Service Manual

Digital Reverb/Effects Processor

Model 224X

lexicon

PREFACE

This service manual for the Lexicon 224X Digital Reverberator has eight sections.

Section 1, **Introduction**, contains a general description of the 224X and lists the specifications.

Section 2, **Service/Warranty**, gives instructions for periodic maintenance and describes how to return units for service and order parts. In addition, it contains the limited warranty.

Section 3, **Theory of Operation**, includes a system overview and describes how each module in the 224X works and how the modules interact with one another.

Section 4, **Performance Tests and Calibration**, lists the equipment required for performance tests and calibration and describes how to conduct these procedures.

Section 5, **Troubleshooting**, contains troubleshooting procedures, including a discussion of the power supplies and the diagnostic programs.

Section 6, **Schematics and Assembly Drawings**, contains all 224X schematic and assembly drawings.

Section 7, **Parts List**, lists the part number, quantity, description, and reference for all parts.

Section 8, **Engineering Changes**, describes modifications to the 224X and provides instructions on how to make the modifications.

Table of Contents

1.2 Specifications

Program Capacity	Varies depending on software version.
Storage Capacity	36 registers (nonvolatile).
Reverberation Time	Adjustable in two bands from approximately 0.6 to 70 seconds (program-dependent).
Mainframe Controls	Power on switch with LED; system reset; Left and Right input level adjustments; A, B, C, and D output level adjustments.
Frequency Response	20 Hz to 15 kHz, ±1.5 dB 20 Hz to 12 kHz, ±0.5 dB.
Dynamic Range*	
Reverberant mode	84 dB typical, 81 dB minimum at Reference Level, 20 Hz to 20 kHz for all reverb times from 0 to 10 seconds.
Nonreverberant mode	90 dB typical, 86 dB minimum, 20 Hz to 20 kHz noise bandwidth.
Total Harmonic Distortion (THD) and Noise*	0.04% typical, 0.07% maximum at Reference Level for all reverberation times between 0 and 35 seconds.
Interchannel Crosstalk	-55 dB at 1 kHz.
Inputs	Two, balanced and transformer-isolated; impedance: 20 kilohm; maximum level adjustable: +8 to 18 dBm.
Outputs	Four, balanced and transformer-isolated; impedance: 90 ohm; maximum level adjustable: +8 to +18 dBm; power-on muting.
Control Head Cable	15 ft standard; optional 25-ft and 50-ft cables available.
Power	Nominal: 100, 120, 220, 240 Vac (-10%, +5%) switch-selectable; 50 to 60 Hz; 150 W.
RFI Shielding	ac power connector, audio connectors, and console cable are RFI-shielded. Complies with FCC limits for Class A computing device.
Protection	Mains and secondaries fused; voltage crowbar and/or current limiting, thermal protection.

1 INTRODUCTION

1.1 Description

This service manual contains specifications, service and warranty information, theory of operation, performance tests and calibration procedures, a troubleshooting guide, schematics and assembly drawings, a parts list, and engineering changes for the 224X Reverberation/Effects Processor. This manual can be used as a reference for standard servicing procedures.

IMPORTANT: As a result of improvements and updates to the 224X, the unit being serviced may differ slightly from the descriptions and specifications in this manual. Service operations must be performed in the order described by a competent service technician only. If you have doubts about performing a procedure, please contact your Lexicon dealer or Lexicon for assistance. Lexicon is not responsible for damage resulting from incorrectly followed service procedures. Lexicon has taken considerable care in determining the accuracy of the information in this manual; however, it is not responsible for consequential damage resulting from the implementation of the procedures described.

WARNING: Hazardous voltages exist inside this unit when the power cord is connected; use extreme caution when servicing or adjusting. Service must be performed by qualified service personnel. Always place the unit on an isolation transformer before servicing.

PRECAUTIONS

Many of the internal components of this unit are extremely sensitive to static electricity. To ensure that static charges are dissipated safely, do not hand a component or board directly to another person -- place the device on a nonconductive surface and then have it picked up. The following practices minimize possible damage to ICs that can result from electrostatic discharge:

1 Minimize handling of integrated circuits (ICs).
2 Keep parts in original containers until ready for use.
3 Discharge personal static before handling devices.
4 Handle each IC by its body.
5 Use antistatic containers for handling and transport.
6 Do not slide devices over a surface.
7 Avoid plastic, vinyl, or styrofoam in the work area.
8 When removing plug-in boards, handle only by nonconductive surfaces and never touch open-edge connectors except at a static-free work station. Placing shorting strips on edge connectors usually provides complete protection to installed ICs.
9 Handle ICs only at a static-free work station.
10 Use only grounded-tip soldering irons.

Always disconnect the power cord before servicing internal components.

Connectors	
Mainframe	Power: standard IEC 3 pin Audio: XLR-3 Control Head: DB-25 Optional Automation Interface: DB-25.
Control Head	Mainframe Cable: DB-25.
Serviceability	Field-serviceable, each major assembly removable.
Diagnostic Programs	Control and display via remote controller.
Cooling	Convection-cooled power supply, forced-air cooling of logic boards.
Environment	Operating: 0 to 35°C (32 to 95°F) Storage: -30 to 75°C (-22 to 167°F) Relative humidity: 95% maximum (without condensation).
Size	
Mainframe	Standard 19-in. rack mount: 19"w x 7"h x 15"d (483 x 178 x 381 mm).
Control Head	5.4"w x 8.8"h x 3"d (137.2 x 223.5 x 76.2 mm).
Weight	
Mainframe	34 lb (15.5 kg); 48 lb (22 kg) shipping.
Control Head	2.5 lb (1.2 kg); 6 lb (2.7 kg) shipping.
Automation Interface	Optional RS-232C serial interface.

Specifications subject to change without notice.

* The Reference Level is set using the zero delay-line diagnostic test program with input level adjustment set just below level at which the +12 dB LED lights with a 1-kHz tone at the input and with output sensitivity set to produce +12 dBm with a 600-ohm load. For reverberant mode, measurements are made using the Concert Hall program with the Mode Enhancement toggle off; for nonreverberant mode, measurements are made using the zero delay-line diagnostic test program.

2 SERVICE/WARRANTY

2.1 Periodic Maintenance

Under normal conditions, the 224X requires minimal maintenance. At six-month intervals, clean or replace the air filters on the right side and front panel of the mainframe. Filter elements can be cleaned using a mild detergent and warm water, and new filters can be obtained from Lexicon (front-panel filter: Lexicon no. 720-03386; side-panel filter: Lexicon no. 720-01261).

Use a soft lint-free cloth lightly dampened with a mild detergent and warm water to clean the exterior surfaces of the 224X. During servicing, use a vacuum or blower to clean dust out of the interior of the 224X.

2.2 Returning Units for Service

If the 224X must be returned to Lexicon or a designated facility for service, Lexicon assumes no responsibility for the unit in shipment from customer to factory, whether in or out of warranty. All shipments must be well packed (using the original packing materials, if possible), properly insured, and consigned to a reliable agent, such as UPS or Federal Air Express. If original packing materials are not available, please procure a new packing kit from Lexicon.

Before returning a unit, always consult with Lexicon to determine the extent of the problem and to decide on a shipping procedure.

When returning a unit for service, include the following information:

- Name
- Company name
- Address
- City, State, ZIP
- Telephone number (include area code)
- Serial number of unit
- Description of problem
- Desired return date
- Preferred method of return shipment

Please include a note describing conversations with Lexicon personnel, and give the name and telephone number of the person directly responsible for maintaining the equipment. Do NOT include accessories, such as power cords, manuals, or remote switches.

2.3 Module Exchange Program

If a defective module is clearly identified, Lexicon can usually provide a repair/exchange module within 24 hours in advance of receipt of the defective module. If a fast turnaround is required, Lexicon can ship a module by Federal Air Express or other expedited air service, resulting in

24-hour delivery if the customer is near a major airport. For this service, the customer is expected to pay shipping charges.

IMPORTANT: When shipping a module for repair or exchange, always call Lexicon before packaging it for shipment; Lexicon ships modules in reuseable static protective bags with appropriate packing materials -- use these materials or procure new materials from Lexicon. Lexicon is not liable for damage resulting from unauthorized shipping procedures.

2.4 Ordering Parts

Replacement parts can be ordered from:

Lexicon, Inc.
60 Turner Street
Waltham, MA 02154 USA
(617) 891-6790
Telex 923 468
Attn: Customer Service

2.5 Limited Warranty

Lexicon warrants each 224X to be free from defects in material and workmanship under normal use and service for one year. This warranty begins on the date of delivery to the purchaser or his authorized agent or carrier. During the warranty period, Lexicon will repair, or at its option replace, at no charge, components that prove to be defective, provided that the equipment is returned, shipping prepaid, to Lexicon's factory or designated service facility.

The warranty is null and void under the following conditions:

1. Abuse, neglect, alteration, or repair by unauthorized personnel.
2. Damage caused by improper use or operation from an incorrect power source.
3. Damage caused by accident, act of God, war, or civil insurrection.

Lexicon is not be responsible for loss or damage, direct or consequential, resulting from machine failure or the inability of the product to perform. Lexicon is not be responsible for damage or loss during shipment to or from its factory or designated service facility.

Lexicon reserves the right to make changes or improvements in the design or construction of the machine without obligation to make such changes or improvements in the purchaser's machine.

No equipment may be returned under this warranty without prior authorization from Lexicon. Shipments must be packed in authorized Lexicon packing material, fully insured, and prepaid.

This warranty is in lieu of all other warranties, expressed or implied, and of any other liabilities on Lexicon's part; in addition, Lexicon does not assume or authorize anyone to make any warranty or assume any liability not strictly in accordance with the above.

3 THEORY OF OPERATION

3.1 System Overview

As shown in Fig. 3.1, the 224X is divided into 11 major functional modules:

1 Control Head
2 Transition
3 Single-Board Computer (SBC)
4 Nonvolatile Storage (NVS)
5 Timing and Control (T&C)
6 Data Memory (DMEM)
7 Arithmetic Unit (ARU)
8 Floating Point Converter (FPC)
9 Audio Input (AIN)
10 Audio Output (AOUT)
11 Power Supplies (PS1, PS2, and PS3)

Except for the control head, Transition module, and power supplies, all modules plug into an 8-slot card cage and are interconnected via a motherboard. The card cage and the power supply are contained in a mainframe. The control head is connected to the mainframe by a 25-conductor cable. The Timing and Control (T&C), Data Memory (DMEM), and Arithmetic Unit (ARU) modules comprise a dedicated, 293-ns-cycle, microprogrammed digital signal processor (DSP).

During normal operation, signal flow begins with the two audio input channels. The Audio Input (AIN) module filters, samples, and digitizes analog audio signals into 14-bit floating point representations (12-bit mantissa, 2-bit exponent). These floating point representations are then converted into 16-bit fixed-point two's complement numbers by the Floating Point Converter (FPC) module. The DSP processes this information and generates up to four independent channels of output data. This processed data is passed back to the FPC module, which reconverts it into floating point form. To generate the audio output, the Audio Output (AOUT) module reconstitutes four analog signals from the digital data stream.

The Single Board Computer (SBC) module is a controller that interfaces the control head to the DSP. The microprocessor (an 8080) on the SBC module scans the switches and pots on the control head and drives the control head displays. It processes the information received from the control head and changes the program running in the DSP. In addition, the SBC module performs various housekeeping tasks, such as power-up diagnostics and storing and retrieving nonvolatile user setups from the Nonvolatile Storage (NVS) module.

3.2 Control Head and Transition Module

The control head contains the switches and slide pots that allow a user to modify the control parameters of the reverberation and effects programs and control program access. In addition, the control head displays program and input signal level information.

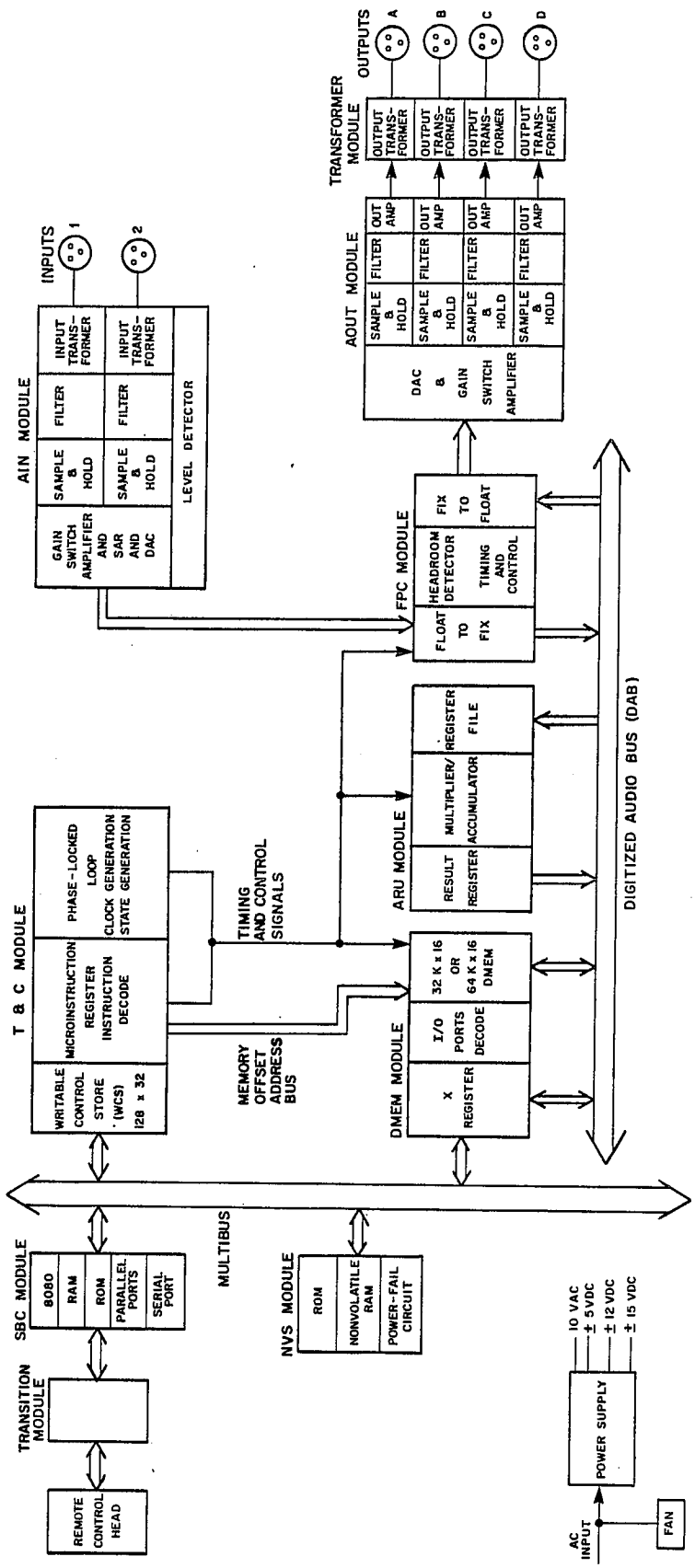


Fig. 3.1. Detailed Block Diagram -- 224X.

The control head consists of two board assemblies connected by a 27-pin flexible cable. The display and pushbutton board has three diodes, eight current-limiting resistors, switches, and LED displays. The second board contains all the remaining electronics, including the slidepots, and a 25-pin I/O connector. The I/O connector has 14 signal wires and two power wires. The rest of the 25 lines are used for digital and chassis ground returns. Ground returns are inserted between signal lines to prevent signal interference. The 14 signal wires connecting the control head to the mainframe consist of three groups of signals from three I/O ports on the SBC module: eight lines from port A form a bidirectional data bus; four lines from port B form a 4-bit address; two lines from port C serve as control signals. Table 3.1 lists the cable and connector wiring runs and tie points between the control head and the SBC module.

Table 3.1. Control Head to Mainframe Wiring.

25-pin Connector (Control Head to Mainframe)	50-pin Connector (Transition to SBC Module)	Function Name
1	2	GND
2	1	PB3
3	3	PB2
4	5	PB1
5	7	PB0
6	4, 6, 8	GND
7	*	GND (Chassis)
8	20	GND
9	21, 29	PC1
10	30	GND
11	25	PC0
12	26	GND
13	33	PA7
14	35	PA6
15	37	PA5
16	39	PA4
17	47	PA3
18	45	PA2
19	41	PA1
20	43	PA0
21	34, 36, 38, 40, 42, 44, 46, 48	GND
22	**	AC1
23	**	AC1
24	**	AC2
25	**	AC2

* Connected to chassis, not to SBC module.
** Connected to 10-Vac secondary, not to SBC module.

The control head interfaces with the SBC module through a 25-pin cable, with a transition at the mainframe to a 50-pin cable: this cable, in turn, connects to the J1 edge connector on the SBC module. The transition from 25 to 50 conductors is made through the Transition module, which is also used as an input point for the AC power to the control head, or 10-Vac power supply generated from a separate secondary of the power transformer. The 10-Vac power supply is fused to protect against cable shorts or similar faulty conditions.

Power Supply. The power supply for the control head consists of a full-wave bridge with filter and a 5-V 7805 regulator. The unregulated dc supply directly powers the LED displays.

Rectification at the control head allows power transmission to the control head without IR voltage drop in the ground returns, because a voltage drop in the ground returns would degrade noise margins and increase noise spikes in the logic signals.

Display Section. The display section is based on a scanned display concept in which all digits share a common segment drive. All digits use a common anode, and current flows through digit segments only if the cathode for that digit is grounded. The display and data transfer sections of the control head use as few interconnection wires as possible. The segment data comes out on port A; the 4-bit address selecting the digit comes out on port B; the control signals come out on port C.

The display cycle is controlled by software. At the end of a cycle, the eight lines of port A are used to send pot or switch data back to the SBC module. Addresses for the switches and pots are the same as for the respective digit just used during a display cycle. Table 3.2 lists the various display and read-back device addresses. The command sequences used are as follows:

```
ACTION

Load Digit, Port B
Load Segments, Port A
Set PC2/ (ACK/)
Set PC0 (STCONV)
Clear PC0
.
Delay Approximately 500 us
.
Clear PC2/
Set PC1/ (Read Enable)
.
Delay 12 us
Read Data
Clear PC1/
.
.
Select Next Digit
Repeat Sequence
```

Table 3.2. Control Head Displays, Pots, and Pushbuttons.

	Port B 4-Bit Addresses																	
	0		1		2		3		4		5		6		7		8	
	0000		0001		0010		0011		0100		0101		0110		0111		1000	
Port A 8-bit data bus	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read
	Digit 0	Bass-Pot	Digit 1	Mid	Digit 2	Cross-over	LEDs	Treble Decay	LEDs	Depth	LEDs	Pre-Delay	LEDs	Push-button	LEDs	Push-button		Push-button
PA0	SEG a	LSB	SEG a	LSB	SEG a	LSB	PROG 1	LSB	IMED	LSB	SEC	LSB	L 0dB	PROG 1	R 0dB	IMED	---	BASS
PA1	SEG b		SEG b		SEG b		PROG 2		SET		MS		L 6dB	PROG 2	R 6dB	SET	---	MID
PA2	SEG c		SEG c		SEG c		PROG 3		CALL		Hz		L 12dB	PROG 3	R 12dB	CALL	---	CROSS-OVER
PA3	SEG d		SEG d		SEG d		PROG 4		SHIFT		kHz		L 18dB	PROG 4	R 18dB	SHIFT	---	TREBLE
PA4	SEG e		SEG e		SEG e		PROG 5		REG A		OVFL		L 24dB	PROG 5	R 24dB	REG A	---	DEPTH
PA5	SEG f		SEG f		SEG f		PROG 6		REG B		---		BASS-POT	PROG 6	TREBLE DECAY	REG B	---	PRE-DELAY
PA6	SEG g		SEG g		SEG g		PROG 7		REG C		---		MID POT	PROG 7	DEPTH	REG C	---	---
PA7	DP	MSB	DP	MSB	DP	MSB	PROG 8	MSB	REG D	MSB	---	MSB	CROSS-OVER	PROG 8	PRE-DELAY	REG D	---	---

A 74LS42 4-to-10 line decoder, controlling 75376 high-current drivers, selects digits. The LEDs are arranged into eight digits: 0, 1, and 2 correspond to the three 7-segment displays, and 3 to 9 are groupings of the various discrete LEDs on the panel. Refer to the schematics for details. 75327 driver arrays, current-limited with 150-ohm resistors, provide segment drive. The RDENB/ signal disables segment drive when pot or switch data is to be transmitted over the eight data lines.

Each time a display cycle is begun, a one-shot U2 fires to start the 75326 drivers for a period of several microseconds. If the SBC module becomes hung up in an unresolved operation, the one-shot times out, turning off all displays to prevent sustained high current (50 mA) from being drawn to any LED. The LEDs can run at high currents for only brief periods.

Slidepot Digitization. The control head uses an ADC-0817, which is a complete A/D subsystem capable of scanning up to 16 inputs and converting each input amplitude to an 8-bit binary code representation. A clock source, a start conversion pulse, and addresses are the only inputs. The ADC-0817 is used in a ratiometric configuration -- that is, the pot terminals and chip +REF (pin 19) are tied to 5 V, and the low terminals and ground (0 V) are tied to -REF (pin 23). The pots represent the complete range from -REF to +REF as a linear function of the position of the slidepots. The ADC translates this to 0000 0000 - 1111 1111 codes.

The start conversion pulse (STCONV) is filtered for noise rejection and routed to the start-convert and address-latch inputs of the ADC. The ADC synchronizes this command to its free-running input clock and begins a conversion cycle. Within 64 clock cycles, or 128 us, assuming a 500-kHz clock, the ADC-0817 completes the conversion and outputs the result at tristate outputs. An internal analog multiplexer selects the desired pot.

The clock to the ADC-0817 A/D converter is generated by a CMOS/RC free-running square-wave oscillator running at a nominal 500 kHz $\pm$150 kHz ($\pm$30%). The actual conversion time ranges from 70 to 130 us. When RDENB/ is LOW and the digit address is 0 through 5, data from the ADC-0817 outputs is gated onto the PA0-7 data bus. A tristate LS244 is used for this function.

Switch Data. The switches are all normally open pushbuttons arranged in three banks corresponding to digits 6 to 8. Germanium diodes 1N283 are used to isolate each bank or column of switches if more than one pushbutton is pressed at the same time.

The banks are wired into rows assigned to data lines PA0-7. Pull-up resistors ensure proper threshold for the tristate buffers. A complete bank or column of switches can be read when RDENB/ is LOW and the bank's digit line is selected. Any pushbutton pressed corresponds to data out onto the bus as a TTL logic "0". Refer to the schematics or Table 3.2 for details of pushbutton and pot assignments.

3.3 Single-Board Computer (SBC) Module

The SBC module is a National Semiconductor BLC-11 (or equivalent) using an 8080 microprocessor. It also includes 1K bytes of RAM at hexadecimal addresses 3C00 to 3FFF and supports four 5-V 2716 ROMs to provide a total of 8K bytes of ROM at hexadecimal addresses 0 to 1FFF.

The SBC module controls all functions of the control head, such as reading switches and slide pots, as well as data display. Its ROMs also contain the reverberation and effects software, which controls the DSP. The multibus provides the pathway for interaction between the SBC and the DSP. The software can be updated and expanded simply by replacing ROMs. The SBC module has three parallel ports and one serial port. The serial port is normally not used, but it has been configured as an RS-232 data set at 4800 baud (settable from 110 to 9600 baud).

Parallel port A is a bidirectional port and is used in mode 2. Parallel port B is used in mode 0 and provides four output bits used as an address to the control head. Parallel port C provides both control bits for port A and the control head.

3.4 Nonvolatile Storage (NVS) Module

The NVS module (sometimes referred to as the memory expansion module) provides nonvolatile memory consisting of (1) battery-backed-up RAM for the 36 user storage registers that hold customized reverberation and effects program variations, and (2) ROM storage expansion for the reverberation and effects software. The NVS module is contained on a single multibus-compatible board that plugs into the OPTION slot on the 224X card cage.

A NiCad battery backup powers the RAM of the NVS module to preserve the memory contents after power has been shut off. The RAM consists of four 1K x 4-bit RAMs (U5, U6, U12, U13) for a total of 2K bytes. It resides in memory address from hexadecimal 2000 to 27FF. The battery backup can protect the memory contents for as long as three months without recharging. All control head settings and register stores can be saved. The batteries are maintained at full charge by a trickle charger that operates when the 224X is turned on. The charger consists of a 78L05 that regulates the +12-V supply down to +5 V plus a diode drop. This voltage powers the battery supply Vbb via CR1 when power is on. The battery is charged via R16, a 270-ohm resistor. The batteries are fully charged after power has been on for 20 hours. An on-board detection circuit monitors the ac mains power and places the memory in protected store mode when a power outage is detected.

The 10-Vac power supply is conditioned to a TTL-compatible level to trigger the one-shot U21. Under normal power-up, the one-shots are continuously triggered, thus disabling the power-fail signal PFAIL. When a power failure occurs, the one-shot is not triggered and PFAIL will be activated. When PFAIL is activated, the write signals to the nonvolatile RAMs are disabled, preventing any accidental erasure to the contents. Part of the power fail circuitry is powered from the battery voltage Vbb to prevent any unpredictable behavior at power fail.

The ROM section of the NVS module has sockets for eight 2732-type 4K x 8 ROMs for storage of reverberation and effects software. The ROM resides in memory address from hexadecimal 8000 to FFFE. Memory location FFFF is mapped to a 4-position dip switch. (Thus the last byte in the last ROM cannot be read by the microprocessor.)

The dip switch may be preset to one of 16 code combinations, corresponding to 15 registers. The software reads the switch setting upon power-up to determine which register, if any, has been selected. By changing the switch settings, the 224X can power up with a predetermined program setup.

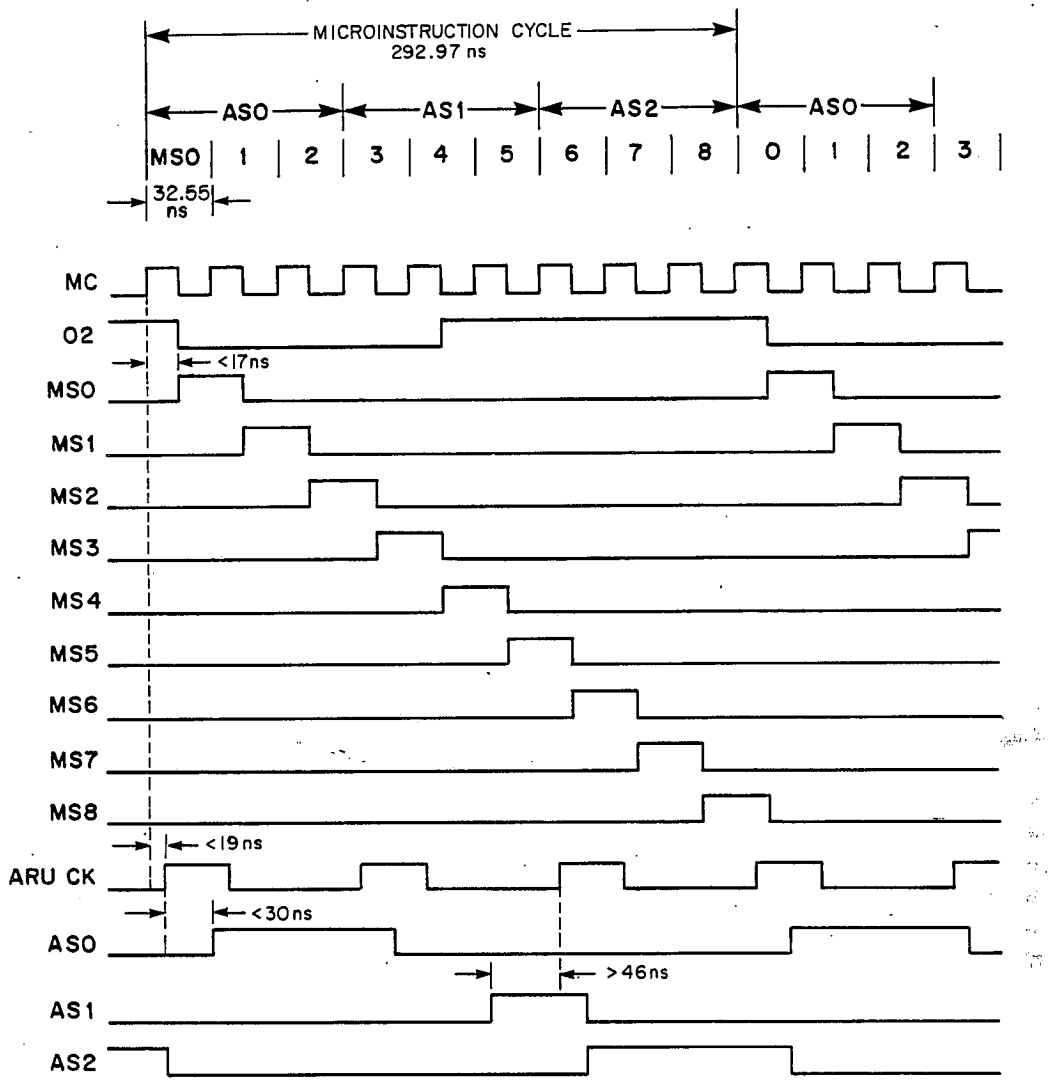
3.5 Timing and Control (T&C) Module

The T&C module contains the clock and state generation circuitry, 512 bytes of microprogram memory, an interface between the SBC module and the microprogram memory, and microinstruction decode and control signal generation logic.

The clock generation circuitry on the T&C module is synchronized to the SBC module by a phase lock loop. 02/ is the clock signal generated by the SBC module, running at 2.048 MHz. An MC4044, U27, forms the phase comparator and the low pass filter. The voltage controlled oscillator is formed by an LC tank oscillator, with a varactor, CR1, for voltage control. A divide-by-15 counter, U41, is embedded in the phase lock loop, making it a frequency multiplier of 15. Thus the master clock, MC, runs at 30.72 MHz. Since the LC tank oscillator output is divided by 2 by a J-K flip-flop, U26, to become MC, the oscillator actually runs at 61.44 MHz. This clock can be observed at TP2 (OSC). MC is driven from a Schottky nand gate, U40, with an active pull-up, Q3.

The state generation circuitry consists of a divide-by-9 counter, U56, and an 8-bit shift register U39. Thus the system clock period is at 3.41 MHz, i.e., 293 ns, which is divided into nine time slots, MS0-MS8. These nine time slots are grouped into three, AS0, AS1, and AS2 by U38, U25, and U23. Refer to Fig. 3.2 for the basic timing of the T&C module.

The control signal generation is achieved through a writable control store (WCS), formed by four 128 x 8 static RAMs (U2, U15, U29, U43). The WCS is cycled by an eight bit program counter (U1, U14). A 100-step control program is allowed, giving a sampling rate of 34.13 kHz. Thus the counter is normally reset at count 99 by a RESET signal that is generated by the WCS itself. The WCS program is loaded from the SBC module. Thus the address from the counter is multiplexed with the address from the SBC module. The bidirectional data bus to the WCS is buffered by bidirectional drivers, U3, U16, U30, U44, to the SBC module.



NOTES:
ARU OPERATES ON A CLOCK THAT CAN LAG MC BY <19ns.
AS1 IS SHORTER THAN EITHER ASO OR AS2 TO AVOID MS4 CLEARING ASO PREMATURELY.

Fig. 3.2. T&C Module Timing.

The least significant 16 bits of the WCS word are normally used as an address for the data memory. The remaining 16 bits contain the multiplier coefficient, the register file addresses, and miscellaneous control signals. They are clocked by a 32-bit microinstruction register, U4, U5, U17, U18, U31, U45. The upper 16 bits of the microinstruction register are formed by 74S163 counters for the synchronous clear functions that they provide. The upper 16 bits of the microinstruction register are cleared whenever the cycle is used by the SBC module in accessing the WCS, since the data on the microinstruction bus, MI0-MI31, may not be valid. The microinstruction word is set up such that all zeros correspond to a no-operation. The lower 16 bits of the microinstruction word can be "don't cares," since they represent only an address.

The remaining control signal generation circuitry consists of decoders (U47, U48, U49, U32, U34), which generate the control signals that are encoded in the instruction word; register U19, U20, which further pipelines and synchronizes the required control signals; and flip-flops U24, U22, U21, U20, which generate more complicated control signals from the basic timings MS0-MS8. The multiplier coefficient from the microinstruction word, C0/ to C5/, is serialized into an even and an odd stream, M0/ and M1/, by shift registers U10 and U11 for the serial multiplier in the ARU module.

The access to the WCS from the SBC module is decoded by U50 and synchronized by U52 and U53. Since the multibus is an asynchronous bus, an acknowledge signal to the SBC module, XACK/, is generated by U54. The WCS can be accessed from the SBC module in two modes. First, the DSP can be halted by stopping the program counter (U1, U14) by asserting HALT/. In this mode, the SBC module can read from and write to the WCS anytime. The WCS is mapped into hexadecimal address locations 4000 - 41FF of the SBC module address space. The decoder U46 decodes the least significant two bits of the address from the SBC module to select one out of the four 128 x 8 bit static RAMs and the corresponding bidirectional drivers. Alternatively, the SBC module can also access the WCS while the DSP is running, allowing it to change program characteristics on the fly. In this mode, a protect bit in the microinstruction determines when the SBC module can access the WCS. The program must be organized such that the microinstruction, which is displaced during an SBC access, is a no-operation. Normally, the SBC module only writes into the WCS in this mode, which only takes up one microinstruction time. Reading from the WCS in this mode can take up to three microinstruction times. In this mode, a flip-flop, half of U53, is used to attempt to synchronize pairs of SBC module accesses in the same sample time: an allowed access slot not utilized will disable the next access slot.

Finally, there is some diagnostic hardware included in the T&C module. Three groups of eight timing control signals can be read by the SBC module via tristate bus drivers, U6, or registers U7 and U8. The DSP is halted when these diagnostic ports are being read. In the registers U7 and U8, the signals being read are dynamic and thus need to be sampled by appropriate clocks. Note that the digital overload signal SAT is also read through one of these diagnostic ports, U8. This allows the SBC module to detect when digital overflow has occurred in the ARU module. The SAT signal is first clocked through a flip-flop. Then it triggers a one-shot since the SAT signal can be transient. When the overflow is continuous, the one-shot is not triggered. Thus the SAT signal is OR-ed with the output of the one-shot, which is then read by the SBC module. U9 forms a shift register to perform a serial-to-parallel conversion of the four serial bit streams S0, S1, M0/, M1/ to be observed. Exclusive or gates U12 minimize the hardware needed to observe the bit streams. ARUCK fires one-shot U13, the output of which drives an LED on the edge of the board. This gives a preliminary indication of whether the clock is running. Another test point TP1 is available for test synchronization purposes.

3.6 Data Memory (DMEM) Module

The DMEM module contains the data memory, control signal and address generation circuitry, the XREG (DMEM transfer register), diagnostic ports, and the 8080 port-decoding circuitry. The DMEM communicates with the rest of the system over the digitized audio bus (DAB).

The address to the data memory coming from the microinstruction is in the form of an offset relative to a current position in memory. This current position is held by a 16-bit current position counter (U51 and U65) and is normally incremented once every sampling interval. The absolute address of a memory reference is computed by subtracting the offset from the current position. A 2's complement subtraction is performed by adding the complemented 16-bit word, OFST/, to the output of the current position counter and tying the carry input of the adder (U49, U50, U63, and U64) high. A multiplexer (U18 and U36) is used to multiplex the resulting address onto the eight address lines of the 64k dynamic RAMs. The circuitry is set up such that either one bank of 64k dynamic RAMs or two banks of 16k dynamic RAMs can be used. The address and control lines of all the RAMs are tied together. Because the RAM outputs are capable of fanning out to ten low-power Schottky TTL loads, they are tied directly to the DAB without buffering.

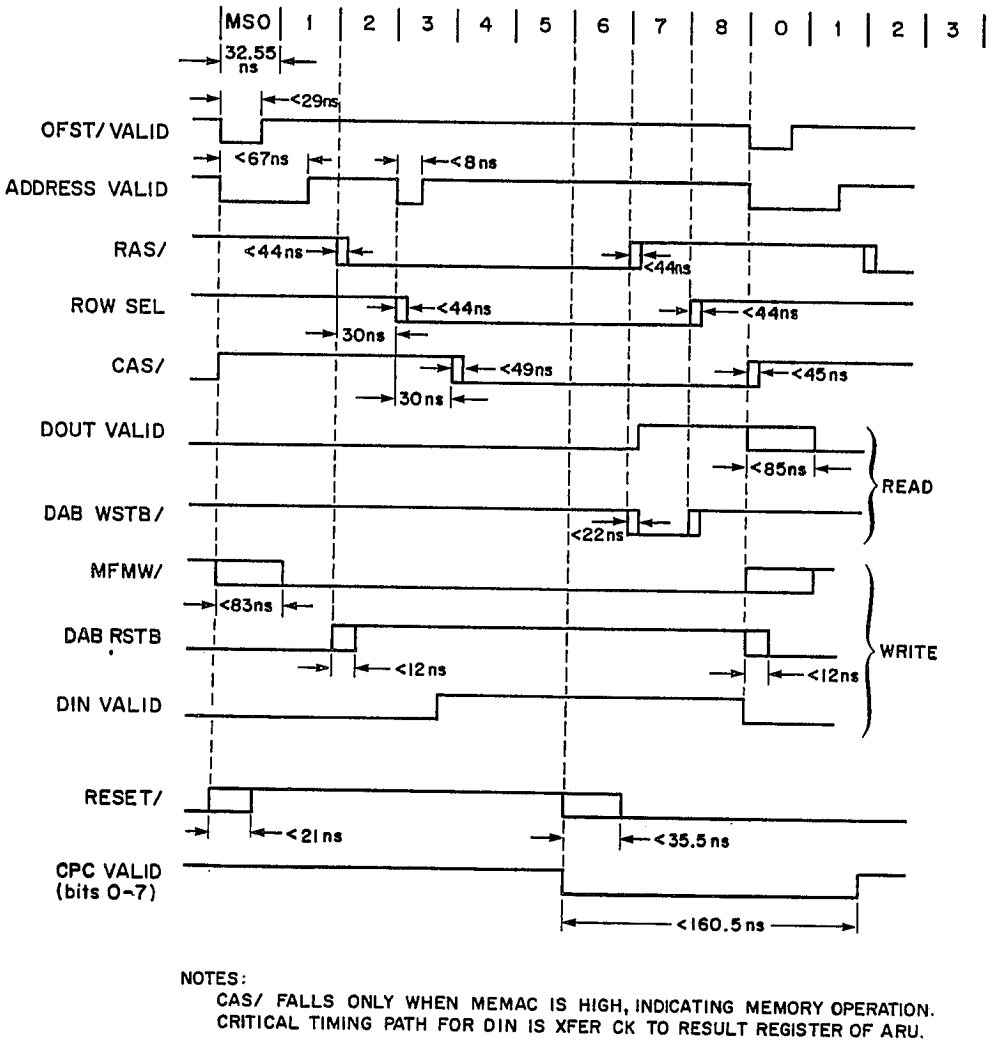
The timing and control signals for the DMEM modules are generated by a delay-line circuit (U59) based on signals supplied by the T&C module MEMAC, DABSTB, and MEMR. Refer to Figure 3.3 for the data memory timing.

In addition to the data memory circuitry, the DMEM module also contains some decoders (U55, U56, U57) which are used to generate the strobes used in the I/O access of the ports used in various modules in the DSP from the SBC module. The open collector-gate U52 is used to return an acknowledge, XACK/ to the SBC module after an I/O access. The NAND gates U53 and U54 are used to implement the single cycle/halt/run control modes of the DSP.

The module can single cycle, halt, or let continue run the DSP through accessing these latches via the I/O ports.

Some diagnostic circuitry is also included on the DMEM module. The tristate bus drivers U48 and U62 are used to enable the SBC module to read the OFST/ lines when they are static. U42 forms the bus test register, which enables the SBC module to sample and read its own data bus DATA/ on the DMEM module. U38, U39, U40, and U41 form the X register, which enables the SBC module to read from and write to the DAB.

U38 and U40 are used to send data from the DAB to the SBC module and U39 and U41 are used to send data from the SBC module to the DAB.



NOTES:
CAS/ FALLS ONLY WHEN MEMAC IS HIGH, INDICATING MEMORY OPERATION.
CRITICAL TIMING PATH FOR DIN IS XFER CK TO RESULT REGISTER OF ARU.

Fig. 3.3. DMEM Timing.

3.7 Arithmetic Unit (ARU) Module

The ARU consists of a 4 x 16-bit register file, a 16 x 6-bit 2's complement multiplier with saturation logic, a 20-bit accumulator, and a 16-bit result register. The 4 x 16-bit register file acts as a temporary store for the multiplicands taken from the DAB. The source of the multiplicand can thus be from the FPC module, DMEM module, the SBC module via the X registers on the DMEM module or even from the result register. The multiplier performs a 16 x 6-bit multiply and accumulate every system clock time (i.e., 293 ns). The 6-bit multiplier coefficient and the control signals to the multiplier are generated from the T&C module. The result register acts as a buffer between the outputs of the multiplier and the DAB, allowing the multiplier to perform the next multiplication without having to wait for its previous result to be read by the other parties on the DAB. In a similar manner, other parts on the ARU are pipelined to maximize the operating speed of the essentially serial multiplier through the register file, the partial product register, and the accumulator.

The 4 x 16-bit register file (U29, U30, U31, U32) has independent write addresses (WA0, WA1) and read addresses (RA0, RA1), which are controlled by the microinstruction. In this way, data on the DAB can be written into the register file at one address while data at another address can be read by the multiplier. Note that the write signal to the register, DAB WSTB/, is active every system clock time (293 ns) although the data on the DAB is not always relevant. Address 3 in the register file is used as a pass-through location in these instances.

The multiplier is implemented by a modified shift and add serial multiply technique. Instead of the normal shift and add, two shifts and adds are performed at the same time such that the multiply is twice as fast. A system cycle time (293 ns) is divided into three ARU states: AS0, AS1, and AS2. During each of these states, a double shift and add is performed. This gives a 6-bit multiply in a system cycle time. The double shift is performed by a "dual rank" shift register (one which shifts by two bits at a time) (U3, U4, U15, U16, U17, and U18). The double shift is performed by interleaving the bits to two sets of the shift register: U4, U18, and U15 form one shift register that receives the even-numbered bits, and U3, U17, and U16 form another register that receives the odd-numbered bits. In the first ARU state, AS0, the contents of the register file are simply loaded into the shift register. The output of the shift register is split into two groups: one is the direct output and the other the output shifted right by one bit. Depending on the 6-bit multiplier coefficient from the microinstruction, which is serialized into bit streams M0/ and M1/ in the T&C module, these two are blanked or added to the other (by the nand gates U14, U26, U27, U28, U40, U41, U50, U51, U52, and U53). The result is loaded into the partial product register (U10, U11, U12). Note that the adder forming the partial products is used as a negative logic adder because the nand gates provide an inversion, and the carry input of the adder is tied high. This inversion is taken into account by the following stage of exclusive or gates.

The partial product register acts as a pipeline register for the second stage of addition. As the double shift and add circuit previously described proceeds to perform another double shift and add in the second ARU state, AS1, the partial product is added to the accumulator. The outputs of the partial product register are passed through a set of exclusive or gates (U5, U6, U7, U8, and U9) controlled by the sign bit of the multiply CSIGN/. Depending on the logic state of CSIGN/, the data can be negated by inverting the data and tying high the carry input of the adder that follows. U19, U20, U21, U22, and U23 form the adder that adds the partial product to the accumulator.

Overflow in the ARU has to be handled properly. In this system, saturation arithmetic is performed. In the event of a positive or negative overflow, the most positive number or the most negative number is forced in place of the overflow number. This is implemented by the most significant two bits in the 20-bit data path within the multiplier. It should be noted that, in forming the 20-bit word to the multiplier from the 16-bit data from the register file, the most significant bit of the 16-bit word is the two most significant bits in the 20-bit word and the

least significant three bits of the 20-bit word are tied to zero. Thus, the most significant two bits of the 20-bit word should always be the same unless an overflow has occurred. This condition is detected by exclusive or gate U42. This would force the multiplexors (U33, U34, U35, U36, and U37) to select either the most positive or the most negative numbers, depending on the MSB of the overflow number. The accumulator is formed by 4-bit counters 74LS163s (U45, U46, U47, U48, and U49). The counting function is not used, however; only the synchronous load and clear functions are used.

Because of pipelining, the final result of the multiply and accumulate does not become available until the very end of AS0 of the next system cycle. If a transfer to the result register command is present in the microinstruction, the result register is loaded at this time by XFER CK. If the zero accumulator command is given, the accumulator is also cleared at this instant. Refer to Fig. 3.4 for the ARU module timing.

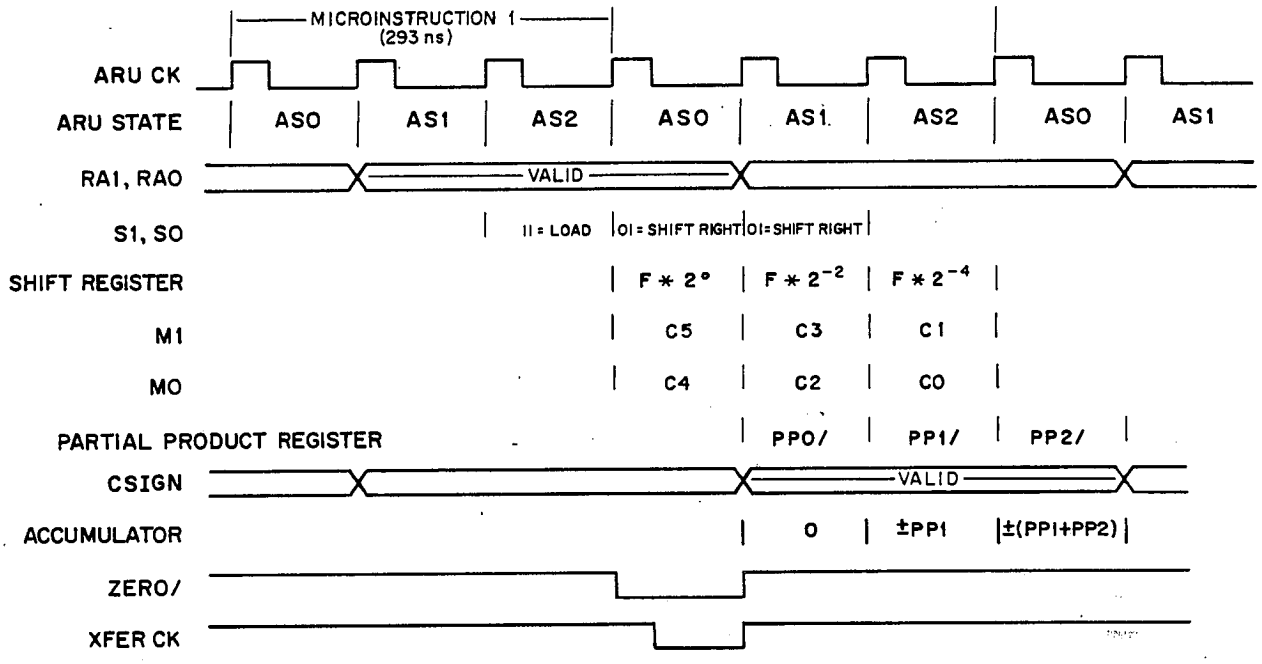
3.8 Floating Point Converter (FPC) Module

The FPC module serves as an interface between the DSP and the two analog modules: AIN and AOUT. For the DSP, the analog I/O looks simply like another device that can be read from and written into via the DAB. For the analog modules, the FPC module is the source of the timing strobes and clocks that direct the A/D and D/A conversion processes. In addition, the FPC module is responsible for making the floating point/fixed-point translation required for communication between the two analog modules and the DAB.

The FPC module has four major functions:

1. Timing and control generation
2. Input floating-to-fixed-point conversion
3. Output fixed-to-floating-point conversion
4. Headroom level indication.

Timing and Control Generation Circuitry. Besides supplying its own timing and control signals, the FPC module generates the timing and control signals for the analog modules. It generates these signals based on several signals from the T&C module: FPC CK, which occurs every system clock time (293 ns), provides the basic clock; RESET/, which occurs every sample time (29.3 ns), synchronizes the timing cycles; RD AD/ and WR DA/, which control the reading from and writing to the floating-to-fixed-point circuitry. The timing and control signals are generated by an 8-bit input cycle counter (U7 and U8), which drives a 256- x 4-bit ROM (U6). Some of the outputs of the ROM are deglitched by a register (U18), and some are directly used as timing and control signals. Because 100 system clock times occur in each sample time, only the first 100 locations of the ROM are used.



NOTES:
1. MICROINSTRUCTION 1 HAS ZERO/ AND XFER/ BITS ASSERTED.
ONLY ACTIONS RESULTING FROM MICROINSTRUCTION 1 ARE SHOWN.

Fig. 3.4. ARU Module Timing.

Two multiplexors (U4 and U42) implement a self-test mode in which the FPC CK signal is replaced by 02/, the SBC system clock (488 ns) and the RESET/, RD AD/, WR DA/, and the output channel select signals SDAA, SDAB< SDAC< SDAD, are substituted by signals decoded from the counter by nand gates (U5).

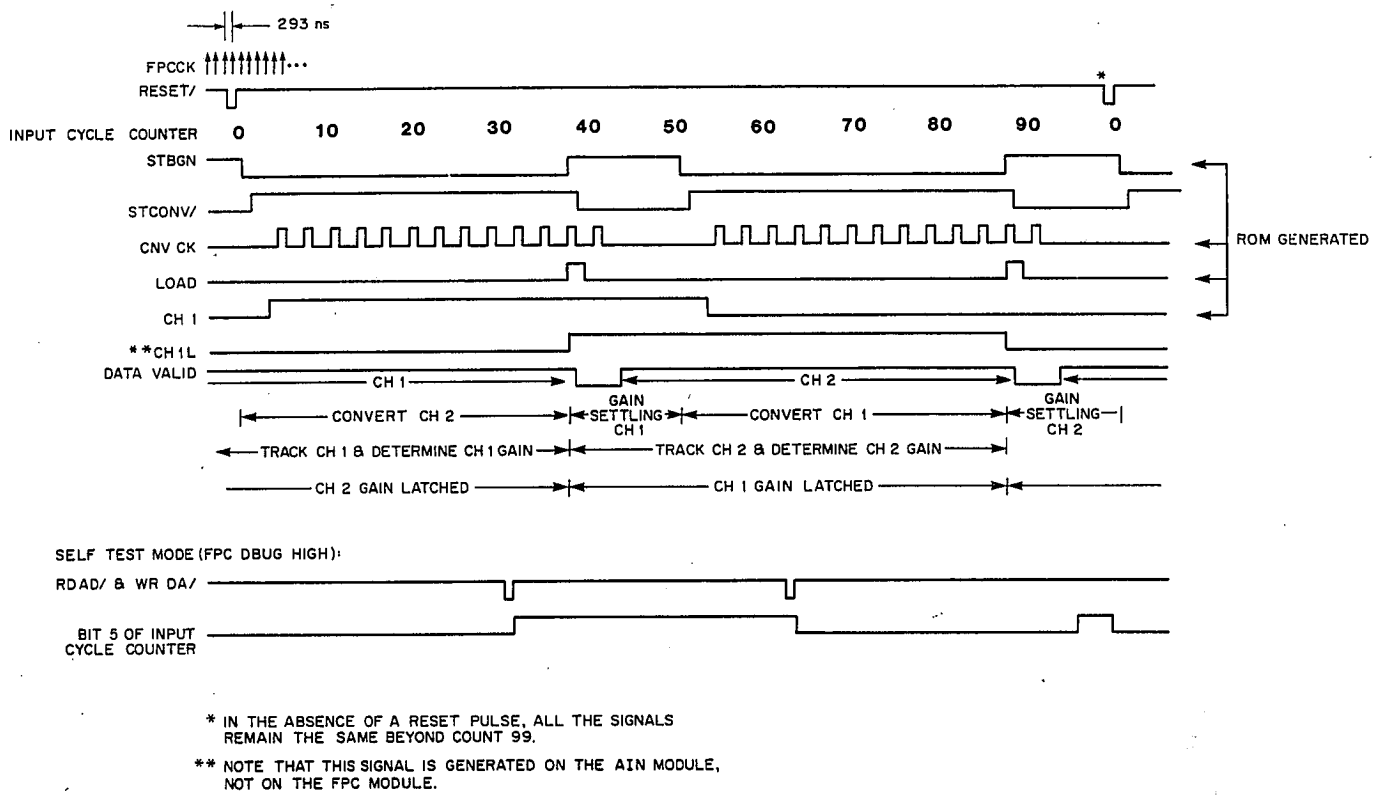
The select signal to the multiplexors, FPC DBUG, is tied low in the T&C, ARU, and DMEM modules. Thus, when these modules are removed, the FPC DBUG signal floats high and the self-test mode is automatically activated. In the self-test mode, the only external signal needed is the 02/ clock. The input from the left channel is immediately transmitted to the output channels A and B via the FPC module. Similarly, the right channel is transmitted to channels C and D. In this way, the FPC, the AIN, and the AOUT modules can be checked independently of the DSP. However, in using the 02/ signal from the SBC module, the sampling frequency changes from 34.13 kHz to 20.48 kHz. To obtain the correct sampling rate, the SBC module must be removed also and a 3.413-MHz TTL-compatible input clock must be supplied to pin A28 of the backplane connector using a signal generator.

Input Floating-to-Fixed Point Conversion Circuitry. At the beginning of a sample cycle (starting with state 0 of the input cycle counter), the successive approximation register (SAR) on the AIN module is instructed to start an input conversion by bringing STCONV/ signal high and sending thirteen clock pulses on the CNVCK signal. Just after the twelfth clock pulse, the SAR contains valid input data. The LOAD signal to the shift registers (U27, U28, U38, and U39) is then brought high, loading the input data into the shift registers. STCONV/ is brought low again and the thirteenth clock pulse on the CNVCK resets the SAR, readying it for the next conversion.

Shift register U27, U28, U38, and U39 and counter U16 perform the floating-point-to-fixed-point conversion. Note that the LOAD signal is asserted for two clock pulses. The first clock pulse loads the input gain counter, U16, with the input gain bits IGA1 and IGA0. Because a one is also loaded into bit 2 of the input gain counter (U16 pin 12), which is connected to the S1 input of the shift register, both S1 and S0 of the shift register are high for the second clock pulse, causing it to load the 12 bits from the SAR. When LOAD returns low, the input gain counter counts up, and the shift register shifts left until QC QB QA = 000. Gain bits of 00 result in four shifts; 01 results in three shifts; 10 in two shifts; and 11 in one shift. By the fourth clock pulse following the falling edge of LOAD, the Channel 2 conversion is complete. Tristate drivers U25 and U26 enable this data onto the DAB when the DSP asserts the RD AD/ line. Meanwhile, CH1L (a signal derived from CH1 on the AIN module) goes high, causing an input channel switch. A similar conversion for Channel 1 takes place during the second half of the input conversion cycle. Refer to Fig. 3.5 for the floating-to-fixed-point conversion and A/D conversion cycle timing.

Output Fixed-to-Floating-Point Conversion Circuitry. The 4-bit register, U40, and the 16-bit register, U36, U37, comprise a double buffer that stores the output channel select code, SDAA-SDAD, and the 16-bit fixed point output value from the DSP, respectively. When the DSP signals an output to the D/A by asserting WR DA/, the double buffer is loaded and NEW DAT/ (U3 pin 6) is asserted, indicating that the double buffer is full. At the next clock pulse, BUSY from the strobe counter, U1, U2, is inspected. If BUSY is high, indicating that a D/A conversion is currently taking place, nothing happens. If BUSY is low, the 16-bit data stored in the double buffer is loaded into shift register U23, U24, U34, U35; the 4-bit select code stored in the double buffer is loaded into register U41; and the flag NEW DAT/, is deasserted, indicating that the double buffer is ready for the next output value. NOR gate U14 pin 1 ensures that this flag is not deasserted if the DSP reloads the double buffer, just as the old information in the double buffer is loaded into the shift registers.

When the shift register is loaded, strobe counter, U1, U2, and output gain counter U43 are loaded, initiating an output cycle. Refer to Fig. 3.6. The output gain counter counts up from zero and the shift register shifts left until NOR gate U14 pin 4 detects one of two conditions: (1) The sign bit is about to be shifted out of the shift register (that is, the two MSBs disagree). When STOP/ goes low, the fixed-to-floating-point conversion is complete. (2) The counter has incremented three times.



* IN THE ABSENCE OF A RESET PULSE, ALL THE SIGNALS REMAIN THE SAME BEYOND COUNT 99.

** NOTE THAT THIS SIGNAL IS GENERATED ON THE AIN MODULE, NOT ON THE FPC MODULE.

Fig. 3.5. Floating-to-Fixed-Point Conversion and A/D Cycle Timing.

The two LSBs of the output gain counter are transmitted to the gain switch amplifier (GSA) on the AOUT module as output gain bits OGA1, OGA0. Meanwhile, the strobe counter has been counting up from its initially loaded value of hexadecimal 2A. After allowing enough time for the fixed-to-floating-point conversion to complete and then enough time for the GSA and D/A converter on the AOUT module to settle, flip-flop U3 pulses the multiplexor enable U42 pin 15, thereby strobing the appropriate output line OUTA-OUTD.

Headroom Level Circuitry. The headroom level information is sent to the FPC module from the AIN module, where rectifiers and comparators generate a 5-bit code representing the instantaneous levels of the analog inputs. Because this information is multiplexed between the two input channels, the FPC module demultiplexes it by clocking two headroom registers, U31, U32 and U21, U20, on opposite edges of the channel select signal, CH1. Peak detection occurs by clearing a register bit any time the corresponding headroom bit is asserted. What remains in the register, then, is the complement of the largest headroom word that has occurred since the register was initialized. The SBC module reads a headroom register by strobing either HR1/ or HR2 low, enabling the tristate drivers U19 or U30 onto the SBC module data bus. The rising edge of the strobes trigger a one-shot, which initializes the corresponding headroom register.

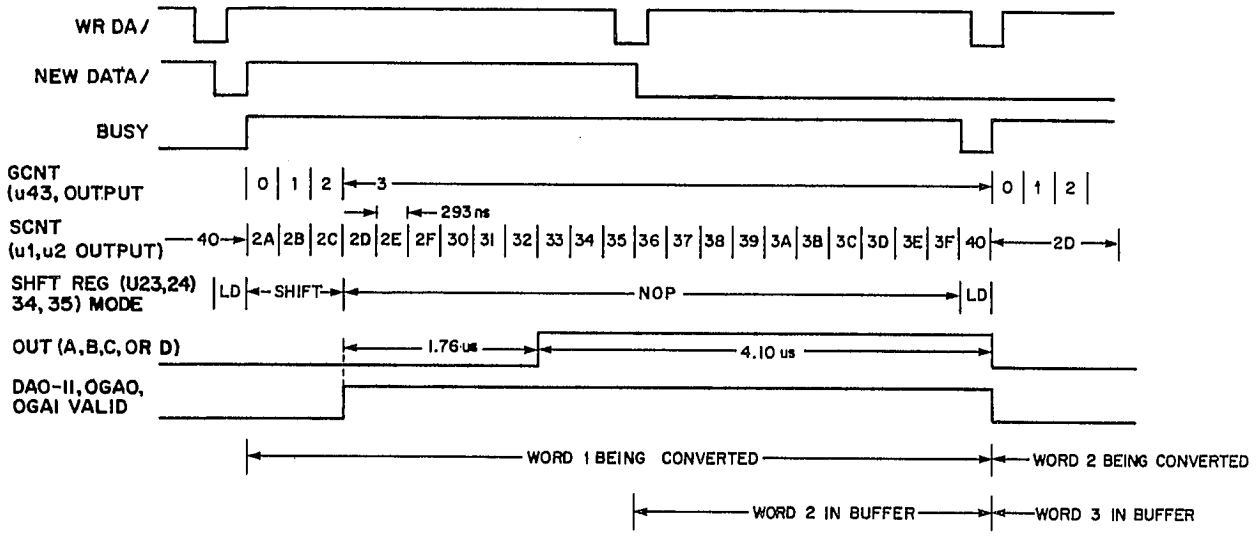


Fig. 3.6. Fixed-to-Floating-Point Conversion and D/A Cycle Timing.

3.9 Audio Input (AIN) Module

The AIN module gain conditions, filters, and digitizes two input channels of audio signals in a floating point format. The major subsections of the module are:

1. Input gain conditioning and filtering
2. Sample-and-hold and multiplexer circuits
3. Gain ranger
4. Analog-to-digital converter (ADC)

Input Gain Conditioning and Filtering. Inputs are transformer-coupled and then gain-conditioned by a buffer stage with an adjustment range of 15 dB. The nominal level at the output of buffer stage U1 is +13 dBm (5-V peak) at 1 kHz. This amplitude corresponds to the onset of clipping in the ADC. Diode clamps prevent overloading the input stage of U1.

The input filters are 7-pole active elliptical (or Cauer) networks synthesized from "FDNR" networks. The nominal cut-off frequency for the input filters is 15 kHz to prevent aliasing distortion at a sampling rate of 34.13 kHz. The next stage is a shelving preemphasis network with 50-us

and 12.5-us time constants. The last filter stage provides aperture correction to compensate for the slight amount of high-frequency loss introduced by the sampling process.

Sample-and-Hold and Multiplexer Circuits. The input sample-and-hold (S&H) circuits are designed so that when one channel is tracking, the other channel is in hold mode. Control signal CH1L places U20 in hold mode when HIGH, simultaneously placing U21 in tracking mode. Analog switch U22 is controlled by HLCH1L, an inverted and level-shifted version of CH1L. This switch is configured so that the "held" channel is commutated to the gain switch amplifier (GSA) stage.

Gain Ranger. Both filtered channels are sent to precision full-wave rectifier circuits that give a positive output equal to the peak amplitude of their inputs. The rectified output of the tracked channel is routed by analog switch U14 to an amplitude quantizer made up of five comparators biased at 5.0 V, 2.24 V, 1.12 V, 0.56 V, and 0.280 V, respectively. These thresholds are arranged so that 5 V corresponds to the onset of clipping in the ADC, and each of the lower thresholds is 6 dB apart and allows determination of the optimum gain to be used for the GSA. Table 3.3 shows how the proper gain is selected for signals of various amplitudes.

