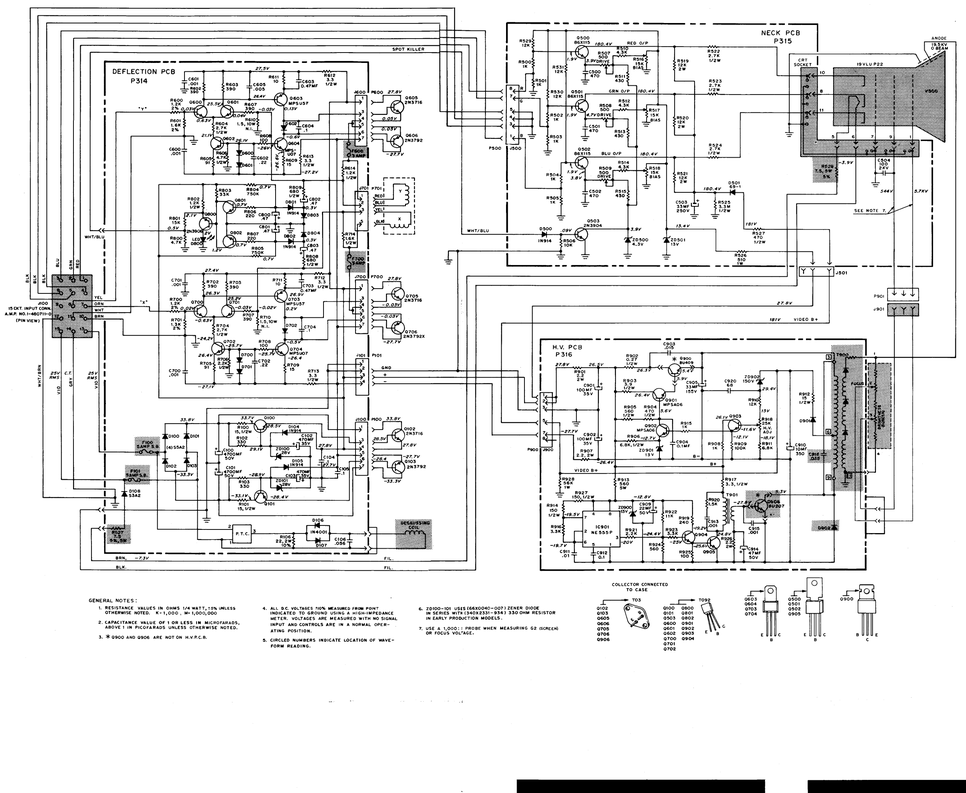
WELLS-GARDNER COLOR X-Y DISPLAY SCHEMATIC (19K6101-5617A A+)



Components identified by shading have special characteristics important to safety and should be replaced only with identical types.

Self-Test Procedure Part 1

Operator Information Display

The information below is displayed on the screen if you set the self-test switch to **on** during the attract mode. Look at the displayed numbers for *SECONDS ON* and *SECONDS PLAYED*. If these numbers run together vertically, make adjustments to the X and Y outputs of the game PCB.

To continue with self-test, rotate the control knob until the message *FOR SELF TEST PRESS FIRE AND SUPERZAPPER* appears on the monitor. Then press both FIRE and SUPERZAPPER. To end the operator information display, set self-test switch to **off.**

To erase High Score Table:
1. Turn control knob until top line reads *PRESS FIRE AND START 2 TO ZERO HIGH SCORES.*
2. Press both FIRE and START 2.
3. The word *ERASING* appears and blinks on the screen until the entire table is erased. **Wait until the word *ERASING* disappears** before continuing with other tests.

To erase Game Times:
1. Turn control knob until top line reads *PRESS FIRE AND START 1 TO ZERO TIMES.*
2. Press both FIRE and START 1.
3. The word *ERASING* appears and blinks on the screen until the entire table is erased. **Wait until the word *ERASING* disappears** before continuing with other tests.

Self-Test Procedure Part 2

Instruction	Test Passes	Test Fails
1. Set self-test switch to **on** (see Figure 5). Press RESET on the PCB, or turn power off and on again.	After about 5 seconds, the monitor displays the picture below. No sounds are produced.	**RAM FAILURE** is indicated by a sequence of 1 to 12 tones and an *R* displayed in top half of screen. You will hear a short low tone and see a short flash on the LED start pushbutton for each good RAM chip, and a long high tone accompanied by a long pulse on the start pushbutton for a failing RAM chip. The test stops with the first failing RAM. To restart the sequence, press RESET on the PCB, or power game to **off**, then to **on** again. Identify the bad RAM chip with the table below. Example: four short low tones followed by a long high tone indicates failure of RAM at location M3.

