



MAINTENANCE MANUAL  
FRONT COVER ASSEMBLY  
19D904151G1  
(Display Boards 19D903957G1 & G2)

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DESCRIPTION

The Front Cap Assembly for the MDX provides the user interface with the radio. It houses the four watt internal 8-ohm speaker and display board.

DISPLAY BOARD

The display boards, 19D903957G1 & G2, contain all user interface controls including the 8 character dot matrix LED (5 by 5 dot matrix characters), a microcontroller which manages the alphanumeric displays, eight icon LED's, 12 backlight LED's, and twelve printed wire board switch contacts. It also has two connectors which provide the interface to the microphone and the audio amplifier board.

The display board communicates with the audio/logic board (straight through connection on the audio amplifier board) in the mobile radio, through a three wire serial interface, in order to update display information, report key closures, perform an audio mute to the speaker, and report hookswitch and floorswitch status.

Microcontroller

Microcontroller U1 is an 8 bit control oriented micro-controller, with internal input/output interface and 256 by 8 bit internal random access memory, operating at a crystal clock rate of 11.0592 MHz. The microcontroller controls the operation of the display board and performs the following functions.

- Samples 11 of the 12 push-button key closures
- Controls the 8 character alphanumeric display
- Controls the 8 icon LED's
- Samples the hookswitch input
- Samples the floorswitch (Option) input
- Communicates with the audio/logic board in the radio
- Dual Control Unit Operation



Ericsson GE Mobile Communications Inc.  
Mountain View Road • Lynchburg, Virginia 24502

The microcontroller contains internal masked software operational code. It executes the internal software code with the EA pin (U1-29) at 5 volts and is reset via the power up/down reset output on the audio amplifier Board (U1-4).

The serial protocol for communication in MDX EDACS and MDX Conventional mobile radios is established with the MODE SELECT input line at a TTL high level (U1-10). The MODE SELECT line is set at a TTL high level through a jumper configuration on the audio amplifier board. Once MODE SELECT is high, the communication protocol is set at 9600 bits per second, 9 bit data field, one start bit, and one stop bit.

With MODE SELECT low, serial protocol is established for MDX GE-MARC radios at 4800 bits per second, 9 bit data field, one start bit, and one stop bit.

For MDX radios, the microcontroller communicates with the audio/logic board through DISPLAY SERIAL (U1-5), KEYPAD SERIAL (U1-7), and SERIAL RQST (U1-9), which are TTL compatible lines. DISPLAY SERIAL is an input, KEYPAD SERIAL is an output, and SERIAL RQST is an output.

DISPLAY SERIAL and KEYPAD SERIAL are double-buffered by open drain buffer U2. The microcontroller receives commands on the DISPLAY SERIAL input line and transmits status information (key closures, hookswitch, and floorswitch option) on the KEYPAD SERIAL output line. SERIAL RQST is set low by the microcontroller to indicate a status update to be sent to the audio/logic board.

The microcontroller is addressed via the proprietary protocol for the information to be sent. It then transmits the status information and subsequently raises its SERIAL RQST line. The microcontroller receives display update information from the audio/logic board at any time, irrespective of the state of the SERIAL RQST line. The microcontroller passes status information back only in the proper sequence which begins with its SERIAL RQST line going low.

The microcontroller updates the 8 character alphanumeric display as requested by the audio/logic board, through a three wire interface, LOAD (U1-11), SDCLK (U1-12), and DATA (U1-13). The microcontroller also controls the intensity of the alphanumeric display through the three wire interface.

The microcontroller updates the 8 icon LED's, CR1 through CR8, through individual output controls, PVT LED (U1-2), SCN LED (U1-3), TX LED (U1-21), BSY LED (U1-22), S LED (U1-23), P1 LED (U1-24), and P2 LED (U1-25). Note that the PVT LED output line controls CR1 and CR8 simultaneously. In addition to turning the icon LED's on and off, the microcontroller also controls the intensity by modulating the on/off rate (duty cycle) from 0% to 100%.

The microcontroller senses the key closures (POWER SW is the only one that is not read), the hookswitch input (CG DIS/HOOK SW, U1-40), the floorswitch input (OPTION), and requests to transmit the information back to the audio/logic board.

