial number.

NOTE

If replacement of U706 serial number ROM or U104 personality EEPROM is necessary contact Ericsson Technical Assistance Center to obtain programming information.

AUDIO SIGNAL PROCESSOR U804

Integrated circuit U804 is the ASP (Audio Signal Processor) that handles most of the audio functions for the radio. The following outline describes basic signal paths for the various operating modes.

Receive Audio Paths

EDACS & Conventional RX Audio Modes

Detected audio from the receiver (P107 pin 7) is applied to the inverting input of an op-amp buffer stage in the ASP. The input is on U804 pin 44 through R609. R610 is the feedback resistor around the op-amp. Together these resistors set the stage gain.

In the ASP, the buffered detector audio is 300 to 3000 Hz bandpass filtered, applied to a multiplex switch (ISA/ISB), and then passed through de-emphasis stages. The de-emphasized audio then passes through a digital volume control (RA0-RA5) and audio switch (RXO) before it is applied to the ASP's receive audio output terminal at U804 pin 27. The receive audio path for EDACS and conventional modes never loop out and back into the ASP. After leaving the ASP, the audio signal is routed to the volume control on the RF board. Audio from the volume control feeds amplifier U603.

High-Speed Data Limiter

In the ASP, buffered and unfiltered audio from the input buffer stage passes through an audio switch (TDS) to pin 45. Busy tone decode switch Q603 is normally off (SW5 is high) so data passes through R612 to the non-inverting input (U804 pin 32) of a comparator in the ASP. This comparator forms the high-speed limiter. The average dc level of the serial data signal is applied to the comparator's inverting input as a dc reference for the comparator. R611 and C605 filter the signal component to provide the dc reference. R632 adds hysteresis to this stage.

The output of the limiter stage (U804 pin 21) is inverted by Q602 and the serial data is applied to the modem for serial-to-parallel conversion. It is also connected to the micro controller U701 pin 7. This pin is normally at a high impedance but is switched low during transmit to clamp limited noise out of the modems receive data input.

Transistor Q601 on the RX AUDIO line allows the high-speed and low-speed data limiters to settle quickly after the receiver locks on to a new frequency. Since the charge across C601 must be quickly brought back to 2.5 Vdc before the limiter can function properly, Q601 is turned on for 5-10 milliseconds after the synthesizer locks via the SW1 output from the ASP (U804 pin 17). Since the RX AUDIO output impedance of the RF Board is relatively low (less than 500 ohms), this action charges C601 to 2.5 Vdc considerably fast.

Low-Speed Tone/Data Decoding

In the ASP, buffered detector audio from the input buffer stage passes through an audio switch (TX) and feeds a low-pass filter that removes all voice signals. The filters output is any low frequency CG (Channel Guard) tone or low-speed data signals present in the received signal. Cutoff for this low-pass filter is switched to 105 Hz when the programmed CG decode tone is equal to or less than 105 Hz. The filter is switched to a cutoff of 210 Hz if the programmed CG decode tone is greater than 105 Hz or if the radio is in the data decode mode.

The output of the low-pass filter passes through an audio switch (CGE) and then out of the ASP via U804 pin 37. The tones/data feed U804 pin 35 which is the non-inverting input to a comparator that forms the low-speed data limiter. The average dc level of the tones/data signal is applied to the inverting input of the comparator as a dc reference. R618 and C610 filter the signal to provide the dc reference. The output of the limiter on U804 pin 22 is applied to micro controller U701 pin 8 for decoding.

GE-MARC Mode RX Audio

Detector audio enters the ASP at U804 pin 44. In the ASP, this audio is buffered, 300-3000 Hz bandpass filtered, and then passed through a switch (TDS) to the output on U804 pin 45. The filtered receive audio is applied to U602 which is a digital switched capacitance filter. Notch frequency is determined by U107 on the RF board via J108 pin 1. This frequency synthesizer allows detection of the

standard 3052 Hz busy tone or the alternate 2918 Hz busy tone.

The output of the notch filter is U602 pin 9 (VOUT) which is feed to U804 pin 28. In the ASP, the multiplex audio switch (ISA/ISB) routes the notched audio to the digital volume control. The output of the volume control is routed through another switch (RXO) and leaves the ASP on U804 pin 27 to be volume adjusted by RV104 of the RF board and then amplified by U603.

GE-MARC Tone Decoding

Bandpass filtered detector audio on U804 pin 45 is applied to notch filter U602, bandpass filter U301.B & U601.A, and the high-speed limiter.

For signaling tone decode, busy tone decode switch Q603 is off since the SW5 output from the ASP (U804 pin 13) is high. Wide band audio passes from U804 pin 45 through R612 to the non-inverting input (U804 pin 32) of the comparator in the ASP. This comparator forms the high-speed limiter. The average DC level of the signal is applied to the comparator's inverting input (U804 pin 31) as a dc reference for the comparator. R611 and C605 filter the signal component to provide the DC reference. The output of the limiter (U804 pin 21) is sent to micro controller U701 pin 6 for tone decoding.

During a busy tone decode (Q603 is on), bandpass filtered audio at the busy tone frequency feeds the high-speed data limiter through U301.B, U601.A, and Q603. Since the output impedance of U601.A is very low and Q603 is on, wide-band audio from U804 pin 45 is greatly attenuated across R612. The 3 kHz low-pass filtered audio from U804 pin 45 provides some of the high-frequency roll-off. U301.B provides a notch at 2.3 kHz plus a high -pass response to reject voice frequencies. U601.A is a bandpass filter centered at 3 kHz. From this point, the busy tones are decoded similarly to signaling tone decodes.

Receive Noise Squelch

The squelch circuit monitors the detector's high-frequency noise level to determine if a carrier is quieting the receiver. A D/A (Digital-to-Analog) converter in the ASP sets the squelch threshold level. This level is normally 8 dB SINAD. When receiver noise falls below the threshold level, the ASP CAS (Carrier Activity Sensor) output at U804 pin 23 switches low. The ASP CAS signal feeds the input on micro controller U701 pin 43.

Buffered and unfiltered detector audio leaves U804 pin 43 and feeds pin 50 which is the input to the squelch high-pass filter (7.5 KHz). In the ASP, the high-pass filtered audio is rectified and sent out on U804 pin 52. The rectified noise is filtered by C612 (and C611 if Q604 is on) to provide an average dc level proportional to receiver noise level. This dc level is applied to a non-inverting dc buffer amplifier at U804 pin 55. The output of the amp is on U804 pin 53. The gain of the dc amp is set by R620, R622, R623, and thermistor RT601. The thermistor increases in resistance at colder temperatures therefore causing an increase in the dc amps gain. This compensates for a decrease in receiver noise level from the RF Board at colder temperatures.

The buffered DC level that is tracking receiver noise level is sent to a comparator's inverting input at U804 pin 49. This comparator's non-inverting input is set to a voltage generated by the D/A converter in the ASP. The comparator's output switches high when the DC level falls below the comparator's reference level. This output is inverted and it appears at U804 pin 23. This ASP CAS output is normally high and switches low when a carrier is detected.

To tighten the squelch, the D/A reference voltage is lowered. Hysteresis for the squelch is done with software. When the ASP CAS output switches to indicate a signal is detected, the D/A reference value is increased slightly to loosen the squelch. This action eliminates "bubbling" or chattering noises in the speaker. "Bubbling" is normally caused by changes in the dc level around the reference point.

Transistor Q604 is normally turned on via SW2 output at U804 Pin 16 (SW2 = high). This action places C611 into the dc level averaging circuit. C611 provides slow squelch (60 ms) operation to prevent audio chopping with rapid squelch closings in weak signal areas. When Q604 is turned off, a 5ms fast squelch is provided by only C612.

Receive Alert Tones

The programmable alert tones are generated in the ASP using a 66.6 kHz clock divided by a 6-bit divider and then divided by two. Therefore, the lowest alert tone frequency that can be generated is 66.6 kHz divided by 64 then divided by 2 (520 Hz).

The output of the alert tone divider is on U804 pin 76. This output connects back to U804 pin 30 to feed the audio multiplex switch (ISA/ISB) in the receive audio path. The tones then pass through de-emphasis stages. The de-emphasized audio passes through the digital volume control, through an audio switch (RXO), RV 103 on the RF Board via P107 pin 2, and U603 for amplification.

Transmit Audio Paths

The microphone receives a dc bias through R315. Mic audio is coupled into U804 pin 74 via J901 pin 3, U604.B, and C303. In the ASP, Microphone. audio passes through an audio switch (MIS) to the microphone amplifier. A second switch in the Mic. amp circuit (MGS) sets the gain of the Mic. amp. This switch is normally closed for low Mic. gain. The audio from the Mic. amp is the pre-emphasized and 300 Hz high-pass filtered. The Mic. audio then leaves the ASP on U804 pin 70.

Pre-emphasized Mic. audio is coupled into U804 pin 57 by C304. The audio is passed through muting switch (AEN) and then it feeds the limiter circuit. This limiters threshold can be stepped up by the micro controller so peak deviation of the Mic. audio can be increased when Channel Guard is not present.

Limited Mic. audio then passes through the summing amp in the ASP which sums the Mic. audio, tones, and data. The output of the summing amp feeds a switch (PBY) that switches the Mic. audio to the 3 kHz post limiter filter (for limited Mic. audio) or directly to the transmit deviation level control circuit in the ASP for data transmissions. The output of the digital deviation control passes to the output on U804 pin 60.

The TX audio output feeds U301.A. This circuit provides a gain of two for any voice, tone, or data that is to be transmitted. C308 and R310 provide a low-pass characteristic that begins to roll-off at approximately 10 kHz. U301.A also serves to invert transmit data before it is applied to the modulating circuitry on the RF Board.

High-Speed Data Encoding

When the radio is transmitting high-speed data, the serial data from the modem is applied to U804 pin 80. Inside the ASP, this data passes through a Bessel filter and then the output of the filter is sent to the TX summing amplifier. The output of the summing amp feeds an audio switch (PBY) to allow 3 kHz post limiter filter bypassing during data transmissions. The data then passes through the digital deviation control and through an audio switch (TXO) output U804 pin 60 to feed U301.A and modulating circuitry.

During high-speed data transmissions, the modem input from the receive data limiter requires muting to prevent the modem from being disturbed by excessive receiver noise. Micro controller U701 pin 7 switches low during transmit to clamp the line to ground.

CG Tones And Low-Speed Data Encoding

Micro controller U701 generates the low-frequency Channel Guard tones and low-speed data using its WB1 and WB2 Walsh bit outputs. These two bits are also used to generate GE-MARC signaling tones as described in the following section entitled "GE-MARC SIGNALING TONE ENCODING".

The 2-bit low-frequency Walsh bits are summed into the ASP at U804 pin 38. These stepped tones or data, pass through an audio switch (TX) in the ASP and then the 105/210 Hz low-pass filter. Cutoff for this filter is switched to 105 Hz when the programmed CG encode tone is equal to or less than 105 Hz. The filter is switched to a cutoff at 210 Hz if the programmed CG encode tone is greater than 105 Hz or if the radio is in the data encode mode.

The filtered tones/data, pass through a gate (CGE) and then out of the ASP at U804 pin 37, through R317 via the TX CG line, and back into the ASP on U804 pin 58 (CGIN). GE-MARC busy tones are also fed into this pin through C310.

In the ASP, the filtered tones/data pass from U804 pin 58 (CGIN) through an audio switch (BEN) to feed the transmit summing amplifier. The output of the summing amp feeds another switch (PBY) that switches the 3 kHz post limiter filter in-line. The output of the post limiter passes through the digital deviation control, through another switch (TXO), and then out of the ASP to U301.A. See section entitled "TRANSMIT AUDIO PATHS" for details on U301.A.

