MAINTENANCE MANUAL
KEYPAD/FREQUENCY SELECT BOARD
344A3383P1

TABLE OF CONTENTS

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LBI-39047

DESCRIPTION

Keypad/Frequency Select Board 344A3383P1 is installed in MTD, MVS and TMX Desk Top Stations. The board performs two (2) interface-type functions for the Desk Top Station.

First, it interfaces the 12-button keypad installed on the station's front panel to the mobile radio within the station. This keypad allows a user to key-in digits when placing telephone interconnect or EDACS individual calls.

Second, it provides the "frequency select" or "Special Function" interfacing between the DC/Tone Remote Board and the mobile radio within the Desk Top Station. This interfacing is required when one or more RCN-1000 Remote Control Consoles are connected to the Desk Top Station for remote control operations. The "Special Function", or simply "SF" protocol is an EDACS interface protocol used between the Desk Top Station and an EDACS RCN-1000 to remotely select one of five system/group combinations and control PTT operation.

Tone remote controlled conventional Desk Top Stations use Tone Remote Board 19A704686P4 or P6. DC remote controlled conventional Desk Top Stations use DC Remote Board 19A704686P3. EDACS remote controlled Desk Top Stations use Tone Remote Board 19A704868P8.

Communication between the desk top station's mobile radio and the Keypad/Frequency Select Board is accomplished by a serial data link between the two units. This serial link operates at 9600 baud. The board also has several input and output logic lines used for station interfacing.

CONFIGURATION

The Keypad/Frequency Select Board must be configured for either conventional *or* EDACS operation. This is accomplished by a installing *or* removing a jumper on the board. If the board is ordered in a package with the Desk Top Station, the board is normally configured correctly at the factory before the Desk Top Station package ships. The following information is presented for board replacement and/or field upgrade procedures:

- For EDACS trunked systems, remove/cut the jumper between H2-1 and H2-2.
- For conventional radio systems, install a jumper between H2-1 and H2-2.

CIRCUIT ANALYSIS

INTERFACE LOGIC

Microprocessor U701 and EPROM U703

Integrated circuit U701 is an 80C31 8-bit microprocessor. It provides all of the interface processing functions for the board. The sections that follow provide in-depth circuit analysis details on these interface functions.

Crystal Y701 sets the U701's internal clock to 11.0592 MHz. Regulated +5 Vdc power from regulator U705 is applied to U701 at pin 44 and the power-up reset pulse is applied to U701 pin 10. Additional details on +5 Vdc power and the reset circuitry are contained in the section entitled "**VOLTAGE REGULATOR U705**".

The microprocessor executes the operating program stored in EPROM U703. This device is an 87C257 32K x 8-bit EPROM with built-in latches for the 80C31's multiplexed address bus and data bus. No external octal latch is required. Port 0 of the 80C31 (U701 pins 36 - 43) is the I/O port for the multiplexed buses. All fifteen address bits are latched into U703 on the falling edge of the ALE (address latch enable) signal from the microprocessor (U701 in 33). The data byte at the addressed location is sent from U703 to U701 when U701's PSEN output (U701 pin 32) transitions low.

Keypad Interfacing

U701 Parallel Inputs

As shown on sheet 2 of the Desk Top Station's interconnection diagram (see LBI-38635), the keypad is interconnected to the Keypad/Frequency Select Board at J401 via a 13-wire interconnect cable. J401 pin 1 is the ground or low logic level point. The microprocessor reads, via transceivers U702 and U704, the open/closed status of the keypad's switches. This is accomplish by simply reading the logic level of each switch input line (J401 pins 2 through 13); no row-to-column matrix scanning is used. When a key is pressed, the respective switch input line transitions low (connects to J401 pin 1).

Octal bus transceivers U702 and U704 are utilized to interface the keypad switch input lines to the microprocessor's data bus (port 0). U704 interfaces keys "1", "2", "3", "4", "5", "6", "8" & "9" and U702 interfaces keys"0", "7", "#" and "*". U702 is also used to interface the four inputs at P207 pins 9 through 12 as described in the following section entitled "**DC/Tone Remote Board Interfacing**".

Both octal transceivers are hard-wired to buffer data only in a single direction — from the keypad or P207 inputs to the microprocessor. This is accomplished by the logic low state on the DIRection pin (pin 1) at each IC. The "B" side is the input and the "A" side is the output.

All twelve (12) keypad switch input lines are connected to the "B" side of U702 and U704 via 330-ohm series resistors and the associated cable interconnections. During a switch open condition (key *not* pressed), an input line is pulled high (to the +5 Vdc power line) by the respective 100k-ohm pull-up resistor.

Dual-diode packages CR1 through CR12 clamp the keypad input lines to within 0.5-volt above the +5 Vdc power line and 0.5-volt below ground. This prevents static discharges at the keypad from damaging the logic circuitry on the board.

To read the upper group of eight keys on the keyboard, U701 reads U704 by pulling its /G enable input at pin 19 low. Gates U713-A, U712-B and U713-C provide the necessary decoding logic of the microprocessor's control lines. During a U704 read, U701's PSEN output at pin 32 is high, the /RD line at pin 19 is low and port 2 bit 7 at pin 31 is high.

To read the lower group of four keys on the keyboard, U701 reads U702 by pulling its /G enable input at pin 19 low. Gates U712-A and U713-B provide the necessary decoding logic. During a U702 read, U701's PSEN output at pin 32 is high, the /RD line at pin 19 is low and port 2 bit 7 at pin 31 is low.

U701 Serial Outputs

When a key is pressed, microprocessor U701 pulls the SERIAL RQST line (P208 pin 8) low to signal the mobile radio. The radio responds by sending a one-byte poll message to the board over the BUF DISPLAY SERIAL line (P208 pin 7). Inverters U726-A and U726-B buffer the serial data and apply it to U701's receive data input at pin 11. Upon receiving the poll message, the U701 brings SERIAL RQST back to a high logic level and it sends four bytes of data to the radio over the BUF KEYPAD SERIAL line (P208 pin 6). The entered keypad data is contained within these four bytes of serial data. This same serial communication sequence also occurs when a key is released.

