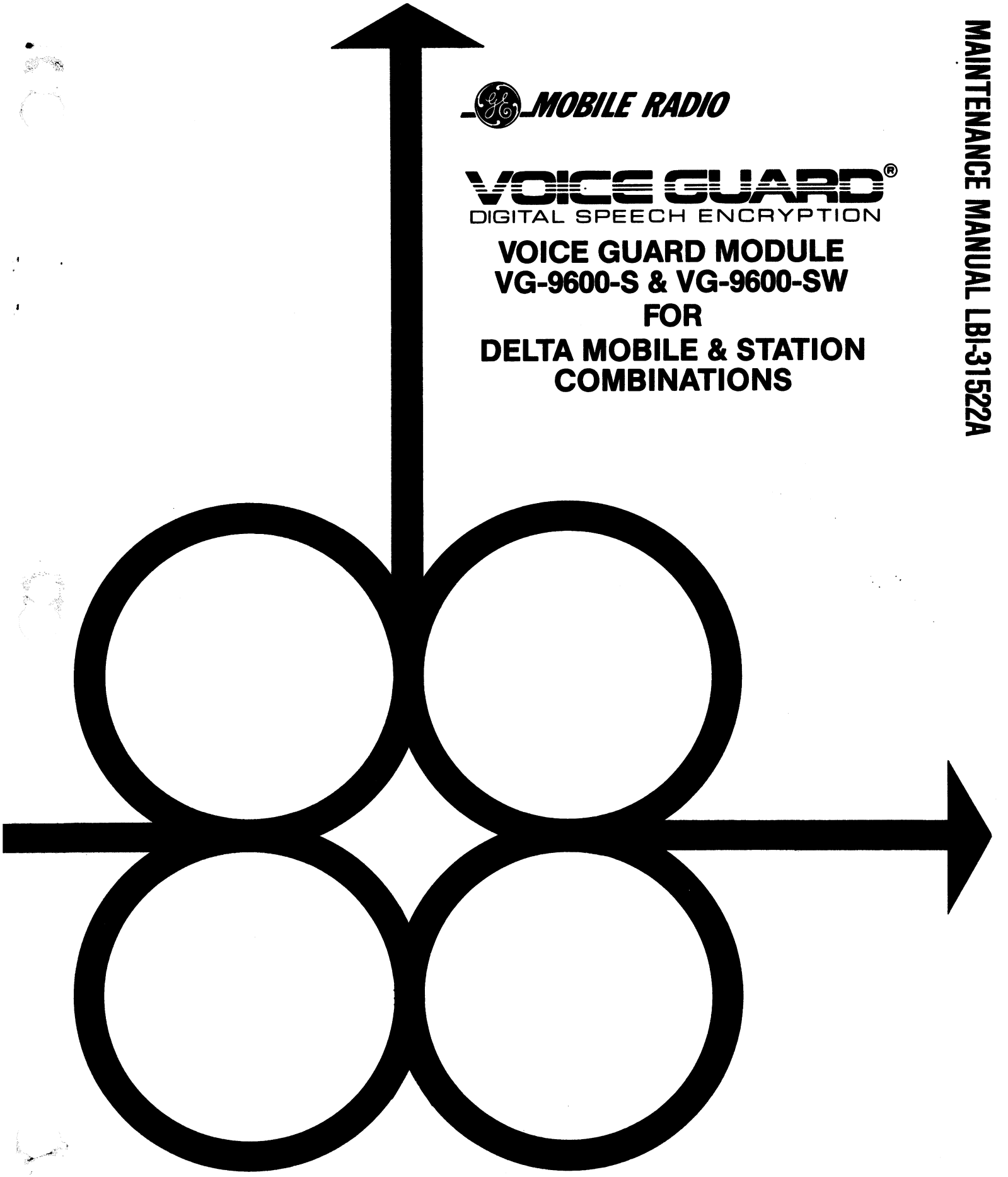
MAINTENANCE MANUAL LBI-31522A

MOBILE RADIO

VOICE GUARD®

DIGITAL SPEECH ENCRYPTION

VOICE GUARD MODULE VG-9600-S & VG-9600-SW FOR DELTA MOBILE & STATION COMBINATIONS



GENERAL ELECTRIC

* Key Loader in back of manual

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SPECIFICATIONS

Cryptographic

Encryption Technique:	DES 64-bit output Feedback Mode.
Key Permutations:	7.2×10^{16}. User selected using Key Variable Loader.
Endorsement:	Federal Standard FS-1027 (VG-9600-S only).

System

Guarded Mode Performance:	90% acquisition at 12 dB SINAD (SINAD measured in clear mode).
Speech Digitization:	9600 baud Sub-Band Coding.
Automatic Clear/Guarded Switching:	Automatically receives clear or guarded signals based on presence of digital sync data.
Signalling:	Digital Continual Signalling in guarded mode. Thirty-two Outside Addresses available in some applications.
Programming:	Externally programmable using General Electric Universal Radio Programmer TQ2310.

Electrical

Key Storage:	30-second power interruption allowed.
RAM Keep - Alive Current:	12 mA Maximum.
Power Requirement:	+10.8 to +16 VDC, 200 mA nominal during quiesent state, 500 mA nominal during guarded TX or RX.

Mechanical

Height:	51.6 mm (2.03 in.)
Width:	175 mm (6.9 in.)
Depth:	206 mm (8.1 in.)
Weight (with mounting bracket)	9.5 Kg (4.3 lb.)

Environmental

Temperature Range:	-30°C to +60°C (-22°F to +140°F)
Altitude:	5 km (16,500 ft.)
Shock:	EIA
Vibration:	EIA, USFS

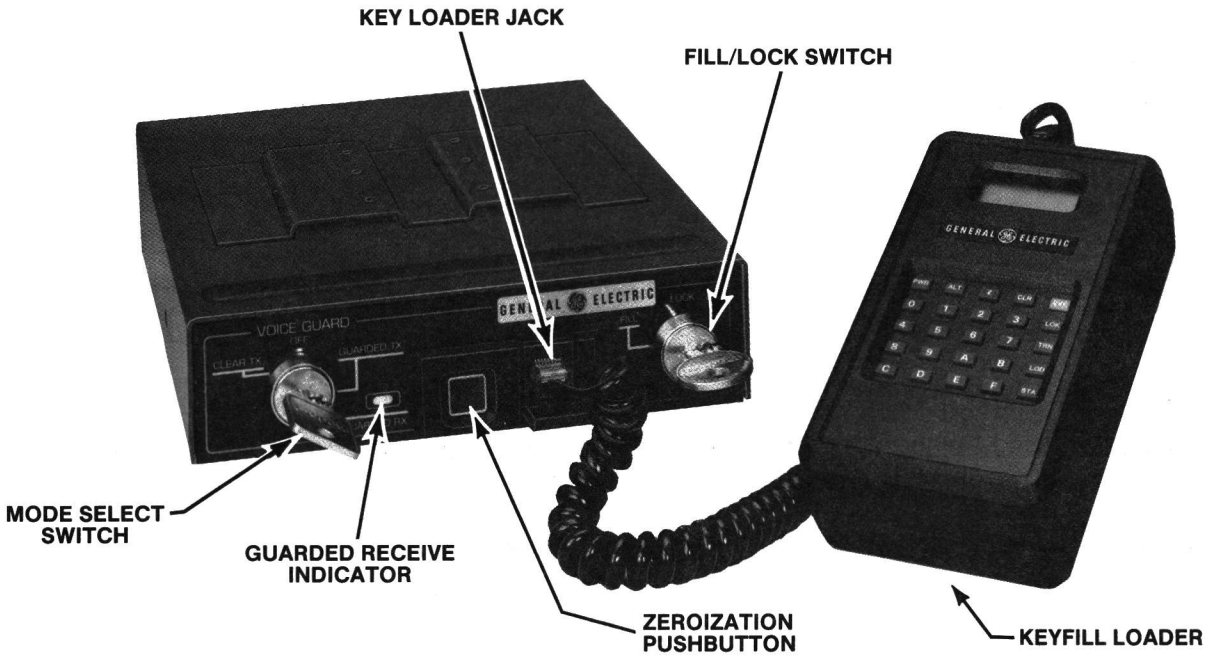

Figure 1 - Operating Controls (FS-1027 Endorsed)

DESCRIPTION

General Electric Voice Guard modules VG-9600-S and VG-9600-SW are used in digital speech encryption/ decryption systems with Delta mobile and station combinations. The Voice Guard (VG) module provides the digital encryption/ decryption with no reduction in the radio range.

The VG-9600 module permits the operator to switch between the CLEAR (not encrypted) or GUARDED (encrypted) mode when transmitting. The module automatically switches to the correct mode when receiving.

The VG module is used with local control, Desk Top Delta station applications. The VG module is also used with Delta mobile radios in direct mobile-to-station, mobile-to-mobile (or personal radio), and in Voting systems.

The VG-9600 module is available in two different versions. The two versions are:

- FS-1027 endorsed - includes DES algorithm and the required security provisions required by Fed Std 1027.
- Non-FS-1027 endorsed - includes DES algorithm without the security requirements of FS-1027.

The two versions are compatible (i.e., can communicate with each other) when equipped with the same cryptographic key. The model number, GE Part Number, description and application for each of the VG modules is shown in Table I.

FED-STD-1027

FS-1027 endorsed VG equipment means equipment that encrypts, decrypts or stores the cryptographic key meets the requirements of Federal Standard FS-1027 including use of the DES algorithm, and provides the required physical and electrical security. The physical security consists of pickproof keylocks for mode control and for enabling cryptographic key loading on the unit. The electrical security provides added methods for safeguarding the loaded cryptographic key.

DES ALGORITHM

The Data Encryption Standard (DES) algorithm uses a 64-bit binary number (56 bits plus 8 bits of parity) as a cryptographic code or "key". There are 7.2 X 10^{16} possible keys. This electronic key is used for encryption and decryption of the digitized voice data being transmitted, and precludes unauthorized monitoring of voice communications.

A Cryptographic Keyfill Loader is available for programming the cryptographic key into the Voice Guard unit.

CRYPTOGRAPHIC KEY

The term "cryptographic key" refers to an electronic code inserted through the Key Loader Jack on the front of the VG module.

If no valid cryptographic key has been loaded into the VG module when an encrypted message is received, the radio will remain muted. The "no key" condition will be indicated in an attempt to transmit in the GUARDED mode. Any attempt to transmit in the GUARDED mode without a valid cryptographic key will cause a two-tone alert to be heard at the speaker, and the transmission will be inhibited.

NOTE

To complete communications path in the GUARDED mode, the cryptographic key must be the same in both the transmitting and receiving units.

KEYFILL LOADERS

Cryptographic Key Loader Option V4025 is a small, handheld calculator-type keyboard display unit that permits easy entry, storage and transfer of the cryptographic keyword (key). The Keyloader connects into the Key Loader Jack located on the front of the VG module through a coil-cord cable.

In FS-1027 endorsed VG modules, a mechanical key must be inserted into the FILL/LOCK switch and the switch set in the FILL position before the cryptographic keys can be loaded into the VG module. After the key is loaded into the VG module, the FILL/LOCK switch is placed back into the LOCK position, after which the mechanical key and the Key Loader cable is removed.

In non-FS-1027 endorsed VG modules, simply inserting the cable from the Key Loader into the Key Loader jack enables the keyloading circuit in the VG module. Removing cable after the key is loaded returns the VG module to the operating mode.

Complete operating instructions for the key loader are contained in LBI-31541.

The VG module is contained in a metal housing. In mobile applications, the top of the housing has a mounting bracket for mounting a control unit, if desired. A metal frame assembly provides mounting support for the logic and analog

TABLE I - VG MODULE CONFIGURATION

MODEL NUMBER	GE PART NUMBER	DESCRIPTION	APPLICATION
VG-9600-S	19A148909P1	DES, FS-1027 endorsed	Delta Mobile
VG-9600-SW	19A148909P10	DES, Non-FS-1027 endorsed	Delta Mobile
VG-9600-S	19A148909P11	DES, FS-1027 endorsed	Delta Station
VG-9600-SW	19A148909P15	DES, Non-FS-1027 endorsed	Delta Station

printed boards, and the front panel. The front panel contains all operating controls. All external system connections are made to four connectors at the rear of the VG module.

OPERATION

Two different operating procedures are required for the VG modules. One procedure is for operating the FS-1027 endorsed VG modules, and one for the non-FS-1027 endorsed VG modules (see Table I).

FS-1027 ENDORSED MODULES

All controls and indicators, to operate the VG unit, are conveniently located on the front panel. These controls consist of the Mode Select switch, a Zeroization pushbutton switch, FILL/LOCK switch and the GUARDED RX indicator (see Figure 1).

Mode Select Switch

This three-position key switch determines the operating mode of the VG unit. The operator normally has possession of the key to this switch. The three positions are as follows:

1. CLEAR TX: All transmissions are made in the "clear" (unencrypted) mode. This mode is characterized by a short single warning tone heard in the operator's speaker preceding each transmission to remind the operator that the transmission is in the clear and may be monitored. Received messages may be either clear or guarded. A GUARDED RX (receive) indicator will light, when received messages are guarded. Clear messages, including normal Channel Guard operation, are received as on a standard radio.

2. OFF: The VG function is inoperative and the radio operates normally in the clear voice mode, for both transmit and receive. Each time the PTT switch is operated, a short 2-tone warning tone indicating a clear transmission is sounded to indicate a CLEAR (unencrypted) transmission. If an encrypted message is received, the receiver will remain muted. However, if Channel Guard is disabled, a noise similar to that of an unsquelched receiver will be heard.

3. GUARDED TX: All transmissions are encrypted and no warning tone is sounded. The receiver operates as described under CLEAR TX. Both clear and encrypted messages will be received.

Zeroization Pushbutton

The zeroization (key dump) pushbutton enables the operator to immediately erase the cryptographic key. The key must be re-loaded to resume encrypted communications. After zeroization, communications are possible only in the CLEAR voice mode with the Mode Select switch "OFF", or in "CLEAR TX".

FILL/LOCK Switch

The FILL/LOCK switch must be in the "FILL" position to allow a cryptographic key to be loaded into the VG unit. The

radio will be inoperative until this switch is placed in the "LOCK" position after cryptographic key loading. The FILL/LOCK key is not normally in the possession of the operator since it is only used for loading the cryptographic key, and for physical removal of the VG module.

To start sending or receiving messages:

1. Insert the key in the mode select switch and select the desired operating mode:

   CLEAR TX (Clear transmission, clear or guarded receive).

   OFF (Clear transmit, clear receive).

   GUARDED TX (Guarded transmit, clear or guarded receive) the key may be removed in any position desired.

2. Operation is now similar to operating a standard, non-VG equipped radio. Monitor the channel to insure it's not in use before transmitting.

NON-ENDORSED VG MODULES

The non-FS-1027 endorsed VG module has only one operating control: a CLEAR or GUARDED mode switch on the front panel selects the mode for transmitting only. When receiving, the GUARDED or CLEAR mode is automatically selected regardless of the mode switch position.

The single-tone warning beep will be heard when the PTT is depressed when in the CLEAR mode. No beep will be heard when transmitting in the GUARDED mode.

CIRCUIT ANALYSIS

The VG unit contains two printed wiring boards: an analog board and a digital logic board.

The analog board consists of a CODEC integrated circuit (IC), audio filtering, transmit data filtering, receive data filtering, analog signal switching, CODEC timing, I/O buffering and power supply and voltage regulation circuitry. The CODEC IC provides "anti-aliasing" filtering, analog to digital (A/D) and digital to analog (D/A) conversion and output reconstruction filtering.

The digital logic board consists of a control microprocessor, a digital signal processing (DSP) IC for speech bandwidth compression, a DATA ENCRYPTION STANDARD (DES) IC for encryption/decryption, a modem IC for NRZ (Non-return to zero) data transmission and reception, a key RAM to store the cryptographic key and, input and output logic circuits.

A block diagram of the VG module is shown in Figure 2.

In the transmit mode, the VG circuitry converts the analog voice to a digital bit stream. Then a bandwidth compression is performed using a sub-band coding algorithm programmed into a Digital Signal Processor. This reduces the digital voice data rate from about 46 kb/s to about 9.2 kb/s. This bit stream

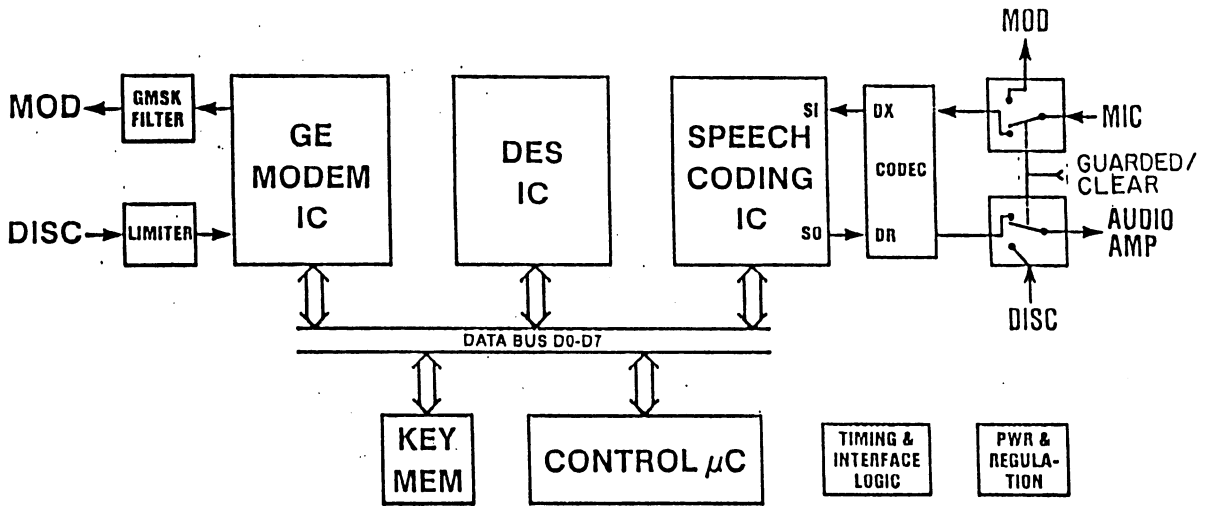

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Figure 2 - VG-9600 Block Diagram

of data is then encrypted and synchronization and overhead bits are added to form a 9600 baud data signal. This signal is then filtered and passed on to the radio transmitter modulator circuit.

When the VG module is in the receive mode, the process is reversed. Synchronization and overhead bits are removed from the incoming 9600 baud signal. The signal is decrypted, a bandwidth expansion is performed, and the CODEC converts the digital bit stream to an analog signal which is passed on to the receive audio circuit.

Refer to the Functional Block Diagram listed in the Table of Contents.

When operating in the encrypted mode, the function of multi-tone Channel Guard encode/decode in the clear mode can be duplicated by using the eight unencrypted bits in the recurring synchronization header (see Figures 3 and 4).

These eight bits comprise the Outside Address(es) (OA). They are assigned to individual channel(s) when programmed into the VG module EEPROM using the TQ2310 Programmer and the Voice Guard EPROM Kit, TQ2344. The OA can be used for selective unit or group calling, or selective repeater activation.

