

IX. THEORY OF OPERATION

INTRODUCTION

The character based graphics system designated GG-III has two main subdivisions. The first subdivision is the Central Processor Unit (CPU) which has three partitions:

- a. Microprocessors
- b. Memory
- c. Input and Output ports (I/O)

The Intel 8088 microprocessor is used and 32K bytes of memory is reserved for programming space and has 5 input ports and 5 output ports. The second subdivision is the video state machine which generates and controls the video signal to the monitor. The state machine has three partitions:

- a. System Clock (CLK)
- b. Foreground generator (FGND)
- c. Background generator (BGND)

The system clock is driven by a 20MHZ crystal, divided down for a 5MHZ dot clock.

All inputs and outputs including the video control and general purpose I/O are memory-mapped, (i.e. everything within the system can be addressed in a single segment of 64K addresses as memory).

The video control unit is divided into an "object-oriented" foreground driver and "character-oriented" background driver. The screen resolution is 256 pixels horizontally, and 240 lines vertically for both foreground and background. The CPU communicates with the foreground driver and background driver by writing data into the

designated memory areas in a certain format. The foreground is designed to display moving objects on the screen with a minimum overhead to the processor. The game programs will only have to specify the vertical and horizontal position and the object select number to the foreground driver. The background video supplements the foreground with relatively static figures on the screen. The CPU specifies all the character positions on the screen with desired "character" patterns.

A 5MHZ system clock drives a 9 bit horizontal dot counter and an 8 bit vertical line counter. The horizontal counter counts from 0 to 255 during active scan line and 256 to 317 during horizontal blanking time. When the horizontal counter reaches 317, the horizontal counter resets to 0. At the beginning of the horizontal blanking time (horizontal counter = 256) it increments the vertical counter. The vertical counter counts from 0 to 239 during active vertical scan time and 240 to 255 during vertical blanking time.

The battery backup system supports two battery RAM's that store all of the bookkeeping functions. The battery is maintained at a +3.6V reference by a trickle charge supplied on the logic board regulated by a current limiting resistor. If the AC power to the game is interrupted, the battery allows the RAM's to store the data contained in the Distributors table and the Options/Parameters screen.

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

TABLE OF CONTENTS

| | PAGE |
|--|-----------|
| LOGIC BOARD ASSY. (A1) | |
| COMPONENT LOCATION AND PARTS LIST | 13 |
| SCHEMATIC DIAGRAM (SHEET 1 OF 3) | 16 |
| SCHEMATIC DIAGRAM (SHEET 2 OF 3) | 18 |
| SCHEMATIC DIAGRAM (SHEET 3 OF 3) | 21 |
| POWER SUPPLY ASSY. (A3) | |
| COMPONENT LOCATION AND PARTS LIST | 24 |
| SCHEMATIC DIAGRAM | 25 |
| SOUND/SPEECH ASSY. (A6) | |
| COMPONENT LOCATION AND PARTS LIST | 27 |
| SCHEMATIC DIAGRAM | 28 |
| PRIMARY POWER/FILTER BOARD/ INTERCONNECTION DIAGRAM | 30 |

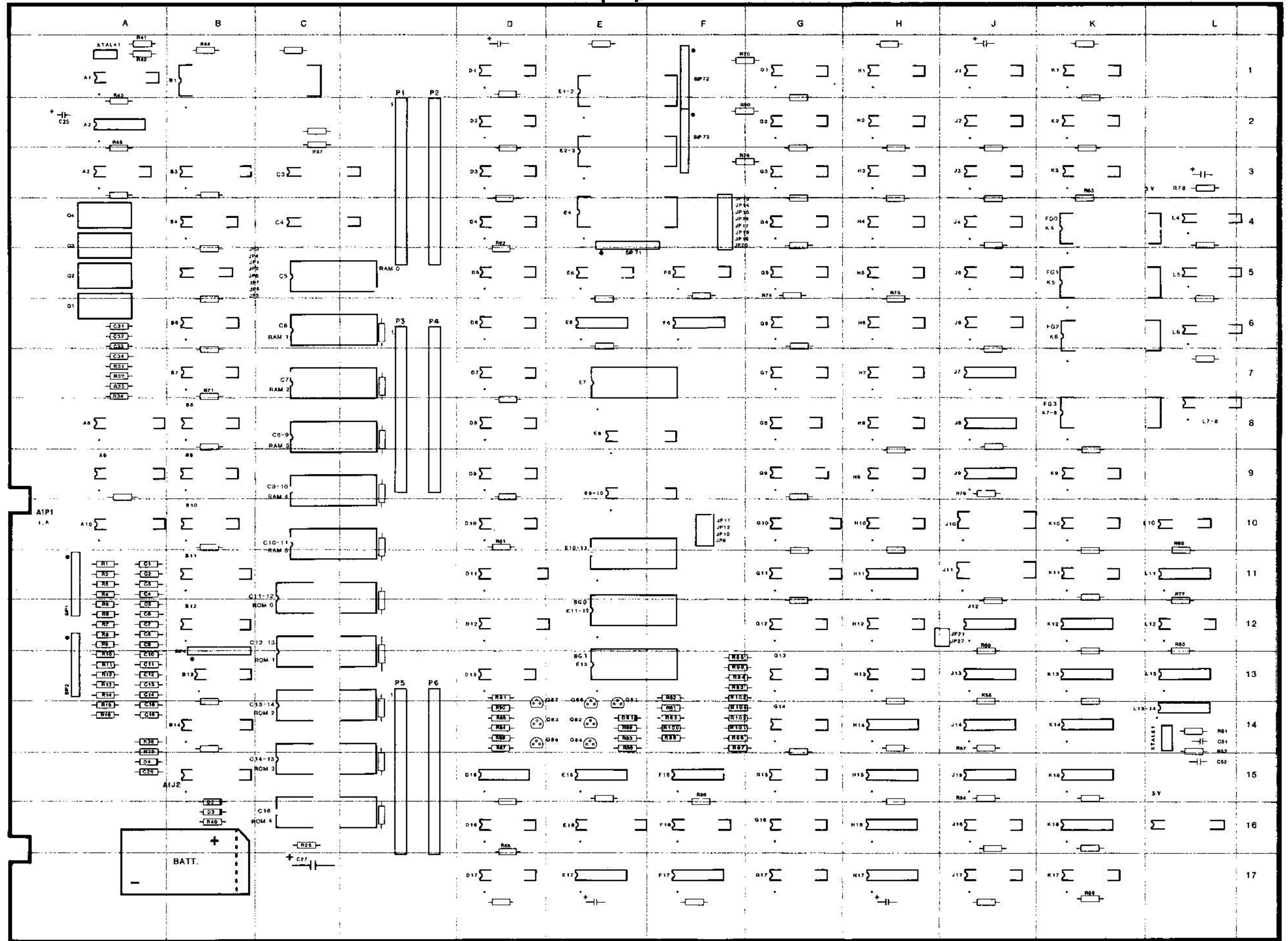
X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