Bad RAM Chip Location

Long High Tone	on Analog Vector-Generator PCB
1st	R2
2nd	P2
3rd	R4
4th	P4
5th	M3
6th	M4
7th	L3
8th	L4
9th	K3
10th	K4
11th	J3
12th	J4

ROM FAILURE is indicated by a vertical pair of hexadecimal numbers on the top of the screen. The top number indicates the location of the failing ROM(s). Ignore the bottom hexadecimal number in the pair. Identify the bad ROM with the table immediately below.

Displayed No.	Bad ROM Chip Location	PCB Location
B	R1	
A	P1	
9	M/N1	
8	L/M1	Analog Vector-Generator PCB
7	K1	
6	J1	
5	H1	
4	F1	
3	E1	
2	D1	
1	R3	
0	N/P3*	

EAROM, Audio and Math Box Failure are indicated by a single letter in the center of the display. Identify the failure with the table below.

Displayed Letter	Failure	PCB Location
E	EAROM	C3 (Aux. PCB)
P	Audio 1	B/C2 (Aux. PCB)
Q	Audio 2	C/D2 (Aux. PCB)
R	RAM	See RAM test above
M	Math Box**	

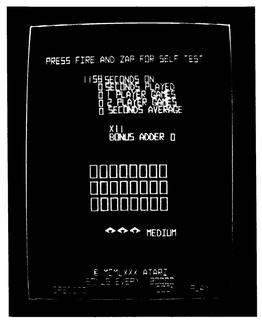
*If this ROM is bad, you will hear a continuous low tone, and the program may be unable to display a screen image.

**Math-box failure is explained in TM-195, Tempest Troubleshooting Guide.

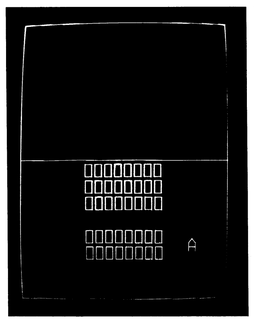
2. Activate start, fire, Superzap, SLAM, and coin switches.*	As switch activates, you'll hear a beep and 0 changes to 1 on the screen.	You will not hear a beep and 0 will remain on the screen for the defective switch.
3. Rotate encoder wheel clockwise and counterclockwise.	The right hexadecimal number on the screen will increase with counter clockwise motion, and decrease with clockwise motion.	Incorrect progression of numbers indicates encoder wheel harness wires were connected incorrectly. No number change indicates encoder wheel is bad or harness wires are loose.
4. Observe the white frame around the outside of the screen.	Each frame corner should be within ½-inch of each monitor bezel corner.	Consult Tempest™ Drawing Package to adjust video pots.
5. Activate SLAM switch.	A white cross hatch pattern appears. A character set appears at the bottom of the screen.	If display is not centered and symmetrical on the monitor, adjust video pots (see Tempest Drawing Package) on the main PCB. If character set is incorrect, check Vector ROMs (see Troubleshooting Guide).
6. Activate SLAM switch.	Horizontal and vertical lines cross in the center of the screen displaying a large "plus" sign. Audio I/O 1 and 2 alternate to produce four tones.	Lines not crossing indicates video pot on main PCB needs adjusting (see Drawing Package for procedure). No sound indicates failure of an audio amplifier and/or the custom audio chip(s).
7. Activate SLAM switch.	Tests purple, cyan, yellow, white, green, blue, and red for color and intensity. Displays seven groups of vertical lines, each with right line the brightest and left line the dimmest.	Use this pattern for tracking adjustments (see the Color X-Y Monitor Manual).
8. Activate SLAM switch.	A checkerboard pattern touches the sides and corners of the monitor. Rotate the control knob to change color.	Use this pattern for purity and convergence adjustments (see Color X-Y Monitor Manual).
9. Activate SLAM switch.	A white frame is displayed on the screen.	Perform math-box signature analysis (see Troubleshooting Guide).
10. When satisfied with test, set self-test switch to **off** position.		

Activate coin switches by inserting at least one coin in each coin slot. You will not trip the coin counters as long as you are in self-test.

