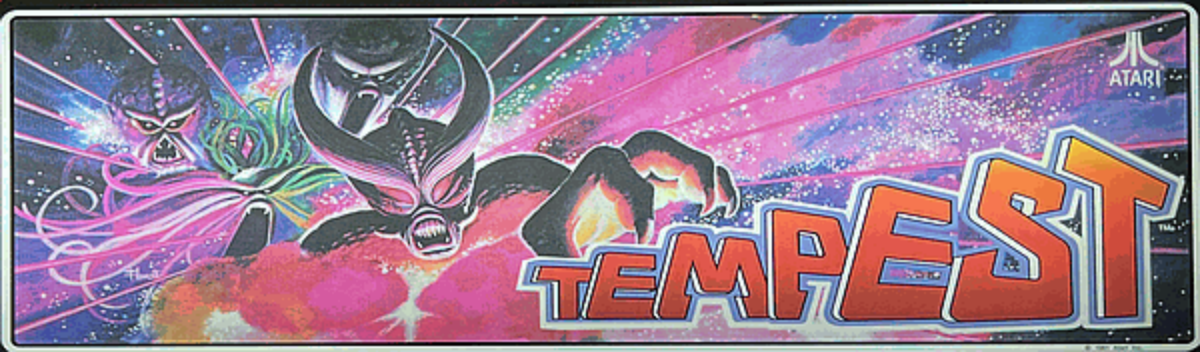

ATARI
TEMPEST

INSTRUCTIONS:

Insert coin
Push One or Two player select
Pick the difficulty of your starting surface with the rotary control, then push "FIRE" to start game.
Win Bonus points if you survive the chosen surface.

TO PLAY:

Shoot the approaching enemy and enemy charges.
Player loses a life when:

- caught by an enemy
- hit by a charge
- skewered by a spike

HINTS:

Hold the fire button down for continuous fire.
Use the "SUPERZAPPER" to zap all enemies on the tube.
You get one "SUPERZAP" per tube.
Avoid spikes when you zoom down the tube.

KILL ENEMY AT TOP BY:

- Shooting enemy as it flips
- Firing into long enemy spikes for best machine gun effect which will kill enemies flipping toward you.

KILL PULSAR BY:

- Shooting at it when it is not pulsing. Pulsing lines kill.

KILL FUSEBALL BY:

- Shooting it as it crosses between lines. Touching a fuseball is fatal.

SCORING



FUSEBALL — 250, 500 or 750 pts. Zips up and down line



PULSARS — 200 pts. Pulsate adjacent lines. VERY DANGEROUS



FLIPPERS — 150 pts.



TANKERS — 100 pts. Splits into two Flippers when hit.



SPIKER — 50 pts. Builds Green Spikes which the player must shoot away.

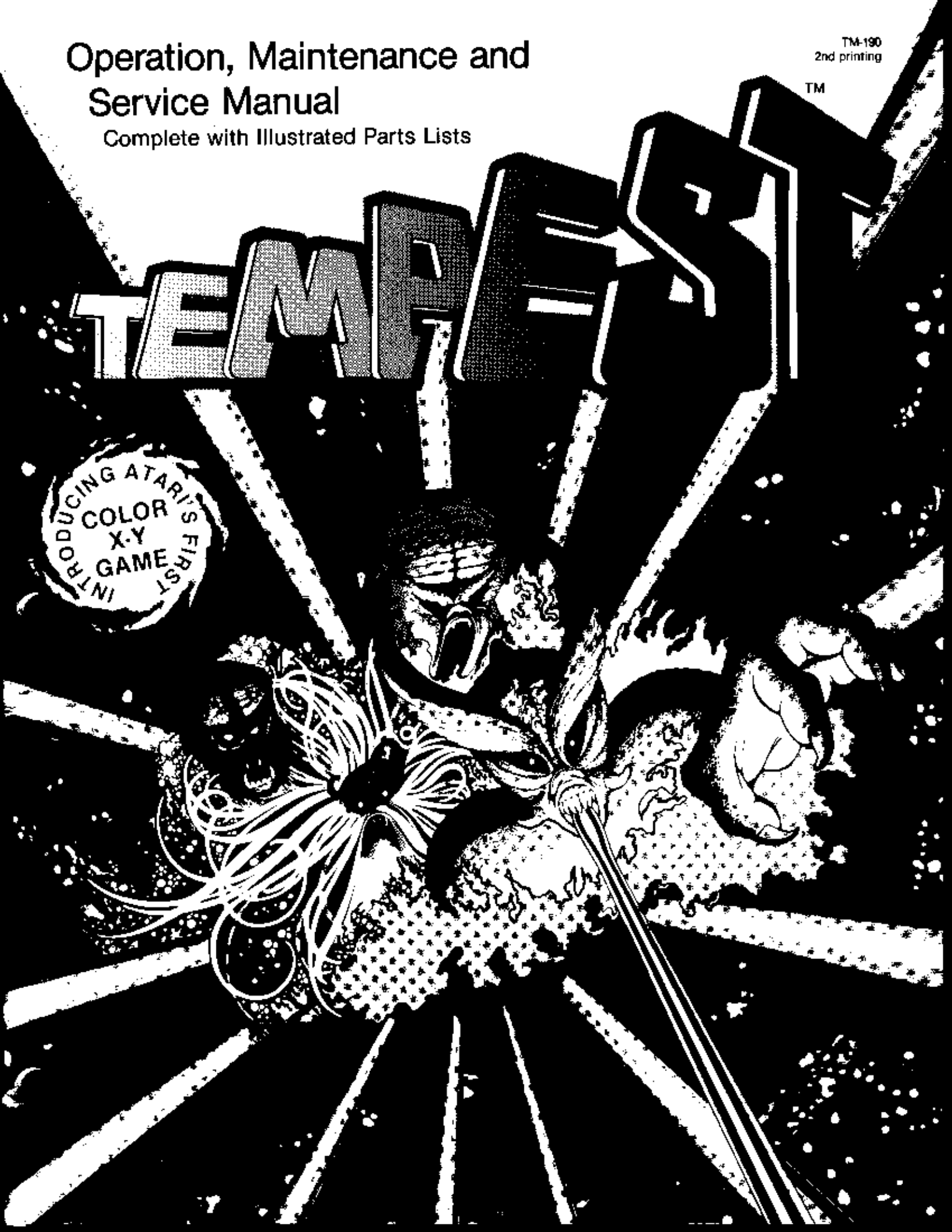
Operation, Maintenance and Service Manual

Complete with Illustrated Parts Lists

TM-190
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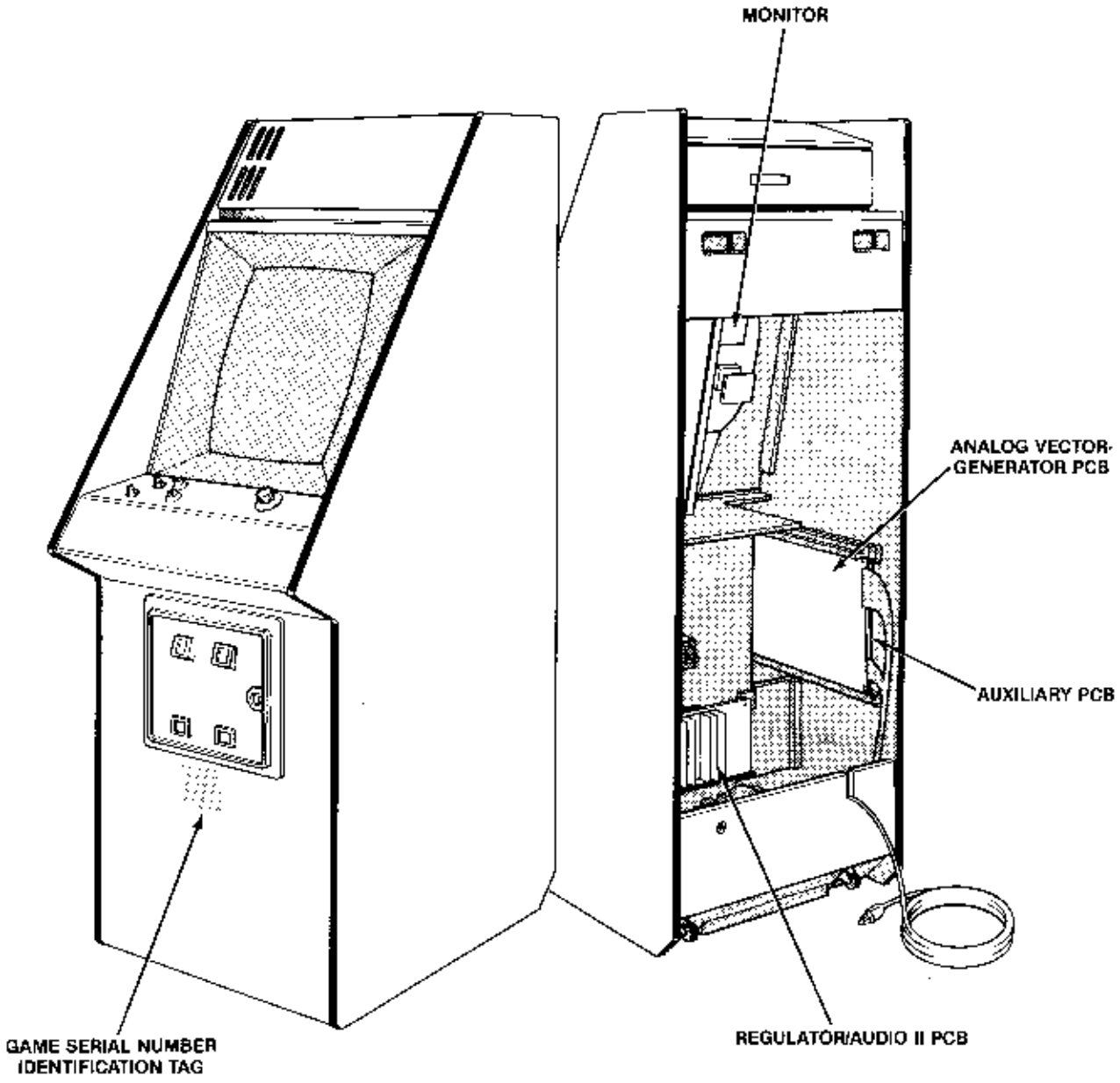
TM

TEMPEST



GAME SERIAL NUMBER LOCATION

Your game's serial number is stamped on a label on the outside of the game. The same number is also stamped on the chassis of the monitor, Regulator/Audio II PCB, and The Tempest™ Analog Vector-Generator PCB and Auxiliary PCB. Please mention this number whenever calling your distributor for service.

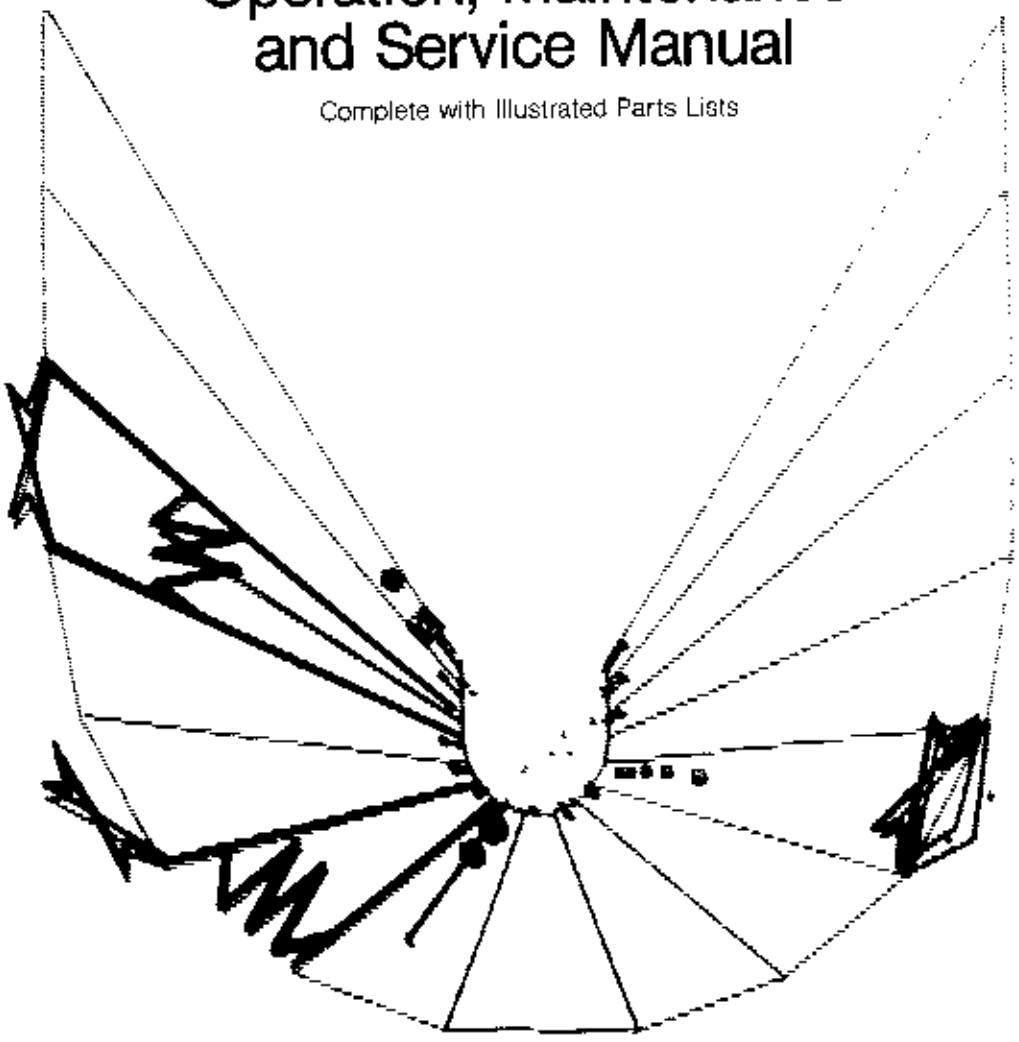


Introducing Atari's *First* Color X-Y Video Game...

TEMPEST™

Operation, Maintenance and Service Manual

Complete with Illustrated Parts Lists



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Notice Regarding Non-Atari Parts

WARNING

Use of non-Atari parts or modifications of your Atari game circuitry may adversely affect the safety of your game, and may cause injury to you and your players.

Atari, Inc.'s warranty (printed on the inside back cover of this manual) may be voided, if you do any of the following:

1.) you substitute non-Atari parts in your coin-operated game, or

2.) you modify or alter any circuits in your Atari game by using kits or parts not supplied by Atari.

Not only may the use of any non-Atari parts void your warranty, but any such alteration may also adversely affect the safety of your game, and may cause injury to you and your players.

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NOTE

If reading through this manual does not lead to solving a certain maintenance problem, call Tele-Help® at the Atari Customer Service office in your geographical area, as shown below.

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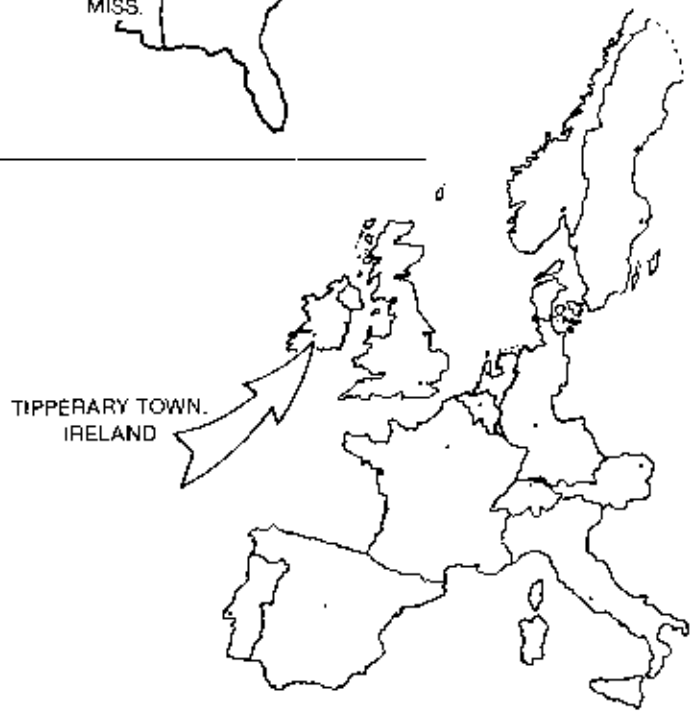
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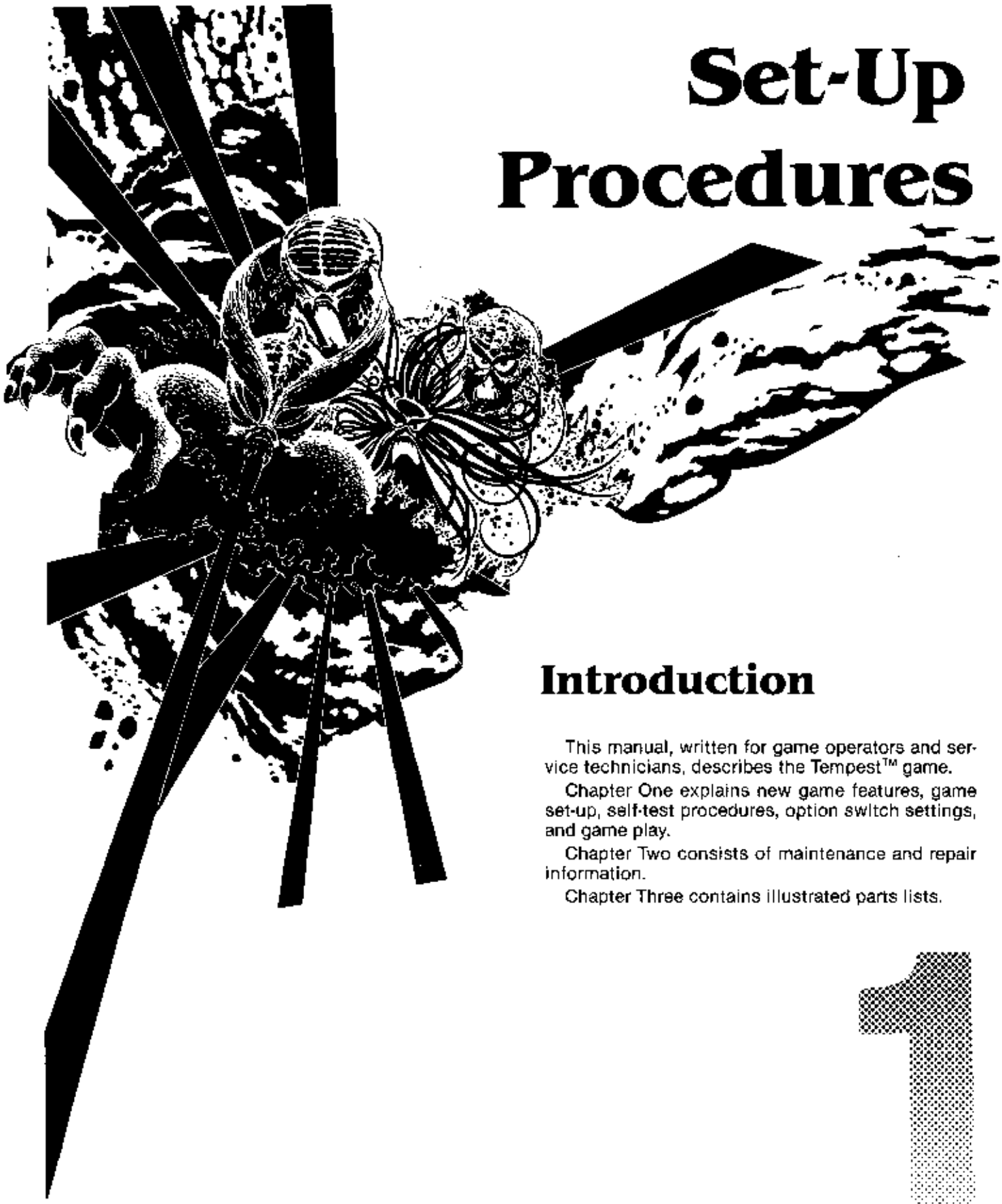
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Set-Up Procedures

Introduction

This manual, written for game operators and service technicians, describes the Tempest™ game.

Chapter One explains new game features, game set-up, self-test procedures, option switch settings, and game play.

Chapter Two consists of maintenance and repair information.

Chapter Three contains illustrated parts lists.

1

WARNING:
SHOCK HAZARD

Connect this game only to a grounded 3-wire outlet. If you have only a 2-wire outlet, we recommend you hire a licensed electrician to install a grounded outlet. **Players may receive an electric shock** if this game is not properly grounded!

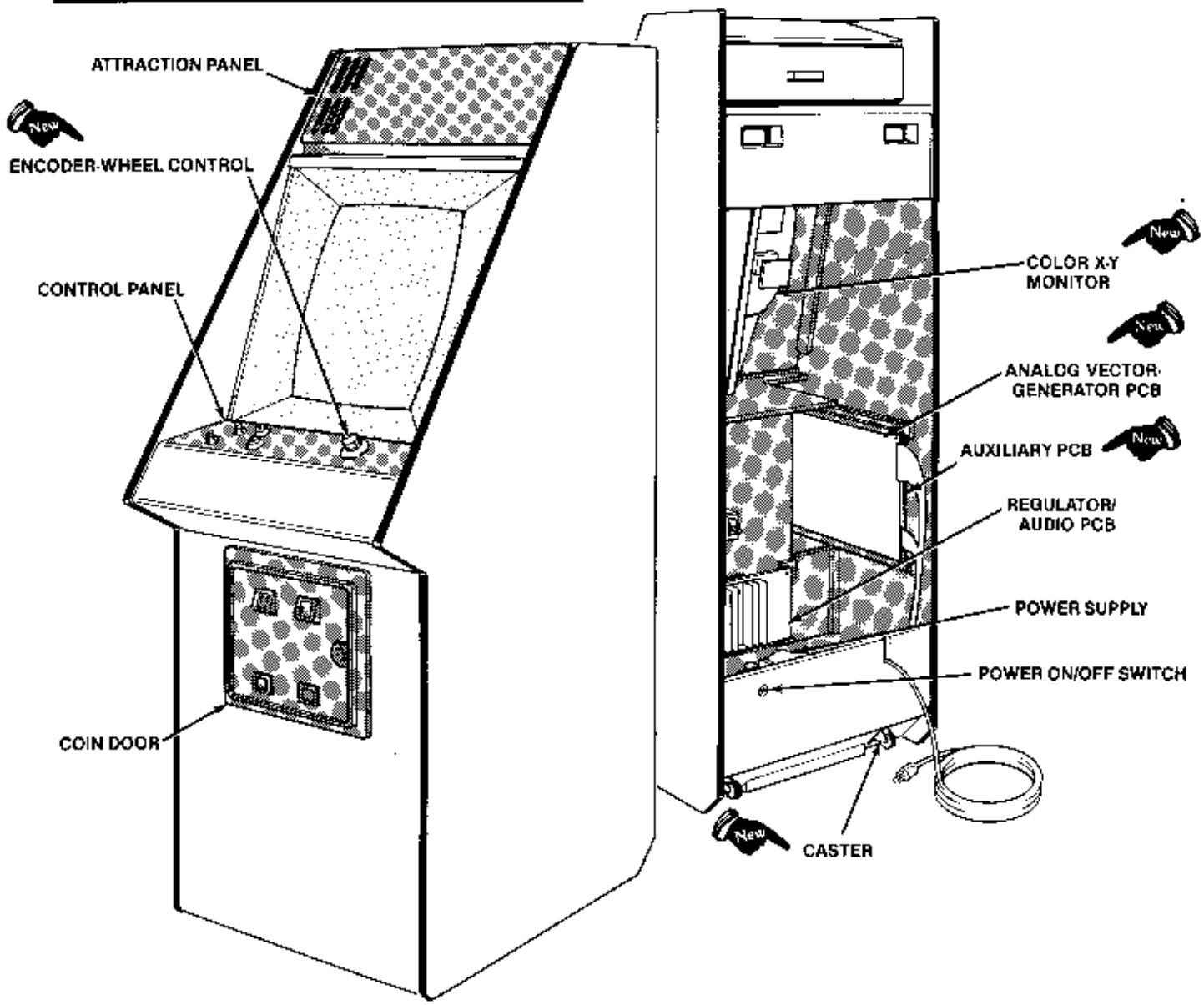


Figure 1 Overview of Game

A. New Features

The Tempest™ game has five new features. Even if you are familiar with Atari games, you should note these important differences. The new features are:

- **Color X-Y Monitor and Game PCBs.** Tempest is Atari's *first* color X-Y game. The color monitor produces a great number of colors in varying intensities. Atari's X-Y game circuitry has been redesigned for a color display.
- **Game Play.** Atari introduces *Skill-Step™*, and 99 levels of play on 16 different playfields. A demonstration mode allows you to accelerate through 98 levels of play. In addition, a special switch setting lets you freeze the game action (see *Section F, Game Play).*
- **Encoder Wheel.** This new control has a compact, simplified design which makes servicing easy. This control's circuitry is contained on a single PCB. The very smooth action is designed for greater player accuracy.
- **Cabinet Design.** The newly designed cabinet has casters at the back of the game, allowing you to easily move the game within your establishment. The attraction panel, with its new construction, uses a polycarbonate decal laminated to tempered glass. Luggage-style latches allow easy opening of the control panel. A wood panel separates the coin box from the components in the back of the game, eliminating the need for a power-interrupt interlock switch on the coin door. Finally, the game and auxiliary PCBs are mounted back-to-back on the cabinet wall and are separated by plastic standoffs.
- **Fluorescent Light and Speaker.** For ease of service, the fluorescent light and speaker board slide out of the back of the game. In addition, the game audio is improved because the speaker is positioned in a resonating chamber.

These new features, as well as all other major parts in the game, are illustrated in Figure 1. Throughout this manual, wherever one of these new features is mentioned, you will see this symbol:



⚠ WARNING ⚠

To avoid possible unpleasant electrical shock, do not touch internal parts of the monitor with your hands or metal objects held in your hands!

B. Game Inspection

This new game is ready to play upon removal from the shipping carton. However, your careful inspection is needed to supply the final touch of quality control. Please follow these steps to help us insure that your new game was delivered to you in good condition.

NOTE

Do not plug the game in yet!

1. Examine the exterior of the game cabinet for dents, chips, or broken parts.
2. Remove the screws that were used as extra security to seal the rear access panel. Unlock and open this panel, as well as the coin door; inspect the interior of the game as follows:
   - Check that all plug-in connectors (on the game harness) are firmly seated. Replug any connectors found unplugged. **Don't force connectors together.** The connectors are keyed so they only go on in the proper orientation. **A reversed edge connector will damage a PCB** and will void your warranty.
   - Check that all plug-in integrated circuits on the game PCBs are firmly seated in their sockets.
   - Check that the plastic standoffs are in place, holding the PCBs away from each other.
   - Remove the tie-wrap that holds the coiled power cord on the inside cabinet wall. Check the cord for any cuts or dents in the insulation. Place the square black plastic strain-relief plate in the wood slot at the bottom of the rear panel opening.
   - Note the location of the game's serial number—it is printed on the special label below the coin door on the front of the game cabinet. Verify that the serial numbers on the Tempest™ Analog Vector-Generator PCB, Tempest Auxiliary PCB, Regulator/Audio II PCB, power supply and monitor are all identical. A drawing of the serial-numbered components is on the inside front cover of this manual. Please mention this number whenever you call your distributor for service.
   - Check all major subassemblies such as the power supply, control panel and monitor for secure mounting.

C. Game Installation

Figure 2 Installation Requirements

Power	250 watts maximum
Temperature	0 to 38°C (32 to 100°F)
Humidity	Not over 95% relative
Space Required	64 x 81 cm (25¼ x 32 in.)
Game Height	176 cm (69½ in.)

1. Voltage Selection

The power supply used in this game operates on the line voltage of almost any country in the world. The power supply comes with either one, two or three colored voltage selection plugs.

Before plugging in your game, check your power supply. If the supply doesn't have voltage selection plugs and a connector at J3 (see Figure 3), then the game operates on any voltage from 105 to 135 VAC. If the supply has the colored voltage selection plugs, make sure that the voltage selection plug on the power supply is correct for your location's line voltage. Check the wire color on the plug and see if it is correct per Figure 3.

2. Interlock and Power On/Off Switches

To minimize the hazard of electrical shock while working on the inside of the game cabinet, an interlock switch has been installed (see Figure 4). It is located behind the access panel. This switch removes all AC line power from the game circuitry when the panel is opened.