GE-MARC Signaling Tone Encoding

Micro controller U701 generates the GE-MARC signaling tones using its WB1 and WB2 Walsh bit outputs. These two bits are also used to generate Channel Guard tones and low-speed data as described in the previous section entitled "CG TONES AND LOW-SPEED DATA ENCODING".

The 2-bit generated GE-MARC tones feed U804 pin 59. In the ASP, the tones pass through audio switch (DEN) and the summing amplifier in the TX audio path. The tones are next routed to the 3kHz post limiter filter, through another audio switch (PBY). They are then filtered, sent through the digital deviation control, audio switch (TXO), and then out of the ASP on U804 pin 60.

GE-MARC Busy Tone Encoding

Micro controller U701 pin 27 generates either the standard 3052 Hz or the alternate 2918 Hz busy tone. This square wave signal is summed into the TX audio path at the same point as low-frequency CG tones/data at U804 pin 58 (CGIN). C752, R753, and R316 determine the 1kHz deviation level. C310 couples the tone into U804 pin 58.

The tones then follow the same path in the ASP as CG tones/data.

DTMF Tone Encoding

Encoder U106 of the display board generates DTMF tones during conventional mode DTMF dialing and trunked mode DTMF over dialing operations. U106 pin 5 feeds U804 pin 73 via JP1 pin 8. In the ASP, an audio gate (MIS) passes the DTMF tones to the Mic. amp while muting the Mic. audio. A second switch in the Mic. amp circuit (MGS) determines the Mic. amp gain; it is set for high gain during DTMF transmissions. The amplified DTMF tones are then pre-emphasized and follow the same path as the Mic. audio.

To provide DTMF side tone operation, the DTMF tones are also fed to the receive audio path via U804 pin 29. The side tone audio is selected by the receive audio multiplex switch (ISA/ISB) and the it passes to de-emphasis stages. The de-emphasized audio passes through the digital volume control, through an audio switch (RXO) and then out of the ASP at U804 pin 27.

5-VOLT REGULATOR U801

Regulator U801 supplies 5V dc power to the logic and analog circuits on the board. The battery port on the RF Board supplies U801 with 7.5 Vdc power via P107 pin 1.

Regulator U801 generates a reset signal at power-up and if its output falls out of regulation. U801 pin 5 stays low at power-up until the output power rises above 4.75 Vdc. It will also switch low if the supply falls below 4.75 Vdc during radio operation. This reset signal is inverted by Q804 and applied to the modems active high reset input at U702 pin 33. See the modem circuit analysis section entitled "RESET LOGIC" for complete details on the board's reset circuitry.

DISPLAY BOARD THEORY OF OPERATION 650-170-0001

DESCRIPTION

Display board 650-170-0001 contains circuitry used to control external speaker/mic switching and L.C.D. backlighting. The Display Board mounts on top of the Digital Board. Connectors on the board interconnect the Display Board to the Digital Board.

The Display Board contains the following major items.

- Liquid Crystal Display Module (L.C.D.)
- IIC Liquid Crystal Display Driver
- DTMF Tone Generator
- Personality EEPROM
- (2) 8-bit Serial Output Shift Registers
- High Voltage EL-Lamp Driver for L.C.D. Blacklight Control
- Control Switches (Channel, Scan, Mute, Keypad Lock, Etc.)
- Microphone
- Speaker

CIRCUIT ANALYSIS

CONTROL SWITCHES

The control switches include the up\down arrows, Scan, Home, Recall, Store, Special Call, *, #, and the digits 0-9. A rubber switch pad, that fits into the front cover, consists of momentary contact switches with carbon contacts. When pressed, these switches make direct contact with printed runs on the display board. All the switch lines are pulled high to +5Vdc through resistors on the display board. The switch lines are active low by switch grounding the shift register input line when the key is pressed. The 8-bit shift registers (U101 and U102) are polled by the micro controller every 10 mS. Keypad Clk. (P1 pin 5) and Keypad Load (P1 pin 6) determine when the 16-bit data get shifted to the micro controller via Keypad Data line (P1 pin 7). Three switches, CH. up, CH. dwn, and Spc call, are tied directly to the micro controller.

LIQUID CRYSTAL DISPLAY (LCD)

The primary function of the Display Board is to drive the individual segment lines of the LCD. Serial display data from the Digital Board Microprocessor is sent to the driver on the IIC DATA and IIC CLK lines (Inter Integrated Circuit Bus). The data is converted by U103 to drive the LCD.

Another function of the Display Board is to provide backlighting of the LCD module using an electroluminescent panel. The panel is controlled by the backlight line, a logic switch output from the Audio Signal Processor (ASP) U804-14. When this line is high Q101 is turned on. U107 and C106 then have a path to ground. U107 is the High-Voltage Lamp Driver which performs the function of DC to AC conversion. The EL lamp driver frequency is determined by R123.

PERSONALITY EEPROM U104

All personality data is stored in 4096 x 8-bit EEPROM U104. This data, programmed with the PC programming equipment, includes systems, groups, special cal l information, frequencies, tones, option information, mic deviation levels, data deviation levels, and squelch levels. There is also a unique serial number stored in the EEPROM that must match the serial number stored in the serial number ROM U706. EEPROM U104 is programmed through the same PC programming interface that programs flash EEPROM U703. The micro controller serially communicates with the EEPROM on the IIC CLK and IIC DATA lines.

DTMF ENCODER U803

DTMF (Dual-Tone Multi-Frequency) tones are generated by encoder U106. A 3.579545 MHz clock set by crystal X101 runs only when a tone is being generated during transmit keying. The encoders oscillator is disabled by software to prevent harmonic and other spurious RF signals from interfering with the receiver. When a software command to generate a tone is sent to U106, the clock oscillator recovers in less than 3 milliseconds.

The micro controller serially communicates with the DTMF encoder on the IIC CLK and IIC DATA lines. The DTMF tones at the output (U106 pin 5) are sent to the receivers audio path in the ASP (U804 pin 29) to provide DTMF side tones. They are also sent to the TX audio path via U804 pin 73.

MICROPHONE AND SPEAKER

The microphone mounts directly into the front panel. The microphone receives acoustic power through a hole in the front panel.

The speaker, mounted to the front panel, connects to the Display Board through a 4 pin connector, J100. A protective grill is placed in the front housing before the speaker is mounted to screen out foreign material.

INTERNAL/EXTERNAL SPEAKER/MIC. SWITCH

When the external Speaker/Mic. is used, the internal speaker and microphone are turned off. When the external Speaker/Mic. is connected to the radio through connector J104 of the RF Board, pin 4 of J104 is connected to ground. This will turn off Q102 and disconnect the internal speaker and microphone.

DISASSEMBLY

FRONT PANEL ASSEMBLY REMOVAL AND REPLACEMENT

To remove the front panel assembly:

1. Remove the battery by holding EDACS Monogram radio in left hand, press the locking latch tab, push battery out and away from transceiver.
2. Using a Phillips head screwdriver (No. 1) remove the four (4) screws holding the bottom cover to front panel.
3. Remove the bottom cover.
4. Turn transceiver over where DTMF keypad is face-up.
5. Holding the frame firmly, place thumb of free hand under the speaker grill near the (+) terminal. Lift the front panel from chassis.

To replace the front panel assembly:

1. Ensure that all gaskets in position and not broken.
2. Place the lip at the top end of the panel assembly into the gasket recess of front panel.
3. Press the front panel assembly firmly into position.
4. Place the bottom cover into position, and using a Phillips head screwdriver (No. 1) tighten screws into front panel assembly.

DIGITAL PRINTED CIRCUIT BOARD REMOVAL AND REPLACEMENT

To remove the Printed Circuit Board:

1. Using a Phillips head screwdriver (No. 1) remove the four (4) screws which hold the RF shield to front panel assembly.

2. Remove RF shield from front panel assembly.

3. Firmly grasp front panel assembly in one hand and lift Digital Printed Circuit Board from top panel assembly.

NOTE

Before replacing Digital Printed Circuit Board, be sure to replace Speaker, Mic, DTMF Pad, or Keypad.

To replace the Digital Printed Circuit Board, reverse the procedures given in steps 1 to 3.

MICROPHONE AND SPEAKER REMOVAL AND REPLACEMENT

To remove the microphone and speaker:

1. Remove the RF shield and Digital Printed Circuit Board.

2. Desolder orange and yellow wires from speaker, and then the brown and blue wires from microphone.

3. Unscrew the two (2) speaker mounting screws using a No. 1 screwdriver.

4. Gently press the rubber microphone holder with needle-nose pliers through the microphone slot on the top panel assembly.

5. Remove the speaker and microphone.

To replace the speaker and microphone, reverse the procedures above.

KEYPAD BOARD REMOVAL AND REPLACEMENT

To remove the Keypad Board:

1. Remove the RF shield and Digital Printed Circuit Board.

2. Using a Phillips head screwdriver (No. 1) remove the six (6) screws holding the Keypad Board to front panel assembly. Note the location of two (2) brackets shield.

3. Lift Keypad Board from front panel assembly.

To replace the Keypad Board, reverse the procedures described above.

RF BOARD REMOVAL AND REPLACEMENT

To remove RF board:

1. Remove front panel assembly and bottom cover.

2. Gently hold PTT harness connector and lift from RF board connection.

3. Desolder positive red lead from battery connector.

4. With thumb beneath control know, lift away knob.

5. Using needle nose pliers, unscrew nut that holds Volume control in place.

6. If soldered connection is used, desolder six-pin ribbon PCB from RF board. If connector is used, simply unplug it.

7. Unscrew antenna locking nut, Desolder both the coil and capacitor from antenna connection.

8. Using a No. 1 Phillips screwdriver, remove (2) screws holding shields on P.A. The antenna and P.A. shield will lift off. Then raise the P.A. to a vertical position.

9. Notice (2) screws that hold RF board to frame. Remove these (2) screws with No. 1 Phillips screwdriver.

10. With the controls to the left and surface mounted components to the top, grasp the frame with your left hand. Gently lift while tilting the RF board as it is removed from the assembly.

    To replace the RF board, reverse the procedures above.

PTT Switch Assembly Removal and Replacement:

1. Remove the bottom cover and front frame assembly.

2. Gently hold PTT harness and connector and lift from RF board connection.

3. Using a Phillips screwdriver (No. 1) remove the (2) screws which hold PTT assembly to frame.

4. Remove PTT assembly.

To replace PTT assembly, reverse the procedures above.

TROUBLESHOOTING

Before troubleshooting, be sure to read and fully understand the Theory of Operation for the various boards. Also check the following before proceeding.

- Power source is normal and aux. test equipment is connected properly.

- There is no visible damage to the radio's case or boards.