The transmit data output from microprocessor U701 drives the BUF DISPLAY SERIAL line via transistors Q701 and Q702. Transistor Q701 operates in an open-collector fashion. Its collector is pulled high by a pull-up resistor in the mobile radio.

DC/Tone Remote Board Interfacing

SF Inputs At Connector J402

The Keypad/Frequency Select Board has five (5) logic inputs at connector J402 that are used to transfer dc/tone decode information from the DC/Tone Remote Board to the Keypad/Frequency Select Board. These inputs (J402 pins 1 through 5) are used in conventional and EDACS remote control applications; however, they are identified as "SF1" through "SF5", in accordance with EDACS "Special Function" signalling.

When the DC/Tone Remote Board decodes a control function from a remote control unit (RCN-1000, for example) it pulls one of five SF inputs low. As shown on the schematic diagram, the SF1 - SF5 input lines are applied to the lower five bits of U701's port 0. These bits are set-up as inputs by the microprocessor.

EDACS Desk Top Stations

All remote controlled EDACS Desk Top Stations are equipped with Tone Remote Board 19A704686P8. This board contains the tone decode and encode (generation) circuitry necessary for EDACS remote control applications.

The decode circuitry decodes the Secur-It™/function tone sequences originating from the EDACS RCN-1000(s). The decoders' outputs drive the Keypad/Frequency Select Board's SF inputs at J402.

The tone encode circuitry generates 2175 Hz tone bursts used for remote handshaking and update signalling. This tone generation circuitry is directly controlled by the Keypad/Frequency Select Board.

2175 Hz Generator Control

Two (2) output control lines from microprocessor U701 connect to the Tone Remote Board. These output lines control the Tone Remote Board's 2175 Hz tone generator. They are identified as LOCAL PTT (P207 pin 6) and HANDSHAKE (P207 pin 7). The HANDSHAKE line provides on/off tone control and the LOCAL PTT line provides high/low level tone control. Pull-up resistors are located on the Tone Remote Board for the open-collector transistor drivers, Q704 and Q706.

LBI-39047

SEC DET Validation/Initialization

In a EDACS Desk Top Station, the Keypad/Frequency Select Board *does not* process any remote input (SF lines or PTT (FROM REMOTE) line) until it receives a Secur-It tone validation pulse on the SEC DET line (P207 pin 12). The Tone Remote Board pulls this line low when the Secur-It tone is present on the transmit phone line (line from RCN-1000). SF or PTT (FROM REMOTE) input changes *not* preceded by a SEC DET pulse are considered invalid and are thus not acted upon by the Keypad/Frequency Select Board.

High-Level 2175 Hz Handshake To Remotes

Immediately after the Secur-It tone is detected (SEC DET transitions low), microprocessor U701 brings LOCAL PTT and HANDSHAKE high. With LOCAL PTT and HANDSHAKE high, the Tone Remote Board outputs a high-level 2175 Hz handshake tone burst to the EDACS RCN-1000(s) via the receive phone line pair. This tone burst informs the initiating EDACS RCN-1000 that the Desk Top Station received its Secur-It tone. It also informs any paralleled EDACS RCN-1000(s) that a control function is occurring from another (the initiating) EDACS RCN-1000; this temporarily prevents any paralleled remote from transmitting a Secur-It/function or Secur-It/function/hold tone sequence. The high-level 2175 Hz tone burst lasts approximately 140 milliseconds and it is sent out at a level equal to the Secur-It tone (approximately +10 dBm). See Figure 1.

Microprocessor-To-Radio Communications

Microprocessor U701 reads the SF inputs at J402 twenty (20) milliseconds after the Secur-It tone drops. This is exactly in the center of the 40 millisecond function tone, thus ensuring an accurate function tone decoder read.

Next, U701 starts a serial communication sequence with the radio. This sequence transfers the new SF information to the mobile radio. It is similar to the sequence used for keypad communication — first, SERIAL RQST (P208 pin 8) falls low, then message activity occurs between the board and radio over the BUF KEYPAD SERIAL and BUF DISPLAY SERIAL lines and finally, SERIAL RQST transitions back to a high logic state.

Next, the radio checks its personality memory to see if the new SF selection information is a valid system/group. It responds with a serial communication sequence to U701 on the Keypad/Frequency Select Board.

5-Bit SF Update Word To Remotes

At this point, the Keypad/Frequency Select Board sends a 5-bit SF update word to the EDACS RCN-1000(s) via the receive phone line pair(s) using the 2175 Hz tone generator on the Tone Remote Board. This word updates the SF selection LED indicators at any paralleled EDACS RCN-1000s and it communicates valid/invalid SF selection (per radio SF personality programming) to the initiating EDACS RCN-1000. If the selection is not valid, the initiating remote will return to the previous SF selection and any paralleled remotes will never change their SF selections.

The 5-bit SF update word is generated by switching the 2175 Hz tone generator on the Tone Remote Board on and off. As shown in Figure 1, a logic 1 is represented by a high-level 2175 Hz tone and a logic 0 is represented by a quiet line. Each bit period last 50 milliseconds. The start bit is 0, three data bits follow, and the stop bit is 1. The LOCAL PTT (P207 pin 6) and HANDSHAKE (P207 pin 7) outputs from the Keypad/Frequency Select Board control the tone generator circuit on the Tone Remote Board. Both are high when a high-level 2175 Hz tone is present (logic 1) and both are low during a quiet line (logic 0) period.