The microcontroller is also capable of operating as a second unit in a dual control unit system. This function is activated by cutting the run between HL-1 and HL-2 on the printed wire board (near and on the same printed wire board side as the microcontroller).

Optionally, a clock shift circuit, consisting of Q5 and C21, can be switched in to remove spur frequencies from the radio channels.

To mute the speaker audio, the microcontroller generates an active logic low on AUDIO MUTE (U1-8) upon command from the audio/logic board.

8 Character Display

The display consists of a CMOS IC containing control logic and drivers for eight 5 X 5 characters. The use of the serial data interface provides an efficient interconnection between the display and the microcontroller. The CMOS IC accepts decoded serial data, which is stored in the internal random access memory. Asynchronously, the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. Each character of the display is written by the microcontroller as a sequence of 6 eight bit bytes using the LOAD (U3-2), SDCLK (U3-1), and DATA (U3-27) serial interface lines. Bringing the LOAD line low enables the display to accept the bytes of data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). After eight clock transitions of SDCLK, the LOAD line is brought high and the first byte of data has been accepted. Once loaded, the internal oscillator and character multiplexer of the display reads the data from the RAM. These characters are row strobed with column data at a rate determined by the internal clock of the device. The internal strobe rate of the display is nominally 750 Hz.

Along with the display of specific characters, there are control functions that control the brightness and blanking of the display. The brightness levels are 0%, 6.6%, 13%, 20%, 27%, 40%, 53%, and 100% of full maximum brightness.

The reset input (U3-13) is brought low at power up to clear the internal character, control, and RAM information and blanks the display.

The CLKSEL (U3-16) is tied low to enable the internal strobe rate of the display device.

ICON LED'S

Eight icon LED's are used to indicate the status of the radio as determined by the audio/logic board in the mobile radio. Two of the icon LED's (CR1 and CR8) are driven by the same signal.

The icon LED controls are derived from the microcontroller (U1) through PVT LED (U1-2), SCN LED (U1-3), TX LED (U1-21), BSY LED (U1-22), S LED (U1-23), P1 LED (U1-24), P2 LED (U1-25).

PVT LED is used to turn two LED's, CR1 and CR8 on and off. All others are used to turn their respective LED on and off.

The LED's are turned on and off by dual pass transistors, Q1 through Q4. If the line from the microcontroller is high, the respective transistor is turned off and removes power to the LED. If the line from the microcontroller is low, the respective pass transistor is turned on and this in turn supplies power to the LED.

Backlight LED'S

Backlight LED's CR11 through CR23 provide the backlighting for the buttons on the front panel. The power source is derived from 12V SW (P707-13). The 12V SW supply is generated on the audio amplifier board through a filter regulator circuit.

Optionally, the audio/logic board in the mobile radio can be programmed to turn the 12V SW supply on and off (used for surveillance applications).

Switch Contact Closures

There are twelve switch contact closures used on the display board. Eleven of the twelve push-button switches are sensed by microcontroller U1. The PWR switch is the only one not sensed by the microcontroller and is used instead to control the on/off flip flop on the system board which enables/disables power from the continuous battery power, A+, to switched power, SW A+.

The eleven switch contacts sensed by the microcontroller are :

Switch	Micro Pin	MDX EDACS Function	MDX Conv Function	MDX GE-MARC
S2	U1-37	VOL UP	VOL UP	VOL UP
S3	U1-36	VOL DN	VOL DN	VOL DN
S4	U1-35	GRP UP	CH UP	AREA UP

S5	U1-34	GRP DN	CH DN	AREA DN
S6	U1-33	SCN	SCN	GRP UP
S7	U1-32	SYS	MON	GRP DN
S8	U1-31	A1	A1	A1
S9	U1-30	MNU	MNU	MNU
S10	U1-18	A2	A2	A2
S11	U1-19	CLR	CLR	CLR
S12	U1-20	EMER	EMER	EMER

When the microcontroller senses the switch contact closure, it initiates the sequence of events used to transfer the status information back to the audio/logic board.

Connectors

There are two connectors used on the display board, J725 (mic connector) and P707 (audio amplifier board interface connector).