Table 3.3. Comparator Outputs Showing Selected Gains for Various Signals.

Signal	U15-13 (5.0 V)	U15-1 (2.2 V)	U15-2 (1.12 V)	U16-1 (560 mV)	U16-2 (280 mV)	GAIN A (dB)	IGA1	IGA0
>5.0 V	0	0	0	0	0	0	0*	0*
2.24-5.0 V	1	0	0	0	0	0	0	0
1.12-2.24 V	1	1	0	0	0	6	0	1
560 mV-1.12 V	1	1	1	0	0	12	1	0
280 mV-560 mV	1	1	1	1	0	18	1	1
<280 mV	1	1	1	1	1	18	1	1

*Comparator outputs are decoded and latched to provide gain-control signals IGA0 and IGA1.

The 5-V and the 280-mV comparator outputs are needed for headroom display only, while all of the additional comparators provide gain-change information as well as headroom display. A gain of 6 dB is added whenever a signal falls below 45% of the clipping level. A signal level falling to 45% of the clipping level would then be increased by a factor of two to

about 90% of clipping level to take full advantage of the ADC's usable dynamic range. The technique of gain ranging used here is commonly referred to as "instantaneous floating point conversion" -- that is, an appropriate gain is selected just before converting each sample. The gain thus follows the envelope of the converted signal.

Excellent signal reconstruction can be achieved if the ADC is properly offset to deliver a zero code for 0-V input. Good gain matching is provided by using a precision resistor network to set the gain of U23. The resistor feedback ratio is selected by analog switch U24. Because U24 conducts negligible current, errors resulting from switch resistance are also negligible. U24 also provides a decode function for gain bits HLG0 and HLG1. Voltage offset in this stage is not important, provided that it is proportional to gain. Maximum offset due to accumulated errors should never exceed 80 mV at this output stage.

Analog-To-Digital Converter. The analog-to-digital converter (ADC) is a 12-bit successive-approximation type. A 12-bit current output digital-to-analog converter (DAC) is sequenced by a successive approximation register (SAR) chip, U26. This device receives its start command (STCONV) and conversion clock (CNVCLK) from the FPC module. An LM211 comparator is used to compare the DAC's output with the input signal. The output of this comparator is used as the input to the SAR.

3.10 Audio Output (AOUT) Module

The AOUT module provides four output channels serviced from a single timeshared DAC and gain switch amplifier. The AOUT module has four major subsections:

1. Digital-to-analog converter (DAC)
2. Gain ranger
3. Demultiplexor and sample-and-hold circuits
4. Filtering and output gain conditioning

Digital-to-Analog Converter. The DAC, U2, is updated by 12-bit word DA0 to DA11. The DAC responds with an analog output in the range of -5 to +5 V.

Gain Ranger. Gain control is set by two bits, OGA1 and OGA0, which control analog switch U3. U3 selects one of four taps from precision divider network RD2. Gain selection is either 1, 1/2, 1/4, or 1/8 $\pm$0.05%. U4 operates as a high input impedance follower to prevent loading of the attenuator network.

Demultiplier and Sample-and-Hold Circuits. The corresponding channel-selection signal OUT A, B, C or D goes high approximately 1.76 us after DAC and gain data become valid. This delay allows time for the DAC and GSA to stabilize before placing the selected output sample-and-hold in the sample mode. The OUT (sample) command is valid for approximately 4.08 us. During this time, U6 switches the output gain-conditioned DAC voltage to capacitor C13, 16, 17, or 20. U7 and U8 provide high impedance buffering to prevent discharge of the sample capacitors during the hold period.

The +7- and -7-V CMOS switch bias is provided by zener diode regulators, CR5 and CR6. Power-on muting is provided by transistor Q9, which is held off for several seconds after power is applied. R159 charges a 22-uF capacitor from -7 to +7 V. Saturation of Q9 places a ground signal on pin 6 of U3, enabling U3 to pass signal.

Filtering and Output Gain Conditioning. Output deemphasis is provided by stages U13 and U21. Filtering is provided by 7-pole elliptical (Cauer) filters. Adjustments to compensate component sensitivity are provided for each section. These settings should never need adjustment if related components are not changed.

The output stage consists of a level adjustment potentiometer and an opamp stage with a complementary output transistor buffer for each channel. Overall, negative feedback is provided around the stage to maintain fixed gain and provide low distortion. A loading network is also provided to maintain high-frequency stability. Each output stage drives an output transformer on the audio transformer board at the rear of the chassis with the audio I/O connectors. The output transformer provides a voltage gain of about 2.5.

3.11 Power Supplies

The three 224X power supplies produce six regulated dc voltages and one unregulated ac voltage.

+5-V and -5-V Power Supplies. The +5-V and -5-V power supplies are derived from a single secondary winding fused in both legs by a pair of 15-amp slow-blow fuses. The +5-V power supply consists of a uA723 regulator, a current boost transistor, and a pair of high-current pass transistors. The regulator is a current foldback design that limits short-circuit currents to less than 3 A.

Over-voltage protection is provided by a crowbar circuit. The +5-V power supply is designed to provide a continuous 10 A. Both voltage and current limits are adjustable.

The -5-V power supply is a 7905 monolithic regulator fused at 2.5 A. This power supply is both current-limited and thermally protected. It is designed to provide 250 mA.

+12-V and -12-V Power Supplies. The +12-V and -12-V power supplies are derived from a single secondary fused in both legs by a pair of 3-A slow-blow fuses. The +12-V power supply consists of a LM317K monolithic voltage regulator controlled by a pair of 1% resistors. This power supply is both thermal- and current-protected, and provides 1.25 A. The -12-V power supply is derived from a 7912 monolithic voltage regulator that is both thermal- and current-protected, and provides 150 mA.

The +12-V power supply is interlocked with the -5-V power supply so that +12 V is not available until after -5 V is available. Should any problems occur with the +12-V power supply, check to be sure that the -5-V power supply is available.

+15-V and -15-V Power Supplies. The +15-V and -15-V power supplies use a tracking design that allows the -15-V power supply to track the +15-V power supply. Both are derived from a single secondary fused in both legs by a pair of 2-A slow-blow fuses. The +15-V power supply is an LM317 monolithic voltage regulator incorporating an adjustable resistor network.

The -15-V power supply is a 7912 controlled by an LM301 opamp that senses the difference between the +15-V and -15-V outputs and forces the -15-V output to track the +15-V output. A balance control is provided to trim the -15-V output. The ±15-V power supplies are not ground-referenced to the ±5-V or ±12-V power supplies unless the analog boards are installed in the 224X chassis. All voltage measurements must be referenced to the correct ground. The ±15-V power supplies provide 750 mA and are current and thermal protected.

Mains Circuit. The mains circuit for the 224X uses a dual primary transformer with 120-V and 100-V taps (a pair of DPDT switches select the operating voltage: 100, 120, 220, 240 V). This supply is switched on both sides of the line. A primary fuse is provided on the chassis ahead of the RFI filter unit. Fan power is maintained at 120 V by placing the fan across one of the 120-V primaries.

4 PERFORMANCE TESTS AND CALIBRATION

Performance tests are used to check the operation of the unit. Always execute the performance tests before proceeding to calibration.

4.1 Test Equipment Required

The following equipment is needed for performance tests and calibrations:

1. Variable ac voltage source with isolation transformer, voltmeter, and ammeter
2. Digital voltmeter (DVM)
3. Dual trace oscilloscope with >60-MHz bandwidth
4. Audio band low distortion sine wave generator with a 20-dBm maximum output
5. Harmonic distortion analyzer with level meter
6. Noise meter
7. High-quality music source
8. Lexicon-compatible footswitch and footpedal
9. Headphone amplifier and headphones
10. Cables and dip clips
11. Extender card (Lexicon no. 750-01850)
12. 1.15-ohm, 30-W resistor.

See Figs. 4.2 and 4.3 at the end of this section for interior views of the 224X mainframe.

4.2 System Tests

Diagnostics, nonvolatile storage, and listening tests. When the 224X is turned on or reset, it runs a series of diagnostic programs.

1. Make sure that the unit passes all power-up diagnostics. Repeat the diagnostics several times.
2. Store a control-head setting in a register, then leave the unit off for a while (>1 min). Turn on the unit and make sure that the setting is restored. Check to see that the contents of the register are unchanged by calling the register.
3. Using various signals from signal generators and music sources, listen carefully to all programs and variations. Make sure that there are no excess or unusual noises, birdies, or intermittents.
4. Make sure that moving or gently shaking the control head or mainframe does not affect its output.

Visual Inspection. Inspect the 224X and control head for obvious signs of physical damage. If possible, compare it with a unit operating properly. Remove the front panel of the unit and make the following checks:

1. The protective shield should be in place for the power switch and wiring.

2. The fuse ratings should be as follows:

Primary		
100/120 V	3 AG	3 A slow blow
220/240 V	3 AG	1.5 A slow blow
Secondary*		
F1, F2	±15 Vac	2 A slow blow
F3, F4	±12 Vac	3 A slow blow
F5	+10 Vac	2 A slow blow
F6, F7	±5 Vac	15 A slow blow
F8	-5 Vdc	2.5 A slow blow

*Schematic fuse no.

3. The ac voltage changeover switches should be set correctly (see Sec. 1 of Owner's Manual).
4. All jacks, pots, and switches should operate smoothly.
5. XLR connectors should be secure.
6. There should be no loose screws.
7. All ribbon cables and connectors should be secure.
8. All ICs should be securely in their sockets.
9. There should be no parts missing.

4.3 Power Supplies (PS1, PS2, and PS3)

The nominal and operating line voltages for the 224X are as follows:

Nominal (Vac)	Operating (Vac)
100	90-105
120	108-126
220	198-231
240	216-252

Measure all power supplies. Compare voltages to Table 4.1. All power supplies must provide the correct voltage; if they do not, repair and/or calibration is required.

Table 4.1. Test Point Locations for Power Supplies.

Number	Supply (Vdc)	Limits (Vdc)	Location description	Adjustment Location
1	+5	4.85 to 5.15	SBC module; U16, pin 16: left front-most IC; left front IC pin; verify left LED lit on NVS module	R7 on PS3
2	-5	-4.75 to 5.25	SBC module; J72 at the rear and right of U16**	*
3	+12	11.4 to 12.6	SBC module; R8 front lead; 2.7-Kohm, 1/4-W resistor, left of U15; verify center LED lit on NVS module	*
4	-12	-11.4 to 12.6	SBC module; R4 front lead; 270-ohm, 1/2-W resistor, right of U15	*
5	+15	14.75 to 15.25	AIN module; +15 = test point, ground to test point	R6 on PS2
6	-15	-14.75 to 15.25	AIN module; -15 = test point, ground to test point	R5 on PS2
7	+7	6.3 to 7.7	AIN module; +7 = test point, ground to test point	*
8	-7	-6.3 to 7.7	AIN module; -7 = test point, ground to test point	*
9	+7	6.3 to 7.7	AOUT module; +7 = test point, ground to test point	*
10	-7	-6.3 to 7.7	AOUT module; -7 = test point, ground to test point	*
11	10 Vac	8 to 14 Vac	Power molex connector on Transition module	*

*No adjustment.
** To access this test point, turn off the 224X and loosen the SBC module from its backplane connector, connect a test lead to the J72 test point, and then reinsert the SBC module into the backplane.

4.4 Analog Tests

Apply a 1-kHz, +12-dBm sine wave from the oscillator to both input channels. (This signal is used for standard input tests.) Run the zero-delay test program.

4.4.1 Input sensitivity

Adjust the signal generator output for +8 dBm. Advance input gain adjust pots R1 and R2 until the onset of clipping is reached (the gain pots should be close to their full clockwise rotation). Next, set the signal generator for +18 dBm and rotate the input gain pots counterclockwise (CCW) to just below the clipping level. This should be close to full CCW rotation. Design tolerances allow most machines to operate within a +7- to +22-dBm input range, even though the device is rated at +8 to +18 dBm. Adjust R1 and R2 so that the "0 dB" LED headroom indicator just goes off when the signal generator output is set at +12 dBm.

4.4.2 Output sensitivity

Check each channel for audio output. Make sure that each output can deliver +8- to +18-dBm output into a 600-ohm load by varying the output gain potentiometers; then set each output gain for an output level of +12 dBm.

4.4.3 Frequency response

Check frequency response for each output channel and compare with the frequency response curves in Fig. 4.1. Make sure that the frequency response is within system specification: ±1.5 dB from 20 Hz to 15 kHz; ±0.5 dB from 20 Hz to 12 kHz.

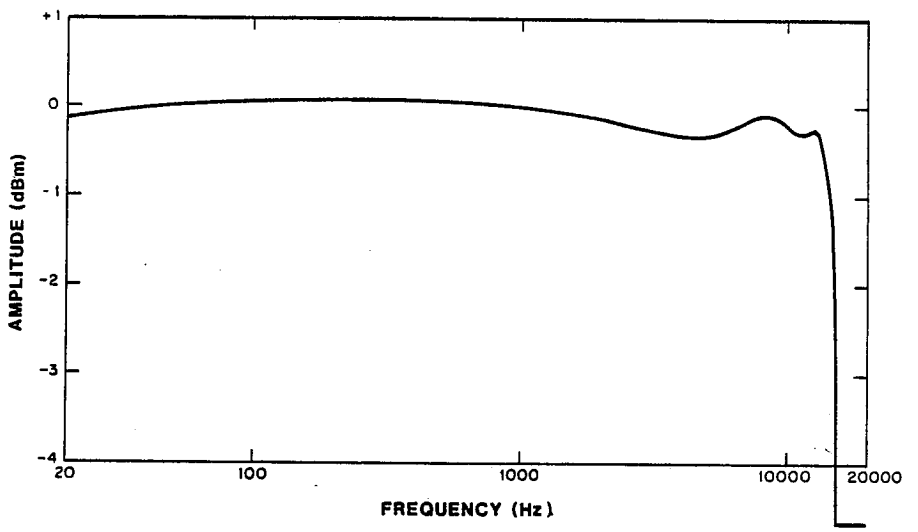


Fig. 4.1. Typical Overall System Frequency Response.

4.4.4 Total harmonic distortion (THD) and noise

THD and noise measured at 1 kHz and 10 kHz should be as follows:

Signal Level (dBm)	Frequency (kHz)	THD and Noise (%)
+12	1	<0.04
0	10	<0.50

4.4.5 Noise floor/signal-to-noise ratio

With 600-ohm loads connected to both inputs and outputs, the noise level at each output should be within the following limits:

	Wide Band (20 Hz to 20 kHz)	A-Weighted
Noise floor	<-68 dBm	<-80 dBm
Ratio relative to +12 dBm	>80 dB	>92 dB

4.4.6 Channel separation

On the left channel input, remove the signal source and connect a 600-ohm load. Apply the standard input test signal to the right channel input. Residual signal measured in output channels A and D should be 60 dB or more below +12 dBm (-48 dBm or below).

Next, remove the input signal to the right channel input and connect a 600-ohm load. Apply the standard input test signal to the left channel input. Residual signal measured in output channels B and C should be -48 dBm or below.

4.5 Calibration

Before proceeding with calibration procedures, the performance tests (Secs. 4.1 to 4.4) should be carried out to determine whether adjustments are necessary.

4.5.1 +5-V current foldback adjustment

1. Turn off the 224X and remove the NVS module from its slot (labeled OPT.).
2. Clip a 1.15-ohm 30-W resistor onto pins 1 and 3, and attach a DVM's minus lead to pin 1 and its positive lead to pin 3. Insert the extender board into the OPT. slot.
3. Turn on the unit. Adjust R11 on power supply module 3 until the meter reads approximately 3.00 V (2.8 to 3.2 V).
4. Remove the extender board and replace the NVS module.

Caution: The 1.15-ohm resistor must handle at least 30 W; it may become hot during use.

4.5.2 Phase-lock loop calibration

1. Connect channel 1 of the oscilloscope to U27 pin 3 and synchronize on channel 1.
2. Connect channel 2 of the oscilloscope to U27 pin 8 (clip on the end of R10, 1K resistor).
3. Adjust the variable capacitor C12 for a loop control voltage, U27 pin 8, of about 3.8 V.

4.5.3 Input offset calibration

Power down and carefully remove U23. Connect a jumper from pin 6 of the U23 socket (hook onto CR21 cathode) to a quiet ground (for example, low side of C73). Power up and connect one channel of the oscilloscope to U19 pin 1 (CH1L) and the other channel to U26 pin 21 (MSB of A/D word). Synchronize on CH1L (positive going) and set the oscilloscope to 5 us/DIV and 2 V/DIV on each channel. Offset (R90) should now be adjusted so that the MSB (most-significant bit) dithers between 1 and 0 with equal intensity when viewed on the oscilloscope.

Power down, remove jumper, and replace U23. This procedure ensures that the analog-to-digital converter (ADC) responds with code 1000 0000 0000 or 0111 1111 1111 for a true 0-V input. This will ensure good gain step matching during output conversion.

4.5.4 Output offset calibration

Set up mainframe with the AOUT module on an extender card. Apply a 1-kHz, +12-dBm sine wave from the oscillator to both input channels. Run the zero-delay test program. Adjust the input level potentiometers (R1 and R2) on the AIN module so that the overload indicator in the headroom display is just turned off. Measure the level of the output of Channel A. Adjust the Channel A output level potentiometer (R119) so that the output level is +12 dBm. Measure the distortion of the Channel A output. Adjust R4 for minimum distortion.

4.5.5 Output filter calibration

Each of the four output filters has three null adjustments to compensate for component sensitivity. The nulling procedure is done by removing the signals to the audio inputs and then injecting signals at various frequencies at certain points. The following procedure outlined for channel A should be executed on all four channels.

1. Apply a 22.153-kHz signal with peak amplitude of 0.5 V to the high side of R43 and adjust R19 for a null at node R20/R21.
2. Apply a 19.200-kHz signal with peak amplitude of 0.5 V to node R20/R21 and adjust R25 for a null at node R26/R27.
3. Apply a 35.850-kHz signal with peak amplitude of 0.5 V to node R26/R27 and adjust R31 for a null at node R32/R33.
4. If nulls can't be achieved, carefully examine all component values of the stage in question.

Repeat for channels B, C, and D. Refer to schematics for corresponding test points.

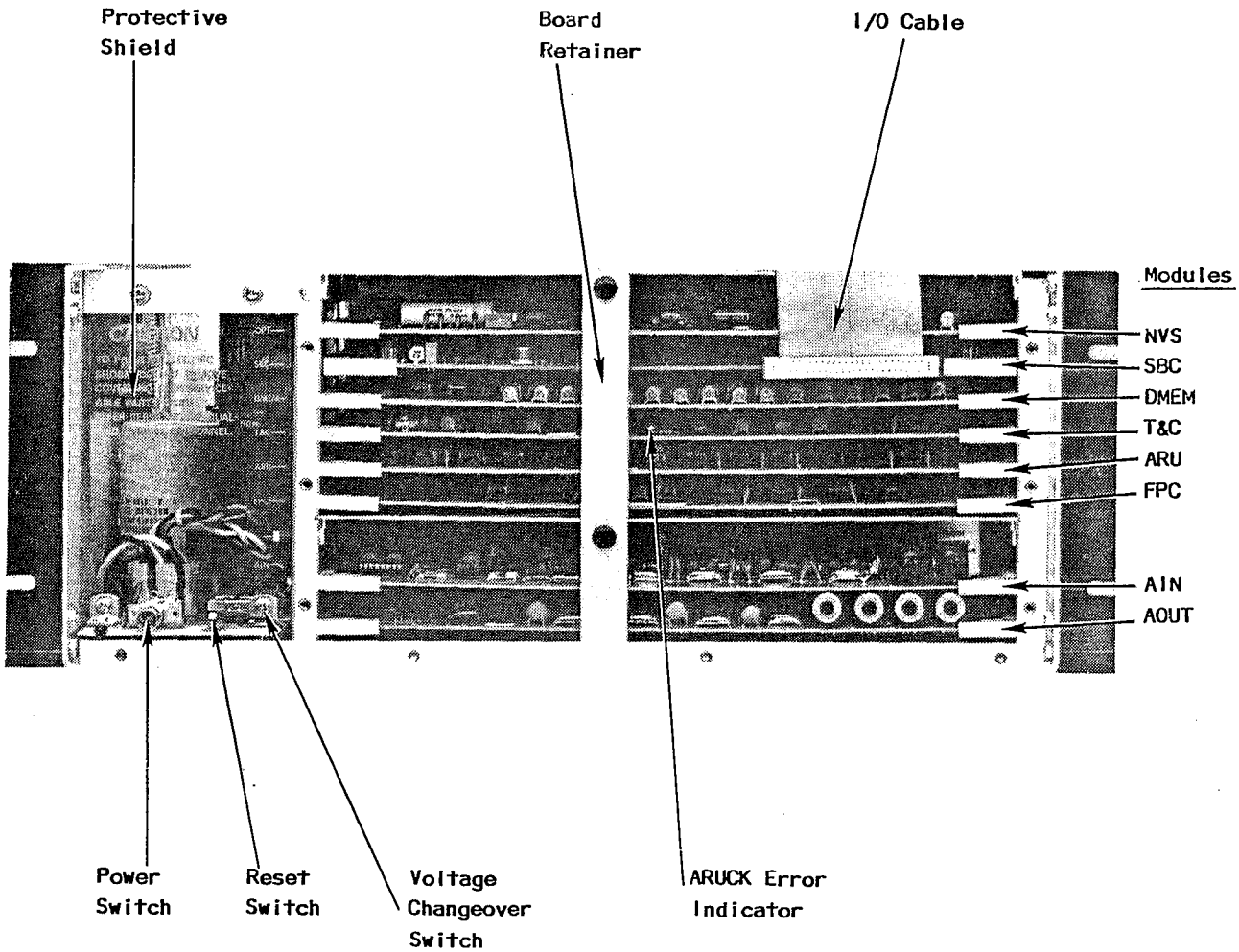


Fig. 4.2. 224X Mainframe Interior -- Front View.

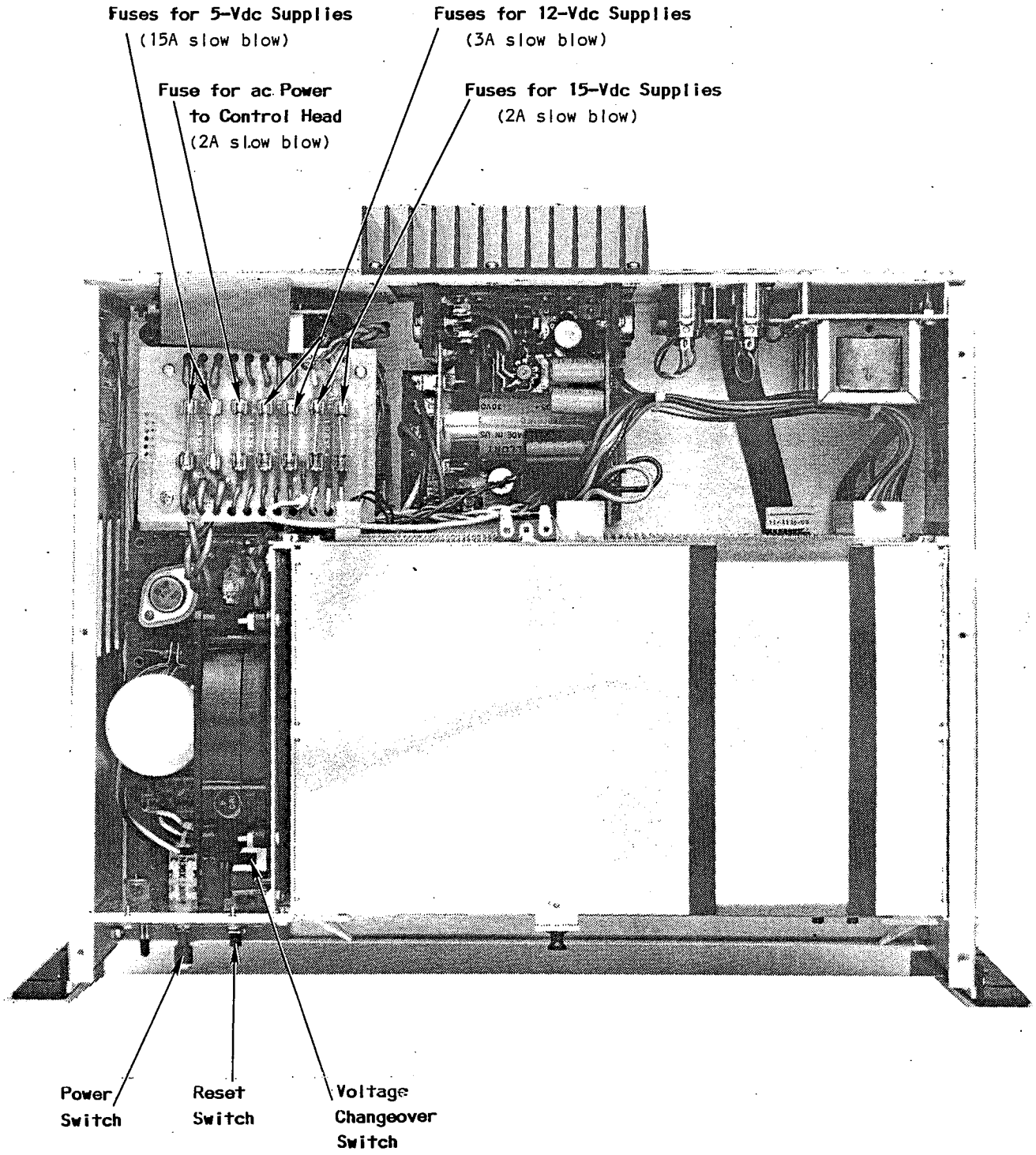


Fig. 4.3. 224X Mainframe Interior -- Top View.

5 TROUBLESHOOTING

5.1 Overall Approach

A through visual inspection of the 224X and control head is good general troubleshooting practice. Check for any obvious component failures, such as burnt or overheated parts or damaged PC board traces. There should be no loose ICs, connectors, or cables. Observe whether the malfunction is intermittent, heat related, or shock related.

Figure 5.1 shows a flow chart for troubleshooting problems in the Model 224X. As can be seen, the power-up software diagnostics are an important tool in the troubleshooting process. One of the first things to do is to see whether the unit can run the power-up diagnostics. If these diagnostics do not run, the problem probably is in the power supply module, the SBC module, or the remote control head. (Note that the power-up diagnostics will run with only these three modules in the unit.) First look at the power supplies, then check the cable to the control head. If the problem is with the control head or the connecting cable, and the mainframe is functional, the unit will eventually run one of the reverberation/effects programs (after running the power-up diagnostics), with the remote control head disconnected.

If the unit can run the power-up diagnostics, the diagnostic error codes it produces often supply some information about the nature of the malfunction. Note that the power-up diagnostics test only the digital signal processor (DSP) circuitry, that is, the NVS, SBC, DMEM, T&C, and ARU modules. Although the power-up diagnostics are thorough, they do not test these modules completely. Also, with noise-related or intermittent problems, the power-up diagnostics may not catch an error. Thus, if the unit passes power-up diagnostics, but the reverberation/effects programs sound bad, the DSP may have problems that are not diagnosed by the power-up diagnostics, or the analog conversion system, that is, the FPC, AIN, and AOUT modules, may have problems.

Furthermore, it is possible for the reverberation/effects programs to sound OK and the unit to fail power-up diagnostics. Possibly, the diagnostic hardware or a low-order bit may be malfunctioning. In any case, these kinds of problems should be pursued.

The analog conversion system can be tested on its own through a self-test procedure. Self-test is accomplished by removing the DSP, NVS, DMEM, T&C, and ARU modules. The SBC module is retained to generate a clock signal. If the unit works in the self-test mode, the problem is likely to lie with the DSP.

The 224X has several other diagnostic programs available to help when troubleshooting problems. These programs are called by pushing one of the eight program pushbuttons at the beginning of the power-up diagnostics. The diagnostic programs are listed in Table 5.1.

The first diagnostic programs to run are a maximum delay (0.5-sec) program (diagnostic program 8) and a zero delay program (diagnostic program 7).

These delay programs are similar, except that the maximum delay program uses the DMEM module and the zero delay program does not. Thus, if the unit works in the zero delay program, but not in the maximum delay program, the problem is probably in the DMEM module. These two programs also help in exercising the digital-to-analog interface that is not tested in the self-test mode and in diagnosing where a problem is in the analog conversion system. (Note that the self-test mode does not run at the correct sampling rate when the SBC module is used to generate the clock signal.)

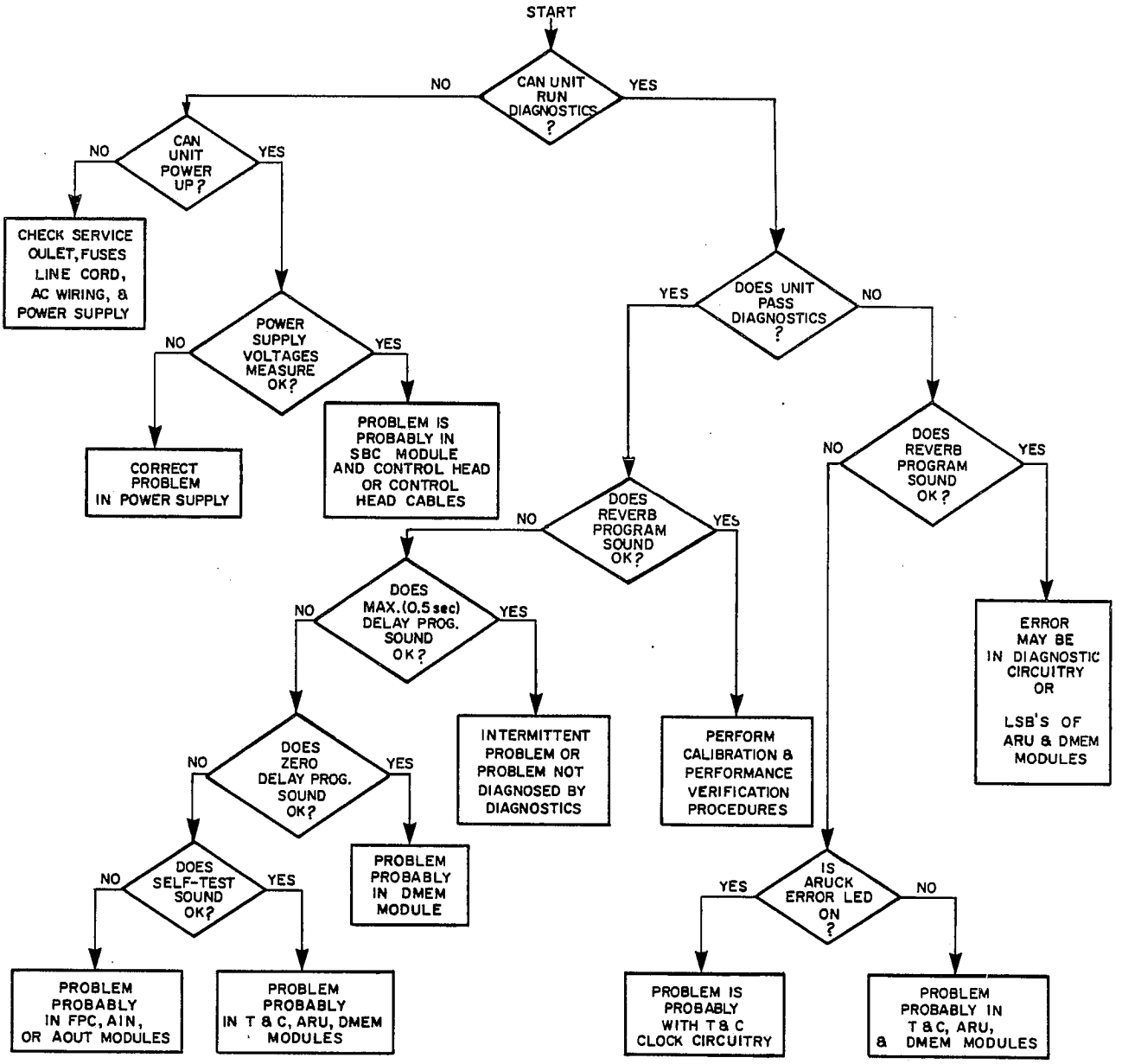


Fig. 5.1. Troubleshooting Approach.

Table 5.1. Diagnostic Programs.

Program*		Description
1	RESTART	restarts self-testing power-up diagnostics and returns to normal operation
2	QUICK EXIT	exits directly to normal operation
3	ARU SIGNAT	generates signature analysis signals; for use by service personnel to test the ARU module
4	ARU TEST	runs a quick test of the ARU module and returns to menu
5	NVS STROBE	generates analysis signals; to test the NVS module
6	FPC SIGNAT	generates signature analysis signals; to test the FPC module
7	ZERO DELAY	loads a 0-second delay-line program for setting input and output levels; Left input passes to outputs A and D, and Right input passes to outputs B and C
8	MAX DELAY	loads a 0.5-second delay-line program for setting input and output levels; Left input passes to outputs A and D, and Right input passes to outputs B and C

*Programs 3, 4, 5, 6, and 7 are not implemented in V8.0 software.

The ARU test (diagnostic 4) exercises the ARU module more thoroughly than the power-up diagnostics and can be tried when the unit passes power-up diagnostics but the ARU is still suspected to be bad. The NVS strobe program (diagnostic 5) continuously sends signals to the NVS module so that they can be checked with an oscilloscope. In addition, two signature programs (diagnostics 3 and 6) can be used with signature analyzers for troubleshooting some of the modules. The signature programs are also useful in troubleshooting with oscilloscopes, because they provide simplified and more observable signals to the various modules.

5.2 Power Supplies

If the 224X does not power up, first check the ac line cord for a good connection and the service outlet for power. Next check the power fuse at the rear of the mainframe. If the fuse is blown, replace with an exact replacement fuse: 3AG 3A slow blow for 100/120 Vac operation, 3AG 1.5A slow blow for 220/240 Vac operation.

The 224X mainframe has a 10-Vac unregulated power supply (ac-fused), three pairs of ac-fused regulated power supplies, and one dc-fused regulated power supply. A blown internal fuse generally indicates a problem in the related power supply circuitry, which should be thoroughly checked out.

Table 5.2 lists the power supply fuses. Replacement fuses should always have the correct rating to ensure protection from circuit damage or fire. Table 5.3 shows the location of each of the power supplies.

Table 5.2. Power Supplies and Fuses.

Schematic Fuse No.	Fuse Board Designation	Power Supply Fusing	Fuse Rating
F1, F2	±15 V	±15 Vac Secondary	2 A slow blow
F3, F4	±12 V	±12 Vac Secondary	3 A slow blow
F5	Viso	+10 Vac Secondary	2 A slow blow
F6, F7	±5 V	±5 Vac Secondary	15 A slow blow
F8	-5 Vdc	-5 Vdc	2.5 A slow blow

Table 5.3. Location of Power Supplies.

Power Supply	Output Supply Voltage/Current Rating	Location	
		Rectified/ Filtered	Regulated
+15 V	+15 Vdc/750 mA	PS2	PS2
-15 V	-15 Vdc/750 mA	PS2	PS2
+12 V	+12 Vdc/1.25 A	PS3	PS2
-12 V	-12 Vdc/150 mA	PS3	PS3
+10 Viso	+5 Vdc/500 mA	Control Head	Control Head
+5 V	+5 Vdc/10 A	PS1	PS3
-5 V	-5 Vdc/250 mA	PS1	PS3

The first test of any faulty operation is to make sure all power supplies are working properly.

5.3 Power-up Diagnostics

The 224X diagnostic programs test many components of the digital hardware. Although a diagnostic routine may not point out the exact component that has failed, a faulty module or section can usually be isolated. Diagnostic error messages are easier to understand if you are familiar with the overall operation of the 224X and the hexadecimal numbering system.

Table 5.4 shows number conversion between decimal, hexadecimal, and binary numbering systems. Figure 5.2 shows how errors and correct data are displayed on the control head.

Table 5.4. Number System Conversion.

Decimal	Hex	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111
16	10	0001 0000
.	.	.
.	.	.
.	.	.
255	FF	1111 1111

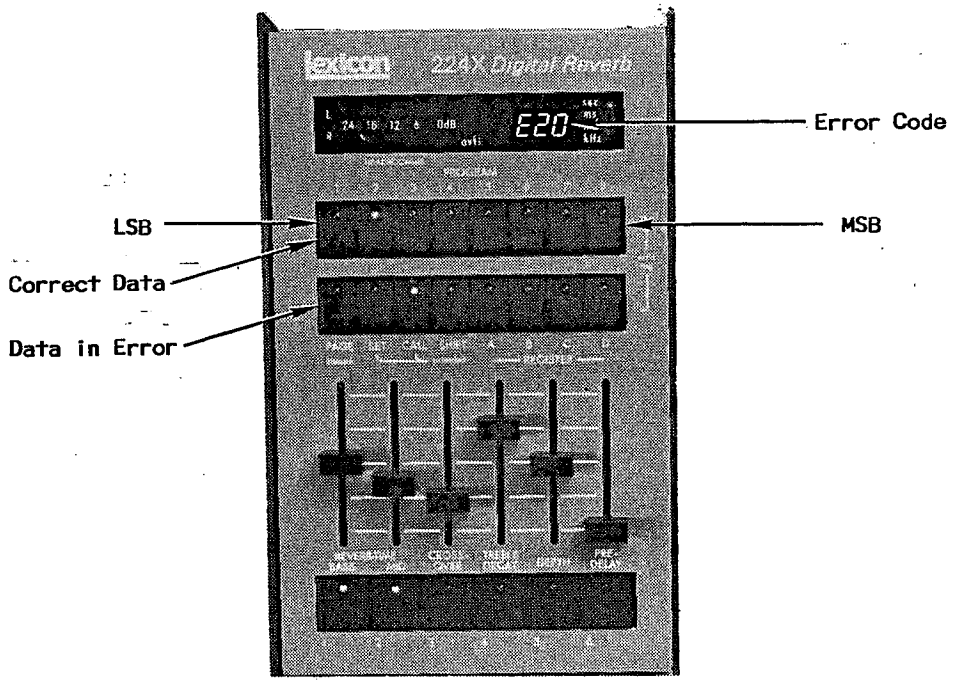


Fig. 5.2. Control Head Error Display.

The 224X diagnostic programs are run whenever the machine is turned on or reset. They can also be run by holding the SHIFT key while pushing CALL and PROGRAM 1 (SHIFT/CALL/PGM 1). The diagnostics make a single pass through all testable features of the machine. If the 224X passes all tests, normal operation begins. If an error is detected, an error message is displayed.

The diagnostic sequence varies for the nonvolatile storage (NVS) module, depending on how the diagnostics are started. When the diagnostics are started by powering up or resetting the 224X, a checksum test is performed on all ROMs on the NVS module, but the nonvolatile RAM is not tested because data can be lost if the power becomes unstable during testing. When the key sequence CALL/SHIFT/PGM 1 is used to start the diagnostics, testing of the nonvolatile RAM on the NVS module is included in the diagnostic program sequence. When the NVS module's nonvolatile RAM is tested, the contents are loaded into the RAM on the SBC module and reloaded to the NVS module when the test is finished, This procedure ensures that registers are not lost as a result of testing.

Caution: Do not reset or power down the unit while the NVS diagnostic is in progress; otherwise contents of the NVS registers may be lost.

During a diagnostic test, or when an error is displayed, all controls and pushbuttons on the control head, except the PROGRAM pushbuttons, are inactive. Briefly pushing PGM 1 allows the unit to go to the next diagnostic test after an error display. Pushing PGM 2 bypasses all further diagnostics and starts normal system operation. Pushing PGM 7 calls a zero delay test program and pushing PGM 8 calls a maximum delay test program.

The diagnostic programs compare the actual data in one part of the machine to the data that should be there if the machine were working perfectly. The diagnostic programs display the expected data pattern (the good data) using the LEDs on the PROGRAM pushbuttons. If different from the expected data pattern, the pattern of the actual data resident in the machine is displayed using the mode/register pushbutton LEDs. Usually an error is displayed when the two data patterns do not agree. The patterns displayed by these LEDs are essential in determining the cause of error. If errors appear, the error message numbers and the lighting patterns of the LEDs should be noted in the order of occurrence when diagnosing or referring a problem to Lexicon service technicians. Table 5.5 is a summary of the 224X error codes, Sec. 5.3.1 describes in detail how to run the programs during troubleshooting, and Sec. 5.3.2 gives in-depth descriptions of the error codes.

Table 5.5. Summary of 224X Error Codes.

Error Type*	Cause of Error
E0X	SBC ROM checksum
E1X	SBC RAM
E2X, E3X, E4X	T&C (may also be DMEM)
E5X - E8X	ARU (may also be T&C or DMEM)
E91, E92, E95, E96	DMEM
H0X, H2X	NVS ROM checksum
H1X	NVS RAM
H2F, H10	NVS card missing

* Where X is from 0 to 9 or from A to F.

5.3.1 Running the diagnostics

The 224X diagnostic programs are run in a particular order. In general, if the diagnostics indicate an error, the source of the first error should be found before much time is spent on any others. The checksum and microprocessor tests come first. Errors here may not disrupt the reverberation or effects programs and are easy to interpret. The remaining diagnostics work by loading the T&C module with a simple program and testing the effects of the program on the machine. The microprocessor must communicate with the T&C module to perform these tests. Failure to communicate usually results in an E23 error, which means that either the timing is incorrect between the T&C module and the microprocessor or a memory chip on the T&C module is faulty. The T&C module has a single LED diagnostic indicator labeled ARUCK ERROR. If this LED lights, the timing signal ARUCK (ARU Clock) is missing, indicating a failure within the clock circuitry on the T&C module. Because the entire machine depends on the T&C module, any problem on this module generally gives errors in other diagnostic tests, even if other sections are not faulty.

Some parts of the tests cannot be easily separated. All tests of the DMEM module require that the ARU module work at least minimally. Most of the microprocessor communication and test circuits for both the T&C and ARU modules are on the DMEM module. A failure here may cause the T&C test to take a long time to complete and may also cause an unusual flashing pattern of the LEDs on the control head. In addition, a short circuit or defective IC on the ARU or FPC modules can cause an error that appears to be on the T&C module. It is sometimes useful to unplug the ARU and FPC modules to see if the error still occurs. The FPC module is not testable by the microprocessor, and the machine should pass all diagnostics with the FPC module unplugged.

If the machine does not appear to work at all, the cable to the control head should be checked first. If no diagnostic errors occur, the machine will eventually run the sonic ambience programs with the control head unplugged. If so, the control head or the cable is faulty. However, it is more likely that a transformer plug in the power supply has come loose, or that a power supply fuse has opened. See Sec. 5.2 for the power supply test points. Failure of the machine to respond with either diagnostics or reverb programs when the power supplies are good probably means that the SBC module is faulty.

5.3.2 Descriptions of error codes

E00 through E0F: SBC ROM checksum test. Each ROM in the SBC module is checked by adding all data bytes; if the data is correct, the sum is 0. If an error is detected, one of the error messages E00 through E0F is displayed, depending on which ROM is faulty. The least-significant hexadecimal digit of the error code represents an encoded nibble (4-bit quantity) binary value. Within that binary value, the bit positions corresponding to a logic 1 identify which chip numbers are faulty. ROM 1 (U23) is indicated by a binary equivalent of 1, ROMs 2 and 3 are both indicated by a binary equivalent of 6, etc., for example:

Error Message	Binary Representation	Faulty ROM*
E01	0001	1
E02	0010	2
E06	0110	2 and 3
E0F	1111	1, 2, 3, and 4
E0A	1010	2 and 4

*ROM 1 = U23, 2 = U25, 3 = U24, and 4 = U26

Note that a checksum error does not always result in a noticeable machine malfunction.

E10 through E13: SBC module RAM test. The RAM on the SBC module is tested using a semirandom pattern, altering all contents. Errors are indicated by display of one of the error messages E10 to E13, depending on the address of the incorrect byte; for example, E10 corresponds to hexadecimal addresses 3C00 to 3CFF and E11 corresponds to addresses 3D00 to 3DFF. The correct pattern is displayed on the Program LEDs, and any incorrect pattern is displayed on the mode/register LEDs. The bit positions corresponding to the elements of the patterns that do not match isolate the location of the error. The error messages and bit patterns are defined as follows:

Error Messages

E10 = RAM addresses 3C00-3CFF
E11 = RAM addresses 3D00-3DFF
E12 = RAM addresses 3E00-3EFF
E13 = RAM addresses 3F00-3FFF

Bit Patterns

	LSB* 1	2	3	4	5	6	7	MSB 8	
PROGRAM LEDs	0	0	0	0	0	0	0	0	Correct Data
Mode LEDs	0	0	0	0	0	0	0	0	Incorrect Data
Bit No.	0	1	2	3	4	5	6	7	(Bits 0 to 3 are in U36 of the SBC module and bits 4 to 7 are in U37)

*LSB = least significant bit; MSB = most significant bit

The test is accomplished in two passes. First, the memory is loaded with the contents of ROM 1, starting from location zero. This data is complemented twice in two separate passes. The data in RAM is then compared with the original data in ROM. (Data is read from the top down.) The test will stop as soon as any error has been detected. This RAM test is sensitive to addressing errors and data errors.

Control Head Display Test. The panel test outputs data to the control head to light all LEDs (except the 7-segment displays, which display the revision number of the resident software). The test is bypassed if PROGRAM 1 is pushed. The control head display should blank out after the panel test for about 10 to 15 seconds, while the unit is performing diagnostics. Failure of the DMEM and T&C modules to return a ready signal to the SBC module causes the writable control store (WCS) memory test to require more than a minute to complete. If the 224X is not initialized after several minutes, the protect circuitry on the T&C module may be locking the 8080 on the SBC in a hold state. This condition means that the HALT decoding circuitry on the DMEM module or the protect gating on the T&C module is faulty.

E20 through E23: Writable Control Store (WCS) memory test. The WCS (U3, U18, U33, U48, and associated circuits on the T&C module) are tested in the same way as the RAM on the SBC module is tested. The error codes, E20 to E23, are as follows:

Error Message	Hexadecimal Address	Component
E20	4000, 4004 ... 41FC	U49 & associated circuits
E21	4001, 4005 ... 41FD	U33 & associated circuits
E22	4002, 4006 ... 41FE	U18 & associated circuits
E23	4003, 4007 ... 41FF	U3 & associated circuits

Correct data is displayed on the program LEDs, and faulty data is displayed on the mode/register LEDs. Error message E23 could mean that the entire program memory is faulty. If so, or if a problem on the DMEM module prevents data from being properly loaded into the program memory, the memory test will take a long time to complete. Such a delay indicates faults in the SBC bus-decoding checks in the DMEM module or on the T&C module. Two of the memory chips can be swapped to see if different error messages are displayed. Other problems, such as open or shorted address lines, or defective address or data buffers, can also cause a faulty program memory. The diagnostics detect such problems, but require additional steps to isolate them.

E32: 8080 bus test register test. If an error is found when checking the contents of the 8080 bus test register, the 8080 microprocessor in the SBC module cannot communicate with the DSP (consisting of the T&C, ARU, and DMEM modules). If an actual system error occurs, as opposed to a fault in the diagnostic test, it will seriously affect proper operation of further diagnostics as well as the reverberation and effects programs. Short circuits on the T&C or DMEM modules may be the cause. Check to see if the error occurs with the T&C module unplugged. If so, the DMEM module, the Backplane, or the SBC module is faulty. If the reverberation or effects programs seem to be running properly, the bus test register itself (U34 on the DMEM module) is faulty, and the error can be ignored, because it will not interfere with the proper operation of the reverberation and effects programs in the machine.

E40 & E41: Halt and single-step mode tests. Both the halt and single-step mode tests display an error if the return data matches, indicating the halt state cannot be initiated. Because the first program step is continually repeated in the halt state and many tests load known data into the first program step and look for that data at the output of the T&C module, it is necessary to be able to initiate the halt state for subsequent diagnostics to be valid. The halt test works by loading an instruction in the second executable address of the WCS memory. This instruction transfers data from the input of the XREG to the output, and a value loaded into the XREG is checked against the value output. If a halt condition has occurred within the 224X, the values will be different. If no halt has occurred, the values will be identical.

E43: XREG read/write test. The ability of the DSP to read correctly from and write correctly to the transfer register (XREG) on the DMEM module is tested. The WCS memory is first loaded with a NOP and then with an instruction to read the XREG and write to it. If the DSP cannot execute these functions, it means either a faulty XREG itself, or incorrect decoding of the bus control bits of the T&C module. It is important that these errors be corrected before further diagnostics are run, because incorrect XREG contents may invalidate results in all subsequent tests. This error may indicate short circuits or faulty chips at any location along the DAB (digital audio bus). The ARU and FPC modules may be unplugged to be sure they do not contribute to this error. If the same error code is still given, the problem is probably with the transfer registers themselves (U38, U39, U40, and U41 on the DMEM module).

E51 to E7F: ARU register test. All four ARU registers are tested. The registers are composed of four 16-bit memory chips, with each chip organized into four rows of nibbles (4-bit quantities). The first row of chips 1, 2, 3, and 4 constitute the 16 bits of register 1, with chips 1 and 2 containing the higher-order byte of the register and chips 3 and 4 containing the lower-order byte. The second row of the four chips constitutes register 2, the third row register 3, and the fourth row register 4.

Error messages E51 to E5F indicate one or both of the chips comprising the lower-order byte of a register is faulty, E61 to E6F indicate a faulty chip or chips in the higher-order byte of a register, and E71 to E7F indicate chips in both bytes are faulty. The registers are identified by the least-significant hexadecimal digit of the error code. This represents an encoded nibble value. The positions of the bits in a logic 1 state in the binary representation of the nibble value indicate which registers are faulty. For example, the 5 in error code E51 represents a lower-order byte of a register and the 1 corresponds to a binary representation of 0001, indicating an error in register 1. The 9 in E59 corresponds to a binary code of 1001, indicating an error in registers 1 and 4, the 3 in E53 corresponds to 0011, indicating an error in registers 1 and 2, and the 4 in E54 corresponds to 0100, indicating an error in register 3, etc. The following chart shows an example. Incorrect bits within a register are displayed by the mode/register pushbutton LEDs.

ARU register decoding

Error Message	Address Bytes	Binary Code of LSD	Register Number
E67	high	0111	1, 2, and 3
E52	low	0010	2
E69	high	1001	1 and 4
E75	high and low	0101	1 and 3
E7B	high and low	1011	1, 2, and 4

To understand the significance of these diagnostics, examine the following conditions:

1. The multiplier is OK, but the registers are faulty.

   a. If both high and low bytes are faulty, register addressing is probably invalid. This condition could result in an error in some registers and not in others.

   b. If a register file chip is faulty, only one byte is affected, and only part of that byte. This may affect all addresses or just one. The data on the LEDs must be checked to determine which chip is actually faulty.

2. The registers are OK, but the multiplier is faulty.

   All file addresses are incorrect, and this may propagate errors to areas that are not faulty, so that just replacing the faulty chip does not correct the errors.

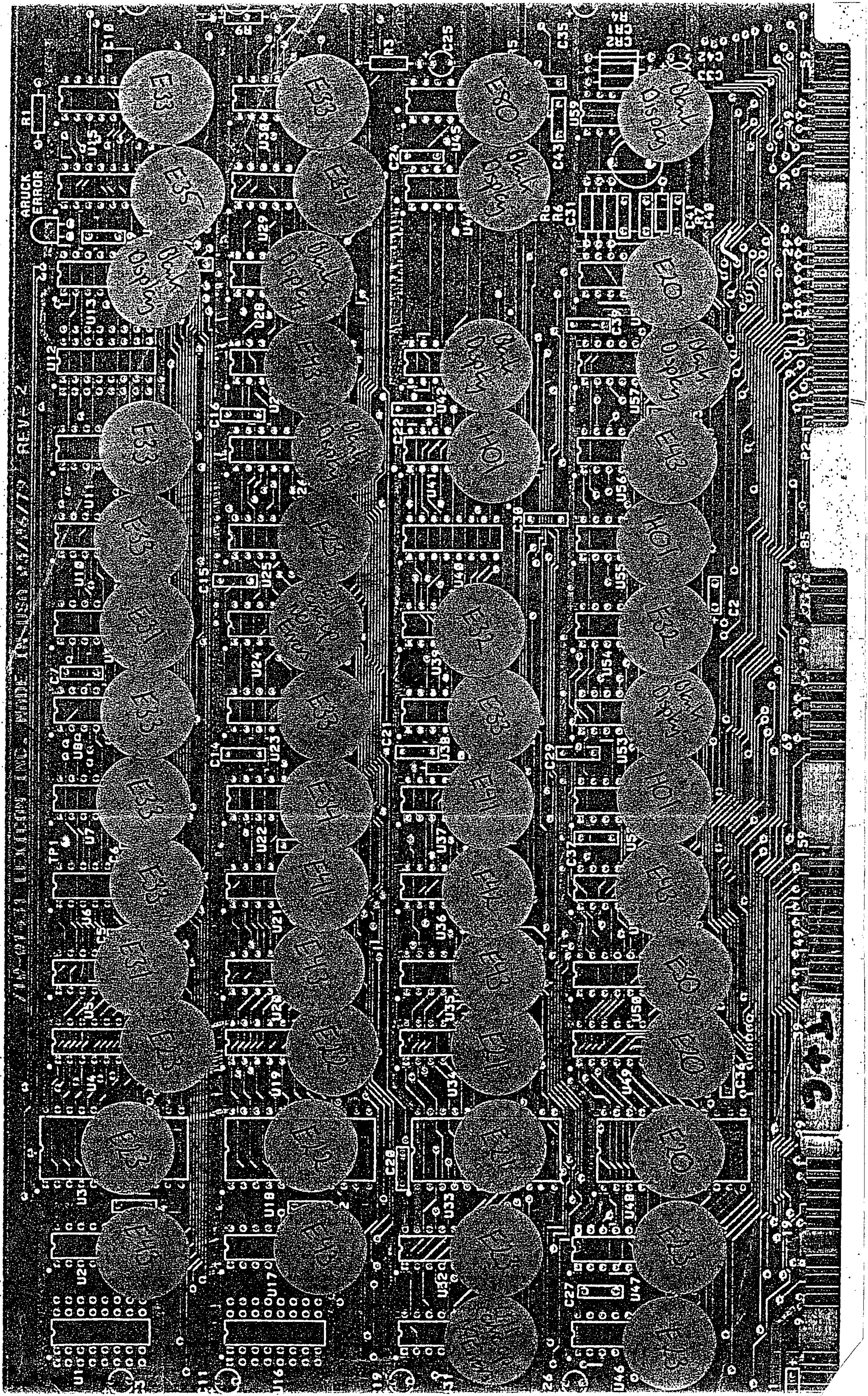
E80 to E8F: Multiplier test. The multiplier test is divided into four parts, each of which displays separate error codes. E81 to E83 indicate an error when the multiply coefficient is ±21/32. E81 indicates a low-order byte error, E82 a high-order byte error, and E83 indicates both bytes are incorrect. E85 to E87 indicate an error when multiplying by ±42/32. E89 to E8B indicate an error in the coefficient ±63/64. Four multiplications are made with each coefficient. The incorrect and correct data are displayed on the pushbutton LEDs in the same way as previous tests. If both the high-order and low-order bytes are incorrect, the data in the low-order byte is displayed. The last two coefficients should set the saturation monostable multivibrator. If not, error code E80 is displayed.

Note that E89 to E8B will test the intermediate address. Therefore, if E89 to E8B is displayed, check U13, U24 to U25, and U38 and U39.

E91, E92, E95, and E96: data memory test. This test makes two passes with complementary data. For this test to be valid, the multiplier must be operating correctly. Error message E91 indicates a low-order byte error and E92 indicates a high-order byte error. If both bytes are incorrect, E91 is displayed, which may mean that the entire memory is faulty, or it may mean that the multiplier or T&C module is faulty. The memory test is sensitive to both data errors and addressing errors, and should detect most problems. If either E91 or E92 are the only errors displayed and only a single LED indicates incorrect data, the problem is most likely to be a faulty memory chip, which is identified by the pushbutton LED. The defective memory chip can be swapped with the lowest-order memory chip (U1). This increases the noise level of the machine by 6 dB, but allows immediate operation if needed. For units with two banks of 16K dynamic RAMs. E91 and E92 refer to bank 1 (U20 to U35), and E95 and E96 refer to bank 2 (U1 to U16).

EA0 to EB3: Additional Multiplier Test. This test is performed when diagnostic program 4 (not available in V8.0) is called. Even error codes indicate a problem with the low byte and the odd error codes indicate a problem with the high byte. The error codes are grouped in fours; in any group, the first two groups use even test data and the second two use odd test data. EA0 to EA3 test a multiply by 1. EA4 to EA7 test a multiply by 1/2. EA8 to EAB test a multiply by -1. EAC to EAF test a multiply by 1/4. EB0 to EB3 test a multiply by 5/4.

If EA0 to EA3 all appear, the coefficients into the 74LS00 (U14, U26 to U28, U40 and U41, and U50 to U53) should be checked. If the high byte is bad with the bad data reading hexadecimal 80 or 7F, check the saturation logic (U42) or the MSB's of the data path through the ARU. If EA0 to EA3 appear, but EA4 to EA7 do not, check the 74LS00's or the intermediate adder (U13, U24, U25, U38, and U39). If EA0 to EA7 appear but EA8 to EAB



do not, check the 74S86's (U5 to U9). EAC to EAF test the shift registers (U3, U4, and U15 to U18) and coefficients. EB0 to EB3 test the second adders (U19 to U23).

5.4 Maximum Delay (0.5-sec) Program

The 224X's maximum delay diagnostic program is stereo and can be used as an abbreviated machine test (or for setting output levels). This program can be called during normal operation by the key sequence CALL/SHIFT/PGM 2, or by pressing PGM 8 at the beginning of the power-up diagnostics. The nonadjustable delay provided by this program is approximately half a second. In this program, the left input is passed to outputs A and D; and the right input is passed to outputs B and C.

5.5 Zero Delay Program

The zero delay program is similar to the maximum delay program except that the DMEM module is not used and the delay is zero; that is, the analog inputs are immediately transmitted to the analog outputs. (The digitized signals still pass through the ARU module, however.) This program is called by pushing PGM 7 at the beginning of the power-up diagnostics. In this program, the left input is passed to outputs A and D; and the right input is passed to outputs B and C. The zero delay program is recommended for troubleshooting the analog circuitry and also for setting input and output levels.

5.6 Self-Test Mode

If operating difficulties arise, it is possible to determine proper operation of the AIN, AOUT, and FPC modules by performing a self-test. This test usually isolates problems in the analog conversion subsystem. To perform the self-test, loosen the DMEM, T&C, ARU, and NVS modules. When these modules are removed from the motherboard, a control signal (FPC DBUG) to the FPC module goes HIGH, initiating self-test mode. Do not remove the DMEM, T&C, ARU, and NVS modules when you loosen them; just free them from their edge connectors. If there is no response of any kind in self-test mode, check the power supplies and connections, as well as the clock on the SBC module. Then perform a stage-by-stage investigation from the AIN to the AOUT module to determine where the problem is.

The self-test allows the 224X analog and digitizing subsystems to operate without any intervention from the DSP. This mode digitizes analog information from the left input, and outputs the information to outputs A and B; the right channel input is passed to outputs C and D. Note that the signal routing is different than that in both the maximum delay and zero delay programs. This can sometimes help in determining which channel is bad in a malfunctioning AIN or AOUT module. For example, if the output B is bad in self-test but good in the zero delay program, then the left input channel is bad. If output B is bad in both self-test and zero delay program, then probably the B output channel is bad.

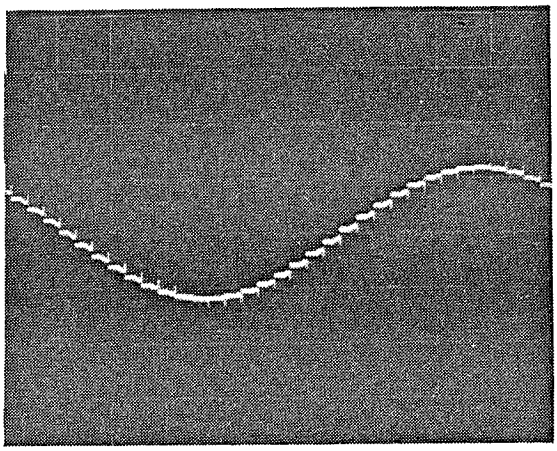
The digital sampling rate in the self-test is only 20 kHz. Therefore, when using the self-test, do NOT use input signals above 10 kHz. The self-test mode samples at only 20 kHz; therefore, it is meant for a preliminary check of the operation of the FPC, AIN, and AOUT modules. If measurements and calibrations are necessary, the zero delay program should be used. The self-test mode can also be exercised at the proper sampling rate of 34.13 kHz by removing the SBC module also and injecting a 3.413-MHz TTL level compatible clock from an external signal generator to pin A28 at the backplane connector for the SBC module. The self-test mode exercises about 95% of the circuitry in the AIN and AOUT modules and about 85% of the circuitry in the FPC module.

5.7 Signature Analysis

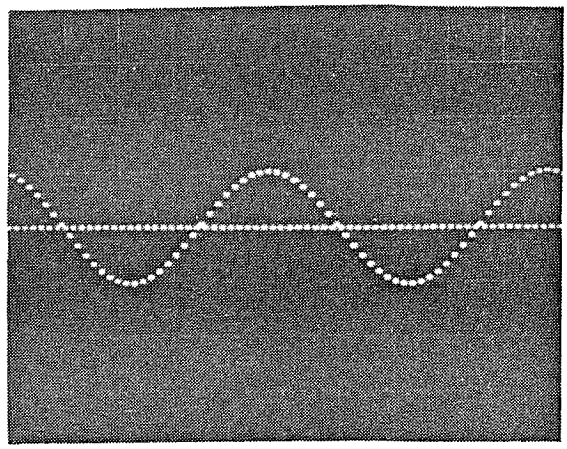
Because the digital signals on the digital modules in the 224X can be quite complex, signature analysis tables have been provided as a useful aid in tracing problems to a malfunctioning node.

Signature analysis is a technique used to troubleshoot electronic logic circuits. A signature analyzer (Hewlett Packard 5004A or equivalent) is connected to the unit being tested and the test program of the unit being tested is started. Long, complex data stream patterns are compressed into a unique 4-segment "signature" that the analyzer will display for each point in the unit being tested as the analyzer probe is moved from point to point. The analyzer requires several signals from the unit under test: the clock signal synchronizes the analyzer and the unit under test; the start and stop signals define the bounds between which the data signal is examined by the analyzer. After the stop signal, the analyzer displays the signature of the data it received. If the signature displayed does not match the corresponding signature given in the table, the circuitry connected to the node is malfunctioning.