The chart in Figure 1 defines the Special Function selections that the three data bits within the 5-bit update word correspond to. The left column is the octal code of the three data bits. Codes 1 through 5 correspond to the desired system/group SF selection (SF1 - SF5 respectively). Codes 0 and 7 are not valid. Figure 1 shows update sequences SF4 and SF5.

Code 6 indicates the selection does not correspond to a programmed system or group in the Desk Top Station's mobile radio. This can occur if the system or group is reprogrammed at the radio or if not all five (5) system/group selections are programmed into the radio. If an EDACS RCN-1000 receives a code 6, it considers it as a "no valid system/group selection" and it turns off all of its SF selection LED indicators.

System/group changes or PTTs made at the EDACS Desk Top Station also causes the 5-bit SF update sequence to occur. The update sequence also occurs when the station is powered up.

Remote Transmit Function

The previous circuit analysis includes information on the control signalling sequences that occur for both a remote (*non-transmit*) function selection and a remote *transmit* function. As shown in Figure 1, additional control signalling is required between the EDACS RCN-1000(s) and the Desk Top Station for a remote *transmit* function. This additional signalling is described in the following paragraphs.

As in a conventional system, the 2175 Hz transmit hold tone sent out from an EDACS RCN-1000 is present on the transmit phone line (line from RCN-1000) until the PTT is unkeyed. This hold tone signals the Desk Top Station that the remote is keyed. During the hold tone period, Tone Remote Board 19A704686P8 pulls the PTT (FROM REMOTE) input at P207 pin 11 low. Microprocessor U701 reads this low via U702 and thus recognizes the keyed EDACS RCN-1000.

As shown in Figure 1, after the 5-bit SF update word is sent out, a low-level 2175 Hz tone is applied to the receive phone line pair (line to RCN-1000). This tone, generated by the Tone Remote Board, signals the EDACS RCN-1000's that the Desk Top Station is waiting for a channel assignment from the EDACS site. As with the initial high-level 2175 Hz handshake and the 5-bit SF update, the Keypad/Frequency Select Board uses its LOCAL PTT (P207 pin 6) and HANDSHAKE (P207 pin 7) outputs to control the 2175 Hz tone generator circuit on the Tone Remote Board. LOCAL PTT is high and HANDSHAKE is low when the low-level 2175 Hz tone is present on the receive phone line pair.

Next, the initiating EDACS RCN-1000 must be notified when the Desk Top Station receives a working channel assignment from the EDACS site. This is accomplished, as shown in Figure 1, by a 50-millisecond high-level 2175 Hz tone burst sent to the EDACS RCN-1000 via the receive phone line pair. This tone burst is known as the "OK to talk" burst. HANDSHAKE switches high for 50 milliseconds to switch the tone generator on the Tone Remote Board to a high-level output. When the initiating EDACS RCN-1000 receives the "OK to talk" tone burst, it opens its mic audio path and sounds its "OK to talk" beep. After the high-level 2175 Hz "OK to talk" burst occurs, the Keypad/Frequency Select Board switches the tone generator back to a low-level for the duration of the remote key. This is accomplished by switching HANDSHAKE back to a low level and leaving LOCAL PTT high for the remainder of the key.

If the Desk Top Station does not receive a working channel assignment from the EDACS site within five seconds, the "OK to talk" burst will not be generated. The Keypad/Frequency Select Board will re-initialize itself for another Secur-It/function/hold tone sequence.

Conventional Desk Top Stations

The Keypad/Frequency Select Board monitors the five (5) SF lines and two (2) other logic lines from the DC/Tone Remote Board. The two other lines are the PTT (FROM REMOTE) line at P207 pin 11 and the SEC DET line at P207 pin 12.

The DC/Tone Remote Board pulls PTT (FROM REMOTE) low when a remote control unit signals for a station key. The SEC DET (Secur-It™ tone detect) line from the DC/Tone Remote Board is a Channel Guard disable line; it does not signal the presence or absence of the Secur-It tone in a conventional tone remote controlled system.

Upon reading a change in one of the input lines, microprocessor U701 starts a serial communication sequence with the radio. This sequence transfers the new channel or function information to the mobile radio. It is similar to the sequence used for keypad communication — first, SERIAL RQST (P208 pin 8) falls low, then message activity occurs on the BUF KEYPAD SERIAL and BUF DISPLAY SERIAL lines, and finally, SERIAL RQST transitions back to a high logic state.

Remote Operation Disabled

Remote control operation of EDACS and conventional Desk Top Stations can be disabled by switching "REMOTE" switch S1 on the Desk Top Station's control panel to the "OFF" position. In this mode, the Keypad/Frequency Select Board completely ignores all remote activity and thus the Desk Top Station can only be controlled locally.

Microprocessor U701 periodically checks the position of S1 by reading the /REMOTE OFF SW line (P207 pin 10). This line connects to S1 via the Interconnect Board and the Remote Interface Board. It is low when S1 is in the "OFF" position.

VOLTAGE REGULATOR U705

Voltage regulator U705 is a 5-terminal linear regulator that provides a 5-volt regulated supply for the logic circuits on the board. U705 also provides a reset pulse for microprocessor U701 at power-up and if the 5 Vdc line falls out of regulation.

Regulator Functions

A+ input power from the station's power supply (13.8 Vdc) is applied to the board at P208 pins 3 and 4. As indicated on the interconnection diagram, this plug mates with J208 on the Interconnect Board. The 13.8 Vdc power is applied to the input terminal of U705 at pin 1 and the 5 Vdc regulated output power appears on U705 pin 5. Supply decoupling capacitors include C24, C25 and C699 on the input pin and C711 on the output pin.