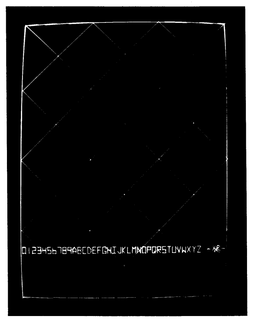
Self-Test Screens



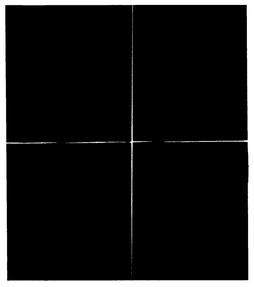
Screen #1



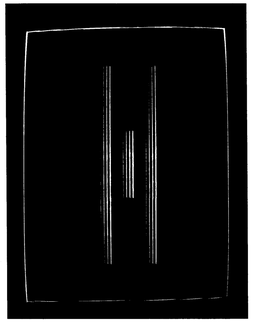
Screen #2



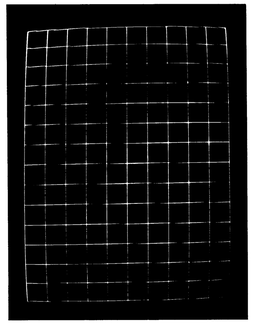
Screen #3



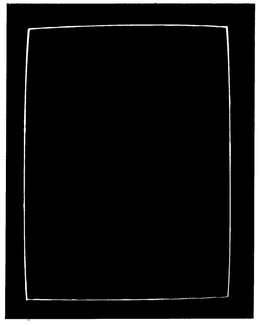
Screen #4



Screen #5



Screen #6



Screen #7

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Drawing Package Supplement to Tempest™

Operation, Maintenance, and Service Manual

Contents of this Drawing Package

Sheet 1, Side A
DP-190-01 2nd printing
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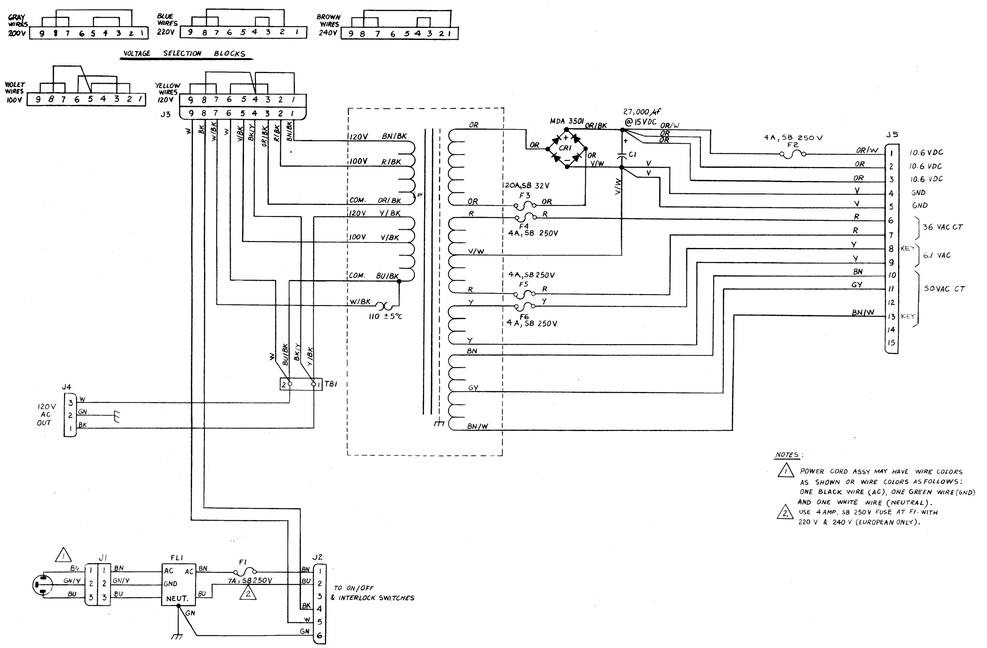
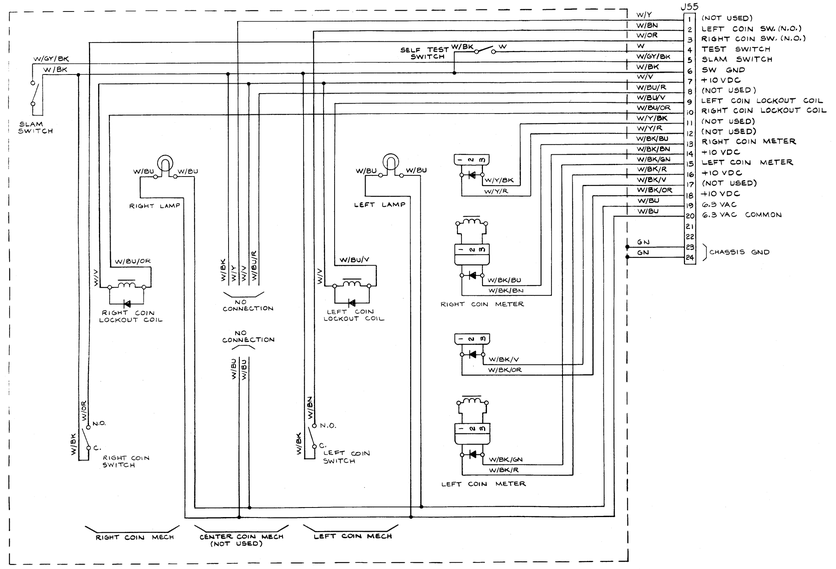
Color X-Y Power Supply Schematic (037394-01 B)



