Williams
Service Manual

- set-up
- operation
- troubleshooting
- logic and schematic diagrams
- parts
MANUAL AMENDMENT

MANUAL AFFECTED: 16-3021-101

PURPOSE: To update the BLASTER manual with information on current-production games.

CHANGE: (1) delete paragraph on BUY-IN FEATURE, p. 5
(2) revise paragraph on Starting difficulty, p. 5
(3) alter the video-screen figures (Fig. 6 and Fig. 7) on pp. 11 and 12 as shown
(4) revise DEFINITIONS OF PRICING TERMS, pp. 13-14

PLAYERS CHOOSE STARTING DIFFICULTY

FOUR WAYS TO START. Players may begin a game in any of the first four waves: (1) Robot Grid; (2) Planetoids; (3) Vampires and (4) Saucerland. This feature allows players to select the amount of challenge the game will offer, while increasing the game's collection for the operator.
BOOKKEEPING TOTALS

LEFT SLOT COINS  432
CENTER SLOT COINS  0
RIGHT SLOT COINS  398
PAID CREDITS  830
EXTRA SHIPS EARNED  172
SHIPS PLAYED  1723
TOTAL PLAYS  517
PLAYS LESS THAN 1:30  116
PLAYS 1:30 TO 3:00  303
PLAYS 3:00 TO 5:00  74
PLAYS 5:00 TO 10:00  22
PLAYS OVER 10:00  2
TIMES WAVE 10 REACHED  201
TIMES WAVE 15 REACHED  74
TIMES WAVE 20 REACHED  7
AVERAGE TIME PER PLAY  2:13

Figure 6. Bookkeeping screen

GAME ADJUSTMENTS

EXTRA SHIP EVERY  100,000 RECOMMENDED
TURNs PER PLAYER  3 RECOMMENDED
GAME PRICING  1 COIN PER PLAYER
COINAGE PARAMETERS  3 USA COINAGE
LEFT SLOT UNITS  1
CENTER SLOT UNITS  4
RIGHT SLOT UNITS  1
UNITS REQUIRED FOR CREDIT  1
UNITS REQUIRED FOR BONUS CREDIT  0
MINIMUM UNITS FOR ANY CREDIT  0
DIFFICULTY OF PLAY  5 RECOMMENDED
LETTERS FOR HIGHEST SCORE NAME  20
RESTORE FACTORY SETTINGS  NO
CLEAR BOOKKEEPING TOTALS  NO
HIGH SCORE TABLE RESET  NO
AUTO CYCLE  NO
SET ATTRACT MODE MESSAGE  NO
SET HIGHEST SCORE NAME  NO

USE JOYSTICK TO SELECT ADJUSTMENT
USE BLAST AND THRUST TO CHANGE THE VALUE
PRESS ADVANCE TO EXIT

Figure 7. Adjustments screen showing factory settings for upright games
DEFINITIONS OF PRICING TERMS

GAME PRICING permits one or more credits to equal one game. Factory settings place a...

- "1" in the CREDITS REQUIRED TO START GAME function (upright and plastic games) or
- "2" in the CREDITS REQUIRED TO START GAME function (cockpit games with ROM-board jumper W3 cut)

COINAGE PARAMETERS allows a shorthand method of setting the pricing functions. If a number from one to nine is entered into the COINAGE PARAMETERS function, a corresponding standard setting (shown in bold type in Table 1 above) will be entered into the game. The rest of the pricing functions are automatically set for that standard.

THE NUMBER OF CREDITS PER COIN is equal to the number of SLOT UNITS for any one slot divided by the number of UNITS PER CREDIT. If the number of LEFT SLOT UNITS equals X and the number of UNITS PER CREDIT equals Y, then the number of credits per coin is X/Y. With factory settings X is "1" and Y is "1". Players receive a credit for a quarter.

UNITS REQUIRED FOR BONUS CREDIT is the number of games that must be purchased before a free game is awarded.

MINIMUM UNITS FOR ANY CREDIT is the least number of coins allowed per credits or credits: Or put another way, the MINIMUM UNITS FOR ANY CREDIT determines the smallest number of whole credits that may be paid for at one time.

For example if you want to allow one credit for a quarter but wish to encourage multiple game-playing, you may enter:

- "0" in the COINAGE PARAMETERS function

This zero value automatically sets all pricing functions. However minimum units for any credit must be raised to "2" or a higher value to achieve your goal. Here are the rest of the functions as they should appear.

- "1" in the LEFT SLOT UNITS function
- "4" in the CENTER SLOT UNITS function
- "1" in the RIGHT SLOT UNITS function
- "1" in the UNITS PER CREDIT function
- "0" in the UNITS REQUIRED FOR BONUS CREDIT function
- "2" in the MINIMUM UNITS FOR ANY CREDIT function

These values allow one credit for a quarter, but ONLY when two or more credits are paid for at a time. Incidentally, the "4" in CENTER SLOT UNITS allows four credits per dollar coin (center slot only). See "2/50¢, 4/$1" in Table 1 above.

GAMES : PRICE ratio to start a game is equivalent to the ratio:

\[ X: Y \]
where:

- X = SLOT UNITS
- V = COIN VALUE
- Y = UNITS PER CREDIT
- S = GAME PRICING

For example at factory settings with quarter chutes the variables produce 1: 25x1x1 or one game for 25¢.
INSTRUCTION MANUAL
FOR UPRIGHT
AND COCKPIT GAMES

including...
• operation
• bookkeeping
• adjustments
• diagnostics
• schematic and logic diagrams
• parts
## ROM SUMMARY

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CHAPTER 1    Game Setup

Warnings and Notices
Game Features
Examine Your Game
Location of Controls
Optional Extension Monitor Connections
Warnings & Notices

WARNING:
1. FOR SAFETY AND RELIABILITY, WILLIAMS does not recommend or authorize any substitute parts or modifications of WILLIAMS equipment.

2. USE OF NON-WILLIAMS PARTS and modifications of game circuitry may adversely affect game play, or may cause injuries.

3. SUBSTITUTE PARTS, MODIFICATIONS AND GAME “CONVERSIONS” may void FCC type-acceptance.

4. SINCE THIS GAME IS PROTECTED by Federal copyright, trademark and patent laws, so-called game “conversions” may be illegal under Federal law.

5. THIS "CONVERSION" PRINCIPLE ALSO APPLIES to unauthorized facsimiles of WILLIAMS equipment, logos, designs, publications, assemblies and game (or game features not deemed to be in the public domain), whether manufactured with WILLIAMS components or not.

RF INTERFERENCE NOTICE:
CABLE HARNESS PLACEMENTS AND GROUND STRAP ROUTING on this game have been designed to keep RF radiation and conduction within levels accepted by FCC regulation.

TO MAINTAIN THESE LEVELS, reposition harnesses and reconnect ground straps to their original placements if they should be disconnected during maintenance.

