Williams® ELECTRONICS, INC.

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This booklet provides operation, auditing, adjustment, and diagnostics for DEFENDER.

POWER TURN ON

With power first applied, a sound is produced, general illumination comes on, and random patterns appear on the CRT as the game sequences through RAM, ROM, and battery checks. The game then comes up in game over. Messages are displayed for RAM or ROM failures; refer to Power Up and Reset RAM/ROM Tests. If the game comes up in Bookkeeping, turn the game OFF and back ON.

a. If the game now sequences through the tests and then comes up in game over, the bookkeeping totals have been reset to zero.

b. If the game still comes up in bookkeeping, open coin door and turn the game OFF and ON. The game will now sequence through the tests and come up in bookkeeping. This is an indication of battery failure and the game has reverted to factory settings. To return to game over:

1. Set switch to MANUAL-DOWN.
2. Depress ADVANCE to display Function 28.
3. Set switch to AUTO-UP and depress ADVANCE.

GAME OPERATION

GAME START - Insert coins - credits are displayed on CRT. Press 1 or 2-player start.

PLAYER CONTROLS

UP-DOWN Switch – maneuvers player ship.
REVERSE Switch - reverses player ship direction.
THRUST Switch - controls player ship speed.
FIRE Switch - activates laser gun.
HYPERSPACE Switch - warps rocket to another quadrant, danger of possible annihilation.
SMART BOMB Switch - destroys all alien ships on screen. A maximum of 3* per play.

GAME PLAY

Destroy alien ships and missiles. Rescue humanoids, pick them up, and return to surface. Destroy all enemy ships for humanoid bonus and additional alien waves. Bonus ships and Smart Bombs provided every 10,000* points.

HIGH SCORE SIGNATURE

Use UP/DOWN to select letters and FIRE button to lock in letter.

CREDITS IN GAME

Twenty or less credits are retained in memory after power down. To remove credits from game post 21 or more credits and depress ADVANCE in AUTO-UP two times in succession. Credits are also removed any time Function 28 is changed.

* Indicates adjustable features.

BOOKKEEPING AND EVALUATION TOTALS (Functions 1-7)

1. In game over mode, set switch to AUTO-UP and depress ADVANCE. The CRT indicates Function 1 and total left chute coins.

2. Records audit totals and depress ADVANCE for functions 1-7. To review a total that has been advanced past, set switch to MANUAL-DOWN and depress ADVANCE. Functions are displayed one at a time as follows:

Function	Tota1*	Description
1	0	(Total) COINS LEFT
2	0	(Total) COINS CENTRE
3	0	(Total) COINS RIGHT
4	0	TOTAL PAID (Games)
5	0	(Total Bonus) SHIPS WON
6	0	TOTAL (Play) TIME (Minutes)
7	0	TOTAL SHIPS (Played)

* Factory Settings

3. Operate ADVANCE to display Function 28, SPECIAL FUNCTION. From Function 28 you can return to game over or zero audit totals and return to game over.

4. With switch set to AUTO-UP, perform a. or b. as desired.
   a. To return to game over depress ADVANCE.
   b. To zero audit totals and return to game over, operate HIGH SCORE RESET to indicate "35" on CRT for Function 28 and then depress ADVANCE.

GAME ADJUSTMENTS (Functions 8-21)

l. In game over mode set switch to AUTO-UP and depress ADVANCE. The CRT indicates Function 1 and total left chute coins.

2. To raise Function number on CRT, operate ADVANCE pushbutton with switch set to AUTO-UP. To lower Function number operate ADVANCE with it set to MANUAL-DOWN.

3. With desired Function indicated, raise adjustment value by operating HIGH SCORE RESET with switch set to AUTO-UP; 1ower value by operating HIGH SCORE RESET with it set to MANUAL-DOWN. Value left on CRT is new setting. For values, see below and, for pricing, Table l.