LOGIC BOARD ASSY. (A1), COMPONENT LOCATION

LOGIC BOARD ASSY. (A1), PARTS LIST

MISCELLANEOUS ELECTRONIC COMPONENTS

| REFERENCE | DESCRIPTION | PART NO. |
|-----------------------------------|---|----------|
| Bat. 1 | Battery, 3.6V | XO-458 |
| C1-C16 | Capacitor, 0.1 UF 50V AX. CR. +80%-20% | XO-230 |
| C25 | Capacitor, 100 UF, 25V EL-AX | XO-212 |
| C26 | Capacitor, 0.1 UF, 50V AX. CR. +80%-20% | XO-230 |
| C27 | Capacitor, 100 UF, 25V EL-AX | XO-212 |
| C31-34 | Capacitor, 0.1 UF, 50V AX. CR. +80%-20% | XO-230 |
| C51 | Capacitor, 100 PF, 100V CMD 5% | XO-198 |
| C52 | Capacitor, 0.1 UF, 100V CMD 5% | XO-196 |
| ALL UNMARKED CAPACITORS | 01 UF, 50V AX. CR. +80%-20% | XO-229 |
| ALL POLARIZED UNMARKED CAPACITORS | 10 UF, 25V AX. TANT. 10% | XO-127 |
| D2 | Diode, 1N4454 | XO-275 |
| D4 | Diode, 1N4733A | XO-274 |
| D61 | Diode, 1N4148 | XO-261 |
| Q1-Q4 | Transistor, 2N6044 | XO-120 |
| Q81-Q87 | Transistor, MPSA70 | XO-309 |
| R1-R16 | Resistor, 470 OHM, 5% 1/4W | XO-35 |
| R37, R38 | Resistor, 330 OHM, 5% 1/4W | XO-34 |
| R39 | Resistor, 130 OHM, 5% 1/4W | XO-172 |
| R40 | Resistor, 270 OHM, 5% 1/4W | XO-68 |
| R41, R42 | Resistor, 510 OHM, 5% 1/4W | XO-25 |
| R43 | Resistor, 130 OHM, 5% 1/4W | XO-172 |
| R44, R45 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R51, R52 | Resistor, 330 OHM, 5% 1/4W | XO-34 |
| R53, R54, R56 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R57, R58 | Resistor, 560 OHM, 5% 1/4W | XO-36 |
| R59-R61 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R63, R64 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R70 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R73, R74 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R76-R80 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R81 | Resistor, 820 OHM, 5% 1/4W | XO-174 |
| R82 | Resistor, 100 OHM, 5% 1/4W | XO-28 |
| R83, R84 | Resistor, 15 OHM, 5% 1/4W | XO-171 |
| R85 | Resistor, 180 OHM, 5% 1/4W | XO-24 |
| R86, R87 | Resistor, 15 OHM, 5% 1/4W | XO-171 |
| R88 | Resistor, 180 OHM, 5% 1/4W | XO-24 |
| R89, R90 | Resistor, 15 OHM, 5% 1/4W | XO-171 |
| R91 | Resistor, 180 OHM, 5% 1/4W | XO-24 |
| R92 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R93 | Resistor, 2K OHM, 5% 1/4W | XO-14 |
| R94 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R95 | Resistor, 470 OHM, 5% 1/4W | XO-35 |
| R96 | Resistor, 240 OHM, 5% 1/4W | XO-173 |
| R97 | Resistor, 2K OHM, 5% 1/4W | XO-14 |
| R98 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R99 | Resistor, 470 OHM, 5% 1/4W | XO-35 |
| R100 | Resistor, 240 OHM, 5% 1/4W | XO-173 |
| R101 | Resistor, 2K OHM, 5% 1/4W | XO-14 |
| R102 | Resistor, 1K OHM, 5% 1/4W | XO-5 |
| R103 | Resistor, 470 OHM, 5% 1/4W | XO-35 |
| R104 | Resistor, 240 OHM, 5% 1/4W | XO-173 |
| SIP 1, SIP 2, SIP 4 | Resistor, Dip, 4 7K, 9 Pin | XO-492 |
| SIP 71, SIP 72, SIP 73 | Resistor, Dip, 1K, 9 Pin | XO-493 |
| X-TAL 1 | Crystal, 15 MHZ | XO-482 |
| XTAL 51 | Crystal, 20 MHZ | XO-494 |
| | Dip Switch | XO-505 |
| | 20 Pin Dip Socket | XO-491 |
| | 22 Pin Dip Socket | XO-467 |
| | 24 Pin Dip Socket | XO-529 |
| | 28 Pin Dip Socket | XO-536 |
| | 40 Pin Dip Socket | XO-530 |