CAUTION
FOUR GREEN #18 WIRES Terminate at the power-pack (transformer) assembly chassis D-9886. These wires provide earth ground to the marquee, monitor, switch brackets and PCB-plate mounting brackets. If one of these chassis-ground wires is disconnected during servicing, it must be reconnected to maintain safety standards.

NOTICE:
Assemblies secured to the plastic-upright cabinet use special #8 x 1/4" screws, WILLIAMS part no. 4606-01081-11. Always replace these screws with the same type. NEVER attempt to substitute ordinary sheet-metal screws.

Game Features

FIRST-PERSON ACTION
IN MOST VIDEO GAMES players have to watch a “hero” go through the motions for them. Not so in BLASTER video!

IN BLASTER VIDEO players are right there in the action. When they move the joystick, their whole point-of-view changes just as it would in a jet aircraft or in the space shuttle! When they press THRUST the stars, asteroids and interstellar gas clouds shoot by at death-defying speed.

BUY-IN FEATURE
CONTINUED GAMES. After completing a game players are encouraged to continue where they left off. (At factory settings upright BLASTER models even offer continued games at half-price.) Continued games more challenging than original games. So continued games tend to involve skilled players at the level they prefer and to increase collections.

PLAYERS CHOOSE STARTING DIFFICULTY
FOUR WAYS TO START. Players may begin a game in any of the first four waves: (1) Planetoids; (2) Robot Grid; (3) Saucerland and (4) Vampires. This feature allows players to select the amount of challenge the game will offer, while increasing the game's collection for the operator.

49-WAY OPTO JOYSTICK
MODELED AFTER A MILITARY AIRCRAFT JOYSTICK, the BLASTER joystick is engineered to fit the hand and provide quick game response as well as durability.

ELECTRONICALLY THE JOYSTICK IS UNIQUE. Six opto-isolators (three on the X-axis and three on the Y-axis) are positioned to accept both direction and speed cues. A resolution of 49 directions and speed combinations is possible. See PLAYER CONTROLS below.

STEREO COCKPIT SOUND
STEREO SOUND. Since “true” stereo requires two sound sources, BLASTER video has not only two speakers, but two entire sound boards.
Examine your Game

When you receive a new WILLIAMS game, examine it carefully before you power it up. Be sure it was delivered in good condition.

☐ INSPECT THE OUTSIDE of the shipping carton and/or game cabinet for shipping damage.

☐ UPRIGHTS: Unlock and set aside the top-rear panel. Undo the two trunk latches on the inside of the bottom door. Open the door. Now check circuitry.

☐ PLASTIC UPRIGHT: Unlock and open the rear door. Now check circuitry.

☐ COCKPIT GAMES: See Figure 1. (1) Unlock the access door on the front of the game. (2) Now extend your arm to the left and right inside the door. Undo the two hood trunk latches. (3) Raise the hood. (4) Loosen the two access screws at the sides of the circuit board panel. (5) Raise the panel and inspect circuitry.

☐ ARE CONNECTORS SECURELY ATTACHED? Reconnect any found loose. DON'T FORCE CONNECTORS. They're keyed and only fit one way.

☐ ARE PLUG-IN CHIPS FIRMLY seated in their sockets?

☐ UNWRAP THE POWER CORD coiled inside the cabinet. UPRIGHT GAMES: place the strain-relief plate in the slots as shown in Figure 2. PLASTIC GAMES: position the cord in the groove of the cabinet floor. COCKPIT GAMES: Strain-relief provided: the power cord is secured under the front edge of the cabinet below the access door; free the power cord. Strain-relief not provided: extend the power cord through the hole in the cabinet floor. DON'T PLUG IT IN YET!

☐ SCRUTINIZE MAJOR SUBASSEMBLIES, such as the monitor, control panel, transformer chassis and power supply. Make sure they're securely-mounted.

Location Of Controls

THE ON-OFF SWITCH is located: in the top right corner of the rear of the cabinet (UPRIGHT) on the bottom of cabinet below access door (COCKPIT) in center over rear door (PLASTIC).

THE POWER INTERLOCK SWITCH is located behind the top-right corner of rear door UPRIGHT & PLASTIC inside the access door on the front of the game COCKPIT. The interlock switch is a spring-loaded DPDT type that will turn off the game when you open the door. For servicing purposes, pull the switch out and the game will power up.

THE DUAL VOLUME CONTROL is located on the circuit board panel. On uprights and plastic cabinets you can adjust it from the coin door. On cockpits models open the hood to adjust volume.

DIAGNOSTIC SWITCHES are on the inside of the coin door in upright and plastic cabinet games. In cockpit games they're under the hood and on the top right side as you face the front of the game.

These switches are used to access the Diagnostic-Mode Tests, the BOOKKEEPING TOTALS screen and the GAME ADJUSTMENTS screen. Refer to appropriate sections for information on each of these important features.

MISCELLANEOUS CONTROLS. The memory-protect interlock switch is near the diagnostic switch bracket (see above). This switch must be open when you clear BOOKKEEPING TOTALS or make GAME ADJUSTMENTS. It automatically opens when the coin door is open on upright and plastic cabinet games and when the hood is up on cockpit games. The CPU board reset switch is located on the CPU board beside the batteries. The cashbox advance switch, found inside the cashbox door on all models, allows bookkeeping information to be audited without permitting it to be zeroed. A sound-board diagnostic switch is diagonally across each sound board from a large, strap-mounted axial capacitor. Sound-board diagnostics are explained in chapter 3.

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**Figure 1. Cockpit model with hood raised.**

**Figure 2. Power Cord Strain Relief (Upright)**
Optional Extension Monitor Installation

An extension monitor must be connected to 115VAC power through a 1:1 isolation transformer. The transformer must have a minimum current rating of 1A. Connections from the WILLIAMS video system to the monitor inputs may simply be paralleled to provide the extension monitor with sync and video.

**CAUTION:** These monitor connections void the game's FCC certification and UL listings. These may not be restored when the extension monitor is disconnected.

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*Figure 3. Cockpit Model Cashbox Security Plate*

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*Figure 4. Access to Plastic Cabinet Control Panel*
CHAPTER 2  Game Operation

Power Turn-On
Game Operation
Bookkeeping Totals
Game Adjustments
Definitions of Pricing Terms
Power Turn-On

**CAUTION:** This game must be plugged into a properly-grounded outlet to prevent shock hazard and to ensure proper game operation. DO NOT use a “cheater” plug to defeat the ground pin on the power cord, and DO NOT cut off the ground pin.

**WHEN THE GAME IS FIRST TURNED ON** general illumination should come on and a moment later a scanning “rug pattern” indicating the RAM test should appear on the screen. Next the rug should become stationary as the ROM test is performed. In a correctly-running game the rug pattern will be followed by the message “INITIAL CHECKS INDICATE OPERATIONAL”. If RAM or ROM failure messages come up on the screen instead, refer to Power-Up Tests in TROUBLESHOOTING PROCEDURES.