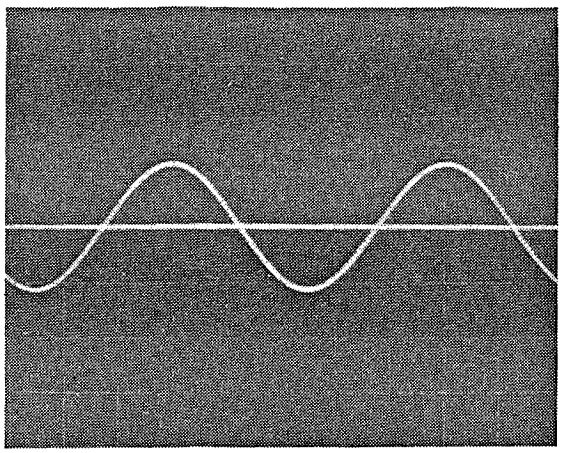
The correct signatures for the various modules in the 224X are summarized in the signature tables that follow. The conditions for taking the signatures are listed with each module and setup. Figure 5.3 shows what some of the waveforms should look like.



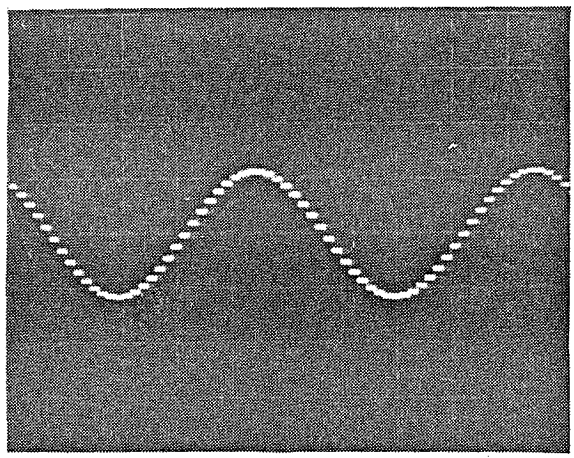
U21 pin 5, AIN board (AGR)
(output of input S/H)
2 V/DIV., 0.1 ms/DIV.
1 kHz input



U22 pin 4, AIN board
(output of channel MUX)
2 V/DIV., 0.2 ms/DIV.
1 kHz input



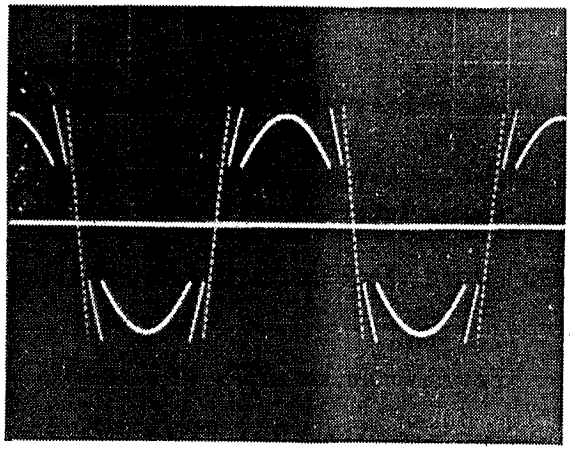
U4 pin 6, AOUT board
(output of output gain range amplifier)
2 V/DIV., 0.2 ms/DIV.
1 kHz input



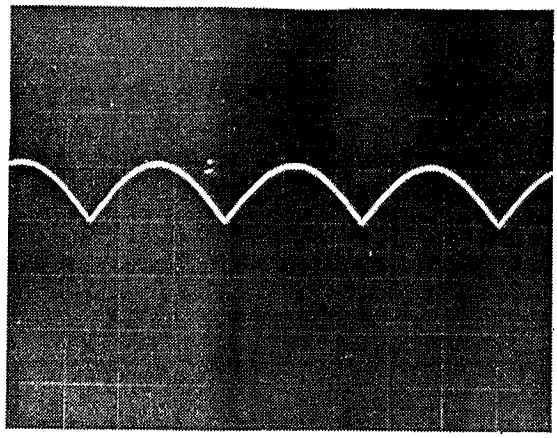
U8 pin 1, AOUT board
(output of output S/H)
2 V/DIV., 0.2 ms/DIV.
1 kHz input

These waveforms are observed with the unit in zero delay program. Input signal level is +12 dBm to the left input channel; input level potentiometer is set so that the level indicator is just beneath overload.

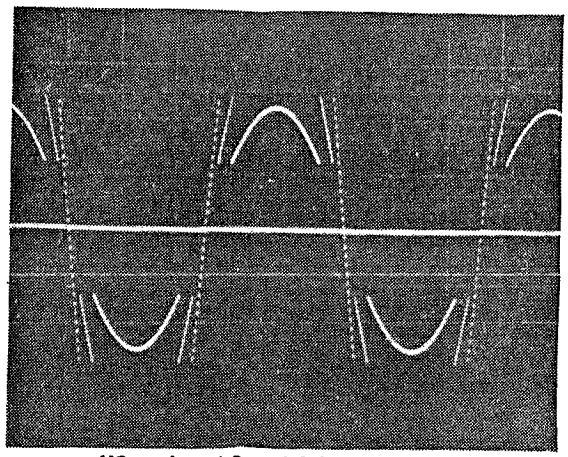
Fig. 5.3. Converter Waveforms.



U23 pin 6, AIN board
(output of input gain range amplifier)
2 V/DIV., 0.2 ms/DIV.
100 Hz input



U12 pin 7, AIN board
output of gain range rectifier)
2 V/DIV., 0.2 ms/DIV.
1 kHz input



U2 pin 18, AOUT board
(output of DAC)
2 V/DIV., 2 ms/DIV.
100 Hz input

These waveforms are observed with the unit in zero delay program. Input signal level is +12 dBm to the left input channel; input level potentiometer is set so that the level indicator is just beneath overload.

Fig. 5.3 (cont'd.). Converter Waveforms.

T & C -- Version 8.2.1

SETUP = in Diagnostic Program 3 (ARU Signatures).
Refer to Schematic #060-02475.

NOTE: Blue control head should display EOA.

START = RESET U19 pin 9
STOP = RESET U19 pin 9
CLOCK = DAB RSTB/ U20 pin 6
+5V = FP54
GROUND = 0000

U1	1	-	16	FP54	U2	1	0000	24	FP54
	2	-	15	-		2	07P6	23	45FF
	3	-	14	3U9F		3	FP4C	22	F344
	4	-	13	0000		4	03UA	21	95CP
	5	-	12	0000		5	3U9U	20	A36H
	6	-	11	-		6	F5AA	19	3U9F
	7	FP54	10	40A5		7	A0A8	18	0000
	8	0000	9	FP54		8	53PH	17	0000
						9	028H	16	FP54
						10	-	15	0000
						11	0000	14	0000
						12	0000	13	-

U3	1	07P6	20	FP54	U4	1	FP54	16	FP54
	2	FP4C	19	-		2	-	15	-
	3	03UA	18	-		3	07P6	14	03U3
	4	3U9U	17	-		4	FP4C	13	6725
	5	F5AA	16	-		5	03UA	12	01UH
	6	A0A8	15	-		6	3U9U	11	1UFU
	7	53PH	14	-		7	0000	10	0000
	8	028H	13	-		8	0000	9	0000
	9	FP54	12	-					
	10	0000	11	FP54					

U5	1	FP54	16	FP54	U10	1	FP54	16	FP54
	2	-	15	-		2	-	15	-
	3	F5AA	14	P2H5		3	-	14	-
	4	A0A8	13	H054		4	1UFU	13	8146
	5	53PH	12	29U6		5	H054	12	-
	6	028H	11	8146		6	8146	11	F1C3
	7	0000	10	0000		7	8146	10	-
	8	0000	9	0000		8	0000	9	-

T & C -- Version 8.2.1 (Cont'd.)

U11	1	FP54	16	FP54	U14	1	-	16	FP54
	2	-	15	-		2	-	15	-
	3	-	14	-		3	-	14	45FF
	4	01UH	13	29U6		4	-	13	F344
	5	P2H5	12	-		5	-	12	95CP
	6	2PU6	11	FPAA		6	-	11	A36H
	7	29U6	10	-		7	FP54	10	FP54
	8	0000	9	-		8	0000	9	FP54
U15	1	0000	24	FP54	U16	1	C5A9	20	FP54
	2	C5A9	23	45FF		2	909P	19	-
	3	909P	22	F344		3	0000	18	-
	4	0000	21	95CP		4	0000	17	-
	5	0000	20	A36H		5	8C99	16	-
	6	8C99	19	3U9F		6	0H10	15	-
	7	0H10	18	0000		7	0000	14	-
	8	0000	17	0000		8	7302	13	-
	9	7302	16	FP54		9	FP54	12	-
	10	-	15	0000		10	0000	11	FP54
	11	0000	14	0000					
	12	0000	13	-					
U17	1	FP54	16	FP54	U18	1	FP54	16	FP54
	2	-	15	-		2	-	15	-
	3	C5A9	14	U3AA		3	8C99	14	PFC2
	4	909P	13	484U		4	0H10	13	2UU6
	5	0000	12	0000		5	0000	12	0000
	6	0000	11	0000		6	7302	11	3981
	7	0000	10	0000		7	0000	10	0000
	8	0000	9	0000		8	0000	9	0000
U19	1	-	20	FP54	U20	1	-	16	FP54
	2	0000	19	FP54		2	-	15	-
	3	0000	18	FP54		3	-	14	FP54
	4	PFC2	17	6725		4	-	13	-
	5	PFC2	16	6725		5	-	12	-
	6	2UU6	15	03U3		6	-	11	-
	7	2UU6	14	03U3		7	-	10	FP54
	8	FP54	13	3981		8	0000	9	9FF0
	9	672A	12	3981					
	10	0000	11	-					

T & C -- Version 8.2.1 (Cont'd.)

U28	1	FP54	16	FP54
	2	-	15	0000
	3	3U9F	14	-
	4	3U9F	13	-
	5	-	12	-
	6	0000	11	-
	7	0000	10	0000
	8	0000	9	0000

U29	1	0000	24	FP54
	2	4496	23	45FF
	3	P265	22	F344
	4	2P14	21	95CP
	5	F71H	20	A36H
	6	C10H	19	3U9F
	7	A80H	18	0000
	8	CA09	17	0000
	9	909P	16	FP54
	10	-	15	0000
	11	0000	14	0000
	12	0000	13	-

U30	1	4496	20	FP54
	2	P265	19	-
	3	2P14	18	-
	4	F71H	17	-
	5	C10H	16	-
	6	A80H	15	-
	7	CA09	14	-
	8	909P	13	-
	9	FP54	12	-
	10	0000	11	FP54

U31	1	0000	20	FP54
	2	7132	19	A24C
	3	P265	18	4496
	4	F71H	17	2P14
	5	638P	16	970A
	6	H406	15	71U8
	7	A80H	14	C10H
	8	909P	13	CA09
	9	484U	12	HH04
	10	0000	11	-

U32	1	A24C	14	FP54
	2	A24C	13	7132
	3	A24C	12	7132
	4	970A	11	7132
	5	970A	10	638P
	6	970A	9	638P
	7	0000	8	638P

U33	1	-	14	FP54
	2	-	13	-
	3	484U	12	-
	4	861C	11	-
	5	-	10	-
	6	-	9	-
	7	0000	8	-

U34	1	861C	14	FP54
	2	830C	13	3981
	3	0000	12	-
	4	861C	11	-
	5	HH05	10	-
	6	0001	9	U7H5
	7	0000	8	-

U42	1	FP54	16	FP54
	2	-	15	0000
	3	45FF	14	-
	4	45FF	13	A36H
	5	-	12	A36H
	6	F344	11	-
	7	F344	10	95CP
	8	0000	9	95CP

T & C -- Version 8.2.1 (Cont'd.)

U43	1	0000	24	FP54
	2	0616	23	45FF
	3	7P28	22	F344
	4	F237	21	95CP
	5	CA0C	20	A36H
	6	0616	19	3U9F
	7	7P28	18	0000
	8	F184	17	0000
	9	1C45	16	FP54
	10	-	15	0000
	11	0000	14	0000
	12	0000	13	-

U44	1	0616	20	FP54
	2	7P28	19	-
	3	F237	18	-
	4	CA0C	17	-
	5	0616	16	-
	6	7P28	15	-
	7	F184	14	-
	8	1C45	13	-
	9	FP54	12	-
	10	0000	11	FP54

U45	1	0000	20	FP54
	2	3U14	19	830C
	3	7P28	18	0616
	4	CA0C	17	F237
	5	HH05	16	611C
	6	3U14	15	830C
	7	7P28	14	0616
	8	1C45	13	F184
	9	8HA2	12	F9CF
	10	0000	11	-

U46	1	FP54	16	FP54
	2	FP54	15	-
	3	-	14	FP54
	4	FP54	13	-
	5	FP54	12	FP54
	6	FP54	11	FP54
	7	FP54	10	FP54
	8	0000	9	FP54

U47	1	0000	16	FP54
	2	U3AA	15	-
	3	484U	14	71U8
	4	-	13	H406
	5	484U	12	-
	6	U3AA	11	-
	7	CCP5	10	-
	8	0000	9	-

U48	1	U3AA	14	FP54
	2	-	13	-
	3	-	12	6725
	4	861C	11	-
	5	-	10	-
	6	-	9	-
	7	0000	8	-

U49	1	-	14	FP54
	2	861C	13	F9CF
	3	3U14	12	-
	4	861C	11	861C
	5	-	10	FP54
	6	-	9	8HA2
	7	0000	8	55C6

ARU -- Version 8.2.1 -- no feedback

SETUP = Diagnostic Program 3 (ARU Signatures).
Refer to Schematic #060-01318.

NOTE: Blue control head should display EOA.

START = RESET/ extender card pin 16
STOP = XFERCK U43 pin 11
CLOCK = ARUCK U10 pin 11
+5V = 29F3
GROUND = 0000

U2	1	-	14	29F3	U3	1	29F3	16	29F3
	2	-	13	C356		2	F494	15	C77H
	3	-	12	9A95		3	0000	14	0C0P
	4	-	11	C356		4	0000	13	-
	5	9A95	10	9A95		5	-	12	-
	6	C356	9	C8P7		6	-	11	0000
	7	0000	8	9124		7	-	10	8FC4
						8	0000	9	29F3
U4	1	29F3	16	29F3	U5	1	3H61	14	29F3
	2	U69F	15	8575		2	9A95	13	9A95
	3	46PU	14	8653		3	A7U4	12	P600
	4	0000	13	-		4	9A4H	11	7F95
	5	-	12	-		5	9A95	10	9A95
	6	-	11	0000		6	00H8	9	5779
	7	-	10	8FC4		7	0000	8	FHPF
	8	0000	9	29F3					
U6	1	91A4	14	29F3	U7	1	697U	14	29F3
	2	9A95	13	9A95		2	9A95	13	9A95
	3	0C31	12	CU83		3	U3PA	12	PHC1
	4	HF27	11	2516		4	7U69	11	7724
	5	9A95	10	9A95		5	9A95	10	9A95
	6	46C2	9	0AU0		6	P5UF	9	5FF8
	7	0000	8	9065		7	0000	8	F65H
U8	1	9A15	14	29F3	U9	1	A175	14	29F3
	2	9A95	13	9A95		2	9A95	13	9A95
	3	0080	12	4070		3	3CP0	12	2272
	4	H39H	11	HAP5		4	6750	11	C8P7
	5	9A95	10	9A95		5	9A95	10	9A95
	6	4908	9	8441		6	UHF5	9	2272
	7	0000	8	1PH4		7	0000	8	C8P7

ARU -- Version 8.2.1 -- no feedback (Cont'd.)

U10	1	0000	20	29F3
	2	2272	19	9A15
	3	3PA1	18	4P6P
	4	3PA1	17	HH7P
	5	2272	16	H39H
	6	6750	15	8441
	7	C4P4	14	72F6
	8	38AU	13	UAA5
	9	A175	12	4070
	10	0000	11	0000

U11	1	0000	20	29F3
	2	PHC1	19	91A4
	3	A127	18	590F
	4	F3H4	17	F20A
	5	5FF8	16	HF27
	6	7U69	15	0AU0
	7	8497	14	6UA4
	8	A8CC	13	0543
	9	697U	12	CU83
	10	0000	11	0000

U12	1	29F3	16	29F3
	2	P600	15	3H61
	3	-	14	-
	4	C645	13	0087
	5	H4C6	12	4PHU
	6	-	11	-
	7	5779	10	9A4H
	8	0000	9	0000

U13	1	4PHU	16	29F3
	2	4CU5	15	8595
	3	2FP9	14	78P0
	4	0087	13	H4C6
	5	0097	12	A6FH
	6	29H3	11	3F61
	7	29F3	10	C645
	8	0000	9	2FP9

U14	1	8575	14	29F3
	2	90U2	13	90U2
	3	78P0	12	C77H
	4	F494	11	2FP9
	5	90U2	10	90U2
	6	A6FH	9	8653
	7	0000	8	0097

U15	1	29F3	16	29F3
	2	4FF4	15	4FF4
	3	3312	14	0U19
	4	8244	13	57U8
	5	PH68	12	6U15
	6	C156	11	0000
	7	-	10	8FC4
	8	0000	9	29F3

U16	1	29F3	16	29F3
	2	4FF4	15	4FF4
	3	3312	14	35FC
	4	5F3P	13	75F4
	5	AC87	12	UF7F
	6	U7C9	11	0000
	7	-	10	8FC4
	8	0000	9	29F3

U17	1	29F3	16	29F3
	2	UF7F	15	UCC9
	3	3312	14	3PF5
	4	5F3P	13	A574
	5	9895	12	F494
	6	F4AC	11	0000
	7	-	10	8FC4
	8	0000	9	29F3

U18	1	29F3	16	29F3
	2	6U15	15	F9C1
	3	75UH	14	0FFH
	4	1AH1	13	977F
	5	HP7A	12	U69F
	6	8244	11	0000
	7	-	10	8FC4
	8	0000	9	29F3

U19	1	6A6H	16	29F3
	2	00H8	15	FHPF
	3	H9P3	14	U0U6
	4	1PU7	13	8P4F
	5	0A55	12	HUPH
	6	A7U4	11	7F95
	7	C356	10	7A3U
	8	0000	9	3P92

ARU -- Version 8.2.1 -- no feedback (Cont'd.)

U20	1	2161	16	29F3
	2	46C2	15	9065
	3	5941	14	CA1P
	4	7819	13	P813
	5	4HCA	12	6HA3
	6	0C31	11	2516
	7	3P92	10	8AHH
	8	0000	9	F268

U21	1	HCUP	16	29F3
	2	P5UF	15	F65H
	3	5938	14	44PA
	4	94F5	13	CA12
	5	A547	12	9152
	6	U3PA	11	7724
	7	F268	10	HPH3
	8	0000	9	38A5

U22	1	6P49	16	29F3
	2	4908	15	1PH4
	3	1UP4	14	7H7H
	4	313U	13	5C0F
	5	091A	12	85A6
	6	0080	11	HAP5
	7	38A5	10	67P6
	8	0000	9	38A5

U23	1	F2A5	16	29F3
	2	UHF5	15	C8P7
	3	07F5	14	H491
	4	97CF	13	54H3
	5	94U9	12	H491
	6	3CP0	11	C8P7
	7	38A5	10	54H3
	8	0000	9	-

U24	1	C4P4	16	29F3
	2	0CHA	15	819U
	3	9PP9	14	9PP9
	4	38AU	13	3PA1
	5	9321	12	9PP9
	6	8767	11	819U
	7	2FP9	10	3PA1
	8	0000	9	-

U25	1	8497	16	29F3
	2	3P83	15	2HF9
	3	9CF3	14	FUFA
	4	A8CC	13	F3H4
	5	4380	12	11P7
	6	8777	11	943H
	7	6F4F	10	A127
	8	0000	9	24UH

U26	1	F9C1	14	29F3
	2	90U2	13	90U2
	3	FUFA	12	UCC9
	4	0FFH	11	9CF3
	5	90U2	10	90U2
	6	4380	9	UF7F
	7	0000	8	11P7

U27	1	0FFH	14	29F3
	2	4471	13	4471
	3	3P83	12	F9C1
	4	UCC9	11	943H
	5	4471	10	4471
	6	2HF9	9	3PF5
	7	0000	8	8777

U28	1	8575	14	29F3
	2	4471	13	4471
	3	3F61	12	0C0P
	4	8653	11	29H3
	5	4471	10	4471
	6	4CU5	9	C77H
	7	0000	8	8595

U29	1	-	16	29F3
	2	-	15	-
	3	-	14	29F3
	4	U7C9	13	29F3
	5	AC87	12	29F3
	6	PH68	11	0000
	7	5F3P	10	3312
	8	0000	9	8244

ARU -- Version 8.2.1 -- no feedback (Cont'd.)

U30	1	-	16	29F3
	2	-	15	-
	3	-	14	29F3
	4	U7C9	13	29F3
	5	AC87	12	29F3
	6	75UH	11	0000
	7	U7C9	10	AC87
	8	0000	9	C156

U31	1	-	16	29F3
	2	-	15	-
	3	-	14	29F3
	4	U7C9	13	29F3
	5	AC87	12	29F3
	6	HP7A	11	0000
	7	5F3P	10	3312
	8	0000	9	1AH1

U32	1	-	16	29F3
	2	-	15	-
	3	-	14	29F3
	4	U7C9	13	29F3
	5	AC87	12	29F3
	6	46PU	11	0000
	7	F4AC	10	9895
	8	0000	9	8244

U33	1	0000	16	29F3
	2	1PU7	15	0000
	3	9124	14	7A3U
	4	1PU7	13	9124
	5	6A6H	12	7A3U
	6	9124	11	8P4F
	7	6A6H	10	9124
	8	0000	9	8P4F

U34	1	0000	16	29F3
	2	7819	15	0000
	3	9124	14	8AHH
	4	7819	13	9124
	5	2161	12	8AHH
	6	9124	11	P813
	7	2161	10	9124
	8	0000	9	P813

U35	1	0000	16	29F3
	2	94F5	15	0000
	3	9124	14	HPH3
	4	94F5	13	9124
	5	HCUP	12	HPH3
	6	9124	11	CA12
	7	HCUP	10	9124
	8	0000	9	CA12

U36	1	0000	16	29F3
	2	313U	15	0000
	3	9124	14	67P6
	4	313U	13	9124
	5	6P49	12	67P6
	6	9124	11	5C0F
	7	6P49	10	9124
	8	0000	9	5C0F

U37	1	0000	16	29F3
	2	97CF	15	0000
	3	9124	14	54H3
	4	97CF	13	C8P7
	5	F2A5	12	54H3
	6	9124	11	54H3
	7	F2A5	10	C8P7
	8	0000	9	54H3

U38	1	HH7P	16	29F3
	2	968C	15	2H9U
	3	2A87	14	3P2C
	4	4P6P	13	72F6
	5	45PP	12	1789
	6	2U7H	11	8160
	7	24UH	10	UAA5
	8	0000	9	2FP9

U39	1	F20A	16	29F3
	2	3PH5	15	F772
	3	95C9	14	F1CU
	4	590F	13	6UA4
	5	U2F4	12	1789
	6	8721	11	7P86
	7	2FP9	10	0543
	8	0000	9	6F4F

ARU -- Version 8.2.1 -- no feedback (Cont'd.)

U40	1	U69F	14	29F3
	2	4471	13	4471
	3	3PH5	12	A574
	4	977F	11	F772
	5	4471	10	4471
	6	7P86	9	F494
	7	0000	8	8721

U41	1	977F	14	29F3
	2	90U2	13	90U2
	3	F1C0	12	A574
	4	3PF5	11	95C9
	5	90U2	10	90U2
	6	1789	9	U69F
	7	0000	8	U2F4

U42	1	54H3	14	29F3
	2	54H3	13	-
	3	0000	12	-
	4	-	11	-
	5	-	10	29F3
	6	-	9	29F3
	7	0000	8	0000

U43	1	2839	20	29F3
	2	-	19	-
	3	97CF	18	6P49
	4	67P6	17	5C0F
	5	-	16	-
	6	-	15	-
	7	54H3	14	HPH3
	8	F2A5	13	313U
	9	-	12	-
	10	0000	11	-

U44	1	2839	20	29F3
	2	-	19	-
	3	94F5	18	2161
	4	8AHH	17	P813
	5	-	16	-
	6	-	15	-
	7	CA12	14	7A3U
	8	HCUP	13	7819
	9	-	12	-
	10	0000	11	-

U45	1	3108	16	29F3
	2	0000	15	-
	3	7A3U	14	HUPH
	4	8P4F	13	U0U6
	5	6A6H	12	H9P3
	6	1PU7	11	0A55
	7	0000	10	0000
	8	0000	9	0000

U46	1	3108	16	29F3
	2	0000	15	-
	3	8AHH	14	6HA3
	4	P813	13	CA1P
	5	2161	12	5941
	6	7819	11	4HCA
	7	0000	10	0000
	8	0000	9	0000

U47	1	3108	16	29F3
	2	0000	15	-
	3	HPH3	14	9152
	4	CA12	13	44PA
	5	HCUP	12	5938
	6	94F5	11	A547
	7	0000	10	0000
	8	0000	9	0000

U48	1	3108	16	29F3
	2	0000	15	-
	3	67P6	14	85A6
	4	5C0F	13	7H7H
	5	6P49	12	1UP4
	6	313U	11	091A
	7	0000	10	0000
	8	0000	9	0000

U49	1	3108	16	29F3
	2	0000	15	-
	3	54H3	14	H491
	4	54H3	13	H491
	5	F2A5	12	07F5
	6	97CF	11	94U9
	7	0000	10	0000
	8	0000	9	0000

ARU — Version 8.2.1 -- no feedback (Cont'd.)

U50	1	UF7F	14	29F3
	2	4471	13	4471
	3	2U7H	12	57U8
	4	6U15	11	8160
	5	4471	10	4471
	6	968C	9	75F4
	7	0000	8	2H9U

U51	1	6U15	14	29F3
	2	90U2	13	90U2
	3	45PP	12	33FC
	4	75F4	11	1789
	5	90U2	10	90U2
	6	2A87	9	57U8
	7	0000	8	3P2C

U52	1	0U19	14	29F3
	2	4471	13	4471
	3	0CHA	12	35FC
	4	4FF4	11	8767
	5	4471	10	4471
	6	819U	9	4FF4
	7	0000	8	819U

U53	1	0U19	14	29F3
	2	90U2	13	90U2
	3	9321	12	4FF4
	4	4FF4	11	9PP9
	5	90U2	10	90U2
	6	9PP9	9	4FF4
	7	0000	8	9PP9

U54	1	HP7A	14	29F3
	2	U7C9	13	C931
	3	0000	12	90U2
	4	29F3	11	6HC2
	5	8244	10	4471
	6	AC87	9	0000
	7	0000	8	29F3

ARU -- Version 8.2.1

SETUP = Diagnostic Program 3 (ARU Signatures).
Refer to Schematic #060-01318.

NOTE: Blue control head should display E0A.

START = RESET/ extender card pin 16
STOP = RESET/ extender card pin 16
CLOCK = ARUCK U10 pin 11
+5V = 3696
GROUND = 0000

U2	1	-	14	3696	U3	1	3696	16	3696
	2	-	13	U804		2	9C33	15	8P47
	3	-	12	FP92		3	0000	14	U8A9
	4	-	11	U804		4	0000	13	-
	5	FP92	10	FP92		5	-	12	-
	6	U804	9	3P2U		6	-	11	0000
	7	0000	8	08C9		7	-	10	4573
						8	0000	9	3696

U4	1	3696	16	3696	U5	1	85U0	14	3696
	2	343H	15	2149		2	FP92	13	FP92
	3	50U5	14	5465		3	4C62	12	HFUF
	4	0000	13	-		4	H10A	11	126P
	5	-	12	-		5	FP92	10	FP92
	6	-	11	0000		6	1U98	9	0HP6
	7	-	10	4573		7	0000	8	F374
	8	0000	9	3696					

U6	1	H827	14	3696	U7	1	4808	14	3696
	2	FP92	13	FP92		2	FP92	13	FP92
	3	16C5	12	5C3U		3	869A	12	3A87
	4	876U	11	95AH		4	UP8C	11	U415
	5	FP92	10	FP92		5	FP92	10	FP92
	6	49UH	9	162P		6	3019	9	FCFH
	7	0000	8	H8CF		7	0000	8	055U

U8	1	361P	14	3696	U9	1	C7C3	14	3696
	2	FP92	13	FP92		2	FP92	13	FP92
	3	U88F	12	H021		3	7921	12	U0CH
	4	A1P2	11	1PC3		4	6U12	11	3P2U
	5	FP92	10	FP92		5	FP92	10	FP92
	6	6U70	9	3077		6	A180	9	U0CH
	7	0000	8	UPP5		7	0000	8	3P2U

ARU -- Version 8.2.1 (Cont'd.)

U10	1	0000	20	3696
	2	U0CH	19	361P
	3	CAF1	18	3786
	4	CAF1	17	187U
	5	U0CH	16	A1P2
	6	6U12	15	3077
	7	859P	14	3C55
	8	34HF	13	UCU9
	9	C7C3	12	H021
	10	0000	11	0000

U11	1	0000	20	3696
	2	3A87	19	H827
	3	2PC5	18	PCU4
	4	FF20	17	5565
	5	FCFH	16	876U
	6	UP8C	15	162P
	7	A6AF	14	77P6
	8	FCAC	13	PHF4
	9	4808	12	5C3U
	10	0000	11	0000

U12	1	3696	16	3696
	2	HFUF	15	85U0
	3	-	14	-
	4	P243	13	505C
	5	4077	12	U9AP
	6	-	11	-
	7	0HP6	10	H10A
	8	0000	9	0000

U13	1	U9AP	16	3696
	2	U903	15	6FF1
	3	1P6H	14	3276
	4	505C	13	4077
	5	33UP	12	3P50
	6	5533	11	F27P
	7	3696	10	P243
	8	0000	9	1P6H

U14	1	2149	14	3696
	2	86CP	13	86CP
	3	3276	12	8P47
	4	9C33	11	1P6H
	5	86CP	10	86CP
	6	3P50	9	5465
	7	0000	8	33UP

U15	1	3696	16	3696
	2	0UAH	15	0UAH
	3	3PC5	14	5140
	4	UH8F	13	HU4H
	5	9CPU	12	2C67
	6	F339	11	0000
	7	-	10	4573
	8	0000	9	3696

U16	1	3696	16	3696
	2	0UAH	15	0UAH
	3	3PC5	14	APH6
	4	58H6	13	2344
	5	FC1A	12	UC7F
	6	93FF	11	0000
	7	-	10	4573
	8	0000	9	3696

U17	1	3696	16	3696
	2	UC7F	15	81PA
	3	3PC5	14	567U
	4	58H6	13	9FFP
	5	U5AU	12	9C33
	6	AH79	11	0000
	7	-	10	4573
	8	0000	9	3696

U18	1	3696	16	3696
	2	2C67	15	2PP4
	3	6P40	14	U971
	4	0823	13	33F0
	5	A55A	12	343H
	6	UH8F	11	0000
	7	-	10	4573
	8	0000	9	3696

U19	1	2A65	16	3696
	2	1U98	15	F374
	3	60CU	14	09U9
	4	P885	13	9AH7
	5	5CP3	12	34P3
	6	4C62	11	126P
	7	U804	10	F5F1
	8	0000	9	F7P1

ARU -- Version 8.2.1 (Cont'd.)

U20	1	U9U2	16	3696
	2	49UH	15	H8CF
	3	4815	14	6A06
	4	9136	13	P978
	5	4062	12	011F
	6	16C5	11	95AH
	7	F7P1	10	U058
	8	0000	9	440C

U21	1	PHPF	16	3696
	2	3019	15	055U
	3	0H92	14	8U4F
	4	PC08	13	P9P4
	5	2999	12	CA59
	6	869A	11	U415
	7	440C	10	12U0
	8	0000	9	5F4F

U22	1	411A	16	3696
	2	6U70	15	UPP5
	3	4U40	14	2U18
	4	CHH8	13	C5PH
	5	1918	12	1126
	6	U88F	11	1PC3
	7	5F4F	10	5064
	8	0000	9	UA22

U23	1	6665	16	3696
	2	A180	15	3P2U
	3	4FF8	14	P1UC
	4	0HH7	13	77AH
	5	8PH4	12	P1UC
	6	7921	11	3P2U
	7	UA22	10	77A3
	8	0000	9	-

U24	1	859P	16	3696
	2	6P1P	15	5141
	3	P500	14	P500
	4	34HF	13	CAF1
	5	PU81	12	P500
	6	809C	11	5141
	7	5CF6	10	CAF1
	8	0000	9	-

U25	1	A6AF	16	3696
	2	4H81	15	0C16
	3	FHUC	14	P1P0
	4	FCAC	13	FF20
	5	C6PH	12	AH67
	6	P33P	11	A5A9
	7	9P78	10	2PC5
	8	0000	9	267C

U26	1	2PP4	14	3696
	2	86CP	13	86CP
	3	P1P0	12	81PA
	4	U971	11	FHUC
	5	86CP	10	86CP
	6	C6PH	9	UC7F
	7	0000	8	AH67

U27	1	U971	14	3696
	2	0205	13	0205
	3	4H81	12	2PP4
	4	81PA	11	A5A9
	5	0205	10	0205
	6	0C16	9	567U
	7	0000	8	P33P

U28	1	2149	14	3696
	2	0205	13	0205
	3	F27P	12	U8A9
	4	5465	11	5533
	5	0205	10	0205
	6	U903	9	8P47
	7	0000	8	6FF1

U33	1	000P	16	3696
	2	P885	15	0000
	3	08C9	14	F5F1
	4	P885	13	08C9
	5	2A65	12	F5F1
	6	08C9	11	9AH7
	7	2A6H	10	08C9
	8	0000	9	9AHU

ARU -- Version 8.2.1 (Cont'd.)

U34	1	000P	16	3696
	2	9136	15	0000
	3	08C9	14	U058
	4	9136	13	08C9
	5	U9U2	12	U05P
	6	08C9	11	P978
	7	U9U0	10	08C9
	8	0000	9	P978

U35	1	000P	16	3696
	2	PC08	15	0000
	3	08C9	14	12U0
	4	PC02	13	08C9
	5	PHPF	12	12UF
	6	08C9	11	P9P4
	7	PHPA	10	08C9
	8	0000	9	P9PA

U36	1	000P	16	3696
	2	CHH8	15	0000
	3	08C9	14	5064
	4	CHHP	13	08C9
	5	411A	12	5062
	6	08C9	11	C5PH
	7	4110	10	08C9
	8	0000	9	C5P9

U37	1	000P	16	3696
	2	0HH7	15	0000
	3	08C9	14	77A3
	4	0HHH	13	3P2U
	5	6665	12	77A3
	6	08C9	11	77AH
	7	666C	10	3P2U
	8	0000	9	77A3

U38	1	187U	16	3696
	2	9740	15	1A74
	3	29UF	14	82P8
	4	3786	13	3C55
	5	8476	12	C2A0
	6	958C	11	H721
	7	267C	10	UCU9
	8	0000	9	5CF6

U39	1	5565	16	3696
	2	496H	15	47U5
	3	F27F	14	PP67
	4	PCU4	13	77P6
	5	124C	12	9AU6
	6	P7H2	11	P94A
	7	1P6H	10	PHF4
	8	0000	9	9P78

U40	1	343H	14	3696
	2	0205	13	0205
	3	496H	12	9FFP
	4	33F0	11	47U5
	5	0205	10	0205
	6	P94A	9	9C33
	7	0000	8	P7H2

U41	1	33F0	14	3696
	2	86CP	13	86CP
	3	PP67	12	9FFP
	4	567U	11	F27F
	5	86CP	10	86CP
	6	9AU6	9	343H
	7	0000	8	124C

U42	1	77A3	14	3696
	2	77AH	13	-
	3	000P	12	-
	4	-	11	-
	5	-	10	3696
	6	-	9	3696
	7	-	8	0000

U43	1	25C5	20	3696
	2	-	19	-
	3	0HHH	18	4110
	4	5062	17	C5P9
	5	-	16	-
	6	-	15	-
	7	77A3	14	12UF
	8	666C	13	CHHP
	9	-	12	-
	10	0000	11	-

ARU -- Version 8.2.1 (Cont'd.)

U44	1	25C5	20	3696	U45	1	8658	16	3696
	2	-	19	-		2	0000	15	-
	3	PC02	18	U9U0		3	F5F1	14	34P3
	4	U05P	17	P978		4	9AHU	13	09U9
	5	-	16	-		5	2A6H	12	60CU
	6	-	15	-		6	P885	11	5CP3
	7	P9PA	14	F5F1		7	0000	10	0000
	8	PHPA	13	9136		8	0000	9	0000
	9	-	12	-					
	10	0000	11	-					
U46	1	8658	16	3696	U47	1	8658	16	3696
	2	0000	15	-		2	0000	15	-
	3	U05P	14	011F		3	12UF	14	CA59
	4	P978	13	6A06		4	P9PA	13	8U4F
	5	U9U0	12	4815		5	PHPA	12	0H92
	6	9136	11	4062		6	PC02	11	2999
	7	0000	10	0000		7	0000	10	0000
	8	0000	9	0000		8	0000	9	0000
U48	1	8658	16	3696	U49	1	8658	16	3696
	2	0000	15	-		2	0000	15	-
	3	5062	14	1126		3	77A3	14	P1UC
	4	C5P9	13	2U18		4	77A3	13	P1UC
	5	4110	12	4U40		5	666C	12	4FF8
	6	CHHP	11	1918		6	0HHH	11	8PH4
	7	0000	10	0000		7	0000	10	0000
	8	0000	9	0000		8	0000	9	0000
U50	1	UC7F	14	3696	U51	1	2C67	14	3696
	2	0205	13	0205		2	86CP	13	86CP
	3	958C	12	HU4H		3	8476	12	APH6
	4	2C67	11	H721		4	2344	11	C2A0
	5	0205	10	0205		5	86CP	10	86CP
	6	9740	9	2344		6	29UF	9	HU4H
	7	0000	8	1A74		7	0000	8	82P8
U52	1	5140	14	3696	U53	1	5140	14	3696
	2	0205	13	0205		2	86CP	13	86CP
	3	6P1P	12	APH6		3	PU81	12	0UAH
	4	0UAH	11	809C		4	0UAH	11	P500
	5	0205	10	0205		5	86CP	10	86CP
	6	5141	9	0UAH		6	P500	9	0UAH
	7	0000	8	5141		7	0000	8	P500

ARU -- Version 8.2.1 (Cont'd.)

U54	1	A55A	14	3696
	2	93FF	13	C028
	3	0000	12	86CP
	4	3696	11	3493
	5	UH8F	10	0205
	6	FC1A	9	0000
	7	0000	8	3696

DMEM -- Version 8.2.1

SETUP = Diagnostic Program 3 (ARU Signatures).
Lift U65 pin 13 and jumper to U65 pin 1.
Refer to Schematic #060-02512.

NOTE: Blue control head should display EOA.

START = MSB of CPC; U65 pin 8
STOP = MSB of CPC; U65 pin 8
CLOCK = RESET/ U58A pin 1
+5V = 826P
GROUND = 0000

U1-	1	-	16	0000	U17	1	-	16	-
U16,	2	-	15	-		2	0AU1	15	0AU1
U20-	3	-	14	-		3	A6F7	14	A6F7
U35	4	-	13	0AU1		4	UH56	13	UH56
	5	UH56	12	A6F7		5	FU8U	12	FU8U
	6	P279	11	FU8U		6	P279	11	P279
	7	861U	10	44U7		7	44U7	10	44U7
	8	-	9	-		8	861U	9	861U
U18	1	0000	16	826P	U36	1	0000	16	826P
	2	FU8U	15	0000		2	UH56	15	0000
	3	1F7P	14	8HU0		3	UF4C	14	A6F7
	4	FU8U	13	9237		4	UH56	13	6266
	5	44U7	12	-		5	861U	12	A6F7
	6	6633	11	-		6	5439	11	P279
	7	44U7	10	74P1		7	861U	10	440H
	8	0000	9	0AU1		8	0000	9	P279
U48	1	826P	20	826P	U49	1	5439	16	826P
	2	826P	19	826P		2	0000	15	0000
	3	-	18	-		3	2A1F	14	A206
	4	0000	17	0000		4	UF4C	13	440H
	5	-	16	-		5	7P25	12	C133
	6	0000	15	0000		6	0000	11	0000
	7	-	14	-		7	826P	10	6266
	8	0000	13	0000		8	0000	9	9241
	9	-	12	-					
	10	0000	11	0000					
U50	1	6633	16	826P	U51	1	-	14	826P
	2	0000	15	826P		2	0000	13	C133
	3	3319	14	7C47		3	7P25	12	0000
	4	1F7P	13	74P1		4	2A1F	11	8P3U
	5	8P3U	12	C25F		5	A206	10	3319
	6	0000	11	0000		6	C133	9	7C47
	7	9241	10	9237		7	0000	8	C25F
	8	0000	9	A077					

DMEM -- Version 8.2.1 (Cont'd.)

U62	1	826P	20	826P
	2	0000	19	826P
	3	-	18	-
	4	0000	17	826P
	5	-	16	-
	6	0000	15	0000
	7	-	14	-
	8	0000	13	0000
	9	-	12	-
	10	0000	11	0000

U63	1	861U	16	826P
	2	0000	15	0000
	3	19H6	14	HP66
	4	UH56	13	P279
	5	5H21	12	U81P
	6	0000	11	0000
	7	A077	10	A6F7
	8	0000	9	10F0

U64	1	44U7	16	826P
	2	0000	15	0000
	3	19H6	14	HP66
	4	FU8U	13	0AU1
	5	5H21	12	U81P
	6	826P	11	0000
	7	10F0	10	8HU0
	8	0000	9	FPHA

U65	1	C25F	14	826P
	2	0000	13	C25F
	3	5H21	12	0000
	4	0000	11	5H21
	5	HP66	10	19H6
	6	U81P	9	HP66
	7	0000	8	U81P

FPC -- Version 8.2.1

SETUP = Diagnostic Program 6 (FPC Signatures).
Lift pin 11 of SAR IC (U26) on AIN module and jumper to +5V.
Refer to Schematic #060-01320.

NOTE: Blue control head should display EOF.

START = RESET U4 pin 2 
STOP = RESET U4 pin 2 
CLOCK = FPCCLK U4 pin 5 
+5V = 96F6
GROUND = 0000

U1					U2				
	1	96F6	16	96F6		1	96F6	16	96F6
	2	0000	15	-		2	0000	15	80F0
	3	0000	14	1686		3	0000	14	-
	4	96F6	13	388A		4	96F6	13	H48C
	5	0000	12	AP4F		5	0000	12	-
	6	0000	11	-		6	96F6	11	-
	7	80F0	10	80F0		7	96F6	10	388A
	8	0000	9	C869		8	0000	9	C869

U3					U4				
	1	96F6	16	96F6		1	0000	16	96F6
	2	-	15	96F6		2	4C63	15	0000
	3	5151	14	AP4F		3	96F6	14	5151
	4	0000	13	UC7P		4	4C63	13	H30A
	5	96F6	12	0000		5	0000	12	5151
	6	-	11	96F6		6	-	11	96F6
	7	-	10	5F99		7	0000	10	H30A
	8	0000	9	-		8	0000	9	96F6

U5					U6				
	1	AU07	14	96F6		1	AU07	16	96F6
	2	P11U	13	1H0P		2	P11U	15	0000
	3	-	12	96F6		3	1H0P	14	0000
	4	1C7C	11	-		4	1358	13	0000
	5	CHC5	10	-		5	1C7C	12	38UP
	6	96F6	9	2712		6	CHC5	11	7FU6
	7	0000	8	H30A		7	26HC	10	72A7
						8	0000	9	6HU5

U7					U8				
	1	4C63	16	96F6		1	4C63	16	96F6
	2	0000	15	0000		2	0000	15	2712
	3	-	14	1H0P		3	-	14	1C7C
	4	-	13	P11U		4	-	13	CHC5
	5	-	12	AU07		5	-	12	26HC
	6	-	11	0000		6	-	11	1358
	7	96F6	10	2712		7	96F6	10	96F6
	8	-	9	96F6		8	-	9	-

FPC -- Version 8.2.1 (Cont'd.)

U12	1	0000	14	96F6
	2	-	13	1686
	3	96F6	12	H48C
	4	-	11	UC7P
	5	-	10	87H6
	6	-	9	C869
	7	0000	8	3UCU

U13	1	-	14	96F6
	2	-	13	-
	3	-	12	-
	4	-	11	-
	5	-	10	1A65
	6	-	9	4325
	7	0000	8	5940

U14	1	-	14	96F6
	2	-	13	2PAU
	3	C869	12	-
	4	1110	11	388A
	5	HP96	10	-
	6	5940	9	-
	7	0000	8	-

U15	1	0000	14	96F6
	2	-	13	-
	3	5151	12	-
	4	-	11	1110
	5	-	10	87H6
	6	-	9	2PAU
	7	0000	8	C869

U16	1	96F6	16	96F6
	2	0000	15	-
	3	96F6	14	-
	4	96F6	13	-
	5	96F6	12	36UA
	6	-	11	-
	7	36UA	10	36UA
	8	0000	9	UC33

U17	1	AU07	14	96F6
	2	-	13	P11U
	3	-	12	77H9
	4	-	11	-
	5	-	10	-
	6	-	9	6HU5
	7	0000	8	UC33

U18	1	96F6	16	96F6
	2	-	15	3953
	3	6C8P	14	-
	4	41HA	13	72A7
	5	38UP	12	7FU6
	6	-	11	A8CH
	7	41HA	10	3P7C
	8	0000	9	0000

U23	1	96F6	16	96F6
	2	-	15	1A65
	3	428H	14	4325
	4	9U57	13	2U46
	5	P3A1	12	6211
	6	A12F	11	0000
	7	010H	10	3UCU
	8	0000	9	2PAU

U24	1	96F6	16	96F6
	2	-	15	010H
	3	HHHA	14	52A5
	4	PA30	13	2513
	5	P3A1	12	76CC
	6	H44C	11	0000
	7	010H	10	3UCU
	8	0000	9	2PAU

U25	1	96F6	20	96F6
	2	96F6	19	96F6
	3	-	18	-
	4	96F6	17	96F6
	5	-	16	-
	6	96F6	15	96F6
	7	-	14	-
	8	36UA	13	96F6
	9	-	12	-
	10	0000	11	96F6

FPC -- Version 8.2.1 (Cont'd.)

U26	1	96F6	20	96F6
	2	7C6U	19	96F6
	3	-	18	-
	4	96F6	17	0000
	5	-	16	-
	6	96F6	15	0000
	7	-	14	-
	8	96F6	13	0000
	9	-	12	-
	10	0000	11	HC53

U27	1	96F6	16	96F6
	2	-	15	HC53
	3	AH63	14	0000
	4	AH63	13	0000
	5	AH63	12	0000
	6	AH63	11	0000
	7	7C6U	10	36UA
	8	0000	9	6HU5

U28	1	96F6	16	96F6
	2	-	15	7C6U
	3	AH63	14	96F6
	4	CA1F	13	96F6
	5	735H	12	96F6
	6	0A75	11	0000
	7	96F6	10	36UA
	8	0000	9	6HU5

U34	1	96F6	16	96F6
	2	-	15	010H
	3	HHHA	14	52A5
	4	PA30	13	2513
	5	P3A1	12	76CC
	6	H44C	11	0000
	7	010H	10	3UCU
	8	0000	9	2PAU

U35	1	96F6	16	96F6
	2	-	15	010H
	3	HHHA	14	-
	4	PA30	13	-
	5	P3A1	12	-
	6	H44C	11	0000
	7	-	10	3UCU
	8	0000	9	2PAU

U36	1	5151	20	96F6
	2	HHHA	19	H44C
	3	-	18	-
	4	-	17	-
	5	PA30	16	P3A1
	6	P3A1	15	PA30
	7	-	14	-
	8	-	13	-
	9	H44C	12	HHHA
	10	0000	11	0000

U37	1	5151	20	96F6
	2	428H	19	H44C
	3	-	18	-
	4	-	17	-
	5	9U57	16	P3A1
	6	P3A1	15	PA30
	7	-	14	-
	8	-	13	-
	9	A12F	12	HHHA
	10	0000	11	0000

U38	1	96F6	16	96F6
	2	-	15	96F6
	3	2550	14	96F6
	4	P0C4	13	96F6
	5	H808	12	96F6
	6	9U1U	11	0000
	7	96F6	10	36UA
	8	0000	9	6HU5

FPC — Version 8.2.1 (Cont'd.)

U39	1	96F6	16	96F6
	2	-	15	96F6
	3	57UH	14	96F6
	4	2PP1	13	96F6
	5	81F2	12	36UA
	6	9426	11	0000
	7	0000	10	36UA
	8	0000	9	6HU5

U40	1	96F6	16	96F6
	2	0000	15	-
	3	CCC4	14	HHHA
	4	HHHA	13	A12F
	5	3PAP	12	9U57
	6	9U57	11	7567
	7	0000	10	0000
	8	0000	9	5151

U41	1	96F6	16	96F6
	2	0000	15	-
	3	HHHA	14	779C
	4	A12F	13	49P0
	5	9U57	12	6HUP
	6	7567	11	F543
	7	0000	10	0000
	8	0000	9	C869

U42	1	000U	16	96F6
	2	779C	15	5F99
	3	P11U	14	F543
	4	C3U7	13	77H9
	5	49P0	12	43PH
	6	P11U	11	6HUP
	7	3833	10	77H9
	8	0000	9	0276

U43	1	96F6	16	96F6
	2	0000	15	HP96
	3	0000	14	584H
	4	0000	13	9P3F
	5	96F6	12	-
	6	96F6	11	-
	7	1110	10	96F6
	8	0000	9	C869

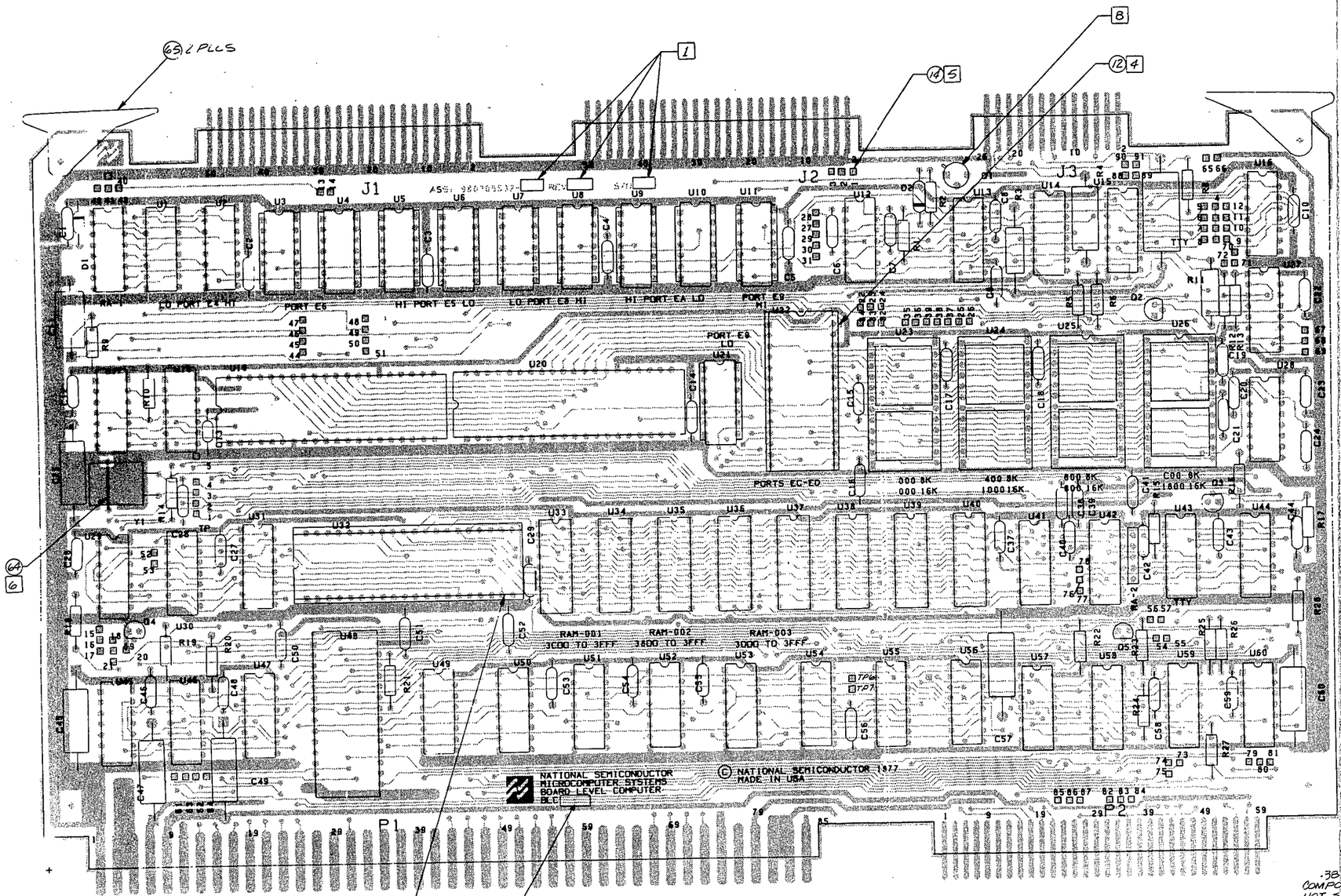
6 SCHEMATICS AND ASSEMBLY DRAWINGS

The following schematics and assembly drawings are contained in this section in the order listed:

Title	Lexicon Drawing No.
Single Board Computer Schematic	
Single Board Computer Assembly	
Arithmetic Unit Board Schematic	060-01318
Arithmetic Unit Board Assembly	030-02735
Floating Point Converter Board Schematic	060-01320
Floating Point Converter Board Assembly	030-01420
Analog Input Board Schematic	060-01321
Analog Input Board Assembly	030-02733
Analog Output Board Schematic	060-01322
Analog Output Board Assembly	030-02734
Power Supplies Schematic	060-01324
Power Supply #1 Assembly	030-01423
Power Supply #2 Assembly	030-01424
Power Supply #3 Assembly	030-01425
Motherboard Schematic	060-01360
Motherboard Assembly	030-01428
Memory Expansion Board Schematic	060-02273
Memory Expansion Board Assembly	080-02281
Timing and Control Board Schematic	060-02475
Timing and Control Board Assembly	030-02481
Data Memory Board Schematic	060-02512
Data Memory Board Assembly	030-02516
Data Memory Board Block Diagram	
Fuse Board Schematic (see Power Supply Schematic)	
Fuse Board Assembly	030-02647
Output Transformer Board Schematic	060-01359
Output Transformer Board Assembly	030-02769
Transition Board Assembly	030-01426
Remote Control Head (Panel) Schematic (Logic and Display)	060-01323
Remote Control Head Assembly	080-01757

Power Supply Module Assembly	080-01611
Power Transformer Assembly	080-01650
Chassis-1 Assembly	080-01662
Chassis-2 Assembly	080-01676
Chassis-3 Assembly	080-01845
LARC Schematic	060-03534
LARC Display Board Assembly	080-03397
LARC Electronics Board Assembly	080-03403
LARC Panel Board Assembly	080-03409
LARC Transition Board Schematic	060-03576
LARC Transition Board Assembly	080-03447

REVISIONS			
APPROVED	DATE	DCN NUMBER	REV
[illegible]	11/8/78	PROD REL 687	A
[illegible]	8/4/78	DCN # IMP 3001	B
[illegible]	11/81	DCN # IMP 3056	C
[illegible]	1-2-1-78	DCN # IMP-3072	D
[illegible]	1-26-79	DCN # IMP-3186	D1



VIEW COMPONENT SIDE

1 MARK APPLICABLE DASH NO., REV LEVEL AND S/N .12-.18 HIGH CHARACTERS APPROX. AS SHOWN.

2. LOCATION NO./REF DESIGNATIONS SHOWN FOR REF ONLY

3. FOR LOGIC DIAGRAM SEE DWG NO. 8703055532.

4 INSTALL SOCKET (ITEMS 10 & 12) BEFORE INSTALLING U22 & U32.

5 WIRE WRAP PINS ARE STAKED INTO BOARD (93 PLCS) IN LOCATIONS 1-31 AND TP1-7.

6 INSTALL ITEM #64 (#22 GA WIRE) WHERE SHOWN.

7. INSTALL JUMPERS (ITEM) BETWEEN WIRE WRAP PINS AS SHOWN IN APPROPRIATE TABLE BELOW (32 PLCS) INSTALL WHERE INDICATED BY □.

8 INSTALL PAD (ITEM 63) UNDER Q1 WHERE SHOWN.

JUMPER INSTALLATION -00, -04
1K RAM 2708 PROM 2308 ROM

TO	FROM	TO	FROM	TO	FROM	TO	FROM
1	2	30	31	58	51	76	77
4	8	33	34	54	55	80	81
13	14	35	36	56	57	83	84
15	16	38	39	61	63	86	87
19	20	40	41	62	64	88	89
23	24	44	45	68	69	90	91
25	26	46	47	71	72	TP3	TP4
27	29	48	49	74	75	TP6	TP7

JUMPER INSTALLATION -02, -05
2K RAM 2708 PROM 2308 ROM

TO	FROM	TO	FROM	TO	FROM	TO	FROM
1	2	30	31	58	51	76	77
4	8	33	34	54	55	80	81
13	14	35	36	56	57	82	83
15	16	38	39	61	63	86	87
19	20	40	41	62	64	88	89
23	24	44	45	68	69	90	91
25	26	46	47	71	72	TP3	TP4
27	29	48	49	74	75	TP6	TP7

JUMPER INSTALLATION -03, -06
4K RAM 2708 PROM 2308 ROM

TO	FROM	TO	FROM	TO	FROM	TO	FROM
1	2	30	31	58	51	76	77
4	8	33	34	54	55	79	80
13	14	35	36	56	57	82	83
15	16	38	39	61	63	85	86
19	20	40	41	62	64	88	89
23	24	44	45	68	69	90	91
25	26	46	47	71	72	TP3	TP4
27	29	48	49	74	75	TP6	TP7

ROM/PROM JUMPER INSTALLATION
2316, 2708 — 2316, 2716

FROM	TO	FROM	TO	FROM	TO	FROM	TO
58	59	74	75	67	68	73	74
71	72	76	77	70	71	76	78

.385 MAX → COMPONENTS NOT SHOWN

.075 ALL COMPONENT LEADS

9 MARK APPLICABLE MARKETING NUMBER IN .12-.18 HIGH CHARACTERS APPROX. AS SHOWN:

80/11 FOR -001 VERSION
80/12 FOR -002 VERSION
80/14 FOR -003 VERSION
80/11T FOR -004 VERSION
80/12T FOR -005 VERSION
80/14T FOR -006 VERSION

MATERIAL

FINISH

TOLERANCE

ANG	2 PL	3 PL

UNLESS OTHER SPECIFIED
DIMENSIONS ARE IN INCHES AND INCLUDE CHEMICALLY APPLIED OR PLATED FINISHES
REMOVE BURRS AND SHARP EDGES BREAK SHARP CORNERS .015 MAX
DO NOT SCALE DRAWING

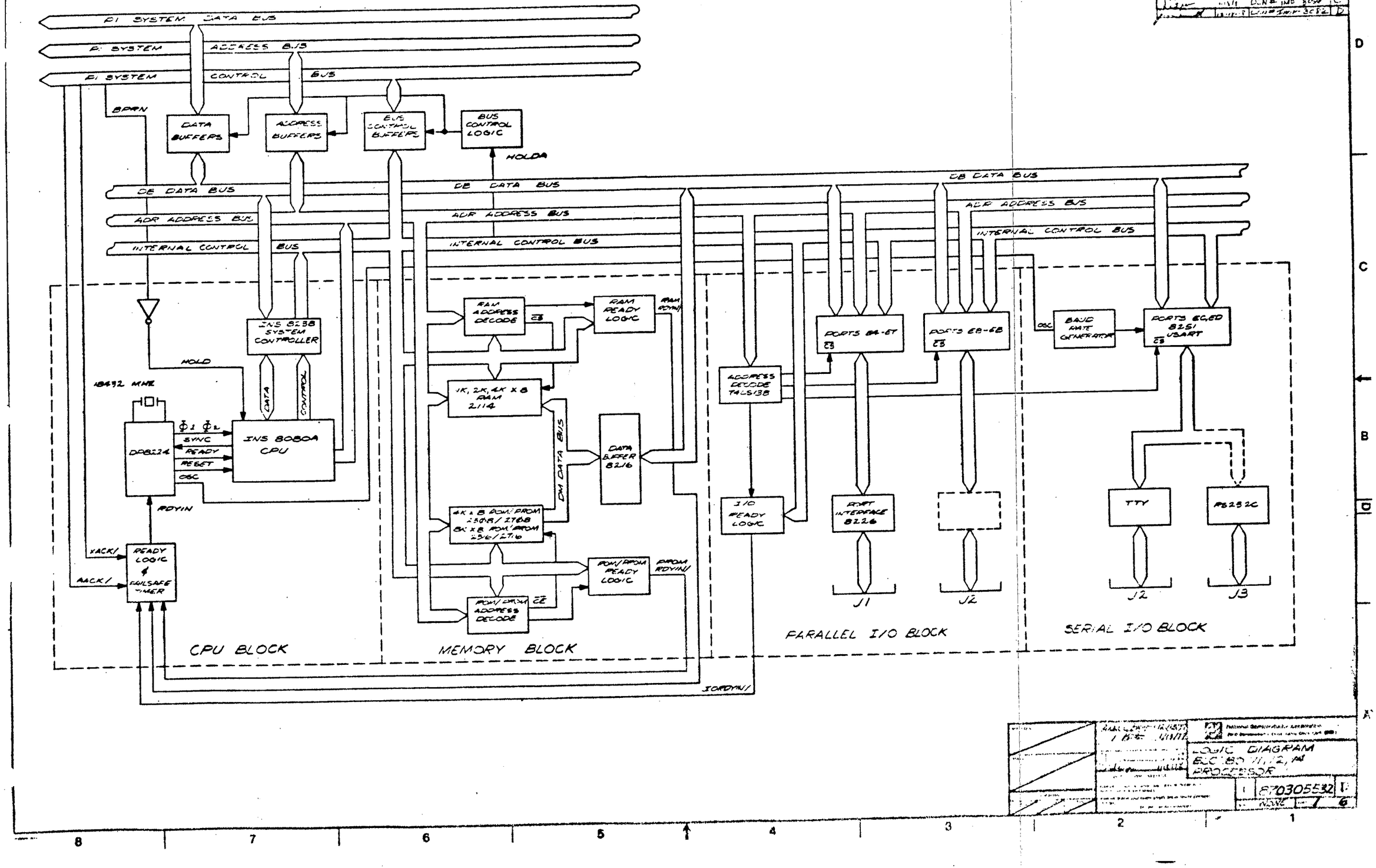
DR BY [illegible] 1-13-78
CHK BY [illegible] 1-13-78
M.E.
E.E.
P.E. [illegible] 11/11/78

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, Calif. 95051

DWA
BLC 80/11.12.14

SIZE D | DR NO 8703055532 | D

SCALE | SHEET 1 OF 1



		LOGIC DIAGRAM	
		BLC 80 11, 12, A1	
		PROCESSOR	
		8703055-32	1
		SHEET 7 OF 6	

REVISIONS			
APPROVED	DATE	DESCRIPTION	BY

NOTES; UNLESS OTHERWISE SPECIFIED:

1. RESISTOR VALUES ARE IN OHMS. ¼ WATT, ±5%.
2. U3 THRU U11, U13 THRU 26 ARE SHOWN FOR CLARITY. ACTUAL COMPONENTS ARE CUSTOMER INSTALLED.
3. CAPACITOR VALUES ARE IN MICROFARADS. 50V ± 80-20%
4. ON J1 AND J2 EVEN PINS ARE GND.
5. ON ALL 14 PIN PACKAGES PIN 7 = GND PIN 14 = VCC
   ON ALL 16 PIN PACKAGES PIN 8 = GND PIN 16 = VCC
   ON ALL 18 PIN PACKAGES PIN 9 = GND PIN 18 = VCC.
6. ON PACKAGE U48, PIN 14 = GND PIN 28 = VCC
7. SYMBOL □-□ INDICATES JUMPER (INSTALLED = 88Z ONLY).