POWER SUPPLY AND VOLTAGE REGULATION

The logic power supply of +5 volts is provided by two regulators supplied by the radio switched B+. Analog -5 volts, required by the CODEC and associated analog circuitry, is derived from a switching inverter powered by the radio switched B+ followed by a -5 volt regulator. Analog +8 volts that is required by some of the analog circuitry, is provided from the radio switch B+ by a separate regulator.

CONTROL MICROCOMPUTER

Control microprocessor U1 controls the data flow between the DSP IC (U10), the DES IC (U9) and the Modem IC (U6). U1 also provides interfacing to the key variable loader and the Key RAM (U11). In addition, the control processor monitors VG and radio control tones (e.g. PTT, Guarded/Clear...etc.) to determine the proper mode of operation.

DIGITAL SIGNAL PROCESSOR

The digital signal processor (U10) receives A/D converted data from CODEC IC U4-A. It is programmed with a proprietary Sub-Band Coder bandwidth compression algorithm, which reduces the digitized voice data rate from 46.4 kb/s to 9244 bits-per-second. The Sub-Band Coder compressed voice data is then passed to the control processor through the 8-bit wide parallel data bus.

A/D AND D/A CONVERSION

When transmitting in the GUARDED mode, the microphone signal is filtered by U1-A, then applied to CODEC U4-A. The CODEC provides input anti-aliasing filtering, A/D conversion, D/A conversion and output reconstruction filtering. On transmit, the A/D converter provides an 8-bit u-law companded representation of the input waveform every 172.4 usec. This 8-bit sample is shifted serially into the SI port of the DSP IC, U9.

DES IC

U9 is the DES IC. The control processor is programmed to implement the 64-bit output feedback mode (OFB) of U9. This is done by using the DES chip as an Electronic Code Book (ECB) DES device and loading the input with an initialization vector, feeding the output back to the input and XOR'ing the results with the data to be encrypted.

DES IC TIMING

In order to interface U9 to control microprocessor U1, some additional timing circuitry is required. The RD, WR and ALE signal lines of U1 are gated to provide a continuous clock to the E and 2XE clock inputs of the DES (U9). IC's U19 and U7 provide this function.

KEY RAM

Key RAM U11 is a CMOS, 2K X 8, static RAM. The key is transferred from the key loader through the control processor to the Key RAM. In addition, the initial Initialization Vector (IV) is stored in the key RAM and maintained through normal radio power-off times in the same manner the key(s) are maintained. Precautions are also provided to insure that intermediate key locations in the processor RAM are properly zeroized.

The key(s) and IV are scrambled and stored in image RAM locations to assure data integrity.

RAM KEEP-ALIVE CIRCUITRY

In FS-1027 endorsed Delta mobile applications, power for the Key RAM is supplied through diode D30 on the Analog board and the cover interlock circuit to RAM Vcc at P6-8. Capacitor C21 has sufficient capacity to keep the RAM Vcc

above two volts for at least 30 seconds. This is normally sufficient to cover vehicle start-ups or other brief interruptions of power.

In Delta station applications, power for the Key RAM is supplied from two sources. One source originates from the normal station supply, providing Key RAM Vcc through diode D30 to P6-8.

BACK-UP SUPPLY

In the event of power failure to the station, keep-alive power from the 9-Volt battery back-up provides a second supply through diode CR2 on the station battery back-up supply to the 3.9-Volt Zener diode (D21) on the analog board. The 3.9-Volt Zener output is then coupled through diode D20 to RAM Vcc supply at P6-8 to retain the Key RAM memory.

ZEROIZE CIRCUITRY

The zeroize (key dump) circuitry is required for FS-1027 endorsed VG modules only. The RAM Vcc goes through two switches on the analog board before being applied to the Logic board. One of these switches is the cover interlock switch. When the VOICE GUARD unit is locked on its base, this switch is depressed, allowing power to the RAM. If the unit is moved on its base, this switch will operate. When it is operated, RAM Vcc is isolated from the power source and connected to ground. This immediately dumps the cryptographic keys.

The second switch is the zeroization switch that is recessed in the VOICE GUARD front panel to prevent accidental operation. One pole of the switch normally connects the RAM to Vcc. When the switch is depressed, the RAM is disconnected from Vcc and connected to ground. This insures erasure of the cryptographic keys.

The second pole of the switch resets the Voice Guard unit. Part of the reset process is to zeroize all working key locations within the control processor. Reset also zeroizes the DES IC, U9. The RAM zeroize switch will make the Voice Guard unit unable to transmit or receive guarded transmissions.

Pressing the zeroize button does not do any physical damage to the Voice Guard unit.

However, since the microprocessor operation has been randomly interrupted by zerozing the cryptographic keys, the Voice Guard unit may not work even in the CLEAR mode after zeroization until the radio has been momentarily turned OFF and then turned back ON.

MODEM IC

The discriminator output is presented to the limiter circuitry composed of U3A and associated components. The non-inverting comparator input uses the low-pass filtered data stream, which is an estimate of the average DC level of the received signal. The discriminator output (VOL/SW HI) is then compared to this voltage to produce the 0 to 5 volt NRZ (non-return to zero) data stream which is input to modem U6.

Modem U6 contains a digital Phase-Locked loop, which provides bit sync on the incoming 9600 b/sec data. The modem also contains a hardware correlator circuit which can be enabled to look for the 11-bit Barker code sequence (11100010010) which is used to establish frame synchronization. Upon reception of the 11-bit Barker code, the modem IC interrupts the control processor. The control processor then reads succeeding bytes of received data from the modem over the data bus.

TIMING AND CLOCK GENERATION

The required clocks for control microprocessor U1 and modem U6 are derived by a crystal oscillator, running at 7.3728 MHz. The DSP and CODEC are provided an input from an 8.0 MHz crystal oscillator, located on the analog board. Timing and control signals for the CODEC IC are derived from the 8.0 MHz clock using U6 and U7A IC.

ANALOG SIGNAL GATES

Analog switches are used to route various signals. Analog switch U5A switches the receive CLEAR/GUARDED signals. U5B is the TX GUARDED data enable switch, and U5C is the alert tone generator switch.

I/O EXPANDERS AND BUFFERS

The control processor's data bus is connected to two input port IC's (U13 and U16) and two output port IC's (U14 and U15). IC U13 buffers the mode switch and frequency select lines. U16 buffers the multiple key select inputs. Power switching, alert tones and radio controls are output by U14 and U15.

TRANSMIT DATA FILTER

The TX data filter is composed of U2A (sections a, b and d). It filters the sharp transitions of the NRZ logic level data stream to reduce the frequency spectrum of the transmitted data. Jumper P14A permits the use of a second stage of filtering in some test configurations.

ALERT TONE GENERATION

Alert tones are generated by software and outputted as logic level squarewaves and applied to the analog board on P6-7. The signal is applied to a voltage divider consisting of R81, R37 and R28. P17 allows R81 to be bypassed to increase the alert for applications requiring a higher level tone.

PREAMBLE FORMAT

At the start of transmission (PTT), a preamble consisting of dotting, repeated sync, initiatization vector IV and addressing information is sent before voice encryption begins. The preamble provides a high probability of correct reception of sync, IV and outside address (see Figure 3).

FRAME HEADER

The encrypted voice data frame header is shown expanded in Figure 4. Information is provided at the beginning of a frame to insure maintenance of data and cryptographic sync and to allow late entry into a conversation during GUARDED receive. Following the 112 bits of the VG frame header are 2040 bits of encrypted SBC voice data. The VG frame header is then repeated with a new IV.

END OF MESSAGE (EOM)

In order to signal the end of a transmission an inverted sync-plus-dotting sequence is transmitted for about 50 msecs. This allows for a long fade in the signal and still ensures that the receiver decodes the EOM correctly.

MAINTENANCE

This section contains maintenance and troubleshooting information required to service the VG-9600 module. Included in this section are the Set-Up and VG module Configuration Procedures, Disassembly Procedures, and two levels of troubleshooting for the VG module. This section also includes Mechanical Layout Diagrams, Outline and Schematic Diagrams, and Parts Lists for the VG module.

The Set-Up and Adjustment procedure includes an introduction to the test program called SIMON (SImple MONitor).

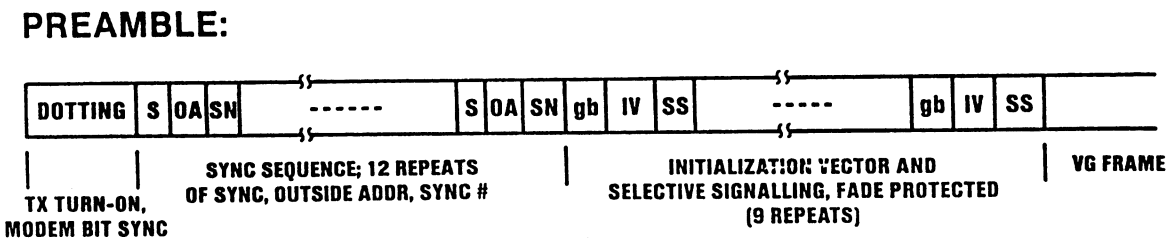

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Figure 3 - Preamble Format

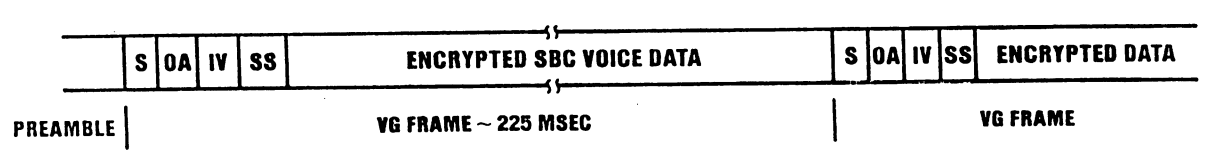

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Figure 4 - Frame Header Format

Instructions for using SIMON for the VG module are contained in LBI-31550.

CONFIGURATION JUMPERS

Voice Guard modules must be configured for Delta mobile operations in both mobile and station applications by positioning jumpers on the VG analog board as shown in Table II. In addition, the module must also be configured for either FS-1027 endorsed or non-FS-1027 endorsed operation as shown in Table III. No damage will occur if the VG unit is operated with the analog board set for a different configuration. If this should happen, the VG module will simply not operate correctly.

NOTE

The letter "W" in the model number suffix denotes a non-FS-1027 configuration. Model numbers without the letter "W" denote a FS-1027 endorsed configuration (see Table III).

DATA POLARITY

The data polarity is selected so as to satisfy the criteria that a data '0' is a decreasing (or lower) transmitted RF frequency and a data '1' is an increasing (or higher) transmitted RF frequency. At logic level, a data '0' is a nominal zero volts while a data '1' is a nominal +5 volts.

Different transmitters and receivers may or may not invert the data as it passes thru. Since VG data is NRZ (non-return to zero), it cannot be inverted and retain it's original information content. Therefore, if the polarity shown in Table IV is "non-inverted", the VG personality prom programming should also be non-inverted. If Table IV indicates inverted, the corresponding VG prom programming should be inverted.

TABLE II - Analog Board Jumper-Plug Chart

JUMPER	POSITION 1-2	POSITION 2-3	DELTA MOBILE & STATION
P10	FLAT RX AUDIO	PRE-EMPHASIZED RX AUDIO	2-3
P11	LOW LVL RX AUDIO	HIGH LVL RX AUDIO	1-2
P13	REMOTE CONTROLLER	MOBILE	2-3
P14	1 STAGE TX DATA FILTER	2 STAGE TX DATA FILTER	1-2
P15	CONTROL OUTPUTS TO GROUND	CONTROL OUTPUTS TO CONTROL A-	1-2 (SEE NOTE 1)
P17	HIGH LVL ALERT TONE	LOW LVL ALERT TONE	2-3
P18	HIGH GAIN MIC INPUT	LOW GAIN MIC INPUT	2-3
P19	6dB/OCTAVE PRE-EMPHASIS	12dB/OCTAVE PRE-EMPHASIS	2-3
P20	NO MIC BIAS	MIC BIAS	2-3
P21	UNSWITCHED TX DATA	SWITCHED TX DATA	2-3
P22	UNSW A+ NOT REGULATED	UNSW A+ REGULATED TO 3.9V	2-3
P23	RX DATA FROM DVG AUD HI	RX DATA FROM DVG RX AUDIO	1-2 (SEE NOTE 2)

NOTE 1: MOVE P15 TO POSITION 2-3 FOR MOBILE DUAL CONTROL APPLICATIONS.

ADJUSTMENT PROCEDURE

Two adjustments are normally required in the initial set-up of the Voice Guard system. The adjustments consist of setting the analog and digital deviation on the DELTA radio.

Analog Deviation Adjustment

Balancing the modulation between the VCO loop and the reference oscillator is required for good Voice Guard operation. The procedure is as follows:

Table III - FS-1027/Non-FS-1027 Configuration (See Note 2)

POSITION 1-2		POSITION 2-3	NON-FS-1027, "W" SUFFIX	FS-1027, NO "W" SUFFIX
P24	KEYLOAD ENABLED W/FILL/LOCK SWITCH	KEYLOAD ENABLED W/LOADER JACK	2-3	1-2
P16	ANTI-TAMPER SWITCH		J16-1 TO J16-2	P16 (From Anti-Tamper Switch) TO J16

NOTE 2: THESE STEPS APPLY ONLY TO ANALOG BOARDS WITH REVISION 3 AND LATER PRINTED WIRING PATTERNS.

TABLE IV - Delta Radio Data Polarity

FREQUENCY RANGE	DELTA-S SYSTEM BOARD	DELTA-S SYSTEM BOARD	DELTA-SX SYSTEM BOARD
136-174 MHz:	19D900951 (EARLIER MODELS)	19D901720 (LATER MODELS)	19D901650
TX: 136-153	non-inverted	inverted	inverted
TX: 150.8-174	non-inverted	inverted	inverted
RX: 136-153	non-inverted	non-inverted	non-inverted
RX: 150.8-174	non-inverted	non-inverted	inverted
403-512 MHz:	19D900920 (EARLIER MODELS)	19D901620 (LATER MODELS)	19D901670
TX: 403-430	non-inverted	inverted	
TX: 403-440			inverted
TX: 440-470	non-inverted	inverted	
TX: 470-494	non-inverted	inverted	
TX: 494-512	non-inverted	inverted	
TX: 440-470			inverted
RX: 403-430	non-inverted	non-inverted	
RX: 403-440			non-inverted
RX: 450-470	non-inverted	non-inverted	
RX: 470-494	non-inverted	non-inverted	
RX: 494-512	non-inverted	non-inverted	
RX: 440-470			inverted

1. Apply a 1-kHz signal at 1 volt RMS to the microphone audio input terminals.
2. Depress the Tx PTT button.
3. Set VCO DEVIATION (R237 for all 'S', R323 for 'SX') on the DELTA system board for 4.5 kHz deviation.
4. Connect the audio generator to J603, pin 15.
5. Adjust the audio generator level to produce 2.0 kHz deviation.
6. Re-adjust the audio generator frequency to 10 Hz while maintaining the audio level just established.
7. Set AUDIO MOD ADJUSTMENT (R368 for old 'S', R366 for new 'S' and 'SX') on the DELTA system board for 2.0 kHz deviation.

Digital Deviation Adjustment

Do not set the digital deviation until the analog deviation balance has been set as described above. After the analog balance adjustments have been performed, set the digital deviation as follows:

1. Digital deviation adjust R11 is located on the digital interface board mounted in the option position nearest the front of the DELTA radio casting. With the VG module in the GUARDED mode, adjust R11 for 3.0 kHz deviation, or 3.2 kHz absolute maximum deviation on the worst case channel. Refer to the TRS section in the appropriate DELTA Radio Maintenance Manual for identification of worst case channels.
2. If the deviation monitor has an oscilloscope output, a 9600 baud eye pattern display of the transmitted data should be seen with a peak-to-peak deviation of approximately +3, -3 kHz. Turning R11 fully clockwise should only produce a maximum of 3.6 to 4.0 kHz deviation. It is not necessary to apply audio to the microphone input when setting deviation in the Guarded mode.

NOTE

Setting the analog (clear) deviation affects the digital deviation, but setting the digital deviation does not interact with the analog deviation. Therefore, always set the analog deviation first.

DISASSEMBLY PROCEDURE

To remove the mobile VG unit from the vehicle (Refer to Installation Manual LBI-31521):

1. Disconnect the Interconnect Harness and Control Cable from the rear of the Control Unit and VG unit.
2. Disconnect speaker from A2J1-14 and -17.
3. Disconnect MIC Hookswitch from A2J1-10 and -14.
4. Remove the two machine bolts from either side of the Control Unit mounting bracket and remove the Control Unit from the top of the VG module.
5. In FS-1027 endorsed modules, insert round key into FILL/LOCK switch and turn to FILL position. Then push unit backward on the interlocking support and lift off the VG and attached Control Unit.

   In non-FS-1027 endorsed modules, remove the two machine bolts from either side of the VG mounting bracket and remove the VG module from the bracket.

To remove the VG cover:

1. Remove the two pan-head screws located on each side of the cover, and the flat-head screw located at the back of the top cover.
2. While holding the VG Unit, push on the back of the VG chassis and slide the chassis forward and out of the cover.

To remove the logic board:

1. Remove the chassis from the cover.
2. Remove the 11 pan-head screws securing the board to the chassis, and the two 4-40 nuts securing the back supporting plate to the chassis assembly. These are located on the outside edges of the heatsink. NOTE: There are two screw sizes used to secure the board (4-40 x 1/4 and 4-40 x 7/16). Remember the sizes and locations for reassembly.
3. Unplug connector from J9.
4. Unplug optional rotary or toggle switch connectors if installed.
5. Remove the five flat head screws located on the side of the chassis assembly.
6. The Logic Board and attached metal shield can now be lifted free of the chassis assembly. Be careful not to damage connectors when removing and replacing Logic Board.

To remove the Analog Board from mounting frame:

1. Remove Logic Board. The Analog Board is now accessible for servicing.
2. Remove the VG front panel by removing the four 4-40 nuts from the panel studs.
3. Remove the six 4-40 x 1/4" pan-head screws from the bottom of the Analog Board. Remove the Analog Board.
4. Unsolder the ground wire between the rear of the analog board and the mounting board.
5. Remove the analog board.

VG-9600 MAINTENANCE

Two levels of maintenance and troubleshooting are provided for servicing the VG module. The first level uses a SYMPTOM/CAUSE table involving functional operation and response. Also, some voltage and waveform checks are provided on the Schematic Diagrams for the analog and logic boards.

These checks will result in a complete functional system checkout, and a fairly complete checkout of the analog board. This will also permit isolation of a problem to a particular printed wire board for board substitution.

The second level of maintenance requires a VG-9600 service kit that includes a PROM containing a test program called SIMON, for SImple MONitor. The kit also contains an adapter for connecting an RS-232, 2400 baud data terminal to the suspect VG unit. After a few simple checks are made to the logic board of the VG unit, the test PROM can be plugged into the logic board in place of the VG operating program residing in the EPROM (U2). The 2400-baud terminal can now communicate with SIMON, and a number of specific tests can be run to isolate the problem to a specific area of circuitry, and possibly to a specific component.

The service kit contains:

1-Microprocessor 19A149173G2 (8751) with SIMON in residence.

1-PROM 19A149173G1 (27C64) with an expanded version of SIMON in residence.

1-SIMON level adapter cable 19A149116P1 to interconnect an RS-232 terminal to a Voice Guard unit.

