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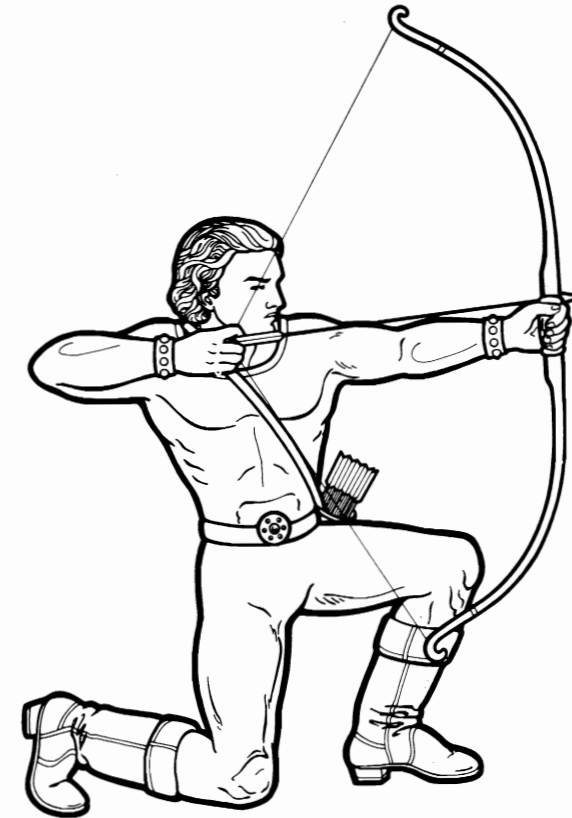
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NOTE
This staple temporarily holds the schematic package together. Remove the staple before using these schematics.



Schematic Package Supplement to

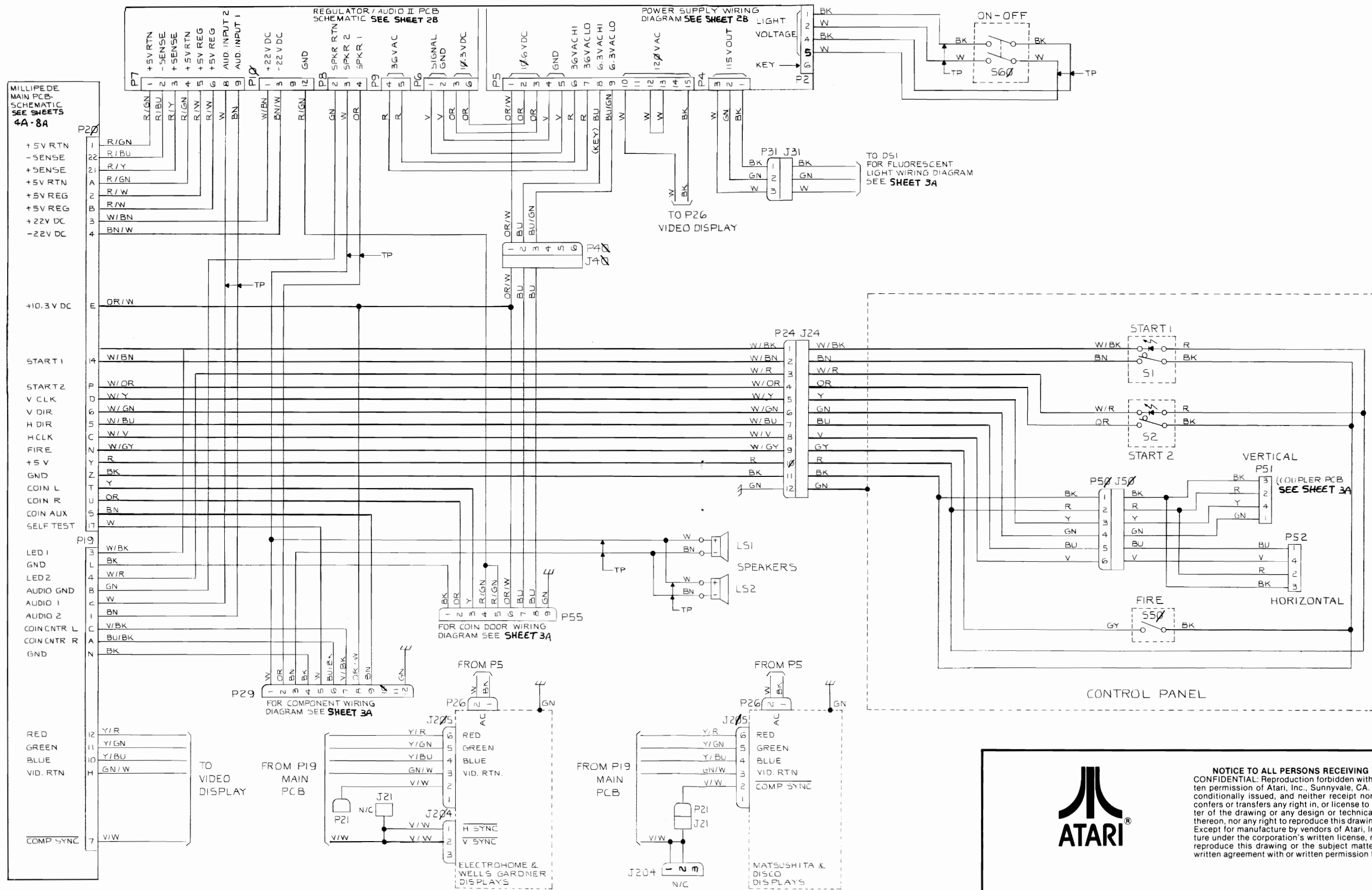
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Operation, Maintenance, and Service Manual

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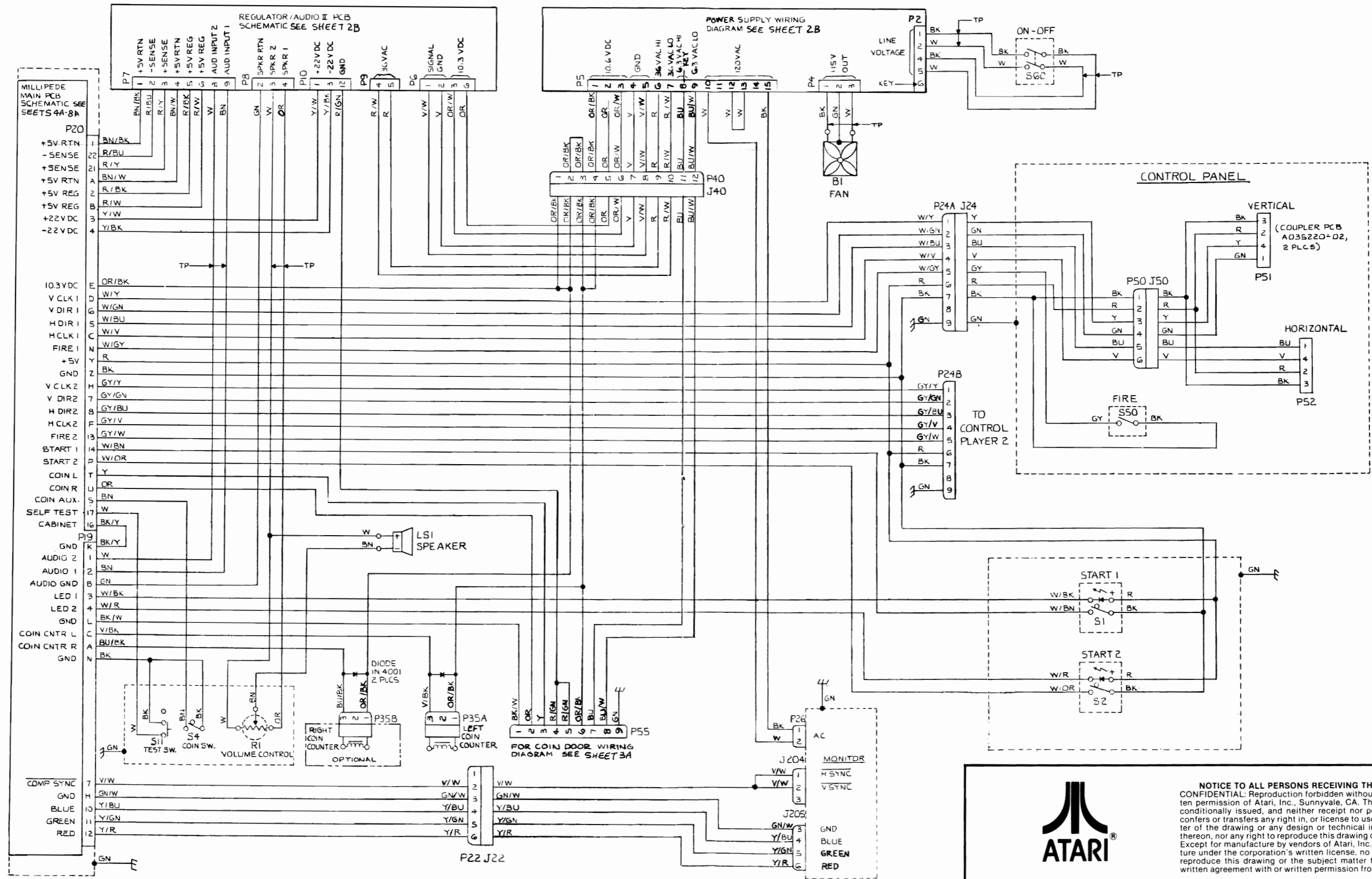
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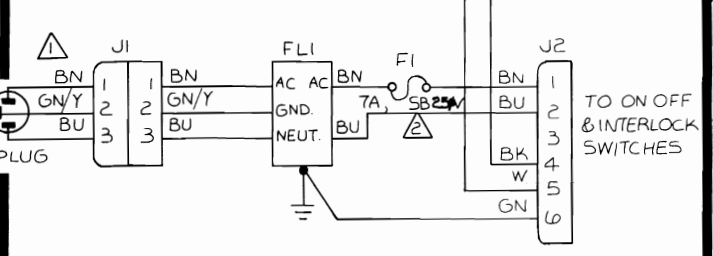
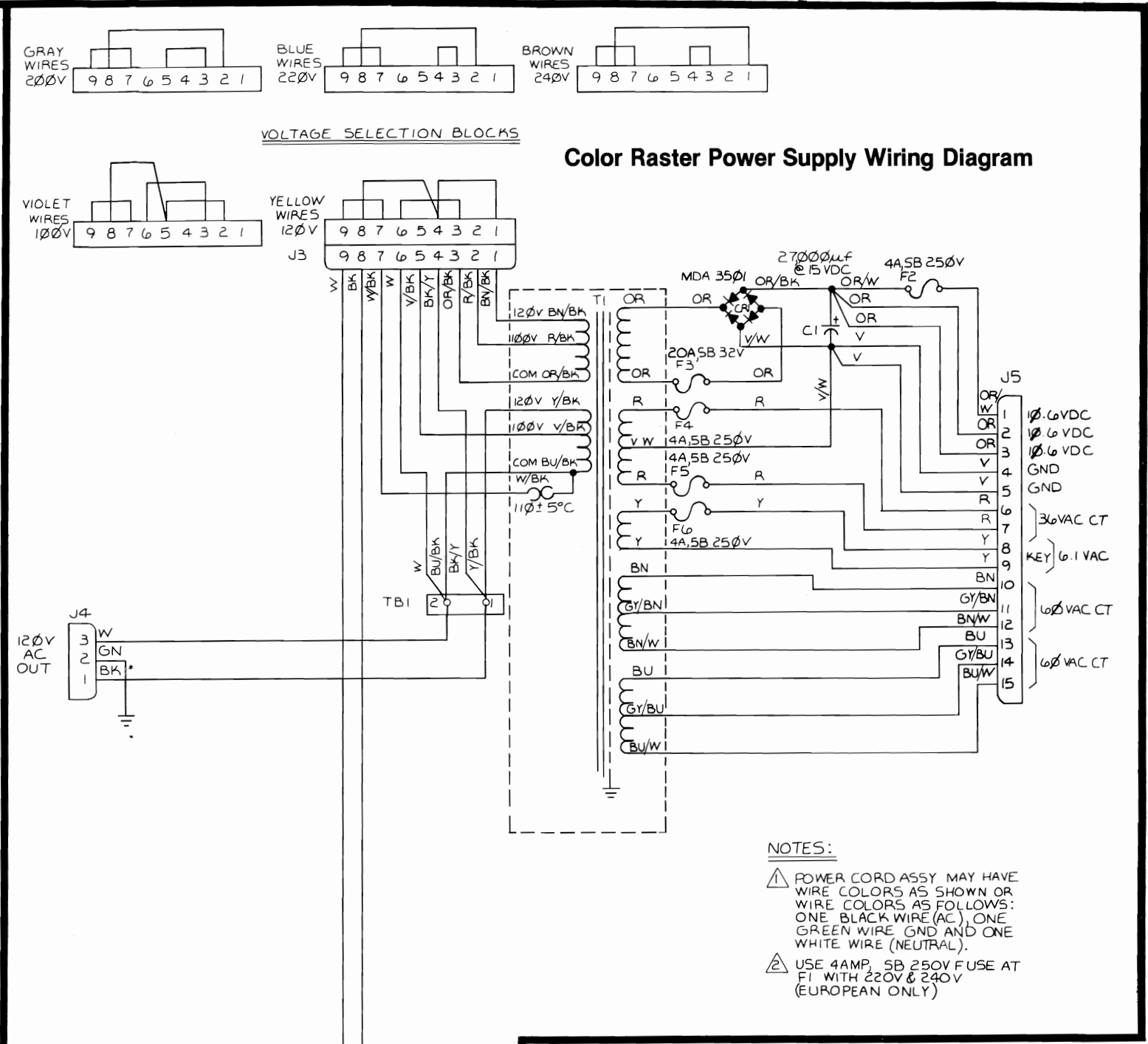
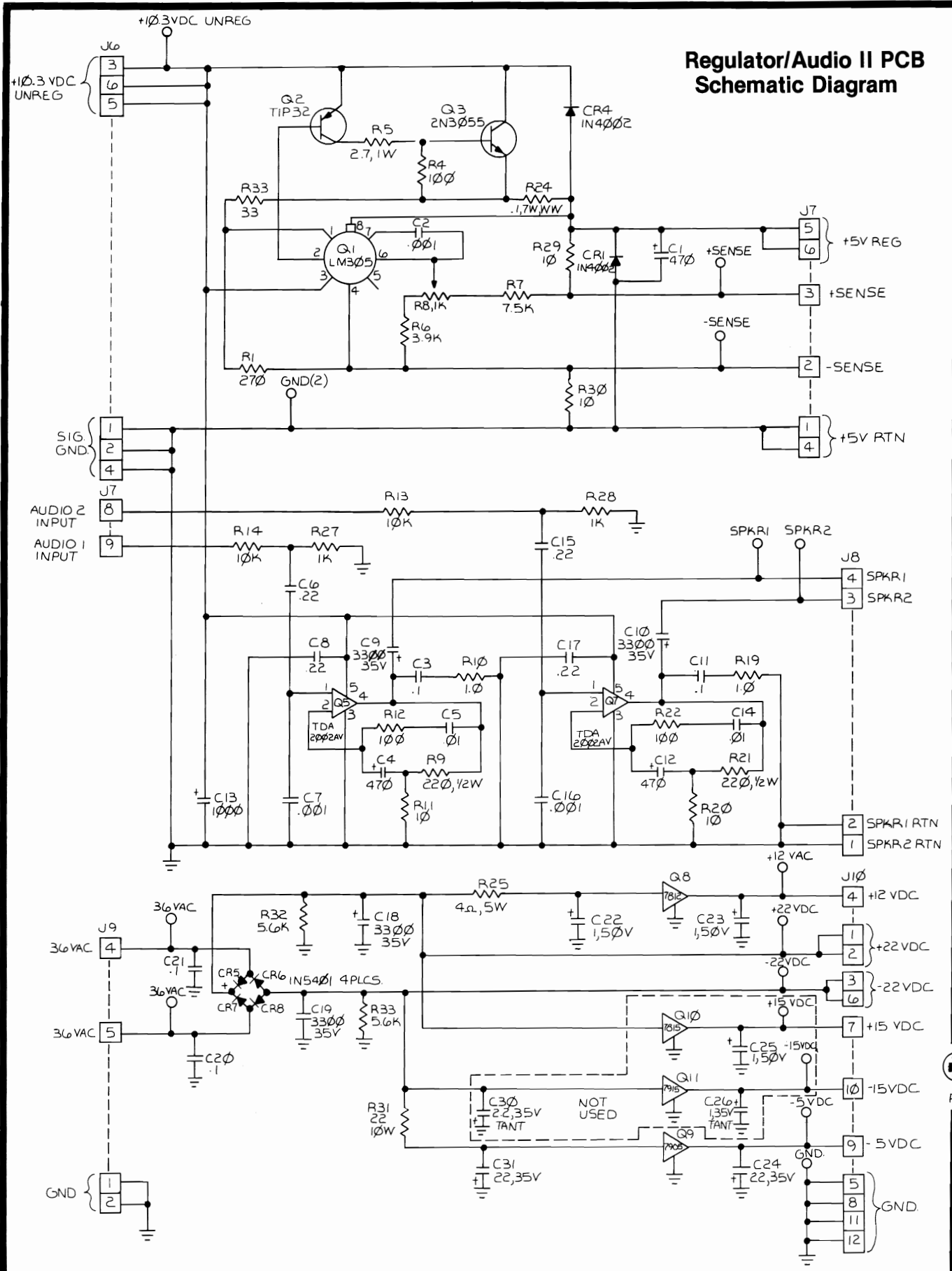
Millipede™ Upright Main Wiring Diagram