Symptom	Probable Cause	Corrective Action
Radio appears dead.	1. On/off switch is defective. 2. Power supply fuse (F101) is defective. 3. Bad 5V regulator (U109,110,801) 4. DC Power problem.	1. Replace on/off switch. 2. Replace fuse. 3. Replace bad regulator. 4. Check PCB pattern or input power circuit. R170, D106, etc.
LCD is blank with no problems in the voltage source.	1. Bad LCD driver chip (U103). 2. Radio operating code is corrupt. 3. CPU crystal oscillator problem. 4. CPU reset problem. 5. CPU problem.	1. Replace U103 or entire keypad board. 2. Re-flash radio. 3. Check that oscillator frequency is 11.0592 MHz +/- 1000 Hz. If not replace X701. 4. Check that U801 pin 5 is +5Vdc. If not replace U801. 5. Replace U701 or entire digital board..
"PRS ERR" is displayed on LCD.	1. EEPROM (U104) memory is corrupted.	1. Reprogram the radio's personality. If problem still persists replace U104.
"SYN LOC" is displayed on LCD.	1. Problem in PLL network including U106, C155, C156, etc. 2. Defective dc-dc converter including U105, 108, D105, etc. 3. Defective TCXO. 4. Defective VCO. 5. Digital and RF board interconnect problem.	1. Program a high and low frequency channel. If either channel works the VCO may need adjusted. Re-adjust TC301. If neither channel works do not readjust TC301 2. Check for +8Vdc on pin 5 of U106. If it is not there, problem is in converter. 3. Check TCXO oscillation frequency for 12.8 MHz. 4. Check for VCO power at VCO output terminal. 5. Be sure RF and digital boards are seated tightly together.
When transmitting in talk-around "SYN LOC" is displayed on LCD.	1. Problem with Q107 which controls voltage of VCO T/A pin.	1. Replace Q107 if necessary.
Low battery indicator with fully charged battery.	1. Problem with voltage divider R801 and R802. 2. Defective fuse (F101).	1. Replace R801 or R802. 2. Check F101 for resistance. If greater than 1.0 ohm replace fuse.
Low or no received audio power at internal or external speaker.	1. Mis-aligned quadrature detector (L105). 2. Defective volume control knob (RV103). 3. Defective audio amplifier (U603). 4. Defective internal/external speaker switch (Q102). 5. Defective internal or external speaker. 6. Defective audio signal processor chip (U804).	1. Re-align L105 for proper audio output signal. 2. Check volume pot resistance. If greater than 20K ohms replace volume knob. 3. If audio signal is present at pin 3 but not at pin 5 replace audio amp. 4. Replace Q102. 5. Check speaker resistance. If greater than 8 ohms replace speaker. 6. Replace ASP or entire digital board.

Symptom	Probable Cause	Corrective Action
Low sensitivity.	1. Defective antenna switch (U102). 2. Defective front-end filter (F101,102). 3. Defective RF amp (Q101,102). 4. Defective mixer (Q103). 5. Problem with VCO injection circuit. 6. Damage to F103,104. 7. L101, 103 mis-aligned. 8. Defective IF amp (Q104). 9. Defective 2nd LO (L104, X101). 10. Defective IF IC (U101).	1. When receiving pin 4 of U102 should be 0 volts. If not check TX/RX switch. 2. Replace defective filter. 3. Compare voltages of Q101,102 with voltage chart. 4. Compare voltages of Q103 with voltage chart. 5. Check D101 and C133. 6. Replace crystal filter pair. 7. Re-align for proper sensitivity. 8. Compare voltages of Q104 with voltage chart. 9. Check that 2nd LO frequency is 45.755 MHz. Adjust TC101 or repair. 10. Replace IC.
Radio appears dead.	1. On/off switch is defective. 2. Power supply fuse (F101) is defective. 3. Bad 5V regulator (U109,110,801) 4. DC Power problem.	1. Replace on/off switch. 2. Replace fuse. 3. Replace bad regulator. 4. Check PCB pattern or input power circuit. R170, D106, etc.
Squelch not functioning properly.	1. Squelch is mis-adjusted. 2. Squelch tracking data is corrupt. 3. Defective squelch circuitry (RT601, R620, etc.). 4. Defective ASP chip.	1. Re-adjust squelch from keypad. 2. Determine that squelch tracking data is valid using Maint2 program. 3. Replace defective component. 4. Replace ASP or entire digital board.
Low sensitivity and severe distortion.	1. TCXO is off frequency. 2. Mis-alignment of L101,103 or L105. 3. 2nd LO frequency is off.	1. Check frequency by transmitting. 2. Re-align for proper distortion measurement. 3. Check that frequency is 45.755 MHz +/- 100 Hz. Adjust TC101.
Will not receive an EDACS or channel guarded call.	1. Clock oscillator X701 is defective. 2. High-speed data limiter is defective (Q602, R603, etc.). 3. Low-speed data limiter is defective (C610, R618, etc.). 4. Defective Modem IC. 5. Defective CPU. 6. Defective ASP.	1. Oscillator frequency should be 11.0592 MHz +/- 1000 Hz. 2. Replace defective component. 3. Replace defective component. 4. Check U702 pin 23 for received data if present replace Modem or digital board. 5. Check U701 pins 7&8 for received data if present replace CPU or digital board. 6. Check for ASP data throughput. If defective replace ASP or digital board.
Will not receive a GE-MARC call.	1. Defective high-speed data limiter (Q602, R603, etc.). 2. Defective busy-tone B.P.F. (U301, 601, etc.). 3. Defective busy-tone notch filter (U602, U107, etc.). 4. Defective ASP.	1. Replace defective component. 2. If busy tone is present at C625 but not at pin 1 U601 filter is bad. Replace defective component. 3. Check for clock signal at pin 5 U602. If no signal replace U107. If clock signal is present, check that busy tone input is present at U602 pin 9 and output tone at pins 11&12. 4. Check for ASP data throughput. If defective replace ASP or digital Board.
Radio will not transmit. (No TX LED)	1. Defective PTT switch. 2. Bad contact at J109. 3. TX/RX switch malfunction (Q112, Q113, etc.).	1. J108 pin 3 should be +5Vdc with no button press and 0Vdc when PTT is pressed. If not switch may be defective. 2. Replace PTT wiring harness. 3. If J107 pin 5 is +5Vdc for transmit and 0Vdc for receive problem is in TX/RX switch. If not problem is on digital board.

Symptom	Probable Cause	Corrective Action
Low or no transmitting power. (TX LED illuminated)	1. P.A. control signal error. 2. P.A. ramp signal error. 3. Transmit tracking data is corrupt. 4. Defective power module (U103). 5. Defective antenna switch (U102). 6. Defective APC circuit (U104B, D102, etc.)	1. Base of Q111 should be low during transmit if not the problem is on the digital board. 2. J108 pin 7 should be 1-5 Vdc. If not the problem is on the digital board. If voltage is present the problem may be with U104A. 3. Check tracking data by using Maint2 program. 4. Refer to voltage chart. 5. Voltage at pin 4 of U102 should be 5 Vdc. 6. Voltage at U104 pin 7 should be 1-5 Vdc during transmit. If not there is an APC problem.
No internal or external microphone modulation.	1. Bad internal or external mic. 2. Defective internal/external mic switch (Q102, R125, etc.) 3. Voice modulation tracking data is corrupt. 4. Defective ASP.	1. Replace defective microphone. 2. Replace defective component. 3. Check that tracking data is valid by using Maint2 program. 4. If voice signal is present at U804 pin 74, but not at pin 60 replace ASP or entire digital board.
No data modulation or poor modulation balance.	1. RV101 mis adjusted. 2. Defective Walsh-bit resistor. R741, 742 (low-speed data). 3. Data modulation tracking data is corrupt. 4. Defective ASP. 5. Defective Modem IC (high-speed data). 6. Defective CPU.	1. Re-adjust “eye pattern” 2. Check for Walsh-bit resistor data throughput. 3. Check that tracking data is valid by using Maint2 program. 4. Check for ASP data throughput. For example, data input is pin 80 output is pin 60. 5. Look for TX data on U702 pin 25. If data is not present replace modem or entire digital board. 6. Lood for data on appropriate pin (14 for Walsh-bit 1, 27 for busy tone, etc.). If not present replace CPU or entire digital board.
No data or voice modulation.	1. Defective modulation amplifier (U301A, R310, etc.). 2. Bad connection from Digital to RF board. 3. Defective VCO.	1. If a good modulation signal is present at pin 60 of ASP but not at pin 1 of U301 the amplifier is malfunctioning. Replace bad component. 2. If a modulation signal is present at pin 1 of U301, but is not present on RF board make sure interconnect pins are seated tightly. 3. Modulation signal is present at VCO mod pin but transmitter is not modulated. Replace VCO.
Radio will not “FLASH” program.	1. Equipment connection error. 2. Programming voltage error. 3. U701 pins 9&56 voltage error. 4. RX data path is open. 5. Defective serial number ROM (U706). 6. Defective CPU. 7. Defective FLASH chip.	1. Double check equipment connections. 2. Power supply voltage must be 11.5-12.5Vdc. 3. Compare with voltage chart. 4. Check for data at U601 pin 7. If data is not present problem is in this circuit or there is an open at J104. 5. Replace U706. 6. Replace CPU or digital board. 7. Replace FLASH chip or digital board.
Personality programming error.	1. Equipment connection error. 2. RX data path is open. 3. Defective EEPROM (U104). 4. Defective CPU.	1. Double check equipment connections. 2. Check for data at U601 pin 7. If data is not present problem is in this circuit or there is an open at J104. 3. Replace U104 or keypad board. 4. Replace CPU or digital board.

VOLTAGE CHART

This voltage chart was measured under the following conditions:

A) Power supply voltage = 7.5 Vdc
B) Receive frequency = CH# 300 (conventional with no channel guard)
C) Transmit frequency = CH# 300 (conventional no channel guard)
D) PLL condition = locked
E) Voltage dimension = Average DC

Transistors

	Receive						**Transmit**		
	B	C	E	B	C	E	B	C	E
Q101	.76	4.59	0	.76	4.59	0	-	-	-
Q102	4.01	2.61	4.59	4.01	2.61	4.59	-	-	-
Q103	.69	4.97	.105	.69	4.97	.105	-	-	-
Q104	.719	1.99	0	.719	1.99	0	-	-	-
Q105	.73	2.31	0	.73	2.31	0	-	-	-
Q106	1.93	4.48	1.34	2.22	4.48	1.61	-	-	-
Q107	-	-	-	-	-	-	4.93 T/A (4.93)	4.93 T/A (0)	.598 T/A (4.86)
Q108	2.63	4.34	1.99	2.63	4.34	1.99	2.63	3.95	1.99
Q109	.744	4.52	0	.744	4.52	0	.744	4.52	0
Q110	-	-	-	-	-	-	1.49	5.60	.71
Q111	4.35	0	0	4.35	0	0	0	2.07	0
Q112	7.25	0	7.25	7.25	0	7.25	7.25	6.65	6.55
Q113	0	7.25	0	0	7.25	0	4.69	0	0

Diodes

	Receive			**Transmit**		
	1	2	3	1	2	3
D101	.806	0	.042	0	.878	.097
D102	0	0	0	.815	0	0
D103	4.82	4.82	4.90	3.57	3.57	3.57
D104	0	0	-	1.78	0	-
D105	7.5	13.73	10.34	7.39	12.5	9.15
D106	7.5	0	-	6.9	0	-

IC'S

	U101		U102		U103		U104	U105	
PIN #	SQ.	UNSQ	RX	TX	RX	TX	TX	RX	TX
1	4.43	4.43	0	0	0	3.60	3.48	0	0
2	3.73	3.73	0	0	0	6.32	2.08	0	0
3	3.57	3.57	0	0	7.5	6.51	2.08	0	0
4	4.48	4.48	0	1.57	7.5	6.51	0	7.95	7.75
5	3.50	3.50	0	0	0	0	0	0	0
6	3.50	3.50	0	0	-	-	.19	13.19	12.16
7	3.50	3.50	0	0	-	-	.43	-	-
8	4.50	4.50	-	-	-	-	6.88	-	-
9	1.74	1.92	-	-	-	-	-	-	-
10	0	0	-	-	-	-	-	-	-
11	4.35	4.35	-	-	-	-	-	-	-
12	0	0	-	-	-	-	-	-	-
13	0	0	-	-	-	-	-	-	-
14	0	0	-	-	-	-	-	-	-
15	0	0	-	-	-	-	-	-	-
16	1.76	1.76	-	-	-	-	-	-	-

