MAINTENANCE MANUAL

MULTISITE COORDINATOR II
4-CHANNEL AUDIO BOARD
19D903302P1, REVISION E&M

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SPECIFICATIONS

TEMPERATURE	-30°C to +60°C
DIMENSIONS (Height X Width)	200 mm X 330 mm (typical)
WEIGHT	1.0 kG (typical)
POWER	+5.0 Volts ±10% 1.75 Amperes (maximum) 2.0 Amperes Fuse +15 Volts ±10% 0.3 Amperes (maximum) 0.5 Amperes Fuse - 15 Volts ±10% 0.3 Amperes (maximum) 0.5 Amperes Fuse
RELAY OUTPUTS:	
120 Volts AC or DC	Maximum Switching Voltage
At 0.2 Amperes	Maximum Switching Current
30 Volts	Maximum Carry Current
30 VA	Maximum Switching Power
DIGITAL LEVELS	TTL/CMOS/HCMOS RS-232C RS-485 FUTUREBUS OPTOCOUPLER
DIGITAL DATA RATE	9600 BAUD 1 MEGA BAUD 2.048 MEGA BAUD
AUDIO LEVELS	+12 dBm (maximum) - 25 dBm (minimum)
AUDIO DISTORTION	Less Than 2.5%
AUDIO HUM AND NOISE	Less Than 50 dB

TABLE 1 - J1 PIN DEFINITIONS

CONNECTOR PIN	SIGNAL NAME	A(AUDIO) D(DIGITAL)	LEVEL TYPE
J1-32A	GND	-	0 VOLTS
J1-1B	CL (4)	D	FUTUREBUS
J1-2B	GND	-	O VOLTS
J1-3B	CL (5)	D	FUTUREBUS
J1-4B	GND	-	0 VOLTS
J1-5B	CL (6)	D	FUTUREBUS
J1-6B	GND	-	O VOLTS
J1-7B	CL (7)	D	FUTUREBUS
J1-8B	GND	-	O VOLTS
J1-9B	TDM BUS (0)	D	FUTUREBUS
J1-10B	GND	-	0 VOLTS
J1-11B	TDM BUS (1)	D	FUTUREBUS
J1-12B	GND	-	0 VOLTS
J1-13B	TDM BUS (2)	D	FUTUREBUS
J1-14B	GND	-	O VOLTS
J1-15B	TDM BUS (3)	D	FUTUREBUS
J1-16B	GND	-	O VOLTS
J1-17B	TDM BUS (4)	D	FUTUREBUS
J1-18B	GND	-	O VOLTS
J1-19B	TDM BUS (5)	D	FUTUREBUS
J1-20B	GND	-	O VOLTS
J1-21B	TDM BUS (6)	D	FUTUREBUS
J1-22B	GND	-	O VOLTS
J1-23B	TDM BUS (7)	D	FUTURE
J1-24B	GND	-	O VOLTS
J1-1C	+5	-	+5 VOLTS
J1-2C	GND	-	O VOLTS
J1-3C	GND	-	O VOLTS
J1-8C	AUX SER +	D	RS-485
J1-9C	AUX SER -	D	RS-485
J1-12C	GND	-	0 VOLTS
J1-13C	DB (0)	D	TTL
J1-14C	DB (1)	D	TTL
J1-15C	DB (2)	D	TTL
J1-16C	DB (3)	D	TTL
J1-17C	DB (4)	D	TTL
J1-18C	DB (5)	D	TTL
J1-19C	DB (6)	D	TTL
J1-20C	DB (7)	D	TTL
J1-22C	GND	-	0 VOLTS
J1-23C	ENBL (0)	D	TTL
J1-24C	ENBL (1)	D	TTL
J1-25C	ENBL (2)	D	TTL
J1-26C	ENBL (3)	D	TTL
J1-27C	ENBL (4)	D	TTL
J1-28C	ENBL (5)	D	TTL
J1-29C	ENBL (6)	D	TTL
J1-30C	ENBL (7)	D	TTL
J1-31C	+5	-	+5 VOLTS
J1-32C	GND	-	0 VOLTS

TABLE 3 - TEST POINT DEFINITIONS

TEST POINT NUMBER	TEST POINT NAME
TP1	CODEC CO 3 (NU)
TP2	CODEC VFXI 3
TP3	CODEC VFXO 3 (NU)
TP4	STATION 2175 BURST CHANNEL 3
TP5	OP AMP DRIVING CHANNEL 3 OUT
TP6	CODEC CO 2 (NU)
TP7	CODEC VFXI 2
TP8	CODEC VFXO 2 (NU)
TP9	STATION 2175 BURST CHANNEL 2
TP10	OP AMP DRIVING CHANNEL 2 OUT
TP11	CODEC CO 1 (NU)
TP12	CODEC VFXI 1
TP13	CODEC VFXO 1 (NU)
TP14	STATION 2175 BURST CHANNEL 1
TP15	OP AMP DRIVING CHANNEL 1 OUT
TP16	CODEC VFXO 4 (NU)
TP17	CODEC VFXI 4
TP18	CODEC CO 4 (NU)
TP19	OP AMP DRIVING CHANNEL 4 OUT
TP20	STATION 2175 BURST CHANNEL 4
TP21	GND
TP22	-12V
TP23	+ 12V
TP24	-5V
TP25	+ 5V
TP26	2175
TP27	BIT CLK
TP28	SSYNC
TP29	FSYNC
TP30	TDMX BUS 0
TP31	TDMX BUS 1
TP32	TDMX BUS 2
TP33	TDMX BUS 3
TP34	TDMX BUS 4
TP35	TDMX BUS 5
TP36	TDMX BUS 6
TP37	TDMX BUS 7
TP38	LCA PROGRAM CHANNEL 4
TP39	SINOUT TO CHANNEL 4
TP40	CODEC SERIAL DATA OUT 4
TP41	LCA PROGRAM CHANNEL 3
TP42	SINOUT TO CHANNEL 3
TP43	CODEC SERIAL DATA OUT 3
TP44	LCA PROGRAM CHANNEL 2
TP45	SINOUT TO CHANNEL 2
TP46	CODEC SERIAL DATA OUT 2
TP47	LCA PROGRAM CHANNEL 1
TP48	SINOUT TO CHANNEL 1
TP49	CODEC SERIAL DATA OUT 1

TABLE 3 - TEST POINT DEFINITIONS

TEST POINT NUMBER	TEST POINT NAME
TP1	CODEC CO 3 (NU)
TP2	CODEC VFXI 3
TP3	CODEC VFXO 3 (NU)
TP4	STATION 2175 BURST CHANNEL 3
TP5	OP AMP DRIVING CHANNEL 3 OUT
TP6	CODEC CO 2 (NU)
TP7	CODEC VFXI 2
TP8	CODEC VFXO 2 (NU)
TP9	STATION 2175 BURST CHANNEL 2
TP10	OP AMP DRIVING CHANNEL 2 OUT
TP11	CODEC CO 1 (NU)
TP12	CODEC VFXI 1
TP13	CODEC VFXO 1 (NU)
TP14	STATION 2175 BURST CHANNEL 1
TP15	OP AMP DRIVING CHANNEL 1 OUT
TP16	CODEC VFXO 4 (NU)
TP17	CODEC VFXI 4
TP18	CODEC CO 4 (NU)
TP19	OP AMP DRIVING CHANNEL 4 OUT
TP20	STATION 2175 BURST CHANNEL 4
TP21	GND
TP22	-12V
TP23	+ 12V
TP24	-5V
TP25	+ 5V
TP26	2175
TP27	BIT CLK
TP28	SSYNC
TP29	FSYNC
TP30	TDMX BUS 0
TP31	TDMX BUS 1
TP32	TDMX BUS 2
TP33	TDMX BUS 3
TP34	TDMX BUS 4
TP35	TDMX BUS 5
TP36	TDMX BUS 6
TP37	TDMX BUS 7
TP38	LCA PROGRAM CHANNEL 4
TP39	SINOUT TO CHANNEL 4
TP40	CODEC SERIAL DATA OUT 4
TP41	LCA PROGRAM CHANNEL 3
TP42	SINOUT TO CHANNEL 3
TP43	CODEC SERIAL DATA OUT 3
TP44	LCA PROGRAM CHANNEL 2
TP45	SINOUT TO CHANNEL 2
TP46	CODEC SERIAL DATA OUT 2
TP47	LCA PROGRAM CHANNEL 1
TP48	SINOUT TO CHANNEL 1
TP49	CODEC SERIAL DATA OUT 1

TABLE 4 - LED DEFINITIONS

LED	LED DEFINITION
CR1	+ 5 VOLTS
CR2	+ 12 VOLTS
CR3	- 12 VOLTS
CR4	- 5 VOLTS
LED 1	FSYNC
LED 2	SSYNC
LED 3	BIT CLK
LED 4	2175
CR5	CHANNEL ADDRESS WRITE
CR6	CPU RUN

DESCRIPTION

Ericsson GE's 4-Channel Audio Board (19D903302G1) is used in the MultiSite Coordinator II switching system and consists of four (4) identical bi-directional audio processing and routing circuits, and a control circuit. Each audio circuit (audio channel section) converts incoming analog audio signals from trunked repeater sites or console(s) into digitized audio signals. These digitized audio signals are then outputted to a **TDM** audio network (refer to Figure 1). The audio channel circuitry also takes selected digitized audio signals from the **TDM** audio network and converts them from digital to analog form. The resulting analog signals are sent to RF repeater sites or consoles "**channels**" for transmission.

The **TDM** audio network is a Timed-Division-Multiplexed **(TDM)** bus. The **TDM** bus provides multiple time-shared channels for routing digitized audio signals between nodes.

NOTE

Since there are four identical audio circuits (channels), the circuitry for only one audio channel (channel 3) is shown in Figure 2 - Audio Circuit Block Diagram and referred to in the following Circuit Analysis.

The control section of the Audio Board provides control and clock signals to the audio channel sections. The control section also provides an interface to the module controller board(s). This interface between the module controller board(s) allows the active controller board to communicate with the control registers and other control circuits of the Audio Board control section. The functions of the module controller board and the Audio Board control section are designed to be overlapping and redundant.

During times when the module controller board is not addressing the Audio Board control section, the on-board 80C535 microprocessor is capable of controlling the audio sections to perform most, not all, of the functions that the Controller Board causes them to perform. The 80C535 microprocessor is provided primarily for diagnostic purposes. Control functions which the microprocessor performs under program control may, as an example, exercise or test the audio channel sections. Such diagnostics may be performed in response to commands received from the controller over the **HDLC** link. The **HDLC** link is an FCC protocol.

In addition to providing redundant or secondary control/addressing of control circuits (control latches) the 80C535 microprocessor performs routine control functions associated with the audio sections. These functions include generating chip select and read/write signals, illuminating status indicators, controlling electronic potentiometer levels.

A clock select latch and multiplexer is used to select between redundant sets of master clocking signals common to the entire MultiSite Coordinator switching system. This ensures that each audio section is synchronized with the **TDM** bus. The selected clocking signals are sent to the audio sections through a **CLOCKS** line.

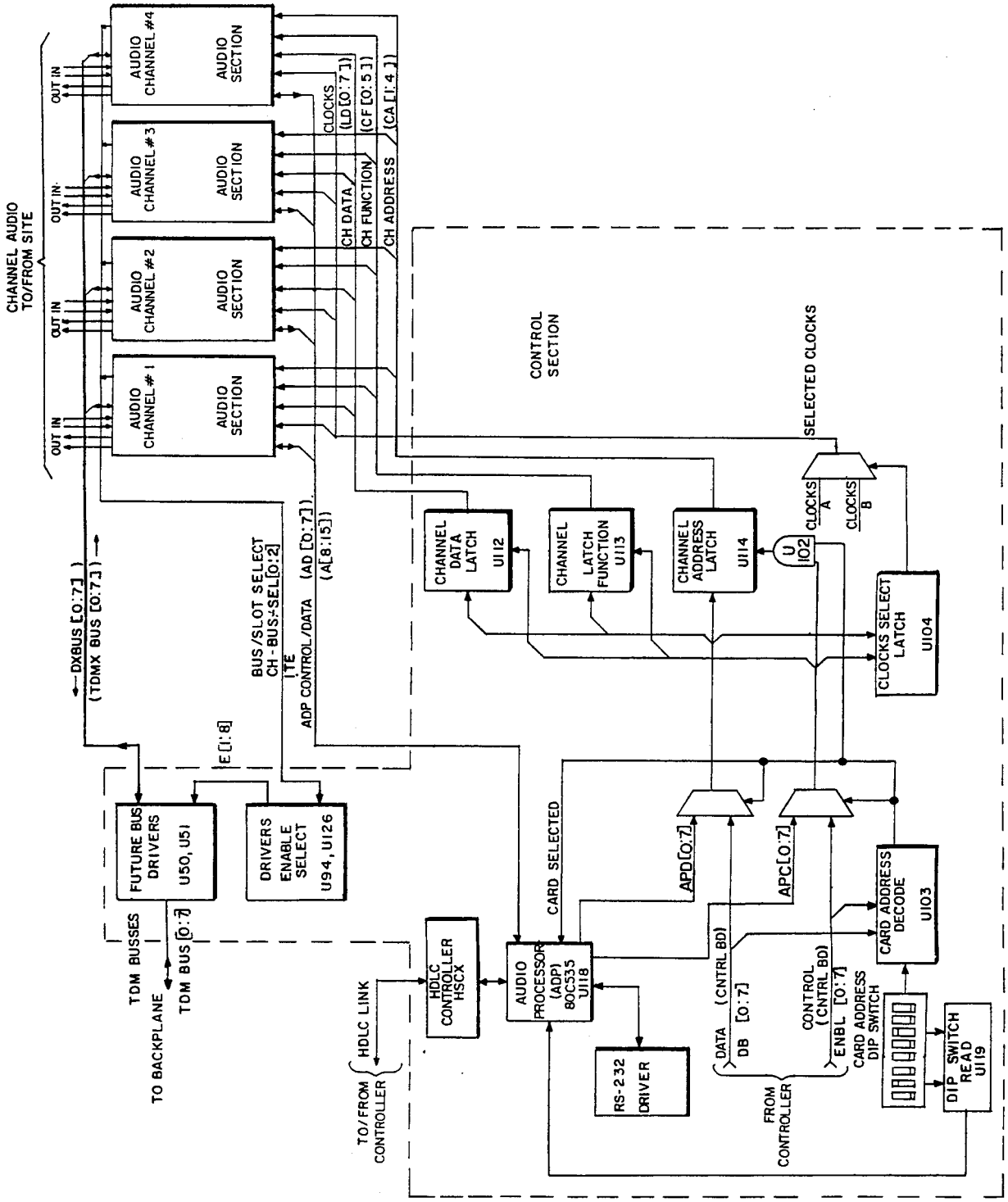


Figure 1 - Audio Board Block Diagram

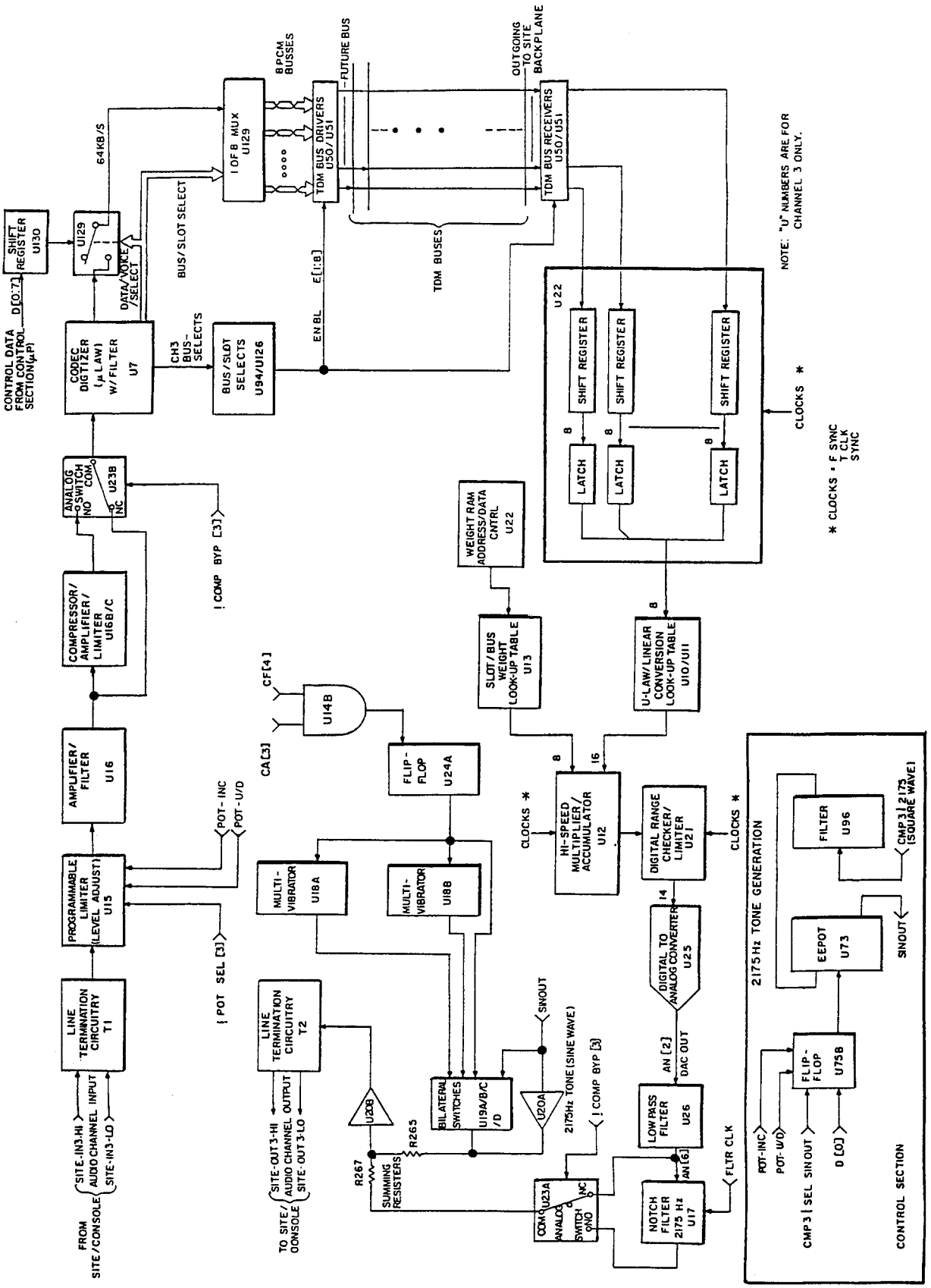


Figure 2 - Audio Circuit Block Diagram

CIRCUIT ANALYSIS

VOLTAGE REGULATION

External voltage input levels to the Audio Board are +5 Vdc, +15 Vdc and -15 Vdc. These levels are regulated to produce +5 Vdc (Vcc), +12 Vdc, -12 Vdc and -5 Vdc respectively. Refer to the Schematic Diagram, Sheet 1.

+5 Vdc (Vcc) Regulation

The external +5 Vdc connects to the Vcc regulation circuit from **CMP2| +5EXT** through 3 amp fuse F1. Filtering is provided by 100 µH inductor L3 and 100 µF capacitor C122. Leaded diode D6 removes any negative transients. LED CR1 illuminates when Vcc is present.

The regulated Vcc output is taken from the point labeled Vcc on the Schematic Diagram. The Vcc can be read, using a voltmeter, between **TP25** (Vcc) and **TP21** (GND).

+12 Vdc Regulation

The external +15 Vdc connects to the +12 Vdc regulation circuits from **CMP2| +15EXT** through 0.5 amp fuse F2. Filtering, ahead of voltage regulator U2, is provided by 8.2 µH inductor L2, 0.1 µF capacitor C2 and 100 µF capacitor C121. Additional filtering, after U2, is provided by 0.1 µF capacitor C3 and 100 µF capacitor C124. Leaded diode D2 removes any negative transients. LED CR2 illuminates when +12 Vdc is present.

The regulated +12 Vdc is taken at the point labeled **+12V** on the Schematic Diagram. The +12 Vdc can be read, using a voltmeter between **TP23** (+12 Vdc) and **TP21** (GND).

-12 Vdc Regulation

The external -15 Vdc connects to the -12 Vdc regulation circuits from **CMP2|-15EXT** through 0.5 amp fuse F3. Filtering, ahead of voltage regulator U1, is provided by 8.2 µH inductor L1, 0.1 µF capacitor C1 and 100 µF capacitor C120. Additional filtering, after U1, is provided by 0.1 µF capacitor C4 and 100 µF capacitor C123. Leaded Diode D1 provides protection from positive transients. LED CR3 illuminates when -12 Vdc is present.

The regulated -12 Vdc is taken at the point labeled **-12V** on the Schematic Diagram. The -12 Vdc can be read, using a voltmeter between **TP22** (-12 Vdc) and **TP21** (GND).

-5 Vdc Regulation

The regulated -12 Vdc is applied to the input of voltage regulator U3. Input filtering is provided by 0.33 µF capacitor C126. Additional output filtering is provided by 0.1 µF capacitor C5 and 100 µF capacitor C125. Leaded diode D7 provides protection from positive transients. LED CR4 illuminates when -5 Vdc is present.

The regulated -5 Vdc is taken at the point labeled **-5V** on the Schematic Diagram. The -5 Vdc can be read, using a voltmeter between **TP24** (-5 Vdc) and **TP21** (GND).

DECOUPLING

Decoupling on the Audio Board is provided by 0.01 µF capacitors (C6 through C255) connected between all voltage inputs of integrated circuits (U1 through U134) and ground (GND). Refer to the Schematic Diagram, Sheet 1.

CONTROL

The Control section of the Audio Board provides control and clock signals to four (4) audio channel sections. The heart of the Control section is microprocessor U118 (SAB80C535). Other microprocessor associated control circuit elements consist of HDLC controller/interface U108 (SAB82525), address decoder U109 (74HC138D), control data latch U115 (multiplex select) (74HC573D), RAM memory U52 (CY7C128-55PC), EPROM U99 (27C256), data multiplexer circuits U106/U107 (74HC157DQ), control signal multiplexer U105 (74HC157DQ) and serial RS-232 port U74 (MAX232C).

Control Registers

Control registers output control signals to audio channel sections. These control registers consist of **Channel Data Latch** U112 (74HC573D), **Channel Function Latch** U113 (74HC573D) and **Channel Address Latch** U114 (74HC573D). The **Channel Address Latch** selects, through the **CH ADDRESS** bus (CA[1:4]), the audio channel section to perform the function specified by the control signals latched in the **Channel Function Latch.** The **Channel Function Latch** provides parallel control signals to the audio channel sections through the **CH FUNCTION** bus (CF[0:5]). Each of the control signals specify a different function to be performed by the audio channel section. The **Channel Data Latch** stores an 8-bit data word sent to each audio channel section through the **DATA LATCH** bus (LD[0:7] (refer to the schematic diagram, sheet 2)). The use of the 8-bit word depends on the function selected by the contents of the **Channel Function Latch.**

Controller Board

The module controller Board can also write to the Audio Board control registers and other Audio Board control circuits by imposing data on the **DATA** bus (DB[0:7]) and additional control signals on the **CONTROL** or **ENABLE** bus (ENBL[0:7]). The address of the Audio Board is set by address DIP switch SW1. The address signals are decoded by address decode logic consisting of 4-bit comparator U103 (74HC85D), enabling NAND gate U101D, flip-flop U123 (74HC74) and other associated NAND gates U102 (74HC00). When the Controller Board places the address, set by SW1, onto data bus DB[0:7]), multiplexers U105, U106 and U107 (74HC157DQ) are controlled to select Controller Board control of the data and control latches.

The circuit consisting of NOR gate U121B (74HC02D), inverter U124F (74HC14D) and latch U119 (74HC2455) is used to latch the switch settings of DIP switch SW1 on to data bus D[0:7]. The setting on SW1 (CMP3|SW[0:7]) is latched onto the microprocessor data bus when the CMP3|!POT_SW input from address decoder U109 and the CMP3|!WR input from microprocessor U118 goes low.

The signals generated on the control bus (ENBL[0:7]) select the type of programming operation that the Controller Board is to perform on the audio module. For example, the selection of which control register is to be loaded with the signals carried by the **DATA** bus is determined by control lines of the control bus from the Controller Board. The following describes bit significance for control words imposed by the Controller Board on the control bus (ENBL[0:7]).

ENBL0: **Channel Data Latch** enable
ENBL1: not used
ENBL2: **Channel Function Latch** enable
ENBL3: Write Codec enable
ENBL4: Clock select enable
ENBL5: not used
ENBL6: Unselect Card (or Clear Card)
ENBL7: **Channel Address Latch** enable

The contents of the **Channel Function Latch** causes control signals to be generated that directly control an audio channel section addressed by the **Channel Address Latch** to perform desired functions. The **CHANNEL FUNCTION** bus (CF[0:5]) output provided by the **Channel Function Latch** is six (6) bits wide. The functional significance of these six signals (CF0-CF5) with respect to audio sections are set as follows:

CF0: Selects type of digitized audio converting (e.g. selects between μlaw or Alaw, or between μlaw and no conversion. **NOTE:** Requires different conversion ROM's (U10, U11).

CF1: Bus Number/Slot Write Enable (the contents of the **Channel Data Latch** are to be loaded into the address audio section and used to designate a TDM bus number/slot. Allows WR line to go low.

CF2: Weighting Table Write enable; ADDR, LATCH ENBL for Weight RAM (Weight RAM has TDMX bus)

CF3: Write Codec Enable

CF4: Activates 2175 Hz Tone Generator

CF5: Enable auxiliary relay (e.g. to light an indicator each time PTT is present).

When the Controller Board is not addressing the Audio Board, multiplexers U105, U106 and U107 (74HC157DQ) select the output of audio processor control/data busses for output to the control register. In this way, local on-board microprocessor U118 can control the audio sections and make them perform some of the functions that the Controller Board can make them perform.

Microprocessor

The microprocessor (U118) is primarily for diagnostic purposes. Control functions which U118 performs under program control may, for example, exercise or test the audio channel sections. Such diagnostics may be performed in response to commands received by U118 from the Controller Board over the HDLC link.

In addition to providing redundant or secondary control/addressing of control latches, U112 through U114, microprocessor U118 performs additional routine control functions associated with the audio channel sections. These function include, as an example, generating chip select and read/write signals, illuminating status indicators, controlling levels set by electronic potentiometers. Such routine control signals are sent to the audio channel sections by U118 through an Address/Data bus (D[0:7]).

Receive Data (CMP3|RXD) and Transmit Data (CMP3|TXD) for diagnostics purposes is written to or read from U118 through 9-Pin connector J3, Pins 2 (J3B) and 3 (J3C) and transmitter/receiver U74 (MAX232C). An RS-232 input is applied to J3B, Pin 1 and to U74, Pin 13. A TTL output is realized on U74, Pin 12 (CMP3|RXD). A TTL input on U74, Pin 11 (CMP3|TXD) is converted to an RS-232 output at U74, Pin 14 and Pin 3 (J3C).

Data Bus D[0:7] to Backplane

Data Bus to backplane interfacing is accomplished using opto couplers U27A and U18A. To write from data bus D[0:7] to the backplane, microprocessor U118 provides an enable signal (CMP3|!IO EN) and a write signal (CMP3|! WR). These signals are then input to NAND gate U121D (74HC02D) (Refer to the Schematic Diagram, Sheet 4). The character "!" implies an active low condition. If there is no "!" present then the condition is an active high. NAND gate U121D outputs to 4-bit latch circuit U29 (74HC175). When the two signals, EN and WR, are present the output of U121D (CMP3|10 WR) is applied to U29, Pin 9 (CLK). This latches the 4-bit D[0:3] data into U29. The data is now present on the output side, CMP3|OUT 1, CMP3|OUT 2, CMP3|OUT 3 and CMP|OUT 4 respectively. These four outputs are applied the inputs of opto couplers U27A,B,C,D, Pins 2, 3, 6 and 7 respectively. The 4-bit output data is now written to backplane TDM busses OUTL[1:4] and OUTH[1:4].

To read from the backplane to Data Bus D[0:7] a read enable command is generated through address decoder U109 (74HC138D). This command (CMP3|!IO EN) is applied to an input of NAND gate U121C (74HC02D). A read command (CMP3|!RD) generated by U118 is connected to the other input of U121C. The output of U121C (CMP3|IO RD) is applied to the OE inputs of operational amplifiers U46A,B,C,D. With this signal present, the data on the backplane (INH(1:4) and INL(1:4) is read through opto couplers U18A,B,C,D and operational amplifiers U46A,B,C,D to Data Bus D[7:4].

Master Clocking

Master clocking of the audio channel sections ensures that each audio section is synchronized with the TDM bus. Clock selection is accomplished by 4-bit multiplexer U104 (74HC157DQ), Flip-Flop U123B (74HC74), NAND gates U101A/B (74HC00) and inverter U124C (74HC14D). Flip-Flop U123B latches the clock selection controlled by LD[0] and WBCN. These circuits select between redundant sets of master clocking signals common to the entire MultiSite Coordinator II switching system. Clocking signals include Bit Clock A (BCLKA), Bit Clock B (BCLKB), Slot Sync Clock A (SSYNCA), Slot Sync Clock B(SSYNCB), Frame Sync Clock A (FSYNCA) and Frame Sync Clock B (FSYNCB). An inverted Frame Sync Clock (**!FSYNC**) is provided through inverter U124E (74HC14D). Clocking signals on the outputs of U104 can be monitored as follows:

Test Point	Clock
TP26	2175 Hz
TP27	BIT CLOCK
TP28	SSYNC
TP29	FSYNC

Clock selection responds to the clock select enable bit of the Control/Data Parallel I/O bus. 4-bit multiplexer circuit (U104) selects between clocks under the control of a signal outputted by flip-flop U123 (74HC74), steering circuit U101A/U101B (74HC00) and inverter U124C (74HC14D). Inputs to the steering circuit are **LD[0]** from multiplexer U106 and **WBCN** from multiplexer U105. The selected clocking signals are provided to the audio channel section through the "**clocks**" line.

Spare flip-flop U75A is provided for future use.

The serial control data signal **(SERCONDATA)** and the Codec Clock **(CODEC CLK)** is generated through logic array U6 (AMPAL22V10AJC). **SERCONDATA** is used in programming codecs (1:4) from the Parallel **I/O (PIO)** data bus (DB[0:7]) or the microprocessor U118 APD[0:7]. Eight-bit shift register U69 (74HC165D) converts the parallel data at the input (MUX[0:7]) to serial. The **CODEC CLK** output from U6 signals the codec when to read in **SERCONDATA**.

2175 Hz Tone

A 2175 Hz square wave is input from U104, Pin 4 (TP26) through 0.1 µf capacitor C245 to a tone processing circuit consisting of filter U96 (TP3040), digitally controlled potentiometer U73 (X9103S) and flip-flop U75B (74HC74). The 2175 Hz square wave is filtered through filter U96 to produce a 2175 Hz sine wave. The output of U96, Pin 1 connects to the input of potentiometer U73 where the required level is set. The level from U73 is altered by, first toggling the output of flip-flop U75B. U75B output /**Q** (not Q) is toggled by the CMP3|SEL-SIN POT signal on the clock input (CLK), Pin 11 and the D[0] signal on the D input, Pin 12. POT_INC allows the pot value to be incremented. POT_U/D controls up or down increments. CMP3|SEL-SIN POT originates from logic array U6, Pin 28 and D[0] originates from data bus D[0:7]. The output on U73, Pin 9 SINOUT connects through 0.01 µf capacitor C235 to the input of operational amplifier U20A (TP42) (refer to Schematic Diagram, Sheet 9 (channel 3)).

Manual Reset

A manual reset is provided by pressing switch SW3. Switch SW3 grounds the input to inverter U124A. This signal is buffered and re-inverted by U124A/B to provide !RESET to U118 and other circuitry on the board. When the input of U124A goes to ground the output goes high **(CMP|RESET)**. This resets the HDLC control/interface U108, Pin 17 (SAB82525).

AUDIO CHANNEL SECTIONS

The audio channel sections (4) provide circuitry that processes and digitizes audio signals coming from RF trunked repeater sites or consoles (source) and places the digitized audio on the **TDM** network. The audio channel section also provides circuitry that converts selected digitized audio signals, taken from the **TDM** network (destination), into analog signals and sends the resulting audio signals to an RF trunked repeater site or console for transmission.

The digitized audio portion of the audio channel sections (destination) is preassigned a **TDM** bus number and bus slot, through the Controller Board at the time of power up. Digitized audio signals are continuously broadcast to the **TDM** network whether or not audio is coming in from the site RF receiver or console (source).

NOTE

The following circuit analysis uses only one of four audio channel sections (Channel 3). Refer to the Schematic Diagram, sheet 9.

Source (Analog to Digital)

A balanced pair (e.g. a telephone line) is used to transmit audio signals from RF repeater sites or consoles to an audio channel section. This balanced pair connects to conventional balanced line termination circuitry consisting of (channel 3 only) capacitors C136 and C137, 600 ohm coupling transformer T1, resistor R29 and surge protectors VR3 and VR4. The surge protectors protect the audio section against spikes and transients.

The 600 ohm line termination circuitry couples analog audio signals to programmable electronic potentiometer level adjust (EEPOT) U15 (X91035). U15 can be set by microprocessor U118 specifying a programmable amount of attenuation. Commands for such programmable attenuation adjustment may be communicated from the Controller Board to U118 through the HDLC link. The output of U15 is applied to the input of high pass filter U16A (MC3303D). This active filter has 3-pole bandwidth with an operating frequency of 240 Hz and a gain of 2v/v.

The output of the filter is applied to the input of a compression amplifier/limiter Circuit. This circuit consists of operational amplifiers U16B, U16C, diode package D3, emitter follower transistor Q3 and limiting transistor Q4. The amplifier dc feedback voltage is taken from the collector of limiting transistor Q4 and connected back to the input of U16B between resistor R52 and capacitor C151. As the audio input amplitude increases at U16B, Pin 7, Q4 conducts harder limiting the input to U16B and keeping the output constant. This compression amplifier/limiter circuit produces an audio signal with a relatively uniform average high level, that ensures all digitized audio signals carried by the **TDM** network have a high signal-to-noise ratio and

also ensures that the analog audio applied to the input of the codec digitizer does not exceed the dynamic range of the digitizer.

Microprocessor U118 can selectively bypass the compression amplifier through analog switch U23B (MAX333). The common (COM) connection of U23B (Pin 8) connects to the input of band pass filter U26 (TP3040). The normally open (NO) connection of U23B (Pin 9) connects to the output of the compressor amplifier at U16B, Pin 7. The normally closed (NC) connection of U23B (Pin 7) connects to the output of the high pass filter U16A. A signal on pin 28 (!COMP-BYP[1]) of U23B from microprocessor U118 causes U23B to select between two outputs: high pass filter U16A and compression amplifier U16B.

The signal to bypass a compression amplifier comes from octal 3-state inverting flip-flop U97. The clock output of U121A, Pin 1 as a result of the inputs, CMP|!WR POTBYPSEL and CMP3|!WR, clocks U97 to latch information from the D[0:7] bus on to the output !POT-SEL[1:4] or !COMP- BYP[1:4]. !POT-SEL[1:4] connects to one of four electronic potentiometers, in this example U15 (!POT-SEL[3]). !COMP-BYP[1:4] connects to one of four analog switches, in this example U23A and U23B (!COMP-BYP[3]). Notch filter U17 is also bypassed with this signal.

The output of the compression amplifier or high pass filter U16A is applied through analog switch U23B to the input of a 200 - 3400 Hz Band Pass Filter U26 (TP3040). The output of U26 connects to the input of conventional μlaw PCM digitizer/codec U7 (TP3076A). The codec output provides an input to a demultiplexing network circuit consisting of programmable logic array (PAL) U129 (AMPAL22V10AJC) for application through a conventional buffer to the **TDM** network. The Controller Board can write instructions to the codec through the Channel Function Latch (U113) and the Channel Address Latch (U114). The codec is programmed for Bus/Slot at power-up by **SERCONDATA.** The Codec has four outputs:

1) **PCM DATA** in the correct slot (Pin 14);

2) **!TE** - active low in correct slot (Pin 15);

3) Bus selection (**CH_BUS_SEL[0:2],** Pins 5,17,18):

4) **PCM DATA SELECT** (CMP30|TX_BUS_SEL_[3])

PAL U129 performs Demultiplexing functions for PCM DATA, puts slot-correct data on the bus specified by CH_BUS_SEL[0:2] or puts the output of U130 (μP simulated PCM DATA) on the bus specified by CH_BUS_SEL[0:2] and the slot specified by !TE (Pin 15 of the codec). This last function is enabled by CPM30|TX_BUS_SEL [3].

U130 is selected to output simulated PCM by OR gates U4A through U4D, in this case U4C. These OR gates monitor the write or send data outputs CMP3|!WR_SD1 through SD4 of address decoder U109. The write signal CMP|!WR originates from U118, Pin 27.

The circuit consisting of flip-flop U24B ((74HC74) and NAND gate U8A (74CH00) allows control information to be written to the Codec. The proper inputs to U8A (CF[3] and CH EN) cause U24B to bring "**low**" the **!CS** input to the codec, enabling the codec to read control information.

A **!CLR** signal is generated from 4-bit mux U105 through NAND gate U98D (74HC00) and sent to flip-flop U24B, Pin 13 to deselect the codec after writing to the audio channel.

Each channel shares eight bus drivers for eight TDM busses. Only the bus drivers to be used are enabled. This is accomplished through PAL's U94 and U126 (AMPAL22V10AJC). For channel 3, bus select lines CH3_SEL[0:2] and !TE[3] connect between codec U7 and PAL's U94 and U126. The enable line output of U94 and U126 (CMP3|E[1:0]) enables the bus driver to be used only during the slot controlled by channel 3.

Bus transceivers U50 and U51 and enable circuits U94 and U126 are shared among all four audio channel sections to decrease component count, simplify circuit design and reduce the number of components connected directly to the **TDM** busses.

The source portion of the audio channel section (analog input from the repeater site/console) continuously outputs digitized audio signals onto the **TDM** network on a preassigned **TDM** bus. All audio channel sections of each **Mastr II Interface Module (MIM)** and **Console Interface Module (CIM)** of the system are audio sources that are continuously broadcasting digitized audio information over the TDM network to all other MIM's and all other CIM's. However, no part of the system actually "**listens**" to any of these continuously active audio channels until digital messages (i.e., slot assignment messages) are sent over the message network indicating that a call is active. Such slot assignment messages for active calls specify a **TDM** bus number/bus slot and also convey information (i.e. radio transceiver group information) that causes all MIM's and CIM's that need to be involved with a call to begin "**listening**" to the appropriate TDM bus slots. They

convert the digitized audio signals contained in these slots into analog audio signals and provide the analog audio signals to an RF repeater or console assigned to handle the call (RF repeaters and associated RF working channels are also assigned in response to an initial slot assignment message).

Destination (Digital to Analog)

The destination portion of the audio channel section includes TDM bus transceivers U50 and U51. It includes serial parallel conversion U22 (XC03070), read only μLaw-to-linear conversion lookup table PROM U10/U11 (CY7C291-35), read/write slot/bus weight lookup table U13, high speed multiplier/accumulator U12 (CY7C510-55) and digital range checker/limiter U21 (refer to the schematic diagram sheet 10). The destination portion of the audio channel section also includes digital-to-analog converter (DAC) U25 (AD7840), additional scaling and filtering through U26 (TP3040), notch filter circuitry through switched capacitor filter U17 (MF5CWM), 2175 Hz tone generation through variable gain amplifier U20A and a 600 ohm line termination circuit T2 (refer to the schematic diagram, sheet 9). The TDM bus receivers U50 and U51 receive signals from all TDM busses. The outputs of this bank of bus receivers (TDMX BUS[0:7]) are applied to serial inputs of a bank of eight (8) shift registers, U22 (XC303070) and associated latch circuits. The shift registers and latch circuits arrangement is accomplished using a VLSI programmable ASIC chip, U22 in this case. There is one shift register and associated latch for each of the individual TDM busses within the TDM network. Shift registers operate at the TDM bus timing bit rate and function as serial-to-parallel converters that continuously shift in a slot worth of PCM digitized audio and convert it to an 8-bit wide parallel output format. Each shift register is 8-bits wide and can hold all PCM data bits for a particular bus slot.