Microphone connector J725 is used to pass MIC HI, MIC LO, PTT, CG DIS/HOOK SW, SW A+, and A- between the microphone and the audio amplifier board. It is also used to pass DISPLAY SERIAL, KEYPAD SERIAL, SW A+, and A- to the PC Programmer which is used to load the radio personality into the radio. Additionally, PTT/FLASH VPP is used to supply the stable 12 volts flash programming voltage to the radio and is used for flash programming the operational code in the audio/logic board's flash memory device.

Audio amplifier board interface connector P707 is used to pass the necessary signals between the microphone and display board back to the audio amplifier and audio/logic boards.

Connector J740 (on the G2 board) is provided for future options.

POWER DISTRIBUTION

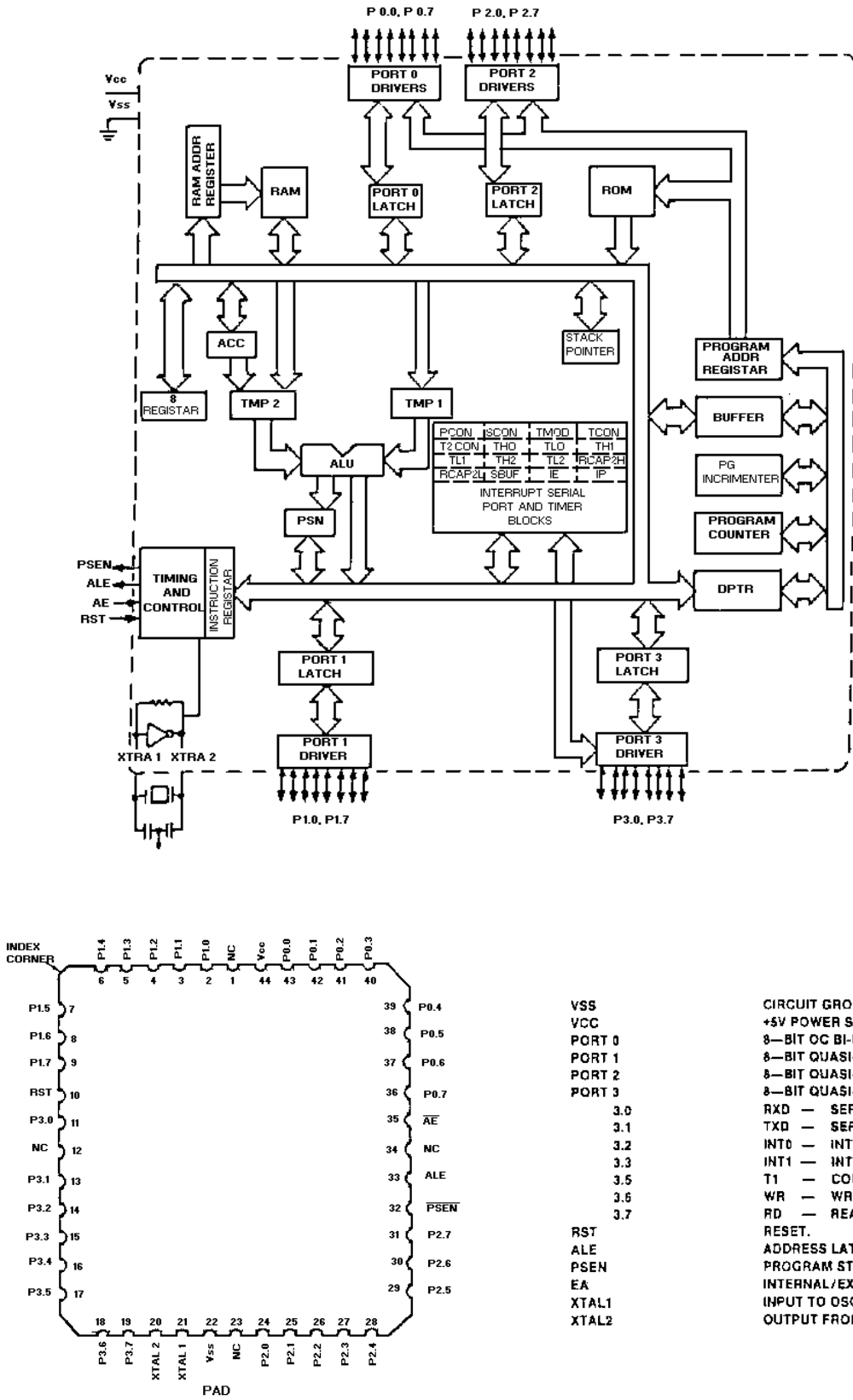
The display board receives +5V power from the regulator on the audio amplifier board. The +5V supply powers microcontroller U1, 8 character display U3, open drain buffer U2, and pass transistors Q1 through Q4.