Function	Tota1*	Description
8	10,000	BONUS SHIP LEVEL(O=No Bonus ships)
9	3	SHIPS PER GAME
10	3	COINAGE SELECT
11	1	LEFT COIN MULT
12	4	CENTER COIN MULT
13	1	RIGHT COIN MULT
14	1	COINS FOR CREDIT
15	0	COINS FOR BONUS
16	0	MINIMUM COINS
17	0	FREE PLAY (Set to 1 for Free Play)
18	5	STARTING DIFFICULTY: O=LIB; 5=MOD; 10=CONS
19	15	PROGRESSIVE WAVE DIFFICULTY LIMIT, 5-30 e.g. 05=LIB; 15=MOD; 25=CONS
20	1	NOT USED
21	5	PLANET RESTORE WAVE NUMBER
22	0	NOT USED
23	0	NOT USED
24	0	NOT USED
25	0	NOT USED
26	0	NOT USED
27	0	NOT USED
28	0	SPECIAL FUNCTION

* Factory Settings

4. Repeat steps 2 and 3 until all desired adjustments have been made.

5. Operate ADVANCE until 28 0 SPECIAL FUNCTION is indicated on CRT. From Function 28 you can return to game over or restore factory setting. Perform step 6 or 7 as desired.

6. To return to game over, depress ADVANCE with switch set to AUTO-UP.

COIN DOOR MECHANISM	CREDITS	FUNCTION						
		10	11	12	13	14	15	16
All USA Variants	1/25¢, 5/$1	00	01	04	01	01	04	00
	2/50¢, 5/$1	00	01	04	01	01	04	02
	●1/25¢, 4/$1	**03**	**01**	**04**	**01**	**01**	**00**	**00**
	2/50¢, 4/$1	00	01	04	01	01	00	02
	1/50¢, 3/$1, 4/$1.25	00	03	12	03	04	15	00
	1/50¢, 3/$1, 7/$2	00	12	48	12	14	96	24
	●1/50¢, 3/$1, 6/$2	**01**	**01**	**04**	**01**	**02**	**04**	**00**
	●1/50¢	**05**	**01**	**04**	**01**	**02**	**00**	**00**
1DM, 5DM	**●1/1DM, 6/5DM**	**02**	**06**	**00**	**01**	**01**	**00**	**00**
20-Cent, 50-Cent	1/20¢, 3/50¢	00	01	00	01	02	00	00
1 Franc, 5 Franc	**●1/2F, 3/5F only**	**04**	**01**	**16**	**06**	**02**	**00**	**00**
25 Cent,	**●1/25¢, 4/1G**	**06**	**01**	**00**	**04**	**01**	**00**	**00**
1 Guilder	1/25¢, 5/1G	00	01	00	04	01	04	00
5 Franc,	**●1/5F, 2/10F**	**07**	**01**	**00**	**02**	**01**	**00**	**00**
10 Franc	**●1/10F**	**08**	**01**	**00**	**02**	**02**	**00**	**00**
1 Franc, 2 Franc	**●2/1F 5/2F**	**02**	**00**	**04**	**01**	**04**	**00**	**00**
100 Lire, 200 Lire	1/200 Lire	00	01	00	02	02	00	00
Twin Coin	**●1/1 Coin**	**03**	**01**	**04**	**01**	**01**	**00**	**00**
	●1/2 Coins	**05**	**01**	**04**	**01**	**02**	**00**	**00**
	1/3 Coins, 2 5 Coins	00	02	00	02	05	00	00
1 Unit, 5 Unit	**●1/2, 3/5**	**04**	**01**	**00**	**06**	**02**	**00**	**00**
	1/1, 5/5	00	01	00	05	01	00	00
	1/3, 2/5	00	02	00	10	05	00	00
● Indicates standard price settings by adjusting **only** Function 10. For other price settings, set Function 10 to 00 and set. Functions 11 through 16 to the values indicated in the chart.								

Table 1. Standard and Custom Price Settings

7. To restore factory settings and zero audit totals:
   a. Operate HIGH SCORE RESET in AUTO-UP to indicate "45" on CRT for Function 28.
   b. Depress ADVANCE. The game returns to Audit Function l.
   c. Set switch to MANUAL-DOWN and depress ADVANCE to indicate Function 28 on the CRT.
   d. Set switch to AUTO-UP and depress ADVANCE.