	U106	U108	U109		U110	
PIN #	RX	RX	RX	TX	RX	TX
1	0	3.98	0	0	3.35	6.02
2	4.9	4.04	0	0	0	0
3	7.95	4.07	0	0	0	0
4	7.95	3.24	4.98	4.12	5.01	0
5	7.95	0	0	0	0	0
6	2.45	7.69	7.74	7.68	7.74	6.68
7	0	0	-	-	-	-
8	4.42	7.69	-	-	-	-
9	4.86	0	-	-	-	-
10	0	7.69	-	-	-	-
11	2.69	0	-	-	-	-
12	4.91	7.69	-	-	-	-
13	3.59	0	-	-	-	-
14	4.91	7.69	-	-	-	-
15	0	-	-	-	-	-
16	4.91	-	-	-	-	-
17	4.86	-	-	-	-	-
18	0	-	-	-	-	-
19	4.86	-	-	-	-	-
20	2.30	-	-	-	-	-

AUDIO SIGNAL PROCESSOR (U801)

PIN #	PIN DESCRIPTION	VOLTAGE
13	Busy Filter Bypass	0 = Busy Tone Decode 5 = Wide Band Decode
14	Backlight	0 = off 5 = on
23	Carrier Activity Sensor	0 = Carrier Detected 5 = No Carrier Detected
27	RX Audio Output	600 mV 1kHz tone, 3kHz deviation
37	CG Tones	RX= 0.35Vp-p TX =2.4Vp-p
40	RX Bias	2.5Vdc
53	Squelch DC Amp	2.5 Vdc= Full Quieting 3.5 Vdc= Noise
55	Squelch DC Amp	2.5 Vdc= Full Quieting 3.0 Vdc= Noise
58	TX CG Tone	2.4Vp-p
60	Deviation Control Output	30 mV p-p Limited Mic.
68	TX GEMARC Tones	1.6Vp-p
73	TX DTMF Tones	10mVp-p
74	TX Mic. Audio	17 mVrms for 3kHz Deviation (1kHz Tone)
76	Alert Tone Generator	1.7Vp-p

The following voltage measurements were taken with the radio supply voltage at 12.5Vdc and the radio in flash programming mode.

	B	C	E	PIN 9	PIN 56
Q801	.608	0	0	-	-
Q802	11.75	12.38	12.38	-	-
U701	-	-	-	0	5.0

BATTERY CHARGING AND CARE

WARNING

- Do not dispose of the battery pack in fire - it may explode, causing injury or death.
- Do not replace the battery in hazardous atmosphere locations.
- Do not carry battery loose in your pocket or purse.
- Do not attempt to repair battery.

The product contains a rechargeable, recyclable battery. The battery is recyclable. At the end of its useful life under various state and local laws it may be illegal to dispose of this battery into the municipal waste stream. Check with your local solid waste officials for details concerning recycling options or proper disposal in your area. Call Toll Free 1-800-8-BATTERY for information and/or procedures for returning rechargeable batteries in your state.

Your radio comes supplied with one 7.5 volt Ni-Cd battery pack, which can be recharged from 500 to 1000 times before requiring replacement. The actual number of charge/recharge cycles vary depending upon usage. We recommend that the battery be charged 14 to 16 hours on the first charge cycle and then in accordance with the charger model instructions thereafter.

To remove the battery pack, push up on the battery latch and slide the battery pack to the right. To replace the battery, align the battery on the track and slide to the left until a click is heard, indicating the battery is correctly installed.

If the battery is to be charged on the radio, ensure that the power switch on the radio is in the off position before charging. Failing to turn the power switch to off during the charge cycle will result in a less than full charge condition, which will noticeably reduce the operating time between charges!

Normal battery operation time is 8 hours. This may vary depending upon how much the receiver audio is present and how much you transmit. The actual time may vary from day to day depending upon operational requirements.

FOR BEST PERFORMANCE

1. Charge battery to full capacity, 14 hours at the standard C/10 rate (capacity X .10). For "rapid" chargers, allow additional time (2-3 hours) for "topping off" the charge after it switches from "fast" to "slow".

2. Use the battery soon and use as much of the battery capacity as possible or practical. A battery that is charged and discharged completely will maintain the longest running time capacity. Also, several charge/discharge cycles are recommended to bring a new battery up to its rated capacity.

3. Store and charge the batteries at room temperature 65°F to 75°F. Batteries that have been stored for over a month should be recharged before putting into service due to chemical self-discharge which occurs at a rate of approximately 1% per day. Do not charge cold batteries (40°F or below).

4. Reduced capacity or "memory effect" may result from repeated identical shallow discharge/full recharge cycles. If such a condition is suspected, run the battery until the instrumentation loses all power, then fully recharge and discharge again. Repeat this cycle 3-4 times.

Prefix the part number with "R29/" when ordering replacement parts

PART NO.	NAME & DESCRIPTION	COMPONENT
550-020-0003	FRONT BEZEL ASSY	
	DIGITAL BOARD RF SHIELD	
	(+) TAPPING SCREW (BH) T2X4-2S ZN-PLAT	SPK. MTG.
	BRACKET (SPEAKER) SPC T0.8 NI-PLAT	
	GASKET SILI. RUBB &1 BLK.	
	KEY PAD SILI. RUBB. 350A1241P1	
	INSULATOR FIBER T0.5	
	SPK. FELT FELT 31.5 T0.15	SPK
	(+) TAPPING SCREW (PH) T2X6-1S ZN-PLAT	DIGITAL PCB MTG.
	(+) TAPPING SCREW (PH) T2X5-1S ZN-PLAT	KEYB'D PCB MTG
	SHIELD PLATE SPTE T0.2 (ETP-4800)	
	CUSHION (LCD) 3X49XT1 EVA SPONGE BLK.	
	INSULATOR POLYESTER T0.1 CLEAR STICKER	
	BUSHING MIC 7.5X5.5H NBR BLK	C-MIC
420-116-8	SPEAKER 8-OHM 1.5W 36MM MS-3602B	SP101
420-206-0	MIC CONDENSER WM-063-AT 6DIA	MIC101
650-170-0001	KEYPAD/DISPLAY BD.	
	LCD DISPLAY X0-132	LCD101
	EL PANEL C045-105	LED101
	CRYSTAL TC38A 3.579545M 18P	X101
	SOCKET ROUND GDRS-06S (2.5)	P5
	HEADER PIN GDRS-10D(M2.5)	P1
	I.C. PCD3312CT PSY-12018-312TZ	U106
	100:MCR10EZH101J CHIP RES	R122,127
	100K:MCR10EZH104J CHIP RES	R101-119, 121
	10K:MCR10EZH103J CHIP RES	R128
	3.3M:MCR10EZH335J CHIP RES.	R123
	2K:MCR10EZH202J CHIP RES.	R126
	330K:MCR10EZH334J CHIP RES	R120, 124
	47K:MCR10EZH473J CHIP RES.	R125
	CHIP TANTALUM 47uF 293D476X0010E2T16V	C108
	CHIP CERAMIC 0.1uF GRM40X7R104K 25V PT	C102,103,104,105
	CHIP CERAMIC 0.1uF GRM432X7R104K 50V PT	C106
	CHIP CERAMIC 22pF GRM40COG220J 50V PT	C101
	CHIP CERAMIC 470pF GRM40COG471J 50V PT	C107
	TRANSISTOR BC848C SOT-23	Q101
	FET 2SK1579-TMOS	Q102
	74HC165D I.C	U101,102
	IC LCD DRIVER PCF8576	U103
	I.C. DRIVER HV801	U107
	I.C. EEPROM X24645	U104
	ZENER DIODE CHIP MMBZ5245BT1	D101
	DIODE CHIP KDS196S	D103
	COIL CHIP LQH4N331K04B1	L101
650-010-0003	DIGITAL BD ASSY	BOM
	CRYSTAL HC49S 11.0592 M-30100PM 20P FUN	X701
	HEADER PIN CONN. 6SBCR (1.2)	J901
	HEADER PIN CONN. GDH-14DBC (6)	P107,108
	HEADER PIN CONN. GDH-10DBCR (1.2)	JP1

PART NO.	NAME & DESCRIPTION	COMPONENT
	DIGITAL BOARD SHIELD (G.E.)	
	CHIP RESISTOR 0 1/16W 5% T 1608	R(20),22,23,313,889
	CHIP RESISTOR 10 1/16W 5% T 1608	R725,736,737,738,739,830
	CHIP RESISTOR 100 1/16W 5% T 1608	R752
	CHIP RESISTOR 1K 1/16W 5% T 1608	R305,604
	CHIP RESISTOR 10 K 1/16W 5% T 1608	R316,317,601,602,611,612,615,616 R618,619,639,641,727,828
	CHIP RESISTOR 100K 1/16W 5% T 1608	R16,18,304,504,603,609,625,634,718,730,731,732,773 R780,806,807,811,812,813,814,815,826,833
	CHIP RESISTOR 1M 1/16W 5% T 1608	R632,633,834
	CHIP RESISTOR 120K 1/16W 5% T 1608	R610
	CHIP RESISTOR 15K 1/16W 5% T 1608	R301,614,617,726
	CHIP RESISTOR 150K 1/16W 5% T 1608	R623
	CHIP RESISTOR 180K 1/16W 5% T 1608	R620,R825
	CHIP RESISTOR 20K 1/16W 5% T 1608	R629,890
	CHIP RESISTOR 22K 1/16W 5% T 1608	R14,606,836
	CHIP RESISTOR 2.4K 1/16W 5% T 1608	R315
	CHIP RESISTOR 2.7K 1/16W 5% T 1608	R778
	CHIP RESISTOR 3.3K 1/16W 5% T 1608	R735
	CHIP RESISTOR 33K 1/16W 5% T 1608	R608,624,733,734,741
	CHIP RESISTOR 330K 1/16W 5% T 1608	R622
	CHIP RESISTOR 4.7K 1/16W 5% T 1608	R19,775
	CHIP RESISTOR 47K 1/16W 5% T 1608	R307,310,320,321,501,613,635,771,772,774,776,801,802 R808,816,827,888
	CHIP RESISTOR 560 1/16W 5% T 1608	R15,17,503,505,701,702,703,704,705,706,707,711,712,713 R714,715,716,717,719,720,740,744,(745),746,747,748,753 R749,750,751,770,779
	CHIP RESISTOR 6.8K 1/16W 5% T 1608	R728
	CHIP RESISTOR 68K 1/16W 5% T 1608	R777
	CHIP RESISTOR 680K 1/16W 5% T 1608	R642
	CHIP RESISTOR 82K 1/16W 5% T1608	R605,742,835
	TCXO CHIP RESISTOR 348K 1/10W 1% T 2012	R640
	TCXO CHIP RESISTOR 249K 1/10W 1% T 2012	R607
	THERMISTOR CHIP 100K KB57421-A104-K-M62	RT601
	CHIP CERAMIC 0.1uF GRM39Y5V104Z 25V PT	C303,304,305,307,608,609,612,615,621,629,728 C729,734,802
	CHIP CERAMIC 0.001uF GRM39X7R102K 50V PT	C616
	CHIP CERAMIC 0.01uF GRM40X7R103K 50V PT	C310,314,602,607
	CHIP CERAMIC 0.22uF GRM40Y5V224K 25V PT	C803
	CHIP CERAMIC 0.0033uF GRM40X7R332K 50V PT	C603,604.627
	CHIP CERAMIC 10 pF GRM39COG100D 50V PT	C738,753
	CHIP CERAMIC 100pF GRM39COG101J 50V PT	C703,704,751
	CHIP CERAMIC 0.001uF GRM40COG102J 50V PT	C625,626
	CHIP CERAMIC 18pF GRM40COG180J 50V PT	C735
	CHIP CERAMIC 220pF GRM40COG221J 50V PT	C726

