MAINTENANCE MANUAL
FRONT COVER ASSEMBLY
19D904151G3
(Display/Keypad Board 19D903957G4)

TABLE OF CONTENTS

DESCRIPTION

The Front Cap Assembly for the MDX provides the user interface with the radio. It has a keypad for ID and Interconnect calls.

DISPLAY/KEYPAD BOARD

The display/keypad board, 19D903957G4, contains 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, 24 backlight LED's, and twenty four printed wire board switch contacts. It also has two connectors which provide the interface to the microphone and the audio amplifier board.

The display/keypad 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 microcontroller, 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 from switches S1 through S12
- 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
- Samples the registers containing the keypad information from switches S13 through S24

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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 microcoomputer reads the keypad registers U4 & U5 through a three-wire interface, KPLOAD (U1-1), TEST/KPCLK (U1-44), and DATA (U1-11). When KPLOAD goes low the data from the keypad is loaded into U4 & U5. On the next clock pulse the KPDATA is sent to U1 via switch Q6. KPLOAD must go high to turn on Q6 and pass the data to the microcomputer input U1-13.

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.

Q5 is used as a switch to isolate registers U4 & U5 from Display Chip U3, when U3 is active. When KPLOAD is low, Q6 is off, isolating U5 from U3.

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.

System Keypad

The SYSTEM version Display Keypad/Board has a 12-key keypad. Refer to the schematic of the Display/Keypad Board in this manual. The keys connect to U4 and U5 shift registers on the board. The microprocessor continuously scans the keypad by serially shifting data out of the registers.

The SYSTEM version Keypad has 3 signal lines which are used to serially clock the data out of the shift registers. 16 bits of information are clocked out of the 2 registers when the keypad is checked by the microprocessor. The first 12 bits are the active low keys, followed by 4 bits of hard-wired 0-1-0-1.

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 and CR25-CR36 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 twenty four switch contact closures used on the display/keypad board. Eleven of the push-button switches are sensed by microcontroller U1. The PWR switch is 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 System/Function
S2	U1-37	VOL UP
S3	U1-36	VOL DN
S4	U1-35	GRP UP
S5	U1-34	GRP DN
S6	U1-33	SCN
S7	U1-32	SYS
S8	U1-31	A1
S9	U1-30	MNU
S10	U1-18	GRP
S11	U1-19	CLR
S12	U1-20	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.

Keypad Switches

Switch	Register Pin	SW#
S13	U4-11	3
S14	U4-12	2
S15	U4-13	1
S16	U4-14	6
S17	U4-3	5
S18	U4-4	4
S19	U4-5	9
S20	U4-6	8
S21	U5-11	7
S22	U5-12	#
S23	U5-13	0
S24	U5-14	*

The registers are updated by KPLOAD from the microcomputer U1. The KPDATA is then sent to U1-13 (DATA INPUT) on the next KPCLK cycle.

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.

POWER DISTRIBUTION

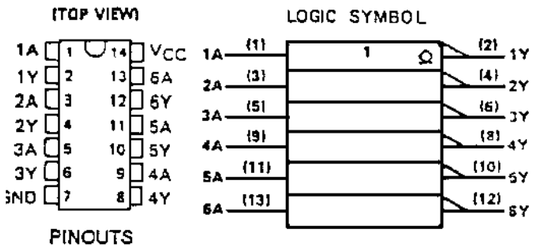
The display board receives +5V power from the regulator on the audio amplifier board. The +5V supply powers microcontroller U1, 8 character display U3, open drain buffer U2, shift resistors U4 & U5, and pass transistors Q1 through Q4.

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 and CR25 through CR36. 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.