Reset Functions

The reset pulse for microprocessor U701 is generated by U705's internal reset circuit. At turn-on, U705 pin 2 remains low until approximately 30 milliseconds *after* the +5 Vdc line raises above 4.85 Vdc. This 30 millisecond delay provides ad-

LBI-39047

ditional power-up stabilization time for the 5 Vdc regulated supply and it also allows the microprocessor's internal clock to fully stabilize before the microprocessor starts. Capacitor C709 on U705 pin 4 sets the reset pulse width time. Transistor Q703 and associated components invert the reset pulse before it is applied to U701 pin 10.

During normal operation, U701 pin 10 remains in a logic low state. If the 5 Vdc supply line falls below 4.85 Vdc, U705 pin 4 will transition low and thus reset the microprocessor via the inverted pulse at U701 pin 10. This non-power-up reset could occur, for example, during ac power brown-out conditions.

QUICK TESTS

In general, the Keypad/Frequency Select Board can be considered operational if the keypad interface functions correctly. Keypad actions test all of the microprocessor logic circuits and the serial link between the board and the radio. The I/O lines not tested by a keypad action can be tested by comparing logic levels at the particular I/O pin and the respective I/O pin at the microprocessor.

A quick tests of the keypad with an EDACS radio can be made by placing the radio in special call mode and then entering numbers at the keypad. Each entered number should appear in the radio's display. Pressing "*" should cause the radio to initiate a telephone interconnect call. Pressing "#" should clear the radio out of special call mode.

If the station is a conventional station, keypad operation may be tested if the radio's current operating channel is programmed for DTMF operation. Pressing a key while the radio is transmitting should transmit the respective DTMF tone. If necessary, monitor the transmitted DTMF tone with a companion receiver and a DTMF decoder.

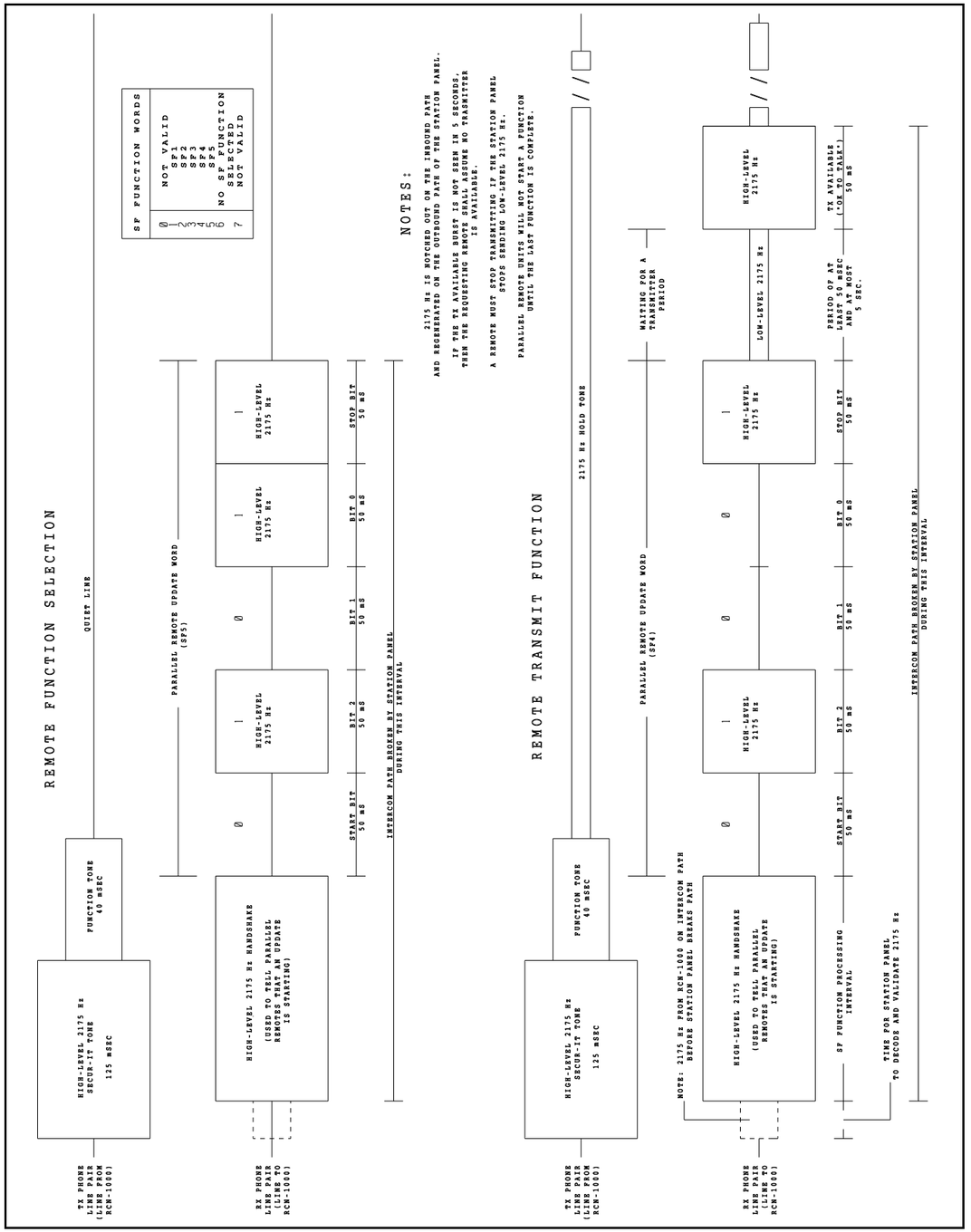
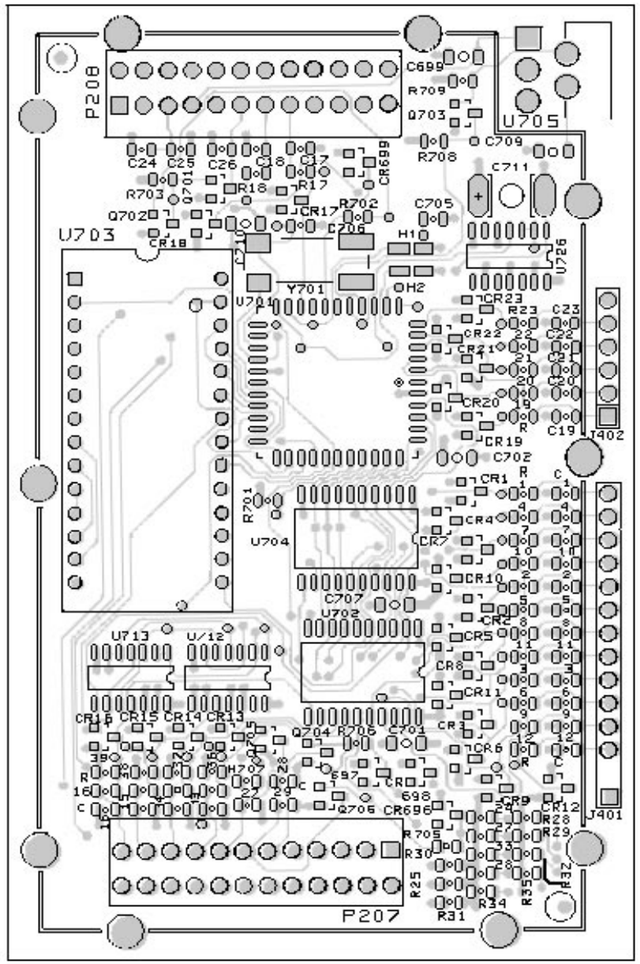