1-Maintenance plug to defeat anti-tamper switch in FS-1027 endorsed units.

1-Instructions for use of SIMON, LBI-31550.

LEVEL ONE MAINTENANCE

In order to evaluate the functional operation of a Voice Guard installation, the following sequence of tests can be performed with the VG unit installed:

1. In FS-1027 endorsed units, place Mode switch on VOICE GUARD to OFF, and the FILL/LOCK switch to LOCK. In non-endorsed VG units, place the mode switch in the CLEAR position.
2. In all VG units, use another radio or service monitor to determine that the unit being examined can receive a clear transmission directed to it. The GUARDED RX light on FS-1027 endorsed VG units should not light.
3. In FS-1027 endorsed units, press the PTT button on the unit being examined. The transmitter should now be on the air, and a momentary two tone beep should be heard in the unit's speaker at the start of the transmission. It should be confirmed on a system monitor or another radio that clear voice modulation capability exists. Let up on the PTT button.
4. In all VG units, place the VG MODE switch in the CLEAR or CLEAR TX position and repeat the test described in Step 3 above. Note that only a single tone alert beep should be heard.
5. In FS-1027 endorsed units, momentarily depress the KEY DUMP button on the front of the VG unit. Place the VG MODE switch in the GUARDED or GUARDED TX position. Depress the PTT button and note that a repetitive two tone alarm sequence is heard from the speaker. (This indicates to all that a transmitter is being used without a valid cryptographic key.) Let up on the PTT button.
6. In FS-1027 endorsed units only, leave the FILL/LOCK switch in the LOCK position. Connect the KEY LOADER to the VG unit and attempt to load a valid cryptographic key. The resultant display on the KEY LOADER should be "ERROR 1". Now, place the FILL/ LOCK switch in the FILL position and repeat the key load sequence. The response should now be "GOOD TRANSFER".

   In Non-FS-1027 endorsed units, connect the key loader to the VG unit. Attempt to load a cryptographic key into the VG unit. The resulting Key Loader display should be "GOOD TRANSFER". Leave the key loader connected to the VG unit.

   Depress the PTT button; nothing should happen. Place the FILL/ LOCK switch to the LOCK position in FS-1027 endorsed units or disconnect the key loader in non-1027 units. Again depress the PTT button. The transmitter should now key on and no beep should be heard from the speaker. It should also be noted that data modulation (sounds like unsquelched receiver noise) should be noted on the system monitor. Also, a companion VG equipped radio with the same cryptographic key and outside address should be recovering any modulating signal applied to the microphone of the unit being examined and the GUARDED RX light on the unit (if present), being examined should be out while the same light on the companion Voice Guard unit (if present) should be lit. Release the PTT button.
7. Depress the PTT button on a companion VG unit having the same cryptographic key and outside address. Note that the GUARDED RX indicator is lit (if present), and the VG unit being examined should be receiving audio modulation being applied to the companion radio.
8. If multiple outside addresses are being employed, confirm proper channel tracking by attempting communication on another channel having a different OA.

At the successful completion of the above sequence of functional tests, the VG unit should be considered as operational. Refer to the SYMPTOM/CAUSE Troubleshooting Procedure of common problems that could cause failure of the above tests.

System Substitution

Should the unit being examined fail the functional tests, the VG unit and its interconnecting cable to the control head can be removed and the DELTA radio control cable can be directly connected to the control head. The radio should now perform as a conventional, non-VG, radio with no other changes or strapping modifications being required.

If substituting a known good VG unit into an installation being examined still results in either no digital or clear modulation with the other being present, the VG INTERFACE board in the DELTA mobile should be considered as the most probable failed item.

VG Failure

Should the failure be determined to be the VG unit, the following preliminary checks can be performed.

1. Remove the VG unit from its base mounting plate or bracket, and remove the three retaining screws from the sides and top of the case.

2. Attach the VG unit with cover removed to a test mobile, or station on a service bench.

3. In FS-1027 endorsed units, insert maintenance plug in hole in the right side of the VG unit in a manner as to hold the anti-tamper microswitch leaf in its depressed position (toward the rear of the unit).

4. Apply power to the test system and confirm that U1-40 and U11-24 on the logic board have +5 volts present. Depress the PTT and confirm presence of +5 volts on U9-6. Release the PTT button.

5. Confirm presence of the following voltages on the bottom side of the analog board:

U4-16	+5 volts
U4-1	-5 volts
U3-3	+8 volts

6. With these voltages all present, then confirm presence of 7.3728 MHz ±100 PPM clock signal at U1-18 on the logic board using an oscilloscope.

7. Then confirm the presence of 8.00 MHz ±100 PPM at J8-5 on the logic board.

8. Confirm that the microprocessor RESET line U1-9 is not stuck in the reset (high) state. This pin should be low for normal operation.

9. If the reset line is pulsing high for a few microseconds approximately every two seconds, or failure of steps 4, 6 or 8, would indicate a most probable logic board problem. If the reset line is continuously held high, or failure of steps 5 or 7 would indicate a most probable analog board problem.

10. Substitution of an otherwise known working logic board or analog board into a VG unit being examined is a valid board level test after the above voltages and signals have been checked.

LEVEL TWO MAINTENANCE

Level Two maintenance on a failed VG unit requires the use of VG Service Kit SPK-8609. The examination of the VG unit should be continued with the test program called SIMON (supplied in the Service Kit). In order to use SIMON (meaning SImple MONitor), an additional 2400 baud RS-232 serial ASCII computer terminal (not supplied in the Service Kit) is required. SIMON Level Adapter Cable 19A149116P1 is supplied to interface from logic board connector J10 to provide the RS-232 terminations for the 2400 baud terminal.

The procedure for setting up for SIMON operation is as follows:

1. Assure that the supply voltage and signal tests described in the level one maintenance section are satisfactory.

2. Remove all power from the unit and replace the VG PROM U2 with the SIMON test PROM. Connect the level adapter to logic board J10, and connect the power lead to +5V at H37. Connect the 2400 baud terminal to the level adapter.

3. Reapply power and continue with the test instructions for SIMON supplied in the Service Kit.

4. If SIMON does not run, there is a possibility that the microprocessor address or data bus may be latched. In order to troubleshoot this circuitry, remove power and replace microprocessor U1 with the 8751 microprocessor supplied in the kit and remove the jumper between H1 and H2 on the logic board. Then proceed with Step 3. The 8751 is a UV PROM version of microprocessor U1 that has a limited version of the SIMON program in residence. (This is due to the limited PROM space in the 8751.) Once the 8751 has successfully verified the address and data bus condition, operation should be moved back to microprocessor U1, and the 27C64 SIMON PROM. Be sure to re-install the jumper between H1 and H2.

5. At completion of the SIMON testing, be sure to replace the SIMON PROM with the VG operational code PROM.

TROUBLESHOOTING PROCEDURE

This troubleshooting procedure provides a series of symptoms and checks for tracing the path through a VG system. Before starting the procedure, make the following checks:

1. The regulators are operating properly.
2. Both 8-MHz and 7.37-MHz clocks are running.
3. Reset is low and not watchdogging.
4. The ALE and PSEN signals out of the processor are running.

A VG unit has no chance of running unless these conditions are met. Typically, such units may receive clear, will not receive private, will not trans- mit, will not accept a key from the key loader, and will not give the usual alert and warning tones. It is and will appear to be dead. Troubleshoot the logic board and the regulators on the analog board until these conditions are met. Remember the TX clock at J5, Pin 7 of the logic board must be running to get -5V.

SYMPTOM I: REDUCTION IN RANGE COMPARED TO OTHER UNITS

If the range reduction is in both private and clear, then the problem is probably in the RF sections of the radio. Check the radio for the usual power, frequency, sensitivity, and deviation. This is probably not a VG unit problem.

If the reduction in range is in guarded mode only, check the guarded transmission by looking at recovered audio of a deviation monitor. The eye pattern will probably be distorted. The most common cause of this is for the deviation on the radio, VG Control Shelf or repeater control shelf to be improperly adjusted. Refer to the appropriate Alignment Procedure for instructions.

- If the deviation is adjusted correctly, refer to SYMPTOM III (DOES NOT TRANSMIT GUARDED).
- Check to see that the waveform at receive data J8-Pin 3 of the logic board seems right. If not, refer to the SYMPTOM VI (DOES NOT RECEIVE GUARDED).

SYMPTOM II: RADIO DOES NOT KEY

Typically, the transmit light will light on the control head but the radio will not transmit.

Check to see that J6, Pin 28 on the logic board follows the Fill key. The radio will not transmit if it thinks it is in the keyfill mode.

Check to see that the PTT (low) is getting to the VG unit on J1, Pin 6 on the analog board. This says that the PTT in signal is getting to the VG unit. If not, the problem is in the interconnect cable.

Check to see that the PTT in signal is getting to the logic board on J6, Pin 21. If not, trace the PTT in line through the analog board.

Note that PTT In is really just a request to key. The radio is really keyed through the PTT Out line. Verify that the PTT Out signal is getting off the logic board on J6, Pin 5. If not, troubleshoot the logic board to see if PTT In is being recognized and PTT Out is indeed being generated.

Check to see if PTT is getting to J2, Pin 14 of the analog board. If not, the signal is not getting through the analog board.

Check to see that PTT appears on J1, Pin 8 of the interface board. If it does not, then the problem is in the radio control cable. If it is, then the problem is in the Delta radio. Refer to the Delta radio Maintenance Manual for further information.

SYMPTOM III: RADIO DOES NOT TRANSMIT GUARDED

The radio will key, but there is no data modulation. The radio transmits in CLEAR mode. It is assumed that a key has been successfully loaded and that the mode select lock is in the private position.

There are three main areas to check for when a radio does not transmit in the private mode. They are:

1. Make sure the radio is in fact in the GUARDED mode.
2. That data is getting out of the VG unit.
3. That data is getting to the modulator.

The first issue is the easiest. If the radio can receive GUARDED, then it is already answered. If it does not receive GUARDED, then one should pay attention to what happens when MIC PTT is pressed. If there is a clear transmission alert tone, then the mode lock is not connected to the logic board (J9). If connected, then

the switch portion of the lock must be open. If there is a two tone warning, then the lock switch has the private and clear Tx lines shorted together. Note that there is a valid key. Hence the DES and RAM IC's are working. The tone should be noticably different than the in/valid key alarm. If there is silence, then the VG unit does in fact see itself as in the private mode and should be transmitting data.

The next area to check is the data getting out of the VG unit. If it is not, the first step would be to see if data is getting to the analog board. If TTL level data is not present on J8, Pin 1 of the logic board, then troubleshoot the logic board. The problem will probably be in modem U6 or DSP U10. It is a good idea to isolate the pin from the jack with a toothpick to make sure something on the analog board is not killing the signal so as to make it appear to be a logic board problem.

Digital data is converted to analog data and switched onto the radio control cable on the analog board. One should be able to follow the data through the filter sections of U2. The DC level should be at 4.5 volts. There should be around 2.5 Vpp of data at the last section of the filter. The data will appear to have its edges rounded off.

The output of the filter goes to a switch section in U3. It should go in on Pin 5 and out on Pin 4. The control line is pin 9 and the controlling signal is Data PTT. Pin 9 of U5 should be low for GUARDED transmit. If not, the switch will be open and no data will get through. If high, check Q1 and Data PTT.

Data seen at the output of the switch should go to the back connector. If it does not, one problem could be with the protection diodes. The DC level should give this away. A level of close to 8V or close to ground indicates one of the diodes is shorted out.

SYMPTOM IV: RADIO TRANSMITS DATA, COMPANION RECEIVER SYNCS UP, BUT THERE IS NO RECOVERED MODULATION

If a 600-ohm microphone is not used, make sure there is a 600-ohm DC resistance to ground on the mic path. If this resistance does not exist, then amplifier U1C will have its input biased near 8V. It will not work under this condition.

If this is not a problem, then the next step would be to look at Pin 15 of codec U14. This is the output of an internal operational amplifier. No modulation here indicates a problem around U1C. If there is audio here, verify the Analog +5 and especially -5V supplies. If these are OK, then the problem is probably internal to the codec.

Transmit audio is also looped through DSP U10 and regenerated on Pin 2 of the codec. The presence of audio here pretty much verifies the operation of the codec and DSP circuits.

SYMPTOM V: RADIO DOES NOT TRANSMIT CLEAR

Clear audio requires a 600-ohm microphone or an appropriately loaded source. It comes into the VG unit on J1, Pin 4 and goes out of the VG unit on J2, Pin 16. Along the path it goes through amp U2C. This is really a switch controlled by the Mic Switch line on the logic board. Verify that audio does in fact get through this switch and gets out of the VG unit. If it does not, check U2 or Q13. Q13 should be turned off for clear audio.

Clear audio is connected through the cable to the Delta radio. It goes through the normal Delta audio circuits and then comes on to the interface board on J3, Pin 2. If there is no audio on J3, Pin 2, then troubleshoot the Delta Tx audio path.

On the interface board, audio goes through amplifier U1D before going to switch U2A. This switch should be on. Switch U2B, which connects data into the modulator, should be off. The control lines to the switches are controlled from Data PTT and Tx Switch. Both of these should be high as they come onto the interface board. If the switches are not at their proper controk, then check this logic. Also check to see that the switches are really in the state that their control lines say that they are in. Again, watch for the shorted switch.

The output of the switch goes through an amplifier before going to the modulator. Verify that audio does get through that switch. If it does, then the problem is in the modulator portion of the Delta radio.

SYMPTON VI: RADIO DOES NOT RECEIVE GUARDED

The first step is to determine if the VG unit thinks it is in the GUARDED mode. If the radio can transmit GUARDED, then it is already answered. If it does not transmit GUARDED, then one should pay attention to what happens when MIC PTT is pressed. If PTT is pressed and if there is a clear transmission alert tone, then the mode switch is not connected to the logic board (J9). If connected, then the switch must be open. If there is a two tone warning, then the mode switch has the private and clear Tx lines shorted together. Note that there is a valid

key. If so, the DES and RAM IC's are working. The tone should be noticably different than the no/invalid key alarm. If there is no tone, then the VG unit does in fact see itself as in the GUARDED mode and should be transmitting data.

Receive GUARDED requires that the receiving radio's key and outside address match that of the transmitting radio. It may be a good idea to verify the EEPROM program. It may not even hurt to verify that the logic board can in fact correctly read the EEPROM.

VOLUME/SQUELCH High comes onto the interface board on P1, Pin 14. It goes through two protection diodes on its way to switch U2D. The DC level should be around 4.5 volts. If not, one of these diodes may be questionable. Switch U2D should be on (Pin 12, 9V) so data goes to DVG DATA HI. There are also protection diodes on the output of this switch.

Switch U2C is off (Pin 6=low) so that the decrypted audio is separated from the data path. Again, be aware of shorted or open switches.

The next step is to check the VG unit. TTL level data should be on J8, Pin 2 on the logic board. There will be a jitter on the trace that is not too clear on the photograph. This is normal. The 9600 bit pattern should be apparent. If it is, then there is probably a problem with the logic board.

If it is not, then the problem is in the analog board. The data coming into J3, Pin 6 should be on the common side of R19 and R20. Pin 9 of the comparator should have an attenuated version of the data. Pin 8 should be almost a DC level. If there is data on Pin 8, then there is a problem with C7. Data on U3, Pin 9 should show up at Pin 14 at TTL levels. If not, the problem is probably the comparator.

Decrypted audio comes out of Pin 2 of the codec (U14) on the analog board. It goes through two or three filter sections before going through switch U5A. This switch switches the decrypted audio or the clear audio onto the VOLUME/SQUELCH high line to the control head. It is controlled by the Rx switch. During private receive, the control pin of this switch (Pin 10), will be low.

If audio is getting out of J1, Pin 16, then it will either be a control head problem or a Delta radio problem.

SYMPTON VII: RADIO DOES NOT RECEIVE CLEAR

The radio will normally want to receive CLEAR. If it does not, the problem will ususally be in the radio. However, there are some items in the VG unit that should be checked.

The logic board controls the signal Rx Mute. This could keep a radio quiet if it is stuck in the wrong state.

Gate U2C on the interface board could also be open. This will also prevent clear audio from getting to the speaker.

Finally, there are numerous protection diodes along the various boards on the audio lines. If one of these shorts, the line will be tied to ground or 8V. Either way, there will not be any audio getting through the system.

SYMPTOM VIII: VOICE GUARD UNIT DOES NOT ACCEPT A VALID KEY

There are three main reasons why a VG unit will not accept a key. The first is that the key-fill microswitch on FS-1027 endorsed units is not functioning or the key fill jack on non-FS-1027 units is defective. A working VG unit will give an alert tone if a keyfill that is turned off is inserted into its jack while in the fill mode. If there is silence with the fill lock in the fill position, then the switch is bad or the jack is defective.

A second reason has to do with the cover interlock microswitch on FS-1027 endorsed units. It may be possible for this to go bad in such a way as it may not be closed by putting the unit on the frame. Without power, the RAM will be useless. Any keyfill operation will then be bad.

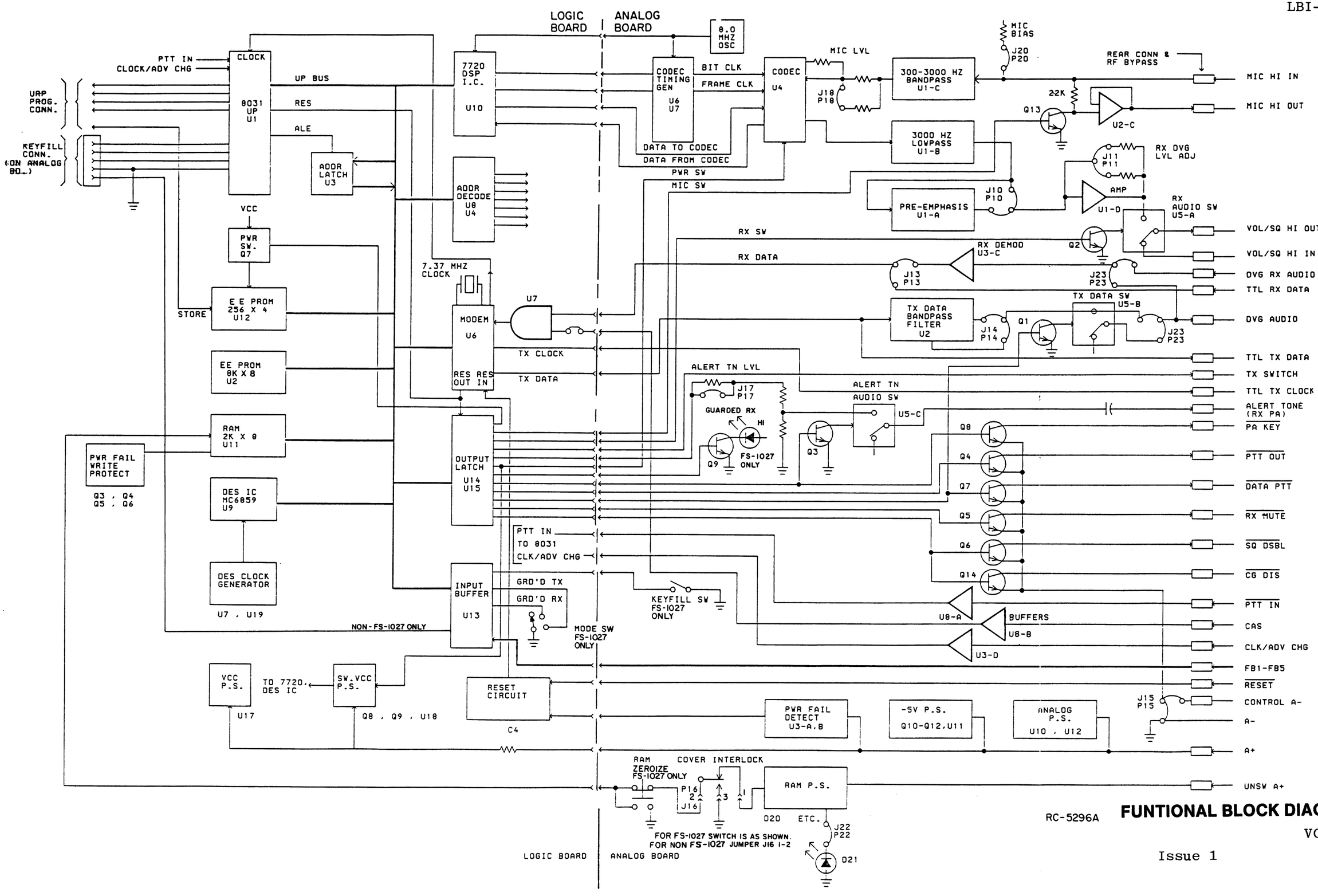
Finally, there are many protection diodes on the keyfill lines. A loss of any of them could cause some lines to behave erractically. That result would probably cause a transfer error.