The latch circuits are clocked at the TDM bus slot timing rate, and operate to latch the parallel output signals provided by shift registers corresponding to a particular bus slot. At the conclusion of a TDM bus duration, each of the latch circuits contain an 8-bit parallel word corresponding to the contents of a single slot of a single associated TDM bus. The latch circuits together provide, in parallel, the slot contents of all TDM busses for the last TDM bus slot.

The data latched by the latch circuits is multiplexed in sequence to the address inputs of a μlaw/linear conversion lookup table within PROMS U10 and U11 (CY7C291-35). This is implemented at a bit clock rate that is a multiple of the TDM bus slot timing. For example, for 32 TDM busses the bit clock rate must be 32 times the TDM slot rate. All circuits from the latch circuits of U22 to multiplier/accumulator U12 are all synchronized to operate at this rate. The parallel output of one latch circuit at a time is enabled onto a multiplexed address bus (CMP32|MD[O:9]). The multiplexing is performed under the control of a counter (part of U22) clocked at the bit clock rate previously described. Incrementing the counter from zero to a maximum value causes the TDM bus data corresponding to the following sequence of TDM bus number/bus slots to be applied to the address input of the lookup table:

TDM BUS (0), Slot (0);
TDM BUS (1), Slot (0);
TDM BUS (2), Slot (0);
•
•
•
TDM BUS (7), Slot (0);
TDM BUS (0), Slot (1);
TDM BUS (1), Slot (1);
TDM BUS (2), Slot (1);
•
•
•
TDM BUS (7), Slot (1);
TDM BUS (0), Slot (2);
TDM BUS (1), Slot (2);
•
•
•
TDM BUS (7), Slot (31)

The signals carried by the multiplexed address bus are used to address the lookup table. The Look up table comprises a 512 by 16-bit ROM (U10 and U11) and performs a linearizing function (LND []). More particularly, the lookup table stores conventional conversion data used to map a μLaw digitized representation to simplify the mathematical operations performed by multiplier/accumulator U12 (CY7C510-55).

The Controller Board can select, through the Channel Function Latch bit CFO, a different mapping (e.g., no mapping at all to accommodate digital data of the type transmitted by a modem of a remote RF transceiver data terminal).

The LND output of the lookup table (CMP32|LND[0:15]) is applied to one input of multiplier/accumulator U12 operating in sync with the bit clock and with the multiplexed address bus. Another input of the multiplier/accumulator receives an 8-bit weighting signal provided by the output of slot/bus weight lookup table within Read/Write memory U13 (CY7C128-55PC). The Lookup table of U13 consists a 256 X 8 bit RAM addressed by the output of program-

mable logic U22 previously described. The address information is provided by the U22 encoding the TDM bus number and TDM slot number. The address supplied to lookup table in U13 specifies a particular location with the lookup table corresponding to a TDM bus number/slot combination.

Two write cycles of the CH DATA bus are used by the Controller Board to rewrite a location within the memory. Once the Controller Board writes the appropriate address information into the Channel Address Latch selecting an appropriate audio channel section, the Controller Board latches a bus number/bus slot value into the Channel Data Latch. The Controller Board then writes an appropriate control word into the Channel Function Latch. This control word specifies that the contents of the Data Latch are to be latched by the audio channel section as a bus number/bus slot. This control word may also specify the CF1 bit to be asserted. The Controller Board then causes the Data Latch to latch the new weighting factor value and writes a further control word into the Channel Function Latch. This control word specifies CF2 = 1, causing a write to memory. One of the ASIC's previously described passes the bus number/bus slot address through to the address inputs of memory. It also multiplexes the contents of the Channel Data Latch onto the data input/output lines of the memory so it can be written into the memory in response to the memory write enable signal.

TDM BUS 0,	Slot 0 Weight Factor	(8 bits)
TDM BUS 1,	Slot 0 Weight Factor	(8 bits)
TDM BUS 2,	Slot 0 Weight Factor	(8 bits)
TDM BUS 3,	Slot 0 Weight Factor	(8 bits)
TDM BUS 4,	Slot 0 Weight Factor	(8 bits)
TDM BUS 5,	Slot 0 Weight Factor	(8 bits)
TDM BUS 6,	Slot 0 Weight Factor	(0 bits)
TDM BUS 7,	Slot 0 Weight Factor	(0 bits)
TDM BUS 0,	Slot 1 Weight Factor	(8 bits)
TDM BUS 1,	Slot 1 Weight Factor	(8 bits)
	• • •	
TDM BUS 6,	Slot 31 Weight Factor	(8 bits)
TDM BUS 7,	Slot 31 Weight Factor	(8 bits)

Figure 3 - Memory Mapping

Figure 3 is a memory map of memory U13. Memory U13 includes individual memory locations uniquely corresponding to TDM bus number/slots (i.e., input sources). These memory locations are organized with respect to the address lines from the counter. This is so the counter, as it is incremented, addresses a sequence of memory locations. These memory locations then correspond to the sequence of data provided by latch circuits over the address bus. Memory U13 stores blocks of latched data corresponding to bus slots, each memory location, includes a weight value for each of the individual TDM slots.

Addressing of memory U13 by the counter results in the following sequence of weighting factors to be outputted from the lookup table (U13), where each weighting factor is indicated by an ordered pair of TDM bus number, TDM slot number:

WF(0,0);
WF(1,0);
WF(2,0);
•
•
•
WF(7,0);
WF(0,1);
WF(1,1);
WF(2,1);
•
•
•
WF(7,1);
WF(0,2);
WF(1,2);
•
•
•
WF(7,31);

High-speed multiplier/accumulator U12 operates at the bit clock rate to multiply the sequences of outputs of the lookup tables together and to sum the products into an output register. The high-speed multiplier/accumulator performs the following sum of products calculation once for each TDM bus frame:

{LND[TDM BUS (0), Slot (0)] * WF(0,0)} +
{LND[TDM BUS (1), Slot (0)] * WF(1,0)} +
{LND[TDM BUS (2), Slot (0)] * WF(2,0)} +
•
•
•
{LND[TDM BUS (7), Slot (0)] * WF(7,0)} +
{LND[TDM BUS (0), Slot (1)] * WF(0,1)} +
{LND[TDM BUS (1), Slot (1)] * WF(0,1)} +
{LND[TDM BUS (2), Slot (1)] * WF(0,1)} +
•
•
•
{LND[TDM BUS (7), Slot (1)] * WF(7,1)} +
{LND[TDM BUS (0), Slot (2)] * WF(0,2)} +
{LND[TDM BUS (1), Slot (2)] * WF(1,2)} +
•
•
•
{LND[TDM BUS (7),Slot (31)]* WF(7,31)} +

The values of weighting factors |WF(0,0)... WF(7,31) determine which TDM bus numbers/bus slots (i.e., PCM digitized audio channels carried by the TDM network contributes to the sum accumulated by the multiplier/accumulator. When the destination served by the audio board is inactive, all of the weighting factors have zero values and the output of the multiplier/accumulator is zero. When the destination served by the audio board is active, one or more of the weighting factors (i.e., the weighting factors corresponding to the TDM bus number(s)/bus slot(s)) are given non-zero weights such that only those bus/slots contribute to the output of the multiplier/accumulator.

Once per TDM frame, the multiplier/accumulator provides a summation output to the input of digital range checker/limiter U21 (XC302070). Range checker/limiter U12 comprises a programmable ASIC that operates at the TDM bus slot rate to check the magnitude of the summation output and if necessary, to substitute a predetermined maximum output value for any value exceeding the dynamic range of Digital-To-Analog Converter (DAC) U25 (AD7840). DAC U25 converts, at the TDM slot rate, the output of the range checker/limiter into an audio signal (14 bit precision) and provides an analog output, DAC OUT (AN[2]) to low pass filtering circuit U26 (Fco = 3400 Hz). The output of U26 connects to the input of 2175 Hz notch filter U17 (NOTCH IN) and to the NC (Pin 4) connection of analog switch U23A. The notch filter, switched capacitor filter U17, can be bypassed through analog switch U23A by the COMP BYP[3] signal from microprocessor U118. The COM connection of U23A (Pin 3) connects through summing resistor R267 to the input of operational amplifier U20B (TL082A).

Presettable counter U125 (74HC161), driven by CMP3|CLKOUT from U118, produces a filter clock (FLTR CLK) for U17, Pin 8.

The 2175 Hz tone is generated in response to channel function latch bit CF4 (U14B, Pin 4) and is used to control the repeater transmitter during operation in the remote repeat mode. While the RF site is also capable of operating in the local repeat mode, the remote repeat mode is used in the multisite switch configuration to permit MIM's to remotely control when their associated repeater transmitters are on the air and transmitting RF signals modulated with audio. The Controller Board controls the addition of a remote repeat tone (2175 Hz) to the audio channel output.

Tone generating circuitry for the 2175 Hz remote repeat control tone consists of AND gate U14B (74HC08C), flip-flop U24A (74HC74) and multivibrators U18A and U18B (74HC123A), bilateral switches U19A,B,C,D (4066BM) and operational amplifier U20A (TL082A). This circuitry selectively generates and applies a 2175 Hz tone to the audio path through summing resistor R265 to the input of operational amplifier U20B. Bilateral switches U19A/B/C are switched on/off by multivibrators U18A/B to provide gain adjust (refer to Figure 4). This is accomplished by switching in or out the appropriate feed back resistance for operational amplifier U20A. U19D enables 2175 Hz tone to be summed into the output audio path. The 2175 Hz remote keying involves a three tone level sequence as shown in Figure 5.

The resulting analog audio and tone output to line termination circuit T2 is applied to the associated RF repeater transmitter audio input through an audio link.

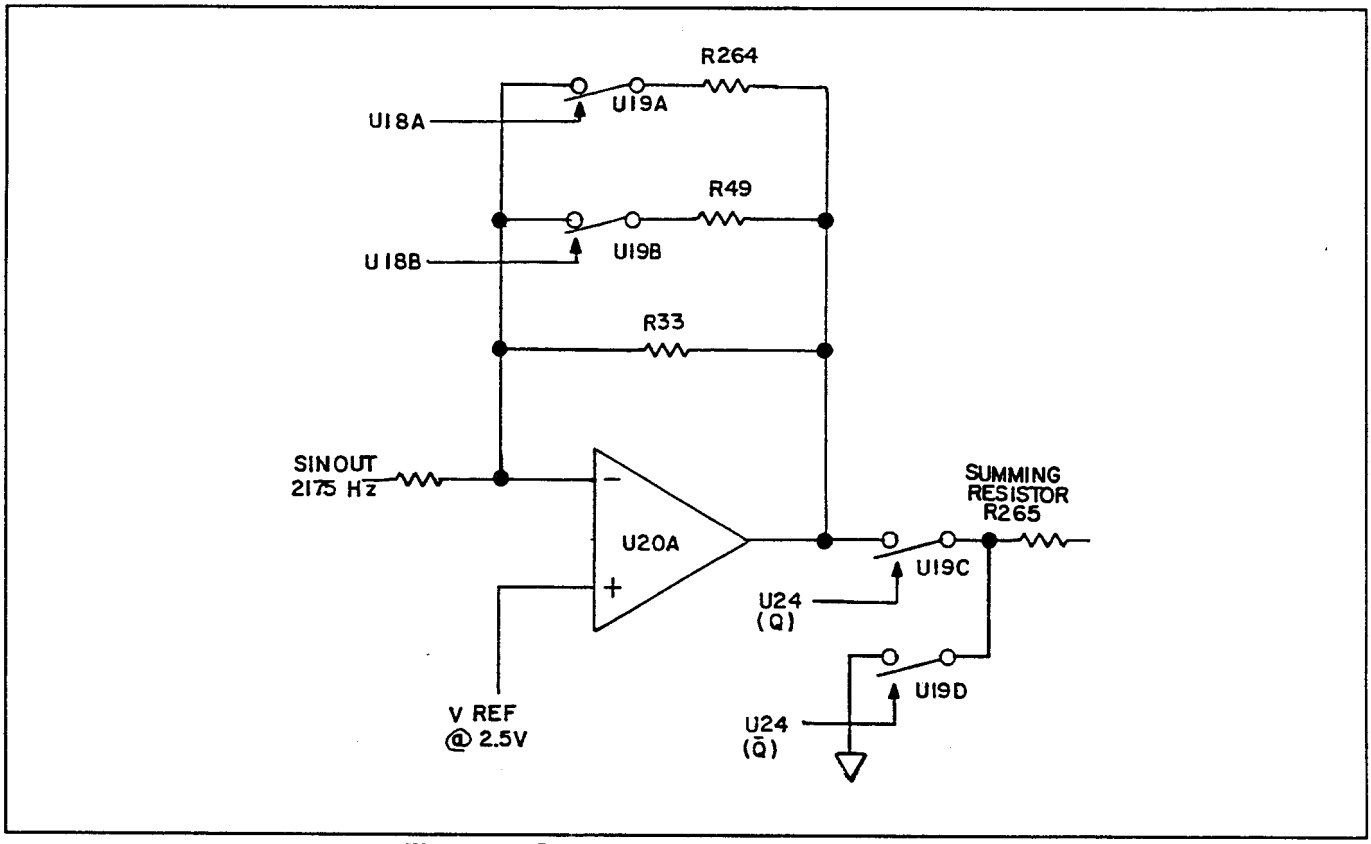
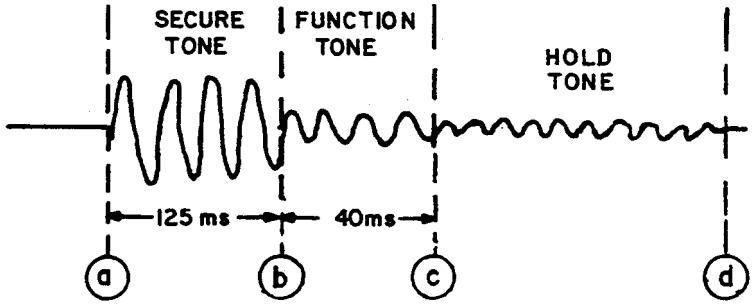


Figure 4 - Operational Amplifier Gain Control



(a) ——> (b) +10 dBm, 2175 Hz, 125 ms initiated by CF4, LD[0] using resistor R33 (Figure 4)

(b) ——> (c) +0 dBm, 2175 Hz, 40 ms initiated by switching in resistor R264 (Figure 4)

(c) ——> (d) -25 dBm, 2175 Hz, continues until CF4, LD[0] initiated by switching in R49 (R264 is still in) (Figure 4)

Figure 5 - 2175 Hz Tone Level Remote Keying Sequence

UNSUPPORTED CIRCUITS

The unsupported circuits on this 4-channel audio board consist of four (4) auxiliary relay circuits and a clock failure detection circuit.

Auxiliary Relays

The auxiliary relay circuits are located in the four (4) audio channel sections. These circuits consist of AND gates U14C, U37C, U60C and U87C (74HC00C), transistors Q1, Q5, Q9 and Q16 and relays K1 through K4 (LM44B00).

Clock Failure Detect

The clock failure detect circuit is part of the control section. It consists of 4-input AND gate U116B (74HC20).

QUICK REFERENCE TO TROUBLESHOOTING

Symptoms	Action
Power LED's (CR-4) not lit	Check power fuses F1-F3
Sanity LED (CR6) not blinking	Check for bent pin(s) on EPROM U99
Card remains in reset; CR5 stays on	Check for bent pin(s) on EPROM U99
No channels Working	1. Verify correct dip switch setting. 2. Reset commanding controller board to make certain that the audio board has been initialized. 3. Verify slot allocation table at **MOM PC.** If slot allocations must be adjusted, after the allocations have been set, all controller boards must be reset. 4. Verify that CR5 on the audio board flashes briefly when audio is routed out of a channel dedicated to that audio board. If not, this most likely is not an audio board problem.
Audio on some but not all channels.	1. Verify slot allocations as describe above. 2. Verify incoming audio to each particular audio board channel by checking at the appropriate test point. 3. Verify outgoing audio from each particular audio board channel by checking at the appropriate test point.

Continued

Continued

QUICK REFERENCE TO TROUBLESHOOTING

Symptoms	Action
	AUDIO BOARD TEST POINTS

Signal	Test Point
Vcc	TP25
-5V	TP24
+ 12V	TP23
-12V	TP22
GND	TP21
!RES	TP50
Channel 1	
SITE IN	TP12
SITE OUT	TP15
Channel 2	
SITE IN	TP7
SITE OUT	TP10
Channel 3	
SITE IN	TP2
SITE OUT	TP5
Channel 4	
SITE IN	TP17
SITE OUT	TP19
Clocks	
2175	TP26
BIT_CLOCK	TP27
SSYNC	TP28
FSYNC	TP29

NOTE: The **SITE IN** test point for each channel specifies audio coming from the base station or console to the MSC II. Likewise, **SITE OUT** specifies audio going from the MSC II to the base station or console.

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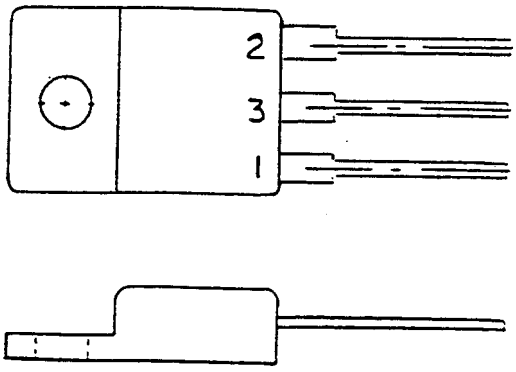
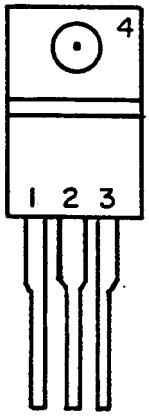
VOLTAGE REGULATORS U001/U003
19A134718P2/P1 (MC7912CT/MC7905CT)



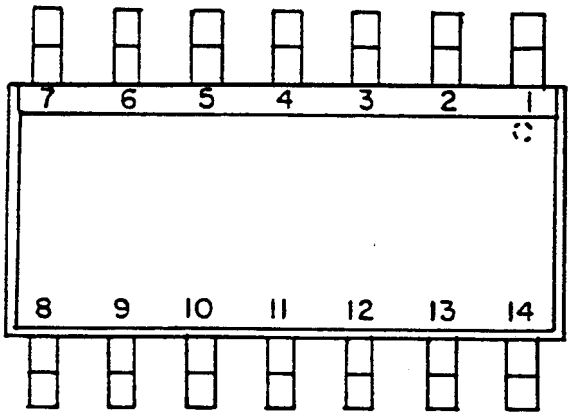
1. COMMON
2. OUTPUT
3. INPUT

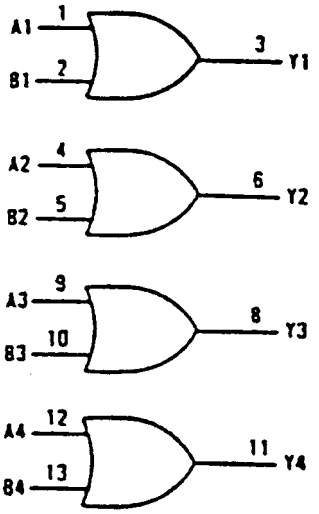
VOLTAGE REGULATOR U002
19A134717P2(MC7812CT)



1. INPUT
2. COMMON
3. OUTPUT
4. TAB COMMON

QUAD 2-INPUT OR GATE U004
19A703483P311 (74HC32D)



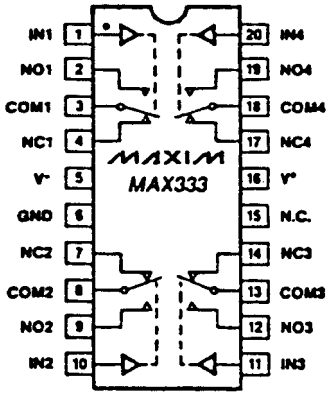


Y = A + B

PIN 14 = V_{CC}
PIN 7 = GND

QUAD SPST ANALOG SWITCH U005/U023
344A3113P101 (MAX333CWP)

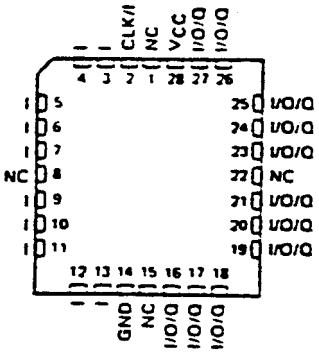
PIN CONFIGURATION



SWITCHES ARE SHOWN WITH LOGICAL 0 INPUT

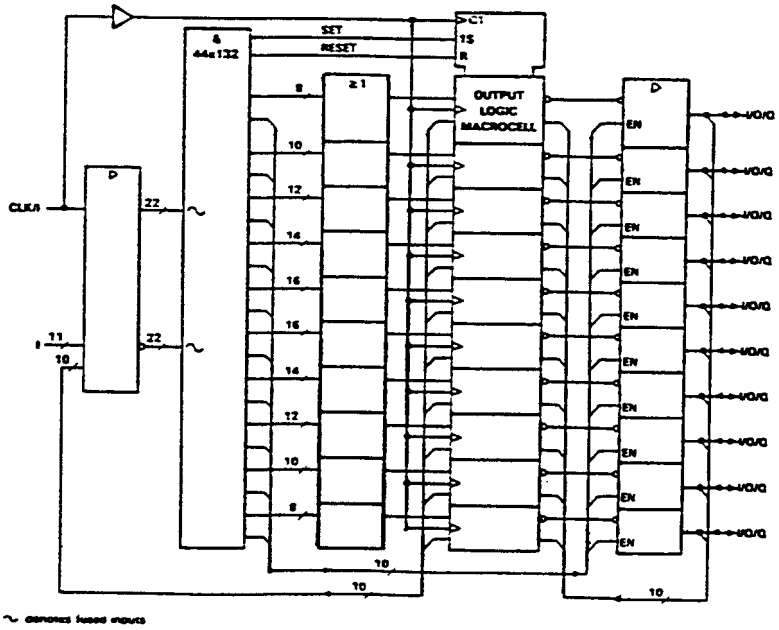
CMOS PROGRAMMABLE ARRAY LOGIC
U006/U094/U126/U127P/U129P/U131P/U133P
344A3377G1,G2,G4/3137P1 (PAL22V10AJC)

PIN IDENTIFICATION



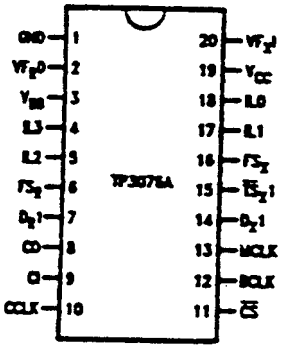
NC—No internal connection
Pin assignments in operating mode

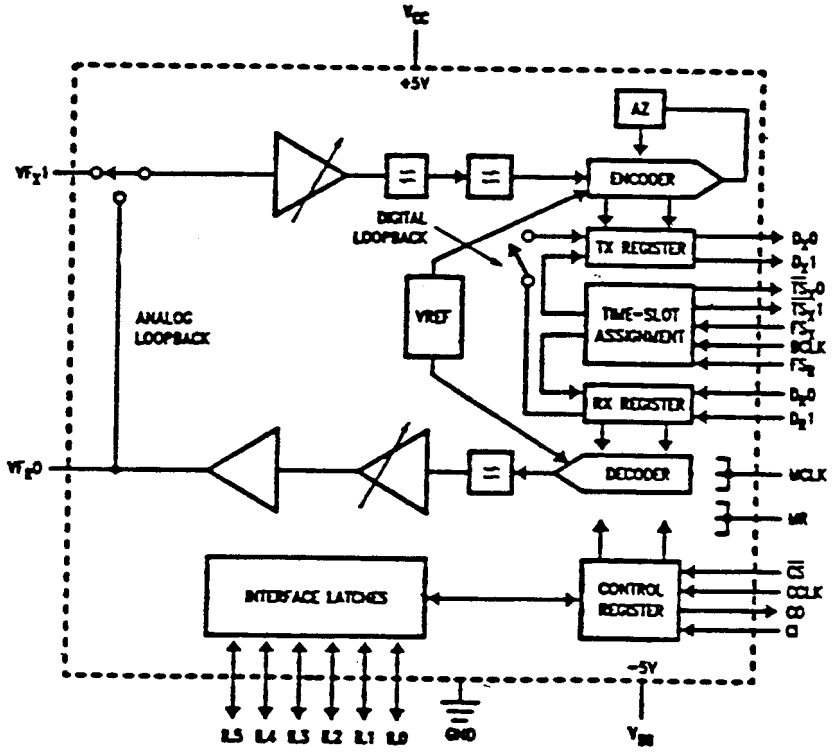
functional block diagram (positive logic)



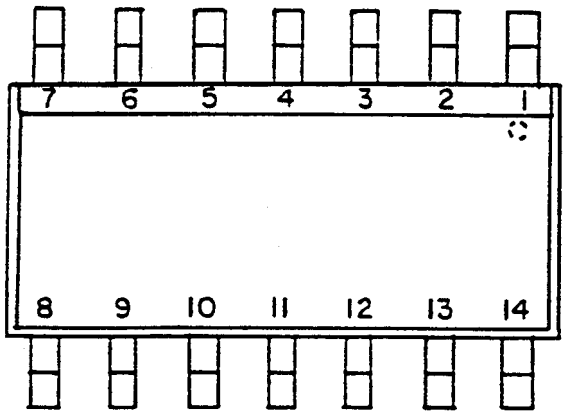
~ denotes fused inputs

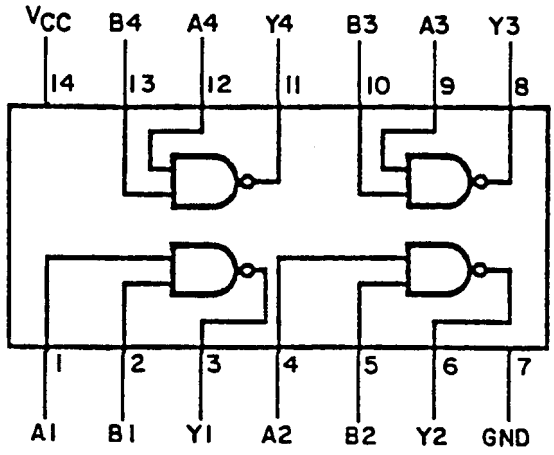
CODEC/FILTER U007/U030/U053/U076
344A3105P1 (TP3076A)



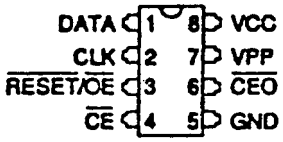


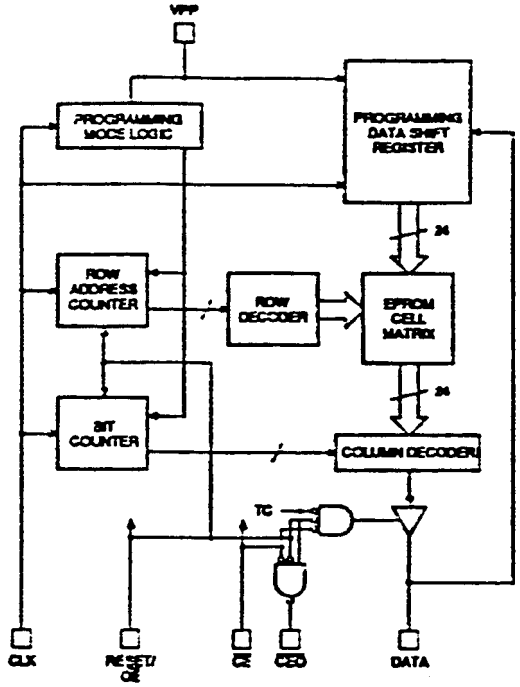
QUAD 2-INPUT NAND GATE
U008/U031/U054/077/U098/U101/U102
19A703483P302 (74HC00)





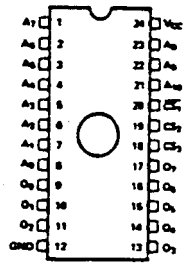
SERIAL CONFIGURATION PROM
U009SP/U032SP/U055SP/U078SP
344A3377G53128P1 (XC1736A)

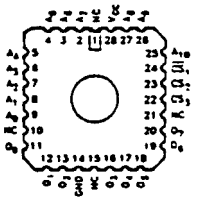




EPROM (256K X 8)
U010SP/U033SPU011SP/U034SP/
U056SP/U080SPU057SP/U079SP
344A3377G6&G7/3118P1 (CY7C291-35)

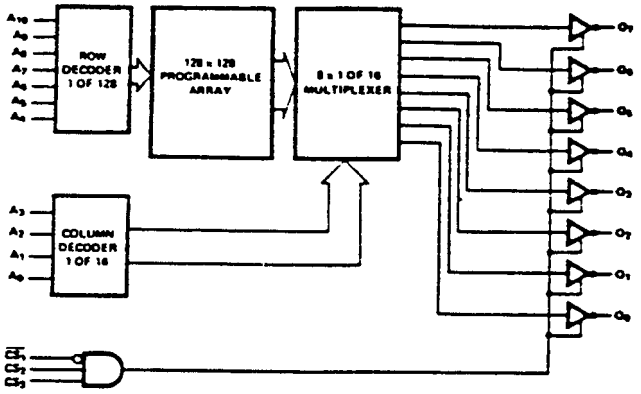
Pin Configurations



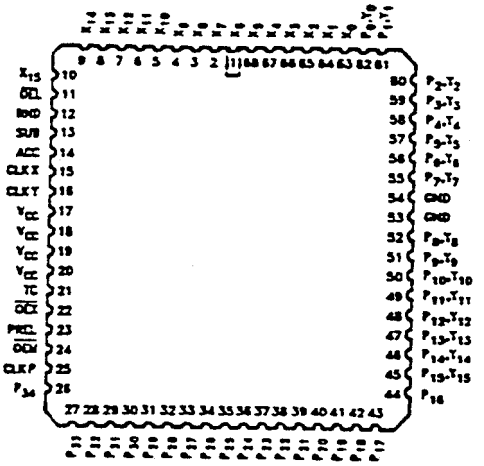


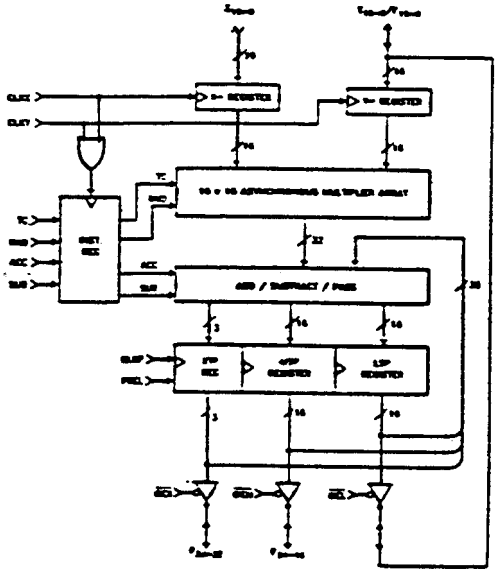
Window available on
300 mil cerdip only

Logic Block Diagram

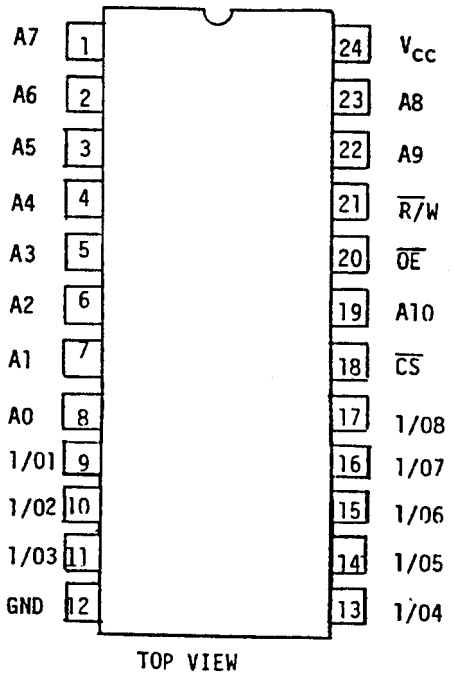


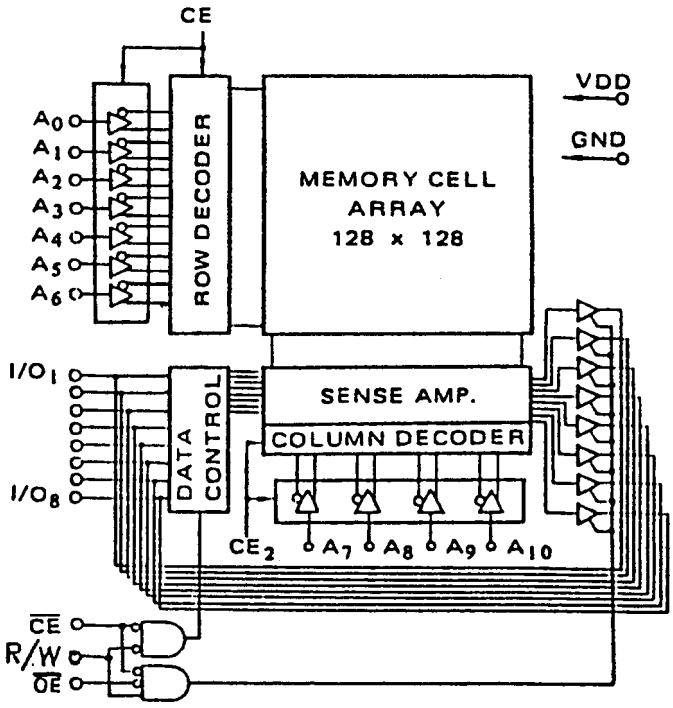
DIGITAL 16X16 MULTIPLIER ACCUMULATOR
U012/U035/U058/U081
344A3112P1 (CY7C510-55)





READ/WRITE MEMORY
U013/U036/U052/U059/U082
19A702934P2/P4 (CY7C128-55PC)

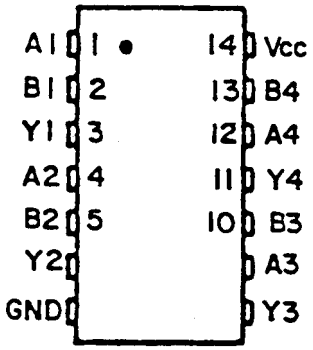




$A_0 \sim A_{10}$	ADDRESS INPUTS
R/W	READ/WRITE CONTROL INPUT
$\overline{OE}$	OUTPUT ENABLE INPUT
$\overline{CS}$	CHIP SELECT INPUT
I/O1 ~I/O8	DATA INPUT/OUTPUT
V_{CC}	POWER (+5 VDC)
GND	GROUND

QUAD 2-INPUT AND GATE
U014/U037/U060/U084
19A703483P305 (74HC08C)

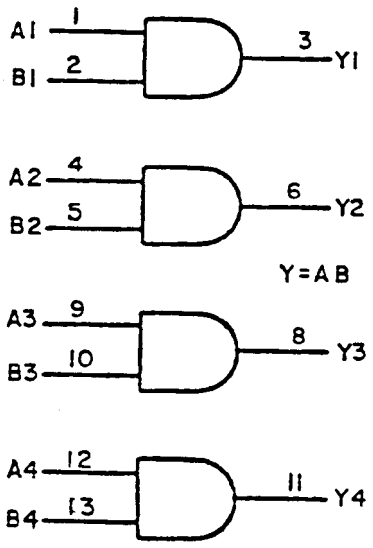
PIN ASSIGNMENT



FUNCTION CHART

INPUT		OUTPUT
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	H

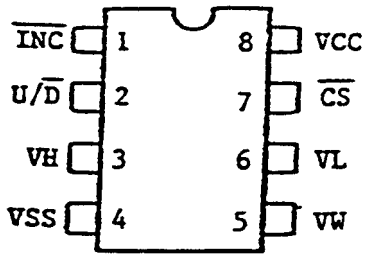
LOGIC DIAGRAM



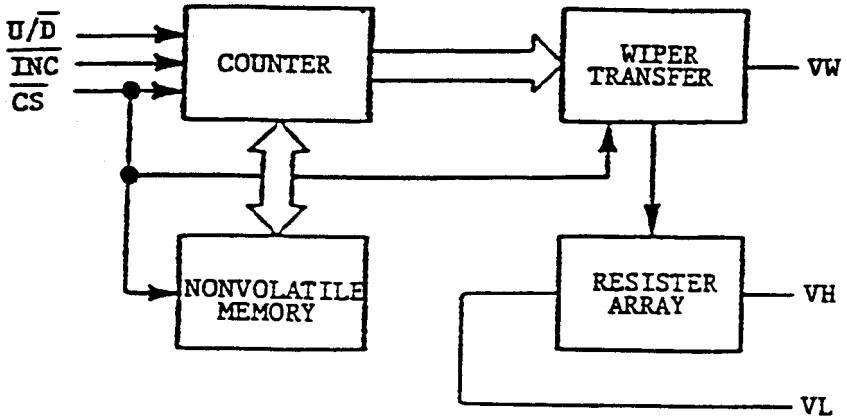
PIN 14 = Vcc
PIN 7 = GND

DIGITALLY CONTROLLED POTENTIOMETER
U015/U038/U061/U073/U085
19A705180P102 (X9103S)

PIN CONFIGURATION



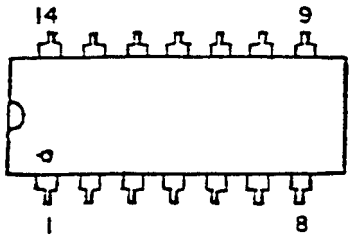
FUNCTIONAL DIAGRAM

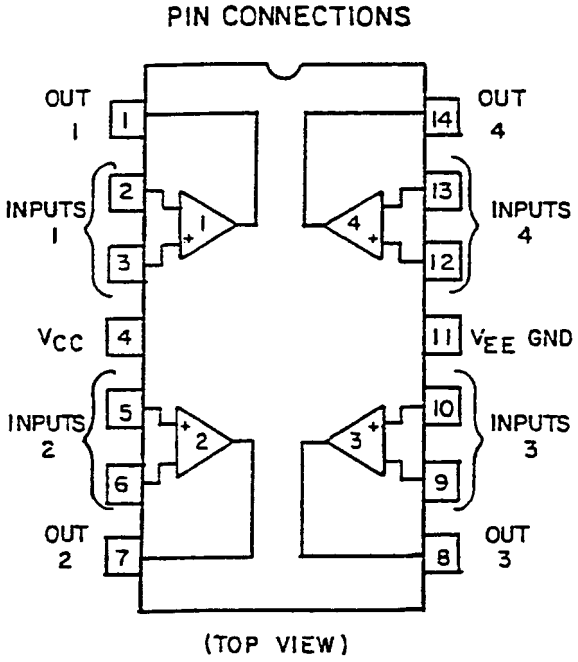


PIN NAME

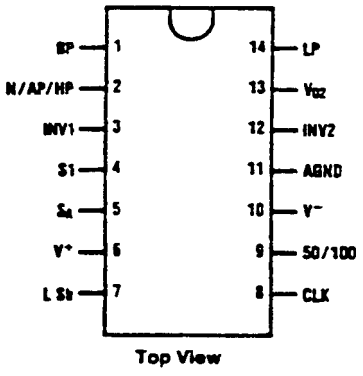
VH	HIGH TERMINAL OF POT
VW	WIPER TERMINAL OF POT
VL	LOW TERMINAL OF POT
VSS	GROUND
VCC	SYSTEM POWER
U/D	UP / DOWN CONTROL
$\overline{INC}$	WIPER MOVEMENT CONTROL
$\overline{CS}$	CHIP SELECT