The display board receives 12V SW power from the audio amplifier board. The 12V SW power is used to provide the power to backlight LED's CR11 through CR24. Optionally, the audio/logic board can turn off the 12V SW power on the audio amplifier board for surveillance applications.

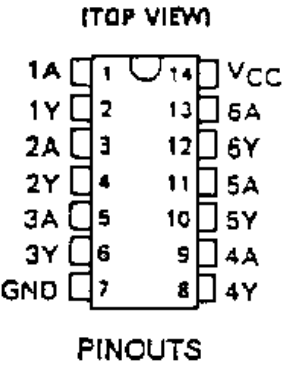
The display board passes A+ SW power from the audio amplifier board to microphone connector J725, where it is used to power an optional DTMF microphone or supply power to the PC/Flash Programmer Interface module.

U1, MICROCOMPUTER  
19A705557P10

FUNCTION DIAGRAM



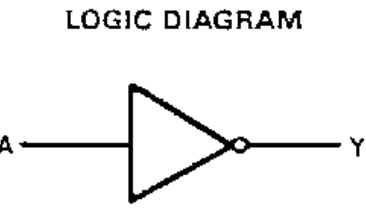
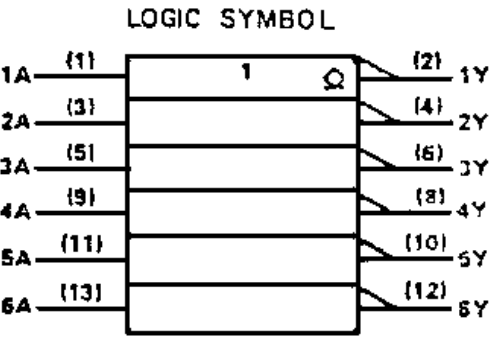
U2, HEX INVERTER  
19A703483P322



FUNCTION TABLE

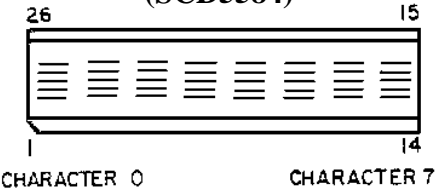
Input	Output
A	Y
H	L
L	H

HEX OPEN - DRAIN INVERTER  
19A703483P322  
(74HC05)



