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 Distrubutors 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 BOARD ASSY. (A6)
- **COMPONENT LOCATION AND PARTS LIST** **27**
- **SCHEMATIC DIAGRAM** **28**

PRIMARY POWER/FILTER BOARD/ INTERCONNECTION DIAGRAM **30**

INTERFACE ASSY. (A2)
- **SCHEMATIC DIAGRAM** **33**
- **COMPONENT LOCATION AND PARTS LIST** **34**

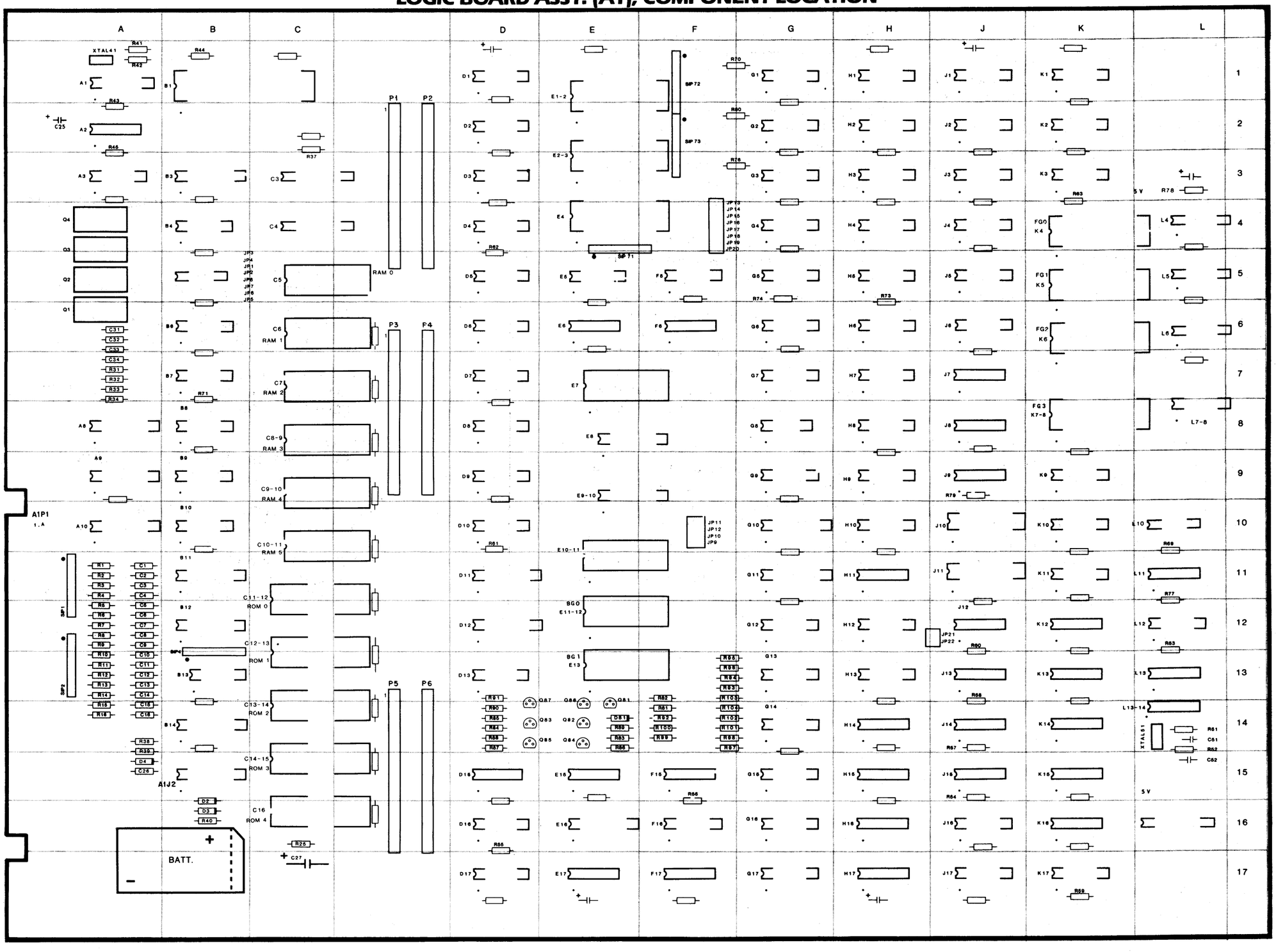
X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS

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
D81	Diode, 1N4148	XO-261
Q1-Q4	Transistor, 2N6044	XO-120
Q81-Q87	Transistor, MPSA70	XO-309
R1-R16	Resistor, 470 OHM, 5% ¼W	XO-35
R37, R38	Resistor, 330 OHM, 5% ¼W	XO-34
R39	Resistor, 130 OHM, 5% ¼W	XO-172
R40	Resistor, 270 OHM, 5% ¼W	XO-68
R41, R42	Resistor, 510 OHM, 5% ¼W	XO-25
R43	Resistor, 130 OHM, 5% ¼W	XO-172
R44, R45	Resistor, 1K OHM, 5% ¼W	XO-5
R51, R52	Resistor, 330 OHM, 5% ¼W	XO-34
R53, R54, R56	Resistor, 1K OHM, 5% ¼W	XO-5
R57, R58	Resistor, 560 OHM, 5% ¼W	XO-36
R59-R61	Resistor, 1K OHM, 5% ¼W	XO-5
R63, R64	Resistor, 1K OHM, 5% ¼W	XO-5
R70	Resistor, 1K OHM, 5% ¼W	XO-5
R73, R74	Resistor, 1K OHM, 5% ¼W	XO-5
R76-R80	Resistor, 1K OHM, 5% ¼W	XO-5
R81	Resistor, 820 OHM, 5% ¼W	XO-174
R82	Resistor, 100 OHM, 5% ¼W	XO-28
R83, R84	Resistor, 15 OHM, 5% ¼W	XO-171
R85	Resistor, 180 OHM, 5% ¼W	XO-24
R86, R87	Resistor, 15 OHM, 5% ¼W	XO-171
R88	Resistor, 180 OHM, 5% ¼W	XO-24
R89, R90	Resistor, 15 OHM, 5% ¼W	XO-171
R91	Resistor, 180 OHM, 5% ¼W	XO-24
R92	Resistor, 1K OHM, 5% ¼W	XO-5
R93	Resistor, 2K OHM, 5% ¼W	XO-14
R94	Resistor, 1K OHM, 5% ¼W	XO-5
R95	Resistor, 470 OHM, 5% ¼W	XO-35
R96	Resistor, 240 OHM, 5% ¼W	XO-173
R97	Resistor, 2K OHM, 5% ¼W	XO-14
R98	Resistor, 1K OHM, 5% ¼W	XO-5
R99	Resistor, 470 OHM, 5% ¼W	XO-35
R100	Resistor, 240 OHM, 5% ¼W	XO-173
R101	Resistor, 2K OHM, 5% ¼W	XO-14
R102	Resistor, 1K OHM, 5% ¼W	XO-5
R103	Resistor, 470 OHM, 5% ¼W	XO-35
R104	Resistor, 240 OHM, 5% ¼W	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