PART NO.	NAME & DESCRIPTION	COMPONENT
	CHIP CERAMIC 220pF GRM39COG221J 50V PT	C501,502,503,701,702,705,706,707,711,712 ,713,714 C715,717,718,719,725,730,732,736,737,740 C741,743,744,745,746,747,748,749,750,752 ,777,778
	CHIP CERAMIC 33pF GRM39COG330J 50V PT	C739,754,755,756
	CHIP CERAMIC 330pFGRM39COG331J 50V PT	C308
	CHIP CERAMIC 0.0047uF GRM40X7R472K 50V PT	C628
	CHIP CERAMIC 470pF GRM40COG471J 50V PT	C606,733
	CHIP CERAMIC 470pF GRM39X7R471K 50V PT	C5
	CHIP TANTALUM 0.22uF 293D224X0016A2T16V	C4
	CHIP TANTALUM 1uF 293D105X0016A2T16V	C306,601,605,611,614,801,810
	CHIP TANTALUM 10uF 293D106X0010B2T10V	C610,720,731,808
	CHIP TANTALUM 100uF 293D107X0006E2T6V	C3,727
	CHIP TANTALUM 2.2uF 293D225X0016A2T16V	C613
	CHIP TANTALUM 47uF 293D476X0010E2T16V	C617
	TRANSISTOR BC848C SOT-23	Q602,604,701,703,704,711,714
	TRANSISTOR BC858B SOT-23	Q601,603,802,804
	TRANSISTOR MMBT3904LT1	Q702,801
	I.C. OP AMP KIA358F	U301,601
	I.C. NOTCH FILTER LMF90CCWM	U602
	I.C. SERIAL NO. ROM DS2401Y (SOT-23)	U706
220-528-9	I.C. 64K SRAM GM76C88ALFW-15	U707
	I.C. MC14066BDR2:SO-14	U604
	I.C. LM386 M1\SO-8	U603
	I.C. LP2951ACM SO-8	U801
	I.C. N83C51GB	U701
	I.C. AUDIO SIGNAL PROCESSOR	U804
	E28F001B-T120	U703
	GE MODEM	U702
	DIODE SI CHIP KDS226	D710
	DIODE SI CHIP KDS184	D720
550-030-0001	REAR PANEL ASSY	
	(+) MACHINE SCREW(BH)M2X23 (+) BH BLK	UP +BO COVER
	COVER BOTTOM ALDC12 BLK GUNSUL A330-B0070	
	PROTECTOR "A" NEOPRENE RUBBER BLK.	
	GASKET SILI. RUBB, &1 GRAY	
	BELT CLIP ASSY	
550-040-0002	CHASSIS / RF Bd. ASSY	
550-050-0001	PTT SWITCH ASSY	
	SW TACT SKHUPF	SW201, 202, 203
	(+) MACHINE SCREW (PH) M2.6X6 PH BLK.	PTT HOLDER MTG.
	47PF:GRM40COG470J 50V PT CERAMIC CH	C201,202,203
	PTT CABLE ASSY	
	3P HOUSING ASS'Y 3P 80MM	CON206
	CHASSIS ASSY	
	PCB FLEX CABLE ASSY.	
	TDH CONN TDH2-6SG	J105
	HEADER PIN CON. GDH2-6DBC	J104
	FRAME ASSY	

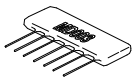
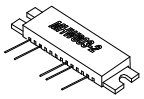
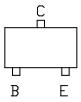
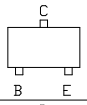
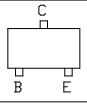
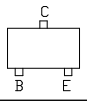
PART NO.	NAME & DESCRIPTION	COMPONENT
	(+) MACHINE SCREW (PH) M2.6X8 NI-PLAT	PWR MODULE MTG.
	(+) MACHINE SCREW (BH) M2X4 ZN-PLAT	RF PCB MTG:2
	(+) MACHINE SCREW (FH) M2X5 NI-PLAT	MAIN SLIDER MTG:4
	NUT RING M7X0.75(P) &9.5 BSBM	VOL. MTG.
	E RING &1.5 BLK.	CONTACT HOLDER MTG.
	FRAME AL12DC BLK	
	HOLDER (ANT) SPTE T0.3	ANT. GROUND WASHER
	HOLDER (STOPPER) ABS. BLK.	
	HOLDER ABS. BLK.	(+) CONTACT
	SLIDER (MAIN) SUS27 T0.8	
	SHIELD PLATE (ANT) CNP3 T0.2	
	KNOB (VOL.) ABS 94HB BLK.	
	CAP DUST NYLON12 BLK	
	SPRING (COIL) SUS304-WPA &0.35	(+) CONTACT
	SPRING (PLATE) SUS27 T0.6	
	COIL SPRING 1.2X0.5X3T:R SMD	L108
	3PF:GRM40COG030C 50V PT CERAMIC CH	C150
550-040-0002	RF BD. ASSY	
	SHIELD PLATE CNP3 T0.2	POWER MODULE R1
	BUSHING BSBM SN-P &4.7X2.6X2.5	POWER MODULE MOUNTING R2
	PIN CU& 1.1X13(101-01)	PIN201
	ELECT CAPACITOR 100uF 16V 20% 8X9	C190
223-439-7	I.C. 806-870 MHZ MHW803-2	U103 R7
	DIODE 1N4001 (1A 50V)	D106
	LED LAMP SPR-39MVW3 RED	D104
	FILTER GIGA DFC3R860P02BHD	F101,102
	FILTER CERAMIC SFGM455C	F106
	FILTER CERAMIC SFGM455E	F105
	FILTER CRYSTAL 45.3MHZ	F103,104
	CRYSTAL 45.755 MHZ	X101
	FUSE (125V 4A SLOW) USE P/N 280-089-7 FOR P.P	FU101
	COIL AXIAL 2.2uH:LAL03TB2R2M	L102
	COIL 455KHZ DETECTOR	L105
	600 nH 45 MHZ	L101,103
	HEADER PIN CON. GDH2-3SBC(1.2)	J109
	HEADER PIN CON. TDH-14SG	J107,108
	SW. ANT. MD003(G471710)	U102
	VR 20KA;rk0971111	RV102
	10:MCR10EZH100J CHIP RES	R160,161,168
	100:MCR10EZH101J CHIP RES	R104,107,112,124,129,135,139,140
	1K:MCR10EZH102J CHIP RES	R111,121,152,162
	10K:MCR10EZH103J CHIP RES	R117,118,122,145,147,163,164
	100K:MCR10EZH104J CHIP RES	R132,155,156,169
	1M:MCR10EZH105J CHIP RES	R167
	120K:MCR10EZH124J CHIP RES	R113
	150:MCR10EZH151J CHIP RES	R130
	1.5K:MCR10EZH152J CHIP RES	R114,115
	15K:MCR10EZH153J CHIP RES	R148
	150K:MCR10EZH154J CHIP RES	R108
	180:MCR10EZH181J CHIP RES	R120

PART NO.	NAME & DESCRIPTION	COMPONENT
	18K:MCR10EZH183J CHIP RES	R143,144,157
	22:MCR10EZH220J CHIP RES	R125,158
	220:MCR10EZH221J CHIP RES	R109
	22K:MCR1OEZH223J CHIP RES	R128
	2.4K:MCR10EZH242J CHIP RES	R151
	2.7K:MCR10EZH272J CHIP RES	R136,138
	27K:MCR10EZH273J CHIP RES	R106
	330:MCR10EZH331J CHIP RES	R149,150
	3.3K:MCR10EZH332J CHIP RES	R110
	33K:MCR10EZH333J CHIP RES	R116
	330K:MCR10EZH334J CHIP RES	R102
	39K:MCR10EZH393J CHIP RES.	R146
	47:MCR10EZH470J CHIP RES	R134,141,154
	470:MCR10EZH471J CHIP RES	R142,165
	4.7K:MCR10EZH472J CHIP RES	R105,126,133
	47K:MCR10EZH473J CHIP RES	R101,119,159
	51:MCR10EZH510J CHIP RES.	R131
	560:MCR10EZH561J CHIP RES.	R123,153
	6.8K:MCR10EZH682J CHIP RES	R137
	820:MCR10EZH821J CHIP RES	R166
	8.2K:MCR10EZH822J CHIP RES	R127
	82K:MCR10EZH823J CHIP RES	R103
	0.001uF GRM40X7R102K 50V PT CERAMIC CH	C113,119,136,158
	0.1uF GRM40X7R104K 25V PT CERAMIC CH	C102,104,117,118,121,125,146,151,160,162,168 C169,174,180
	0.01uF GRM40X7R103K 50V PT CERAMIC CH	C108,112,120,147,165,167
	100PF:GRM40COG101J 50V PT CERAMIC CH	C106,127,170,175,176,177
	.5PF :GRM40COG0R5C50V PT CERAMIC CH	C109
	1PF:GRM40COG010C 50V PT CERAMIC CH	C103,130,134
	10pF:GRM40COG100C 50V PT CERAMIC CH	C140
	15PF:GRM40COG150J 50V PT CERAMIC CH	C116
	1.5PF:GRM40COG1R5C 50V PT CERAMIC CH	C142
	18pF:GRM40COG180J 50V PT CERAMIC CH	C107,115
	2PF:GRM40COG020C 50V PT CERAMIC CH	C133,143,149
	20PF :GRM40COG200J 50V PT CERAMIC CH	C157
	220PF:GRM40COG221J 50V PT CERAMIC CH	C105,124,129,131,132,138,148,153,164,178,182 C183,185,186
	22pF :GRM40COG220J 50V PT CERAMIC CH	C111
	.022 :GRM40COG223J50V PT CERAMIC CH	C179
	33PF:GRM40COG330J 50V PT CERAMIC CH	C110
	.0033 :GRM40COG332J 50V PT CERAMIC CH	C128
	.0039 :GRM40COG392J 50V PT CERAMIC CH	C154
	4PF:GRM40COG040C 50V PT CERAMIC CH	C101
	4.7pF :GRM40COG4R7C 50V PT CERAMIC CH	C137
	47PF:GRM40COG470J 50V PT CERAMIC CH	C114,126,135,141,144,145,172,173,(191,192,193)
	56PF :GRM40COG560J 50V PT CERAMIC CH	C159,181
	6pF :GRM40COG6R0C 50V PT CERAMIC CH	C139
	.1UF :293A104X0010A2T10V TANTALUM	C155
	1UF :293D105X0010B2T10V TANTALUM	C161