Game Operation

**GAME START**

**INSERT COINS.** The number of COINS RECEIVED is displayed on the CRT. With four or more coins displayed, pressing 2-PLAYER START initiates a 2-player, 3-turn game (adjustable feature).

**PLAYER CONTROLS**

**CONTROLLED BY THE JOYSTICK,** a unique configuration of optoswitches provides a faster response and a greatly-increased number of vectors in each quadrant for the precise aiming of your spaceship.

**TWO SETS OF THREE OPTOSWITCHES** each are arranged at right angles to each other. One set is for aiming along the X-axis; the other is for aiming along the Y-axis. With the joystick in the center position all six optoswitches are blocked.

**AS THE JOYSTICK IS MOVED** it actuates one or both sets of switches. The spaceship responds with extraordina precision due to the sequential action of the optoswitches in each set. Each switch in the set is offset so that joystick action multiplies the circuitry brought in by the switches, increasing the precision aiming of the spaceship.

**THE RATE OF X-Y COURSE CHANGE INCREASES** as the joystick is moved further from the center position; it decreases as the joystick is returned toward the center position.

**SPECIAL CIRCUITRY** is included so the spaceship can respond immediately to sudden reversals of joystick movement.

**PRESS BLAST!** The spaceship fires at planetoids and enemies.

**PRESS THURST!** The spaceship accelerates to maximum speed.

**GAME PLAY**

**IN A VALIANT SPACESHIP** the player defies space and time while waging robots, vampires, cat fighters and other fearsome foes. The player must BLAST enemies or stay out of their way to protect his shields [and his turn]. A shield may be hit three times before it disintegrates. **GAME ACTION IS DIVIDED INTO WAVES.** Each wave may have one or several goals. Some of the more-important goals are to...

- BLAST enemies and planetoids (fleet bonus for eliminating all of one type)
- pick up spacemen [in time tunnel or space]
- dock with energizer E’s [restores shields]
- BLAST the red saucer first or last (at Saucerland)
- fly through the magic arches [on the Robot Grid]
- attain wave 30 to enter astral paradise

**BAD GUYS**

- android
- cat fighter
- death rider
- destroyer
- enduro
- master mind
- planetoids
- red saucer
- runway ship
- saucer
- space cowboy
- space robot
- star cruiser
- vampire
- X-29 fighter

Bookkeeping Totals

**ENTERING BOOKKEEPING MODE.** See Figure 5. Inside the coin door (or under the hood on cockpit-model games) is a bracket with three button switches. Set the AUTO-UP/ MANUAL-DOWN (center) switch to AUTO-UP. Press the ADVANCE switch to display BOOKKEEPING TOTALS on the screen (Figure 3). Now check those totals. Here’s what to look for...

![Figure 5. Diagnostic Button Switches](image)

**BOOKKEEPING TOTALS SHOW YOU AT A GLANCE** if game settings are bringing you a satisfactory return on your investment! Only games by WILLIAMS ELECTRONICS have this feature. Think of it as a unique way to keep your BLASTER game the leader of the pace when it comes to earnings... location after location, week in and week out!

**ENTERING BOOKKEEPING MODE.** See Figure 5. Inside the coin door (or under the tabletop on cocktail-model games) is a bracket with three button switches. Set the AUTO-UP/ MANUAL-DOWN (center) switch to AUTO-UP. Press the ADVANCE switch to display BOOKKEEPING TOTALS on the screen (Figure 6). Now check those totals. Here’s what to look for...
**BOOKKEEPING TOTALS**

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<tr>
<td>Center Slot Coins</td>
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<tr>
<td>Right Slot Coins</td>
<td>398</td>
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<tr>
<td>Paid Credits</td>
<td>830</td>
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<tr>
<td>Extra Ships Earned</td>
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<td>Plays 3:00 to 5:00</td>
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<td>Plays 5:00 to 10:00</td>
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</tr>
<tr>
<td>Plays Over 10:00</td>
<td>2</td>
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<tr>
<td>Times Wave 20 Reached</td>
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<tr>
<td>Times Wave 30 Reached</td>
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<td>Average Time Per Play</td>
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**Figure 6. Bookkeeping screen**

**AVERAGE TIME PER PLAY: TWO MINUTES.** Your most important figure on the BOOKKEEPING TOTALS screen is AVERAGE TIME PER PLAY. You’ll want to pay special attention to this figure every day for this reason. Thorough field and factory research has shown that two-minute games both satisfy players and also keep the quarters flowing.

If games aren’t running about two minutes long, then collections probably aren’t at their peak. But...is someone throwing the average off? Now you can check. Because BLASTER video even tells you how many people played at each of five skill (time) levels. Most of them should be grouped at PLAYS 1:30 to 3:00. How many players reached upper waves? BLASTER video even lets you know this! These features help you tailor your game to your game-playing public. It’s easy. But only WILLIAMS games let you do it!

**Game Adjustments**

**ANOTHER EXCLUSIVE IN WILLIAMS GAMES!** No other brand of games permits such a broad range of GAME ADJUSTMENTS. Without expensive “speed-up kits” or risky modifications you can make BLASTER play to your advantage...whatever your location needs may be. This feature makes BLASTER video a very versatile performer. And it means that BLASTER video has phenomenal staying power! Now here’s the secret...

**USE THE DIAGNOSTIC SWITCHES.** With the AUTO-UP/MANUAL-DOWN switch set to AUTO-UP press the ADVANCE switch twice. The GAME ADJUSTMENTS screen will come up (See Figure 7. Factory settings are shown there).

Now for the multiple choice section! Choose one or more:

- Use the BLAST (longer game) and THRUST (shorter game) buttons to choose the appropriate difficulty level (1 = easiest or extra liberal, 4 = average, 9 = hardest or extra conservative).

- For a shorter game, increase the bonus points figure (EXTRA SHIP EVERY) or set it to zero. For a longer game, reduce it. (50,000 = long/200,000 = short).

- For a shorter game, decrease the number of TURNS PER PLAYER. For a longer game, increase the number. (1 = short/20 = long).

**SET ATTRACT MODE MESSAGE**

1. Move the cursor to SET ATTRACT MODE MESSAGE.
2. Press BLAST.
3. Press ADVANCE.
4. Enter up to two lines of your message by following instructions on the screen.
5. Press ADVANCE to enter Game-Over Mode.

