

December 21, 1976

Subject: DEVIATIONS FROM ROCKWELL SPECIFICATION
PW01-P800-01 Dated 1/28/76
(50 Prototype Units Only)

1.0 SCOPE:

The controller system shall consist of the following items:

1. Microprocessor controller 8112 consisting of:
 - A. Microprocessor P.C. Board
 - B. Input/Output P.C. Board
 - C. 3 piece plastic box container
2. Price Board
3. Solenoid Driver Modules
4. Single & Three Lamp Driver Modules
5. Master Score Display Driver (Gas Discharge Type)
6. Slave Score Display Driver (Gas Discharge Type)
7. Miscellaneous Display Driver (Gas Discharge Type)

2.0 Applicable Documents:

Rockwell Specification PW01-P800-01

3.0 GENERAL REQUIREMENTS:

- 3.1 Not Applicable
- 3.2 Not Applicable
- 3.3 No Change
- 3.4 Products Division shall provide whatever component data or other advise to help Williams design shielding.
- 3.5 Products Division shall provide Williams with 50 assembled power supplies and schematics.

4.0 MECHANICAL REQUIREMENTS:

- 4.1 Shall consist of 10 printed circuit modules which have been designated microprocessor board, I/O board, price board, solenoid driver board, 3 lamp driver board, single lamp driver board, lamp driver mother board, solenoid driver mother board, master score display driver, slave score display driver and miscellaneous display driver.
- 4.2 Electrical interconnections between all printed circuit boards will be either edge type or connector to connector type of connections.
- 4.3 Electrical connections to lamps and solenoids shall be solder type of connections. Electrical connections to displays shall be edge type of connectors.
- 4.4 The game prom shall be soldered on the price board. Products Division shall provide an ~~edge~~ type of connector (or equivalent) mounted to the microprocessor board, that will accept the price board. On price board, the matrix section shall be flexible through diode patching to determine game parameters. Prom will be programmed and provided by Products Division.
- 4.5 Mounting for the microprocessor controller 8112 shall be a metal wrap around furnished by Products Division. Mounting of score drivers boards shall be on an insert board furnished by Williams.
- 4.5 Approximate Dim. = Microprocessor Controller 8112: 6-1/2 x 6-1/2
Master & Slave Score Driver: 5 x 21
Misc. Score Driver: 3-1/2 x 12
Price Board: 5-1/2 x 4
Solenoid & Lamp Drivers: 1-1/2 x 2-1/2

5.0 ELECTRICAL REQUIREMENTS:

5.1 The Controller system shall be implemented with the National SC/MP Microprocessor and standard Bi-polar and MOS type of IC's.

5.2 The Microprocessor Controller will contain all the low power logic circuits and necessary I/O circuits that are required to drive the lamp and solenoid driver boards. The I/O outputs shall provide a lamp or solenoid turn-on signal that shall be no higher than 0.4 volts at a current of 16ma.

(Note: a zero type of output signal turns load on, a one type turns load off).

5.2.1 Sixteen pins are provided on the module interface to input contact closure information from the pinball machine. Functionally, these lines are structured to scan up to 64 sets of switch contacts in an 8 x 8 matrix configuration. These contact closure interface lines designated as Row A through H and column 1 through 8 are electrically connected to the microprocessor controller 8112.

5.2.2 The Switch status of the following will be monitored and input to the Microprocessor Controller.

1. Continuous Test
2. Single Step Test
3. Advance Test Position
4. Pulse Present Position
5. Basic Credit
6. Basic Credit XN
7. Basic Credit XN'
8. Game Over
9. Game Start
10. Tilt
11. Outhole

No other contact closure status is known to be required at this time.

5.3 Input/Output Driver Board

5.3.1 The Input/Output Driver Board shall have the output capability to drive the following components located on the pinball machine:

Panaplex Numeric Display Drivers

Incandescent Status or Indicator Lamp Drivers

Solenoid and Relay Drivers

5.3.1.1 Numeric Displays:

The system will have an output drive capability for up to 32 display digits. The display digits will be addressed by a twin address bus. One will contain digit information, which is time multiplexed, for the first & second player, credit and number of players. The second bus will contain digit information, time multiplexed, for the third & fourth player, number match and ball in play. In the one and two player games, the digits not required will be blanked out.

The scan time for displaying 16 digits is 16 milliseconds consisting of 920 microseconds per digit display and 80 microseconds of blanking between digits. The per segment drive currents must be below 5ma and above 2 ma. The drive voltage must be below ± 110 VDC and above ± 95 VDC. The display shall be as per Figure 5.

5.3.1.2 Incandescent Status Lamps:

A total of 64 outputs are available at the interface of the I/O board; each lamp driver output circuit shall be an TTL type of buffer under control of the microprocessor program. Each output shall be capable of driving of up to 4 of the lamp drivers provided by Products Division. Two type of output drive circuits are provided: A type 1 driver capable of driving a single #55 lamp, and a type 2 driver capable of driving up to three #55 lamps in parallel. In addition, should lamps short, drivers have current limiting to prevent output transistors from burning out. Functionally, the incandescent lamp display drivers are grouped as follows:

	<u>Function</u>	<u>Driver Type</u>	<u>Lamps Used</u>
Score Board Lamp	Tilt	2	2
	Game Over	2	2
	Same Player Shoots	2	3
	Player Up (4 each)	1	4
Playfield Lamps	Left Indicator	1	1
	Right Indicator	1	1
	Jet Bumper (1)	1	1
	Jet Bumper (2)	1	2
	2 Type A Series String (10 ea.)	1	20
	2 Type B Series String (9 ea.)	1	18
	2 10th Lamp of Series String B +1000 when lit	2	4
	Left Special	1	1
	Left Extra Ball	1	1
	Left Arrow	2	2
	Star 1	1	1
	Star 2	1	1
	Star 3	1	1
	Star 4	1	1
	Right Arrow	2	2
	Right Extra Ball	1	1
	Right Special	1	1
	Credit OK	1	1

Maximum number of lamps that can be on at anytime is:

10 Type 1 & 4 Type 2 on playfield

1 Type 1 & 1 Type 2 on score board.

This requires 750ma from the 5 volt supply and 9.5 amperes from the 8 volt full wave supply.

1ST PLAYER

(P1)

P1	P1	P1	P1	P1	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

2ND PLAYER

P2	P2	P2	P2	P2	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

(P2)

3RD PLAYER

(P3)

P3	P3	P3	P3	P3	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

4TH PLAYER

P4	P4	P4	P4	P4	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

(P4)

BALL IN
PLAY

16B	15B

NUMBER
MATCH

	O
7B	8B

CREDIT

7A	8A

NUMBER
CAN
PLAY

OFF	
15A	16A

2. PLAYERS

1ST PLAYER

(P1)

P1	P1	P1	P1	P1	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

BALL IN
PLAY

	OFF
16B	15B

NUMBER
MATCH

	O
7B	8B

2ND PLAYER

P2	P2	P2	P2	P2	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

(P2)

CREDIT

7A	8A

NUMBER
CAN
PLAY

OFF	
15A	16A

1. FLIP 1

1ST PLAYER

(P1)

P1	P1	P1	P1	P1	
L	T	K	C	D	O
1A	2A	3A	4A	5A	6A

BALL IN
PLAY

	OFF
16B	15B

NUMBER
MATCH

	O
7B	8B

CREDIT

7A	8A

5.3.1.3 Solenoid Type Controls (Coil Drivers)

A total of 16 outputs are available at the interface of the 1/0 board, each coil driver output circuit shall be an TTL type of buffer under control of the microprocessor program. Each output shall be capable of driving of up to 4 of the coil drivers provided by Products Division.

Functionally, the coil drivers are grouped as follows:

<u>Function</u>		<u>Coil Type</u>	<u>*Peak Current at 24VAC</u>
Driven by One Output	Left Eject	28VAC G23-750	6.5 Amp
	Right Eject	28VAC G-23-750	6.5 Amp
	Top Eject	28VAC G23-750	6.5 Amp
	Drop Target A	28VAC G22-550	8.6 Amp
	Drop Target B	28VAC G22-550	8.6 Amp
	Drop Target C	28VAC G22-550	8.6 Amp
	Drop Target D	28VAC G22-550	8.6 Amp
	Out Hole	28VAC A-22-550	8.6 Amp
	Small Chime	28VAC A2-26-1300	2.1 Amp
	Medium Chime	28VAC A2-26-1300	2.1 Amp
	Large Chime	28VAC A2-26-1300	2.1 Amp
	Knocker	28VAC A2-23-750	6.5 Amp
	Total Play Meter	28VAC -	-
	Money Meter	28VAC -	-
	Coin Lockout	28VAC M1-31-1500	.250 Amp
	Full Wave Rectifier	40VDC -	-
	Noise Maker	28VAC B1-26-800	

*8 Millisecond Sine Wave Peak

The coil drivers as supplied by Products Division are capable of driving a load of up to 12 amperes peak as long as this peak current is a 8 millisecond sine wave type of waveform, and does not consists of more than 6 cycles of a 60 hertz signal. All AC coils are energized at zero crossing of the AC line.