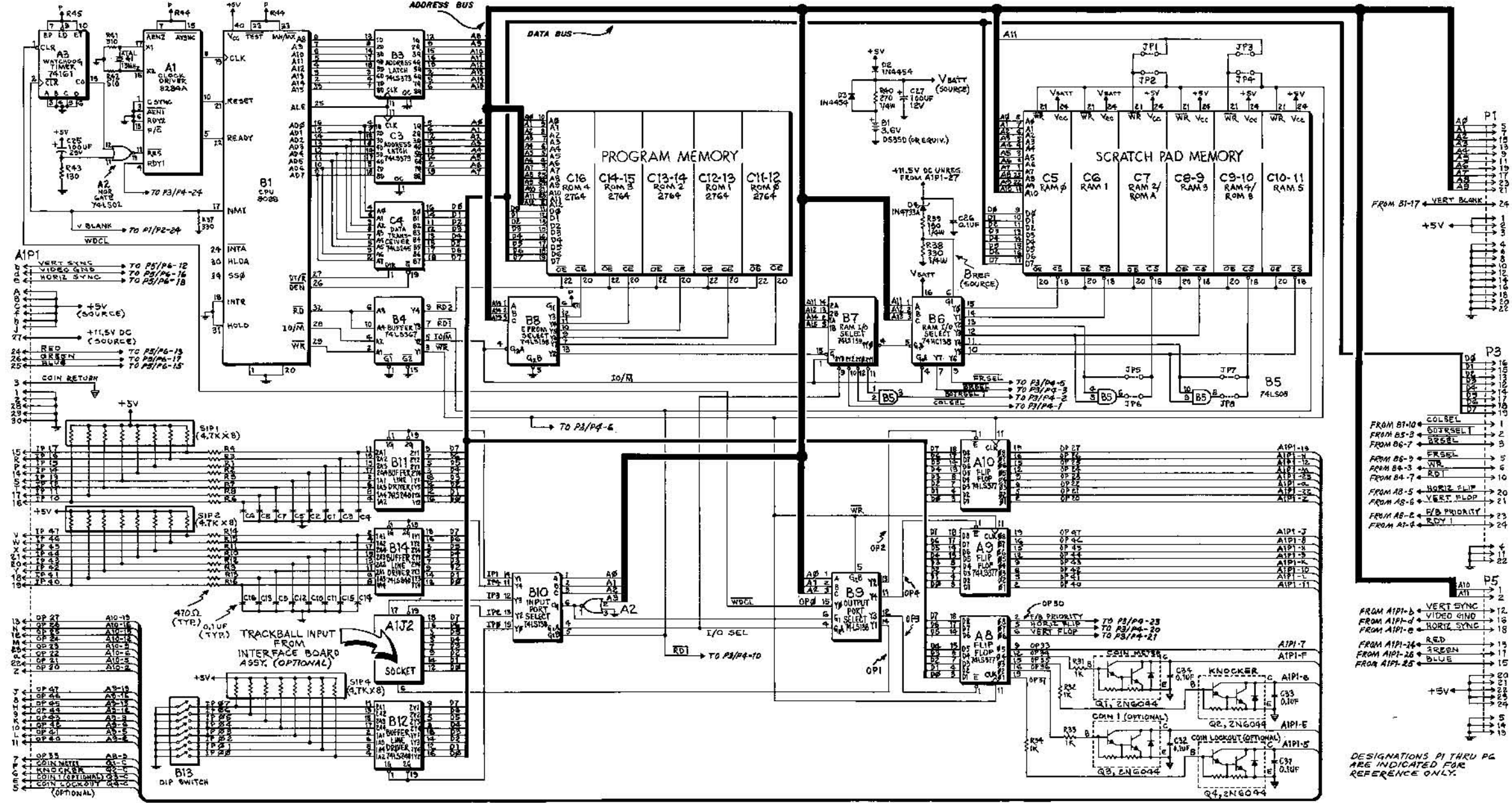


X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

LOGIC BOARD ASSY. (A1), PARTS LIST (CONT.)