To restore the WILLIAMS attract-mode message, perform steps 1 through 3 and then turn the game off and back on.
**GAME ADJUSTMENTS**

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<tr>
<td>Turns Per Player</td>
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<td>Credits Required to Continue Game</td>
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<tr>
<td>Left Slot Units</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Center Slot Units</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Right Slot Units</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Units Required for Credit</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Units Required for Bonus Credit</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Minimum Units for Any Credit</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Difficulty of Play</td>
<td>4</td>
<td>Recommended</td>
</tr>
<tr>
<td>Letters for Highest Score Name</td>
<td>20</td>
<td>Recommended</td>
</tr>
<tr>
<td>Restore Factory Settings</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Clear Bookkeeping Totals</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>High Score Table Reset</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Auto Cycle</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Set Attract Mode Message</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Set Highest Score Name</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

*Use Joystick to Select Adjustment. Use Blast and Thrust to change the value. Press Advance to exit.*

**Figure 7. Adjustments screen showing factory settings for upright games**

**NOTE:** Factory settings vary on the function CREDITS REQUIRED TO CONTINUE GAME. Upright games are set to 1. Cockpit games have a ROM-board jumper providing a 2.

---

**LETTERS FOR HIGHEST SCORE NAME**

The number of letters allowed the highest-scoring player for entering his name can be varied from 3 to 20 and is recommended as 20. If objectionable words are entered as the signature name, you can change the lettered entry leaving the highest score the same. See SETTING HIGHEST SCORE NAME.

**RESTORE FACTORY SETTINGS**

1. Move the cursor to RESTORE FACTORY SETTINGS.
2. Press BLAST.
3. Press ADVANCE twice.

**CLEAR BOOKKEEPING TOTALS**

1. Move the cursor to CLEAR BOOKKEEPING TOTALS.
2. Press BLAST.
3. Press ADVANCE twice.

**HIGH SCORE TABLE RESET**

1. Move the cursor to HIGH SCORE TABLE RESET.
2. Press BLAST.
3. Press ADVANCE to enter Game-Over Mode.

**AUTO CYCLE**

This adjustment is actually a troubleshooting procedure. See Chapter 3.

1. Move the cursor to AUTO CYCLE.
2. Press BLAST to display a "YES".
3. Press ADVANCE to enter Auto-Cycle Mode. The coin door or hood must remain open for this test.
4. To exit Auto-Cycle Mode, turn the game off and on.

**SET HIGHEST SCORE NAME**

1. Move the cursor to SET HIGHEST SCORE NAME.
2. Press BLAST.
3. Press ADVANCE.
4. Enter the new signature.
5. Press ADVANCE to enter Game-Over Mode.

An alternate, simpler method enters the factory highest-score signature. In the Game-Over Mode hold down the HIGH SCORE RESET button. After a few seconds a sound is produced and the factory highest-score signature is activated.
Table 1. Game Pricing

<table>
<thead>
<tr>
<th>Coin Door Mechanism</th>
<th>Credits/Money</th>
<th>Pricing Selection</th>
<th>Left Slot Units</th>
<th>Center Slot Units</th>
<th>Right Slot Units</th>
<th>Units Per Credit</th>
<th>Unis Req'd For Bonus Credit</th>
<th>Min. Units For Any Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin Quarter</td>
<td>1/25C, 5/$1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2/50C, 5/$1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>*1/25C, 4/$1</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2/50C, 4/$1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1/50C, 3/$1, 4/25</td>
<td>0</td>
<td>3</td>
<td>12</td>
<td>3</td>
<td>4</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1/50C, 3/$1, 7/2</td>
<td>0</td>
<td>12</td>
<td>48</td>
<td>12</td>
<td>14</td>
<td>96</td>
<td>24</td>
</tr>
<tr>
<td>1DM, 5DM</td>
<td>*2/1DM, 12/5DM</td>
<td>5</td>
<td>12</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20-Cent, 50-Cent</td>
<td>*1/4DM, 6/5DM</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 Franc, 5 Franc</td>
<td>*1/2F, 3/5F only</td>
<td>4</td>
<td>1</td>
<td>16</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25 Cent, 1G</td>
<td>*1/25C, 4/1G</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 Gulden</td>
<td>1/25C, 5/1G</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5 Franc</td>
<td>*1/5F, 2/10F</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10 Franc</td>
<td>*1/10F</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 Franc, 2 Franc</td>
<td>*2/1F, 5/2F</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100 Lire, 200 Lire</td>
<td>*1/200 Lire</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Twin Coin</td>
<td>*1/1 Coin</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>*1/2 Coins</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1/2 Coins, 1/4 Coins</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1/3 Coins, 2/5 Coins</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-Unit, 5-Unit</td>
<td>*1/2, 3/5</td>
<td>4</td>
<td>1</td>
<td>16</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1/4, 5/5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1/3, 2/5</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Any</td>
<td>*Free Play</td>
<td>9</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Definitions of Pricing Terms

CREDITS REQUIRED TO START GAME permits one or more credits to equal one game. Factory settings place a...
- "2" in the CREDITS REQUIRED TO START GAME function

CREDITS REQUIRED TO CONTINUE GAME lets you offer players a price-incentive when they continue games. The factory setting is:
- "1" in the CREDITS REQUIRED TO CONTINUE GAME function

This "1" means that players (who paid 50 to initiate their first game) may continue playing for only 25.

PRICING SELECTION allows a shorthand method of setting the pricing functions. If a number from one to nine is entered into the PRICING SELECTION function, a corresponding standard setting (shown in bold type in Table 1 above) will be entered into the game. The rest of the pricing functions are automatically set for that standard.

THE NUMBER OF CREDITS PER COIN is equal to the number of SLOT UNITS for any one slot divided by the number of UNITS PER CREDIT. If the number of LEFT SLOT UNITS equals X and the number of UNITS PER CREDIT equals Y, then the number of credits per coin is X/Y. With factory settings X is "1" and Y is "1". Players receive a credit for a quarter.

UNITs REQUIRED FOR BONUS CREDIT is the number of games that must be purchased before a free game is awarded.

MINIMUM UNITS FOR ANY CREDIT is the least number of credits allowed per credits or credits. Or put another way, the MINIMUM UNITS FOR ANY CREDIT determines the smallest number of whole credits that may be paid for at one time.

For example, if you want to allow one credit for a quarter but wish to encourage multiple game-playing, you may enter:
- "0" in the PRICING SELECTION function

This zero value automatically sets all pricing functions. However minimum units for any credit must be raised to "2" or
a higher value to achieve your goal. Here are the rest of the functions as they should appear:

- "1" in the LEFT SLOT UNITS function
- "4" in the CENTER SLOT UNITS function
- "1" in the RIGHT SLOT UNITS function
- "1" in the UNITS PER CREDIT function
- "0" in the UNITS REQUIRED FOR BONUS CREDIT function
- "2" in the MINIMUM UNITS FOR ANY CREDIT function

These values allow one credit for a quarter, but ONLY when two or more credits are paid for at a time. Incidentally, the "4" in CENTER SLOT UNITS allows four credits per dollar coin (center slot only). See "2/50, 4/$1" in Table 1 above.