U2, HEX INVERTER 19A703483P322

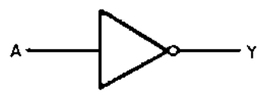
HEX OPEN - DRAIN INVERTER (74HC05)



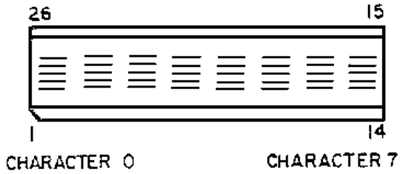
FUNCTION TABLE

Input	Output
A	Y
H	L
L	H

LOGIC DIAGRAM



U3, DIGITAL DISPLAY 344A4184P1

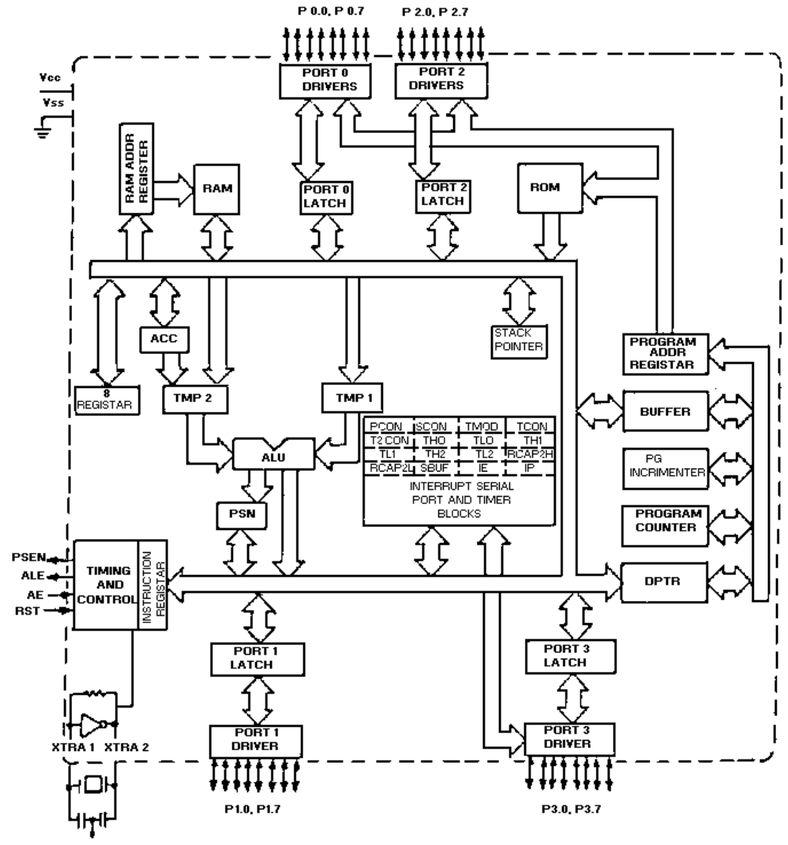


PIN ASSIGNMENTS

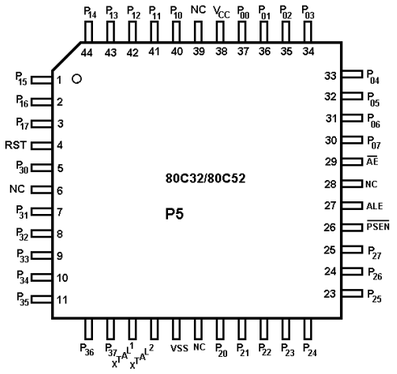
PIN	FUNCTION	PIN	FUNCTION
1	SDCLK	28	GND
2	LOAD	27	DATA
3	NC	26	NC
4	NC	25	NC
5	NC	24	NC
6	Vcc	23	Vcc
7	Vcc	22	Vcc
8	Vcc	21	Vcc
9	Vcc	20	Vcc
10	NC	19	Vcc
11	NC	18	NC
12	NC	17	NC
13	RST	16	CLKSEL
14	GND	15	CLK I/O