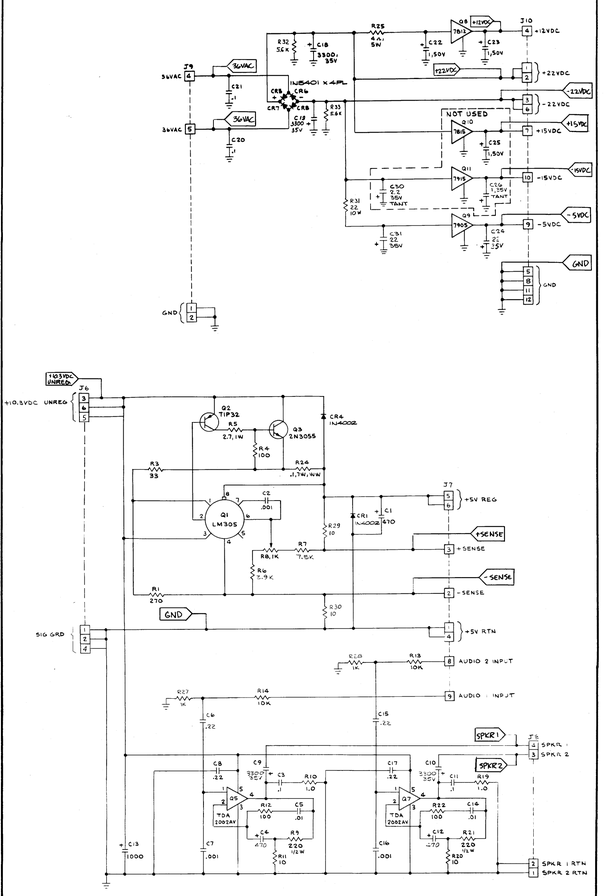
NOTES:

1. POWER CORD ASSY MAY HAVE WIRE COLORS AS SHOWN OR WIRE COLORS AS FOLLOWS: ONE BLACK WIRE (AC), ONE GREEN WIRE (GND) AND ONE WHITE WIRE (NEUTRAL).
2. USE 4 AMP, SB 250V FUSE AT F1 WITH 220 V & 240 V (EUROPEAN ONLY).