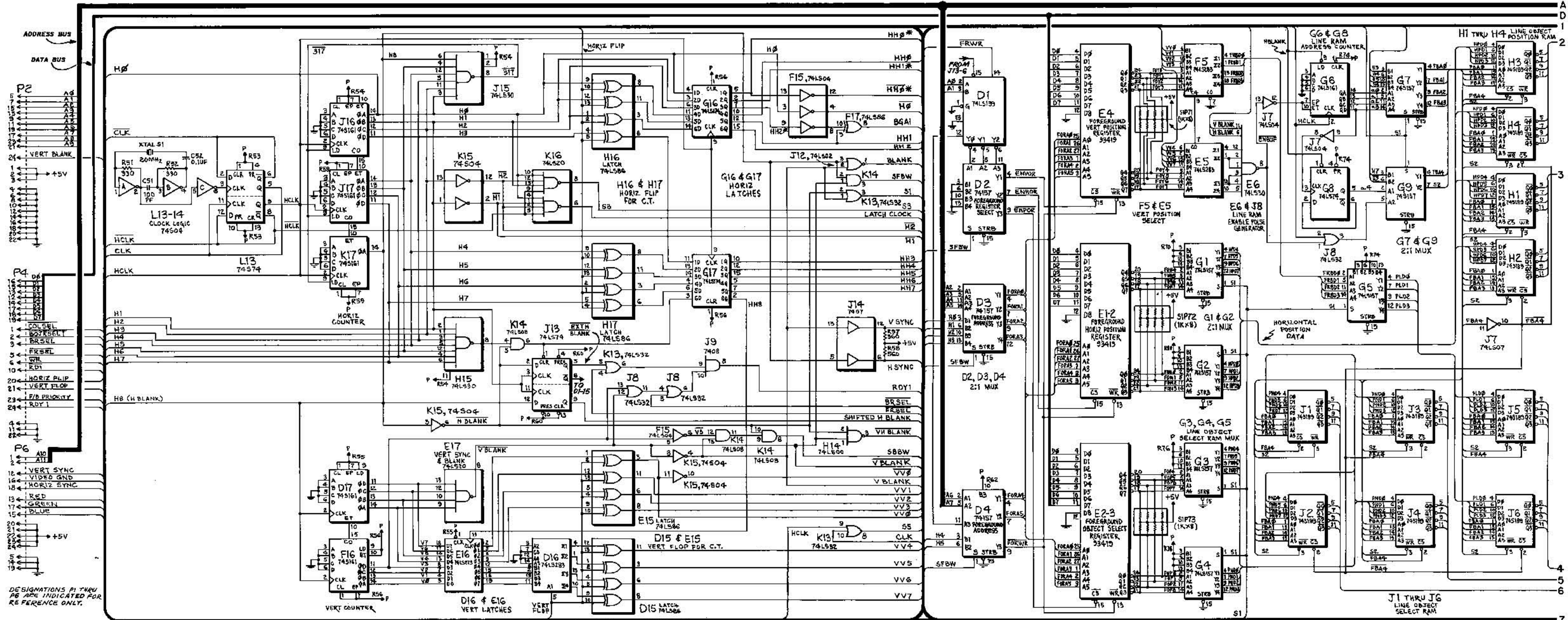
INTEGRATED CIRCUITS

| REFERENCE | DESCRIPTION | PART NO. | REFERENCE | DESCRIPTION | PART NO. |
|--------------------------------|--|----------|-----------------|--|----------|
| A1 | Logic Board Assy. | MA-378 | G7 | 74157 Quad 2-input multiplexer | XO-114 |
| A2 | 8294 CLK Driver | XO-478 | G8 | 741574 Dual D-type flip flop | XO-434 |
| A3 | 741502 Quad 2-input "NOR" gate | XO-428 | G9 | 741517 Quad 2-input multiplexer | XO-124 |
| A8, A9, A10 | 74161 Synchronous 4-bit counter | XO-192 | G10 | 7415245 Octal bus transceiver | XO-79 |
| B1 | 9088 CPU | XO-490 | G11 | 7415374 Octal D-type flip flop | XO-390 |
| B3 | 7415373 Octal D-type flip flop | XO-445 | G12 | 7415157 Quad 2-input multiplexer | XO-88 |
| B4 | 7415367 Hex 3-state buffer | XO-444 | G13, G14, G15 | 7489 64-bit RAM | XO-82 |
| B5 | 741508 Quad 2-input "AND" gate | XO-465 | G16, G17 | 741574 Hex D flip flop | XO-442 |
| B6 | 74HC138 Decoder/multiplexer | XO-190 | H1, H2, H3, H4 | 741519 64-bit RAM | XO-89 |
| B7 | 7415139 Dual 1 of 4 decoder | XO-419 | H5, H6 | 7415161 Synchronous presettable binary counter | XO-488 |
| B8, B9, B10 | 7415138 1 of 8 decoder | XO-437 | H7, H8, H9, H10 | 7415157 Quad 2-input multiplexer | XO-390 |
| B11, B12, B14 | 7415240 Octal Buffer/line driver | XO-471 | H11 | 7415250 Dual 5-input "NOR" gate | XO-73 |
| C3 | 7415373 Octal D-type flip flop | XO-445 | H12 | 7415296 Quad 2-part register | XO-119 |
| C4 | 7415245 Octal Bus transceiver | XO-79 | H13 | 7415157 Quad 2-input multiplexer | XO-390 |
| C5 | RAM 8 6116LP-4 | XO-191 | H14 | 741500 Quad 2-input "NAND" gate | XO-427 |
| C6 | RAM 1 6116LP-4 | XO-191 | H15 | "NAND" gate | XO-432 |
| C7 | RAM 2 2128-2 | XO-195 | H16, H17 | 741530 B input "NAND" gate | XO-432 |
| C8-9 | RAM 3 2128-2 | XO-195 | | 741586 Dual 2-input exclusive "OR" gate | XO-435 |
| C11-12 | ROM #1 2764 8K x 8 EPROM | XO-489 | J1, J2, J3 | | |
| C12-13 | ROM 1 2764 8K x 8 EPROM | XO-489 | J4, J5, J6 | | |
| C13-14 | ROM 2 2764 8K x 8 EPROM | XO-489 | J7 | | |
| D1 | 7415139 Dual 1 of 4 Decoder | XO-419 | J8 | | |
| D2, D3, D4, D5, D6, D7, D8, D9 | | | J9 | | |
| D10 | 741517 Quad 2-input multiplexer | XO-114 | J10, J11 | | |
| D11 | 7415374 Octal D-type flip flop | XO-96 | J12 | | |
| D12 | 7415244 Octal buffer/line driver | XO-471 | J13 | | |
| D13 | 7415157 Quad 2-input multiplexer | XO-390 | J14 | | |
| D15 | 741586 Quad 2-input exclusive "OR" gate | XO-435 | J15, J16 | | |
| D16 | 7415283 4-bit binary full adder | XO-95 | J17 | | |
| D17 | 7415161 Synchronous presettable binary counter | XO-488 | J18 | | |
| E1-2, E2-3, E4 | 93419 64 x 9 bipolar RAM | XO-99 | K1 | | |
| E5 | 7415283 4-bit binary full adder | XO-95 | K2, K3 | | |
| E6 | 741530 B-input "NAND" gate | XO-432 | K4 | | |
| E7 | 4801 1K x 8 RAM | XO-193 | K5 | | |
| E8, E9-10 | 7415245 Octal Bus Transceiver | XO-79 | K6 | | |
| E10-11 | 4801 1K x 8 RAM | XO-193 | K7 | | |
| E11-12 | 2732A (BG1) 4K x 8 EPROM | XO-485 | K8 | | |
| E13 | 2732A (BG1) 4K x 8 EPROM | XO-485 | K9, K10, K11 | | |
| E15 | 741586 Quad 2-input exclusive "OR" gate | XO-435 | K12 | | |
| E16 | 7415273 8-bit register | XO-94 | K13 | | |
| E17 | 741520 Dual 4-input "NAND" gate | XO-430 | K14 | | |
| F5 | 7415283 4-bit binary full adder | XO-95 | K15 | | |
| F6 | 741532 Quad 2-input "OR" gate | XO-433 | K16 | | |
| F15 | 741504 Hex inverter | XO-418 | L4, L5, L6, L7 | | |
| F16 | 7415161 Synchronous presettable binary counter | XO-488 | L10 | | |
| F17 | 741586 Quad 2-input exclusive "OR" gate | XO-435 | L11 | | |
| G1, G2, G3 | | | L12 | | |
| G4, G5 | 7415157 Quad 2-input multiplexer | XO-390 | L13 | | |
| G6 | 7415161 Synchronous presettable binary counter | XO-440 | L13-14 | | |