U1, MICROCOMPUTER 349A9744G2

FUNCTION DIAGRAM



PIN CONFIGURATION

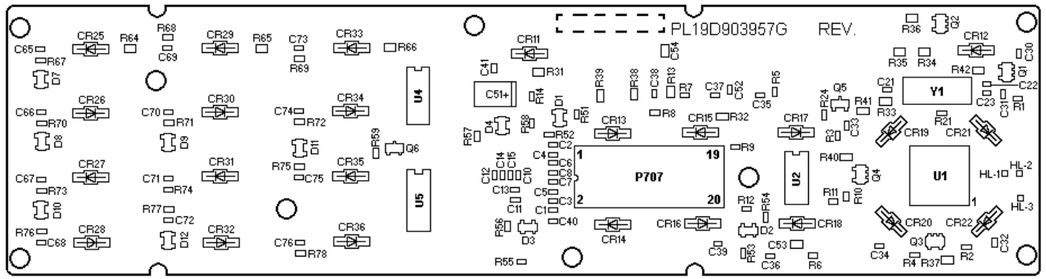


VSS	CIRCUIT GROUND POTENTIAL
VCC	+5V POWER SUPPLY
PORT 0	8—BIT OC BI-DIRECTIONAL I/O PORT.
PORT 1	8—BIT QUASI-BIDIRECTIONAL I/O PORT.
PORT 2	8—BIT QUASI-BIDIRECTIONAL I/O PORT.
PORT 3	8—BIT QUASI-BIDIRECTIONAL I/O PORT.
3.0	RXD — SERIAL PORT RECEIVER DATA.
3.1	TXD — SERIAL PORT TRANSMITTER DATA.
3.2	INT0 — INTERRUPT 0 INPUT.
3.3	INT1 — INTERRUPT 1 INPUT.
3.5	T1 — COUNTER 1 INPUT.
3.6	WR — WRITE CONTROL.
3.7	RD — READ CONTROL.
RST	RESET.
ALE	ADDRESS LATCH ENABLE.
PSEN	PROGRAM STORE ENABLE OUTPUT.
EA	INTERNAL/EXTERNAL INSTRUCTION FETCH.
XTAL1	INPUT TO OSCILLATOR AMPLIFIER.
XTAL2	OUTPUT FROM OSCILLATOR AMPLIFIER.