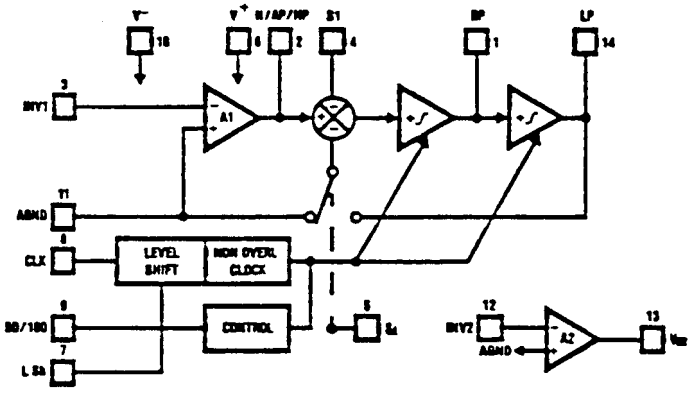
OPERATIONAL AMPLIFIER
U016/U039/U062/U086
19A704883P2 (MC3303D)



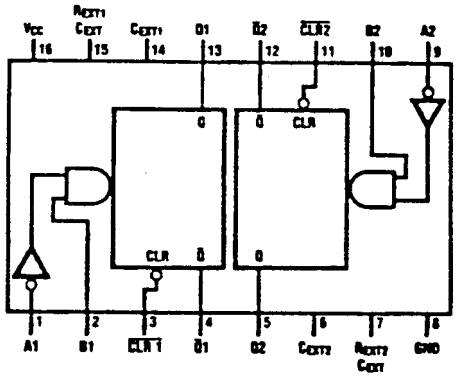


SWITCHED CAPACITOR FILTER
U017/U040/U063/U088
344A3124P1 (MF5CWM)





MONOSTABLE MULTIVIBRATOR
U018/U041/U064/U089/U110/U111
19A704380P321 (74HC123A)

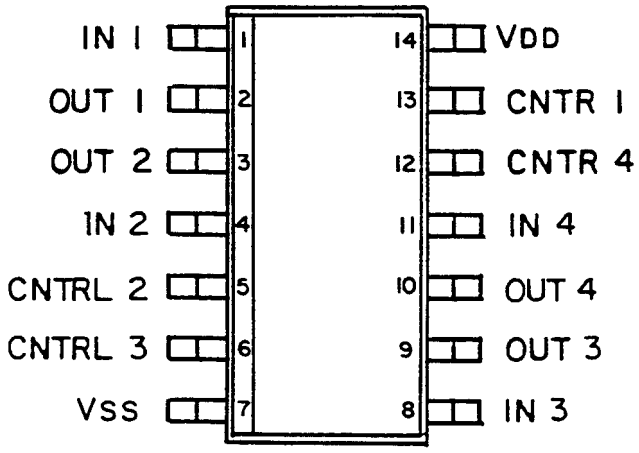


Truth Table

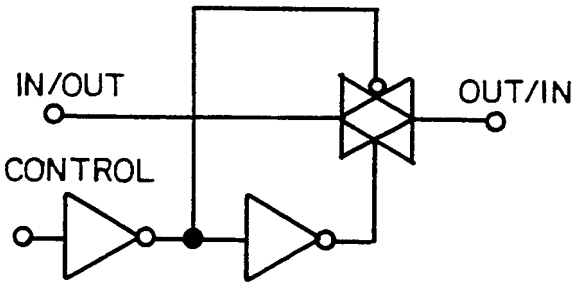
Inputs			Outputs	
$\overline{\text{Clear}}$	A	B	Q	$\overline{Q}$
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑	⎍	⎍
H	↓	H	⎍	⎍
↑	L	H	⎍	⎍

BILATERAL SWITCH
U019/U042/U065/U090
19A702705P4 (4066BM)

PIN CONFIGURATION



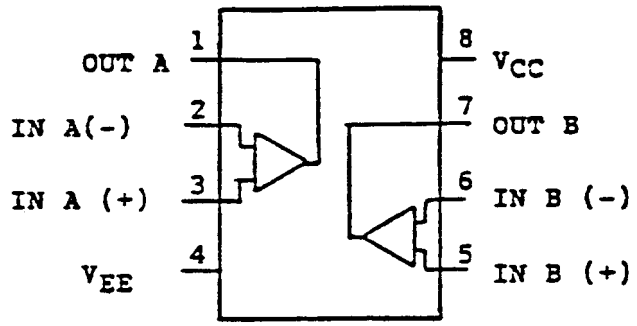
LOGIC DIAGRAM



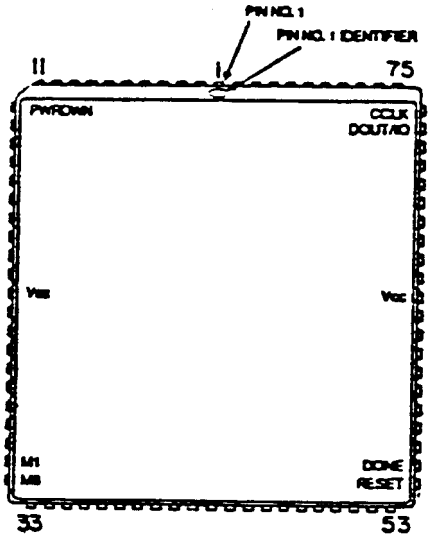
(1/4 OF DEVICE SHOWN)

CONTROL	SWITCH
0	OFF
1	ON

OPERATIONAL AMPLIFIER
U020/U043/U066/U091
344A3070P2 (TL082A)



DIGITAL LOGIC CELL ARRAY
U021/U022/U044/U045/
U067/U068/U092/U093
344A3129P1 (XC3020-70)



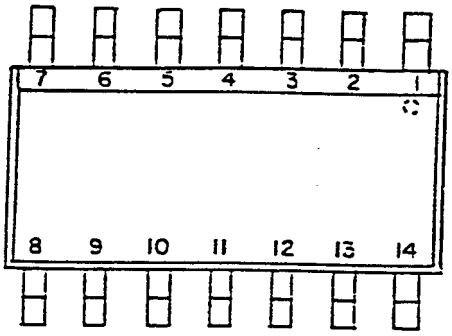
XC3000 Family 68-Pin PLCC Pinouts

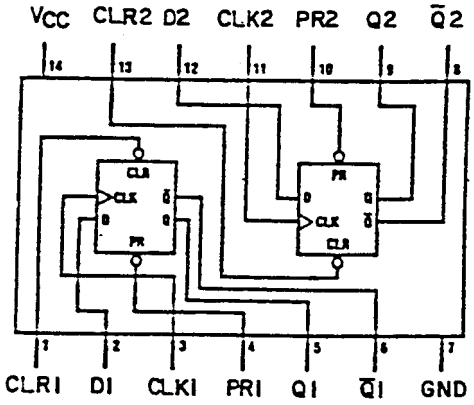
PLCC Pin Numbers	XC-3020
10	PWRDN
11	TCLKIN-I/O
12	I/O
13	I/O
14	I/O
15	I/O
16	I/O
17	I/O
18	VCC
19	I/O
20	I/O
21	I/O
22	I/O
23	I/O
24	I/O
25	M1-RDATA
26	M0-RTRIG
27	M2-I/O
28	HDC-I/O
29	I/O
30	LDC-I/O
31	I/O
32	I/O
33	I/O
34	INIT-I/O
35	GND
36	I/O
37	I/O
38	I/O
39	I/O
40	I/O
41	I/O
42	I/O
43	XTL2(IN)-I/O

PLCC Pin Numbers	XC-3020
44	RESET
45	DONE-PG
46	D7-I/O
47	XTL1(OUT)-BCLKIN-I/O
48	D6-I/O
49	D5-I/O
50	CS2-I/O
51	D4-I/O
52	VCC
53	D3-I/O
54	CS1-I/O
55	D2-I/O
56	D1-I/O
57	RDY/BUSY-RCLK-I/O
58	D0-DIN-I/O
59	DOUT-I/O
60	CCLK
61	A0-WS-I/O
62	A1-CS2-I/O
63	A2-I/O
64	A3-I/O
65	A15-I/O
66	A4-I/O
67	A14-I/O
68	A5-I/O
1	GND
2	A13-I/O
3	A6-I/O
4	A12-I/O
5	A7-I/O
6	A11-I/O
7	A8-I/O
8	A10-I/O
9	A9-I/O

Unprogrammed IOBs have a default pull-up. This prevents an undefined pad level for unbonded or unused IOBs.
Programmed outputs are default slew-limited.

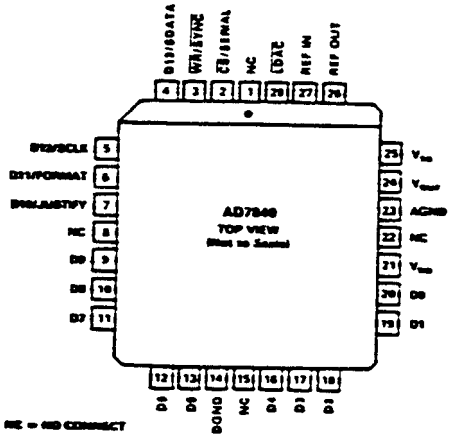
CMOS DUAL D FLIP-FLOP W/SET-RESET
U024/U047/U070/U075/U095/U123
19A704380P302 (74HC74)



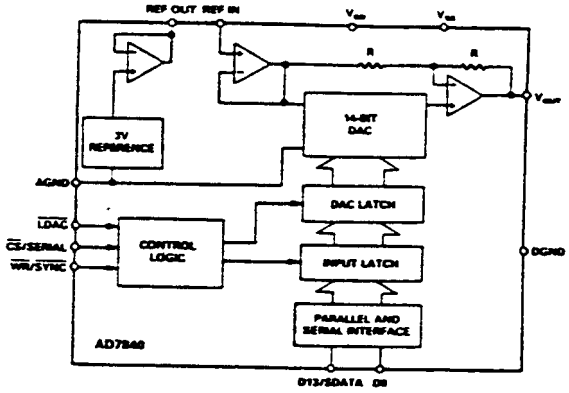


Inputs				Outputs	
PR	CLR	CLK	D	Q	Q̄
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q0	Q̄0

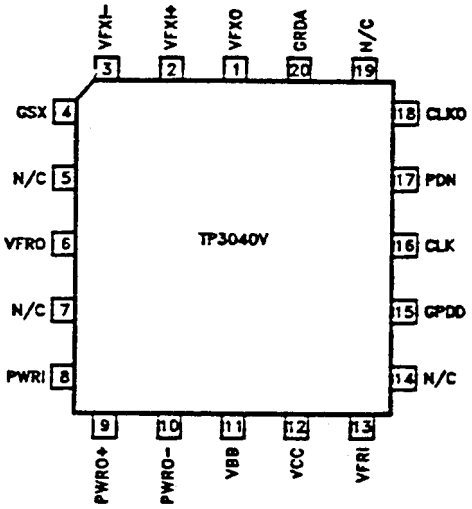
DIGITAL TO ANALOG CONVERTER (DAC)
U025/U048/U071/U083
344A3123P1 (AD7840)

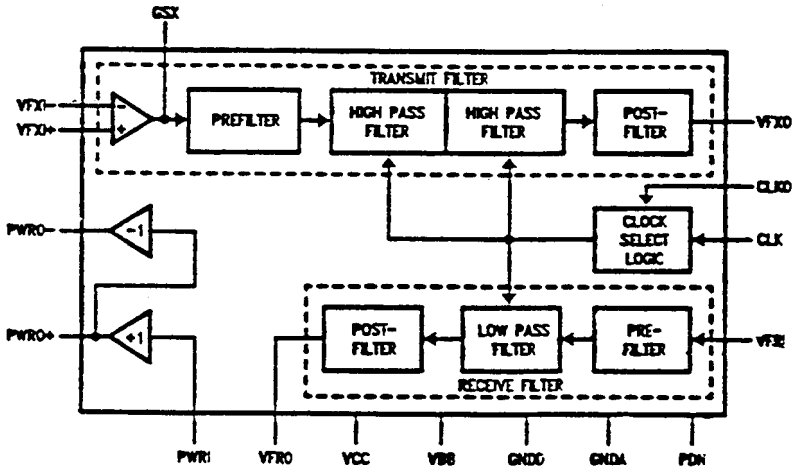


FUNCTIONAL BLOCK DIAGRAM

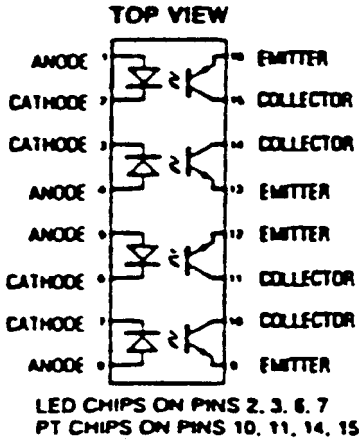


TRANSMIT (HP) FILTER/RECEIVER (LP) FILTER
U026/U049/U072/U087/U096
344A3122P1 (TP3040)





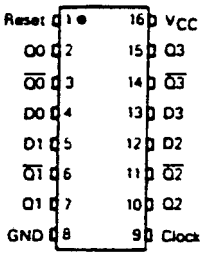
OPTO-COUPLER
U027/U028
344A3071P2 (LQ66-4)



LED CHIPS ON PINS 2, 3, 6, 7
PT CHIPS ON PINS 10, 11, 14, 15

QUAD FLIP-FLOP WITH CLEAR
U029
19A704380P310 (74HC175)

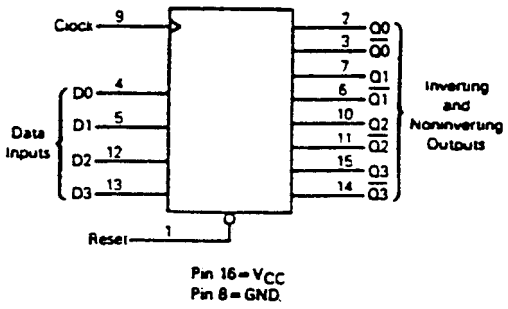
PIN ASSIGNMENT



FUNCTION TABLE

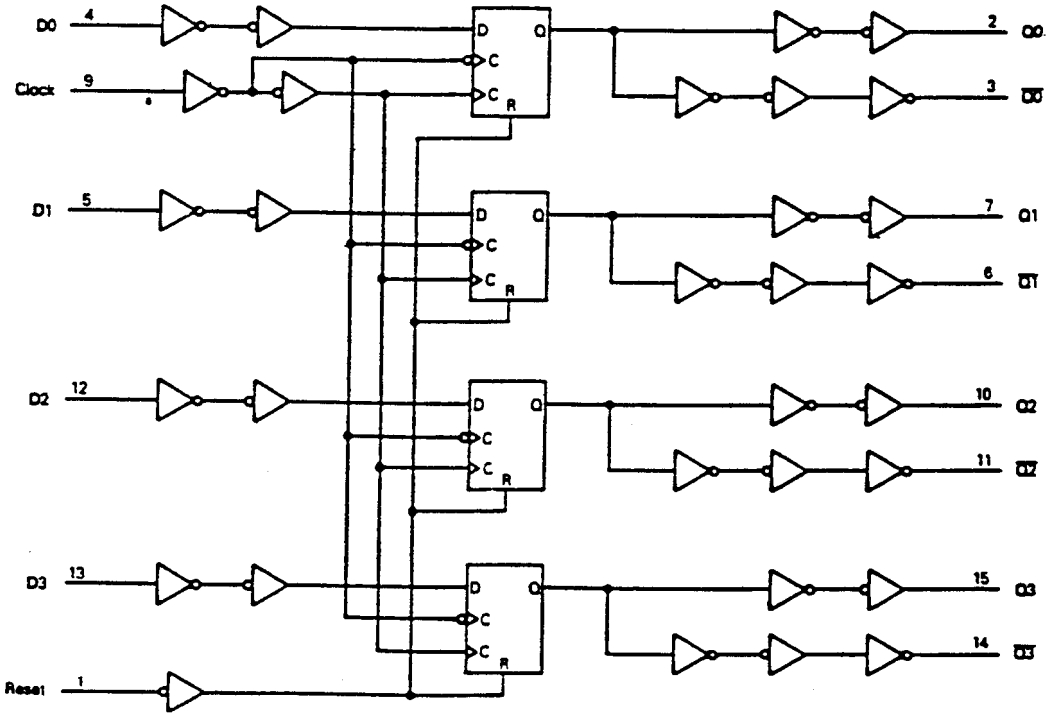
Inputs			Outputs	
Reset	Clock	D	Q	$\overline{Q}$
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	no change	

LOGIC DIAGRAM



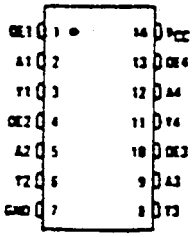
Pin 16 = V_{CC}
Pin 8 = GND

EXPANDED LOGIC DIAGRAM



QUAD 3-STATE NON-INVERTING BUFFER
U046
19A703471P305 (74HC126)

PIN ASSIGNMENT

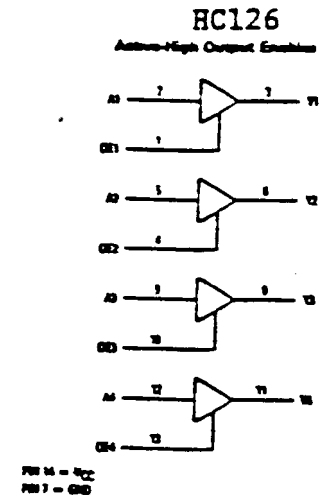


FUNCTION TABLE

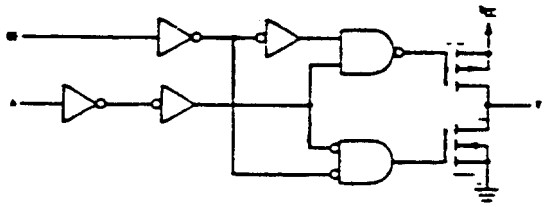
HC125			HC125		
Inputs		Output	Inputs		Output
A	OE	Y	A	OE	Y
H	L	H	H	H	H
L	L	L	L	H	L
X	H	Z	X	L	Z

X = don't care
Z = high impedance

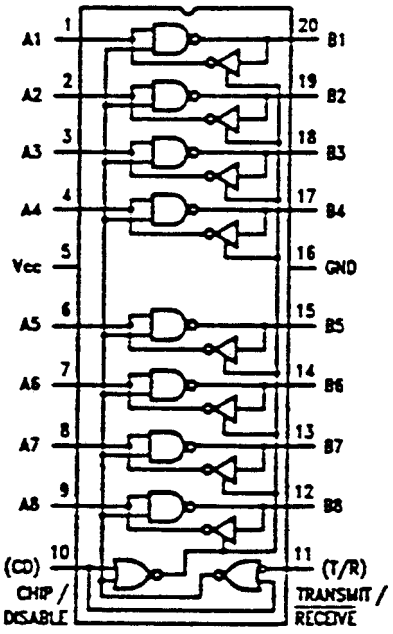
LOGIC DIAGRAM



(1/4 OF DEVICE)

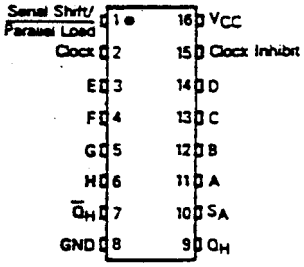


TRANSCEIVER
U050/U051
19A149953P202 (DS3897M)

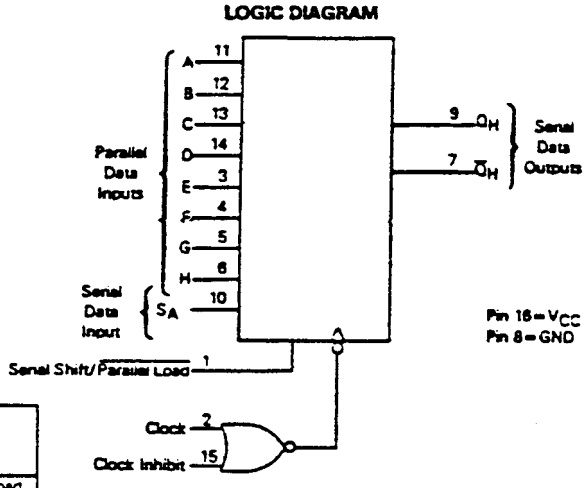


8-BIT SHIFT REGISTER
U069/U128/U130/U132/U134
19A703987P322 (74HC165D)

PIN ASSIGNMENT



LOGIC DIAGRAM

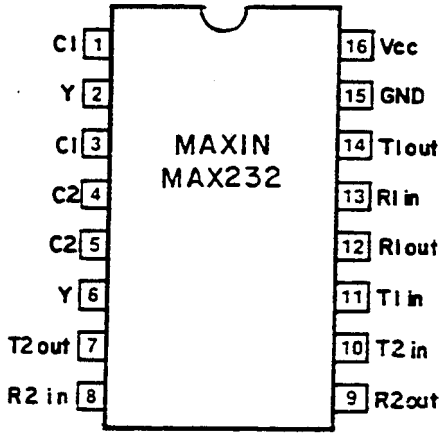


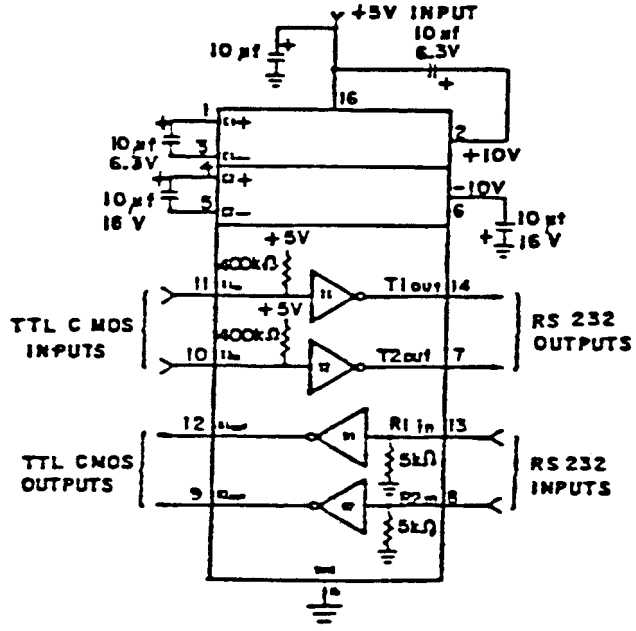
FUNCTION TABLE

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	↑	L	L	X	L	Q_{An}	Q_{Gn}	Serial Shift via Clock
H	↑	L	H	X	H	Q_{An}	Q_{Gn}	
H	L	↑	L	X	L	Q_{An}	Q_{Gn}	Serial Shift via Clock Inhibit
H	L	↑	H	X	H	Q_{An}	Q_{Gn}	
H	X	H	X	X	no change			Inhibited Clock
H	H	X	X	X				
H	L	L	X	X	no change			No Clock

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

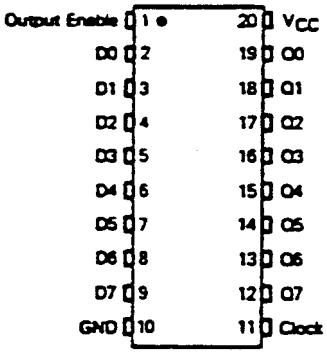
RS-232 TRANSMITTER/RECEIVER
U074
19A149446P2 (MAX232C)





OCTAL 3-STATE INVERTING D FLIP-FLOP
U097
19A704380P315 (74HC564DQ)

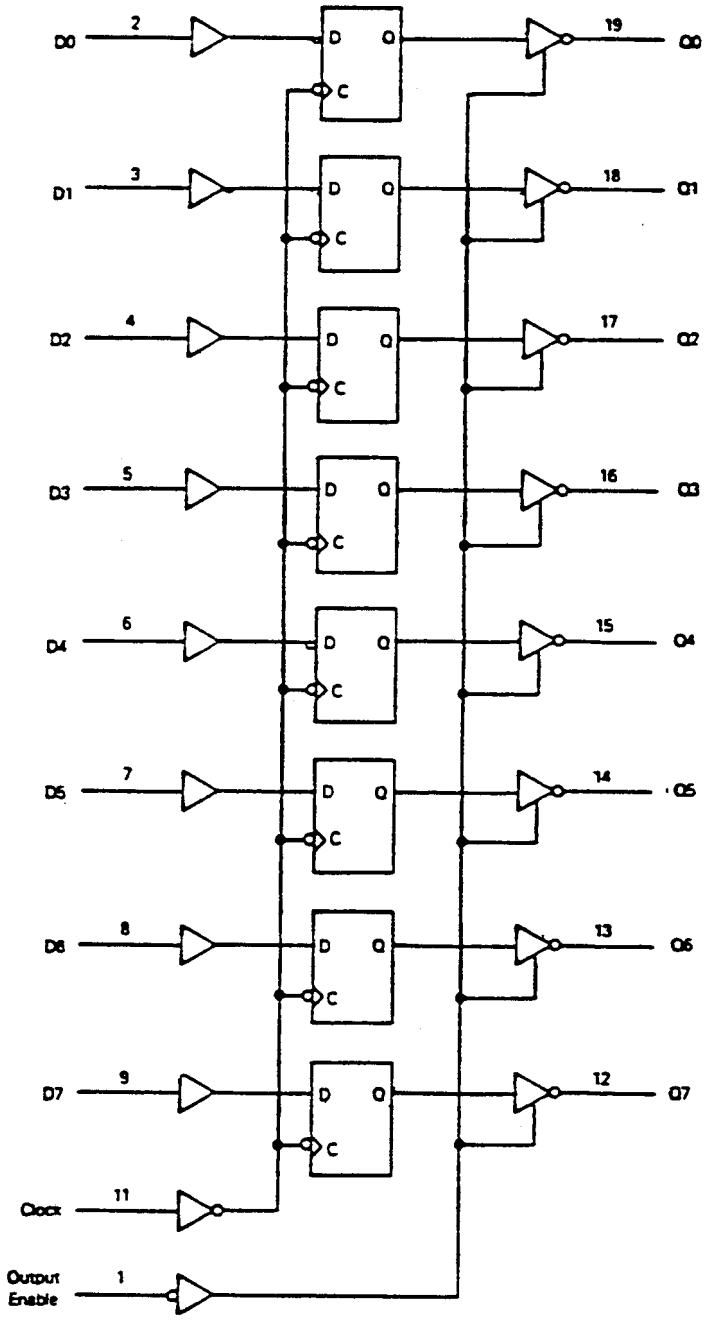
PIN ASSIGNMENT



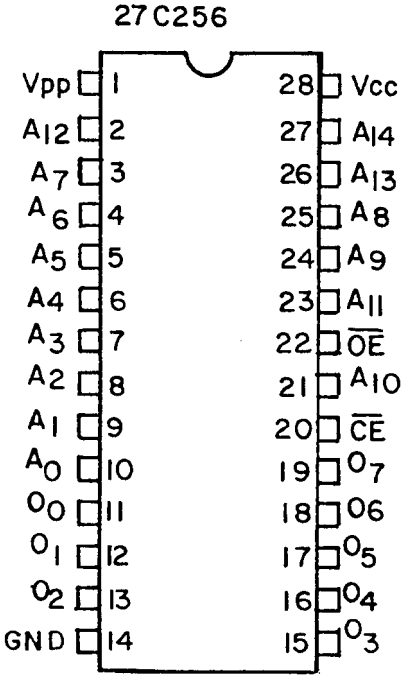
FUNCTION TABLE

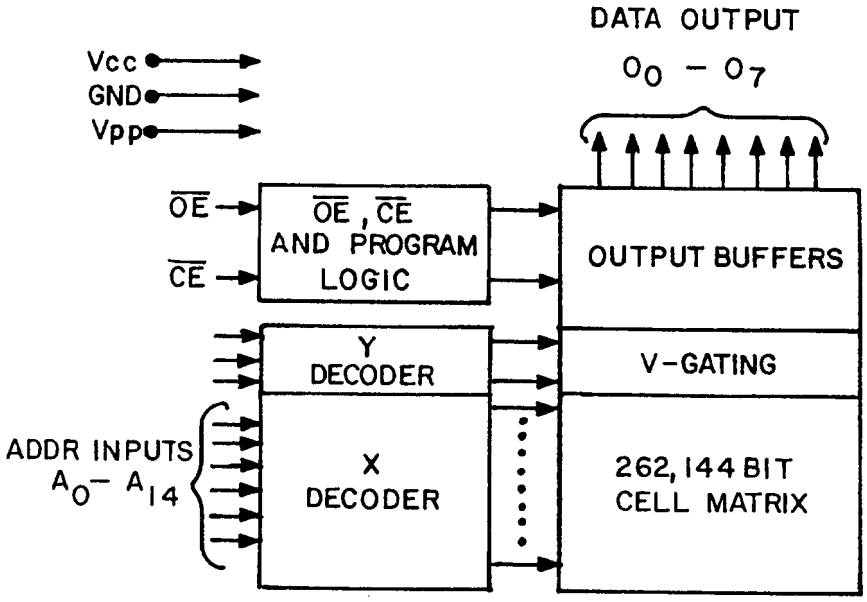
Inputs			Output
Output Enable	Clock	D	Q
L	↑	H	L
L	↑	L	H
L	L,H,↓	X	no change
H	X	X	Z

X = don't care
Z = high impedance



EPROM (256K)
U099SP
344A3377G8 (27C256(A704305P5))



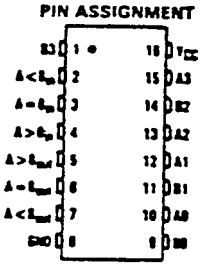


PIN NAME

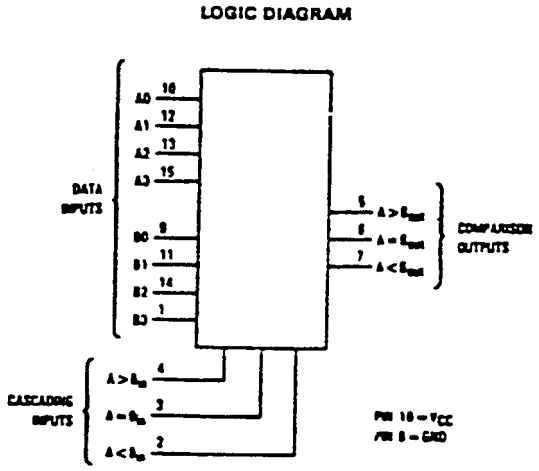
$A_0 - A_{14}$	ADDRESSES
CE	CHIP ENABLE
OE	OUTPUT ENABLE
$O_0 - O_7$	OUTPUTS

4-BIT MAGNITUDE COMPARATOR
U103
19A703483P319 (74HC84D)

PIN ASSIGNMENT



LOGIC DIAGRAM



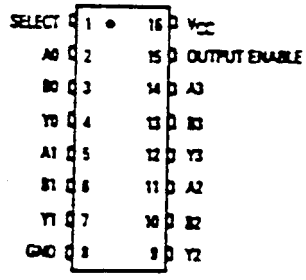
FUNCTION TABLE

Data Inputs				Cascading Inputs			Outputs		
A3, B3	A2, B2	A1, B1	A0, B0	$A>B_{in}$	$A=B_{in}$	$A<B_{in}$	$A>B_{out}$	$A=B_{out}$	$A<B_{out}$
A3>B3	X	X	X	X	X	X	H	L	L
A3<B3	X	X	X	X	X	X	L	L	H
A3=B3	A2>B2	X	X	X	X	X	H	L	L
A3=B3	A2<B2	X	X	X	X	X	L	L	H
A3=B3	A2=B2	A1>B1	X	X	X	X	H	L	L
A3=B3	A2=B2	A1<B1	X	X	X	X	L	L	H
A3=B3	A2=B2	A1=B1	A0>B0	X	X	X	H	L	L
A3=B3	A2=B2	A1=B1	A0<B0	X	X	X	L	L	H
A3=B3	A2=B2	A1=B1	A0=B0	L	L	L	H	L	H
A3=B3	A2=B2	A1=B1	A0=B0	L	L	H	L	L	H
A3=B3	A2=B2	A1=B1	A0=B0	H	L	L	H	L	L
A3=B3	A2=B2	A1=B1	A0=B0	H	L	H	L	L	L
A3=B3	A2=B2	A1=B1	A0=B0	X	H	X	L	H	L

X = Don't Care

QUAD 2-INPUT DATA SELECTOR/MUX
U104/U105/U106/U107
19A703471P323 (74HC157DQ)

PIN ASSIGNMENT

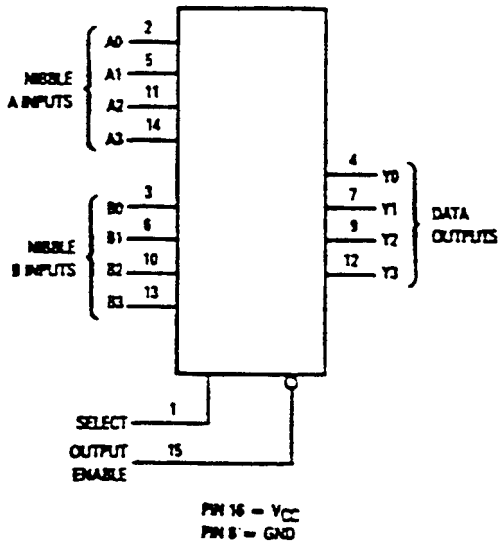


FUNCTION TABLE

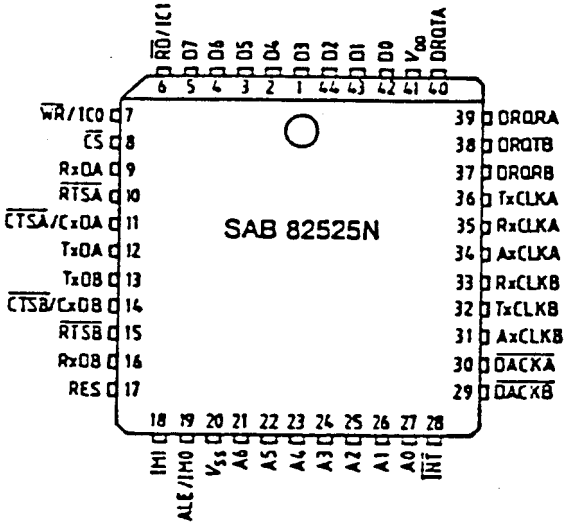
Inputs		
Output Enable	Select	Outputs Y0–Y3
H	X	L
L	L	A0–A3
L	H	B0–B3

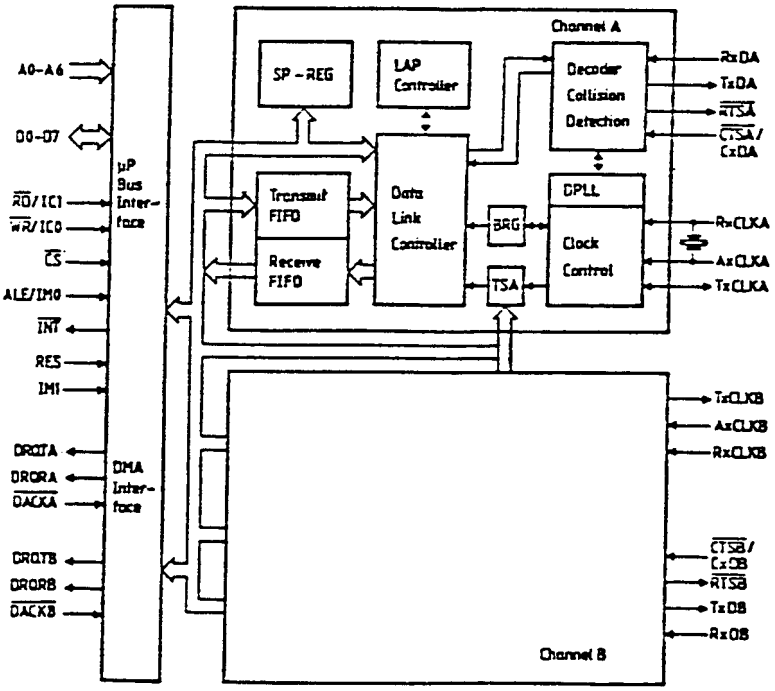
X = don't care
A0–A3, B0–B3 = the levels of the respective Data-Word inputs.