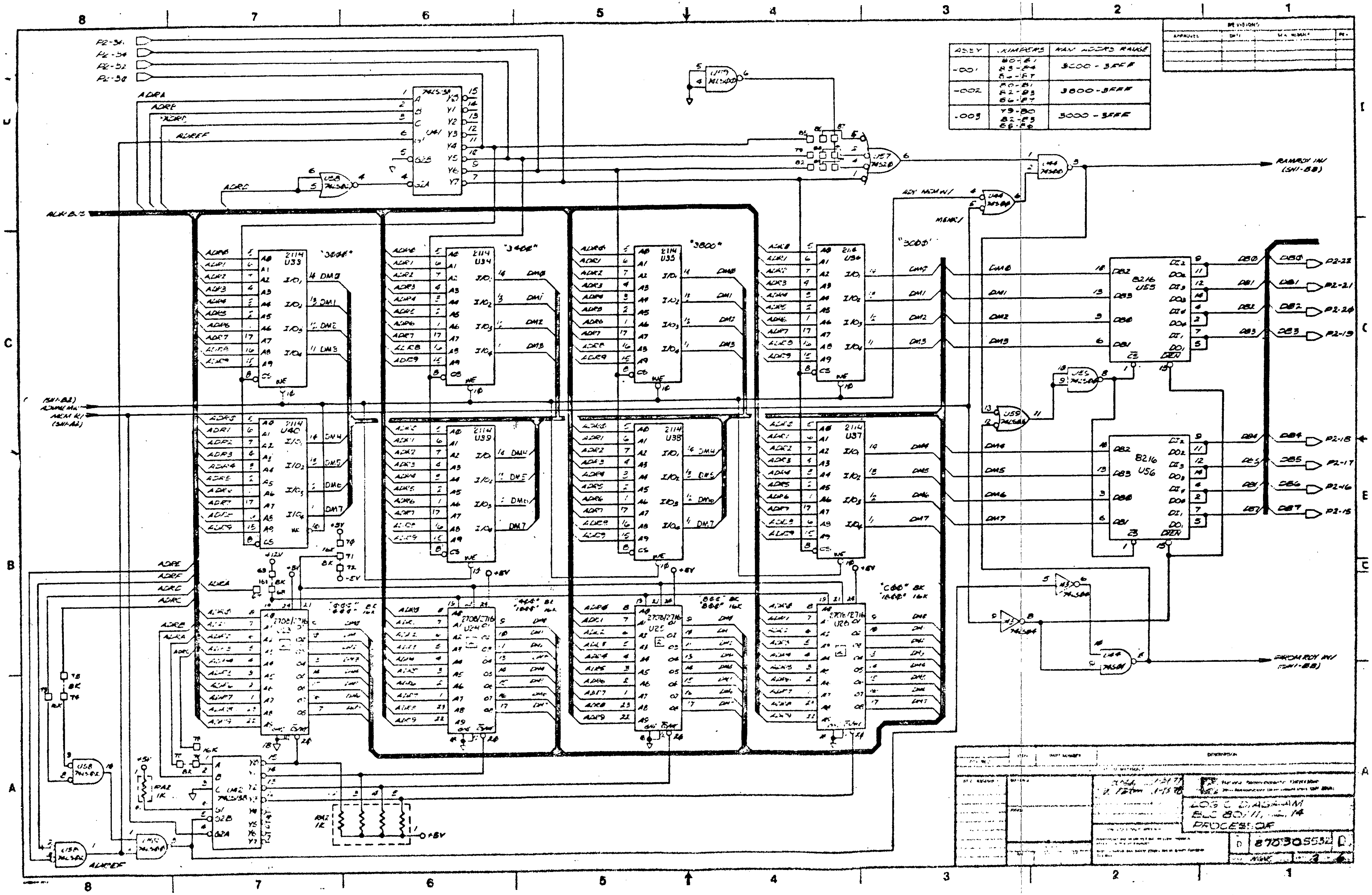
DB BUS

ADR BUS

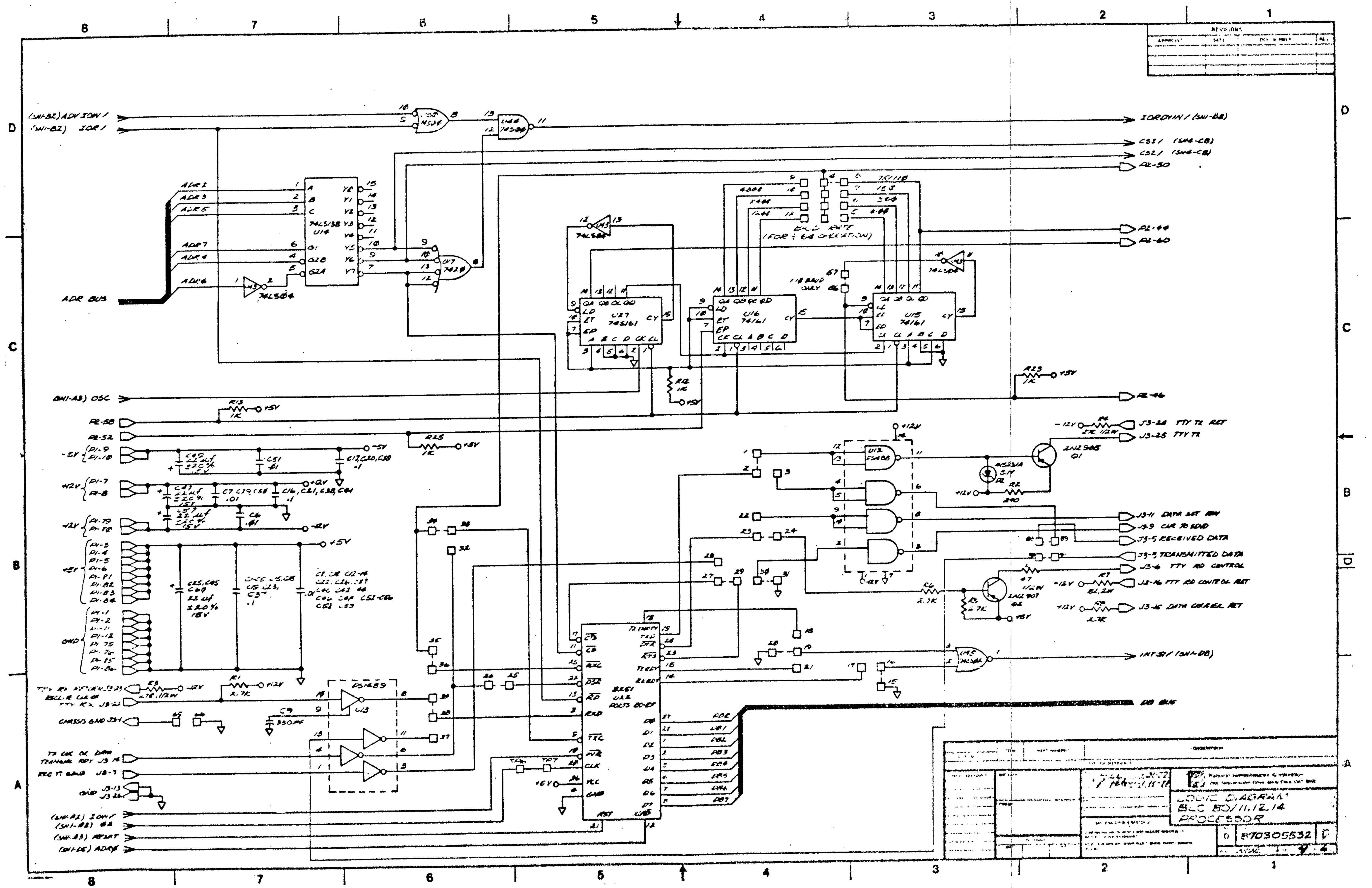
LOGIC DIAGRAM
BLC 80/11 12 M
PROCESSOR

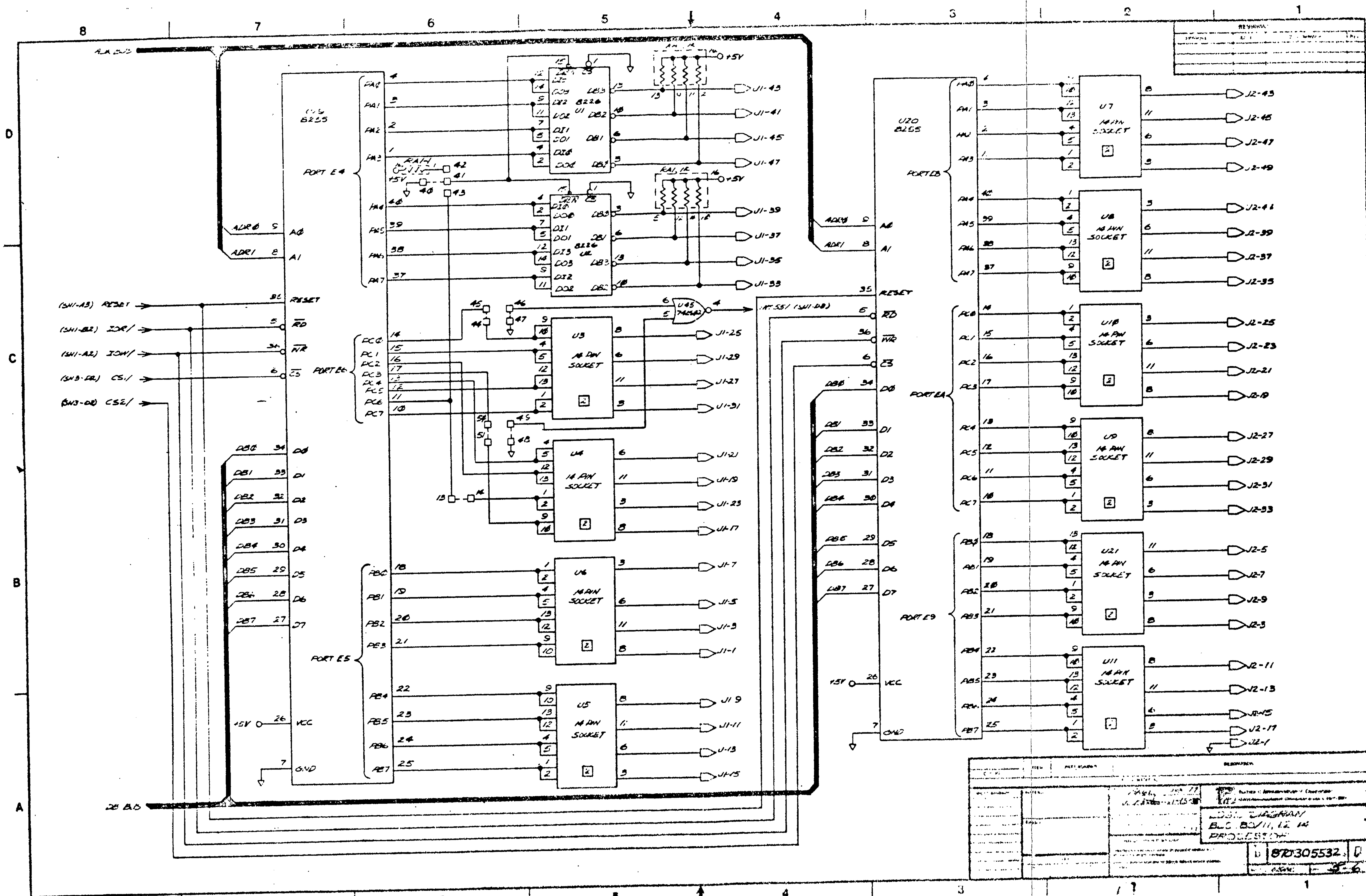
D 8700305532 D

SCALE: 2 SHEET 1



ASSY | JUMPERS | RAM ADDRS RANGE
-001 | 3C00 - 3FFF
-002 | 3800 - 3FFF
-003 | 3000 - 3FFF
2114 U33
2114 U34
2114 U35
2114 U36
2114 U40
2114 U39
2114 U38
2114 U37
8216 U55
8216 U56
RAMRDY INV (SH1-B8)
PROMRDY INV (SH1-B8)
ADR BUS
LOGIC DIAGRAM
BLC 80/11, ..., 14
PROCESSOR
D 870305552 D


LOGIC DIAGRAM
BLC 80/11,12,14
PROCESSOR
870305532
IORDYIN/ (SH1-B8)
CS1/ (SH4-C8)
CS2/ (SH4-C8)
ADR BUS
74LS138
U14
74LS04
74LS161
U15
U16
U17
BAUD RATE
8251
U22
DB BUS
J3-25 TTY TX
J3-11 DATA SET RDY
J3-9 CLR TO SEND
J3-5 RECEIVED DATA
J3-6 TTY RD CONTROL
INT-51/ (SH1-D8)
OSC
DS1489
U13
+5V
-12V
+12V
GND



U20 8255
U7 14 PIN SOCKET
U8 14 PIN SOCKET
U10 14 PIN SOCKET
U9 14 PIN SOCKET
U21 14 PIN SOCKET
U11 14 PIN SOCKET
U3 14 PIN SOCKET
U4 14 PIN SOCKET
U6 14 PIN SOCKET
U5 14 PIN SOCKET
8226 U1
8226 U2
PORT E4
PORT E6
PORT E5
PORT E8
PORT EA
PORT E9
RESET
+5V
VCC
GND
LOGIC DIAGRAM
BLC 80/11, 12, 14
PROCESSOR
870305532

1	GND SIGNAL GND	2	VCC +5VDC
3	VCC +5VDC	4	VCC +5VDC
5	VCC +5VDC	6	VCC +5VDC
7	VDD +12VDC	8	VDD +12VDC
9	VBB -10VDC	10	VBB -10VDC
11	GND SIGNAL GND	12	GND SIGNAL GND
13	BUS CLK BUS CLOCK	14	INIT/ INITIALIZE
15	BHEN BUS HI EN	16	
17	BUSY/ BUS BUSY	18	
19	MRDC/ MEM READ CMD	20	MWTC/ MEM WRITE CMD
21	IORC/ I/O READ CMD	22	IOWC/ I/O WRITE CMD
23	XACK/ XFER ACK	24	
25	AACK/ ADVANCE ACK	26	
27		28	
29		30	
31	CCLK/ COMMON CLOCK	32	
33		34	
35		36	
37		38	
39		40	
41		42	INTR/ INTERRUPT REQUEST
43	ADR E/	44	ADR F/
45	ADR C/	46	ADR D/
47	ADR A/	48	ADR B/
49	ADR 8/	50	ADR 9/
51	ADR 6/	52	ADR 7/
53	ADR 4/	54	ADR 5/
55	ADR 2/	56	ADR 3/
57	ADR 0/	58	ADR 1/
59		60	
61		62	
63		64	
65		66	
67	DAT 6/	68	DAT 7/
69	DAT 4/	70	DAT 5/
71	DAT 2/	72	DAT 3/
73	DAT 0/	74	DAT 1/
75	GND SIGNAL GND	76	GND SIGNAL GND
77	VBB -10VDC	78	VBB -10VDC
79	VAA -12VDC	80	VAA -12VDC
81	VCC +5VDC	82	VCC +5VDC
83	VCC +5VDC	84	VCC +5VDC
85	GND SIGNAL GND	86	GND SIGNAL GND

CONNECTOR P2

PIN	SIGNAL	COMMENT
P2-1	GND	TEST POINT
P2-16	DB 1	
P2-17	DB 2	
P2-18	DB 3	
P2-19	DB 4	
P2-20	DB 5	
P2-21	DB 6	
P2-22	DB 7	
P2-23	CLOC	
P2-30	RAM 2000 ENABLE/	
P2-32	RAM 3000 ENABLE/	
P2-34	RAM 3800 ENABLE/	
P2-36	RAM 3F00 ENABLE/	
P2-38	PECLN	
P2-40	CCC INH/	
P2-42	DATA BUS INH/	
P2-44	BAUD RATE CLK, TTY	
P2-46	DIS DISABLE	
P2-48	SPKR	
P2-50	BAUD RATE CLK	
P2-52	DE DISABLE	
P2-54	TONE OUT ENABLE	
P2-55	B AND C CLK SEL/	
P2-56	STATUS STROBE	
P2-57	RDY IN INH/	
P2-58	BAUD RATE CLEAR/	
P2-67	OSC/2	TEST POINT

CONNECTOR J1

COMPONENT SIDE		SOLDER SIDE	
PIN	SIGNAL	PIN	SIGNAL
2	GND	1	PORT 2-BIT 3
4		3	PORT 2-BIT 2
6		5	PORT 2 BIT 1
8		7	PORT 2 BIT C
10		9	PORT 2 BIT 4
12		11	PORT 2 BIT 5
14		13	PORT 2 BIT 6
16		15	PORT 2 BIT 7
18		17	PORT 3 BIT 3
20		19	PORT 3 BIT 2
22		21	PORT 3 BIT 4
24		23	PORT 3 BIT 6
26		25	PORT 3 BIT C
28		27	PORT 3 BIT 5
30		29	PORT 3 BIT 1
32		31	PORT 3 BIT 7
34		33	PORT 1 BIT 7
36		35	PORT 1 BIT 6
38		37	PORT 1 BIT 5
40		39	PORT 1 BIT 4
42		41	PORT 1 BIT 1
44		43	PORT 1 BIT C
46		45	PORT 1 BIT 2
48		47	PORT 1 BIT 3
50		49	EXT INTR 1/

CONNECTOR J2

COMPONENT SIDE		SOLDER SIDE	
PIN	SIGNAL	PIN	SIGNAL
2	GND	1	GND
4		3	PORT 5 - BIT 3
6		5	PORT 5 - BIT 0
8		7	PORT 5 - BIT 1
10		9	PORT 5 - BIT 2
12		11	PORT 5 - BIT 4
14		13	PORT 5 - BIT 5
16		15	PORT 5 - BIT 6
18		17	PORT 5 - BIT 7
20		19	PORT 6 - BIT 3
22		21	PORT 6 - BIT 2
24		23	PORT 6 - BIT 1
26		25	PORT 6 - BIT 0
28		27	PORT 6 - BIT 4
30		29	PORT 6 - BIT 5
32		31	PORT 6 - BIT 6
34		33	PORT 6 - BIT 7
36		35	PORT 4 - BIT 7
38		37	PORT 4 - BIT 6
40		39	PORT 4 - BIT 5
42		41	PORT 4 - BIT 4
44		43	PORT 4 - BIT 0
46		45	PORT 4 - BIT 1
48		47	PORT 4 - BIT 2
50	GND	49	PORT 4 - BIT 3

CONNECTOR J3

COMPONENT SIDE		SOLDER SIDE	
PIN	SIGNAL	PIN	SIGNAL
2		1	GND
4		3	TRANSMITTED DATA
6	TTY RD CONTROL	5	RECEIVED DATA
8		7	REQUEST TO SEND
10		9	CLR TO SEND
12		11	DATA SET READY
14	[illegible] TO DATA TERMINAL RDY	13	GND
16	TTY RD CONTROL RET	15	DATA CARRIER RET
18		17	
20		19	
22		21	
24	TTY TX RET	23	
26	GND	25	TTY TX

REV. 3 9-10-81 ADD 224-H INFO. MG/

REV. 4 10-18-84 UPDATED 224X IC INFO TO PARTS LIST & DWG. AV R.T. 10/10/84

FPC DBUG 15

DAB WST&/ A41•

WA1 A45• WAO A44• RA1 A42• RA0 A46•

U54: LS14

REGISTER FILE

DUAL RANK SHIFT REGISTER

SI A51•

SO A43•

10-LS00 10,5, 2,13

MQ/ A58• MI/ A47•

ARUCKE/ A83•

CS3BN/ A48•

ZERO/ A49•

XFER CK A27•

RDREG/ A50•

ACCUM-ULATOR

A90• SAT

PARTIAL PRODUCT REGISTER

RESULT REGISTER

SPARE LOCATION: U1, 1/3 OF U2 AND 1/2 OF U42.

+5

GND

C1, C2 22µf/15V 2 PLACES

4.7µF C3,12,13, 24,25,34, 35,41

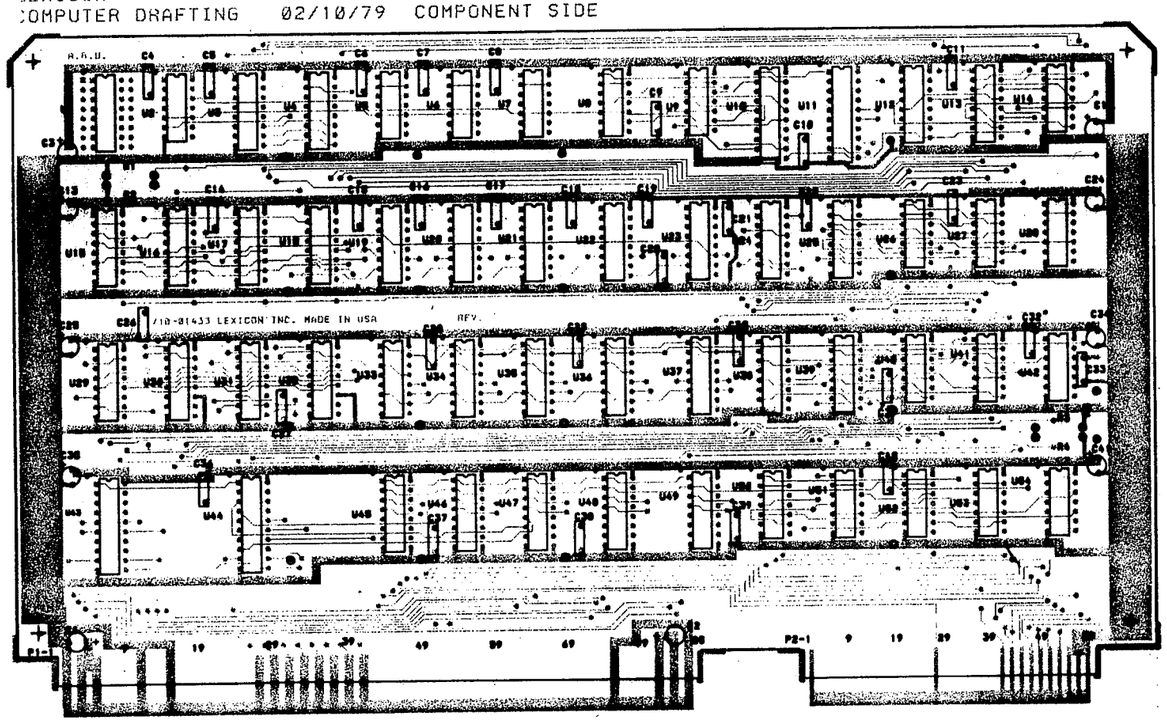
.01 C4-11, C19-23 C26-33, C36-40

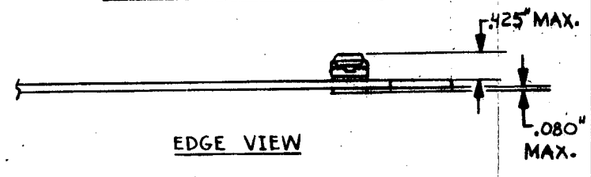
FOR 224X VERSION ONLY	
REF.	PART
U13, U19-U25, U38, U39	74F283
U10, U11, U43, U44	74F374
U12	74S175
U7, U9	74S86
U33, U34, U35, U36, U37	74F157
U54	74S04

LEXICON INC, WALTHAM MA 02154

SCALE: NA	APPROVED BY: CS 7-26-79	DRAWN BY R.KAO	
DATE: 7-11-78		REVISED 4/10-18-84	
ARU - MODEL 224			
SHEET 1 OF 1		DRAWING NUMBER 060-01318	

LEXICON 030-01347 REV NO. 2
COMPUTER DRAFTING 02/10/79 COMPONENT SIDE





EDGE VIEW

NOTES

1. REFER TO PARTS LIST NO. 020-02601
2. COMPONENT HEIGHT MAX. .425"
3. SOLDER TAIL PROTRUSION MAX. .080"
4. SPARE LOCATIONS: U1 & C33.
5. ALL RESISTORS IN Ω.
6. ALL CAPACITORS IN μf UNLESS OTHERWISE SPECIFIED.
7. SOCKET ALL IC POSITIONS EXCEPT U1.

REV.	DATE	DESCRIPTION	INIT/APP'V'D

lexicon

APPROVALS	DATE
DRAWN	4/23/81
CHECKED	4/27/81
ISSUED	12/14/81

PC DOC. ASS'Y DWG.
ARU BD., 224X

SCALE	SIZE	DWG. NO.	REV.
1:1	C	030-02735	0

SHEET 1 OF 1

INPUT CYCLE COUNTER

SELECT CODE DOUBLE BUFFER

STROBE COUNTER

INPUT GAIN COUNTER

OUTPUT GAIN COUNTER

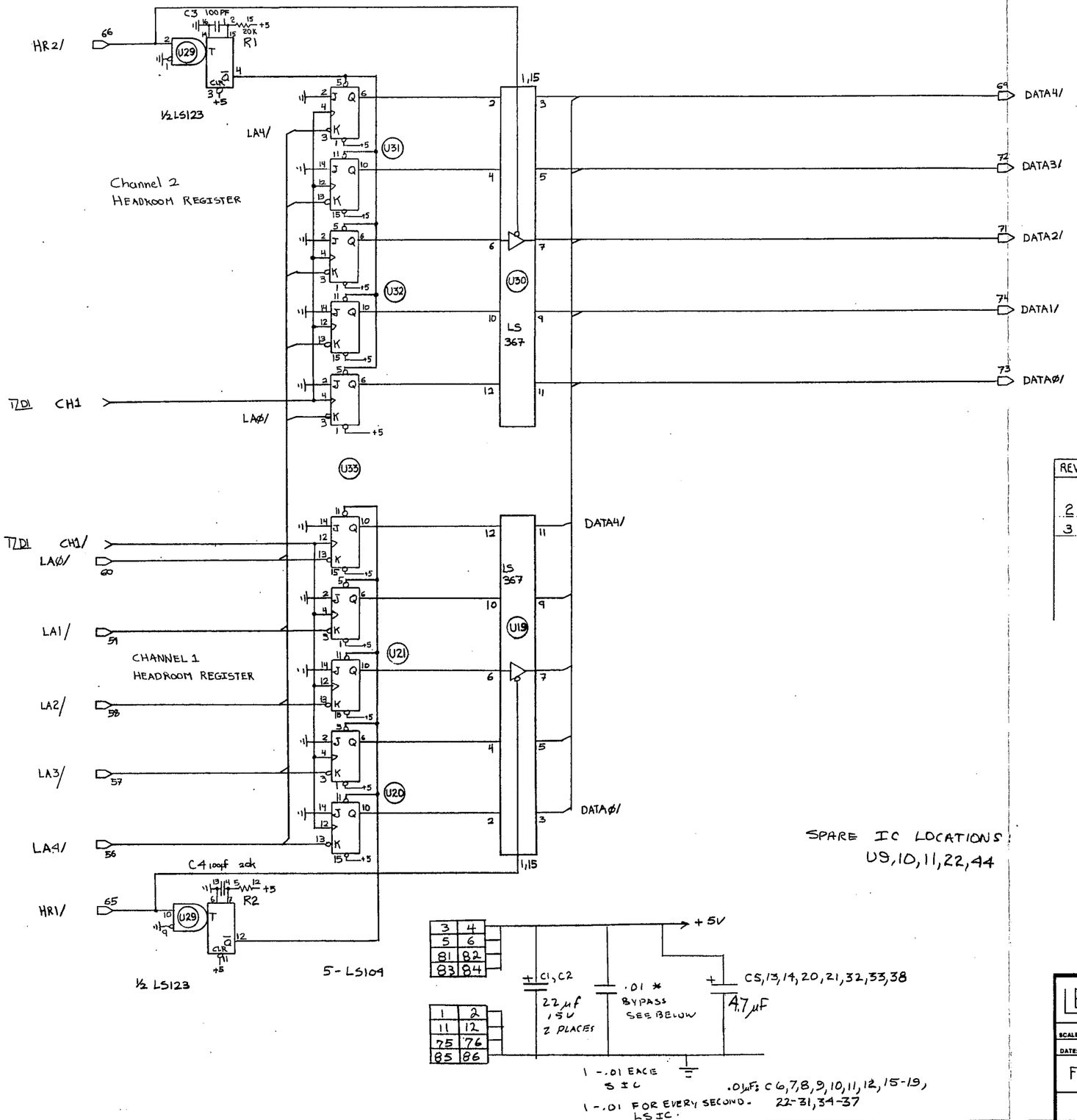
DATA DOUBLE BUFFER

SCNTR

GCNTR

LEXICON INC, WALTHAM MA 02154

SCALE: NA	APPROVED BY C.B.	DRAWN BY R. KAO	
DATE: 7-31-78		REVISED 5/26/82	
FLOATING POINT CONVERTER-MODEL 224			
SHEET 1 OF 2		DRAWING NO. 060-01320	



SPARE IC LOCATIONS:
U9,10,11,22,44

REV.	DATE	DESCRIPTION	INIT.
2	8-14-79	LA9/ - LAØ/ NOW LAØ/ - LA9/	MB
3	5/26/82	CHANGE U43 TO U42	SL

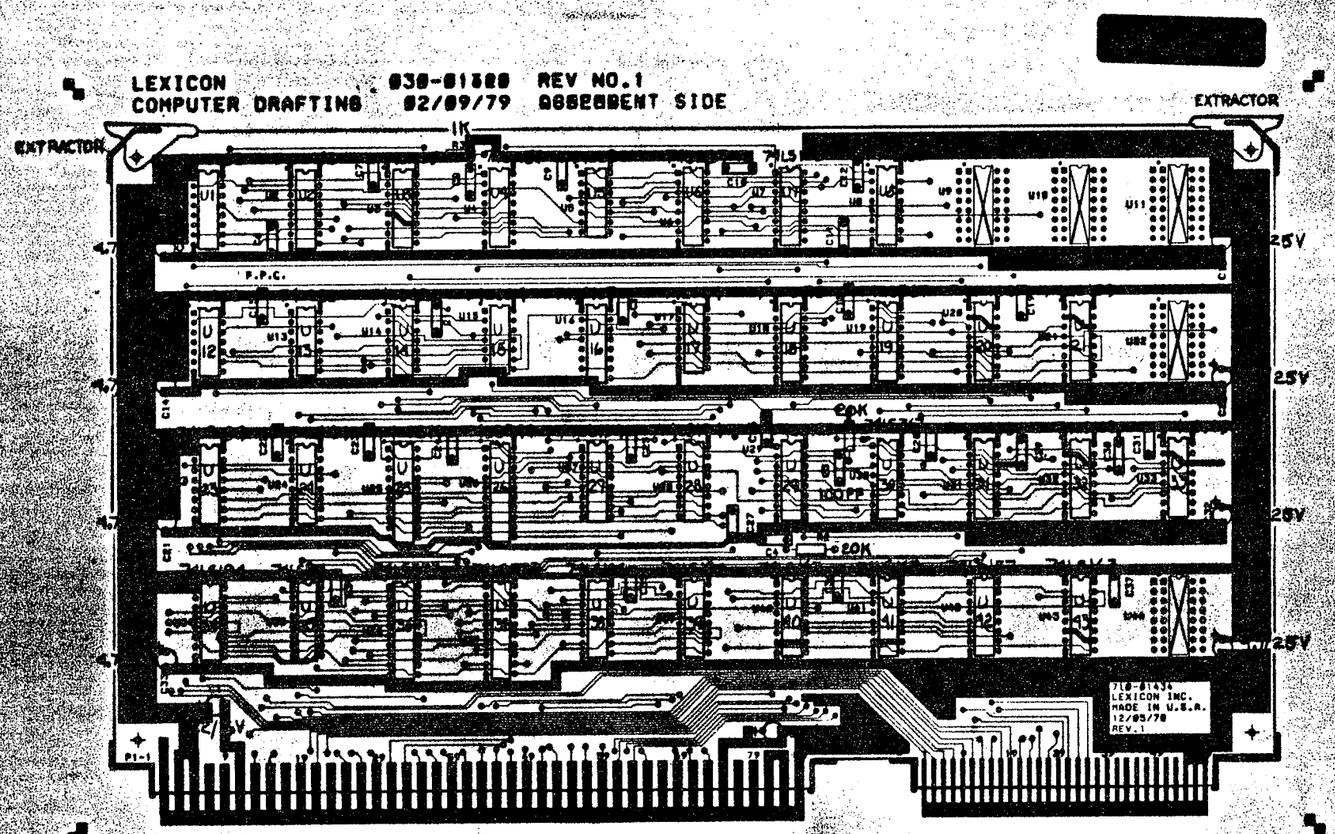
LEXICON INC, WALTHAM MA 02154

SCALE: NA	APPROVED BY: C.B.	DRAWN BY R. Kao
DATE: 8/29/78		REVISED 5/26/82

FLOATING POINT CONVERTER - MODEL 224

SHEET 2 OF 2 | DRAWING NUMBER 060-01320

LEXICON 030-01420 REV NO.1
COMPUTER DRAFTING 02/09/79 ASSEMBLY SIDE



NOTES

1. REF. PARTS LIST NO. 020-01354
2. COMPONENT HEIGHT MAX. 3/8"
3. SOLDER TAIL PROTRUSION MAX. 3/32"
4. SOCKET ALL IC POSITIONS EXCEPT U9, U10, U11, U32 & U44.
5. ALL RESISTORS IN OHMS
6. ALL CAPACITORS IN μf UNLESS OTHERWISE SPECIFIED.
7. BYPASS CAPACITORS AT .01/16V ARE C6-12, 15-19, 22-31, 34-37

REV'E	DATE	REVISIONS	INIT.
1.	3-5-79	COMBINED NOTE 8 WITH NOTE 4	SM

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ±1/64 ANGLES ± 1°	lexicon Inc., WALTHAM, MA. 02154
APPROVALS / DATE	ASS'Y DWG., FPC BOARD
DRAWN JHG 3-29-79	MODEL 224
CHECKED	SCALE 1:1 SIZE C DRAWING NO. 030-01420-C
E.B. 4-5-79	
REV. 1 9-5-79	RECORD OF CHANGES SHEET 1 OF 1

WHEN MAKING BLUELINES OF THIS DWG., USE SETTING "55" ON PRINT MACHINE.

FOR 224X VERSION ONLY	
REF.	PART
U1,6,11,12,13	LF353
R19,25,31,39,46,52,58,66,	JUMPERS
R69,70	JUMPERS
R27,54	5.23K
R15,42	1.5K
R26,53	8.66K
R30,37,38,57,64,65	10.0K
R34,61	6.98K
R24,51	9.76K
R21,48	7.15K
R20,47	14.7K
R18,45	13.3K
R14,41	16.5K
R13,40	11.3K
R35,62	21.0K
R36,63	28.0K
R16,17,22,23,28,29,33,43,	4.99K
R44,49,50,55,56,60,100,102	4.99K
R99,101	133K
R32,59	182K
C88,89 (ELECTROLYTIC)	47/25
C90,91	.1/50

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	CHANGED U14 AND U22 WIRING	1-8-79 JMG	
2	CHANGED R91 FROM 1% TO 5%	3-1-79 JMG	
3	ADD NOTES 8,9,10; CHANGE R82 FROM 3.1K TO 24K; ADD RP3 DETAIL; INDICATE BYPASS CAPS; MISC. CHANGES AND CORRECTIONS	3-16-79 JMG	
4	SEE SHEET 2		
5	INSERT REFS., 2K, ¼W, 5% (2 PLACES) FROM U20, PIN 5 TO U22 PIN 1 & FROM U21, PIN 5 TO U22 PIN 12.	JMG 7-10-79	
6	ASSIGN REF. DESIGNATIONS TO 2 RES. ADDED IN REV. 5; CORRECT PIN-OUT OF U26	JMG 7-18-79	
7	DWG. TITLE WAS "INPUT ANALOG NOW "SCHEMATIC, INPUT BD."	JMG 8-31-79	
8	ADD 224X INFO.	9-11-81 JMG	
9		1-13-79 JMG	SMB

REF.	WAS	NOW
R27,54	1.65K	5.23K
R15,42	4.12K	1.5K
R26,53	5.62K	8.66K
R37,38 64,65	9.31K	10.0K
R24,51	8.25K	9.76K
R21,48	7.32K	7.15K
R18,45	11.5K	13.3K
R14,41	12.1K	14.5K
R20,47	12.1K	14.7K
R13,40	12.7K	11.3K
R19,25,31, 46,52,58	2K TRIM	JUMPERS

CONT. BELOW

REV'S FOR 224X ONLY

NOTES

1. ANALOG GND
2. DIGITAL GND
3. ALL CAPS. OVER .15μf ARE TANT.
4. ALL RES. ¼ W, 5% UNLESS OTHERWISE NOTED
5. ALL 1% RES. ⅛ W SIZE
6. DIODES 4148 UNLESS OTHERWISE NOTED
7. 10 K RES. = 10KX8 NETWORK
8. IC'S 4558 +15V AT PIN 8, -15V AT PIN 4 (U12,U13)
9. OTHER BYPASS CAPS .02μf/16V: C56,57,59, 60,64,65,72,74
10. OTHER BYPASS CAP .01μf/16V, C58
11. HIGHEST REF. NO'S: R102, C93, U26, CR23

REV	DESCRIPTION			DATE	APP'V
9	REF.	WAS	NOW		
	R32,59	JUMPER	182K	224X ONLY	
	R33,60	JUMPER	1.99K		
	R30,57	10.7K	10.0K		
	ADD: R16,17,22,23,28,29,43,44, 49,50,55,56,100,102,99,101, C88-91				
	REF.	WAS	NOW	224X 224Y	
	CR14,15	751	754		
	R91 (AT U17)	2M, 5%	1.24M, 1%		
	U14	LA1-LA3 7819	LA1/-LA3/ 4053		
	C80 U19, PIN 2	.01/100 HIGH	.01/100 LOW		

G1	GØ	A
1	1	+18 dB
1	0	12
0	1	6
0	0	0

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
XX NA
XXX

MATERIAL NA

FINISH NA

DO NOT SCALE DRAWING

CONTRACT NO.

lexicon

APPROVALS	DATE
DRAWN JMG	1-8-79
CHECKED CR	8-6-79
ISSUED	

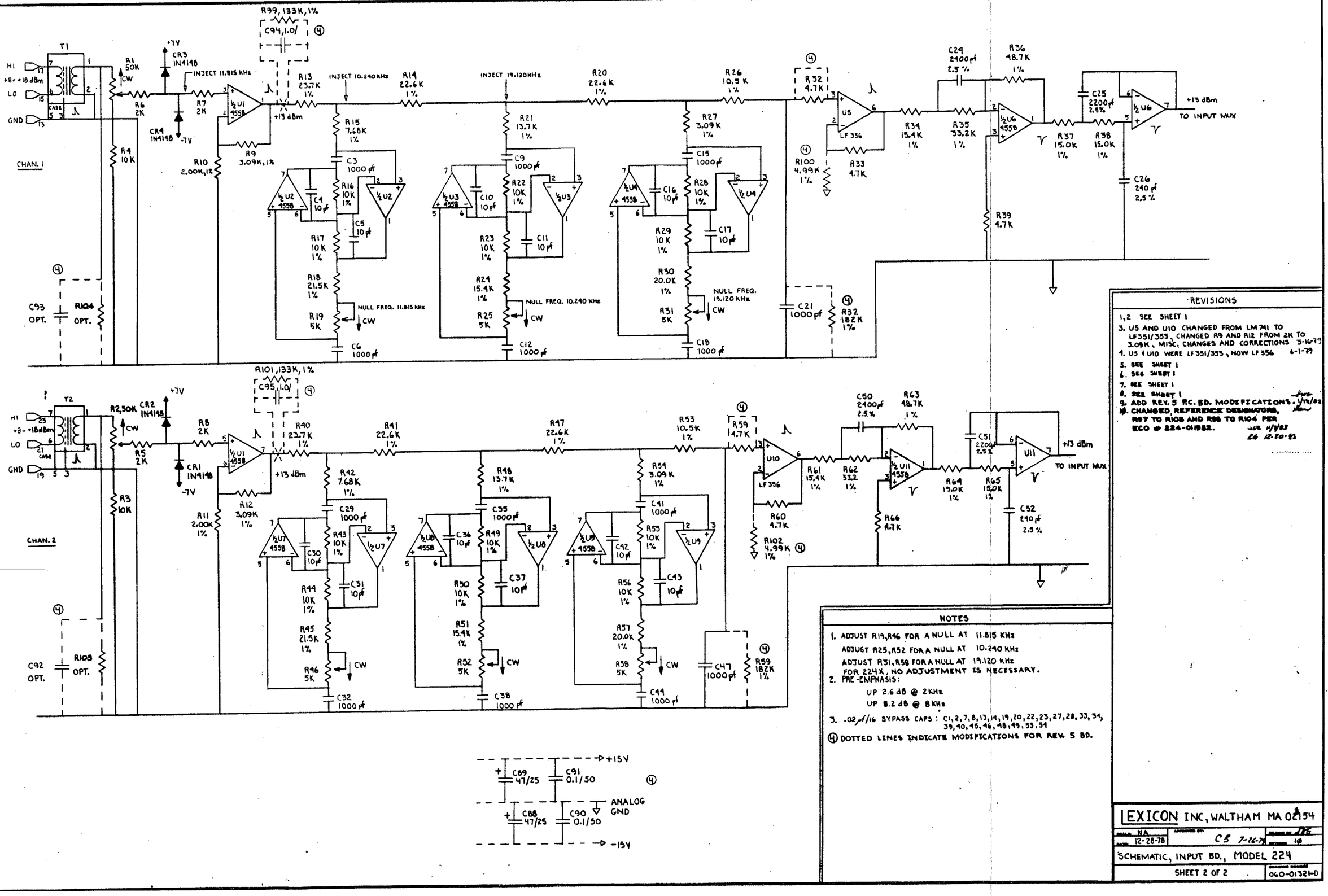
SCHEMATIC, INPUT BD., 224

SIZE | FSCM NO. | DWG. NO. 060-01321-D | REV. 9

SCALE NA | SHEET 1 OF 2

NEXT ASSY	USED ON
	MODEL 224

APPLICATION



REVISIONS

1,2 SEE SHEET 1

3. U5 AND U10 CHANGED FROM LM 741 TO LF351/353, CHANGED R9 AND R12 FROM 2K TO 3.09K, MISC. CHANGES AND CORRECTIONS 3-16-79

4. U5 & U10 WERE LF 351/355, NOW LF 356 6-1-79

5. SEE SHEET 1

6. SEE SHEET 1

7. SEE SHEET 1

8. SEE SHEET 1

9. ADD REV. 5 PC. BD. MODIFICATIONS. 11/8/82

10. CHANGED REFERENCE DESIGNATORS, R97 TO R103 AND R98 TO R104 PER ECO # 224-01982. 11/9/82 4/9/83 LG 12-20-83

NOTES

1. ADJUST R19, R46 FOR A NULL AT 11.815 KHz
   ADJUST R25, R52 FOR A NULL AT 10.240 KHz
   ADJUST R31, R58 FOR A NULL AT 19.120 KHz
   FOR 224X, NO ADJUSTMENT IS NECESSARY.
2. PRE-EMPHASIS:
   UP 2.6 dB @ 2KHz
   UP 8.2 dB @ 8KHz
3. .02 µf/16 BYPASS CAPS: C1, 2, 7, 8, 13, 14, 19, 20, 22, 23, 27, 28, 33, 34, 39, 40, 45, 46, 48, 49, 53, 54

④ DOTTED LINES INDICATE MODIFICATIONS FOR REV. 5 BD.

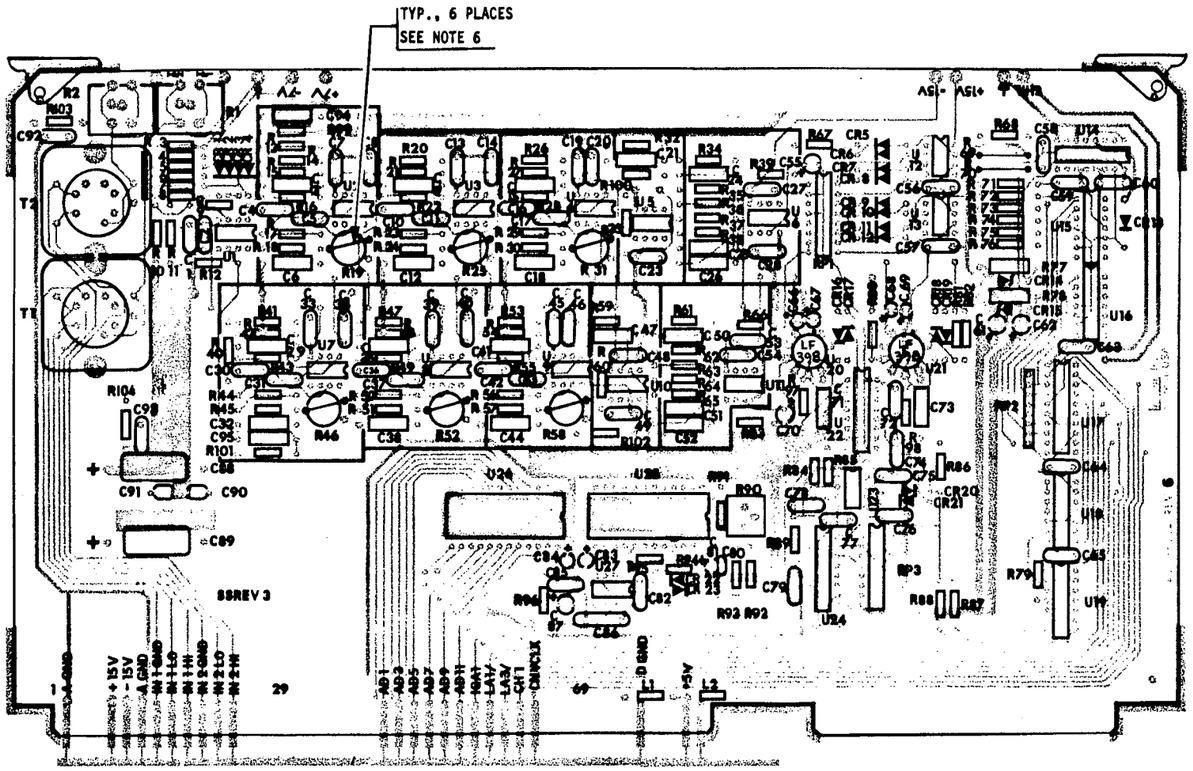
LEXICON INC, WALTHAM MA 02154

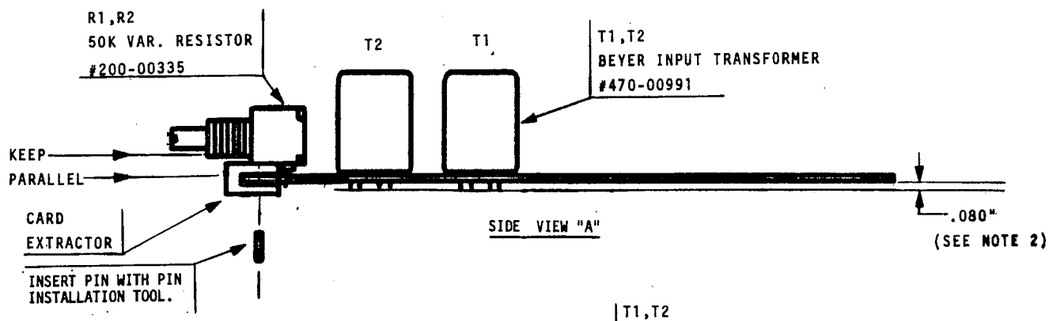
DRAWN NA	APPROVED BY CS 7-26-79	SIZE B	
DATE 12-28-78		REVISED 10	

SCHEMATIC, INPUT BD., MODEL 224

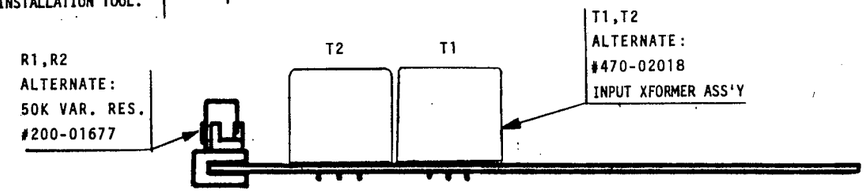
SHEET 2 OF 2

DRAWING NUMBER 060-01321-0





SIDE VIEW "A"



SIDE VIEW "B"

NOTES

1. REFER TO PARTS LIST NO. 020-02603.
2. SOLDER TAIL PROTRUSION MAX. .080"
3. SOCKET ALL IC POSITIONS EXCEPT U20 & U21.
4. EITHER ONE OF THE ALTERNATE PARTS SHOWN IN SIDE VIEW "B" MAY BE SUBSTITUTED ON THIS BOARD.
5. INSTALL LF398 SUCH THAT TAB ON IC CORRESPONDS WITH TAB ON SILKSCREEN. SEE DETAIL.

6. TRIM POTS REPLACED BY JUMPERS: R19,25,31,46,52,58.
7. RESISTORS REPLACED BY JUMPERS: R69 & R70.
8. COMPONENT HEIGHT MAX. .425" EXCEPT POTS AND TRANSFORMERS

REV.	DATE	DESCRIPTION	INIT/APP'V'D
1	12/2/83 JCR	REVISED PER ECO NUMBER 224-011982.	JA 12/2/83 EG 12/20/83

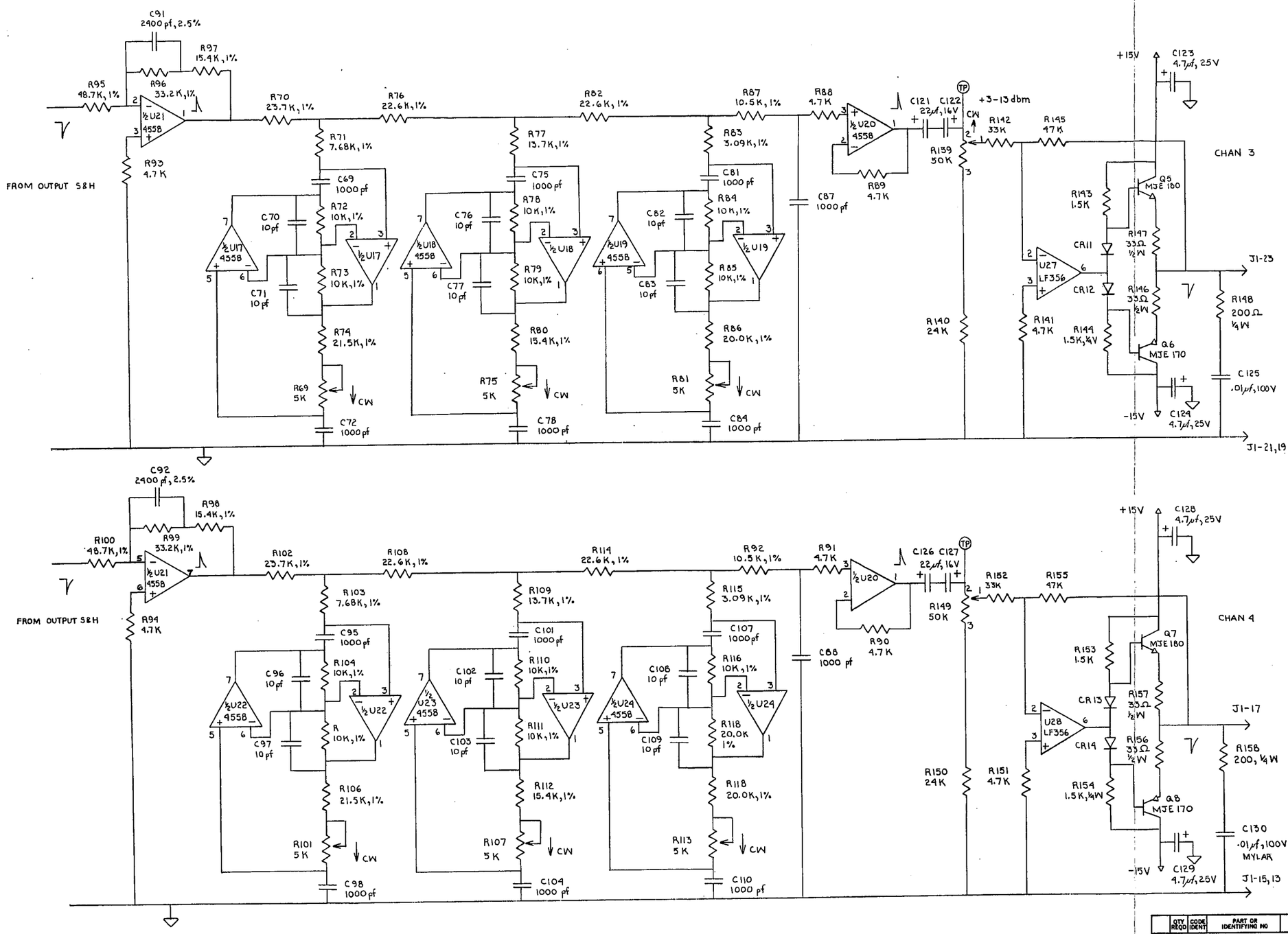
lexicon

APPROVALS	DATE
DRAWN Carl Smith	11/20/81
CHECKED	12-7-81
ISSUED	12/9/81

PC DOC., ASS'Y DWG., ANALOG INPUT BD.,224X

SCALE	SIZE	DWG. NO.	REV.
1:1	C	030-02733	1

SHEET 1 OF 1



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	(SEE SHEET 2)		
	(REV. 2-4 SEE SHEET 1)		
5	ADD NULL FREQ. FOR 224X	1/13/82	[illegible]
6	REDESIGNATE PINS ON U21	5/24/82	dt

NOTES

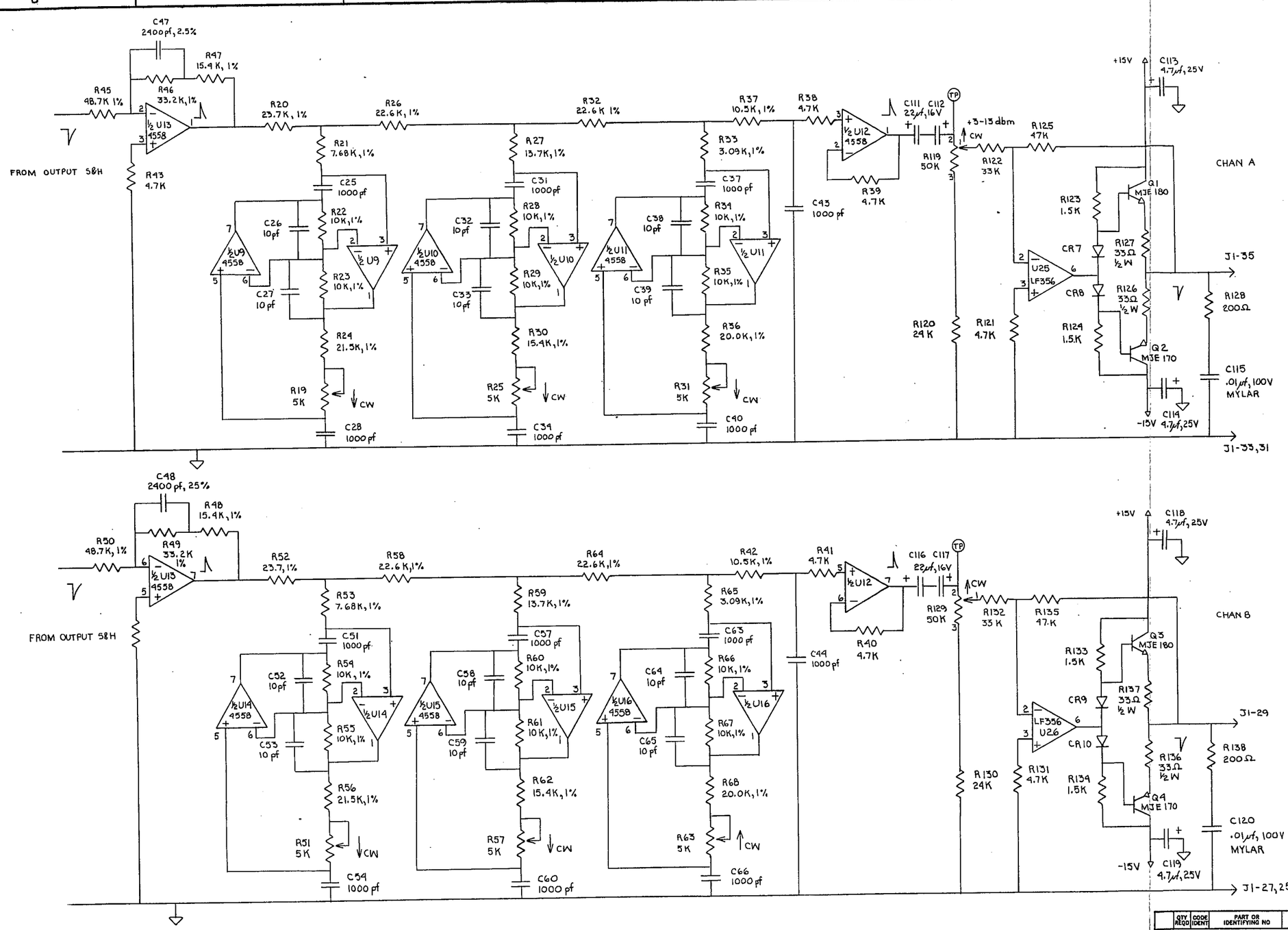
1. ALL RESISTERS ARE 5%, ¼W UNLESS OTHERWISE INDICATED.
2. ALL 1% RESISTERS ARE ⅛W, METAL FILM.
3. ALL 1000µf CAPACITORS ARE POLYPROPYLENE.
4. ALL DIODES ARE IN4148.
5. ADJUST R69, R101 FOR A NULL AT 11.815 kHz
   - - - R75, R107 - - - - - 10.2398 kHz
   - - - R81, R113 - - - - - 19.1204 kHz

   ADJUST R69, R101 FOR A NULL AT 22.153 kHz
   - - - R75, R107 - - - - - 19.200 kHz
   - - - R81, R113 - - - - - 35.850 kHz

* SHEET 1 IS "C" SIZE

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
			PARTS LIST	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX NA .XXX	CONTRACT NO.		lexicon
MATERIAL NA	APPROVALS	DATE	SCHEMATIC, ANALOG OUTPUT BD., 224
FINISH NA	DRAWN MG	1-23-79	
NEXT ASSY / USED ON: 224	CHECKED CB	2-26-79	SIZE C / FSCM NO. / DWG. NO. 060-01322-D / REV. G
APPLICATION	ISSUED		SCALE NA / SHEET 3 OF 3
DO NOT SCALE DRAWING			



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1.	DWG. TITLE WAS "OUTPUT FILTERS" NOW "SCHEMATIC, OUTPUT BD." (REV. 2-4, SEE SHEET 1)	8-31-79	JWG.
5.	ADD NULL FREQ. FOR 224-X	1/13/82	JWG / Mar

NOTES

1. ALL RESISTORS ARE 5%, ¼W UNLESS OTHERWISE INDICATED.
2. ALL 1% RESISTORS ARE ⅛ W, METAL FILM.
3. ALL 1000 pf CAPACITORS ARE POLYPROPYLENE.
4. ALL DIODES ARE IN4198.
5. ADJUST R19, R51 FOR A NULL AT 11.815 kHz
   - - - R25, R57 - - - - - 10.2398 kHz
   - - - R31, R63 - - - - - 19.1209 kHz

   ADJUST R19, R51 FOR A NULL AT 22.153 kHz
   - - - R25, R57 - - - - - 19.200 kHz
   - - - R31, R63 - - - - - 35.850 kHz

*SHEET 1 IS "C" SIZE

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

224			
NEXT ASSY	USED ON		
APPLICATION			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
XX NA
XXX NA
MATERIAL NA
FINISH NA
DO NOT SCALE DRAWING

CONTRACT NO.

lexicon

SCHEMATIC, ANALOG OUTPUT BD., 224

APPROVALS	DATE
DRAWN JWG	1-25-79
CHECKED C.B.	7-26-79
ISSUED	

SIZE D | FSCM NO. | DWG. NO. 060-01322-D | REV. 5

SCALE | SHEET 2 OF 3

REVISIONS (CONT.)					
REV	DESCRIPTION			DATE	APP.
5	REF.	WAS	NOW		
	R24 ETC.	11.5K	10.2K		
	R4	25K	100K		
	R5,6	5K	4.99K		
	R3	1M	1.24M,1%		
	R19,25,31,51,57,63, 69,75,81,101,107, 113 WERE 2K TRIM, NOW DELETED.				
	ADD: R9,12,13,16 C13,16,17,20				
	ALSO: REF. SHEETS 2&3				

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	(REFER TO SHEET 2)		
2	ADD POLARITY & REF. DESIGNATION TO C133	10-6-79 JMS	
3	ADD 224X INFO. JMS	9-10-81	
4	CORRECT U3 PINOUT PIN 6 WAS TO Q9, NOW ↓ ADD PIN 9 TO Q9	12-30-81 JMS	
5	REF. / WAS / NOW: R43,44 93,94 — JUMPER — (DEL.); R30 ETC. — 8.25K — 7.15K; R36 ETC. — 10.7K — 9.53K	1/13/82 JMS JLM	(REV'S CONT. ABOVE LEFT)

FOR 224X VERSION ONLY	
R7,8,10,11,14,15,38,39-41, 88-91	JUMPERS
R33,65,83,115	1.65K
R21,53,71,103	4.12K
R37,42,87,92	5.62K
R47,48,97,98	6.98K
R30,62,80,112	7.15K
R36,68,86,118	9.53K
R24,56,74,106	10.2K
R26,32,58,64,76,82,108,114	12.1K
R20,52,70,102	12.7K
R46,49,96,99	21.0K
R45,50,95,100	28.0K
R27,59,77,109	7.32K
R9,12,13,16,	270Ω
C13,16,17,20	510pf

NOTES

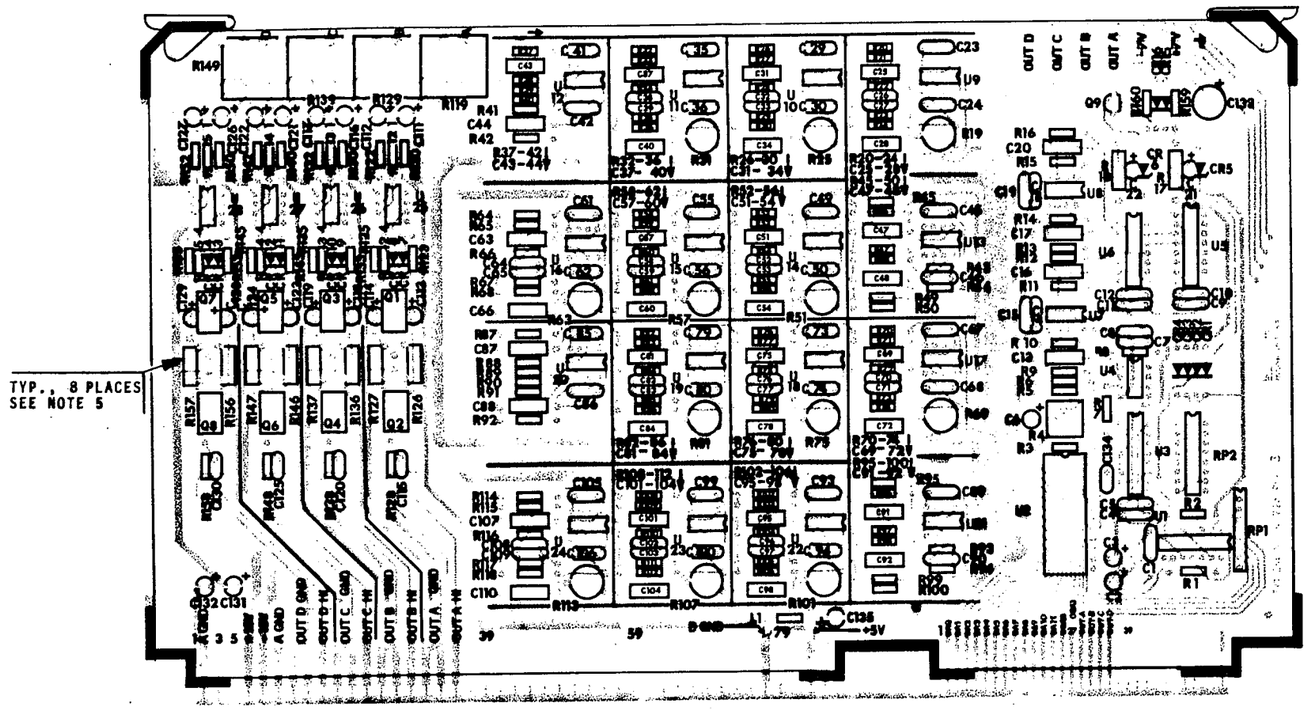
1. CR1–CR4 ARE IN4148
2. RP2 IS A THIN FILM RESISTOR NETWORK, 1K, 0.1% X8

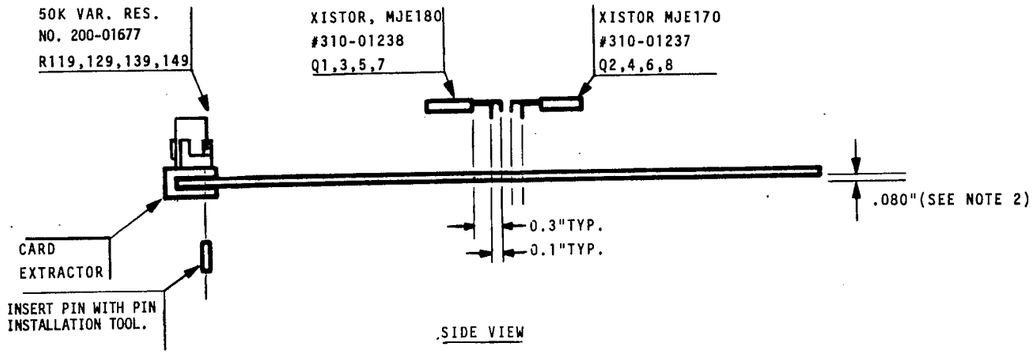
QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX NA .XXX NA	CONTRACT NO.
MATERIAL NA	APPROVALS / DATE: DRAWN JMS 1-19-79; CHECKED C.B. 8-6-79; ISSUED
FINISH NA	lexicon
DO NOT SCALE DRAWING	SCHEMATIC, ANALOG OUTPUT BD., 224
224 / 224X	SIZE C; FSCM NO.; DWG. NO. 060-01322-C; REV. 5
NEXT ASSY / USED ON	SCALE NA; SHEET 1 OF 3
APPLICATION	

SHEETS 2&3 ARE "D" SIZED

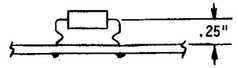




SIDE VIEW

NOTES

1. REFER TO PARTS LIST 020-02605
2. SOLDER TAIL PROTRUSION MAX. .080"
3. SOCKET ALL IC POSITIONS.
4. RESISTORS REPLACED BY JUMPERS:
   R7,8,10,11,14,15,38-41,88-91.
5. R126,127,136,137,146,147,156,157 SHALL BE RAISED .25" FROM THE SURFACE OF THE PC BOARD. SEE DETAIL.