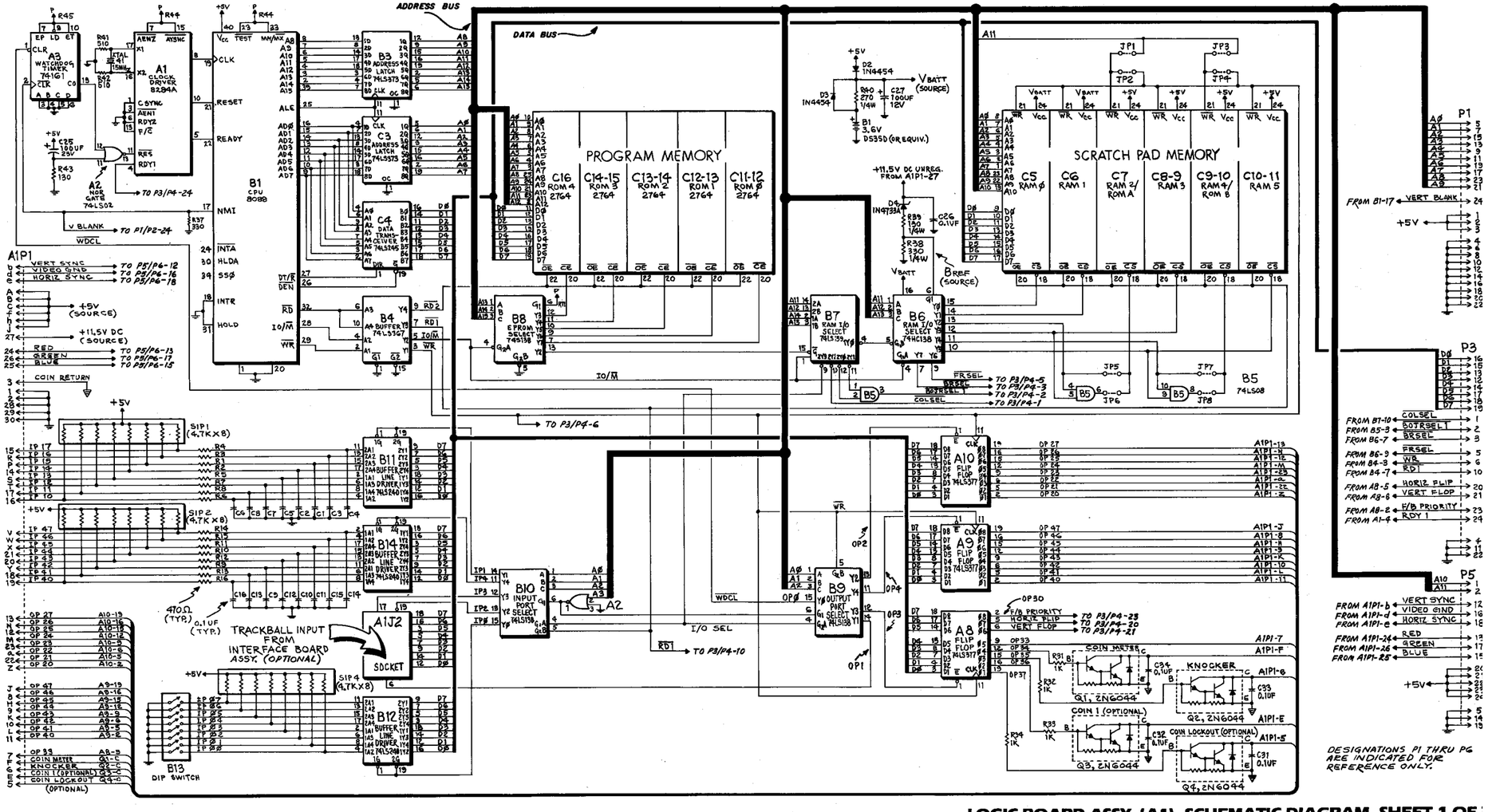
LOGIC BOARD ASSY. (A1), COMPONENT LOCATION