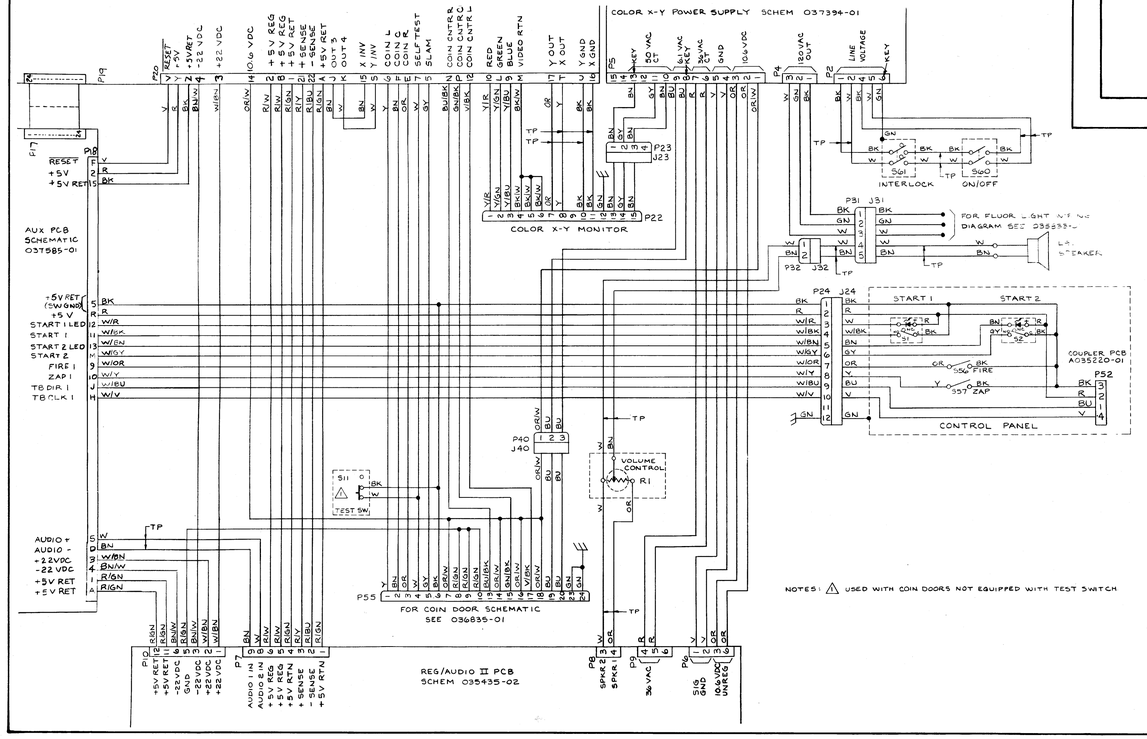
Double Mech Coin Door Wiring Diagram (036835-01 A)



Regulator Audio II PCB Schematic (035435-02 E)



Tempest™ Upright Wiring Diagram (037774-01 A)



NOTES: ⚠ USED WITH COIN DOORS NOT EQUIPPED WITH TEST SWITCH

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Tempest Upright Wiring Diagram
Coin Door
Color X-Y Power Supply
Regulator Audio II PCB Schematic

Sheet 1, Side B
DP-190-01 2nd printing
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Regulator/Audio II PCB

The Regulator/Audio II PCB has the dual functions of regulating the +5 VDC logic power to the game PCB and amplifying the audio from the game PCB.

Regulator Circuit

The regulator consists of voltage regulator Q1, power pass transistor Q3 and Q3's driver transistor Q2. The regulator accurately regulates the logic power input to the game PCB by monitoring the voltage through high-impedance inputs +SENSE and −SENSE. The inputs are directly from the +5 VDC and ground inputs to the game PCB. Therefore, the regulator regulates the voltage on the game PCB. This eliminates a reduced voltage due to IR loss in the wire harness between the regulator and the game PCB. Variable resistor R8 is adjusted for the +5 VDC on the game PCB. Once adjusted, the voltage at the input of the game PCB will remain constant at this voltage.

Regulator Adjustment

1. Connect a voltmeter between +5 V and GND test points of the game PCB.
2. Adjust variable resistor R8 on the Regulator/Audio II PCB for +5 VDC reading on the voltmeter.
3. Connect a voltmeter between +5 V REG and GND on the Regulator/Audio II PCB. Voltage reading must not be greater than +5.5 VDC. If greater, try cleaning edge connectors on both the game PCB and the Regulator/Audio II PCB.
4. If cleaning PCB edge connectors doesn't decrease voltage difference, connect minus lead of voltmeter to GND test point of Regulator/Audio II PCB and plus lead to GND test point of game PCB. Note the voltage.

   Now connect minus lead of voltmeter to +5 REG test point on Regulator/Audio II PCB and plus lead to +5 V test point on game PCB. From this you can see which harness circuit is dropping the voltage. Troubleshoot the appropriate harness wire or harness connector.

Audio Circuit

The audio circuit contains two independent audio amplifiers. Each amplifier consists of a TDA2002AV amplifier with an effective gain of 2.2.

MEMORY MAP										
HEXA-DECIMAL ADDRESS	R/W	DATA D7	D6	D5	D4	D3	D2	D1	D0	FUNCTION
0000-7FFF	R/W	D	D	D	D	D	D	D	D	Program RAM (2K)
0800-080F	W					D	D	D	D	Color RAM
0C00	R								D	Right Coin Switch
0C00	R							D		Center Coin Switch
0C00	R						D			Left Coin Switch
0C00	R					D				Slam Switch
0C00	R				D					Self-Test Switch
0C00	R			D						Diag. Step Switch
0C00	R		D							HALT
0C00	R	D								3KHz
0D00	R	D	D	D	D	D	D	D	D	Option Switch Inputs
0E00	R	D	D	D	D	D	D	D	D	Option Switch Inputs
2000-2FFF	R/W	D	D	D	D	D	D	D	D	Vector RAM (4K)
3000-3FFF	R	D	D	D	D	D	D	D	D	Vector ROM (4K)
4000	W								D	Right Coin Counter
4000	W							D		Center Coin Counter
4000	W					D				Video Invert X
4000	W				D					Video Invert Y
4800	W									VG GO