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Millipede™ Cocktail Main Wiring Diagram





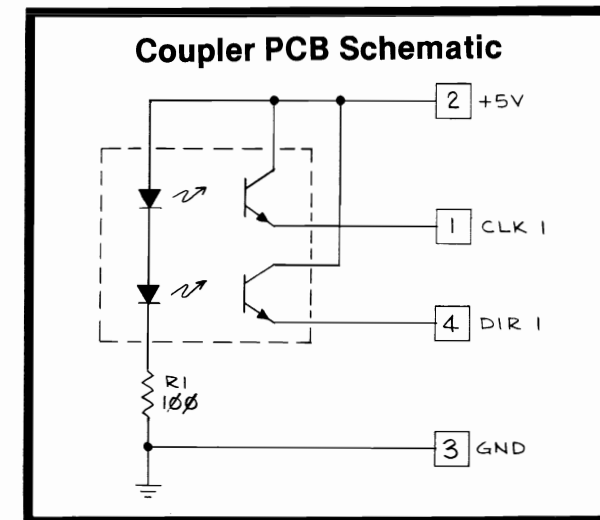
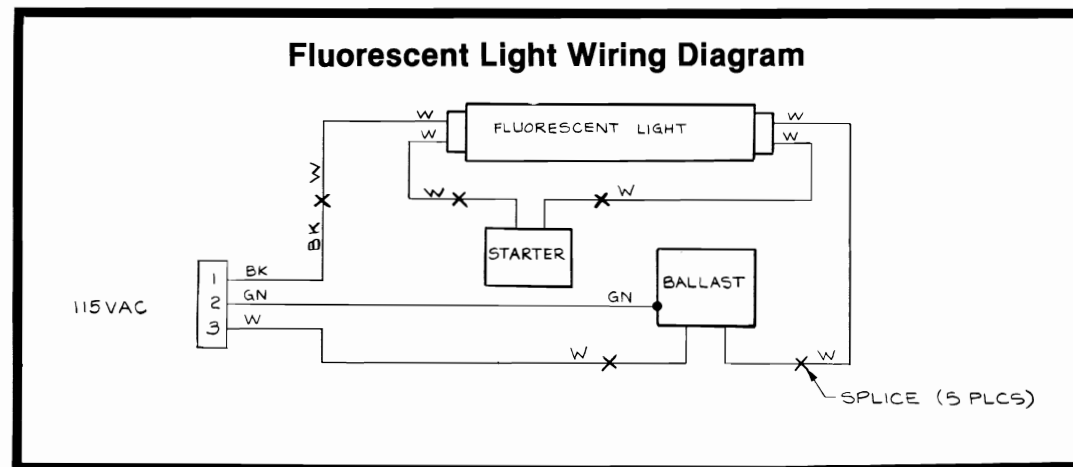
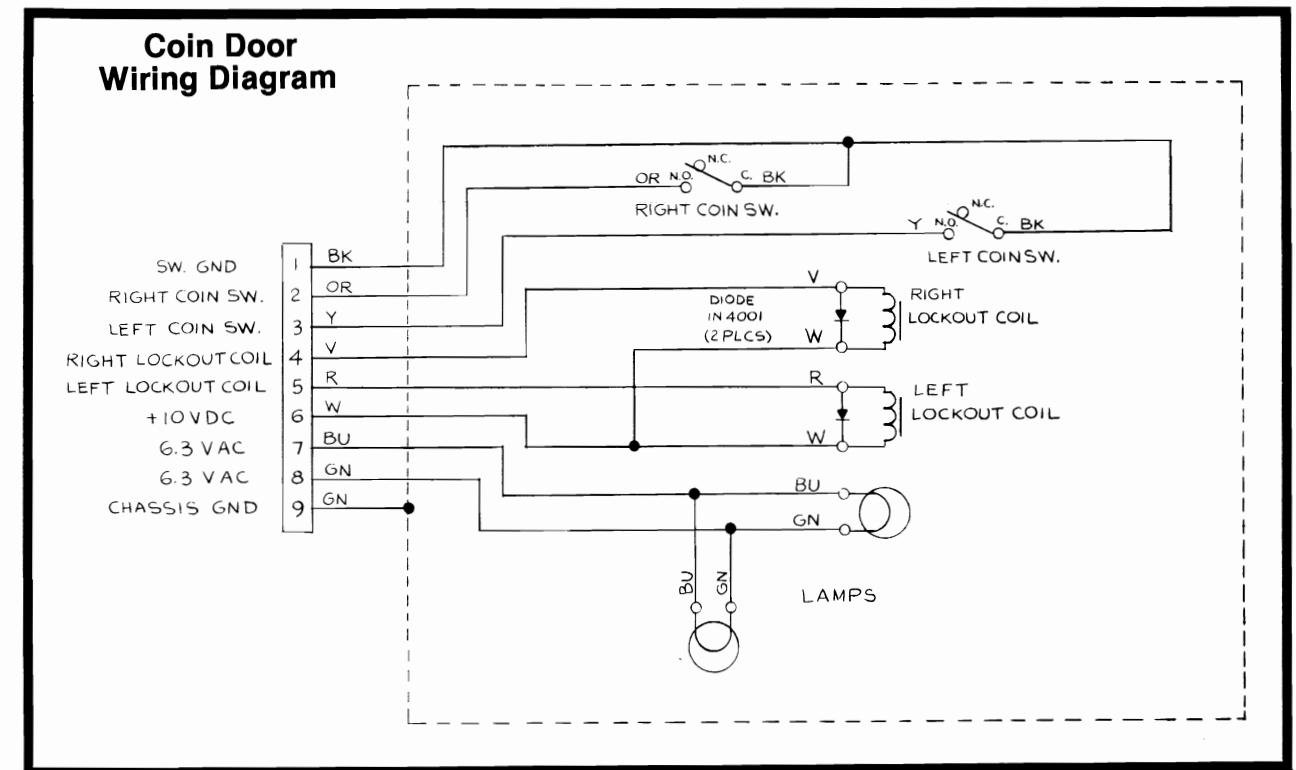
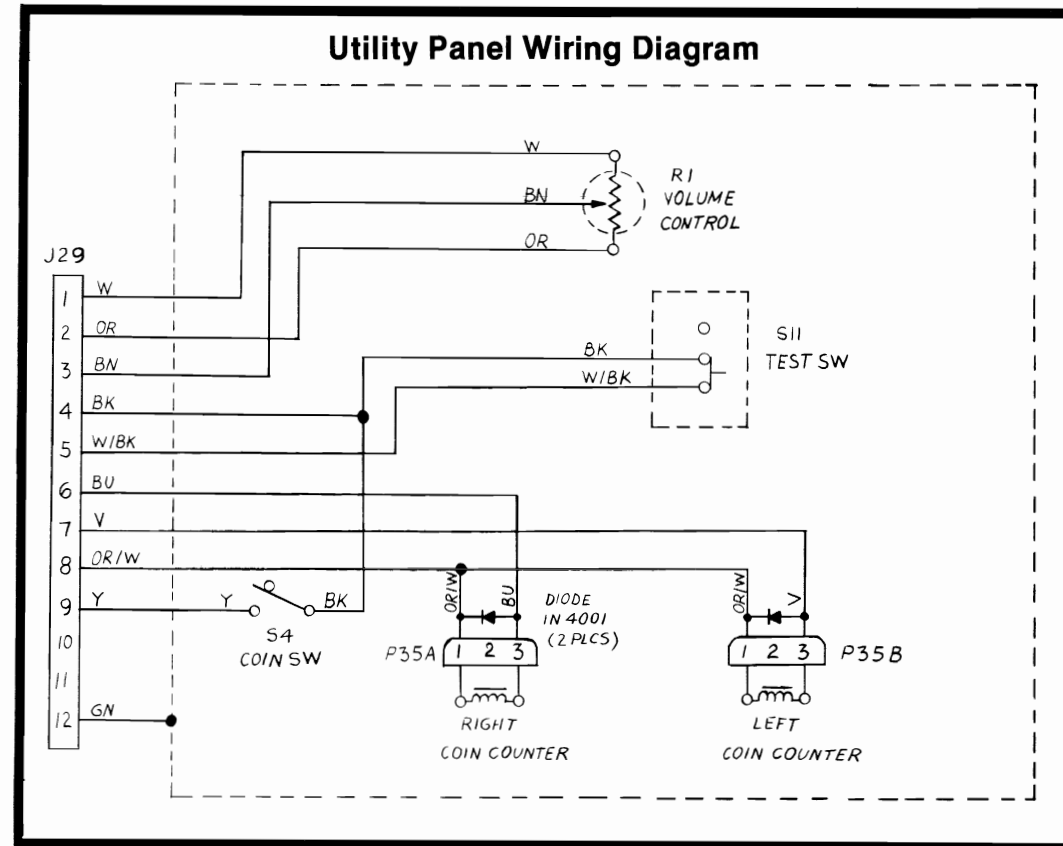
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Millipede™ Reg./Audio II PCB and Power Supply Diagrams

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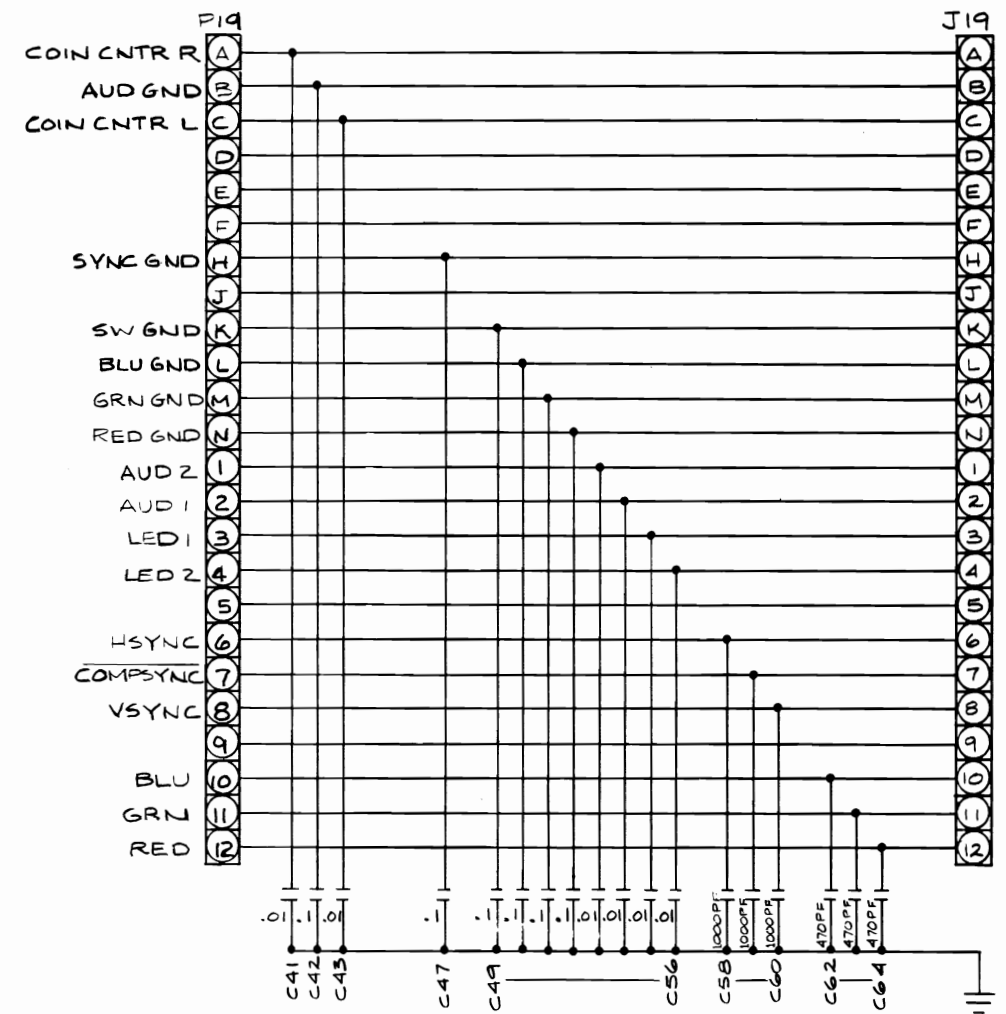
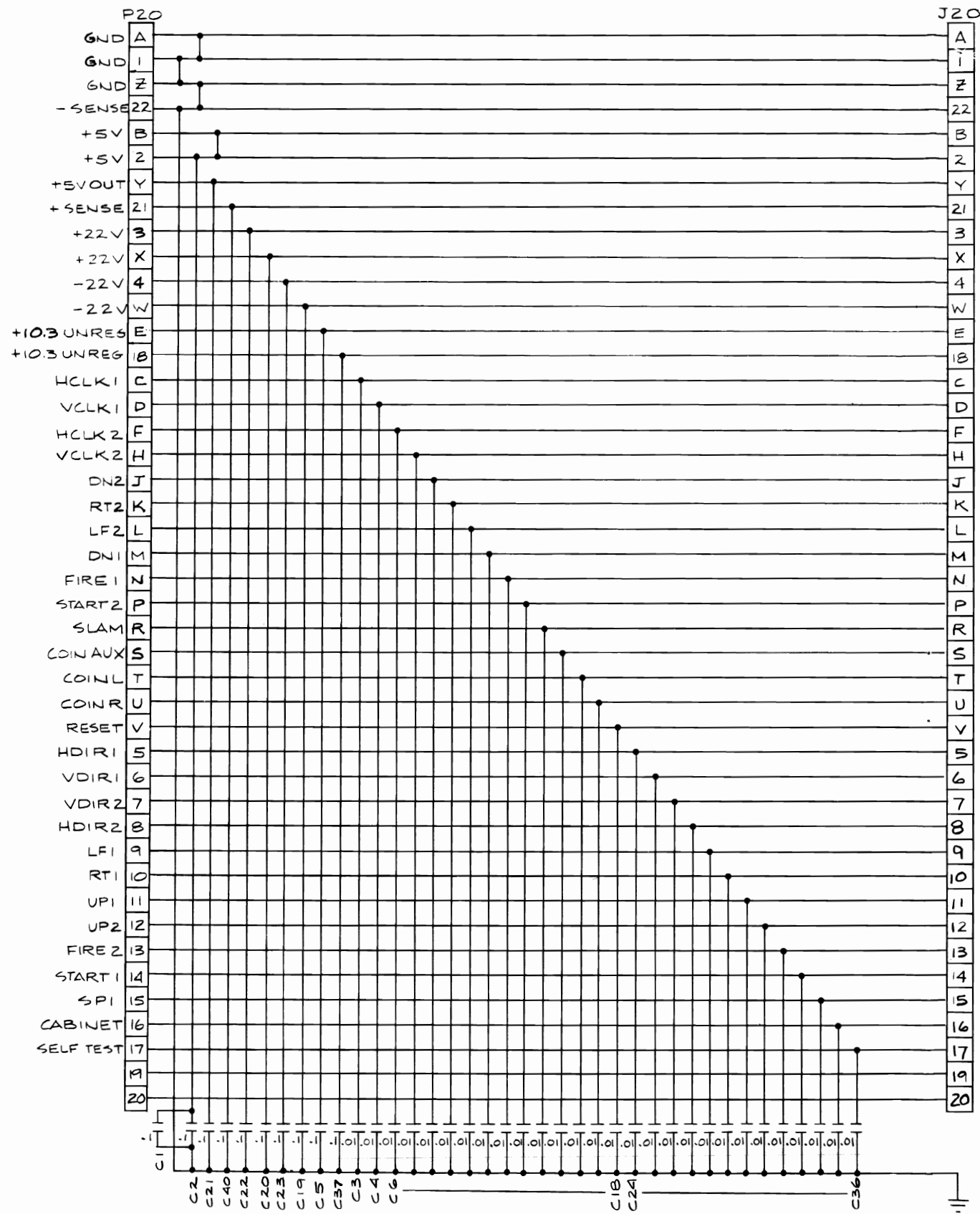
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Millipede™ Game Wiring Interfaces