SYMPTOM 1X: VOICE GUARD UNIT DOES NOT RETAIN KEYS

In this situation, a VG unit will accept a key. However, it will forget that key before within 30 seconds of losing power. The main cause for this is probably the loss of the Schottky diode (D30). When it acts like a resistor, the RAM +5 will follow Vcc to ground quite rapidly.

Other causes could include the cover interlock microswitch if present, loss of C21, loss of D20, and the loss of D21.

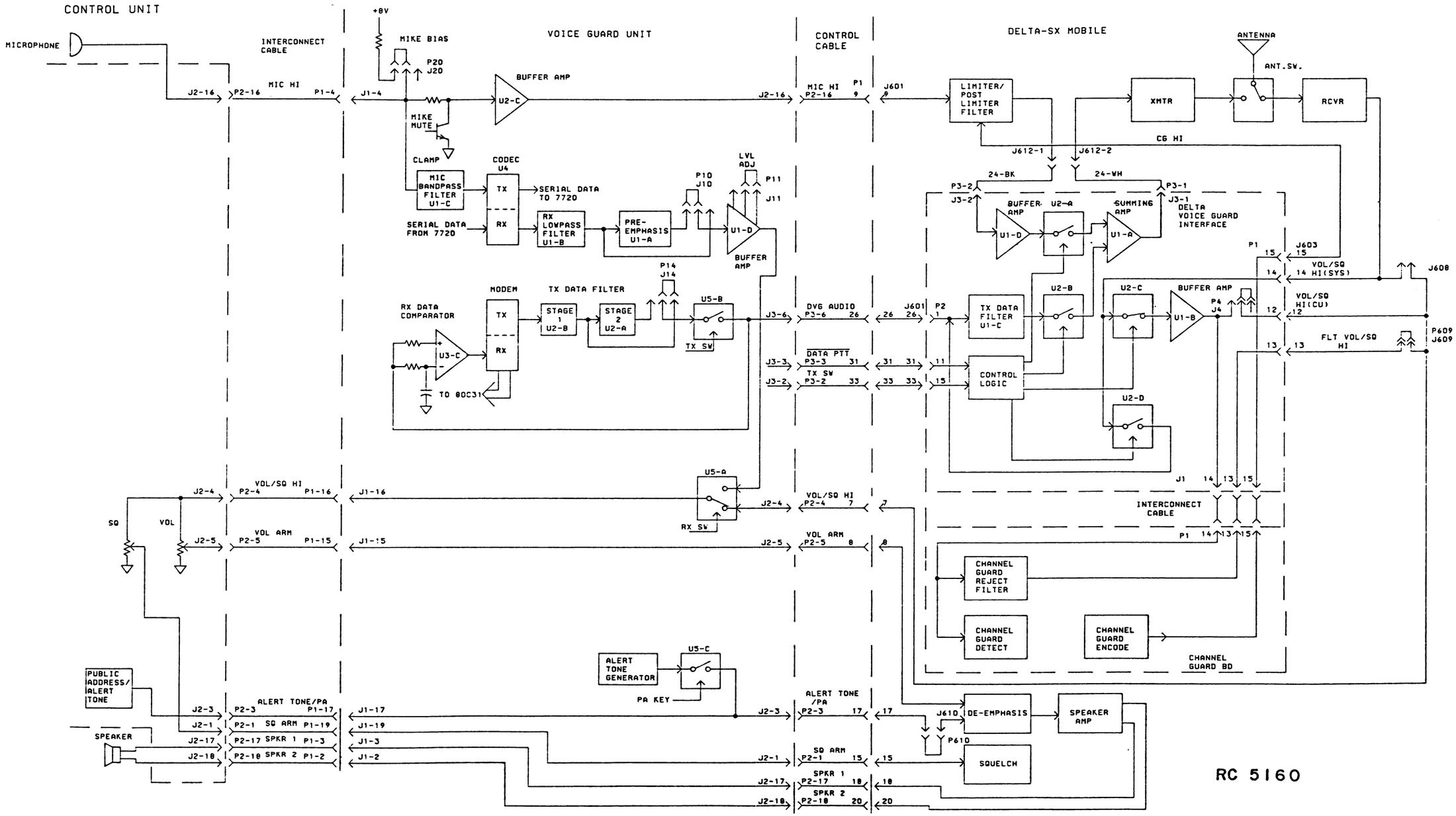
GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U S A



RC-5296A

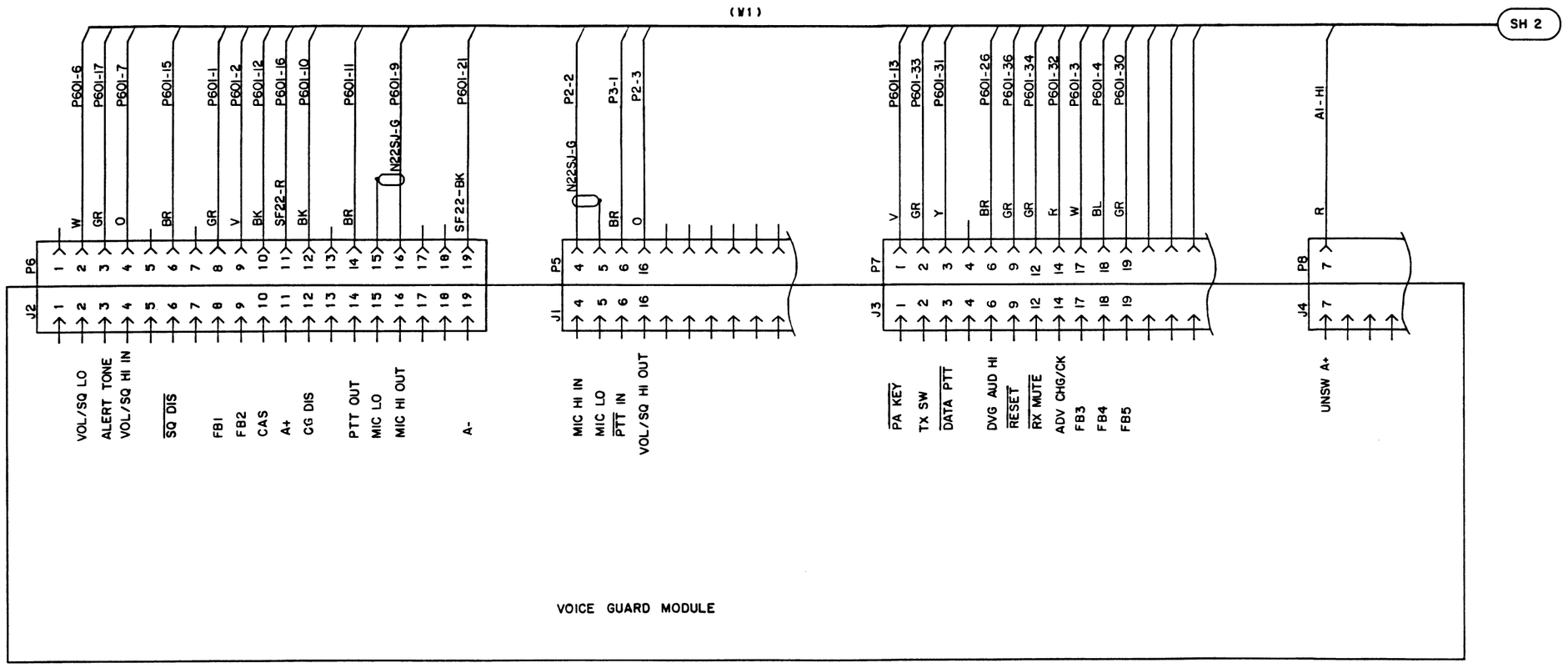
FUNTIONAL BLOCK DIAGRAM

VG-9600



INTERCONNECTION DIAGRAM

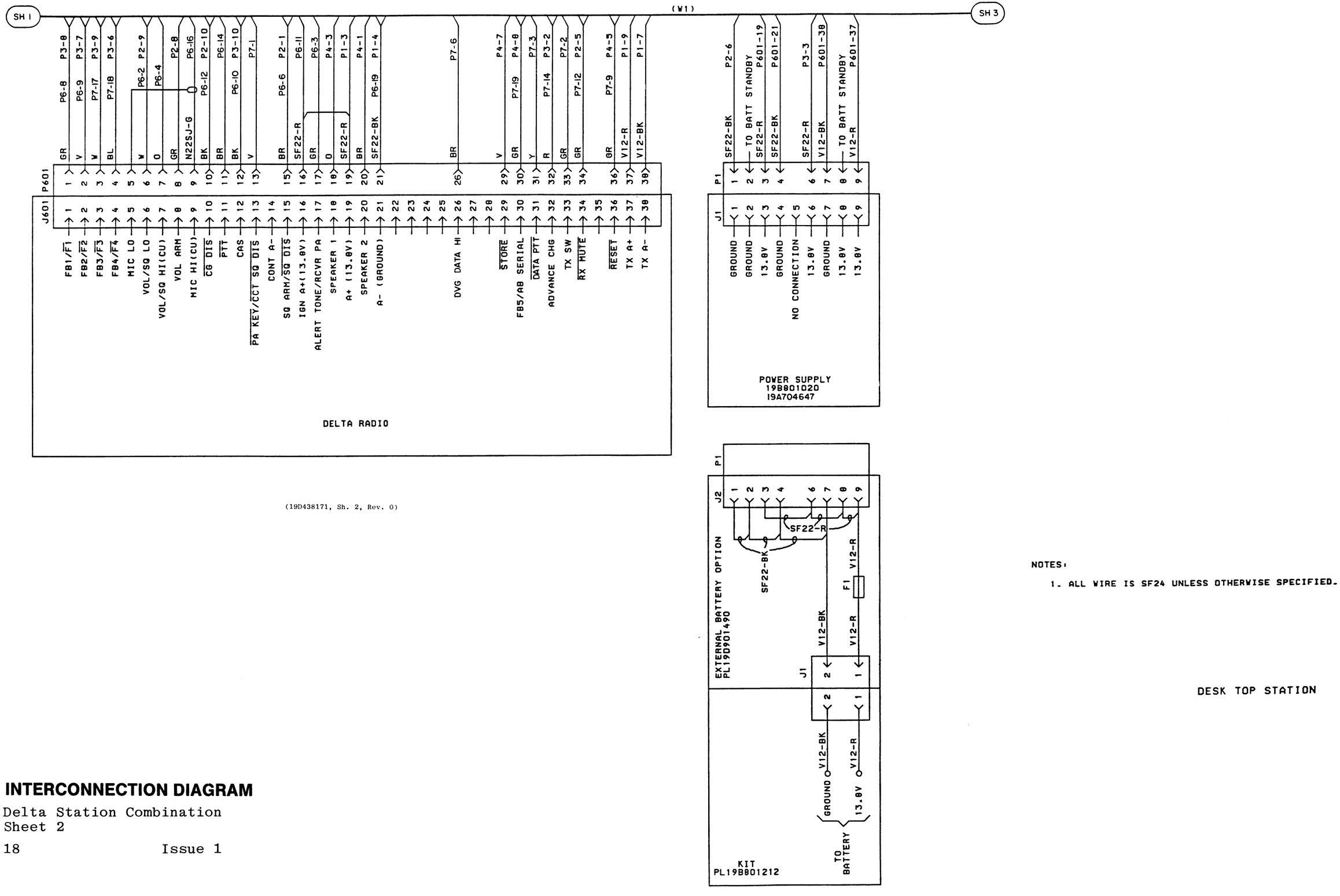
Mobile Combination



(19D438171, Sh. 1, Rev. 0)

INTERCONNECTION DIAGRAM

Delta Station Combination
Sheet 1



(19D438171, Sh. 2, Rev. 0)

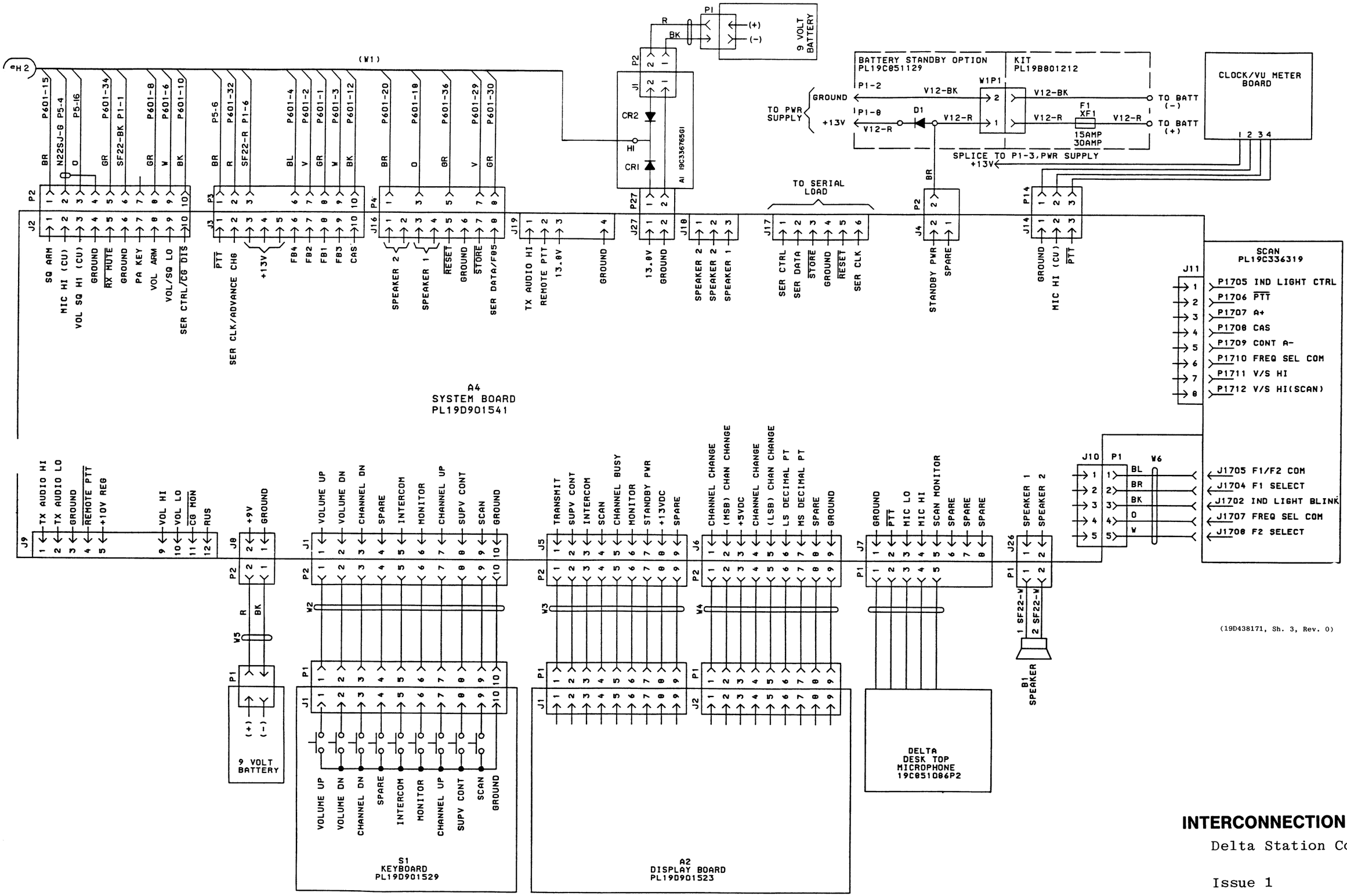
NOTES:

1. ALL WIRE IS SF24 UNLESS OTHERWISE SPECIFIED.

DESK TOP STATION

INTERCONNECTION DIAGRAM

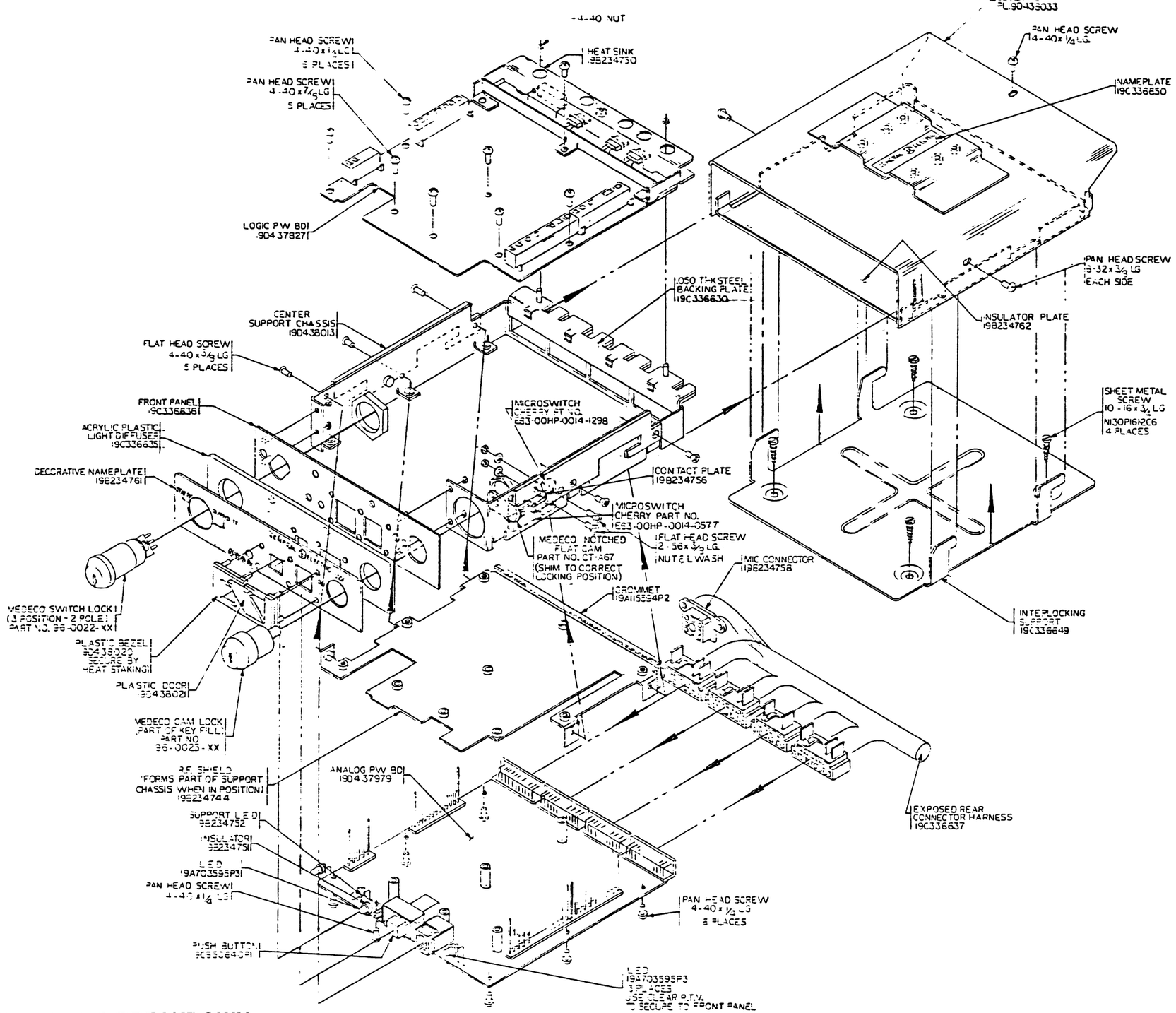
Delta Station Combination
Sheet 2



(19D438171, Sh. 3, Rev. 0)