MEMORY MAP										
HEXA-DECIMAL ADDRESS	R/W	DATA D7	D6	D5	D4	D3	D2	D1	D0	FUNCTION
5000	W									WD CLEAR
5800	W									VG Reset
6000-603F	W	D	D	D	D	D	D	D	D	EAROM Write
6040	W	D	D	D	D	D	D	D	D	EAROM Control
6040	R	D								Math Box Status
6050	R	D	D	D	D	D	D	D	D	EAROM Read
6060	R	D	D	D	D	D	D	D	D	Math Box Read
6070	R	D	D	D	D	D	D	D	D	Math Box Read
6080-609F	W	D	D	D	D	D	D	D	D	Math Box Start
60C0-60CF	R/W	D	D	D	D	D	D	D	D	Custom Audio Chip 1
60D0-60DF	R/W	D	D	D	D	D	D	D	D	Custom Audio Chip 2
60E0	R								D	One Player Start
60E0	R							D		Two Player Start
60E0	R						D			FLIP
9000-DFFF	R	D	D	D	D	D	D	D	D	Program ROM (20K)

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Analog Vector-Generator PCB
Microprocessor
Address Decoding
Power Input
Clock
IRQ Counter
Power Reset and Watchdog Counter
ROM Memory
RAM Memory
Memory Map
Section of 037383-01 & -02B