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

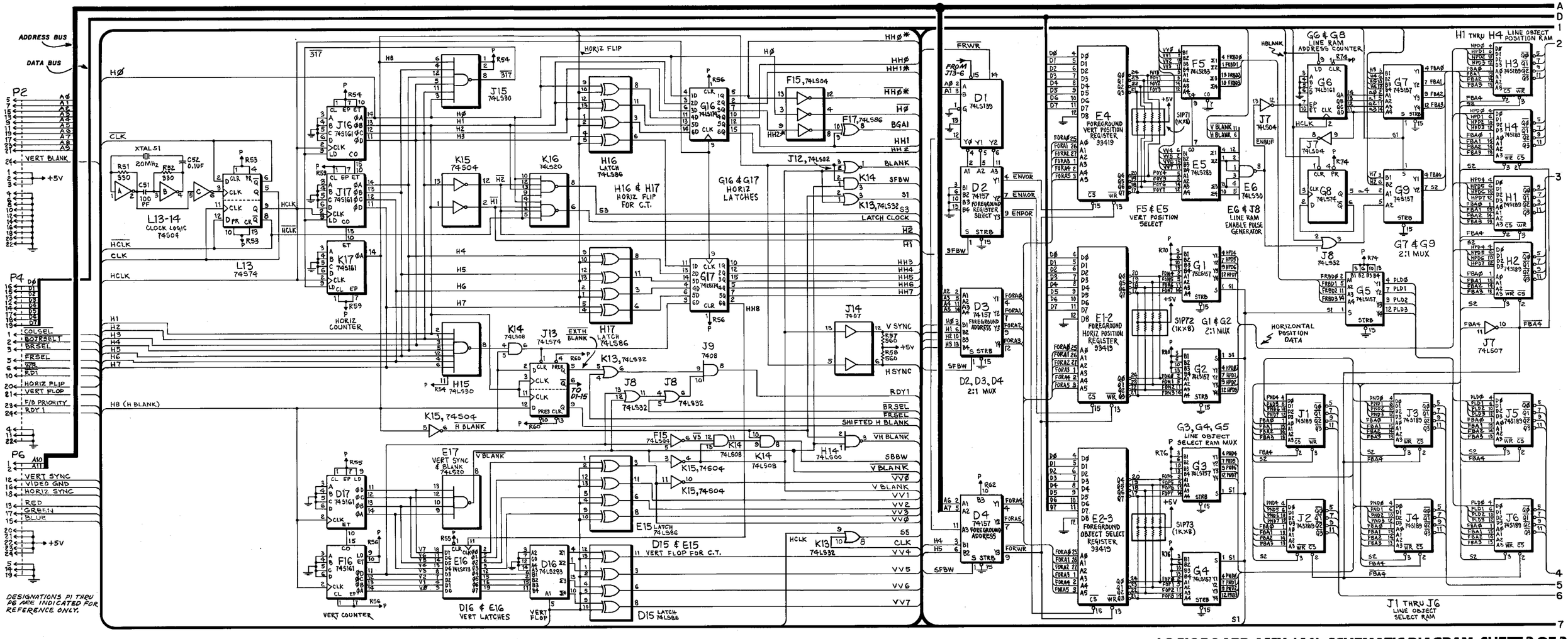
INTEGRATED CIRCUITS

REFERENCE	DESCRIPTION	PART NO.
	Logic Board Assy.	MA-378
A1	8284 CLK Driver	XO-478
A2	74LS02 Quad 2-input "NOR" gate	XO-428
A3	74161 Synchronous 4-bit counter	XO-192
A8, A9, A10	74LS377 Octal "D" Flip Flop	XO-97
B1	8088 CPU	XO-490
B3	74LS373 Octal D-type flip flop	XO-445
B4	74LS367 Hex 3-state buffer	XO-444
B5	74LS08 Quad 2-input "AND" gate	XO-86
B6	74HC138 Decoder/demultiplexer	XO-190
B7	74LS139 Dual 1 of 4 decoder	XO-419
B8	74 S138 1 of 8 decoder	XO-113
B9, B10	74LS138 1 of 8 decoder	XO-437
B11, B12, B14	74LS240 Octal Buffer/line driver	XO-91
C3	74LS373 Octal D-type flip flop	XO-445
C4	74LS245 Octal Bus transceiver	XO-79
C5	RAM @ 6116LP-4	XO-191
C6	RAM 1 6116LP-4	XO-191
C7	RAM 2 2128-2	XO-195
C11-12	ROM @ 2764 8K x 8 EPROM	XO-489
C12-13	ROM 1 2764 8K x 8 EPROM	XO-489
C13-14	ROM 2 2764 8K x 8 EPROM	XO-489
D1	74LS139 Dual 1 of 4 Decoder	XO-419
D2, D3, D4, D5, D6, D7, D8, D9, D10	74157 Quad 2-input multiplexer	XO-114
D11	74LS374 Octal D-type flip flop	XO-96
D12	74LS244 Octal buffer/line driver	XO-117
D13	74LS157 Quad 2-input multiplexer	XO-390
D15	74LS86 Quad 2-input exclusive "OR" gate	XO-435
D16	74LS283 4-bit binary full adder	XO-95
D17	74S161 Synchronous presettable binary counter	XO-488
E1-2, E2-3, E4	93419 64 x 9 bipolar RAM	XO-99
E5	74LS283 4-bit binary full adder	XO-95
E6	74LS30 8-input "NAND"	XO-432
E7	4801 1K x 8 RAM	XO-193
E8, E9-10	74LS245 Octal Bus Transceiver	XO-79
E10-11	4801 1K x 8 RAM	XO-193
E11-12	2732A (BG@) 4K x 8 EPROM	XO-485
E13	2732A (BG1) 4K x 8 EPROM	XO-485
E15	74LS86 Quad 2-input exclusive "OR" gate	XO-435
E16	74LS273 8-bit register	XO-94
E17	74LS20 Dual 4-input "NAND" gate	XO-430
F5	74LS283 4-bit binary full adder	XO-95
F6	74LS32 Quad 2-input "OR" gate	XO-433
F15	74LS04 Hex inverter	XO-418
F16	74LS161 Synchronous presettable binary counter	XO-488
F17	74LS86 Quad 2-input exclusive "OR" gate	XO-435
G1, G2, G3, G4, G5	74LS157 Quad 2-input multiplexer	XO-390
G6	74LS161 Synchronous presettable binary counter	XO-440
G7	74157 Quad 2-input multiplexer	XO-114
G8	74LS74 Dual D-type flip flop	XO-434
G9	74S157 Quad 2-input multiplexer	XO-124
G10	74LS245 Octal bus transceiver	XO-79
G11	74LS374 Octal D-type flip flop	XO-96
G12	74LS157 Quad 2-input multiplexer	XO-390
G13, G14, G15	7489 64-bit RAM	XO-88
G16, G17	74LS174 Hex D flip flop	XO-442
H1, H2, H3, H4	74S189 64-bit RAM	XO-89
H5, H6, H7, H8, H9, H10	74LS161 Synchronous presettable binary counter	XO-488
H11	74LS157 Quad 2-input multiplexer	XO-390
H12	74LS260 Dual 5-input "NOR" gate	XO-93
H13	74LS298 Quad 2-port register	XO-118
H14	74LS157 Quad 2-input multiplexer	XO-390
H15	74LS00 Quad 2-input "NAND" gate	XO-427
H16, H17	74LS30 8 input "NAND" gate	XO-432
	74LS86 Dual 2-input exclusive "OR" gate	XO-435
J1, J2, J3, J4, J5, J6	74S189 64-bit RAM	XO-89
J7	74LS04 Hex inverter	XO-418
J8	74LS32 Quad 2-input "OR" gate	XO-433
J9	7408 Quad 2-input "AND" gate	XO-404
J10, J11	93422 256 x 2 bipolar RAM	XO-100
J12	74LS02 Quad 2-input "NOR" gate	XO-428
J13	74LS74 Dual D-type flip flop	XO-434
J14	7407 Hex buffer/driver	XO-384
J15	74LS30 8 input "NAND" gate	XO-432
J16, J17	74LS161 Synchronous presettable binary counter	XO-488
K1, K2, K3	74LS379 Quad D-type flip flop	XO-98
K4	FG0 2764-3 8K x 8 EPROM	XO-489
K5	FG1 2764-3 8K x 8 EPROM	XO-489
K6	FG2 2764-3 8K x 8 EPROM	XO-489
K7-8	FG3 2764-3 8K x 8 EPROM	XO-489
K9, K10, K11	74LS157 Quad 2-input multiplexer	XO-390
K12	74LS260 Dual 5-input "NOR" gate	XO-93
K13	74LS32 Quad 2-input "OR" gate	XO-433
K14	74LS08 Quad 2-input "AND" gate	XO-86
K15	74LS04 Hex inverter	XO-418
K16	74LS20 Dual 4-input "NAND" gate	XO-430
K17	74S161 Synchronous presettable binary counter	XO-488
L4, L5, L6, L7	74LS166 8-bit shift register	XO-391
L10	74LS74 Dual flip flop	XO-434
L11	74LS20 Dual 4-input "NAND" gate	XO-430
L12	74LS161 Synchronous presettable binary counter	XO-440
L13	74S74 Dual D-type pos. edge trig. flip flop (T. f. only)	XO-87
L13-14	74S04 Hex inverter	XO-400