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EMI Shield PCB Wiring Diagram

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MEMORY MAP

HEXA-DECIMAL ADDRESS	ADDRESS BUS SIGNAL LINES										R/W	DATA BUS SIGNAL LINES								FUNCTION				
	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5		A4	A3	A2	A1	A0	D7	D6	D5		D4	D3	D2	D1
0000-03FF	0	0	0	0	0	A	A	A	A	A	A	A	A	A	A	D	D	D	D	D	D	D	D	RAM
0400-0410 0408	0	0	0	0	1						A	A	A	A		R	D	D	D	D	D	D	D	I/O S0 OPTION SWITCH 0
0800-0810 0808	0	0	0	1	0						A	A	A	A		R	D	D	D	D	D	D	D	I/O S1 OPTION SWITCH 1
1000-13BF 13C0-13CF 13D0-13DF 13E0-13EF 13F0-13FF	0	0	1			A	A	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	PLAYFIELD RAM MOTION OBJECT PICTURE MOTION OBJECT VERTICAL MOTION OBJECT HORIZONTAL MOTION OBJECT COLOR
2000	0	1	0	0	0				0	0				0			D							TRACKBALL HORIZ DIR VBLANK START 1 SWITCH FIRE 1 SWITCH TRACKBALL HORIZ COUNT OPTION SWITCH 2
2001	0	1	0	0	0				0	0				1			D							TRACKBALL VERT DIR START 2 SWITCH FIRE 2 SWITCH TRACKBALL VERT COUNT OPTION SWITCH 2
2010	0	1	0	0	0				0	1				0			D	D	D					COIN SWITCHES SLAM SWITCH JOYSTICK POSITIONS
2011	0	1	0	0	0				0	1				1			D							SELF-TEST SWITCH CABINET SELECT
2030	0	1	0	0	0				1	1							D	D	D	D	D	D	D	EAROMRD
2480-248F 2490-249F	0	1	0	0	1	0	0	1			0	A	A	A	A	W	D	D	D	D	D	D	D	STAMP COLOR RAM MOTION OBJECT COLOR RAM
2501	0	1	0	0	1	0	1	0			0	0	1			W	D							COIN CNTR L
2502	0	1	0	0	1	0	1	0			0	1	0			W	D							COIN CNTR R
2503	0	1	0	0	1	0	1	0			0	1	1			W	D							START LED 1
2504	0	1	0	0	1	0	1	0			1	0	0			W	D							START LED 2
2505	0	1	0	0	1	0	1	0			1	0	1			W	D							TRACKBALL ENABLE (TBEN)
2506	0	1	0	0	1	0	1	0			1	1	0			W	D							VIDEO ROTATE (VIDROT)
2507	0	1	0	0	1	0	1	0			1	1	1			W	D							CONTROL SELECT (CNTRLSEL)
2600	0	1	0	0	1	1	0	0								W								IRQRES
2680	0	1	0	0	1	1	0	1								W								WATCHDOG
2700	0	1	0	0	1	1	1	0								W				D	D	D	D	EAROMCON
2780	0	1	0	0	1	1	1	1								W	D	D	D	D	D	D	D	EAROMWR
300-3FFF 400-7FFF	0	1	1	A	A	A	A	A	A	A	A	A	A	A	A	R	D	D	D	D	D	D	D	ROM (NOT USED)
	1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	R	D	D	D	D	D	D	D	ROM

Schematic Reference Designators and Symbols

Logic symbols depict the logic function performed by that particular device and may differ from the manufacturer's data.

REFERENCE DESIGNATORS:

- C** Capacitor
- CR** Diode, signal or rectifier
- F** Fuse
- J** Connector

- L** Inductor, fixed or variable
- LS** Speaker
- P** Connector
- Q** Transistor or silicon-controlled rectifier

- R** Resistor, fixed or variable
- S** Switch
- T** Transformer
- TP** Twisted wire pair

- VR** Voltage regulator
- Y** Crystal

WIRE COLORS:

- R** Red
- GN** Green
- Y** Yellow
- W** White

- BU** Blue
- BN** Brown
- BK** Black
- OR** Orange

- V** Violet
- GY** Gray

Electrical components shown on the schematic diagrams are in the following units unless otherwise noted:

- Capacitors = microfarads (μ f)
- Resistors = ohms (Ω)
- Inductors = microhenrys (μ h)

SYMBOLS:



Ground



PCB edge connector pad



Test Point

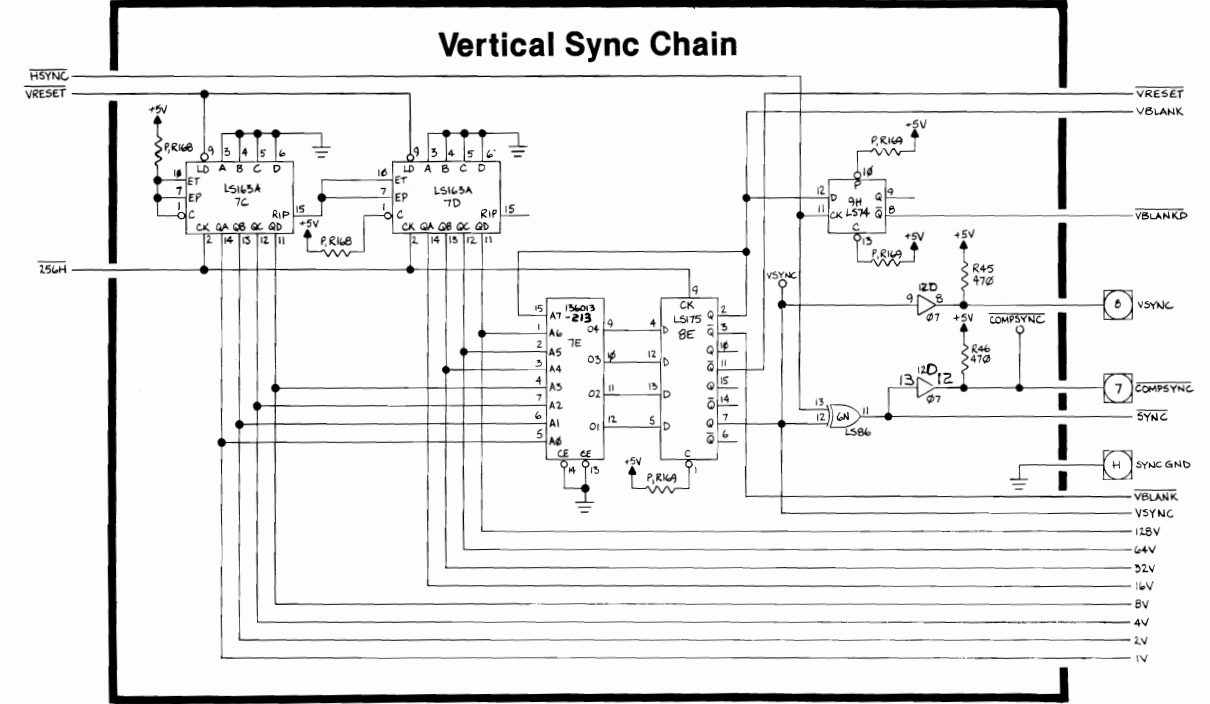
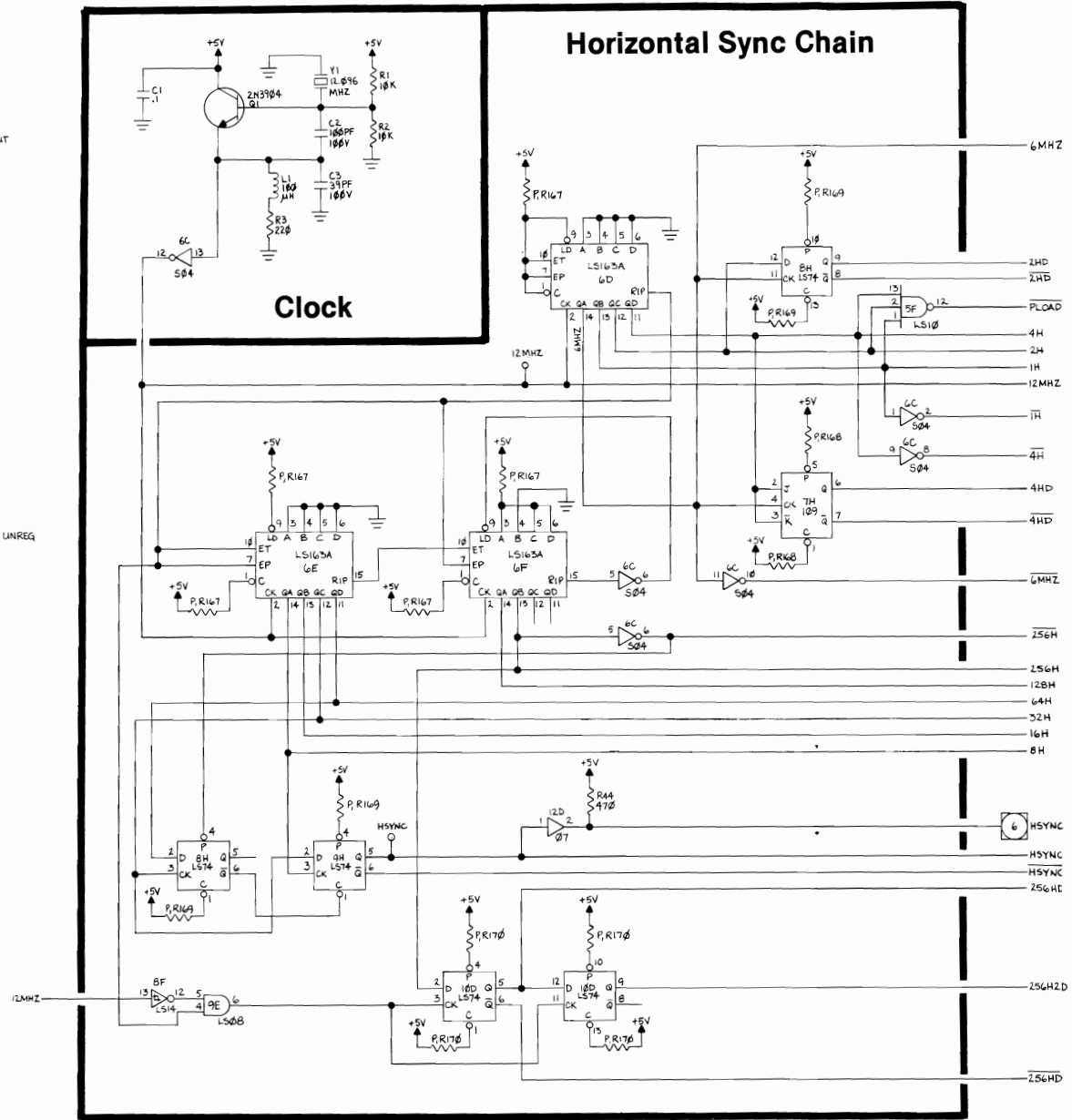
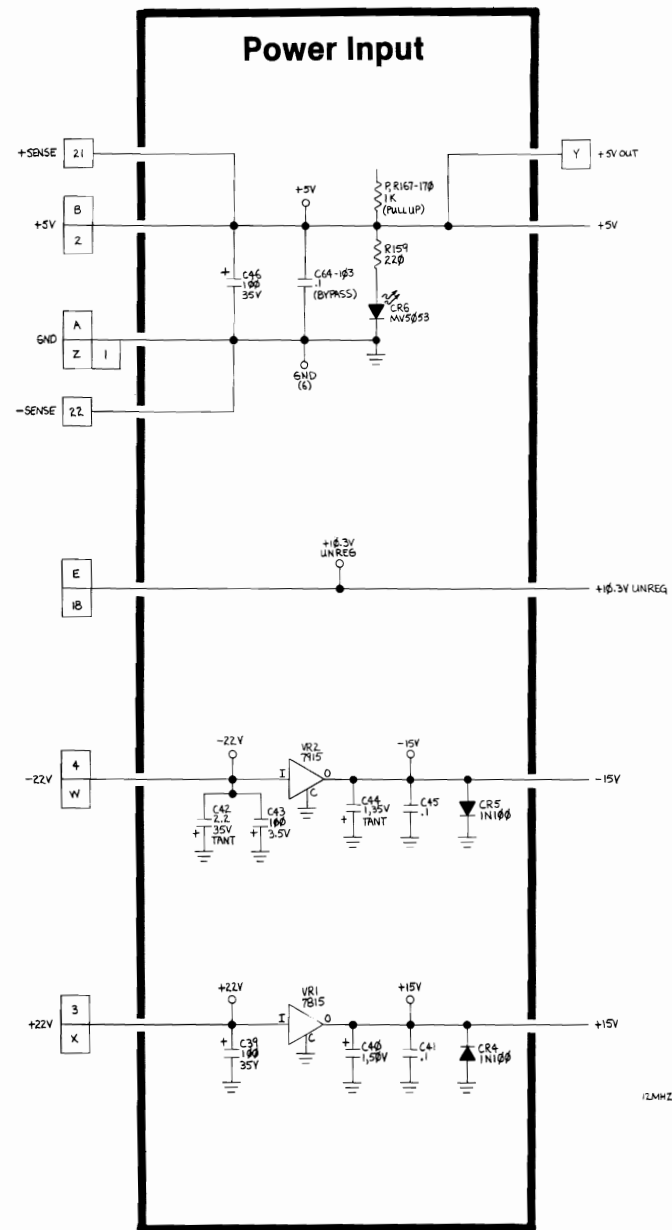


PCB test connector pad



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Millipede™ Memory Map and Schematic Notes