Figure 1 - EDACS Remote Control Signalling

COMPONENT SIDE



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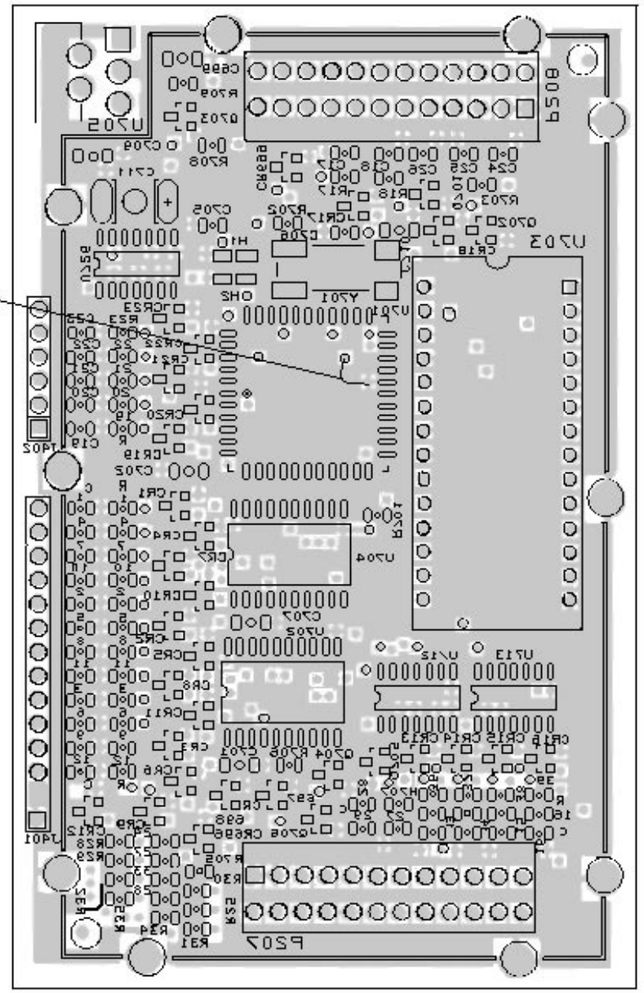
SOLDER SIDE



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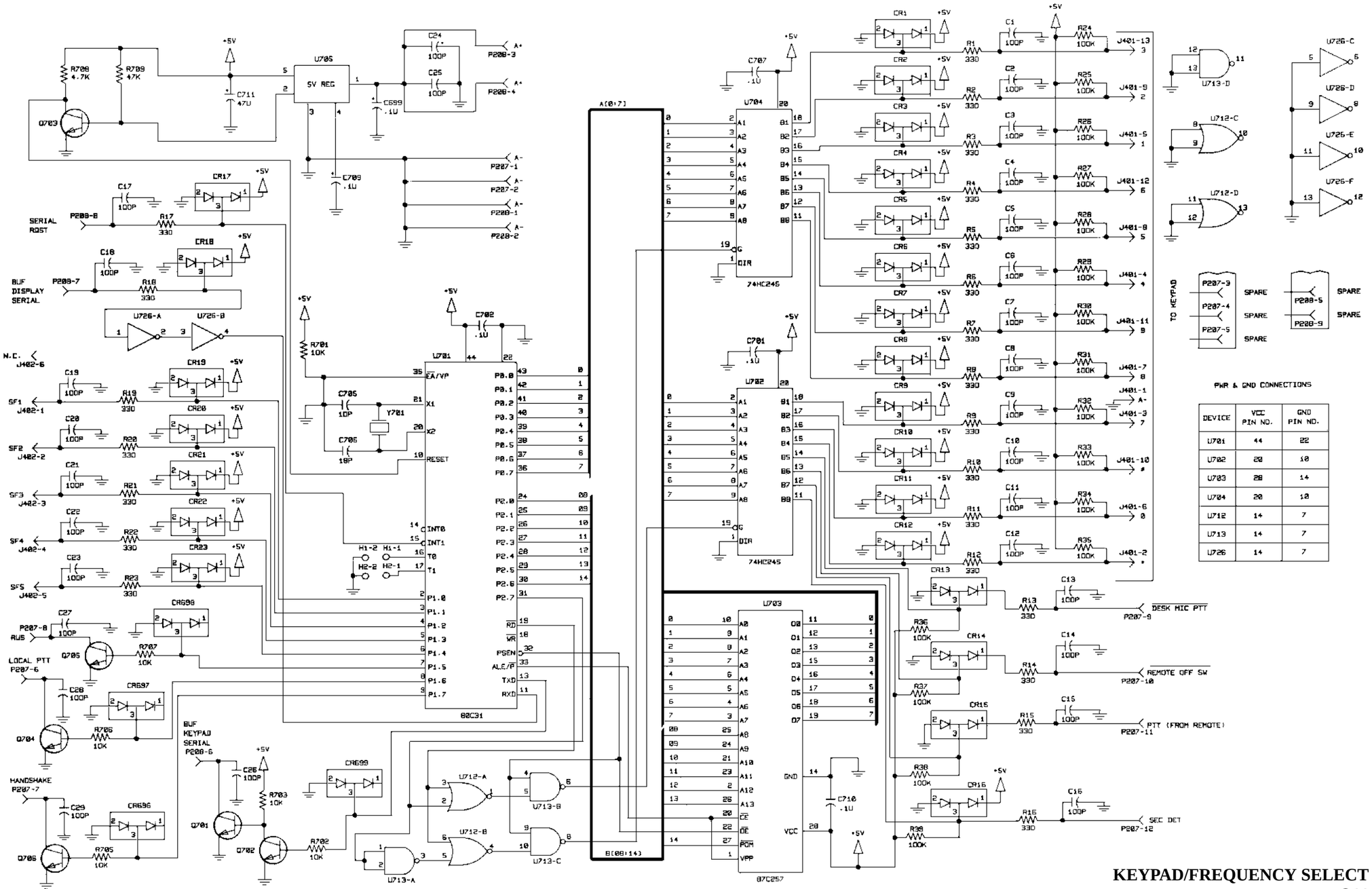
KEYPAD/FREQUENCY SELECT BOARD
344A3383P1