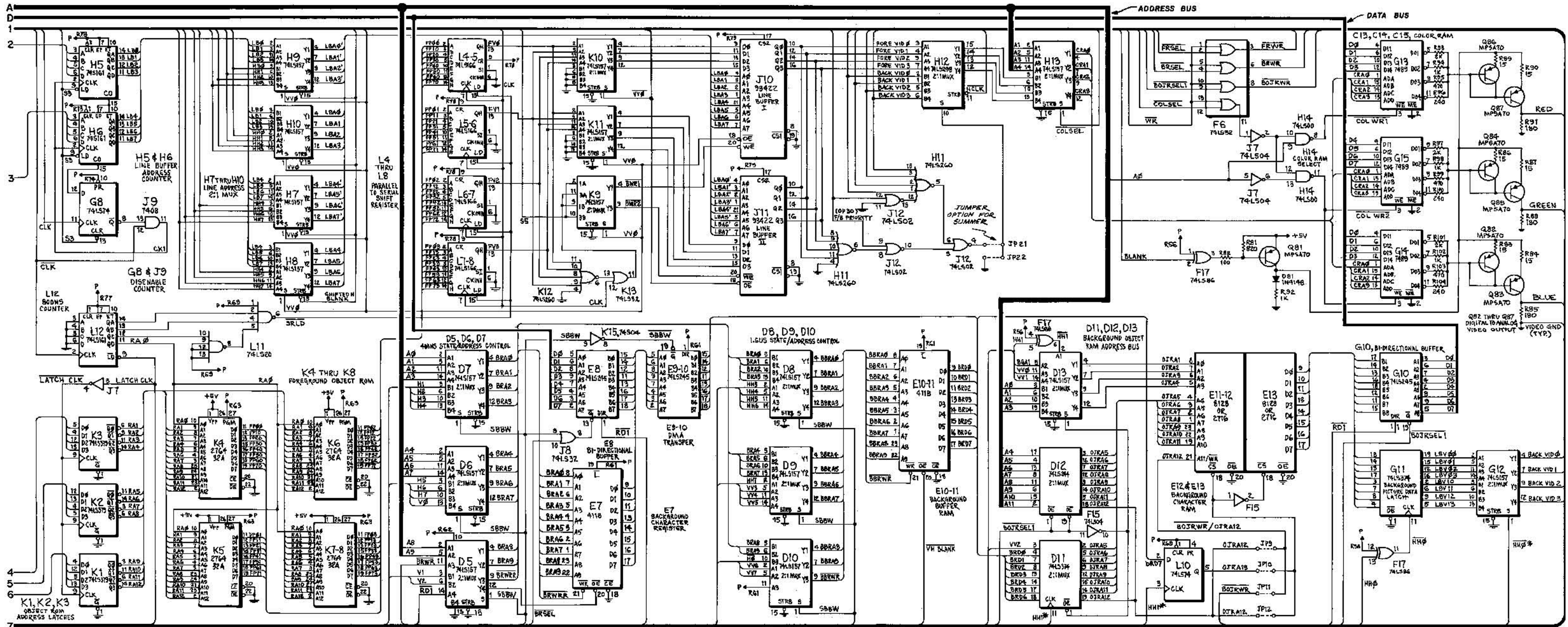


LOGIC BOARD ASSY. (A1), SCHEMATIC DIAGRAM, SHEET 1 OF 3

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

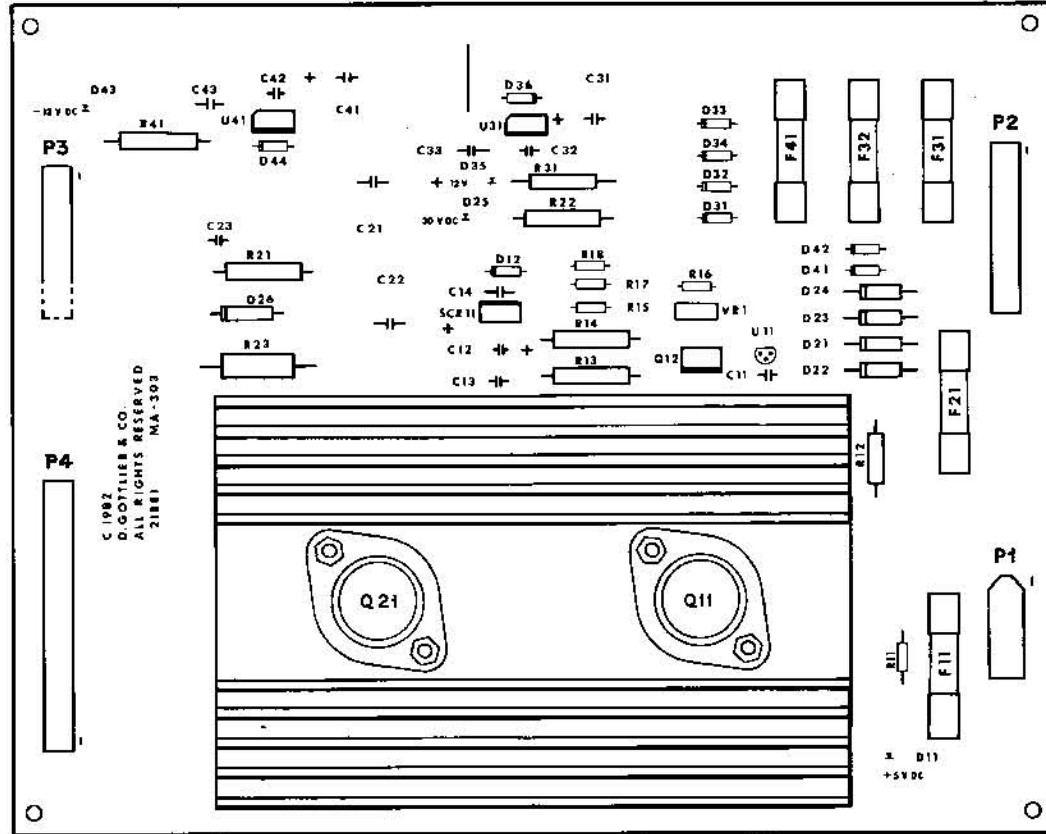


X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS



X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

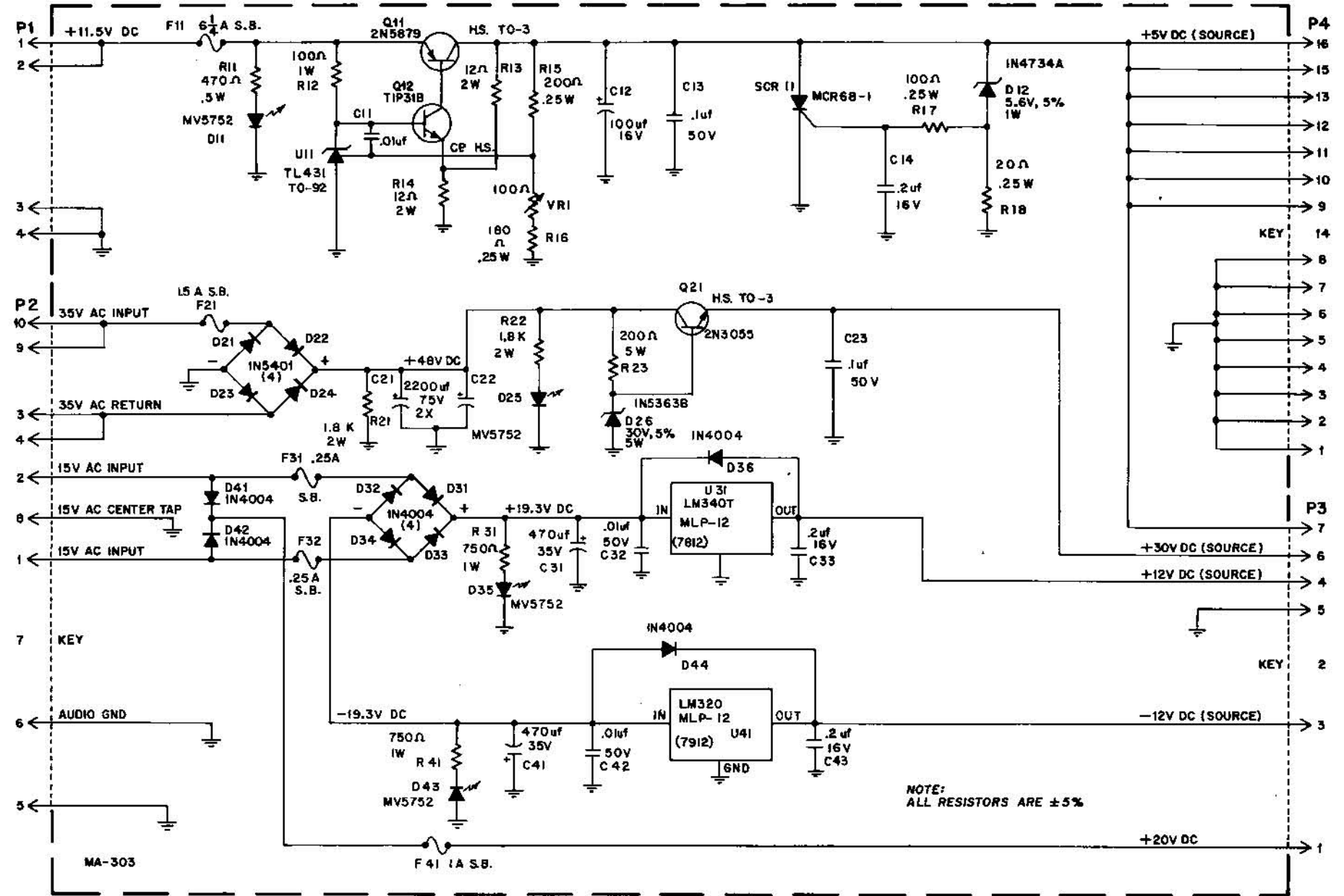
POWER SUPPLY ASSY. (A3), COMPONENT LOCATION



POWER SUPPLY ASSY. (A3), PARTS LIST

| REFERENCE | DESCRIPTION | PART NO. | REFERENCE | DESCRIPTION | PART NO. |
|---------------|------------------------------------|----------|-----------|---------------------------------|----------|
| | Power Supply Assy. | MA-303 | P2 | Connector, 10 PIN | XO-531 |
| C11, C32, C42 | Capacitor, .01uF, 16V | XO-278 | P3 | Connector, 7 PIN | XO-526 |
| C12 | Capacitor, 100uF, 16V | XO-235 | P4 | Connector, 16 PIN | XO-372 |
| C13, C23 | Capacitor, 0.1uF, 100V | XO-234 | O11 | Transistor, PNP, 2N5879 | XO-323 |
| C14, C33, C43 | Capacitor, 0.2uF, 16V | XO-205 | O12 | Transistor, NPN, TIP31B | XO-641 |
| C21, C22 | Capacitor, 2200uF, 75V | XO-132 | Q21 | Transistor, NPN, 2N3055 | XO-301 |
| C31, C41 | Capacitor, 470uF, 35V | XO-284 | R1 | Resistor, 470 OHM, 5% 1/4W | XO-55 |