RESETTING HIGH SCORE SIGNATURES

To reset the “TODAYS GREATEST” signatures to factory settings, turn game OFF and ON or depress HIGH SCORE RESET in game over mode. To also reset “ALL TIME GREATEST” signatures to factory settings, set Function 28 to 15 and depress ADVANCE in AUTO-UP.

POWER-UP AND RESET RAM/ROM TESTS

Test initiated at power turn-on and after depressing RESET pushbutton on CPU/Video Board.

RESULT	CRT INDICATION	LED INDICATION	CORRECTIVE ACTION
PASS	INITIAL TESTS OK	4 LEDs blink twice	-
FAIL RAM	RAM TEST FAILED	●○○● 1st and 4th LED’s light	Depress ADVANCE in MANUAL-DOWN while failure message is displayed to enter Diagnostics.
FAIL ROM	ROM TEST FAILED	None	

ROM DIAGNOSTICS – TEST 1

From game over, depress ADVANCE IN MANUAL-DOWN.

RESULT	CRT INDICATION	LED INDICATION	CORRECTIVE ACTION
PASS	ALL ROMS OK	○●○○ 2nd LED blinks twice.	None
FAIL	ROM FAILURE x (x=ROM No 1 – 12)	○●○○ 2nd LED lights. Chip Indicated: ○○○● ○○●○ ○○●● ●○○○ ●○○● ●○●○ ●○●● ○●○○ ○●○● ○●●○ ○●●● ●●○○	Replace ICx on ROM Board or depress ADVANCE in MANUAL-DOWN; Replace: IC1 IC2 IC3 IC4 IC5 IC6 IC7 IC8 IC9 IC10 IC11 IC12

RAM DIAGNOSTICS – TEST 2

From ROM Diagnostics depress ADVANCE in AUTO-UP.

RESULT	CRT INDICATION	LED INDICATION	CORRECTIVE ACTION
TESTING	Random Pattern	-	Depress ADVANCE in AUTO to bypass test.
PASS	ALL RAMS OK	●○○○ 1st LED blinks twice.	-
FAIL	RAM FAILURE xy (x=Bank, y=Chip No)	●○○○ 1st LED lights.	Replace RAM (see following) or depress ADVANCE in MANUAL-DOWN
		Bank Indicated: ○●○○ = 1 ●○○○ = 2 ○○●○ = 3	Depress ADVANCE in MANUAL-DOWN
		Chip Indicated: ○○○● = 1 ○○●○ = 2 ○○●● = 3 ●○○○ = 4 ●○○● = 5 ●○●○ = 6 ●○●● = 7 ○●○○ = 8	Replace in bank: 1 2 3 1R 2R 3R 1S 2S 3S 1T 2T 3T 1U 2U 3U 1W 2W 3W 1X 2X 3X 1Y 2Y 3Y 1Z 2Z 3Z

CMOS RAM DIAGNOSTICS – TEST 3

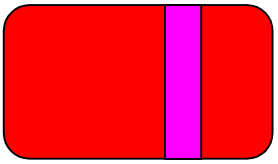
From RAM Diagnostics depress ADVANCE in AUTO-UP.

RESULT	CRT INDICATION	LED INDICATION	FAULTY AREA
PASS	CMOS RAM TEST PASSED	○○●○ 3rd LED blinks twice.	-
FAIL	CMOS RAM FAILURE	○○●○ 3rd LED lights.	CMOS RAM 1E memory protect gates 4J, 6H, or address decoder 4K, 5P.
	CMOS INTERLOCK FAILURE	○○●○ 3rd LED lights.	Coin door interlock, Memory protect gates 5B, 6H,4J, OR CMOS RAM 1E

COLOUR RAM TEST – TEST 4

From CMOS RAM test depress ADVANCE in AUTO-UP.

CRT SEQUENCES THROUGH 8 COLOURS, 2 SECONDS EACH



VERTICAL BAND INDICATES COLOUR RAM FAULT.