PWR & GND CONNECTIONS

DEVICE	VCC PIN NO.	GND PIN NO.
U701	44	22
U702	20	10
U703	28	14
U704	20	10
U712	14	7
U713	14	7
U726	14	7

KEYPAD/FREQUENCY SELECT BOARD
344A3383P1

(19D903567, Rev. 0)

KEYPAD/FREQUENCY SELECT BOARD 344A3383P1

Issue 2

SYMBOL	PART NO.	DESCRIPTION
		---------- CAPACITORS ----------
C1 thru C29	19A702061P61	Cer, 0805, 5%, 50V, NPO, 100pf
C699, C701, C702, C707, C709, C710,	19A702052P26	Cer, 1206, 20%, 50VMIN, Z5U, 0.1 uF
C705	19A702061P13	Cer, 0805, 5%, 50V, COG, 10pf
C706	19A702061P25	Cer. 0805, 5%, 50V, COG, 18pf
C711	19A705205P111	Tant, (D), 20%, 10V, 47 uF
		----------DIODES ----------
CR1 thru CR23, and CR696 thru CR699	19A700053P2	DIO, SW Dual, SOT23, 7000, 100V
		---------- JACKS ----------
J401	19A703248P11	HDR, 14, S RW, V MT, W/PP, 10U" AU CT
J402	19A703248P11	HDR, 06, S RW, V MT, .1CTR, 10U" AU CT
		---------- PLUGS ----------
P207, P208	19A704779P11	PCBCON, 12, BTM, NTRY, .1CTR, 10U" AU CT
		----------TRANSISTORS ----------
Q701 thru Q706	19A700076P2	General Purpose, NPN, SOT23, 3904
		----------RESISTORS ----------
R1 thru R23	19B801251P331	0805, 5%, 1/10W, 330 Ohms
R24 thru R39	19B801251P104	0805, 5%, 1/10W, 100K Ohms
R701 thru R703 and R705 thru R707	19B801251P103	0805, 5%, 1/10W, 10K Ohms
R708	19B801251P472	0805, 5%, 1/10W, 4.7K Ohms
R709	19B801241P473	0805, 5%, 1/10W, 47K Ohms
		----- INTEGRATED CIRCUITS ------
U701		8-BIT MICROPROCESSOR, N80C31BH
U702 and U704	19A703471P108	BUS/LINE TRANSCEIVER, 74HC245
U703	344A3758G3	EPROM, 87C257
U705	19A704970P1	VOLTAGE REGULATOR (5V), L387A
U712	19A703483P101	2-INPUT NOR GATE, 74HC02
U713	19A703483P302	2-INPUT NAND GATE, 74C00
U726	19A703483P321	SCHMITT-TRIGGER-INVERTER, 74HC14
		----------SOCKET ----------
XU703	19A700156P3	DIP28, D WP, 0/BD, 10U" AU CT
		---------- CRYSTAL ----------
Y701		SMT, 20PF, 100PPM, 11.0592 MHz

• COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PRODUCTION CHANGES

Changes in the equipment to improve or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

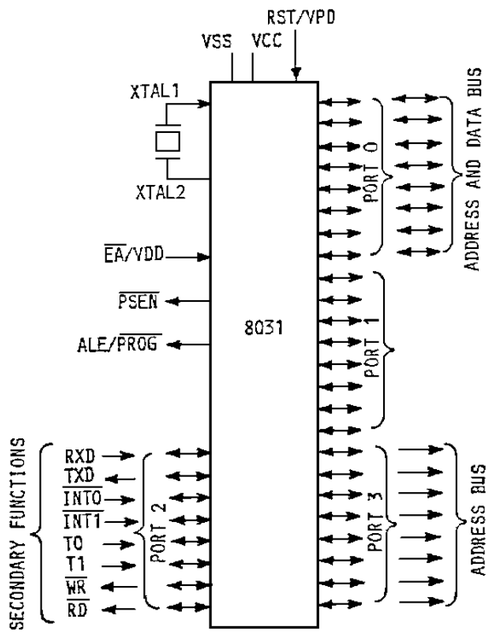
REV. A - KEYPAD/FREQ SEL BOARD 344A3383P1
Incorporated in initial shipments.