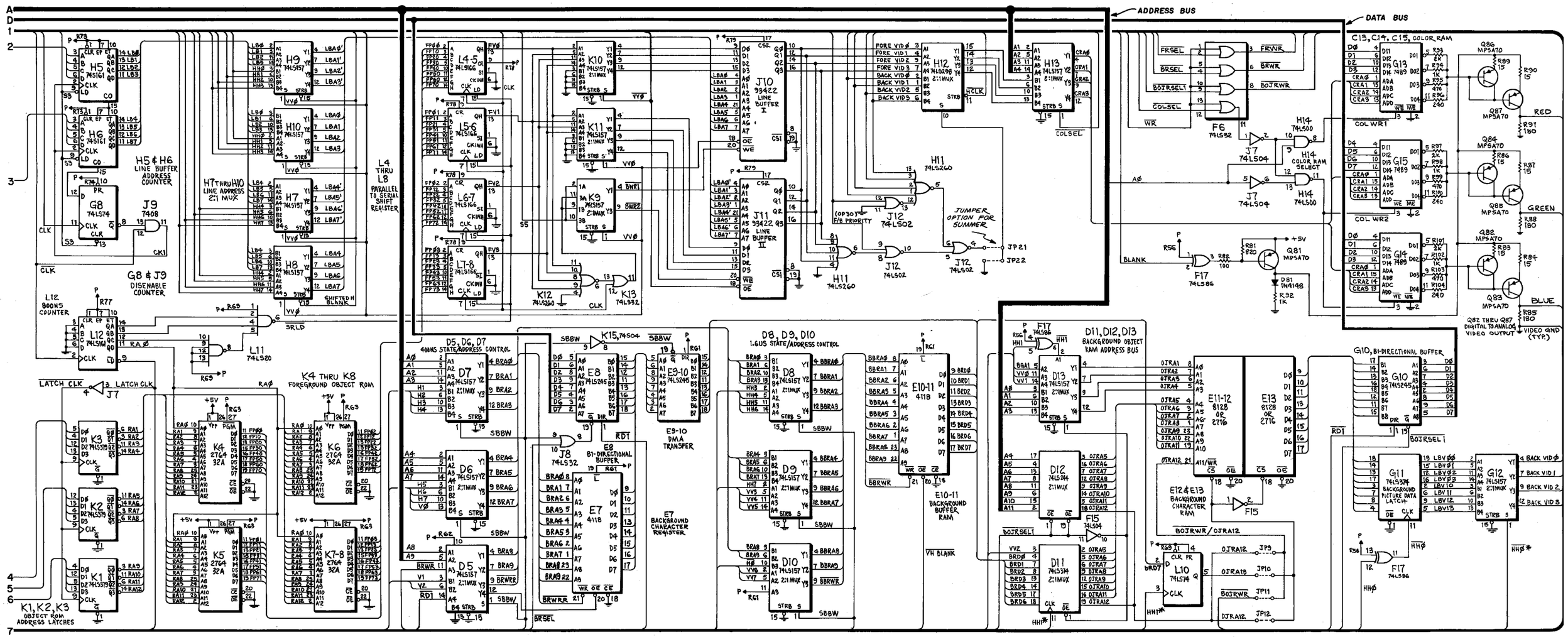


DESIGNATIONS P1 THRU P5 ARE INDICATED FOR REFERENCE ONLY.