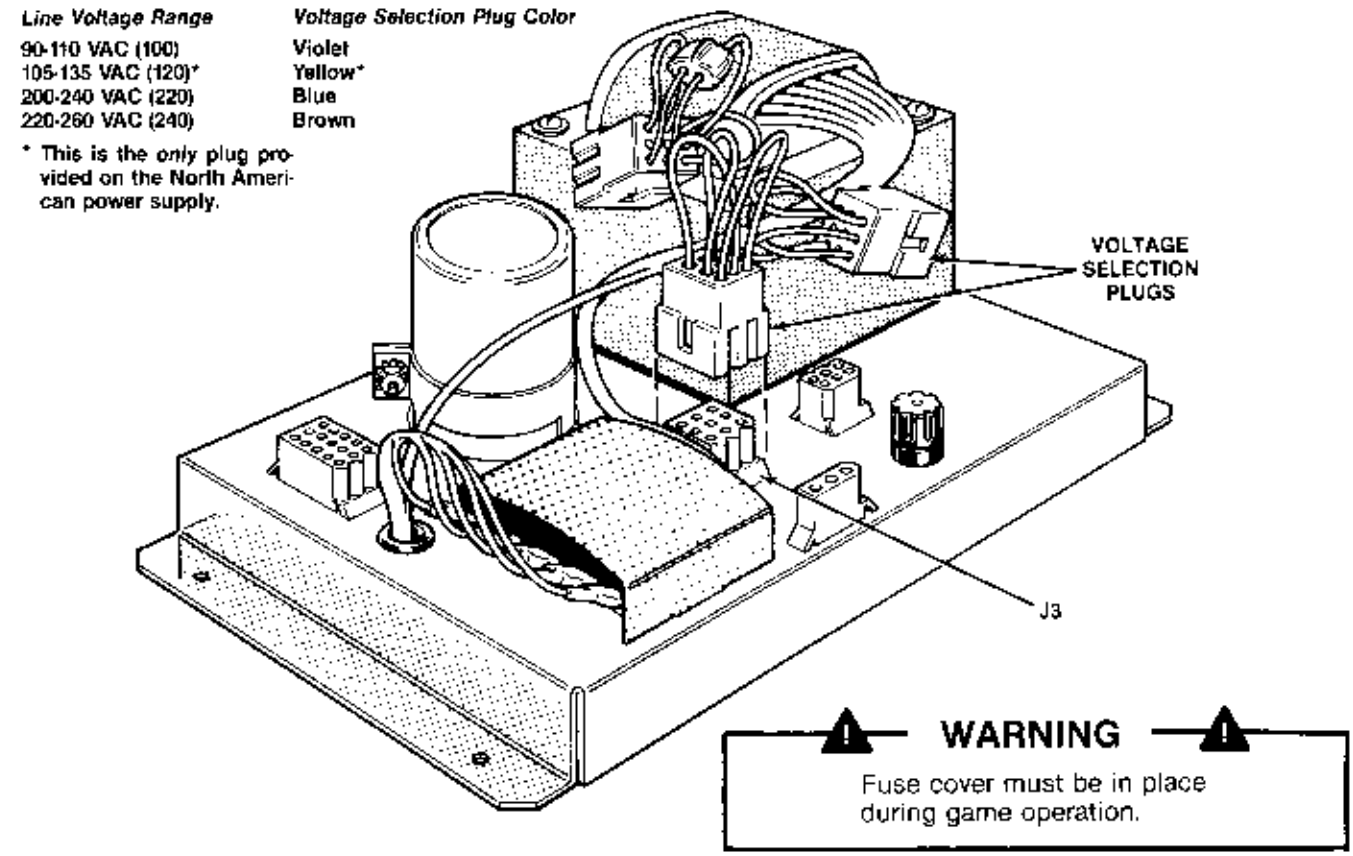


Figure 3 International Voltage Plug Selection

Check for proper operation of the interlock switch by performing the following steps:

- Be sure the rear access panel is closed.
- Plug the AC line power cord into an AC outlet.
- Set the power on/off switch to the "on" position. Within 30 seconds the monitor should display a picture.
- Slowly open the rear access panel. The monitor picture should disappear when the panel is opened approximately 2.5 cm (1 inch). Close and lock this panel.
- If the results of the preceding step are satisfactory, the interlock switch is operating properly. If the monitor doesn't go off as described, check to see if the interlock switch is broken from its mounting or stuck in the "on" position.

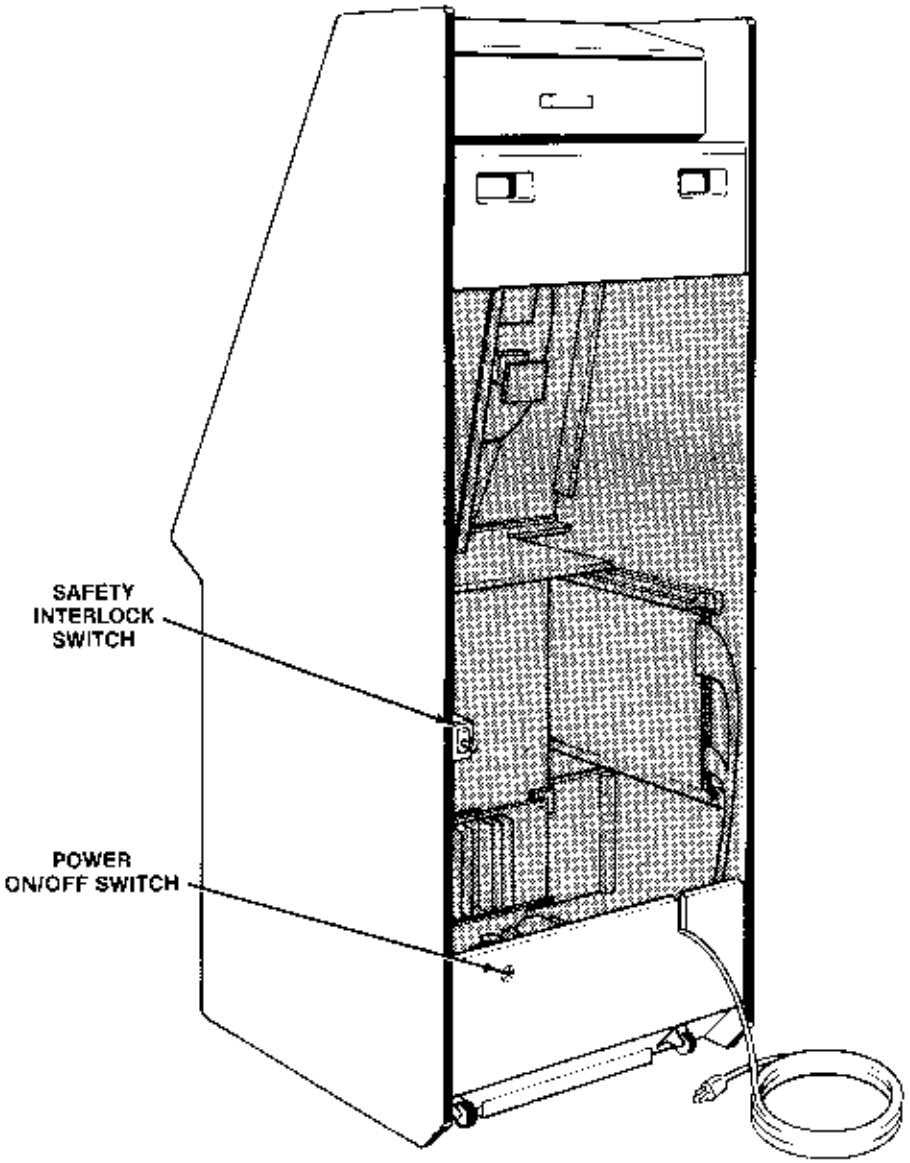


Figure 4 Interlock and Power On/Off Switches

D. Self-Test Procedure

This game will test itself and provide data to demonstrate that the game's circuitry and controls are operating properly. The data is provided on the monitor and the game speaker; no additional equipment is necessary.

Part 1 of the self-test procedure includes a display of the operator-selectable game options, and game time and high score table information. Part 2 includes ROM and RAM, control panel and monitor information.

We suggest you run the self-test procedure any time you collect money from the game or any time you change the game's options. Refer to Figure 5 for location of the self-test switch and option switches. To run the self-test, follow the instructions outlined in Figure 6.

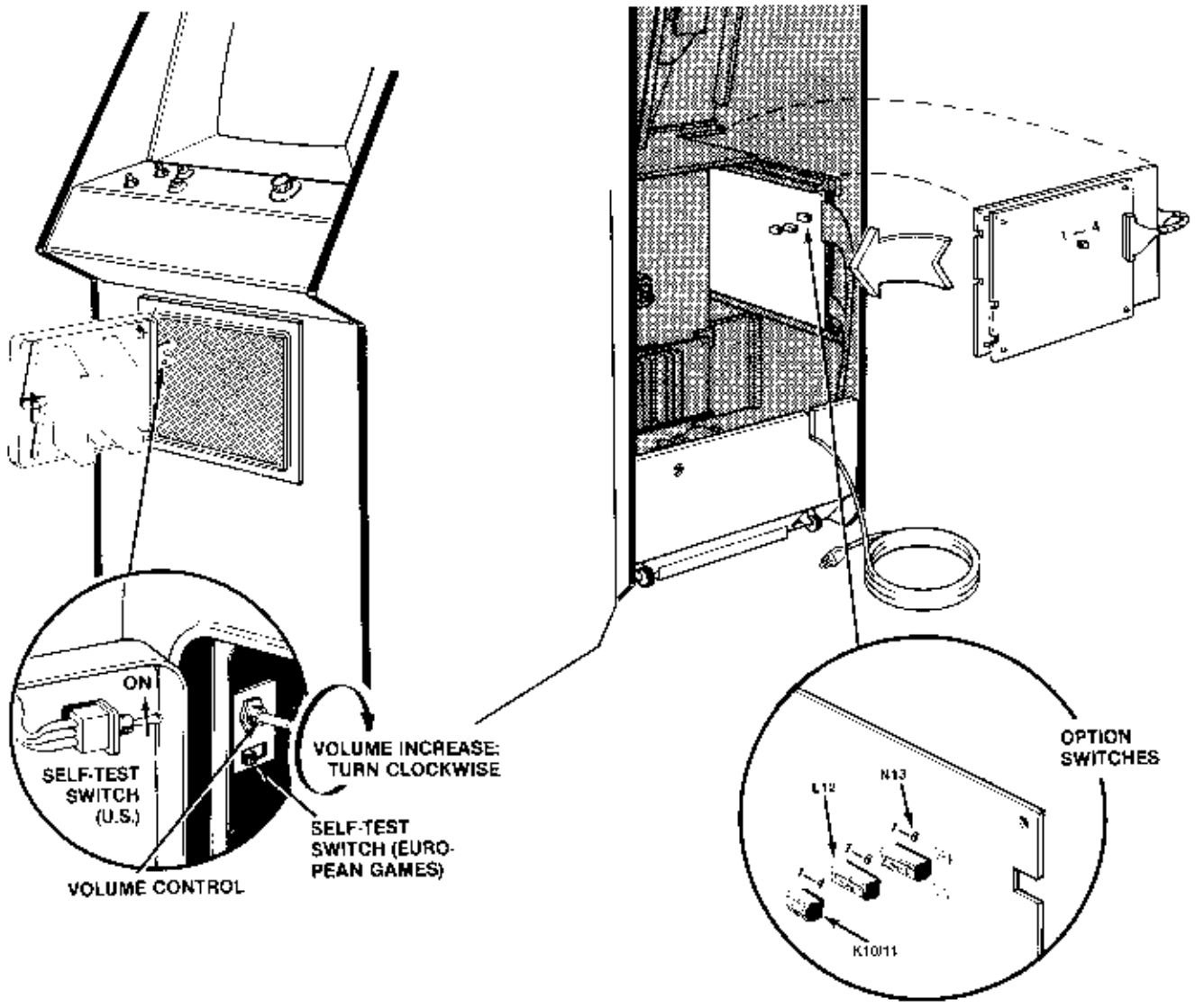
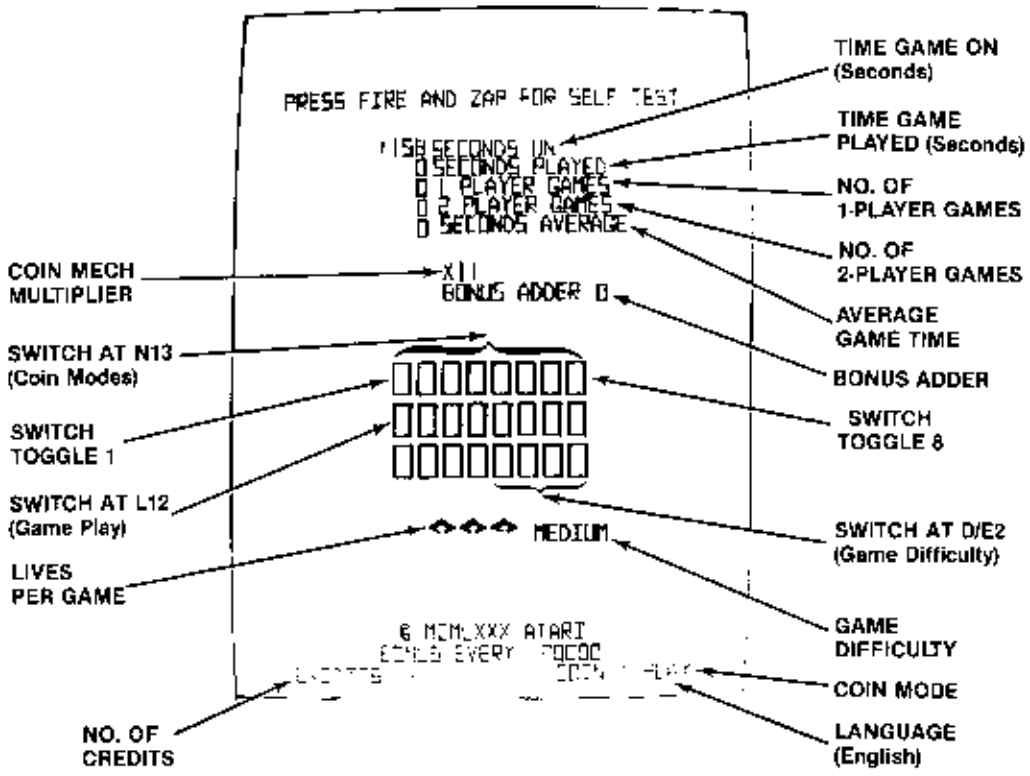


Figure 5 Location of Self-Test Switch, Volume Control and Option Switches

Self-Test Procedure Part 1

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 go to Self-test Part 2, rotate the control knob until the message *PRESS FIRE AND SUPERZAPPER FOR SELF-TEST* appears on the monitor. Then press both FIRE and SUPERZAPPER. To end the operator information display, set self-test switch to **off.**



Operator Information Display

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.

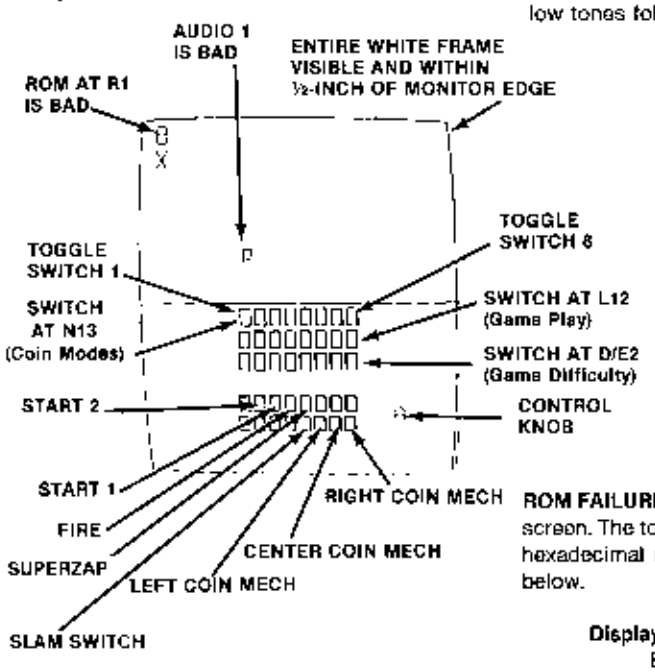
To erase Game Times:

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 is continued on next page]

Figure 6 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.



Long High Tone	Bad RAM Chip Location 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-
7	K1	Generator PCB
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.

[Self-test is continued on next page]

Figure 6 Self-Test Procedure Part 2, continued

Instruction	Test Passes	Test Fails
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.	See 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.*

E. Option Switch Settings

1. Bonus Play Feature

Tempest™ offers a bonus play for certain combinations of coins inserted. This bonus feature is operator-selectable, meaning you may choose to offer it or not.

With your game set at 25¢ per play, players who deposit four successive quarters or a $1.00 coin, then press the start button, can receive a bonus play. Therefore, players can receive 5 plays for $1.00.

This bonus feature encourages players to insert more money than just the minimum 25¢ required for one game. Various other bonuses are also available (see Figure 8).

Figure 7 Game Option Settings

To change toggle positions on the switch assemblies, you need not remove the game PCB. The switches are accessible when the Tempest™ Analog Vector-Generator PCB is mounted in place. To change positions on the Auxiliary PCB slide the board out as far as possible.

When changing the options, verify proper results on the monitor display **by performing the self-test.** Note that changing an option on any of the following eight toggles will **not** cause an immediate change on the monitor screen during the attract mode.

Settings of 8-Toggle Switch on Tempest Analog Vector-Generator PCB *(at L12)*

1	2	3	4	5	6	7	8	Option
							On	1-credit minimum $
							Off	2-credit minimum
					On	On		English $
					On	Off		French
					Off	On		German
					Off	Off		Spanish
								Bonus life granted at every:
		On	On	Off				10,000 points
		On	On	On				20,000 points $
		On	Off	On				30,000 points
		On	Off	Off				40,000 points
		Off	On	On				50,000 points
		Off	On	Off				60,000 points
		Off	Off	On				70,000 points
		Off	Off	Off				No bonus life
Off	Off							2 lives per game
On	On							3 lives per game $
On	Off							4 lives per game
Off	On							5 lives per game

Settings of 4-Toggle Switch on Auxiliary PCB *(at D/E2)*.

Not Used				
		Off	Off	Game difficulty*
		Off	On	Modium
		On	Off	Easy
		On	On	Hard
				Medium $
	Off			Minimum rating range: 1, 3, 5, 7, 9 $
	On			Minimum rating range tied to high score

$ Manufacturer's suggested settings

** Easy—Enemies move slower and one less enemy shot on the screen at one time.*

Hard—One more enemy, enemies move faster and 1-4 more enemy shots on the screen at one time.

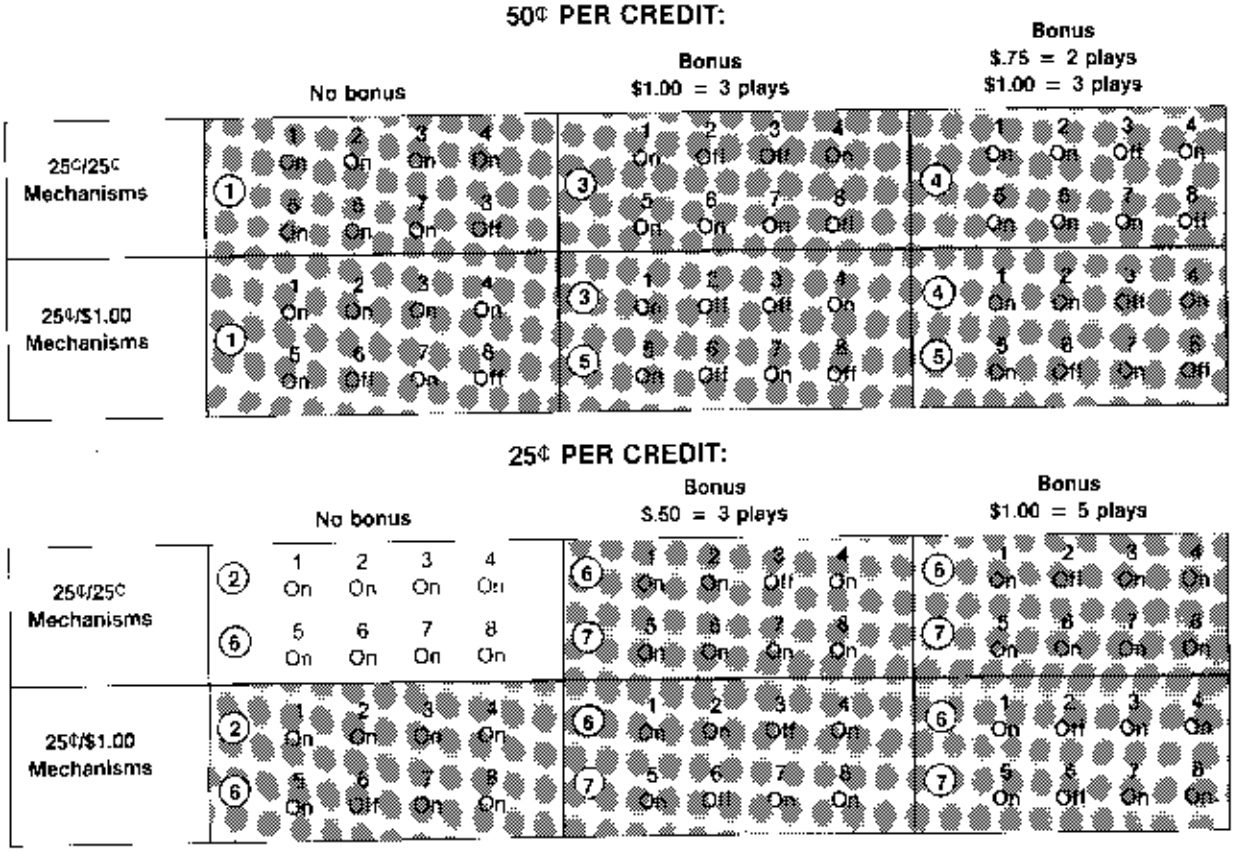
For pricing for "credits," see Figure 8.

Changing toggles 1-5 erases the high score table.

Figure 8 Game Price Settings

The white block below contains Atari's suggested settings. All numbers 1 thru 8 are toggle settings on the 8-toggle switch at location N13, on the Tempest™ Analog Vector-Generator PCB.

Circled numbers refer to game pricing labels you should use with each situation (labels are below). Use the label no. 6 (indicated with ⑥) only if you set toggle 8 at PCB switch assembly L12 to off.



Game Pricing Labels:

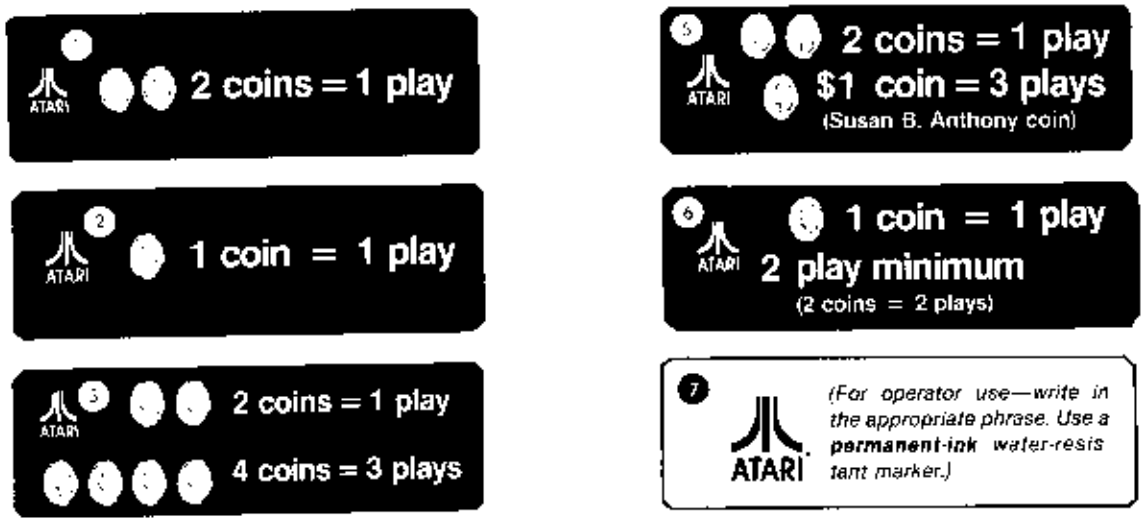


Figure 8 Game Price Settings, continued

The table below contains the switch settings for those options relating to game price, coin mechanism multipliers, bonus play, demonstration and freeze mode. This information is useful if you want to view all 99 levels of play or freeze the action, if you need to temporarily set the Tempest™ game on free play, or if you have German coin mechanisms in your door.

To achieve bonus plays, all coins must be inserted before pressing the start button. Use game pricing label no. 6 **only** if you set toggle 8 at PCB switch assembly L12 to **off**.

The Demonstration Mode** allows you to choose any level (1-81) in the ready-to-play mode and accelerate through the tubes without having to kill the enemies. Freeze allows you to stop the action. The score is zeroed at the end of the game in this mode.

Set the toggles per the table below for the Demonstration Mode. Next, rotate the control knob. You may choose level 1 through 81 during the ready-to-play mode. Press either START button to accelerate through the tubes. Press the FIRE button to clear the spikes at the bottom of the tube. To freeze play, set switch 1 to off.

Toggle Settings of 8-Toggle Switch on Tempest Analog Vector-Generator PCB *(at N13)*

1	2	3	4	5	6	7	8	Option
						Off	On	Free play
						Off	Off	1 coin* for 2 credits
						On	On	1 coin* for 1 credit $
						On	Off	2 coins* for 1 credit
				On	On			Right coin mech × 1 $
				On	Off			Right coin mech × 4
				Off	On			Right coin mech × 5
				Off	Off			Right coin mech × 6
			On					Left coin mech × 1 $
			Off					Left coin mech × 2
On	On	On						No bonus coins $
On	On	Off						For every 2 coins* inserted, game logic adds 1 more coin*
On	Off	On						For every 4 coins* inserted, game logic adds 1 more coin*
On	Off	Off						For every 4 coins* inserted, game logic adds 2 more coins*
Off	On	On						For every 5 coins* inserted, game logic adds 1 more coin*
Off	On	Off						For every 3 coins* inserted, game logic adds 1 more coin*

Demonstration and Freeze Mode**

On	Off					Off	On	Demonstration Mode
Off	Off					Off	On	Demonstration-Freeze Mode

**In the U.S., a "coin" is defined as 25¢. In Germany a "coin" is 1 DM.*

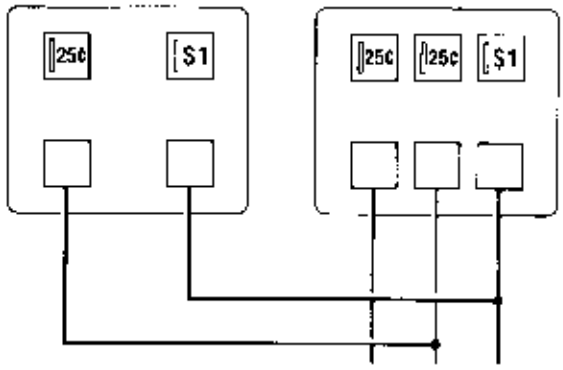
*** **If you press RESET during this mode, game will lock up. To recover, set switch 1 to on.***

$ Manufacturer's suggested settings

2. Coin Mechanism Multipliers

Since early 1980, Atari has made available its new coin door which has either two or three coin mechanisms. All recent Atari game PCBs identify the different coin mechanisms in a certain pattern.

The right coin mechs are all the same to the game's logic, regardless of whether you have two or three mechs in your door. In addition, the logic sees the left mech in a 2-mech door and the center mech in a 3-mech door as the same (refer to the diagram to the right).



This pattern is important for you to know, so you can correctly set the "multipliers" for each coin mech. The multipliers determine how much each coin mech will be worth to the game's logic.

The basic unit of measurement is 25¢, which equals a multiplier of ×1. Therefore, if you have a 25¢/25¢/$1 coin door, you will probably want to set the center and right option-switch multipliers at ×1/×4. (The left coin mech in a 3-coin mech door always has a value of ×1—you cannot change its value.)

You can set these multipliers with toggles 4 through 6 on the Tempest™ Analog Vector-Generator PCB switch assembly at location N13. For exact settings of these toggles, refer to Figure 8.

3. Examples of Game Price Settings

Figure 8 explains the game price settings, giving twelve examples of the most common U.S. situations. The toggles mentioned in Figure 8 are all in the switch at location N13; they **only** relate to game price, coin mech multipliers, and bonus plays.

Figures 7, 8 and 9 provide "$" symbols indicating Atari's recommended settings. All toggles are preset in the **"on"** position as per these recommendations. However, you may change the settings to suit your individual needs.

Figure 9 Coin Counter Option Settings

[These toggles determine which coin mechanisms activate which counters]

Toggle Settings of 4-Toggle Switch on Analog Vector-Generator PCB (K10/11)				Two coin acceptors in the coin door:	Three coin acceptors in the coin door:*
4	3	2	1		
Not Used	*Not Used*	On	Off	Both acceptors activate all coin counters simultaneously.	Left acceptor activates one coin counter; center and right acceptor activate another coin counter. *Not for any currently designed 3-mech coin door.*
		Off	On	Both acceptors activate 2 counters separately. **$$**	Left and center acceptor activate one coin counter; right acceptor activates another coin counter.
		Off	Off	Both acceptors activate 2 counters separately.	Left, center and right acceptors activate 3 coin counters separately. **$$$**
		On	On	Both acceptors activate all coin counters simultaneously. **$**	All 3 are same denomination and they activate all coin counters simultaneously.

***$** Manufacturer's suggested settings for games with 1 coin counter.*

***$$** Manufacturer's suggested settings for games with two coin counters.*

***$$$** Manufacturer's suggested settings for games with optional second and third coin counters.*

** See Drawing Package DP-190 for additional components required for operating the third coin counter.*

F. Game Play

Atari's Tempest™ game is a one- or two-player game with a color X-Y or vector-generator monitor. This new monitor, with its 3-color guns and higher voltage, has the same technology that was used in Atari's black-and-white X-Y monitors. However, this new monitor displays dazzling color and unique visual effects in a spectacular three-dimensional video display.

Tempest™ introduces additional new features:

- Skill-Step™ with 99 skill levels of play
- Operator-information display
- Demonstration mode with freeze

Skill-Step™ allows a player to start a game at the same level as was previously achieved (he must start the next game within 30 seconds), without having to start over at the beginning levels. Therefore, skillful players continue to be challenged while less experienced players try to master higher levels. The **99 skill levels** of play include 16 different playfields and 6 different targets.

The **Operator-Information Display** is a special sequence in the self-test mode displaying game-time information: number of seconds the game has been on and been played and the average game time. This display lists the number of one- and two-player games played, option switch settings, number of lives, level of difficulty, bonus levels, credits, and game pricing information. In this mode, you may clear the special "permanent" memory by erasing the high-score table or game-time information. The word *ERASING* appears on the screen during either of these processes.

The **Demonstration Mode** allows you to accelerate through 98 tubes by blasting down the tube toward the far rim without having to kill the enemies. Also, you can **freeze** game action so you can enjoy the dazzling effects of your journey through the tubes.

In addition to these new features, Tempest™ has five possible modes of operation: attract, ready-to-play, play, high score initial and self-test. Self-test is a special mode for checking the game switches and computer functions. You may enter self-test at any time (if you enter Part 1 all credits are retained; enter Part 2 and all credits are cancelled). Wait at least eight seconds after a game has been played before entering self-test or turning off the power. Otherwise, you may erase the high score table.

1. Attract Mode

The attract mode begins when power is applied to the game, after a play or high score initial mode, or after self-test. This mode is continuous and is only interrupted when a game is paid for and accepted, or when in self-test. In the attract mode, the monitor displays one of three possible pictures.

One of the pictures is the high score display which lasts for 12 seconds. The score(s) from the last game is at the top of the screen. Following is the highest score and player's initials. The top eight scores and their matching initials appear in the center of the screen. The ranking (from 1 to 99) for the last player(s) appears under the high score table.

© *MCMLXXX ATARI* appears three lines from the bottom of the screen. Next, if the 2-game option is selected, *BONUS EVERY 20,000* alternates with *2 CREDIT MINIMUM*. Credits and game price appear on the bottom line of the screen.