- 5.3.1.3 The microprocessor controller will disable the flippers, jet bumpers, and kickers when the game is in tilt or game over condition.

The triac timing for momentary solenoids is as follows:

	ON	OFF
Small Chime	72 Milliseconds	56 Milliseconds
Medimum Chime	72 Milliseconds	56 Milliseconds
Money Meter	70 Milliseconds	82 Milliseconds

- 5.3.1.4 Adjustment to shorten on and off times not provided.
- 5.3.1.5 No radio frequency detector provided: System tested with a 5 watt Police Walkie-Talkie and no problems occurred.

No static discharge detector provided: System will be built to withstand a discharge of 97 picofarad capacitor, through a 500 ohm resistor, that has been charged to 22K Volts.

5.4 Power Requirements:

The following power supply levels will be required to operate:

1. Line Voltage: For Logic Circuits 85 - 130 VAC
For Displays 95 - 130 VAC
2. +5VDC $\pm 5\%$ for MOS & TTL Drive: 3 Amp
3. +4.5VDC for Drivers: 1.5 Amp
4. -7.0VDC $\pm 5\%$ for SC/MP: 100MA
5. +100VDC $\pm 10\%$
For Panaplex Display: 50MA
6. -100VDC $\pm 10\%$
7. 16VAC Center Tapped $\pm 10\%$ for Status Lamp and Full
wave rectified with no
filtering: 8 Amp
8. 29VAC $\pm 10\%$ for Solenoid Drive
9. 6VAC $\pm 10\%$ for Background Lights.

5.4 Environment:

Operator adjustable functions are accomplished by the operator placing diodes in specific locations on the price board. Adjustments are as follows:

PRICE BOARD EXPLANATION

The Price Board is set up as a 10 word by 8 bit matrix. A diode is defined as a logical "1"; no diode is defined as a logical "0".

<u>WORD</u>	<u>BITS</u>	<u>NAME</u>	<u>U S E</u>
0	0-3	PLY 1	Number of plays awarded for price group 1. Coded in <u>Hex</u> , Variations, 0-15 If 1 play, diode in bit 0 If 2 plays, diode in bit 1 If 3 plays, diode in bit 0 & 1, etc.
0	4-7	PLY 2	Number of plays awarded for price group 2. Coded in <u>Hex</u> , Variations 0-15. If 1 play, diode in bit 4. If 2 plays, diode in bit 5. If 3 plays, diode in bits 4 & 5, etc.
1	0-3	UNIT 1	Cost, in terms of the number of least significant coins for Price Group 1. Coded in Hex, Variations 0-15. If price group 1 is 25¢, UNIT 1 is 5 (5 least significant coins (nickels) equals 25¢). If single coin chute, this should still be set to 5 so that a 0, 5 money meter will advance 5 times.
1	4-7	UNIT 2	Cost, in terms of the number of least significant coins for Price Group 2. Coded in Hex, variations 0-15. Bit 4 is least significant, Bit 7 is most significant. See UNIT 1 for details. If single coin chute, (quarter play) set to 5.
2	0-3	CH 1	Value of coin chute 1, which is the least significant coin. If 3 chute game, set for standard U.S. currency, this would be set to 1. If single chute game (quarters only), this is set to 1.

<u>WORD</u>	<u>BITS</u>	<u>NAME</u>	<u>U S E</u>
2	4-7	CH 2	Value of coin chute 2, which is the medium value coin. This determines the ratio of the medium value coin to the least significant coin. If 3 chute game, set for standard U.S. currency, this would be set to 2. If single chute game, (quarters only) this is set to 0. Bit 4 is least significant, bit 7 is most significant.
3	0-3	CH 3	Value of coin chute 3, which is the most significant coin. This determines the ratio of the coin to the least significant coin. If quarter game, set to 5.
3	4-7	BPG	Number of balls per game. Coded in Hex, variations 0-15. If three ball game, diodes in bits 4 & 5. If five ball game, diodes in bits 6 & 4.
4	0-3	PMX	Maximum number of players. If 4 players, diode in bit 2. If 2 players, diode in bit 1.
4	4	MATCH	If diode in bit 4, match will be active, If no diode, no match.
4	5-7		Adjustments - These three bits are used for game engineer assigned game feature adjustments.
5	0-7	ADJ 1	High score replay or add-a-ball adjustment. This is the lowest high score adjust. Split up into two BCD digits, Bits 4-7 are the hundred thousands digit, Bits 0-3 are the ten thousands digit. Example-if 530,000 - set to 53.
6	0-7	ADJ 2	Medium high score adjustment. Split up into two BCD digits, Bits 4-7 are the hundred thousands digit, bits 0-3 are the ten thousands digit. Example - if 740,000 - set to 74.