6. COMPONENT HEIGHT MAX. .425" EXCEPT POTS AND INPUT TRANSFORMERS

REV.	DATE	DESCRIPTION	INIT/APP'V'D

lexicon

APPROVALS	DATE
DRAWN	11/14/81
CHECKED	12/7/81
ISSUED	12/11/81

PC DOC., ASS'Y DWG., ANALOG OUTPUT BD., 224X

SCALE	SIZE	DWG. NO.	REV.
1:1	C	030-02734	0

SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	WAS 315-2, NOW 315-1; WAS 315-1, NOW 315-3; +15V WIRE WAS BLU, NOW GRY; -15V WIRE WAS GRY, NOW BLU	7-18-79	
2	CORRECT POLARITY ON CR5	8-5-79	
3	CORRECT FAN PLUG CONN.	8-16-79	
4	OMIT CR7; CR10, NOW CR2; CR10, NOW CR12	2-25-82	
5	ADD VOLTAGE NOTATIONS; 5500/25 CAP WAS C8, NOW C2	5-20-82 JB	CHECKED M.M. 5/23/83 C.P. 5/24/83
6	ADDED FUSE BOARD AND REVISED PS #1, PS #2 AND PS #3	4-21-83 JB	
7	REVISED AS PER ECO #831214-00	12-23-83 JB	SC 7-2-84
8	UPDATE NOTES	2/23/84 JCR	CHECKED JMM 3/23/84 SC 3/26/84 RG 3-27-84

NOTES

1. RESISTORS 5%, ¼W UNLESS OTHERWISE IND.
2. CAPACITORS IN μf UNLESS OTHERWISE IND.
3. DIODES ARE IN4004 UNLESS OTHERWISE IND.
4. ▽ ANALOG GND. ⏚ CHASSIS GND. ⏚ DIGITAL GND.
5. AC WIRING & POWER SUPPLY #1 & #2 ARE ENCLOSED BY DOTTED BOXES; ALL ELSE LIES ON P.S. #3.
6. SEE LEXICON DWG. #080-01611; ASSEMBLY, POWER SUPPLY FOR SEMICONDUCTOR LOCATIONS AND CONN. IDENTIFICATION.
7. ALL VOLTAGES TAKEN WITH INPUT VOLTAGE AT 115V/60Hz AND STD 224 WITH NVS OPTION AS LOAD.

TO TRANSITION BD, REMOTE CONTROL HEAD FOR M224/X/XL. TO MOTHERBOARD (TO PINS A1 AND A2 OF SPEED CONTROL BOARD) FOR M1200/B. BOTH VIA 3 PIN CONNECTOR FROM FUSE BOARD.

1200(ALL)	224X
224XL	224
NEXT ASSY	USED ON
APPLICATION	

PARTS LIST

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

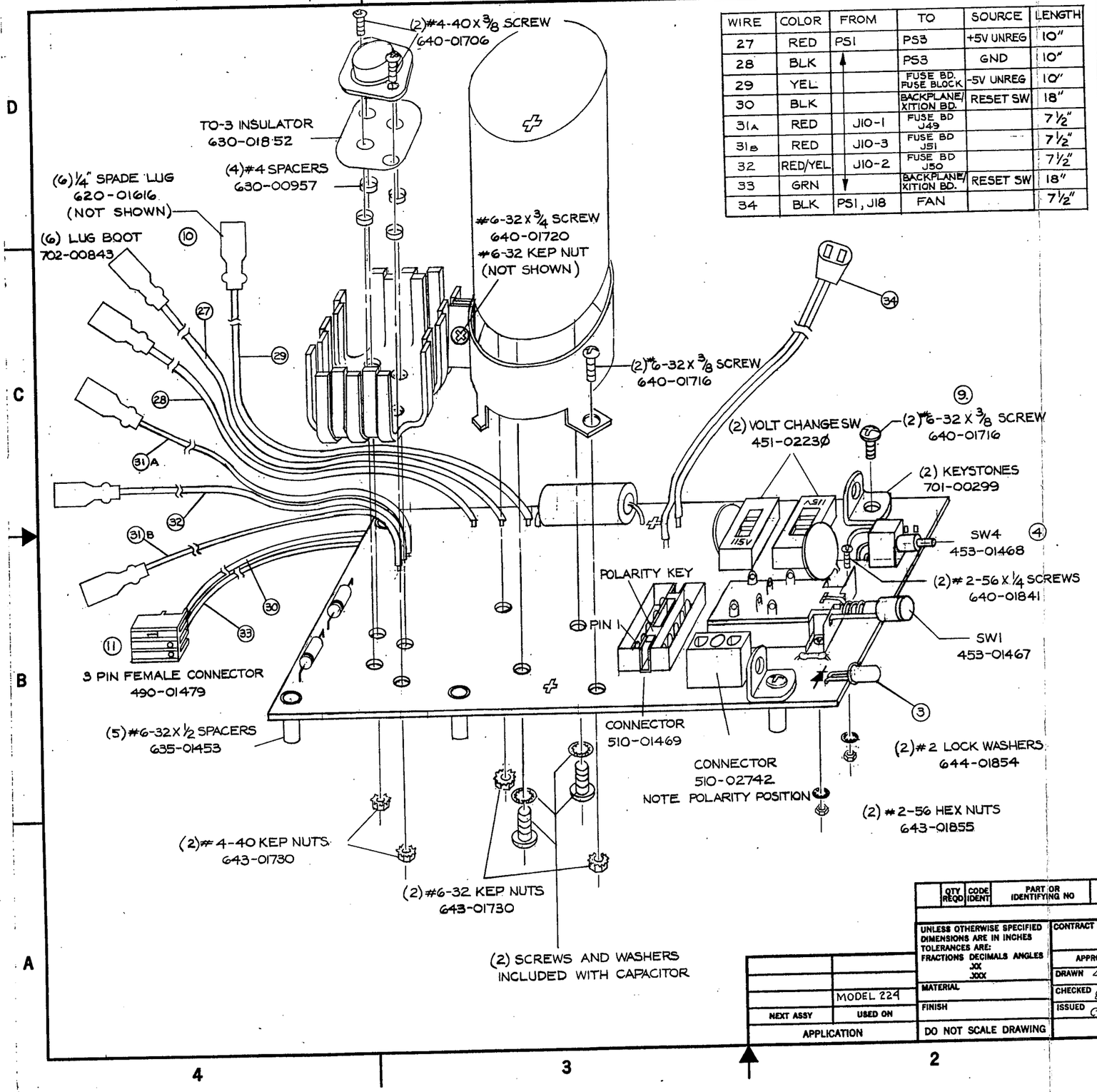
APPROVALS	DATE
DRAWN PMG	6-18-79
CHECKED CB	6-20-79
ISSUED	

lexicon

SCHEMATIC, POWER SUPPLY

SIZE D | FSCM NO. | DWG. NO. 060-01324-D | REV. B

SCALE NA | SHEET 1 OF 1



WIRE	COLOR	FROM	TO	SOURCE	LENGTH
27	RED	PS1	PS3	+5V UNREG	10"
28	BLK		PS3	GND	10"
29	YEL		FUSE BD. FUSE BLOCK	-5V UNREG	10"
30	BLK		BACKPLANE/ XITION BD.	RESET SW	18"
31A	RED	J10-1	FUSE BD J49		7 1/2"
31B	RED	J10-3	FUSE BD J51		7 1/2"
32	RED/YEL	J10-2	FUSE BD J50		7 1/2"
33	GRN		BACKPLANE/ XITION BD.	RESET SW	18"
34	BLK	PS1, J18	FAN		7 1/2"

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	DELETE SPADE LUGS AND COVERS FROM BLACK UL AND WHITE UL WIRES	11-16-79	JMG/A.P.
2	ADD MOLEX CONNECTOR. RELOCATE FAN PLUG. ADD 14 AWG WIRES.	4-12-83 JCR CHECKED 4/13/83 A.H.	CB 9/19/83
3	CHANGED NOTE 1.	5/14/84 JCR	6/7/84

NOTES

1. REFER TO BOM NO. 023-01337 AND ASSEMBLY NOTES FOR POWER SUPPLY BDS. DOC# 080-01802.
2. SOLDER JOINTS OF CONN. PINS MUST BE HOT, USE FLUX AND HIGH WATTAGE SOLDERING IRON
3. BEND LED LEADS ON LEXICON LED BENDING JIG. JIG IS INSCRIBED WITH THE LED PART NO., 930-00904.
4. MOUNT MOMENTARY SWITCH SO THAT THE SWITCH BUSHING IS PARALLEL TO THE P.C. BOARD SURFACE.
5. STRIP WIRE 1/8" FOR HARDWARE CONNECTIONS, STRIP & TIN WIRE 1/4" FOR SOLDER CONNECTIONS.
6. BLACK OUT VOLTAGE CHANGEOVER SWITCHES (#451-02230) WITH BLACK INDELIBLE FELT-TIPPED MARKER.
7. ALL UL WIRE IS UL #1015, 18 AWG, INSUL. .032" THK., RATED FOR 600V, MAX. AMBIENT TEMP. 105° C.
8. TORQUE SPEC.:

#2-56 PNH	MTG. PWR. SWITCH	4 IN. LBS.
#4-40 "	" DIODE BRIDGE	8 "
#6-32 "	" STANDOFFS, KEYSTONE BRACKETS, LG. ELEC CAP	18 "
#10-32 "	MTG. LG. ELEC. CAP	28 "

9. ADD A DROP OF "LOC-TITE #242" TO THE 2 KEYSTONE BRACKET MTG. SCREWS
10. CRIMP TOOL: AMP # 18-14 TYPE F.
11. CRIMP TOOL: MOLEX #11-20-0340.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	USED ON
	MODEL 224
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN 4-20-79	JMG
CHECKED 8-6-79	CB
ISSUED CB	9/19/83

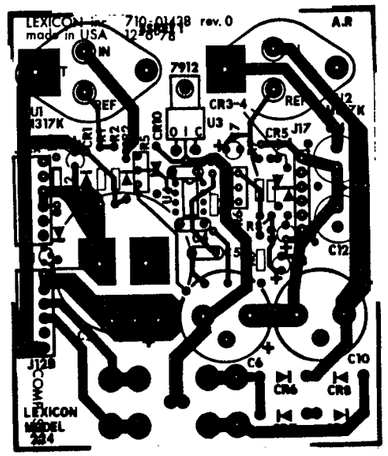
lexicon

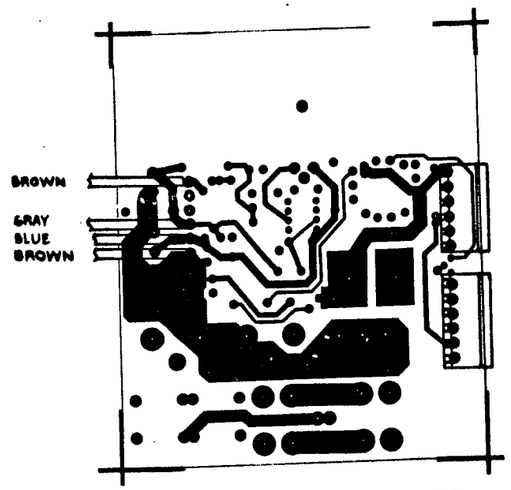
ASS'Y DWG., POWER SUPPLY BD. #1

SIZE	FSCM NO.	DWG. NO.	REV.
C		030-01423-C	3

SCALE 1:1 SHEET 1 OF 1

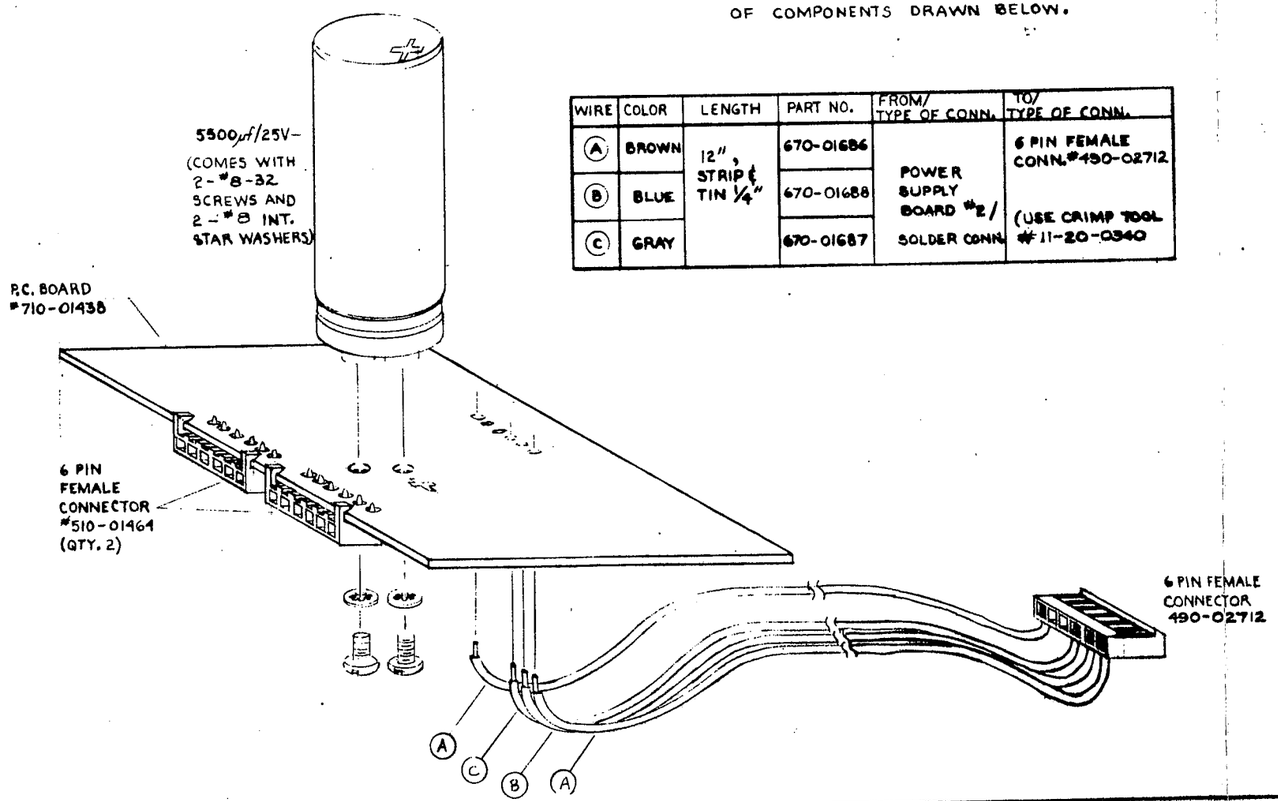
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
1	REVERSE BLUE & GRAY WIRE LOCATIONS	8-31-79	JAS
2	REMOVE FUSES. ADD 6 PIN CONN.	4-12-83 JCR	M.H. 8/23/83 CB 9/9/83
3	CHANGED NOTE 1.	6/4/84 JCR	6/6/84





ETCH SIDE - SHOWING BOTTOM VIEW OF COMPONENTS DRAWN BELOW.

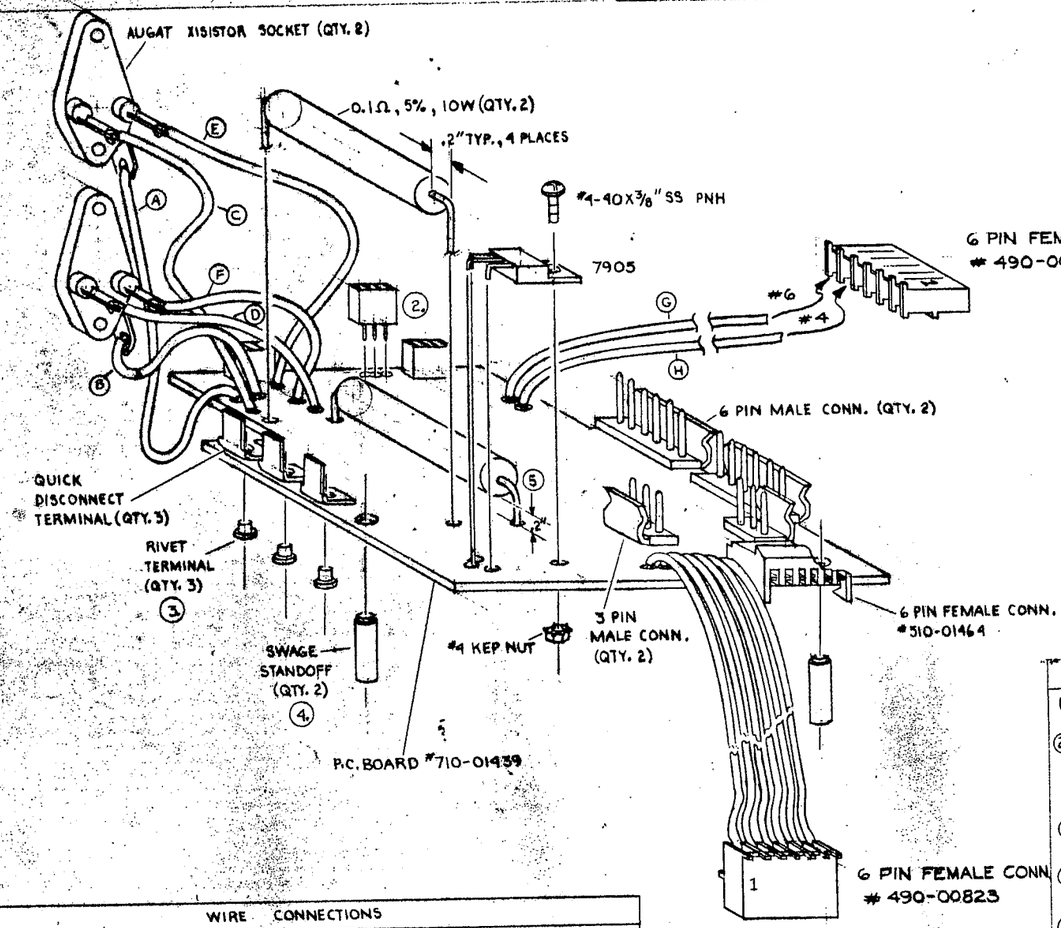
WIRE	COLOR	LENGTH	PART NO.	FROM/ TYPE OF CONN.	TO/ TYPE OF CONN.
(A)	BROWN	12", STRIP & TIN 1/4"	670-01686	POWER SUPPLY BOARD #2/ SOLDER CONN.	6 PIN FEMALE CONN. #490-02712 (USE CRIMP TOOL #11-20-0340
(B)	BLUE		670-01688		
(C)	GRAY		670-01687		

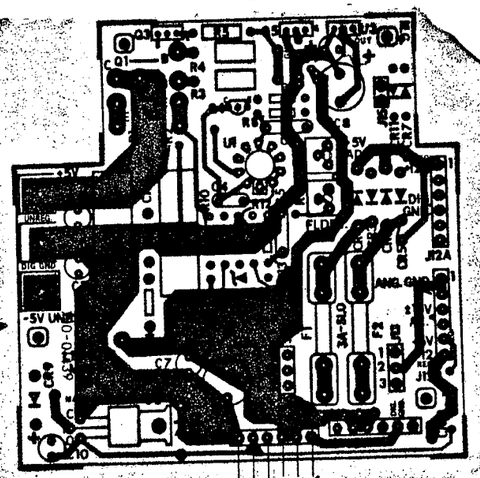


NOTES

1. USE THIS ASS'Y DWG. ALONG WITH BOM NO. #025-01338.
2. TORQUE SPEC: #8-32 PNH MTG. C2 25 IN. LBS.

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DEC ANGLES ± ± ±	lexicon Inc.		
APPROVALS	DATE	ASS'Y DWG., POWER SUPPLY #2	
DRAWN JAS	6-14-79		
CHECKED	CB	SCALE 1:1	SIZE C
ENG. S	8-31-79	DRAWING NO. 030-01424-C	
QUALITY 224		RECORD OF CHANGES	SHEET 1 OF 1





NOTE ORDER OF WIRES

WIRE	COLOR	LEXICON PART NO.	LENGTH	FROM/ TYPE OF CONN.	TO/ TYPE OF CONN.
(A)	RED	670-01688	5½"	AUGAT SOCKET / SOLDER (STRIP & TIN ¼")	POWER SUPPLY BOARD #3 / SOLDER (STRIP & TIN ¼")
(B)			3½"		
(C)	ORANGE	670-01689	5½"		
(D)			3½"		
(E)	PURPLE	670-01690	5½"		
(F)			3½"		
(G)	ORANGE	670-01689	10"	(# 490-00823) 6 PIN FEMALE CONN (2 PLACES) USE CRIMP TOOL # 11-20-0340	
(H)	BLACK	670-01687			
SEE TOP VIEW	BLACK	670-01687	14"		
	YELLOW	670-01691			
	PURPLE	670-01690			
	RED	670-01688			
	RED	670-01688			
	BLACK	670-01687			

WIRE CONNECTIONS

NOTES

1. USE THIS ASS'Y DWG. ALONG WITH BOM NO. #025-01339.
2. NOTE PLACEMENT OF TRANSISTOR SOCKET (3 PLACES)

SIDE VIEW — P.C. BOARD

3. TOOLS FOR INSTALLING RIVET TERMINALS ARE IN MECH. ASS'Y AREA, MARKED WITH AN ORANGE DOT.
4. TOOLS FOR INSTALLING SWAGE STANDOFFS ARE IN MECH. ASS'Y AREA, INSCRIBED WITH #630-01955
5. BOTTOM OF BODY OF R1 / R2 IS OFFSET 0.2" FROM TOP SURFACE OF P.C. BOARD.
6. TORQUE SPEC: #4-40 PNH MTG. 7905 8 IN. LBS.

REV.	DESCRIPTION	DATE	INIT.
1	ADD 6 PIN FEMALE CONNECTORS	4/1/83 JCE	CHECK 4/1/83
2	CHANGED NOTE 1.	6/1/83 JCE	6/1/83

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS DEC. ANGLES
± ± ±

APPROVALS	DATE
DRAWN JAG	6-1-79
CHECKED	6-1-79
REV. 2	
USER ENG. 224	

lexicon Inc.

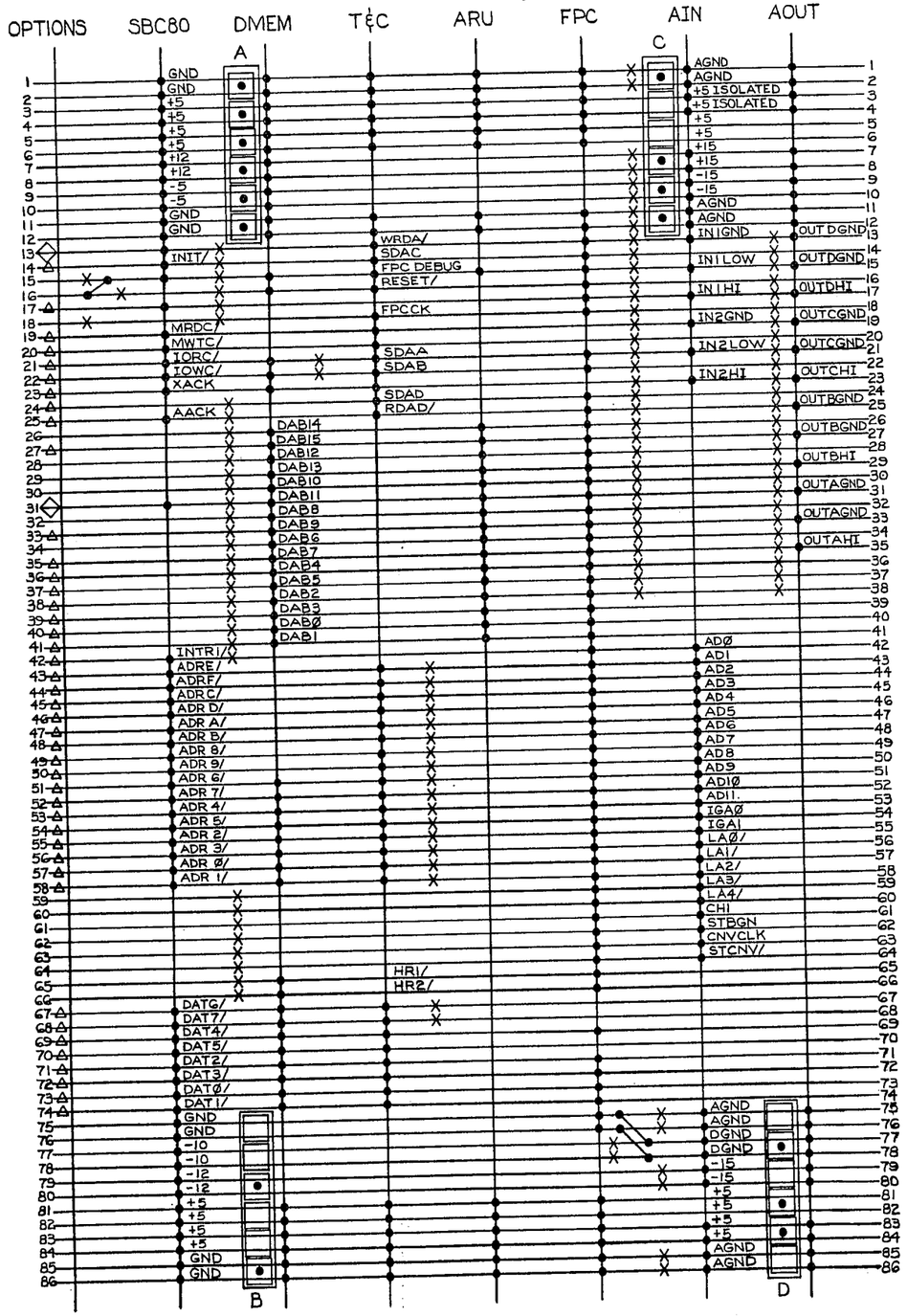
ASS'Y DWG., POWER SUPPLY BD. #3

SCALE 1:1 · SIZE · DRAWING NO. 030-01425-C

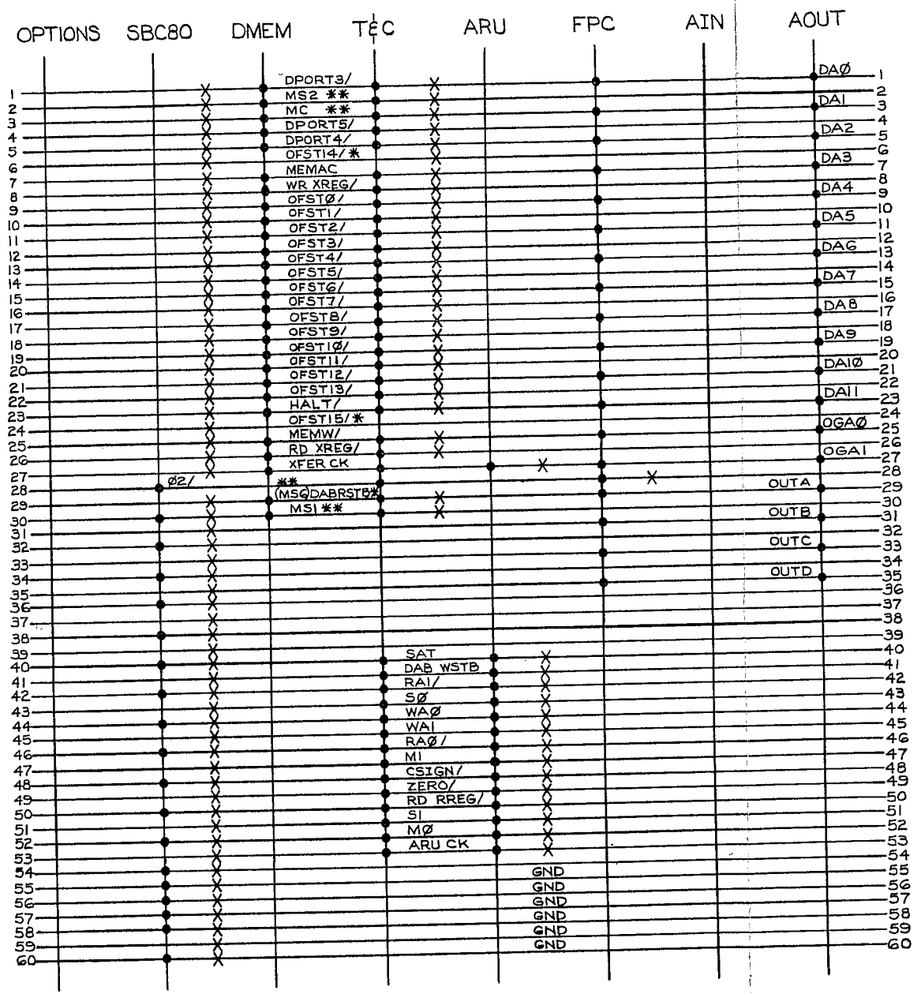
RECORD OF CHANGES SHEET 1 OF 1

WHEN MAKING PRINTS OF THIS DWG., USE SETTING 5 TO 6 ON PRINT MACHINE.

CONNECTOR P1



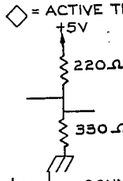
CONNECTOR P2



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
2	REDRAWN AND CHANGED AS PER ECO #830909-00	9-20-83 JB	SHM 9/21/83 CB 9/29/83

NOTES

1. * SIGNALS ADDED FOR 224X
2. ** SIGNALS DELETED FOR 224X
3. X INDICATES CUT IN BUS, BUS RUN MUST BE DELETED BETWEEN SLOTS.
4. ☐ = KK156 POST
5. △ = 2.2K PULL UP, UNLESS OTHERWISE NOTED.
6. ◇ = ACTIVE TERMINATION 220/330 Ω,



7. ⊣ OR ⊢ = CONNECTION TO EDGE CONNECTOR PIN.

PARTS LIST

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

DO NOT SCALE DRAWING

NEXT APPLICATION

USED ON

CONTRACT NO.

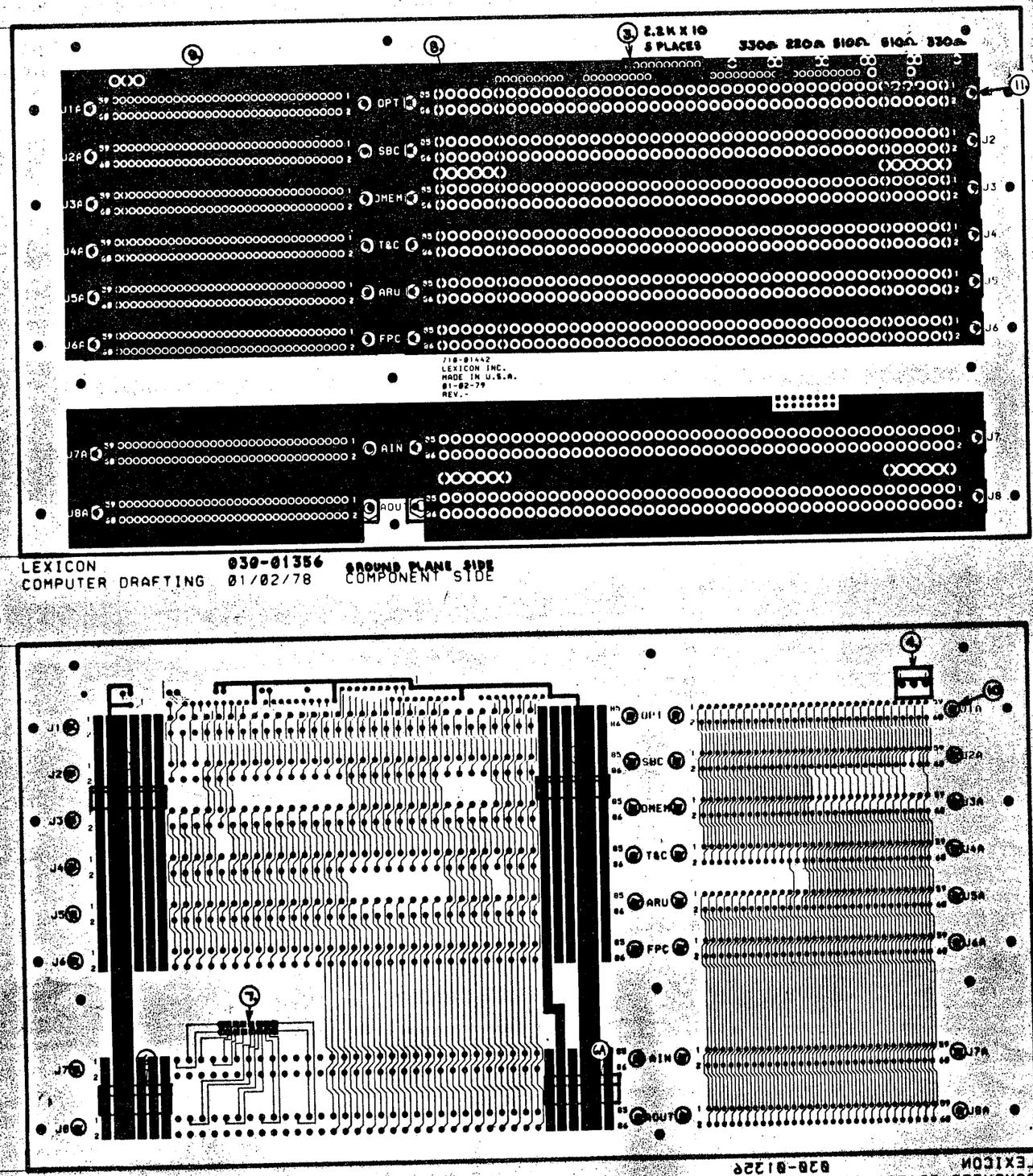
APPROVALS	DATE
DRAWN JB	9-20-83
CHECKED S LHM	9-21-83
ISSUED CB	9/29/83

lexicon

SCHEMATIC, MOTHERBOARD, MODEL 224/X

SIZE D | FSCM NO. | DWG. NO. 060-01360 | REV. 2

SCALE NA | SHEET 1 OF 1



REVISIONS			
REV	DESCRIPTION	DATE	APPR.
1	ADDED LEXICON PARTS LIST NOS., NOTES 10, 11 & 12.	3-20-79	JMG
2	314 (6A) WAS 09-66-1062, NOW 09-65-1065	6/5/79	JMG

APPLICABLE PARTS LIST: LEXICON #020-01342

1. ETCH DOES NOT NEC. CONFORM TO CURRENT REVS.
2. DO NOT SCALE PRINT.
3. ● INDICATES PIN 1 OF RES. NETWORK, 5 PLACES.
4. CONN., MALE, 3 PIN, MOLEX #09-65-1031, 1 PLACE. LEXICON #810-01468
5. CONN., MALE, 5 PIN, MOLEX #09-60-1052, 3 PLACES. LEXICON #490-00827
6. CONN., MALE, 6 PIN, MOLEX #09-65-1062, 1 PLACE. LEXICON #810-01481
7. CONN, MALE, 6 PIN MOLEX #09-64-1065, 1 PLACE. LEXICON #490-00828
8. CONN., MALE, 8 PIN, MOLEX #22-03-2081, 2 PLACES. LEXICON #810-01514
9. CONN., EDGE, 43/86 PIN, ELFAB #851562 A-43 PBB, 8 PLACES. LEXICON #800-01817
10. CONN., EDGE, 30/60 PIN, ELFAB #851930A-30 PBB, 8 PLACES. LEXICON #800-01810
11. SCREW, 4-40 X 1/4, SS, RD. HD. PHIL., 32 PLACES.
12. NUT, HEX, 4-40, 32 PLACES.

FOR ELFAB ASS'Y ONLY

13. PRESS-FIT .025" SQUARE PINS TO .250" EXTENSION ABOVE SURFACE OF BOARD, 16 PLACES. GOLD FINISH
14. PRESS-FIT CONN., EDGE, 43/86 PIN, 8 PLACES.
15. PRESS-FIT CONN., EDGE, 30/60 PIN, 8 PLACES.
16. ALL EDGE CONNECTORS 30μ" SELECTIVE GOLD PLATING.
17. CONNECTOR CONTACT TAILS MAY PROTRUDE 3/32" MAX. FROM BOARD
18. MATERIAL 1/16" FR4 LAMINATE - 2OZ. CU (FINISHED LINE THICKNESS)

Lexicon Inc. WALTHAM, MA. 02154		
SCALE: 1:1	APPR.	DRAWN: JMG
DATE: 3/6/79		REV. 2
MOTHERBOARD ASS'Y DWG.		
MODEL 224		030-01428

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	REDRAWN	3/5/81	
2	ADD GND TO A16 & A24 ADD 12VAC TO A34 ADD JUMPER 41-42 ADD CR5 REF. DES. DELETE INTØ/; ADD INT1/ (A42)	3/24/81 JMS	
3	CORRECT PINOUT - U21 PULL-UP & BYPASS PINS R14 WAS 12K, NOW 13.7K SEE ECO 224-06-19-81	6/29/81 JB	
4	CHANGED U16 FROM 74LS367 TO CD4503, POWERED WITH BATTERY. ADD POWER-ON RESET TO PFAIL CIRCUIT WITH 4.7K AND 22UF. CHANGED: R14 TO 14.7K C21 TO 5% CORRECTED U15 PIN 3 & 7	6-21-83 JB SLMM 6-30-83	C8 7/6/83

NOTES

1. CAPACITORS ARE IN μf/V
2. RESISTORS ARE ¼ W, 5%
3. DIODES ARE IN914 UNLESS OTHERWISE INDICATED.
4. ⏚ INDICATES DIGITAL GND.
5. CONN. PINS ARE ON "A" CONN. UNLESS OTHERWISE INDICATED.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

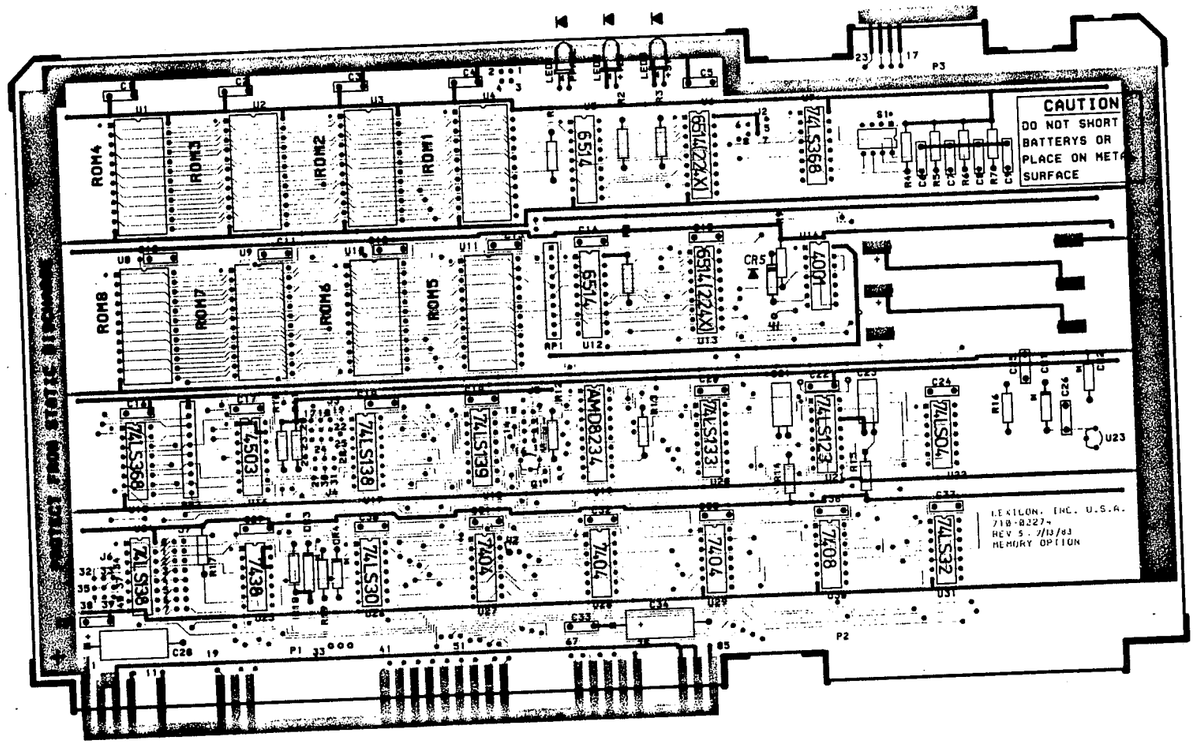
lexicon

APPROVALS	DATE
DRAWN Goldsmith	3/5/81
CHECKED	3/6/81
ISSUED C. Lynch	3/16/81

SCHEMATIC, 224 MEMORY EXPANSION BOARD

SIZE D | FSCM NO. | DWG. NO. 060-02273-D | REV. 4

SCALE NA | SHEET 1 OF 1



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
Ø	RELEASE FOR PRODUCTION	8·15·83 JCR	CLB 9/13/83

NOTES

1. FOR M224 REFER TO BOMS 024-03040 AND 025-03708.
   FOR M224X REFER TO BOMS 024-03704 AND 025-03705.
   FOR M224XL REFER TO BOMS 024-03027 AND 025-03026.
2. SOLDER TAIL PROTRUSION .080" MAX.
3. SOCKET ALL IC POSITIONS.
4. COMPONENT HEIGHT .425" MAX.
5. NOTE DIRECTION OF BATTERIES DURING INSTALLATION.
6. LEDS ARE NOT TO PROTRUDE BEYOND EDGE OF BOARD.
7. DO NOT SOLVENT CLEAN SI OR BATTERIES.
8. JUMPERS INSTALLED FOR STANDARD M224

JUMPER	PINS
J1	3 TO 4
J2	5 TO 6
J3	17 TO 18, 20 TO 21, 23 TO 24
J4	26 TO 27

JUMPERS INSTALLED FOR M224X AND M224XL

J1	1 TO 2
J2	7 TO 8
J3	18 TO 19, 21 TO 22, 24 TO 25
J4	27 TO 28

ONLY POSITIONS J1-J4 GET MALE JUMPER PINS.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES XX XXX	CONTRACT NO.	lexicon
	APPROVALS / DATE	ASSEMBLY DRAWING MEMORY EXPANSION BD., M224/M224X
MATERIAL	DRAWN JCR 8·15·83	SIZE C · FSCM NO. · DWG. NO. 080-02281 · REV. Ø
FINISH	CHECKED MAH. 8/23/83	
DO NOT SCALE DRAWING	ISSUED CLB 8/23/83	SCALE FULL · SHEET 1 OF 1

NEXT ASSY	USED ON
APPLICATION	

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	REDRAWN JB.	4-16-82	

NOTES

1. UNLESS OTHERWISE NOTED, ALL RESISTORS ARE IN OHMS.
2. UNLESS OTHERWISE NOTED, ALL CAPACITORS IN UF/V.
3. ⏚ CHASIS GROUND | ⏚ DIGITAL GROUND
4. 1/A1 DENOTES SHEET NUMBER AND INTERSECT COORDINATE
5. ⟵ ON BOARD CONNECTION - TO ⟶ ON BOARD CONNECTION - FROM
6. HIGHEST REFERENCE DESIGNATION: R16 ; C63 ; U56 ;

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO.		lexicon
	APPROVALS	DATE	SCHEMATIC , MODEL 224X
	DRAWN JB	4-16-82	TIMING AND CONTROL(HIGH SPEED)
	CHECKED M H	5/11/82	
	MATERIAL		SIZE D FSCM NO. DWG. NO. 060-02475-D REV. 1
	FINISH		ISSUED D. Bayuk 5/18/82
M224X / USED ON	NEXT ASSY		SCALE N.A. SHEET 1 OF 2
	APPLICATION	DO NOT SCALE DRAWING	

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	REDRAW JB	5-4-82	

NOTES

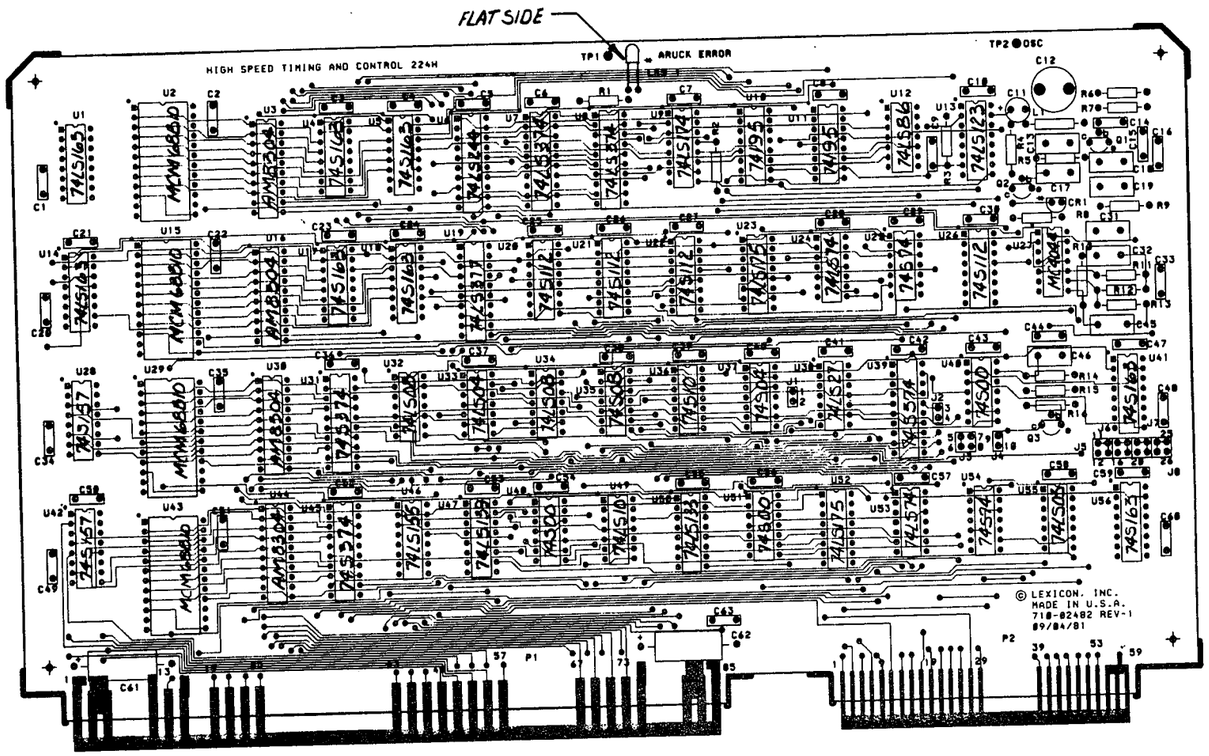
QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

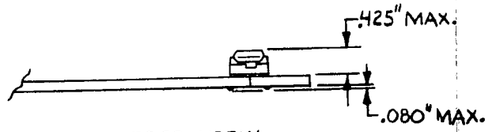
PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX ±
.XXX ±

CONTRACT NO.		lexicon	
APPROVALS	DATE	SCHEMATIC, MODEL 224X, TIMING AND CONTROL (HIGH SPEED)	
DRAWN JB	5-4-82		
CHECKED M H	5/11/82		
ISSUED J. Bayuk	5/18/82	SIZE D; FSCM NO.; DWG. NO. 060-02475D; REV. 1	
MATERIAL		SCALE NA; SHEET 2 OF 2	
FINISH			
DO NOT SCALE DRAWING			

NEXT ASSY	M 224X
APPLICATION	USED ON





EDGE VIEW

NOTES

1. REFER TO PARTS LIST NO. 020-02476.
2. COMPONENT HEIGHT MAX. .425"
3. SOLDER TAIL PROTRUSION MAX. .080"
4. SOCKET ALL IC POSITIONS.
5. ALL RESISTORS IN Ω.
6. ALL CAPACITORS IN μf UNLESS OTHERWISE SPECIFIED.
7. LED SHOULD NOT EXTEND BEYOND THE EDGE OF THE BOARD.
8. SPARE LOCATION: C13.

REV.	DATE	DESCRIPTION	INIT/APP'V'D

lexicon

APPROVALS	DATE
DRAWN J.Goldsmith	11/24/81
CHECKED	12/1/81
ISSUED	

PC DOC., ASS'Y DWG.
T&C BD.,224X

SCALE	SIZE	DWG. NO.	REV.
1:1	C	030-02481	0

SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
2	REDRAWN	4-19-82	
3	CHANGED JUMPERS J1-J4 PER ECO # 830126-00 AND ADDED DOCUMENT CONTROL BLOCK	5/1/85	J. Custer 5/7/85

NOTES

1. RESISTORS ARE IN OHMS.
2. CAPACITORS ARE IN μF UNLESS OTHERWISE INDICATED.
3. ICS 1-16 ARE IDENTICAL, ICS 20-35 ARE IDENTICAL.
4. ON BOARD CONNECTIONS
   → TO ← FROM
5. DIGITAL GND ⏚
6. 7/A1 DENOTES SHEET NO. AND INTERSECT COORDINATE.

A14 64K x 1 x 16 150 nsec.

DOCUMENT CONTROL BLOCK	
SHEET	REVISION
1 OF 2	3
2 OF 2	3

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN JCR	4-19-82
CHECKED MH	4/24/82
ISSUED CR	4/14/82

lexicon

SCHEMATIC, DATA MEMORY AND I/O
MODEL 224X

SIZE D | FSCM NO. | DWG. NO. 060-02512 | REV. 3
SCALE NA | SHEET 1 OF 2

NEXT ASSY | USED ON
APPLICATION

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
2	REDRAWN	4-19-82	
3	CHANGED JUMPER J5 PER ECO # 830126-00	5/1/85	9 Curtis 5/7/85

-5V — C20,38,85 — 22µF 25V — 0.1µF 50V — -5V — C2,4,6,8,10,12,14,16,43,45,47,49,51,53,55,57

+12V — C84 47µF 25V — C42,37 22µF 25V — 0.1 50V — +12V — C1,3,5,7,9,11 13,15 44,46,48,50,52 54,56,58,83

SEE BYPASS RULES FOR MEMORY ARRAY

+5V — C82,86 47µF 25V — 0.1 50V — 0.1 50V — +5V — C17,39,59-68,71-78

GND — C18,19,21-36,40,41,69,70,79-81,87

U52 1/4 LS03

RESET ← 1/D7

R6, 1K +5V

1/6 S04 U58E

1/4 LS03 U52

ADR7/ 52
ADR6/ 51
ADR5/ 54
ADR4/ 53
ADR3/ 56
IOWC/ 22
IORC/ 21

U54B 1/2 LS20

U55 LS138 — G2A, G1, G2B, C, B, A — Y7 OUT PORT Ø, Y6, Y5, Y4, Y3, Y2 CPCCLR, Y1 OUT PORT 7, Y0

U53A 1/4 LS00 — U53B 1/4 LS00 — U53D 1/4 LS00 — U54A 1/2 LS20 — U53C 1/4 LS00 — HALT/ → A23 HALT/

XACK/ → 23

1/6 S04 U58F

CPCCLR 1/D8
WRL XREG/ 1/A8
WRH XREG/ 1/A8

ADR2/ 55
ADR1/ 58
ADRØ/ 57

U56 LS138 — G2A, G1, G2B, C, B, A — Y7 INPORT Ø, Y6, Y5, Y4, Y3, Y2, Y1, Y0 INPORT 7

DPORT Ø/ 1/D8
DPORT 1/ 1/D8
DPORT 2/ 1/D8
DPORT 3/ A1
DPORT 4/ A5
DPORT 5/ A4
RDL XREG/ 1/A8
RDH XREG/ 1/A8

1/6 S04 U58B

U57 LS138 — G2A, G1, G2B, C, B, A — Y7 INPORT 8, Y6 INPORT 9

HRI/ 65
HR2/ 66

1/8 LS244 U61A — 1/8 LS244 U61G — 1/8 LS244 U61F — 1/8 LS244 U61D — 1/8 LS244 U61C

1/C2 AI4
MEMAC A7
DAB RSTB (M56) A29
MSI A30
MC A3

DIGITAL DELAY MODULE

DLG308 U59 — 30ns, 60ns, 120ns, 150ns — +5V

U46A 1/2 S74

1/4 S02 U60C — 1/4 S02 U60B — U47B 1/2 S74 — U47A 1/2 S74 — U60D 1/4 S02 — U46B 1/2 S74 — 1/4 S02 U60A

1/4 S00 U44A — U44B — U44C — 1/6 S04 U58D — U43A 2/3 S10 — U43B 2/3 S10

1/4 S08 U45B — 1/4 S08 U45A

R3 1K +5V

R2 33Ω CAS Ø/ 1/B8
R1 33Ω CAS1/ 1/B8
ROW SEL 1/C8
R4 33Ω RAS/ 1/A8

* NOT USED IF DIGITAL DELAY MODULE IS USED.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
XX
.XXX

MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
DO NOT SCALE DRAWING

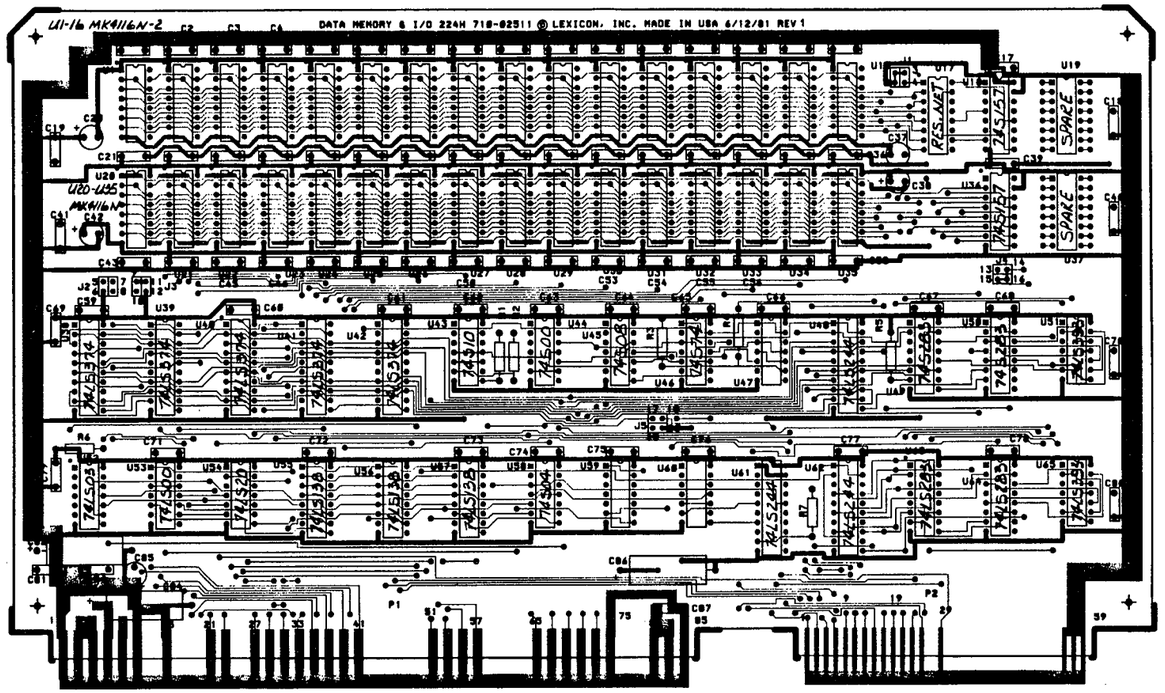
CONTRACT NO.