| D11, D25 | Diode, Light Emitting MV-5752 | XO-270 | R2 | Resistor, 100 OHM, 5% 1/4W | XO-137 |
| D35, D43 | Diode, Zener, 5.6V, 5%, 1W, 1M 73A | XO-255 | R3, R4 | Resistor, 12 OHM, 5% 2W | XO-128 |
| D12 | Diode, Zener, 5.6V, 5%, 1W, 1M 73A | XO-255 | R5 | Resistor, 200 OHM, 5% 1/4W | XO-143 |
| D21-D24 | Diode, IN5401 | XO-263 | R6 | Resistor, 180 OHM, 5% 1/4W | XO-24 |
| D26 | Diode, Zener, 30V, 5%, 5W, IN5363B | XO-273 | R7 | Resistor, 100 OHM, 5% 1/4W | XO-28 |
| D31-D34, D36 | Diode, IN4004 | XO-254 | R8 | Resistor, 20 OHM, 5% 1/4W | XO-29 |
| D41, D42, D44 | Fuse, 6 1/4 AMP SLO-BLO | EL-8 | R21, R22 | Resistor, 1.8K OHM, 5% 2W | XO-135 |
| F1 | Fuse, 1.5 AMP SLO-BLO | EL-34 | R23 | Resistor, 200 OHM, 5% 5W | XO-133 |
| F31, F32 | Fuse, 1/4 AMP SLO-BLO | EL-5 | R31, R41 | Resistor, 750 OHM, 5% 1W | XO-136 |
| F41 | Fuse, 1 AMP SLO-BLO | EL-6 | SCR11 | Silicon Controlled Rectifier | XO-137 |
| P1 | Connector, 4 PIN | PS-87 | U11 | Diode, Programmable Zener TL431 | XO-272 |
| | | | U31 | Voltage Regulator -12V, LM 340T | XO-473 |
| | | | U41 | Voltage Regulator -12V, LM 320 | XO-130 |
| | | | VRI | Potentiometer, 100 OHM | XO-134 |