○○○●
4TH LED REMAINS LIT DURING TEST

COLOUR SEQUENCES	FAULT	
	RAM 2C	RAM 1C
1 LIGHT RED 2 RED 3 DARK RED	Band of red intensity variance or washout	Band of magenta
4 LIGHT GREEN 5 GREEN 6 DARK GREEN	Band of yellow	Band of cyan
7 LIGHT BLUE 8 BLUE 9 DARK BLUE	Band of magenta	Band of blue intensity variance or washout
4 LIGHT GREEN	Band of green	Band of dark green or washout
5 GREEN	Band of light green	Band of faint green, Band of darker green
6 DARK GREEN		Band of washout
Note that a blank sequence or two sequences with same shade indicate 2C or 1C RAM or color analogue circuit faulty.		

Tests 5 and 7 provide sequential subtests. To stop automatic cycling set switch to MANUAL/DOWN. Depress ADVANCE in MANUAL-DOWN to step through subtests.

SOUND TEST – TEST 5

From Color RAM test, depress ADVANCE in AUTO-UP.

Test sequences sounds 1 through 31, skipping 19, 27, and 28.

Missing	Check
1	2P4/10P3 Pin 3
2	2P4/lOP3 Pin 2
4	2P4/10P3 Pin 5
8	2P4/10P3 Pin 4
16	2P4/10P3 Pin 7
All	Perform Sound Board Diagnostics

SWITCH TEST – TEST 6

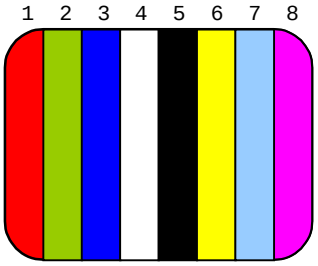
CRT indicates AUTO-UP closed and any stuck switches. Set switch to MANUAL-DOWN and clear any stuck switches. CRT should indicate no switches closed. Operate switches and check for display of switch name.

Coin Door	Player Panel
ADVANCE	UP
HIGH SCORE RESET	DOWN
LEFT COIN	REVERSE
CENTER COIN	1 - PLAYER START
RIGHT COIN	2 - PLAYER START
	HYPERSPACE
	SMART BOMB
	THRUST
	FIRE

MONITOR SET UP TEST PATTERNS - TEST 7

From Switch Test depress ADVANCE in AUTO-UP.

Pattern	Alignment/Adjustment
CROSS HATCH	Vertical and Horizontal Linearity, Convergence, Focus
RED	}
GREEN	} Color Purity
BLUE	}
COLOUR BARS	}



1 = RED
2 = GREEN
3 = BLUE
4 = WHITE
5 = BLACK
6 = YELLOW
7 = CYAN
8 = MAGENTA

The color bar pattern is also analyzed to detect color RAM faults. If Color RAM Test 4 indicates no faults, a double-width band, half width bands, transposition or missing bands indicates a fault in 2E, 1C, or 2C chips.

To return to game over:

l. Depress ADVANCE in AUTO-UP. Audit function 1 is displayed.
2. Set switch to MANUAL-DOWN and depress ADVANCE. Special Adjustment Function 28 is displayed.
3. Set switch to AUTO-UP and depress ADVANCE.

INITIATING AUTO-CYCLE MODE

1. Set switch to AUTO-UP and depress ADVANCE. Audit Function 1 is indicated on CRT.
2. Set switch to MANUAL-DOWN and depress ADVANCE to indicate SPECIAL FUNCTION 28 on CRT.
3. Set switch to AUTO-UP and operate HIGH SCORE RESET to indicate 15 on CRT for Function 28.
4. Depress ADVANCE. The game sequences through ROM, RAM, Sound tests and monitor test patterns.
5. To exit the AUTO-CYCLE mode, depress ADVANCE in AUTO-UP.

SOUND BOARD DIAGNOSTICS

Depress DIAGNOSTIC pushbutton on the bottom of the Sound Board. A check is made of the Sound ROM and sounds are produced if the check is good. If sounds are produced but not produced in Audio Test 5 check for ROM board PIA outputs on Sound Board inputs that is stuck low. If no sound is produced either the Sound ROM, input power, or other Sound Board circuitry is faulty.

"Warning: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference."