WPC Lamp-Matrix

Document History

February 19, 2012, initial draft. Basics on WPC lamp matrix and some info about the attract mode light show.

Document Scope

This document is an informal write-up on what I've discovered about WPC lamp matrix code. The audience of this document is other s/w developers who want some details about WPC lamp matrix and possibly for others who want to play with the lamp matrix and even for those who want to modify how the lamp matrix works.

The examples shown here are from IJ_L7. As always, the specific memory addresses are going to be different on other pins, so you need to search the ROM for other pins with matching non-address bytes (ie opcodes and data struct patterns) to determine the equivalent code and addresses used in your game.

Disclaimer

As always, this information is for educational and entertainment purposes only. Some of the interpretation about code may be incorrect so take some of what is presented with a grain of salt. As always, exercise caution when modifying ROM images as they could have real physical effects which may be undesirable, especially if you modify code that causes hardware components to operate outside of their specifications.

Lamp Memory Arrays

There are multiple 64-bit arrays of bytes used to store lamp memory. In the IJ_L7 disassembly I've been referring to these as "Lamp Banks", however the terminology may change as I've learned more about how it works. The multiple 64-bit arrays are all stored next to each other starting in ram at $280.

Each bit represents a single lamp in the 8x8 lamp matrix. WPC stores data as 1-based lamp index, so lamp 0x01 is the top-left corner of the lamp matrix. Lamp 0x08 is the bottom –left corner of the matrix, and lamp 0x40 is the bottom-right corner of the lamp matrix.

```
Below will describe each of the 8-byte arrays used for lamp data starting at address $0280.

       00 01 02 03 04 05 06 07    08 09 0A 0B 0C 0D 0E 0F
0280:      LampBank+00                LampBank+08         <-- lowest priority
0290:      LampBank+10                LampBank+18         <-- next highest priority
02A0:      LampBank+20                LampBank+28         <-- next highest priority
02B0:      LampBank+30                LampBank+38         <-- highest priority
02C0:      LampBank+40                                    <-- test/diagnostics
```

LampBank+00 , lowest priority array. Actually, bits set in this array won't even turn on any lamps.

LampBank+08, lowest priority "lights-on" array. Bits set in this array will cause lamp to turn on unless it gets overridden by next bank(s)
LampBank+10, next highest priority "override" flags. Any bit set in this bank will prevent the corresponding bit in LampBank+08 from illuminating the lamp.
LampBank+18, next highest priority "lights-on" array. A lamp will illuminate if its bit is set in this array <and> its corresponding bit is also set in the LampBank+10 array.
LampBank+20, next highest priority "override" flags. Any bit set in this bank will prevent the bulb from lighting due to the previous LampBanks.
LampBank+28, next highest priority "lights-on" array. A lamp will illuminate if its bit is set in this array <and> the LampBank+20 array.
LampBank+30, next highest priority "override" flags. Any bit set in this bank will prevent the bulb from lighting due to the previous LampBanks.
LampBank+38, next highest priority "lights-on" array. A lamp will illuminate if its bit is set in this array <and> the LampBank+30 array.

LampBank+40, appears to be used for test purposes and not directly used to determine whether lamp will illuminate. When a bit gets set or cleared in this bank, the WPC code automatically propagates the setting into the other arrays as needed.

Lamp Matrix handling by the ISR.

Every other time through the ISR, the lamp matrix code is checked and a single column of lamps is updated. Since there are 8 columns, this means it takes 16 passes through the ISR to update the entire matrix.