REV. B - KEYPAD/FREQ SEL BOARD 344A3383P1
To add "sleep" command when PC programming. Software changed for U703. Was 344A3758G1.

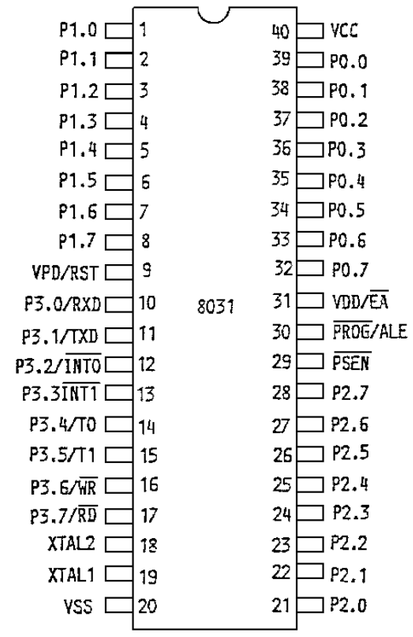
REV. C - KEYPAD/FREQ SEL BOARD 344A3383P1
To support 2-freq. DC control board software changed for U703. Was 344A3758G2.

8-BIT MICROPROCESSOR (U701)

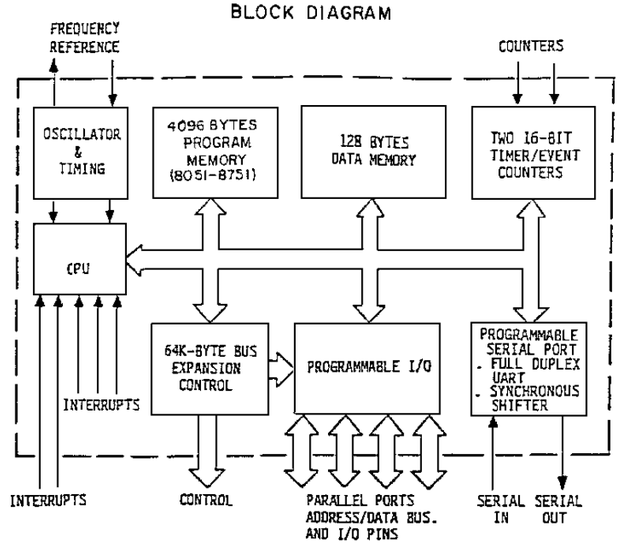
LOGICAL SYMBOL



PIN CONFIGURATION

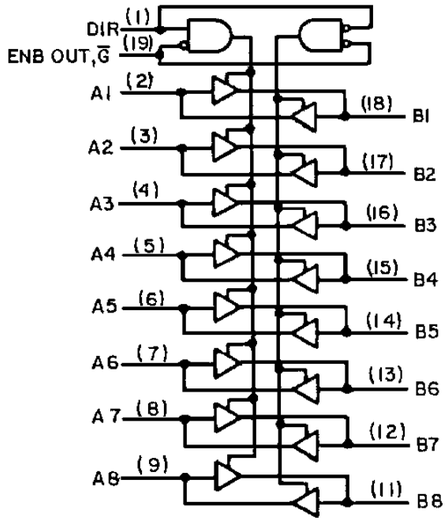


BLOCK DIAGRAM



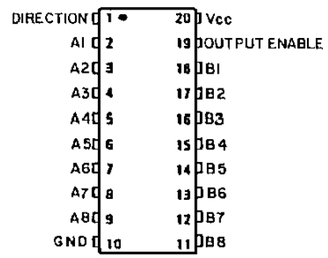
3-STATE BUS/LINE TRANSCEIVER
19A703471P108 (U702, U704)

LOGIC DIAGRAM (POSITION LOGIC)



PIN 10 = GND
PIN 20 = Vcc

PIN ASSIGNMENT

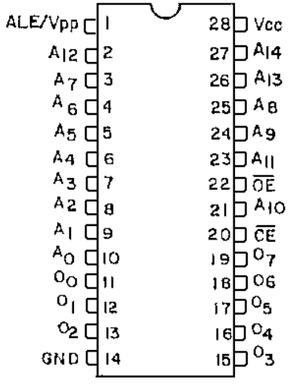


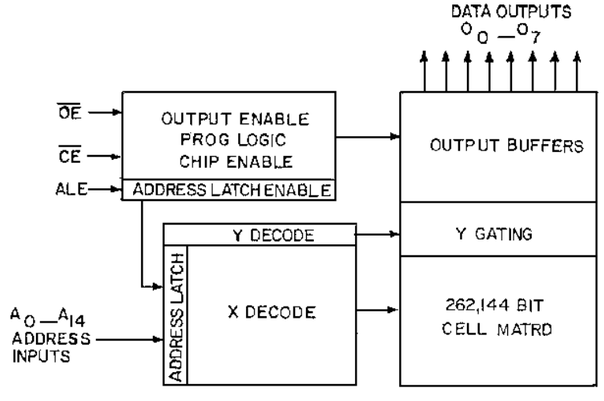
FUNCTION TABLE

CONTROL INPUTS		OPERATION
OUTPUT ENABLE	DIRECTION	
L	L	DATA TRANSMITTED FROM BUS B TO BUS A
L	H	DATA TRANSMITTED FROM BUS A TO BUS B
H	X	BUSES ISOLATOR (HIGH IMPEDANCE STATE)