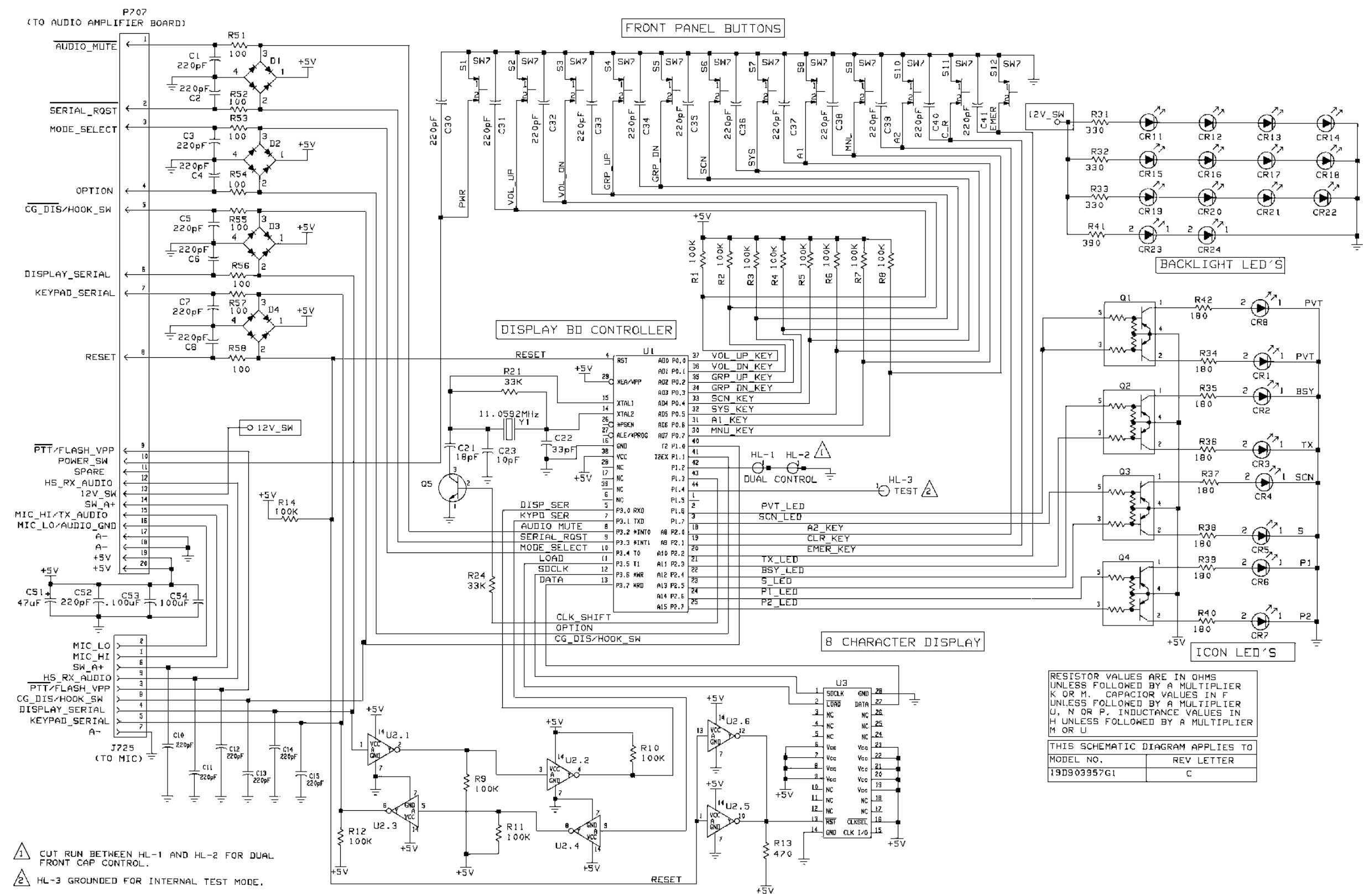
U3, DIGITAL DISPLAY  
344A4184P1

LED 5X5 CHARACTERS DISPLAY  
344A4184P1  
(SCD5584)



PIN ASSIGNMENTS

PIN	FUNCTION	PIN	FUNCTION
1	SDCLK	28	GND
2	LOAD	27	DATA
3	NC	26	NC
4	NC	25	NC
5	NC	24	NC
6	Vcc	23	Vcc
7	Vcc	22	Vcc
8	Vcc	21	Vcc
9	Vcc	20	Vcc
10	NC	19	Vcc
11	NC	18	NC
12	NC	17	NC
13	RST	16	CLKSEL
14	GND	15	CLK I/O