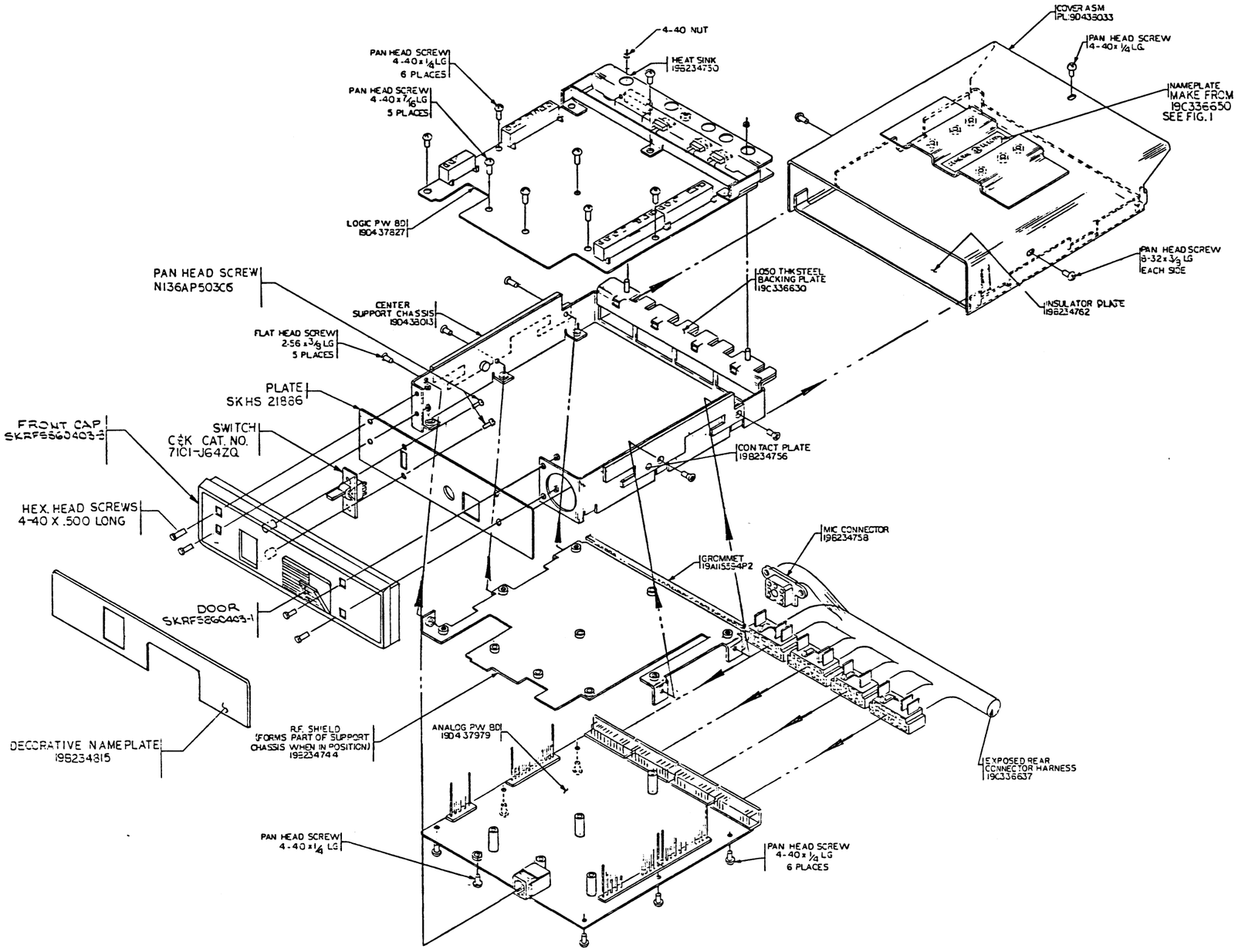
INTERCONNECTION DIAGRAM

Delta Station Combination
Sheet 3



(19C336655, Sh. 1, Rev. 0)

MECHANICAL PARTS BREAKDOWN



(19D438166, Rev. 0)

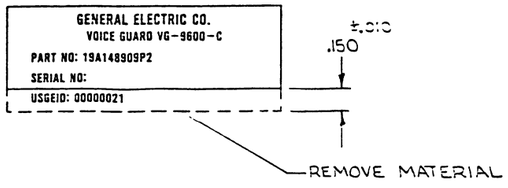
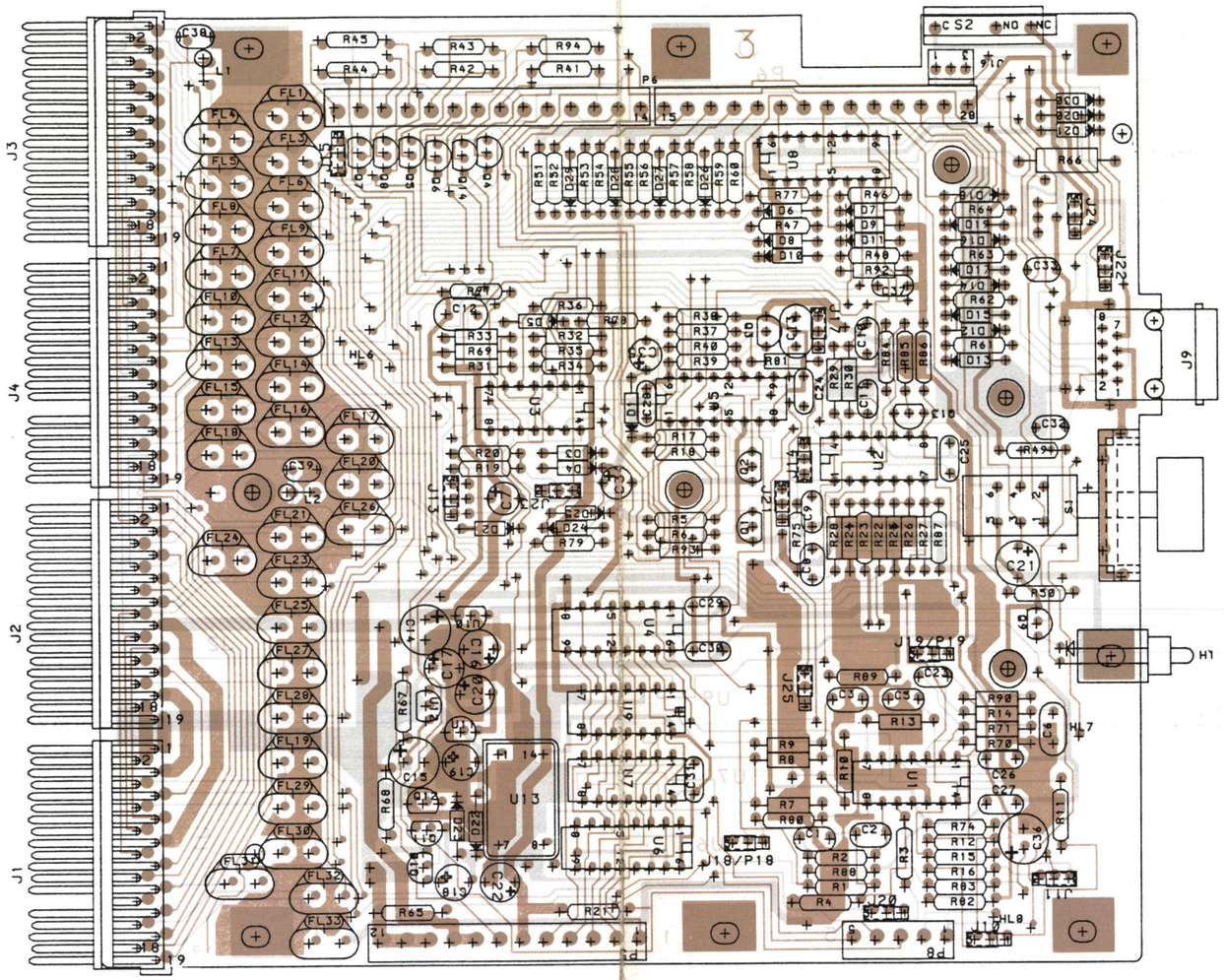
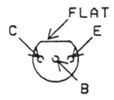


FIG. 1.



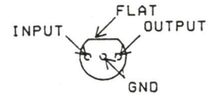
LEAD IDENTIFICATION
FOR Q1 THRU Q14



IN-LINE
TOP VIEW

NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

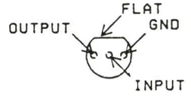
LEAD IDENTIFICATION
FOR U10 AND U12



IN-LINE
TOP VIEW

NOTE: CASE SHAPE IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

LEAD IDENTIFICATION
FOR U11



IN-LINE
TOP VIEW

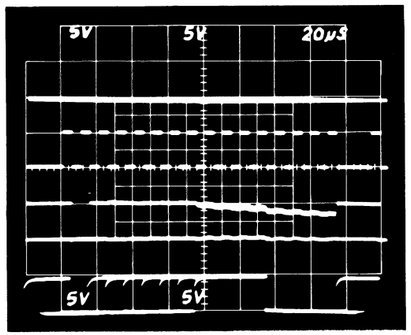
NOTE: LEAD ARRANGEMENT IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

(19D437977, Rev. 3)
(19A148845, Sh. 1, Rev. 3)
(19A148845, Sh. 2, Rev. 3)

OUTLINE DIAGRAM

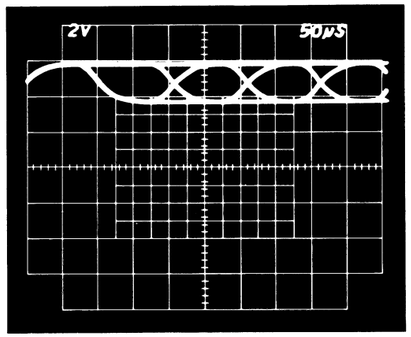
Analog Board
19D437979G1

CODEC - GUARDED TX (P5-2, P5-4, P5-3, & P5-5)



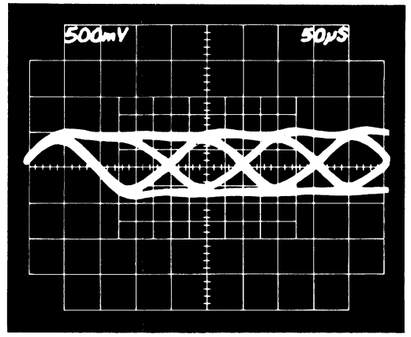
P5-2
P5-4
P5-5
P5-3

SECOND STAGE TX FILTER (U2-14)



0V

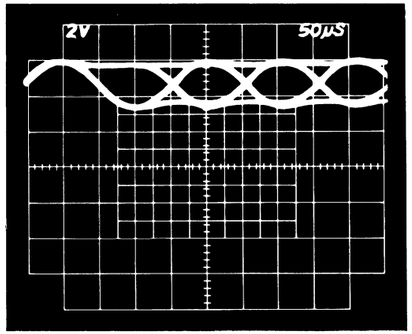
TYPICAL RCVD VG DATA (DVG AUDIO HI)



0
AC
CPLD

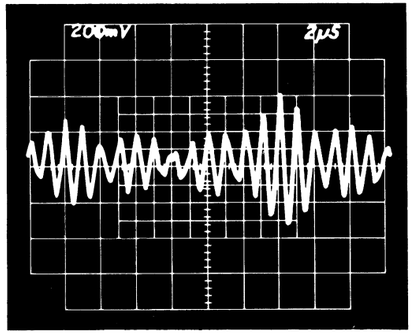
TRANSMITTING UNIT DATA MODULATION SET TO 3 KHz DEVIATION

FIRST STAGE TX FILTER (U2-2)



0V

RCVD GUARDED AUDIO (VOL/SQ HI OUT)



0V

TRANSMITTING UNIT HAD 1 KHz, 300 mV P-P INTO MIC HI

VOLTAGE READINGS (SHEET 3)
(DC,NOMINAL)

OPERATING CONDITION	MEASUREMENT POINT U2(B)-5	U5(A)-10	U5(B)-5	U5(B)-9
GUARDED RX	2.5V	0.5V	4.5V	8V
CLEAR RX	2.5V	8V	4.5V	8V
GUARDED TX	—	8V	—	0.5V
CLEAR TX	2.5V	8V	4.5V	8V

SIGNAL LEVELS (SHEET 3)
(P-P,NOMINAL)

WITH 300 uV P-P @ 1 KHZ SINUSOID SIGNAL INPUT AT J1-4 AND UNIT IN GUARDED TX MODE THE FOLLOWING SIGNAL LEVELS, NOMINAL, SHOULD BE PRESENT.

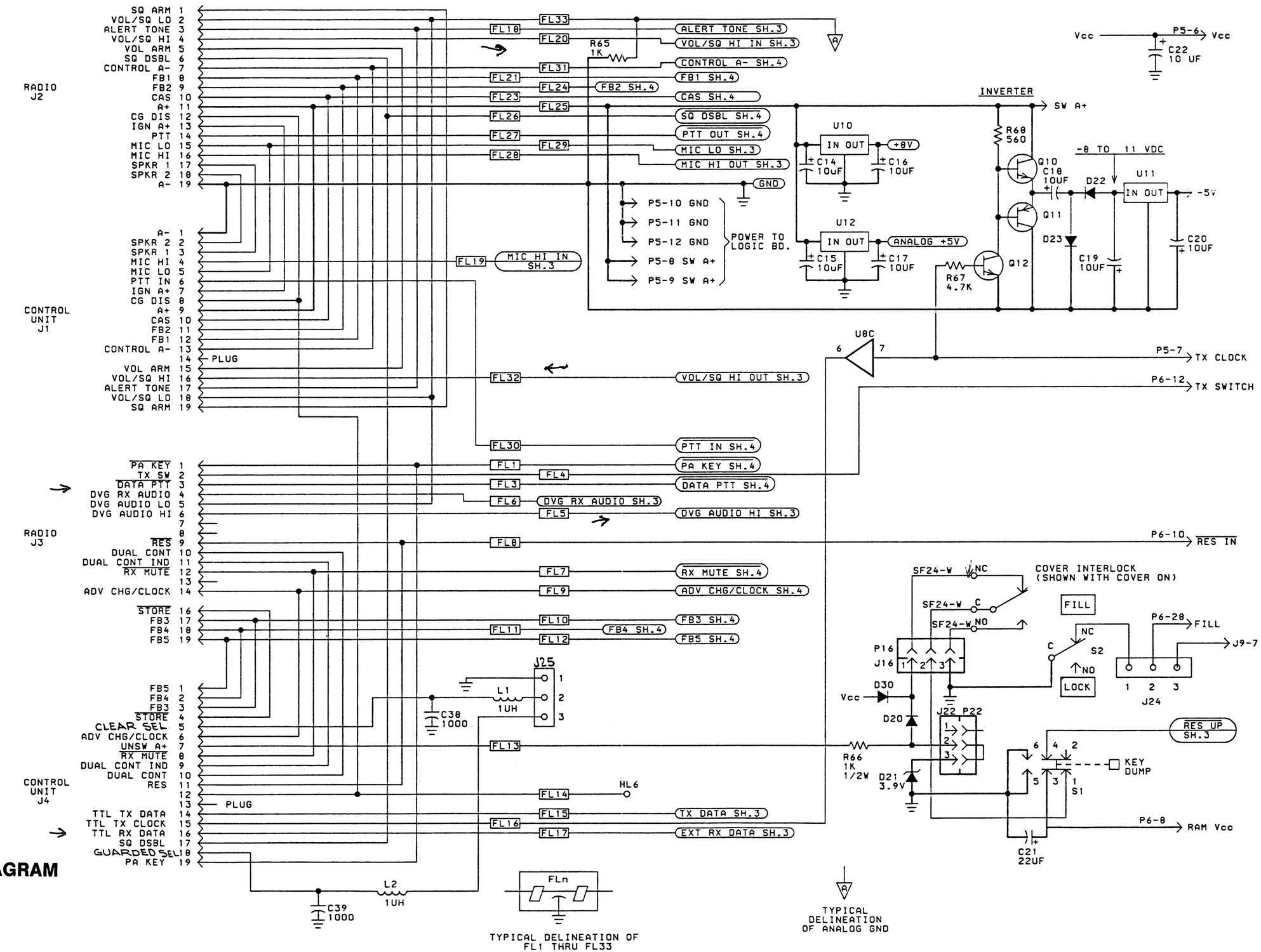
OPERATING CONDITION	MEASUREMENT POINT U1(A)-1	U1(B)-7	U1(C)-8	U1(O)-14	U4-15
—	—	—	300uV	—	—
P18 ON J18-2&3	100uV	200uV	—	450uV	700uV
P18 ON J18-1&2	—	—	—	—	2.2V
P11 ON J11-2&3	—	—	—	450uV	—

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

(19D437976, Sh. 1, Rev. 1)