Below is some commented disassembly of the ISR lamp-matrix code. It should be consistent with that described above for LampBank override logic.

```
DD1C: 9E BF       LDX   $BF             ; X gets bytes from $BF:$C0
DD1E: 30 01       LEAX  $0001,X         ; Increment X
                                        ;
DD20: 96 BE       LDA   $BE             ; A gets byte from $BE which is a rotating
                                        ;  bit-mask 0x01-->0x80
                                        ;
DD22: 48          ASLA                  ; Shift the $BE bit mask byte left
                                        ;
DD23: 26 19       BNE   $DD3E           ; If value is not zero, skip to DD3E below
                                        ;  in the lamp matrix stuff
                                        ; ..otherwise the value of $BE shift mask is 0x00,
                                        ;  lets reset it
                                        ;
DD25: 96 73       LDA   $73             ; A gets byte at $73 (seems to always be 0x00,
                                        ;  during attract, game, test modes)
DD27: 27 10       BEQ   $DD39           ; If $73 is 0x00, skip to $DD39 <-- normal skip to $DD39
                                        ;
DD29: 0A C1       DEC   $C1             ; ..otherwise decrement $C1 (must be some special test
                                        ;      mode where $73 is nonzero and $C1 is meaningful)
DD2B: 2B 08       BMI   $DD35           ; If $C1 decremented from 0x00 to 0xFF, skip to $DD35
DD2D: 7F 3F E4    CLR   $3FE4           ; Clear Lamp Row     LAMPS OFF
DD30: 7F 3F E5    CLR   $3FE5           ; Clear Lamp Column  LAMPS OFF
DD33: 20 55       BRA   $DD8A           ; Skip to post-lamp-matrix code
DD35: 96 74       LDA   $74             ;
DD37: 97 C1       STA   $C1             ;
```

```
DD39: 8E 02 80    LDX   #$0280          ; X gets 0x0280, starting RAM address of lamp matrix data
DD3C: 86 01       LDA   #$01            ; A gets 0x01, column 1 bit mask.
                                        ;
                                        ;
DD3E: 9F BF       STX   $BF             ; Store new X pointer back to $BF:$A0
DD40: 97 BE       STA   $BE             ; Store new shift-mask back to $BE
                                        ;
                                        ;----------------------
DD42: E6 89 00 10 LDB   $0010,X         ; B gets $X+10, lamp-off flags
DD46: 53          COMB                  ;
DD47: E4 89 00 08 ANDB  $0008,X         ; Turn on any lamps in $X+8 however force off any lamps
                                        ;  which are indicated in the $X+10 lamp-off flags.
DD4B: D7 BC       STB   $BC             ; Store result into $BC, $BC stores lamps to turn on for
                                        ;  this column
DD4D: E6 89 00 10 LDB   $0010,X         ; Reload B with $X+10 lamp-off flags
DD51: E4 89 00 18 ANDB  $0018,X         ; AND with $X+18, lamp-on flags.
DD55: DB BC       ADDB  $BC             ; ADD with $BC, Turns on lamps set in $X+10 <and> $X+18
DD57: D7 BC       STB   $BC             ; Result back into $BC
                                        ;----------------------
DD59: E6 89 00 20 LDB   $0020,X         ; B gets $X+20, lamp-off flags
DD5D: E4 89 00 28 ANDB  $0028,X         ; AND $X+28
DD61: D7 BD       STB   $BD             ; Result back to $BD
DD63: E6 89 00 20 LDB   $0020,X         ; B gets $X+20 again
DD67: 53          COMB                  ;
DD68: D4 BC       ANDB  $BC             ; Clear bits in $BC, override $X+20 lamps to off
DD6A: DB BD       ADDB  $BD             ; Add to $BD, Turns on lamps set in $X+20 <and> $X+28
DD6C: D7 BC       STB   $BC             ; Result back to $BC
                                        ;----------------------
DD6E: E6 89 00 30 LDB   $0030,X         ; B gets $X+30
DD72: E4 89 00 38 ANDB  $0038,X         ; AND with $X+38
DD76: D7 BD       STB   $BD             ; Result back to $BD
DD78: E6 89 00 30 LDB   $0030,X         ; B gets $X+30 again
```

```
DD7C: 53          COMB                ;
DD7D: D4 BC       ANDB  $BC           ; Clear bits in $BC, override $X+30 lamps to off
DD7F: DB BD       ADDB  $BD           ; Add to $BD, Turns on lamps set in $X+30 <and> $X+38
                                      ;----------------------
                                      ;
DD81: 7F 3F E4    CLR   $3FE4         ; Clear Lamp Column
DD84: B7 3F E5    STA   $3FE5         ; Store A to Select Lamp Column,
                                      ;   A has a single bit 0x01-0x80
DD87: F7 3F E4    STB   $3FE4         ; Store B to Lamp Outputs, the lamps to turn on
                                      ;   for this column (0 = off, 1 = on)
```

Lamp On/Off Functions

There are a large number of lamp handler functions to set/clear a specified lamp bit in any of the different lamp bank arrays. I haven't fully mapped them out yet. Basically there are function to say "turn on/off lamp X in bank Y" where a function caller species the lamp number (1-64) and the bank (00, 08, 10, 18, 20, 28, 30, 38, 40).