Sheet 2, Side A
DP-190-02 1st printing
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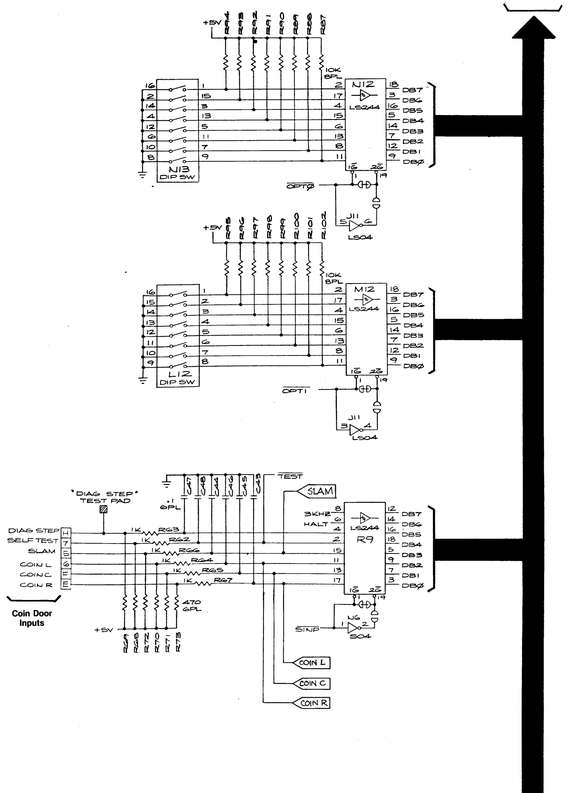
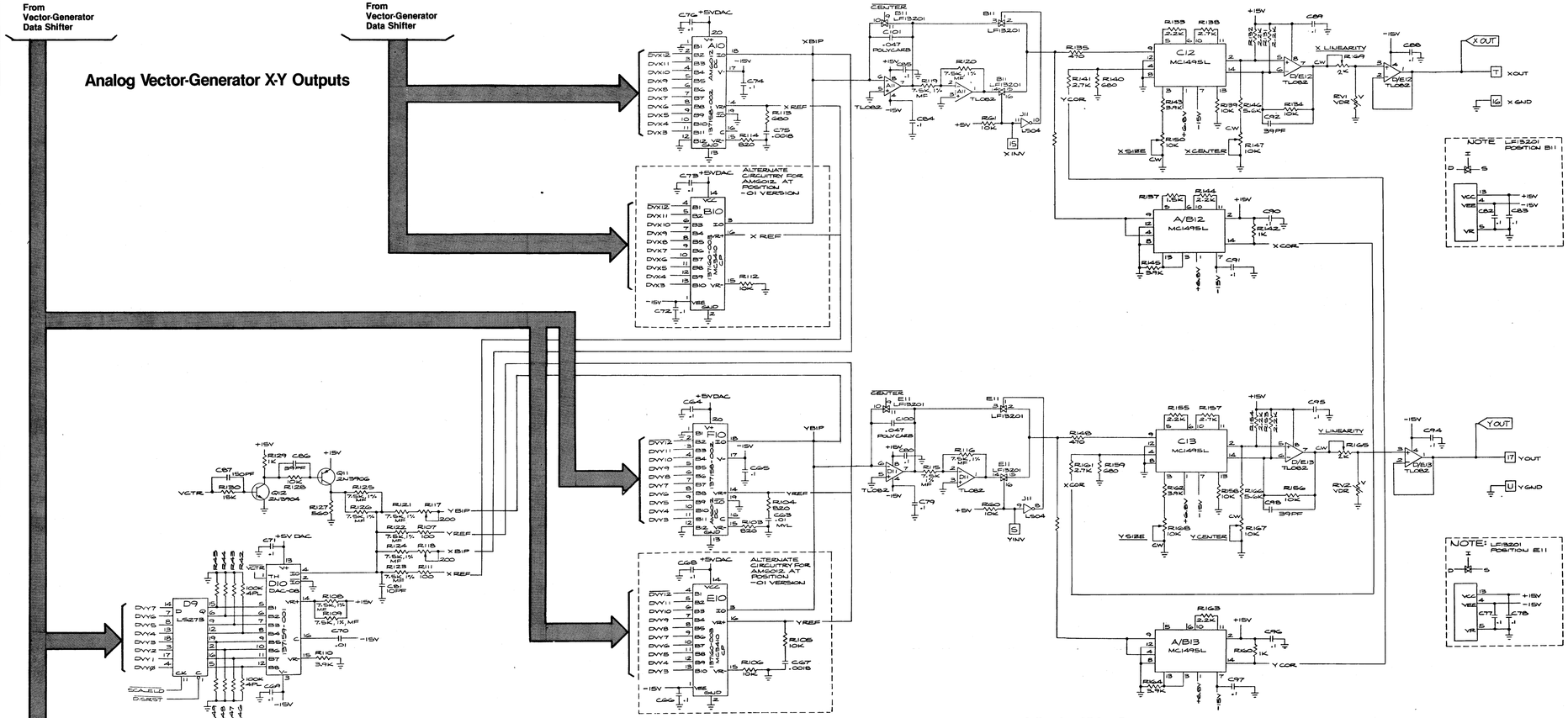
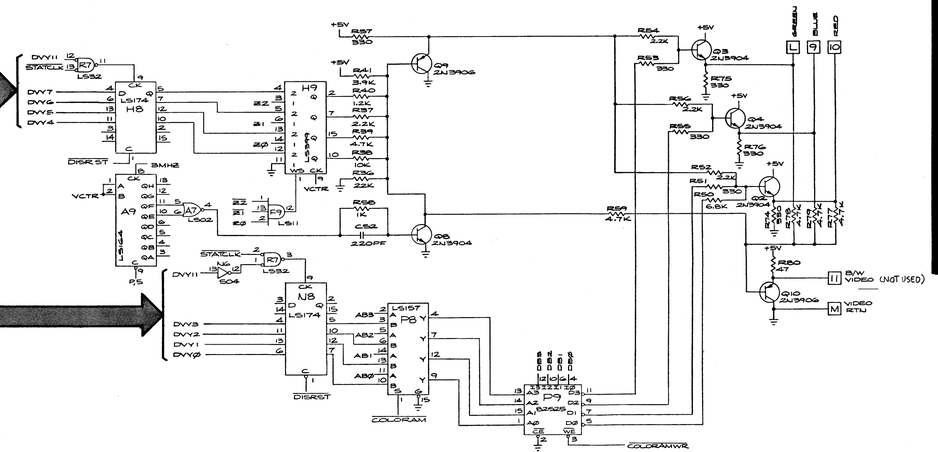
Coin Door and Option Switch Inputs