SCHEMATIC DIAGRAM

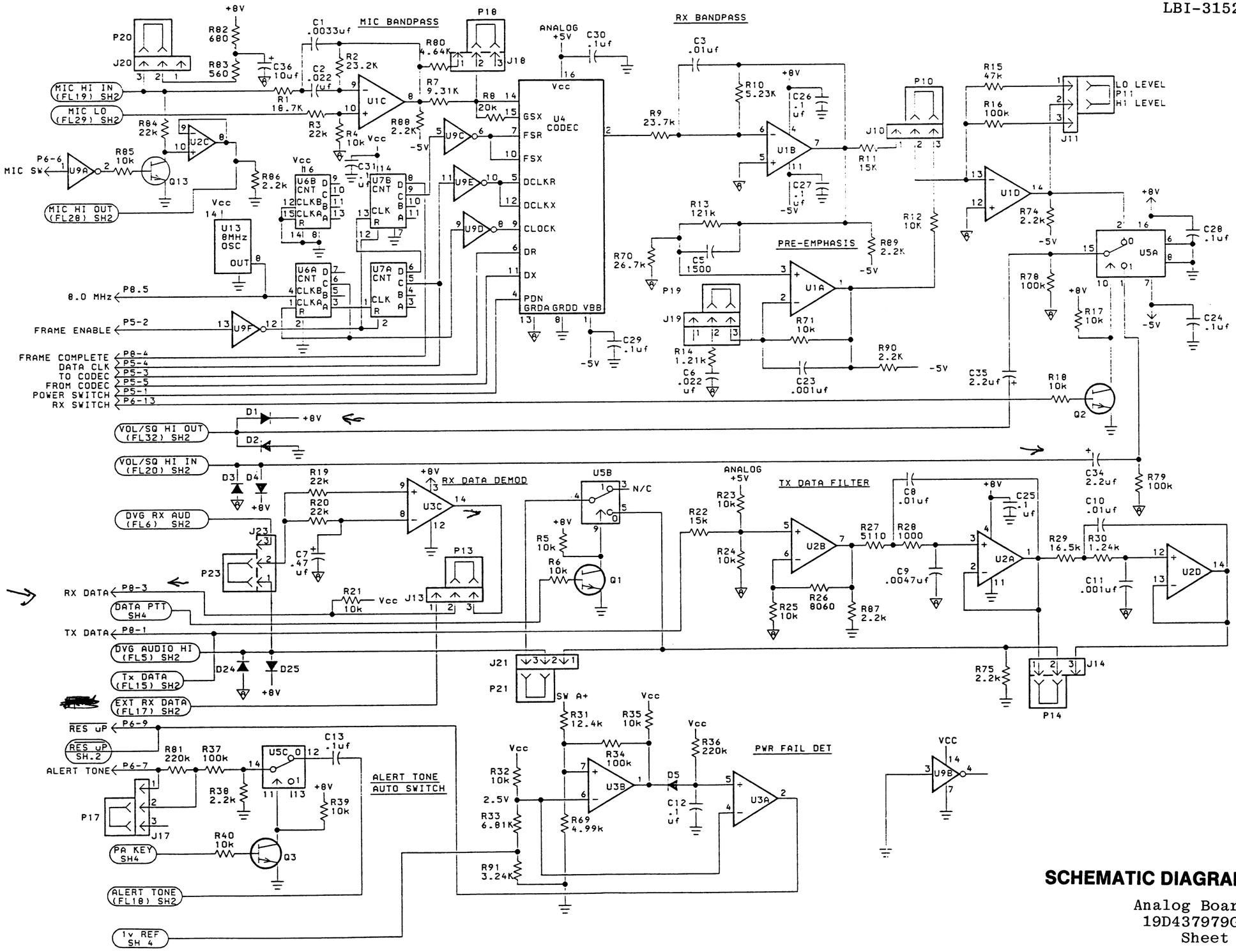
Analog Board
19D437979G1



SCHEMATIC DIAGRAM

Analog Board
19D437979G1
Sheet 2

(19D437976, Sh. 2, Rev. 1)

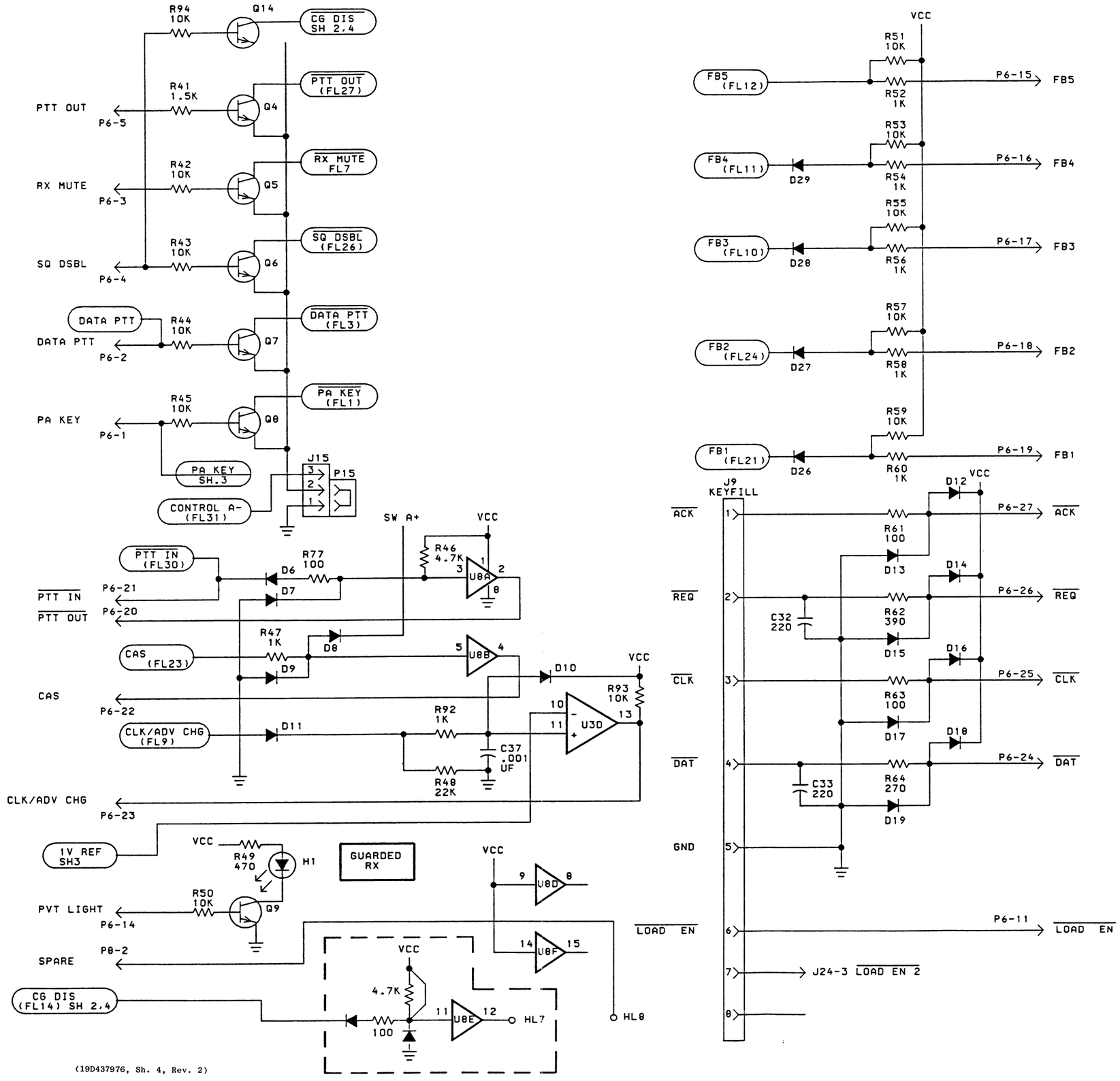


IN HERE

(19D437976, Sh. 3, Rev. 1)

SCHEMATIC DIAGRAM

Analog Board
19D437979G1
Sheet 3



SCHEMATIC DIAGRAM

Analog Board
19D437979G1

PARTS LIST

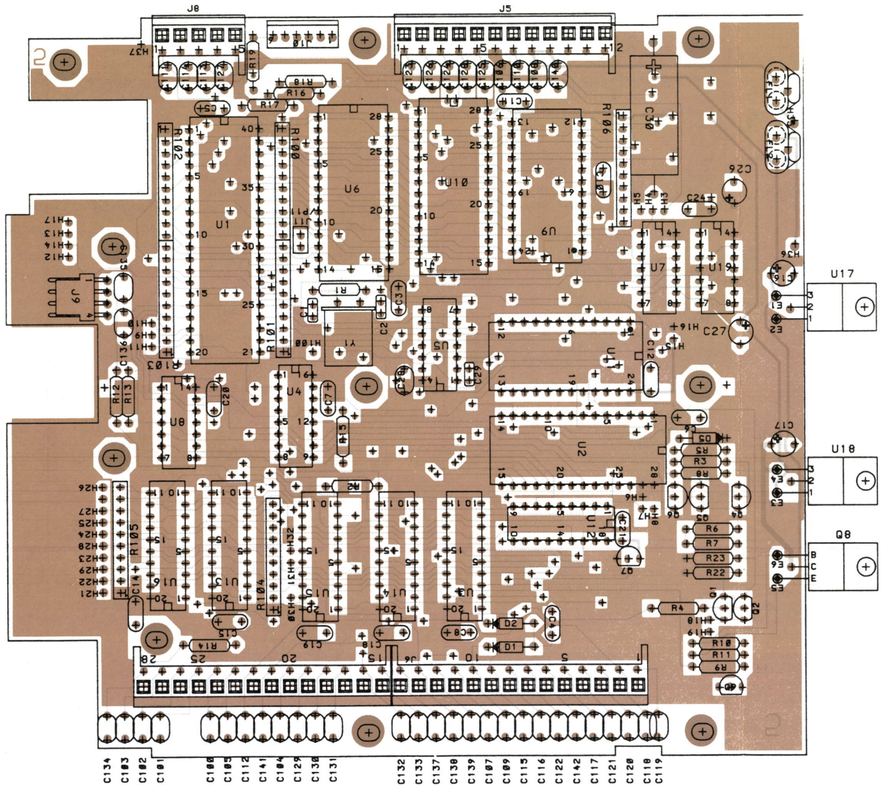
ANALOG BOARD
19D437979G1
(ASY/R300101)

ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
		NOTE: When ordering replacement parts, all vendor part numbers should be preceded by: ASY/
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	T644ACP233J	Polyester: .0033 uF ±5%, 50 VDCW, MFG: NISSEI.
C2	T644ACP322J	Polyester: .022 uF ±5%, 50 VDCW, MFG: NISSEI.
C3	T644ACP310J	Polyester: .010 uF ±5%, 50 VDCW, MFG: NISSEI.
C5	T644ACP215J	Polyester: .0015 uF ±5%, 50 VDCW, MFG: SPRAGUE.
C6	T644ACP322J	Polyester: .022 uF ±5%, 50 VDCW, MFG: NISSEI.
C7	315A6047P474U	Tantalum: 0.47 uF ±20%, 35 VDCW, MFG: SPRAGUE.
C8	T644ACP310J	Polyester: .010 uF ±5%, 50 VDCW, MFG: NISSEI.
C9	T644ACP247J	Polyester: .0047 uF ±5%, 50 VDCW, MFG: NISSEI.
C10	T644ACP310J	Polyester: .010 uF ±5%, 50 VDCW, MFG: NISSEI.
C11	T644ACP210J	Polyester: .0010 uF ±5%, 50 VDCW, MFG: NISSEI.
C12 and C13	19A702250P113	Polyester: 0.1 uF ±10%, 50 VDCW, MFG: NISEEI.
C14 and C15	19A701225P1	Electrolytic: 15 uF -10 +75%, 25 VDCW; MFG: Sprague.
C16 and C17	315A6047P106N	Tantalum: 10 uF ±20%, 16 VDCW, MFG: SPRAGUE.
C18	315A6047P106R	Tantalum: 10 uF ±20%, 25 VDCW, MFG: SPRAGUE.
C19 and C20	315A6047P106N	Tantalum: 10 uF ±20%, 16 VDCW, MFG: SPRAGUE.
C21	315A6047P226N	Tantalum: 22 uF ±20%, 16 VDCW.
C22	315A6047P106N	Tantalum: 10 uF ±20%, 16 VDCW, MFG: SPRAGUE.
C23	T644ACP210J	Polyester: .0010 uF ±5%, 50 VDCW, MFG: NISSEI.
C24 thru C31	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; MFG: CENTRALAB.
C32 and C33	19A700233P3	Ceramic: 220 pF ±10%, 50 VDCW, MFG: GE.
C34 and C35	315A6047P225U	Tantalum: 2.2 uF ±20%, 35 VDCW, MFG: SPRAGUE.
C36	315A6047P106N	Tantalum: 10 uF ±20%, 16 VDCW, MFG: SPRAGUE.
C37	T644ACP210J	Polyester: .0010 uF ±5%, 50 VDCW, MFG: NISSEI.
C38 and C39	19A700233P1	Ceramic: 100 pF ±20%, 50 VDCW.
		- - - - - - - - - - DIODES - - - - - - - - - -
D1 thru D11	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D12	19A700047P2	Silicon, 100 mW, continuous dissipation; MFG: HP.
D13	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D14	19A700047P2	Silicon, 100 mW, continuous dissipation; MFG: HP.
D15	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D16	19A700047P2	Silicon, 100 mW, continuous dissipation; MFG: HP.
D17	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D18	19A700047P2	Silicon, 100 mW, continuous dissipation; MFG: HP.
D19 and D20	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D21	19A700025P4	Silicon, zener: 400 mW max; MFG: GE.
D22 thru D29	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D30	19A700047P2	Silicon, 100 mW, continuous dissipation; MFG: HP.
		- - - - - - - - - - FILTERS - - - - - - - - - -
FL1		Filter, MFG: MURATA ERIE, DSS310-55Y271W.
FL3 thru FL21		Filter, MFG: MURATA ERIE, DSS310-55Y271W.
FL23 thru FL33		Filter, MFG: MURATA ERIE, DSS310-55Y271W.
		- - - - - - - - - - LEDS - - - - - - - - - -
H1	19A703595P2	Optoelectronic: yellow; MFG: HP.
		- - - - - - - - - - JACKS & RECEPTACLES - - - - - -
J1 thru J4	19B234471G1	Connector, MFG: MOLEX.
J9	19J706197P3	Connector: 8 contacts; sim to AMP Type 520251-4.
J10 and J11	19A700072P2	Printed wire: 3 contacts rated @ 2.5 amps; MFG: Molex.
J13 thru J15	19A700072P2	Printed wire: 3 contacts rated @ 2.5 amps; MFG: Molex.
J16 thru J25	19A700072P29	Printed wire: 3 contacts rated at 2.5 amps; MFG: Molex.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1 and L2	19A700024P15	Coil.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P5		Connector, MFG: MOLEX, 2461-12AK.
P6		Connector, MFG: MOLEX, AX-40187-A-YA14AAP102.
P8		Connector, MFG: MOLEX, 2461-05AK.
P10 and P11	19A702104P1	Receptacle: 2 position, shorting, rated at 3 amps; MFG: AMP.
P13 thru P15	19A702104P1	Receptacle: 2 position, shorting, rated at 3 amps; MFG: AMP.
P17 thru P24	19A702104P1	Receptacle: 2 position, shorting, rated at 3 amps; MFG: AMP.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 thru Q10	19A700023P1	Silicon, NPN; MFG: JEDEC.
Q11	19A700022P1	Silicon, PNP; MFG: JEDEC.
Q12 thru Q14	19A700023P1	Silicon, NPN; MFG: JEDEC.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	19A701250P327	Metal film: 18.7K ohms ±1%, 250 VDCW, 1/4 w.
R2	19A701250P336	Metal film: 23.2K ohms ±1%, 1/4 w.
R3	H212CRP322C	Deposited carbon: 22K ohms ±5%, 1/4 w.
R4 thru R6	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R7	19A701250P294	Metal film: 9.31K ohms ±1%, 1/4 w.
R8	19A701250P330	Metal film: 20K ohms ±1%, 1/4 w.
R9	19A701250P337	Metal film: 23.7K ohms ±1%, 1/4 w.
R10	19A701250P27J	Metal film: 5.23K ohms ±1%, 1/4 w.
R11	H212CRP315C	Deposited carbon: 15K ohms ±5%, 1/4 w.
R12	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R13	19A701250P409	Metal film: 121K ohms ±1%, 1/4 w.
R14	19A701250P209	Metal film: 1.21K ohms ±1%, 1/4 w.
R15	H212CRP347C	Deposited carbon: 47K ohms ±5%, 1/4 w.
R16	H212CRP410C	Deposited carbon: 0.1M ohms ±5%, 1/4 w.
R17 and R18	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R19 and R20	H212CRP322C	Deposited carbon: 22K ohms ±5%, 1/4 w.
R21	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R22	19A701250P318	Metal film: 15K ohms ±1%, 1/4 w.
R23 thru R25	19A701250P301	Metal film: 10K ohms ±1%, 1/4 w.
R26	19A701250P288	Metal film: 8060 ohms ±1%, 250 VDCW, 1/4 w.
R27	19A701250P269	Metal film: 5.11K ohms ±1%, 1/4 w.
R28	19A701250P201	Metal film: 1K ohms ±1%, 250 VDCW, 1/4 w.
R29	19A701250P322	Metal film: 16.5K ohms ±1%, 250 VDCW, 1/4 w.
R30	19A701250P213	Metal film: 1240 ohms ±1%, 250 VDCW, 1/4 w.
R31	19A701250P310	Metal film: 12.4K ohms ±1%, 1/4 w.
R32	19A701250P301	Metal film: 10K ohms ±1%, 1/4 w.
R33	19A701250P281	Metal film: 6.81K ohms ±1%, 1/4 w.
R34	H212CRP410C	Deposited carbon: 0.1M ohms ±5%, 1/4 w.
R35	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R36	H212CRP422C	Deposited carbon: 0.22M ohms ±5%, 1/4 w.
R37	H212CRP410C	Deposited carbon: 0.1M ohms ±5%, 1/4 w.
R38	H212CRP222C	Deposited carbon: 2.2K ohms ±5%, 1/4 w.
R39 and R40	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R41	H212CRP215C	Deposited carbon: 1.5K ohms ±5%, 1/4 w.
R42 thru R45	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R46	H212CRP247C	Deposited carbon: 4.7K ohms ±5%, 1/4 w.
R47	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R48	H212CRP322C	Deposited carbon: 22K ohms ±5%, 1/4 w.
R49	H212CRP147C	Deposited carbon: 470 ohms ±5%, 1/4 w.
R50 and R51	H212CRP310C	Deposted carbon: 10K ohms ±5%, 1/4 w.
R52	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R53	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R54	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R55	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R56	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R57	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R58	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R59	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R60	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R61	H212CRP110C	Deposited carbon: 100 ohms ±5%, 1/4 w.
R62	H212CRP139C	Deposited carbon: 390 ohms ±5%, 1/4 w.
R63	H212CRP110C	Deposited carbon: 100 ohms ±5%, 1/4 w.
R64	H212CRP127C	Deposited carbon: 270 ohms ±5%, 1/4 w.
R65	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R66	19A700113P63	Composition: 1K ohms ±5%, 1/2 w.
R67	H212CRP247C	Deposited carbon: 4.7K ohms ±5%, 1/4 w.
R68	H212CRP156C	Deposited carbon: 560 ohms ±5%, 1/4 w.
R69	19A701250P268	Metal film: 4.99K ohms ±1%, 1/4 w.
R70	19A701250P341	Metal film: 26.1K ohms ±1%, 1/4 w.
R71	19A701250P301	Metal film: 10K ohms ±1%, 1/4 w.
R72	19A700113P57	Composition: 560 ohms ±5%, 1/2 w.
R73	19A700113P55	Composition: 470 ohms ±5%, 1/2 w.
R74 and R75	H212CRP222C	Deposited carbon: 2.2K ohms ±5%, 1/4 w.
R77	H212CRP110C	Deposited carbon: 100 ohms ±5%, 1/4 w.
R78 and R79	H212CRP410C	Deposited carbon: 0.1M ohms ±5%, 1/4 w.
R80	19A701250P265	Metal film: 4.6K ohms ±1%, 1/4 w.
R81	H212CRP422C	Deposited carbon: 0.22M ohms ±5%, 1/4 w.
R82	H212CRP168C	Deposited carbon: 680 ohms ±5%, 1/4 w.
R83	H212CRP156C	Deposited carbon: 560 ohms ±5%, 1/4 w.
R84	H212CRP322C	Deposited carbon: 22K ohms ±5%, 1/4 w.
R85	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R86 thru R90	H212CRP222C	Deposited carbon: 2.2K ohms ±5%, 1/4 w.
R91	19A701250P250	Metal film: 3240 ohms ±1%, 1/4 w.
R92	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R93 and R94	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S1 and S2	19B800563P3	Push: DPDT, contacts rated 15 mA at 130 VDC; MFG: SCHADOW.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - -
U1 and U2	19A701789P3	Operational Amplifier: QUAD-OP-AMP; MFG: MOTO.
U3	19J706018P2	Linear, QUAD COMPARATOR; MFG: MOTO.
U4	19A703924P1	Encoder-Decoder. MFG: INTEL.
U5	19A700029P38	Digital: TRIPLE 2-CHANNEL MULTIPLEXER.
U6	19A703987P13	Digital, MFG: MOTO.
U7	19A702987P14	Digital, MFG: MOTO.
U8	19A700029P35	Digital: HEX BUFFER/CONVERTER (NON-INVERTING). MFG: MOTO.
U9	19A703483P4	Digital, hex inverter, MFG: PANASONIC.
U10	19J706031P2	Linear, MFG: MOTO.
U11	19A704013P1	Voltage Regulator. (NEGATIVE). MFG: MOTO.
U12	19J706031P1	Linear: POSITIVE VOLTAGE REGULATOR, MFG: MOTO.
U13		Oscillator, 8.0 MHz, MFG: CTS, MXO-559A-2I.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19C336648P1	Shield.
	19C336647P1	Shield.
		Standoff; MFG: R.A.F. Electronic Hardware, Inc., 3045-B-440-S-1-MOD. L = .600.
	19C850640P1	Knob for S1.
	19A701699P22	Nameplate for S1.