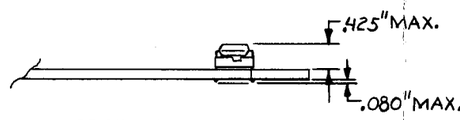
APPROVALS	DATE
DRAWN JCR	4-21-82
CHECKED MH	4/26/82
ISSUED CB	4/26/82

lexicon

SCHEMATIC, DATA MEMORY AND I/O MODEL 224-X

SIZE D | FSCM NO. | DWG. NO. 060-02512 | REV. 3
SCALE NA | SHEET 2 OF 2





EDGE VIEW

NOTES

1. REFER TO PARTS LIST NO. 020-02510.
2. COMPONENT HEIGHT MAX. .425"
3. SOLDER TAIL PROTRUSION MAX. .080"
4. SOCKET ALL IC POSITIONS EXCEPT U19,U37,U47,U60.
5. U59, A DELAY MODULE, REQUIRES NO SOCKET.
6. U17, A RESISTOR ARRAY, REQUIRES NO SOCKET.
7. ALL RESISTORS IN Ω.
8. ALL CAPACITORS IN μf UNLESS OTHERWISE SPECIFIED.

REV.	DATE	DESCRIPTION	INIT/APP'V'D

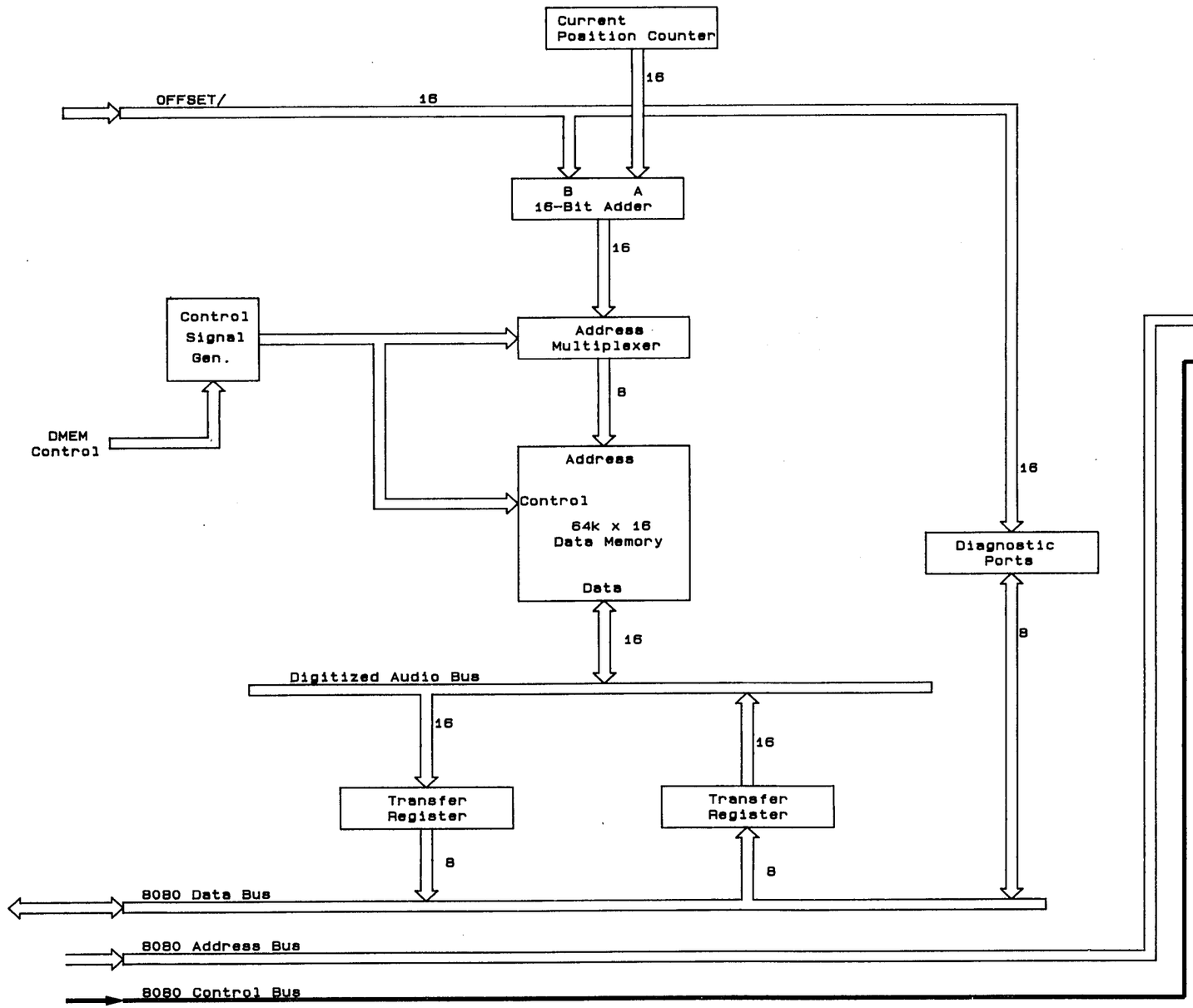
lexicon

APPROVALS	DATE
DRAWN	11/24/81
CHECKED	12/7/81
ISSUED	12/11/81

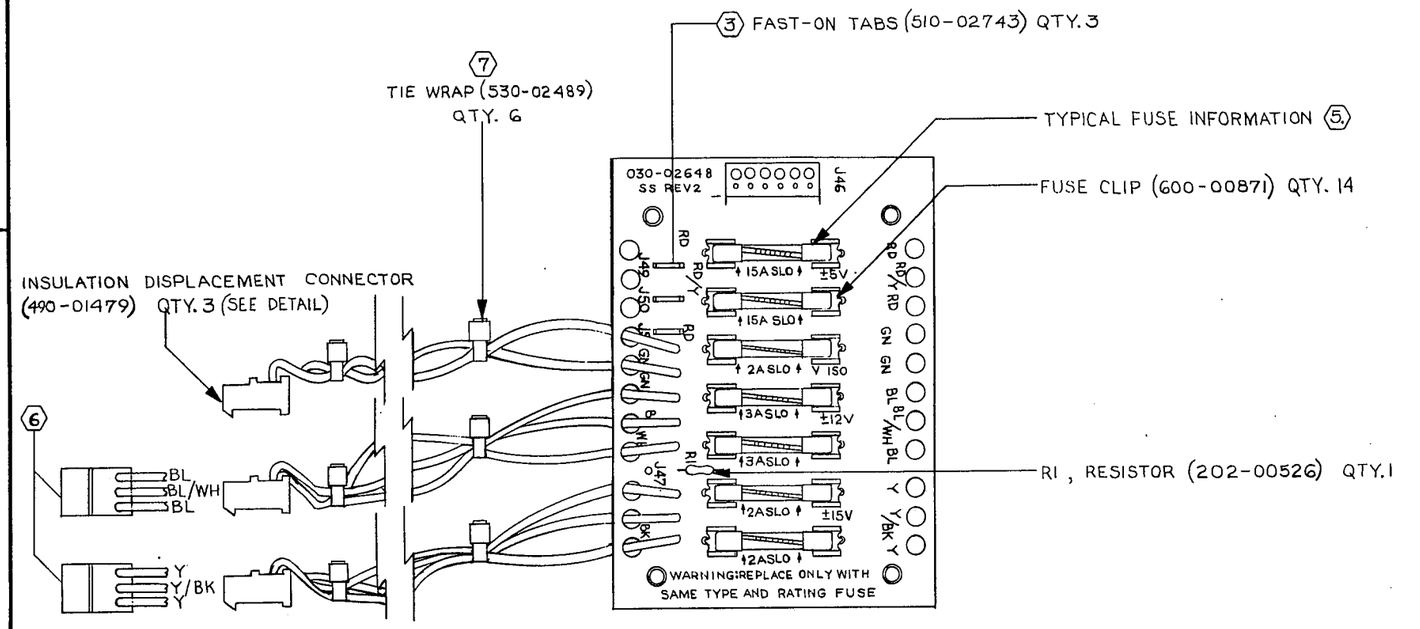
PC DOC., ASS'Y DWG., DMEM BD., 224X

SCALE	SIZE	DWG. NO.	REV.
1:1	C	030-02516	0

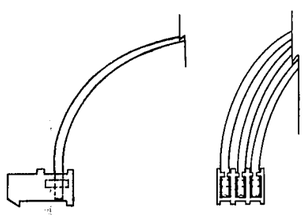
SHEET 1 OF 1



BLOCK DIAGRAM
DATA MEMORY AND I/O
MODEL 224X



DETAIL



LEAVE WIRE END CUT FLUSH.
PRESS WIRE INTO END OF CONNECTOR UNTIL CONTACT IS MADE AS SHOWN.

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED

NOTES

1. REFER TO PARTS LIST NO. 020-02644.
2. SWAGE PROCEDURE:
   A. 4 SWAGE STANDOFFS
   B. STAKING TOOL & ANVIL - KEYSTONE TL-21
   C. TORQUE: APPOX. 40 FT.-LBS. SPACER SHOULD BE FIRMLY SECURED IN PC BOARD.
3. INSTALL FAST-ON TABS USING KEYSTONE TOOL NUMBER 1288 AT J49, J50 & J51.
4. NOTE PIN 1 LOCATION OF J46.
5. NOTE LOCATIONS OF 3 SEPARATE TYPES OF FUSES. FOLLOW SILKSCREENED INFORMATION ON PC BOARD.
6. FOLLOW PCBOARD SILKSCREENED INFORMATION FOR LOCATION OF WIRES ACCORDING TO COLOR.
7. USE 2 TIE WRAPS EVENLY SPACED TO BUNDLE EACH GROUP OF WIRES.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	224
APPLICATION	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN JB	5-20-82
CHECKED MH	5/21/82
ISSUED CB	6-8-82

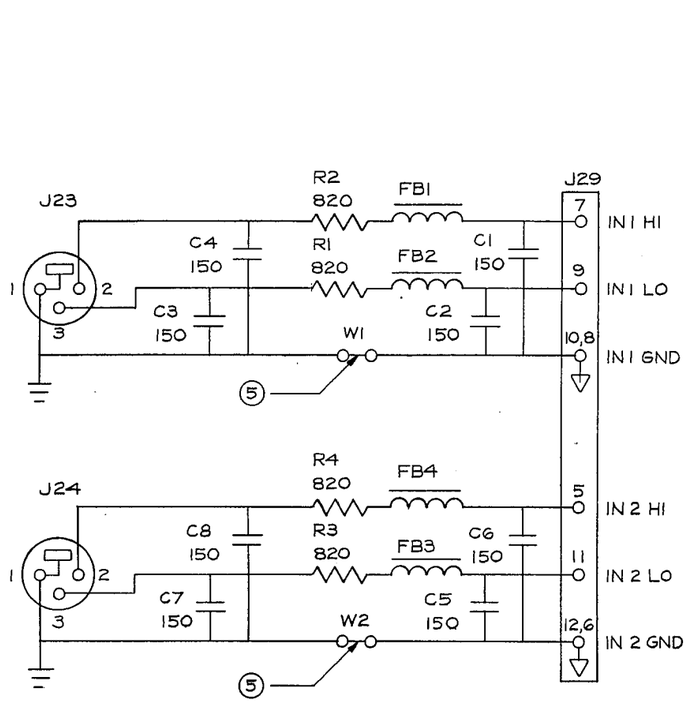
lexicon

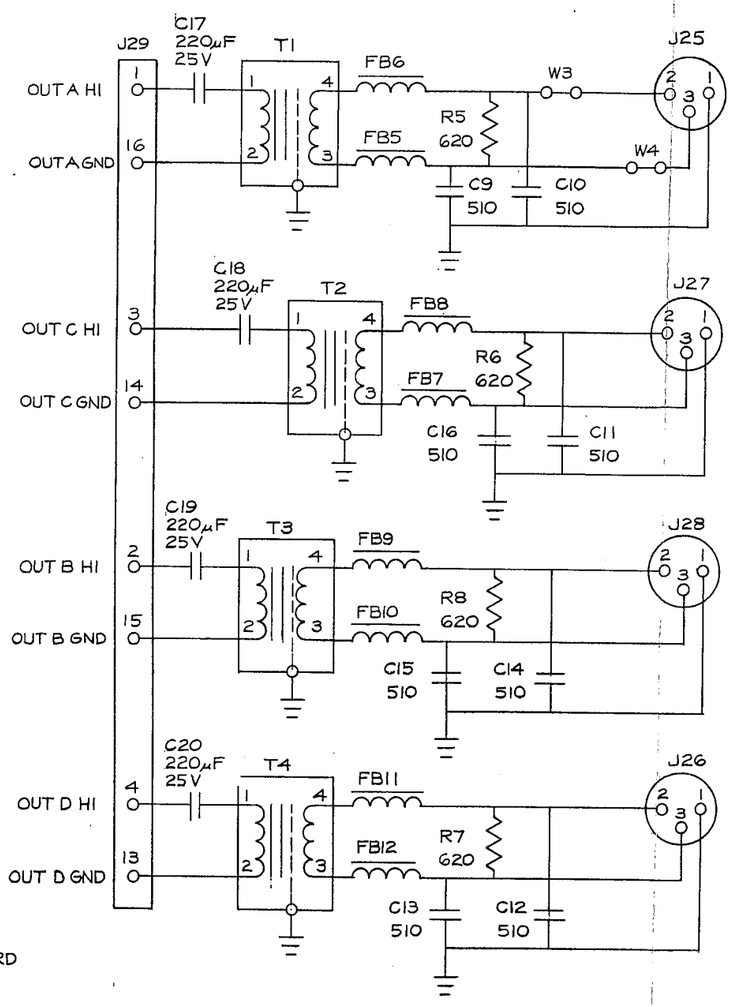
P.C. DOC., ASSEMBLY DRAWING
FUSE BOARD, 224 CHASSIS

SIZE	FSCM NO.	DWG. NO.	REV.
C		030-02647	0

SCALE 1:1 SHEET 1 OF 1

DWG. NO. SH. REV. B





MOTHERBOARD

DUAL IN LINE 16 PIN HEADER J29	AUDIO I/O CONNECTOR	AUDIO BOARD EDGE CONNECTOR		
16	1	31/33	A GND	A OUT CARD
1	2	35	A HI	
15	3	25/27	B GND	
2	4	29	B HI	
14	5	19/21	C GND	
3	6	23	C HI	
13	7	13/15	D GND	
4	8	17	D HI	
12	9			
5	10	23	IN 2 HI	A IN CARD
11	11	21	IN 2 LO	
6	12	19	IN 2 GND	
10	13			
7	14	17	IN 1 HI	
9	15	15	IN 1 LO	
8	16	13	IN 1 GND	

INTERBOARD CONNECTIONS DETAIL (FUNCTIONS)

REVISIONS				
REV.	DESCRIPTION		DATE	APPROVED
4	REDRAWN		3.24.82	
5	SYMBOL / WAS / NOW		5-18-82 JB	MH. 5/19/82 CB 7/27/82
	J23, J24	XLR-D3F / XLR-NEUTRIK 3FDV		
	J25-J28	XLR-D3M / XLR-NEUTRIK 3 MDV		

NOTES

1. ALL RESISTORS IN OHMS
2. ALL CAPACITORS IN PF UNLESS INDICATED. CAPACITORS 17-20 ARE NONPOLARIZED.
3. J29 IS ANSLEY # 609-M161 MASS TERM.
4. J23, J24 ARE XLR-NEUTRIK -3FDV
   J25-J28 ARE XLR-NEUTRIK -3 MDV
5. LINK SHOWN IS THE ONLY GROUND LINK BETWEEN ANALOG GND AND CHASSIS.
6. ⏚ CHASSIS GND ▽ ANALOG GND

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	224
USED ON	
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN JCR	3-24-82
CHECKED S LAM	3-25-82
ISSUED C. Bryant	4-13-82

lexicon

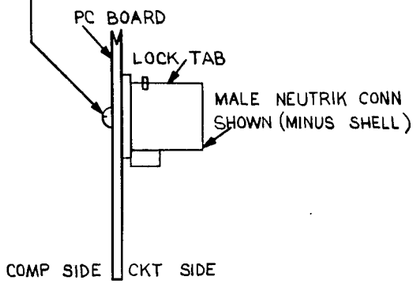
OUTPUT TRANSFORMER BD. SCHEMATIC, 224

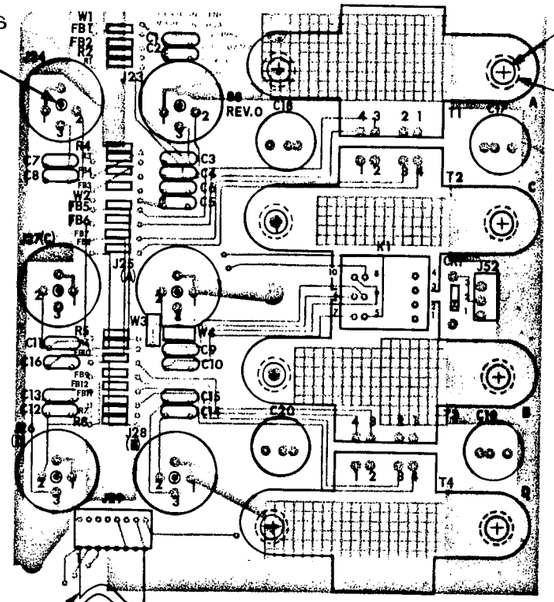
SIZE C | FSCM NO. | DWG. NO. 060-01359-C | REV. 5

SCALE NA | SHEET 1 OF 1

DWG. NO. | SH. | REV.

#2-56 X 3/16 THREAD FORMING SCREWS
P/N 641-02827 QTY (6) PLACES

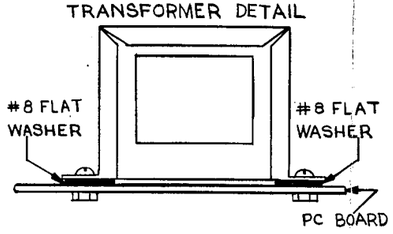




PAN HEAD PHILLIPS SCREW
#6-32 X 3/8 P/N 640-01716
QTY (8) PLACES

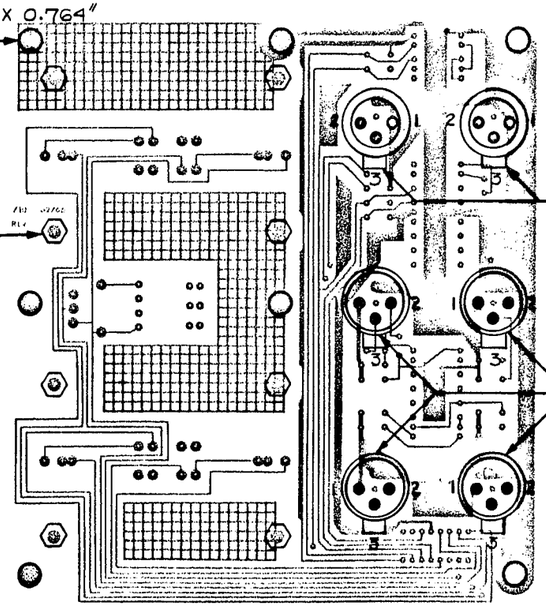
#8 WASHER, FLAT P/N 644-02485
QTY (8) PLACES SEE XFORMER DETAIL

TRANSFORMER DETAIL



STANDOFF SWAGE 1/4 RDX 0.764"
P/N 635-02826
QTY (7) PLACES

#6 KEP NUT P/N 643-01728
QTY (8) PLACES



FEMALE XLR CONN. NEUTRIK
P/N 510-02806 QTY (2) PLACES

MALE XLR CONN. NEUTRIK
P/N 510-02807 QTY (4) PLACES

NOTES

1. REFER TO PARTS LIST #020-02767
2. PRE-ASSEMBLY INSPECTION
   A. INSPECT FOR OVER OR UNDER-ETCHING, ETCH SHORTS OR OPENS, HOLE PLATING.
   B. INSPECT FOR WARPAGE.
3. SWAGE PROCEDURE:
   A. SWAGE STANDOFFS - QTY. 7 (635-02826)
   B. STAKING TOOL & ANVIL - KEYSTONE TL-21
   C. TORQUE: APPROX. 40 FT.-LBS. SPACER SHOULD BE FIRMLY SECURED IN PC BOARD.
4. XLR INSTALLATION (J23-J28)
   A. REMOVE XLR INSERTS FROM SHELLS.
   B. BAG SHELLS & ADD THEM TO CHASSIS KIT.
   C. SECURE INSERTS TO PC BOARD USING SCREW #2-56 X 3/16 (641-02827) THEN SOLDER.
5. TRANSFORMER INSTALLATION (T1-T4)
   A. ATTACH TRANSFORMERS ON COMP. SIDE OF PC BOARD USING #6 HARDWARE AND #8 FLAT WASHERS.
   B. POSITION FLAT WASHER BETWEEN XFORMER TAB AND PC BOARD, TIGHTEN THEN SOLDER LEADS.
6. W1 AND W2 ARE NOT INSTALLED.

REV.	DATE	DESCRIPTION	INIT/APP'V'D

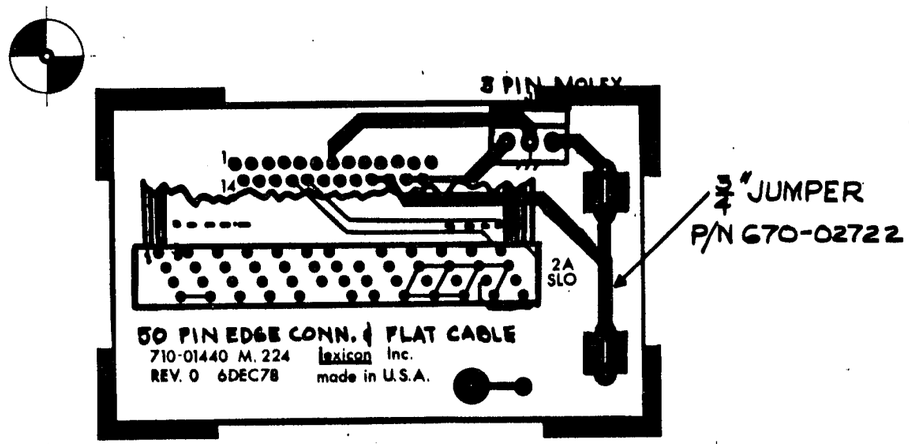
lexicon

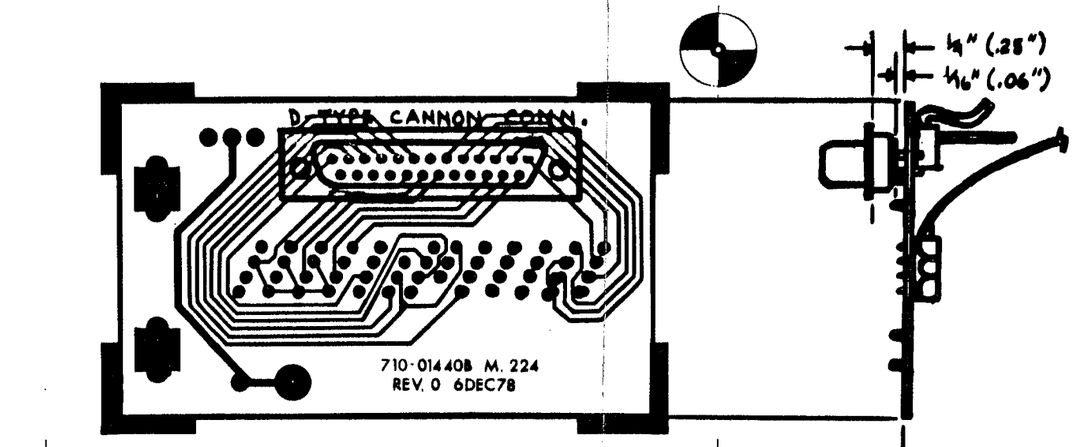
APPROVALS	DATE
DRAWN JB	5/18/82
CHECKED MH	5/19/82
ISSUED CB	6-15-82

PC DOC. ASSEMBLY DWG.
OTPT XFORMER, 224

SCALE	SIZE	DWG. NO.	REV.
1:1		030-02769	0

SHEET 1 OF 1





NOTES	DATE	REVISIONS	INIT.
REF. PARTS LIST NO. 020-01340 RED LINE ON CABLE CONNECTS TO "1" ON BOARD SPACE THE D-TYPE CONNECTOR 1/16" (.06) OFF OF THE BOARD WHEN SOLDERING SO THAT THE DISTANCE FROM THE MOUNTING FLANGE TO THE P.C. BOARD IS ¼" (.25).	12-1-82	REMOVED FUSE AND ADDED JUMPER	JB MH CB 12/6/82

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS ± DEC ± ANGLES ±

APPROVALS	DATE
DRAWN JWG	3-29-79
CHECKED CB	4-5-79
REV. 1	MH 12/6/82

lexicon Inc., WALTHAM, MA.

ASS'Y DWG., TRANSITION BD.
MODEL 224

SCALE 1:1 | SIZE B | DRAWING NO. 030-01426

RECORD OF CHANGES | SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	REDRAWN DJG	3-19-79	
2	REDREW U4, U5 DJG	4-20-79	
3	ADD DIG. GND & +5V TO U2 DJG CORRECT DWG. ERRORS ON S17-22 & DISPLAY DIG. Ø.	7-26-79	
4	FLOAT PINS 9 & 16 OF U4 & U5 DJG	10-5-79	
5	U1 WAS 74LS00, NOW 74LS132 DJG	10-18-79	

NOTES

1. CR1-15 ARE LED, LAMP, 5082-4980
2. S1-16 ARE SWITCH, LED, SCHADOW, DIGITAST, SRL, BLACK
3. S17-22 ARE SWITCH, LED, SCHADOW, DIGITAST, STL, BLACK
4. D0-D2 ARE LED, DISPLAY, 5082-7613
5. ALL CAPS. IN μF UNLESS OTHERWISE NOTED
6. ALL RES. ¼W, 5% UNLESS OTHERWISE NOTED
7. BUS NOTES:

DENOTES BUS CONSISTING OF MULTIPLE AND SEPARATE LINES

2-45° BENDS INDICATES BUS CHANGE OF DIRECTION

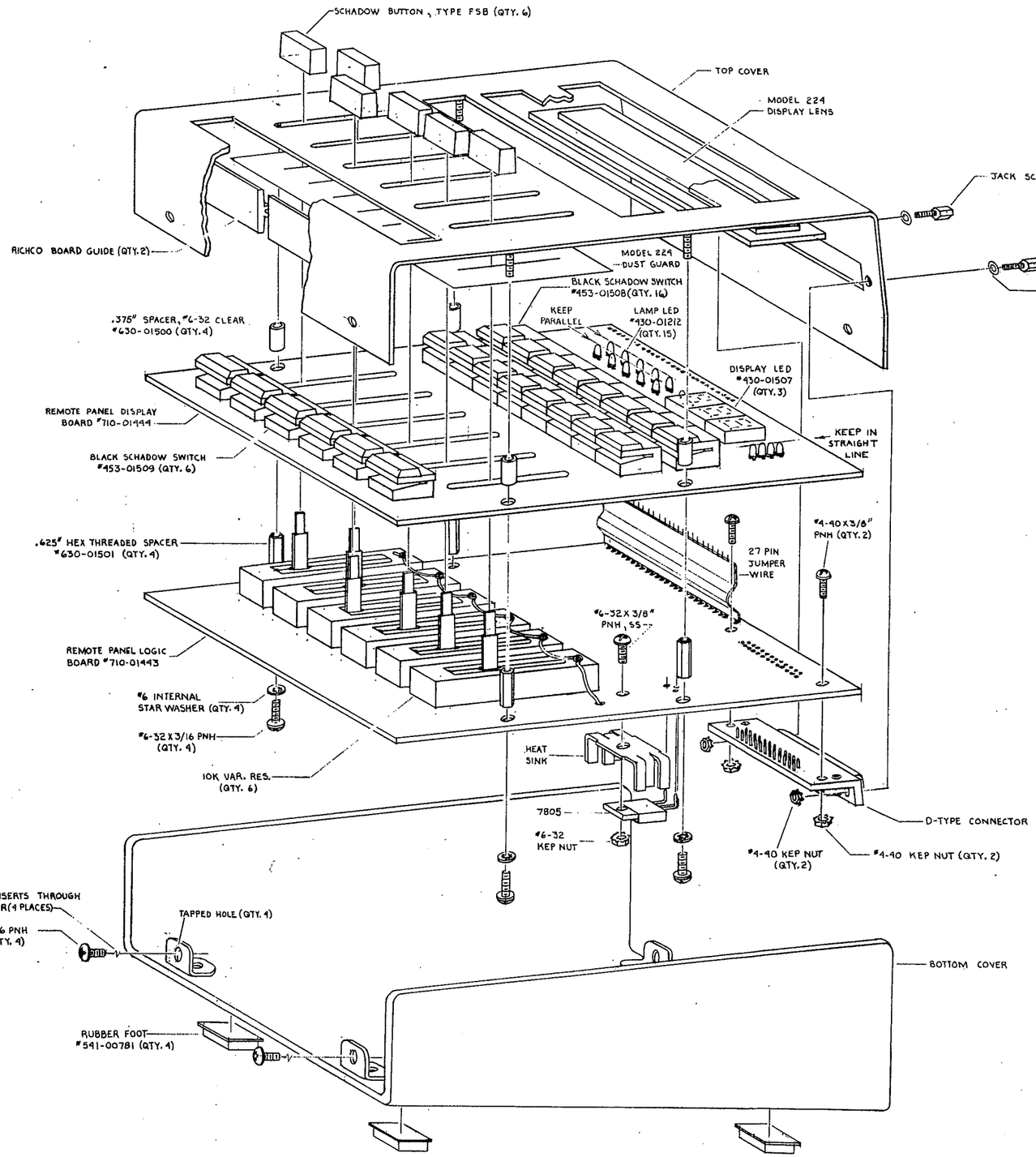
CONNECTION

MAX. COMP. #'S
U13
R12
C11
CR18
RP3
J2
S22
D2

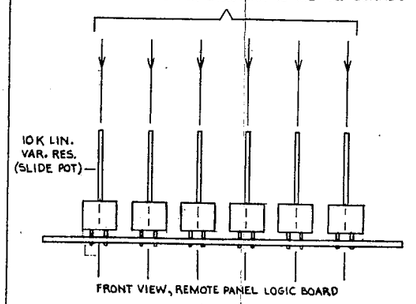
QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

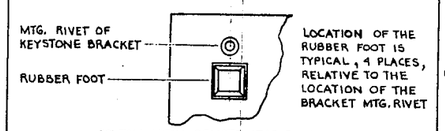
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO.	lexicon	
MATERIAL	APPROVALS	DATE	REMOTE HEAD LOGIC BOARD &! DISPLAY BOARD!
FINISH	DRAWN DJG	3-14-79	
	CHECKED CB	7-26-79	SIZE D · FSCM NO. · DWG. NO. 060-01323-D · REV. 5
NEXT ASSY / USED ON: MODEL 224	ISSUED		SCALE NA · SHEET 1 OF 1
APPLICATION: DO NOT SCALE DRAWING			



IMPORTANT: KEEP POT SLIDERS PARALLEL TO EACH OTHER AND PERPENDICULAR TO THE P.C. BOARD.



FRONT VIEW, REMOTE PANEL LOGIC BOARD



BOTTOM VIEW, REMOTE HEAD BOTTOM COVER

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	ADD NOTE 4	9/25/79	JMS
2	ADD #4 FLAT WASHER #644-01736 (QTY. 2)	2/9/82	JMS

NOTES

1. USE THIS DWG. IN CONJUNCTION WITH PART LISTS NOS. 020-01343, 020-01344, 020-01533 AND REMOTE PANEL ASS'Y PROCEDURES, DOC. NO. 080-01812.
2. TORQUE SPEC.:
   - #6-32 PNH, SS, MTG. 7805 LIN. IC — 8 IN LBS
   - #4-40 PNH, MTG. D-TYPE CONN. — 10 IN LBS
   - #6-32 PNH, MTG. HEX THREADED SPACERS — 18 IN LBS

   TOP COVER MTG. SCREWS (6-32 X 3/16", PNH): ADD A DROP OF "LOC-TITE 242", HAND TIGHTEN, BE CAREFUL NOT TO MAR THE FINISH ON THE SCREWS.
3. TO SHOW CERTAIN ASS'Y PROCEDURES MORE CLEARLY, SOME COMPONENTS THAT ARE PART OF THE 2 P.C. BOARD ASS'YS ARE NOT SHOWN IN THIS DWG.
4. MOUNT DISPLAY LENS WITH "PLIOBOND" ADHESIVE.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

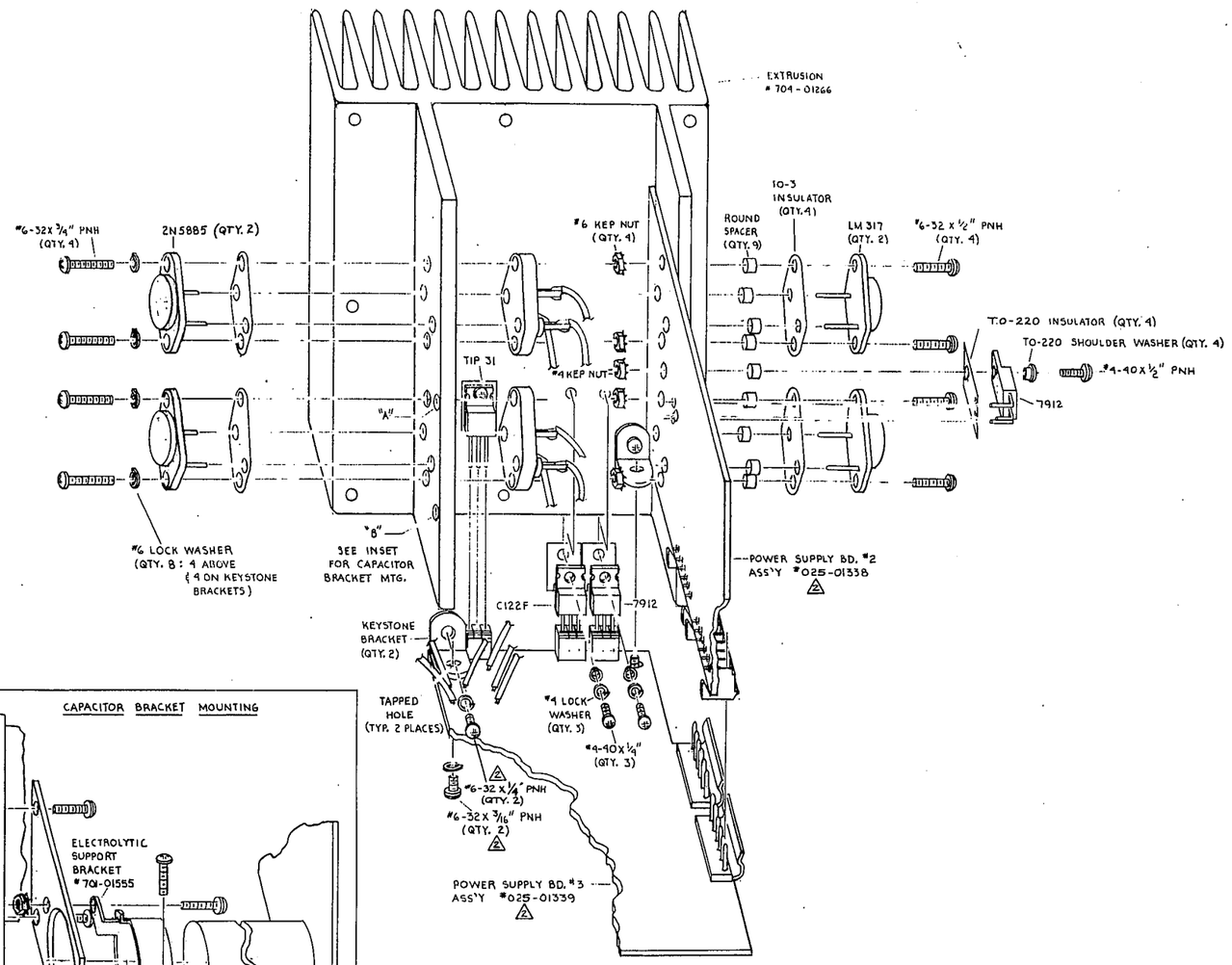
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES XX XXX	CONTRACT NO.
MATERIAL	APPROVALS / DATE
FINISH	DRAWN JAG 8-14-79
NEXT ASSY 224	CHECKED A.L 9-12-79
USED ON	ISSUED A.B 9-12-79
APPLICATION	DO NOT SCALE DRAWING

lexicon

ASS'Y. DWG., REMOTE CONTROL HEAD

SIZE D | FSCM NO. | DWG. NO. 080-01757-D | REV. 2

SCALE 1:1 | SHEET 1 OF 1



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	CHANGED NOTE 1	5/1/84 JCL	6/7/84 CB
2	CORRECTED P/N'S TO REFLECT B.O.M. AND CHANGED SCREW LENGTH	4/21/85 5/23/85	6/3/85

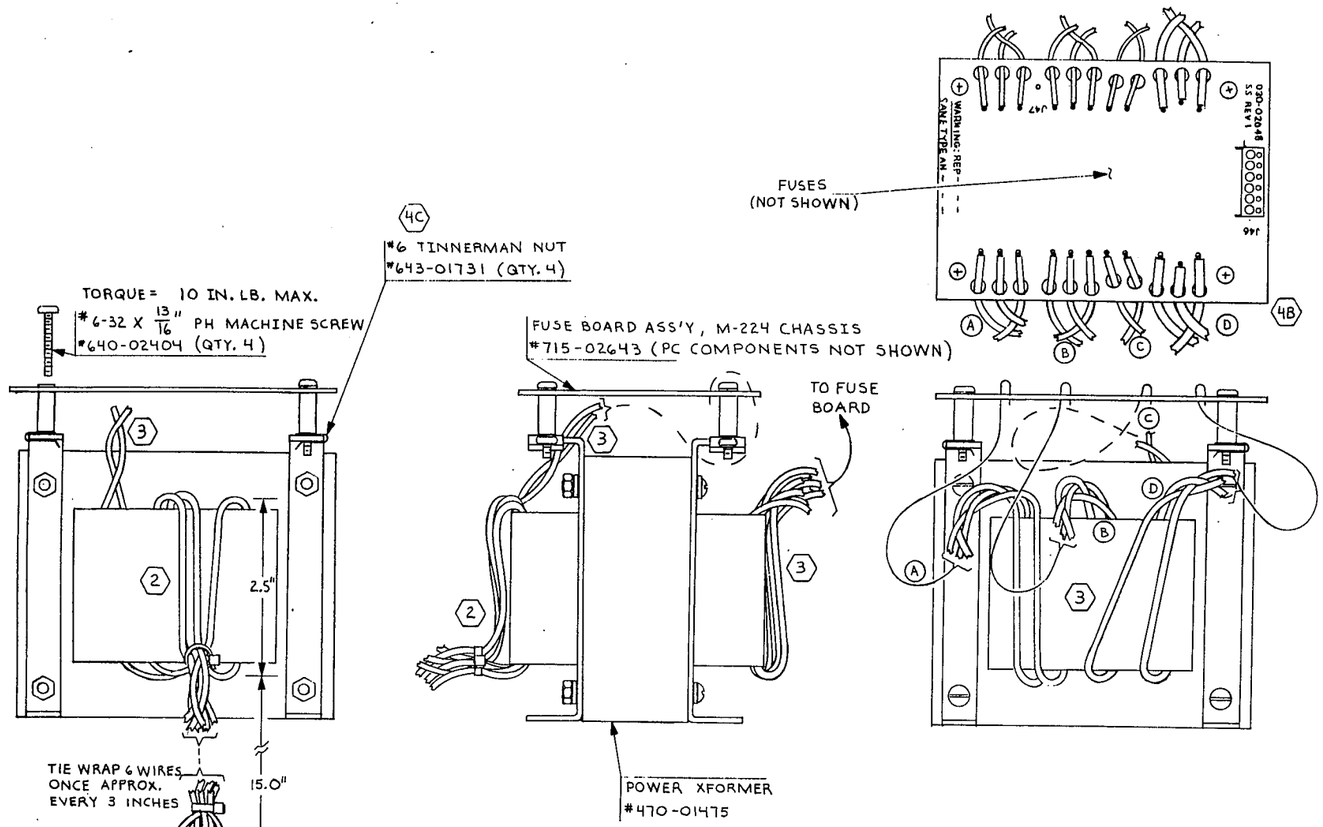
NOTES

1. USE THIS ASS'Y DWG. ALONG WITH "ASSEMBLY NOTES FOR POWER SUPPLY MODULE", DOC. #080-01801 AND BOM NO. 025-03065.
2. TORQUE SPEC:
   #6-32 PNH MTG. LM317 & 2N5885 (QTY. 8) - 8 IN. LBS.
   #4-40 PNH - ALL PLACES - (QTY. 4) - 8 IN. LBS.
   #6-32 PNH MTG. KEYSTONE BRAC. (QTY. 4) - 16 IN. LBS.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
			PARTS LIST	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO.		lexicon
	APPROVALS	DATE	ASS'Y DWG., POWER SUPPLY MODULE
MATERIAL	DRAWN AG	5-23-79	
	CHECKED		
NEXT ASSY / USED ON	FINISH / ISSUED	6/7/84	SIZE D / FSCM NO. / DWG. NO. 080-01611-D / REV. 2
APPLICATION	DO NOT SCALE DRAWING		SCALE 1:1 / SHEET 1 OF 1

MODEL 224



WIRE CHART		
WIRE GROUP	WIRE COLORS	WIRE LENGTH
B	BLUE	7"
	BLUE/W	
	BLUE	
D	RED	7"
	RED/W	
	RED	
A	YEL	7"
	YEL/W	
	YEL	
C	GRN	8.5"
	GRN	

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
3	REDRAWN TO ACCOMODATE FUSE BD. ASS'Y. (DWG. WAS MISLABELLED REV. 2 UNTIL 4/8/82)	10/26/81	
4	ADD WIRE LENGTHS DELETE BRAIDING	7/8/82	11/5/84
5	CHANGED NOTE 1.	6/7/84 JLA	

NOTES

1. REFER TO BOM NO. 023-01589.
2. PRIMARY WIRES: WHITE, BLACK, BLACK-WHITE, ORANGE-WHITE, ORANGE, BROWN
3. SECONDARY WIRES: REFER TO WIRE CHART.
4. ASSEMBLY STEPS:
   A. TIE WRAP WIRE GROUP (2), CRIMP PINS ON WIRE ENDS, INSERT PINS INTO 10-PIN CONNECTOR.
   B. BRAID WIRE GROUPS (A)(B)(C)(D) FAIRLY TIGHT AND CUT TO LENGTH AS PER WIRE CHART. MEASURE FROM BOTTOM OF TRANSFORMER. SOLDER WIRE GROUPS (A)(B)(C)(D) TO FUSE BOARD AS SHOWN. NOTE ORIENTATION OF FUSE BOARD WITH RESPECT TO SECONDARY WIRES. ((A)(B)(C)(D) OPPOSITE J47)
   C. ATTACH FUSE BOARD ASS'Y TO TRANSFORMER USING QTY. 4 #6-32 SCREWS AND TINNERMAN NUTS AS SHOWN.

	224
	224X
1200B	1200
NEXT ASSY	USED ON
APPLICATION	

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
PARTS LIST				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
XX
XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

lexicon

APPROVALS	DATE
DRAWN J. Schmidt	10/6/81
CHECKED DD	11-6-81
ISSUED CB	11/4/81

ASS'Y DWG., POWER TRANSFORMER ASS'Y

SIZE D | FSCM NO. | DWG. NO. 080-01650-D | REV. 5

SCALE 1:1 | SHEET 1 OF 1

7 PARTS LIST

SINGLE BOARD COMPUTER (SBC) BOARD

Part No.	Qty/Description	Ref.
DIGITAL/CMOS IC		
330-00673	2 IC,DIGITAL,7437	U3,6
MEMORY IC		
350-01304	2 IC,EPROM,2716	U23,25
RIB CABLE CONN		
495-01626	1 CONN,XITION,RIBBON/DIP,14MC	U4
PURCH SUB-ASSY		
750-01310	1 COMPUTER BOARD,LEVEL BLC 80/11	

FLOATING POINT CONVERTER (FPC) BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00529	1	RES,CF,5%,1/4W,1K OHM	R3
202-00555	2	RES,CF,5%,1/4W,20K OHM	R1,2
TANTALUM CAP			
241-00652	8	CAP,TANT,4.7uF,25V,RAD	C5,13,14,20,21,32,33,38
241-00654	2	CAP,TANT,22uF,16V,RAD	C1,2
CERAMIC CAP			
245-00588	2	CAP,CER,100pF,1000V,10%	C3,4
245-00598	26	CAP,CER,.01uF,16V,80/20%	C6-12,15-19,22-31,34-37
DIGITAL/CMOS IC			
330-00692	1	IC,DIGITAL,74LS00	U12
330-00693	1	IC,DIGITAL,74LS02	U14
330-00695	2	IC,DIGITAL,74LS04	U15,17
330-00699	1	IC,DIGITAL,74LS20	U5
330-00711	2	IC,DIGITAL,74LS157	U4,42
330-00712	8	IC,DIGITAL,74LS163	U1,2,7,8,16,40,41,43
330-00714	1	IC,DIGITAL,74LS175	U18
330-00718	2	IC,DIGITAL,74LS367	U19,30
330-01288	8	IC,DIGITAL,74LS194	U23,24,27,28,34,35,38,39
330-01290	2	IC,DIGITAL,74LS244	U25,26
330-01294	2	IC,DIGITAL,74LS377	U36,37
330-01313	1	IC,DIGITAL,74LS86	U13
330-01314	6	IC,DIGITAL,74LS109	U3,20,21,31-33
330-01315	1	IC,DIGITAL,74S287	U6
330-01316	1	IC,DIGITAL,74LS123	U29
SOCKETS			
520-00942	6	IC SCKT,14 PIN,PC,LO-PRO	
520-00943	29	IC SCKT,16 PIN,PC,LO-PRO	
520-01361	4	IC SCKT,20 PIN,PC,LO-PRO	
PC HDWR			
610-01594	2	EXTRACTOR,CARD,SCANBE#S-203	
PC BOARDS			
710-01434	1	PC BD,FPC,M224	

ANALOG INPUT (AIN) BOARD

Part No.	Qty	Description	Ref.
POTENTIOMETERS			
200-00335	2	POT,RTY,PC,50K-U,1/4X3/4	R1,2
TRIM RESISTORS			
201-00159	1	RES,TRM,ST,PC,100K,SA,CER	R90
CARBON FLM RES			
202-00502	2	RES,CF,10%,1/2W,270 OHM	R77,78
202-00529	1	RES,CF,5%,1/4W,1K OHM	R79
202-00533	7	RES,CF,5%,1/4W,2K OHM	R5-8,96-98
202-00538	3	RES,CF,5%,1/4W,3.3K OHM	R86-88
202-00539	1	RES,CF,5%,1/4W,3.6K OHM	R95
202-00542	1	RES,CF,5%,1/4W,4.7K OHM	R85
202-00543	2	RES,CF,5%,1/4W,5.1K OHM	R67,68
202-00544	1	RES,CF,5%,1/4W,5.6K OHM	R81
202-00549	4	RES,CF,5%,1/4W,10K OHM	R3,4,80,83
202-00557	1	RES,CF,5%,1/4W,24K OHM	R82
202-00570	1	RES,CF,5%,1/4W,100K OHM	R84
METAL FLM RES			
203-00456	2	RES,MF,1%,1/8W,1.00K OHM	R73,89
203-00457	2	RES,MF,1%,1/8W,1.50K OHM	R15,42
203-00459	3	RES,MF,1%,1/8W,2.00K OHM	R10,11,74
203-00464	19	RES,MF,1%,1/8W,4.99K OHM	R16,17,22,23,28,29,33,43,44 R49,50,55,56,R60,72,92,93,100 102
203-00467	2	RES,MF,1%,1/8W,7.15K OHM	R21,48
203-00471	6	RES,MF,1%,1/8W,10.0K OHM	R30,37,38,57,64,65
203-00479	2	RES,MF,1%,1/8W,14.7K OHM	R20,47
203-00486	2	RES,MF,1%,1/8W,28.0K OHM	R36,63
203-01138	2	RES,MF,1%,1/8W,9.76K OHM	R24,51
203-01145	1	RES,MF,1%,1/8W,1.24M OHM	R91
203-01229	2	RES,MF,1%,1/8W,6.98K OHM	R34,61
203-01249	2	RES,MF,1%,1/8W,5.23K OHM	R27,54
203-01489	2	RES,MF,1%,1/8W,499 OHM	R75,76
203-01490	2	RES,MF,1%,1/8W,3.09K OHM	R9,12
203-01493	1	RES,MF,1%,1/8W,17.8K OHM	R71
203-01664	2	RES,MF,1%,1/8W,133K OHM	R99,101
203-01673	2	RES,MF,1%,1/8W,16.5K OHM	R14,41
203-02613	2	RES,MF,1%,1/8W,21.0K OHM	R35,62
203-02656	2	RES,MF,1%,1/8W,182K OHM	R32,59
203-02700	2	RES,MF,1%,1/8W,11.3K OHM	R13,40
203-02701	2	RES,MF,1%,1/8W,13.3K OHM	R18,45
203-02702	2	RES,MF,1%,1/8W,8.66K OHM	R26,53

ANALOG INPUT (AIN) BOARD cont'd.

Part No.	Qty/Description		Ref.
NETWORK RES			
205-00240	1	RES,NET,SIP,2%,3.3KX7	RP2
205-01133	1	RES,NET,DIP,1%,10KX8	RP1
205-01456	1	RES,NET,DIP,0.5%/0.1%,1KX8	RP3
ELECTROLYT CAP			
240-02048	2	CAP,ELEC,47uF,25V,AX	C88,89
TANTALUM CAP			
241-00651	4	CAP,TANT,.22uF,35V,RAD	C66-69
241-00652	5	CAP,TANT,4.7uF,25V,RAD	C61,62,81,83,84
241-00654	3	CAP,TANT,22uF,16V,RAD	C55,70,87
PCRB/PP CAP			
244-00660	1	CAP,MYL,.01uF,100V,10%,RAD	C80
244-01151	18	CAP,PP,1000pF,2.5%	C3,6,9,12,15,18,21,29,32,35 C38,41,44,47,C71,73,94,95
244-01166	2	CAP,PP,240pF,2.5%	C26,52
244-01169	2	CAP,PP,2200pF,2.5%	C25,51
244-01170	2	CAP,PP,2400pF,2.5%	C24,50
CERAMIC CAP			
245-00598	5	CAP,CER,.01uF,16V,80/20%	C58,63,76,79,85
245-00600	33	CAP,CER,.02uF,35V,80/20%	C1,2,7,8,13,14,19,20,22,23,C27 28,33,34,C39,40,45,46,48,49,53 54,56,57,59,60,64,65,72,74,75 78,82
245-00603	1	CAP,CER,.05uF,50V,80/20%	C86
245-01164	1	CAP,CER,10pF	C77
245-01651	2	CAP,CER,.1uF,50V,80/20%	C90,91
245-02105	12	CAP,CER,5pF,500V,10%,NPO	C4,5,10,11,16,17,30,31,36,C37 42,43
INDUCTORS			
270-00779	2	FERRITE,BEAD	L1,2
DIODES			
300-01027	2	DIODE,1N754	CR14,15
300-01029	21	DIODE,1N914 AND 4148	CR1-13,16-23
DIGITAL/CMOS IC			
330-00668	1	IC,DIGITAL,7406	U19
330-00692	1	IC,DIGITAL,74LS00	U18
330-01293	1	IC,DIGITAL,74LS374	U17
330-02085	1	IC,DIGITAL,AM25L04	U26

ANALOG INPUT (AIN) BOARD cont'd.

Part No.	Qty/Description	Ref.
LINEAR IC		
340-00727	2 IC,LINEAR,LF398	U20,21
340-00740	6 IC,LINEAR,4558	U2-4,7-9
340-01183	3 IC,LINEAR,LF 356	U5,10,23
340-01363	2 IC,LINEAR,LM339	U15,16
340-01364	1 IC,LINEAR,LM211	U27
340-01566	5 IC,LINEAR,LF353,DUAL OP AMP	U1,6,11,12,13
SS SW IC		
346-00769	1 IC,SS SWITCH,4051	U24
346-00770	2 IC,SS SWITCH,4053	U14,22
CONVERTER IC		
355-01362	1 DAC-80-I	U25
TRANSFORMERS		
470-00058	2 XFORMER,INPT	T1,2
SOCKETS		
520-00941	14 IC SCKT,8 PIN,PC,LO-PRO	
520-00942	4 IC SCKT,14 PIN,PC,LO-PRO	
520-00943	3 IC SCKT,16 PIN,PC,LO-PRO	
520-00945	2 IC SCKT,24 PIN,PC,LO-PRO	
520-01361	1 IC SCKT,20 PIN,PC,LO-PRO	
PC HDWR		
610-01594	2 EXTRACTOR,CARD,SCANBE#S-203	
BULK WIRE		
670-01768	10 WIRE,JMP,22AWG,0.5",TEF,WHT	R19,25,31,39,46,52,58,R66,69 70
PC BOARDS		
710-01435	1 PC BD,ANLG INPT,M224	

ANALOG OUTPUT (AOUT) BOARD

Part No.	Qty	Description	Ref.
TRIM RESISTORS			
201-00159	1	RES,TRM,ST,PC,100K,SA,CER	R4
201-00433	12	RES,TRM,ST,PC,5K,SA,CC	R19,25,31,51,57,63,69,75,,R81 101,107,,R113
201-01677	4	RES,TRM,RTY,PC,50K-U,SA	R119,129,139,149
CARBON FLM RES			
202-00502	2	RES,CF,10%,1/2W,270 OHM	R17,18
202-00517	4	RES,CF,5%,1/4W,200 OHM	R128,138,148,158
202-00520	4	RES,CF,5%,1/4W,270 OHM	R9,12,13,16
202-00531	8	RES,CF,5%,1/4W,1.5K OHM	R123,124,133,134,143,144,,R153 154
202-00538	2	RES,CF,5%,1/4W,3.3K OHM	R1,2
202-00542	8	RES,CF,5%,1/4W,4.7K OHM	R43,44,93,94,121,131,,R141,151
202-00549	1	RES,CF,5%,1/4W,10K OHM	R160
202-00557	4	RES,CF,5%,1/4W,24K OHM	R120,130,140,150
202-00560	4	RES,CF,5%,1/4W,33K OHM	R122,132,142,152
202-00563	4	RES,CF,5%,1/4W,47K OHM	R125,135,145,155
202-00573	1	RES,CF,5%,1/4W,130K OHM	R159
202-01157	8	RES,CF,5%,1/2W,33 OHM	R126,127,136,137,146,147,,R156 157
METAL FLM RES			
203-00464	2	RES,MF,1%,1/8W,4.99K OHM	R5,6
203-00467	4	RES,MF,1%,1/8W,7.15K OHM	R30,62,80,112
203-00470	4	RES,MF,1%,1/8W,9.53K OHM	R36,68,86,118
203-00471	24	RES,MF,1%,1/8W,10.0K OHM	R22,23,28,29,34,35,54,55,,R60 61,66,,R67,72,73,78,79,84,85 104,105,,R110,111,116,117
203-00472	4	RES,MF,1%,1/8W,10.2K OHM	R24,56,74,106
203-00476	8	RES,MF,1%,1/8W,12.1K OHM	R26,32,58,64,76,82,108,114
203-00477	4	RES,MF,1%,1/8W,12.7K OHM	R20,52,70,102
203-00486	4	RES,MF,1%,1/8W,28.0K OHM	R45,50,95,100
203-01137	4	RES,MF,1%,1/8W,4.12K OHM	R21,53,71,103
203-01145	1	RES,MF,1%,1/8W,1.24M OHM	R3
203-01229	4	RES,MF,1%,1/8W,6.98K OHM	R47,48,97,98
203-02610	4	RES,MF,1%,1/8W,1.65K OHM	R33,65,83,115
203-02611	4	RES,MF,1%,1/8W,5.62K OHM	R37,42,87,92
203-02612	4	RES,MF,1%,1/8W,7.32K OHM	R27,59,77,109
203-02613	4	RES,MF,1%,1/8W,21.0K OHM	R46,49,96,99
NETWORK RES			
205-00240	1	RES,NET,SIP,2%,3.3KX7	RP1
205-01456	1	RES,NET,DIP,0.5%/0.1%,1KX8	RP2

ANALOG OUTPUT (AOUT) BOARD cont'd.

Part No.	Qty/Description		Ref.
TANTALUM CAP			
241-00652	13	CAP,TANT,4.7uF,25V,RAD	C2,3,6,21,22,113,114,118,,C119 123,124,,C128,129
241-00654	9	CAP,TANT,22uF,16V,RAD	C111,112,116,117,121,122,,C126 127,135
241-00655	3	CAP,TANT,22uF,25V,RAD	C131,132,133
PCRB/PP CAP			
244-00660	5	CAP,MYL,.01uF,100V,10%,RAD	C115,120,125,130,134
244-01151	28	CAP,PP,1000pF,2.5%	C25,28,31,34,37,40,43,44,,C51 54,57,60,,C63,66,69,72,75,78,81 84,,C87,88,95,98,101,104,107 110
244-01170	4	CAP,PP,2400pF,2.5%	C47,48,91,92
244-02486	4	CAP,PP,510pF,160V,2.5%,AX	C13,16,17,20
CERAMIC CAP			
245-00600	45	CAP,CER,.02uF,35V,80/20%	C1,4,5,7-12,14,15,18,19,23,24 C29,30,35,,C36,41,42,45,46,49 50,55,,C56,61,62,67,68,73,74,79 C80,85,86,89,90,93,94,99,,C100 105,106
245-01164	24	CAP,CER,10pF	C26,27,32,33,38,39,52,53,58, C59,64,65,,C70,71,76,77,82,83 96,97,,C102,103,108,109
INDUCTORS			
270-00779	1	FERRITE,BEAD	L1
DIODES			
300-01027	2	DIODE,1N754	CR5,6
300-01029	14	DIODE,1N914 AND 4148	CR1-4,CR7-16
TRANSISTORS			
310-01007	1	TRANSISTOR,2N3904	Q9
310-01237	4	TRANSISTOR,MJE-170,PNP	Q2,4,6,8
310-01238	4	TRANSISTOR,MJE-180,NPN	Q1,3,5,7
DIGITAL/CMOS IC			
330-00668	1	IC,DIGITAL,7406	U1
330-01457	1	IC,DIGITAL,4054(RCA),CMOS	U5
LINEAR IC			
340-00740	16	IC,LINEAR,4558	U9-24
340-01183	5	IC,LINEAR,LF 356	U4,U25-28
340-01566	2	IC,LINEAR,LF353,DUAL OP AMP	U7,8

ANALOG OUTPUT (AOUT) BOARD cont'd.

Part No.	Qty/Description	Ref.
SS SW IC		
346-00769	1 IC,SS SWITCH,4051	U3
346-01366	1 IC,SS,SWITCH,4016	U6
CONVERTER IC		
355-00774	1 DAC,80-CBI-V	U2
SOCKETS		
520-00941	23 IC SCKT,8 PIN,PC,LO-PRO	
520-00942	2 IC SCKT,14 PIN,PC,LO-PRO	
520-00943	2 IC SCKT,16 PIN,PC,LO-PRO	
520-00945	1 IC SCKT,24 PIN,PC,LO-PRO	
PC HDWR		
610-01594	2 EXTRACTOR,CARD,SCANBE#S-203	
BULK WIRE		
670-01768	14 WIRE,JMP,22AWG,0.5",TEF,WHT	R7,8,10,11,14,15,38,39,40,,R41 88,89,,R90,91
PC BOARDS		
710-01436	1 PC BD,ANLG OTPT,M224	

DATA MEMORY (DMEM) BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00508	4	RES,CF,5%,1/4W,33 OHM	R1,2,4,7
202-00529	3	RES,CF,5%,1/4W,1K OHM	R3,5,6
NETWORK RES			
205-01485	1	RES,NET,DIP,2%,33X8	U17
ELECTROLYT CAP			
240-02048	3	CAP,ELEC,47uF,25V,AX	C82,84,86
TANTALUM CAP			
241-00655	2	CAP,TANT,22uF,25V,RAD	C42,85
CERAMIC CAP			
245-00598	20	CAP,CER,.01uF,16V,80/20%	C17,39,59-68,71-78
245-01651	43	CAP,CER,.1uF,50V,80/20%	C1-16,18,19,40,41,43-58,C69,70 79,80,,C81,83,87
DIGITAL/CMOS IC			
330-00692	1	IC,DIGITAL,74LS00	U53
330-00694	1	IC,DIGITAL,74LS03	U52
330-00699	1	IC,DIGITAL,74LS20	U54
330-00716	2	IC,DIGITAL,74LS283	U63,64
330-01256	1	IC,DIGITAL,74S08	U45
330-01270	1	IC,DIGITAL,74S00	U44
330-01272	1	IC,DIGITAL,74S04	U58
330-01273	1	IC,DIGITAL,74S10	U43
330-01276	1	IC,DIGITAL,74S74	U46
330-01282	3	IC,DIGITAL,74LS138	U55,56,57
330-01290	3	IC,DIGITAL,74LS244	U48,61,62
330-01293	5	IC,DIGITAL,74LS374	U38,39,40,41,42
330-01295	2	IC,DIGITAL,74LS393	U51,65
330-02504	2	IC,DIGITAL,74S157	U18,36
330-03341	2	IC,DIGITAL,74F283	U49,50
MEMORY IC			
350-03439	16	IC,DRAM,4164,64KX1,150NS	U20-35
MODULES			
380-02509	1	MOD,DLY,LINE,5 TAPS,30/150 NS	U59
SOCKETS			
520-00942	10	IC SCKT,14 PIN,PC,LO-PRO	
520-00943	25	IC SCKT,16 PIN,PC,LO-PRO	
520-01361	8	IC SCKT,20 PIN,PC,LO-PRO	

DATA MEMORY (DMEM) BOARD cont'd.