Finally, at the top of the screen, the words *INSERT COINS* and *GAME OVER* alternate if there are no game credits. The words *PRESS START* and *GAME OVER* alternate if there are game credits.

A second picture, lasting for 12 seconds, is the *TEMPEST* logo. In this sequence, a multicolored square shrinks toward the center of the screen where a very small *TEMPEST* logo appears. The word *TEMPEST* enlarges in multiple images and changes color. In addition, © *MCMLXXX ATARI* appears on the lower half of the screen.

The next picture, lasting from 5 to 60 seconds, shows the last game score, the highest score and its initials, and the words *PRESS START* or *INSERT COINS* alternating with *GAME OVER* at the top of the screen. Credits, game price, and bonus-life information are at the bottom of the screen. In the center of the screen, the picture duplicates a typical game-play sequence with the computer controlling the shooter.

The shooter rotates on the end of the tubelike surface that is nearest to the player. Enemies land on the end of the tube that is farthest away from the player and climb toward the shooter. The shooter fires down the tube at the approaching enemies. This scene ends when either the shooter gets shot or spiked or when the shooter kills all the enemies and blasts through the tube into space, and lands on the next playfield.

If a player has credits and spins the control-panel knob, the attract mode ends and the words *PRESS START* appear in the center of the screen. Above this is the score from the last game and the highest score and its initials. Below the words *PRESS START* are credits, game price and bonus life information.

If you select the 2-credit minimum option and a player inserts enough money for one credit, the messages *INSERT COINS* and *2 CREDIT MINIMUM* appear in the center of the screen until sufficient coins are inserted for game play.

2. Ready-to-Play Mode



This mode begins when sufficient coins are accepted for a game. Each player rates himself by rotating the control knob. The knob moves a square which frames the level he wishes to select. The surface shape and bonus points for that level are also shown on the screen.

Bonus point incentive encourages play at a higher level, once that level has been reached. For example, starting at level one and playing through level nine awards 34,000 points. Starting at level nine and playing through that level awards 59,000 points. If a player reaches a higher level, he may continue to play near that level by pressing start before the attract mode is over. For example, if a player ended his last game in level 20, he may choose level 1, 3, 5, 7, 9, 11, 13, 15, or 17.

The ready-to-play mode ends when any push-button is pressed or 10 seconds elapse.

3. Play Mode

In the play mode, a player-controlled, yellow claw-like shooter moves around on a three-dimensional tubelike playfield. The shooter rotates on the end of the tube that is nearest to the player. Enemies land on the end of the tube that is farthest away from the player to climb toward and attack the shooter. The shooter fires down the tube at the approaching enemies.

When a player kills all the enemies on a tube, he blasts through the tube, flies through space, lands on a new tubelike playfield, and fights the enemies on that playfield. A player scores points by shooting enemies and by blasting through the tube to a new level. The player loses a life when killed by the enemy. The game is over when all the player's lives are gone.

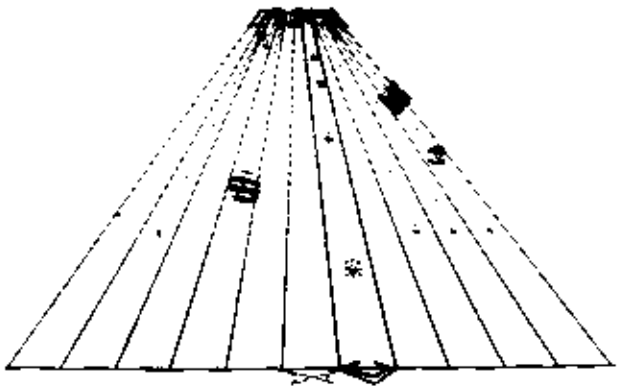
All action occurs on one of sixteen suspended tubelike **playfields.** The three-dimensional tube surfaces are viewed from the top, so the view of the first playfield (a circle) is like looking into a well. Each playfield is made of 16 rails which connect the nearest to the farthest rim. The playfield color changes every 16 levels: level 1 is blue, level 17–red, level 33–yellow, level 49–cyan, 65–*invisible* and 81–green.

In addition, other events cause playfield color variation. The shooter causes the two rails on which it sits to change color. Superzap causes the playfield to flash as enemies are zapped. Playfield rails flash rainbow colors when a player earns a bonus life. Pulsar enemies cause sections of the nearest rim to disappear, and during the pulse phase, adjacent rails to flash.

The player's **shooter** is controlled by rotating the control-panel knob. The shooter moves around on the nearest rim of the tubelike playfield. The ends of the shooter always touch two adjacent rails. The rails on which the shooter sit change color (yellow in levels 1-16) which gives a flashlight effect and helps the player see the enemies in his lane.

A player shoots by pressing the fire button: tap it for one or two shots or press it for all eight shots. A shot is extinguished when it hits an enemy, after it passes the far rim or after it plows a certain distance into an enemy spike. A shot is renewed after it is extinguished so there may be a maximum of eight shots on the screen at one time.

A player may use two **superzaps** per level. A first superzap kills all enemies on the playfield at the time of firing. A second superzap randomly kills one enemy on the playfield. The superzap does not affect enemy shots, spikes or enemies not yet landed on the playfield. Superzap is recharged when the player blasts to a new level.



Enemies in the Tempest™ game

Enemy	Description	Level First Appears	Points for Kill
Flipper 	Originates at far rim and rides up two rails. Flips in the tube on near rim. Kills player by flipping onto shooter or by shooting him. Player kills flipper by shooting when it is in the tube or when it is "standing" up. Or use Superzap.	1	150
Tanker 	Originates at far rim or from a spiker. Rides between rails. Carries one or two flippers, fuseballs, or pulsars and expels these when shot or near rim. Kills player by shooting him. Player kills by shooting tanker in the tube. Or use Superzap.	3	100
Spiker 	Originates at far rim. Rides up between rails on spike which it builds. Kills player on contact. Player kills by shooting one or more times.	4	50
Spike 	Originates at far rim and builds up toward near rim. Kills player on contact. Player kills by shooting one or more times.	4	1-3
Fuseball 	Originates at far rim or from Tanker. Quickly rides on one rail, jumps to next rail and seeks out shooter. Kills player on contact. Player kills by shooting when fuseball is jumping between rails. Or use Superzap.	11	250, 500, 750
Pulsar 	Originates at far rim or from Tanker. Rides up and down on two rails. Flips on near rim and seeks out shooter. Kills if player is on same rails when it pulses. flips onto or shoots player. Player kills by shooting pulsar in the tube. Or use Superzap.	20	200

The following hints will help in game play:

- Players should work their way up through the levels to become familiar with game play. Drop down a level if play is too difficult.
- Experienced players should start at highest level possible for maximum points.
- On a new playfield shoot at enemy dots at far rim.
- Shoot the flipper at the top as soon as it starts to flip.
- Use long spikes to reclaim shots and kill enemies (at the top) approaching you from adjacent lanes.
- Avoid shooting fuseball-tankers near the top since emerging fuseballs usually zip up to the top and kill you.
- Use Superzap right before last enemy reaches the top for a few extra points.

4. High Score Initial Mode

This mode begins when a player has one of the eight top scores. First, there is a fireworks display. Next, the high score table appears. Finally, a player enters his initials directly into the table following the instructions at the bottom of the screen. The initials and score are highlighted in a special color. You may bypass this mode by pressing the start button.

All but the three highest scores are erased whenever you enter the self-test mode, or press the RESET button on the game PCB, or turn off the power. This resetting replaces the five lowest scores with fictitious scores and initials.

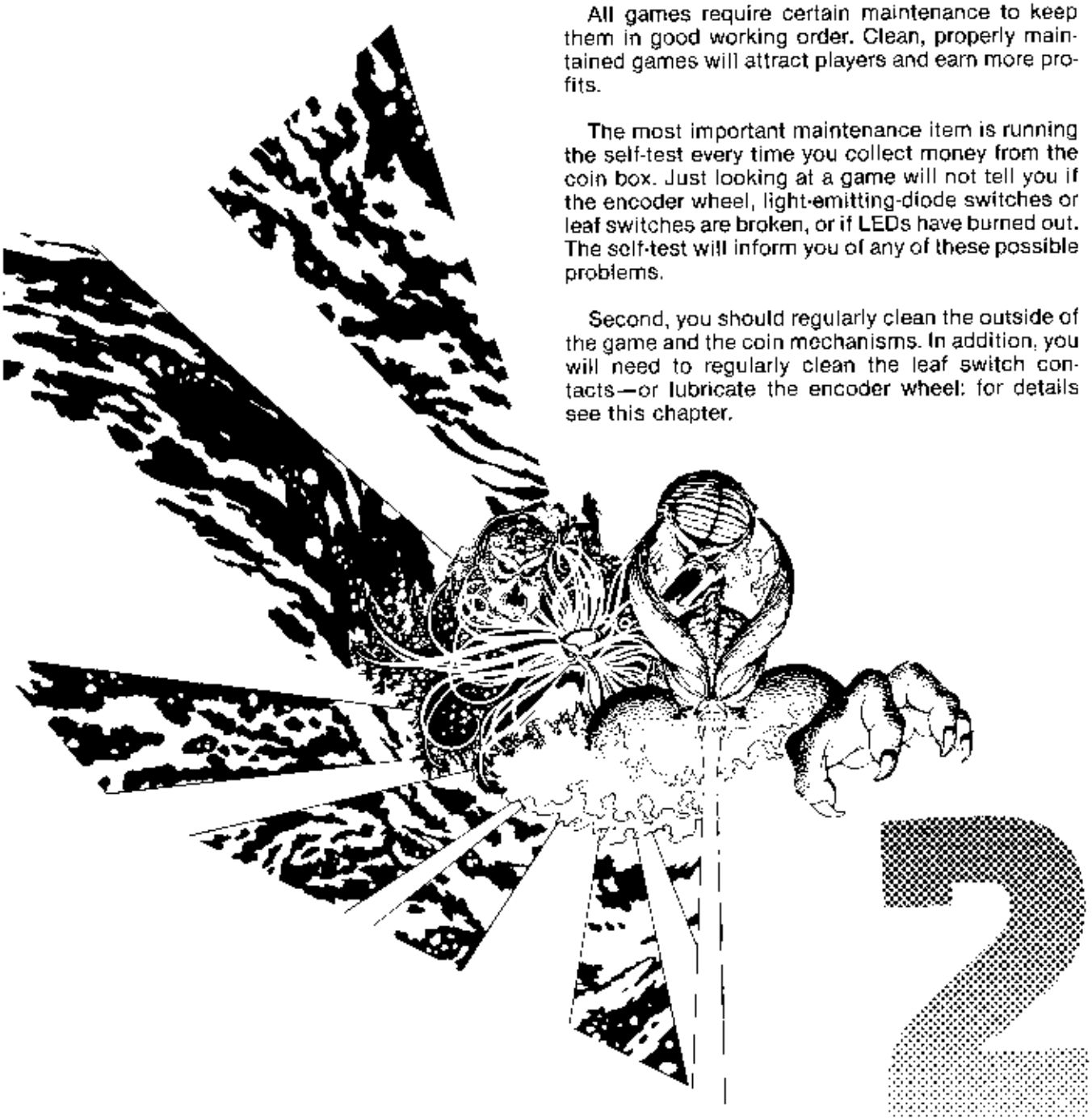
If you change game options, lines per game, bonus level or difficulty, or if you erase the special "permanent" memory, the high score table is replaced with eight fictitious scores and initials. Therefore, the table will always be displayed on the screen, possibly consisting of one or more real scores and players' initials.

Maintenance and Repair

All games require certain maintenance to keep them in good working order. Clean, properly maintained games will attract players and earn more profits.

The most important maintenance item is running the self-test every time you collect money from the coin box. Just looking at a game will not tell you if the encoder wheel, light-emitting-diode switches or leaf switches are broken, or if LEDs have burned out. The self-test will inform you of any of these possible problems.

Second, you should regularly clean the outside of the game and the coin mechanisms. In addition, you will need to regularly clean the leaf switch contacts—or lubricate the encoder wheel: for details see this chapter.



2

A. Cleaning

The exterior of the game cabinet and the metal and acrylic surfaces may be cleaned with any non-abrasive household cleaner. If desired, special coin machine cleaners that leave no residue can be obtained from your distributor.

Do not dry-wipe any of the acrylic panels, because dust can scratch the surface and result in fogging the plastic. The large monitor shield is made of tempered glass and the attraction panel is made of polycarbonate laminated to tempered glass. Both surfaces should be scratch-resistant and easy to maintain.

B. Fuse Replacement

This game contains six fuses—all on the power supply assembly (not including the monitor fuses). Replace fuses only with the same type as listed in Figure 25 of this manual. See the color X-Y monitor manual, TM-183, for the monitor fuse data.

C. The Control Panel

Prior to repairing or replacing any switch on the control panel or prior to removing the monitor, unplug the game. Then open the coin door.

Reach through the opening and open the luggage-style latch, located at each end on the underside of the control panel (see Figure 10). Close the coin door. Lift up on the control panel at the topmost edge and tilt it toward you.

The control panel edge next to the monitor shield has foam tape applied to it. This tape acts as a cushion for the glass and prevents spilled liquids from entering the cabinet interior. Always make sure this tape is in good condition.

NOTE

Adjust switches for a narrow gap. When a switch button is depressed, the resulting wiping action of the contacts provides a self-cleaning feature.

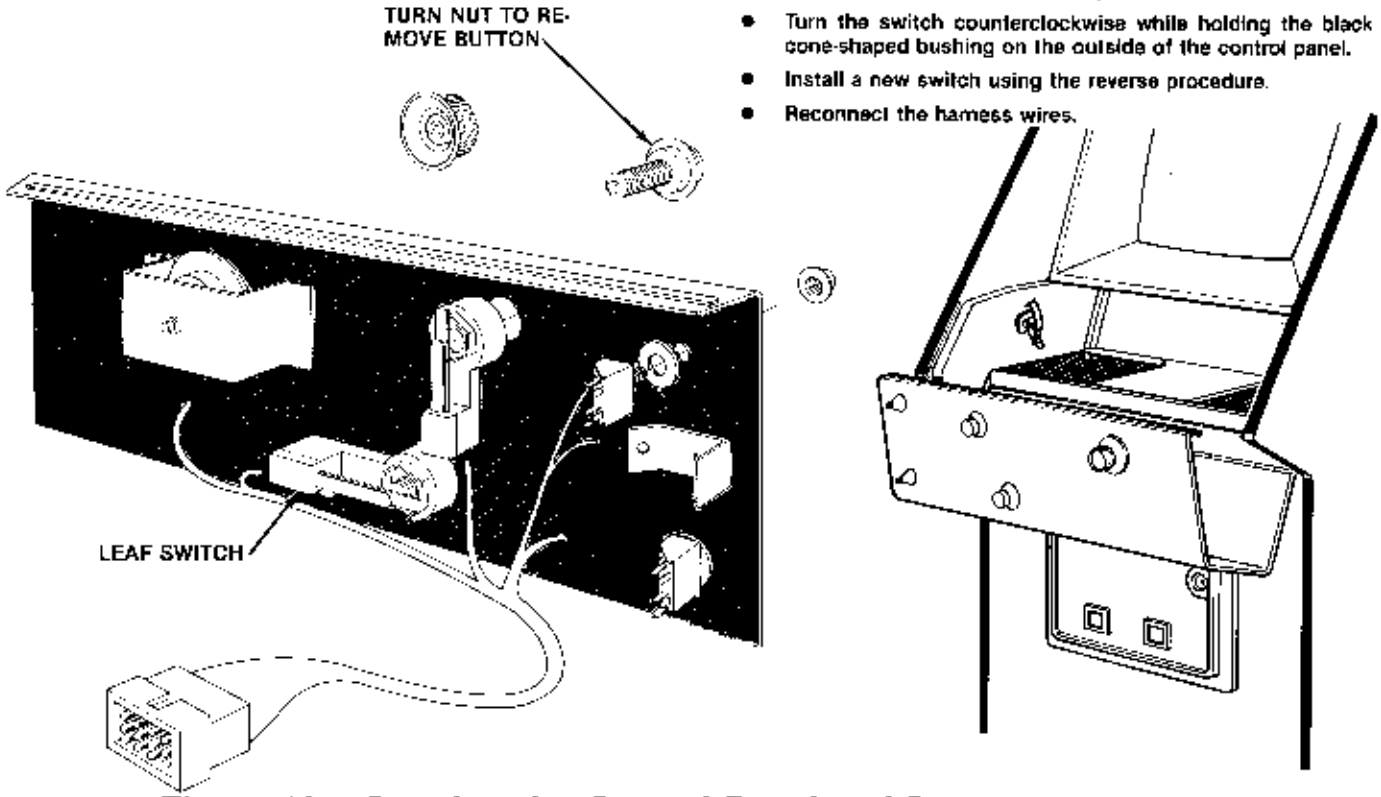


Figure 10 Opening the Control Panel and Replacing Switches

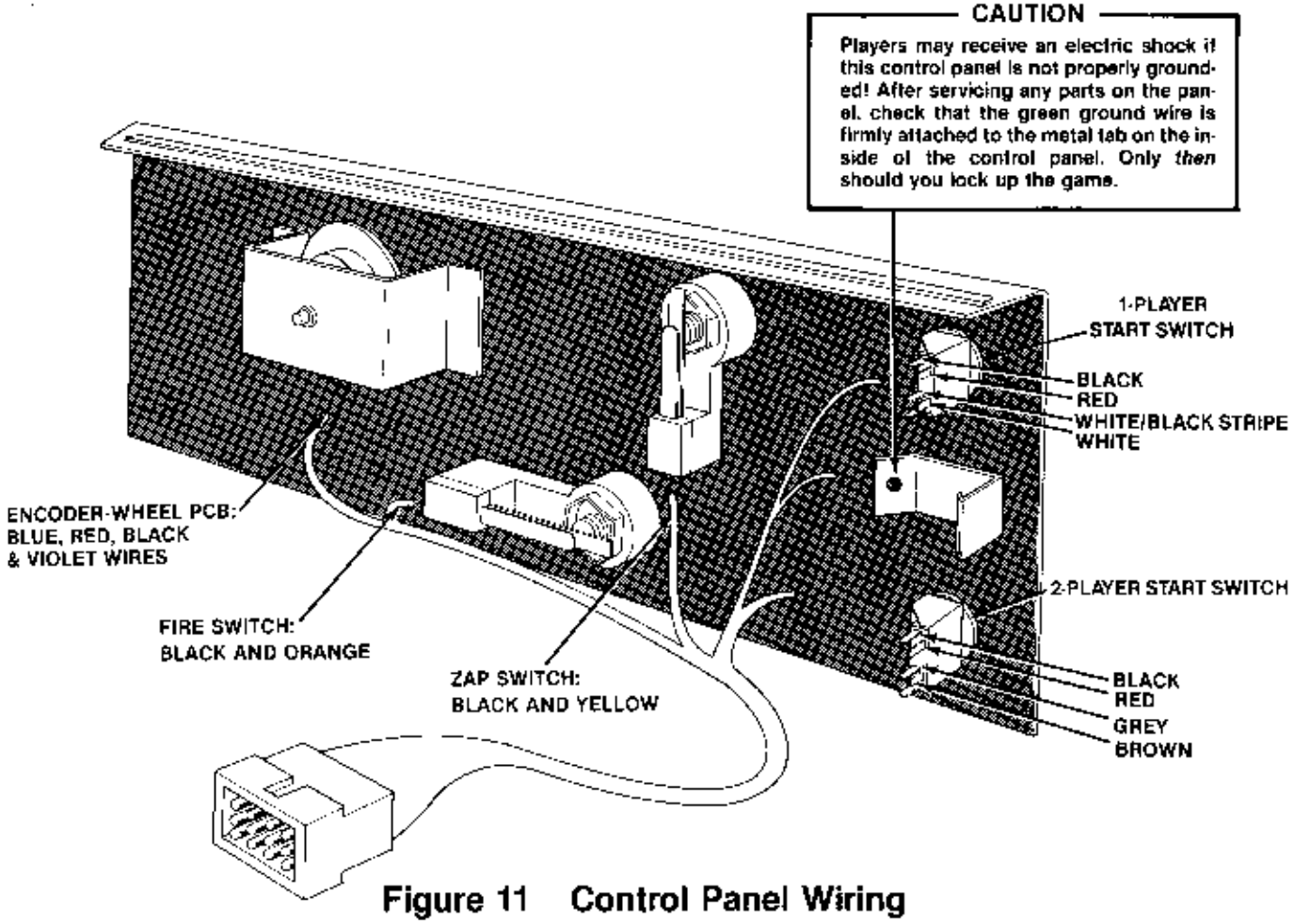


Figure 11 Control Panel Wiring

1. Leaf Switch Replacement

The leaf switches operate on 5 volts at a very low current. Therefore, pitting of these switches would be extremely rare. Probably the only reason that pitting would occur is very high-humidity.

Don't burnish the switch contacts. Burnishing them removes their plating, thus increasing the corrosion of the contacts. **The best method of cleaning the switch contacts is to wipe them with a non-abrasive surface.** A business card works very well.

To replace a leaf switch, remove the screw with a Phillips-head screwdriver—see Figure 10.

If the black button itself needs to be replaced, turn the stamped nut with a wrench in a counterclockwise direction, as seen from the inside of the control panel. The black ring on the outside of the control panel should not spin, due to its design.

2. LED Start-Switch Replacement

The light-emitting diode (LED) switches on the control panel have a very low failure rate. In case a switch should ever be suspect, first test it per the description that follows. To replace the switch, refer to Figures 10 and 11.

- Remove the wires from the suspected switch.
- Set multimeter to ohms scale. Set ohms scale to R x 1, then zero the meter.
- Connect multimeter leads to appropriate LED switch contacts (see Figure 11 for designation of switch contacts and meter lead placement).

  Check contacts (push and release the switch button) for closed and open continuity.

  If the contacts do not operate sharply or always remain closed or open, then replace the LED switch as outlined in Figure 10. Reconnect the wires as shown in Figure 11.

Disassemble in the order indicated. (Circled numbers match the steps described below.)

Close the control panel. Remove the two set screws in the control knob.
Open the control panel. Unplug the four-pin harness connector. Remove the carriage bolts that hold the encoder wheel frame to the control panel.

To Lubricate:

1. Loosen the two socket-head screws that attach the hub to the shaft.
2. Unsnap the bottom clip ring. Pull the shaft up and out of the frame being careful not to drop the flywheel.
3. Lightly lubricate the washer and the two nylon bushings that snap into the top and bottom the the frame. Apply Nyogel 779 to a cotton swab for this process.

To Replace the Encoder Wheel:

4. Remove the three socket-head screws that attach the top to the bottom flywheel.
5. Remove the etched encoder wheel and replace it with a new one. Reassemble in reverse, making sure that you *center the new wheel between the photosensor device.*

To Replace the Coupler PCB:

6. Remove the two socket-head screws, lock washers and hex nuts that hold the coupler PCB to the frame.
7. Remove the coupler PCB and repair as needed.

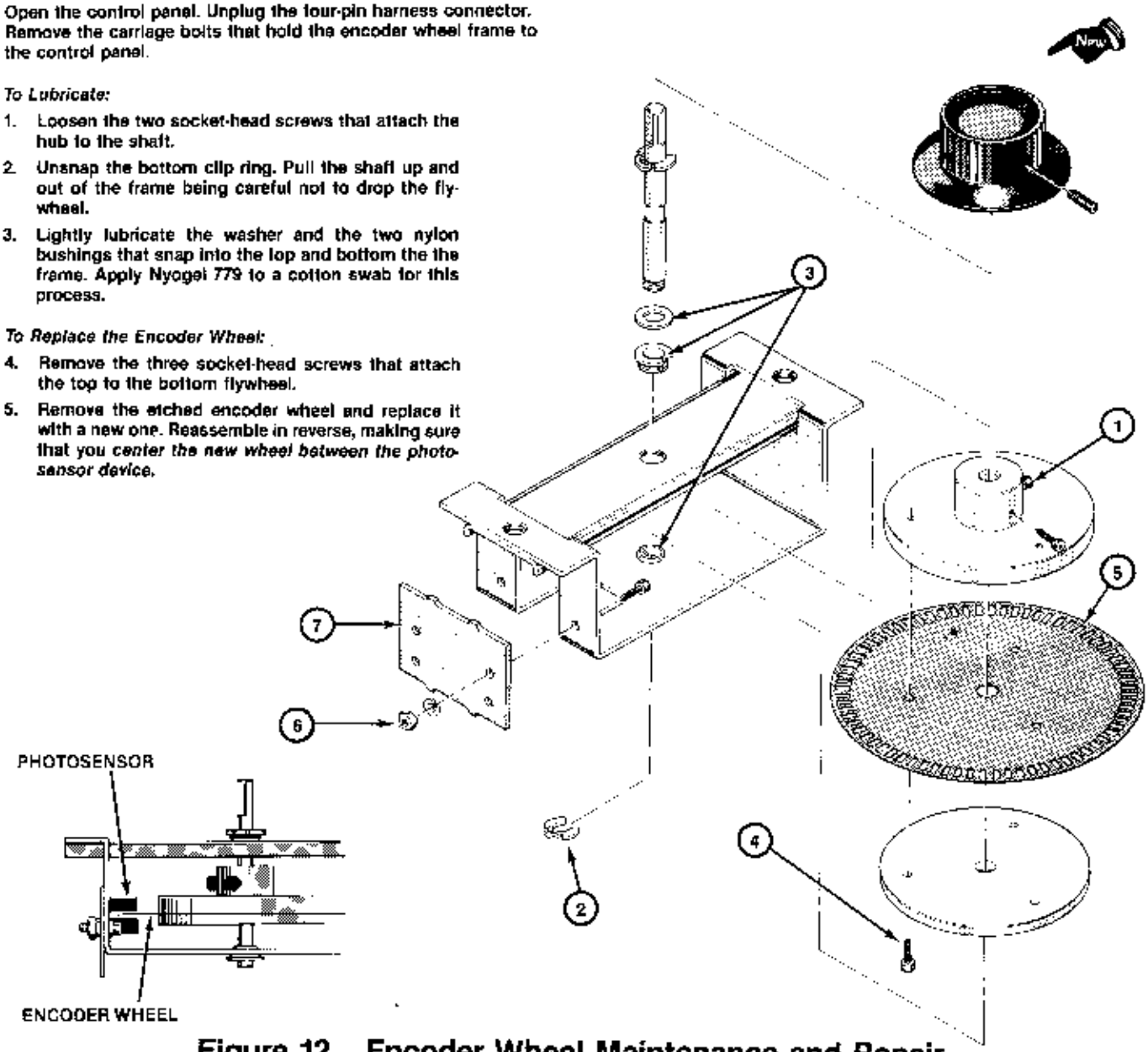


Figure 12 Encoder Wheel Maintenance and Repair

3. Encoder Wheel Maintenance and Repair

The encoder-wheel control requires lubrication of its bushings approximately every 10,000 credits and as you deem necessary. To lubricate or repair the control, remove the control from the control panel and disassemble it as illustrated in Figure 12.

For lubrication, use only Nyogel 779 lubricant *(Atari part no. 178027-001)* on the two bushings of the encoder-wheel control.

For further instructions on how to replace the coupler PCB or the encoder wheel, see Figure 12.

D. Monitor Removal

The following procedure should only be performed by a **qualified service technician.**

WARNING

Shock Hazard

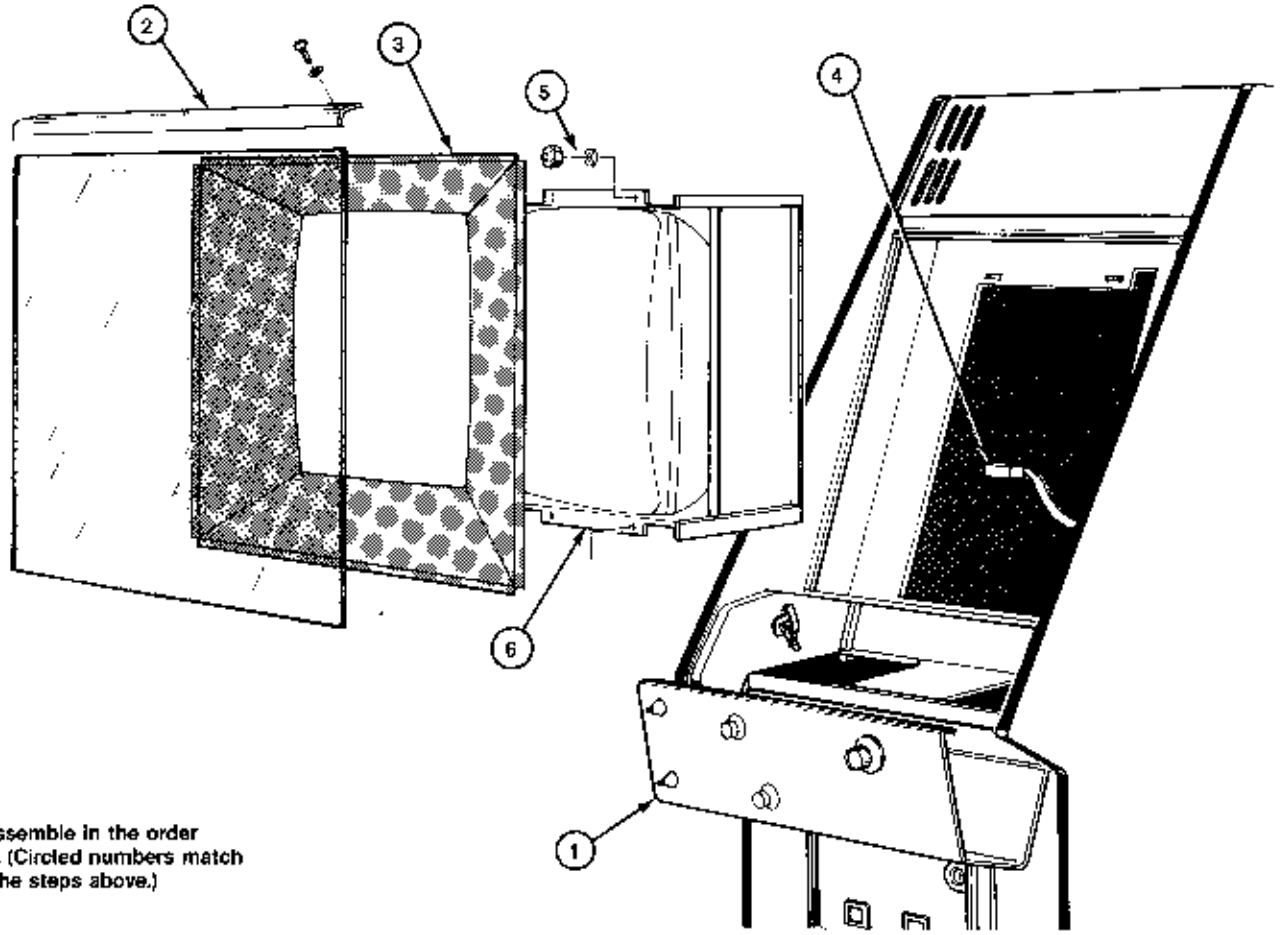
High voltages may exist in any television or monitor, even with power disconnected. Use extreme caution and do not touch electrical parts of the yoke area with your hands or with metal objects in your hands!