LOGIC DIAGRAM



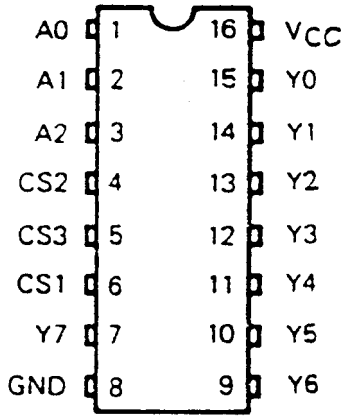
SERIAL COMMUNICATION CONTROLLER
U108S
19A149956P1 (SAB82525N)



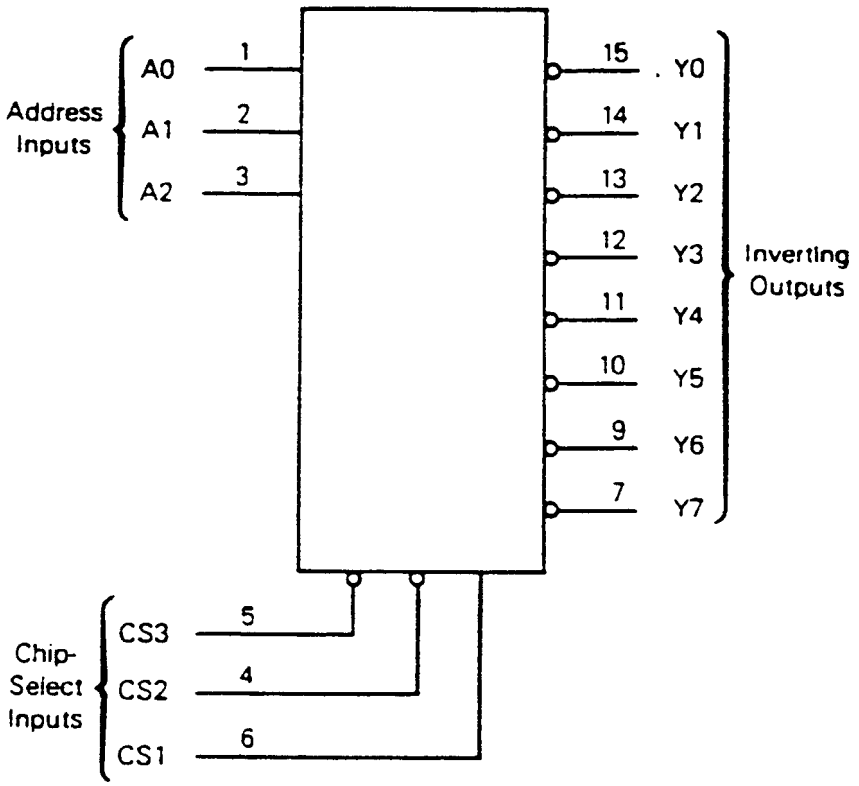


ADDRESS DECODER U109
19A704445P101 (74HC138D)

PIN ASSIGNMENT



BLOCK DIAGRAM



FUNCTION TABLE

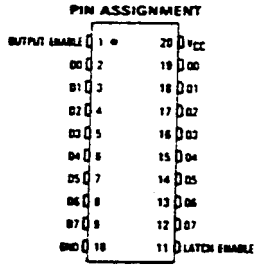
Inputs						Outputs							
CS1	CS2	CS3	A2	A1	A0	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	X	H	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	L	H	H	H	H	H	L	H	H	H	H
H	L	L	H	L	L	H	H	H	H	L	H	H	H
H	L	L	H	L	H	H	H	H	H	H	L	H	H
H	L	L	H	H	L	H	H	H	H	H	H	L	H
H	L	L	H	H	H	H	H	H	H	H	H	H	L

V_{CC} = Pin 16
GND = Pin 8

H = High Level (steady state)
L = Low Level (steady state)
X = Don't Care

OCTAL 3-STATE NON INVERTING TRANSMIT LATCH
U112/U113/U114/U115
19A703471P318 (74HC573D)

PIN ASSIGNMENT

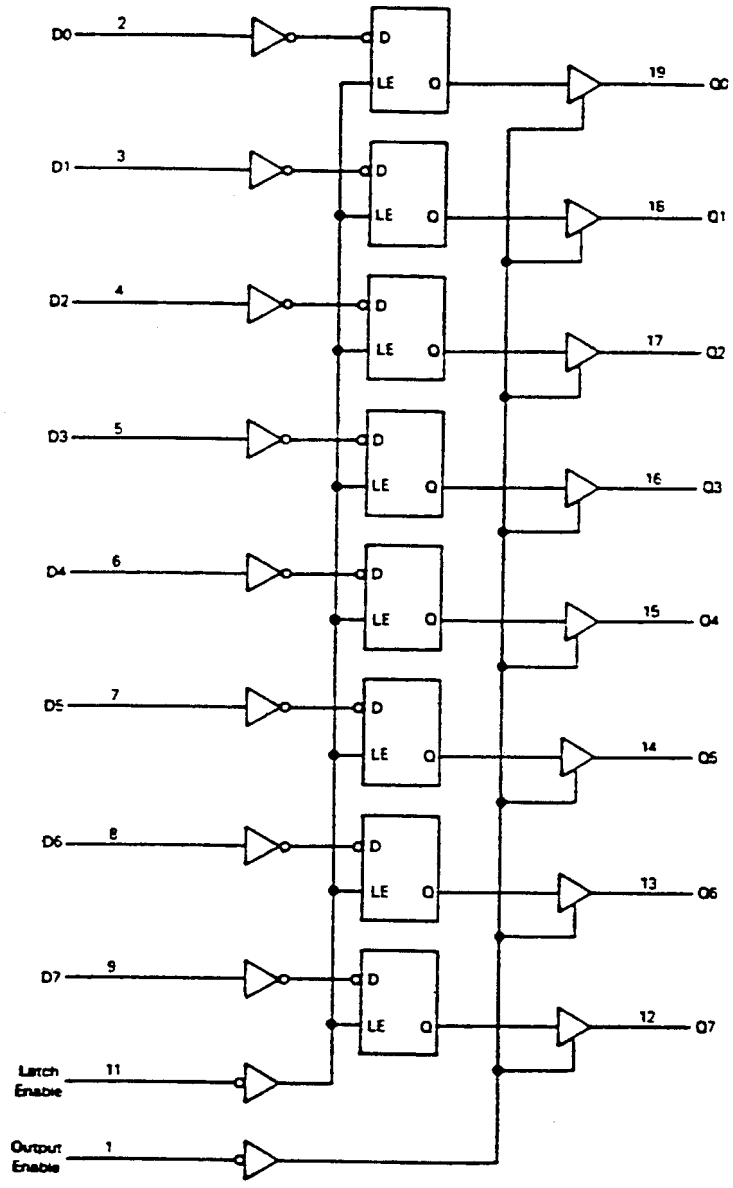


FUNCTION TABLE

Inputs			Output
Output Enable	Latch Enable	D	Q
L	H	H	H
L	H	L	L
L	L	X	no change
H	X	X	Z

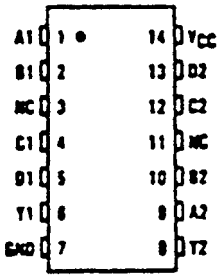
X = don't care
Z = high impedance

EXPANDED LOGIC DIAGRAM



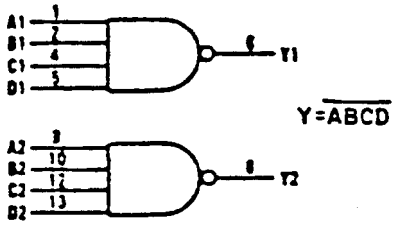
DUAL 4-INPUT NAND GATE U116
19A703483P308 (74HC20)

PIN ASSIGNMENT



NC=NO CONNECTION

LOGIC DIAGRAM

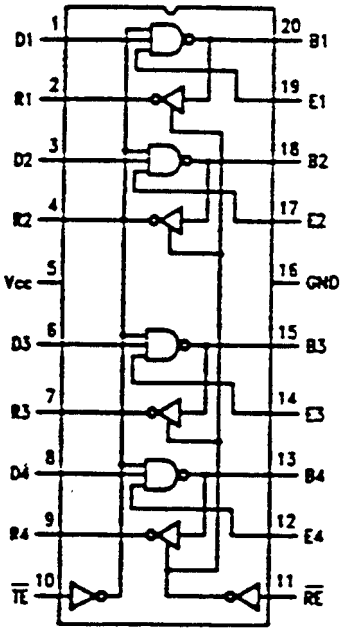


PIN 14= Vcc
PIN 7 = GND
PINS 3, 11 NO CONNECTION

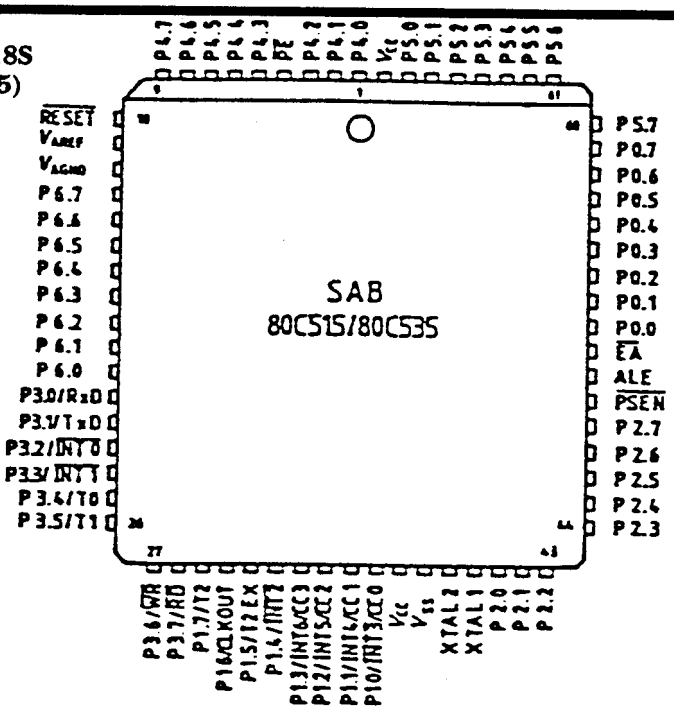
FUNCTION TABLE

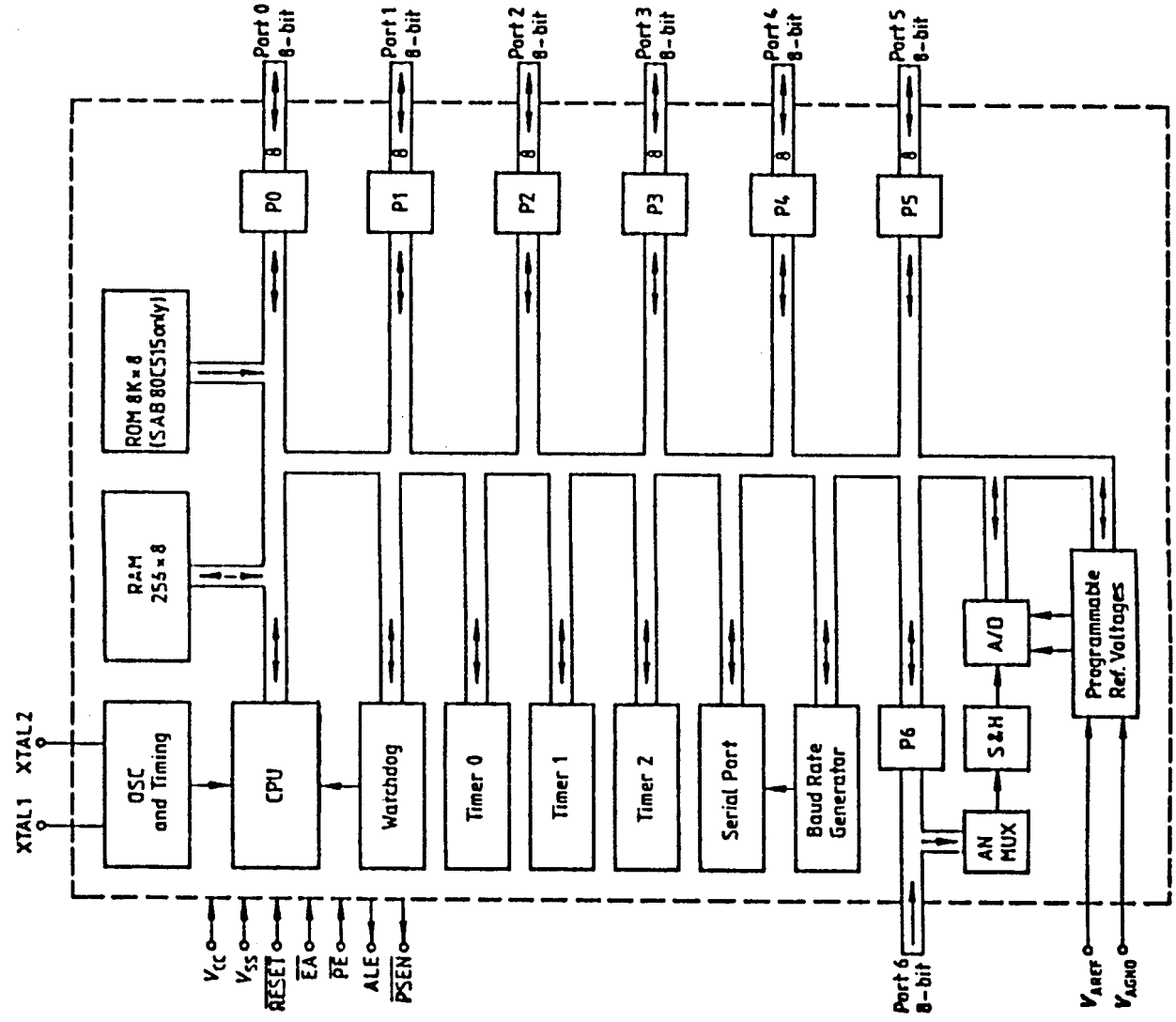
Inputs				Output
A	B	C	D	Y
L	X	X	X	H
X	L	X	X	H
X	X	L	X	H
X	X	X	L	H
H	H	H	H	L

TRANSCEIVER
U117
19A149953P201 (DS3896)



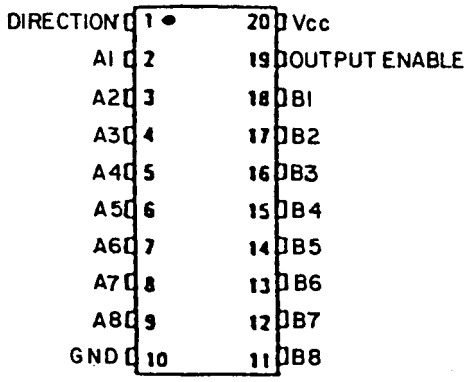
MICROCOMPUTER U118S
19A705828P1 (SAB80C535)



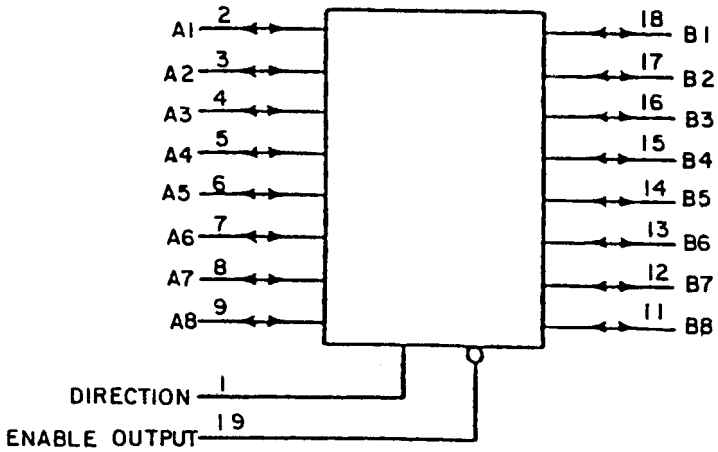


OCTAL 3-STATE NONINVERT BUS TRANSCEIVER U119
19A703471P108 (74HC245S)

PIN ASSIGNMENT



LOGIC DIAGRAM



PIN 10 = GND
PIN 20 = Vcc

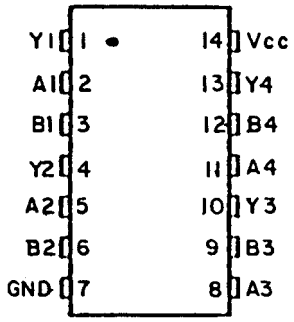
FUNCTION TABLE

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

QUAD 2-INPUT NOR GATE U121
19A703483P301 (74HC02D)

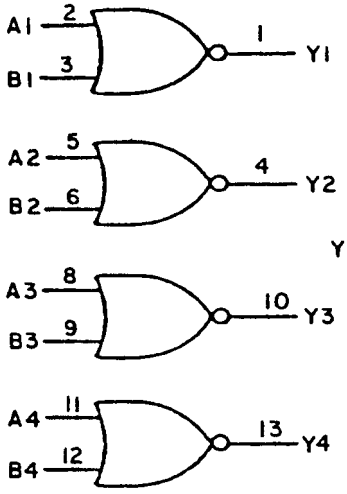
PIN ASSIGNMENT



FUNCTION DIAGRAM

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

LOGIC DIAGRAM

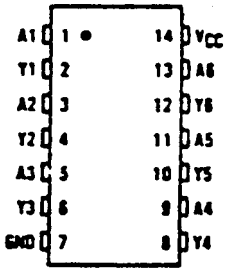


$Y = \overline{A + B}$

PIN 14 = Vcc
PIN 7 = GND

HEX SCHMITT TRIGGER INVERTERS
U124
19A703483P321 (74HC14D)

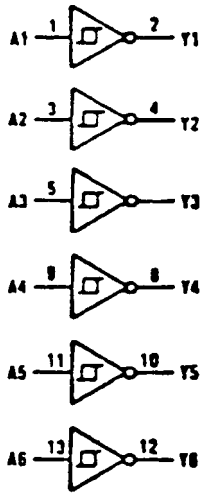
PIN ASSIGNMENT



FUNCTION TABLE

Input	Output
A	Y
L	H
H	L

LOGIC DIAGRAM

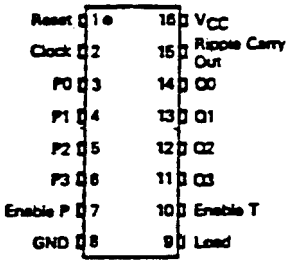


$Y = \overline{A}$

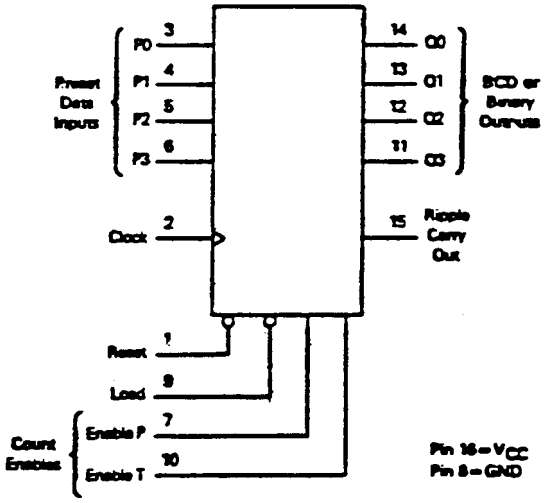
PIN 14 = V_{CC}
PIN 7 = GND

PRESETTABLE COUNTER
U125
19A703987P306 (74HC161)

PIN ASSIGNMENT



LOGIC DIAGRAM



FUNCTION TABLE

Inputs					Output
Clock	Reset*	Load	Enable P	Enable T	Q
⌐	L	X	X	X	Reset
⌐	H	L	X	X	Load Preset Data
⌐	H	H	H	H	Count
⌐	H	H	L	X	No Count
⌐	H	H	X	L	No Count

*HC162 and HC163 only. HC160 and HC161 are Asynchronous-Reset Devices

H = high level
L = low level
X = don't care

4-CHANNEL AUDIO BOARD
19D903302P1, REV. EM1

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - -CAPACITORS- - - - - - - - - - -
C001 thru C005	19A702052P26	CHIP: .1µF
C006 thru C119	19A702052P14	CHIP: .01µF
C120 thru C122	19A703314P12	LEADED: 100µF
	19A703314P12	LEADED: 100µF
C123 and C124	19A705205P211	CHIP: 47µF
C125	19A705205P6	CHIP: 10µF
C126	19A705205P12	CHIP: .33µF
C127 thru C132	19A702052P26	CHIP: .1µF
C133 thru C135	19A705205P12	CHIP: .33µF
C136 and C137	19A705205P211	CHIP: 47µF
C138 thru C147	19A702052P14	CHIP: .01µF
	19A702052P14	
C148	19A702052P1	CHIP: 220PF
C149 and C150	19A702052P14	CHIP: .01µF
C153	19A702052P105	CHIP: 1000pF
C155 and C156	19A705205P18	CHIP: 4.7µF
C157	19A705205P211	CHIP: 47µF
C158 thru C163	19A702052P26	CHIP: .1µF
C164 thru C166	19A705205P12	CHIP: .33µF
C167 and C168	19A705205P211	CHIP: 47µF
C169 thru C179	19A702052P14	CHIP: .01µF
C180	19A705205P2	CHIP: 1µF
C181	19A702052P1	CHIP: 220PF
C184	19A702052P105	CHIP: 1000pF
C186 and C187	19A705205P18	CHIP: 4.7µF
C188	19A705205P211	CHIP: 47µF
C189 thru C194	19A702052P26	CHIP: .1µF
C195 thru C197	19A705205P12	CHIP: .33µF
C198	19A702052P14	CHIP: .01µF
C199 and C200	19A705205P211	CHIP: 47µF
C201 thru C208	19A702052P14	CHIP: .01µF
C209 and C214	19A702052P26	CHIP: .1µF
C215 thru C217	19A705205P12	CHIP: .33µF
C218 and C219	19A705205P211	CHIP: 47µF
C220	19A702052P1	CHIP: 220pF
C221	19A702052P14	CHIP: .01µF
C222 and C224	19A702052P14	CHIP: 220PF
C226 and C229	19A702052P105	CHIP: 1000pF
C231 thru C234	19A705205P18	CHIP: 4.7µF
C235 and C236	19A702052P14	CHIP: .01µF
C237 and C238	19A702061P33	CHIP: 27pF
C239	19A702052P26	CHIP: .1µF
C240	19A702052P105	CHIP: 1000pF
C241 and C242	19A702052P14	CHIP: .01µF
C243 and C244	19A702061P49	CHIP: 56pF
C245	19A702052P26	CHIP: .1µF
C246	19A705205P18	CHIP: 4.7µF
C247	19A705205P211	CHIP: 47µF
C248	19A702052P14	CHIP: .01µF
C249	19A702052P26	CHIP: .1µF
C250 thru C252	19A702052P14	CHIP: .01µF
C253	19A705205P211	CHIP: 47µF
C254 thru C256	19A702052P14	CHIP: .01µF
C257 thru C261	19A705205P6	CHIP: 10µF
C266	19A702052P14	CHIP: CAP .01UµF
		- - - - - - - - - - - DIODES- - - - - - - - - - -
CR01 thru CR06	19A703595P10	HLMP-1301-010
D001 thru D005	19A700053P2	CHIP DIODE
D006 and D007	T324ADP1041	LEADED DIODE
D008 and D014	19A700053P2	CHIP DIODE
		- - - - - - - - - - - FUSES - - - - - - - - - - -
F001	19A134961P22	FUSE 3A
F002 and F003	19A134961P10	FUSE .5A
		- - - - - - - - - - CONNECTORS - - - - - - - - - -
J001 and J002	19B801587P4	96 PIN CONN
J003	19B209727P37	DB-9

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - - RELAYS- - - - - - - - - - -
K001 thru K004	19B235621P1	RELAY LM44BOO CP CLARE
		- - - - - - - - - - -INDUCTORS- - - - - - - - -
L001 and L002	19A700021P28	CHIP IND 8.2 µH
L003	19A149806P2	LEADED IND 100µH
		- - - - - - - - - - - -LED's- - - - - - - - - - -
LED1 thru LED4	19A703595P10	HLMP-1301-010
		- - - - - - - - - - -TRANSISTORS- - - - - - - - -
Q001 and Q002	19A700076P2	CHIP TRANSISTOR
Q004	19A702524P3	CHIP FET
Q005 and Q006	19A700076P2	CHIP TRANSISTOR
Q008	19A702524P3	CHIP FET
Q009 and Q010	19A700076P2	CHIP TRANSISTOR
Q012 and Q013	19A702524P3	CHIP FET
Q015 thru Q018	19A700076P2	CHIP TRANSISTOR
		- - - - - - - - - - - RESISTORS- - - - - - - - - -
R001	19A702931P230	CHIP RESISTOR 2.0K 1%
R002 and R003	19A702931P266	CHIP RESISTOR 4.75K 1%
R004	19A702931P230	CHIP RESISTOR 2.0K 1%
R005	19A702931P401	CHIP RESISTOR 100K 1%
R006 and R007	19A702931P301	CHIP RESISTOR 10.0K 1%
R008	19B800607P151	CHIP RESISTOR 150 5%
R009	19A702931P401	CHIP RESISTOR 100.0K 1%
R010	19A702931P360	CHIP RESISTOR 12.7K 1%
R011	19A702931P301	CHIP RESISTOR 10.0K 1%
R012 and R013	19B800607P151	CHIP RESISTOR 150 5%
R014	19B800607P273	CHIP RESISTOR 27K 5%
R015 thur R22	19A702931P266	CHIP RESISTOR 4.7K 5%
R023	19A702931P301	CHIP RESISTOR 10.0K 1%
R024	19A702931P266	CHIP RESISTOR 4.7K 5%
R025 and R026	19A702931P301	CHIP RESISTOR 10.0K 1%
R027 and R028	19B800607P102	CHIP RESISTOR 1.0K 5%
R029 and R030	19A702391P176	CHIP RESISTOR 604 1%
R031	19A702931P320	CHIP RESISTOR 15.8K 1%
R032	19A702931P407	CHIP RESISTOR 115K 1%
R033	19A702931P360	CHIP RESISTOR 41.2K 1%
R034	19B800607P564	CHIP RESISTOR 560K 5%
R035	19A702931P320	CHIP RESISTOR 15.8K 1%
R036 and R037	19A702931P360	CHIP RESISTOR 41.2K 1%
R038	19B800607P333	CHIP RESISTOR 33K 5%

SYMBOL	GE PART NO.	DESCRIPTION
R039	19A702931P301	CHIP RESISTOR 10.0K 1%
R040	19B800607P563	CHIP RESISTOR 56K 5%
R041	19A702931P301	CHIP RESISTOR 10.0K 1%
R042	19B800607P225	CHIP RESISTOR 2.2M 5%
R043	19B800607P102	CHIP RESISTOR 1.0K 5%
R044	19A702931P401	CHIP RESISTOR 100.0K 1%
R045	19B800607P563	CHIP RESISTOR 56K 5%
R046	19A702931P301	CHIP RESISTOR 10.0K 1%
R047	19A702931P295	CHIP RESISTOR 9.53K 1%
R048	19A702931P461	CHIP RESISTOR 422K 1%
R049	19A702931P259	CHIP RESISTOR 4.02K 1%
R050	19B800607P151	CHIP RESISTOR 150 5%
R051	19A702931P301	CHIP RESISTOR 10.0K 1%
R052	19A702931P401	CHIP RESISTOR 100.0K 1%
R053 and R054	19A702931P301	CHIP RESISTOR 10.0K 1%
R055	19A702931P385	CHIP RESISTOR 75.0K 1%
R056	19A702931P374	CHIP RESISTOR 57.6K 1%
R057	19B800607P564	CHIP RESISTOR 560K 5%
R058	19B800607P223	CHIP RESISTOR 22K 5%
R059	19A702931P301	CHIP RESISTOR 10.0K 1%
R060	19A702931P401	CHIP RESISTOR 100K 1%
R061 and R062	19A702931P301	CHIP RESISTOR 10.0K 1%
R063	19B800607P151	CHIP RESISTOR 150 5%
R064	344A3206P4	LEADED 11.0K .1%
R065	19A702931P360	CHIP RESISTOR 12.7K 1%
R066	19A702931P301	CHIP RESISTOR 10.0K 1%
R069	19B800607P273	CHIP RESISTOR 27K 5%
R070 thru R077	19A702931P266	CHIP RESISTOR 4.7K 5%
R078	19A702931P301	CHIP RESISTOR 10.0K 1%
R079	19A702931P266	CHIP RESISTOR 4.7K 5%
R080 and R081	19A702931P301	CHIP RESISTOR 10.0K 1%
R082 and R083	19B800607P102	CHIP RESISTOR 1.0K 5%
R084 and R085	19A702391P176	CHIP RESISTOR 604 1%
R086	19A702931P320	CHIP RESISTOR 15.8K 1%
R087	19A702931P407	CHIP RESISTOR 115K 1%
R088	19A702931P374	CHIP RESISTOR 57.6K 1%
R089	19A702931P385	CHIP RESISTOR 75.0K 1%
R090	19A702931P320	CHIP RESISTOR 15.8K 1%
R091 and R092	19A702931P360	CHIP RESISTOR 41.2K 1%
R093	19A702931P320	CHIP RESISTOR 15.8K 1%
R094	19B800607P333	CHIP RESISTOR 33K 5%
R095	19A702931P301	CHIP RESISTOR 10.0K 1%
R096	19B800607P563	CHIP RESISTOR 56K 5%
R097	19A702931P301	CHIP RESISTOR 10.0K 1%
R098	19B800607P225	CHIP RESISTOR 2.2M 5%
R099	19B800607P102	CHIP RESISTOR 1.0K 5%
R100	19A702931P401	CHIP RESISTOR 100.0K 1%
R101	19B800607P563	CHIP RESISTOR 56K 5%
R102	19A702931P301	CHIP RESISTOR 10.0K 1%

SYMBOL	GE PART NO.	DESCRIPTION
R103	19A702931P295	CHIP RESISTOR 9.53K 1%
R104	19A702931P461	CHIP RESISTOR 422K 1%
R105	19A702931P259	CHIP RESISTOR 4.02K 1%
R106	19B800607P102	CHIP RESISTOR 1.0K 5%
R107	19A702931P301	CHIP RESISTOR 10.0K 1%
R108	19A702931P401	CHIP RESISTOR 100.0K 1%
R109 and R110	19A702931P301	CHIP RESISTOR 10.0K 1%
R111	19A702931P385	CHIP RESISTOR 75.0K 1%
R112	19A702931P374	CHIP RESISTOR 57.6K 1%
R113	19B800607P564	CHIP RESISTOR 560K 5%
R114	19B800607P223	CHIP RESISTOR 22K 5%
R115	19A702931P301	CHIP RESISTOR 10.0K 1%
R116	19A702931P401	CHIP RESISTOR 100K 1%
R117 and R118	19A702931P301	CHIP RESISTOR 10.0K 1%
R119	19B800607P151	CHIP RESISTOR 150 5%
R120	344A3206P4	LEADED 11.0K .1%
R121	19A702931P360	CHIP RESISTOR 12.7K 1%
R122	19A702931P301	CHIP RESISTOR 10.0K 1%
R125	19B800607P273	CHIP RESISTOR 27K 5%
R126 thru R133	19A702931P266	CHIP RESISTOR 4.7K 5%
R134	19A702931P301	CHIP RESISTOR 10.0K 1%
R135	19A702931P266	CHIP RESISTOR 4.7K 5%
R136	19A702931P301	CHIP RESISTOR 10.0K 1%
R137	19A702931P301	CHIP RESISTOR 10.0K 1%
R138 and R139	19B800607P102	CHIP RESISTOR 1.0K 5%
R140 and R141	19A702391P176	CHIP RESISTOR 604 1%
R142	19A702931P320	CHIP RESISTOR 15.8K 1%
R143	19A702931P407	CHIP RESISTOR 115K 1%
R144 and R145	19A702931P360	CHIP RESISTOR 41.2K 1%
R146	19A702931P320	CHIP RESISTOR 15.8K 1%
R147	19A702931P360	CHIP RESISTOR 41.2K 1%
R148	19B800607P333	CHIP RESISTOR 33K 5%
R149	19A702931P301	CHIP RESISTOR 10.0K 1%
R150	19B800607P563	CHIP RESISTOR 56K 5%
R151	19A702931P301	CHIP RESISTOR 10.0K 1%
R152	19B800607P225	CHIP RESISTOR 2.2M 5%
R153	19B800607P102	CHIP RESISTOR 1.0K 5%
R154	19A702931P401	CHIP RESISTOR 100.0K 1%
R155	19B800607P563	CHIP RESISTOR 56K 5%
R156	19A702931P301	CHIP RESISTOR 10.0K 1%
R157	19A702931P295	CHIP RESISTOR 9.53K 1%
R158	19A702931P461	CHIP RESISTOR 422K 1%
R159	19A702931P259	CHIP RESISTOR 4.02K 1%
R160	19B800607P102	CHIP RESISTOR 1.0K 5%
R161	19A702931P301	CHIP RESISTOR 10.0K 1%
R162	19A702931P401	CHIP RESISTOR 100.0K 1%
R163 and R164	19A702931P301	CHIP RESISTOR 10.0K 1%
R165	19A702931P385	CHIP RESISTOR 75.0K 1%
R166	19A702931P374	CHIP RESISTOR 57.6K 1%

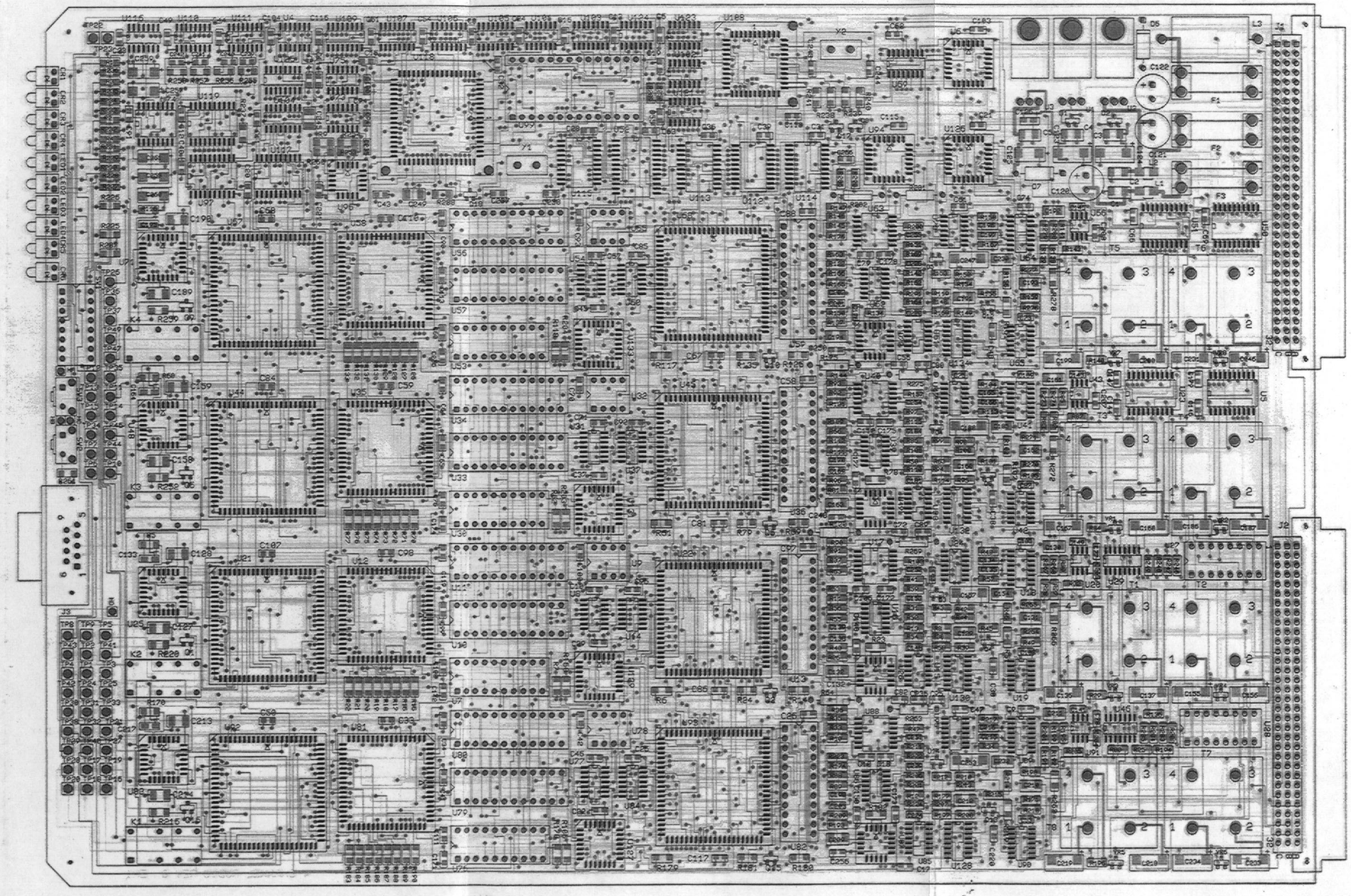
SYMBOL	GE PART NO.	DESCRIPTION
R167	19B800607P564	CHIP RESISTOR 560K 5%
R168	19B800607P223	CHIP RESISTOR 22K 5%
R169	19A702931P301	CHIP RESISTOR 10.0K 1%
R170	19A702931P401	CHIP RESISTOR 100K 1%
R171	19A702931P371	CHIP RESISTOR 53.6K 1%
R174	19A702931P301	CHIP RESISTOR 10.0K 1%
R175	344A3206P4	LEADED 11.0K .1%
R176	19A702931P360	CHIP RESISTOR 12.7K 1%
R177	19B800607P151	CHIP RESISTOR 150 5%
R178 and R179	19A702931P301	CHIP RESISTOR 10.0K 1%
R180	19B800607P273	CHIP RESISTOR 27K 5%
R181	19A702931P266	CHIP RESISTOR 4.7K 5%
R182	19A702931P301	CHIP RESISTOR 10.0K 1%
R183 thru R190	19A702931P266	CHIP RESISTOR 4.7K 5%
R191 and R192	19B800607P102	CHIP RESISTOR 1.0K 5%
R193 and R194	19A702931P301	CHIP RESISTOR 10.0K 1%
R195 and R196	19A702391P176	CHIP RESISTOR 604 1%
R197	19B800607P223	CHIP RESISTOR 22K 5%
R198	19A702931P348	CHIP RESISTOR 30.9K 1%
R199	19A702931P401	CHIP RESISTOR 100.0K 1%
R200	19A702931P295	CHIP RESISTOR 9.53K 1%
R201	19A702931P393	CHIP RESISTOR 90.9K 1%
R202	344A3206P4	LEADED 11.0K .1%
R203 and R204	19B800607P102	CHIP RESISTOR 1.0K 5%
R205	19A702931P407	CHIP RESISTOR 115K 1%
R206	19A702931P320	CHIP RESISTOR 15.8K 1%
R207	19B800607P333	CHIP RESISTOR 33K 5%
R208	19A702931P301	CHIP RESISTOR 10.0K 1%
R209	19B800607P563	CHIP RESISTOR 56K 5%
R210	19B800607P225	CHIP RESISTOR 2.2M 5%
R211	19A702931P301	CHIP RESISTOR 10.0K 1%
R212	19B800607P102	CHIP RESISTOR 1.0K 5%
R213	19A702931P401	CHIP RESISTOR 100.0K 1%
R214	19A702931P301	CHIP RESISTOR 10.0K 1%
R215	19B800607P563	CHIP RESISTOR 56K 5%
R216	19A702931P266	CHIP RESISTOR 4.7K 5%
R217	19A702931P461	CHIP RESISTOR 422K 1%
R218	19A702931P259	CHIP RESISTOR 4.02K 1%
R219	19A702931P301	CHIP RESISTOR 10.0K 1%
R220	19A702931P266	CHIP RESISTOR 4.7K 5%
R221	19A702931P401	CHIP RESISTOR 100.0K 1%
R222 thru R224	19A702931P301	CHIP RESISTOR 10.0K 1%
R225 and R226	19A702931P230	CHIP RESISTOR 2.0K 1%
R227 thru R229	19A702931P230	CHIP RESISTOR 2.0K 1%
R230 thru R241	19A702931P301	CHIP RESISTOR 10.0K 1%

SYMBOL	GE PART NO.	DESCRIPTION
R246 thru R249	19B800607P122	CHIP RESISTOR 1.2K 5%
R250	19A702931P301	CHIP RESISTOR 10.0K 1%
R252 and R253	19A702931P266	CHIP RESISTOR 4.7K 5%
R254	19B800607P102	CHIP RESISTOR 1.0K 5%
R255	19A702931P371	CHIP RESISTOR 53.6K 1%
R256 thru R258	19A702931P401	CHIP RESISTOR 100K 1%
R259	19A702931P266	CHIP RESISTOR 4.7K 5%
R260 and R261	19A702931P401	CHIP RESISTOR 100K 1%
R262	19A702931P393	CHIP RESISTOR 90.9K 1%
R263	344A3206P3	LEADED RESISTOR 12.4K .1%
R264	19A702931P371	CHIP RESISTOR 53.6K 1%
R265	19A702931P348	CHIP RESISTOR 30.9K 1%
R266	19A702931P401	CHIP RESISTOR 100.0K 1%
R267 and R268	19A702931P393	CHIP RESISTOR 90.9K 1%
R269	344A3206P3	12.4K .1%
R270	19A702931P371	CHIP RESISTOR 53.6K 1%
R271	19A702931P348	CHIP RESISTOR 30.9K 1%
R272	19A702931P401	CHIP RESISTOR 100.0K 1%
R273 and R274	19A702931P393	CHIP RESISTOR 90.9K 1%
R275	344A3206P3	12.4K .1%
R276	19A702931P371	CHIP RESISTOR 53.6K 1%
R277	19A702931P348	CHIP RESISTOR 30.9K 1%
R278	19A702931P401	CHIP RESISTOR 100.0K 1%
R279 and R280	19A702931P393	CHIP RESISTOR 90.9K 1%
R281	344A3206P3	12.4K .1%
R282 thru R285	19B800607P122	CHIP RESISTOR 1.2K 5%
R286	19B800607P273	CHIP RESISTOR 27K 5%
R287	19A702931P230	CHIP RESISTOR 2.0K 1%
R288	19B800607P273	CHIP RESISTOR 27K 5%
R289	19A702931P401	CHIP RESISTOR 100K 1%
R290	19A702931P230	CHIP RESISTOR 2.0K 1%
R291	19B800607P151	CHIP RESISTOR 150 5%
R292 thru R295	19A702931P301	CHIP RESISTOR 10.0K 1%
		- - - - - - - - - -SWITCHES- - - - - - - - - -
SW01	19A149955P1	SW9955P1
SW02 and SW03	19A149923P1	1 POS
		- - - - - - - - -TRANSFORMERS- - - - - - - - -
T001 thru T008	344A3106P1	LXFMRA3106P1
		- - - - - - -TEST POINT CONNECTORS- - - - - -
TP01 thru TP49	344A3367P1	TP1622P1
		- - - - - - - INTEGRATED CIRCUITS - - - - - - -
U001	19A134718P2	MC7912CT TO-220 MOT
U002	19A134717P2	MC7812CT TO-220 MOT
U003	19A134718P1	MC7905CT TO-220 MOT