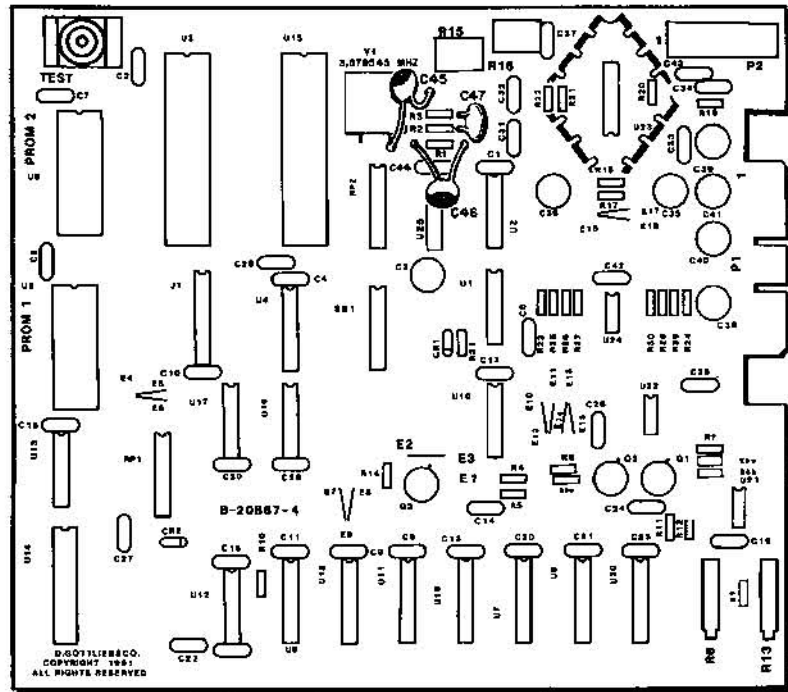
X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS



POWER SUPPLY ASSY. (A3), SCHEMATIC DIAGRAM

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

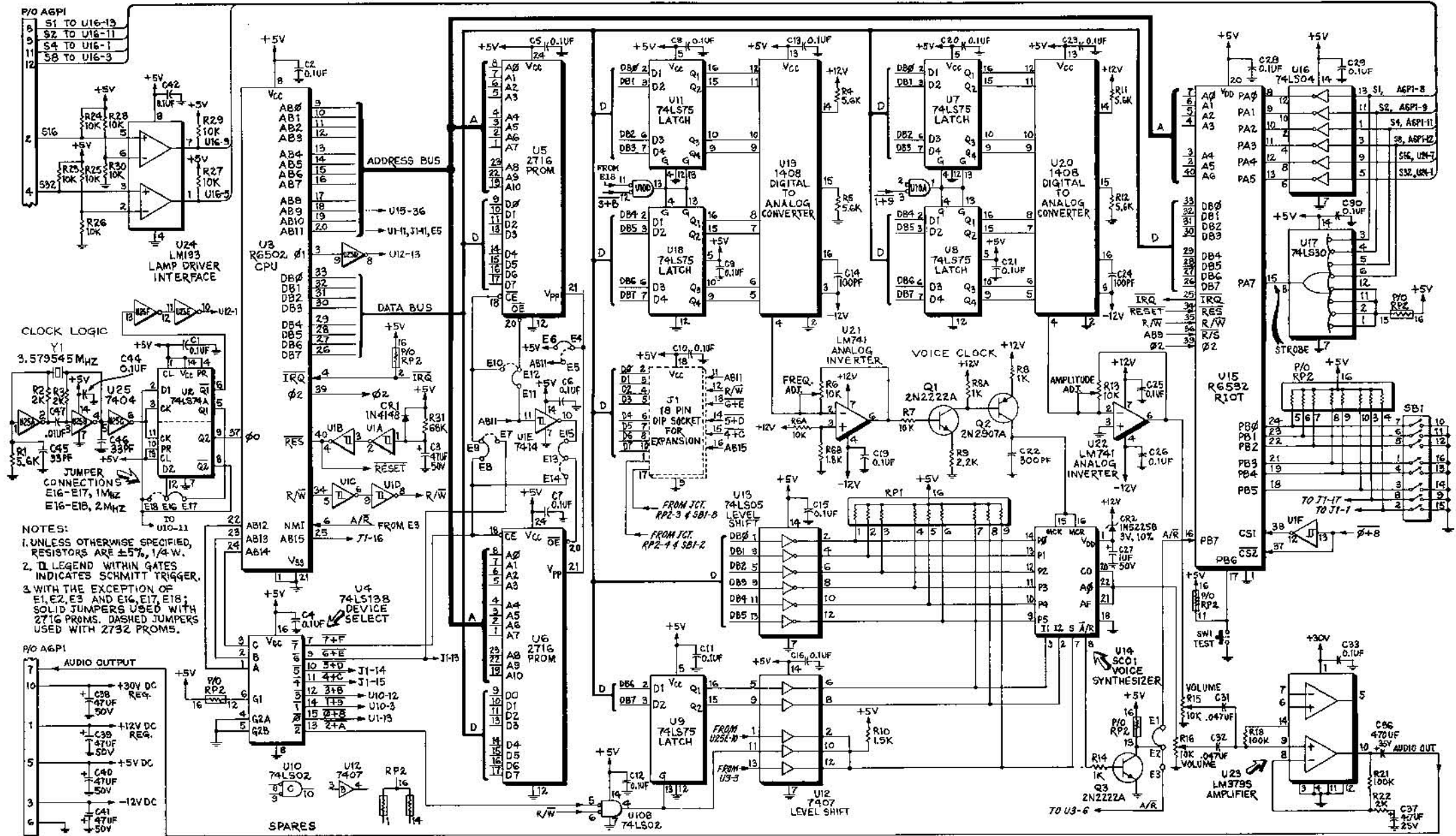
SOUND/SPEECH ASSY. (A6), COMPONENT LOCATION