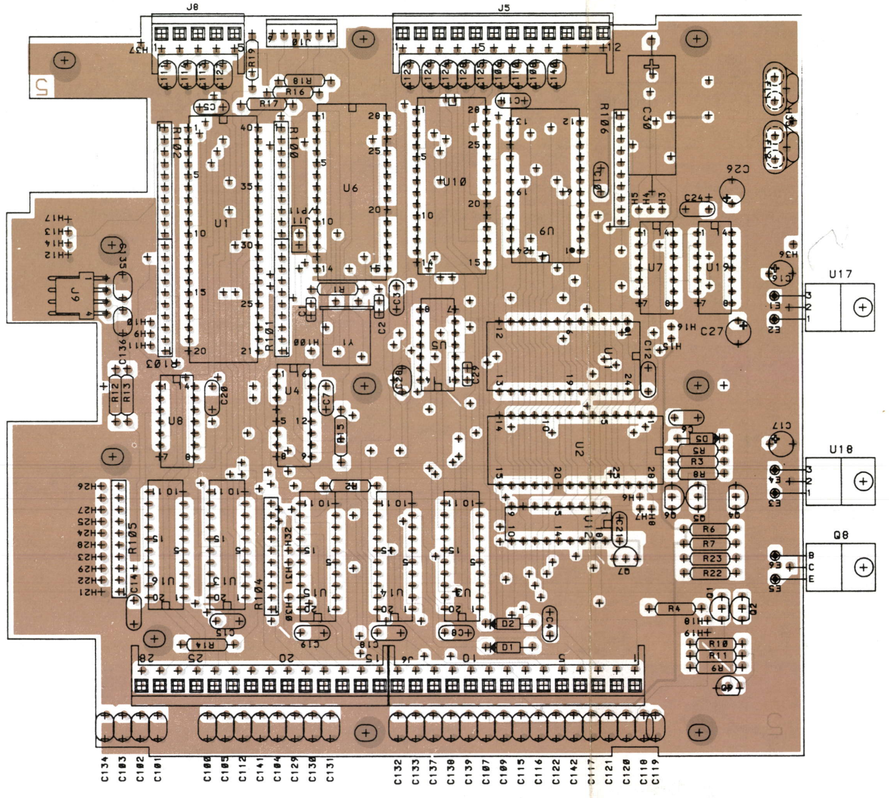
*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

COMPONENT SIDE



(19D437828, Rev. 0)
(19A148718, Sh. 1, Rev. 5)
FIRST LAYER - COMPONENT SIDE
(19A148718, Sh. 2, Rev. 5)
SECOND LAYER - GROUND LAYER

COMPONENT SIDE

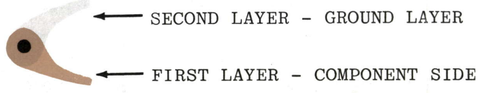


(19D437828, Rev. 0)
(19A148718, Sh. 3, Rev. 5)
THIRD LAYER - POWER LAYER
(19A148718, Sh. 4, Rev. 5)
FOURTH LAYER - SOLDER SIDE

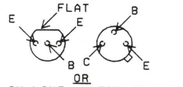
OUTLINE DIAGRAM

Logic Board
19D437827G1

28 Issue 1

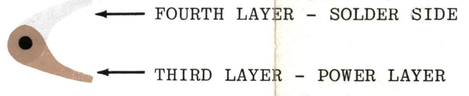


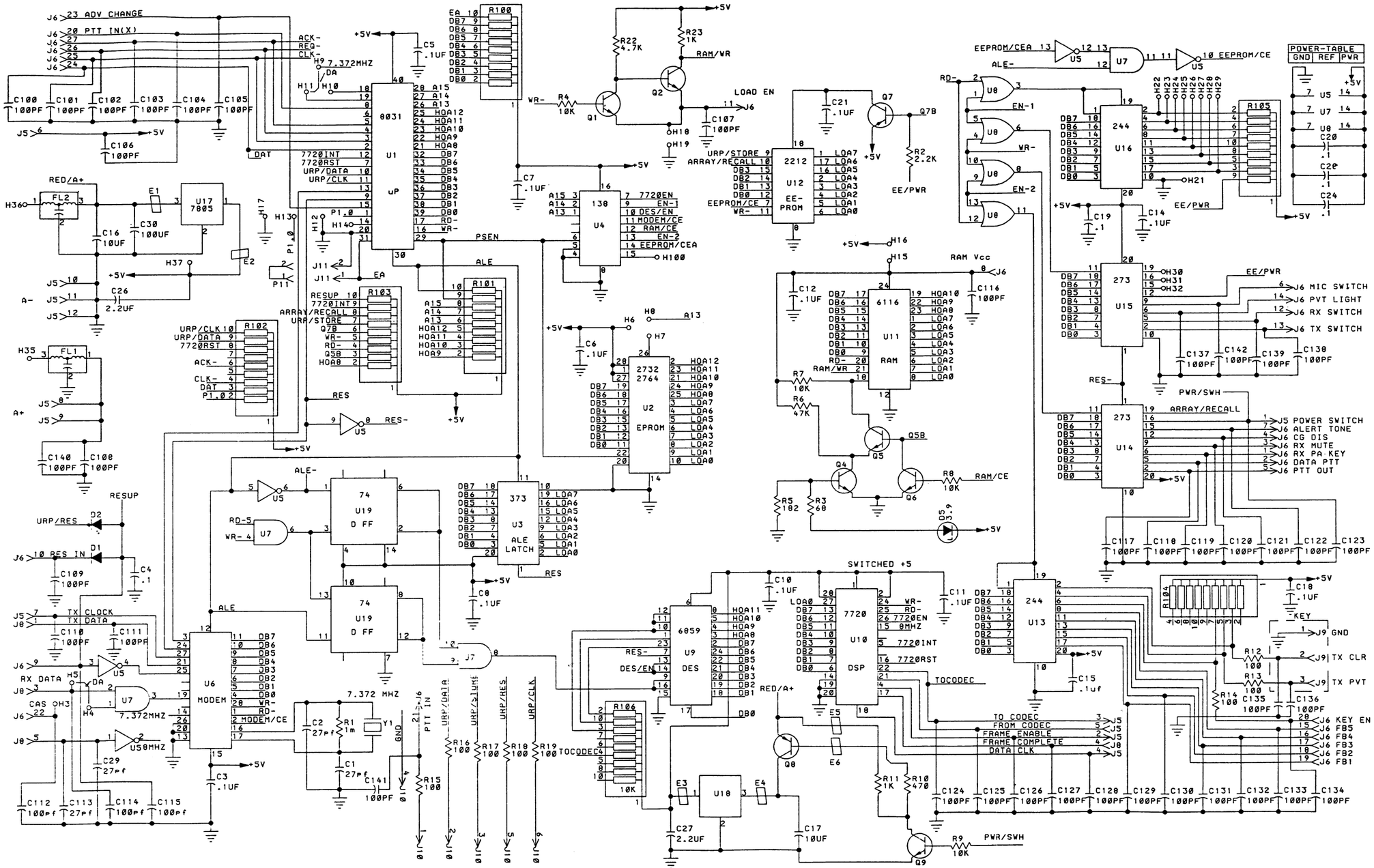
LEAD IDENTIFICATION
FOR Q1,Q2,Q4-Q7,& Q9



IN-LINE TRIANGULAR
TOP VIEW

NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.





SCHEMATIC DIAGRAM

Logic Board
19D437827G1

(19D437980, Rev. 0)

PARTS LIST

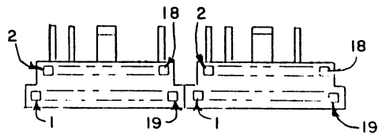
LOGIC BOARD
19D437827G1

ISSUE 2

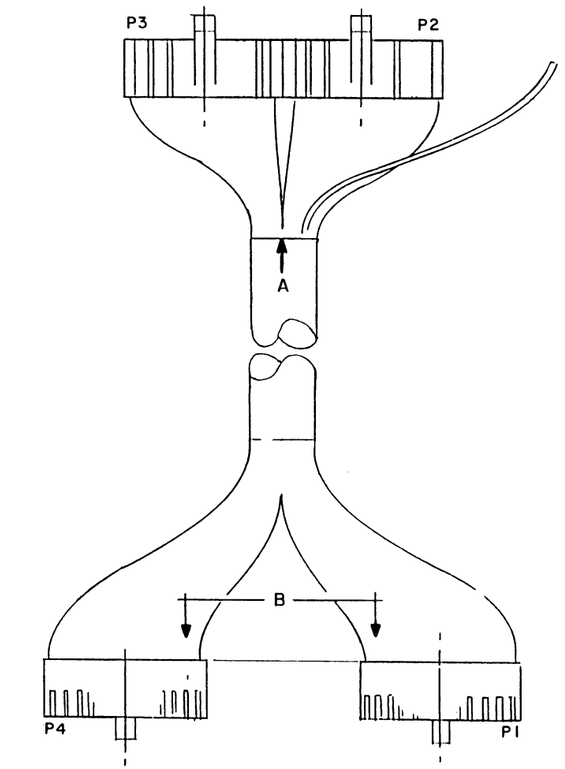
SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1 and C2	19A700219P44	Ceramic: 27 pF ±5%, 100 VDCW.
C3 thru C8	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; MFG: ERIE.
C10 thru C15	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; MFG: ERIE.
C16 and C17	19A703314P1	Electrolytic: 100 uF -10+50%, 10 VDCW; MFG: SPRAGUE.
C18 thru C21	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; MFG: ERIE.
C24 and C25	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; MFG: ERIE.
C26 and C27	315A6047P225U	Tantalum: 2.2 uF ±20%, 35 VDCW; MFG: SPRAGUE.
C28	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; MFG: ERIE.
C30	19A700064P4	Electrolytic: 100 uF, -10+150%, 250 VDCW.
C100 thru C142	19A700233P1	Ceramic: 100 pF ±20%, 50 VDCW.
		- - - - - - - - - - DIODES - - - - - - - - - -
D1 and D2	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; MFG: JEDEC.
D5	19A700025P3	Silicon, zener: 400 mW max; MFG: MEDEC.
D6 thru D9		Diode, LED, Green. MFG: HP.
		- - - - - - - - - - JACKS - - - - - - - - - -
J5		Connector. Sim to: MOLEX 26-11-6125.
J6		Connector. Sim to: MOLEX 26-11-6145.
J8		Connector. Sim to: MOLEX 26-11-6055.
J9		Connector. Sim to: MOLEX 22-05-3041.
J10	19A700072P32	Printed wire: 6 contacts rated at 2.5 amps; MFG: MOLEX.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P11 thru P15	19A702104P1	Receptacle: 2 position, shorting, rated at 3 amps; MFG: AMP.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	19A701537P1	Composition: 10M ohms ±5%, 250 VDCW, 1/4 w.
R2	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R3	H212CRP410C	Deposited carbon: 0.1M ohms ±5%, 1/4 w.
R4	H212CRP310C	Deposited carbon: 10K ohms ±5%, 1/4 w.
R5	H212CRP339C	Deposited carbon: 39K ohms ±5%, 1/4 w.
R6	H212CRP347C	Deposited carbon: 47K ohms ±5%, 1/4 w.
R7 thru R9	H212CRP310C	Deposited carbon: 10K ±5%, 1/4 w.
R11	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R12 thru R19	H212CRP110C	Deposited carbon: 100 ohms ±5%, 1/4 w.
R20	5493035P1	Wirewound: 5 ohms ±5%, 5 watt; MFG: HAMILTON HALL.
R22	H212CRP247C	Deposited carbon: 4.7K ohms ±5%, 1/4 w.
R23	H212CRP210C	Deposited carbon: 1K ohms ±5%, 1/4 w.
R24 thru R27	H212CRP127C	Deposited carbon: 270 ohms ±5%, 1/4 w.
R100 thru R106	19A701630P2	Resistor, network: 9 resistors rated 10K ohms ±2%, 50 VDCW; MFG: BOURNS.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 and Q2	19A700084P1	Silicon, NPN; MFG: MOTO.
Q4	19A700023P1	Silicon, NPN; MFG: JEDEC.
Q5 and Q6	19A700084P1	Silicon, NPN; MFG: MOTO.
Q7	19A700022P1	Silicon, PNP; MFG: JEDEC.
Q8	19A116942P1	Silicon, PNP, MFG: GE.
Q9	19A700023P1	Silicon, NPN; MFG: JEDEC.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - -
U1	19A704345P1	IC, Microcomp, MFG: INTEL.
U2	19A704422P1	IC, Digital, MFG: INTEL.
U3	19A703471P2	IC, Digital, MFG: MOTO.
U4	19A704445P1	IC, Digital, MFG: MOTO.
U5	19A103483P4	IC, Digital, MFG: PANASONIC.
U6	19B801136G2	IC, Modem, MFG: GE.
U7	19A703483P5	IC, Digital, MFG: RCA.
U8	19A703483P11	IC, Digital, MFG: MOTO.
U9	19A704421P1	IC, Enco, MFG: MOTO.
U10	19A703984P40	IC, Microprocessor, MFG: GE.
U11	19A702934P1	READ/WRITE MEMORY, MFG: RCA.
U12	19A703072P1	Digital. (STATIC RAM); MFG: XICOR.
U13	19A703471P1	Digital: OCTAL TRI-STATE BUFFER, MFG: MOTO.
U14 and U15	19A704380P11	IC, Digital, MFG: MOTO.
U16	19A703471P1	Digital: OCTAL TRI-STATE BUFFER, MFG; MOTO.
U17 and U18	299A6459P8685	Linear: POSITIVE VOLTAGE REGULATOR; MFG: MOTO.
U19	19A704380P2	IC, Digital, MFG: MOTO.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XU1		Sim to: C.A. CA-40SDL-1T
XU2		Sim to: C.A. CA-28SDL-1T
XU6		Sim to: C.A. CA-28SDL-1T
XU9		Sim to: C.A. CA-24SDL-1T
XU10		Sim to: C.A. CA-28SDL-1T
XU11		Sim to: C.A. CA-24SDL-1T
XU12		Sim to: C.A. CA-18SDL-1T
		- - - - - - - - - - CRYSTALS - - - - - - - - - -
Y1	19A702511	7.372800.54 MHz, MFG: NDK.