**GAMES : PRICES** ratio to start a game is equivalent to the ratio:

\[
X : VY \text{S}
\]

where:

- \(X\) = SLOT UNITS
- \(V\) = COIN VALUE
- \(Y\) = UNITS PER CREDIT
- \(S\) = CREDITS REQUIRED TO START GAME

For example, at factory settings with quarter chutes the variables produce 1 : 25x1x2 or one starting game for 50¢

**GAMES : PRICE** ratio to continue a game is equivalent to the ratio:

\[
X : VY \text{C}
\]

where:

- \(X\) = SLOT UNITS
- \(Y\) = UNITS PER CREDIT
- \(C\) = CREDITS REQUIRED TO CONTINUE

For example, at factory settings for upright and plastic cabinet games the variables produce 1 : 25x1x1 or one continued game for 25¢.
CHAPTER 3  Troubleshooting Procedures

Introduction
Power-Up Tests
  + 5VDC Power Supply Adjustments
Self-Diagnostics
Diagnostic Mode Tests
Sound Board Diagnostics
CMOS RAM Data Test Protocol
INTRODUCTION

Certain types of game malfunctions may inhibit the game's diagnostic or display facilities. Troubleshooting procedures for most of these types of malfunctions as well as malfunctions that permit self-diagnosis are covered below. Our trouble-shooting algorithm begins with Power-Up and continues until Game-Over Mode. All procedures can be performed with minimal test equipment or merely by observing the game itself.

POWER-UP TESTS

<table>
<thead>
<tr>
<th>NO GENERAL ILLUMINATION</th>
<th>NO INITIAL VIDEO (RUG PATTERN)</th>
<th>CHECKING POWER SUPPLY BOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Check fuse F2 on power supply board. (2) Check for proper installation of jumpers W1, W2, W3 and/or resistor R27. (Some machines MAY NOT have an R27. Refer to your drawing set.) (3) Check 4P1/J1, 4P3/J3, 6P2/J2 and 6P3/J3 (4) If all the above don't turn up the problem, check power supply board.</td>
<td>(1) Press reset button on CPU Board. (2) Try RAM and ROM tests (see below). (3) If all the above don't turn up the problem, check power supply board.</td>
<td>(1) Swap power supply board with one from known-good game. (2) If game plays, problem is on power supply board. (3) If game doesn't play, check power transformer with volt meter. (4) If known-good power supply is unavailable for tests above, check +5V, +12V and +12V outputs on power supply in game. Each MUST BE within 2% of rated output with less than 0.1% AC hum.</td>
</tr>
</tbody>
</table>

MORE POWER-UP TESTS

<table>
<thead>
<tr>
<th>TEST</th>
<th>ROM BOARD LEDS RECOGNIZE CONDITION</th>
<th>ROM BOARD LEDS IDENTIFY BAD CHIPS</th>
<th>VIDEO</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL</td>
<td>&quot;0&quot; means all power-up tests passed</td>
<td>—</td>
<td>(1) scanning rug pattern (2) stationary rug pattern (3) &quot;INITIAL TESTS INDICATE ALL SYSTEMS OPERATIONAL&quot; (4) Game-Over Mode</td>
<td>If any video (see left) is missing or error message is displayed, proceed to Diagnostic Mode tests.</td>
</tr>
<tr>
<td>CMOS (See Appendix A)</td>
<td>&quot;0&quot; means tests passed</td>
<td>—</td>
<td>&quot;HIGH SCORE TABLE RESET&quot; &quot;BOOKKEEPING TOTALS CLEARED&quot; &quot;ADJUSTMENT FAILURE&quot; &quot;RESTORE FACTORY SETTINGS BY OPENING FRONT DOOR OR HOOD AND TURNING GAME ON AND OFF&quot;</td>
<td>(1) Open coin door or hood and turn power off and on.</td>
</tr>
<tr>
<td></td>
<td>&quot;0&quot; means tests passed</td>
<td>—</td>
<td>&quot;FACTORY SETTINGS RESTORED&quot;</td>
<td>(2) Press ADVANCE. Game should return to Game-Over Mode.</td>
</tr>
<tr>
<td>BATTERY (See Appendix A)</td>
<td>&quot;0&quot; means tests passed</td>
<td>—</td>
<td>&quot;HIGH SCORE TABLE RESET&quot; &quot;BOOKKEEPING TOTALS CLEARED&quot; &quot;ADJUSTMENT FAILURE&quot; &quot;RESTORE FACTORY SETTINGS BY OPENING FRONT DOOR OR HOOD AND TURNING GAME ON AND OFF&quot;</td>
<td>(1) Open coin door or hood and turn power off and on. Or, press ADVANCE. In either case, game should return to Game-Over Mode. (2) Check AA alkaline cells on CPU Board. (3) If problem persists, proceed with CMOS RAM test by putting the game into its Diagnostic Mode [see Self-Diagnostics].</td>
</tr>
<tr>
<td>MEMORY PROTECT INTERLOCK (See Appendix A)</td>
<td>&quot;0&quot; means tests passed</td>
<td>—</td>
<td>&quot;HIGH SCORE TABLE RESET&quot; &quot;BOOKKEEPING TOTALS CLEARED&quot; &quot;ADJUSTMENT FAILURE&quot; &quot;RESTORE FACTORY SETTINGS BY OPENING FRONT DOOR OR HOOD AND TURNING GAME ON AND OFF&quot;</td>
<td>(1) Making and breaking memory protect interlock switch, check with VOM and replace if faulty. (2) Replace if faulty Memory protect gates U56, U57, U59, Q1 or CMOS RAM U38.</td>
</tr>
<tr>
<td>SPECIAL CHIP</td>
<td>&quot;0&quot; means tests passed</td>
<td>—</td>
<td>(1) scanning rug pattern (2) blank screen instead of &quot;INITIAL TESTS INDICATE ALL SYSTEMS GO&quot; (3) high score table with no scores (4) intro blank or program crash</td>
<td>(1) Turn power off. (2) To find bad chip, replace 2 special chips one at a time with known good chips. (3) Turn machine on after each replacement and run through Power-Up Tests.</td>
</tr>
</tbody>
</table>
+5VDC Power Supply Adjustments

BEFORE ADJUSTING THE VOLTAGE OUTPUT, always check at the output of the supply for AC hum. This hum should never rise above ±0.05V. If it does, consult your schematic drawing set for proper DC voltages throughout the circuit. Test these with the DC setting of your multimeter. Make a second check using the AC setting. Pay particular attention to readings at TP5 (top of capacitor C10). If the voltage here is low (less than +8VDC) or if you find excessive ripple (more than 700mVRms), replace the capacitor.

If TP1 is less than +4.95VDC, then check precision resistors R25 and R26. If they are within the 1% tolerance, then check IC2.