PRICE BOARD EXPLANATION (CONT'D)

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<u>WORD</u>	<u>BITS</u>	<u>NAME</u>	<u>U S E</u>
7	0-7	ADJ 3	Highest high score adjustment. Split up into two BCD digits, Bits 4-7 are the hundred thousands digit, bits 0-3 are the ten thousands digit. Example-if 880,000 - set to 88.
8	0-8	XTRA 8	Extra 8 bit word. Use defined by game prom. In Grand Prix, if diode in bit 1, stars are conservative. If no diode, stars are liberal.
9	0-1	NOT ASSIGNED	
9	2-6	RPL	Replay limits. Coded in binary. Determines number of game credits before coin lockout de-energizes. Bit 2 is least significant, Bit 6 is most significant. For example, if limit is 18, Bits 6 and 3 have diodes.
9	7		If diode, high score and specials give credit. If no diode, high score and specials give extra ball.

6.2 Game Prom

6.2.1 General: For Control Board Substitute Game Prom-Rest - No Change

6.2.2 Game Definitions: Not Applicable

6.2.3 Game Control Functions: Not Applicable

6.2.3.1 With exception of ten second delay, Products Division system reads the same.

6.2.3.2 Ready State Functions (Game Over)

In the ready state, the microprocessor sets the coin lockout so that coins may be accepted and the coin information converted to play or replay credits. When credits are available the credit OK Lamp is turned on and the microcomputer interprets all contact switch information after the game start switch is made.

6.2.3.3 Credit System Functions: See Price Board Explanation on pages 9, 10 and 11.

6.2.3.4 Start Function: No change

6.2.3.5 Ready to Play Status: No change

6.2.3.6 Play Status: No change

6.2.3.7 Playfield Operation: No provisions for causing scoring, bonus, or control operations to flash.

6.2.3.7.1 A, B & C: No change. Para D - Chimes are activated as follows:

10,000 score activates Large Chime
1,000 score activates Medium Chime
100 or 10 score activates Small Chime

E. No change

F. Should be steps B through E

6.2.3.7.1

Cont'd

G. Add immediate byte value of 10 to ram location labeled 'Match' (which counts from 00 through 90 and then repeats) and continue to add in increments of 10 for each switch closure. This will subsequently be used for number match comparison.

H. No change

6.2.3.7.2

Increment Bonus:

A. No Change

B. Determine if that bonus register is at maximum value. (Determined by parameters read from game program circuit).

C. No Change

D. No Change

E. No Change

F. No Change

6.2.3.7.2.1

Special Playfield Functions: No change

6.2.3.7.3

End of Ball Sequence

A. No Change

B. No Change

C. No Change

D. No Change

E. No Change

F. No Change

G. No Change

H. No Change

I. No Change

J. One player game software not in present system.

K. Change ball index register to read ram location location labeled 'Match'. Also change credit counter to read ram location 'Cred'.

- 6.2.3.8 Contact Matrix Definition: No Change
- 6.2.3.9 Lamp Driver Conditions: No Change
- 6.2.3.10 Coil Driver Conditions:

1. Coin Lockout: No Change
2. Money Meter: Pulsed for each basic coin increment.
3. Total Play Meter: No Change
4. Ball Return: No Change
5. Ball Actuator #1
6. Ball Actuator #2
7. Ball Actuator #3
8. Ball Actuator #4
9. Ball Actuator #5
10. Ball Actuator #6
11. Ball Actuator #7
12. Free Ball Gate: Determined by Diode Matrix
13. Small Chime: Pulsed by score 100 or 10
14. Medium Chime: Pulsed by score 1,000
15. Large Chime: Pulsed by score 10,000
16. Sound Drum: No Change
17. Replay Up Count: No provisions
18. Replay Down Count: No Provisions
19. Bell: No Change

70ms Drive Pulse. Pulsed by
Game Program

Electronic Display

6.3 Programming the Price Board: No Change

- 6.3.1 Williams defined Game Parameters: See para 6.1.
- 6.3.2 Williams defined Game Functions for contact matrix - no change
- 6.3.3 Pinball Game Oriented Language: Not Applicable. Products Division will supply Williams instruction set applicable to their software.