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

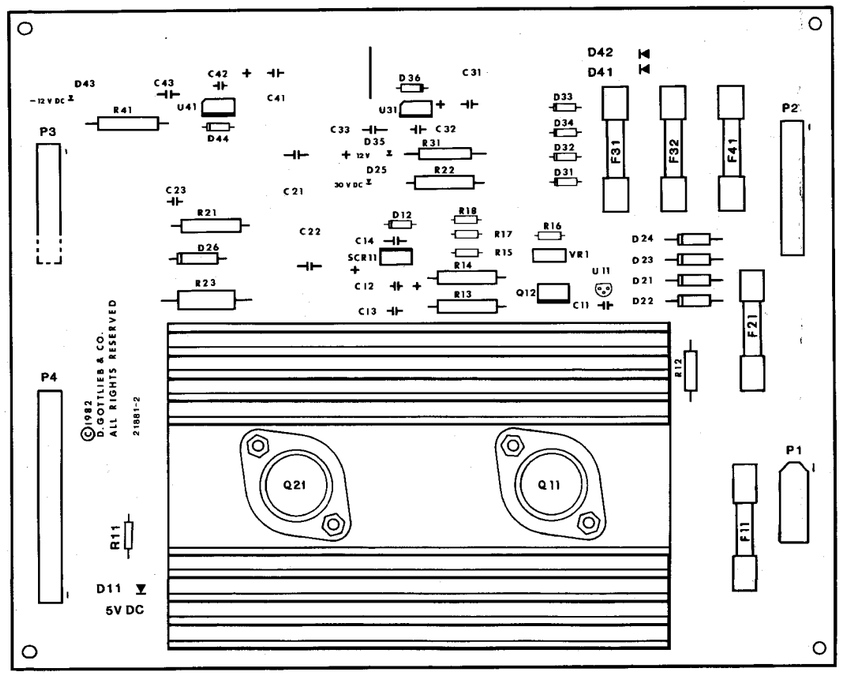


LOGIC BOARD ASSY. (A1), SCHEMATIC DIAGRAM, SHEET 2 OF 3



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

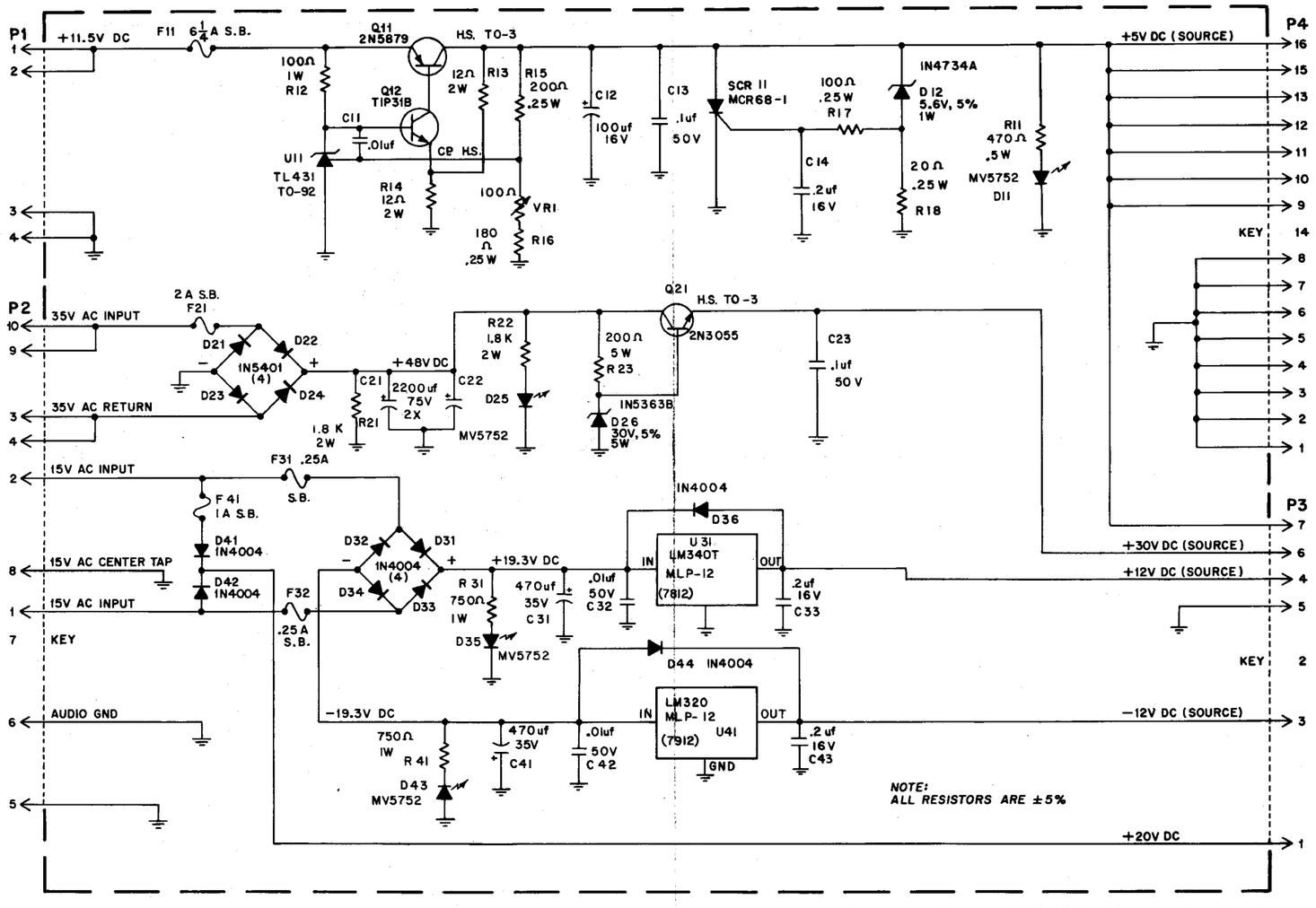
POWER SUPPLY ASSY. (A3), COMPONENT LOCATION



POWER SUPPLY ASSY. (A3), PARTS LIST

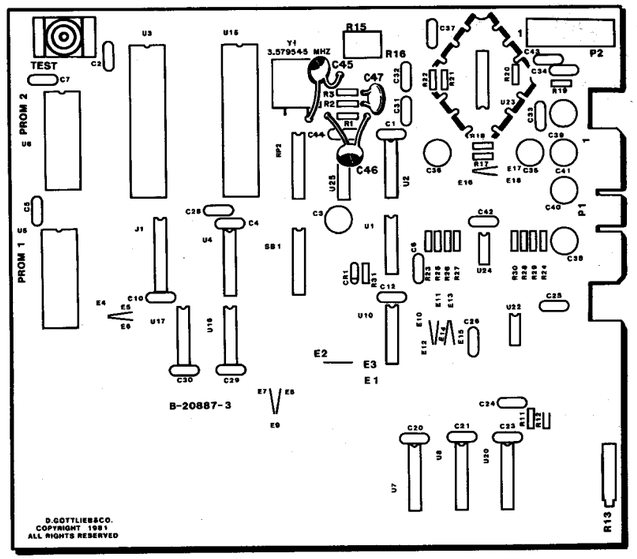
REFERENCE	DESCRIPTION	PART NO.
	Power Supply Assy.	MA-430
C11, C32, C42	Capacitor, .01 mfd., 50V	XO-229
C12	Capacitor, 100UF, 16V	XO-235
C13, C23	Capacitor, 0.1UF, 100V	XO-234
C14, C33, C43	Capacitor, 0.2UF, 16V	XO-205
C21, C22	Capacitor, 2200UF, 75V	XO-132
C31, C41	Capacitor, 470UF, 35V	XO-284
D11, D25		
D35, D43	Diode, Light Emitting MV-5752	XO-270
D12	Diode, Zener, 5.6V, 5%, 1W, 1N4734A	XO-255
D21-D24	Diode, 1N5401	XO-263
D26	Diode, Zener, 30V, 5%, 5W, 1N5363B	XO-273
D31-D34, D36		
D41, D42, D44	Diode, 1N4004	XO-254
F11	Fuse, 6¼ AMP SLO-BLO	EL-8
F21	Fuse, 2 AMP SLO-BLO	EL-7
F31, F32	Fuse, ¼ AMP SLO-BLO	EL-5
F41	Fuse, 1 AMP SLO-BLO	EL-6
P1	Connector, 4 PIN	PS-87
P2	Connector, 10 PIN	XO-531
P3	Connector, 7 PIN	XO-526
P4	Connector, 16 PIN	XO-372
Q11	Transistor, PNP, 2N5879	XO-323
Q12	Transistor, NPN, TIP31B	XO-641
Q21	Transistor, NPN, 2N3055	XO-301
R11	Resistor, 470 OHM, 5% ½W	XO-55
R12	Resistor, 100 OHM, 5% 1W	XO-137
R13, R14	Resistor, 12 OHM, 5% 2W	XO-138
R15	Resistor, 200 OHM, 5% ¼W	XO-143
R16	Resistor, 180 OHM, 5% ¼W	XO-24
R17	Resistor, 100 OHM, 5% ¼W	XO-28
R18	Resistor, 20 OHM, 5% ¼W	XO-29
R21, R22	Resistor, 1.8KOHM, 5% 2W	XO-135
R23	Resistor, 200 OHM, 5% 5W	XO-133
R31, R41	Resistor, 750 OHM, 5% 1W	XO-136
SCR11	Silicon Controlled Rectifier	XO-131
U11	Diode, Programmable Zener TL431	XO-272
U31	Voltage Regulator +12V, LM 340T	XO-473
U41	Voltage Regulator -12V, LM 320	XO-130
VR1	Potentiometer, 100 OHM	XO-134