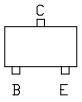
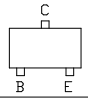
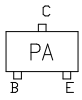
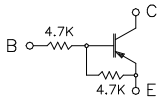
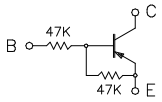
PART NO.	NAME & DESCRIPTION	COMPONENT
	10UF : 293D106X0010B2T10V TANTALUM	C188,189
	100uF: 293D107X0006E2T6V TANTALUM	C184
	0.33UF: 293D334X0035A2T35V TANTALUM	C123,156
	3.3UF: 293D335X0010A2T10V TANTALUM	C122
	4.7UF: 293D475X0010A2T10V TANTALUM	C163,166
	47UF: 293D476X06R3C2T6.3V TANTALUM	C187
	.68uF :GRM40X7R684K 50V PT	C152
	TRANSISTOR BC858 SOT-23	Q102
	TRANSISTOR KRC104SND	Q111,113
	TRANSISTOR LMMBT9426CLT1	Q104,105
	TRANSISTOR BCX-18LY1	Q112
	TRANSISTOR MMBT3904LT1	Q106
	TRANSISTOR MMBR941LT1	Q103
	TRANSISTOR MMBR951 SOT-23	Q108,109,110
	TRANSISTOR MRF9411LT1	Q101
	TRANSISTOR KRA101S	Q107
	REGULATOR I.C TK11450MTR	U109,110
	I.C OP AMP KIA358F	U104
	I.C. PLL MC145190	U106
	I.C MC3371DR2	U101
	I.C MC145158DW2 SOG16	U107
	REGULATOR IC TK11480MTR	U105
	MC14106BD	U108
	DIODE CHIP KDS196S	D102
	DIODE CHIP 1SS268	D101
	KDS226	D105
	KDS193	D103
	1uH	L104
	0 OHM CHIP RESISTOR T 1206	R170
	.22uH :380NB-22M 32CS	L107,L109
	3T	L106
	10KA	RV101
	200KA	RV103
	DIP TRIMMER 6pF TSW3P180	TC101 (VALUE?)
	KXN1274A VCTCXO	
650-030-0001	VCO BD.	
	SHIELD PLATE (VCO) SPTE T0.3	BOTTOM COVER
	PIN CU 1.1X13(101-01)	PIN301,302,303,304,305,306
	DIP TRIMMER 6pF TSW3P180	TC301
	RESONATOR CERAMIC DRR040UE/10MM	CF301
	10K:MCR10EZH103J CHIP RES	R303,R307
	27K:MCR10EZH273J CHIP RES	R304
	1.5K:MCR10EZH152J CHIP RES	R302
	180:MCR10EZH181J CHIP RES	R309
	22:MCR10EZH220J CHIP RES	R308
	22K:MCR10EZH223J CHIP RES	R310
	3.3K:MCR10EZH332J CHIP RES	R311
	4.7K:MCR10EZH472J CHIP RES	R305
	47K:MCR10EZH473J CHIP RES	R301
	5.6K:MCR10EZH562J CHIP RES	R306
	0.001UF:GRM40X7R102K 50V PT CERAMIC	C301

PART NO.	NAME & DESCRIPTION	COMPONENT
	0.5PF:GRM40COG0R5C 50V PT CERAMIC CHIP	C304
	100PF:GRM40COG101J 50V PT CERAMIC CH	C310
	1.5PF:GRH708COG1R5C 50V PT CERAMIC CH	C306,307
	2.2PF :GRM40COG2R0C 50V PT	C303
	220PF:GRM40COG221J 50V PT CERAMIC CH	C302,311
	3PF:GRH708COG030C 50V PT CERAMIC CH	C309
	4.7PF :GRM40COG4R7C 50V PT CERAMIC CH	C305
	5PF:GRM40COG050C 50V PT CERAMIC CH	C314
	5.6PF :GRM40COG5R6C 50VPT CERAMIC CH	C308
	4.7UF :293D475X0010B2T10V TANTALUM	C312,313
	TRANSISTOR BC848C SOT-23	Q304
	TRANSISTOR KRC104SND	Q301
	TRANSISTOR MRF5711LT1	Q302
	TRANSISTOR MMBR951 SOT-23	Q303
	DIODE CHIP 1SS268	D301
	DIODE CHIP MMBV809L	CR301,302
	COIL CHIP 0.22uH:LER015TR22M	L301,302,303

RF BOARD

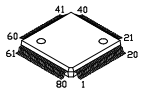
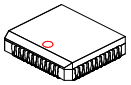
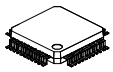
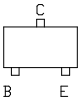
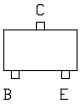
Ref. Number	Mfr. Number	Base Diagram	Schematic
U102	MD003		RX/TX PIN SWITCH
U103	MHW803-2		PA
F101 F102	GIGAFIL		806-825 mHz Filter
Q101	MRF9411	10P	
Q102	BC858	3K	
Q103	MMBR941	7Y0	
Q104 Q105	LMMBT9426CLT1	N/A	
Q106	MMBT3904	1AMU	

RF BOARD

Ref. Number	Mfr. Number	Base Diagram	Schematic
Q108 Q109 Q110	MMBR951	7ZC	
Q112	BCX-18	T2	
Q107 Q119 Q120	KRA101S		
Q111 Q113	KRC104S		
D101	MC804	N/A	 1. Anode 2. Anode 3. Cathode
D102	KDS196	G3	 1. N/C 2. Anode 3. Cathode
D103	KDS193	F3	 1. Anode 2. N/C 3. Cathode
D105	BAV99	26CL	 1. Anode 2. Cathode 3. Anode/ Cathode

COMPONENT PINOUT
(780-202-0009, Sh. 1, Rev. A)

DIGITAL BOARD

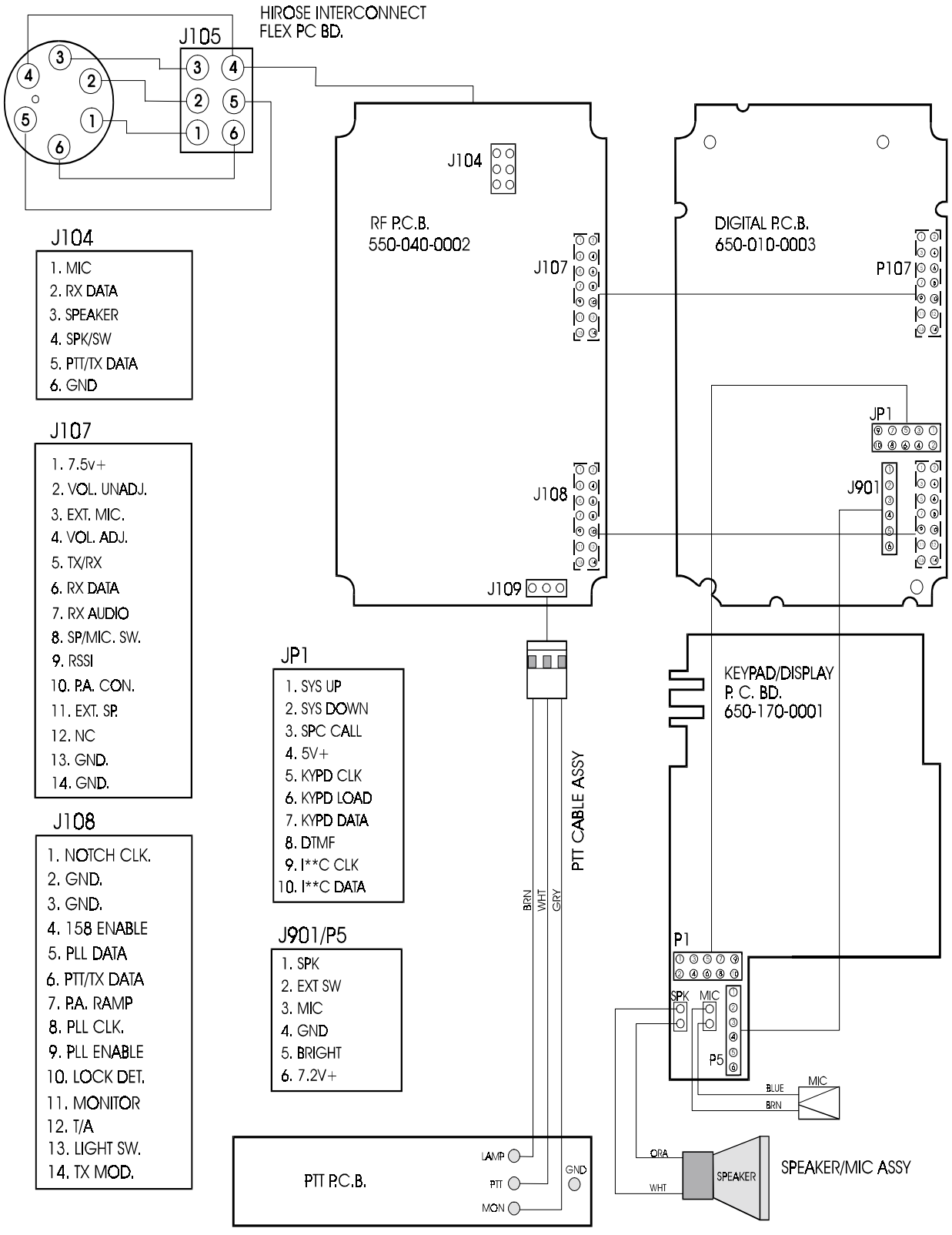
Ref. Number	Mfr. Number	Base Diagram	Schematic
U804	ASP		CPU
U701	N87C51GB		8 Bit Microcontroller
U702	GE MODEM		Modem
U706	DS2400Z		Serial Number ROM
D710	KDS226		 1. Anode 2. Cathode 3. Anode/ Cathode
D720	KDS184		 1. Anode 2. Anode 3. Cathode
Q702 Q801	MMBT3904		
Q601 Q603 Q802 Q804	BC858		
Q602 Q604 Q703 Q704 Q711 Q714 Q701	BC848		

KEY PAD BOARD

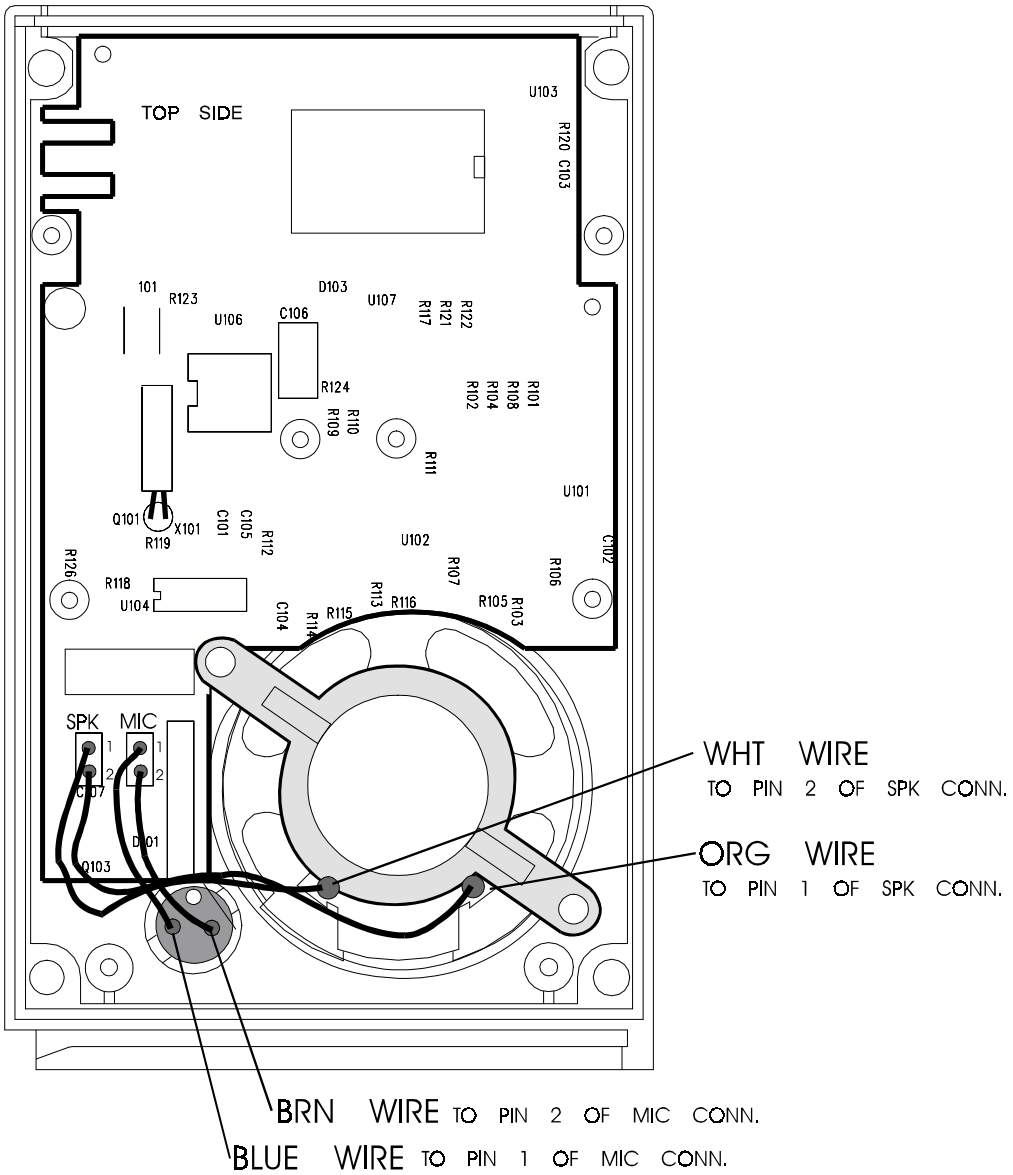
Ref. Number	Mfr. Number	Base Diagram	Schematic
D103	KDS196		 1. N/C 2. Anode 3. Cathode
D101	MMBZ52458VJ		
Q101	BC848C		
Q102	25K1579		