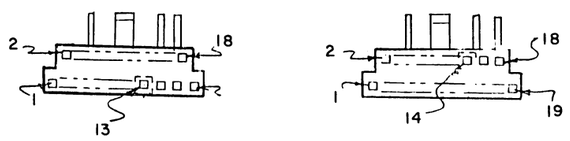
*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

OUTLINE DIAGRAM



VIEW AT A



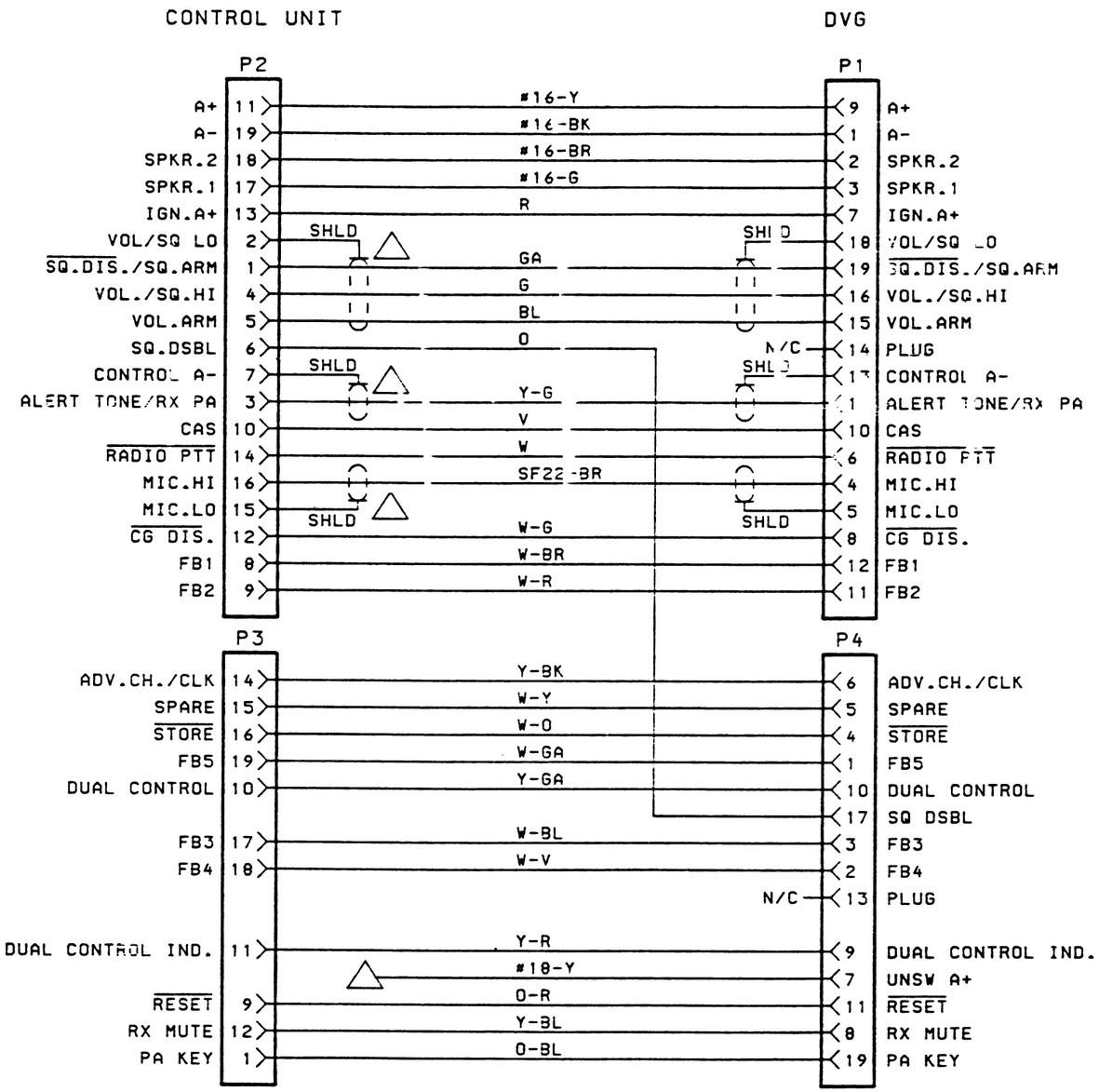


VIEW AT B

RC-5157A

(19C336637, Rev. 1)

SCHEMATIC DIAGRAM



(19C336658, Rev. 0)

SERVICE SHEET

Mobile Interconnect Cable
19C336637G1-G3

Issue 1

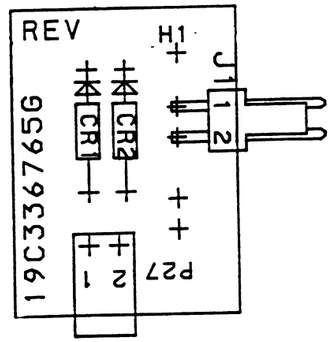
PARTS LIST

VOICE GUARD
INTERCONNECT CABLE
19C336637G1 1 FT
19C336637G2 9 FT
19C336637G3 18 FT
ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - - PLUGS - - - - - - - - - - -
P1	19C320257P1	Shell. Uses following contacts:
P1-1 thru P1-3	19A116781P3	Contact, electrical: wire range No. 16-20 AWG; sim to Molex 08-50-0105.
P1-4 and P1-5	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P1-7 and P1-8	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P1-9	19A116781P3	Contact, electrical: wire range No. 16-20 AWG; sim to Molex 08-50-0105.
P1-10 thru P1-13	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P1-15 thru P1-19	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P2	19C320257P1	Shell. Uses following contacts:
P2-1 thru P2-10	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P2-11	19A116781P3	Contact, electrical: wire range No. 16-20 AWG; sim to Molex 08-50-0105.
P2-12 thru P2-16	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P2-17 thru P2-19	19A116781P3	Contact, electrical: wire range No. 16-20 AWG; sim to Molex 08-50-0105.
P3	19C320257P1	Shell. Uses following contacts:
P3-1	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P3-9 thru P3-12	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P3-14 thru P3-19	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P4	19C320257P1	Shell. Uses following contacts:
P4-1 thru P4-6	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P4-7	19A116781P3	Contact, electrical: wire range No. 16-20 AWG; sim to Molex 08-50-0105.
P4-8 thru P4-11	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P4-17	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P4-19	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	7139880P16	Lacing for Cable.
	19A116889P4	Yellow Stranded Wire.

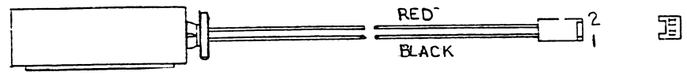
*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

VG Battery Backup Board



(19C336765, Rev. 0)

9-Volt Battery Assembly



(19B801331, Rev. 2)

PARTS LIST

9 VOLT BATTERY ASSEMBLY
19B801331G1

ISSUE 1

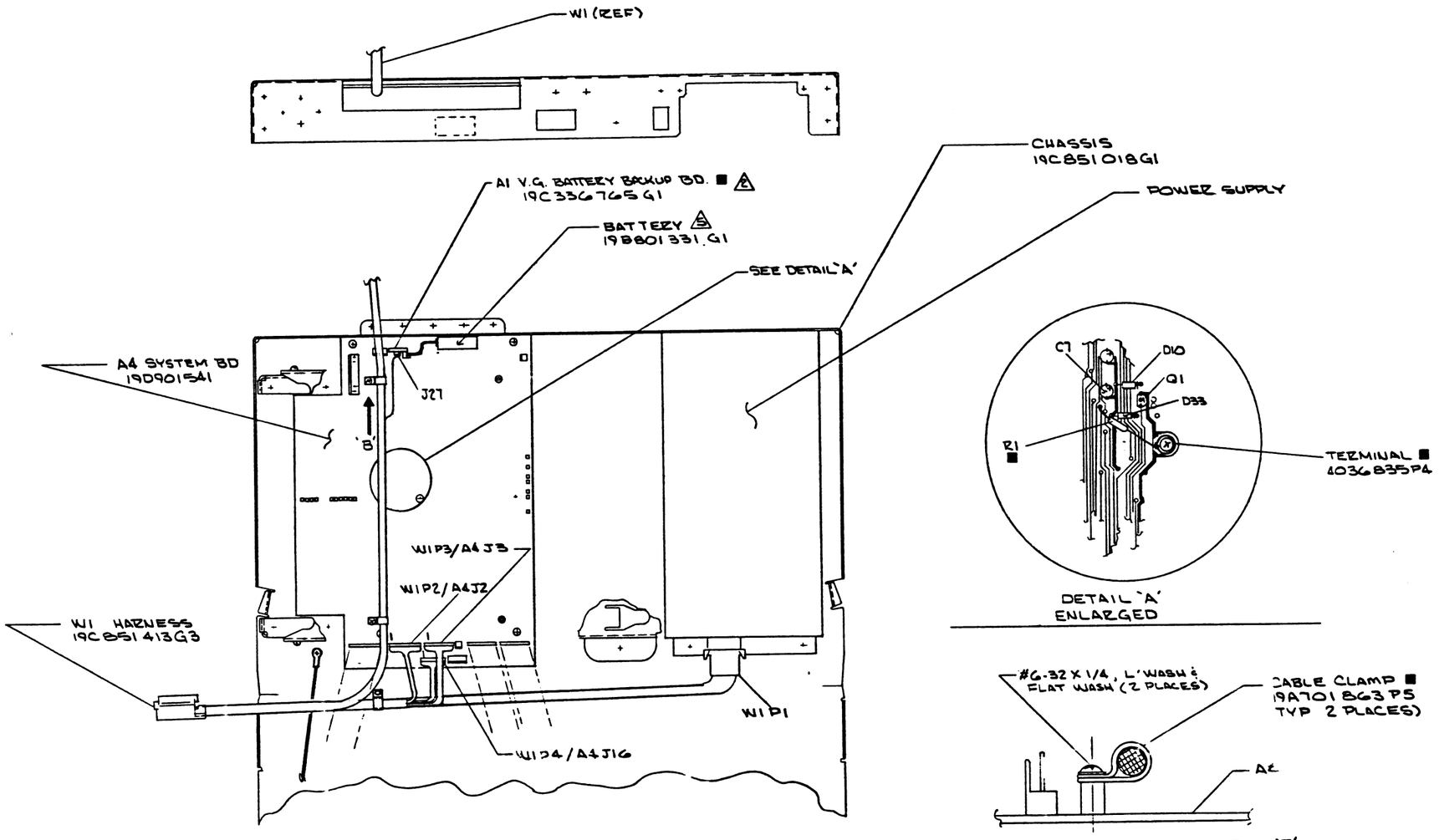
SYMBOL	GE PART NO.	DESCRIPTION
	19A704508P1	Battery.
	19A700041P28	Connector.
	19A700041P26	Contact: sim to Molex 08-50-0113.
	19A704489P1	Terminal. (Connects to Battery).
	19A701748P1	Pressure Sensitive Tape.

SERVICE SHEET

Battery Backup for
Key RAM Keep-Alive

(1) INSTALLATION INSTRUCTIONS ADDING V.G. IN DELTA DESKTOP STATION

1. ITEMS MARKED ■ ARE PART OF INSTL. KIT 19A705022.
2. PLUG BATTERY BACKUP BOARD ON J27 AS SHOWN AND SOLDER RED WIRE FROM W1 INTO H1 OF BATTERY BACKUP BOARD. PLUG BATTERY PLUG ON A1/J1 (BATTERY BACKUP BOARD)
3. INSTALL R1 AS SHOWN IN DETAIL "A"
4. SOLDER ALL ELECTRICAL CONNECTIONS.
5. BATTERY NOT USED IN VGE UNITS.



DETAIL 'A' ENLARGED

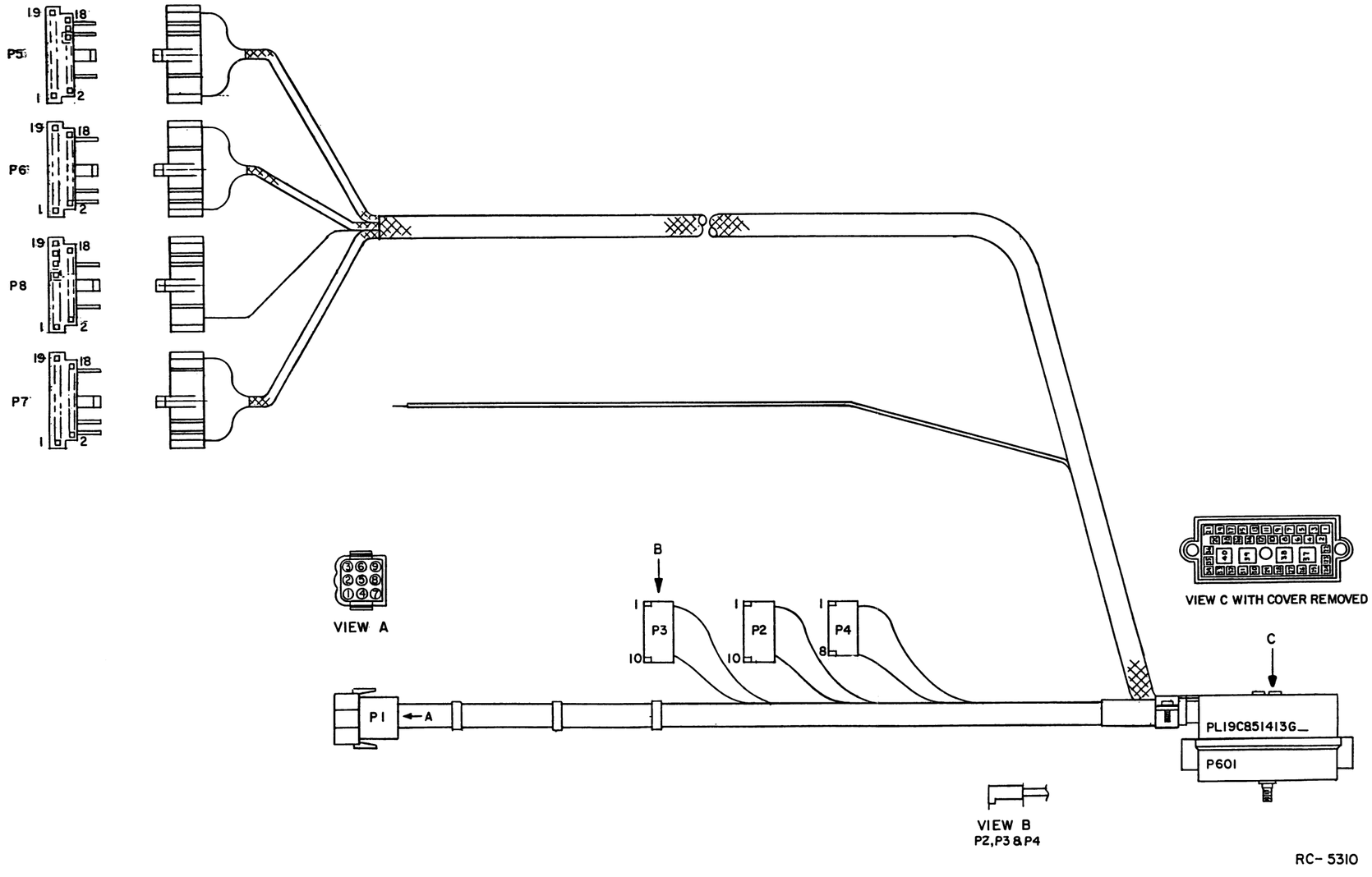
VIEW IN DIRECTION OF ARROW 'B' ENLARGED

PARTS LIST

DELTA STATION
VG HARDWARE KIT
19A705022G1
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
A1		BATTERY-UP BOARD 19C336765G1
		- - - - - - - - - - - DIODES - - - - - - - - - - -
CR1 and CR2	19A700028P1	Silicon, fast recovery: fwd current 75 mA, 75 PIV; sim to Type 1N4148.
		- - - - - - - - - - - JACKS - - - - - - - - - - -
J1	19A700072P132	Printed wire: 2 contacts rated at 2.5 amps; sim to Molex 22-05-3021.
		- - - - - - - - - - - PLUGS - - - - - - - - - - -
P27	19A700041P77	Plug.
		- - - - - - - - - - - RESISTORS - - - - - - - - - - -
R1	19A700106P63	Composition: 1K ohms ±5%, 1/4 w.
		- - - - - - - - - - - MISCELLANEOUS - - - - - - - - - - -
	19A701863P5	Cable clamp; sim to WEC Kesser 3/16-4.
	4036835P4	Solderless terminal.

(19D901797, Rev. 0)



PARTS LIST

DESK TOP STATION
INTERCONNECTION CABLE
19C851413G3
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - - PLUGS - - - - - - - - - - -
P1		Connector. Includes:
	19A134281P3	Plug.
	19A134282P4	Contact, electrical.
	19A134282P5	Contact, electrical.
P2 and P3		Connector. Includes:
	19A700041P26	Contact: sim to Molex 08-50-0113.
	19A700041P36	Shell.
P4		Connector. Includes:
	19A700041P26	Contact: sim to Molex 08-50-0113.
	19A700041P34	Shell.
P5 thru P8		Connector. Includes:
	19C320257P1	Shell.
	19A116781P4	Contact, electrical: wire range No. 22-26 AWG; sim to Molex 08-50-0107.
P601		Connector. Includes:
	19A701376P1	Contact, electrical rated @ 4 amps; sim to AMP 350657-1.
	19A701376P3	Contact, electrical rated @ 35 amps; sim to AMP 350655-1.
	19D900037P1	Shell.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	19A703061P3	Clip. (Used with P601).
	19B800951G1	Connector Cover. (Used with P601).
	19A701192P2	Thumbscrew. (Used with P601).
	19A701289P1	Retaining ring: 3/16 inches; sim to National Lockwasher WA 510. (Used with P601).
	19A702381P508	Screw, thd. form: No. 3.5-0.6 x 8. (Used with P601).
	19J706152P5	Retainer strap: sim to Panduit Corp. SST-1. (Used with P1).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

This addendum contains Revision Letter and other changes and additions not yet included in the Maintenance Manual. This addendum contains:

- Revision A to the Analog Board,
- Changes and additions to the Logic Board,
- Logic Board jumper chart.

ANALOG BOARD CHANGE

Rev. A - Analog Board 19D437979G1

To make Voice Guard compatible with Type 90, Type 99, DTMF and emergency GE-STAR when signalling is initiated by other than microphone PTT. Added C40, C41, R95 and R96. Changed J25 from a vertical type jack to a horizontal type jack.

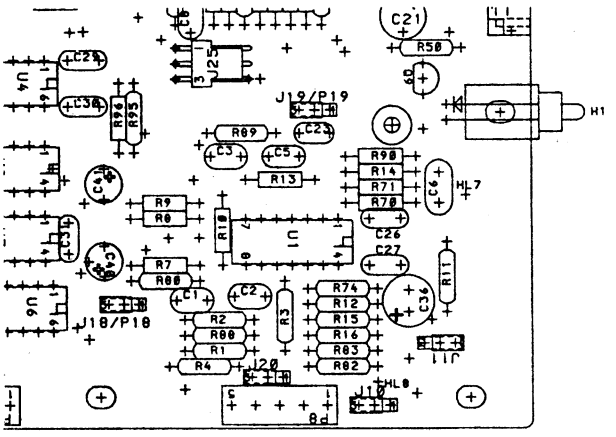
Components are:
C40 - 315A6047P225U: Tantalum, 2.2 uF ±20%, 35 VDCW, MFG: and SPRAGUE.
C41

R95 - H212CRP315C: Deposited Carbon, 15K ohms ±5%, 1/4 w.

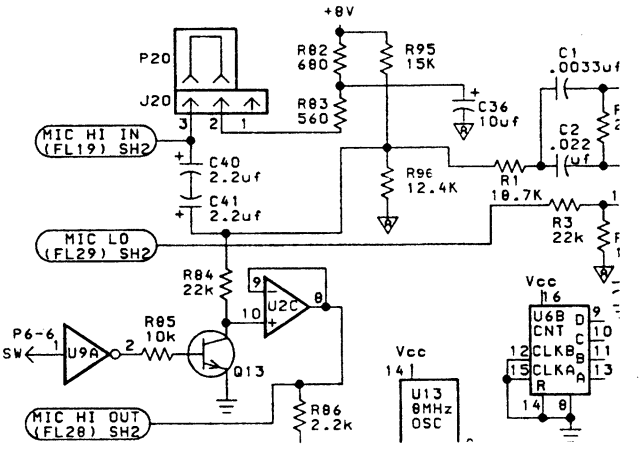
R96 - 19A701250P310: Metal Film, 12.4K ohms ±1%, 1/4 w.

J25 - New Part Number is: MOLEX® #22-05-3031.

OUTLINE DIAGRAM IS:



SCHEMATIC DIAGRAM IS:



LOGIC BOARD CHANGES

The program PROM (U2) Part Number on the Logic Board was changed to 19A148972G2. Also, a 100 pF capacitor was added from U10-14 to U10-16 to provide digital noise bypassing.

Capacitor is: 19A700219P64.

LOGIC BOARD JUMPER CHART

LOGIC BOARD JACKS	STANDARD CONNECTIONS	EXCEPTIONS
J11/P11 (H1 & H2)	J11/P11 connected. (H1 to H2 connected in earlier boards).	Jumper-plug removed when using 8751 SIMON PROM.
H3, H4 & H5	Jumper-plug connected from H4 to H5. (H3 not used).	Jumper-plug may be removed for field test.
H6, H7 & H8	Jumper-plug connected from H7 to H8 when using standard 2764 PROM.	Jumper-plug connected from H6 to H7 if using 2732 PROM.
H9, H10 & H11	Jumper-plug connected from H9 to H11. H10 not used.	Jumper-plug may be removed for field test.
H15 & H16	Open. (H15 and H16 not used).	Jumper-plug may be connected for testing RAM Vcc.
H18 & H19	Jumper-plug connected from H18 to H19.	Jumper-plug may be removed for field test.
H21 & H22	Jumper-plug connected for single key.	Removing jumper-plug will produce Key Loader ERROR 1. Key will not load.