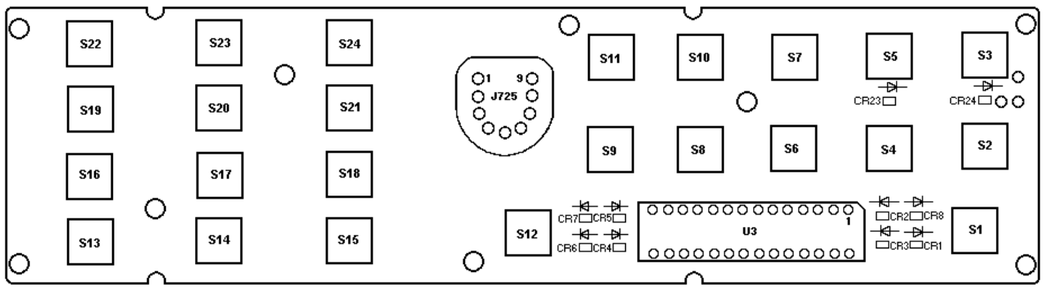
FRONT CAP ASSEMBLY - MDX
19D904151G3

SYMBOL	PART NO.	DESCRIPTION
A3		**DISPLAY/KEYPAD BOARD**
		19D903957G4
		- - - - - - - - - - CAPACITORS - - - - - - - - -
C1 thru C8	19A149897P47	Ceramic: 220 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C10 thru C15	19A149897P47	Ceramic: 220 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C21	19A149897P21	Ceramic: 18 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C22	19A149897P27	Ceramic: 33 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C23	19A149897P15	Ceramic: 10 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C30 thru C41	19A149897P47	Ceramic: 220 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C51	19A705205P111	Tantalum: 47 + or -10%, 10 VDCW; sim to Sprague 293D.
C52	19A149897P47	Ceramic: 220 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
C53 and C54	19A702052P134	Ceramic: 0.1 uF + or - 5%, 25 VDCW.
C65 thru C76	19A149897P47	Ceramic: 220 pF + or -5%, 50 VDCW, temp coef 0 + or -30 PPM.
		- - - - - - - - - - DIODES - - - - - - - - - -
CR1	RKZ433634/5	LED SMT ,GREEN
CR2	RKZ433634/3	LED SMT ,YELLOW
CR3	RKZ433634/10	LED SMT ,RED
CR4 thru CR8	RKZ433634/5	LED SMT ,GREEN
CR11 thru CR22	19A705713P5	LED ,SUBMINIATURE, GREEN
CR23 and CR24	RKZ433634/5	LED SMT ,GREEN
CR25 thru CR36	19A705713P5	LED ,SUBMINIATURE, GREEN
D1 thru D4	19A149615P1	Silicon: Diode Bridge; sim to BGX50A.
D7 thru D12	19A149615P1	Silicon: Diode Bridge; sim to BGX50A.
		- - - - - - - - - - JACKS - - - - - - - - - -
J725	344A4485P1	Connector, special; sim to CONXAL E4408.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P707	19B801689P3	Socket,IC: 20 pin, surface mount, gold contacts.
		- - - - - - - - - - TRANSISTORS - - - - - - - - -
Q1 thru Q4	19A705943P1	Silicon, Dual PNP: sim to R OHM FMAI.
Q5 and Q6	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1 thru R12	19A149818P104	Metal film: 100K ohms + or -5%, 1/16 w.
R13	19B801251P471	Metal film: 470 ohms + or -5%, 1/10 w.
R14 R21	19A149818P104 19A149818P333	Metal film: 100K ohms + or -5%, 1/16 w. Metal film: 33K ohms + or -5%, 1/16 w.
R24	19A149818P333	Metal film: 33K ohms + or -5%, 1/16 w.
R31 thru R33	19B801251P331	Metal film: 330 ohms + or -5%, 1/10 w.
R34 thru R40	19B801251P181	Metal film: 180 ohms + or -5%, 1/10 w.
R41	19B801251P471	Metal film: 470 ohms + or -5%, 1/10 w.
R42	19B801251P181	Metal film: 180 ohms + or -5%, 1/10 w.
R51 thru R58	19A149818P101	Metal film: 100 ohms + or -5%, 1/16 w.
R59	19A149818P473	Metal film: 47K ohms + or -5%, 1/16 w.
R64 thru R66	19B801251P331	Metal film: 330 ohms + or -5%, 1/10 w.
R67 thru R78	19A149818P104	Metal film: 100K ohms + or -5%, 1/16 w.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - -
U1	349A9744G2	OTPTICAL
U2	19A703483P322	Digital: Hex inverter; sim to 74HC05.
U3	344A4184P1	DISPLAY ,LED 5X5, 8 CHARACTERS
U4 and U5	19A703987P322	Digital: 8-Bit Shift Register; sim to 74HC165.
		- - - - - - - - - - CRYSTALS - - - - - - - - -
Y1	19A702511G64	Crystal unit, quartz: 11.0592 MHz.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
4	19D904031P1	KEYPAD
5	19D904035P1	BRACKET, FRONT CAP
6	19D904031P2	KEYPAD
8	19B802675P1	LENS
9	19D904032P12	KEYCAP, HOME/EMER
10	19D904032P11	KEYCAP, PWR
11	19D904032P21	KEYCAP, VOLUME
12	19D904032P22	KEYCAP, +/-
13	19A702364P306	SCR, MACHINE
15	19D904030P2	CAP, FRONT

VIEW FROM COMPONENT SIDE

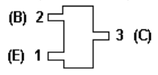


VIEW FROM SOLDER SIDE

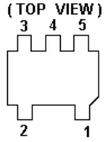


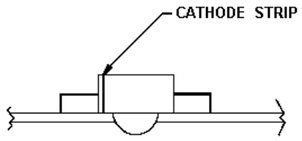
LEAD IDENTIFICATION FOR
D1 - D4 & D7 - D12
(SOT) DIODES

LEAD IDENTIFICATION FOR
Q5 & Q6
(SOT) TRANSISTORS
(TOP VIEW)

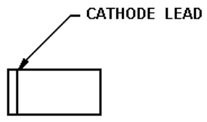


LEAD IDENTIFICATION FOR
Q1 - Q4
(SOT) TRANSISTORS
(TOP VIEW)