Self-Diagnostics

If RAM or ROM failure messages are displayed on the CRT after the “rung pattern” proceed with self-diagnostics. Self-diagnostic procedures are controlled by the AUTO-UP/MANUAL-DOWN switch to the MANUAL-DOWN position and depress the ADVANCE pushbutton. The game is now in its Diagnostic Mode and a ROM test is performed. With ROM test results present on the CRT display, set the AUTO-UP/MANUAL-DOWN switch to the AUTO-UP position. Depressing the ADVANCE pushbutton initiates the RAM test.

Further tests (CMOS, sounds, switch, color RAM and monitor test patterns) are initiated as the ADVANCE pushbutton is depressed (once more for each subsequent test).

MONITOR TEST PATTERNS (“19” Wood Cabinet Upright Games only). For ease in adjustments, the monitor may be slid back and the screen viewed in the CRT mirror on the inside top of the cabinet. Remove the two bolts and carefully slide the monitor back in its shelf. Secure the monitor in the extended position by inserting the two bolts through holes provided at the left side of the monitor.

AUTO-CYCLE MODE. From the color bar pattern (or Game-Over with the switch set to AUTO-UP) depress ADVANCE two times to display GAME ADJUSTMENTS.
1. Position the cursor on AUTO CYCLE with the PLAYER 1 joystick and push the PLAYER 2 joystick right.
2. Depress ADVANCE.
3. The system will now sequence through ROM, RAM, and CMOS RAM tests repeatedly. The coin door or hood must be open during the Auto-Cycle test. If an error is detected, the test is terminated and the failure indication is displayed on the CRT.
4. To terminate the Auto-Cycle test, turn the game OFF and ON.
### Troubleshooting Procedures: Diagnostic Mode Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>ROM Board LEDs Recognize Condition</th>
<th>ROM Board LEDs Identify Bad Chips</th>
<th>Video</th>
<th>Remedy or Adjustment</th>
</tr>
</thead>
</table>
| ROM  | "2" means ROM error                | 2-digit ROM chip no.              | "ROM ERROR" and ROM chip no. | (1) Turn power off.  
(2) Replace suspected chip. |
| RAM  | "1" means RAM error                | Bank no first...then chip no. in bank (see figure 4) | "RAM ERROR" followed by RAM bank no. and chip no. (Note: with multiple RAM failures this display may not appear) | *(1) Check for these normal voltages on indicated RAM chip: -5pin 1, +12pin 8, +5pin 9.  
(2) Turn power off.  
(3) Replace suspected chip.  
(4) With multiple RAM failures always check power supply. See POWER-UP TESTS. |
| CMOS (see CMOS RAM Test Protocol) | "3" means CMOS RAM error           |                                   | "CMOS RAM ERROR OR WRITE PROTECT FAILURE" | (1) With power off, check pin 16 of CMOS RAM for 3.2VDC minimum. If present, replace CMOS chip U38. If absent, replace AA alkaline cells.  
(2) With new alkaline cells and power off, check for 3.2V minimum at pin 16. If still absent, replace diodes D1 and D2.  
(3) Upon power-up and reentry into diagnostics if CMOS error message persists, check CMOS RAM memory protect and address decoding circuits with a logic probe. |

Tests 4 and 7 provide sequential subtests. To stop automatic cycling set switch to MANUAl-DOWN. Depress ADVANCE in MANUAL-DOWN to step through subtests. LED indications are not made for these tests.

### Test & Procedures

<table>
<thead>
<tr>
<th>SOUND Test 4</th>
<th>Video</th>
<th>Remedy or Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;RIGHT SOUND LINE 1&quot;</td>
<td>MISSING CHECK</td>
</tr>
<tr>
<td></td>
<td>&quot;RIGHT SOUND LINE 2&quot;</td>
<td>1 2P3:10P3:13P3 pin 3</td>
</tr>
<tr>
<td></td>
<td>&quot;RIGHT SOUND LINE 3&quot;</td>
<td>2 2P3:10P3:13P3 pin 2</td>
</tr>
<tr>
<td></td>
<td>&quot;RIGHT SOUND LINE 4&quot;</td>
<td>3 2P3:10P3:13P3 pin 5</td>
</tr>
<tr>
<td></td>
<td>&quot;RIGHT SOUND LINE 5&quot;</td>
<td>4 2P3:10P3:13P3 pin 4</td>
</tr>
<tr>
<td></td>
<td>&quot;RIGHT SOUND LINE 6&quot;</td>
<td>5 2P3:10P3:13P3 pin 8</td>
</tr>
<tr>
<td></td>
<td>(These appear one at a time.)</td>
<td>6 2P3:10P3:13P3 pin 6</td>
</tr>
<tr>
<td></td>
<td>All Right: 2P3:13P3 pin 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All Left: 2P3:13P3 pin 8</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** If any two sounds are the same, check for a short between the select lines with the same sound.

### Switch Test 5

1. Set switch to MANUAL-DOWN and clear any switch switches.
2. CRT should indicate no switches closed.
3. Operate switches and check for display of switch name.

<table>
<thead>
<tr>
<th>CRT indicates AUTO UP closed and any stuck switches. CRT Display for each Switch...</th>
<th>ROM Board SW.</th>
<th>INTERFACE BOARD SW.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADVANCE</td>
<td>1-PLAYER START</td>
<td>1-PLAYER START</td>
</tr>
<tr>
<td>AUTO-UP</td>
<td>2-PLAYER START</td>
<td>2-PLAYER START</td>
</tr>
<tr>
<td>HIGH SCORE</td>
<td>UP-DOWN A</td>
<td>UP-DOWN A</td>
</tr>
<tr>
<td>RESET</td>
<td>UP-DOWN B</td>
<td>UP-DOWN B</td>
</tr>
<tr>
<td>LEFT COIN</td>
<td>UP-DOWN C</td>
<td>UP-DOWN C</td>
</tr>
<tr>
<td>(next to hinge)</td>
<td>UP-DOWN DIRECTION</td>
<td>UP-DOWN DIRECTION</td>
</tr>
<tr>
<td>CENTER COIN</td>
<td>RIGHT-LEFT A</td>
<td>RIGHT-LEFT A</td>
</tr>
<tr>
<td>RIGHT COIN</td>
<td>RIGHT-LEFT B</td>
<td>RIGHT-LEFT B</td>
</tr>
<tr>
<td>SLAM SWITCH</td>
<td>RIGHT-LEFT DIRECTION</td>
<td>RIGHT-LEFT DIRECTION</td>
</tr>
<tr>
<td></td>
<td>THRUST (JOYSTICK)</td>
<td>THRUST (JOYSTICK)</td>
</tr>
<tr>
<td></td>
<td>BLAST</td>
<td>BLAST</td>
</tr>
<tr>
<td></td>
<td>THRUST (PANEL)</td>
<td>THRUST (PANEL)</td>
</tr>
</tbody>
</table>

(Refer to CABINET WIRING Diagram)

1. ROM BOARD SWITCH STUCK: Disconnect 2P3.
2. INTERFACE BOARD SWITCH STUCK: Disconnect 3P2 or 3P3.
3. ROM BOARD SWITCH DOES NOT OPERATE: Ground corresponding pin of 2P3.
4. INTERFACE BOARD SWITCH DOES NOT OPERATE: Ground corresponding pin of 3P2 or 3P3.
5. **SYMPTOM REMAINS SAME...** ROM Board or Interface Board Faulty.
6. **SYMPTOM CLEARS UP...** Problem is in switches or wiring.