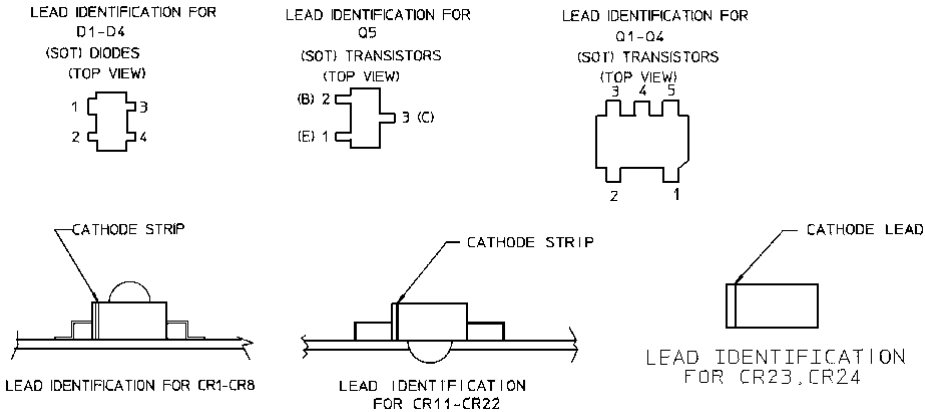
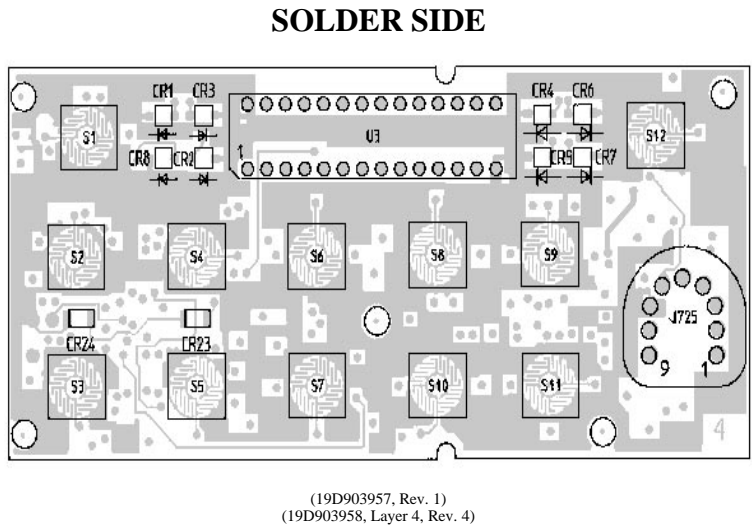
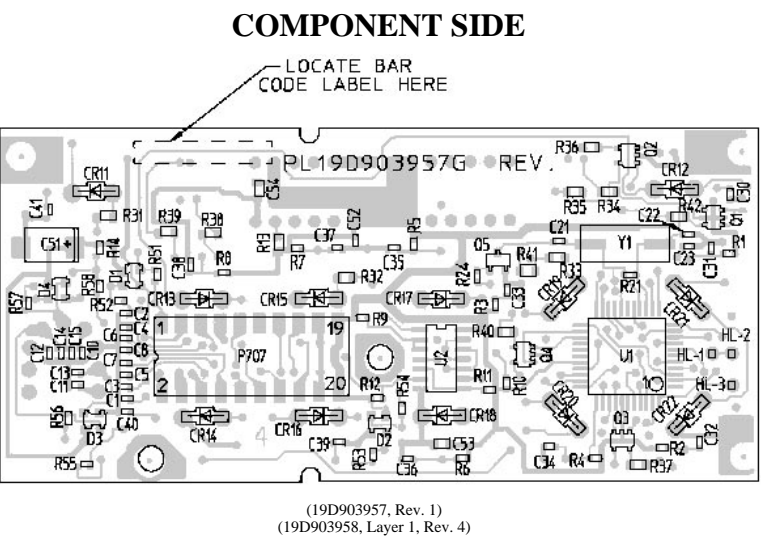
FRONT CAP ASSEMBLY AND DISPLAY BOARD