Implosion Hazard

If you drop the monitor and the picture tube breaks, **it will implode!** Shattered glass and the yoke can fly 6 feet or more from the implosion. Use care when replacing any monitor.

To remove the color X-Y monitor, follow steps 1 through 6 listed below. Refer to Figure 13.

1. Open the control panel as described in *Section C, Opening the Control Panel.* **Be sure the game is unplugged from its wall outlet!**
2. Remove the monitor shield retainer at the top of the monitor shield. Unscrew the three Allen-head screws that secure the monitor shield retainer to the game cabinet. Lift out the tempered glass monitor shield.
3. Carefully remove the four staples that secure the cardboard bezel and remove the bezel. As an extra precaution, *we highly recommend you discharge the high voltage from the picture tube.*
4. Open the rear access panel and unplug the 15-pin monitor harness connector. Unfasten the monitor chassis from the monitor bracket.
5. Remove the four sets of hardware that secure the monitor frame to the wood frame.
6. Carefully pull the monitor chassis out the front of the game.



Disassemble in the order indicated. (Circled numbers match the steps above.)

Figure 13 Monitor Removal

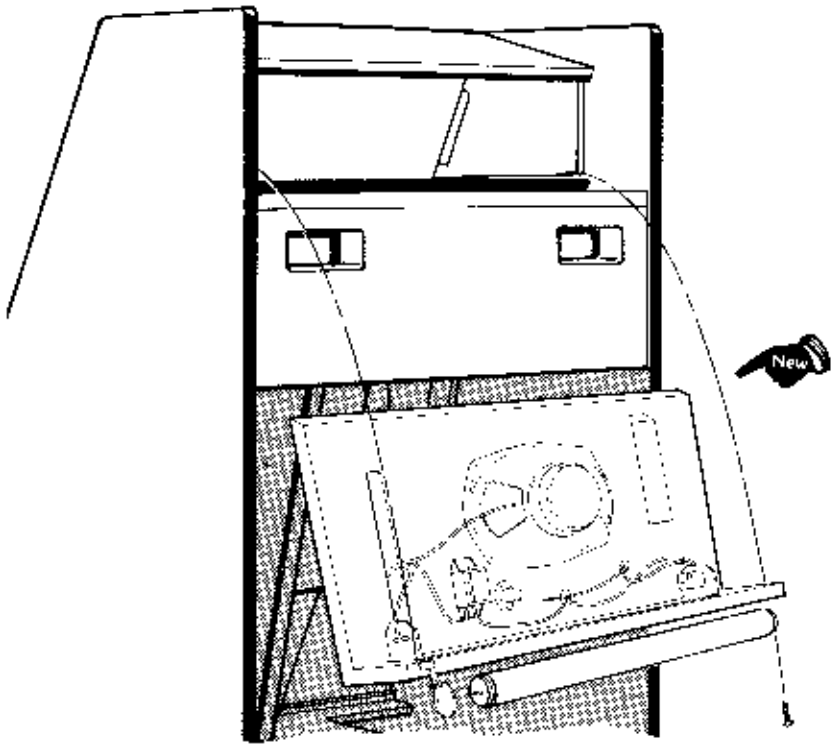


Figure 14 Fluorescent Tube and Speaker Replacement

E. Fluorescent Tube and Speaker Replacement

⚠ WARNING ⚠

If you drop a fluorescent tube and it breaks it will implode! Shattered glass can fly 6 feet or more from the implosion. Use care when replacing any fluorescent tube.

To replace the speaker or the white fluorescent tube behind the front graphics attraction panel, follow this procedure (see Figure 14):

1. Be sure the game is unplugged from the wall outlet. Remove the four Phillips-head screws from the top panel at the back of the game. Grasp the handle and slide out the entire assembly. The fluorescent tube and speaker harness has extra length, so you can pull it out about seven inches. If you need to unplug it, the harness connector is accessible from the access panel.
2. To replace the speaker, unplug the two plug-in connectors on the speaker. Unplug the harness and slide the wood board out of the game. Remove the hardware that attaches the speaker to the board. Replace the speaker, reinstall the wood board and reconnect the harness.
3. To replace the fluorescent tube, remove the gray cardboard locking tab at each end of the tube. Slightly rotate the tube up or down, and carefully remove it from the lampholders.
4. Replace with a new tube. Do not snap the tube in vigorously—**you may break it, causing an implosion!** Replace the locking tabs.
5. Check that the green ground wire is securely attached to the large metal bracket and the ballast transformer on the wood panel. If the tube is not grounded, it may not start.
6. Slide the wood board back into the game and replace the rear panel.

F. Printed-Circuit Board Removal

You may wish to remove the Analog Vector-Generator printed-circuit board (PCB), Auxiliary PCB or the Regulator/Audio II PCB for service or inspection. To do this, refer to Figure 15 and proceed as follows:

1. Open the rear access panel.
2. Locate the hardware that secures the PCBs to the cabinet, and remove this hardware. (The game PCBs have one set of this securing hardware: a screw, washer and two spacers. The Regulator/Audio II PCB has two sets of this securing hardware: a screw and washer.)
3. If you are removing the game boards, first remove the two machine screws or tie wraps that fasten the edge connectors to the game PCBs. Then unplug the edge connectors on the game PCBs. If you are removing the Regulator/Audio II PCB, disconnect the five small harness connectors on this board.
4. Carefully slide the PCBs straight out of their slots. The Analog Vector-Generator and Auxiliary PCBs slide out together. Be careful not to twist the boards, as this may loosen connections or components. Replace or repair as required.
5. Reinstall the PCBs, making sure that the connectors are properly plugged in. Note that they are keyed to fit on only one way, so if they don't slip on easily, don't force them! **A reversed connector will probably damage your game** and will void the warranty.
6. Replace the securing screws and fiber washers in the PCB. Reinstall the fasteners used to secure the edge connectors to the PCB. Close and lock the rear access panel.
7. Check that the operation of the game is correct and **perform the self-test.** This is especially important with any game when you repair a PCB. Normally the **only** adjustments on this game are option switch changes (made on the 8-toggle DIP switch). Unless you are a qualified technician, ***do not turn any of the knobs near the game PCB's edge connector. Also do not turn the small knobs on the Regulator/Audio II PCB.***

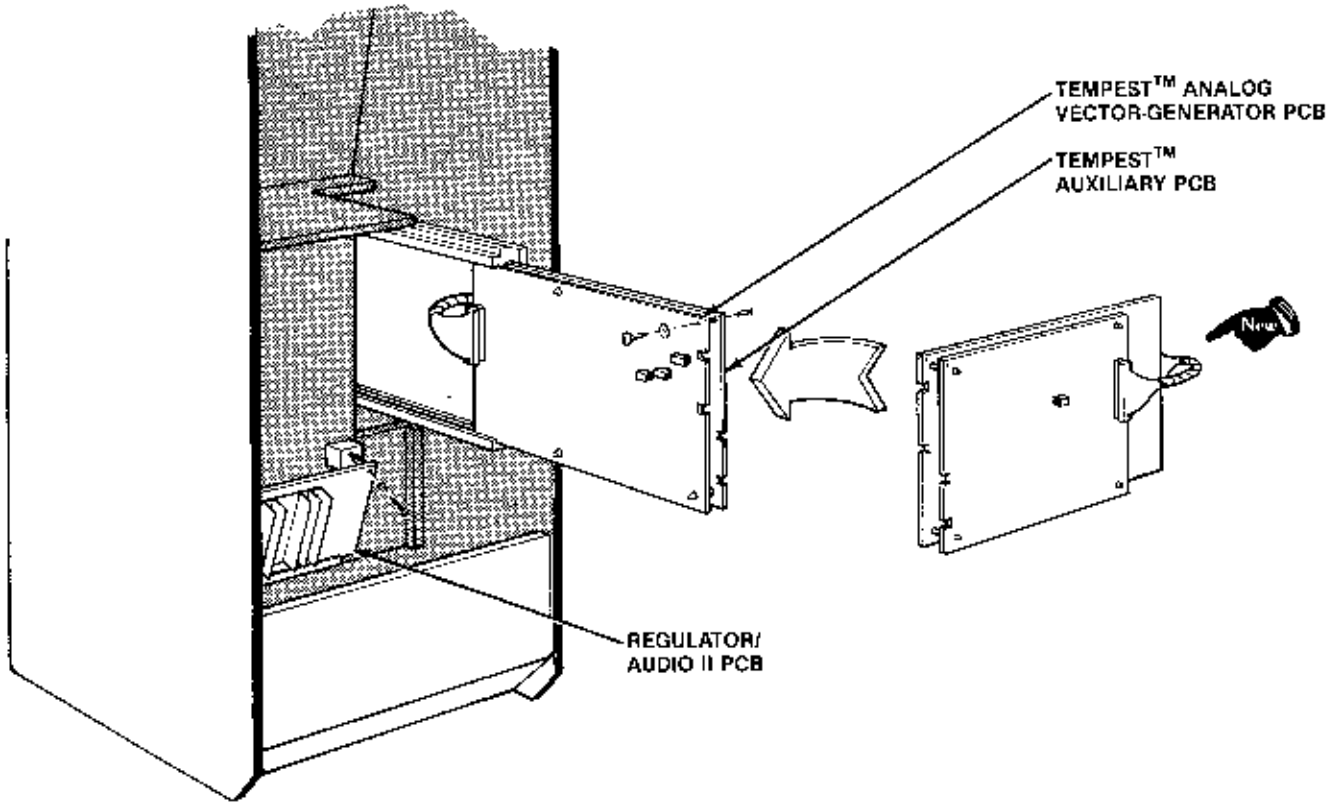


Figure 15 Printed-Circuit Board Removal

G. Game Operation

With this manual you received three large sheets that contain the wiring and schematic diagrams for the Tempest™ game. Sheet 1, Side A, includes information that shows the arrangement of these diagrams. These diagrams explain the functions of the circuits and define inputs and outputs.

In addition, you received the Tempest Troubleshooting Guide, which includes information on signature analysis, CAT Box tests and the memory map.

Atari's Tempest is a microprocessor-controlled game. The microprocessor is contained on the game PCB. The game PCB receives switch inputs from the control panel and coin door. These inputs are processed by the game PCBs and output to the monitor, Regulator/Audio II PCB, and control panel.

The color X-Y monitor receives signals for the X and Y axes and three color intensity signals (red, green and blue). Since the location of the beam in the monitor is controlled by the X- and Y-axis outputs of the game PCB, the game PCB does not contain a standard sync circuit. The X-and Y-axis inputs to the monitor step in increments of approximately 760 steps for the X (horizontal) axis, and approximately 1000 steps for the Y (vertical) axis. The three intensity signals control the brightness of the three electron guns (red, green and blue).

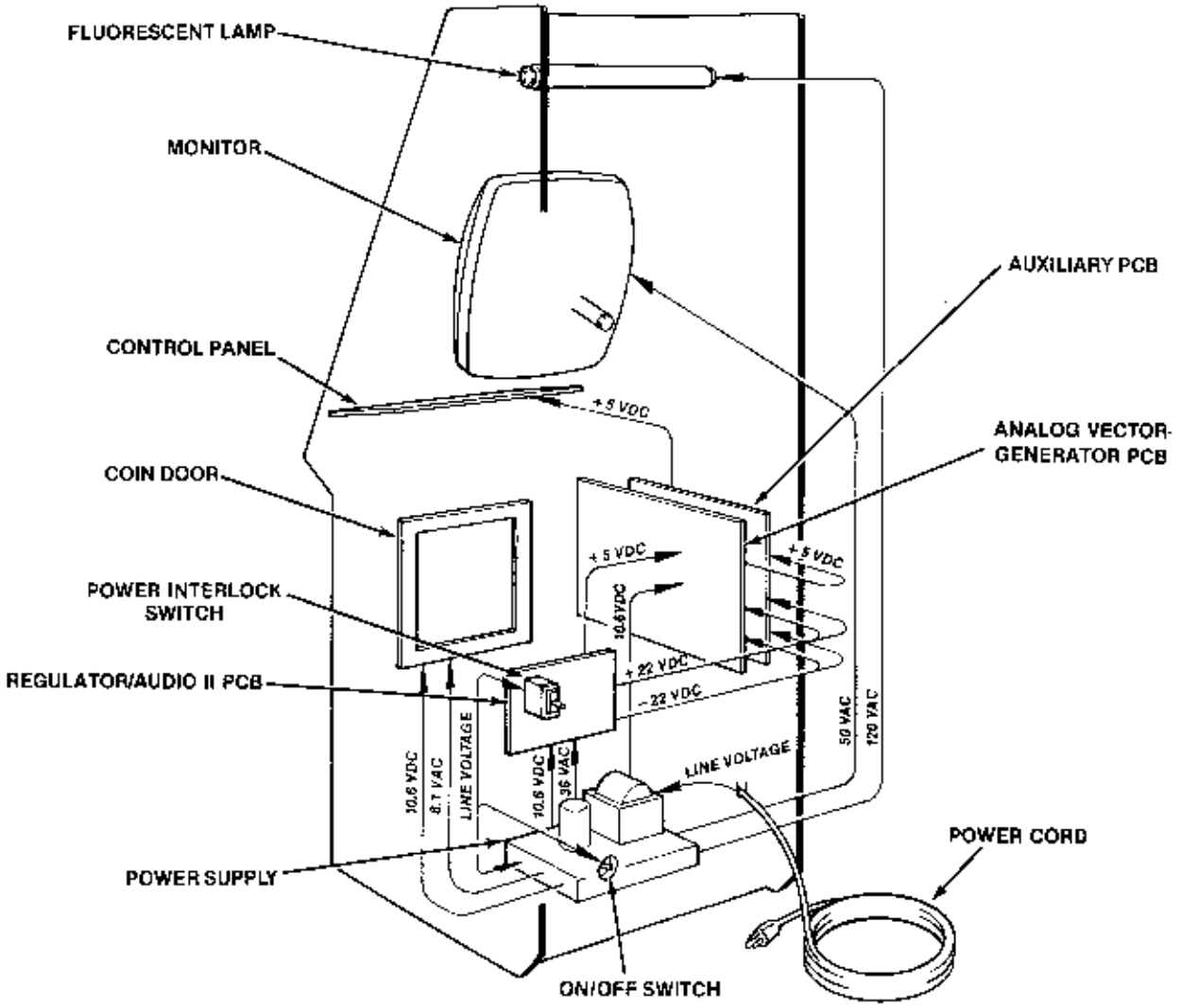


Figure 16 Power Distribution

The Regulator/Audio II PCB performs three functions: 1) it regulates the voltages from the power supply to ±5 VDC, 2) it rectifies and filters ±22 VDC, and 3) it amplifies the audio output from the Auxiliary PCB.

Specifically, the +5 VDC from the Regulator/Audio II PCB provides most logic power to the Analog Vector-Generator and Auxiliary PCBs: ±22 VDC is regulated on the Analog Vector-Generator PCB to produce ±15; and +22VDC provides power for the audio output of the Auxillary PCB. The audio output from the Regulator/Audio II PCB directly drives the game speaker and is controlled by the volume control, mounted inside the coin door.

The power supply is the source of all voltages in the game. These voltages are protected by five fuses in the fuse block on the power supply chassis. The primary winding of the power supply transformer is protected by the cartridge-type fuse in the power supply chassis.

Figure 16 illustrates the distribution of power in this game. Figure 17 illustrates the distribution of signals.

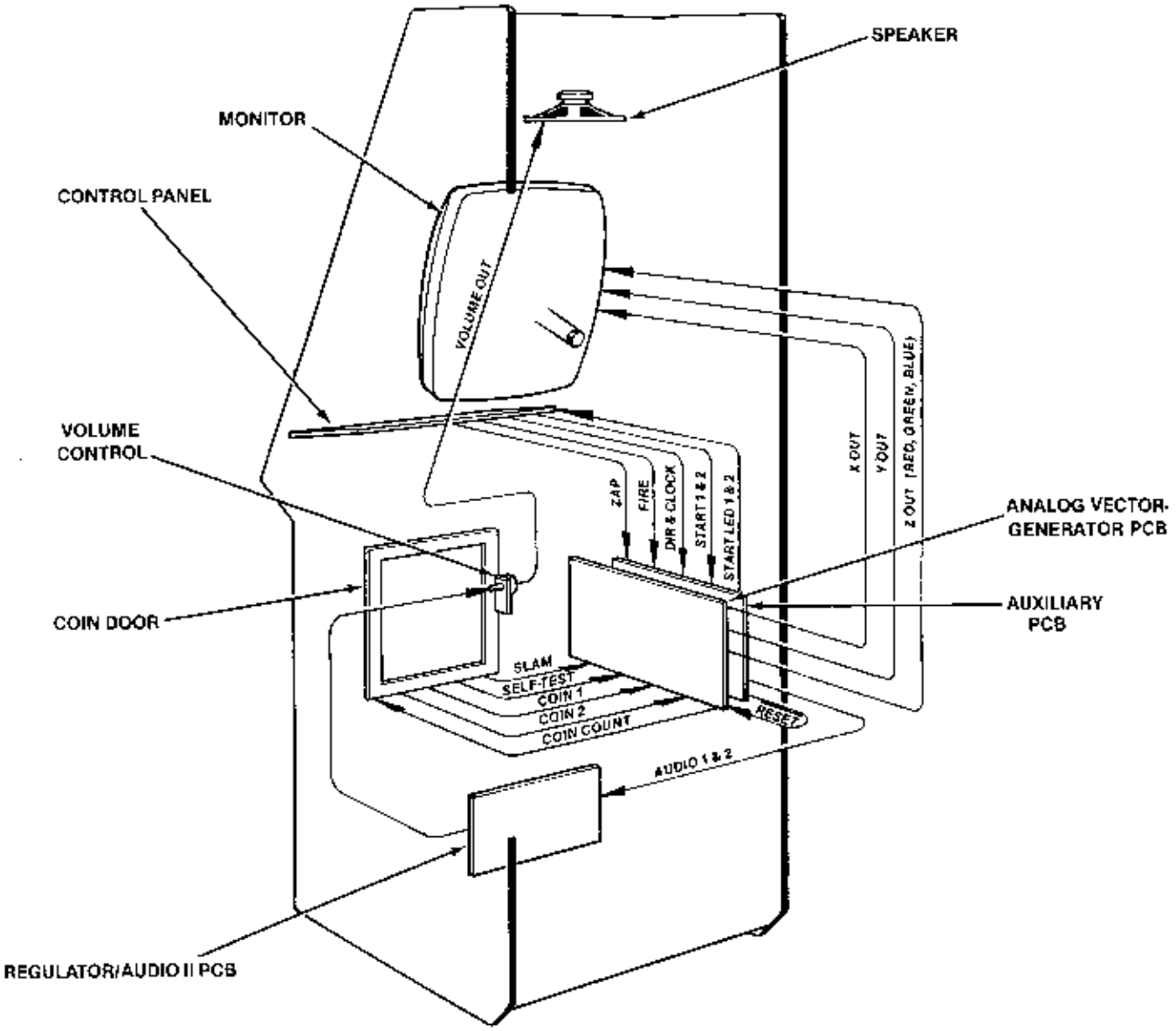


Figure 17 Signal Distribution

Illustrated Parts Lists



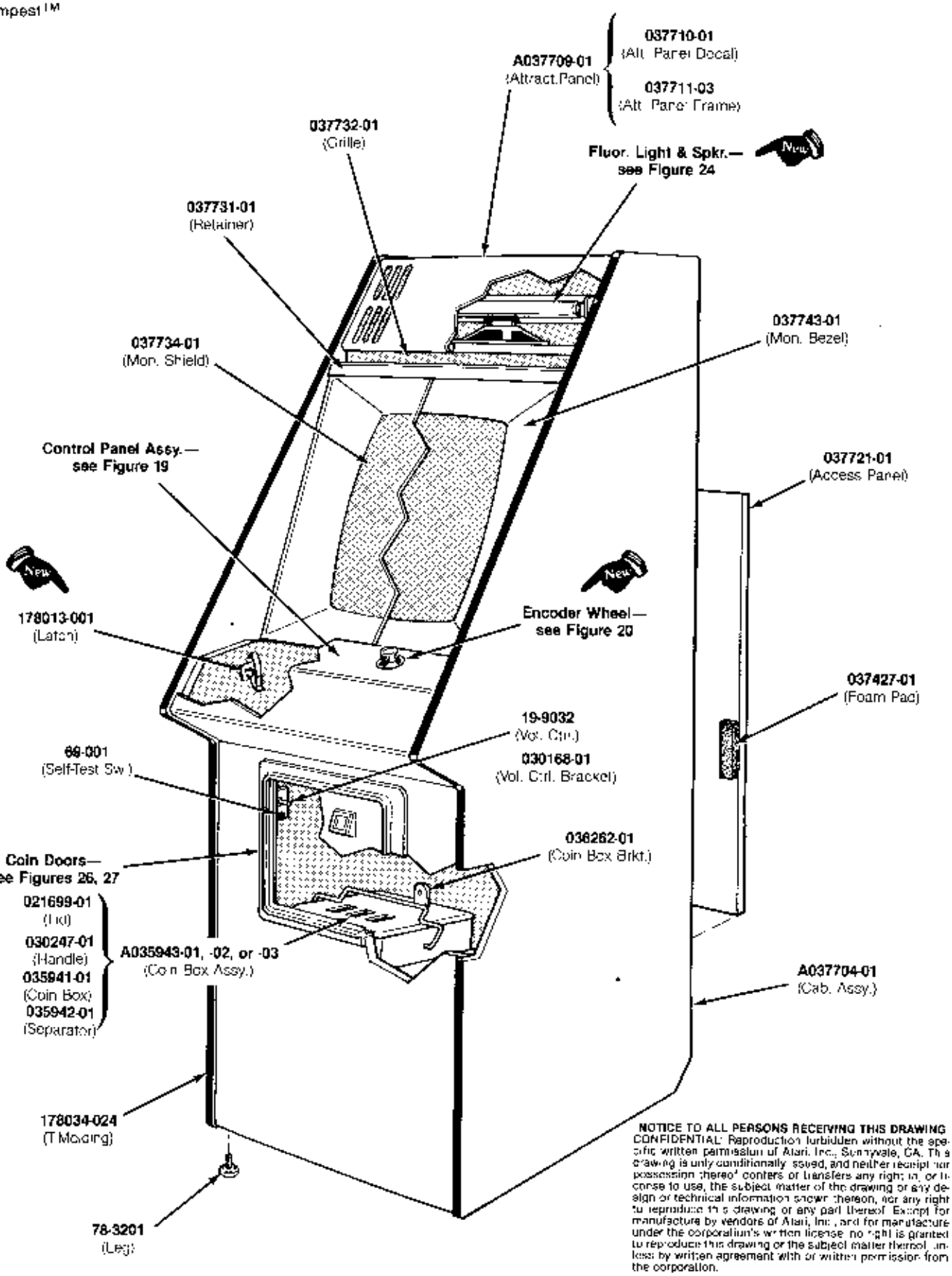
This chapter provides the necessary information for you to order replacement parts for the Tempest™ game. Please note that, for simplicity, **common hardware has been deleted** from most of these parts lists. This includes screws, nuts, washers, bolts, etc.

The parts lists are arranged in alphanumeric order. For example, all "A-" prefix numbers come first. Following these are numbers in sequence evaluated up to the hyphen, namely 00- through 99-, then 000598- through approximately 190000-.

When ordering parts from your distributor, give the part number, part name, applicable figure number of this manual, and serial number of your game. This will help to avoid confusion and mistakes in your order. We hope the results will be less downtime and more profit from your game.

Atari Customer Service numbers are listed on page vi for your convenience.

3



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Figure 18 Cabinet-Mounted Assemblies
A037702-xx B

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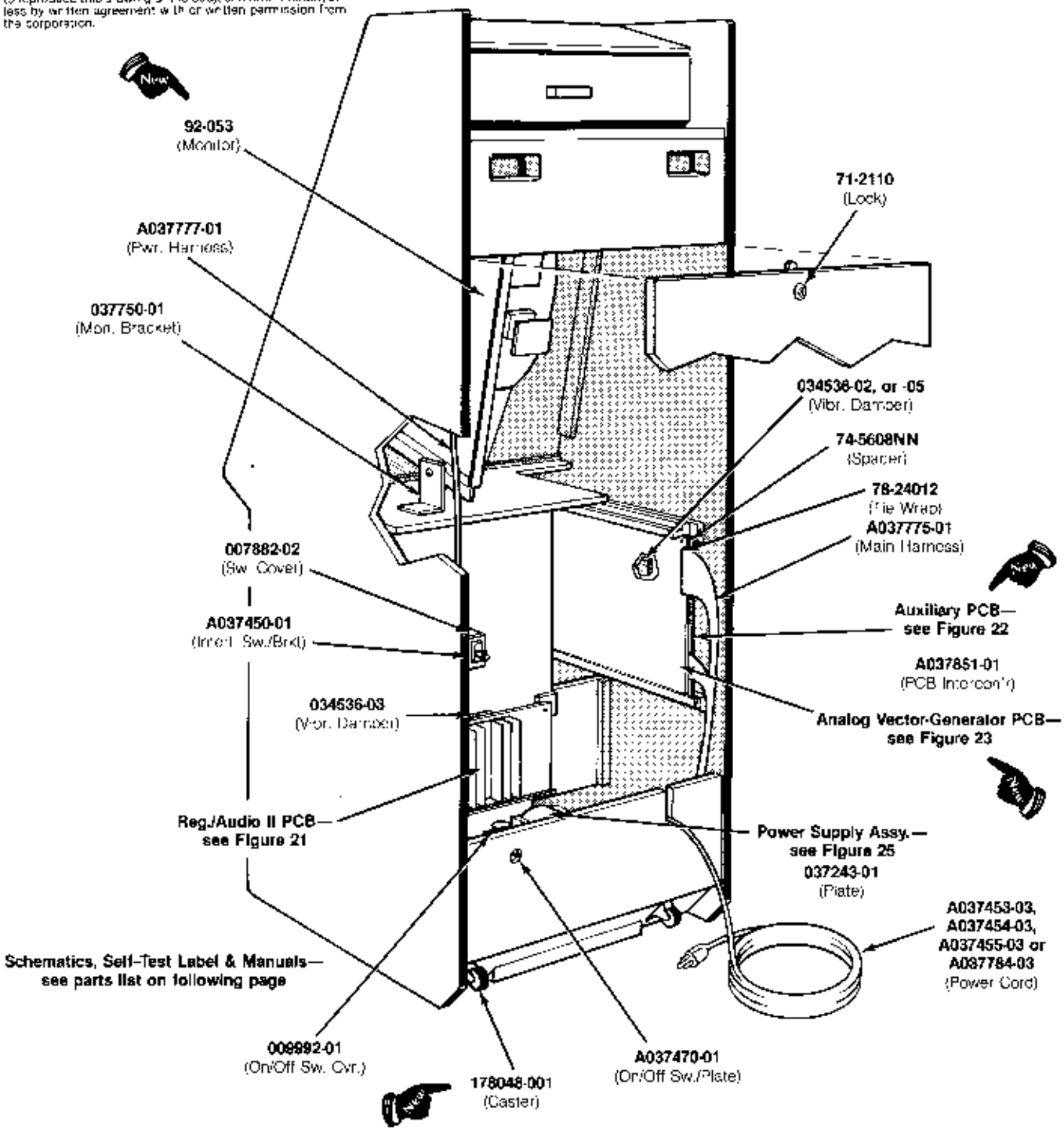


Figure 18 Cabinet-Mounted Assemblies
A037702-xx B

Figure 18 Cabinet-Mounted Assemblies, continued
Parts List

Part No.	*Description*
A035943-01	Deep-Well Coin Box Assembly *(for all the same coins)*
A035943-02	Deep-Well Coin Box Assembly *(for two different coin denominations—has one separator)*
A035943-03	Deep-Well Coin Box Assembly *(for three different coin denominations—has two separators)*
A037450-01	Interlock Switch/Bracket Assembly *(modified for safety)*
A037453-03	Strain-Relief Power Cord *(U.S. and Canada)*
A037454-03	Strain-Relief Power Cord *(Austria, Belgium, Chile, Denmark, Finland, France, Germany, Greece, Indonesia, Italy, Netherlands, Norway, Spain, Sweden, and Uruguay)*
A037455-03	Strain-Relief Power Cord *(Australia and New Zealand)*
A037470-01	Power On/Off Switch/Mounting Plate Assembly
A037704-01	Cabinet Assembly *(includes legs and PCB retainers, but not the rear access panel)*
A037709-01	Attraction Panel with Graphics Assembly
A037775-01	Main Harness Assembly
A037777-01	Power Harness Assembly
A037784-03	Strain-Relief Power Cord Assembly *(United Kingdom, Ireland, Lebanon, Saudi Arabia, India, Hong Kong, Singapore, Egypt, Nigeria, Republic of South Africa, Zimbabwe)*
A037851-01	Printed-Circuit Board Interconnector
	The following seven items are the technical information supplements to this game:
DP-190-01, 02, 03	Tempest™ Schematic Drawings *(Sheets 1,2,3)*
ST-190	Tempest Label with Self-Test Procedure and Option Switch Settings
TM-183	Service Manual for 19-Inch Wells Gardner Color X-Y Monitor
TM-190	Tempest Operation, Maintenance and Service Manual
TM-195	Tempest Troubleshooting Guide
19-9032	Volume Control
69-001	DPDT Self-Test Switch *(for British-made coin doors)*
71-2110	Panel Cartridge Lock Mechanism *(for rear access panel)*
74-5608NN	Spacer for Mounting Printed-Circuit Boards
78-24012	5-Inch Beaded Nylon Tie Wrap *(for game PCB edge connectors)*
78-3201	Cabinet-Leveling Leg
92-053	19-Inch Wells-Gardner Color X-Y Monitor
007882-02	Interlock Switch Cover
009992-01	On/Off Switch Cover
021699-01	3-Slide Coin Box Lid
030168-01	Volume Control Mounting Bracket *(also holds self-test switch in games with British-made coin doors)*
030247-01	Coin Box Handle
034536-02	Foam Vibration Damper *(goes between game PCBs)*
034536-03	Foam Vibration Damper *(for Regulator/Audio II PCB)*
034536-05	Foam Vibration Damper *(goes between main PCB and cabinet wall)*
035941-01	Molded Coin Box
035942-01	Deep-Well Coin Box Separator
036262-01	Coin Box Bracket
036686-01	Card of Game Pricing Labels
037243-01	Metal Base Plate *(located underneath power supply)*
037710-01	Attraction Panel Decal
037711-03	Attraction Panel Frame
037721-01	Rear Access Panel *(does not include lock)*
037427-01	Rear Access Panel Foam Pad
037731-01	Top Monitor Shield Retainer
037732-01	Speaker Grille
037734-01	Monitor Shield
037743-01	Cardboard Monitor Bezel
037750-01	Monitor Support Bracket
178013-001	Spring Draw Latch
178034-024	¾-Inch Black Plastic T-Molding
178048-001	Rigid Caster