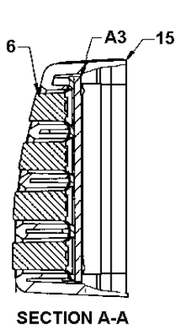


LEAD IDENTIFICATION
FOR CR11 - CR22
AND CR25 - CR36

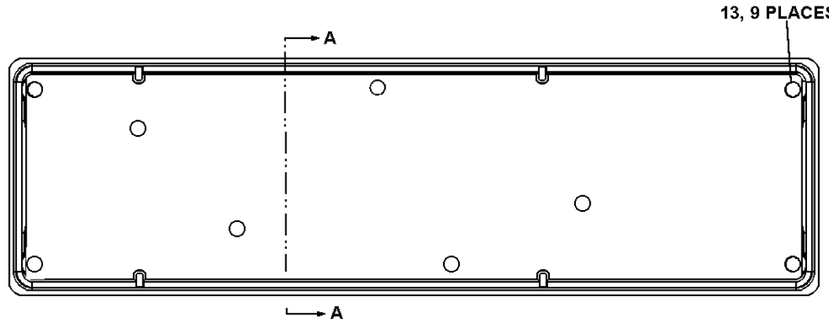


LEAD IDENTIFICATION
FOR CR1 THRU CR8, CR23 & CR24

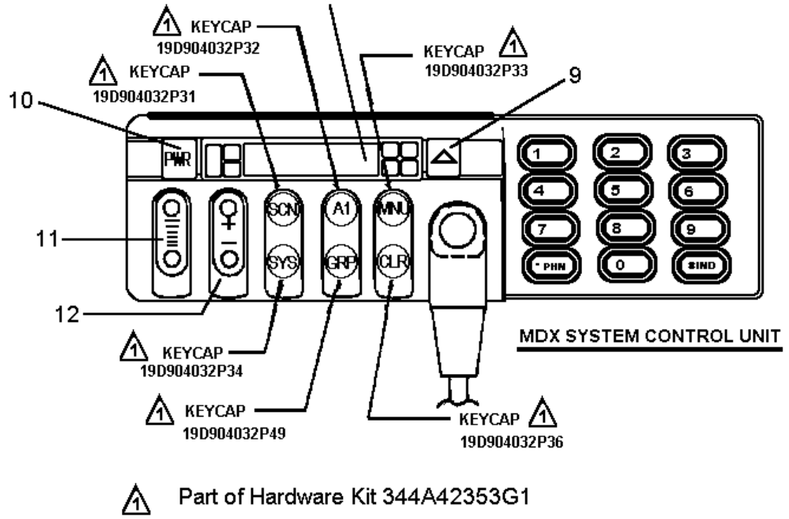
DISPLAY/KEYPAD BOARD
19D903957G4



SECTION A-A



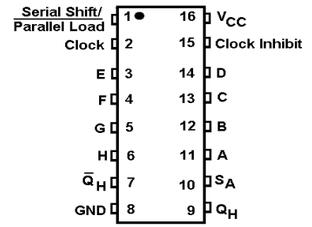
OTHERWISE SAME AS PART 1



1 Part of Hardware Kit 344A42353G1

FRONT CAP ASSEMBLY
19D904151G1/19D903957G2
(19D904151 Sh. 2, Rev. 5A)
(19D904183 Sh. 5, Rev. 6)