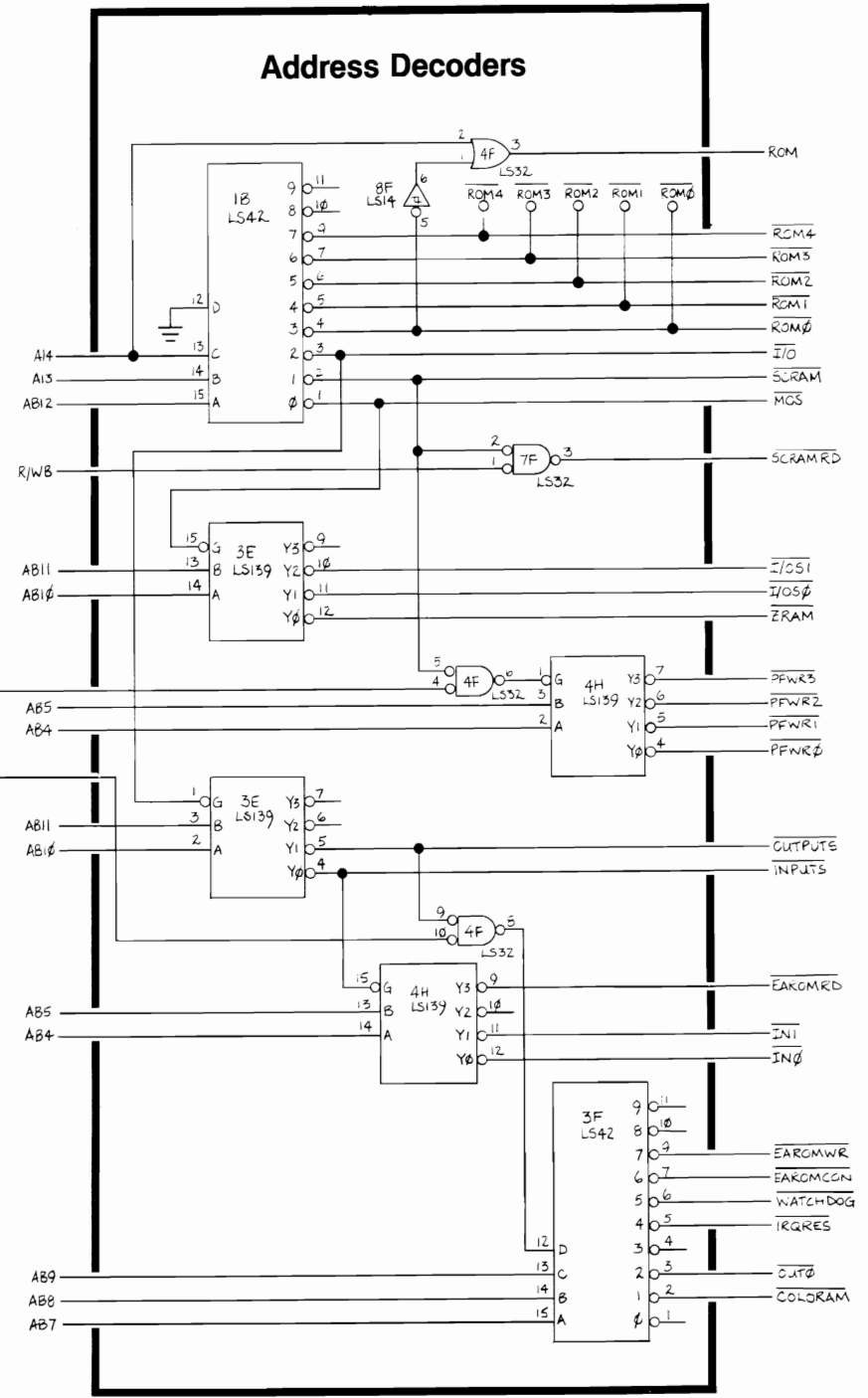
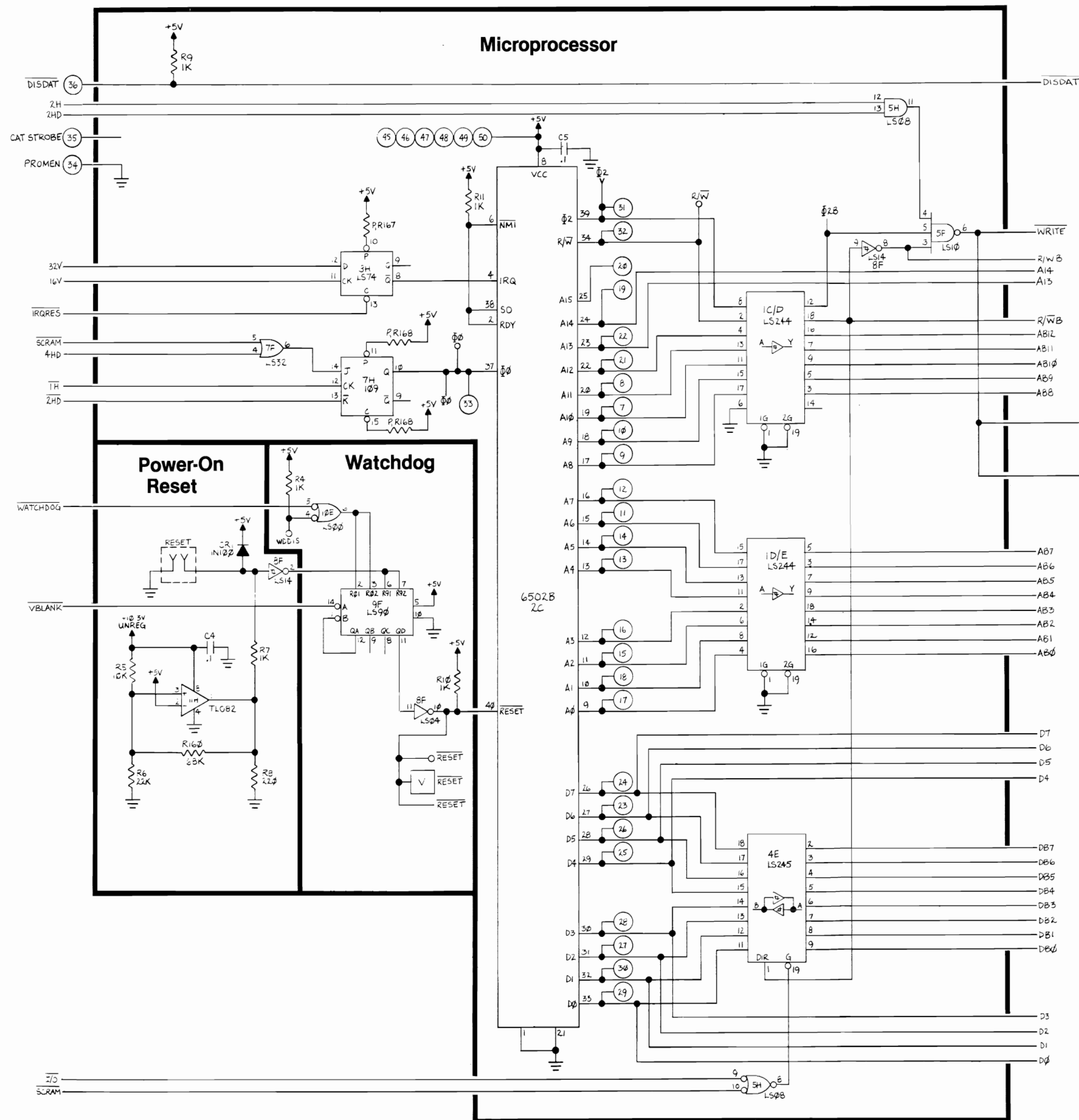



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Millipede™ PCB Schematic Diagram

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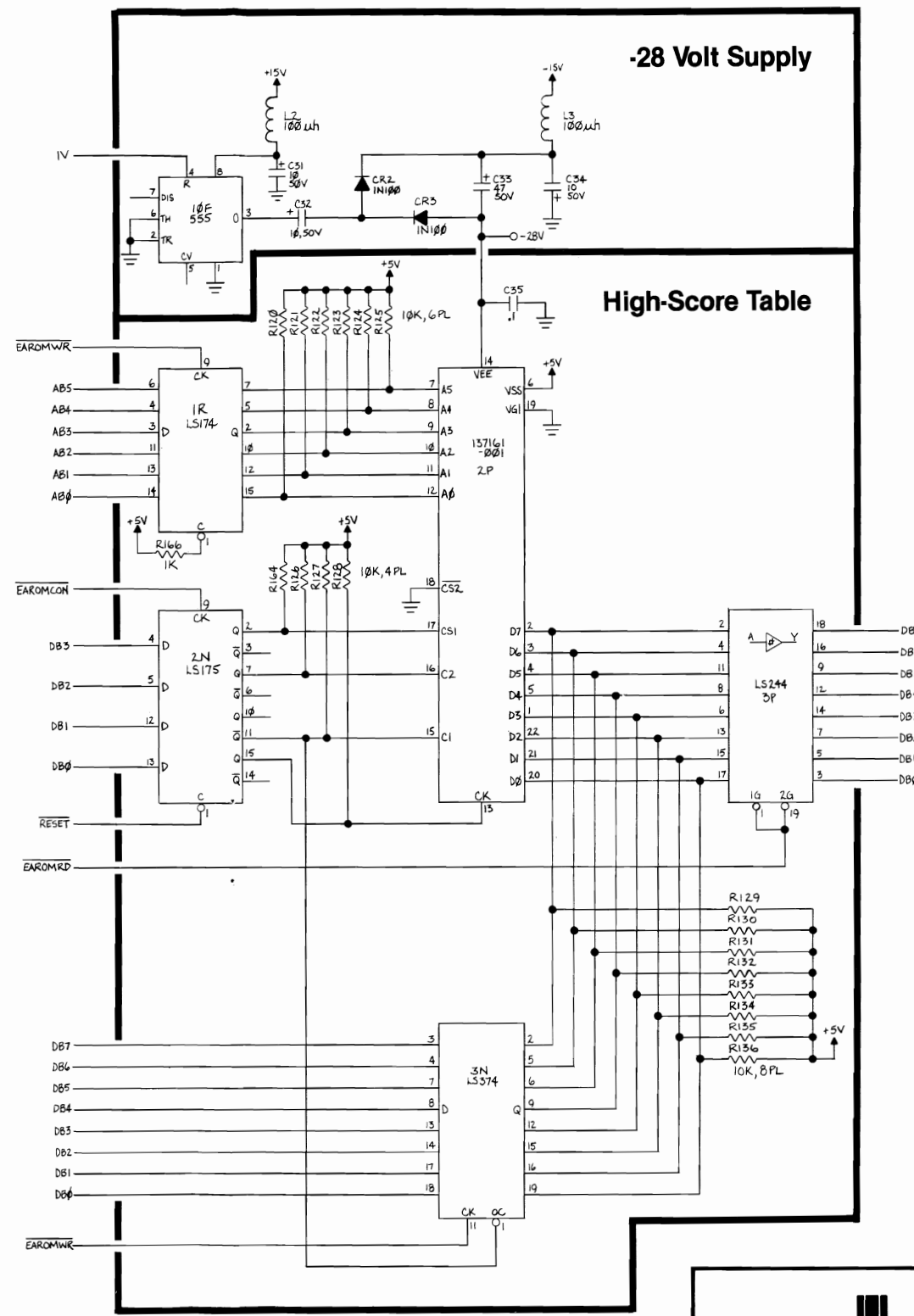
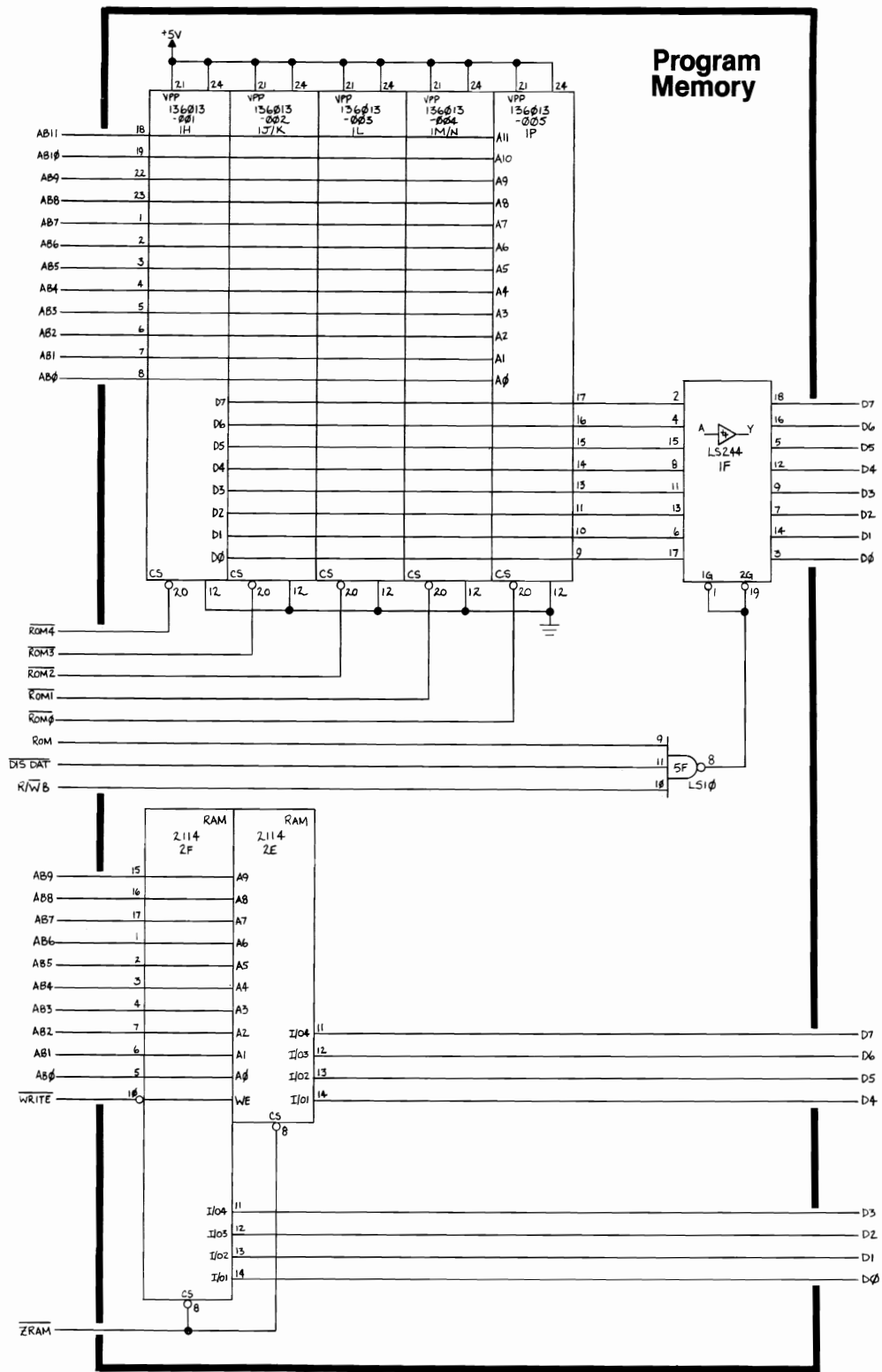

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Millipede™ PCB Schematic Diagram