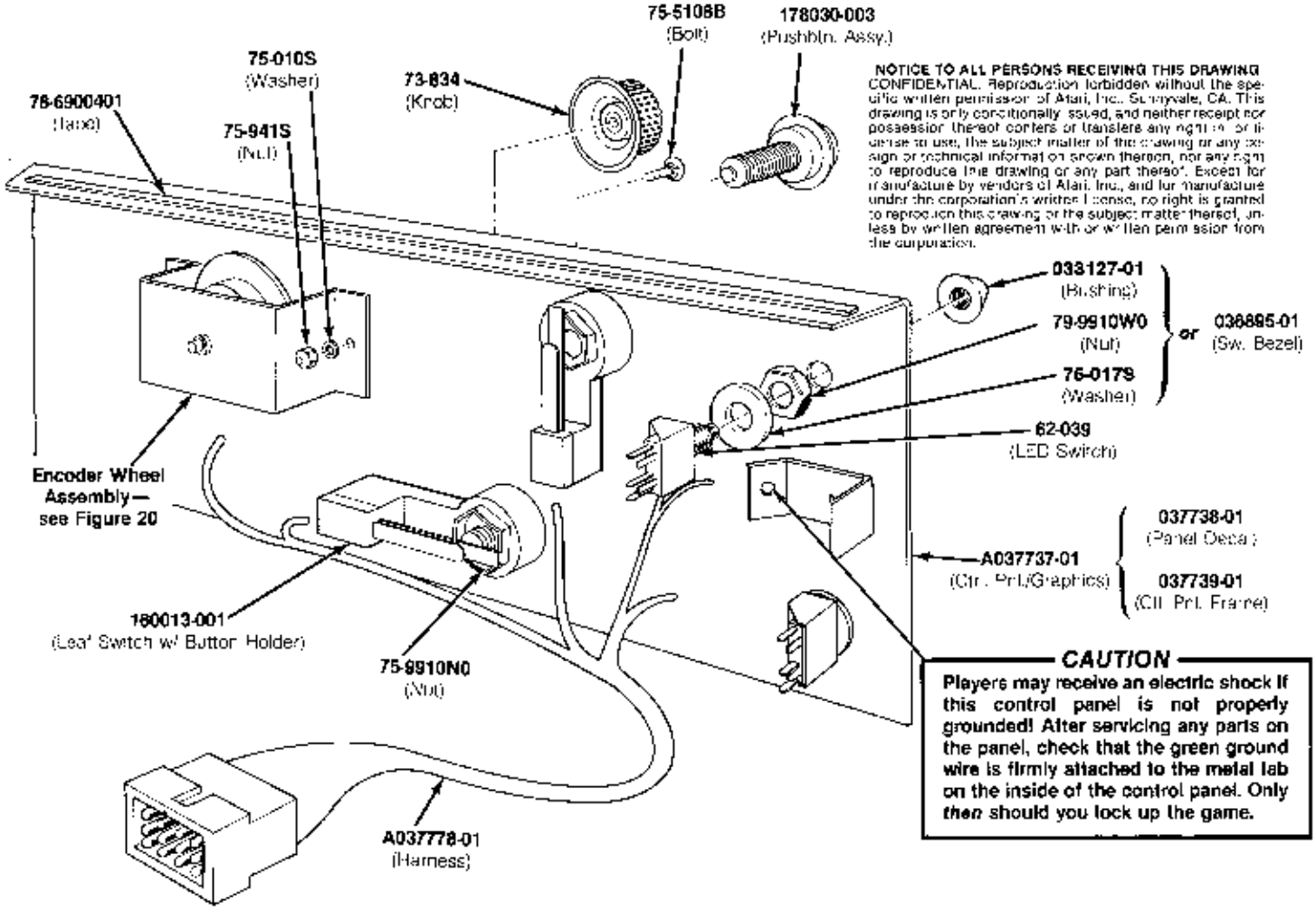


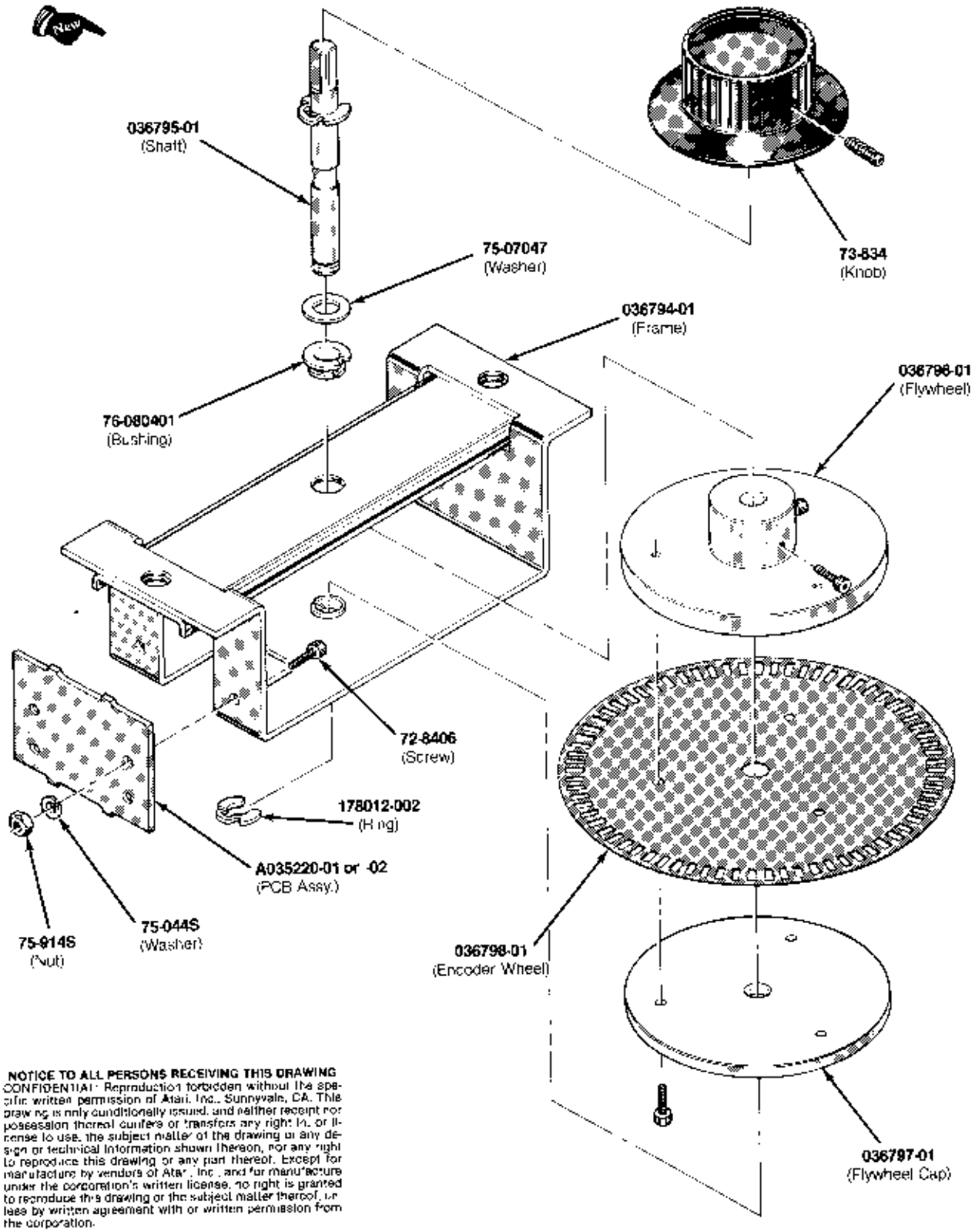
Figure 19 Control Panel Assembly A037736-01 B

Parts List

Part No.	Description
A037737-01	Control Panel with Graphics
A037778-01	Control-Panel Harness
62-039	SPDT Momentary-Contact Pushbutton Start Switch with Red Light-Emitting Diode
73-834	Control Knob with Skirt
75-010S	#10 Flat Washer
75-941S	#10-24 Polymer Hex Nut
75-5108B	#10-24 × ½-Inch Carriage Bolt
75-9910N0	#⅜-11 Steel Stamped Nut
78-6900401	Vinyl Foam Single-Coated-Adhesive Tape, ¼-inch wide × ⅛-inch thick *(19 in. required)*
036895-01*	Black Molded Switch Bezel
037738-01	Control Panel Graphics Decal
037739-01	Control Panel Frame
160013-001	Leaf Switch and Button Holder *(leaf switch only is part no. 160012-001)*
178030-003	Pushbutton Assembly

** If not available, the following may be used:*

75-017S	⅜-inch Steel Flat Washer
75-9910W0	Stamped Nut
033127-01	Black Molded Switch Bushing



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Figure 20 Encoder Wheel Assembly
A037781-01 A

Figure 20 Encoder Wheel Assembly Parts List

Part No.	*Description*
A035220-01 or -02	Coupler PCB Assembly
A036096-01	Harness Assembly
72-8406	#4-40 × ⅜-Inch Hex Socket-Head Cap Alloy Steel Machine Screw
73-834	Control Knob
75-044S	#4 Zinc-Plated Steel Split-Lock Washer
75-07047	Nylon Washer
75-914S	#4 Hex Socket-Head Cap Steel Machine Nut
76-080401	Dual Shoulder Radial Polymer Bushing
036794-01	Frame
036795-01	Shaft
036796-01	Top Flywheel
036797-01	Bottom Flywheel Cap
036798-01	Etched Encoder Wheel
178012-002	"Klip-Ring" Retaining Ring
178027-001	Nyogel 779 Lubricant

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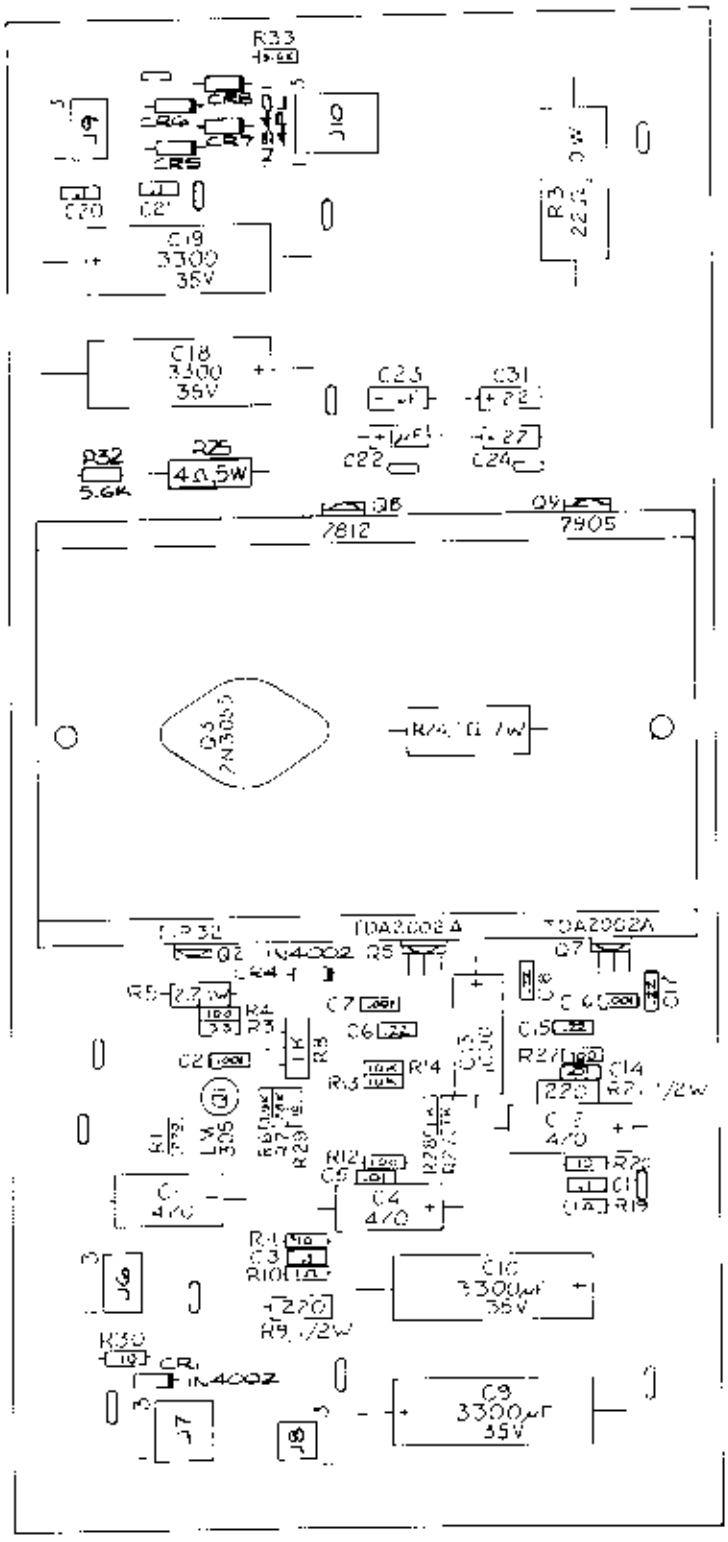


Figure 21 Regulator/Audio II PCB Assembly
A035435-02 E

Figure 21 Regulator/Audio II PCB Assembly Parts List

Part No.	*Description (Reference Designations and Locations in Bold)*
12-52P7	2.7 Ohm, ±5%, 1W Resistor **(R5)**
16-54P0	4 Ohm, ±5%, 5W Wirewound Resistor **(R25)**
19-100P1015	.1 Ohm, ±3%, 7W Wirewound Resistor **(R24)**
19-315102	1K Ohm Vertical PCB-Mounting Cermet Trimpot **(R8)**
24-250108	1000 uf Aluminum Electrolytic Fixed Axial-Lead 25V Capacitor **(C13)**
24-250477	470 uf Aluminum Electrolytic Fixed Axial-Lead 25V Capacitor **(C1, 4, 12)**
24-350226	22 uf Aluminum Electrolytic Fixed Axial-Lead 35V Capacitor **(C24, 31)**
24-350338	3300 uf Aluminum Electrolytic Fixed Axial-Lead 35V Capacitor **(C9, 10, 18, 19)**
24-500105	1 uf Aluminum Electrolytic Fixed Axial-Lead 50V Capacitor **(C22, 23)**
29-088	.1 uf Ceramic-Disc 25V Radial-Lead Capacitor **(C3, 11, 20, 21)**
31-1N4002	100V 1-Amp. Silicon Rectifier Type 1N4002 Diode **(CR1, 4)**
31-1N5401	100V 3-Amp. Silicon Rectifier Type 1N5401 Diode **(CR5-8)**
33-TIP32	PNP Power Transistor, Type TIP32 **(Q2)**
34-2N3055	NPN Silicon Transistor, Type 2N3055 **(Q3)**
37-LM305	5V Linear Voltage Regulator **(Q1)**
37-7812	+12V Voltage Regulator, Type 7812 **(Q8)**
37-7905	−5V Voltage Regulator, Type 7905 **(Q9)**
72-1608C	#6-32 × ½-Inch Cross-Recessed Pan-Head Corrosion-Resistant Steel Machine Screw
72-6606S	#6 × ⅜-Inch Pan-Head Thread-Forming Cross-Recessed Type-AB Zinc-Plated-Steel Screw **(Q8)**
75-F60405	#6-32 × ¼-Inch Binder-Head Nylon Screw **(Q5, 7)**
75-99516	#6-32 Nut/Washer Assembly
78-16008	Thermally Conductive Compound **(Q3)**
78-16014	Thermally Conductive Silicon Insulator **(Q2, 9)**
79-58306	6-Position Connector Receptacle **(J6, 9)**
79-58308	9-Position Connector Receptacle **(J7)**
79-58346	12-Position Connector Receptacle **(J10)**
79-58354	4-Position Connector Receptacle **(J8)**
020670-01	Test Point
034531-01	Heat Sink
100015-103	.01 uf Ceramic-Disc 25V Radial-Lead Capacitor **(C5, C14)**
110000-010	1 Ohm, ±5%, ¼W Resistor **(R10, 19)**
110000-100	10 Ohm, ±5%, ¼W Resistor **(R11, 20, 29, 30)**
110000-101	100 Ohm, ±5%, ¼W Resistor **(R4, 12, 22)**
110000-102	1K Ohm, ±5%, ¼W Resistor **(R27, 28)**
110000-103	10K Ohm, ±5%, ¼W Resistor **(R13, 14)**
110000-271	270 Ohm, ±5%, ¼W Resistor **(R1)**
110000-330	33 Ohm, ±5%, ¼W Resistor **(R3)**
110000-392	3.9K Ohm, ±5%, ¼W Resistor **(R6)**
110000-562	5.6K Ohm, ±5%, ¼W Resistor **(R32, 33)**
110000-752	7.5K Ohm, ±5%, ¼W Resistor **(R7)**
110001-221	220 Ohm, ±5%, ½W Resistor **(R9, 21)**
116000-220	22 Ohm, ±5%, 10W Wirewound Resistor **(R31)**
122002-102	.001 uf Ceramic-Disc Minimum 25V Radial-Lead Capacitor **(C2, 7, 16)**
122004-224	.22 uf Ceramic-Disc 25V Capacitor **(C6, 8, 15, 17)**
137151-002	Type TDA2002A 8W Linear Audio Amplifier Integrated Circuit **(Q5, 7)**

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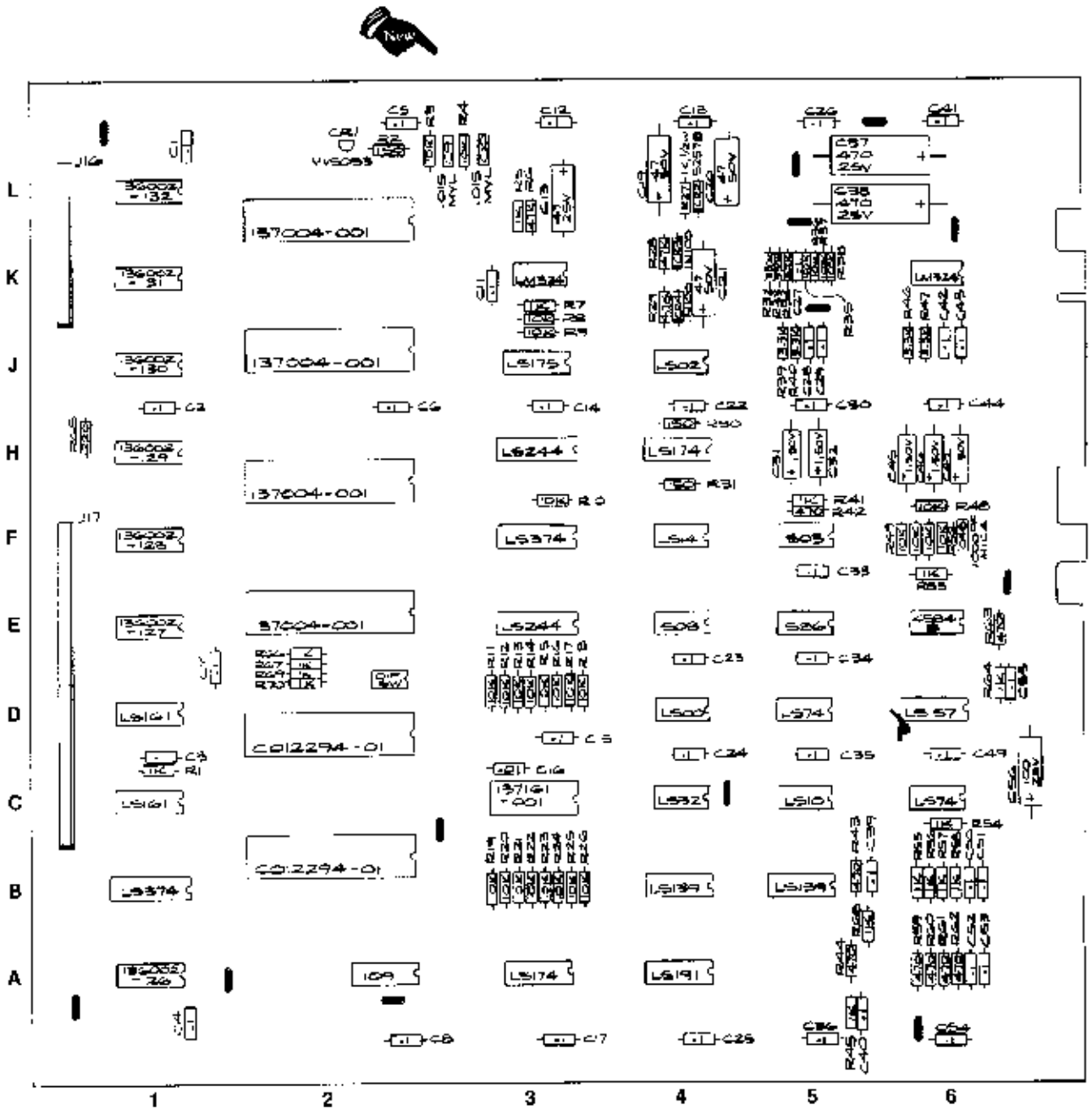


Figure 22 Tempest™ Auxiliary PCB Assembly
A037585-01 B

Figure 22 Tempest™ Auxiliary PCB Assembly Parts List

Part No.	*Description (Reference Designations and Locations in Bold)*
C012294-01	Audio I/O N-Channel MOS/LSI Custom Chip **(B/C2, C/D2)**
21-101153	.015 uf, ±10%, Radial-Lead Epoxy-Dipped 100V Mylar Capacitor **(C9, 10)**
24-250107	100 uf Aluminum Electrolytic Fixed Axial-Lead 25V Capacitor **(C56)**
24-250476	47 uf Aluminum Electrolytic Fixed Axial-Lead 25V Capacitor **(C13)**
24-250477	470 uf Aluminum Electrolytic Fixed Axial-Lead 25V Capacitor **(C37, 38)**
24-500105	1 uf Aluminum Electrolytic Fixed Axial-Lead 50V Capacitor **(C31, 32, 45-47)**
24-500476	47 uf Aluminum Electrolytic Fixed Axial-Lead 50V Capacitor **(C19-21)**
29-088	.1 uf Ceramic-Disc Radial-Lead 25V Capacitor **(C1-8, 11, 12, 14, 15, 17, 18, 22-30, 33-36, 39-44, 49-55)**
31-1N100	100V Type-1N100 Switching Diode **(CR3, 4)**
37-LM324	Type-LM324 Integrated Circuit **(K3, K6)**
37-4584B	Type-4584B Integrated Circuit **(E6)**
37-74109	Type-74109 Integrated Circuit **(A2)**
37-74LS00	Type-74LS00 Integrated Circuit **(D4)**
37-74LS02	Type-74LS02 Integrated Circuit **(J4)**
37-74LS10	Type-74LS10 Integrated Circuit **(C5)**
37-74LS14	Type-74LS14 Integrated Circuit **(F4)**
37-74LS32	Type-74LS32 Integrated Circuit **(C4)**
37-74LS74	Type-74LS74 Integrated Circuit **(C6, D5)**
37-74LS139	Type-74LS139 Integrated Circuit **(B4, B5)**
37-74LS157	Type-74LS157 Integrated Circuit **(D6)**
37-74LS161	Type-74LS161 Integrated Circuit **(C1, D1)**
37-74LS174	Type-74LS174 Integrated Circuit **(A3, H4)**
37-74LS175	Type-74LS175 Integrated Circuit **(J3)**
37-74LS191	Type-74LS191 Integrated Circuit **(A4)**
37-74LS244	Type-74LS244 Integrated Circuit **(E3, H3)**
37-74LS374	Type-74LS374 Integrated Circuit **(B1, F3)**
37-74S08	Type-74S08 Integrated Circuit **(E4)**
38-MV5053	Type-MV5053 Red Light-Emitting Diode **(CR1)**
66-114P1T	4-Station, Single-Throw, Dual-Inline-Package Bit Switch **(D/E2)**
79-42C16	16-Contact Medium-Insertion-Force Integrated Circuit Socket **(A1, E1, F1, H1, J1, K1, L1)**
79-42C22	22-Contact Medium-Insertion-Force Integrated Circuit Socket **(C3)**
79-42C40	40-Contact Medium-Insertion-Force Integrated Circuit Socket **(B/C2, C/D2, E2, F/H2, J2, K/L2)**
020670-01	Test Point
110000-102	1K Ohm, ±5%, ¼W Resistor **(R1, 5, 7, 41, 45, 53-58, 64, 66-70)**
110000-103	10K Ohm, ±5%, ¼W Resistor **(R3, 4, 8-26, 36, 48-52)**
110000-104	100K Ohm, ±5%, ¼W Resistor **(R35, 37, 38)**
110000-151	150 Ohm, ±5%, ¼W Resistor **(R2, 30, 31)**
110000-221	220 Ohm, ±5%, ¼W Resistor **(R65)**
110000-223	22K Ohm, ±5%, ¼W Resistor **(R34)**
110000-332	3.3K Ohm, ±5%, ¼W Resistor **(R39, 40, 46, 47)**
110000-334	330K Ohm, ±5%, ¼W Resistor **(R32, 33)**
110000-471	470 Ohm, ±5%, ¼W Resistor **(R42-44, 59-63)**
110000-472	4.7K Ohm, ±5%, ¼W Resistor **(R29)**
110000-473	47K Ohm, ±5%, ¼W Resistor **(R6, 28)**

[Continued on next page]

Figure 22 Tempest™ Auxiliary PCB Assembly, continued
Parts List

Part No.	*Description (Reference Designations and Locations in Bold)*
110001-102	1K Ohm, ±5%, ½W Resistor **(R27)**
122005-103	.01 uf Ceramic-Disc 25V Radial-Lead Capacitor **(C16)**
126002-102	1000 pf Radial-Lead Epoxy-Dipped 100V Mica Capacitor **(C48)**
131003-001	Type-1N5257B Zener Diode **(CR2)**
136002-126	Programmable Read-Only Memory **(A1)**
136002-127	Programmable Read-Only Memory **(E1)**
136002-128	Programmable Read-Only Memory **(F1)**
136002-129	Programmable Read-Only Memory **(H1)**
136002-130	Programmable Read-Only Memory **(J1)**
136002-131	Programmable Read-Only Memory **(K1)**
136002-132	Programmable Read-Only Memory **(L1)**
137002-001	Type-74S86 Integrated Circuit **(E5)**
137003-001	Type-74S03 Integrated Circuit **(F5)**
137004-001	Transistor Array **(E2, F/H2, J2, K/L2)**
137161-001	Read-Only Memory ER2055 **(C3)** *Note: If you replace this part, **you must erase** this ROM before locking up the game. See Figure 6, Self-Test Procedure, in this manual for instructions. If you do not erase the ROM, the self-test will show the ROM to be "defective" by displaying the letter **E** on the screen.*
179014-012	12-Pin Polarized PCB Header **(J16, J17)**