PIN ASSIGNMENT

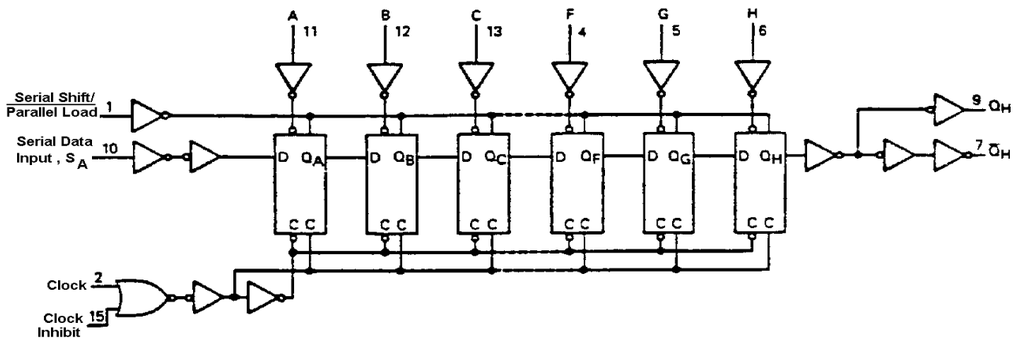


FUNCTION TABLE

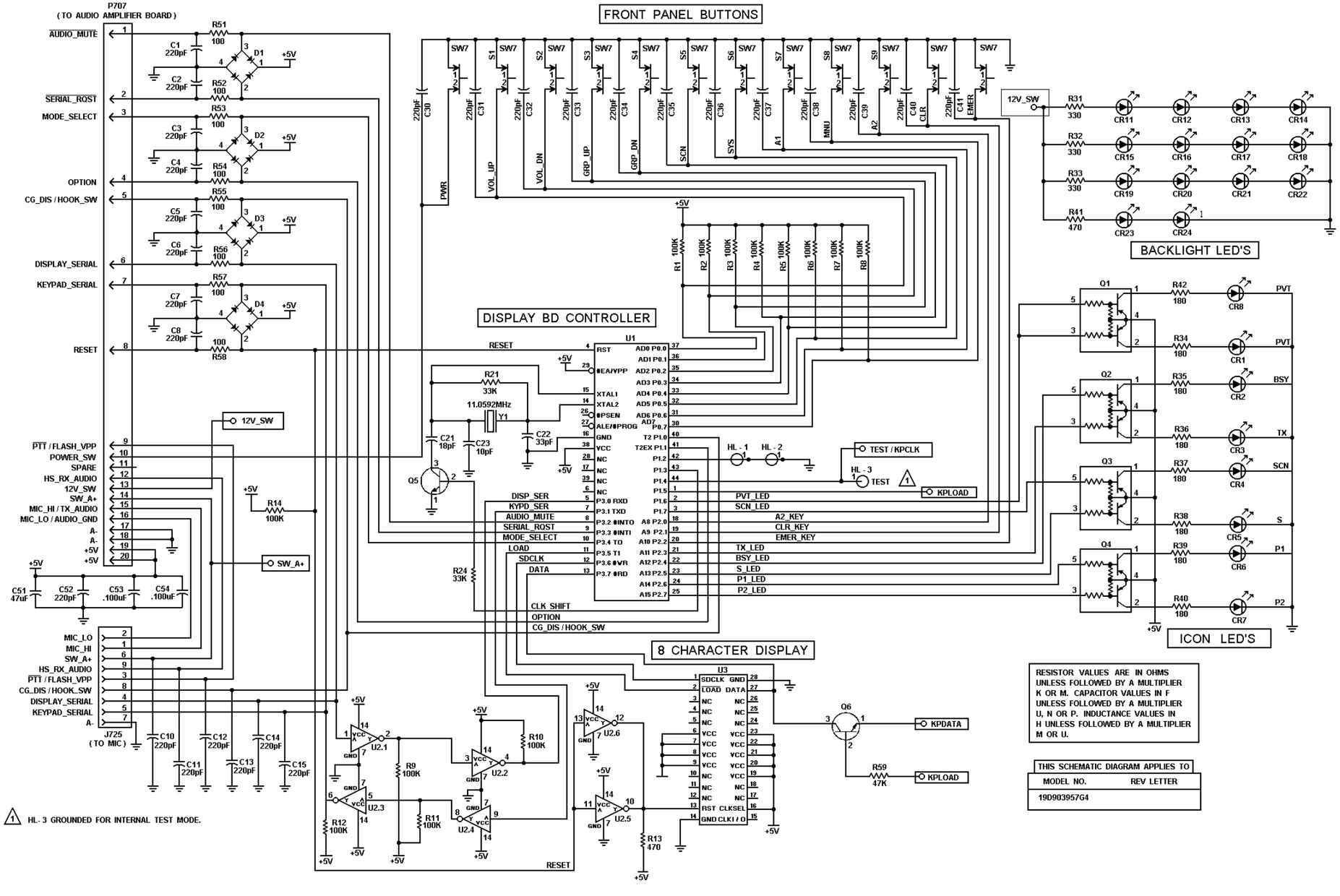
Inputs					Internal Stages		Output	
Serial Shift/ Parallel Load	Clock	Clock Inhibit	S_A	A-H	Q_A	Q_B	Q_H	Operation
L	X	X	X	a...h	a	b	h	Asynchronous Parallel Load
H H	⎍	L L	H	X X	L H	Q_{An} Q_{An}	Q_{Gn} Q_{Gn}	Serial Shift via Clock
H H	L L	⎍	L H	X X	L H	Q_{An} Q_{An}	Q_{Gn} Q_{Gn}	Serial Shift via Clock Inhibit
H H	X H	H X	X X	X X	no change			Inhibited Clock
H	L	L	X	X	no change			No Clock