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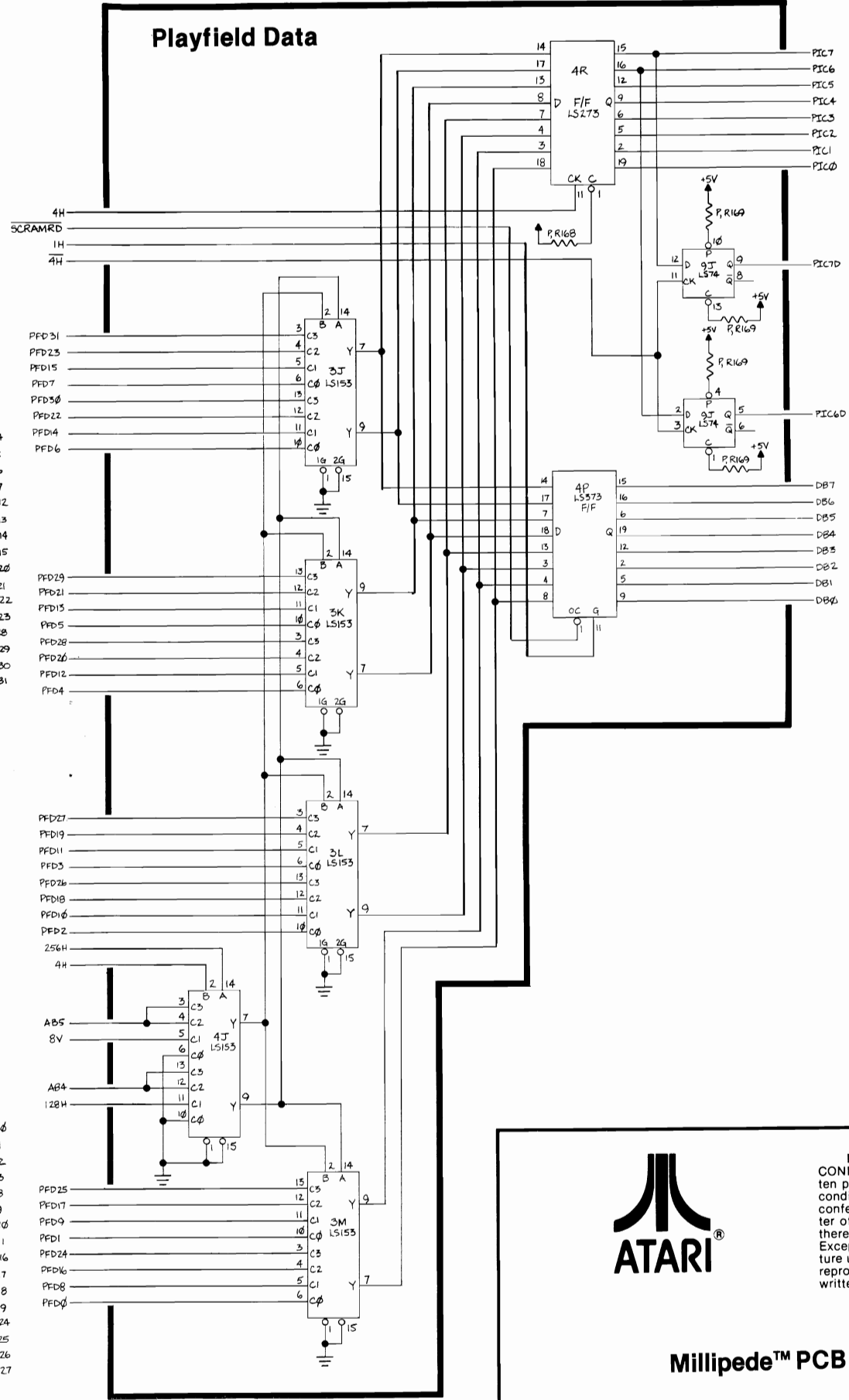
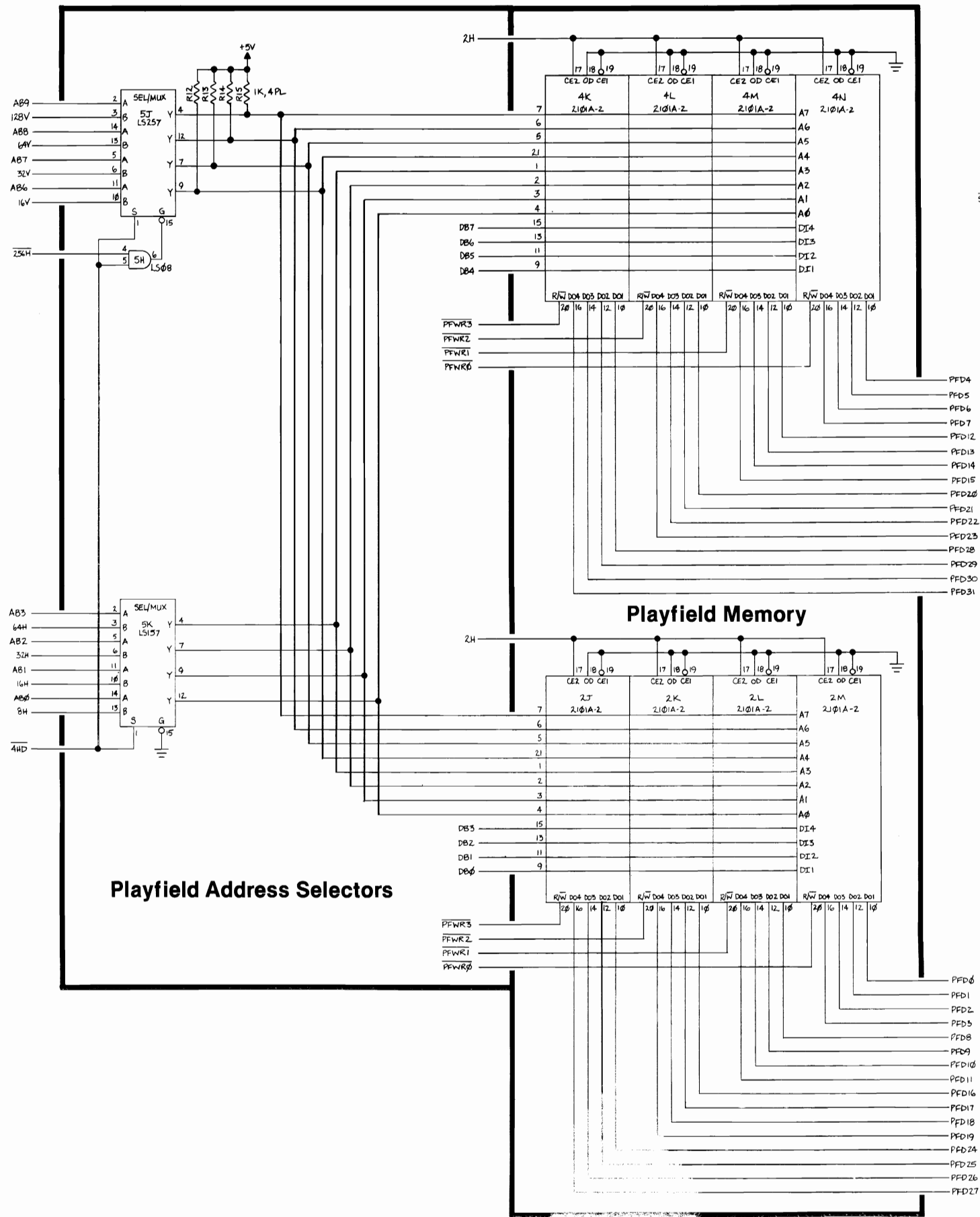




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Millipede™ PCB Schematic Diagram

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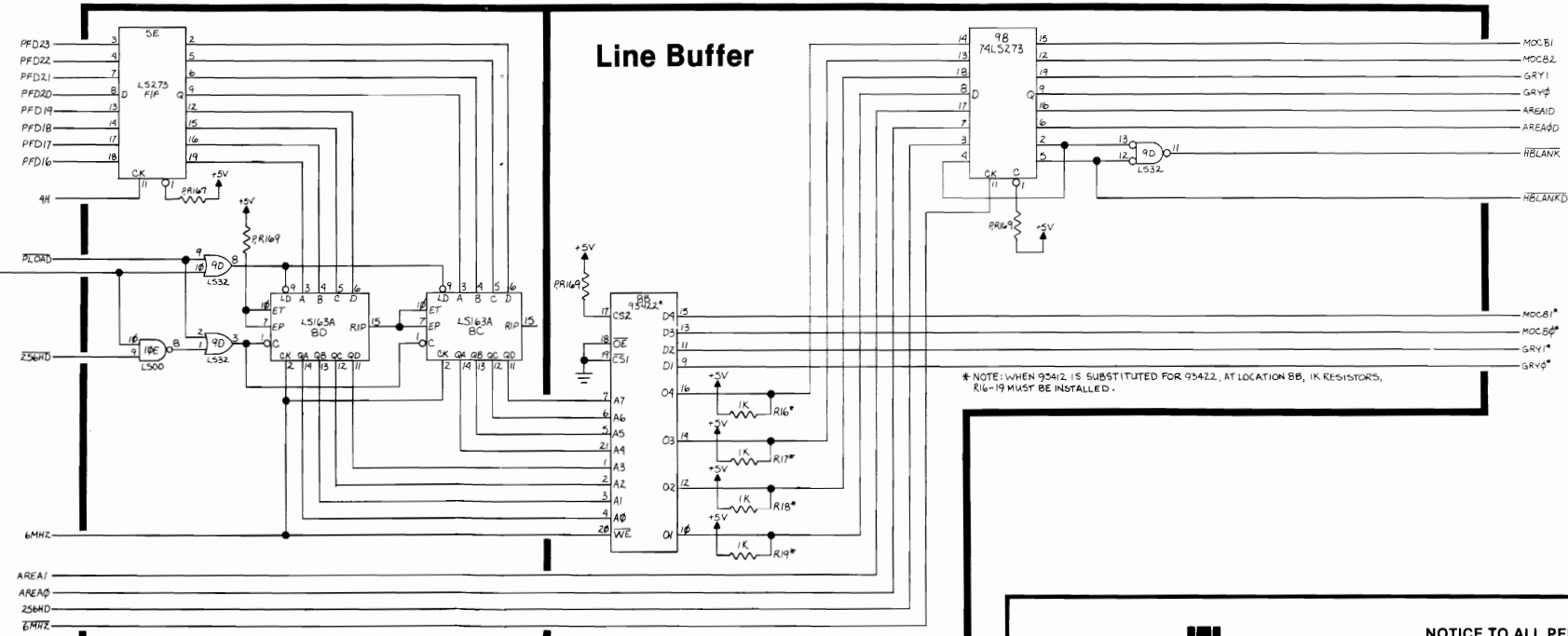
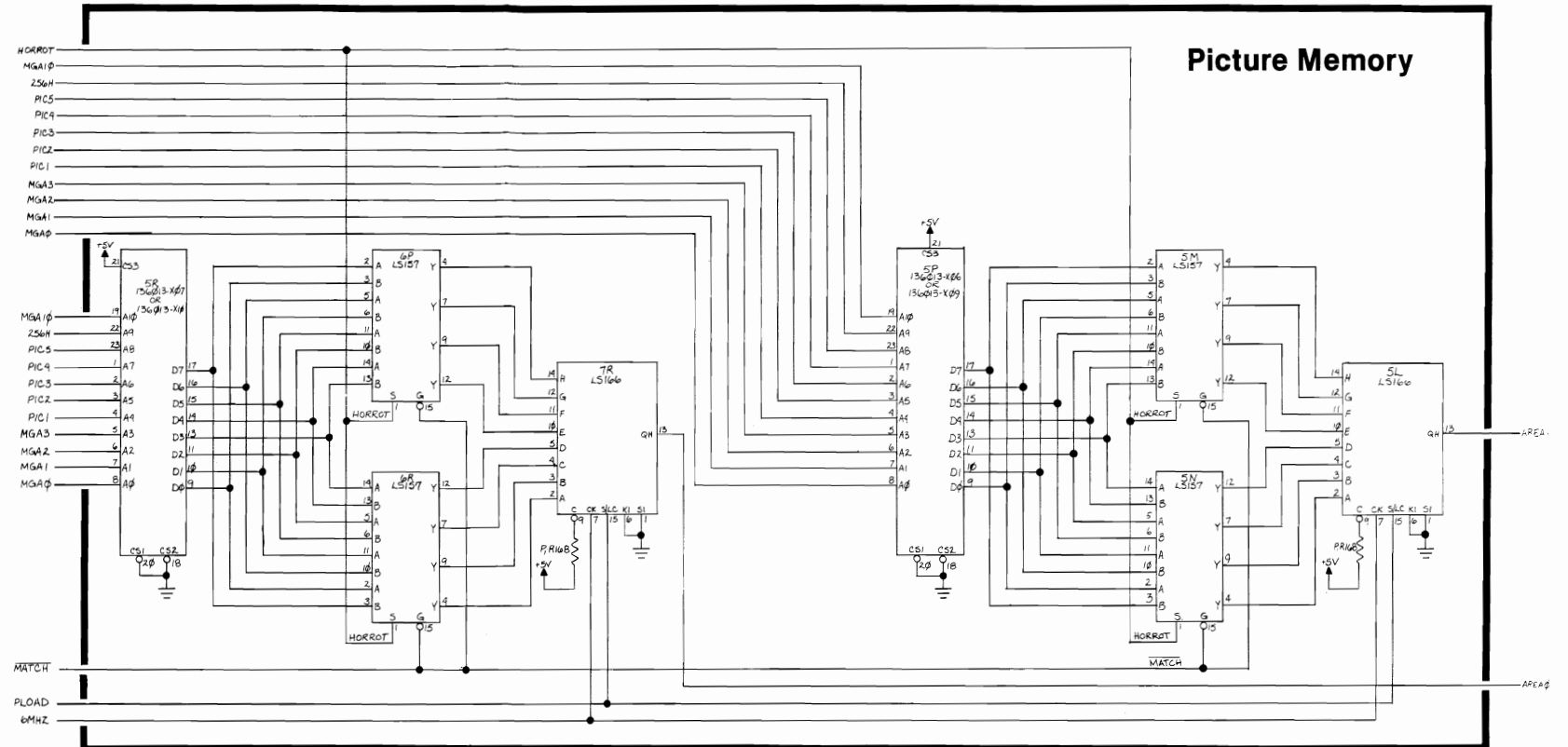
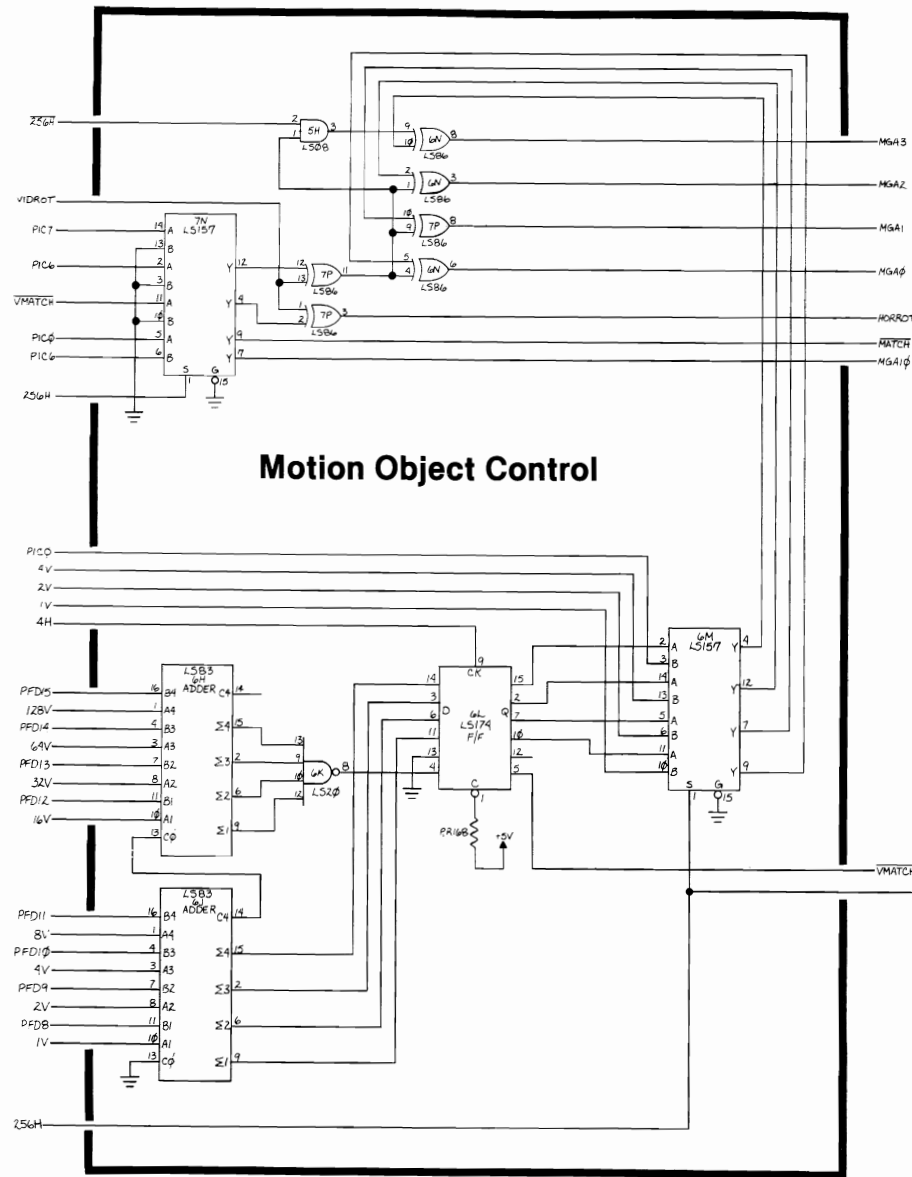



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Millipede™ PCB Schematic Diagram