X. WIRING AND SCHEMATIC DIAGRAMS, PARTS LISTS



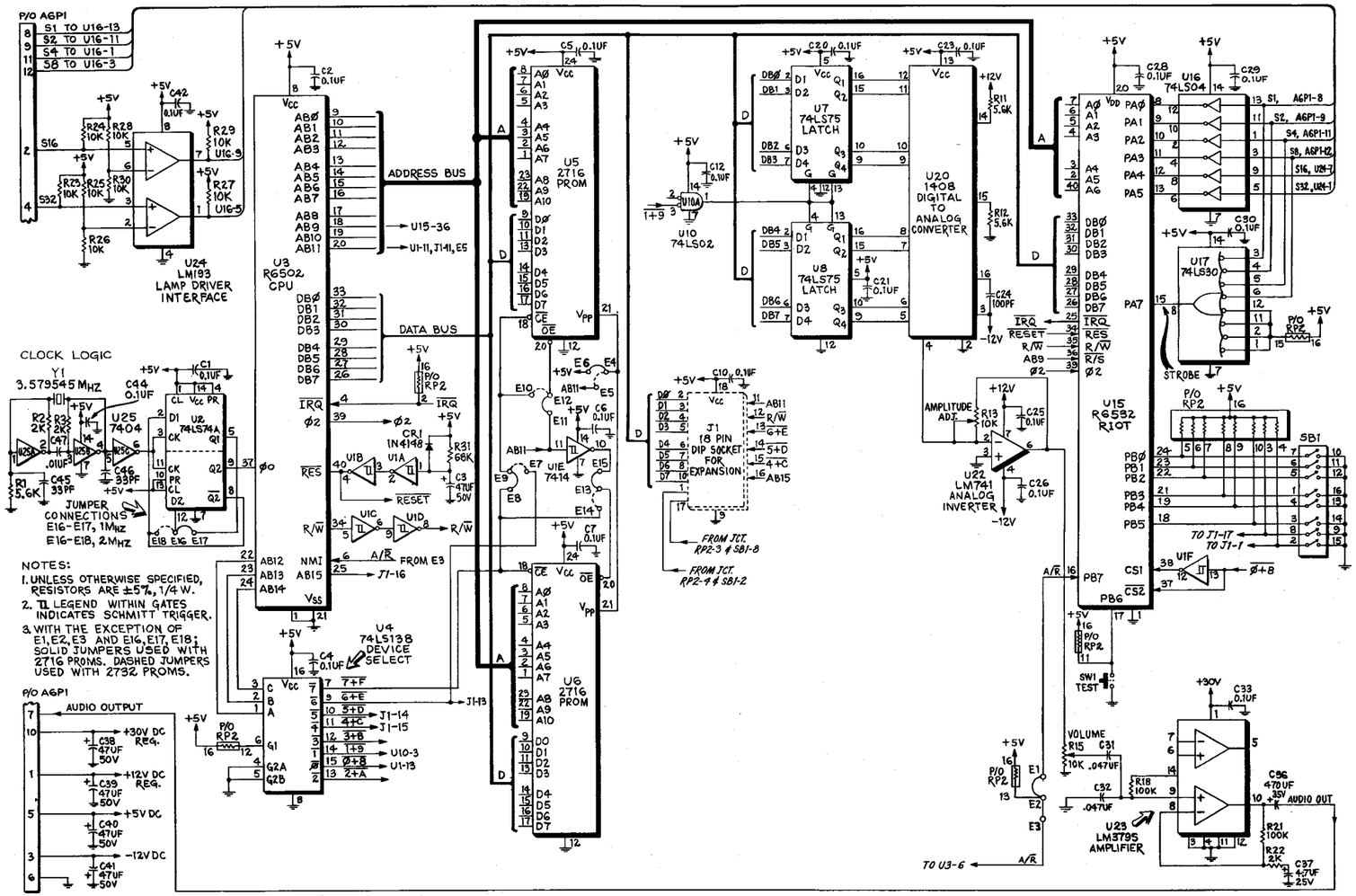
POWER SUPPLY ASSY. (A3), SCHEMATIC DIAGRAM