SYMBOL	GE PART NO.	DESCRIPTION
U004	19A703483P311	74HC32D SO-14 MOT,TI,RCA
U005	344A3113P101	MAX333CWP SO-W-20 MAXIM
U006P	344A3377G1/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U007	344A3105P1	TP3076A DIP-20 NATIONAL
U008	19A703483P302	74HC00 SOIC-14 MOT,TI,RCA
U009SP	344A3377G5/ 344A3128P1	XC1736A DIP-8 XILINX
U010SP and U011SP	344A3377G6/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U012	344A3112P1	CY7C510-55 PLCC-68 CYPRESS or etc.
U013	19A702934P2	CY7C128-55PC DIP-24 CYPRESS or etc.
U014	19A703483P305	74HC08C SOIC-14 MOT,TI,RCA
U015	19A705180P102	X9103S SOIC-14 XICOR
U016	19A704883P2	MC3303D SOIC-14 MOT
U017	344A3124P1	MF5CWM SO-W-14 NATIONAL
U018	19A704380P321	74HC123A SOIC-16 MOT,TI,RCA
U019	19A702705P4	4066BM SO-14 MOT,RCA
U020	344A3070P2	TL082A SO-8 TI
U021	344A3129P1	XC3020-70 PLCC-84 XILINX
U022	344A3129P1	XC3020-70 PLCC-84 XILINX
U023	344A3113P101	MAX333CWP SO-W-20 MAXIM
U024	19A704380P302	74HC74 SOIC-14 MOT,TI,RCA
U025	344A3123P1	AD7840 PLCC-28 ANALOG DEVICES
U026	344A3122P1	TP3040 PLCC-20 NATIONAL
U027 and U028	344A3071P2	ILQ66-4 DIP-16 HP,TI
U029	19A704380P310	74HC175 SOIC-16 MOT,TI,RCA
U030	344A3105P1	TP3076A DIP-20 NATIONAL
U031	19A703483P302	74HC00 SOIC-14 MOT,TI,RCA
U032SP	344A3377G5/ 344A3128P1	XC1736A DIP-8 XILINX
U033SP	344A3377G6/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U034SP	344A3377G7/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U035	344A3112P1	CY7C510-55 PLCC-68 CYPRESS or etc.
U036	19A702934P2	CY7C128-55PC DIP-24 CYPRESS or etc.
U037	19A703483P305	74HC08C SOIC-14 MOT,TI,RCA
U038	19A705180P102	X9103S SOIC-14 XICOR
U039	19A704883P2	MC3303D SOIC-14 MOT
U040	344A3124P1	MF5CWM SO-W-14 NATIONAL
U041	19A704380P321	74HC123A SOIC-16 MOT,TI,RCA
U042	19A702705P4	4066BM SO-14 MOT,RCA
U043	344A3070P2	TL082A SO-8 TI
U044	344A3129P1	XC3020-70 PLCC-84 XILINX
U045	344A3129P1	XC3020-70 PLCC-84 XILINX
U046	19A703471P305	74HC126 SOIC-14 MOT,TI,RCA
U047	19A704380P302	74HC74 SOIC-14 MOT,TI,RCA
U048	344A3123P1	AD7840 PLCC-28 ANALOG DEVICES
U049	344A3122P1	TP3040 PLCC-20 NATIONAL
U050 and U051	19A149953P202	DS3897M SO-W-20 NATIONAL
U052	19A702934P4	CY7C128-55PC SOIC-W-24 CYPRESS or etc.
U053	344A3105P1	TP3076A DIP-20 NATIONAL
U054	19A703483P302	74HC00 SOIC-14 MOT,TI,RCA
U055SP	344A3377G5/ 344A3128P1	XC1736A DIP-8 XILINX

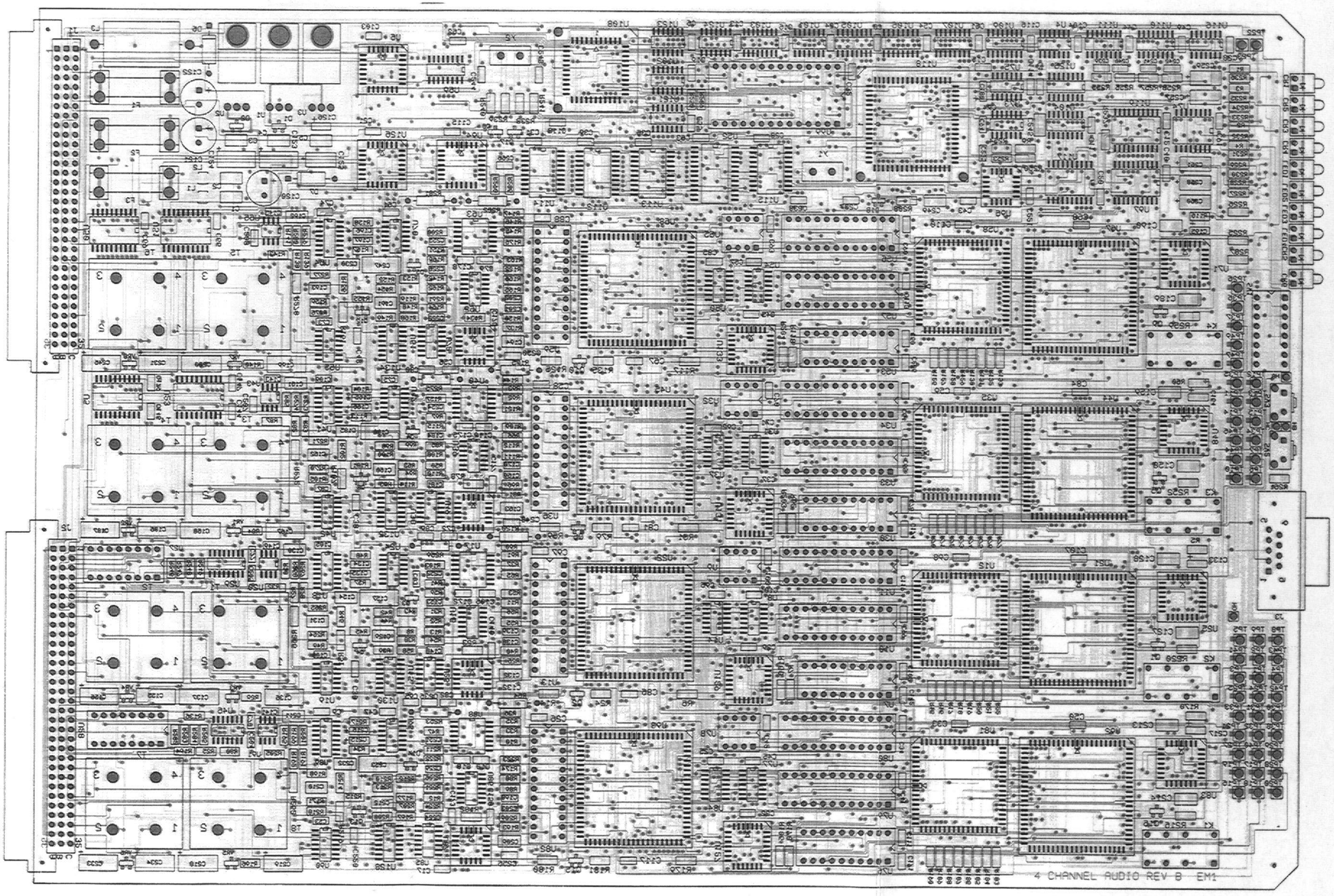
SYMBOL	GE PART NO.	DESCRIPTION
U056SP	344A3377G6/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U057SP	344A3377G7/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U058	344A3112P1	CY7C510-55 PLCC-68 CYPRESS or etc.
U059	19A702934P2	CY7C128-55PC DIP-24 CYPRESS or etc.
U060	19A703483P305	74HC08C SOIC-14 MOT,TI,RCA
U061	19A705180P102	X9103S SOIC-14 XICOR
U062	19A704883P2	MC3303D SOIC-14 MOT
U063	344A3124P1	MF5CWM SO-W-14 NATIONAL
U064	19A704380P321	74HC123A SOIC-16 MOT,TI,RCA
U065	19A702705P4	4066BM SO-14 MOT,RCA
U066	344A3070P2	TL082A SO-8 TI
U067 and U068	344A3129P1	XC3020-70 PLCC-84 XILINX
U069	19A703987P322	74HC165D SO-W-16 MOT,TI,RCA
U070	19A704380P302	74HC74 SOIC-14 MOT,TI,RCA
U071	344A3123P1	AD7840 PLCC-28 ANALOG DEVICES
U072	344A3122P1	TP3040 PLCC-20 NATIONAL
U073	19A705180P102	X9103S SOIC-14 XICOR
U074	19A149446P2	MAX232C SOIC-W-16 MAXIM
U075	19A704380P302	74HC74 SOIC-14 MOT,TI,RCA
U076	344A3105P1	TP3076A DIP-20 NATIONAL
U077	19A703483P302	74HC00 SOIC-14 MOT,TI,RCA
U078SP	344A3377G5/ 344A3128P1	XC1736A DIP-8 XILINX
U079SP	344A3377G7/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U080SP	344A3377G6/ 344A3118P1	CY7C291-35 DIP-24 CYPRESS or etc.
U081	344A3112P1	CY7C510-55 PLCC-68 CYPRESS or etc.
U082	19A702934P2	CY7C128-55PC DIP-24
U083	344A3123P1	AD7840 PLCC-28 ANALOG DEVICES
U084	19A703483P305	74HC08C SOIC-14 MOT,TI,RCA
U085	19A705180P102	X9103S SOIC-14 XICOR
U086	19A704883P2	MC3303D SOIC-14 MOT
U087	344A3122P1	TP3040 PLCC-20 NATIONAL
U088	344A3124P1	MF5CWM SO-W-14 NATIONAL
U089	19A704380P321	74HC123A SOIC-16 MOT,TI,RCA
U090	19A702705P4	4066BM SO-14 MOT,RCA
U091	344A3070P2	TL082A SO-8 TI
U092 and U093	344A3129P1	XC3020-70 PLCC-84 XILINX
U094P	344A3377G2/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U095	19A704380P302	74HC74 SOIC-14 MOT,TI,RCA
U096	344A3122P1	TP3040 PLCC-20 NATIONAL
U097	19A704380P315	74HC564DQ SOIC-W-20 MOT,TI,RCA
U099SP	344A3377G8	27C256(A704305P5) DIP-28 INTEL,TI
U101 and U102	19A703483P302	74HC00 SOIC-14 MOT,TI,RCA
U103	19A703483P319	74HC85D SO-16 MOT,TI,RCA
U104 thru U107	19A703471P323	74HC157DQ SOIC-16 MOT,TI,RCA
U108S	19A149956P1	SAB82525N SOIC-44 SIEMENS
U109	19A704445P101	74HC138D SO-16 MOT,TI,RCA
U110 and U111	19A704380P321	74HC123A SOIC-16 MOT,TI,RCA
U112 thru U115	19A703471P318	74HC573D SOIC-W-20 MOT,TI,RCA
	19A703471P318	
U116	19A703483P308	74HC20 SOIC-14 MOT,TI,RCA
U117	19A149953P201	DS3896 SO-W-20 NATIONAL
U118S	19A705828P1	SAB80C535 PLCC-68 SIEMENS
U119	19A703471P108	74HC245S SOIC-W-20 MOT,TI,RCA
U121	19A703483P301	74HC02D SOIC-14 MOT,TI,RCA
U123	19A704380P302	74HC74 SOIC-14 MOT,TI,RCA
U124	19A703483P321	74HC14D SOIC-14 MOT,TI,RCA
U125	19A703987P306	74HC161 SO-16 MOT,TI,RCA
U126P	344A3377G3/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U127P	344A3377G4/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U128	19A703987P322	74HC165D SO-W-16 MOT,TI,RCA
U129P	344A3377G4/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U130	19A703987P322	74HC165D SO-W-16 MOT,TI,RCA
U131P	344A3377G4/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U132	19A703987P322	74HC165D SO-W-16 MOT,TI,RCA
U133P	344A3377G4/ 344A3137P1	PAL22V10AJC PLCC-28 AMD,CYPRESS,TI
U134	19A703987P322	74HC165D SO-W-16 MOT,TI,RCA
		- - - - - - - - - ZENER DIODES- - - - - - - - - -
VR01 thru VR08	19A700083P101	ZENIER
		- - - - - - - - - -FUSE HOLDERS- - - - - - - - - -
XF01 thru XF06	19A116688P2	FUSE CLIPS CLIPS
		- - - - - - - - - - IC SOCKETS- - - - - - - - - -
XU009	19A700156P15	SOCKET DIP-8
XU010 and XU011	19A700156P19	SOCKET DIP-24-N
XU032	19A700156P15	SOCKET DIP-8
XU033 and XU034	19A700156P19	SOCKET DIP-24-N
XU055	19A700156P15	SOCKET DIP-8
XU056 and XU057	19A700156P19	SOCKET DIP-24-N
XU078	19A700156P15	SOCKET DIP-8
XU079 and XU080	19A700156P19	SOCKET DIP-24-N
XU099	19A700156P3	SOCKET DIP-28
XU108	344A3339P3	SOCKET PLCC-44
XU118	344A3339P5	SOCKET PLCC-68
		- - - - - - - - - - -CRYSTALS- - - - - - - - - - -
Y001	19A702511G15	LY2511G5 11.0592MHZ DALE,CTS,GE
Y002	19A702511G5	LY2511G5 11.520MHz DALE,CTS,GE

CAUTION
OBSERVE PRECAUTIONS FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICES



RUNS ON SOLDER SIDE
RUNS ON BOTH SIDES
RUNS ON COMPONENT SIDE

AUDIO BOARD
19D903302G1
Sheet 1 of 2

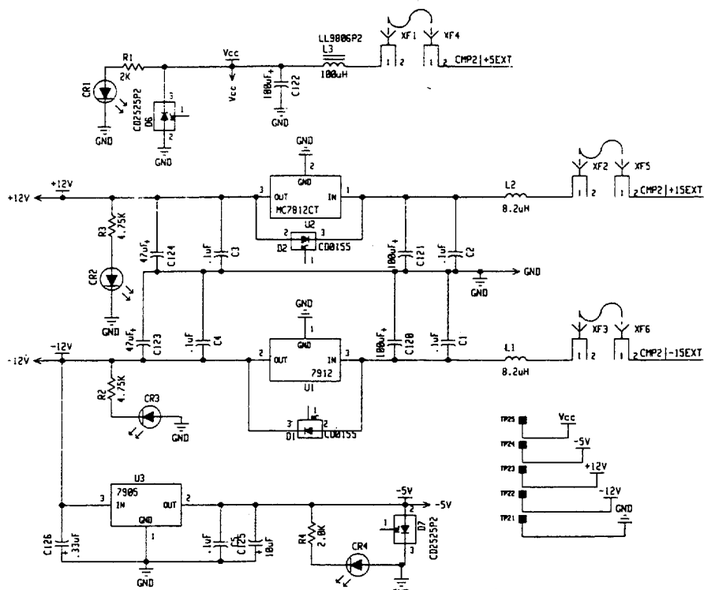


CAUTION
OBSERVE PRECAUTIONS FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICES

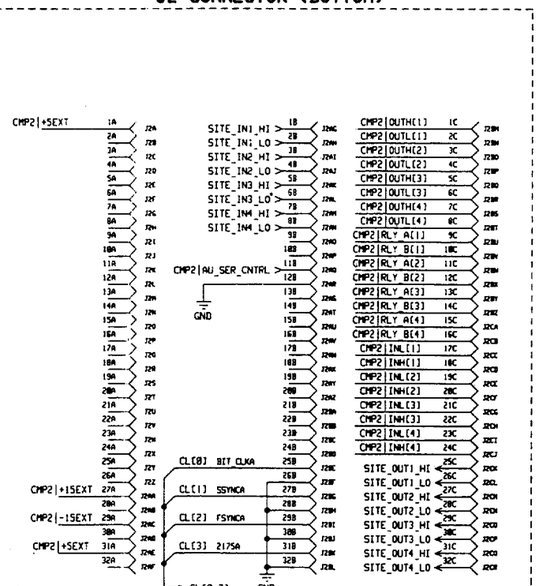
RUNS ON SOLDER SIDE
RUNS ON BOTH SIDES
RUNS ON COMPONENT SIDE

AUDIO BOARD
19D903302G1
Sheet 2 of 2

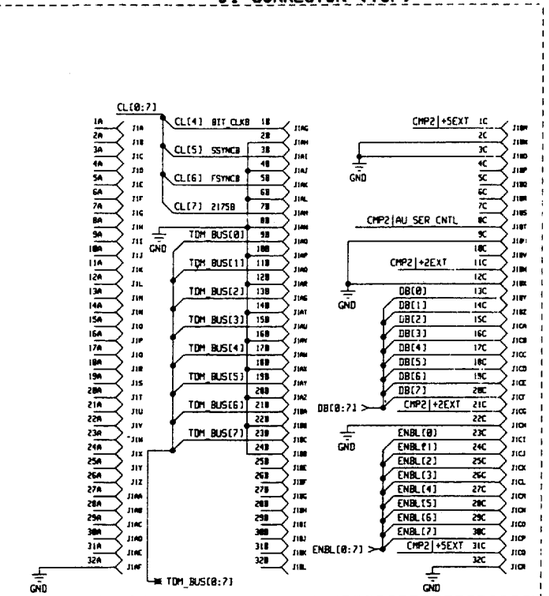
VOLTAGE REGULATION



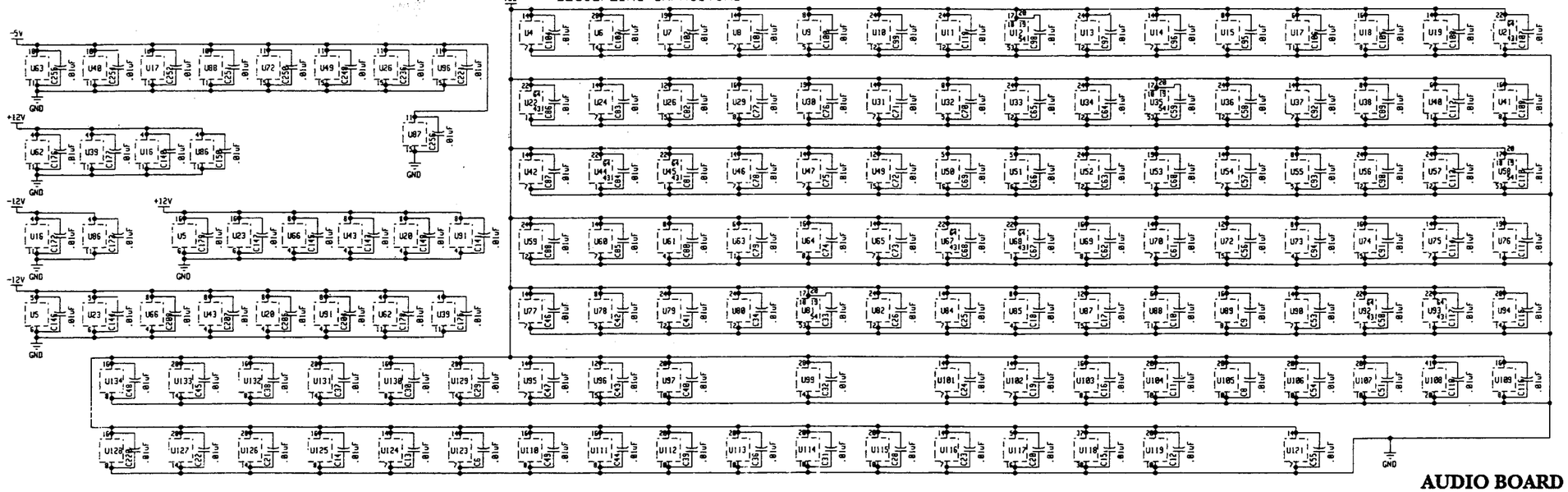
J2 CONNECTOR (BOTTOM)



J1 CONNECTOR (TOP)

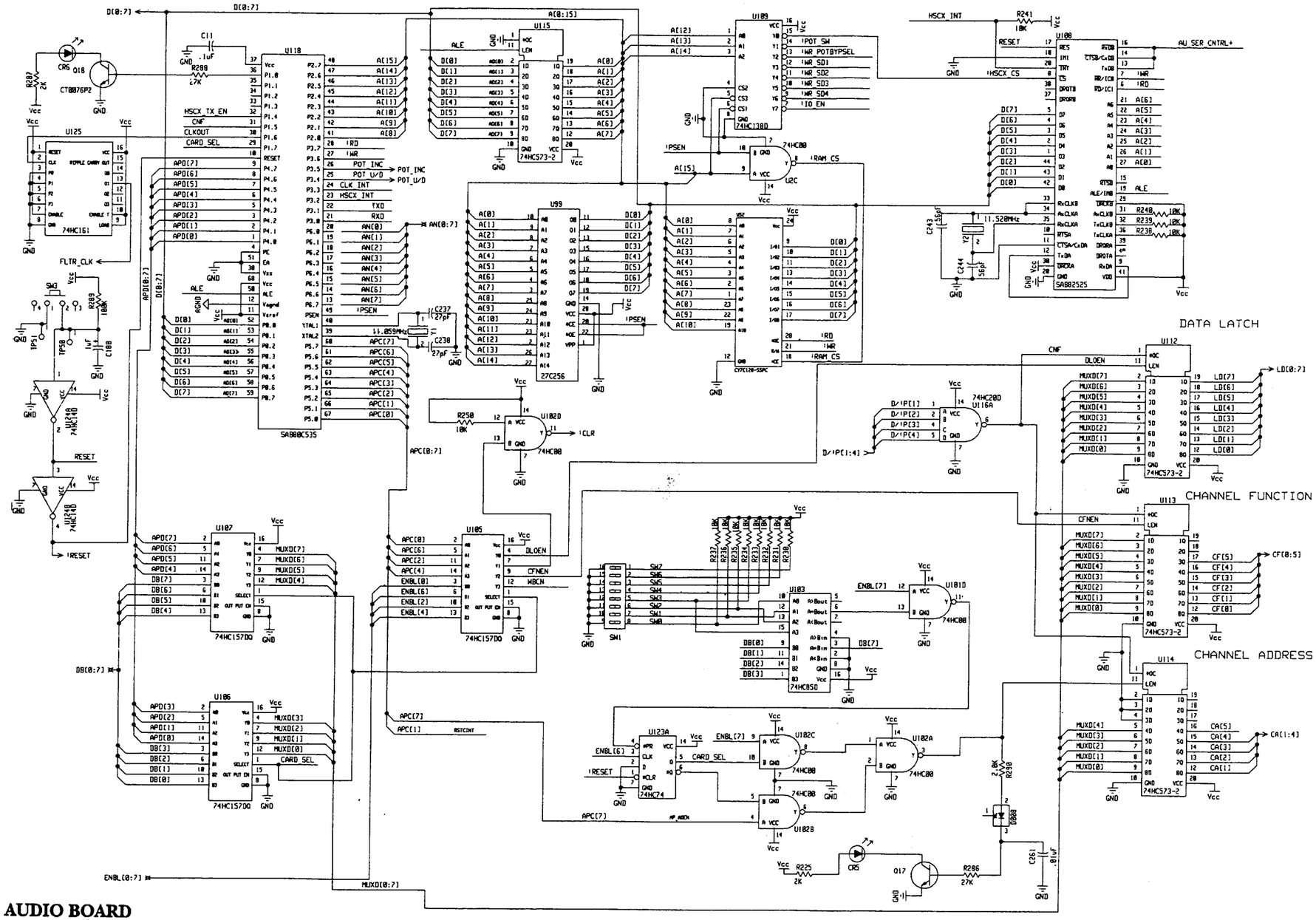


DECOUPLING CAPACITORS



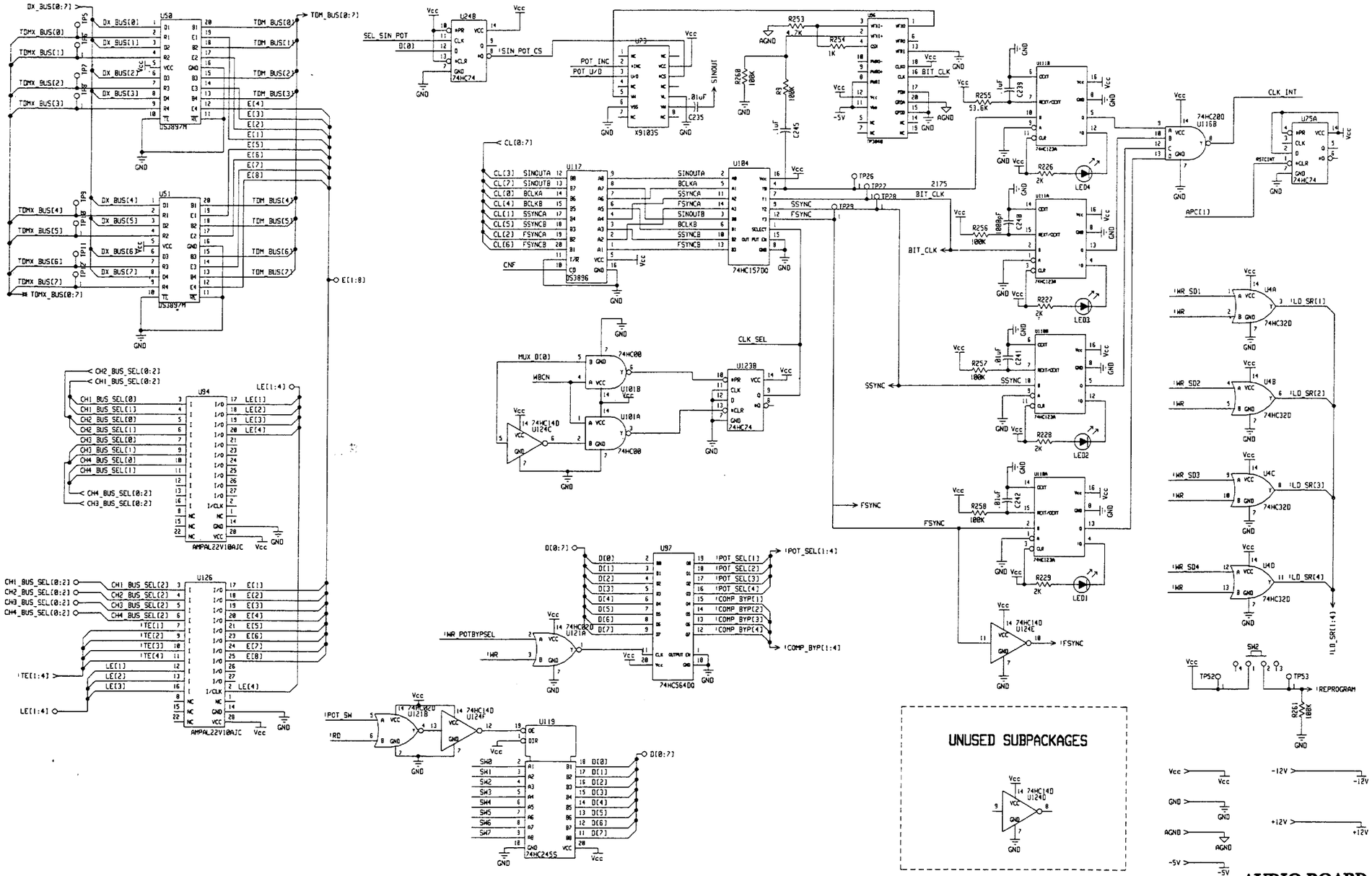
AUDIO BOARD
19D903302G1

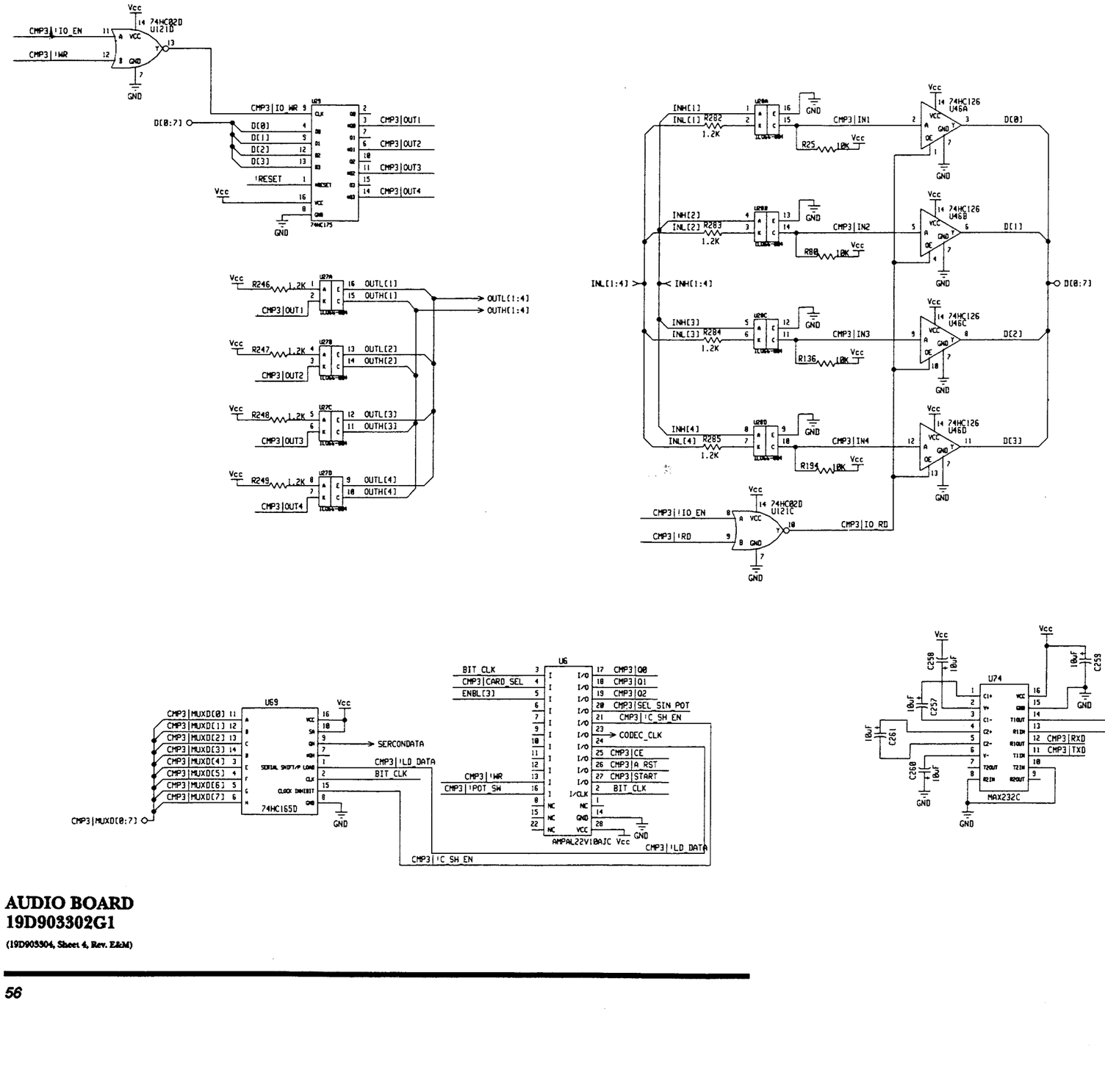
(19D903504, Sheet 1, Rev. E&M)



AUDIO BOARD
19D903302G1

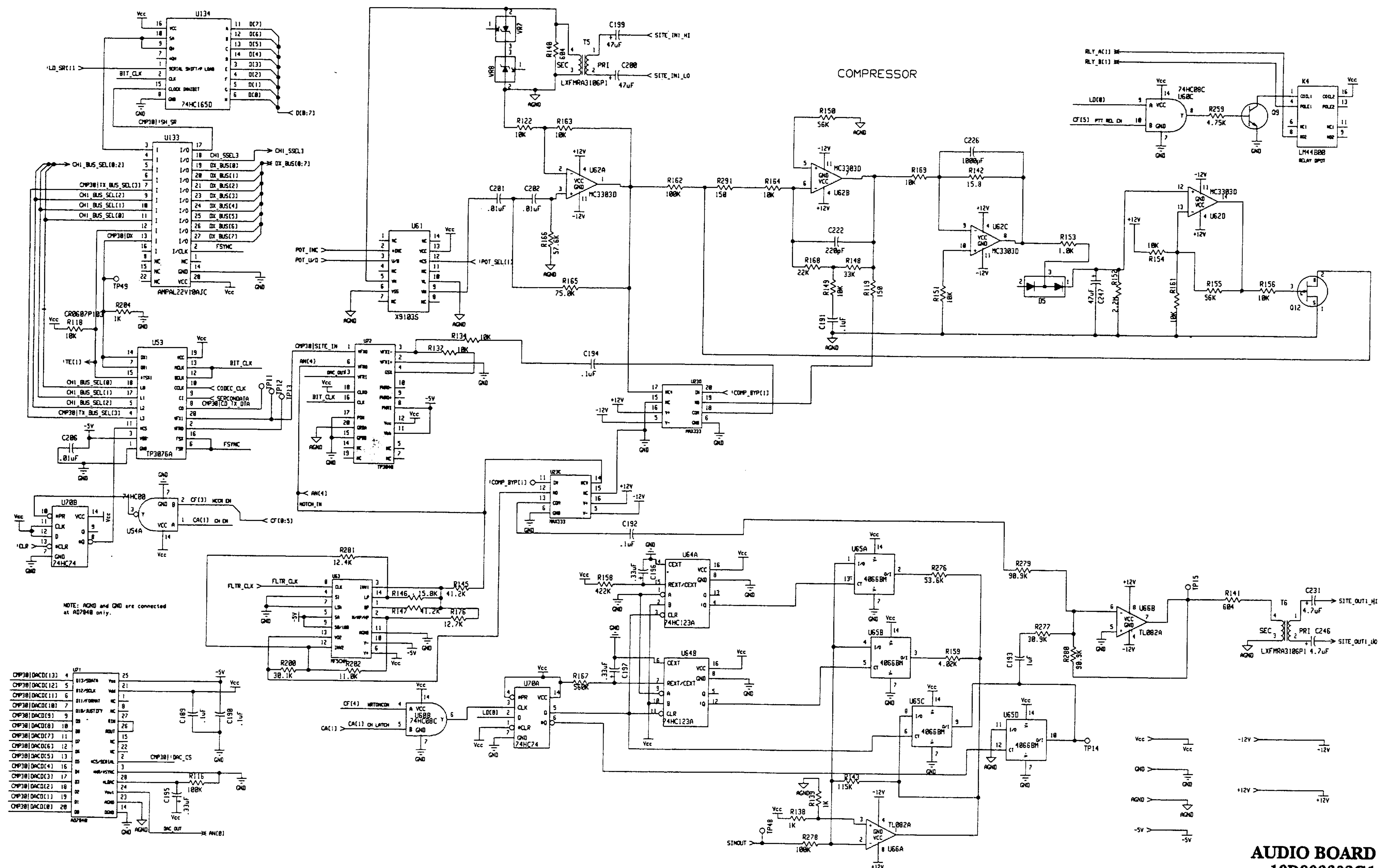
(19D903504, Sheet 2, Rev. E&M)


UNUSED SUBPACKAGES
AUDIO BOARD
19D903302G1
(19D903304, Sheet 5, Rev. Ldm)



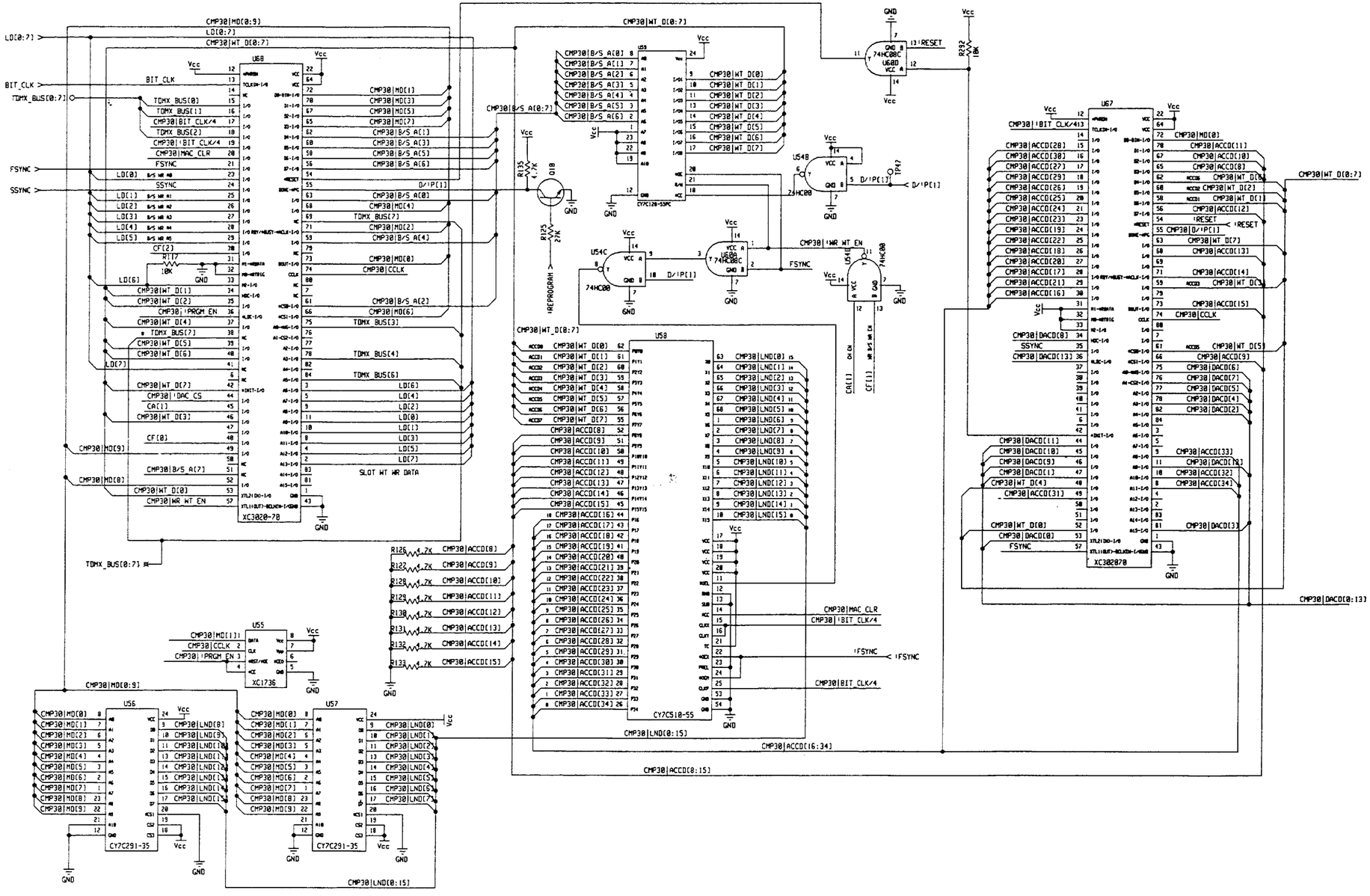
AUDIO BOARD
19D903302G1

(19D905304, Sheet 4, Rev. E&M)