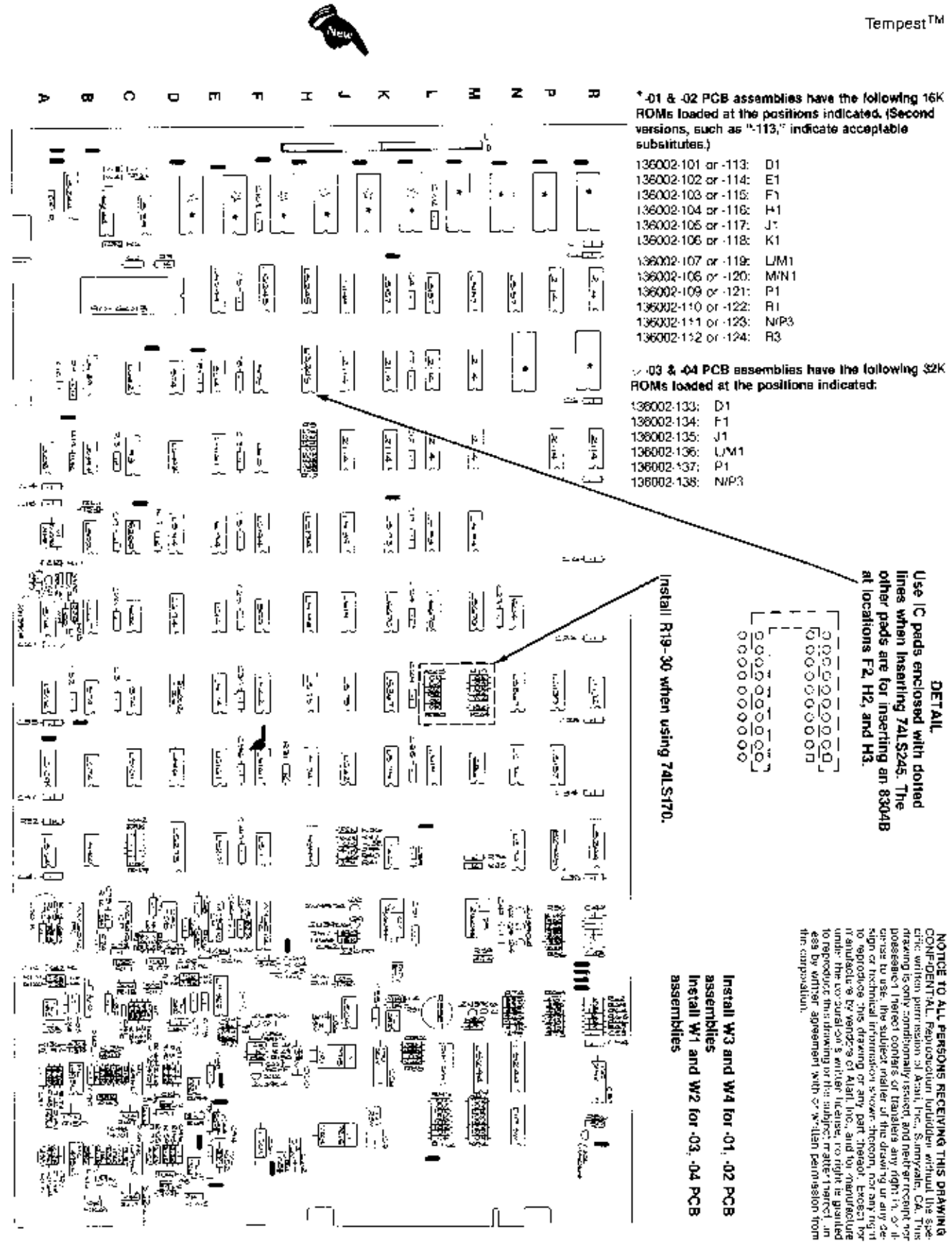


Figure 23 Tempest™ Analog Vector-Generator PCB Assembly A037383-01 thru -04 C

Figure 23 Tempest™ Analog Vector-Generator PCB Assembly, continued Parts List

Part No.	*Description (Reference Designations and Locations in Bold)*
19-315103	10K Vertical PCB-Mounting Cermet Trimpot **(R147, 150, 167, 168)**
19-315201	200 Ohm Vertical PCB-Mounting Cermet Trimpot **(R117, 118)**
19-315202	2K Ohm Vertical PCB-Mounting Cermet Trimpot **(R165, 169)**
21-101103	.01 uf, ± 10%, Radial-Lead Epoxy-Dipped 100V Mylar Capacitor ***(For -02 & -04 PCB assy. only:* C63)**
24-250107	100 uf Aluminum Electrolytic Fixed Axial-Lead 25V Capacitor **(C57-59)**
24-500105	1 uf Aluminum Electrolytic Fixed Axial-Lead 50V Capacitor **(C61, 62)**
27-102182	.0018 pf, ± 10%, Radial-Lead Ceramic-Disc 1000V Capacitor ***(For -01 & -03 PCB assy. only:* C67. *For -02 & -04 PCB assy. only:* C75)**
29-006	1 uf, ± 10%, 35V Tantalum Capacitor **(C60)**
29-088	.1 uf Ceramic-Disc 25V Radial-Lead Capacitor **(C1-19, 22-49, 51, 53-55, 69, 71, 77-80, 82-85, 88-91, 93-97, 99, 102, 103.)** ***Also, for -01 & -03 PCB assy. only:* C66, 68, 72, 73. *For -02 & -04 PCB assy. only:* C64, 65, 74, 76)**
31-1N100	100V Type-1N100 Switching Diode **(CR4)**
31-1N914	75V Type-1N914 Switching Diode **(CR1)**
33-2N3906	Type-2N3906 PCB Switching and Amplifying Transistor **(Q9-11)**
34-2N3904	Type-2N3904 NPN 60V 1-Watt Transistor **(Q1-4, 8, 12)**
34-2N6044	Type-2N6044 Darlington NPN Transistor **(Q5, 7)**
37-TL082CP	Type-TL082 Integrated Circuit **(A11, D11, D/E12, D/E13, K11)**
37-1495	Type-MC1495L Integrated Circuit **(A/B12, A/B13, C12, C13)**
37-13201	Type-LF13201 Integrated Circuit **(B11, E11)**
37-74LS00	Type-74LS00 Integrated Circuit **(K9)**
37-74LS02	Type-74LS02 Integrated Circuit **(A7, B5)**
37-74LS04	Type-74LS04 Integrated Circuit **(J11)**
37-74LS08	Type-74LS08 Integrated Circuit **(A4)**
37-74LS10	Type-74LS10 Integrated Circuit **(F4)**
37-74LS14	Type-74LS14 Integrated Circuit **(E6)**
37-74LS20	Type-74LS20 Integrated Circuit **(E9)**
37-74LS27	Type-74LS27 Integrated Circuit **(B6)**
37-74LS32	Type-74LS32 Integrated Circuit **(C3, J8, B9, R7)**
37-74LS42	Type-74LS42 Integrated Circuit **(F7)**
37-74LS74	Type-74LS74 Integrated Circuit **(B8, D3)**
37-74LS109	Type-74LS109 Integrated Circuit **(A8)**
37-74LS139	Type-74LS139 Integrated Circuit **(B3, C1, J2, J5, P7)**
37-74LS157	Type-74LS157 Integrated Circuit **(K2, L2, M2, N2, P8)**
37-74LS161	Type-74LS161 Integrated Circuit **(E4, C8, D8, E8, F8)**
37-74LS164	Type-74LS164 Integrated Circuit **(A9)**
37-74LS174	Type-74LS174 Integrated Circuit **(E7, H8, N8, N9)**
37-74LS175	Type-74LS175 Integrated Circuit **(H7, J7, K8)**
37-74LS191	Type-74LS191 Integrated Circuit **(J6, L8)**
37-74LS193	Type-74LS193 Integrated Circuit **(K5, L5, M5)**
37-74LS194	Type-74LS194 Integrated Circuit **(D5, D6, E5, F5, H5, H6)**
37-74LS244	Type-74LS244 Integrated Circuit **(A/B1, B/C1, E2, M12, N12, R9)**
37-74LS245	Type-74LS245 Integrated Circuit **(F2, H2, H3)** *Acceptable substitute is part no. 37-8304B.*
37-74LS273	Type-74LS273 Integrated Circuit **(D9)**
37-74LS367	Type-74LS367 Integrated Circuit **(K7, N7)**
37-74LS393	Type-74LS393 Integrated Circuit **(B4, D4)**

[Continued on next page]

Figure 23 Tempest™ Analog Vector-Generator PCB Assembly, continued Parts List

Part No.	Description (Reference Designations and Locations in Bold)
37-74LS399	Type-74LS399 Integrated Circuit **(H9)**
37-74LS670	Type-74LS670 Integrated Circuit **(K6, L6, M6)** *Acceptable substitute is part no. 37-74LS170.*
37-74S00	Type-74S00 Integrated Circuit **(F6)**
37-74S02	Type-74S02 Integrated Circuit **(C6)**
37-74S04	Type-74S04 Integrated Circuit **(A6, E3, N6)**
37-74S08	Type-74S08 Integrated Circuit **(F3)**
37-74S74	Type-74S74 Integrated Circuit **(B7, C7)**
37-74S260	Type-74S260 Integrated Circuit **(C5)**
37-74193	Type-74193 Integrated Circuit **(C4)**
37-7815	+15V Voltage Regulator **(VR3)**
37-7915	−15V Voltage Regulator **(VR1)**
38-MV5053	Type-MV5053 Light-Emitting Diode **(CR2)**
41-3003	100 uH, ±10%, Hot-Molded Plastic Fixed R.F. Choke **(L1)** *Acceptable substitute is part no. 141002-001.*
62-001	SPST Momentary Pushbutton Switch **(Reset)**
66-114P1T	4-Station Single-Throw, Dual-Inline-Package Bit Switch **(K10/11)**
66-118P1T	8-Station Single-Throw, Dual-Inline-Package Bit Switch **(L12, N13)**
78-13003	General Electric RTV #108 Sealing Compound
79-42C16	16-Contact Medium-Insertion-Force Integrated Circuit Socket **(D7)**
79-42C24	24-Contact Medium-Insertion-Force Integrated Circuit Socket **(D1, E1, F1, H1, J1, K1, L/M1, M/N1, P1, R1, N/P3, R3)**
79-42C40	40-Contact Medium-Insertion-Force Integrated Circuit Socket **(C2)**
81-4302	Nylon Snap-In Fastener
90-6013	Microprocessor **(C2)**
90-7005	Random-Access Memory **(P9)**
90-7033	Random-Access Memory **(J3, J4, K3, K4, L3, L4, M3, M4, P2, P4, R2, R4)**
99-130430	Voltage-Dependent Resistor **(RV1, 2)** *Acceptable substitute is part no. 110004-001.*
020670-01	Test Point
110000-101	100 Ohm, ±5%, ¼W Resistor **(R107, 111)**
110000-102	1K Ohm, ±5%, ¼W Resistor **(R3, 13, 15, 31, 32, 34, 35, 62–67, 81, 129, 142, 160)**
110000-103	10K Ohm, ±5%, ¼W Resistor **(R1, 2, 4–12, 14, 16, 17, 38, 60, 61, 84, 87–102, 128, 134, 139, 156, 158.** ***Also, for -01 & -03 PCB assy. only:*** **105, 106, 112.** ***Also, for any PCB assy. if you are using part no. 37-74LS170 in locations K6, L3, M6:*** **R19–30)**
110000-104	100K Ohm, ±5%, ¼W Resistor **(R42–49)**
110000-122	1.2K Ohm, ±5%, ¼W Resistor **(R40)**
110000-151	150 Ohm, ±5%, ¼W Resistor **(R86)**
110000-152	1.5K Ohm, ±5%, ¼W Resistor **(R137)**
110000-153	15K Ohm, ±5%, ¼W Resistor **(R58, R130)**
110000-221	220 Ohm, ±5%, ¼W Resistor **(R18, 85)**
110000-222	2.2K Ohm, ±5%, ¼W Resistor **(R37, 52, 54, 56, 131–133, 144, 153–155, 163)**
110000-223	22K Ohm, ±5%, ¼W Resistor **(R36, 82)**
110000-272	2.7K Ohm, ±5%, ¼W Resistor **(R141, 157, 161)**
110000-331	330 Ohm, ±5%, ¼W Resistor **(R51, 53, 55, 57, 74–76)**
110000-392	3.9K Ohm, ±5%, ¼W Resistor **(R41, 110, 138, 143, 145, 162, 164)**
110000-470	47 Ohm, ±5%, ¼W Resistor **(R80)**
110000-471	470 Ohm, ±5%, ¼W Resistor **(R68–73, 135, 136, 148, 151, 170, 173)**

[Continued on next page]

Figure 23 Tempest™ Analog Vector-Generator PCB Assembly, continued Parts List

Part No.		Description (Reference Designations and Locations in Bold)
110000-472		4.7K Ohm, ±5%, ¼W Resistor **(R39, 59, 77-79)**
110000-561		560 Ohm, ±5%, ¼W Resistor **(R127)**
110000-562		5.6K Ohm, ±5%, ¼W Resistor **(R146, 168)**
110000-681		680 Ohm, ±5%, ¼W Resistor **(R140, 159. *Also, for -02 & -04 PCB assy. only:* R113)**
110000-682		6.8K Ohm, ±5%, ¼W Resistor **(R50)**
110000-683		68K Ohm, ±5%, ¼W Resistor **(R83)**
110000-821		820 Ohm, ±5%, ¼W Resistor ***(For -02 & -04 PCB assy. only:* R103, 104, 114)**
110001-271		270 Ohm, ±5%, ½W Resistor **(R152)**
110003-752		7.5K Ohm, ±1%, ⅛W Resistor **(R108, 109, 115, 116, 119-126)**
121007-473		.047 uf, ±10%, Radial-Lead Epoxy-Dipped 50V Polycarbonate Capacitor **(C100, 101)** *Acceptable substitute is part no. 121006-473.*
122000-225		2.2 uf, ±10%, 35V Tantalum Capacitor **(C56)**
122005-103		.01 uf, Ceramic-Disc 25V Radial-Lead Capacitor **(C70)**
128002-100		10 pf Radial-Lead Epoxy-Dipped 100V Mica Capacitor **(C81)**
128002-101		100 pf Radial-Lead Epoxy-Dipped 100V Mica Capacitor **(C21)**
128002-151		150 pf Radial-Lead Epoxy-Dipped 100V Mica Capacitor **(C87)**
128002-221		220 pf Radial-Lead Epoxy-Dipped 100V Mica Capacitor **(C52)**
128002-390		39 pf Radial-Lead Epoxy-Dipped 100V Mica Capacitor **(C20, 86, 92, 98)**
131002-001		6.8V, 400 mW, ±5%, Zener Diode **(CR5)**
136002-101	*Used on -01, -02 PCB assemblies only*	Programmable Read-Only Memory **(D1)** *Acceptable substitute is part no. 136002-113.*
136002-102		Programmable Read-Only Memory **(E1)** *Acceptable substitute is part no. 136002-114.*
136002-103		Programmable Read-Only Memory **(F1)** *Acceptable substitute is part no. 136002-115.*
136002-104		Programmable Read-Only Memory **(H1)** *Acceptable substitute is part no. 136002-116.*
136002-105		Programmable Read-Only Memory **(J1)** *Acceptable substitute is part no. 136002-117.*
136002-106		Programmable Read-Only Memory **(K1)** *Acceptable substitute is part no. 136002-118.*
136002-107		Programmable Read-Only Memory **(L/M1)** *Acceptable substitute is part no. 136002-119.*
136002-108		Programmable Read-Only Memory **(M/N1)** *Acceptable substitute is part no. 136002-120.*
136002-109		Programmable Read-Only Memory **(P1)** *Acceptable substitute is part no. 136002-121.*
136002-110		Programmable Read-Only Memory **(R1)** *Acceptable substitute is part no. 136002-122.*
136002-111		Programmable Read-Only Memory **(N/P3)** *Acceptable substitute is part no. 136002-123.*
136002-112		Programmable Read-Only Memory **(R3)** *Acceptable substitute is part no. 136002-124.*
136002-125		Programmable Read-Only Memory **(D7)**
136002-133	*Used on -03, -04 PCB assemblies only*	Programmable Read-Only Memory **(D1)**
136002-134		Programmable Read-Only Memory **(F1)**
136002-135		Programmable Read-Only Memory **(J1)**
136002-136		Programmable Read-Only Memory **(L/M1)**
136002-137		Programmable Read-Only Memory **(P1)**
136002-138		Programmable Read-Only Memory **(N/P3)**
137002-001		Type-74S86 Integrated Circuit **(M8)**
137149-001		Type-74LS11 Integrated Circuit **(F9)**
137158-002		Type AM6012PC 12-Bit Digital-to-Analog Converter ***(For -02 & -04 PCB assy. only:* A10, F10)** *Acceptable substitute is part no. 137150-001.*
137159-001		Type DAC-08CN 8-Bit Digital-to-Analog Converter **(D10)**
137160-003		Type MC3410 10-Bit Digital-to-Analog Converter ***(For -01 & -02 PCB assy. only:* B10, E10)** *Acceptable substitute is part no. 137160-004.*
144000-001		12.096 MHz, ±.005%, Crystal **(Y1)** *Acceptable substitute is part no. 90-102.*
179014-012		12-Pin Polarized PCB Header **(J19)**

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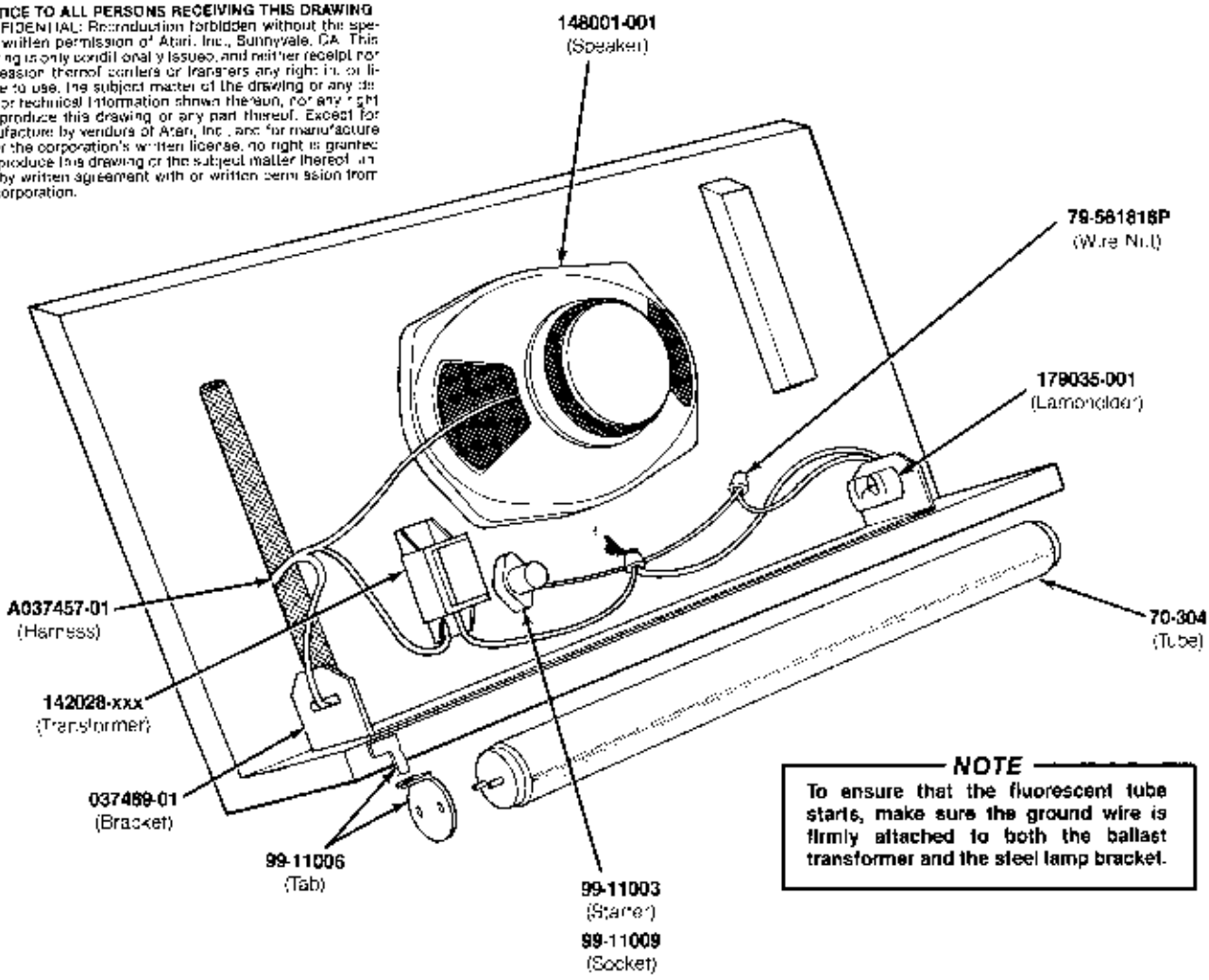


Figure 24 Fluorescent Light and Speaker Assembly A037740-01 and -02 B

Parts List

Part No.	*Description*
A037457-01	Light and Speaker Harness
A037540-01	Ground Wire with Ring Lug
70-304	18-Inch 15-Watt Cool White Fluorescent Tube
79-561816P	Spring-Connector Wire Nut for 16- to 18-Guage Wires
99-11003	Fluorescent Lamp Starter
99-11006	Fluorescent Lamp Locking Tab *(tab consists of two pieces)*
99-11009	Starter Socket
037469-01	Steel Lamp Bracket
142028-001	60-Hz 118-Volt Ballast Transformer *(used on A037417-01 assembly)*
142028-002	50-Hz 118-Volt Ballast Transformer *(used on A037417-02 assembly)*
148001-001	6 × 9-Inch 4-Ohm 15-Watt Oval High-Fidelity Speaker
179035-001	2-Pin Fluorescent Lampholder

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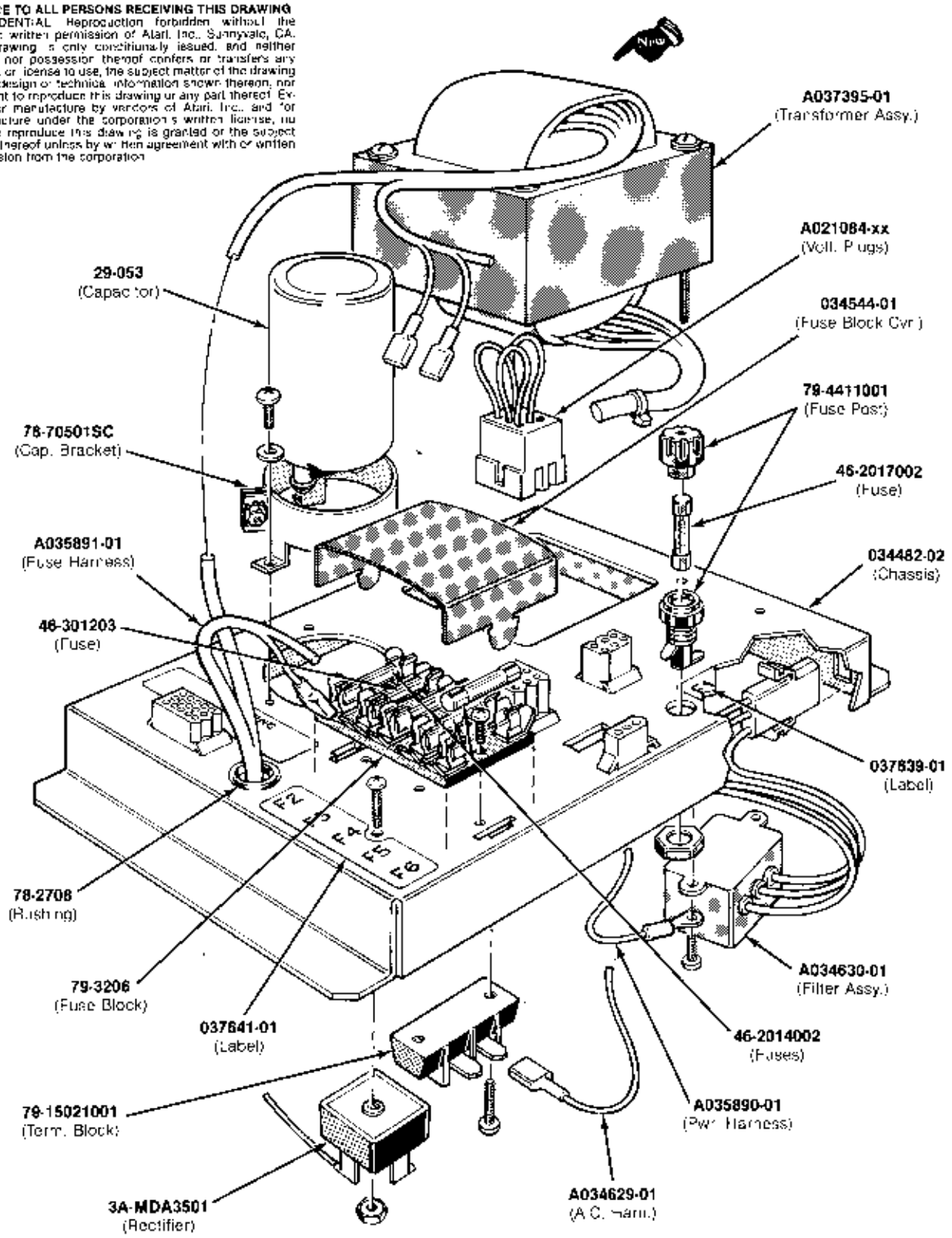


Figure 25 Color X-Y Power Supply Assembly A037396-xx B

Figure 25 Color X-Y Power Supply Assembly Parts List

Part No.	*Description (Reference Designations in Bold)*
A021084-01	Voltage Plug for 100V *(violet)*
A021084-02	Voltage Plug for 120V *(yellow)*
A021084-04	Voltage Plug for 220V *(blue)*
A021084-05	Voltage Plug for 240V *(brown)*
A034629-01	A.C. Harness Assembly
A034630-01	RFI Filter Assembly **(FL1)**
A035890-01	Power Harness Assembly
A035891-01	Fuse Harness Assembly
A037395-01	Transformer Assembly **(T1)**
29-053	27,000 uf 15 VDC Electrolytic Capacitor **(C1)**
3A-MDA3501	Bridge Rectifier, Type MDA 3501 **(CR1)**
46-2014002	4-Amp. 250 V 3AG Slow-Blow Glass Cartridge-Type Fuse **(F2, F4–F6)**
46-2017002	7-Amp. 250 V 3AG Slow-Blow Glass Cartridge-Type Fuse **(F1)**
46-301203	20-Amp. 32 V 3AG Slow-Blow Glass Cartridge-Type Fuse **(F3)**
78-2708	Nylon Type 6/6 Hole Bushing with ⅜-Inch Inside Diameter × ⅝-Inch Outside Diameter × ¼-Inch Thick
78-70501SC	2-Inch Diameter Capacitor Mounting Bracket
79-15021001	2-Circuit Single-Row Terminal Block
79-3206	5-Position 3AG Fuse Block with ¼-Inch Quick-Disconnect Terminals
79-4411001	Panel-Mounting Non-Indicating 3AG Cartridge-Type Fuse Post
034482-02	Power Supply Chassis
034544-01	Fuse Block Cover
037639-01	Label for Fuse Value **(F1)**
037641-01	Label for Fuse Values **(F2–F6)**

NOTE:
A037396-01 power supply assembly has 120V plug
A037396-02 has the 100V, 220V and 240V plugs
A037396-03 has the 220V and 240V plugs

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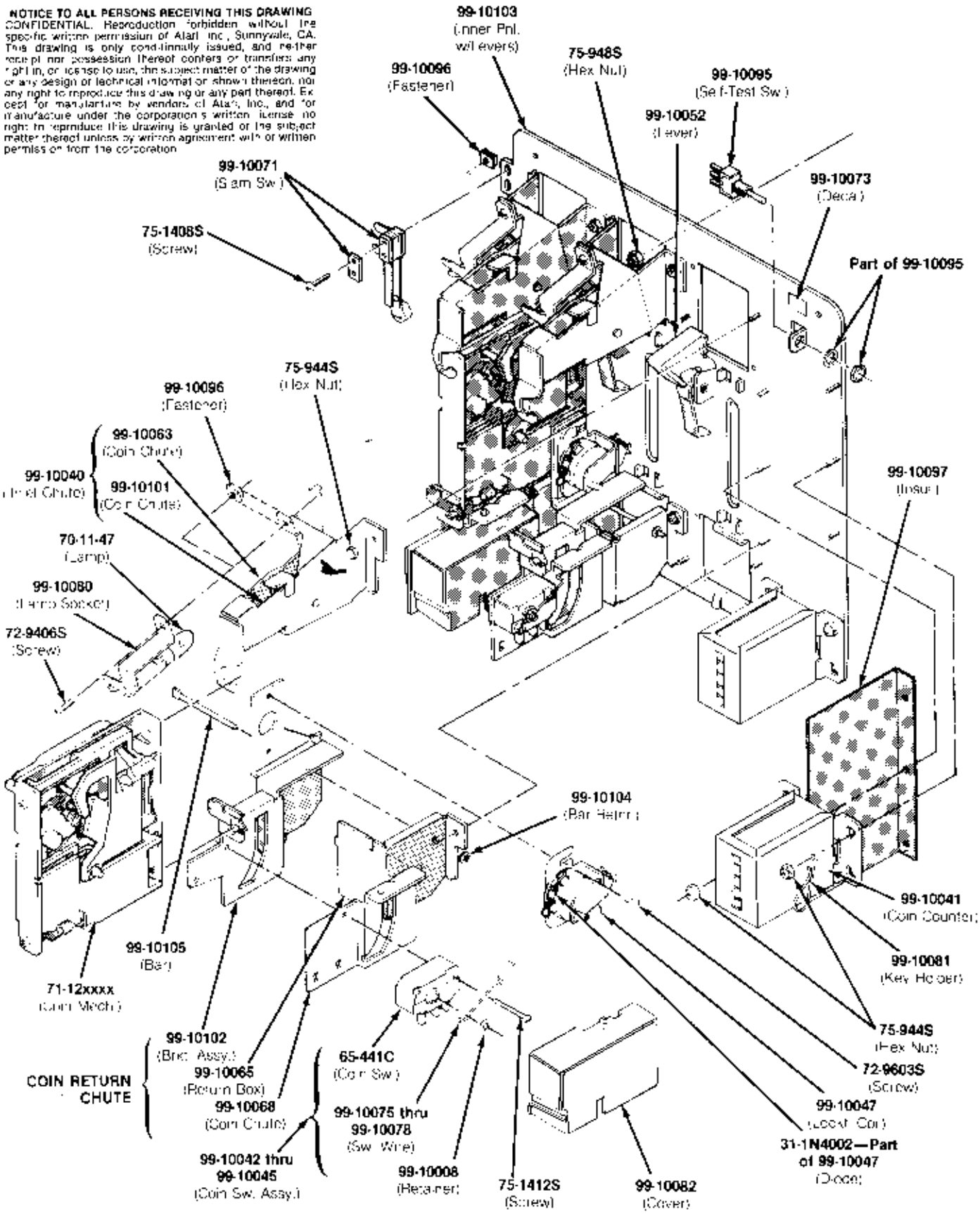
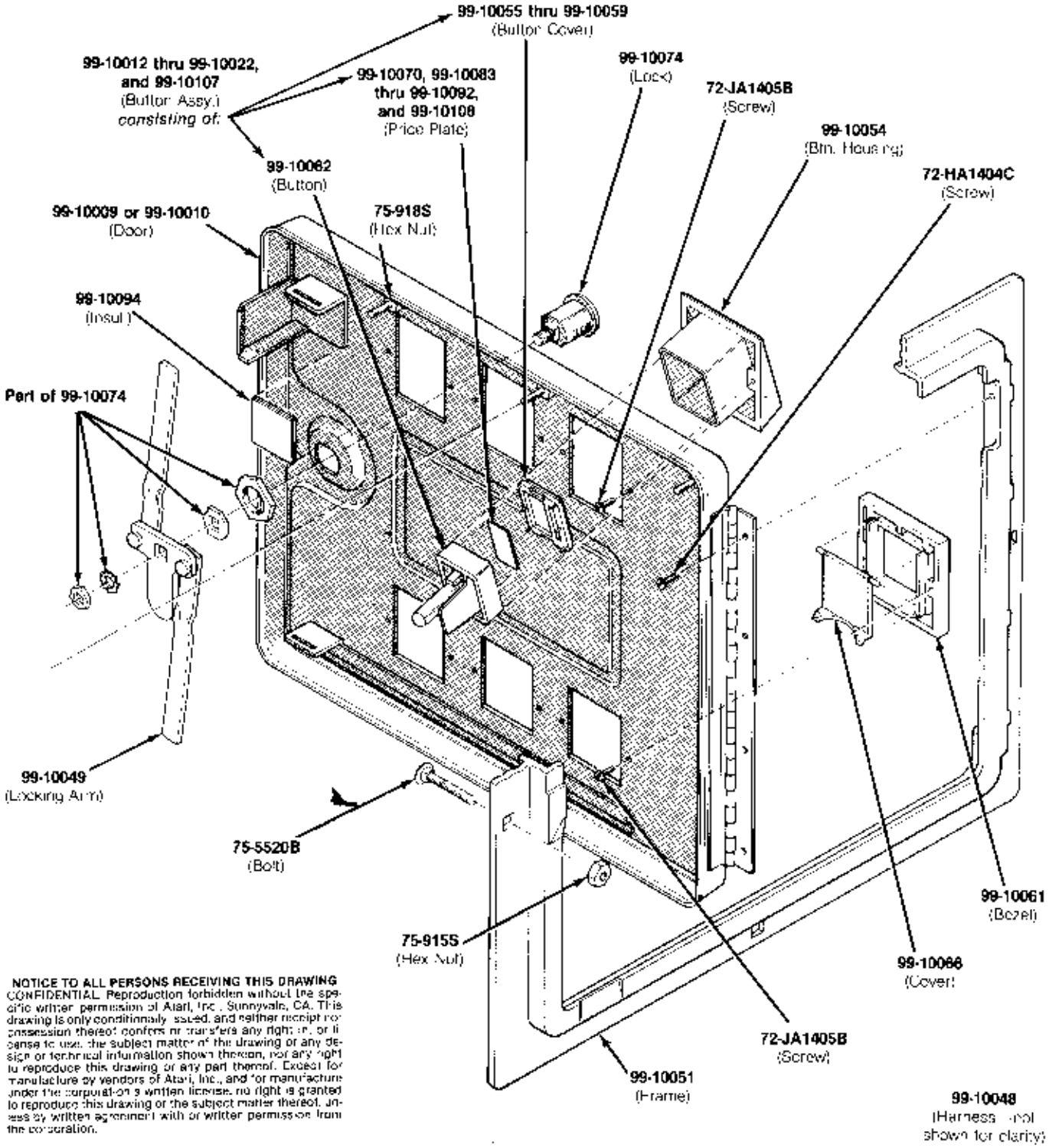