### Additional Tests for Optoswitches:

1. Check that +5VDC is at pin 4 or 12P1.
2. With joystick in center position, check for 0.7V at base of ON transistor(s) (Q1 thru Q6) and 0.1V at pins 2, 3, 4, 6, 7, and 8 of 12P1.
3. With joystick moved from center position, check for 0.1V at base of OFF transistor(s), and 5V at corresponding pins 2, 3, 4, 6, 7, and 8 of 12P1.
4. With joystick in center position, check for +5V at pins 5 and 9 of 12P1. With joystick in Down (Left) position, check for +5V at pin 5 (9) of 12P1. With joystick in Up (Right) position, check for 0V at pin 5 (9) of 12P1.
**MORE DIAGNOSTIC MODE TESTS**

<table>
<thead>
<tr>
<th>TEST &amp; PROCEDURES</th>
<th>VIDEO SEQUENCES</th>
<th>REMEDY OR ADJUSTMENT</th>
</tr>
</thead>
</table>
| COLOR RAM (Test 6) | 1) light red screen  
2) red screen  
3) dark red screen  
4) light green screen  
5) green screen  
6) dark green screen  
7) light blue screen  
8) blue screen | REPLACE RAM U91  
REPLACE RAM U90 |
| Note that a blank sequence or two sequences with the same shade indicate a faulty U92 latch, U90 RAM or U91 RAM or a failure in the color analog circuit. Check voltages on Q10 (red transistor), Q11 (green transistor) and Q12 (blue transistor). During the eight full-screen color tests, the base voltage (center pin) on each transistor should vary between 3.8V (brightest color) and 4.4V (no color). |
| **Color RAM Check** | | |
| (1) CRT sequences through 8 colors, 2 seconds each.  
(2) Thick vertical band indicates color RAM fault. | | |

<table>
<thead>
<tr>
<th>MONITOR &amp; COLOR RAM (Test 7)</th>
<th>cross hatch pattern</th>
<th>Aids you in setting up vertical and horizontal linearity, convergence, and focus.</th>
</tr>
</thead>
</table>
green screen  
blue screen  
color pattern | Aid you in optimizing color purity and color balance. |
| Color Bar Pattern | | |

| color bars  
• double-width  
• half-width  
• transposed  
• missing | If color RAM test 6 indicates no faults, symptoms at left suggest a fault in U77, U90, U91 or U92 chips. |
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>TEST &amp; PROCEDURES</th>
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<tr>
<td><strong>MISSING SOUNDS; NO SOUND—STEP 1</strong> (ASSUMPTION: INPUT SECTION FAILURE)</td>
<td>□ CHECK SOUND-SELECT INPUTS</td>
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<tr>
<td><strong>TEST</strong></td>
<td><strong>TOOL</strong></td>
</tr>
</tbody>
</table>
| Sound Board connector 10P3/13P3 pins 2 to 8 | logic probe (game on and in Test 4) | • PULSING—proceed  
• LOW—check jacks, foils  
• STILL LOW—perform ROM BOARD checkbox |
| SR1 DIP resistors R3-R9 | VOM-reading ohms (game off) | • ALL 4.7K—proceed  
• ANY OPEN—replace SR1 |
| C3-C9 | VOM-reading ohms (game off) | • ALL OKAY—proceed  
• ANY SHORTED—replace bad |
| IC5-1, IC7-14 (power pins) | logic probe (game on and in Test 4) | • HIGH—proceed  
• LOW—replace C19 (IC5) or C21 (IC7)  
• STILL LOW—replace bad IC |
| IC5-2, 4, 6, 10, 12, 15; IC7-4, 6 | logic probe (game on and in Test 4) | • PULSING—proceed  
• LOW—replace chip |
| IC10-18 and 19 (PIA) | logic probe (game on and in Test 4) | • PULSING—proceed  
• LOW—liff C20, retest  
• PULSING NOW—replace C20  
• STILL LOW—replace IC6, retest |
| IC10-10 to 17 (PIA) | logic probe (game on and in Test 4) | • PULSING—proceed  
• SOME LOW—replace IC  
• ALL LOW—liff C31, retest  
• PULSING NOW—replace C31  
• STILL LOW—replace IC |

**NOTE:** In games where no sounds are produced from either sound board, disconnect both 9-pin connectors from one board and then the other. This isolates certain faults to a single Sound Board. If sounds are still not produced from either board, check ROM Board outputs on page 21 first.
### MORE SOUND BOARD DIAGNOSTICS