COMPONENT PINOUT

(780-202-0009, Sh. 2, Rev. A)

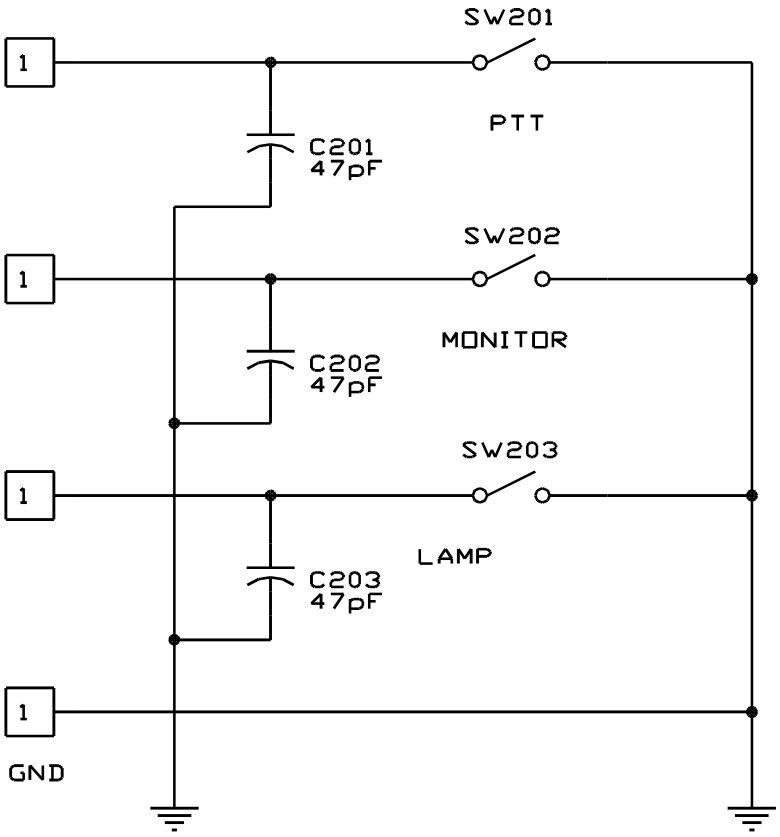


SYSTEM WIRING DIAGRAM
(930-010-0002, Rev. A)



Part placement and designators are for reference only and may vary depending upon revision of PCB.

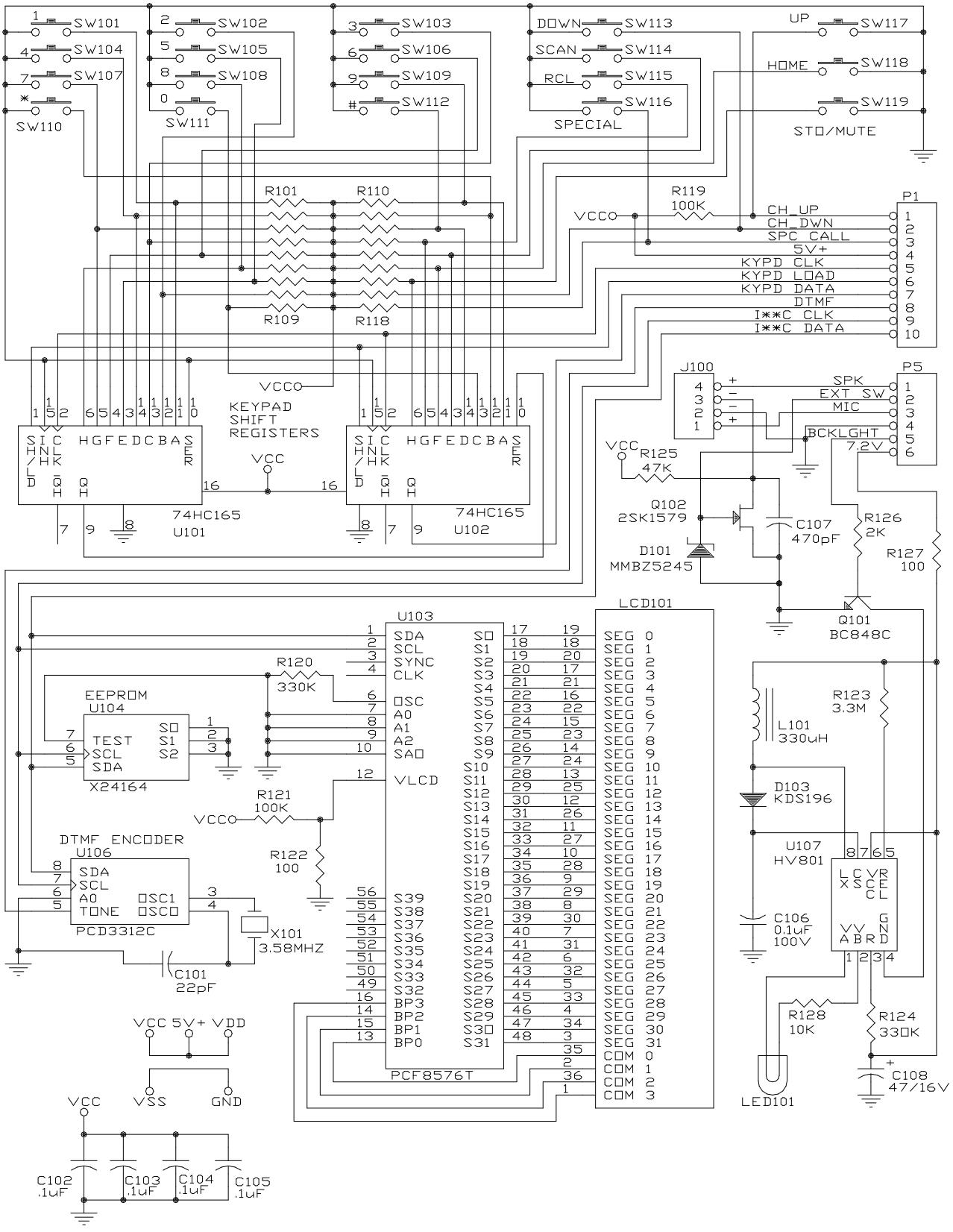
KEYPAD/DISPLAY BOARD
(930-010-0002, Rev. A)



PTT SWITCH BOARD

650-180-0001

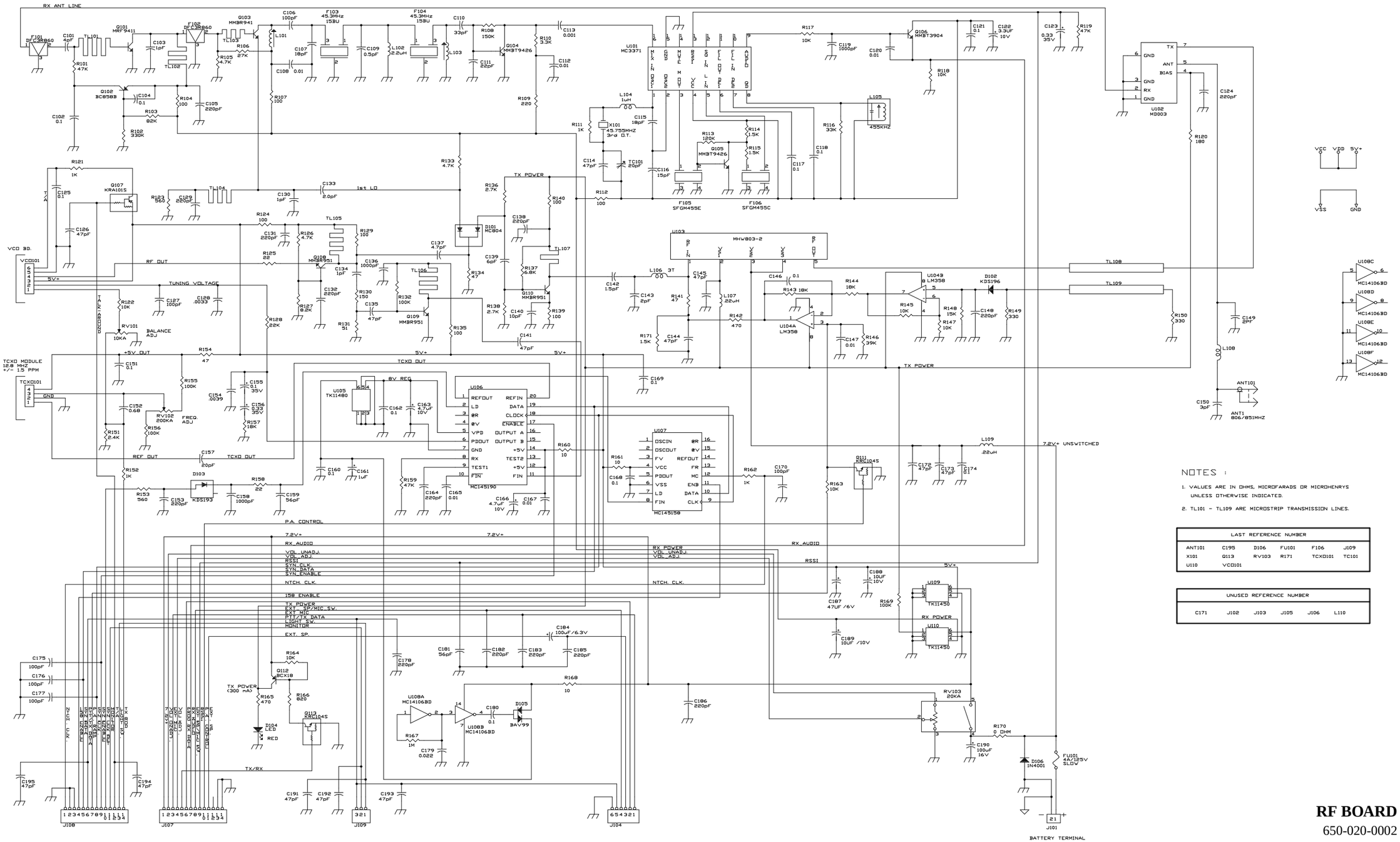
(S1800001, Rev. A)



KEYPAD/DISPLAY BOARD

650-170-0001

(S1700001, Rev. A)



NOTES :

1. VALUES ARE IN OHMS, MICROFARADS OR MICROHENRYS UNLESS OTHERWISE INDICATED.
2. TL101 - TL109 ARE MICROSTRIP TRANSMISSION LINES.