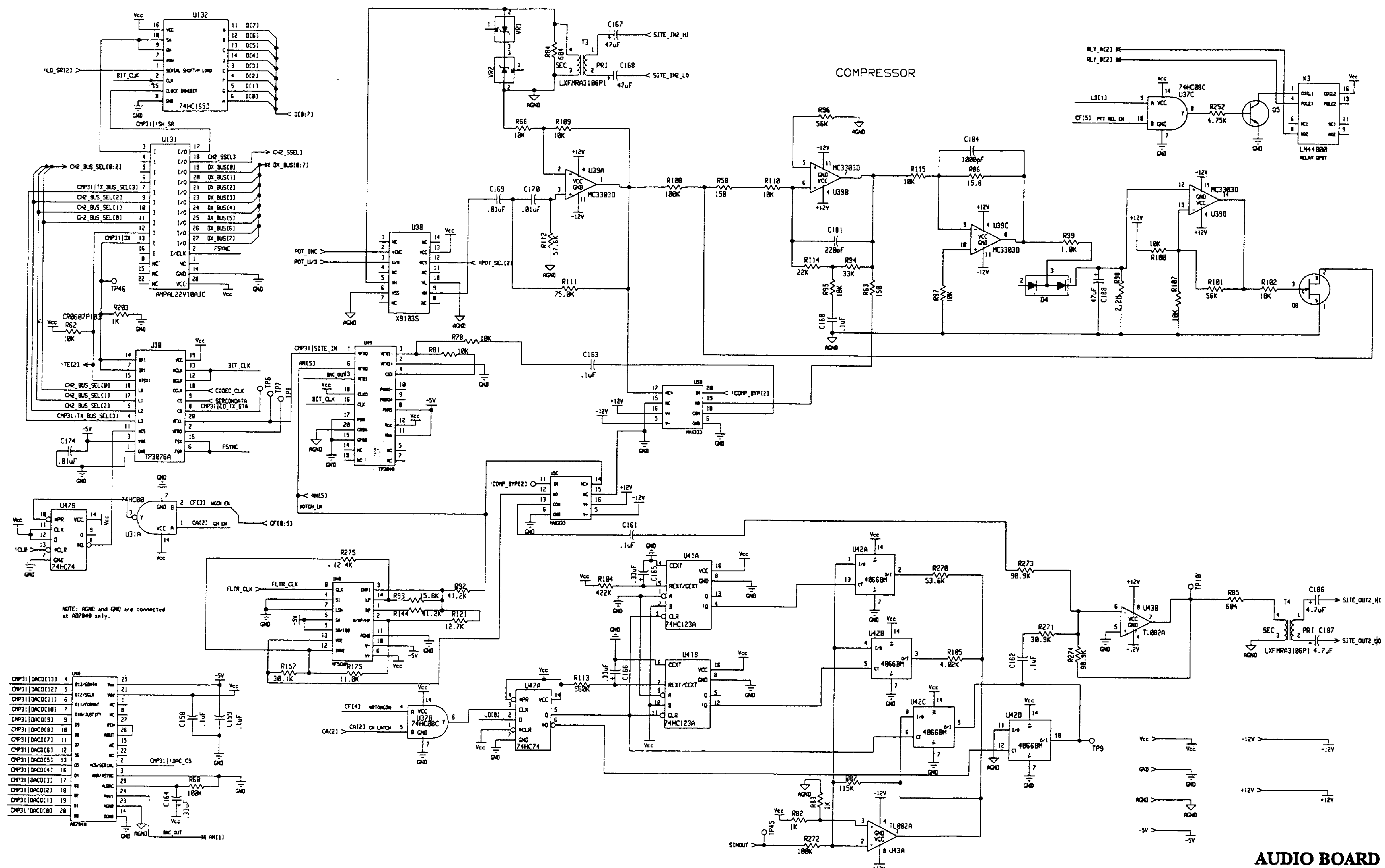
AUDIO BOARD
19D903302G1

(19D903504, Sheet 5, Rev. E&M)



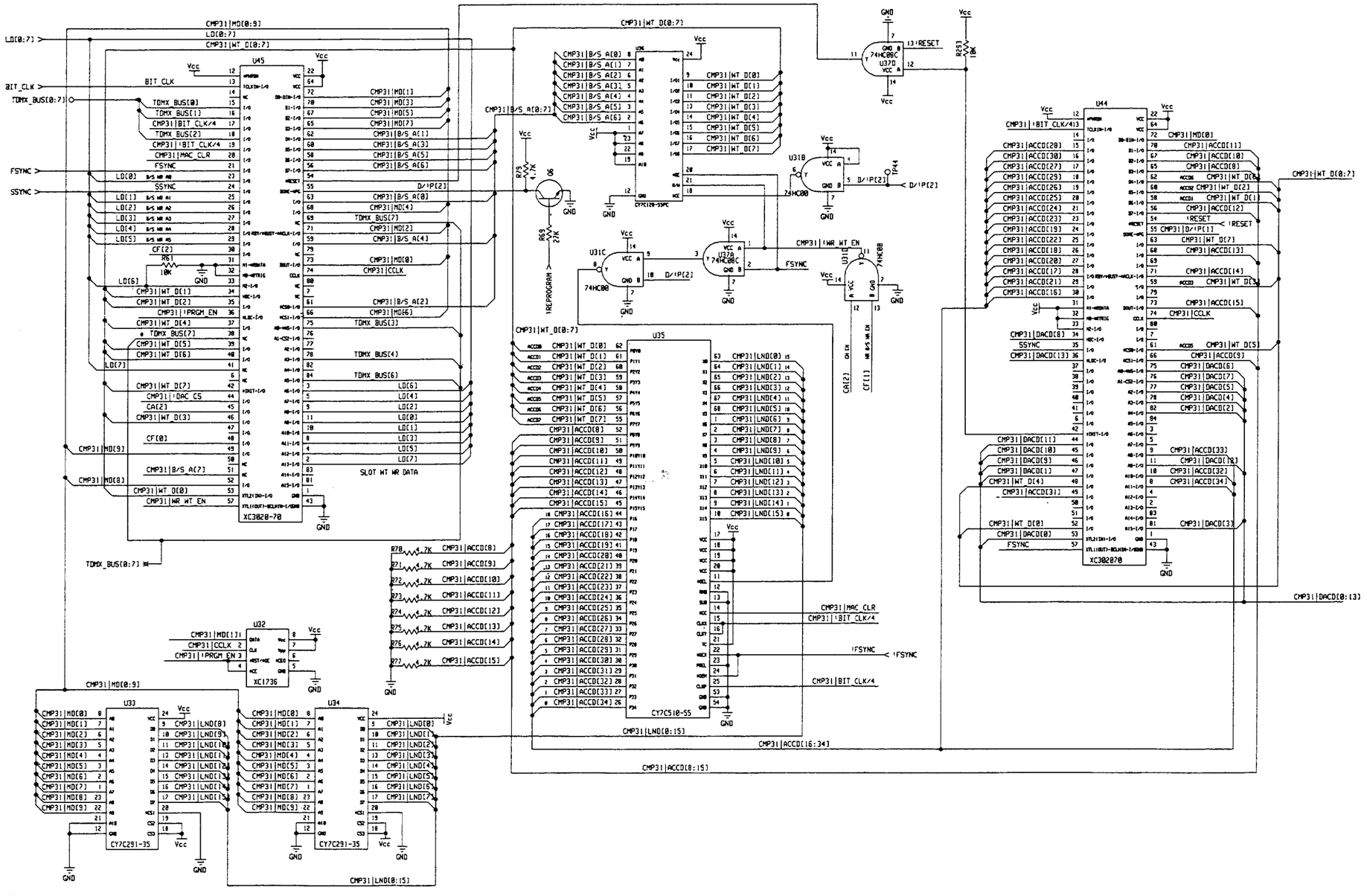
AUDIO BOARD
19D903302G1

(19D905504, Sheet 6, Rev. E&M)



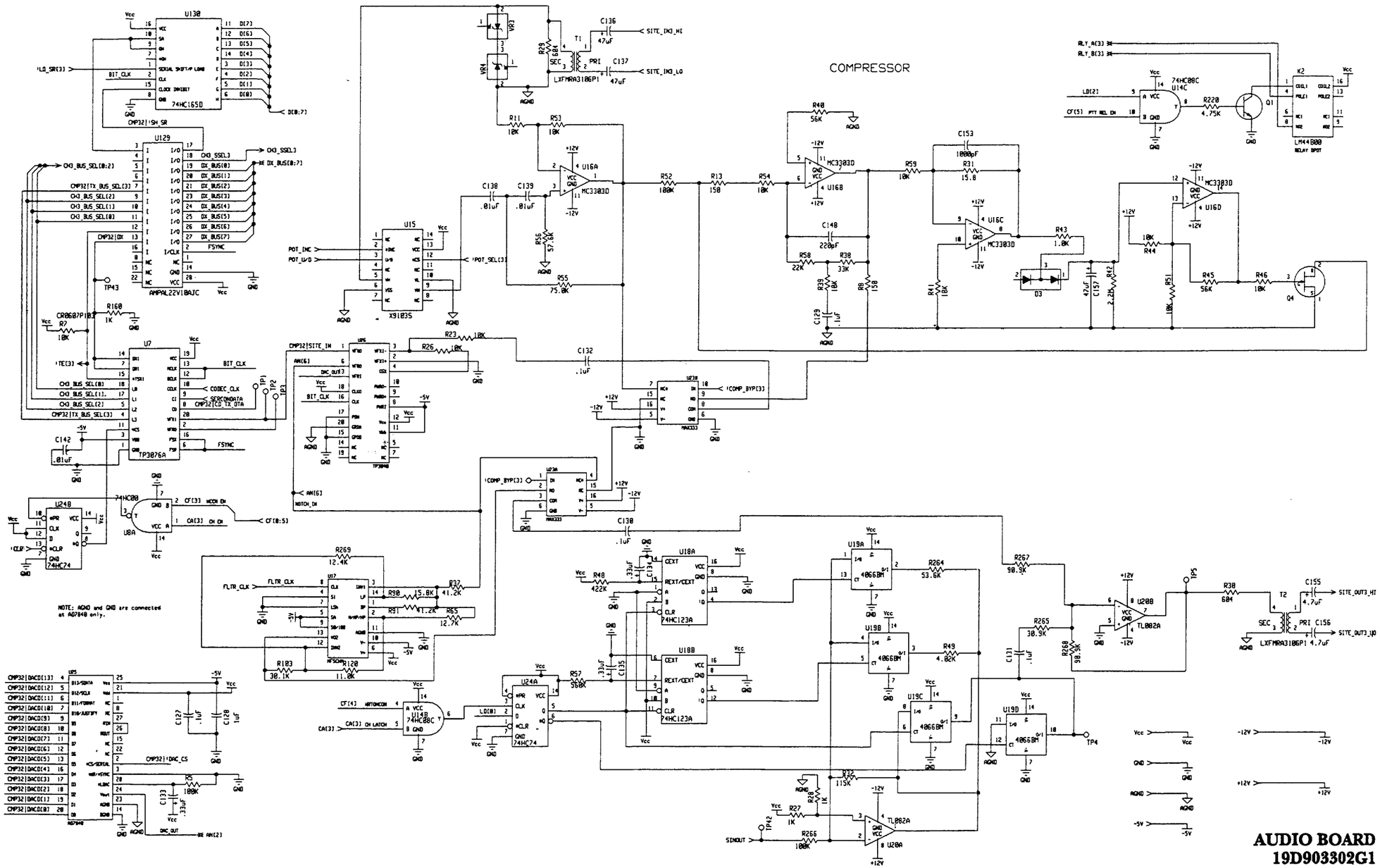
AUDIO BOARD
19D903302G1

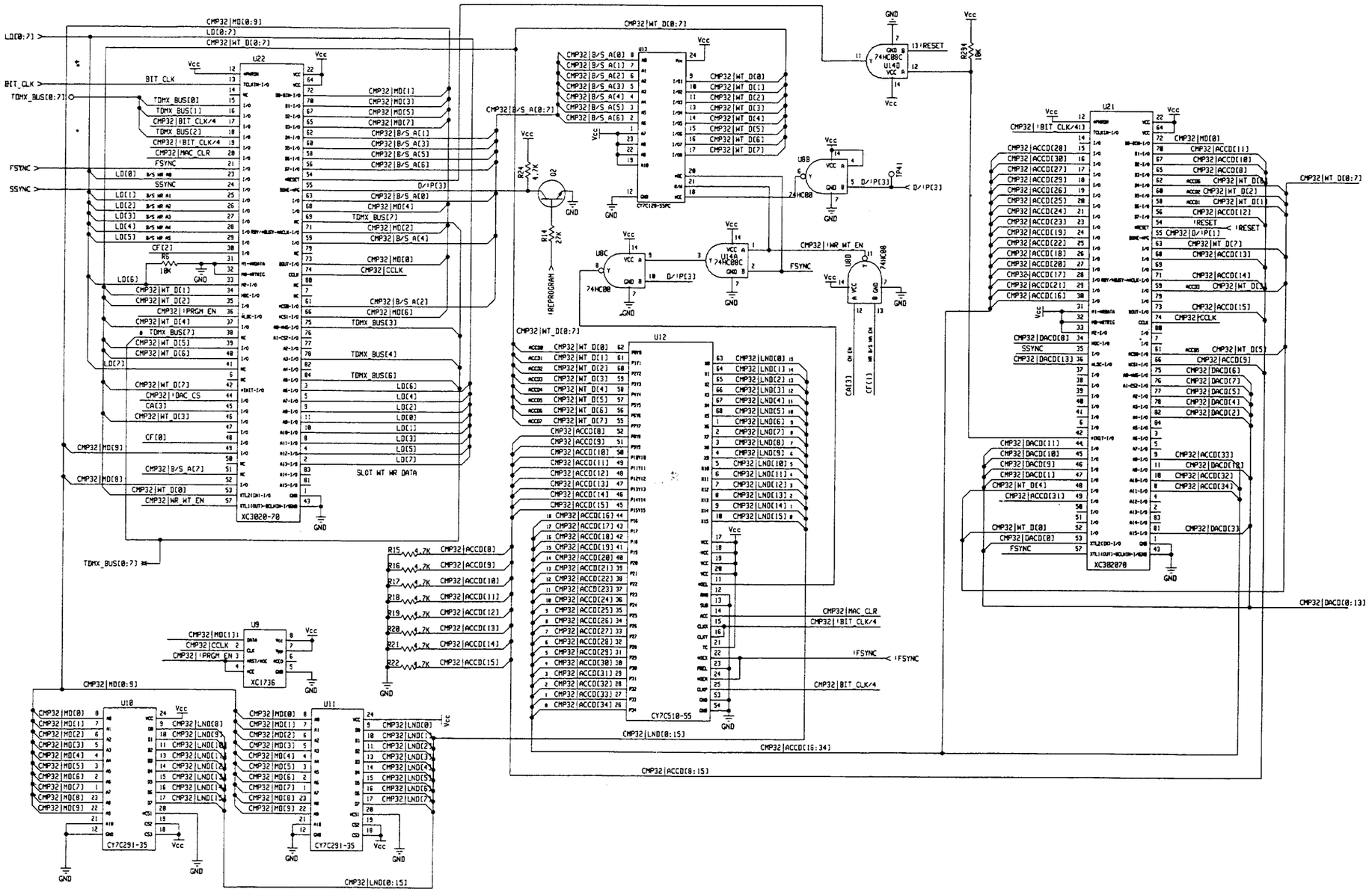
(19D903304, Sheet 7, Rev. E&M)



AUDIO BOARD
19D903302G1

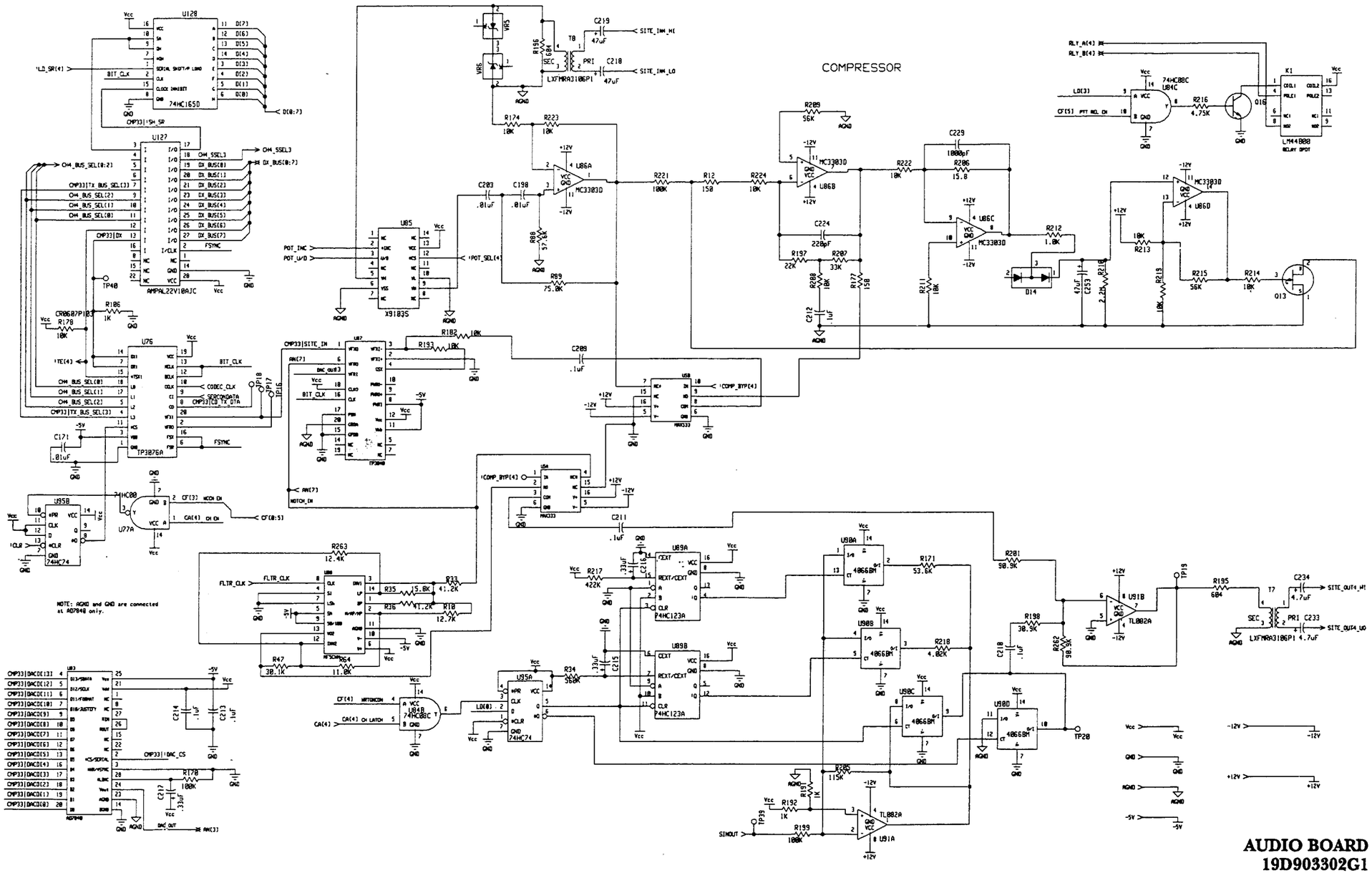
(19D903304, Sheet 8, Rev. E&M)


COMPRESSOR
U130
74HC165D
U129
AMPAL22V10AJC
U15
X9103S
U7
TP3076A
U24B
74HC08
U24A
74HC74
U16A
MC33083D
U16B
U16C
U16D
U14B
74HC86C
U14C
74HC08C
U17
U23A
U23B
MAX333
U18A
U18B
74HC123A
U19A
U19B
U19C
U19D
4066BM
U20A
U20B
TL082A
U4
U5
AD7848
U24B
74HC74
Q1
Q3
Q4
K2
LM44B00
T1
T2
LXFMRA3106P1
VR3
VR4
D3
TP43
TP42
TP4
TP5
CR0687P1R2
NOTE: AGND and GND are connected at AD7848 only.
AUDIO BOARD
19D903302G1
(19D903304, Sheet 9, Rev. E&M)



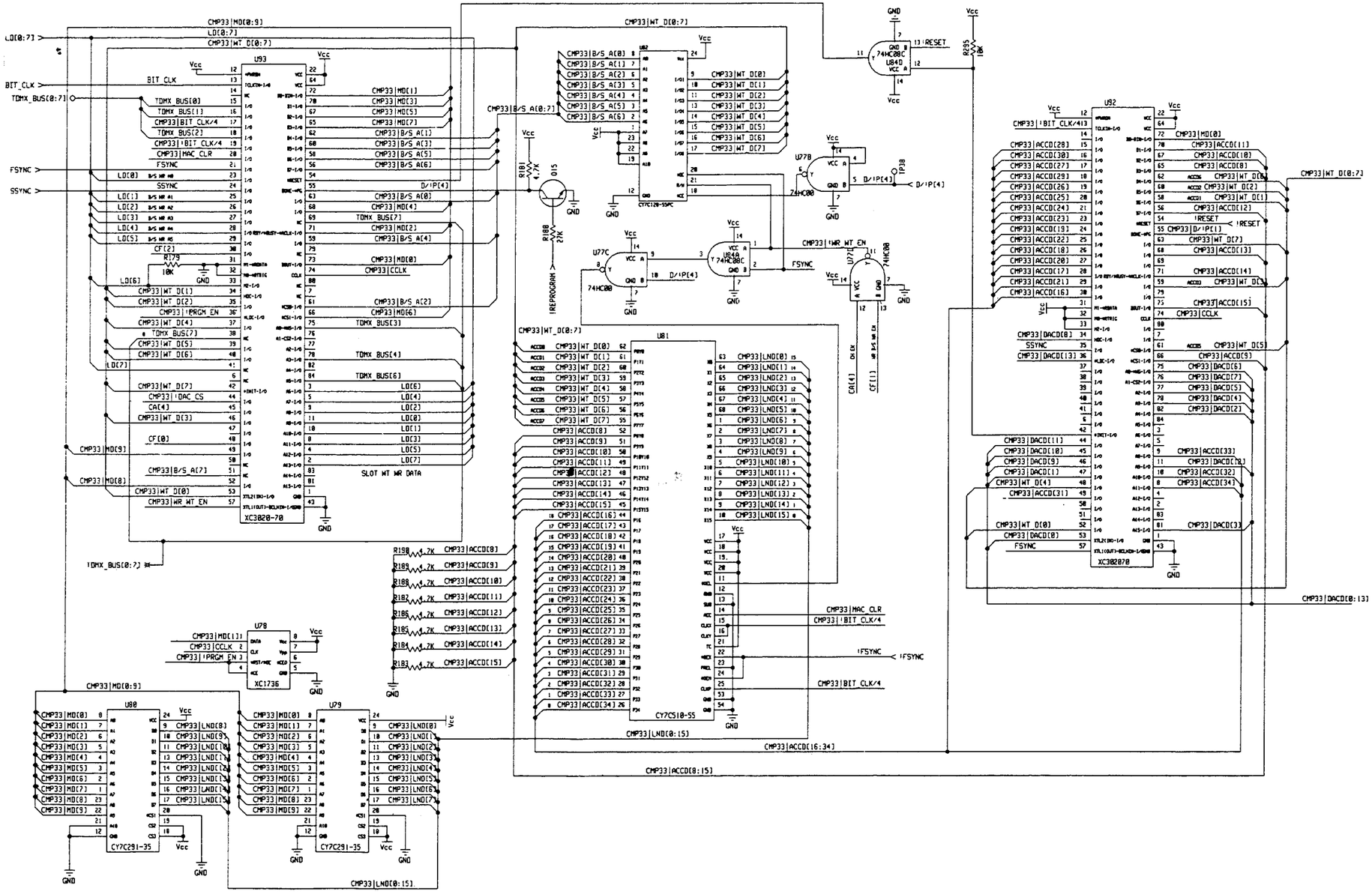
AUDIO BOARD
19D903302G1

(19D903304, Sheet 10, Rev. E&M)



AUDIO BOARD
19D903302G1

(19D903304, Sheet 11, Rev. E&M)



AUDIO BOARD
19D903302G1

(19D905504, Sheet 12, Rev. E&M)

This addendum makes a correction in Table 2 - Connector J2 Pin Definitions. The fifth listing below the heading "Connector Pin" should read "J2-1B" instead of "J2-1A".

1. INTRODUCTION

This addendum incorporates high-level information on Audio Board 19D903302P3. This Audio Board replaces Audio Board 19D903302P1 in all CEC/IMC Digital Audio Switch applications. Backwards compatibility with the P1 Audio Board is retained. A revised maintenance manual completely documenting P3 Audio Board will be issued at a later date. Contact your service representative for additional information.

The CEC/IMC Audio Board is used to interface four (4) channels of audio to the CEC/IMC backplane system. These audio channels may support a radio system such as an EDACS site, a dispatch console such as a C3 Maestro console, or some other external device such as a logging recorder. The board can be configured to interface channels 1 - 4 or 5 - 8 or 9 - 12, etc. by changing the board address at DIP switch SW1. Refer to LBI-38664 or LBI-38938 for a more detailed description.

In comparison to the P1 Audio Board, the P3 Audio Board improves the features and/or circuit specifications of the following:

- 2175 Hz Notch Filter Circuit
- S/N Ratio on the Channel Outputs
- System TDM Bus and Clock Loading
- Power-Up / Live Insertion Microprocessor Reset
- Indication LEDs
- Test Point Access

All modifications for features on the P1 Audio Board have been incorporated into the P3 Audio Board. In addition, hardware has been added to the P3 Audio Board to support the following features:

- E & M Signaling
- ID Indicator LED
- Vcc Voltage Monitor
- Futurebus Driver Disable

NOTE

Many of the above features require supporting firmware for full implementation.

2. IMPROVEMENT DETAILS

2.1. ALC CIRCUIT

An Automatic Level Control (ALC) circuit exists on the input section of each audio channel on the Audio Board. This circuit maintains a "not to exceed" analog signal input to the CODEC integrated circuit. The CODEC digitizes the analog signal for placement on the CEC/IMC TDM bus network. Distortion will occur if the analog signal into the CODEC is too high. The analog threshold occurs at approximately +5 dBm into the channel inputs.

The P1 Audio Board contained this functionality. However, the ALC enable was tied to the notch filter enable for each channel such that if one was enabled then both were enabled. Hardware on the P3 Audio Board allows independent enable/disable control of the ALC circuit and the notch filter circuit. This separated enable/disable control is supported in CEC/IMC firmware version 2.0 and later. ALC is enabled/disabled from the CEC/IMC Manager (MOM PC).

2.2. NOTCH FILTER (2175 Hz)

A 2175 Hz notch filter is located in the output section of each audio channel on the Audio Board. When this filter is enabled from the CEC/IMC Manager (MOM PC), all 2175 Hz components in the output (transmit) audio signal are attenuated. This filtering occurs prior to the summation of the 2175 Hz keying tone (if enabled). Notching the 2175 Hz components in the transmit audio prevents destructive interference with the summed 2175 Hz keying tone.

The 2175 Hz notch filter circuit on the P3 Audio Board is enhanced. Additionally, the notch filter can be enabled and disabled independently of the channels ALC circuit, as described in the previous section. The 2175 Hz notch filter is enabled/disabled from the CEC/IMC Manager (MOM PC).

2.3. S/N IMPROVEMENTS

The signal-to-noise ratio of the P3 Audio Board's channel outputs is improved over the P1 Audio Board. These improvements are most evident when using the board with a headset-equipped dispatch console.

2.4. TDM BUS AND CLOCK LOADING

Capacitive loading of the Futurebus lines on the CEC/IMC Backplane by the Audio Board is improved (reduced) when the P3 Audio Board is utilized. This improves the performance of multiple backplane systems.

2.5. POWER-UP/LIVE INSERTION

Power-up/live insertion issues with the P1 Audio Board were addressed on the P3 Audio Boards by two means. First, an IC was added to monitor the Vcc voltage supply during power-up and live insertions. This IC will also reset the microprocessor during low voltage or "brown-outs". Second, the P3 Audio Board is equipped with extended power pins on the 96-pin DIN connectors. This implements a "make first and break last" connection for the power and ground supplies.

2.6. LED INDICATORS

LED colors and functions between the P1 and P3 Audio Boards are different. The P3 Audio Board conforms to the standards initiated by Controller Board 19D903299P3. Green LEDs replace the red LEDs found on the P1 board. Also, the blinking "RUN" LED on the P1 Audio Board is replaced by an LED that remains illuminated when the board is functioning properly. This "RUN" LED on the P3 Audio Board will turn off if the board is in a reset condition or not functioning properly.

Two new LED identifiers were added to the Audio Board for board identification and channel address write:

The new "ID" LED functions exactly the same as the "ID" LED on the P3 Controller Board - it blinks when enabled from the CEC/IMC Manager (MOM PC). This feature provides quick visual board IDentification within the system. Firmware version 2.1 or later is required.

The new channel address write LED is labeled "CARD SEL" on the front panel of the P3 Audio Board. It indicates when the associated Controller Board is controlling some function on the board. For example, this LED will illuminate when the Controller Board commands the P3 Audio Board to route audio on a channel's output (when a call is made).

The "RESET" and "RUN" LEDs on the P1 Audio Board are combined to a single "RUN" LED on the P3 Audio Board. When the "RUN" LED is lit, the microprocessor is running. When it is off, the P3 Audio Board is in a reset condition.

2.7. Vcc VOLTAGE MONITOR

The P3 Audio Board is equipped with a Vcc voltage monitor IC which monitors the +5 Vdc Vcc supply voltage. If the voltage drops too low during a power glitch or power loss, the board will go into reset until the condition clears.

2.8. FUTUREBUS DRIVER DISABLE

The Futurebus drivers on the Audio Board interface the board to the TDM buses on the Backplane. On the P3 Audio Board, a driver disable is initiated automatically when the Audio Board is in reset. This prevents the P3 Audio Board from causing interference on the TDM buses during power-up and reset conditions.

NOTE

Since this feature is activated by a board reset, the Controller Board must first enable the Futurebus drivers before any audio can be routed by the Audio Board. Firmware prior to version 3.0 (G10) requires the Controller Board to be reset after an Audio Board reset to properly initialize this function. Version 3.0 (and later) corrects this issue to allow an Audio Board to be reset and properly initialize itself without resetting the Controller Board.

2.9. E & M SIGNALLING

Audio Board 19D903302P3 supports the 'M' lead keying function for E & M signalling support. This feature provides a relay closure when audio is routed out of the respective channel on the Audio Board. For example, if the Audio Board is configured to interface channels 1 - 4 of site 1, when a call is made to site 1 channel 1 from the CEC/IMC (console originated or multisite originated), relay 1 will close for the duration of the call. A separate relay is provided for each of the four channels.

Additional notes about E & M signalling:

- E & M signalling is selectable on a per channel basis from the CEC/IMC Manager (MOM PC).
- E & M signaling is required for Digital Dispatch Interface Modules (DVIMs).
- Audio Relay Concentrator Card 19D904546G1 (option MSSU3G) is utilized to interface E & M signals to external devices. See LBI-38884 for additional details.

2.10. TEST PORT CONNECTOR

A Test Port Connector is provided on the P3 Audio Board to enhance access to the test points on the board. This connector is accessible through the face plate. It is used with Test Point Breakout Option MSTS3N which includes Test Point Breakout Board 19D904176G1 and associated cables.

3. COMPATIBILITY

Audio Board 19D903302P3 is fully backwards compatible with Audio Board 19D903302P1. A P1 Audio Board can be replaced by a P3 Audio Board equipped with version 2.0 or later firmware.

NOTE

An initialization discrepancy exists for systems running Version 2.x firmware (earlier than G10). See section **2.8 FUTUREBUS DRIVER DISABLE** for details.

The P3 Audio Boards must be used with applications that require E & M signalling such as DVIU equipment. In addition, P3 Audio Boards are favored for CIMs (Console Interface Modules) and XLTRs (Translators) due to the improved S/N ratio at the channel outputs.

3.1. FIRMWARE

The following minimum firmware revisions must be maintained to provide correct functionality in the 19D903302P3 Audio Boards:

- Controller Board (U58, U59) - 344A3567G5 and 344A3568G5 (Version 2.03)
- Controller Board (U3) - 344A3565G4 (Version 2.00)
- Audio Board (U99) - 344A3564G3 (Version 2.00)

The P3 Audio Board will support these and all later revisions of CEC/IMC firmware.

NOTE

A reset procedure must be followed for any interface modules (MIM, CIM, etc.) containing 19D903302P3 Audio Boards ***and*** a Controller Board with version 2.x firmware. When installing or resetting a P3 Audio Board, the Controller Board must be reset ***after*** the Audio Board has been installed and/or reset.

4. INSTALLATION PROCEDURES

The P3 Audio Board was designed to directly replace all earlier revisions of the P1 Audio Board. P3 Audio Boards should be installed in exactly the same manner as the older P1 boards. Refer to LBI-38938 for DIP switch settings - P3 Audio Board DIP switches are set in the same manner as on P1 Audio Board.

If the correct firmware has not been supplied with the P3 Audio Board, remove EPROM U99 from its socket and replace it with a new EPROM containing the revised firmware. **CAUTION: PIN 1 OF THE EPROM MUST BE INSERTED INTO PIN 3 OF THE SOCKET SO THE EPROM IS "RIGHT JUSTIFIED" IN THE SOCKET.**

NOTE

A reset procedure must be followed for any interface modules (MIM, CIM, etc.) containing 19D903302P3 Audio Boards ***and*** a Controller Board with version 2.x firmware. When installing or resetting a P3 Audio Board, the Controller Board must be reset ***after*** the Audio Board has been installed and/or reset.

4.1. SYSTEM INTERRUPTIONS

When replacing a CEC/IMC Audio Board, the four channels of audio interfaced by that board will not be available while the board is removed. If the Audio Board interfaces to four (4) channels of a site audio, all receive and transmit audio to those four channels will be lost until the installation is complete. If the Audio Board is used within a CIM or XLTR interface module, all transmit and receive audio for that single console will be lost until the installation is complete.

4.2. INSTALLATION VERIFICATION

1. Observe the LED indicators on the P3 Audio Board. All LEDs should be lit solid (not blinking) except for the "ID" and "CARD SEL" LEDs.
2. From the CEC/IMC Manager (MOM PC), verify the HDLC Channel B link for the newly installed board becomes active.
3. Verify the clock LEDs on each Audio Board are lit. These LEDs are marked "2175", "BCLK", "SSYNC" and "FSYNC".

EDACS sites interfaced to the CEC/IMC Digital Audio Switch through an Audio Board do not require the 2175 Hz tone keying signalling sequence as described on pages 16 and 17 of this manual. This is also true for all other external equipment (for example – consoles, logging recorders, the CIA rack, etc.) interfaced to the CEC/IMC via an Audio Board. EDACS sites only require a very short 2175 Hz Secure tone burst followed by a 2175 Hz hold tone to keep the site's transmitter keyed. Therefore, specifications for this circuitry on the Audio Board have been relaxed. Note the following changes to the manual (pages 16 and 17):

- duration of the 2175 Hz Secure tone burst has been reduced from ***125 milliseconds (±10%)*** to ***greater than 80 milliseconds***
- presence of the function tone is ***no longer guaranteed***

ADDENDUM NO. 4 TO LBI-38664 (PCMS)

This addendum adds information on Audio Board 19D903302P3. This Audio Board replaces Audio Board 19D903302P1 in all CEC/IMC Digital Audio Switch applications. Backwards compatibility with the P1 Audio Board is retained. Also see Addendum 2 to this manual. A revised maintenance manual completely documenting the P3 Audio Board will be issued at a later date. Contact your service representative for additional information.

Audio Board 19D903302P3 information added by this addendum includes the board's:

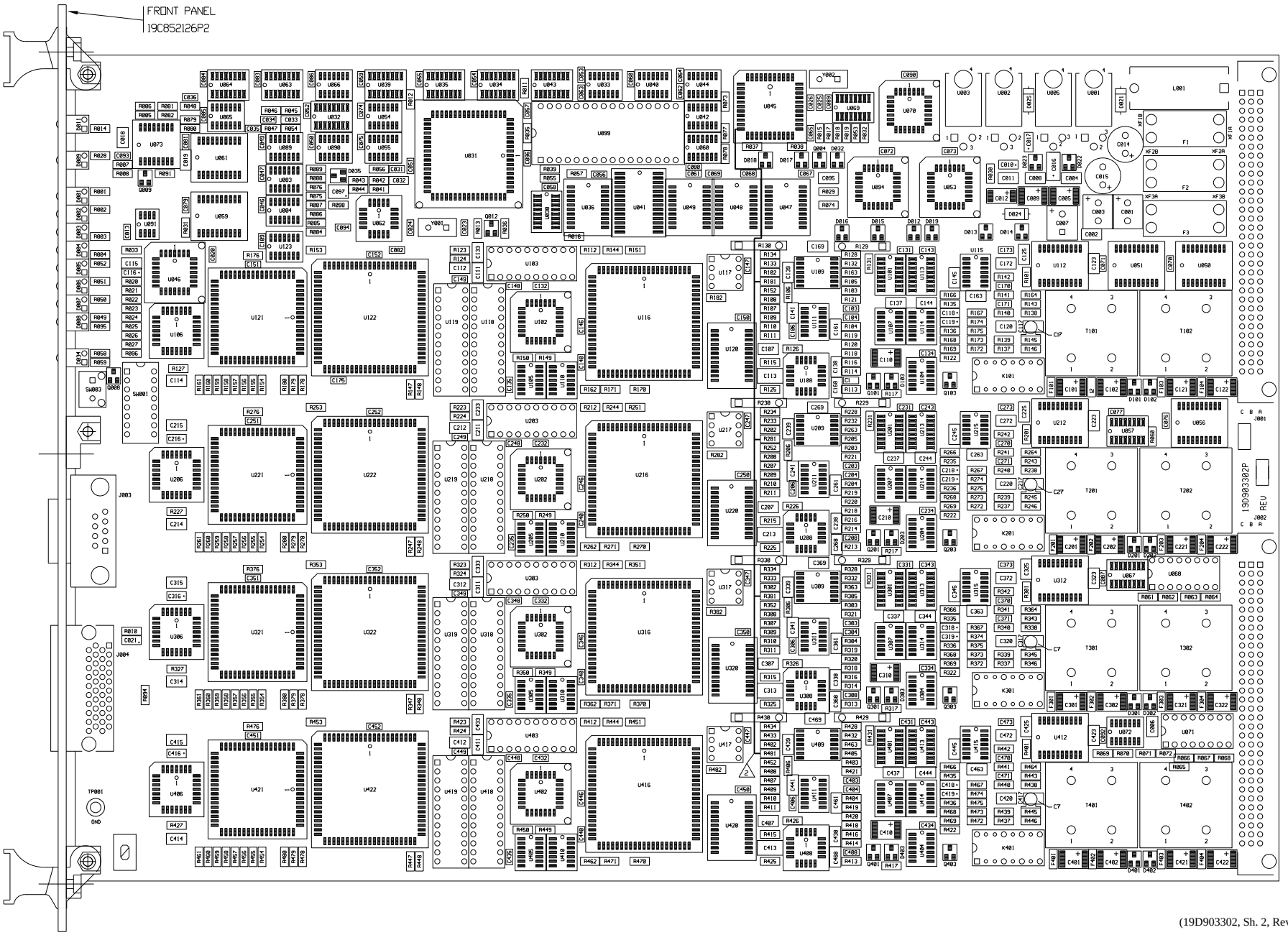
- Assembly/Outline Diagram (pages 2 and 3)
- Schematic Diagram (pages 4 thru 15)
- Parts List (pages 16 thru 25)
- Production Changes (page 25)

NOTES:

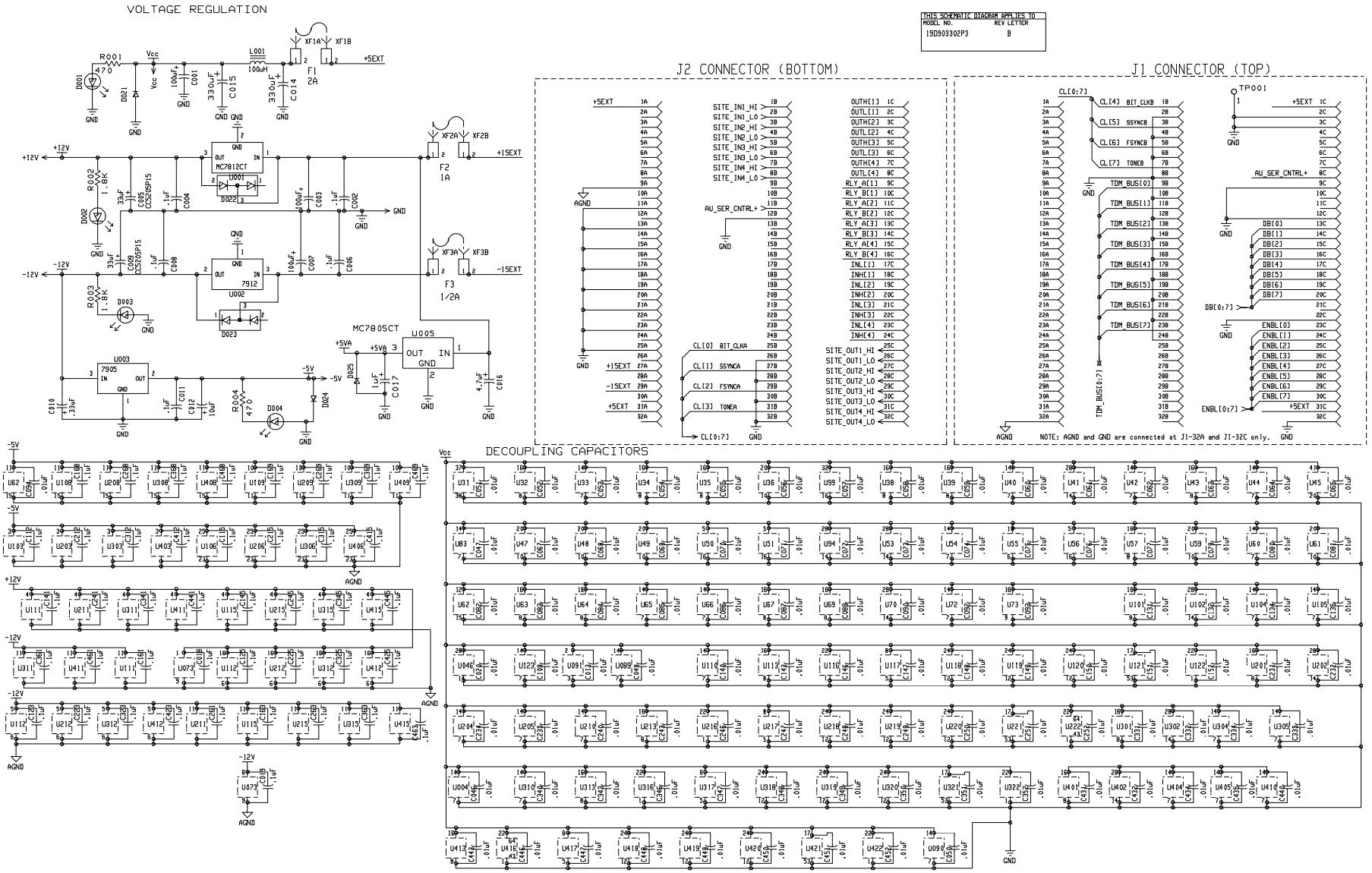
1. SOLDER C174 ACROSS R145 AS SHOWN.
   SOLDER C274 ACROSS R245 AS SHOWN.
   SOLDER C374 ACROSS R345 AS SHOWN.
   SOLDER C474 ACROSS R445 AS SHOWN.