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<td><strong>MISSING SOUNDS; NO SOUND—STEP 2</strong></td>
<td>☐ <strong>CHECK ROM BOARD OUTPUTS</strong></td>
</tr>
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</table>
| **(ASSUMPTION: OFF-BOARD FAILURE)**                                     | (1) If you hear game sounds, disconnect and then reconnect Sound Board connectors 10P3 and 13P3.  
(2) You should hear one or more game sounds. If so, put game in Diagnostic Mode Test 4 and proceed with this checkbox. If not, go ahead to POWER SUPPLY checkbox below. |
| **TEST**                                                                | **TOOL**                                                                                                                                          | **CONDITION & REMEDY**                                                                                                          |
| ROM Board connector 2P4/J4-2 to 7                                       | logic probe (game on and in Test 4)                                                                                                                 | • PULSING—repair cable to Sound Board  
• ANY LOW—repair jack or foil, proceed                                         |
| U30 DIP resistors 2 to 8                                                | VOM-reading ohms (game off)                                                                                                                          | • ALL 4.7K—proceed  
• ANY OPEN—replace U30                                                                 |
| C40-53                                                                  | VOM-reading ohms (game off)                                                                                                                          | • ALL OKAY—proceed  
• ANY SHORTED—replace bad                                                                 |
| U29-10 to 17 (PIA)                                                      | logic probe (game on and in Test 4)                                                                                                                 | • PULSING—proceed  
• SOME LOW—replace U29                                                                 |
| **NO SOUND**                                                             | ☐ **CHECK ON-BOARD POWER SUPPLY**                                                                                                                                                   |
| **(ASSUMPTION: POWER SECTION FAILURE)**                                 | (1) With power off, test for fuse continuity at F1 and F2.  
(2) With power on, check for +12V unregulated DC at TP4 and at pin 5 of IC1.  
(3) Now check for +5V regulated DC between TP4 and TP3. If voltages are absent or low, turn off game and lift one pin of filter capacitors C25, C26 and C27.  
(4) Check each with ohmmeter for possible shorts.  
(5) If capacitors are good and unregulated voltages test okay but you’re missing +5V, replace regulator chip (IC8). |
| **STILL NO SOUND**                                                      | ☐ **CHECK AUDIO (ANALOG) SECTION**                                                                                                                                                   |
| **(ASSUMPTION: AUDIO SECTION FAILURE)**                                 | (1) Turn power on; turn up volume control. Momentarily place powered-up AC soldering pencil on final amplifier’s input pin (IC1, pin 1 or 10P4, pin 2). If you hear low hum, audio IC, volume pot and speaker are okay.  
(2) Repeat test at Q2 emitter. If you hear hum, analog section is okay. Step (1) will also work if you simply touch amplifier’s input pin. However output level of hum will be much lower than with soldering iron. DO NOT use a soldering pencil of over 40 watts. Cordless models will NOT work here. |
| **MISSING SOUNDS; NO SOUND**                                             | ☐ **CHECK SOUND ROM (IC12) AND RELATED CIRCUITRY**                                                                                                                               |
| **(ASSUMPTION: DIGITAL FAILURE)**                                       | (1) Turn power on.  
(2) If you have no game sounds but power supply tests show normal voltages and no ripple on +5V, check crystal clock circuit. Using DVM or logic probe, test for pulsing AC across crystal. If clock signal’s absent, replace crystal and associated capacitors.  
(3) Turn power off.  
(4) Swap sound ROM (IC12) and then microprocessor chip (IC9) with known-good chips.  
(5) Power-up and test Sound Board after each swap by pushing DIAGNOSTIC button. |
CMOS RAM Data Test Protocol

The first sub-test of the CMOS RAM data is that of the ATTRACT MODE MESSAGE checksum. If the test does not pass, the factory ATTRACT MODE MESSAGE is restored. Next, the game adjustments are checked and restored to factory settings if an error is found. If game adjustments are found intact, the high score table is checked for any bad entries. Bad entries are replaced with a score of 4,000 points and no initials. If all entries check, the game returns to the Game Over Mode.

If game adjustments are restored to factory settings, the AUDIT TOTALS are checked. If 5 or more audit digits are other than 0-9 (that is hexadecimal A through F) all audit totals are cleared. This is followed by a check of the high score table and the table is reset to factory settings if errors are found. Finally, game adjustments are rechecked and either OPEN COIN DOOR or FACTORY SETTINGS RESTORED is displayed. With the former, open the coin door and turn the game OFF and ON and then FACTORY SETTINGS RESTORED will be displayed. Return to game over by depressing the ADVANCE pushbutton or by turning the game OFF and ON a second time.
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<td>ROM Board Assembly Drawing</td>
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# CHAPTER 5  Parts

## PLASTIC CABINET

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<tr>
<td>20-9374</td>
<td>Control Panel Twist Latch</td>
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<tr>
<td>01-7607</td>
<td>Speaker Grill</td>
</tr>
<tr>
<td>03-7695</td>
<td>Monitor Bezel</td>
</tr>
<tr>
<td>08-7416</td>
<td>Monitor Glass</td>
</tr>
<tr>
<td>31-1208-3021-UP</td>
<td>Screened Marquee</td>
</tr>
<tr>
<td>01-7745</td>
<td>Rear Door Locking Strip</td>
</tr>
<tr>
<td>5675-09516-00</td>
<td>19&quot; Monitor</td>
</tr>
</tbody>
</table>

## CONTROL PANEL

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-10099</td>
<td>Complete Assembly</td>
</tr>
<tr>
<td>11-761</td>
<td>Wood Panel</td>
</tr>
<tr>
<td>31-1207-3021-UP</td>
<td>Screened Panel Overlay</td>
</tr>
<tr>
<td>03-7794</td>
<td>Molding Strip</td>
</tr>
<tr>
<td>01-7753</td>
<td>Twist Latch Receptacle</td>
</tr>
<tr>
<td>01-7717</td>
<td>Front Hold Down Bracket</td>
</tr>
</tbody>
</table>

## REAR DOOR

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>DESCRIPTION</th>
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</thead>
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<tr>
<td>20-9365</td>
<td>Lock</td>
</tr>
<tr>
<td>01-7670</td>
<td>Lock Plate</td>
</tr>
<tr>
<td>B-9742</td>
<td>Lock Cam</td>
</tr>
<tr>
<td>02-4160</td>
<td>Locking Rod</td>
</tr>
<tr>
<td>02-4161</td>
<td>Locking Rod Bushing</td>
</tr>
<tr>
<td>20-9364</td>
<td>Door Hinge</td>
</tr>
</tbody>
</table>

## POWER GRIP JOYSTICK

<table>
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<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>C-9680</td>
<td>Complete Assembly</td>
</tr>
<tr>
<td>C-9620</td>
<td>Power Grip Handle Assembly</td>
</tr>
<tr>
<td>5647-10160-00</td>
<td>Power Grip Button Switch</td>
</tr>
<tr>
<td>5647-10163-00</td>
<td>Power Grip Trigger Switch</td>
</tr>
<tr>
<td>B-9475</td>
<td>Sliding Interrupter Assembly</td>
</tr>
<tr>
<td>C-9471</td>
<td>P.C. Board Assembly</td>
</tr>
</tbody>
</table>
POWER REQUIREMENTS
115/230VAC Nominal, 50/60Hz
@2.0/1.0A 230W
(20A surge for one cycle
at power turn on)
Normal Line = 98-128VAC
196-252VAC
High Line* = 113-145VAC
226-290VAC
Low Line* = 88-113VAC
176-225VAC
*Transformer jumpers required.
See service manual.

ENVIRONMENT
Operating Temperature
0° to +45°C ambient
(+32° to +113°F)
Storage Temperature
-40° to +65°C ambient
(-40° to +149°F)
90% RH at 40°C (104°F), non-condensing

MONITOR
19" Color Raster
non-interlaced
UL, CSA & DHHS Approved

VIDEO SYSTEM**
256 Colors, 340 x 240 PIXEL Resolution
6809E Microprocessor
ROM: 232K BYTES
Video and Scratch RAM: 50K BYTES
CMOS RAM: 1Kx4

SOUND SYSTEM**
2 Channel Stereo, 2- 6808 Microprocessors
ROM: 8K BYTES (2 Systems)

JOYSTICK**
Optical Sensing
49 discrete directions and degrees of movement
(6 separate speeds in 8 directions
plus center off position)
**Patent Pending

Specifications subject to change
without notice.

SERVICE
For the back-up that keeps you out-front,
call Williams toll-free at 800/621-1253.
In Illinois, call toll-free at 800/572-1324.

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