Figure 26 American-Made Coin Door
71-10xxxx D



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71-102201 — U.S. 25¢/25¢ Coin Door
71-103202 — U.S. 25¢/25¢/25¢ Coin Door
71-103203 — U.S. 25¢/25¢/$1 Coin Door
71-102204 — German 2 DM/1 DM Coin Door
71-103205 — German 1/2/5 DM Coin Door
71-102206 — German 1 DM/5 DM Coin Door
71-102207 — Belgian 5 Fr/5 Fr Coin Door
71-102208 — Swiss 1 Fr/1 Fr Coin Door
71-102209 — Japanese 100Y/100Y Coin Door
71-102210 — British 10 P/10 P Coin Door
71-102211 — Australian 20¢/20¢ Coin Door
71-102212 — Italian 100 L/100 L Coin Door
71-102213 — U.S. 50¢/50¢ (2 x 25¢) Coin Door
71-103214 — U.S. 50¢/50¢/50¢ Coin Door
71-103215 — U.S. 50¢/50¢/$1 Coin Door

Figure 26 American-Made Coin Door
71-10xxxx D

Figure 26 American-Made Coin Door Parts List

Part No.	*Description*
31-1N4002	100V Silicon Rectifier 1N4002 Diode
65-441C	General-Usage Low-Force Miniature Switch
70-11-47	Miniature Bayonet-Base Incandescent Lamp, Type #47
71-1201ADU	U.S. $1.00 Coin Mechanism
71-1201FCH	Swiss 1 Fr Coin Mechanism
71-1201MG	German 1 DM Coin Mechanism
71-1202MG	German 2 DM Coin Mechanism
71-1205FB	Belgian 5 Fr Coin Mechanism
71-1205MG	German 5 DM Coin Mechanism
71-1210PE	U.K. 10 P Coin Mechanism
71-1220CA	Australian 20¢ Coin Mechanism
71-1225CU	U.S. 25¢ Coin Mechanism
71-12100LI	Italian 100 Lire Coin Mechanism
71-12100YJ	Japanese Y100 Coin Mechanism
72-HA1404C	#4 × ¼-Inch Slotted Pan-Head Thread-Rolling Tri-Fluted "Taptite" Cadmium-Plated Screw
72-JA1405B	#4 × 5/16-Inch Slotted Pan-Head Thread-Rolling Tri-Fluted "Plastite" Black Screw
72-9406S	#4-40 × ⅜-Inch Slotted Truss-Head Steel Machine Screw
72-9603S	#6-32 × 3/8-Inch Slotted Truss-Head Steel Machine Screw
75-915S	#¼-20 Standard-Pattern Cadmium-Plated Steel Hex Nut
75-918S	#8-32 Standard-Pattern Cadmium-Plated Steel Hex Nut
75-944S	#4-40 Polymer Self-Locking Steel Hex Nut
75-948S	#8-32 Polymer Self-Locking Steel Hex Nut
75-1408S	#4-40 × ½-Inch Slotted Pan-Head Steel Machine Screw
75-1412S	#4-40 × ¾-Inch Slotted Pan-Head Steel Machine Screw
75-5520B	#¼-20 × 1¼-Inch Round-Head Square-Neck Steel Bolt with Black Finish
99-10008	Switch Wire Retainer
99-10009	2-Mech Coin Door Only
99-10010	3-Mech Coin Door Only
99-10012	U.S. 25¢ Coin Return Button Assembly
99-10013	U.S. $1.00 Coin Return Button Assembly
99-10014	German 1 DM Coin Return Button Assembly
99-10015	German 2 DM Coin Return Button Assembly
99-10016	German 5 DM Coin Return Button Assembly
99-10017	Belgian 5 Fr Coin Return Button Assembly
99-10018	Swiss 1 Fr Coin Return Button Assembly
99-10019	Japanese Y100 Coin Return Button Assembly
99-10020	U.K. 10 P Coin Return Button Assembly
99-10021	Australian 20¢ Coin Return Button Assembly
99-10022	Italian 100 Lire Coin Return Button Assembly
99-10040	Coin Inlet Chute Assembly
99-10041	Coin Counter Assembly
99-10042	Coin Switch Assembly for U.S. 25¢ and Belgian 5 Fr Coins *(silver wire)*
99-10043	Coin Switch Assembly for German 1 DM, Swiss 1 Fr, and Japanese Y100 Coins *(black wire)*
99-10044	Coin Switch Assembly for U.S. $1.00, German 2 DM, and Italian 100 Lire Coins *(gold wire)*
99-10045	Coin Switch Assembly for German 5 DM, U.K. 10 P, and Australian 20¢ Coins *(green wire)*
99-10047	Lockout Coin Assembly
99-10048	Coin Door Harness Assembly

[Continued on next page]

Figure 26 American-Made Coin Door, continued
Parts List

Part No.	*Description*
99-10049	Locking Arm Assembly
99-10051	Coin Door Frame
99-10052	Coin Return Lever
99-10054	Coin Button Housing
99-10055	Coin Return Button Cover for Japanese 100Y Coin
99-10056	Coin Return Button Cover for German 1 DM and Swiss 1 Fr Coins
99-10057	Coin Return Button Cover for U.S. 25¢ and Belgian 5 Fr Coins
99-10058	Coin Return Button Cover for U.S. $1.00, German 2 DM, and Italian 100 Lire Coins
99-10059	Coin Return Button Cover for German 5 DM, U.K. 10 P, and Australian 20¢ Coins
99-10061	Coin Return Bezel
99-10062	Coin Return Button
99-10063	Right Half of Coin Inlet Chute
99-10065	Coin Return Box
99-10066	Coin Return Cover
99-10068	Coin Chute
99-10070	U.S. 25¢ Price Plate
99-10071	Slam Switch Assembly
99-10073	Test Switch Decal
99-10074	Lock Assembly
99-10075	Black Switch Wire for German 1 DM, Swiss 1 Fr and Japanese 100Y Coins
99-10076	Silver Switch Wire for U.S. 25¢ and Belgian 5 Fr Coins
99-10077	Gold Switch Wire for U.S. $1.00, German 2 DM and Italian 100 Lire Coins
99-10078	Green Switch Wire for German 5 DM, U.K. 10 P and Australian 20¢ Coins
99-10080	Miniature Bayonet-Base Lamp Socket
99-10081	Wire Key Holder
99-10082	Switch Cover
99-10083	U.S. $1.00 Price Plate
99-10084	German 1 DM Price Plate
99-10085	German 2 DM Price Plate
99-10086	German 5 DM Price Plate
99-10087	Belgian 5 Fr Price Plate
99-10088	Swiss 1 Fr Price Plate
99-10089	Japanese Y100 Price Plate
99-10090	U.K. 10 P Price Plate
99-10091	Australian 20¢ Price Plate
99-10092	Italian 100 Lire Price Plate
99-10094	Fish Paper Insulation
99-10095	Toggle Switch
99-10096	"U"-Type Fastener
99-10097	Fish Paper Insulation
99-10101	Left Half of Coin Inlet Chute
99-10102	Switch and Lockout Coil Bracket Sub-Assembly
99-10103	Inner Panel with Levers Sub-Assembly
99-10104	Anti-Penny-Flip Bar Retainer
99-10105	Anti-Penny-Flip Bar
99-10107	U.S. 50¢ Coin Return Button Assembly *(for two quarters)*
99-10108	U.S. 50¢ Price Plate *(for two quarters)*

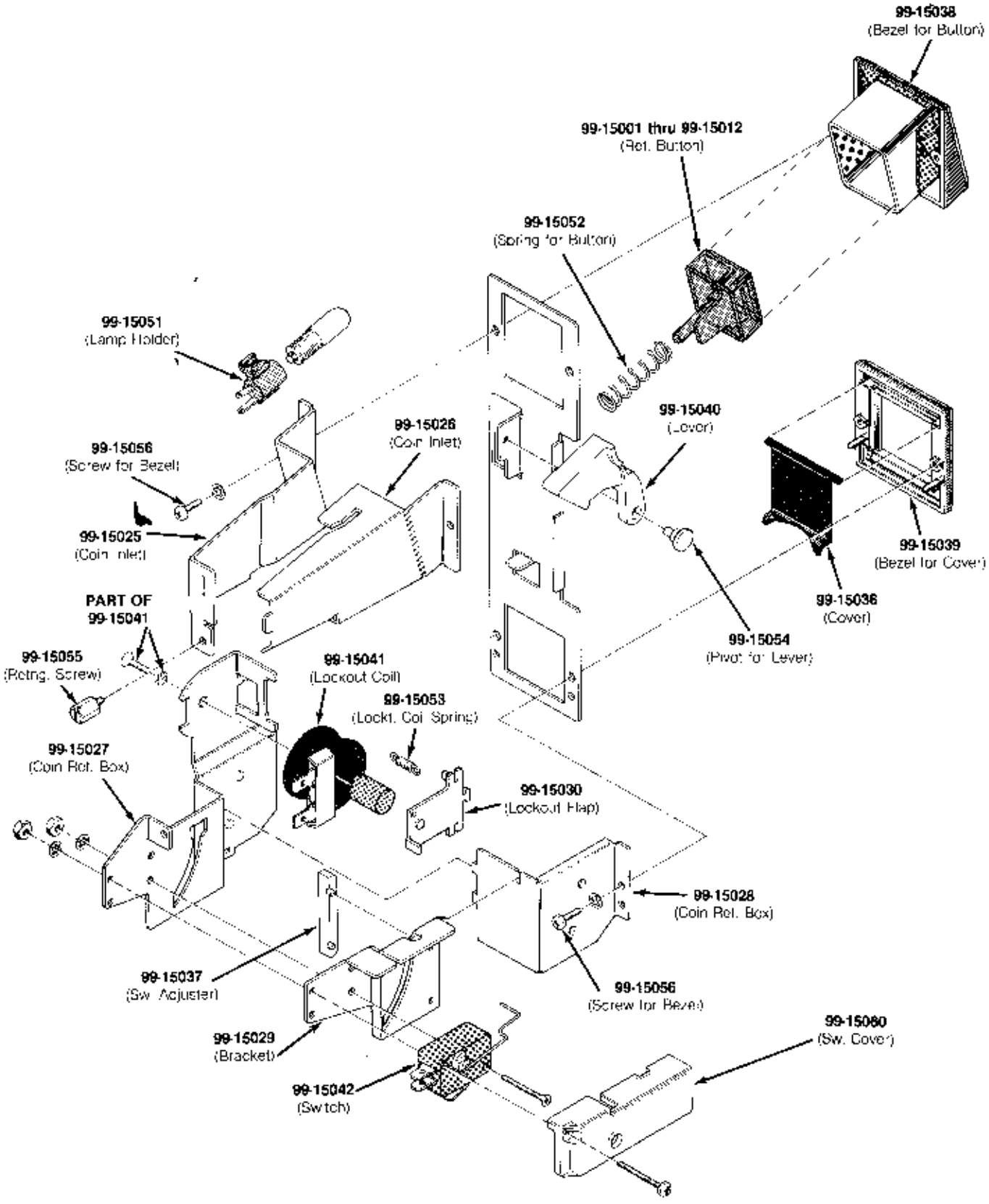
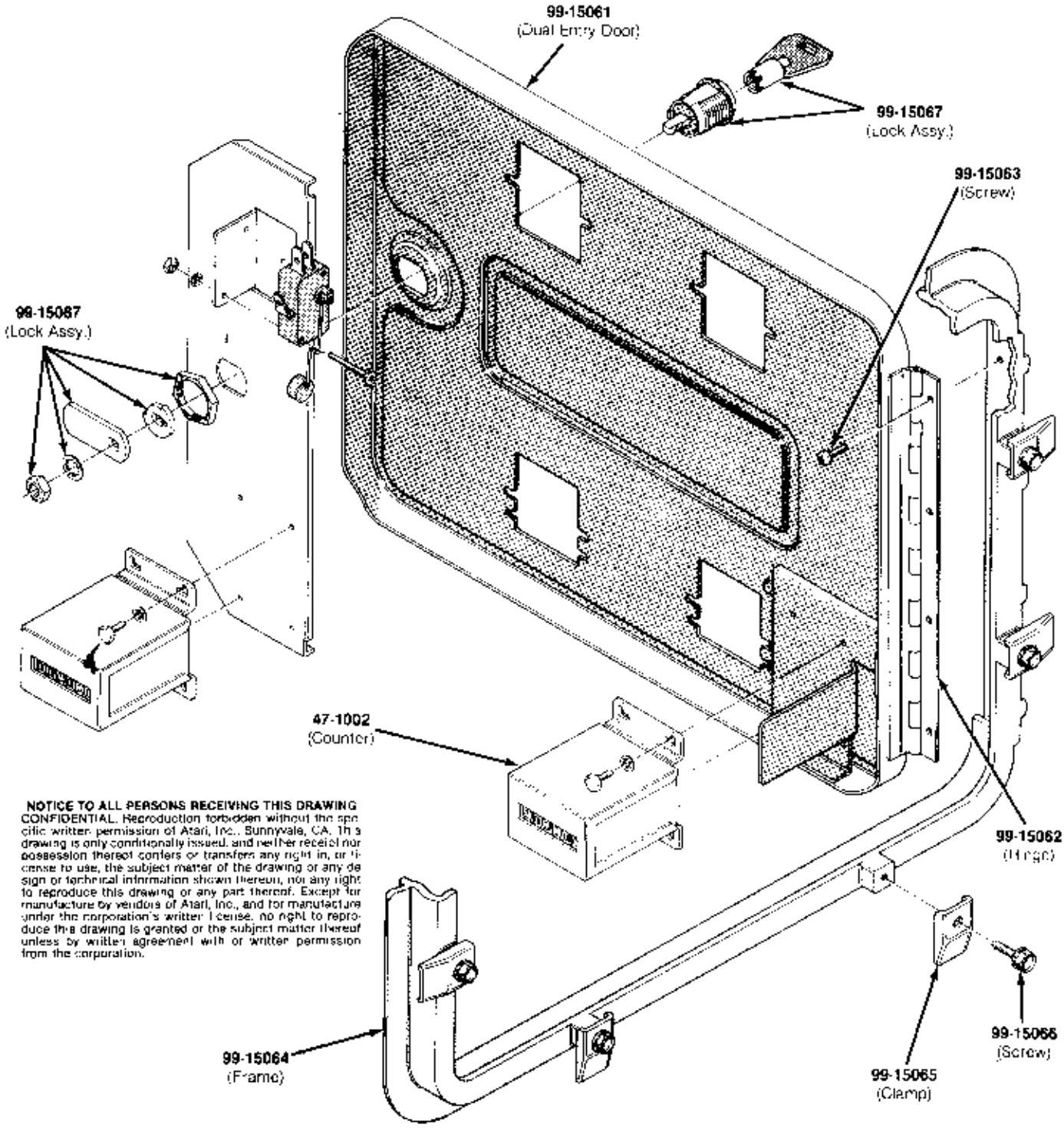


Figure 27 British-Made Coin Door
171001-xxx A



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171001-001 — British 10 P/10 P Coin Door
171001-002 — British 10 P/50 P Coin Door
171001-003 — British 20 P/50 P Coin Door
171001-004 — German 1 DM/1 DM Coin Door
171001-005 — German 2 DM/1 DM Coin Door
171001-006 — German 2 DM/5 DM Coin Door
171001-007 — Belgian 5 Fr/5 Fr Coin Door
171001-008 — French 1 Fr/1 Fr Coin Door
171001-009 — French 2 Fr/1 Fr Coin Door
171001-010 — Swedish 1 Kr/1 Kr Coin Door
171001-011 — Hong Kong $1/$1 Coin Door
171001-012 — Canadian 25¢/25¢ Coin Door
171001-013 — U.S. 25¢/25¢ Coin Door
171001-014 — Spanish 25 Pts/25 Pts Coin Door
171001-015 — Swiss 1 Fr/1 Fr Coin Door

Figure 27 British-Made Coin Door
171001-xxx A

Figure 27 British-Made Coin Door, continued
171001-xxx A

Part No.	*Description*
47-1002	Coin Counter
99-15001	Coin Return Button with U.S. 25¢ Price Plate
99-15002	Coin Return Button with U.S. $1 Price Plate
99-15003	Coin Return Button with German 1 DM Price Plate
99-15004	Coin Return Button with German 2 DM Price Plate
99-15005	Coin Return Button with German 5 DM Price Plate
99-15006	Coin Return Button with Belgian 5 Fr Price Plate
99-15007	Coin Return Button with French 1 Fr Price Plate
99-15008	Coin Return Button with Japanese 100 Yen Price Plate
99-15009	Coin Return Button with British 10 Pence Price Plate
99-15010	Coin Return Button with Australian 20¢ Price Plate
99-15011	Coin Return Button with Italian 100 Lire Price Plate
99-15012	Coin Return Button with U.S. 50¢ (2 x 25¢) Price Plate
99-15025	Left Half of Coin Inlet
99-15026	Right Half of Coin Inlet
99-15027	Side Plate of Coin Return Box
99-15028	Base Plate of Coin Return Box
99-15029	Switch Bracket
99-15030	Flap for Lockout Coil *(U.S. 25¢)*
99-15036	Coin Return Cover
99-15037	Switch Adjuster
99-15038	Bezel for Coin Return Button
99-15039	Bezel for Coin Return Cover
99-15040	Coin Return Lever
99-15041	Lockout Coil
99-15042	Coin Switch for U.S. 25¢
99-15051	Lamp Holder
99-15052	Spring for Coin Return Button
99-15053	Spring for Lockout Coil
99-15054	Pivot for Coin Return Lever
99-15055	Retaining Screw
99-15056	Screw for Both Bezels
99-15060	Switch Cover
99-15061	Dual-Entry Door
99-15062	Hinge
99-15063	Screw for Hinge
99-15064	Coin Door Frame
99-15065	Clamp for Frame
99-15066	Screw for Clamp
99-15067	Lock Assembly

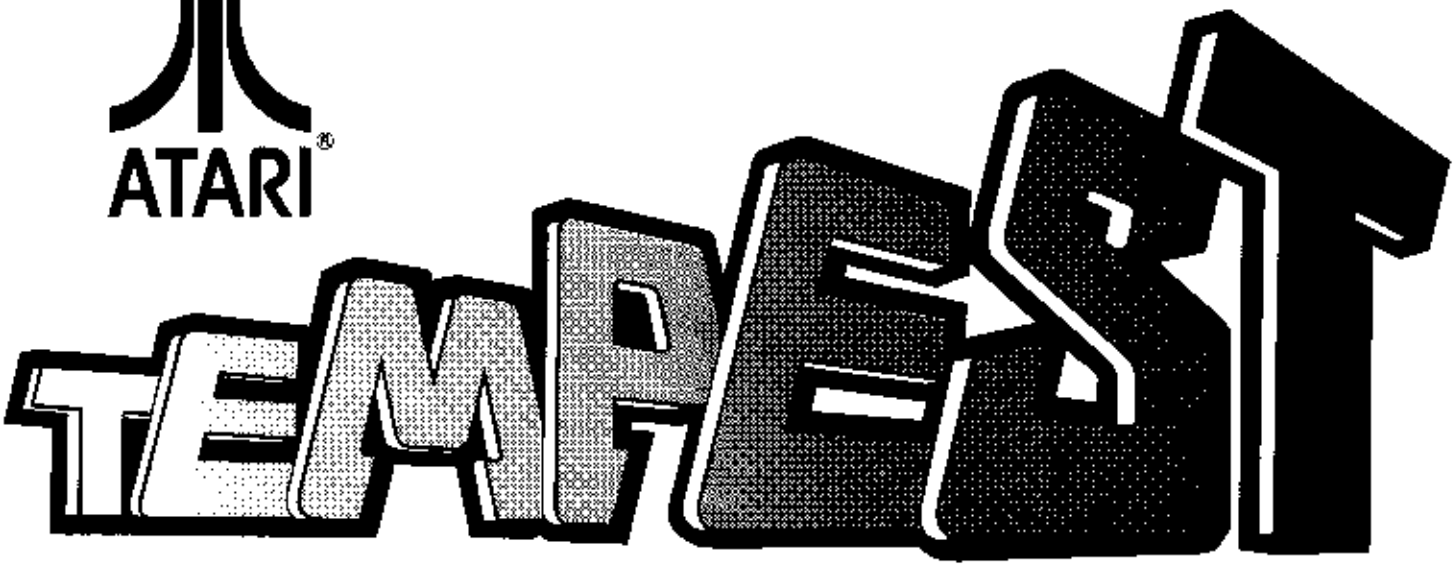


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ATARI®



TROUBLESHOOTING GUIDE

Complete with Signatures and Memory Map

Tempest™ Troubleshooting Guide

Complete with Signatures and Memory Map

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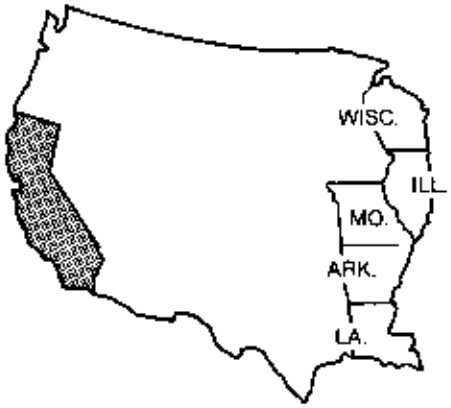
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NOTE

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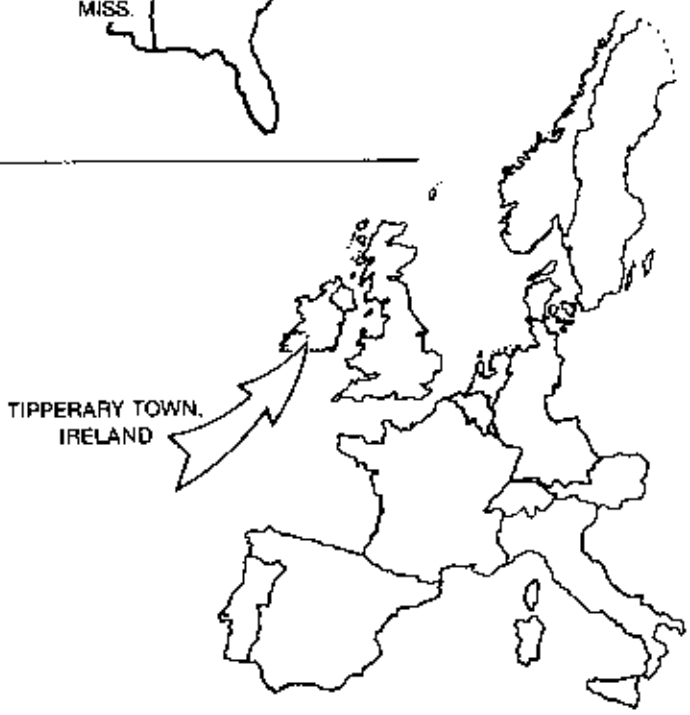
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1 Memory Map

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
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)

Figure 1 Memory Map

2 Watchdog

The Watchdog circuit will cause 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–microprocessor input (pin 40). In a properly operating game, reset should occur during power-up or when the reset push button is activated. A pulsing reset line indicates that something is causing the microprocessor to lose its place within its 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 rather than within either the Math Box or the Analog Vector Generator.

3 Troubleshooting

Using the CAT Box

A. CAT Box Preliminary Set-up

1. Remove:

- The electrical power from the game.
- The wiring harnesses from the game PCBs.
- The main and auxiliary boards from the game cabinet.
- The microprocessor chip C2 from the main PCB.

2. Connect:

- The harnesses from the game to the main and auxillary boards. (Use extender cables if available.)
- Φ0 and Φ2 test points together.
- W DOG DIS test point to ground.
- The CAT Box flex cable to the main PCB test edge connector.

3. Power Up:

- The game.
- The CAT Box.

4. Set CAT Box Switches:

- TESTER SELF-TEST: (OFF)
- TESTER MODE: R/$\overline{W}$
- Press TESTER RESET

B. Address and Data Lines

NOTE: This section assumes that IC F2 is a 74LS245.

1. Perform the CAT Box preliminary set-up.
2. Connect the DATA PROBE to the CAT Box and the game ground test point.
3. TESTER MODE: R/$\overline{W}$

4. BYTES: 1.
5. PULSE MODE: UNLATCHED
6. R/$\overline{W}$ MODE: (OFF)
7. R/$\overline{W}$ to WRITE
8. Key in address pattern on the keyboard *(use AAAA to start)*
9. Push DATA SET
10. Key in data pattern on the key board *(use AA to start)*
11. R/$\overline{W}$ MODE: STATIC
12. Probe the IC-pin with the data probe and check for the 1 or 0 LED as indicated in Figure 2. Repeat this step for each address and data line.
13. Repeat steps 6-11 using *5555* in step 8 and *55* in step 10.

Figure 2 Address and Data Lines

When writing *AAAA* pattern	Address and data lines	When writing *5555* pattern
Logic State	IC-Pin	Logic State
1	B3-1	0
0	B3-3	1
1	B3-2	0
0	A/B-3	1
1	A/B-18	0
0	A/B-16	1
1	A/B-14	0
0	A/B-12	1
1	B/C-3	0
0	B/C-5	1
1	B/C-7	0
0	B/C-9	1
1	B/C-18	0
0	B/C-16	1
1	B/C-14	0
0	B/C-12	1
1	F2-9	0
0	F2-8	1
1	F2-7	0
0	F2-6	1
1	F2-5	0
0	F2-4	1
1	F2-3	0
0	F2-2	1

C. RAM

1. Perform the CAT Box preliminary set-up.
2. Set the CAT Box switches as follows:
   a. Press TESTER RESET
   b. DBUS SOURCE: ADDR
   c. BYTES: 1024
   d. R/$\overline{W}$ MODE: (OFF)
   e. R/$\overline{W}$: WRITE
   f. Enter *0000* on the keypad
   g. Toggle R/$\overline{W}$ MODE to PULSE and back to (OFF)
   h. R/$\overline{W}$: READ
   i. Toggle R/$\overline{W}$ MODE to PULSE and back to (OFF)
3. If the CAT Box reads an address that doesn't compare, the COMPARE ERROR LED lights up, the ADDRESS/SIGNATURE display shows the failing address location, and the ERROR DATA DISPLAY switch is enabled. Using this switch, determine if the error is in the high- or low-order RAM.
4. Repeat the test with DBUS SOURCE set to $\overline{ADDR}$.
5. Repeat steps 2-4, entering *0400* on the keypad (step f).
6. Repeat steps 2-4, entering *2000* on the keypad (step f).
7. Repeat steps 2-4, entering *2400* on the keypad (step f).
8. Repeat steps 2-4, entering *2800* on the keypad (step f).
9. Repeat steps 2-4, entering *2C00* on the keypad (step f).

D. Option Switch Inputs

1. Perform the CAT Box preliminary set-up.
2. BYTES: 1
3. R/$\overline{W}$: READ
4. R/$\overline{W}$ MODE: (OFF)
5. Key in *0D00*
6. R/$\overline{W}$ MODE: STATIC
7. Activate the option switches at location N13 while monitoring the DATA DISPLAY. The DATA DISPLAY will change if the switches are operating properly.
8. Repeat steps 4-7, entering *0E00* in step 5, and activate switches at location L12.

E. Custom Audio I/O Chips

NOTE: Tempest™ has two custom audio I/O chips. Each must be tested separately. There are several ways to test the chips:
- Perform the Self-Test.
- Substitute good part for defective part.
- Use the procedure that follows.

1. Perform the CAT Box preliminary set-up.
2. BYTES: 1
3. R/$\overline{W}$: WRITE
4. R/$\overline{W}$ MODE: (OFF)
5. Enter address from Figure 3
6. Press DATA SET
7. Enter the data from Figure 3
8. R/$\overline{W}$ MODE to PULSE and back to (OFF)
9. Repeat steps 5-8 for each address and data, noting the test results.



Figure 3 Custom Audio I/O Chips

ADDRESS	DATA	TEST RESULTS
60CF	00	
60CF	03	
60C0	55	
60C1	AF	Custom Audio I/O Chip #1 channel 1 produces pure tone.
60C1	00	Custom Audio I/O Chip #1 channel 1 off.
60C2	55	
60C3	AF	Custom Audio I/O Chip #1 channel 2 produces pure tone.
60C3	00	Custom Audio I/O Chip #1 channel 2 off.
60C4	55	
60C5	AF	Custom Audio I/O Chip #1 channel 3 produces pure tone.
60C5	00	Custom Audio I/O Chip #1 channel 3 off.
60C6	55	
60C7	AF	Custom Audio I/O Chip #1 channel 4 produces pure tone.
60C7	00	Custom Audio I/O Chip #1 channel 4 off.