2. CONNECT JUMPER WIRE FROM U45 PIN 17 TO THE PAD OF R181, R281, R381, AND R481 AS SHOWN.

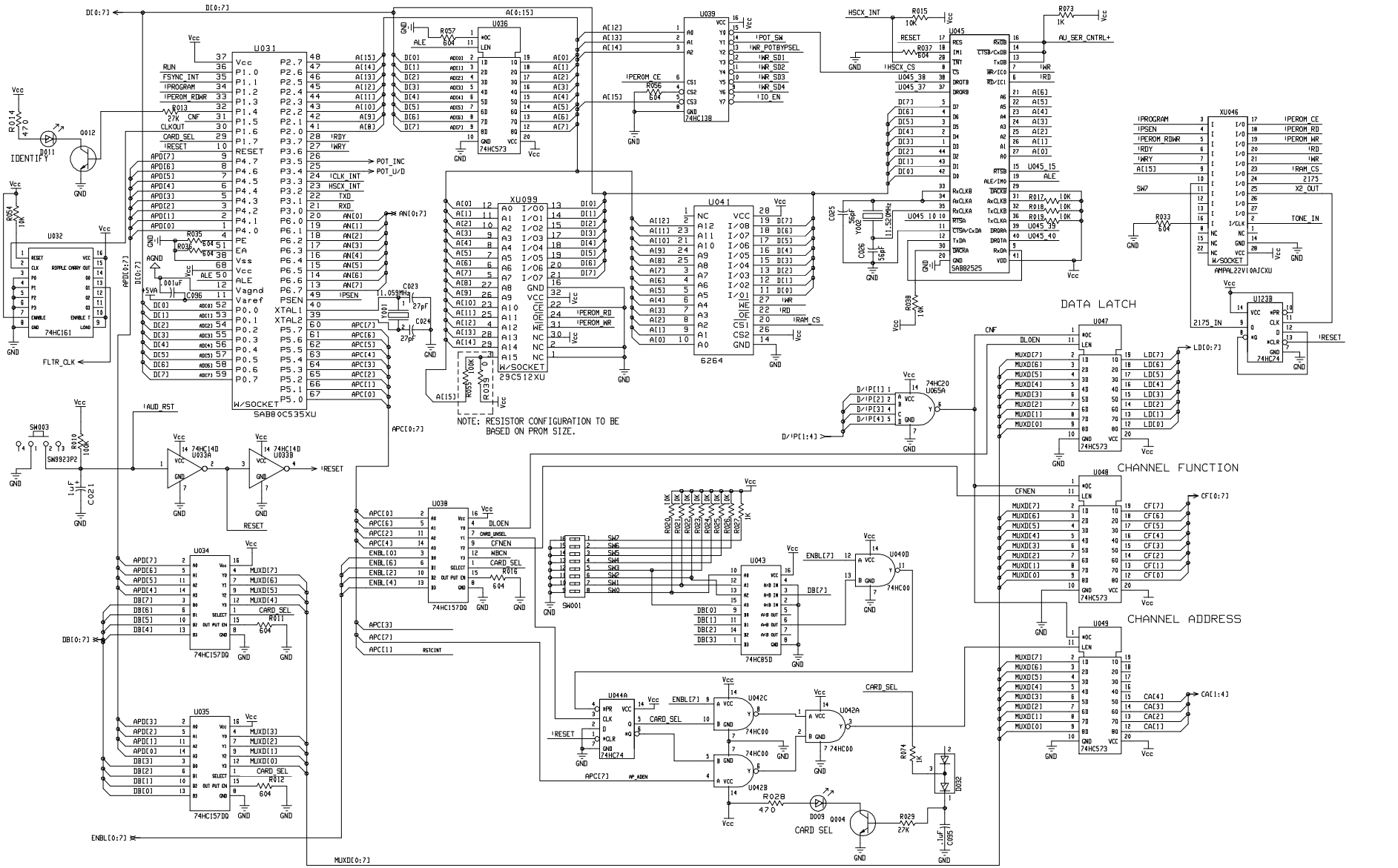
(19D903302, Sh. 2, Rev. 6B)

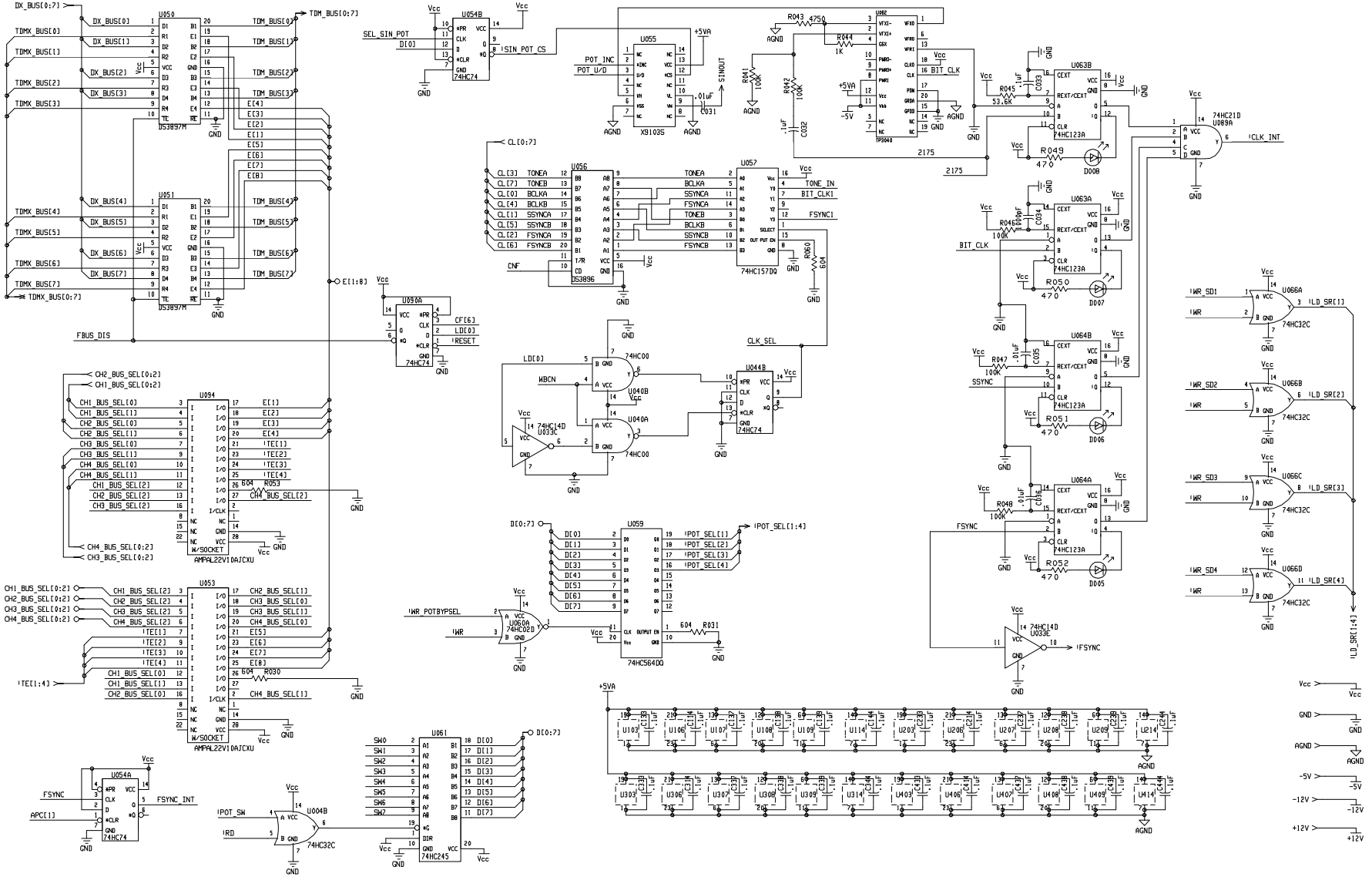


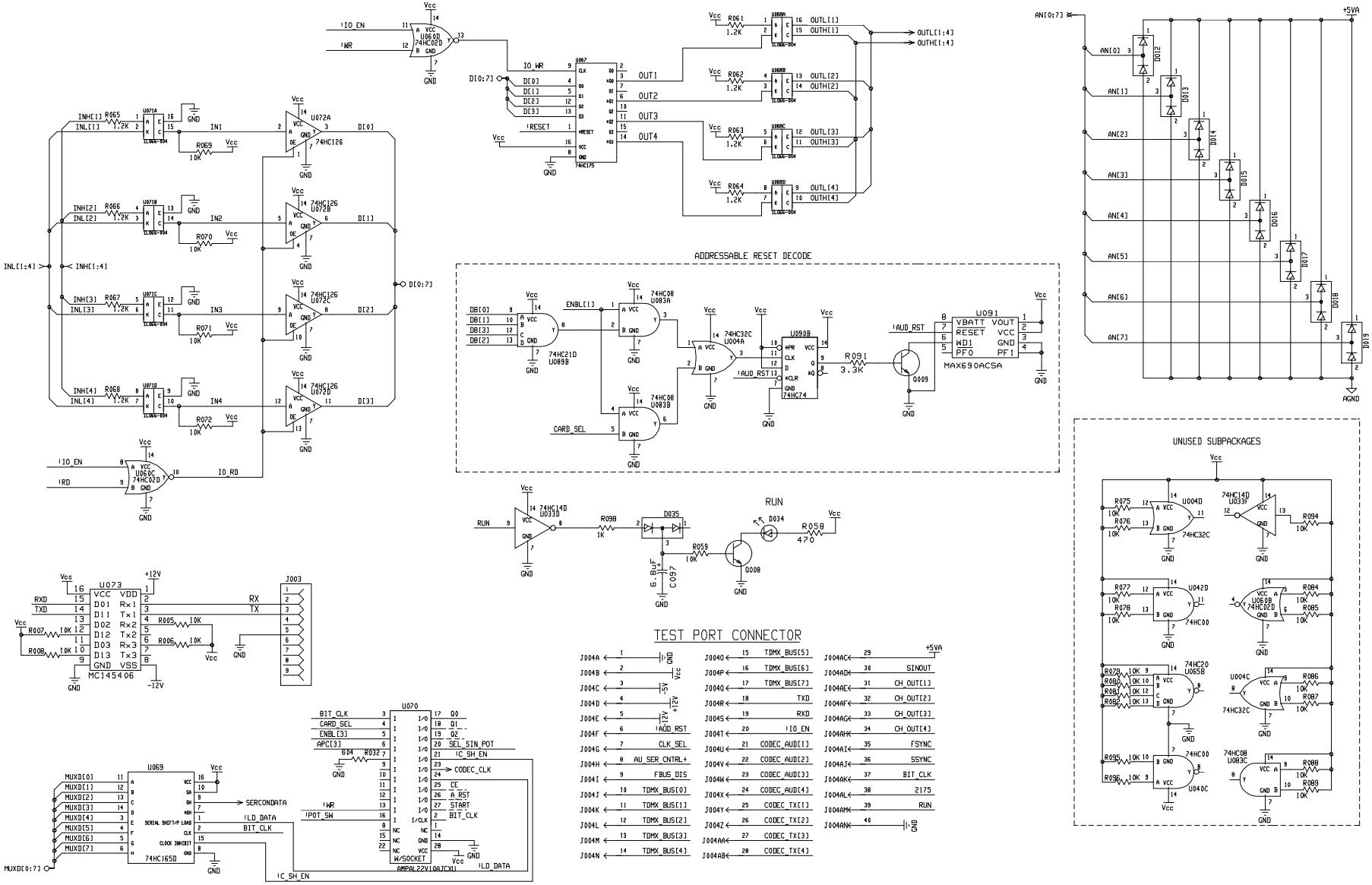
(19D903302, Sh. 2, Rev. 6B)

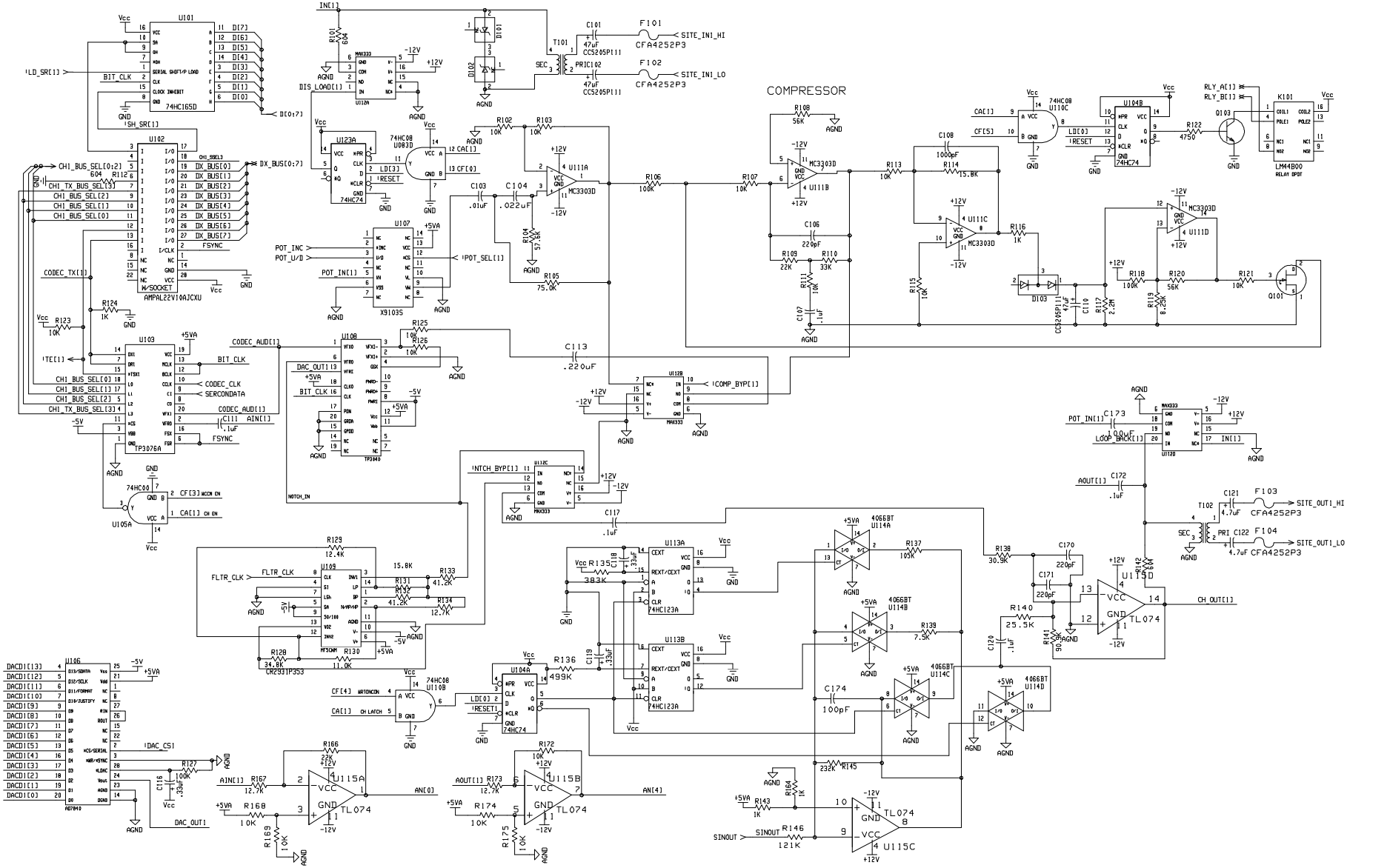


(19D903982, Sh. 1, Rev. 3)

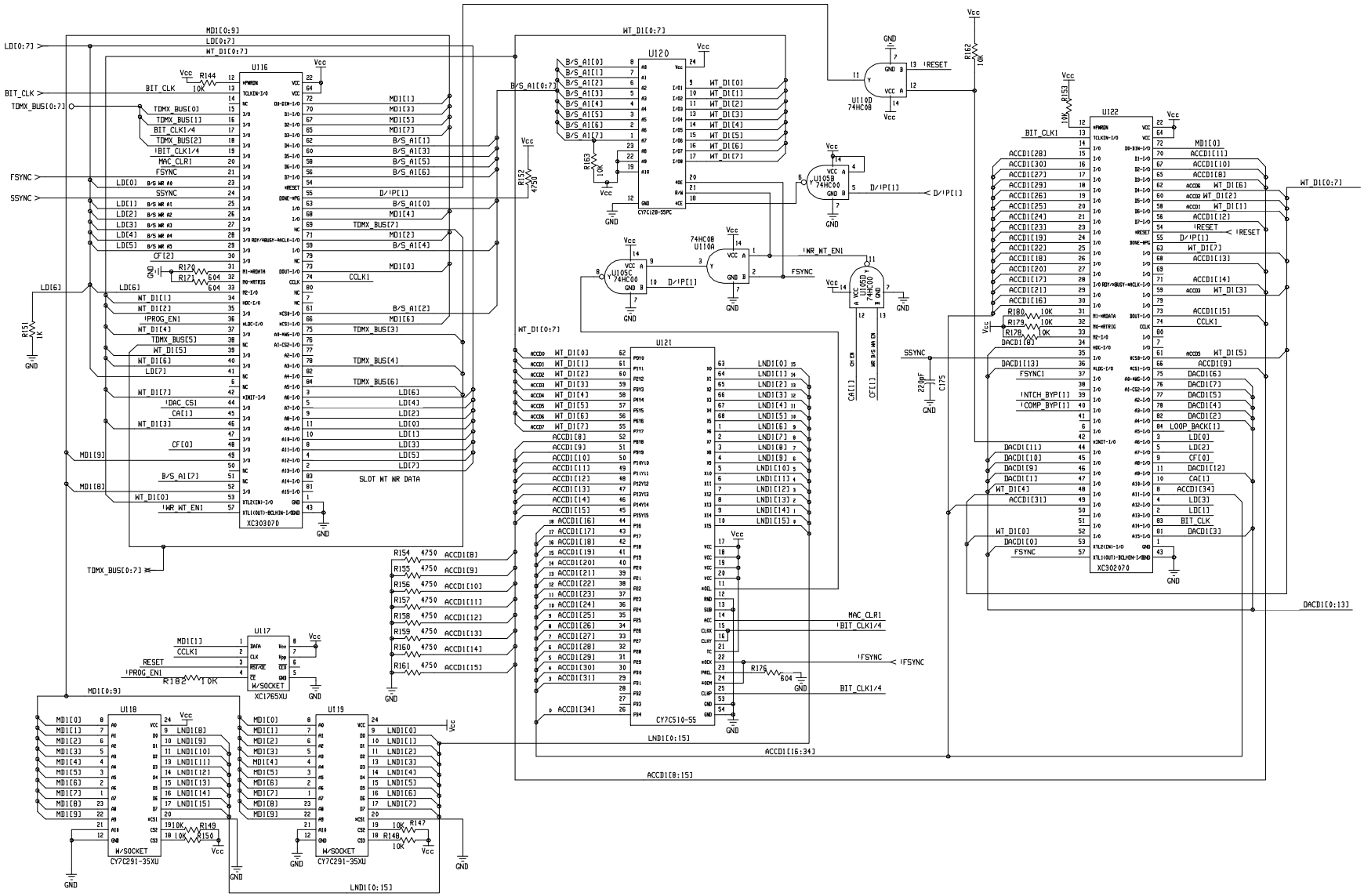

U031
U032
U033A
U033B
U034
U035
U036
U037
U038
U039
U041
U042A
U042B
U042C
U043
U044A
U045
U046
U047
U048
U049
XU099
XU046
U123B
SW003
SW001
Q012
Q004
D011
D009
D032
Y001
SAB8OC535XU
29C512XU
74HC161
74HC157DQ
74HC573
74HC138
74HC74
74HC00
74HC85D
74HC20
6264
SA882525
AMPAL22V10AJCXU
IDENTIFY
FLTR_CLK
RESET
CARD SEL
DATA LATCH
CHANNEL FUNCTION
CHANNEL ADDRESS
NOTE: RESISTOR CONFIGURATION TO BE BASED ON PROM SIZE.
(19D903982, Sh. 2, Rev. 1)



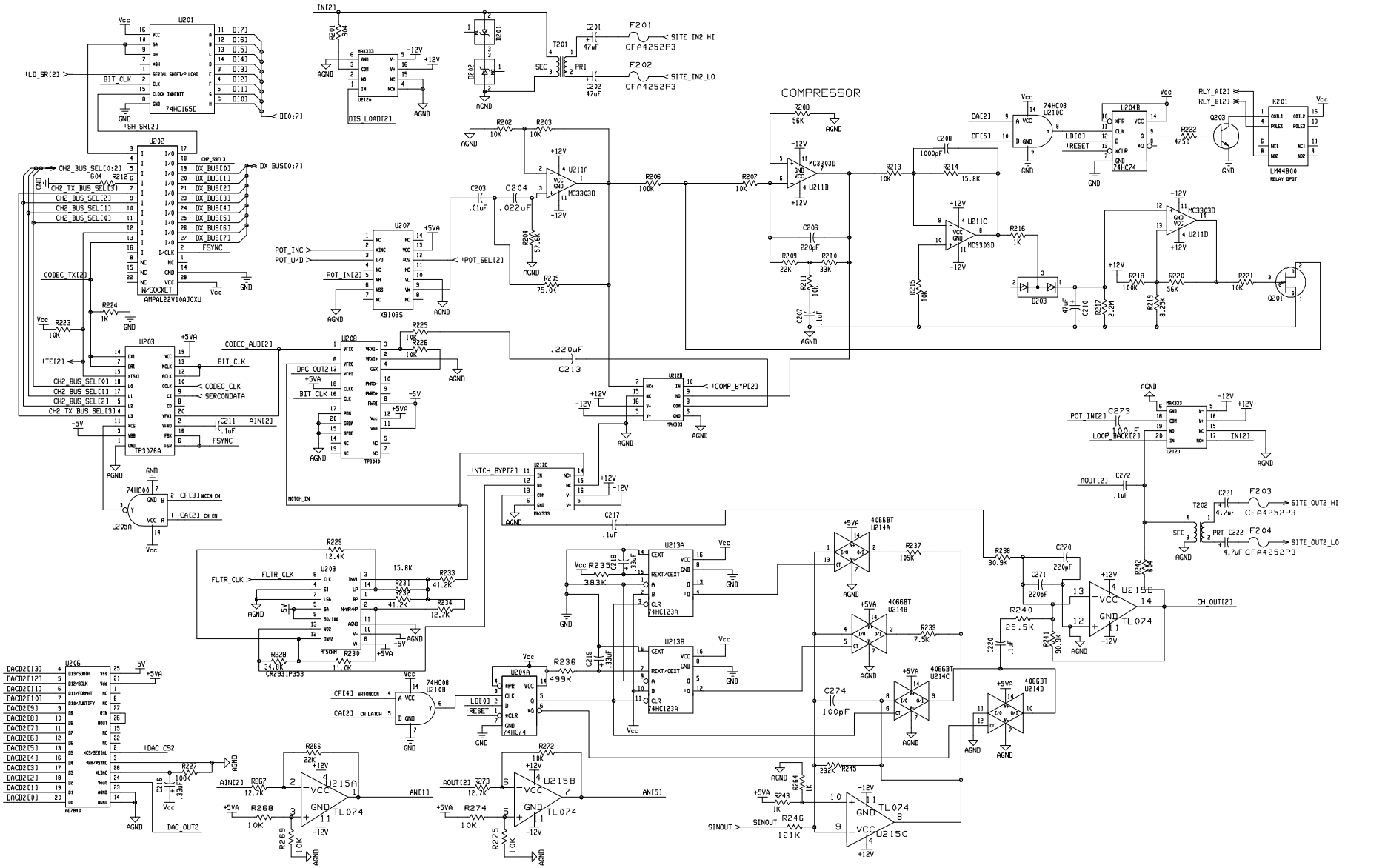

ADDRESSABLE RESET DECODE
UNUSED SUBPACKAGES
RUN
TEST PORT CONNECTOR
MAX690ACSA
MC145406
74HC165D
AMPAL22V10ACXJ
!IO_EN
!WR
!RD
IO_WR
IO_RD
!RESET
!AUD_RST
CARD_SEL
ENBL[1]
SERCONDATA
!LD_DATA
BIT_CLK
!C_SH_EN
CODEC_CLK
SEL_SIN_POT
!POT_SW
CLK_SEL
AU_SER_CNTRL+
FBUS_DIS
SINOUT
CH_OUT[1]
CH_OUT[2]
CH_OUT[3]
CH_OUT[4]
FSYNC
SSYNC
2175
RUN



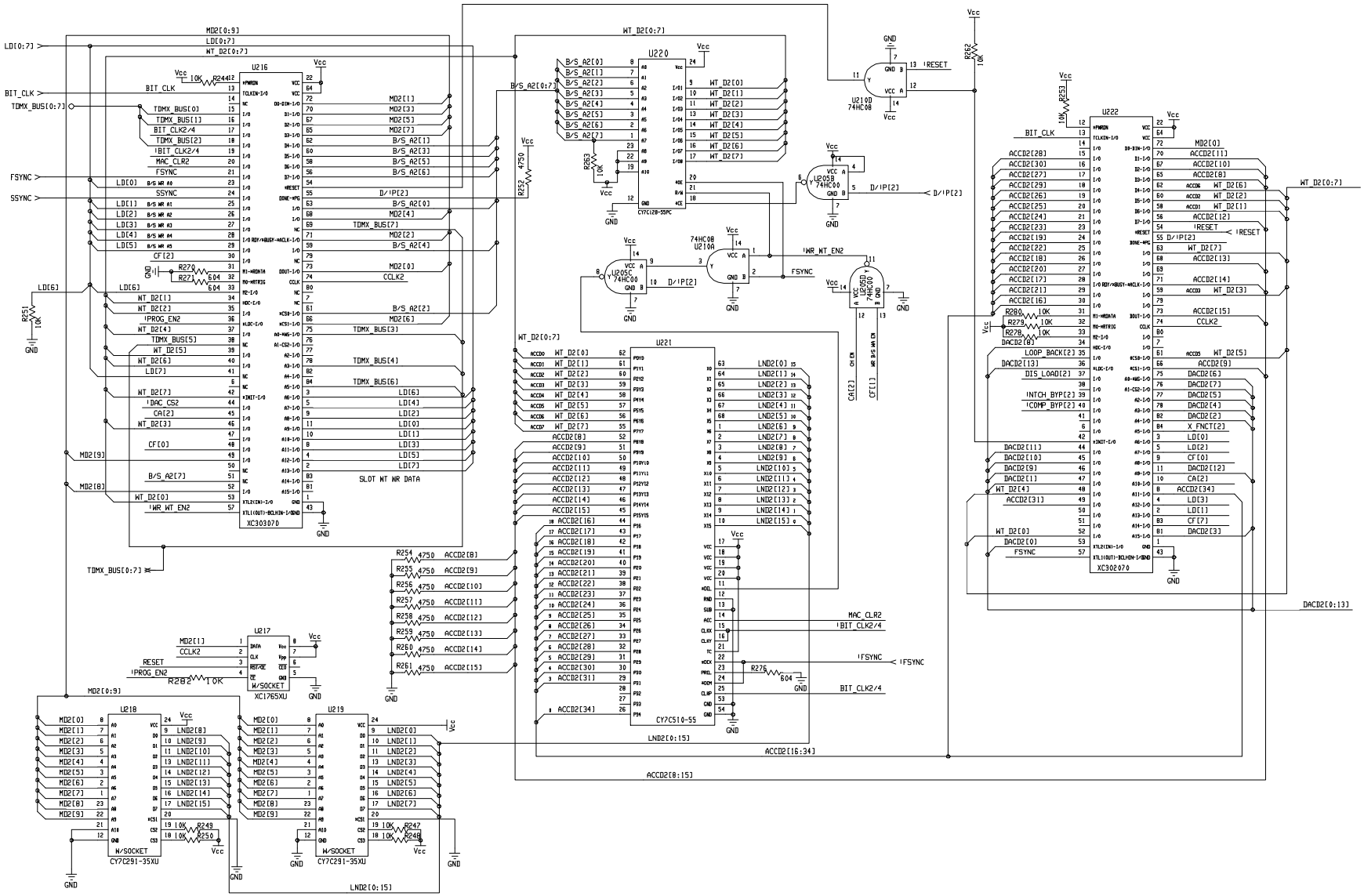
(19D903982, Sh. 5, Rev. 1)



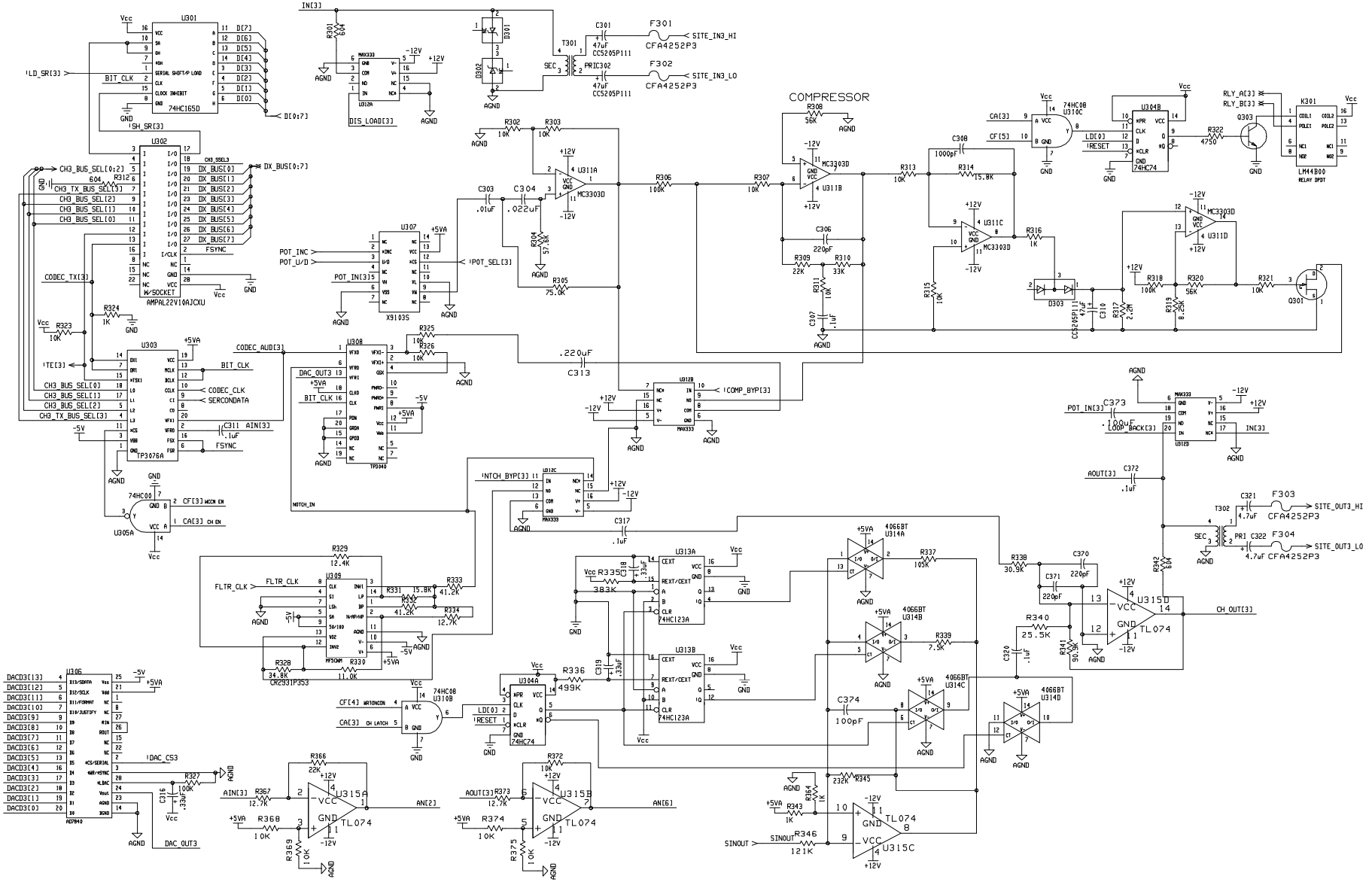
(19D903982, Sh. 6, Rev. 3)



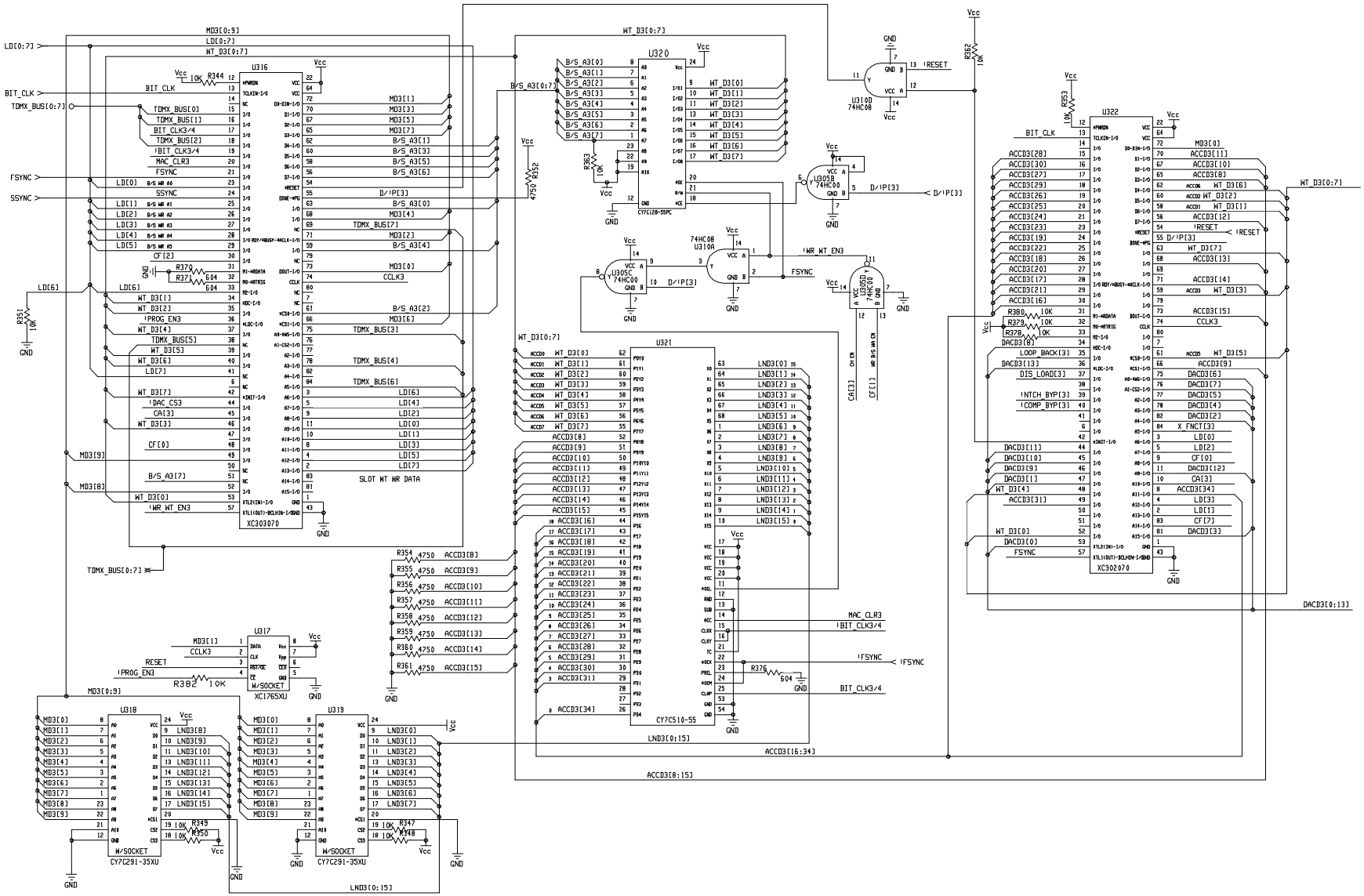
(19D903982, Sh. 7, Rev. 1)