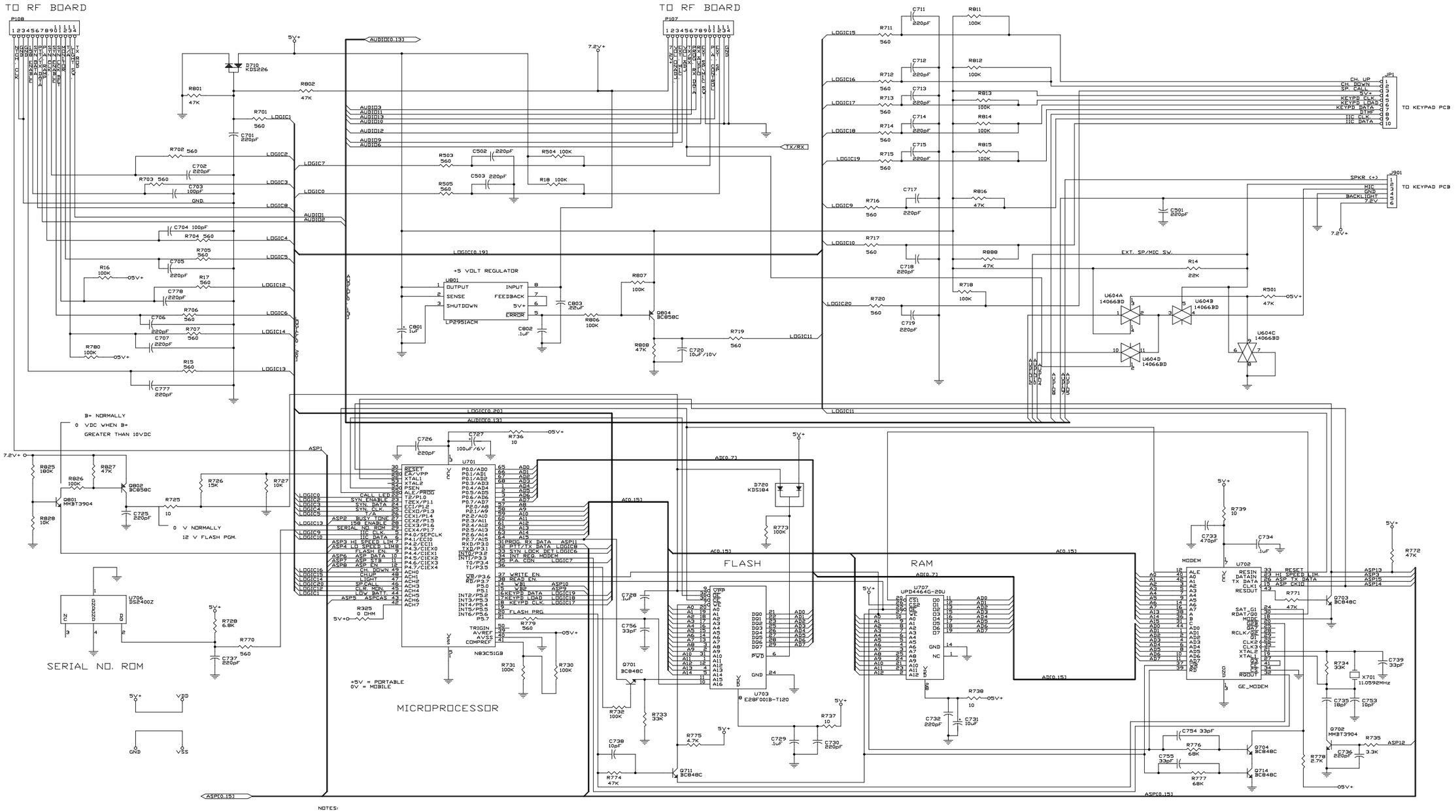
LAST REFERENCE NUMBER					
ANT101	C195	D106	FU101	F106	J109
X101	Q113	RV103	R171	TCXO101	TC101
U110	VCO101				

UNUSED REFERENCE NUMBER					
C171	J102	J103	J105	J106	L110

RF BOARD

650-020-0002

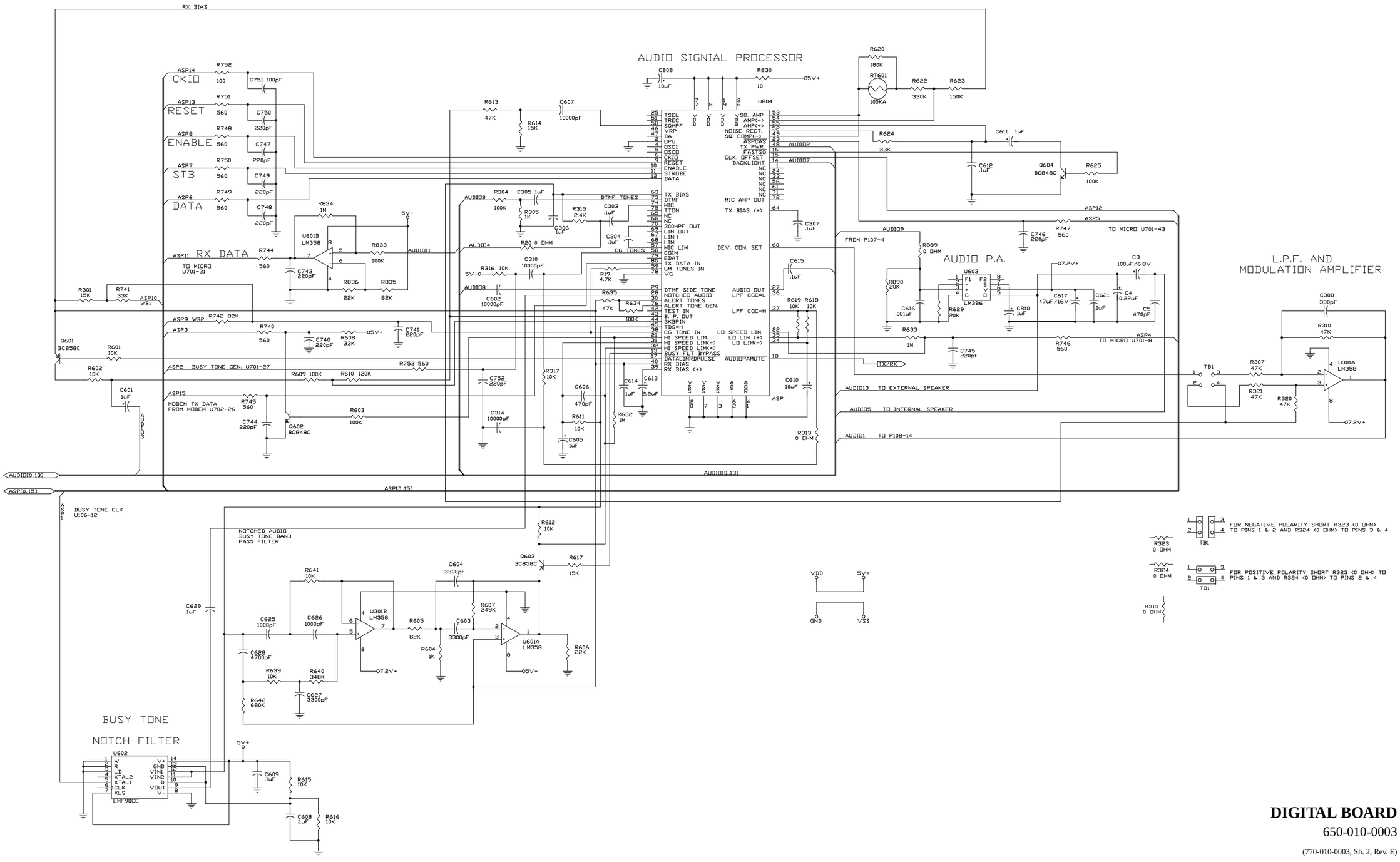
(770-020-0002, Rev. D)



DIGITAL BOARD

650-010-0003

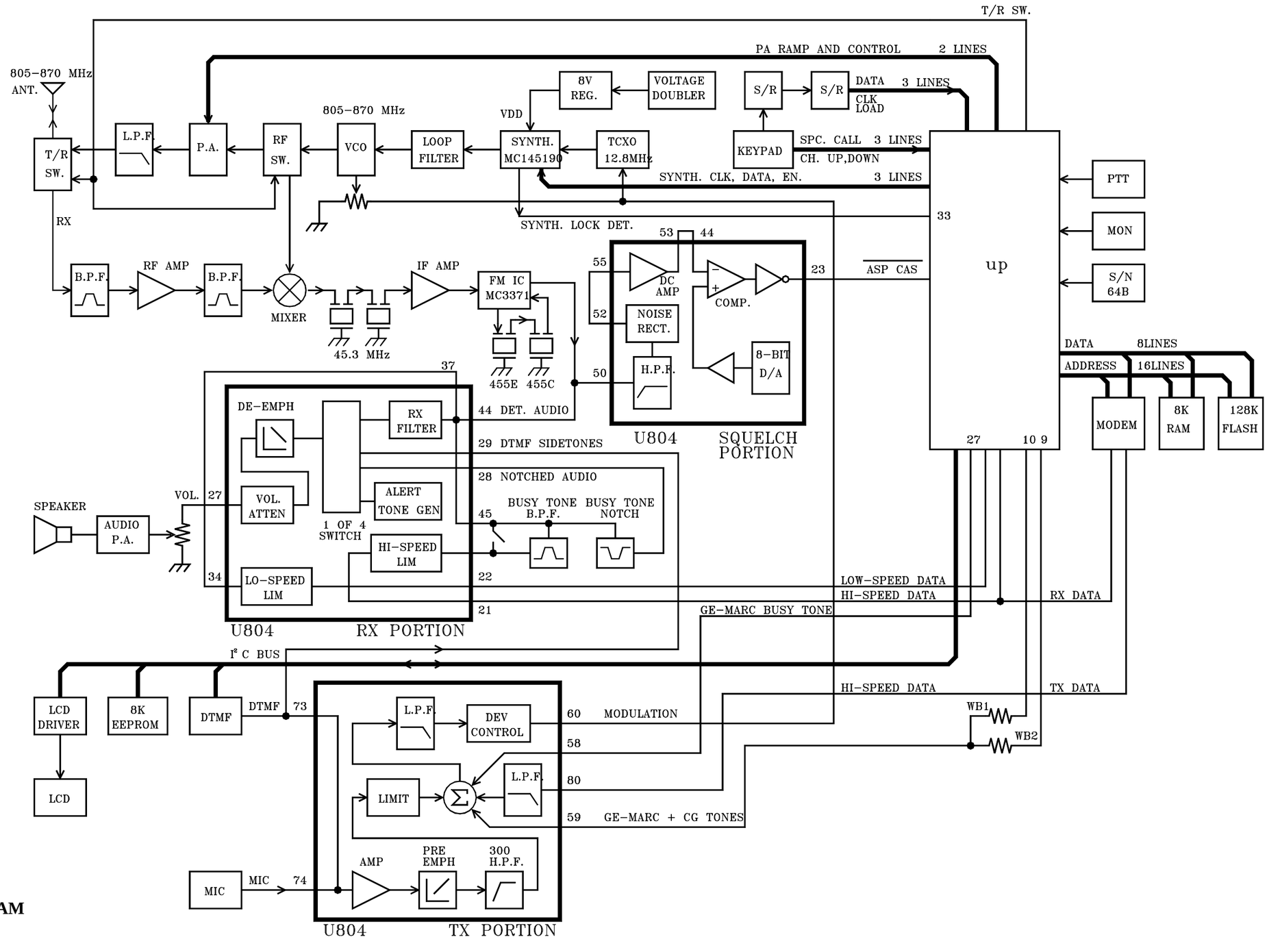
(770-010-0003, Sh. 1, Rev. E)



DIGITAL BOARD

650-010-0003

(770-010-0003, Sh. 2, Rev. E)



BLOCK DIAGRAM

(060-010-0001, Rev. B)

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