Part No.	Qty/Description	Ref.
PC HDWR		
610-01594	2 EXTRACTOR,CARD,SCANBE#S-203	
BULK WIRE		
670-01974	5 WIRE,JMP,22AWG,0.1",NON-INSUL	J1-5
PC BOARDS		
710-02511	1 PC BD,DATA MEM&IO,M224X	

TIMING AND CONTROL (T&C) BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00506	1	RES,CF,5%,1/4W,20 OHM	R16
202-00514	1	RES,CF,5%,1/4W,100 OHM	R8
202-00518	1	RES,CF,5%,1/4W,220 OHM	R15
202-00520	1	RES,CF,5%,1/4W,270 OHM	R9
202-00521	1	RES,CF,5%,1/4W,330 OHM	R2
202-00523	1	RES,CF,5%,1/4W,390 OHM	R1
202-00526	1	RES,CF,5%,1/4W,680 OHM	R13
202-00529	5	RES,CF,5%,1/4W,1K OHM	R5,6,10,11,12
202-00530	1	RES,CF,5%,1/4W,1.2K OHM	R14
202-00537	1	RES,CF,5%,1/4W,3K OHM	R7
202-00555	1	RES,CF,5%,1/4W,20K OHM	R3
202-00572	1	RES,CF,5%,1/4W,120K OHM	R4
ELECTROLYT CAP			
240-02048	2	CAP,ELEC,47uF,25V,AX	C61,62
TANTALUM CAP			
241-00652	1	CAP,TANT,4.7uF,25V,RAD	C11
MICA CAP			
242-00628	1	CAP,MICA,10pF,DM-15,100J	C19
242-00629	1	CAP,MICA,15pF,DM-15,150J	C18
242-00635	1	CAP,MICA,120pF,DM-15,121J	C17
242-00640	1	CAP,MICA,300pF,DM-15,301G	C31
242-00646	1	CAP,MICA,1000pF,DM-15,102J	C32
PCRB/PP CAP			
244-01488	1	CAP,MYL,.22uF,100V,10%,RAD	C45
CERAMIC CAP			
245-00586	1	CAP,CER,30pF,100V,10%	C46
245-00588	1	CAP,CER,100pF,1000V,10%	C9
245-00598	41	CAP,CER,.01uF,16V,80/20%	C2-8,10,14,15,21-30,35-44,47 C50-59
245-01651	9	CAP,CER,.1uF,50V,80/20%	C1,16,20,33,34,48,49,60,63
VARIABLE CAP			
246-01146	1	CAP,TRIM,5-40pF,VAR	C12
INDUCTORS			
270-02506	1	INDUCTOR,.10uH,SHIELDED RF	L1
DIODES			
300-02507	1	DIODE,VARACTOR,MV209	CR1
TRANSISTORS			
310-02517	3	TRANSISTOR,2N5910	Q1,2,3

TIMING AND CONTROL (T&C) BOARD cont'd.

Part No.	Qty	Description	Ref.
DIGITAL/CMOS IC			
330-00694	1	IC,DIGITAL,74LS03	U55
330-00695	1	IC,DIGITAL,74LS04	U33
330-00696	2	IC,DIGITAL,74LS08	U32,34
330-00697	1	IC,DIGITAL,74LS10	U49
330-00703	3	IC,DIGITAL,74LS74	U24,53,54
330-00712	2	IC,DIGITAL,74LS163	U1,14
330-00713	1	IC,DIGITAL,74LS174	U9
330-00714	2	IC,DIGITAL,74LS175	U23,52
330-01256	1	IC,DIGITAL,74S08	U35
330-01270	3	IC,DIGITAL,74S00	U40,48,51
330-01272	1	IC,DIGITAL,74S04	U37
330-01273	1	IC,DIGITAL,74S10	U36
330-01274	1	IC,DIGITAL,74LS27	U38
330-01276	1	IC,DIGITAL,74S74	U25
330-01279	4	IC,DIGITAL,74S112	U20,21,22,26
330-01281	1	IC,DIGITAL,74LS133	U50
330-01283	1	IC,DIGITAL,74LS139	U47
330-01284	1	IC,DIGITAL,74LS155	U46
330-01287	6	IC,DIGITAL,74S163	U4,5,17,18,41,56
330-01289	2	IC,DIGITAL,74195	U10,11
330-01290	1	IC,DIGITAL,74LS244	U6
330-01293	2	IC,DIGITAL,74LS374	U7,8
330-01294	1	IC,DIGITAL,74LS377	U19
330-01298	1	IC,DIGITAL,MC4044	U27
330-01302	4	IC,DIGITAL,AM8304 N	U3,16,30,44
330-01313	1	IC,DIGITAL,74LS86	U12
330-01316	1	IC,DIGITAL,74LS123	U13
330-03340	2	IC,DIGITAL,74F157	U28,42
330-03342	3	IC,DIGITAL,74F374	U31,39,45
MEMORY IC			
350-02626	4	IC,RAM,MCM68B10	U2,15,29,43
DSPLY/IND/LED			
430-00904	1	LED,HP #5082-4850	LED1
SOCKETS			
520-00942	18	IC SCKT,14 PIN,PC,LO-PRO	
520-00943	23	IC SCKT,16 PIN,PC,LO-PRO	
520-00945	4	IC SCKT,24 PIN,PC,LO-PRO	
520-01361	11	IC SCKT,20 PIN,PC,LO-PRO	
PC HDWR			
610-01594	2	EXTRACTOR,CARD,SCANBE#S-203	

TIMING AND CONTROL (T&C) BOARD cont'd.

Part No.	Qty/Description	Ref.
BULK WIRE		
670-01974	1 WIRE,JMP,22AWG,0.1",NON-INSUL	J3
PC BOARDS		
710-02482	1 PC BD,HST&C,M224X	

ARITHMETIC UNIT (ARU) BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00518	2	RES,CF,5%,1/4W,220 OHM	R2,4
202-00521	2	RES,CF,5%,1/4W,330 OHM	R1,3
202-00529	1	RES,CF,5%,1/4W,1K OHM	R5
TANTALUM CAP			
241-00652	8	CAP,TANT,4.7uF,25V,RAD	C3,12,13,24,25,34,35,41
241-00654	2	CAP,TANT,22uF,16V,RAD	C1,2
CERAMIC CAP			
245-00598	30	CAP,CER,.01uF,16V,80/20%	C4-11,14-23,26-32,36-40
DIGITAL/CMOS IC			
330-00692	10	IC,DIGITAL,74LS00	U14,26-28,40,41,50-53
330-00712	5	IC,DIGITAL,74LS163	U45-49
330-01272	2	IC,DIGITAL,74S04	U2,54
330-01277	5	IC,DIGITAL,74S86	U5-7,9,42
330-01288	6	IC,DIGITAL,74LS194	U3,4,15-18
330-01296	4	IC,DIGITAL,74LS670	U29,30,31,32
330-01313	1	IC,DIGITAL,74LS86	U8
330-02505	1	IC,DIGITAL,74S175	U12
330-03340	5	IC,DIGITAL,74F157	U33-37
330-03341	10	IC,DIGITAL,74F283	U13,19-25,38,39
330-03342	4	IC,DIGITAL,74F374	U10,11,43,44
SOCKETS			
520-00942	18	IC SCKT,14 PIN,PC,LO-PRO	
520-00943	31	IC SCKT,16 PIN,PC,LO-PRO	
520-01361	4	IC SCKT,20 PIN,PC,LO-PRO	
ELECTRONIC HDWR			
600-01565	4	BUSS BAR,1C,1.4X4,TIN	
PC HDWR			
610-01594	2	EXTRACTOR,CARD,SCANBE#S-203	
PC BOARDS			
710-01433	1	PC BD,ARU,M224	

MEMORY EXPANSION BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00520	1	RES,CF,5%,1/4W,270 OHM	R16
202-00524	2	RES,CF,5%,1/4W,470 OHM	R1,3
202-00529	2	RES,CF,5%,1/4W,1K OHM	R2,19
202-00533	9	RES,CF,5%,1/4W,2K OHM	R4-7,9,13,17,18,REF
202-00542	1	RES,CF,5%,1/4W,4.7K OHM	ECO REF
202-00563	3	RES,CF,5%,1/4W,47K OHM	R8,10,11
202-00570	1	RES,CF,5%,1/4W,100K OHM	R15
METAL FLM RES			
203-00479	1	RES,MF,1%,1/8W,14.7K OHM	R14
NETWORK RES			
205-02212	2	RES,NET,SIP,2%,47KX9	RP1,2
ELECTROLYT CAP			
240-00611	1	CAP,ELEC,22uF,16V,RAD	C23
240-02048	2	CAP,ELEC,47uF,25V,AX	C28,34
TANTALUM CAP			
241-00654	2	CAP,TANT,22uF,16V,RAD	C25,ECO REF
241-02589	1	CAP,TANT,4.7uF,25V,5%,RAD	C21
CERAMIC CAP			
245-00598	6	CAP,CER,.01uF,16V,80/20%	C6-9,27,33
245-00600	25	CAP,CER,.02uF,35V,80/20%	C1-5,10-20,22,24,29-32,35-37
245-01651	1	CAP,CER,.1uF,50V,80/20%	C26
DIODES			
300-01029	3	DIODE,1N914 AND 4148	CR1,2,4
300-01526	1	DIODE,1N750,ZENER,4.7V	CR3
300-02401	1	DIODE,BAR 35,SCHOTTKY,LOW VF	CR5
DIGITAL/CMOS IC			
330-00667	3	IC,DIGITAL,7404	U27-29
330-00669	1	IC,DIGITAL,7408	U30
330-00674	1	IC,DIGITAL,7438	U25
330-00695	1	IC,DIGITAL,74LS04	U22
330-00700	1	IC,DIGITAL,74LS30	U26
330-00719	2	IC,DIGITAL,74LS368	U7,15
330-00766	1	IC,DIGITAL,4011,CMOS	U14
330-01281	1	IC,DIGITAL,74LS133	U20
330-01282	2	IC,DIGITAL,74LS138	U17,24
330-01283	1	IC,DIGITAL,74LS139	U18
330-01302	1	IC,DIGITAL,AM8304 N	U19
330-01316	1	IC,DIGITAL,74LS123	U21
330-01573	1	IC,DIGITAL,74LS32	U31
330-02707	1	IC,DIGITAL,4503,CMOS	U16

MEMORY EXPANSION BOARD cont'd.

Part No.	Qty/Description	Ref.
LINEAR IC		
340-00744	1 IC,LINEAR,78L05	U23
MEMORY IC		
350-02272	4 IC,RAM,H6514,CMOS,1KX4	U5,6,12,13
350-02427	6 IC,EPROM,4KX8,350NS,2732	U1-4,9,10
DSPLY/IND/LED		
430-00904	3 LED,HP #5082-4850	LED 1,2,3
PC DIP/PROG SW		
455-00968	1 SW,DIP,1P1TX4	S1
BATTERIES		
460-01965	3 BAT,NI CAD,AAA,180mAh,1.2V	B1,2,3
CABLE CONN		
490-02356	6 CONN,JUMPER,.1X025,2FCG	J1-4
PC MNT CONN		
510-02671	8 CONN,POST,100X025,HDR,3MC,GOLD	J1-4
SOCKETS		
520-00942	9 IC SCKT,14 PIN,PC,LO-PRO	
520-00943	8 IC SCKT,16 PIN,PC,LO-PRO	
520-00945	8 IC SCKT,24 PIN,PC,LO-PRO	
520-01361	1 IC SCKT,20 PIN,PC,LO-PRO	
520-02177	4 IC SCKT,18 PIN,PC,LO-PRO	
PC HDWR		
610-01594	2 EXTRACTOR,CARD,SCANBE#S-203	
BULK WIRE		
670-02037	5 WIRE,28AWG,KYNAR,GRN	JUMPER 41-42 CUT (1) 4 1/2" PIECE
PC BOARDS		
710-02274	1 PC BD,MEM EXPAN BD,M224	

OUTPUT TRANSFORMER BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00528	4	RES,CF,5%,1/4W,820 OHM	R1-4
202-01228	4	RES,CF,5%,1/4W,620 OHM	R5-8
ELECTROLYT CAP			
240-02835	4	CAP,ELEC,220uF,25V,RAD,NON-POL	C17-20
CERAMIC CAP			
245-00590	8	CAP,CER,150pF,500V,10%	C1-8
245-00592	8	CAP,CER,510pF,500V,10%	C9-16
INDUCTORS			
270-00779	12	FERRITE,BEAD	FB1-12
TRANSFORMERS			
470-00261	4	XFORMER,OTPT,M92	T1-4
PC MNT CONN			
510-02806	2	CONN,XLR,3FC,PC	J23,24 (PIN ASSY) SHELLS ARE TO BE RETAINED FOR CHASSIS ASSY
510-02807	4	CONN,XLR,3MC,PC	J25-28 (PIN ASSY) SHELLS ARE TO BE RETAINED FOR CHASSIS ASSY
SPCR,NON-INSUL			
635-02826	7	SPCR,SWAGE,1/4RD,0.764-224	
MACHINE SCREWS			
640-01716	8	SCRW,6-32X3/8,PNH,PH,ZN	
THRD-FORM SCRW			
641-02827	6	SCRW,TAP,F,2-56X3/16,PNH,PH,ZN	J23-28
NUTS			
643-01728	8	NUT,6-32,KEP,ZN	
WASHERS			
644-02485	8	WSHR,FL,#8CLX.50DX.05THK	
BULK WIRE			
670-01768	2	WIRE,JMP,22AWG,0.5",TEF,WHT	W1,2
CABLES/CORDS			
680-01558	1	CABLE,AUDIO,16 CONDUCTOR	J29
PC BOARDS			
710-02766	1	PC BD,OTPT XFORMER,M224	

POWER SUPPLY #1

Part No.	Qty/Description	Ref.
CARBON FLM RES		
202-00518	1 RES,CF,5%,1/4W,220 OHM	R1
ELECTROLYT CAP		
240-00619	1 CAP,ELEC,1000uF,25V,AX	C2
240-01329	1 CAP,ELEC,45,000uF,15V	C1
CERAMIC CAP		
245-00596	2 CAP,CER,.005uF,1.6KV,Z5U	C3,4
DIODES		
300-01032	2 DIODE,1N5404	CR1,2
300-01466	1 DIODE,BRIDGE,VARO#R711	U1
DSPLY/IND/LED		
430-00904	1 LED,HP #5082-4850	CR3
SLIDE SWITCH		
451-02230	2 SW,SL,2P2T,V-CHNG,PC,4A	SW2,3
PSH BUT SWITCH		
453-01467	1 SW,PBPP,2P2T,WINK,BLU,SDR	SW1
453-01468	1 SW,PBM,1P2T,C&K,PCRA	SW4
CABLE CONN		
490-01479	1 CONN,POST,156X045,INS-DSP,3FCG	
PC MNT CONN		
510-01469	1 CONN,PIN&SOC,MATE&LOCK,PC,10MC	J9
510-02742	1 CONN,PIN&SOC,MATE&LOCK,3FC,PC	J48
STRAIN REL		
530-02489	2 TIE,CABLE,NYL,.1"X4"	
LUGS		
620-01616	6 LUG,SPADE,1/4",AMP#41729 OR EQ	
INSUL/SPACRS		
630-00957	4 SPCR,#4CLX1/16,3/16RD,NYL	
630-01852	1 INSUL,SEMI,SIL RUB,TO-3	
SPCR,NON-INSUL		
635-01453	5 SPCR,SWAGE,6-32X1/2,1/4RD,BR/N	

POWER SUPPLY #1 cont'd.

Part No.	Qty	Description	Ref.
MACHINE SCREWS			
640-01706	2	SCRW,4-40X3/8,PNH,PH,ZN	
640-01716	4	SCRW,6-32X3/8,PNH,PH,ZN	
640-01720	1	SCRW,6-32X3/4,PNH,PH,ZN	CAP BRKT
640-01841	2	SCRW,2-56X1/4,PNH,PH,ZN	
NUTS			
643-01728	1	NUT,6-32,KEP,ZN	CAP BRKT
643-01730	2	NUT,6-32,KEP,SMALL,ZN	
643-01732	2	NUT,4-40,KEP,ZN	
643-01855	2	NUT,2-56,HEX,SMALL,ZN	
WASHERS			
644-01854	2	WSHR,LOCK,SPLIT,#2	
PRE-CUT WIRE			
675-02839	1	WIRE,16G,RED,10",ST1/4XST&T1/4	
675-02840	1	WIRE,16G,BLK,10",ST1/4XST&T1/4	
675-02842	1	WIRE,16G,YEL,10",ST1/4XST&T1/4	
675-02864	1	WIRE,18G,BLK,18",ST&T1/4XO	
675-02886	2	WIRE,14G,RED,7.5,ST1/4XST&T1/4	
675-02887	1	WIRE,14G,R/Y,7.5,ST1/4XST&T1/4	
675-02891	1	WIRE,18G,GRN,18",ST&T1/4XO	
CABLES/CORDS			
680-01527	1	CORD,FAN,PLUG,M92081-24	J18
BRACKETS			
701-00299	2	BRACKET,KEYSTONE #617	
701-01330	1	BRACKET,CAP	
PANELS			
702-00843	6	COVER,BOOT,TS 253224	
HEAT SINKS			
704-01451	1	HEAT SINK,TO-3,IERC#UP-TO-3-CB	
PC BOARDS			
710-01437	1	PC BD,PS-1,M224	

POWER SUPPLY #2

Part No.	Qty	Description	Ref.
RIM RESISTORS			
201-00425	1	RES,TRM,ST,PCRA,500 OHM,SA,CER	R6
201-01461	1	RES,TRM,ST,PCRA,1K,SA,CER	R5
CARBON FLM RES			
202-00542	1	RES,CF,5%,1/4W,4.7K OHM	R9
METAL FLM RES			
203-00461	1	RES,MF,1%,1/8W,2.43K OHM	R7
203-00471	2	RES,MF,1%,1/8W,10.0K OHM	R3,4
203-01459	2	RES,MF,1%,1/8W,243 OHM	R2,8
203-01460	1	RES,MF,1%,1/8W,2.05K OHM	R1
ELECTROLYT CAP			
240-00609	1	CAP,ELEC,10uF,16V,RAD	C7
240-00623	1	CAP,ELEC,5500uF,25V,COP	C2
240-01262	2	CAP,ELEC,330uF,25V,RAD	C11,12
240-01446	2	CAP,ELEC,3300uF,35V,RAD	C6,10
TANTALUM CAP			
241-00652	3	CAP,TANT,4.7uF,25V,RAD	C1,8,9
MICA CAP			
242-00631	1	CAP,MICA,33pF,DM-15,330J	C3
CERAMIC CAP			
245-00600	2	CAP,CER,.02uF,35V,80/20%	C4,5
DIODES			
300-01030	12	DIODE,1N4004 AND 4005	CR1-12
TRANSISTORS			
310-01007	1	TRANSISTOR,2N3904	Q1
LINEAR IC			
340-00722	1	IC,LINEAR,LM301	U4
CABLE CONN			
490-02712	1	CONN,POST,156X045,INS-DSP,6FCG	J17
PC MNT CONN			
510-01464	2	CONN,POST,156X045,PCRA,6FCG	J12A,B
SOCKETS			
520-00941	1	IC SCKT,8 PIN,PC,LO-PRO	U4

POWER SUPPLY #2 cont'd.

Part No.	Qty	Description	Ref.
PRE-CUT WIRE			
675-02855	2	WIRE,18G,BRN,12",ST&T1/4X0	
675-02857	1	WIRE,18G,GRY,12",ST&T1/4X0	
675-02860	1	WIRE,18G,BLU,12",ST&T1/4X0	
PC BOARDS			
710-01438	1	PC BD,PS-2,M224	

POWER SUPPLY #3

Part No.	Qty	Description	Ref.
TRIM RESISTORS			
201-01619	2	RES,TRM,ST,PC,500 OHM,SA,CER	R7,11
CARBON FLM RES			
202-00495	1	RES,CF,5%,1/2W,1.2 OHM	R5
202-00514	2	RES,CF,5%,1/4W,100 OHM	R9,10
202-00524	1	RES,CF,5%,1/4W,470 OHM	R13
202-00527	1	RES,CF,5%,1/4W,750 OHM	R6
202-00531	1	RES,CF,5%,1/4W,1.5K OHM	R12
202-00535	1	RES,CF,5%,1/4W,2.4K OHM	R8
202-00555	1	RES,CF,5%,1/4W,20K OHM	R14
WIREWOUND RES			
204-01523	2	RES,WW,5%,10W,0.1 OHM	R1,2
CARBON COMP RES			
206-01524	2	RES,CC,5%,2W,27 OHM	R3,4
ELECTROLYT CAP			
240-00620	2	CAP,ELEC,1000uF,35V,RAD	C6,8
TANTALUM CAP			
241-00652	5	CAP,TANT,4.7uF,25V,RAD	C2,3,7,9,10
CERAMIC CAP			
245-00592	1	CAP,CER,510pF,500V,10%	C4
245-00605	2	CAP,CER,.1uF,16V,80/20%	C1,5
DIODES			
300-01027	1	DIODE,1N754	CR2
300-01030	8	DIODE,1N4004 AND 4005	CR1,3,5,7,8,9,10,11
300-01032	2	DIODE,1N5404	CR4,6
300-01526	1	DIODE,1N750,ZENER,4.7V	CR12
TRANSISTORS			
310-01007	1	TRANSISTOR,2N3904	Q4
LINEAR IC			
340-00730	1	IC,LINEAR,UA 723	U1
340-01525	1	IC,LINEAR,7905,-5V REG	U2
CABLE CONN			
490-00823	2	CONN,POST,156X045,INS-DSP,6FCG	J15,16
PC MNT CONN			
510-01464	1	CONN,POST,156X045,PCRA,6FCG	J14
510-01480	2	CONN,POST,156X045,HDR,3MCG,LOK	J11,13
510-01481	2	CONN,POST,156X045,HDR,6MCG,LOK	J12A,B

POWER SUPPLY #3 cont'd.

Part No.	Qty/Description	Ref.
SOCKETS		
520-00831	3 CONN,XISTOR,TO-220/202	Q3,5,U3
520-00947	2 XISTOR SCKT,TO3,SOLDER	Q1,2
TERM/PINS		
525-00988	3 QDC,.250X.032,MALE,RA SCRW MTG	
SPCR,NON-INSUL		
635-01454	2 SPCR,SWAGE,6-32X5/8,1/4RD,BR/N	
MACHINE SCREWS		
640-01706	1 SCRW,4-40X3/8,PNH,PH,ZN	
NUTS		
643-01732	1 NUT,4-40,KEP,ZN	
THREADLS FASTNR		
650-00989	3 EYELET,1/8CLX1/8L,BRASS/SDR	
BULK WIRE		
670-02722	2 WIRE,JMP,22AWG,.75",TEF,WHT	
PRE-CUT WIRE		
675-02862	1 WIRE,18G,BLK,10",ST&T1/4X0	
675-02863	2 WIRE,18G,BLK,14",ST&T1/4X0	
675-02865	1 WIRE,18G,RED,3.5",ST&T1/4X1/4	
675-02866	1 WIRE,18G,RED,5.5",ST&T1/4X1/4	
675-02868	2 WIRE,18G,RED,14",ST&T1/4X0	
675-02869	1 WIRE,18G,ORN,3.5",ST&T1/4X1/4	
675-02870	1 WIRE,18G,ORN,5.5",ST&T1/4X1/4	
675-02872	1 WIRE,18G,ORN,10",ST&T1/4X0	
675-02873	1 WIRE,18G,PRP,3.5",ST&T1/4X1/4	
675-02874	1 WIRE,18G,PRP,5.5",ST&T1/4X1/4	
675-02877	1 WIRE,18G,PRP,14",ST&T1/4X0	
675-02880	1 WIRE,18G,YEL,14",ST&T1/4X0	
PC BOARDS		
710-01439	1 PC BD,PS-3,M224	

POWER SUPPLY HARDWARE

Part No.	Qty	Description	Ref.
TRANSISTORS			
310-01017	1	TRANSISTOR,TIP31 A	Q3 (PS BD #3)
310-01522	2	TRANSISTOR,2N5885	Q1,2 (PS BD #3)
SCR			
320-01014	1	TRANSISTOR,C122F1,SCR	Q5 (PS BD #3)
LINEAR IC			
340-01462	2	IC,LINEAR,LM317,TO-3	U1,2 (PS BD #2)
340-01463	2	IC,LINEAR,7912	U3 (PS BD #2),U3 (PS BD #3)
INSUL/SPACRS			
630-00952	4	INSUL,SEMI,BUSHING,TO-220	
630-00958	9	SPCR,#6CLX1/8,3/16RD,NYL	
630-01852	4	INSUL,SEMI,SIL RUB,TO-3	
630-01853	4	INSUL,SEMI,SIL RUB,TO-220	
MACHINE SCREWS			
640-01700	1	SCRW,4-40X1/2,PNH,PH,SS	U3 (PS BD #2)
640-01705	3	SCRW,4-40X5/16,PNH,PH,ZN	Q3,5,U3
640-01708	4	SCRW,6-32X3/16,PNH,PH,ZN	BRACKET MTG
640-01719	9	SCRW,6-32X1/2,PNH,PH,ZN	U1-2,CAP,BRACKET MTG
640-01720	5	SCRW,6-32X3/4,PNH,PH,ZN	Q1,2 MTG
NUTS			
643-01730	9	NUT,6-32,KEP,SMALL,ZN	U1-2,CAP,BRACKET,MTG
643-01732	1	NUT,4-40,KEP,ZN	U3 (PS BD #2)
WASHERS			
644-01736	3	WSHR,FL,#4CLX.218ODX.032THK	Q3,5,U3
644-01737	3	WSHR,LOCK,SPLIT,#4	
644-01740	8	WSHR,LOCK,SPLIT,#6	
BRACKETS			
701-00299	2	BRACKET,KEYSTONE #617	
701-01541	1	BRACKET,ELECTROLYTIC SUPPORT	
701-01555	1	BRACKET,CAP CLAMP	
HEAT SINKS			
704-01266	1	HEAT SINK,POWER SUPPLY,M224	

TRANSITION BOARD

Part No.	Qty/Description	Ref.
PC MNT CONN		
510-01480	1 CONN,POST,156X045,HDR,3MCG,LOK	
510-01510	1 CONN,D-SUB,25FC,MB,PC	
BULK WIRE		
670-02722	1 WIRE,JMP,22AWG,.75",TEF,WHT	
CABLES/CORDS		
680-01557	1 CABLE,XITION,50 COND	
PC BOARDS		
710-01440	1 PC BD,XITION BD,M224	

CHASSIS HARDWARE

Part No.	Qty/Description	Ref.
FANS/MOTRS/RELY		
410-01529	1 FAN,TUBE,AX,4-1/8X1-1/2,50CFM	FAN ASSY
TRANSFORMERS		
470-01475	1 XFORMER,POWER,M224	XFORMER
CABLE CONN		
490-00396	1 CONN,AC AND RFI FILTER	
490-00812	1 CONN,PIN&SOC,.062,HSG,1F,MB	PWR FAIL SENSE
490-01477	1 CONN,PIN&SOC,MATE&LOCK,HSG,10F	XFORMER
490-02471	2 CONN,PIN&SOC,M&L,CRIMP PIN,14	
490-02741	1 CONN,PIN&SOC,MATE&LOCK,HSG,3M	AC POWER
PC MNT CONN		
510-02806	2 CONN,XLR,3FC,PC	(SOCKET ASSY REMOVED) (ITEM RETAINED FROM 023-02767 DO NOT DRAW FROM STOCK)
510-02807	4 CONN,XLR,3MC,PC	(PIN ASSY REMOVED) (ITEM RETAINED FROM 023-02767 DO NOT DRAW FROM STOCK)
TERM/PINS		
525-00808	1 CONN,PIN&SOC,062,CRIMP SCKT,24	PWR FAIL SENSE
525-01478	6 CONN,PIN&SOC,M&L,CRIMP SCKT	XFORMER
CONN HDWR		
527-00138	2 CONN,D-SUB,JACKSOCKET	XITION BD MTG
STRAIN REL		
530-01520	2 CLIP,RIBBON,CABLE	
530-02489	10 TIE,CABLE,NYL,.1"X4"	XFORMER WIRING,PS1,2 3 MOD WIRING,
530-02738	1 CLIP,WIRE HRNS,.50"DIA,ADH BAK	
GROMMETS		
540-00886	1 PLUG,HOLE,5/8"	
FEET		
541-00780	4 BUMPER,FEET,3-M #SJ5023	
ELECTRONIC HDWR		
600-00859	8 PANEL SCRW,CAPTIVE,6-32	MOUNTED ON FRONT PANEL
600-00872	1 FUSE HOLDER,3AG,PANEL,RA	
LUGS		
620-01999	1 LUG,SOLDER,LCKNG,#6,.020THK	GRNDING LUG

CHASSIS HARDWARE cont'd.

Part No.	Qty	Description	Ref.
INSUL/SPACRS			
630-01591	1	INSUL,LOGIC BOARD,M224	
SPCR,NON-INSUL			
635-01655	1	SPCR,6-32X7/16,1/4HEX,AL	
MACHINE SCREWS			
640-01704	12	SCRW,4-40X5/16,FH,PH,ZN	XLR MTG
640-01706	4	SCRW,4-40X3/8,PNH,PH,ZN	PROTECTIVE COVER,AC POWER CONN
640-01710	2	SCRW,6-32X1/4,PNH,PH,ZN	XFORMER BD MTG,PROT COVER,
640-01711	13	SCRW,6-32X1/4,FH,PH,ZN	PS1,3 MTG,TOP COVER
640-01716	24	SCRW,6-32X3/8,PNH,PH,ZN	GRND LUG,EXTRUSION MTG RACK EAR MTG
640-01720	5	SCRW,6-32X3/4,PNH,PH,ZN	LINE FILT MTG,FAN ASSY
640-01723	4	SCRW,10-32X3/8,FH,100DEG,PH,ZN	PWR XFORMER
640-02404	4	SCRW,6-32X13/16,PNH,PH,ZN	XFORMER
640-03713	3	SCRW,6-32X1/4,PNH,PH,SEMS,ZN	TOP COVER MTG
THRD-FORM SCRW			
641-01717	20	SCRW,TAP,F,6-32X1/4,HWH,SLOT	MOTHERBD MTG,FAN PL MTG
NUTS			
643-01727	4	NUT,10-32,KEP,ZN	
643-01728	4	NUT,6-32,KEP,ZN	FAN ASSY
643-01729	1	NUT,6-32,HEX,SMALL,ZN	GRND LUG
643-01732	2	NUT,4-40,KEP,ZN	OLD XITION BD MTG
643-03538	4	NUT,6-32,SPEED,SLF RETAIN,.093	XFORMER
WASHERS			
644-01735	2	WSHR,FL,#6CLX3/80DX1/32THK	PROTECTIVE COVER
644-01736	2	WSHR,FL,#4CLX.2180DX.032THK	AC CONN MTG
644-01739	17	WSHR,INT STAR,#6	EAR, PROT COVER,GRND LUG
644-01740	28	WSHR,LOCK,SPLIT,#6	
644-01747	2	WSHR,INT STAR,#4	PROTECTIVE COVER
THREADLS FASTNR			
650-02586	2	FASTNR,NYLATCH,HN5G-52-1	PCB RETAINER
650-02587	2	FASTNR,NYLATCH,HN5P-52-4-1	PCB RETAINER
PRE-CUT WIRE			
675-02845	1	WIRE,18G,WHT,17",ST1/4XST&T1/4	
675-02846	1	WIRE,18G,BLK,3",ST1/4XST&T1/4	
675-02850	1	WIRE,18G,BLK,17",ST1/4XST&T1/4	
675-02852	1	WIRE,16G,GRN,4",ST1/4XST&T1/4	AC CONN
675-03565	1	WIRE,24G,BU,11.5,ST1/4XST4T1/4	PWR FAIL SENSE
SLEEVING			
690-02060	6	SLEEVING,SHRINK,3/16"	AC CONN,1/2" LENGTHS

CHASSIS HARDWARE cont'd.

Part No.	Qty	Description	Ref.
CHASSIS/MECH			
700-01265	1	MTG PLATE,FAN,CHASSIS,M224	FAN ASSY
700-01269	1	COVER,TOP,CHASSIS,M224	
700-01308	1	MAINFRAME,ASSY,3-SHEETS,M224	
BRACKETS			
701-02440	2	BRACKET,MTG,RACK,M1200	
PANELS			
702-01311	1	PROTECTIVE COVER,M224	
702-01551	1	COVER,HOLE,DB-25	
702-02750	1	STRAP,RETAINER,PC	PCB RETAINER
702-02758	1	PANEL,FRONT,M224X	
PLASTICS			
720-00436	1	TAPE,FOAM,1/2X1/16X7-1/2	
720-01261	1	AIR FILTER,CHASSIS,M224	
720-01879	2	TAPE,FOAM,1/2X1/8X7-1/2	
720-03272	6	TAPE,FOAM,SGL-STK,1/8THX3/4W	PCB RETAINER
720-03386	1	AIR FILTER,FRONT PANEL,M224X	FP
720-03389	13	VELCRO ARROWHEAD,PRESSURE SENS	FP,CUT INTO (2) 6.5" PIECES
LABEL/NAMEPLTS			
740-02729	1	LABEL,FCC COMPLIANCE	TOP COVER
740-02773	1	LABEL,CLA APPROVAL	

FUSE BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00526	1	RES,CF,5%,1/4W,680 OHM	R1
FUSES			
440-00867	3	FUSE,3AG,SLO-BLO,2AMP	
440-00869	1	FUSE,3AG,SLO-BLO,2.5AMP	
440-01624	2	FUSE,3AG,SLO-BLO,3AMP,250V	
440-02664	2	FUSE,3AG,SLO-BLO,15AMP,32V	
CABLE CONN			
490-01479	3	CONN,POST,156X045,INS-DSP,3FCG	
PC MNT CONN			
510-02743	3	QDC,.250X.032,PC-MALE	J49,50,51
TERM/PINS			
525-00802	1	CONN,PIN&SOC,062,PIN,SWAGE	J47
STRAIN REL			
530-02489	6	TIE,CABLE,NYL,.1"X4"	FUSE BD WIRING
ELECTRONIC HDWR			
600-00871	14	FUSE CLIP,1/4",PC	
600-03171	1	FUSE BLOCK,3AG,1/4"QDC	
LUGS			
620-01616	2	LUG,SPADE,1/4",AMP#41729 OR EQ	
SPCR,NON-INSUL			
635-02361	4	SPCR,SWAGE,#6CLX1/2,1/4RD,BR/N	
MACHINE SCREWS			
640-01706	1	SCRW,4-40X3/8,PNH,PH,ZN	
NUTS			
643-01732	1	NUT,4-40,KEP,ZN	
WASHERS			
644-01737	1	WSHR,LOCK,SPLIT,#4	
PRE-CUT WIRE			
675-02859	2	WIRE,18G,BLU,9",ST&T1/4X0	
675-02879	2	WIRE,18G,YEL,9",ST&T1/4X0	
675-02888	1	WIRE,18G,BLU/WHT,9",ST&T1/4X0	
675-02889	1	WIRE,18G,YEL/BLK,9",ST&T1/4X0	
675-02890	2	WIRE,18G,GRN,9",ST&T1/4X0	
675-03271	1	WIRE,16G,YEL,11",ST1/4X1/4	

FUSE BOARD cont'd.

Part No.	Qty/Description	Ref.
PANELS		
702-00843	2 COVER,BOOT,TS 253224	
PC BOARDS		
710-02642	1 PC BD,FUSE PC BD,M224 CHASSIS	

MOTHERBOARD

Part No.	Qty/Description	Ref.
CARBON FLM RES		
202-00518	2 RES,CF,5%,1/4W,220 OHM	
202-00521	2 RES,CF,5%,1/4W,330 OHM	
202-00525	2 RES,CF,5%,1/4W,510 OHM	
NETWORK RES		
205-01590	5 RES,NET,SIP,2%,2.2KX9	
PC EDGE CONN		
500-01516	8 CONN,EDGE,30/60 C,.100,PC	J1A-8A
500-01517	8 CONN,EDGE,43/86 C,.156,PC	J1-8
PC MNT CONN		
510-00827	2 CONN,POST,156X045,HDR,6MCG,POL	J15,16
510-00828	1 CONN,POST,156X045,HDR,6MCG	J14
510-01480	1 CONN,POST,156X045,HDR,3MCG,LOK	
510-01481	1 CONN,POST,156X045,HDR,6MCG,LOK	J17
510-02898	1 CONN,POST,100X025,HDR,16MC,GLD	
PC HDWR		
610-01654	6 KEY POLARIZATION,PC EDGE CONN	
THRD-FORM SCRW		
641-01717	1 SCRW,TAP,F,6-32X1/4,HWH,SLOT	BRKT MTG
NUTS		
643-01730	1 NUT,6-32,KEP,SMALL,ZN	
BRACKETS		
701-00299	1 BRACKET,KEYSTONE #617	
PC BOARDS		
710-01442	1 PC BD,MOTHERBD,M224	

SHIPPING KIT

Part No.	Qty/Description	Ref.
CUST LITERATURE		
070-02709	1 MANUAL,OWNER'S,M224X	
070-02813	1 CARD,WARRANTY,LEXICON	
CABLES/CORDS		
680-00841	1 CORD,POWER,PHILLIP #13E37-1	
SHIPPING MAT		
730-00201	1 BOX,OUT,15-1/2X12-1/8X8,REM HD	
730-01658	2 INSERT,PACKING,M224	
730-01828	1 BOX,OUT,24X23-3/8X12-3/4,M224	
730-01829	1 BOX,IN,17-5/8X19X8,M224	
730-01830	1 INSRT,CDBD,FR,19X8X1-1/2,M224	
730-01831	1 INSRT,CDBD,RR,53-5/8X8,M224	
730-01832	8 CORNER PAD,HORN,TORO	
730-01833	2 INSRT,CDBD,END,13-1/4X8,M224	
730-01834	1 INSRT,CDBD,TOP,27-1/4X17,M224	
730-03727	1 BAG,CLEAR,9X14X.004	REMOTE CONTROL PKG

115V FUSE OPTION

Part No.	Qty/Description	Ref.
FUSES		
440-01624	1 FUSE,3AG,SLO-BLO,3AMP,250V	PICK AND ADD TO CHASSIS CAGE KIT #023-03021(M224XL) #023-03706(M224X) OR #023-03028 (M224)

230V FUSE OPTION

Part No.	Qty/Description	Ref.
FUSES		
440-01876	1 FUSE,5X20MM,SLO-BLO,1.6AMP	
ELECTRONIC HDWR		
600-01878	1 FUSE,ADAPTOR,5X20MM TO 3AG	

RS232 OPTION

Part No.	Qty/Description	Ref.
CONN HDWR		
527-00138	2 CONN,D-SUB,JACKSOCKET	WITH ACCOMPANYING HARDWARE [(1) #4 SPLIT LOCK WASHER AND (1) #4 NUT]
CABLES/CORDS		
680-01519	1 CABLE,D-25F to 26C EDGE,30"	

V8.1 RETROFIT

Part No.	Qty/Description	Ref.
CUST LITERATURE		
070-03261	1 INSTR,SOFT-UP RETRO,V8.1,M224X	THIS INCLUDES UPDATED SECTIONS OF OWNER'S MANUAL

RCH RPL BOARD

Part No.	Qty	Description	Ref.
POTENTIOMETERS			
200-01445	6	POT,SLD,PC,10K-U,25MM X 45MM	R5-10
CARBON FLM RES			
202-00522	2	RES,CF,5%,1/4W,360 OHM	R3,4
202-00529	1	RES,CF,5%,1/4W,1K OHM	R1
202-00543	2	RES,CF,5%,1/4W,5.1K OHM	R11,12
202-00561	1	RES,CF,5%,1/4W,36K OHM	R2
NETWORK RES			
205-00330	3	RES,NET,SIP,2%,3.3KX9	RP1-3
ELECTROLYT CAP			
240-00619	1	CAP,ELEC,1000uF,25V,AX	C11
TANTALUM CAP			
241-00651	1	CAP,TANT,.22uF,35V,RAD	C4
241-00652	1	CAP,TANT,4.7uF,25V,RAD	C3
MICA CAP			
242-00634	1	CAP,MICA,100pF,DM-15,101J	C9
CERAMIC CAP			
245-00588	1	CAP,CER,100pF,1000V,10%	C1
245-00598	12	CAP,CER,.01uF,16V,80/20%	6 SLIDE POT BYPASSES,C2,5-8,12
DIODES			
300-01030	4	DIODE,1N4004 AND 4005	CR1-4
DIGITAL/CMOS IC			
330-00697	1	IC,DIGITAL,74LS10	U7
330-00768	1	IC,DIGITAL,4049,CMOS	U12
330-01290	2	IC,DIGITAL,74LS244	U8,11
330-01297	1	IC,DIGITAL,74LS42	U6
330-01316	1	IC,DIGITAL,74LS123	U2
330-01592	1	IC,DIGITAL,74LS132	U1
LINEAR IC			
340-00742	1	IC,LINEAR,7805 (LM 340 T-5)	U3
INTERFACE IC			
345-01305	2	IC,INTER,SN75327 N	U9,10
345-01306	2	IC,INTER,SN75326 N	U4,5
CONVERTER IC			
355-01280	1	ADC-0817	U13

RCH RPL BOARD cont'd.

Part No.	Qty	Description	Ref.
PC MNT CONN			
510-01504	1	CONN,D-SUB,25FC,MB,PCRA	J2
510-01505	0	CONN,D-SUB,25FC,MB,PCRA,2ND	
SOCKETS			
520-00942	2	IC SCKT,14 PIN,PC,LO-PRO	U1,7
520-00943	7	IC SCKT,16 PIN,PC,LO-PRO	U2,4-6,9,10,12
520-00946	1	IC SCKT,40 PIN,PC,LO-PRO	U13
520-01361	2	IC SCKT,20 PIN,PC,LO-PRO	U8,11
MACHINE SCREWS			
640-01706	2	SCRW,4-40X3/8,PNH,PH,ZN	J2
640-01714	1	SCRW,6-32X3/8,PNH,PH,SS	U3
640-02746	6	SCRW,2-M3X.5MMX.175L,PNH,PH,ZN	R5-10 GND
NUTS			
643-01730	1	NUT,6-32,KEP,SMALL,ZN	U3
643-01732	2	NUT,4-40,KEP,ZN	J2
HEAT SINKS			
704-01503	1	HEAT SINK,PA1-1CB	
PC BOARDS			
710-01443	1	PC BD,REM PAN LOG,M224	

RCH RPD BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00501	8	RES,CF,5%,1/2W,150 OHM	R1-8
DIODES			
300-01023	3	DIODE,1N283	CR16-18
DSPLY/IND/LED			
430-01212	15	LED,HP #5082-4480	CR1-15
430-01507	3	LED,DSPLY,5082-7613	D0-2
PSH BUT SWITCH			
453-01508	16	SW,PBM,1P2T,DIGITST,ILLUM,.5W	S1-16
453-01509	6	SW,PBM,1P2T,DIGITST,ILLUM,.69W	S17-22
BULK WIRE			
670-01506	1	CABLE,FLEX-JUMP,27 COND,1X0.1	J1
PC BOARDS			
710-01444	1	PC BD,REM PAN DSPLY,M224	

RCH HARDWARE

Part No.	Qty	Description	Ref.
CONN HDWR			
527-00138	2	CONN,D-SUB,JACKSOCKET	
GROMMETS			
540-01502	1	GUARD,DUST,M224	
FEET			
541-00781	4	BUMPER,FEET,3-M #SJ5025	
KNOBS/CAPS			
550-01499	6	BUTTON,TANG,BLK	
PC HDWR			
610-01241	2	GUIDE,CIRCUIT BD	
SPCR,NON-INSUL			
635-01500	4	SPCR,#6CLX3/8,1/4RD,AL	
635-01501	4	SPCR,6-32X5/8,1/4HEX,AL	
MACHINE SCREWS			
640-01709	4	SCRW,6-32X3/16,PNH,PH,BLK	
640-03713	4	SCRW,6-32X1/4,PNH,PH,SEMS,ZN	
NUTS			
643-01732	2	NUT,4-40,KEP,ZN	
CHASSIS/MECH			
700-01449	1	COVER,BOT,REM CNTRL,M224/224X	
700-02696	1	COVER,TOP,REM CNTRL BOX,M224X	
LENS/PLATE/PANL			
703-01498	1	LENS,DISPLAY,M224	

LARC TRANSITION BOARD

Part No.	Qty/Description	Ref.
CARBON FLM RES		
202-00529	1 RES,CF,5%,1/4W,1K OHM	R4
202-00549	3 RES,CF,5%,1/4W,10K OHM	R1-3
ELECTROLYT CAP		
240-00622	1 CAP,ELEC,4700uF,16V,AX	C9
CERAMIC CAP		
245-00590	2 CAP,CER,150pF,500V,10%	C4,5
245-00594	1 CAP,CER,.001uF,500V,10%,Z5F	C7
245-00598	2 CAP,CER,.01uF,16V,80/20%	C3,6
245-01651	3 CAP,CER,.1uF,50V,80/20%	C1,2,8
INDUCTORS		
270-00779	2 FERRITE,BEAD	FB1,2
DIODES		
300-01032	4 DIODE,1N5404	CR1-4
DIGITAL/CMOS IC		
330-00692	1 IC,DIGITAL,74LS00	U3
INTERFACE IC		
345-01584	1 IC,INTER,DS1488N	U1
345-01585	1 IC,INTER,DS1489AN	U2
345-03207	1 IC,INTER,uA9638,LINE DRVR	U5
345-03208	1 IC,INTER,uA9637A,LINE RCVR	U4
CABLE CONN		
490-02356	5 CONN,JUMPER,.1X025,2FCG	W1-5
PC MNT CONN		
510-01480	1 CONN,POST,156X045,HDR,3MCG,LOK	J3
510-01481	1 CONN,POST,156X045,HDR,6MCG,LOK	J1
510-02671	5 CONN,POST,100X025,HDR,3MC,GOLD	W1-5,
510-03551	1 CONN,D-SUB,9FC,MB,PC	J5
SOCKETS		
520-00941	2 IC SCKT,8 PIN,PC,LO-PRO	U4,5
520-00942	3 IC SCKT,14 PIN,PC,LO-PRO	U1-3
SPCR,NON-INSUL		
635-03528	2 SPCR,SWAGE,4-40X3/8,1/4RD,BR/N	J5
635-03529	1 SPCR,SWAGE,6-32X7/16,1/4RD,BR	

LARC TRANSITION BOARD cont'd.

Part No.	Qty/Description	Ref.
CABLES/CORDS		
680-03490	1 CABLE,XITION/EDGE,26 COND,30"	J2
PC BOARDS		
710-03442	1 PC BD,XITION BD,M224X	

LARC HARDWARE KIT

Part No.	Qty/Description	Ref.
CABLE CONN		
490-02416	4 SPLICE,INS-DSP,2 WIRE	NEW XITION BD
490-02712	1 CONN,POST,156X045,INS-DSP,6FCG	
CONN HDWR		
527-00138	2 CONN,D-SUB,JACKSOCKET	NEW XITION BD MTG
STRAIN REL		
530-02489	3 TIE,CABLE,NYL,.1"X4"	NEW XITION BD MTG
MACHINE SCREWS		
640-01705	2 SCRW,4-40X5/16,PNH,PH,ZN	ADAPTOR PLATE MTG
640-01710	1 SCRW,6-32X1/4,PNH,PH,ZN	NEW XITION BD MTG
640-02404	4 SCRW,6-32X13/16,PNH,PH,ZN	FUSE BD TO XFORMER
NUTS		
643-01732	2 NUT,4-40,KEP,ZN	ADAPTOR PLATE MTG
643-03538	4 NUT,6-32,SPEED,SLF RETAIN,.093	FUSE BD TO XFORMER
WASHERS		
644-01740	1 WSHR,LOCK,SPLIT,#6	NEW XITION BD MTG
PRE-CUT WIRE		
675-02863	1 WIRE,18G,BLK,14",ST&T1/4X0	
675-02868	1 WIRE,18G,RED,14",ST&T1/4X0	
675-02877	1 WIRE,18G,PRP,14",ST&T1/4X0	
675-03651	1 WIRE,18G,ORN,12"	
PANELS		
702-03537	1 PLATE,ADAPTOR,DB-25 TO DE-9	
PLASTICS		
720-00436	1 TAPE,FOAM,1/2X1/16X7-1/2	
720-01879	2 TAPE,FOAM,1/2X1/8X7-1/2	

ROM/RAM KIT,LARC

Part No.	Qty	Description	Ref.
DIGITAL/CMOS IC			
330-02504	2	IC,DIGITAL,74S157	U18,36
MEMORY IC			
350-01304	3	IC,EPROM,2716	U23,24,25
350-02427	7	IC,EPROM,4KX8,350NS,2732	U1-4,9-11
350-03439	16	IC,DRAM,4164,64KX1,150NS	U20-35
MICROPROC IC			
365-01583	1	IC,uPROC,8251 A	U22
BULK WIRE			
670-01974	5	WIRE,JMP,22AWG,0.1",NON-INSUL	J1-5
PLASTICS			
720-03002	2	FOAM,CONDUCTIVE,1/4" SHEET	CUT TO 5" x 3-1/2"
SHIPPING MAT			
730-01835	2	BAG,CONDUCTIVE,4.25X8X.004	

LARC SHIPPING KIT

Part No.	Qty	Description	Ref.
CUST LITERATURE			
070-02813	1	CARD,WARRANTY,LEXICON	
070-03695	1	MANUAL,OWNER'S,224XL	
070-03739	1	INSTR,RETROFIT,LARC,M224X	
070-03759	1	INSTR,PANEL MOUNT,LARC	
FUSES			
440-01624	1	FUSE,3AG,SLO-BLO,3AMP,250V	PUT IN POLY BAG #730-02824
440-01876	1	FUSE,5X20MM,SLO-BLO,1.6AMP	PUT IN POLY BAG #730-02824
INSUL/SPACRS			
630-00953	2	WSHR,FL,#6CLX3/80DX1/16,FBR	PUT IN POLY BAG #730-02824
SPCR,NON-INSUL			
635-03720	2	SPCR,6-32X1/2,1/4HEX,BR/N	PUT IN POLY BAG #730-02824
CABLES/CORDS			
680-03525	1	CABLE,50',LURCH	
680-03690	1	CABLE,CASSETTE INTERFACE	
SHIPPING MAT			
730-02824	1	BAG,CLEAR,3X5X.002	STAPLE TO PANEL MOUNT INSTR
730-03085	1	BOX,OUT,23X18.5X7.75	
730-03724	1	BOX,5-1/2X3-7/8X2	
730-03727	1	BAG,CLEAR,9X14X.004	REMOTE CONTROL PKG
LABEL/NAMEPLTS			
740-00000	1	LABEL/NMPL	LABEL,RETURN SHIPPING
TOOLS			
780-01925	1	TOOL,IC EXTRACTOR	

LARC DISPLAY BD

Part No.	Qty/Description	Ref.
CERAMIC CAP		
245-01651	4 CAP,CER,.1uF,50V,80/20%	C1-4
DSPLY/IND/LED		
430-03413	6 LED,DSPLY,4-CHAR,DL-1414	U1-4
~~430-03414~~ 430-04685	8 4 LED,DSPLY,STICK,8 RED	CR1-32
SOCKETS		
520-02718	4 SOCKET STRIP,MACH,.100X020	CR1-32,4 LENGTHS OF 1.6" EA
BULK WIRE		
670-03530	1 CABLE,FLEX-JUMP,29C,1.5X0.1	P3
PC BOARDS		
710-03393	1 PC BD,DISPLAY BD,LURCH	

LARC ELECT BOARD

Part No.	Qty	Description	Ref.
POTENTIOMETERS			
200-01445	6	POT,SLD,PC,10K-U,25MM X 45MM	R23-28
TRIM RESISTORS			
201-00439	1	RES,TRM,ST,PC,25K,SA,CER	R9
CARBON FLM RES			
202-00502	1	RES,CF,10%,1/2W,270 OHM	R22
202-00514	2	RES,CF,5%,1/4W,100 OHM	R12,13
202-00523	1	RES,CF,5%,1/4W,390 OHM	R20
202-00524	2	RES,CF,5%,1/4W,470 OHM	R10,30
202-00529	3	RES,CF,5%,1/4W,1K OHM	R6,14,29
202-00534	1	RES,CF,5%,1/4W,2.2K OHM	R3
202-00538	3	RES,CF,5%,1/4W,3.3K OHM	R1,4,31
202-00542	3	RES,CF,5%,1/4W,4.7K OHM	R15,18,19
202-00549	2	RES,CF,5%,1/4W,10K OHM	R8,11
202-00556	1	RES,CF,5%,1/4W,22K OHM	R21
202-00563	2	RES,CF,5%,1/4W,47K OHM	R7,17
202-00564	1	RES,CF,5%,1/4W,51K OHM	R2
202-00571	1	RES,CF,5%,1/4W,110K OHM	R5
202-00580	1	RES,CF,5%,1/4W,1M OHM	R16
NETWORK RES			
205-03531	4	RES,NET,SIP,2%,10KX5	RP1-4
ELECTROLYT CAP			
240-00609	3	CAP,ELEC,10uF,16V,RAD	C9,17,39
240-00616	1	CAP,ELEC,470uF,16V,AX	C41
240-00619	1	CAP,ELEC,1000uF,25V,AX	C36
240-02048	1	CAP,ELEC,47uF,25V,AX	C37
TANTALUM CAP			
241-00652	1	CAP,TANT,4.7uF,25V,RAD	C26
CERAMIC CAP			
245-00585	2	CAP,CER,18pF,100V,10%	C24,25
245-00590	1	CAP,CER,150pF,500V,10%	C1
245-00594	5	CAP,CER,.001uF,500V,10%,Z5F	C18,23,27,29,40
245-00598	15	CAP,CER,.01uF,16V,80/20%	C2,4,10-16,19-22,34,38
245-01651	12	CAP,CER,.1uF,50V,80/20%	C3,5-8,28,30-32,33,35,42
INDUCTORS			
270-00779	10	FERRITE,BEAD	FB1-9,FB10
270-03497	1	INDUCTOR,300uH,1A,SWITCHING	L1

LARC ELECT BOARD cont'd.

Part No.	Qty/Description	Ref.
DIODES		
300-01024	1 DIODE,1N746	CR6
300-01029	4 DIODE,1N914 AND 4148	CR1-4
300-02401	1 DIODE,BAR 35,SCHOTTKY,LOW VF	CR5
300-03498	1 DIODE,SCHOTTKEY,POWER,3A	CR8
300-03546	1 DIODE,BRIDGE,2A,200V	CR7
TRANSISTORS		
310-03438	1 TRANSISTOR,IRFD9120,FET	Q1
DIGITAL/CMOS IC		
330-00767	1 IC,DIGITAL,4013,CMOS	U10 Switch
330-00768	1 IC,DIGITAL,4049,CMOS	U6
330-03496	1 IC,DIGITAL,CD4515,CMOS	U11
LINEAR IC		
340-00725	1 IC,LINEAR,LM311	U1
340-03499	1 IC,LINEAR,MC34060 OR TL494	U12
INTERFACE IC		
345-00751	1 IC,INTER,75492,LED DRVR	U4
345-02913	1 IC,INTER,NE594,DSP DRVR,8-SEG	U7
345-03207	1 IC,INTER,uA9638,LINE DRVR	U3
345-03208	1 IC,INTER,uA9637A,LINE RCVR	U2
CONVERTER IC		
355-02903	1 IC,CONVERTER,ADC 0809	U5
MICROPROC IC		
365-03524	1 IC,uPROC,8749,EPROM	U9,PICK AND DELIVER TO TEST
365-03526	1 IC,uPROC,CDP1854 or IM6402	U8
CRYSTALS		
390-02210	1 CRYSTAL,4.608 MHz	Y1
FUSES		
440-02466	1 FUSE,1AG,FAST,1AMP,32V	F1
CABLE CONN		
490-00998	1 CONN,DIN,5FC,180DEG	J0
PC MNT CONN		
510-03088	1 CONN,POST,100X025,HDR,10MCG	W1,BREAK INTO 2 LENGTHS OF 5 EA
510-03484	1 CONN,DC POWER,PC,SMK S-G9314	J2
510-03549	1 CONN,D-SUB,9MC,FB,PCRA	J1

LARC ELECT BOARD cont'd.

Part No.	Qty/Description	Ref.
SOCKETS		
520-00941	3 IC SCKT,8 PIN,PC,LO-PRO	U1-3
520-00942	2 IC SCKT,14 PIN,PC,LO-PRO	U4,10
520-00943	2 IC SCKT,16 PIN,PC,LO-PRO	U6,12
520-00945	1 IC SCKT,24 PIN,PC,LO-PRO	U11
520-00946	2 IC SCKT,40 PIN,PC,LO-PRO	U8,9
520-01458	1 IC SCKT,28 PIN,PC,LO-PRO	U5
520-02177	1 IC SCKT,18 PIN,PC,LO-PRO	U7
ELECTRONIC HDWR		
600-00871	2 FUSE CLIP,1/4",PC	F1
INSUL/SPACRS		
630-00953	2 WSHR,FL,#6CLX3/80DX1/16,FBR	COMPONENT SIDE ELECTRONICS BD TO ENCLOSURE, ATTACHED WITH PLIOBOND
630-03544	2 WSHR,FL,#6CLX3/80DX.032,FBR	SUB-PNL TO CIRCUIT SIDE ELECT BD MTG, ATTACHED WITH PLIOBOND
MACHINE SCREWS		
640-01701	2 SCRW,4-40X1/4,PNH,PH,ZN	DE-9 TO ELECT PCB MTG
NUTS		
643-01732	2 NUT,4-40,KEP,ZN	DE-9 TO ELECT PCB MTG
PRE-CUT WIRE		
675-02884	3 WIRE,24G,WHT,1.5",ST&T1/4X1/4	P1 TO J0
675-03722	1 WIRE,24G,WHT,2",ST&T1/4X1/4	P1-1 TO J0-4
PC BOARDS		
710-03398	1 PC BD,ELECT BD,LURCH	

LARC PANEL BOARD

Part No.	Qty	Description	Ref.
CARBON FLM RES			
202-00509	8	RES,CF,5%,1/4W,47 OHM	R5-12
202-00529	4	RES,CF,5%,1/4W,1K OHM	R1-4
ELECTROLYT CAP			
240-00609	1	CAP,ELEC,10uF,16V,RAD	C1
CERAMIC CAP			
245-01651	4	CAP,CER,.1uF,50V,80/20%	C2-5
DIODES			
300-01023	8	DIODE,1N283	CR1-8
DSPLY/IND/LED			
430-03413	6	LED,DSPLY,4-CHAR,DL-1414	U1-6
PSH BUT SWITCH			
453-03440	26	SW,PBM,1P1T,TANG,PC	SW1-16,18-22,26-3
SOCKETS			
520-02718	4	SOCKET STRIP,MACH,.100X020	U1-6 NEED 12 LENGTHS OF .6" EACH
KNOBS/CAPS			
550-03390	6	BUTTON,.57X.47,WHT	SW1-6
SPCR,NON-INSUL			
635-03542	2	SPCR,SWAGE,#6CLX.594,1/4RD,BR	PNL BD TO ELECT BD MTG
BULK WIRE			
670-02837	1	CABLE,FLEX-JUMP,19C,1.5X0.1	P2
670-03530	1	CABLE,FLEX-JUMP,29C,1.5X0.1	P3
PC BOARDS			
710-03404	1	PC BD,PANEL BD,LURCH	

LARC FINISHING KIT

Part No.	Qty	Description	Ref.
CONN HDWR			
527-00138	2	CONN,D-SUB,JACKSOCKET	DE-9 TO CHASSIS BRKT MTG
GROMMETS			
540-03532	1	GUARD,DUST,LURCH	
KNOBS/CAPS			
550-03388	6	KNOB,SLIDE POT,WHITE	
550-03415	1	BUTTON,.57X.47,"PROG" LEG,BLU	
550-03416	1	BUTTON,.57X.47,"REG" LEG,BLU	
550-03417	1	BUTTON,.57X.47,"0" LEG,WHT	
550-03418	1	BUTTON,.57X.47,"1" LEG,WHT	
550-03419	1	BUTTON,.57X.47,"2" LEG,WHT	
550-03420	1	BUTTON.,57X.47,"3" LEG,WHT	
550-03421	1	BUTTON,.57X.47,"4" LEG,WHT	
550-03422	1	BUTTON,.57X.47,"5" LEG,WHT	
550-03423	1	BUTTON,.57X.47,"6" LEG,WHT	
550-03424	1	BUTTON,.57X.47,"7" LEG,WHT	
550-03425	1	BUTTON,.57X.47,"8" LEG,WHT	
550-03426	1	BUTTON,.57X.47,"9" LEG,WHT	
550-03427	1	BUTTON,.57X.47,"VAR" LEG,WHT	
550-03428	1	BUTTON,.57X.47,"BANK" LEG,WHT	
550-03429	1	BUTTON,.57X.47,"STO" LEG,WHT	
550-03430	1	BUTTON,.57X.47,"PARAM" LEG,WHT	
550-03431	1	BUTTON,.57X.47,"MUTE" LEG,WHT	
550-03432	1	BUTTON,.57X.47,"TAPE" LEG,WHT	
550-03433	1	BUTTON,.57X.47,"2nd F" LEG,WHT	
550-03434	1	BUTTON,.57X.47,"PAGE" LEG,WHT	
PC HDWR			
610-02269	2	HARDWARE,PC,RICHCO #MB-3-156	DISPLAY BD TO PANEL BD
SPCR,NON-INSUL			
635-01655	2	SPCR,6-32X7/16,1/4HEX,AL	ELECT BD TO CASE MTG
635-03541	2	SPCR,#6CLX.355,1/4RD,BR/N	SUB-PNL TO PNL BD MTG
MACHINE SCREWS			
640-02378	4	SCRW,6-32X7/16,TH,PH,BLK	PCB TO CASE MTG
640-02746	6	SCRW,2-M3X.5MMX.175L,PNH,PH,ZN	R23-28 MTG NOTE: DO NOT USE METRIC SCREWS PROVIDED WITH THE SLIDERS.
640-02812	2	SCRW,4-40X3/8,PNH,PH,BLK	DIN TO CHASSIS BRKT MTG
640-03713	2	SCRW,6-32X1/4,PNH,PH,SEMS,ZN	CONN BRKT TO PNL BD MTG
THRD-FORM SCRW			
641-03543	2	SCRW,TAP,F,4-40X1/4,PNH,PH,ZN	DSPLY BD MTG

LARC FINISHING KIT cont'd.