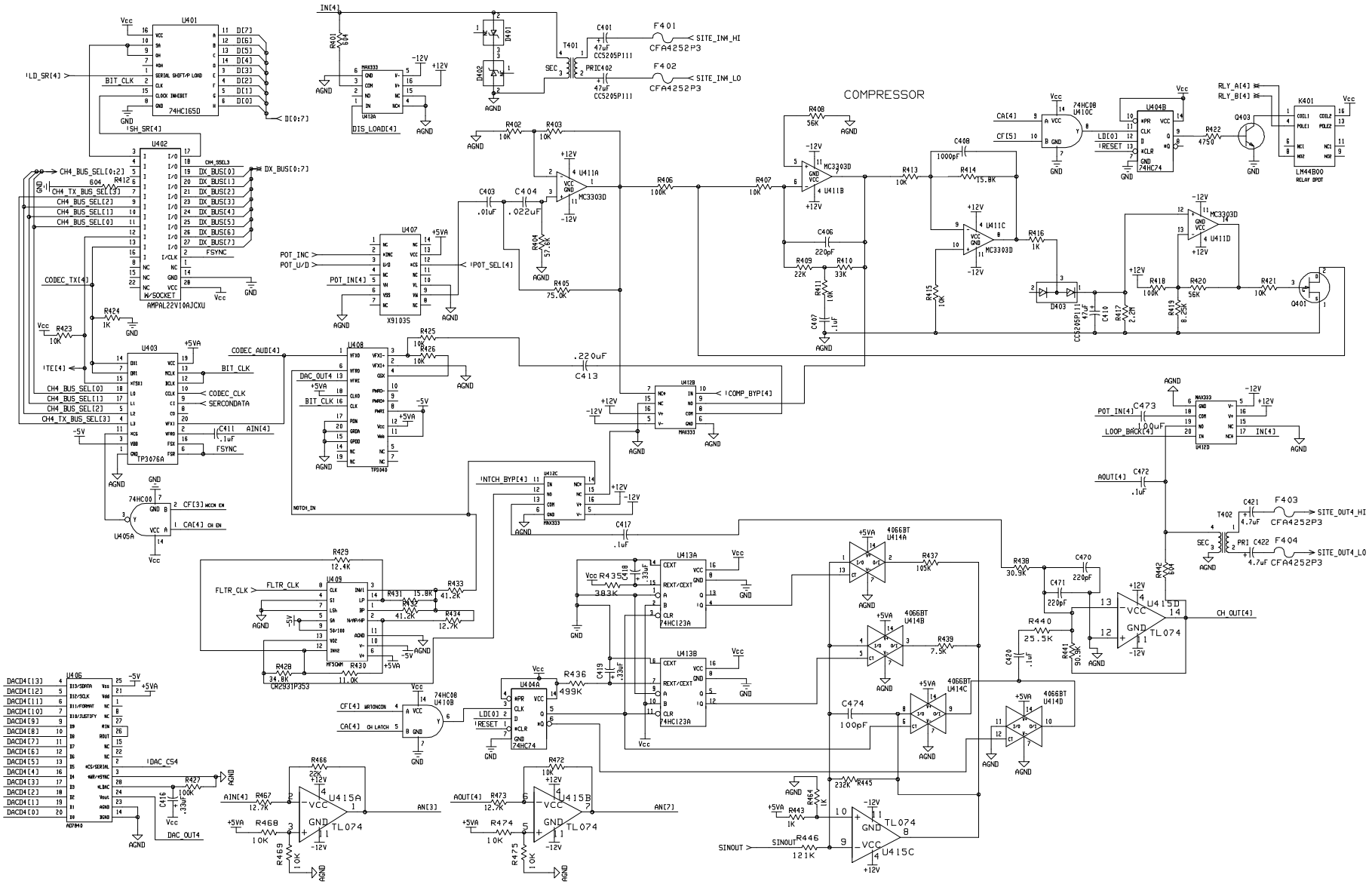
(19D903982, Sh. 8, Rev. 1)



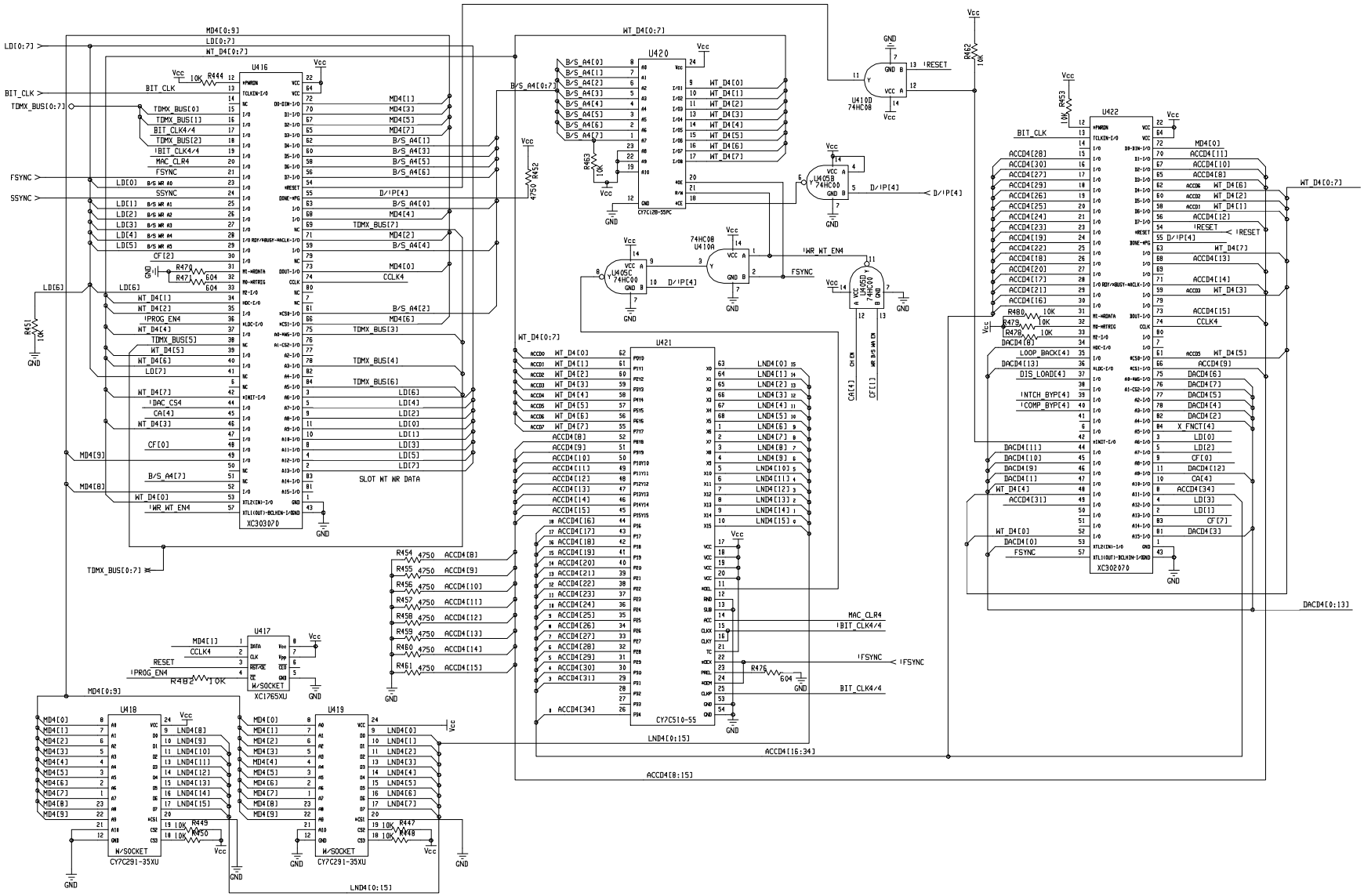
(19D903982, Sh. 9, Rev. 1)



(19D903982, Sh. 10, Rev. 1)



(19D903982, Sh. 11, Rev. 1)



(19D903982, Sh. 12, Rev. 1)

AUDIO BOARD
19D903302P3, Rev. B
(344A4088G1)

ISSUE 1

SYMBOL	PART NUMBER	DESCRIPTION
		---------- CAPACITORS----------
C1	19A703314P12	Electrolytic: 100 µF ±20%, 25 VDCW.
C2	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C3	19A703314P12	Electrolytic: 100 µF ±20%, 25 VDCW.
C4	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C5	19A705205P15	Tantalum: 33 µF, 16 VDCW; sim to Sprague 293D.
C6	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C7	19A703314P12	Electrolytic: 100 µF ±20%, 25 VDCW.
C8	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C9	19A705205P15	Tantalum: 33 µF, 16 VDCW; sim to Sprague 293D.
C10	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C11	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C12	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C13	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C14 and C15	344A4194P331250	Electrolytic: 330 µF ±20%, 25 VDCW.
C16	19A705205P18	Tantalum: 4.7 µF ±20%, 35 VDCW.
C17	19A705205P2	Tantalum: 1 µF, 16 VDCW; sim to Sprague 293D.
C18 and C19	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C20	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C21	19A705205P2	Tantalum: 1 µF, 16 VDCW; sim to Sprague 293D.
C23 and C24	19A702061P33	Ceramic: 27 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C25 and C26	19A702061P49	Ceramic: 56 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C31	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C32 and C33	19A702052P33	Ceramic: 0.1 µF ±10%, 50 VDCW.
C34	19A702052P5	Ceramic: 1000 pF ±10%, 50 VDCW.
C35 and C36	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C46 and C47	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C49 thru C65	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C67 thru C77	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C79 thru C87	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C89 and C90	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C92 thru C94	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C95	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C96	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C97	19A705205P5	Tantalum: 6.8 µF, 10 VDCW; sim to Sprague 293D.
C101 and C102	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C103	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C104	19A702052P30	Ceramic: 0.022 µF ±10%, 50 VDCW.
C106	19A702061P69	Ceramic: 220 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C107	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C108	19A702061P99	Ceramic: 1000 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C109	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C110	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C111 and C112	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C113	19A702052P32	Ceramic: 0.22 µF ±10%, 50 VDCW.
C114 and C115	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C116	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C117	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C118 and C119	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C120	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C121 and C122	19A705205P18	Tantalum: 4.7 µF ±20%, 35 VDCW.
C123	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C125	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C131 and C132	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C133	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C134 and C135	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C137 thru C139	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C140	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C141	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C143	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C144 and C145	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C146 thru C152	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C161	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C163	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C168 and C169	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.

SYMBOL	PART NUMBER	DESCRIPTION
C170 and C171	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C172	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C173	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C174	19A700233P1	Ceramic: 100 pF ±20%, 50 VDCW.
C175	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C201 and C202	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C203	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C204	19A702052P30	Ceramic: 0.022 µF ±10%, 50 VDCW.
C206	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C207	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C208	19A702052P105	Ceramic: 1000 pF ±5%, 50 VDCW.
C210	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C211 and C212	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C213	19A702052P32	Ceramic: 0.22 µF ±10%, 50 VDCW.
C214 and C215	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C216	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C217	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C218 and C219	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C220	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C221 and C222	19A705205P18	Tantalum: 4.7 µF ±20%, 35 VDCW.
C223	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C225	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C231 and C232	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C233	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C234 and C235	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C237 thru C239	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C240	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C241	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C243	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C244 and C245	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C246 thru C252	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C261	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C263	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C268 and C269	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C270 and C271	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.

SYMBOL	PART NUMBER	DESCRIPTION
C272	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C273	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C274	19A700233P1	Ceramic: 100 pF ±20%, 50 VDCW.
C301 and C302	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C303	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C304	19A702052P30	Ceramic: 0.022 µF ±10%, 50 VDCW.
C306	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C307	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C308	19A702052P105	Ceramic: 1000 pF ±5%, 50 VDCW.
C310	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C311 and C312	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C313	19A702052P32	Ceramic: 0.22 µF ±10%, 50 VDCW.
C314 and C315	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C316	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C317	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C318 and C319	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C320	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C321 and C322	19A705205P18	Tantalum: 4.7 µF ±20%, 35 VDCW.
C323	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C325	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C331 and C332	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C333	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C334 and C335	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C337 thru C339	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C340	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C341	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C343	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C344 and C345	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C346 thru C352	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C361	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C363	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C368 and C369	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C370 and C371	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C372	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C373	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C374	19A700233P1	Ceramic: 100 pF ±20%, 50 VDCW.

SYMBOL	PART NUMBER	DESCRIPTION
C401 and C402	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C403	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C404	19A702052P30	Ceramic: 0.022 µF ±10%, 50 VDCW.
C406	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C407	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C408	19A702052P105	Ceramic: 1000 pF ±5%, 50 VDCW.
C410	19A705205P111	Tantalum: 47 ±10%, 10 VDCW; sim to Sprague 293D.
C411 and C412	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C413	19A702052P32	Ceramic: 0.22 µF ±10%, 50 VDCW.
C414 and C415	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C416	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C417	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C418 and C419	19A705205P12	Tantalum: .33 µF, 16 VDCW; sim to Sprague 293D.
C420	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C421 and C422	19A705205P18	Tantalum: 4.7 µF ±20%, 35 VDCW.
C423	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C425	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C431 and C432	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C433	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C434 and C435	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C437 thru C439	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C440	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C441	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C443	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C444 and C445	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C446 thru C452	19A702052P14	Ceramic: 0.01 µF ±10%, 50 VDCW.
C461	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C463	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C468 and C469	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C470 and C471	19A702052P1	Ceramic: 220 pF ±10%, 50 VDCW.
C472	19A702052P26	Ceramic: 0.1 µF ±10%, 50 VDCW.
C473	19A702052P34	Ceramic: 0.1 µF ±10%, 25 VDCW.
C474	19A700233P1	Ceramic: 100 pF ±20%, 50 VDCW.
		----------DIODES----------
D1 thru D9	19A703595P9	Optoelectric: Green LED; sim to HLMP-1540-010
D11	19A703595P9	Optoelectric: Green LED; sim to HLMP-1540-010
D12 thru D19	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D21	T324ADP1041	Silicon: Rectifier; sim to 1N4004.
D22 and D23	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D24 and D25	T324ADP1041	Silicon: Rectifier; sim to 1N4004.
D32	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D34	19A703595P9	Optoelectric: Green LED; sim to HLMP-1540-010
D35	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D101 and D102	19A700083P101	Silicon: 4.7 Volt Zener; sim to BZX84-C4V7.
D103	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D201 and D202	19A700083P101	Silicon: 4.7 Volt Zener; sim to BZX84-C4V7.
D203	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D301 and D302	19A700083P101	Silicon: 4.7 Volt Zener; sim to BZX84-C4V7.
D303	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
D401 and D402	19A700083P101	Silicon: 4.7 Volt Zener; sim to BZX84-C4V7.
D403	19A700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
		---------- FUSES ----------
F1	19A134961P20	Cartridge: 2.0 Amps Slow-Action; sim to Littelfuse 218 002.
F2	19A134961P15	Cartridge: 1.0 Amp Slow-Action; sim to Littelfuse 218 001.
F3	19A134961P10	Cartridge: 0.5 Amp Slow-Action; sim to Littelfuse 218.500.
F101 thru F104	344A4252P3	Surface mount: 0.375 A, 32 V; sim to Avx Kyoera F1206A0-R37FWTR.
F201 thru F204	344A4252P3	Surface mount: 0.375 A, 32 V; sim to Avx Kyoera F1206A0-R37FWTR.
F301 thru F304	344A4252P3	Surface mount: 0.375 A, 32 V; sim to Avx Kyoera F1206A0-R37FWTR.
F401 thru F404	344A4252P3	Surface mount: 0.375 A, 32 V; sim to Avx Kyoera F1206A0-R37FWTR.
		---------- JACKS ----------
J1 and J2	19B801587P13	DIN plug: 96-Position; sim to AMP 2-534068-8.
J3	19B209727P37	Connector: 9 contacts, sim to AMP 745781-4.
J4	19B802174P2	DIN receptacle: 40-Position; sim to AMP 5-175474-5.
		---------- RELAYS ----------
K101	19B235621P1	Reed: 2 Form C contacts; sim to GI Clare HGZM2-C05.
K201	19B235621P1	Reed: 2 Form C contacts; sim to GI Clare HGZM2-C05.

SYMBOL	PART NUMBER	DESCRIPTION
K301	19B235621P1	Reed: 2 Form C contacts; sim to GI Clare HGZM2-C05.
K401	19B235621P1	Reed: 2 Form C contacts; sim to GI Clare HGZM2-C05.
		---------- INDUCTORS ----------
L1	19A149806P2	High-current: 100 uH; sim to Dale IHA-102.
		---------- TRANSISTORS ----------
Q4	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q8 and Q9	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q12	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q101	19A702524P3	Silicon, N-type FET: sim to MMBFJ310.
Q103	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q201	19A702524P3	Silicon, N-type FET: sim to MMBFJ310.
Q203	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q301	19A702524P3	Silicon, N-type FET: sim to MMBFJ310.
Q303	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q401	19A702524P3	Silicon, N-type FET: sim to MMBFJ310.
Q403	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
		---------- RESISTORS ----------
R1	19B800607P471	Metal film: 470 ohms ±5%, 1/8 w.
R2 and R3	19B800607P182	Metal film: 1.8K ohms ±5%, 1/8 w.
R4	19B800607P471	Metal film: 470 ohms ±5%, 1/8 w.
R5 thru R8	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R10	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R11 and R12	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R13	19B800607P273	Metal film: 27K ohms ±5%, 1/8 w.
R14	19B800607P471	Metal film: 470 ohms ±5%, 1/8 w.
R15	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R16	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R17 thru R26	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R27	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R28	19B800607P471	Metal film: 470 ohms ±5%, 1/8 w.
R29	19B800607P273	Metal film: 27K ohms ±5%, 1/8 w.
R30 thru R33	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R35 thru R37	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R38	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R39	19B800607P1	Metal film: Jumper.
R41 and R42	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R43	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R44	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R45	19A702931P371	Metal film: 53.6K ohms ±1%, 1/8 w.
R46 thru R48	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R49 thru R52	19B800607P471	Metal film: 470 ohms ±5%, 1/8 w.
R53	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R54	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R55	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R56 and R57	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R58	19B800607P471	Metal film: 470 ohms ±5%, 1/8 w.
R59	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R60	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R61 thru R68	19B800607P122	Metal film: 1.2K ohms ±5%, 1/8 w.
R69 thru R72	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R73 and R74	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R75 thru R82	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R84 thru R89	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R91	19B800607P332	Metal film: 3.3K ohms ±5%, 1/8 w.
R94 thru R96	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R98	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R101	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R102 and R103	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R104	19A702931P374	Metal film: 57.6K ohms ±1%, 1/8 w.
R105	19A702931P385	Metal film: 75K ohms ±1%, 1/8 w.
R106	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R107	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R108	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R109	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R110	19B800607P333	Metal film: 33K ohms ±5%, 1/8 w.
R111	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R112	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R113	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R114	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R115	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R116	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R117	19B800607P225	Metal film: 2.2M ohms ±5%, 1/8 w.
R118	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R119	19A702931P289	Metal film: 8250 ohms ±1%, 1/8 w.
R120	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R121	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R122	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R123	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R124	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R125 and R126	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R127	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R128	19A702931P353	Metal film: 34.8K ohms ±1%, 1/8 w.
R129	344A3206P3	Metal film: 12.4K ohms ±0.1%, 1/8 w.
R130	344A3206P4	Metal film: 11.0K ohms ±0.1%, 1/8 w.
R131	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R132 and R133	19A702931P360	Metal film: 41.2K ohms ±1%, 1/8 w.
R134	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R135	19A702931P457	Metal film: 383K ohms ±1%, 1/8 w.
R136	19A702931P468	Metal film: 499K ohms ±1%, 1/8 w.
R137	19A702931P403	Metal film: 105K ohms ±1%, 1/8 w.
R138	19A702931P348	Metal film: 30.9K ohms ±1%, 1/8 w.
R139	19A702931P285	Metal film: 7500 ohms ±1%, 1/8 w.
R140	19A702931P340	Metal film: 25.5K ohms ±1%, 1/8 w.
R141	19A702931P393	Metal film: 90.9K ohms ±1%, 1/8 w.
R142	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R143	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R144	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R145	19A702931P436	Metal film: 232K ohms ±1%, 1/8 w.
R146	19A702931P409	Metal film: 121K ohms ±1%, 1/8 w.
R147 thru R150	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R151 *	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R152	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R153	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R154 thru R161	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R162 and R163	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R164	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R166	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R167	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R168 and R169	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R170 and R171	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R172	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R173	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R174 and R175	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R176	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R178 thru R180	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R182	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R201	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R202 and R203	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R204	19A702931P374	Metal film: 57.6K ohms ±1%, 1/8 w.
R205	19A702931P385	Metal film: 75K ohms ±1%, 1/8 w.
R206	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R207	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R208	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R209	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R210	19B800607P333	Metal film: 33K ohms ±5%, 1/8 w.
R211	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R212	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R213	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R214	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R215	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R216	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R217	19B800607P225	Metal film: 2.2M ohms ±5%, 1/8 w.
R218	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R219	19A702931P289	Metal film: 8250 ohms ±1%, 1/8 w.
R220	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R221	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R222	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R223	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R224	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R225 and R226	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R227	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R228	19A702931P353	Metal film: 34.8K ohms ±1%, 1/8 w.
R229	344A3206P3	Metal film: 12.4K ohms ±0.1%, 1/8 w.
R230	344A3206P4	Metal film: 11.0K ohms ±0.1%, 1/8 w.
R231	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R232 and R233	19A702931P360	Metal film: 41.2K ohms ±1%, 1/8 w.
R234	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R235	19A702931P457	Metal film: 383K ohms ±1%, 1/8 w.
R236	19A702931P468	Metal film: 499K ohms ±1%, 1/8 w.
R237	19A702931P403	Metal film: 105K ohms ±1%, 1/8 w.
R238	19A702931P348	Metal film: 30.9K ohms ±1%, 1/8 w.
R239	19A702931P285	Metal film: 7500 ohms ±1%, 1/8 w.
R240	19A702931P340	Metal film: 25.5K ohms ±1%, 1/8 w.
R241	19A702931P393	Metal film: 90.9K ohms ±1%, 1/8 w.
R242	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R243	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R244	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R245	19A702931P436	Metal film: 232K ohms ±1%, 1/8 w.
R246	19A702931P409	Metal film: 121K ohms ±1%, 1/8 w.
R247 thru R251	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R252	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R253	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R254 thru R261	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R262 and R263	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R264	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R266	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R267	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R268 and R269	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R270 and R271	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R272	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R273	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R274 and R275	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R276	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R278 thru R280	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R282	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R301	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R302 and R303	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R304	19A702931P374	Metal film: 57.6K ohms ±1%, 1/8 w.
R305	19A702931P385	Metal film: 75K ohms ±1%, 1/8 w.
R306	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R307	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R308	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R309	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R310	19B800607P333	Metal film: 33K ohms ±5%, 1/8 w.
R311	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R312	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R313	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R314	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R315	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R316	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R317	19B800607P225	Metal film: 2.2M ohms ±5%, 1/8 w.
R318	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R319	19A702931P289	Metal film: 8250 ohms ±1%, 1/8 w.
R320	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R321	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R322	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R323	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R324	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R325 and R326	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R327	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R328	19A702931P353	Metal film: 34.8K ohms ±1%, 1/8 w.
R329	344A3206P3	Metal film: 12.4K ohms ±0.1%, 1/8 w.
R330	344A3206P4	Metal film: 11.0K ohms ±0.1%, 1/8 w.
R331	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R332 and R333	19A702931P360	Metal film: 41.2K ohms ±1%, 1/8 w.
R334	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R335	19A702931P457	Metal film: 383K ohms ±1%, 1/8 w.
R336	19A702931P468	Metal film: 499K ohms ±1%, 1/8 w.
R337	19A702931P403	Metal film: 105K ohms ±1%, 1/8 w.
R338	19A702931P348	Metal film: 30.9K ohms ±1%, 1/8 w.
R339	19A702931P285	Metal film: 7500 ohms ±1%, 1/8 w.
R340	19A702931P340	Metal film: 25.5K ohms ±1%, 1/8 w.
R341	19A702931P393	Metal film: 90.9K ohms ±1%, 1/8 w.
R342	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R343	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R344	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R345	19A702931P436	Metal film: 232K ohms ±1%, 1/8 w.
R346	19A702931P409	Metal film: 121K ohms ±1%, 1/8 w.
R347 thru R351	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R352	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R353	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R354 thru R361	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R362 and R363	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R364	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R366	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R367	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R368 and R369	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R370 and R371	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R372	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R373	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R374 and R375	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R376	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R378 thru R380	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R382	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R401	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R402 and R403	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R404	19A702931P374	Metal film: 57.6K ohms ±1%, 1/8 w.
R405	19A702931P385	Metal film: 75K ohms ±1%, 1/8 w.
R406	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R407	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R408	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R409	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R410	19B800607P333	Metal film: 33K ohms ±5%, 1/8 w.
R411	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R412	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R413	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R414	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R415	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R416	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R417	19B800607P225	Metal film: 2.2M ohms ±5%, 1/8 w.
R418	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R419	19A702931P289	Metal film: 8250 ohms ±1%, 1/8 w.
R420	19B800607P563	Metal film: 56K ohms ±5%, 1/8 w.
R421	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R422	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R423	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R424	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R425 and R426	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R427	19A702931P401	Metal film: 100K ohms ±1%, 1/8 w.
R428	19A702931P353	Metal film: 34.8K ohms ±1%, 1/8 w.
R429	344A3206P3	Metal film: 12.4K ohms ±0.1%, 1/8 w.
R430	344A3206P4	Metal film: 11.0K ohms ±0.1%, 1/8 w.
R431	19A702931P320	Metal film: 15.8K ohms ±1%, 1/8 w.
R432 and R433	19A702931P360	Metal film: 41.2K ohms ±1%, 1/8 w.
R434	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R435	19A702931P457	Metal film: 383K ohms ±1%, 1/8 w.
R436	19A702931P468	Metal film: 499K ohms ±1%, 1/8 w.
R437	19A702931P403	Metal film: 105K ohms ±1%, 1/8 w.
R438	19A702931P348	Metal film: 30.9K ohms ±1%, 1/8 w.
R439	19A702931P285	Metal film: 7500 ohms ±1%, 1/8 w.
R440	19A702931P340	Metal film: 25.5K ohms ±1%, 1/8 w.
R441	19A702931P393	Metal film: 90.9K ohms ±1%, 1/8 w.
R442	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R443	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R444	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R445	19A702931P436	Metal film: 232K ohms ±1%, 1/8 w.
R446	19A702931P409	Metal film: 121K ohms ±1%, 1/8 w.
R447 thru R451	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R452	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R453	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R454 thru R461	19A702931P266	Metal film: 4750 ohms ±1%, 1/8 w.
R462 and R463	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R464	19B800607P102	Metal film: 1K ohms ±5%, 1/8 w.
R466	19B800607P223	Metal film: 22K ohms ±5%, 1/8 w.
R467	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R468 and R469	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R470 and R471	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R472	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.

SYMBOL	PART NUMBER	DESCRIPTION
R473	19A702931P311	Metal film; 12.7K ohms ±1%, 1/8 w.
R474 and R475	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R476	19A702931P176	Metal film: 604 ohms ±1%, 1/8 w.
R478 thru R480	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
R482	19A702931P301	Metal film: 10K ohms ±1%, 1/8 w.
		---------- SWITCHES ----------
SW1	19A149955P1	DIP, rocker: 8-Position; sim to Grayhill 76PSB08S.
SW3	19A149923P2	Pushbutton: Single-Pole Normally-Open; sim to ITT Schadow KSLOV311.
		---------- TRANSFORMERS ----------
T101 and T102	344A3106P1	Audio Frequency, 600-Ohm Coupling; sim to Midcom 671-8000.
T201 and T202	344A3106P1	Audio Frequency, 600-Ohm Coupling; sim to Midcom 671-8000.
T301 and T302	344A3106P1	Audio Frequency, 600-Ohm Coupling; sim to Midcom 671-8000.
T401 and T402	344A3106P1	Audio Frequency, 600-Ohm Coupling; sim to Midcom 671-8000.
		---------- TEST POINTS ----------
TP1	344A3367P1	Metal loop w/orange insulator.
		---------- INTEGRATED CIRCUITS ----------
U1	19A134717P2	Linear: 12 Volt Regulator: sim to MC7812CT.
U2	19A134718P2	Linear: -12 Volt Regulator; sim to uA7912U.
U3	19A134718P1	Linear: -5 Volt Regulator; sim to uA7905U.
U4	19A703483P311	Digital: Quad 2-Input OR Gate; sim to 74HC32.
U5	19A134717P1	Linear: 5 Volt Regulator; sim to MC7805CT.
U31	19A705828P1	Microcomputer: sim to Siemens SAB80C535.
U32	19A703987P306	Digital: Presettable Counter; sim to 74HC161.
U33	19A703483P321	Digital: Hex Schmitt Trigger Inverter; sim to 74HC14.
U34 and U35	19A703471P323	Digital: Quad 2-Input Data Selector/Mux.; sim to 74HC157.
U36	19A703471P318	Digital: Octal Tri-State Transceiver/Latch; sim to 74HC573.
U38	19A703471P323	Digital: Quad 2-Input Data Selector/Mux.; sim to 74HC157.
U39	19A703471P320	Digital: 3-Line To 8-Line Decoder; sim to 74HC138.
U40	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
U41	19A705603P5	Digital: 8K x 8-Bit Static RAM; sim to KM6264AL-10.
U42	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
U43	19A703483P319	Digital: 4-Bit Magnitude Comparator; sim to 74HC85.
U44	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.

SYMBOL	PART NUMBER	DESCRIPTION
U45	19A149956P1	Digital: Serial Communication Controller; sim to 82525N.
U46	344A4826G1	Digital: PAL; sim to TICPAL22V10Z-25C.(Programmed.)
U47 thru U49	19A703471P318	Digital: Octal Tri-State Transceiver/Latch; sim to 74HC573.
U50 and U51	19A149953P202	Digital: 4-Channel Bus Transceiver; sim to DS3897.
U53	344A3559G2	Digital: PAL; sim to TICPAL22V10Z-25C.(Programmed.)
U54	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.
U55	19A705180P102	Digitally Controlled Pot: 40 - 10K ohms; sim to X9103S.
U56	19A149953P201	Digital: 8-Channel Bus Transceiver; sim to DS3896.
U57	344A3064P205	Digital: Quad 2-Input Multiplexer; sim to 74HCT157.
U59	19A704380P315	Digital: Octal 3-State Inverting Flip-Flop; sim to 74HC564.
U60	19A703483P101	Digital: Quad 2-Input NOR Gate; sim to 74HC02.
U61	19A703471P308	Digital: Octal Bus Transceiver; sim to 74HC245.
U62	344A3122P1	Linear: PCM filter; sim to National TP3040.
U63 and U64	19A704380P321	Digital: Monostable Multivibrator; sim to 74HC123.
U65	19A703483P308	Digital: Dual 4-Input NAND Gate; sim to 74HC20.
U66	19A703483P311	Digital: Quad 2-Input OR Gate; sim to 74HC32.
U67	19A704380P310	Digital: Quad Data Flip-Flop w/Clear; sim to 74HC175.
U68	344A3071P1	Linear: Quad Optocoupler; sim to Siemens ILQ66-004T.
U69	19A703987P322	Digital: 8-Bit Shift Register; sim to 74HC165.
U70	344A3557G3	Digital: PAL; sim to TICPAL22V10Z-25C.(Programmed.)
U71	344A3071P1	Linear: Quad Optocoupler; sim to Siemens ILQ66-004T.
U72	19A703471P305	Digital: Quad 3-State Buffer; sim to 74HC126.
U73	344A3039P201	Digital: Driver/Receiver, EIA-232D/V.28; sim to MC145406.
U83	19A703483P305	Digital: Quad 2-Input AND Gate; sim to 74HC08.
U89	19A703483P320	Digital: Dual 4-Input AND Gate; sim to 74HC21.
U90	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.
U91	RYTUA113001/C	Digital: Micro Supervisor; sim to MAX690A.
U94	344A3558G2	Digital: PAL; sim to TICPAL22V10Z-25C.(Programmed.)
U101	19A703987P322	Digital: 8-Bit Shift Register; sim to 74HC165.
U102	344A3560G2	Digital: PAL; sim to TICPAL22V10Z-25C.(Programmed.)
U103	344A3105P1	Digital: PCM CODEC & Filter; sim to TP3076A.
U104	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.

SYMBOL	PART NUMBER	DESCRIPTION
U105	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
U106	344A3123P1	D/A converter: 14-bit; sim to Analog Devices AD7840.
U107	19A705180P102	Digitally Controlled Pot: 40 - 10K ohms; sim to X9103S.
U108	344A3122P1	Linear: PCM filter; sim to National TP3040.
U109	344A3124P1	Linear: Switched capacitor filter; sim to National MF5.
U110	19A703483P305	Digital: Quad 2-Input AND Gate; sim to 74HC08.
U111	19A704883P2	Digital: Quad Op Amp; sim to MC3303D.
U112	344A3113P101	Analog: Quad SPDT Switch; sim to MAX333.
U113	19A704380P321	Digital: Monostable Multivibrator; sim to 74HC123.
U114	19A702705P4	Digital: Quad Analog Switch/Multiplexer; sim to 4066BM.
U115	344A3070P3	Digital: Quad JFET-Input Op Amp; sim to TL074.
U116	344A3129P2	Digital: Logic Cell Array; sim to XC3030-70.
U117	344A3561G9 *	Digital: Serial PROM; sim to XC1736A. (Programmed.)
U118	344A3562G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U119	344A3563G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35.(Programmed.)
U120	19A702934P4	Digital: 2K x 8-bit RAM; sim to Toshiba TC5517AFL.
U121	344A3112P1	Digital: Multiplier Accumulator; sim to Cypress CY7C510-55.
U122	344A3129P1	Digital: Logic Cell Array; sim to XC3020-70.
U123	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.
U201	19A703987P322	Digital: 8-Bit Shift Register; sim to 74HC165.
U202	344A3560G2	Digital: PAL; sim to TICPAL22V10Z-25C. (Programmed.)
U203	344A3105P1	Digital: PCM CODEC & Filter; sim to TP3076A.
U204	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.
U205	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
U206	344A3123P1	D/A converter: 14-bit; sim to Analog Devices AD7840.
U207	19A705180P102	Digitally Controlled Pot: 40 - 10K ohms; sim to X9103S.
U208	344A3122P1	Linear: PCM filter; sim to National TP3040.
U209	344A3124P1	Linear: Switched capacitor filter; sim to National MF5.
U210	19A703483P305	Digital: Quad 2-Input AND Gate; sim to 74HC08.
U211	19A704883P2	Digital: Quad Op Amp; sim to MC3303D.
U212	344A3113P101	Analog: Quad SPDT Switch; sim to MAX333.
U213	19A704380P321	Digital: Monostable Multivibrator; sim to 74HC123.
U214	19A702705P4	Digital: Quad Analog Switch/Multiplexer; sim to 4066BM.

SYMBOL	PART NUMBER	DESCRIPTION
U215	344A3070P3	Digital: Quad JFET-Input Op Amp; sim to TL074.
U216	344A3129P2	Digital: Logic Cell Array; sim to XC3030-70.
U217	344A3561G8 *	Digital: Serial PROM; sim to XC1736A. (Programmed.)
U218	344A3562G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U219	344A3563G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U220	19A702934P4	Digital: 2K x 8-bit RAM; sim to Toshiba TC5517AFL.
U221	344A3112P1	Digital: Multiplier Accumulator; sim to Cypress CY7C510-55.
U222	344A3129P1	Digital: Logic Cell Array; sim to XC3020-70.
U301	19A703987P322	Digital: 8-Bit Shift Register; sim to 74HC165.
U302	344A3560G2	Digital: PAL; sim to TICPAL22V10Z-25C. (Programmed.)
U303	344A3105P1	Digital: PCM CODEC & Filter; sim to TP3076A.
U304	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.
U305	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
U306	344A3123P1	D/A converter: 14-bit; sim to Analog Devices AD7840.
U307	19A705180P102	Digitally Controlled Pot: 40 - 10K ohms; sim to X9103S.
U308	344A3122P1	Linear: PCM filter; sim to National TP3040.
U309	344A3124P1	Linear: Switched capacitor filter; sim to National MF5.
U310	19A703483P305	Digital: Quad 2-Input AND Gate; sim to 74HC08.
U311	19A704883P2	Digital: Quad Op Amp; sim to MC3303D.
U312	344A3113P101	Analog: Quad SPDT Switch; sim to MAX333.
U313	19A704380P321	Digital: Monostable Multivibrator; sim to 74HC123.
U314	19A702705P4	Digital: Quad Analog Switch/Multiplexer; sim to 4066BM.
U315	344A3070P3	Digital: Quad JFET-Input Op Amp; sim to TL074.
U316	344A3129P2	Digital: Logic Cell Array; sim to XC3030-70.
U317	344A3561G8 *	Digital: Serial PROM; sim to XC1736A. (Programmed.)
U318	344A3562G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U319	344A3563G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U320	19A702934P4	Digital: 2K x 8-bit RAM; sim to Toshiba TC5517AFL.
U321	344A3112P1	Digital: Multiplier Accumulator; sim to Cypress CY7C510-55.
U322	344A3129P1	Digital: Logic Cell Array; sim to XC3020-70.
U401	19A703987P322	Digital: 8-Bit Shift Register; sim to 74HC165.
U402	344A3560G2	Digital: PAL; sim to TICPAL22V10Z-25C. (Programmed.)

SYMBOL	PART NUMBER	DESCRIPTION
U403	344A3105P1	Digital: PCM CODEC & Filter; sim to TP3076A.
U404	19A704380P302	Digital: Dual Data Flip-Flop; sim to 74HC74.
U405	19A703483P302	Digital: Quad 2-Input NAND Gate; sim to 74HC00.
U406	344A3123P1	D/A converter: 14-bit; sim to Analog Devices AD7840.
U407	19A705180P102	Digitally Controlled Pot: 40 - 10K ohms; sim to X9103S.
U408	344A3122P1	Linear: PCM filter; sim to National TP3040.
U409	344A3124P1	Linear: Switched capacitor filter; sim to National MF5.
U410	19A703483P305	Digital: Quad 2-Input AND Gate; sim to 74HC08.
U411	19A704883P2	Digital: Quad Op Amp; sim to MC3303D.
U412	344A3113P101	Analog: Quad SPDT Switch; sim to MAX333.
U413	19A704380P321	Digital: Monostable Multivibrator; sim to 74HC123.
U414	19A702705P4	Digital: Quad Analog Switch/Multiplexer; sim to 4066BM.
U415	344A3070P3	Digital: Quad JFET-Input Op Amp; sim to TL074.
U416	344A3129P2	Digital: Logic Cell Array; sim to XC3030-70.
U417	344A3561G8 *	Digital: Serial PROM; sim to XC1736A. (Programmed.)
U418	344A3562G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U419	344A3563G3	Digital: 2K x 8-Bit EPROM; sim to CY7C291-35 or TMS27C291-35. (Programmed.)
U420	19A702934P4	Digital: 2K x 8-bit RAM; sim to Toshiba TC5517AFL.
U421	344A3112P1	Digital: Multiplier Accumulator; sim to Cypress CY7C510-55.
U422	344A3129P1	Digital: Logic Cell Array; sim to XC3020-70.
		---------- FUSE SOCKETS----------
XF1A	19A116688P2	Clip: sim to Littelfuse 111501.
XF1B and XF2A	19A116688P2	Clip: sim to Littelfuse 111501.
XF2B and XF3A	19A116688P2	Clip: sim to Littelfuse 111501.
XF3B	19A116688P2	Clip: sim to Littelfuse 111501.
		---------- SOCKETS ----------
XU31	344A3339P5	PLCC surface mount: 68-Pin; sim to AMP 822070-4.
XU46	344A3339P2	PLCC surface mount: 28-Pin; sim to AMP 822066-4.
XU99	19A700156P17	DIP: 32-Pin low-profile; sim to AMP 2-644018-3.
XU117	19A700156P15	DIP: 8-Pin, tin plated.
XU118 and XU119	19A700156P19	DIP: 24-positions, tin plated; sim to AMP 2-641932-1.
XU217	19A700156P15	DIP: 8-Pin, tin plated.
XU218 and XU219	19A700156P19	DIP: 24-positions, tin plated; sim to AMP 2-641932-1.

SYMBOL	PART NUMBER	DESCRIPTION
XU317	19A700156P15	DIP: 8-Pin, tin plated.
XU318 and XU319	19A700156P19	DIP: 24-positions, tin plated; sim to AMP 2-641932-1.
XU417	19A700156P15	DIP: 8-Pin, tin plated.
XU418 and XU419	19A700156P19	DIP: 24-positions, tin plated; sim to AMP 2-641932-1.
		---------- CRYSTALS ----------
Y1	19A702511G15	Quartz: 11.059200 MHz.
Y2	19A702511G5	Quartz: 11.520000 MHz.
		---------- MISCELLANEOUS ----------
	19C852126P2	Panel, front: aluminum, lettered.
	344A4192P1	Kit, Mounting.
	N80P9005B6	Machine screw, pan head, steel, No.4-40UNC x 5/16".
	N404P11B6	Lockwasher, internal tooth: No.4.
	7141225P2	Nut, Hex: 4-40.

PRODUCTION CHANGES

Changes in the equipment to improve performance 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 the descriptions of parts affected by these revisions.

Rev. A **AUDIO BOARD 19D903302P3**

To improve audio operation, changed PROM U117 from 344A3561G7 to 344A3561G9 and changed PROMs U217, U317 & U417 from 344A3561G6 to 344A3561G8.

Rev. B **AUDIO BOARD 19D903302P3**

To improve FPGA programming at power-up, changed R151 from 10K ohms (19B800607P103) to 1K ohms (19B800607P102).