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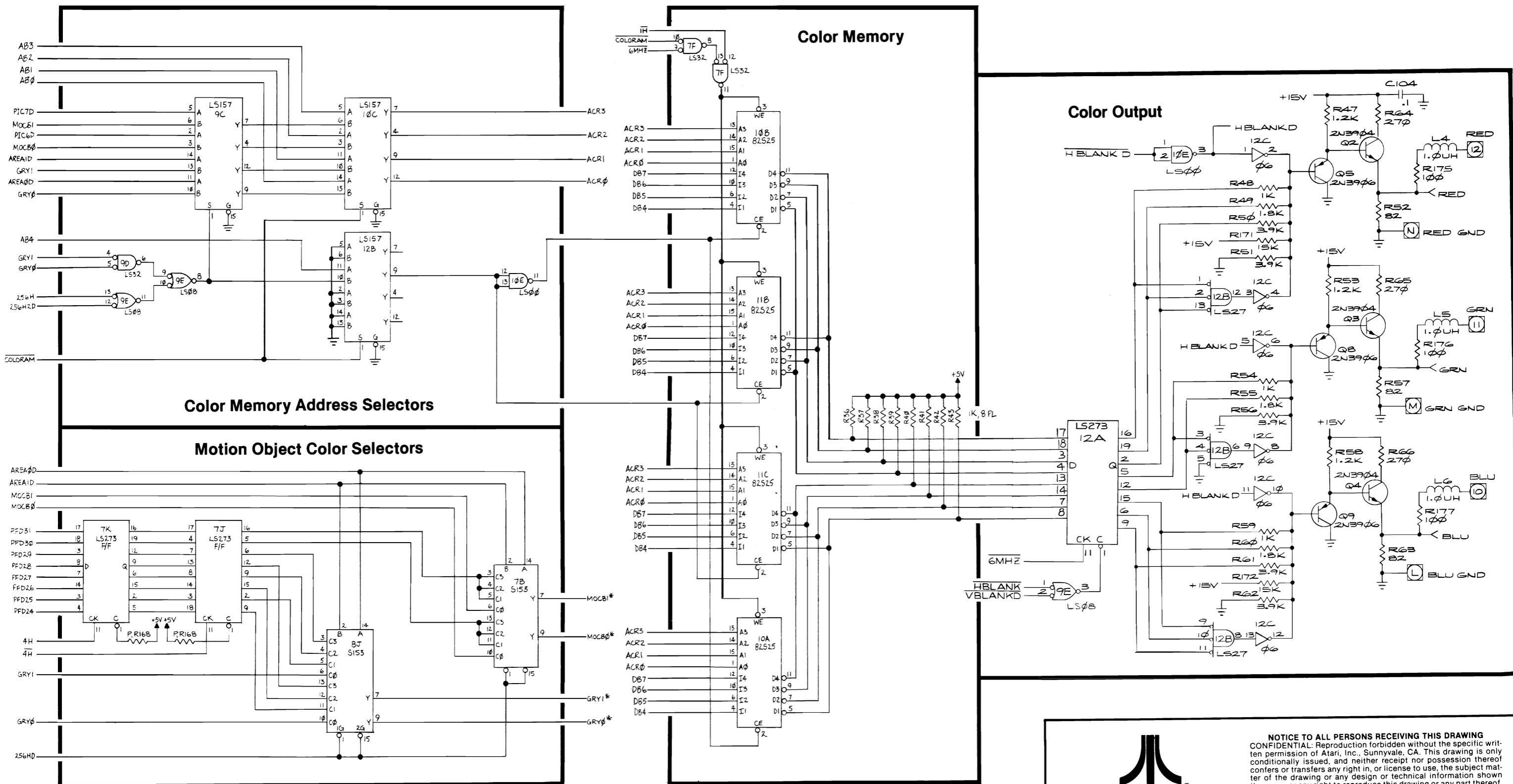


* NOTE: WHEN 9342 IS SUBSTITUTED FOR 93422, AT LOCATION BB, 1K RESISTORS, R16-19 MUST BE INSTALLED.



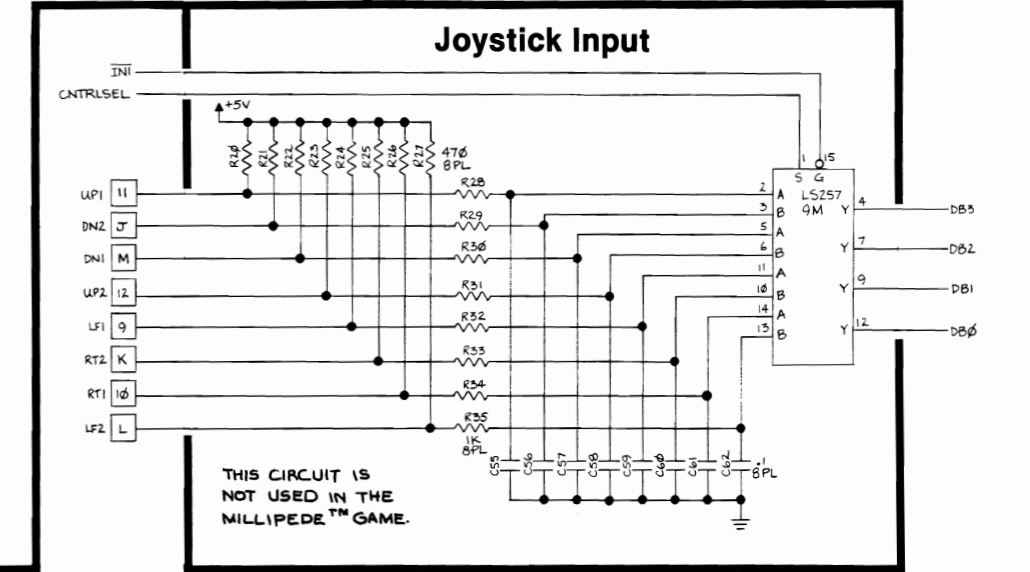
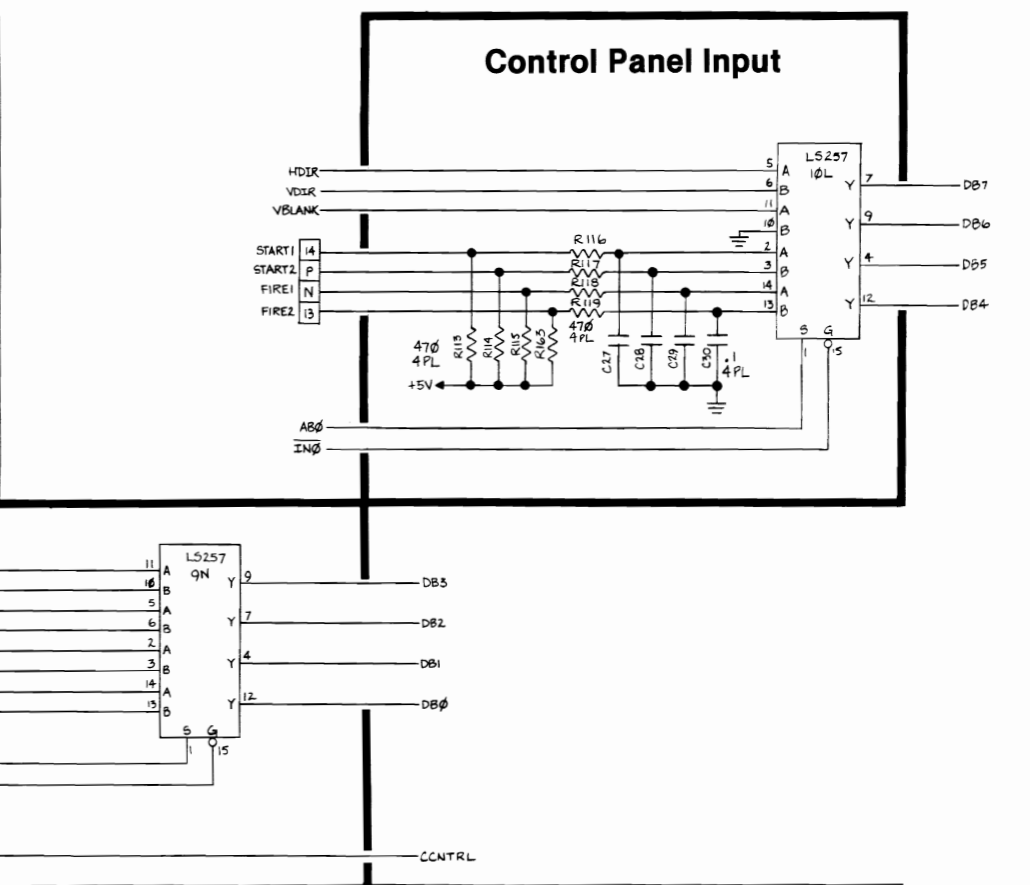
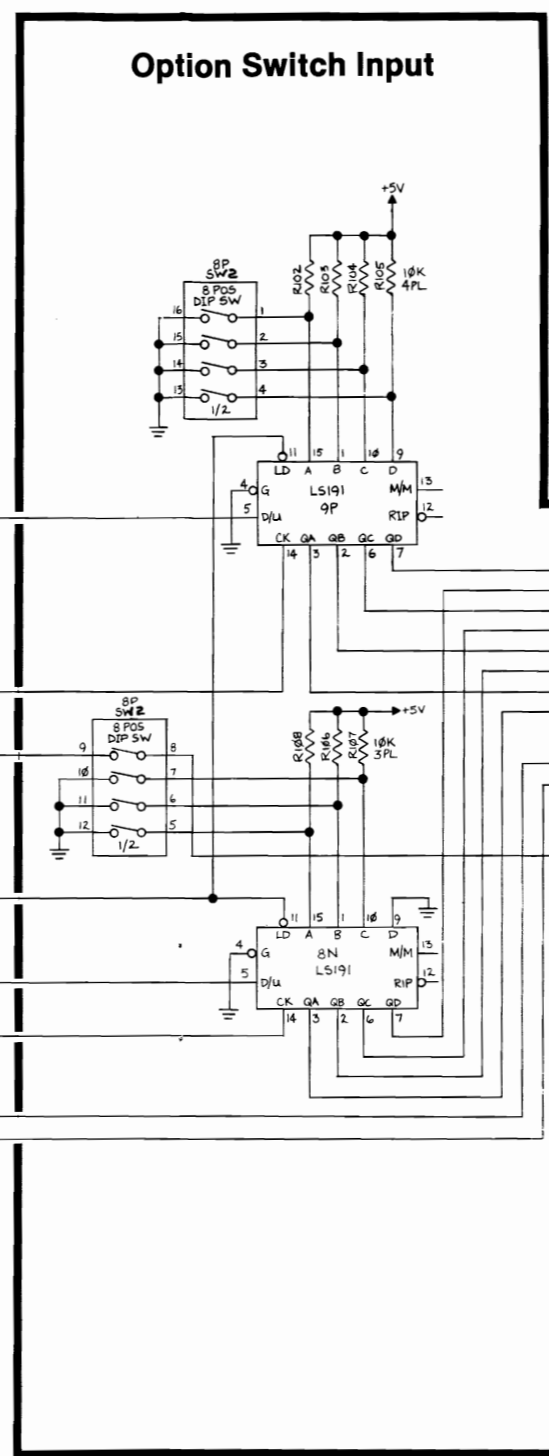
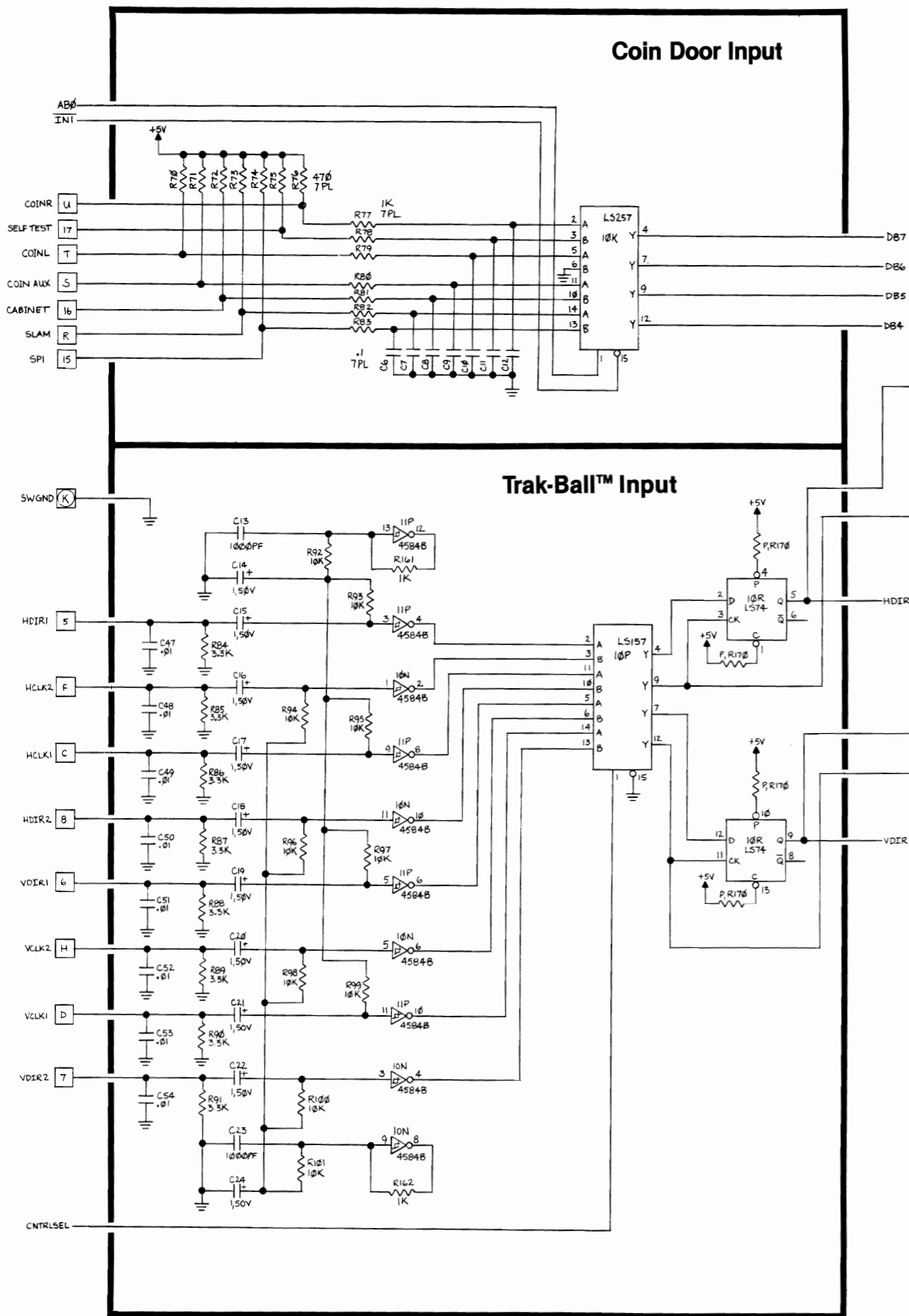
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Millipede™ PCB Schematic Diagram