SOUND BOARD ASSY. (A6), COMPONENT LOCATION



SOUND BOARD ASSY. (A6), PARTS LIST

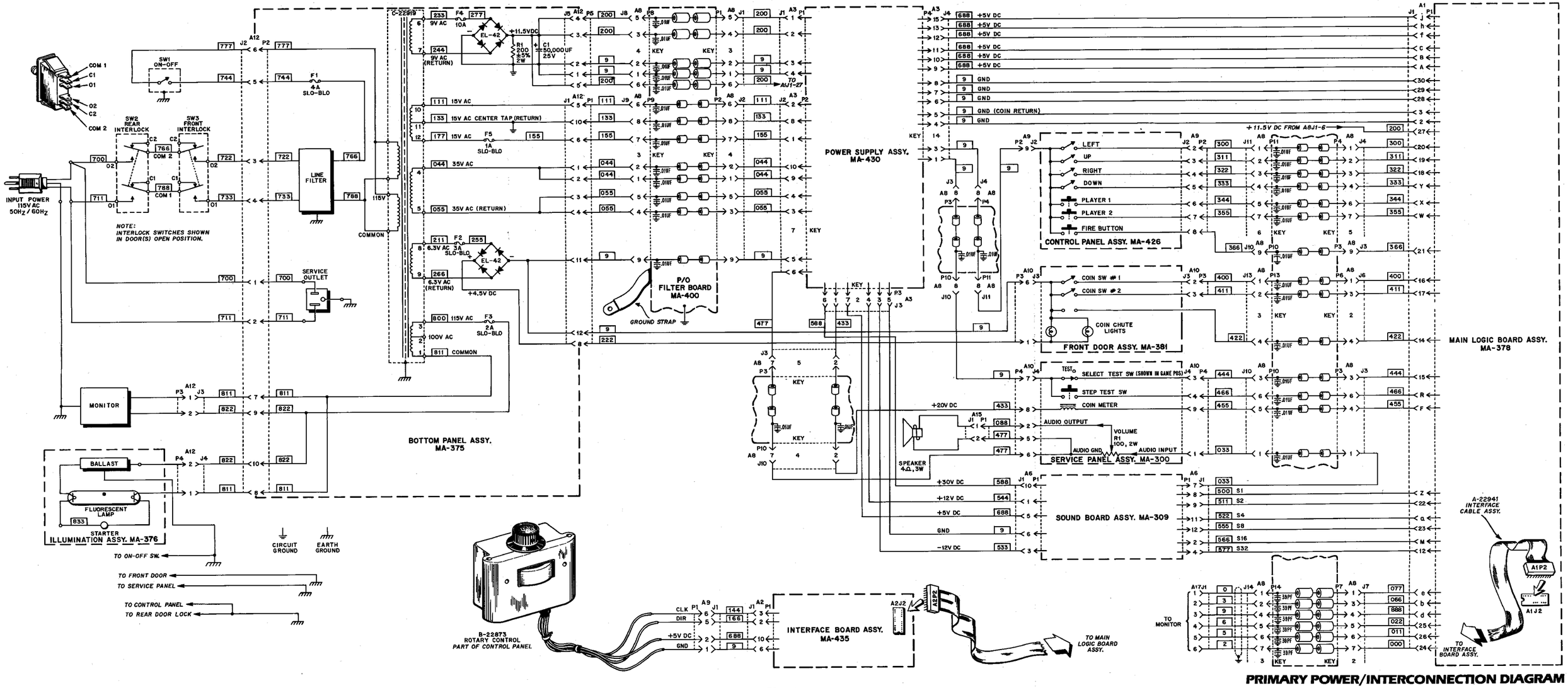
REFERENCE	DESCRIPTION	PART NUMBER
	Sound Board Assembly	WA-309
C1, C2	Capacitor, 0.1UF, 25V	XO-248
C4-C7, C10		
C12, C20, C21		
C23, C25, C26		
C28, C29, C30		
C33, C42, C44		
C31, C32	Capacitor, .047UF, 25V	XO-222
C37	Capacitor, 4.7UF, 35V	XO-291
C3, C38-C41	Capacitor, 47UF, 50V	XO-210
C24	Capacitor, 100PF	XO-223
C36	Capacitor, 470UF, 35V	XO-284
C45, C46	Capacitor, 33PF	XO-277
C47	Capacitor, .01UF, 100V	XO-202
CR1	Diode, 1N4148	XO-261
R1, R11, R12	Resistor, 5.6K ohm, 5%, 1/4W	XO-19
R2, R3	Resistor, 2K ohm, 5%, 1/4W	XO-14
R13	Potentiometer, 10K ohm	XO-108
R23-R30	Resistor, 10K ohm, 5%, 1/4W	XO-18
R15	Potentiometer, 10K ohm	XO-109
R18, R21	Resistor, 100K ohm, 5%, 1/4W	XO-45
R22	Resistor, 2K ohm, 5%, 1/4W	XO-14
R31	Resistor, 68K ohm, 5%, 1/4W	XO-189
RP2	Resistor, DIP	XO-168
SB1	Switch, DIP	XO-505
SW1	Switch, Momentary Pushbutton	XO-515
U1	IC, 7414	XO-397
U2	IC, SN74LS74N	XO-434
U3	CPU, R6502-13	XO-360
U4	IC, SN74LS138N	XO-437
U5, U6	EPROM, 2716	PR-53
U7	IC, SN74LS75	XO-394
U10	IC, SN74LS02N	XO-428
U15	RRIOT, R6532-18	XO-361
U16	IC, SN74LS04N	XO-418
U17	IC, SN74LS30N	XO-432
U20	Converter, PMI, 1408A-6P	XO-416
U22	IC, LM741CP	XO-393
U23	IC, LM3795	XO-395
U24	IC, Dual Comparitor, LM193	XO-396
U25	Inverter, 7404	XO-402
Y1	Crystal, 3.579545MHZ	XO-456
	Socket, 22 Pin DIP	XO-467
	Socket, 24 Pin (2)	XO-529
	Socket, 40 Pin (2)	XO-530



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE ±5%, 1/4 W.
2. ⊓ LEGEND WITHIN GATES INDICATES SCHMITT TRIGGER.
3. WITH THE EXCEPTION OF E1, E2, E3 AND E16, E17, E18; SOLID JUMPERS USED WITH 2716 PROMS. DASHED JUMPERS USED WITH 2732 PROMS.

SOUND BOARD ASSY. (A6), SCHEMATIC DIAGRAM



PRIMARY POWER/INTERCONNECTION DIAGRAM

19" COLOR MONITOR SCHEMATIC DIAGRAM

MODELS 19K4901, 19K4906, 19K4951, 19K4956

Power Supply Voltage and Symbols

Symbol	Voltage	Operating Circuit
■	15V	Vert. Osc. Sync Blanking CRT Cut-Off
⊗	130V	Horiz. Osc. Horz. Drive Horz. Output Vert. Output
◉	175V	Video Output

★

SERVICE TECHNICIAN WARNING
X-RAY RADIATION PRECAUTION:

THIS PRODUCT CONTAINS CRITICAL ELECTRICAL AND MECHANICAL PARTS ESSENTIAL FOR X-RAY RADIATION PROTECTION.
FOR REPLACEMENT PURPOSES, USE ONLY TYPE PARTS SHOWN IN THE PARTS LIST.

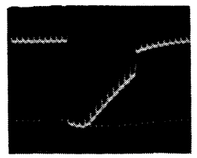
⚠

CAUTION: FOR CONTINUED SAFETY, REPLACE SAFETY CRITICAL COMPONENTS ONLY WITH MANUFACTURER'S RECOMMENDED PARTS.
AVERTISSEMENT: POUR MAINTENIR LE DEGRE DE SECURITE DE L'APPAREIL NE REMPLACER LES COMPOSANTS DONT LE FONCTIONNEMENT EST CRITIQUE POUR LA SECURITE QUE PAR DES PIECES RECOMMANDEES PAR LE FABRICANT.