(19D903956,) for Group 1 Display Board

FRONT CAP ASSEMBLY - MDX  
19D904151G1 & G2

SYMBOL	PART NUMBER	DESCRIPTION
----- ASSEMBLIES -----		
A3	19D903957G32	Display Board, Assembly.
----- CAPACITORS -----		
C1 thru C8	19A149897P47	Ceramic: 220 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C10 thru C15	19A149897P47	Ceramic: 220 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C21	19A149897P21	Ceramic: 18 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C22	19A149897P27	Ceramic: 33 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C23	19A149897P15	Ceramic: 10 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C30 thru C41	19A149897P47	Ceramic: 220 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C51	19A705205P111	47 µF ± 10%, 10WVDC; sim to Sprague 293D.
C52	19A149897P47	Ceramic: 220 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C53 and C54	19A702052P134	Ceramic: 0.1 µF ± 5%, 25 VDCW.
C61 thru C64	19A149897P47	Ceramic: 220pF ±5%, 50 VDCW, temp coef 0 ±30 PPM. (Group 2 only).
----- DIODES -----		
CR1	RKZ433634/5	LED SMT, GREEN (Group 2 only).
CR1	19A705713P6	LED, SUBMINIA (Group 1 only).
CR2	RKZ433634/3	LED SMT, YELLOW (Group 2 only).
CR2	19A705713P9	LED, SUBMINIA (Group 1 only).
CR3	RKZ433634/10	LED SMT, RED (Group 2 only).
CR3	19A705713P7	LED, SUMINIA (Group 1 only).
CR4 thru CR8	RKZ433634/5	LED SMT, GREEN (Group 2 only).
CR11 thru CR22	19A705713P5	LED: SUBMINIA (Group 1 only).
CR23 and CR24	RKZ433634/5 344A4533P1	LED SMT, GREEN (Group 2 only). CHIP LED, S.M. (Group 1 only).
----- DIODES -----		
D1 thru D4	19A149615P1	Silicon: Diode Bridge; sim to BGX50A.
D5 and D6	19A149615P1	Silicon: Diode Bridge; sim to BGX50A. (Group 2 only).
J725	344A4485P1	Connector, special; sim to CONXAL E4408.
----- PLUGS -----		
P707	19B801689P3	Socket, IC: 20 pin, surface mount, gold contacts.

SYMBOL	PART NUMBER	DESCRIPTION
----- TRANSISTORS -----		
Q1 thru Q4	19A705943P1	Silicon, Dual PNP: sim to R OHM FMAI.
Q5	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
----- RESISTORS -----		
R1 thru R12	19A149818P104	Metal film: 100K ohms ±5%, 1/16 w.
R13	19B801251P471	Metal film: 470 ohms ±5%, 1/10 w.
R14	19A149818P104	Metal film: 100K ohms ±5%, 1/16 w.
R21 and R24	19A149818P333	Metal film: 33K ohms ±5%, 1/16 w.
R31 thru R33	19B801251P331	Metal film: 330 ohms ±5%, 1/10 w.
R34	19B801251P181	Metal film: 330 ohms ±5%, 1/10 w.
R40	19B801251P391	Metal film: 390 ohms ±5%, 1/10 w. (Group 1 only).
R41	19B801251P471	Metal film: 470 ohms ±5%, 1/10 w. (Group 2 only).
R42	19B801251P181	Metal film: 180 ohms ±5%, 1/10 w.
R51 thru R58	19A149818P101	Metal film: 100 ohms ±5%, 1/16 w.
R61 thru R63	19A149818P101	Metal film: 100 ohms ±5%, 1/16w. (Group 2 only).
----- INTEGRATED CIRCUITS -----		
U1	19A705557P10	Microcomputer: CMOS, 8-bit, control oriented CPU, includes 8k bytes ROM; sim to 80C52.
U2	19A703483P322	Digital: Hex inverter; sim to 74HC05.
U3	344A4184P1	Display, LED, 8 characters, 5 X 5 dot matrix; sim to Siemens SCD5584.
----- CRYSTALS -----		
Y1	19A702511G64	Crystal unit, quartz: 11.0592 MHz.
----- LOUDSPEAKERS -----		
LS1	19A705165P2	Speaker: 8 ohm, 4 watts, includes weather resistant cone and dust cover.
	19D904038P1	Speaker gasket.
----- MISCELLANEOUS -----		
2	19D904030P1	Front cap.
4	19D904031P1	Keypad.
5	19D904035P1	Front cap bracket.
7	19D904844P1	PWB for Group 2.
8	19D903957G8	Assembly (Group 2).
	19B802675P1	Display lens.
9	19D904032P12	Keycap: Emergency/Hazard.
10	19D904032P11	Keycap: Power.
11	19D904032P21	Keycap: Volume up, Volume UP/DOWN.
12	19D904032P22	Keycap: Group/Channel UP/DOWN.