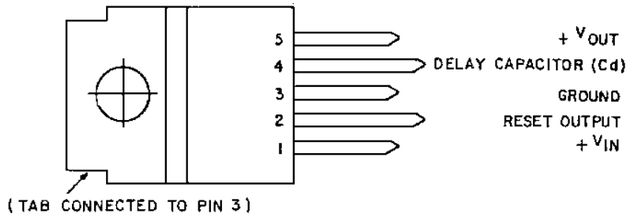
X=DON'T CARE

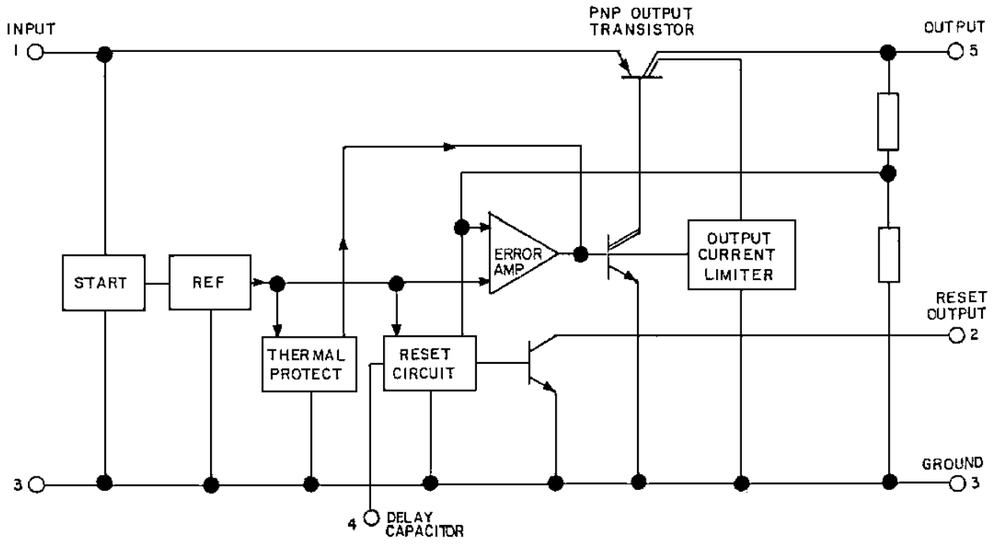
EEPROM
3443758G1 (U703)





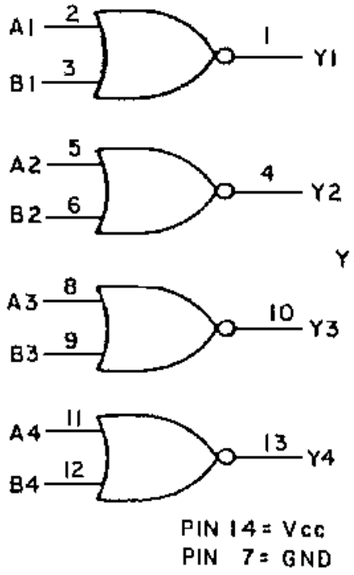
VOLTAGE REGULATOR
19A704970P1 (U705)





QUAD 2-INPUT NOR GATE
19A703483P101 (U712)

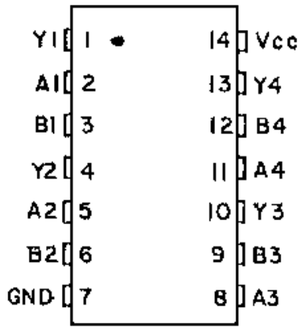
LOGIC DIAGRAM



$Y = \overline{A + B}$

PIN 14 = Vcc
PIN 7 = GND

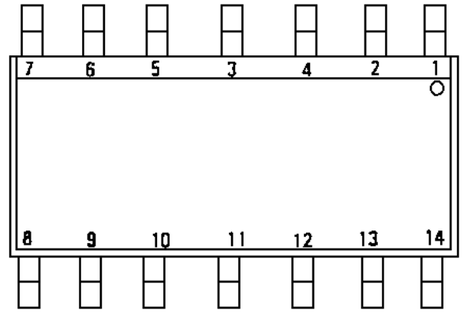
PIN ASSIGNMENT

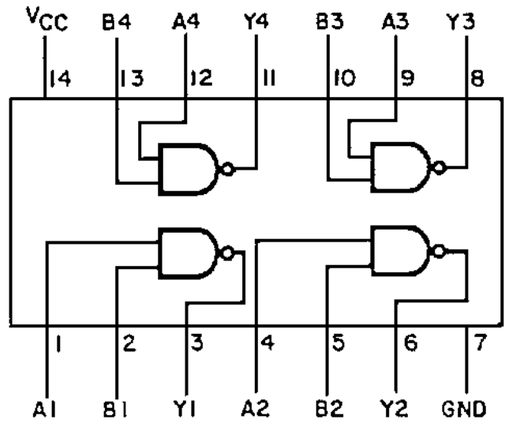


FUNCTION DIAGRAM

INPUTS		OUTPUT
A	B	Y
L	L	H
L	H	L
H	L	L
H	H	L

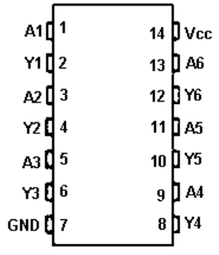
QUAD 2-INPUT NAND GATE
19A703483P302 (U713)





SCHMITT-TRIGGER-INVERTER
19A703483P321 (U726)

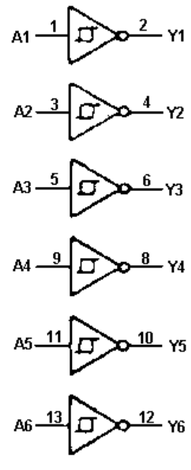
PIN ASSIGNMENT



FUNCTION TABLE

Input	Output
A	Y
L	H
H	L

LOGIC DIAGRAM



$Y = \overline{A}$

PIN 14 = Vcc
PIN 7 = GND

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