OSCILLOSCOPE WAVEFORM PATTERN

The waveforms shown are as observed on the wide band oscilloscope with the monitor turned to a reasonably strong signal and a normal picture. The voltages shown on each waveform are the approximate peak amplitudes.
If the waveforms are observed on the oscilloscope with a poor high frequency response, the corner of the pulses will tend to be more rounded than those shown and the amplitude of any high frequency pulse will tend to be less.

A

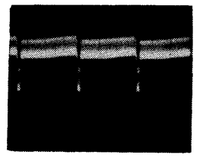


1V/DIV 200uSEC/DIV

Q351 COLLECTOR

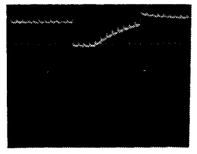
20V/DIV 10uSEC/DIV

TP-81



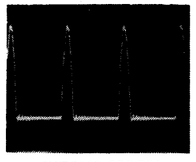
0.5/DIV 5MSEC/DIV

TP-31 DC COUPLED
BOTTOM LINE = 0 VDC



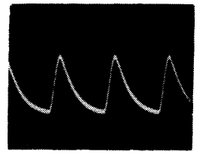
2V/DIV 200MSEC/DIV

J402-3



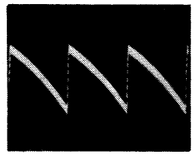
5V/DIV 20uSEC/DIV

B



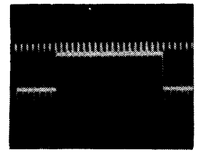
0.5/DIV 20u SEC/DIV

I.C. 301, PIN 3



1V/DIV 5MSEC/DIV

F

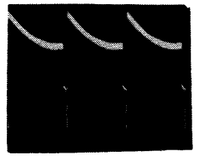


1V/DIV 20u SEC/DIV

I.C. 301, PIN 15

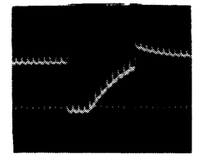
1V/DIV 10uSEC/DIV

TP-82



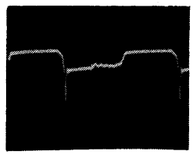
20V/DIV 5MSEC/DIV

TP-31, AC COUPLED



1V/DIV 200uSEC/DIV

D

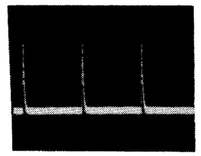


2V/DIV 10uSEC/DIV

I.C. 301, PIN 13

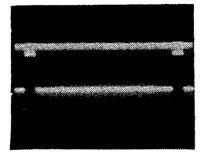
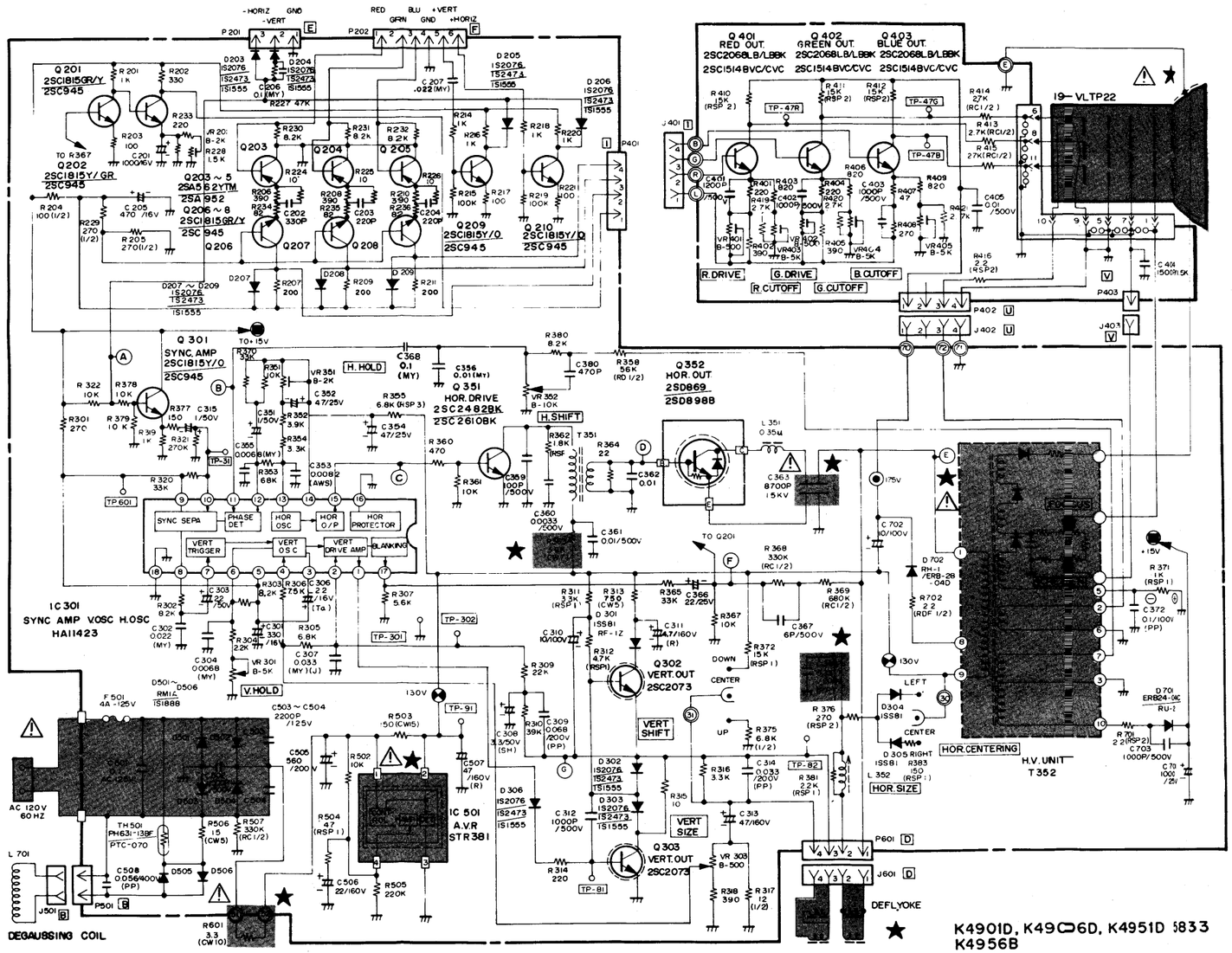
1VDIV 200uSEC/DIV

NEGATIVE SIDE OF C303



2V/DIV 5MSEC/DIV

F



1VDIV 2MSEC/DIV