SOUND/SPEECH ASSY. (A6), PARTS LIST

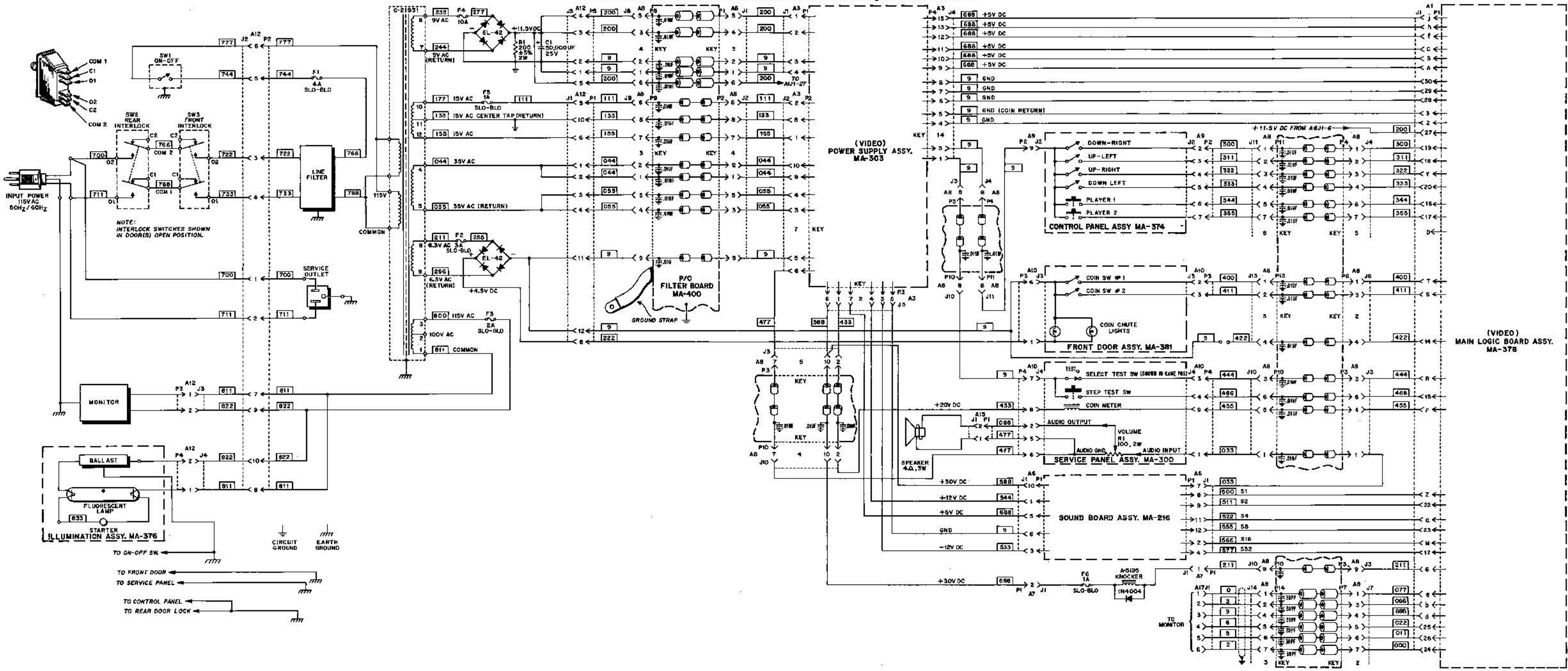
| REFERENCE | DESCRIPTION | PART NUMBER | REFERENCE | DESCRIPTION | PART NUMBER |
|------------------|------------------------------|-------------|-----------------|------------------------------|-------------|
| C1, C2 | Sound/Speech Assembly | MA-216 | R15, R16 | Potentiometer, 10K ohm | XO-109 |
| C4, C13 | Capacitor, 0.1UF, 25V | XO-248 | R18, R21 | Resistor, 100K ohm, 5%, 1/4W | XO-45 |
| C15, C16, C19 | Capacitor, 0.1UF, 25V | | R22 | Resistor, 2K ohm, 5%, 1/4W | XO-14 |
| C20, C21, C23 | Capacitor, 4.7UF, 50V | | R31 | Resistor, 68K ohm, 5%, 1/4W | XO-189 |
| C25, C26 | Capacitor, 100PF | | RP1, RP2 | Resistor, Dip | XO-168 |
| C28-C30, C33 | Capacitor, 300PF | | SB1 | Switch, Dip | XO-505 |
| C42, C44 | Capacitor, .047UF, 25V | XO-222 | SW1 | Switch, Momentary Pushbutton | XO-515 |
| C31-C32 | Capacitor, 4.7UF, 35V | XO-291 | U1 | IC, 7414 | XO-397 |
| C3 | Capacitor, 47UF, 50V | XO-210 | U2 | IC, SN74LS74N | XO-434 |
| C4, C24 | Capacitor, 100PF | XO-223 | U3 | CPU, R6502-13 | XO-360 |
| C22 | Capacitor, 300PF | XO-283 | U4 | IC, SN74LS138N | XO-437 |
| C27 | Capacitor, 1UF, 50V | XO-217 | U5, U6 | EPROM, 2716 | PR-53 |
| C36 | Capacitor, 470UF, 35V | XO-284 | U7-L9, U11, U18 | IC, SN74LS75 | XO-394 |
| C45, C46 | Capacitor, 33PF | XO-277 | U10 | IC, SN74LS02N | XO-428 |
| C47 | Capacitor, .01UF, 100V | XO-202 | U12 | IC, SN7407N | XO-384 |
| CR1 | Diode, 1M148 | XO-261 | U13 | IC, Inverter, SN74LS05N | XO-411 |
| CR2 | Diode, Zener, 1N5225B | XO-269 | U14 | Voice Chip, SCD1 | XO-468 |
| G1, G3 | Transistor, NPN, 2N2222A | XO-320 | U15 | IC, RRIOT, R6532-1B | XO-361 |
| G2 | Transistor, PNP, 2N2907A | XO-321 | U16 | IC, SN74LS04N | XO-418 |
| R1, R4, R5 | Resistor, 5.6K ohm, 5%, 1/4W | XO-19 | U17 | IC, SN74LS30N | XO-432 |
| R11, R12 | Resistor, 1K ohm, 5%, 1/4W | XO-14 | U19, 20 | Converter, PMI, 1408A-6P | XO-416 |
| R2, R3 | Resistor, 2K ohm, 5%, 1/4W | XO-108 | U21, U22 | IC, LM741 ICP | XO-393 |
| R6, R13 | Potentiometer, 10K | XO-18 | U23 | IC, LM3795 | XO-395 |
| R6A, R7, R23-R30 | Resistor, 10K ohm, 5%, 1/4W | XO-5 | U24 | IC, Dual Comparator, LM193 | XO-396 |
| R8, R8A, R14 | Resistor, 1K ohm, 5%, 1/4W | XO-37 | U25 | Inverters, 7404 | XO-402 |
| R6B | Resistor, 1.8K ohm, 5%, 1/4W | XO-27 | Y1 | Crystal, 3.579545MHZ | XO-456 |
| R9 | Resistor, 2.2K ohm, 5%, 1/4W | XO-529 | | Socket 22 Pin Dip | XO-467 |
| R10 | Resistor, 1.5K ohm, 5%, 1/4W | XO-20 | | Socket 24 Pin (Z) | XO-529 |
| | | | | Socket 40 Pin (Z) | XO-530 |

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS



SOUND/SPEECH ASSY. (A6), SCHEMATIC DIAGRAM

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS



PRIMARY POWER/FILTER BOARD/INTERCONNECTION DIAGRAM