Part No.	Qty	Description	Ref.
NUTS			
643-01733	2	NUT,4-40,HEX,SMALL,ZN	DIN TO CHASSIS BRKT MTG
WASHERS			
644-01736	2	WSHR,FL,#4CLX.2180DX.032THK	DSPLY BD MTG
644-01737	2	WSHR,LOCK,SPLIT,#4	DIN TO CHASSIS BRKT MTG
644-01747	6	WSHR,INT STAR,#4	
644-02379	4	WSHR,FL,#6CLX3/80DX.049THK,BLK	PCB TO CASE MTG
644-02716	2	WSHR,FL,#4CLX.3120DX.03THK	DIN TO CHASSIS BRKT MTG
CHASSIS/MECH			
700-03391	1	ENCLOSURE,BOTTOM,LURCH	
700-03392	1	ENCLOSURE,TOP,LURCH	
700-03448	1	CHASSIS,BRACKET,LURCH	
PANELS			
702-03374	1	PANEL,SUB,LURCH	
702-03375	1	PANEL,OVERLAY,LURCH	
702-03545	1	PROTECTIVE COVER,LURCH	
LENS/PLATE/PANL			
703-00994	1	TRIMPLATE,ALUM,FOIL,GP	CHASSIS BOTTOM
703-03410	1	LENS,DISPLAY,LURCH	
PLASTICS			
720-03548	2	TAPE,FOAM,1/16X1/2X3.4	BUMPER FEET
720-03673	1	GASKET,DBL-STK,LURCH LENS MTG	LENS MTG
LABEL/NAMEPLTS			
740-03676	1	LABEL,LARC,PRODUCT ID & FCC	

25' CABLE OPTION

Part No.	Qty/Description	Ref.
CABLES/CORDS		
680-02045	1 CABLE,CNTRL HD,SHLD,25FT,RND	PICK AND ADD TO FIN KIT #024-03700 (M224X) OR #022-03061 (M224)

50' CABLE OPTION

Part No.	Qty/Description	Ref.
CABLES/CORDS		
680-02055	1 CABLE,CNTRL HD,SHLD,50FT,RND	PICK AND ADD TO FIN KIT #022-03700 (M224X) OR #022-03061 (M224)

Model 224XL

Service Manual Addendum

lexicon

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Waltham, MA 02154
(617) 891-6790
Telex 923 468

070-04297 5/85

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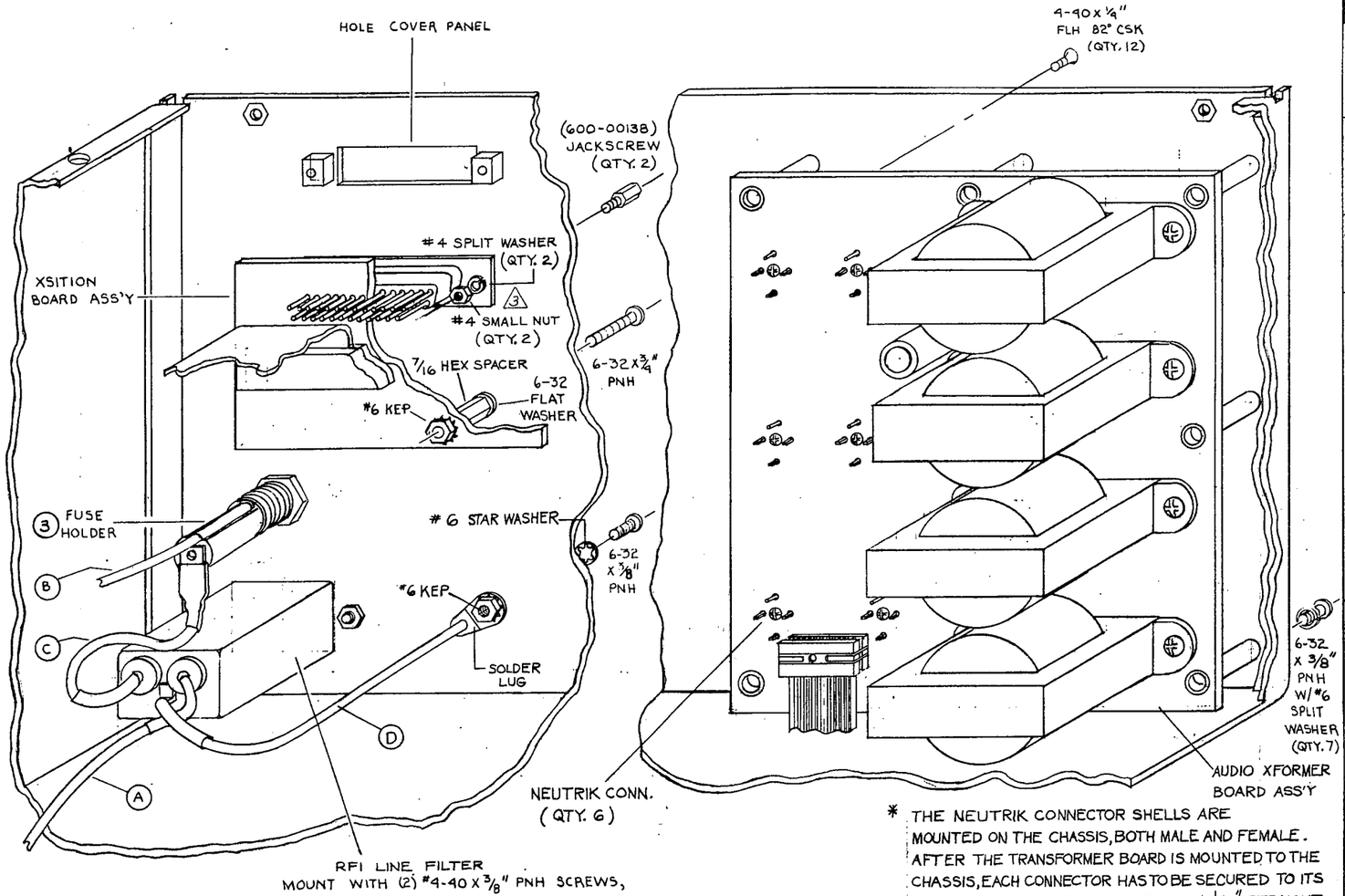


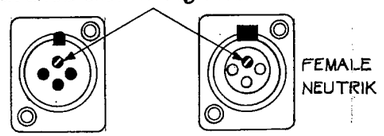
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	DELETE: MOLEX POWER CONN. & CORCOM LINE FILTER ADD: CORCOM 3EF1 LINE FILTER. CHANGE HARDWARE & WIRING ACCORDINGLY.	11-15-79	JX6 / A.P.
2	UPDATE DRAWING TO CONFORM TO NEW CHASSIS AND TRANSFORMER BOARD. CONNECTION BETWEEN GROUND WIRE OF AC CONNECTOR AND CHASSIS.	4.22.82	M.H.
3	DELETE #4 KEP NUT USED IN XITION BOARD MOUNTING. CHANGED TO #4 SMALL NUT WITH SPLIT WASHER.	8/10/82 JCR	CB 8/14/82

NOTES

1. WHEN 25 CONN. I/O CABLE IS TO BE MOUNTED ON THE CHASSIS, MT. CONN. IN PLACE OF THE HOLE COVER PANEL USING #4 JACK SCREWS & #4 SMALL NUT
2. WIRES A, B & C ARE UL #1015, 18 AWG, INSUL. .032 THK., RATED FOR 600V, MAX. AMBIENT TEMP. 105°C; WIRE D IS UL #1015, 16 AWG
3. FUSE HOLDER HARDWARE - INSTALL HEX NUT ON INSIDE OF CHASSIS, RUBBER WASHER ON OUTSIDE OF CHASSIS.
4. TORQUE SPECS:

#4-40 PNH, FLH MTG. HOLE COVER, NEUTRIK CONN.	10 IN-LBS
#6-32 PNH SWAGE STANDOFFS, HOPKINS IN LINE FILTER	18 " "

* THE NEUTRIK CONNECTOR SHELLS ARE MOUNTED ON THE CHASSIS, BOTH MALE AND FEMALE. AFTER THE TRANSFORMER BOARD IS MOUNTED TO THE CHASSIS, EACH CONNECTOR HAS TO BE SECURED TO ITS SHELL. THIS IS DONE BY INSERTING A 1/16" STRAIGHT BLADE SCREWDRIVER INTO THE HOLE SHOWN ON THE DIAGRAM AND GIVING IT A 1/6 TURN CLOCKWISE.



WIRE CONNECTIONS

WIRE	COLOR	LENGTH	FROM / TYPE OF CONNECTION	TO / TYPE OF CONNECTION
A	WHITE UL	17"	HOPKINS F85105 IN LINE FILTER / SOLDER JOINT - STRIP & TIN 1/4", COVER W/ 1" SHRINK TUBING	P.S. 1, J48 PIN 3
B	BLACK UL	17"	FUSE HOLDER / STRIP & TIN 1/4" COVER WITH 1" OF SHRINK TUBING	P.S. 1, J48 PIN 1
C	BLACK UL	4"	FUSE HOLDER / 1/4" SPADE LUG WITH SPADE LUG BOOT	RFI FILTER / STRIP & TIN 1/4", COVER WITH 1" OF SHRINK TUBING
D	GREEN UL	4"	HOPKINS IN LINE FILTER / SOLDER JOINT - STRIP AND TIN 1/4", COVER WITH 1" SHRINK TUBE.	SOLDER LUG / SOLDER JOINT - STRIP AND TIN 1/4".

FOR SPADE LUG #620-01616, USE AMP CRIMPING TOOL #90165-1

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

	224
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN JX6	5-8-79
CHECKED CB	
ISSUED	

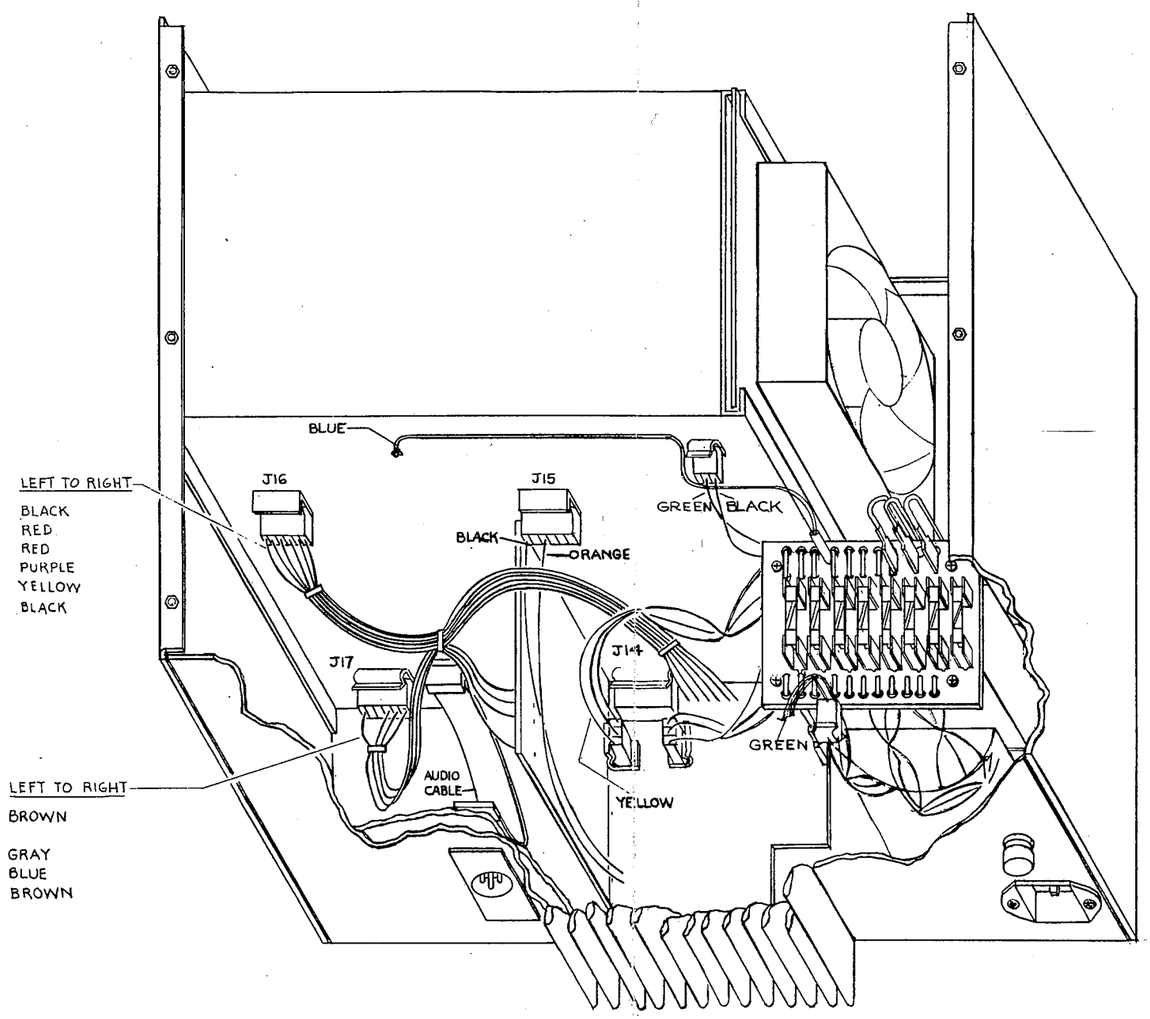
lexicon

ASS'Y DWG., CHASSIS, PART I OF III

SIZE	FSCM NO.	DWG. NO.	REV.
		080-01662-C	S

SCALE 1:1 SHEET 1 OF 1

CHAS. NO. SUF. REV. B



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	ADDED FUSE BOARD	4-18-83 JB	CHECKED MH 6-23-83 CB 7/6/83

NOTES

1. OBSERVE POLARITY ON ALL CONNECTORS.
2. CONNECTOR ATTACHES TO MOTHERBOARD ON MODEL 1200.

	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

	1200
	224
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN MG	9-10-79
CHECKED DB	9-13-79
ISSUED	

lexicon

ASS'Y DWG., CHASSIS, PART III OF III

SIZE	FSCM NO.	DWG. NO.	REV.
C		080-01845-C	1

SCALE 1:2 SHEET 1 OF 1

DWG. NO. SH. REV.

Notes

1. RESISTORS ARE ¼ W, 5% UNLESS OTHERWISE INDICATED.
2. CAPACITOR VALUES ARE IN μF/VOLTS UNLESS OTHERWISE INDICATED.
3. DIODES ARE IN4148 UNLESS OTHERWISE INDICATED.
4. ON BOARD CONNECTIONS: TO ⟶ FROM ⟶
5. O—DENOTES SOLDER CONNECTION.
6.

PIN	RP1	RP2	RP3	RP4
1	+5V	+5V	+5V	+5V
2	S0	A6	A5	A2
3	D4	D0	A4	A5
4	D5	D1	S3	307 KHz
5	D6	D2	S2	A1
6	D7	D3	S1	A0

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
PARTS LIST				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX ±.XXX

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

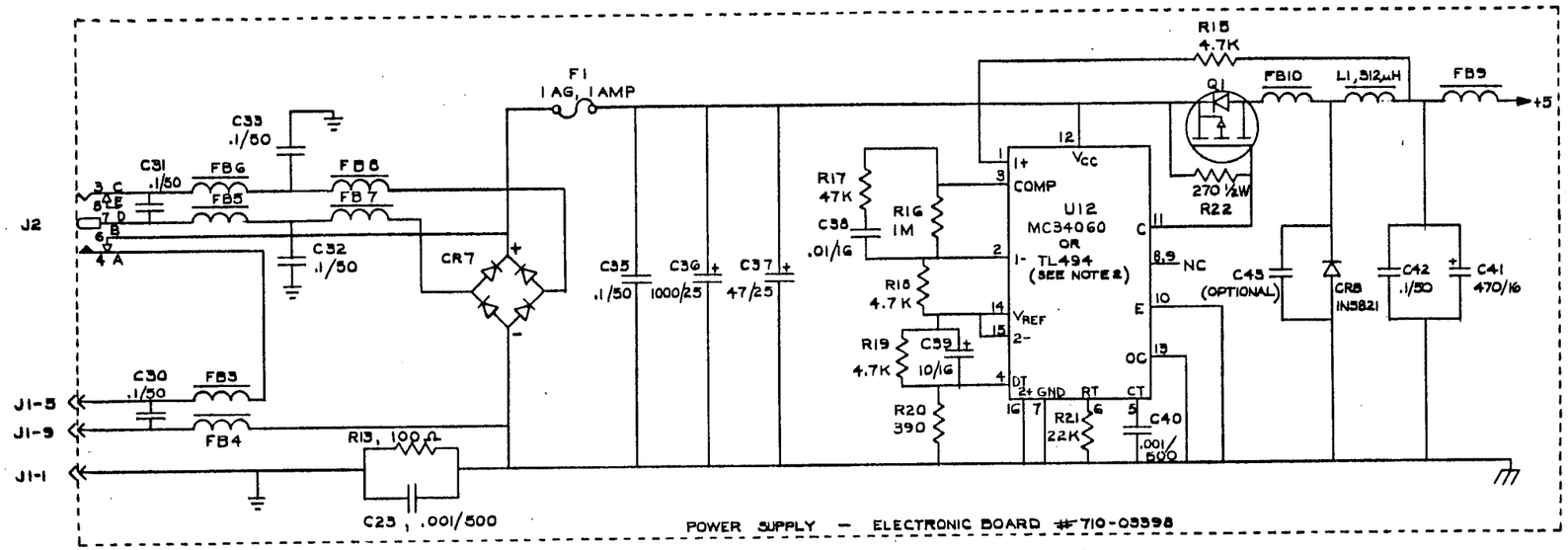
APPROVALS	DATE
DRAWN JCR	3-18-83
CHECKED	4-26-83
ISSUED	4/5/83

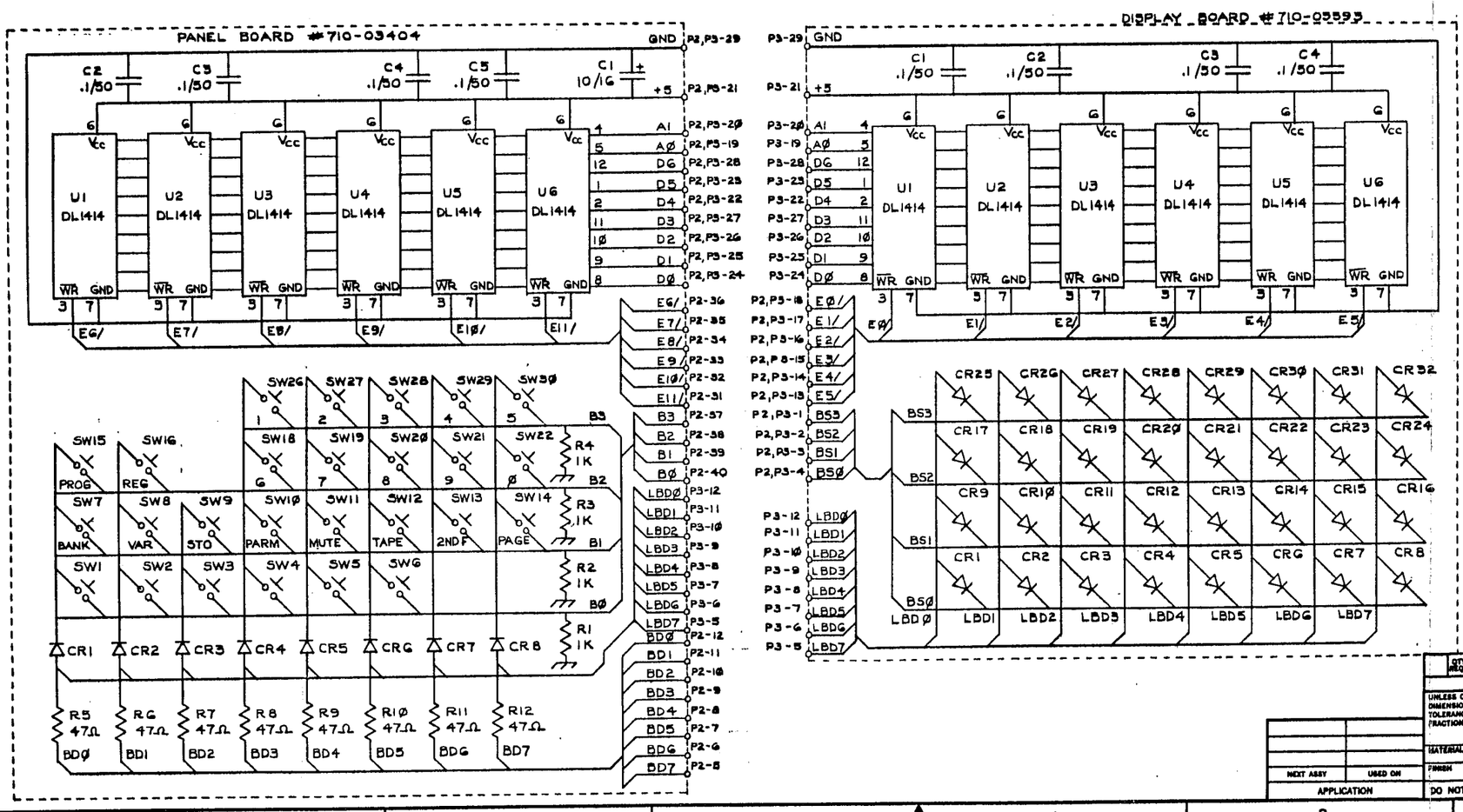
lexicon

SCHEMATIC, LARC

SIZE D | FSCM NO. | DWG. NO. 060-03534 | REV. 2

SCALE NA | SHEET 1 OF 2





NOTES

1. PINS P2-1 THROUGH P2-4 ARE CONNECTED TO P3-1 THROUGH P3-4 AND P2-13 THROUGH P2-29 ARE CONNECTED TO P3-13 THROUGH P3-29. THESE CONNECTIONS ARE MADE ON THE PANEL BOARD.
2. THE MC34060 (14 PIN PACKAGE) AND THE TL494 (16 PIN PACKAGE) ARE PINOUT COMPATIBLE WITH PIN 1 BEING THE SAME ON EACH. PIN NUMBERS LISTED ARE FOR THE TL494.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX ±
.XXX ±

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

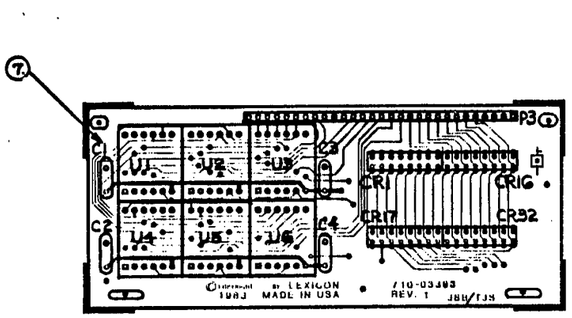
lexicon

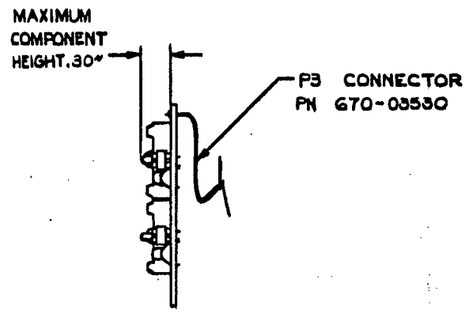
APPROVALS	DATE
DRAWN JSB	3-18-83
CHECKED	4-26-83
ISSUED	4/26/83

SCHEMATIC, LARC

SIZE D | FSCM NO. | DWG. NO. 060-03534 | REV. 2

SCALE NA | SHEET 2 OF 2





NOTES

1. REFER TO BOM # 024-03367.
2. SOLDER TAIL PROTRUSION .080 MAX.
3. MAXIMUM COMPONENT HEIGHT .30" MAX.
4. DO NOT SOCKET UI-G, PART NUMBER 430-03413.
5. USE SOCKET #520-02718 FOR INSTALLATION OF CR1-32, LED DISPLAY STICK, PART NUMBER 430-03414.
6. INSERT FLEX CABLE, PART NUMBER 670-03530 FROM CIRCUIT SIDE AND SOLDER FROM COMPONENT SIDE.
7. COMPONENT REFERENCE DESIGNATIONS ARE IN ETCH ON THE CIRCUIT SIDE.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN JB	5-12-83
CHECKED	5-23-83
ISSUED C. Bryant	6/1/83

lexicon

PC ASSEMBLY DRAWING
DISPLAY BOARD, LARC

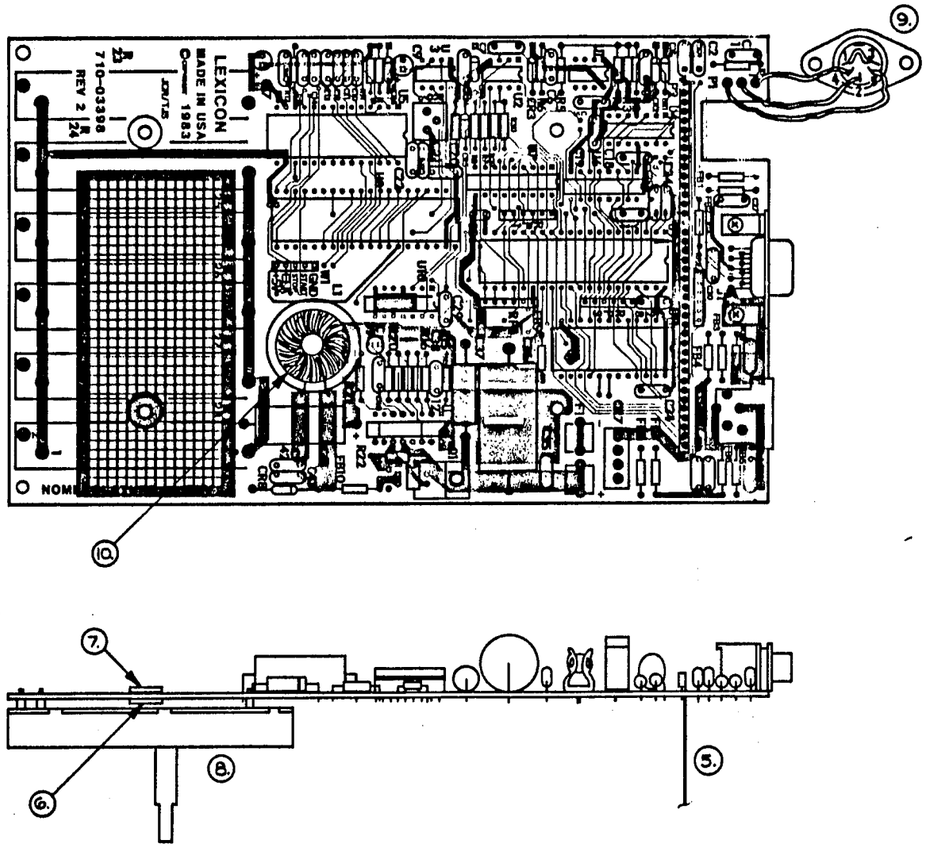
SIZE	FSCM NO.	DWG. NO.	REV.
C		080-03397	1

SCALE NA SHEET 1 OF 1

DWG. NO.

NEXT ASSY

USED ON



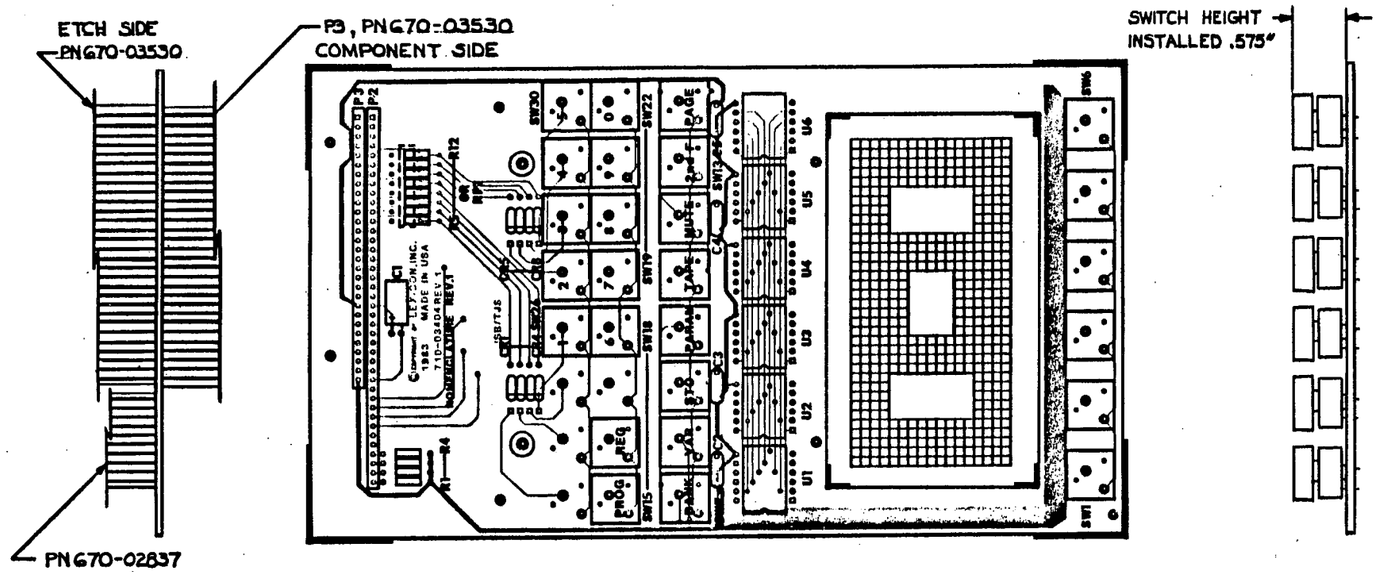
NOTES

1. REFER TO BOM NO 026-03369 AND 025-03370.
2. SOCKET ALL IC POSITIONS.
3. SOLDER MASK HOLES ARE INDICATED BY SOLID CIRCLES.●
4. SOLDER TAIL PROTRUSION .080" MAXIMUM.
5. FLEX CONNECTOR P2 TO BE INSERTED FROM CIRCUIT SIDE AND SOLDERED FROM COMPONENT SIDE.
6. FIBER WASHERS (QTY 2) P/N 630-03544 TO BE ATTACHED TO CIRCUIT SIDE OF PCB WITH GOODYEAR PLIOBOND. THIS IS TO BE DONE BEFORE THE INSTALLATION OF R23-R28.
7. FIBER WASHERS (QTY 2) P/N 630-00953 TO BE ATTACHED TO COMPONENT SIDE OF PCB WITH GOODYEAR PLIOBOND.
8. R23-R28 TO BE MOUNTED ON CIRCUIT SIDE AND SOLDERED FROM COMPONENT SIDE.
9. HARDWIRE DIN CONNECTOR J0 P/N 490-00998 AS SHOWN.
10. APPLY A DAB OF SILICONE RUBBER UNDER L1 AND PRESS FLUSH TO PCB.
11. APPLY A DAB OF SILICONE RUBBER UNDER ALL FERRITE BEADS, FB1-FB10.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO.		lexicon
MATERIAL	APPROVALS	DATE	PC ASSEMBLY DRAWING ELECTRONICS BOARD, LARC
FINISH	DRAWN JCR	11/1/83	
	CHECKED GB	1/24/84	SIZE C · FSCM NO. · DWG. NO. 080-03403 · REV. 1
NEXT ASSY · USED ON	ISSUED GB	1/24/84	
APPLICATION	DO NOT SCALE DRAWING		SCALE FULL · SHEET 1 OF 1



NOTES

1. REFER TO BOM # 024-03371
2. SOLDER TAIL PROTRUSION .080 MAX.
3. USE SOCKET PN520-02718 FOR IC POSITIONS U1-U6.
4. COMPONENT HEIGHT .450 MAX EXCEPT SWITCHES.
5. SWITCHES 1-30 , PN453-03440, TO BE PERPENDICULAR TO BOARD.
6. CONNECTOR P3 TO BE INSERTED FROM COMPONENT SIDE.
7. CONNECTOR P2 TO BE INSERTED FROM SOLDER SIDE AND SOLDERED FROM COMPONENT SIDE. PN670-03530 TO BE INSERTED IN PINS 1-29. PN670-02837 TO BE INSERTED IN PINS 31-40.
8. SW17, SW23, SW24, SW25 ARE NOT INSTALLED FOR THIS ASSEMBLY.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

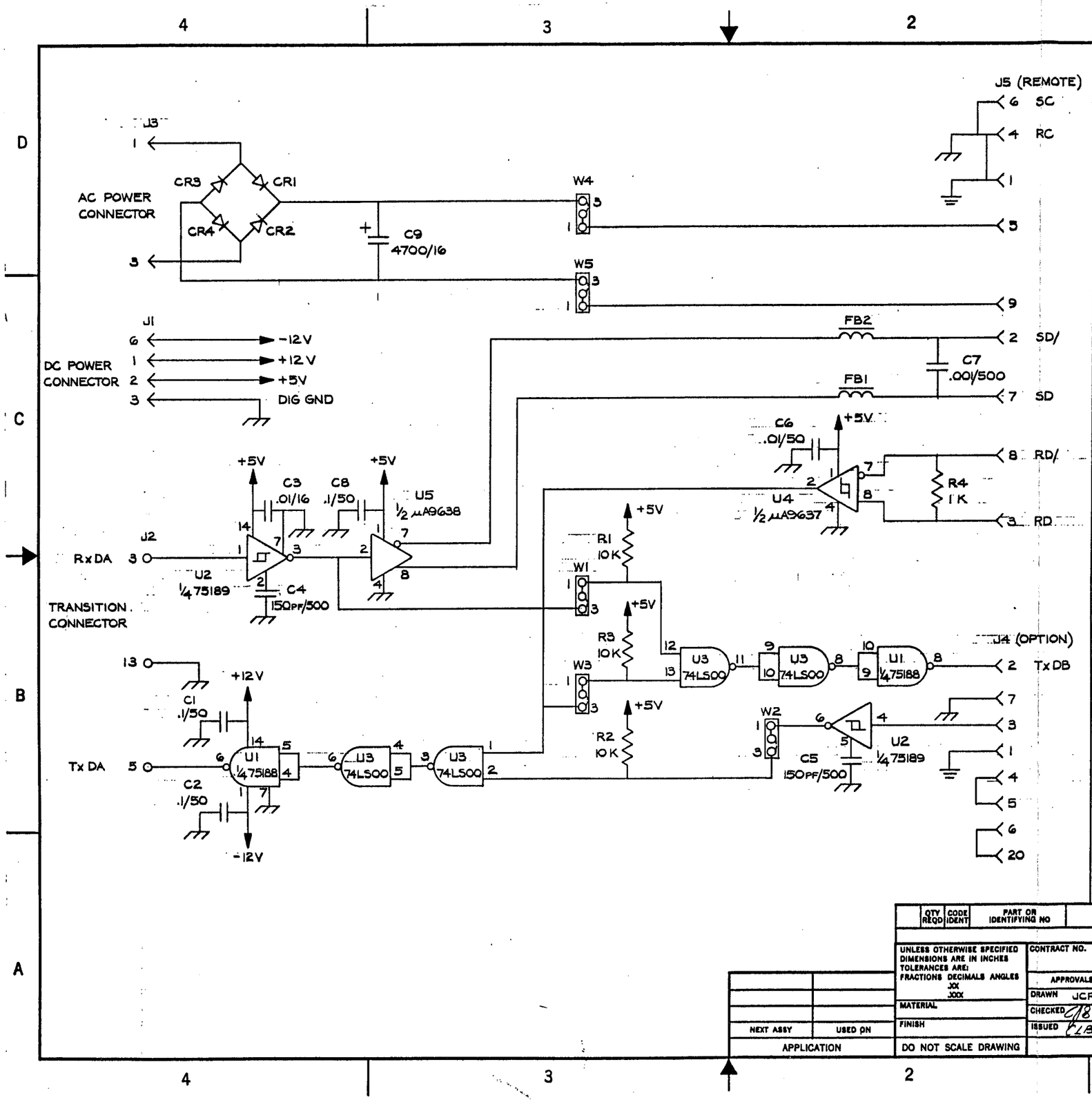
APPROVALS	DATE
DRAWN JB	5-13-83
CHECKED	5-23-83
ISSUED GB.	8/24/83

lexicon

PC, ASSEMBLY DRAWING, PANEL BOARD, LARC

SIZE	FSCM NO.	DWG. NO.	REV.
C		080-03409	1

SCALE NA SHEET 1 OF 1



NOTES

1. RESISTORS ARE ¼W, 5% UNLESS OTHERWISE INDICATED.
2. CAPACITOR VALUES ARE IN µF/VOLTS UNLESS OTHERWISE INDICATED.
3. DIODES ARE IN5404 UNLESS OTHERWISE INDICATED.
4. ON BOARD CONNECTIONS: TO ——► FROM ►——
5. DIGITAL GND ⏚ CHASSIS GND ⏚
6. ○ ○ INDICATES JUMPER BOOT INSTALLED ON JUMPER BLOCK.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

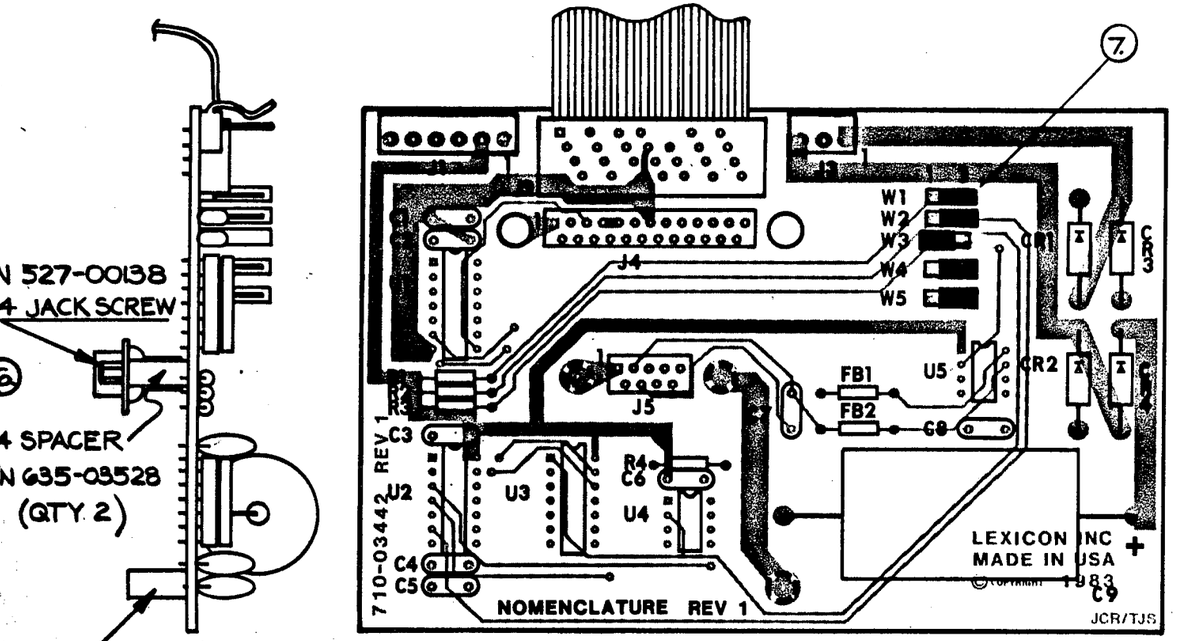
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO.
MATERIAL	APPROVALS / DATE: DRAWN JCR 6.20.83; CHECKED 8.25.83; ISSUED 8/31/83
FINISH	
DO NOT SCALE DRAWING	
NEXT ASSY / USED ON	
APPLICATION	

lexicon

PC SCHEMATIC
XITION BOARD, (NEW), M224X

SIZE	FSCM NO.	DWG. NO.	REV.
C		060-03576	Ø

SCALE NA — SHEET 1 OF 1



NOTES

1. REFER TO BOM NO. 023-03373.
2. SOLDER TAIL PROTRUSION .080" MAXIMUM.
3. SOCKET ALL IC POSITIONS.
4. J1, J2, AND J3 ARE TO BE INSERTED FROM COMPONENT SIDE AND SOLDERED FROM CIRCUIT SIDE.
5. INSTALL THREADED SPACERS (QTY 3) FROM CIRCUIT SIDE OF PCB. THESE ARE INDICATED BY DASHED CIRCLES ◯.
6. REMOTE CONNECTOR INSTALLATION (J5)
   - A. INSERT CONNECTOR FROM CIRCUIT SIDE.
   - B. SECURE CONNECTOR TO SPACERS WITH #4 JACK SCREWS.
   - C. SOLDER LEADS.
7. JUMPERS INSTALLED:

JUMPER NO.	POSITIONS
W1	2-3
W2	2-3
W3	1-2
W4	2-3
W5	2-3

8. APPLY A DAB OF SILICONE RUBBER UNDER C9 AND PRESS FLUSH TO PCB.

	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

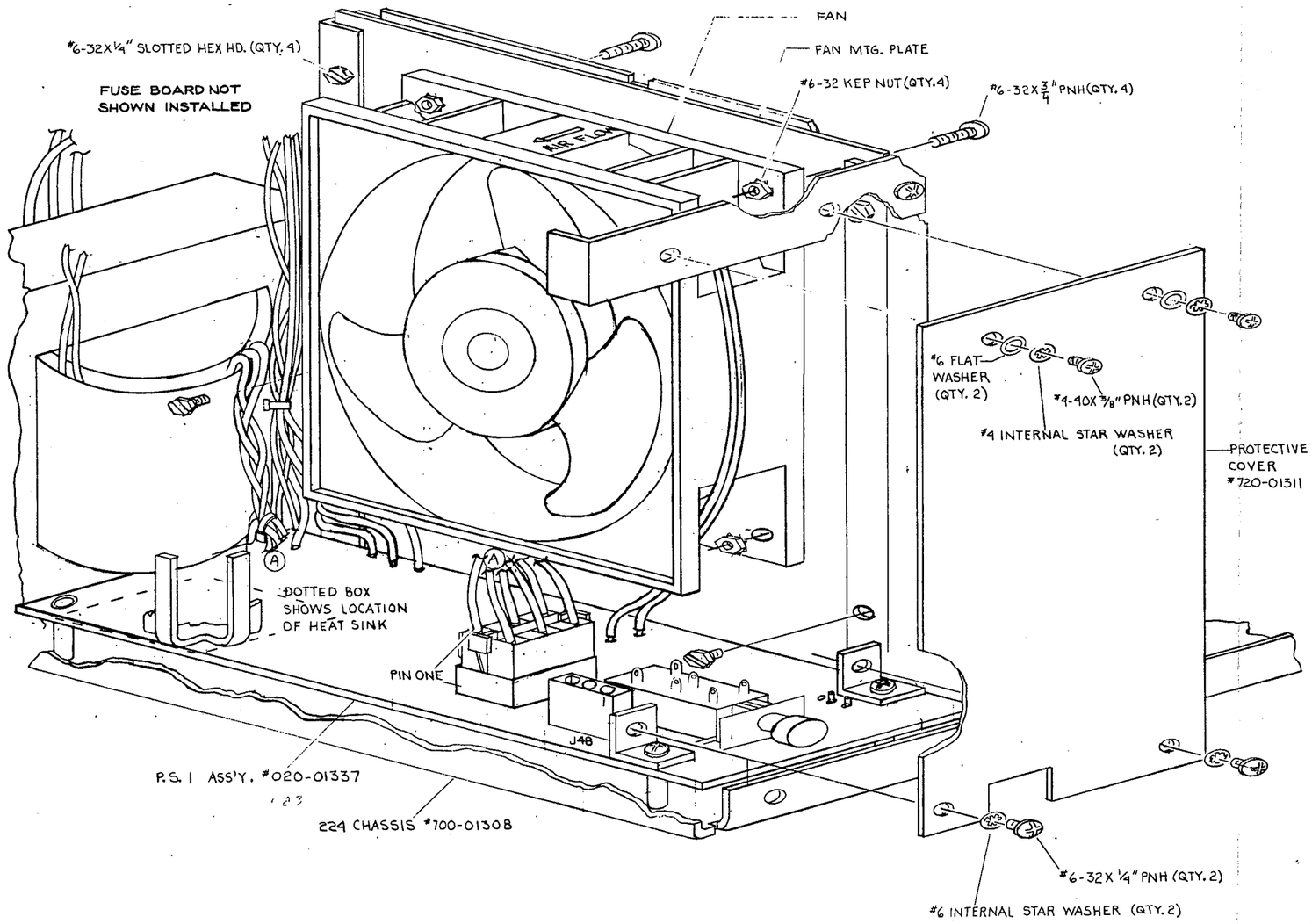
APPROVALS	DATE
DRAWN JCR	6-21-83
CHECKED [illegible]	8-25-83
ISSUED [illegible]	8/31/83

lexicon

PC ASSEMBLY DRAWING
XITION BOARD, NEW, M224X

SIZE	FSCM NO.	DWG. NO.	REV.
C		080-03447	Ø

SCALE FULL | SHEET 1 OF 1



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
1	SHOW AMP CONN. WIRES DRESSED FROM BOTTOM OF XFORMER COIL AND RUNNING UNDER FAN.	5/1/80 JAG	
2	FAN HOLD-DOWN SCREWS WERE 1/2" L, NOW 3/4" L	6/25/81 JG	
3	UPDATE TO CONFORM WITH REVS ON POWER SUPPLY BOARDS.	4-14-83 JCR	CHECKED MH 6-23-83 CB 7/6/83

1. USE THIS ASS'Y. DWG. WITH PART LISTS # 020-01473 AND #020-01471.
2. CABLE (A): CONNECT MALE TO FEMALE AMP. CONN'S (RUN CABLE UNDER FAN), PIN 1 TO PIN 1. CABLE (B): PUSH THE TWO AC WIRES DOWN OFF THE PC BOARD SUCH THERE WILL BE NO POSSIBILITY OF CONTACT BETWEEN THE WIRES AND THE HEAT SINK. CABLE (C): RUN GREEN & BLACK WIRES (24 AWG) UNDER PC BOARD AS SHOWN, TIE WRAP TOGETHER WITH RED, YELLOW & BLACK WIRES (16 AWG.)

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	USED ON
	224
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX
.XXX
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN JAG	8-22-79
CHECKED	
ISSUED CB	9-5-79

lexicon

ASS'Y DWG., CHASSIS, PART II OF III

SIZE C | FSCM NO. | DWG. NO. 080-01676-C | REV. 3

SCALE 1:1 | SHEET 1 OF 1

DWG. NO. | SHT. | REV.

1 LARC Theory of Operation

Information in this section is presented in the following order:

1.1 Power Supply

The power supply for the LARC is a 5V switching regulator. The central item in this regulator is an MC34060 or TL494 pulse width modulation (PWM) control chip. The 34060 produces an output control whose duty cycle multiplied by the input voltage is equal to 5V. This control is then applied to a pass transistor (Q1) located between the input voltage and an output filter. The output filter is a low-pass filter with a single pole at a frequency sufficiently low to attenuate the switching frequency and harmonic components in the switched square wave.

The input section is relatively simple. The LARC may be powered from one of two sources; from the mainframe through J1, or from an alternate power source through J2. Note that whenever a plug is inserted into J2, an integral switch disconnects the mainframe power source. C30, and FB3-4 form a simple RF filter for the mainframe power source; C23 and R13 provide a bypass for RF and static between the cable shield and LARC ground; and C31-33 and FB5-8 form a two stage RF filter for the alternate power source. The CR7 bridge rectifier is provided so that either AC or DC power may be used (the mainframe power is rectified). C35-37 form a composite filter capacitor operating over a large frequency range with low ESR. F1 was chosen through extensive testing to be a 1 amp fast fuse. Note, however, that one fault condition can occur that can not be protected by this (or any other) fuse: while the LARC is being powered by the mainframe, the fuse will not blow if a short occurs in the LARC circuitry after the regulator, because the mainframe can not provide enough power to blow the fuse. This fault condition will not damage the regulator or the mainframe.

The 34060 accepts a Vcc input (pin 12) from which the chip is powered and a 5 V reference (Vref, pin 14) is produced. This Vcc may be from 7 to 40 Vdc, and need not be carefully regulated. The dead time input (DT, pin 4) is used to "soft-start" the regulator; when DT is near Vref the regulator is effectively shut down, and when DT is near ground the regulator is allowed to function normally. Thus as C39 is charged from Vref through R19 and R20, the output of the power supply ramps up from 0 V to the normal 5 V output. The 34060 generates the switching frequency internally using the external timing components RT (pin 6 connected to R21) and CT (pin 5 connected to C40). The switching frequency is 1.1/(RT*CT), which figures out to approximately 50 kHz in the LARC. The output transistor of the 34060 is controlled by the product of comparators whose inputs are an internal ramp waveform at the switching frequency, the dead time input, and the sum of two other comparators whose inputs are pins 1 and 2, and 16 and 15. The first comparator is used to compare the regulator output voltage with the reference voltage. The second comparator (which is normally used for current limiting) is not used, and its inputs are tied off. The COMP input (pin 3) is used for compensation of the comparators. The output transistor is used common-emitter fashion to control the pass transistor.

The output section of the regulator consists of the pass transistor (a P-channel MOSFET) and output filter (a single pole LC low-pass filter). The pass transistor is turned on when its gate is pulled to ground by the output transistor of the 34060. R22 is used to quickly discharge the pass transistor's stray gate capacitance when the 34060 output transistor turns off. The output of the pass transistor is a 50 kHz square wave which swings from ground to the input voltage and whose average voltage is 5 V. The output filter (which consists of CR8, FB 9 and 10, L1, and composite capacitor C41 and C42) has its pole at 83 Hz and is used to block the 50 Khz (and higher harmonic) components of the square wave, yielding only the DC component at the output (the desired 5 VDC).

1.2 CPU

The central processing unit of the LARC is an 8749, containing the CPU, clock oscillator, RAM, UV erasable ROM, and three 8-bit I/O ports on a single chip.

The XTAL 1 and XTAL 2 (pins 2 and 3) are connected to a 4.608 MHz crystal, yielding a processor throughput of 307,200 instruction cycles/second. The ALE output (pin 11) is a 20% duty cycle square wave at the same frequency as instruction cycles (307.2 kHz), and is present whenever the 8749 has power. This the first place to verify that the processor's clock is correctly functioning.

The three I/O ports are used as follows: The BUS port (pins 12-19) is used as a bidirectional data bus. It is used in two modes; in the tristate mode to transfer 8-bit data to the Litronix DL-1414 intelligent displays from the ADC0809 A/D converter, and both to and from the CDP1854 UART; and in the latched mode (through the NE594 buffer/driver) to scan the switches and headroom LEDs. Bits 0-6 of Port 2 are outputs used as the address bus bits A0-A6, and bit 7 is used as the FSK tape output. Bits 0-3 of Port 1 are used as inputs from the switch array (B0-B3), and bits 4-7 are used as outputs controlling which section/row is lit in the headroom LED array (S0-S3).

There are also several control pins on the 8749: the SS input (pin 5), which must be unconnected for correct operation; the EA input (pin 7), which must be grounded for correct operation; the INT/ input (pin 6), which the UART pulls low to signal the processor when a character is available; the T0 input (pin 1), which the processor can read to determine if there was a framing error on the last character received (this feature is not currently used by the software); the T1 input (pin 39), which the processor reads during FSK tape input; the PROG/ output (pin 25), which is normally used with a 8243 I/O port expander, but is used in the LARC to clock the address of the slider to convert into the ADC0809; and the RD, WR and PSEN (pins 8, 9, and 10) outputs, which are normally used for external memory access, but are not used in the LARC.

1.3 Reset Logic

Both the 8749 and the CDP1854 need to be reset after power up. A simple RC (R7 and C9) circuit is used as an input to a differential driver (U3, the uA9638) to produce the required RES and RES/ signals, which are asserted for approximately 1/4 second after power is applied. The CR5 Schottky diode is used to quickly discharge C9 when power is removed (or when power is momentarily lost). To manually reset the LARC, momentarily ground pin 3 of U3.

1.4 Address Decoding Logic

In order to be able to access the devices that share the data bus (the ADC0809, CDP1854, and 12 DL-1414s), an address decoder is used. Address bits A2-A5 are decoded into 16 low-active chip select lines using a CD4515 4-to-16 line decoder. Address bit A6 is used as the decoder enable so that any race conditions (which may cause glitches in the decoder outputs) are eliminated.

When addressing devices, the software in the 8749 goes through several steps to assure that the addressing is done without any glitches. When addressing devices for output (such as the CDP1854 and DL-1414s), the 8749 first places the output data on the BUS port, presents the address of the desired device on A0-A5, then pulls A6 low to address the device, and lastly pulls A6 high again to disable the device. When addressing devices for input (such as the CDP1854 and ADC0809), the 8749 first tristates the BUS port, presents the address of the desired device on A0-A5, pulls A6 low to address the device, then reads the desired input data from the BUS port, and lastly pulls A6 high again to disable the device.

A simple device address map is presented here:

Device	A5	A4	A3	A2	A1	A0
DL-1414, U1, Display Bd	0	0	0	0	C	C
DL-1414, U2, Display Bd	0	0	0	1	C	C
DL-1414, U3, Display Bd	0	0	1	0	C	C
DL-1414, U4, Display Bd	0	0	1	1	C	C
DL-1414, U5, Display Bd	0	1	0	0	C	C
DL-1414, U6, Display Bd	0	1	0	1	C	C
DL-1414, U1, Panel Bd	0	1	1	0	C	C
DL-1414, U2, Panel Bd	0	1	1	1	C	C
DL-1414, U3, Panel Bd	1	0	0	0	C	C
DL-1414, U4, Panel Bd	1	0	0	1	C	C
DL-1414, U5, Panel Bd	1	0	1	0	C	C
DL-1414, U6, Panel Bd	1	0	1	1	C	C
CDP1854 character output	1	1	0	0	X	X
CDP1854 character input	1	1	0	1	X	X
ADC0809 input	1	1	1	0	X	X

Where: XX are don't cares, and CC is the code for the character within a DL-1414 display chip: 00 is the right-most character, 01 is the second from the right, 10 is the second from the left, and 11 is the left-most character.

1.5 ADC Logic

The first item of interest concerning the ADC0809 is its power source; in order to guarantee that any switching supply noise will not affect the converter, a filter is used between the 5 V supply and the ADC0809's Vcc input. The filter is an RC filter consisting of R12 and the composite capacitor C16 and C17. Since the ADC0809 is CMOS (and consequently low power), the voltage drop across R17 is minimal. Note also that all the analog inputs are decoupled for further noise immunity.

Parts of the addressing logic for the ADC0809 are slightly more complicated than the other chips on the data bus. The ADC0809's internal analog multiplexer address (the address of the slider to convert) is transferred to the ADC0809 using the 8749's PROG/ output, which is normally used with 8243 Port 2 expander chips. When the processor wishes to change the address of the slider to convert, it uses a command which places a flurry of (mostly useless) information on A0-A3. During this command, the address of the slider to convert is placed on A0-A3 400 ns before the rising edge of PROG/, and is held for 90 ns after the rising edge.

After the processor sets up the address of the next slider to convert, the processor will read the results of the last conversion and start the next conversion simultaneously by addressing the ADC0809 for input as described in section 4. Note that the ADC0809's end of conversion (EOC) output is not used since the processor's software never accesses the ADC0809 more often than the 250 microsecond conversion time.

The last item of interest concerning the ADC0809 is the circuitry associated with analog inputs IN6 and IN7, which is used to measure the 5 V power supply's actual voltage. The circuit connected to IN6 is a resistor/zener diode constant voltage source (R10 and CR6). The digital code resulting from the conversion of this signal will change as the supply voltage to the ADC0809 changes, because the ratio of the supply voltage to the constant voltage will change. The circuit connected to IN7 is simply a resistive voltage divider (R9 and R11) with an adjustable output voltage. Since the voltage source to this divider is the same as the ADC0809 supply voltage, the resulting digital code from the conversion of this signal will be always a constant. If the adjustable voltage source is adjusted so that it is the same as the constant voltage source when the 5 V power supply is at 5.00 V, then the actual voltage of the 5 V power supply is calculated using a linearization of the system equations governing these circuits.

1.6 UART Logic

The UART data is read and written using the addressing scheme in section 4. The UART clock inputs (RCLK and TCLK pins 17 and 40), which are 16 times the 9600 baud data rate, are derived by dividing the 307.2 kHz ALE clock by two using 1/2 of the CD4013 flip-flop. The UART is strapped to provide and recognize 8-bit characters with no parity and 2 stop bits. The UART data available (DA, pin 19) output, which signals that the UART has received a complete character, is inverted before being used to interrupt the processor.

1.7 RS-422 Logic

The serial data to and from the UART is converted to RS-422 compatible signals by the uA9637 (U2) differential receiver and the uA9638 (U3) differential driver. The LC filter comprised of C27, FB1 and FB2 is used to rate limit the signal rise and fall times (and thereby reduce RF noise), and the R14 termination resistor is used to eliminate signal reflections.

1.8 Litronix Display Logic

The Litronix DL-1414 displays act very much like as a memory device that happens to display its memory's contents. Once a character has been written to the DL-1414, it will be displayed without any need for refresh from the processor. When the addressing scheme from section 4 is used to output data to the DL-1414, the data on the BUS port is the character to display (in ASCII), the A0 and A1 lines correspond to the character to display within a given display chip, and the A2-A5 lines correspond to the address of the display chip. Remember that these lines are decoded by the CD4515 into low-going enable lines, which are connected to the WR/ (pin 3) lines of the DL-1414s and used to clock the data into the displays. Remember that the characters within a chip are numbered from character 00 on the right to character 11 on the left.

1.9 Tape Interface Logic

As much as possible of the tape interface has been done in the software of the processor; the hardware portion of the tape interface is mostly buffers and filters the signals. The processor recognizes and generates 4800 Hz (logic 1) and 2400 Hz (logic 0) FSK data at a 600 baud rate.

The tape output circuitry is rather simple. Since the uA9637 (U2) buffer has a differential input, the R29/R30 voltage divider is used to set the transition threshold. The output is protected with clamp diodes CR3 and CR4, then AC coupled, current limited, and low-pass filtered with C6, R6, and C2.

C1 is used for RF bypass, R1, CR1, CR2, C3, and C4 provide current and voltage limiting and a low-pass filter. R2, R3, and R4 set the input biasing and transition threshold of the LM311 (U1). R5 provides positive feedback for hysteresis, and R31 is used as a pull up for CMOS output compatibility. Note that if nothing is connected to the input, or the input is a low frequency or DC, then the comparator output will oscillate at random frequencies between 100 and 400 Hz. The output of the comparator is divided by two using 1/2 of the CD4013 (U10) in order to make the tape data have close to a 50% duty cycle.

1.10 Buffered Bus and Sink logic

The NE594 driver circuit buffers the BUS port and provides current drive capability for the headroom LEDs. No headroom LEDs, however, will light unless the appropriate current sink (the 75492, U4) is activated also. Therefore when the processor is using the data bus to communicate with the DL-1414s, ADC0809, or the CDP1854, it keeps the sinks deactivated so that the LEDs do not light up spuriously. Upon reset of the 8749, all the bits on Port 1 and Port 2 are set to logic 1; therefore Port 1 bits 4-7 are inverted before the 75492 so the LEDs do not light up during power up. R5-R12 on the Panel board are provided for LED current limiting.

The Panel board switches are also scanned from the NE594 buffered BUS output. CR1-CR8 of the Panel board are provided so that "sneak paths" will not cause the LEDs to light if multiple buttons are pushed. R1-R4 of the Panel board provide a pulldown to ground, which is the default condition when buttons are not pushed.

Unlike many other Lexicon products, the LARC processor software does not scan its LEDs and switches simultaneously. The software first will scan the LEDs, lighting eight at a time: the data for each group is placed on the BUS port, then the appropriate bit on Port 1 is set low for several hundred microseconds, then it is set high again. After all the LEDs have been scanned, then the processor will scan all the switches, scanning four at a time: the appropriate bit for each group on the BUS port is set high, then the processor reads the B0-B3 bits from Port 1 to determine the states of the buttons in the selected column. Note that the processor scans only the switches during the Diagnostic Menu Mode; the LEDs are not scanned.

2 Troubleshooting Notes

Touching a slider puts unit in diagnostic mode

Some LARCs were shipped with a Signetics 4515 (U11) that has proved to be unreliable. Almost any other brand of 4515 will work correctly.

A pop is audible when changing programs or using Mute switch

The pop is caused by U7 and U8 (LF353 dual opamps) on the AOUT board. Select new U7 and U8 for low bias current.

Unpredictable operation with LARC

There is a four-position switch on the NVS board. All switches should be in the OPEN position, but a few units were shipped with switches in the CLOSED position.

LARC doesn't work with 1000 feet or more cable between it and mainframe

Some LARC transition boards were shipped with a 10 kilohm resistor at R4. This should be a 1 kilohm resistor. Note that this will only cause a problem with extremely long cable runs (1000 feet or more).

Miscellaneous notes

1. Do not exchange boards between 224, 224X, and 224XL units.
2. Do not exchange Power Supply modules with new modules.
3. Known software version 8.2 bugs:

   - No B output on the Dark Hall program.
   - A and C outputs on Rich Split mute when Mid Decay control is set to infinite (--).
   - Variation 5 of Dark Hall can cause reverb runaway.

Diagnostics

Starting with software version 8.2, the ROM checksum diagnostics have been improved. All the serial communications code is in the first SBC ROM, as is the checksum diagnostics program. Thus if the first SBC ROM is functioning, errors on the other ROMs will be reported.

Each ROM has been given a checksum which is identical to its ROM number. Thus SBC ROM 1 has a checksum of 1, as does NVS ROM 1.

If a checksum error is detected, the data is displayed as follows:

E01 is an error in SBC ROM 1
E02 is an error in SBC ROM 2 (the ROM in the third socket)
E03 is an error in SBC ROM 3
H01 is an error in NVS ROM 1
H02 is an error in NVS ROM 2

...and so forth.

If there is more than one error, the errors are displayed sequentially by pressing button 1 after each error is displayed.

If a checksum error occurs, the bottom display on the LARC contains some useful information. "C=" gives the actual checksum read from the ROM, and "B=" gives the expected checksum. "Address" gives the last address tested, plus one. Thus if SBC ROM 3 is inadvertently installed in the socket for SBC ROM2, the error E02, C=03, B=02, Address 1000 will be displayed. This is conclusive evidence that the two higher SBC ROMS are reversed.

If C is equal to 0, FF, or some random 2-digit number, the indicated ROM has probably been damaged, and should be replaced.