ADDRESS	DATA	TEST RESULTS
60DF	00	
60DF	03	
60D0	55	
60D1	AF	Custom Audio I/O Chip #2 channel 1 produces pure tone.
60D1	00	Custom Audio I/O Chip #2 channel 1 off.
60D2	55	
60D3	AF	Custom Audio I/O Chip #2 channel 2 produces pure tone.
60D3	00	Custom Audio I/O Chip #2 channel 2 off.
60D4	55	
60D5	AF	Custom Audio I/O Chip #2 channel 3 produces pure tone.
60D5	00	Custom Audio I/O Chip #2 channel 3 off.
60D6	55	
60D7	AF	Custom Audio I/O Chip #2 channel 4 produces pure tone.
60D7	00	Custom Audio I/O Chip #2 channel 4 off.

F. Player Input Switches and Encoder Wheel

1. Perform the CAT Box Preliminary Set-up
2. DBUS SOURCE to DATA
3. BYTES: 256
4. R/$\overline{W}$: WRITE
5. R/$\overline{W}$ MODE: (OFF)
6. Key in *60D0*
7. Press DATA SET
8. Key in *00*
9. Toggle R/$\overline{W}$ MODE to PULSE and back to (OFF)
10. BYTES: 1
11. R/$\overline{W}$: READ
12. Key in *60D8*
13. R/$\overline{W}$ MODE: STATIC
14. Pushing the following player input switches should cause the DATA DISPLAY to change: FIRE, SUPERZAPPER, 1-player start and 2-player start. (Also Player-2 FIRE and Player-2 SUPERZAPPER in cocktail* games.)

NOTE: For the encoder wheel, repeat the above instructions keying in *60C0* in step 6 and *60C8* in step 12. Turning the encoder wheel should cause the DATA DISPLAY to change.

*To test player-2 inputs in cocktail games connect IC D6-1 to +5.

G. LED and Coin Counter Outputs

1. Perform the CAT Box Preliminary set-up.
2. DBUS SOURCE to DATA
3. BYTES: 1
4. R/$\overline{W}$: WRITE
5. R/$\overline{W}$ MODE: (OFF)
6. Key in address from Figure 4
7. Press DATA SET
8. Key in on or off data from Figure 4
9. R/$\overline{W}$ MODE to STATIC and back to (OFF)
10. Repeat steps 6-9 to turn off coin counter solenoids, or to test another address.

If you write data that activates a solenoid, deactivate it by pressing the reset button on the game board or by writing "off" data. If you leave a solenoid activated for more than about 10 seconds it will overheat and may have to be replaced.

Figure 4 LED and Coin Counter Addresses

ADDRESS	ON-DATA	OFF-DATA	OUTPUT NAME
4000	01	00	Right Coin Counter
4000	02	00	Center Coin Counter
4000	04	00	Left Coin Counter
60E0	FD	FF	1-player start LED
60E0	FE	FF	2-player start LED

H. Analog Vector-Generator

1. Test:

1. Perform CAT Box preliminary set-up.
2. DATA SOURCE: DATA
3. R/$\overline{W}$: WRITE
4. R/$\overline{W}$ MODE: (OFF)
5. Key in address from Figure 5 or press ADDRESS INC.
6. Press DATA SET
7. Key in data from Figure 5
8. Set R/$\overline{W}$ MODE to PULSE and then to (OFF)
9. Repeat steps 5-8 for each address in Figure 5

CAUTION

You may damage the circuitry of the X-Y monitor if you key in the VG GO signal without first checking all the addresses and data. Check the data by reading each address location using steps 10-14:

10. R/$\overline{W}$: READ
11. R/$\overline{W}$ MODE: (OFF)
12. Key in address or press ADDRESS INC.
13. R/$\overline{W}$ MODE: PULSE
14. Check the data in the DATA DISPLAY against the data in Figure 5

If you are sure the data is correct, proceed to steps 15-19:

15. R/$\overline{W}$ MODE: WRITE
16. R/$\overline{W}$: (OFF)
17. Key in VG GO address (4800 for TEMPEST™)
18. R/$\overline{W}$ to PULSE and then back to (OFF)
19. After writing to the VG GO address, the monitor should show a large plus sign. Failure of the horizontal or vertical circuits shows up as a single line drawn on the monitor. *If your monitor does not display a large plus sign, contact Atari Field Service.*

Figure 5 Analog Vector-Generator Data

Address	Data	Address	Data	Address	Data
2000	40	200C	FF	2018	00
2001	80	200D	03	2019	40
2002	00	200E	00	201A	80
2003	70	200F	62	201B	00
2004	00	2010	40	201C	80
2005	1E	2011	80	201D	1F
2006	00	2012	80	201E	00
2007	1E	2013	00	201F	00
2008	00	2014	00	2020	FF
2009	60	2015	00	2021	40
200A	FF	2016	01	2022	00
200B	03	2017	1F	2023	E0

4 Troubleshooting

With Signature Analysis

A. Signature Analysis Set-up

1. Perform the CAT Box Preliminary set-up.
2. Connect the three BNC to E-Z clip cables (supplied with the CAT Box) to the SIGNATURE ANALYSIS CONTROL START, STOP and CLOCK jacks on the CAT Box.
3. Attach the three black E-Z clips to a ground loop on the Tempest™ game PCB.
4. Attach the CAT Box data probe to the DATA jack on the CAT Box.
5. The colored E-Z clips on the cables will be moved about for each group of signatures to be taken.
6. Set the CAT Box switches as follows:
   - TESTER MODE: SIG
   - TESTER SELF-TEST: OFF
   - PULSE MODE: LATCHED
   - START: As indicated
   - STOP: As indicated
   - CLOCK: As indicated
7. Power up the game board and the CAT Box.

B. Address Lines

1. CAT Box Settings for Address Bus Test

Probe	*Trigger*	*IC-Pin*	*Test Pt.*
Start	⌐	A6-3	
Stop	⌐	A6-3	
Clock	⌐	C2-39	Φ2

Verify CAT Box settings and connections as follows:
- probe GND test point = 0000 signature
- probe +5V test point = 0001 signature

2. Signatures

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
B/C1-12	AB0	UUUU
B/C1-14	AB1	5555
B/C1-16	AB2	CCCC
B/C1-18	AB3	7F7F
B/C1-9	AB4	5H21
B/C1-7	AB5	0AFA
B/C1-5	AB6	UPFH
B/C1-3	AB7	52F8
A/B1-12	AB8	HC89
A/B1-14	AB9	2H70
A/B1-16	AB10	HPP0
A/B1-18	AB11	1293
A/B1-3	AB12	HAP7
B3-2	A13	3C96
B3-3	A14	3827
B3-1	A15	755U
A6-4	$\overline{A15}$	755P

C. Address Decoder

NOTE: While testing decoders and ROMs, it may be necessary to add 270 pF capacitors to ADDR 12, 13, 14 and 15 to eliminate unstable signatures.

1. CAT Box Settings for Address Decoder Test

Probe	*Trigger*	*IC-Pin*	*Test Pt.*
Start	⌐	A6-3	
Stop	⌐	A6-3	
Clock	⌐		Φ 2

2. Signatures

NOTE: To obtain Signatures from IC J5, ground R/$\overline{W}$ testpoint.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
B3-7	$\overline{I/O}$	F2A6
E3-2	$\overline{I/O}$	F2A7
F3-8	$\overline{EI/O}$	F2A6
J5-9	$\overline{VGRST}$	5969
J5-10	$\overline{WDCLR}$	0PC5
J5-11	$\overline{VGGO}$	270P
J5-12	BB*	9CH2
B3-5	$\overline{VMEM}$	12U3
B3-4	AA*	4P0A
J2-7	$\overline{ROM8}$	56C3
J2-6	$\overline{ROM7}$	8019
J2-5	$\overline{ROM6}$	5AH1
J2-4	$\overline{ROM5}$	9HUC
J2-9	$\overline{ROM4}$	1920
J2-10	$\overline{ROM3}$	C34C
J2-11	$\overline{ROM2}$	597C
J2-12	$\overline{ROM1}$	UA87
C1-7	$\overline{ROM0}$	4154
C1-6	$\overline{ROMX}$	960F

3. CAT Box Settings for Address Decoder Test

Probe	*Trigger*	*Testpoint*
Start	⌐	A6-4
Stop	⌐	A6-4
Clock	⌐	Φ2

4. Signatures

Verify CAT Box setting and connections as follows: probe +5V = 755U signature.

Logic Probe on IC-Pin	*Signature Should Be*
B3-9	970C
B3-10	868C
B3-11	7FF8
B3-12	1817

D. ROM and Data Lines

NOTE: When taking signatures on ROMs, install a 270 pF capacitor between IC B3, Pin 2 and ground.

1. CAT Box Settings for ROMX Test

(I.C. D1 for ROM part no. 136002-101, -113 or -133.)

Probe	*Trigger*	*Testpoint*
Start		$\overline{ROMX}$
Stop		$\overline{ROMX}$
Clock		Φ2

2. Signatures

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
D1-9	DB0	1F4H
D1-10	DB1	4P55
D1-11	DB2	P2C5
D1-13	DB3	UH32
D1-14	DB4	4HFA
D1-15	DB5	0P76
D1-16	DB6	86CP
D1-17	DB7	P29C

3. CAT Box Settings for ROM0 Test

(I.C. E1 for ROM part no. 136002-102 or -114. I.C. D1 for ROM part no. 136002-133.)

Probe	*Trigger*	*Testpoint*
Start		$\overline{ROM0}$
Stop		$\overline{ROM0}$
Clock		Φ2

4. Signatures

Verify CAT Box settings and connections as follows: probe + 5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
E1-9	DB0	6481
E1-10	DB1	P6A9
E1-11	DB2	9552
E1-13	DB3	40F3
E1-14	DB4	37C2
E1-15	DB5	0A18
E1-16	DB6	A2C0
E1-17	DB7	9HC5

5. CAT Box Settings for ROM1 Test

(I.C. F1 for ROM part no. 136002-103, 115 or -134.)

Probe	*Trigger*	*Testpoint*
Start		$\overline{ROM1}$
Stop		$\overline{ROM1}$
Clock		Φ2

6. Signatures

Verify CAT Box settings and connections as follows: probe + 5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
F1-9	DB0	3892
F1-10	DB1	01U5
F1-11	DB2	PH6P
F1-13	DB3	UP9F
F1-14	DB4	UP44
F1-15	DB5	CA33
F1-16	DB6	3U05
F1-17	DB7	8CP3

7. CAT Box Settings for ROM2 Test

(I.C. H1 for ROM part no. 136002-104 or -116. I.C. F1 for ROM part no. 136002-134.)

Probe	*Trigger*	*Testpoint*
Start		$\overline{ROM2}$
Stop		$\overline{ROM2}$
Clock		Φ2

8. Signatures

Verify CAT Box settings and connections as follows: probe + 5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
H1-9	DB0	7550
H1-10	DB1	A01F
H1-11	DB2	A540
H1-13	DB3	5U60
H1-14	DB4	2068
H1-15	DB5	9767
H1-16	DB6	54CA
H1-17	DB7	7F8F

9. CAT Box Settings for ROM3 Test

(I.C. J1 for ROM part no. 136002-105, -117 or -135.)

Probe	*Trigger*	*Testpoint*
Start	⌐	$\overline{\text{ROM3}}$
Stop	⌐	$\overline{\text{ROM3}}$
Clock	⌐	Φ2

10. Signatures

Verify CAT Box settings and connections as follows: probe +5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
J1-9	DB0	09A6
J1-10	DB1	6A12
J1-11	DB2	91CA
J1-13	DB3	10HP
J1-14	DB4	F53U
J1-15	DB5	C67C
J1-16	DB6	8272
J1-17	DB7	F651

11. CAT Box Settings for ROM4 Test

(I.C. K1 for ROM part no. 136002-106 or -118. I.C. J1 for ROM part no. 136002-135.)

Probe	*Trigger*	*Testpoint*
Start	⌐	$\overline{\text{ROM4}}$
Stop	⌐	$\overline{\text{ROM4}}$
Clock	⌐	Φ2

12. Signatures

Verify CAT Box settings and connections as follows: probe +5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
K1-9	DB0	A8FU
K1-10	DB1	U3U7
K1-11	DB2	C8CH
K1-13	DB3	353F
K1-14	DB4	93FU
K1-15	DB5	UFH1
K1-16	DB6	A165
K1-17	DB7	5399

13. CAT Box Settings for ROM5 Test

(I.C. L/M1 for ROM part no. 136002-107, -119 or -136.)

Probe	*Trigger*	*Testpoint*
Start	⌐	$\overline{\text{ROM5}}$
Stop	⌐	$\overline{\text{ROM5}}$
Clock	⌐	Φ2

14. Signatures

Verify CAT Box settings and connections as follows: probe +5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
L/M1-9	DB0	4876
L/M1-10	DB1	5397
L/M1-11	DB2	7396
L/M1-13	DB3	C9CH
L/M1-14	DB4	HF73
L/M1-15	DB5	11U6
L/M1-16	DB6	43C8
L/M1-17	DB7	2P85

15. CAT Box Settings for ROM6 Test

(I.C. M/N1 for ROM part no. 136002-108 or -120. I.C. L/M1 for ROM part no. 136002-136.)

Probe	*Trigger*	*Testpoint*
Start	⌐	$\overline{\text{ROM6}}$
Stop	⌐	$\overline{\text{ROM6}}$
Clock	⌐	Φ2

16. Signatures

Verify CAT Box settings and connections as follows: probe +5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
M/N-9	DB0	A4AC
M/N-10	DB1	3A7C
M/N-11	DB2	0F22
M/N-13	DB3	H221
M/N-14	DB4	2H07
M/N-15	DB5	818A
M/N-16	DB6	1699
M/N-17	DB7	4149

17. CAT Box Settings for ROM7 Test

(I.C. P1 for ROM part no. 136002-109, -121 or -137.)

Probe	*Trigger*	*Testpoint*
Start	┐└	$\overline{ROM7}$
Stop	┘┌	$\overline{ROM7}$
Clock	┐└	Φ2

18. Signatures

Verify CAT Box settings and connections as follows: probe + 5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
P1-9	DB0	P4F3
P1-10	DB1	2C06
P1-11	DB2	4614
P1-13	DB3	7A63
P1-14	DB4	434C
P1-15	DB5	3C66
P1-16	DB6	P8U6
P1-17	DB7	2C3A

19. CAT Box Settings for ROM8 Test

(I.C. R1 for ROM part no. 136002-110 or -122. I.C. P1 for ROM part no. 136002-137.)

Probe	*Trigger*	*Testpoint*
Start	┐└	$\overline{ROM8}$
Stop	┘┌	$\overline{ROM8}$
Clock	┐└	Φ2

20. Signatures

Verify CAT Box settings and connections as follows: probe + 5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
R1-9	DB0	9HFP
R1-10	DB1	U7HH
R1-11	DB2	F32H
R1-13	DB3	F66U
R1-14	DB4	U379
R1-15	DB5	490P
R1-16	DB6	5P99
R1-17	DB7	CFA8

21. CAT Box Settings for Vector ROM Test (I.C. N/P3 for part no. 136002-111, -123 or -138.)

NOTE: When taking signatures on IC N/P3, ground IC-Pin B3-5.

Probe	*Trigger*	*IC-Pin*	*Testpoint*
Start	┐└	C1-10	
Stop	┘┌	C1-10	
Clock	┐└		Φ2

22. Signatures

Verify CAT Box settings and connections as follows: probe + 5V = 7A70 signature.

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
N/P3-9	DB0	H1U9
N/P3-10	DB1	5U8C
N/P3-11	DB2	0C59
N/P3-13	DB3	507P
N/P3-14	DB4	2A8P
N/P3-15	DB5	9F0C
N/P3-16	DB6	AH97
N/P3-17	DB7	29AH

23. CAT Box Settings for Vector ROM1 Test (I.C. R3 for part no. 136002-112 or -124.)

NOTE: When taking signatures on I.C. R3, ground IC-Pin B3-5.

Probe	*Trigger*	*IC-Pin*	*Testpoint*
Start	┐└	C1 Pin 9	
Stop	┘┌	C1 Pin 9	
Clock	┐└		Φ2

24. Signatures

Logic Probe on IC-Pin	*Signal Name*	*Signature Should Be*
R3-9	DB0	3FH3
R3-10	DB1	0H59
R3-11	DB2	9H5H
R3-13	DB3	98PF
R3-14	DB4	PA27
R3-15	DB5	5U3H
R3-16	DB6	97FC
R3-17	DB7	583A

E. Math Box

The Math Box signature analysis procedure is somewhat different from other procedures, so follow these set-up instructions for the three tests carefully.

In addition to your CAT Box or signature analyzer, you'll need an SA Harness Assembly. Order Atari part number A036836-01 or see Figure 6 to make your own.

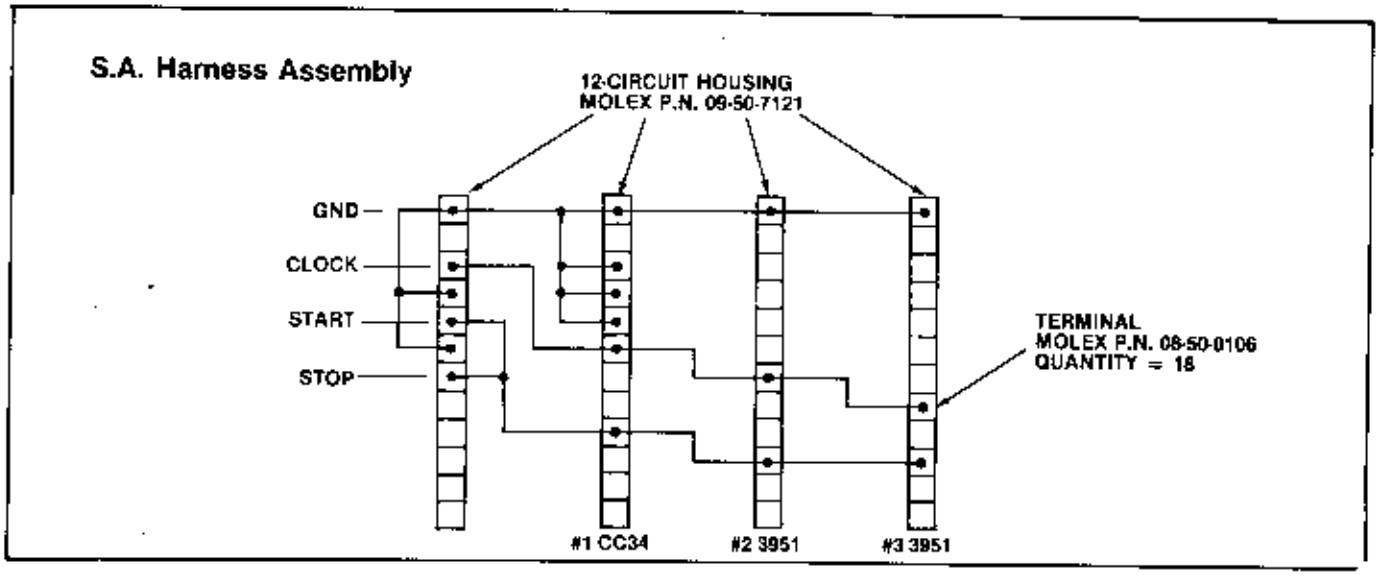
A. Math Box Test #1 Procedure:

1. Plug SA Harness Assembly Test #1 connector onto Signature Analyzer connector (J16) on the Auxiliary PCB.
2. Connect the CAT Box Start, Stop and Clock E-Z hooks to the SA Harness Assembly as shown in Figure 7.
3. On the main PCB, connect PWR ON RESET test point to ground, and power-up the game and the CAT Box.
4. Don't remove the microprocessor (6502A) from the main PCB.
   Don't connect the 50 pin ribbon cable to the main PCB edge connector.
   Don't connect W DOG DIS to ground.
5. Set the CAT Box switches as follows:
   a. START _┌
   b. STOP _┌
   c. CLOCK _┌
   d. TESTER MODE: SIG
   e. Press TESTER RESET
6. With the logic probe touching the +5V test point on the Auxiliary PCB, the ADDRESS/SIGNATURE display should read CC34. This will verify that your test set-up is correct. If you don't get CC34, recheck your set-up.

NOTE: Signatures are listed in the order that they should be done. As often as possible, *IC-Pin* refers to a chip output. As a general rule, when a bad signature is discovered, the IC listed in the *IC-Pin* column can be suspected as faulty.

Those signatures marked with an asterisk (*) should be taken with a 1K resistor clipped between the logic probe and the +5V test point.

Figure 6 S.A. Harness Assembly



Signatures

Logic Probe on IC-Pin	*Signature Should Be*
C1-11	H58A
C1-12	77F7
C1-13	85PA
C1-14	7P25
D1-11	5CP0
D1-12	P5PH
D1-13	725C
D1-14	96PF
F1-12	4PPF
F1-11	OUF0
F1-10	3CAP
F1-9	A6A3
H1-12	26A6
H1-11	91HA
H1-10	P9C1
H1-9	2987
J1-12	96U0
J1-11	UC59
J1-10	6989
J1-9	3FU4
K1-12	05A6
K1-11	60H6
K1-10	PPF6
K1-9	34C2
L1-12	58A1
L1-11	1AA2
L1-10	F74F
L1-9	6CF6
E1-12	F765
E1-11	CPU8
E1-10	0000
E1-9	F515
F4-2	CC34
E4-6	A6A3
A2-6	0000
B1-2	8A7H
B1-5	CU2P
B1-6	1C6C
B1-9	6U30
B1-12	5AAH
B1-15	03A7
B1-16	9A08
B1-19	2327
K/L2-33	6PUP
K/L2-16	9AFH*
K/L2-8	809A*
F/H2-33	9CPP
F/H2-16	11C5*
F/H2-8	78AA*
J2-33	8631
J2-16	11C5*
J2-8	7U19*
E2-34	A1F7
E2-31	1781
E2-16	9AFH*
E5-11	C646
D4-8	0600
E4-11	CC34
F5-11	C835*
D4-6	C4U4
F5-6	753F
E4-8	CPU8
E5-8	45A1*

B. Math Box Test #2A Procedure

1. Plug SA Harness Assembly Test #2 connector onto Signature Analyzer connector (J16) on the Auxiliary PCB.
2. Connect the CAT Box Start, Stop and Clock E-Z hooks to the SA Harness Assembly as shown in Figure 7.
3. Don't remove the microprocessor (6502A) from the main PCB.
   Don't connect the 50 pin ribbon cable to the main PCB edge connector.
   Don't connect W DOG DIS to ground.
   Don't connect PWR ON RESET to ground.
4. Set the CAT Box switches as follows:
   a. START ⎍‾
   b. STOP ‾⎍
   c. CLOCK ‾⎍_
   d. TESTER MODE: SIG
   e. Press TESTER RESET
5. Enter the self-test mode and advance the screen with the slam switch until the large blank rectangle appears. This procedure is described in Figure 6, Chapter 2 of the Tempest™ Operation, Maintenance, and Service Manual.
6. With the logic probe touching the +5V test point on the Auxiliary PCB, the ADDRESS/SIGNATURE display should read *3951*. This will verify that your test set-up is correct. If you don't get 3951, recheck your set-up.

NOTE: Signatures are listed in the order that they should be done. As often as possible, *IC-Pin* refers to a chip output. As a general rule, when a bad signature is discovered, the IC listed in the *IC-Pin* column can be suspected as faulty.

Signatures

Logic Probe on IC-Pin	*Signature Should Be*
A1-14	F722
A1-13	C4P5
A1-12	6UAC
A1-11	3441
A1-10	2P61
A1-9	92F3
A1-7	A856
A1-6	3050
A1-5	H8F9
A1-4	9569
A1-3	3U53
A1-2	9F47
A1-1	4FUF

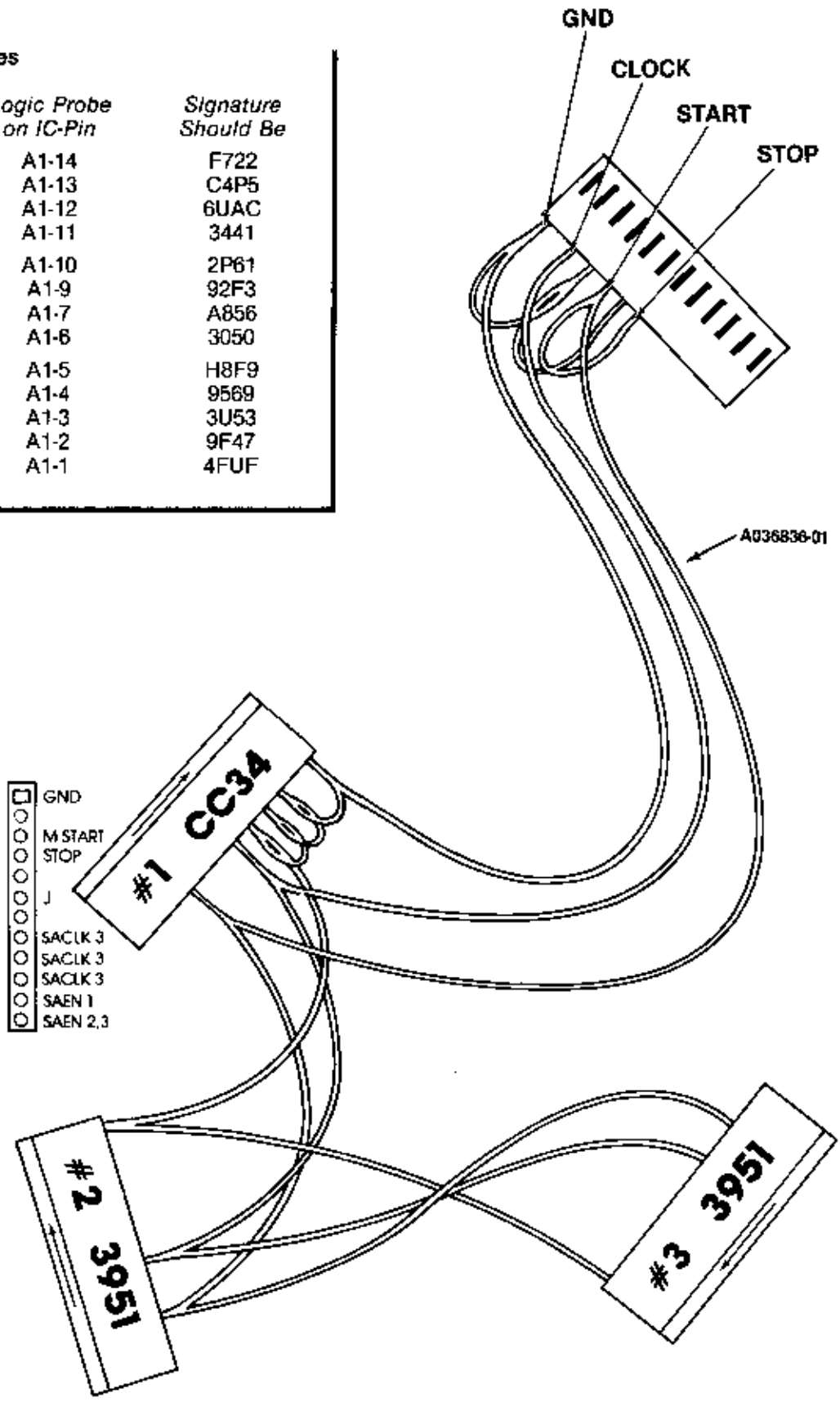


Figure 7 S.A. Harness Assembly

C. Math Box Test #2B Procedure

1. Plug SA Harness Assembly Test #2 connector onto Signature Analyzer connector (J16) on the Auxiliary PCB.
2. Connect the CAT Box Start, Stop and Clock E-Z hooks to the SA Harness Assembly as shown in Figure 7.
3. Don't remove the microprocessor (6502A) from the main PCB.
   Don't connect the 50 pin ribbon cable to the main PCB edge connector.
   Don't connect W DOG DIS to ground.
   Don't connect PWR ON RESET to ground.
4. Set the CAT Box switches as follows:
   a. START ⌐
   b. STOP ¬
   c. CLOCK ⌐
   d. TESTER MODE: SIG
   e. Press TESTER RESET
5. Enter the self-test mode and advance the screen with the slam switch until the large blank rectangle appears. This procedure is described in Figure 6, Chapter 2 of the Tempest™ Operation, Maintenance, and Service Manual.
6. With the logic probe touching the +5V test point on the Auxiliary PCB, the ADDRESS/SIGNATURE display should read *3951*. This will verify that your test set-up is correct. If you don't get *3951*, recheck your set-up.

NOTE: Signatures are listed in the order that they should be done. As often as possible, *IC-Pin* refers to a chip output. As a general rule, when a bad signature is discovered, the IC listed in the *IC-Pin* column can be suspected as faulty.

Signatures

Logic Probe on IC-Pin	*Signature Should Be*
C1-11	92F3
C1-12	A856
C1-13	3050
C1-14	H8F9
D1-11	9569
D1-12	3U53
D1-13	9F47
D1-14	4FUF

D. Math Box Test #3 Procedure

1. Plug SA Harness Assembly Test #3 connector onto Signature Analyzer connector (J16) on the Auxiliary PCB.
2. Connect the CAT Box Start, Stop and Clock E-Z hooks to the SA Harness Assembly as shown in Figure 7.
3. Don't remove the microprocessor (6502A) from the main PCB.
   Don't connect the 50 pin ribbon cable to the main PCB edge connector.
   Don't connect W DOG DIS to ground.
   Don't connect PWR ON RESET to ground.
4. Set the CAT Box switches as follows:
   a. START ⌐
   b. STOP ¬
   c. CLOCK ⌐
   d. TESTER MODE: SIG
   e. Press TESTER RESET
5. Enter the self-test mode and advance the screen with the slam switch until the large blank rectangle appears. This procedure is described in Figure 6, Chapter 2 of the Tempest™ Operation, Maintenance, and Service Manual.
6. With the logic probe touching the +5V test point on the Auxiliary PCB, the ADDRESS/SIGNATURE display should read *3951*. This will verify that your test set-up is correct. If you don't get *3951*, recheck your set-up.

NOTE: Signatures are listed in the order that they should be done. As often as possible, *IC-Pin* refers to a chip output. As a general rule, when a bad signature is discovered, the IC listed in the *IC-Pin* column can be suspected as faulty.

Signatures

Logic Probe on IC-Pin	*Signature Should Be*
E2-22	1441
E2-23	2883
E2-24	5107
E2-25	A20P
J2-22	441H
J2-23	883A
J2-24	1074
J2-25	20P9



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