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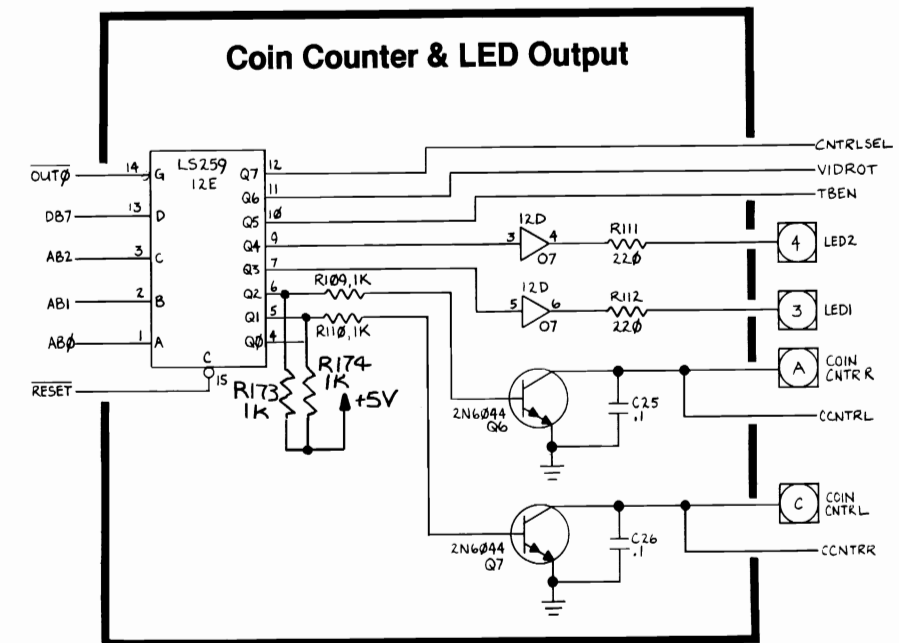
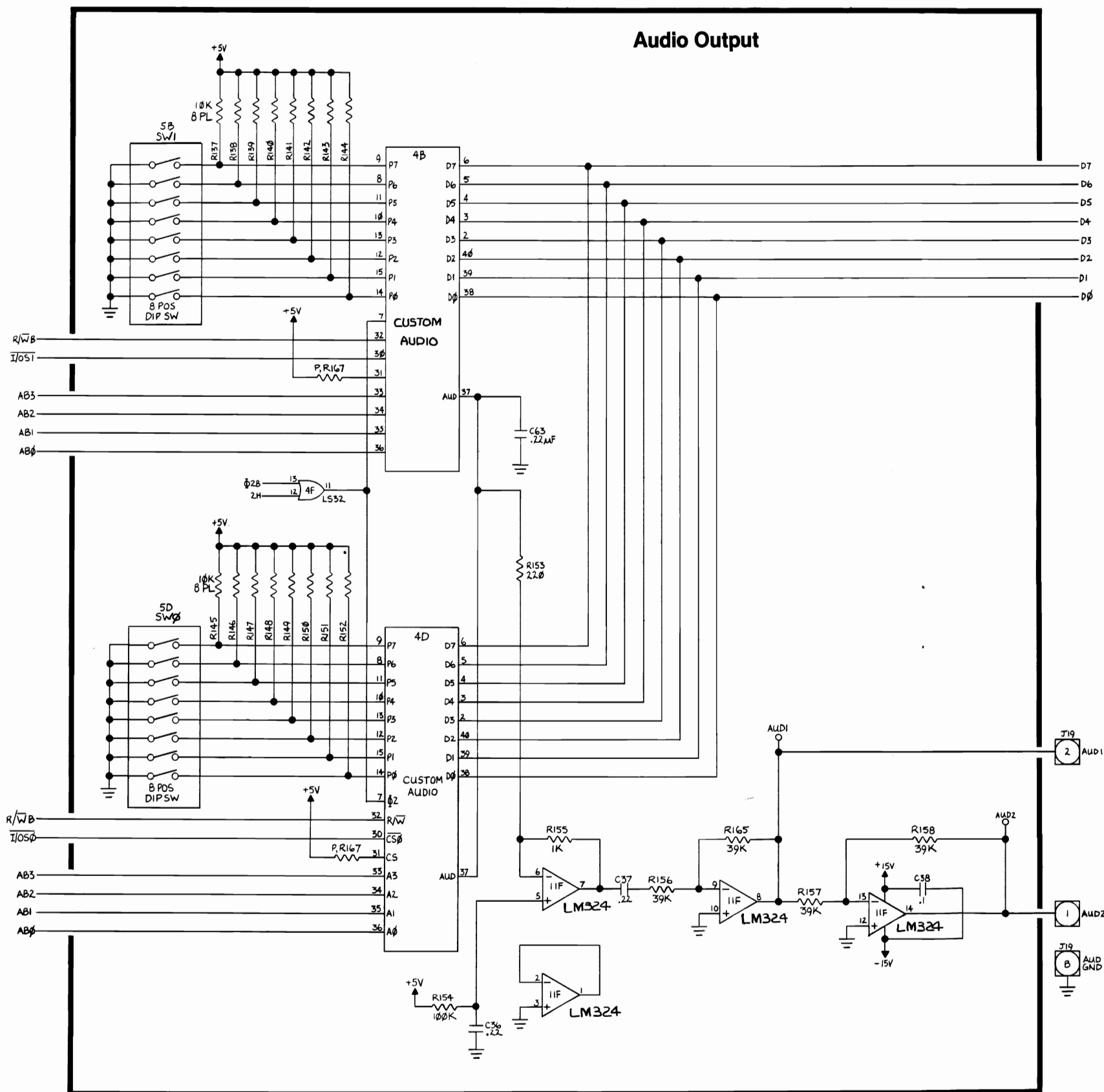
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Millipede™ PCB Schematic Diagram

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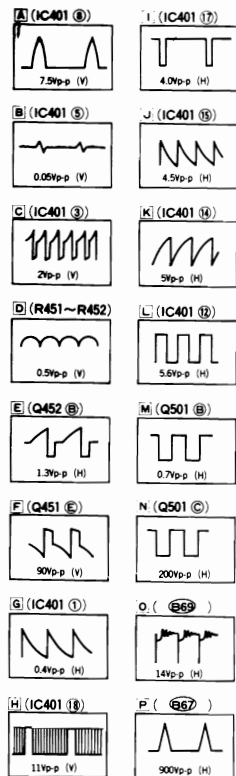
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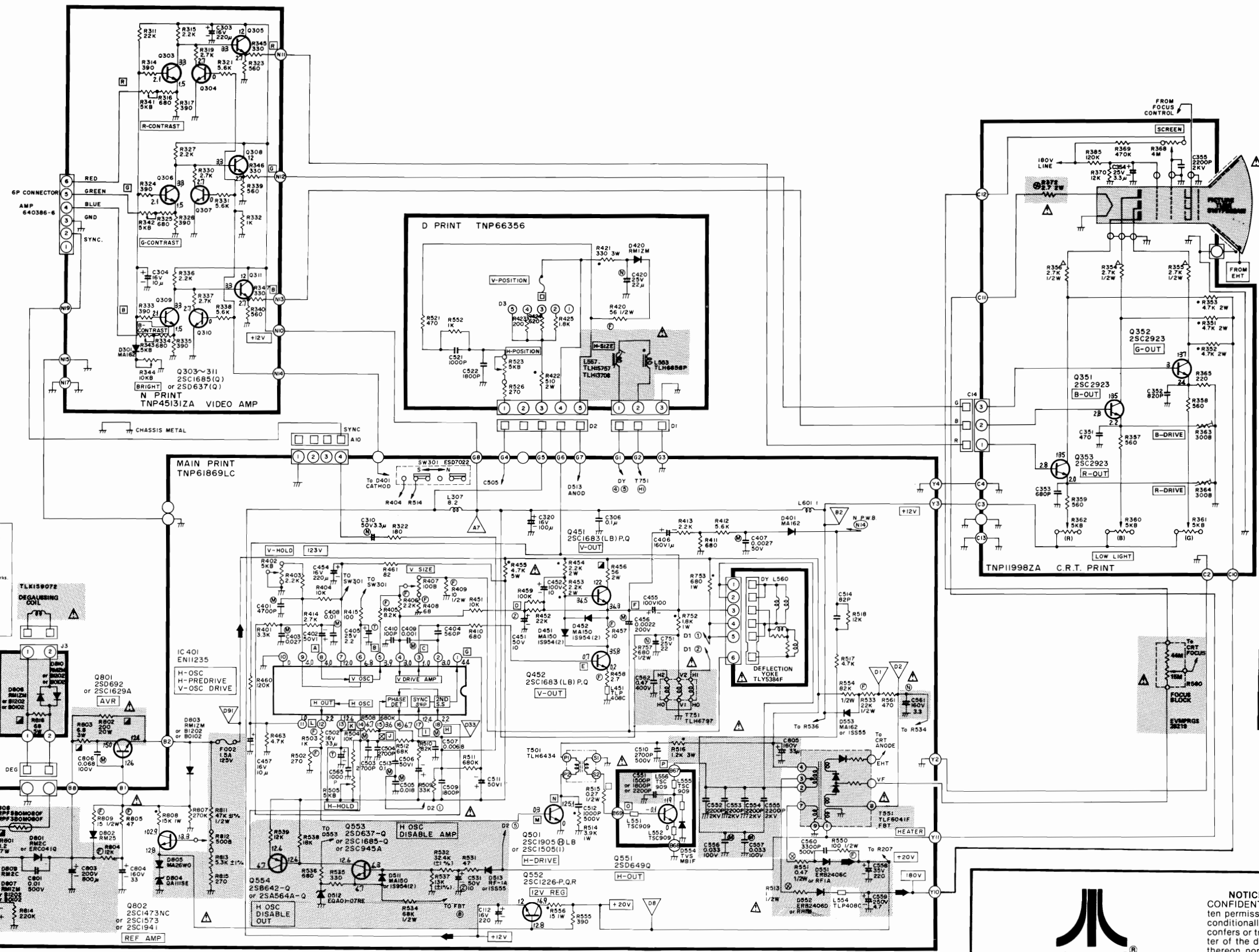
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Waveform



- NOTE**
- RESISTOR**
All resistors are carbon 1/4W resistor, unless otherwise noted the following marks:
Unit of resistance is OHM (Ω), K = 1,000, M = 1,000,000.
□ Solid
▨ Wire Wound
⊕ Non-Flammable
⊖ Cement
 - CAPACITOR**
All capacitors are ceramic 50V capacitor, unless otherwise noted the following marks:
Unit of capacitance is μF, unless otherwise noted.
⊖ Electrolytic
⊕ Safety Vent
⊙ Trimmer
⊚ Z type
⊛ Diprod Tantulum
⊜ Cement
 - COIL**
Unit of inductance is μH.
 - TEST POINT**
Y Test point position



WARNING
Components identified by shading have special characteristics important to safety and must be replaced only with identical parts.

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Matsushita Display Schematic Diagram

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Electrohome 19-Inch Color Raster-Scan Video Display Schematic Diagram

Schematic Notes

Unless otherwise specified

Resistance: (Ω) (K→KΩ, M→MΩ), 1/4 (W) carbon resistor

Capacitance: 1 or higher→ (pF), less than 1→ (μF)

working voltage→ 50 (V)

ceramic capacitor

Inductance: (μH)

Electrolytic Cap: Capacitance Value (μF)/working voltage (V),
NP → non-polar (or bipolar) electrolytic cap.

Refer to the parts list for additional component information.

⊕ indicates test point connection

⏏ indicates chassis ground unless otherwise specified

Hz indicates cycles per second

For **safety** purposes (and continuing reliability)

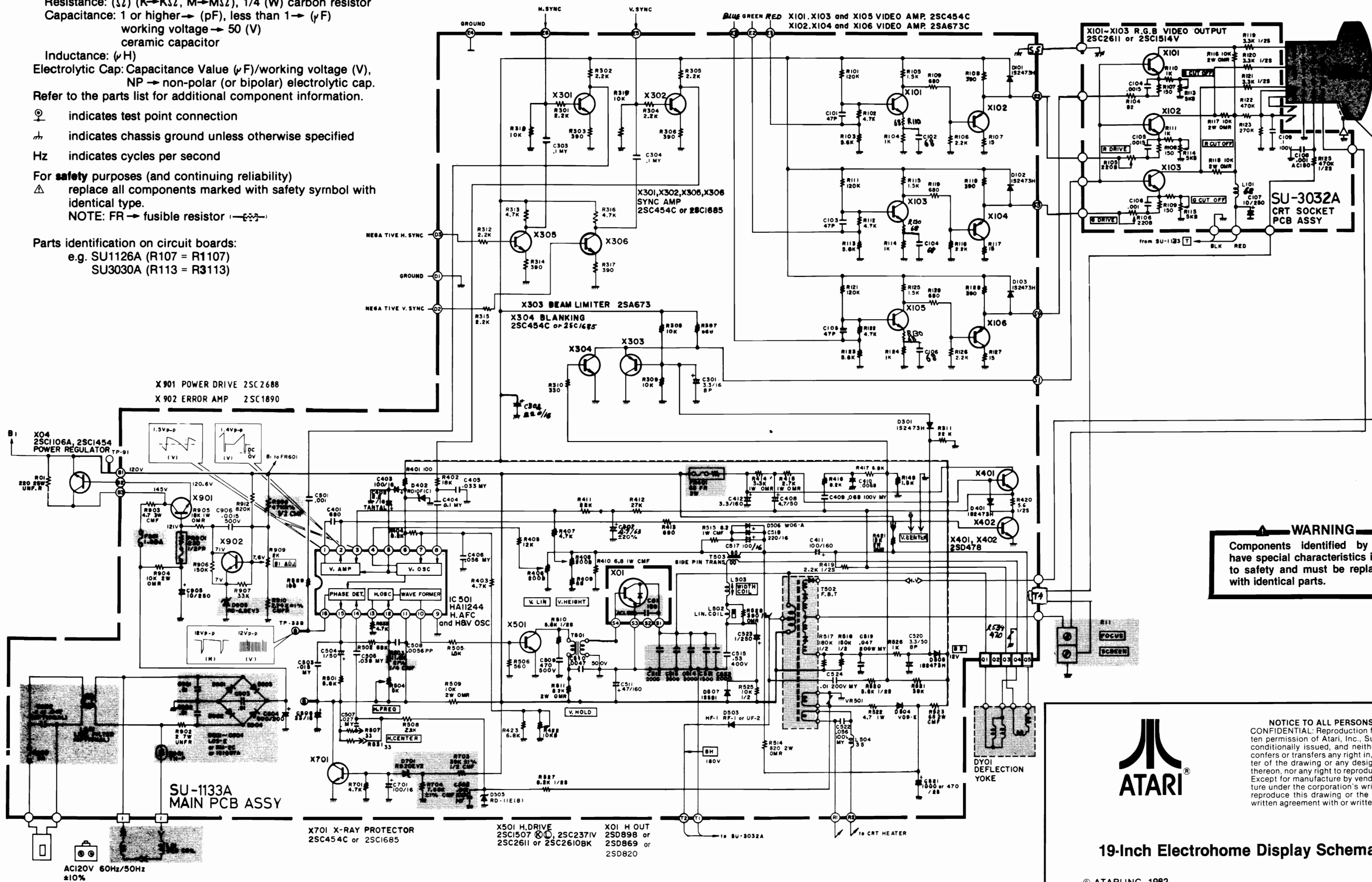
⚠ replace all components marked with safety symbol with identical type.

NOTE: FR → fusible resistor

Parts identification on circuit boards:

e.g. SU1126A (R107 = R1107)

SU3030A (R113 = R3113)



WARNING
Components identified by shading have special characteristics important to safety and must be replaced only with identical parts.