Analog Vector-Generator X-Y Outputs



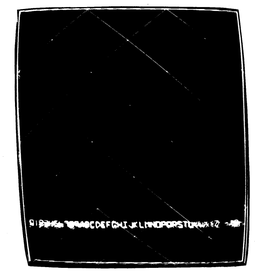
Analog Vector-Generator Color Outputs



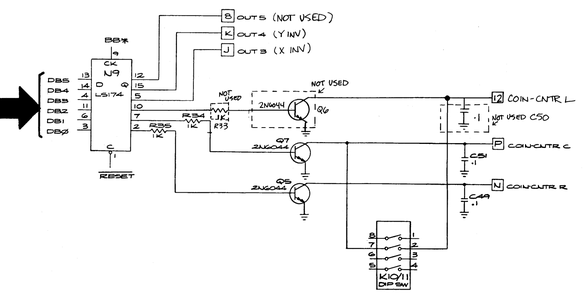
Adjusting Video Pots

If you replace the Tempest™ Analog Vector-Generator PCB (Main PCB) or the monitor, you may have to make the following adjustments:

1. Enter self-test and advance screen to diagonal crosshatch pattern.
2. Adjust "CENTER" pots: Adjust X-CENTER (R147) and Y-CENTER (R167) so that the crosshatch pattern is located at the middle od the screen.
3. Adjust "SIZE" pots: Adjust X-SIZE (R150) and Y-SIZE (R168) so that the crosshatch pattern exactly covers the whole visible screen.
4. Adjust the "BIP" pots: Adjust the X-BIP (R118) and Y-BIP (R117) so that the corners of the diagonal lines rest exactly on the sides of the outer rectangle.
5. Adjust the "LIN" pots: Adjust the X-LINEAR (R169) and Y-LINEAR (R165) so that the diagonal lines are straight. Since the "LIN" pots change the size of the displayed picture on the screen, you may have to readjust the "SIZE" pots in order to get the correct adjustment.



Coin Counter and Video Invert Outputs



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Analog Vector-Generator PCB
Coin Door and Option Switch Inputs
X-Y Outputs
Color Outputs
Coin Counter and Video Invert Outputs
Section of 037383-01 & -02B

Stack and Program Counter

From MPU Buffered Address AB0 thru AB12

Vector-Generator Address Selector

Vector-Generator RAM

Vector-Generator Data Buffer

NOTE:
Either a 74LS245 or an AM8304B may be used at location H3. Pin numbers not enclosed in parentheses are for 74LS245. Pin numbers in parentheses are for an AM8304B.

MPU Data Bus

Vector-Generator Data Shifter

To Vector Timer Control and Vector-Generator X-Y Output

To Stack Input and Vector-Generator Output

To Vector Timer Control, Vector Timer, State Machine and Stack

To Vector-Generator Color Output

To Vector Timer Control and Vector-Generator Output

Vector-Generator ROM

NOTE:
- Indicates edge connector (J20)
- Indicates interconnect connector (J19)
- Indicates test point

State Machine Control

Vector Timer Control

To Vector-Generator Memory Shifter

Vector Timer

State Machine

To Vector Timer Control and Stack

To Vector-Generator Memory Shifter

To Vector-Generator Output

Vector Halt Latch

From Reset Counter

From Address Decoder

From Address Decoder

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Sheet 3, Side A

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Vector-Generator Program Counter
Vector-Generator RAM
Vector-Generator ROM
Vector-Generator Data Shifter
Vector-Generator Data Buffer
Vector-Generator Address Selector
Vector-Generator Vector Timer
Vector-Generator State Machine
Section of 037383-01 thru -04 C

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Auxiliary Board Address Decoder

Math Box

High Score Memory

Player Inputs and Audio Output

Blue arrows indicate signal flow of each test during signature analysis.

External Address Bus
From Sheet 2 Side A
EAB 7
EAB 6
EAB 5
EAB 4
EAB 3
EAB 2
EAB 1
EAB Ø

External Data Bus
From Sheet 2 Side A
EDB 7
EDB 6
EDB 5
EDB 4
EDB 3
EDB 2
EDB 1
EDB Ø

ORIGIN
ORIGIN 1

Power Inputs

+5V @ C1-8,12,14,15,17,18,22,26,30,33-36,41,44,49,54 0.1 BYPASS
+5V RET
GND
-2.2V @ C37 470 25V
+22V @ C38 470 25V

Encoder Wheel PCB (A035220-01 A)

+5V
CLK 1
DIR 1
GND

NOTE

- Indicates edge connector (J18)
- Indicates interconnect connection (J17)
- Indicates SA connector (J16)
- Indicates test point

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Sheet 3, Side B

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High Score Memory
Auxiliary PCB
Audio Output
Control Panel Input
Math Box
Encoder Wheel
037585-01 B

Sheet 3, Side B
DP-190-03 2nd printing
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