**CAUTION**

OBSERVE PRECAUTIONS FOR HANDLING

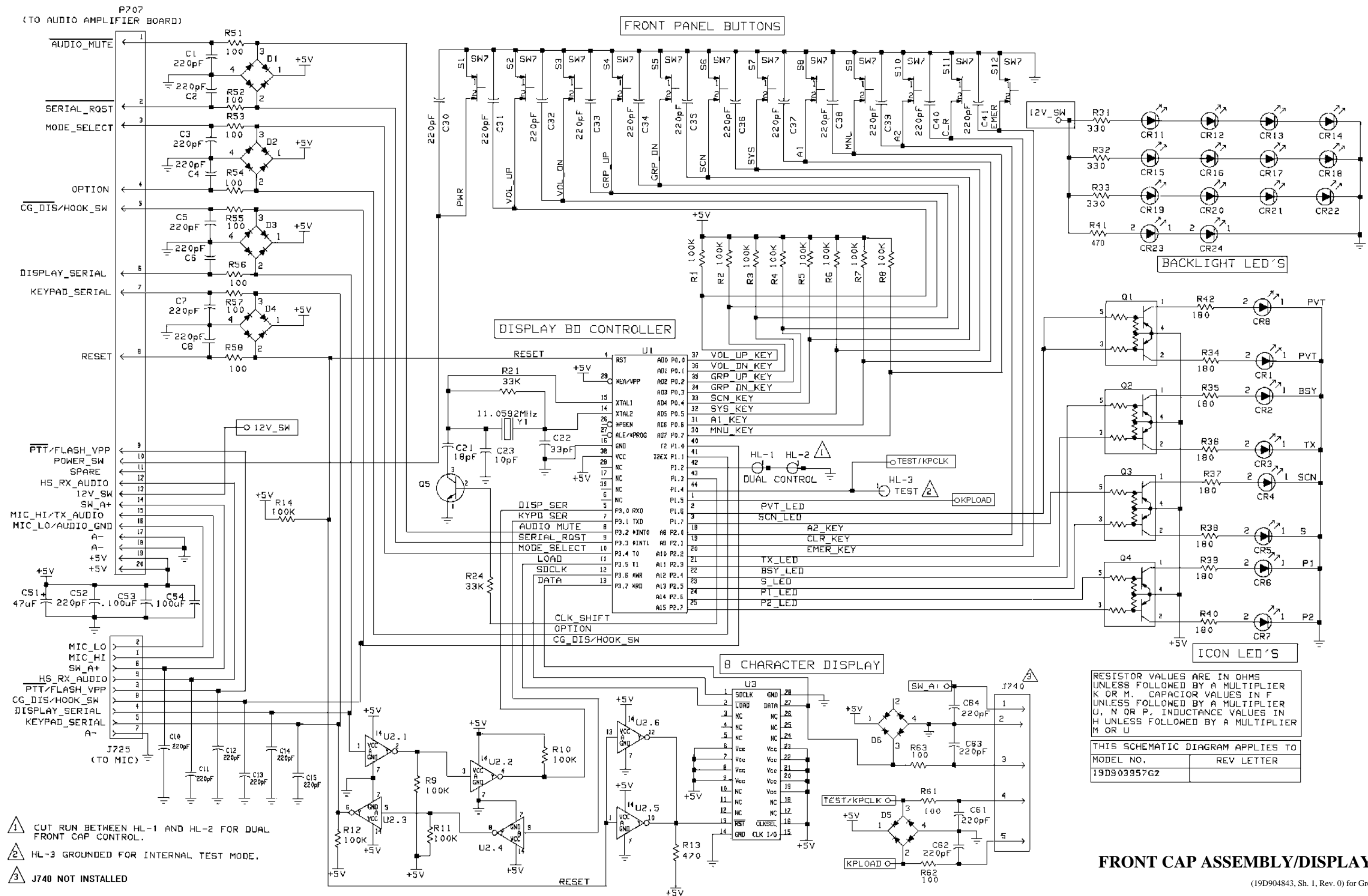
ELECTROSTATIC SENSITIVE DEVICES

FRONT CAP ASSEMBLY AND DISPLAY BOARD  
19D904151G1/19D903957G2

\* COMPONENTS, ADDED, DELETED OR CHANGED BY PRODUCTION

PRODUCTION CHANGES

Rev A. - **Display Board 19D903957G1**  
Incorporated in initial shipment.



- 1 CUT RUN BETWEEN HL-1 AND HL-2 FOR DUAL FRONT CAP CONTROL.
- 2 HL-3 GROUND FOR INTERNAL TEST MODE.
- 3 J740 NOT INSTALLED