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19-Inch Electrohome Display Schematic Diagram

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AC120V 60Hz/50Hz
±10%

SU-1133A
MAIN PCB ASSY

X701 X-RAY PROTECTOR
2SC454C or 2SC1685

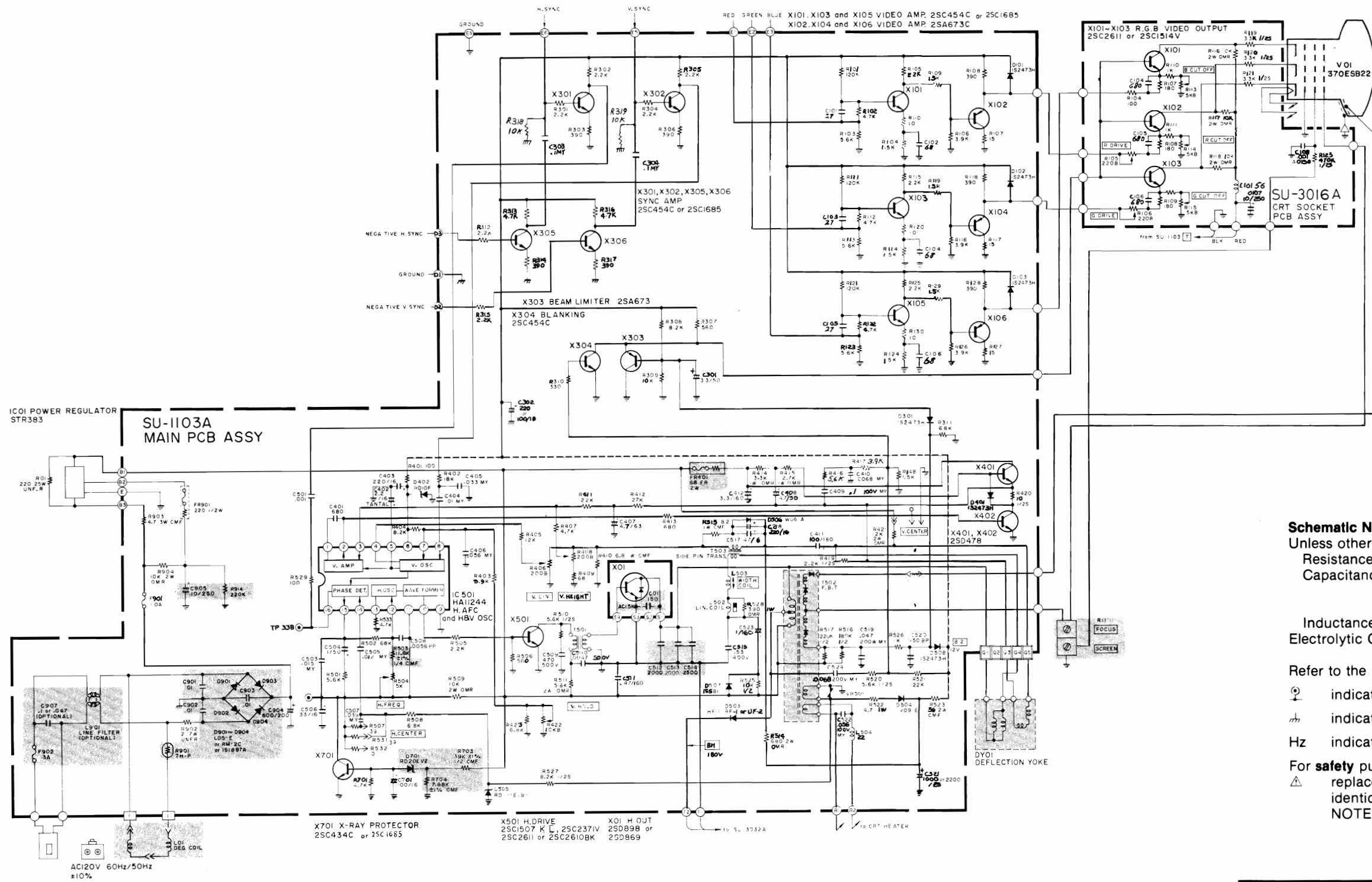
X501 H.DRIVE
2SC1507, 2SC237IV
2SC2611 or 2SC2610BK

X01 H OUT
2SD898 or
2SD869 or
2SD820

19-Inch Electrohome Display Schematic Diagram

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Schematic Notes

- Unless otherwise specified
- Resistance: (Ω) (K \rightarrow K Ω , M \rightarrow M Ω), 1/4 (W) carbon resistor
- Capacitance: 1 or higher \rightarrow (pF), less than 1 \rightarrow (μ F)
- working voltage \rightarrow 50 (V)
- ceramic capacitor
- Inductance: (μ H)
- Electrolytic Cap: Capacitance Value (μ F)/working voltage (V), NP \rightarrow non-polar (or bipolar) electrolytic cap.
- Refer to the parts list for additional component information.
- \odot indicates test point connection
- \perp indicates chassis ground unless otherwise specified
- Hz indicates cycles per second
- For **safety** purposes (and continuing reliability)
- \triangle replace all components marked with safety symbol with identical type.
- NOTE: FR \rightarrow fusible resistor



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14-Inch Electrohome Display Schematic Diagram

Millipede™ Troubleshooting with the CAT Box

Troubleshooting with the Read/Write Controller

A. CAT Box Preliminary Set-Up

1. Remove the electrical power from the game and the CAT Box.
2. Remove the game PCB from the game cabinet.
3. Remove Microprocessor 2C from the game PCB.
4. Connect the harness from the game to the game PCB.
5. Connect together the $\Phi 0$ and $\Phi 2$ test points on the game PCB with the shortest possible jumper.
6. Connect the \overline{WDDIS} test point to ground.
7. Connect the CAT Box flex cable to the game PCB edge test connector.
8. Apply power to the game and to the CAT Box.
9. Set CAT Box switches as indicated:
 - a. TESTER SELF-TEST: OFF
 - b. TESTER MODE: R/W
10. Press TESTER RESET.
11. Connect the DATA PROBE to the CAT Box. Connect the DATA PROBE ground clip to a game PCB ground test point.

B. Checking the Address Lines

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
 - a. BYTES: 1
 - b. PULSE MODE: UNLATCHED
 - c. R/W MODE: (OFF)
 - d. R/W: READ
3. Key in the address pattern given in Table 1 (*use AAAA to start*) with the CAT Box keyboard.
4. Set R/W MODE to STATIC.
5. Probe the IC-pin with the DATA PROBE and check that the 1 or 0 LED indicated in Table 1 lights up. Repeat this step for each address line listed in Table 1.
6. Repeat parts 2-c through 5 using address 5555.

Table 1 Address Lines

Logic State For Address AAAA	IC-Pin	Logic State For Address 5555
1	2C-25	0
0	1B-13	1
1	1B-14	0
0	1C/D-16	1
1	1C/D-7	0
0	1C/D-9	1
1	1C/D-5	0
0	1C/D-3	1
1	1D/E-5	0
0	1D/E-3	1
1	1D/E-7	0
0	1D/E-9	1
1	1D/E-18	0
0	1D/E-14	1
1	1D/E-12	0
0	1D/E-16	1

C. Checking the Data Lines

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
 - a. BYTES:1
 - b. R/W MODE: (OFF)
 - c. R/W: WRITE
3. Key in address 0000 with the keyboard.
4. Press DATA SET. Key in data AA with the keyboard.
5. Set R/W MODE to STATIC.
6. Probe the IC-pin with the DATA PROBE and check that the 1 or 0 LED indicated in Table 2 lights up. Repeat this check for each IC-pin in Table 2.
7. Set R/W MODE to (OFF).
8. Repeat parts 4 through 6 using data 55 in part 4.

Table 2 Data Lines

Logic State For Data AA	IC-Pin	Logic State For Data 55
1	4E-18	0
0	4E-17	1
1	4E-16	0
0	4E-15	1
1	4E-14	0
0	4E-13	1
1	4E-12	0
0	4E-11	1
1	4E-2	0
0	4E-3	1
1	4E-4	0
0	4E-5	1
1	4E-6	0
0	4E-7	1
1	4E-8	0
0	4E-9	1

D. Checking the RAM

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
 - a. DBUS SOURCE: ADDR
 - b. BYTES:1024
 - c. R/W MODE: (OFF)
 - d. R/W: WRITE
3. Enter address 0000 with the keyboard.
4. Set the CAT Box switches as indicated:
 - a. R/W MODE to PULSE and back to (OFF)
 - b. R/W to READ
 - c. R/W MODE to PULSE and back to (OFF)
5. If the CAT Box reads an address that doesn't compare with that written, the COMPARE ERROR LED will light up. The ADDRESS/SIGNATURE display of the CAT Box will show the failing address location and the ERROR DATA DISPLAY switch is enabled. Using this switch, determine if the error is in the high-order or low-order RAM.
6. Repeat this test with DBUS SOURCE set to \overline{ADDR} .
7. Set the CAT Box switches as indicated:
 - a. BYTES: 256
 - b. DBUS SOURCE: ADDR
 - c. R/W MODE: (OFF)
 - d. R/W: WRITE
8. Repeat parts 5 through 6 using addresses 1000, 1100, 1200, and 1300.



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Millipede™ PCB Troubleshooting Procedures

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E. Checking the Custom Audio I/O Chips

NOTE

Millipede has two custom audio I/O chips. Each must be tested separately. There are several ways to test these chips:

- Perform the self-test.
- Substitute a known good part for a suspected defective part.
- Use the following procedure.

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
 - a. BYTES: 1
 - b. R/W: WRITE
 - c. R/W MODE: (OFF)
3. Enter the address from Table 3 with the keyboard.
4. Press DATA SET and enter the data from Table 3 with the keyboard.
5. Set R/W MODE to PULSE and back to (OFF).
6. Repeat parts 3 through 5 for each address and data listed in Table 3. Check for the response indicated.

Table 3 Custom Audio I/O Chips

Address	Data	Test Results
040F	00	Custom Audio I/O Chip 4D channel 1 produces pure tone.
040F	03	
0400	55	
0401	AF	
0401	00	Custom Audio I/O Chip 4D channel 1 turns off.
0402	55	Custom Audio I/O Chip 4D channel 2 produces pure tone.
0403	AF	
0403	00	Custom Audio I/O Chip 4D channel 2 turns off.
080F	00	Custom Audio I/O Chip 4B channel 1 produces pure tone.
080F	03	
0800	55	
0801	AF	
0801	00	Custom Audio I/O Chip 4B channel 1 off.
0802	55	Custom Audio I/O Chip 4B channel 2 produces pure tone.
0803	AF	
0803	00	Custom Audio I/O Chip 4B channel 2 off.

Table 4 Player Switches, Option Switches, and Trak-Ball™ Inputs

Entry	Address	Data	Input Switch/Signals	Test Results
1	2507	00	Option Switch 0 Toggles 1-4, Trak-Ball™ 1 HDIR, FIRE1, VBLANK, START1	DATA display changes when any of these switches or signals is activated.
	2000			
2	2001	FF	Option Switch 0 Toggles 5-8, Trak-Ball™ 1 VDIR, FIRE2, START2	DATA display changes when any of these switches or signals is activated.
	2010		Left Coin Switch, Right Coin Switch, Auxillary Coin Switch, SLAM	
	2011		Self-Test Switch, CABINET	
3	2505	FF	Trak-Ball™ 1 HCOUNT and HDIR, VBLANK, START1, FIRE1	DATA display changes when any of these switches or signals is activated.
	2000		Trak-Ball™ 1 VCOUNT and VDIR, START2, FIRE2	
	2001		Trak-Ball™ 2 HCOUNT and HDIR, VBLANK, START1, FIRE1	
3	2507	FF	Trak-Ball™ 2 VCOUNT and VDIR, START2, FIRE2	DATA display changes when any of these switches or signals is activated.
	2000			
	2001			

F. Checking the Player Switch, Option Switch, and Trak-Ball™ Inputs

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
 - a. BYTES: 1
 - b. R/W: WRITE
 - c. R/W MODE: (OFF)
3. Enter address 2505 with the keyboard.
4. Press DATA SET and enter data 00 with the keyboard.
5. Set R/W MODE to PULSE and back to (OFF).
6. For each entry listed in Table 4, do the following:
 - a. Set R/W MODE to (OFF).
 - b. Set R/W to WRITE.
 - c. Enter the first address with the keyboard.
 - d. Press DATA SET and enter the data for that address with the keyboard.
 - e. Set R/W MODE to PULSE and back to (OFF).
 - f. Set R/W to READ.
 - g. Enter the next address.
 - h. Set R/W MODE to STATIC.
 - i. Activate the input switch or signal indicated in Table 4 and check the test result.
 - j. Set R/W MODE to (OFF).
 - k. Repeat parts g through j for each subsequent address given for the entry.



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Millipede™ PCB Troubleshooting Procedures

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G. Checking the LED, Coin Counter, and Video Rotate Outputs

1. Perform the CAT Box preliminary set-up.
2. Set CAT Box switches as indicated:
 - a. DBUS SOURCE: DATA
 - b. BYTES: 1
 - c. R/W: WRITE
 - d. R/W MODE: (OFF)
3. Enter the address in Table 5 with the keyboard.

CAUTION

If you write ON data to activate a solenoid, deactivate the solenoid immediately by writing the OFF data. If you leave a solenoid activated for more than 10 seconds, you may have to replace the solenoid and/or its driver, due to overheating.

4. For each address listed in Table 5, do the following:
 - a. To activate the output:
 - Press DATA SET.
 - Enter the ON data with the keyboard.
 - Set R/W MODE to STATIC and back to (OFF).
 - b. To deactivate the output:
 - Press DATA SET.
 - Enter the OFF data with the keyboard.
 - Set R/W MODE to STATIC and back to (OFF).

Table 5 LED and Coin Counter Outputs

Address	On Data	Off Data	Output Device
2501	FF	00	Left Coin Counter
2502	FF	00	Right Coin Counter
2503	00	FF	Player 1 LED
2504	00	FF	Player 2 LED
2506	FF	00	VIDROT

Troubleshooting with Signature Analysis

A. Checking the Address Bus

1. Perform the CAT Box preliminary set-up.
2. Connect the three BNC-to-EZ clip cables supplied with the CAT Box to the SIGNATURE ANALYSIS CONTROL START, STOP, and CLOCK jacks of the CAT Box.
3. Connect the three black EZ clips to a game PCB ground test point.

4. Set the CAT Box switches as indicated:
 - a. TESTER MODE: SIG
 - b. TESTER SELF-TEST: OFF
 - c. PULSE MODE: LATCHED
 - d. START: Negative-going edge trigger
 - e. STOP: Negative-going edge trigger
 - f. CLOCK: Negative-going edge trigger
5. Press TESTER RESET on the CAT Box.
6. Connect the CAT Box Signature Analysis probe tips as indicated:
 - a. START: Pin 25 of Microprocessor 2C
 - b. STOP: Pin 25 of Microprocessor 2C
 - c. CLOCK: ϕ 2 test point
7. Verify the set-up connections by connecting the DATA PROBE to a game PCB ground test point. The CAT Box ADDRESS/SIGNATURE display should show 0000. Now connect the DATA PROBE to a +5V test point. The ADDRESS/SIGNATURE display should show 0001.
8. Probe the IC-pin listed in Table 6 with the DATA PROBE and check for the signature indicated. Repeat this check for each IC-pin listed.

NOTE

To avoid faulty readings while performing these troubleshooting tests, take care NOT to short-circuit two or more IC pins with the CAT Box DATA PROBE. Should this accidentally occur, you must start the test again.

Table 6 Address Bus Signatures

IC-Pin	Signal Name	Signature
1D/E-16	AB0	UUUU
1D/E-12	AB1	5555
1D/E-14	AB2	CCCC
1D/E-18	AB3	7F7F
1D/E-9	AB4	5H21
1D/E-7	AB5	0AFA
1D/E-3	AB6	UPFH
1D/E-5	AB7	52F8
1C/D-3	AB8	HC89
1C/D-5	AB9	2H70
1C/D-9	AB10	HPP0
1C/D-7	AB11	1293
1C/D-16	AB12	HAP7
1B-14	A13	3C96
1B-13	A14	3827
2C-25	A15	755U

B. Checking the Address Decoders

1. Perform A. Checking the Address Bus.
2. Probe the IC-pin listed in Table 7 with the DATA PROBE and check for the signature indicated. Repeat this check for each IC-pin listed.

Table 7 Decoder Signatures

IC-PIN	Signal Name	Signature
1B-1	MOS	822A
1B-2	SCRAM	A169
1B-3	I/O	C5U3
1B-5	ROM1	ICFH
1B-6	ROM2	0319
1B-7	ROM3	U6U2
1B-9	ROM4	H601
3E-4	INPUTS	72P5
3E-5	OUTPUTS	062F
3E-10	I/O1	HCC5
3E-11	I/O0	9PPA
3E-12	ZRAM	9ACA
4F-3	ROM	96C0
4H-9	EAROMRD	61F3
4H-11	IN1	4696
4H-12	IN0	4H6H

Table 8 ROM Checksums

Address	Checksum
4000	CE95
5000	1203
6000	7A4B
7000	176F

Troubleshooting the Watchdog Circuit

The Watchdog circuit will send continuous reset pulses to the microprocessor if a problem exists within the microprocessor circuit. If the self-test fails to run, it is a good practice to check the RESET line.

RESET is a microprocessor input (pin 40). In a properly operating game, reset should occur during power-up or when the RESET test point is grounded. A pulsing RESET line indicates that something is causing the microprocessor to lose its place within the program. Typical causes are:

1. Open or shorted address or data bus lines.
2. Bad microprocessor chip.
3. Bad bus buffers.
4. Bad ROM.
5. Bad RAM.
6. Any bad input or output that causes an address or data line to be held in a constant high or low state.

A pulsing RESET signal indicates a problem exists somewhere within the microprocessor circuitry. To aid in troubleshooting, the WDDIS test point can be connected to a ground test point to prevent resets. This will sometimes allow the Self-Test to be used to diagnose the failure during a RESET condition.

Troubleshooting with Checksums

NOTE

This procedure can only be done with those CAT Boxes equipped with a Checksum Switch. While testing with checksums, adding 270 pF capacitors to A14 and A13 may be necessary.

1. Perform the CAT Box preliminary set-up.
2. Set the CAT Box switches as indicated:
 - a. BYTES: 256
 - b. DBUS SOURCE: DATA
 - c. R/W MODE: OFF
 - d. CHECKSUM SWITCH: ON



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