X=don't care
Q_{An}-Q_{Gn}=Data shifted from the preceeding stage

EXPANDED LOGIC DIAGRAM

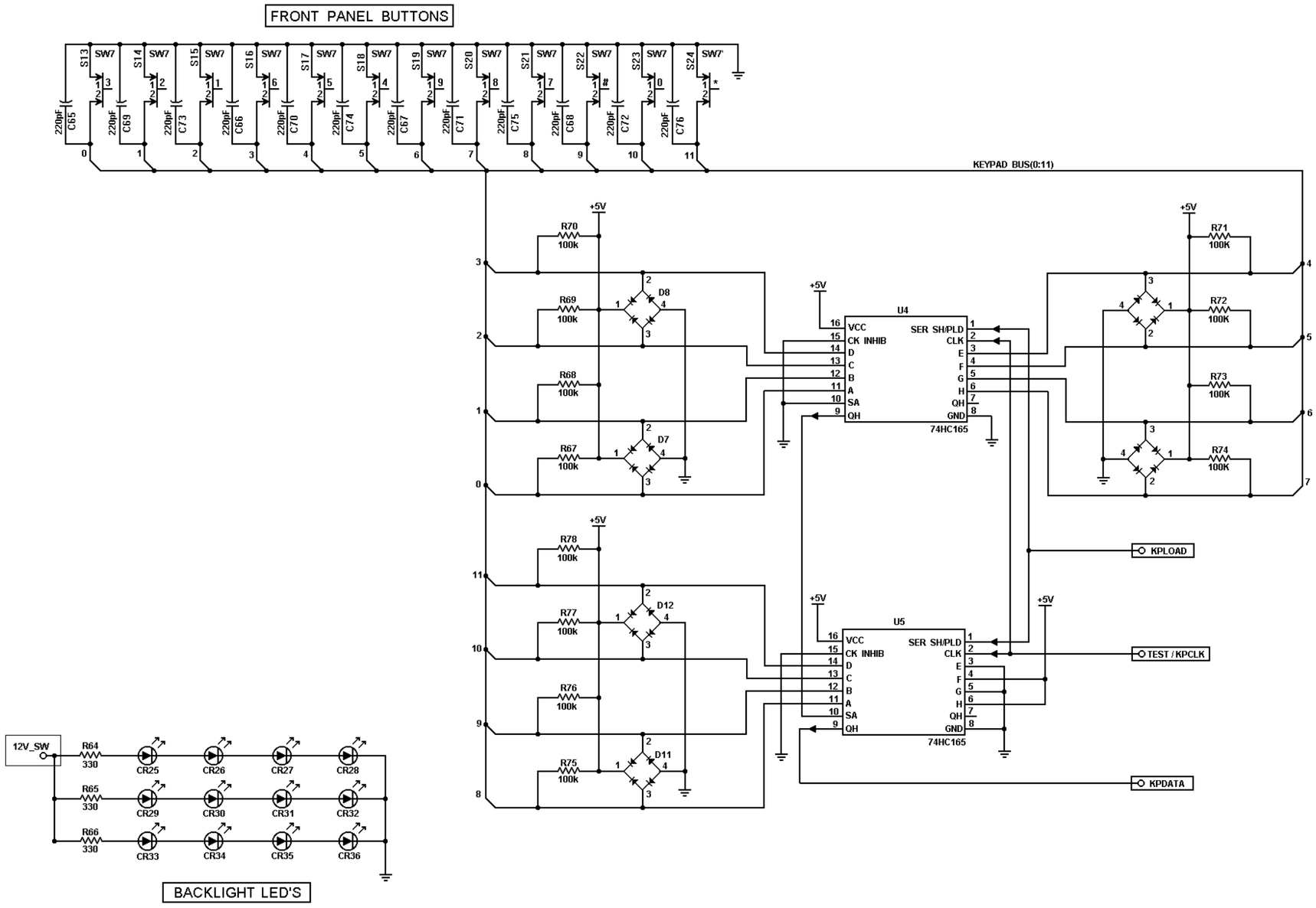


U4, U5 8-BIT SHIFT REGISTER



DISPLAY/KEYPAD BOARD

(188D6132, Sh. 1, Rev. 2)



DISPLAY/KEYPAD BOARD

(188D6132, Sh.2, Rev. 2)