Attract-Mode Lamp Functions

There are also a handful of functions to handle the attract-mode lamp data. I have found that during attract mode the lamp data in LampBank +08 is constantly updated with one pattern of lamps. In IJ_L7 this is the "random" sort of effect where everything is blinking in somewhat random pattern. If you look carefully, you'll see it's not really random, but there is a fixed pattern. This is especially noticeable with Indy's Friends arch at the bottom where the arch lamps illuminate left/right/left/right, etc.

Then, every once in awhile, a special wipe-pattern is performed on the entire playfield. After the wipe pattern is performed 6 times, the lamps return to the "random" effect for awhile and then another, different, wipe is performed for 6 times. This repeats indefinitely. In IJ_L7 there are 5 different wipe patterns that are done and in this order:

a. Center-out, out-center
b. Diagonal bottom-left to top-right, and top-right to bottom-left.
c. Diagonal bottom-right to top-left, and top-left to bottom-right.
d. Horizontal, bottom-top to top-bottom
e. Vertical, left-right to right-left

Interestingly, after performing the 5 wipe patterns 15 times, IJ_L7 will then call a function that checks if Attract Mode Sounds are enabled, and if so, plays the IJ music for awhile.

As mentioned, the "random" light data is constantly being updated in LampBank+08. When the wipe-pattern comes along, it does the following;

a. Set all bits in LampBank+10 to 1 (except for start-button lamp bit). This overrides the "random" light data
b. Use LampBank+18 to update the wipe pattern lamp bits until the entire wipe pattern is finished.
c. Clear all bits in LampBank+10 so that the normal "random" effect is then used.

Attract Mode Code

Below is the code that fires up the attract mode lamp patterns. This includes the background "random" light effects which update in LampBank+08, along with the loops that periodically update with a wipe pattern utilizing LampBank+18.

```
;
; AttractModeLampShowPerform()
;
73CD: BD 88 11    JSR   $8811           ; PerformLampClearAgainstLightShowDataParamBytes()
73D0: 01 20                             ;  0x01 == AttractModeLightShowData01[], Process all 64 lamps.
                                        ;  0x20 == Lamp bank 0x20
                                        ;
73D2: BD 88 11    JSR   $8811           ; PerformLampClearAgainstLightShowDataParamBytes()
73D5: 01 10                             ;  0x01 == AttractModeLightShowData01[], Process all 64 lamps.
                                        ;  0x10 == Lamp bank 0x10
                                        ;
73D7: BD 88 11    JSR   $8811           ; PerformLampClearAgainstLightShowDataParamBytes()
73DA: 01 00                             ;  0x01 == AttractModeLightShowData01[], Process all 64 lamps.
                                        ;  0x00 == Lamp bank 0x00
                                        ;
73DC: BD 88 11    JSR   $8811           ; PerformLampClearAgainstLightShowDataParamBytes()
73DF: 01 40                             ;  0x01 == AttractModeLightShowData01[], Process all 64 lamps.
                                        ;  0x40 == Lamp bank 0x40
                                        ;
73E1: BD 9B AE    JSR   $9BAE           ; Set59_5AOffset2CBit80()
73E4: 86 0A       LDA   #$0A            ; A = 0x0A
73E6: BD A0 5F    JSR   $A05F           ; WriteAto70and71()
                                        ;
73E9: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
73EC: 07                                ;  Lamp 0x07, Shoot Again
                                        ;
73ED: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
73F0: 3E                                ;  Lamp 0x3E, Totem Top Arrow
                                        ;
73F1: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
73F4: 3F                                ;  Lamp 0x3F, Center Lock
                                        ;
73F5: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
73F8: 20                                ;  Lamp 0x20, Left Loop
```

```
                                        ;
73F9: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
73FC: 28                                ;  Lamp 0x28, Right Loop
                                        ;
73FD: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
7400: 30                                ;  Lamp 0x30, Right Ramp Arrow
                                        ;
7401: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
7404: 11                                ;  Lamp 0x11, Left Ramp Arrow
                                        ;
7405: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
7408: 35                                ;  Lamp 0x35 ,Mini Top Arrow
                                        ;
7409: BD 85 0F    JSR   $850F           ; SetSingleLampBank40()
740C: 3D                                ;  Lamp 0x3D, Mini Bottom Arrow
                                        ;
                                        ;
740D: BD 89 9B    JSR   $899B           ; SpawnInBankedFunction()
7410: 74 8F 36                          ;  $748f,36, LampShow_SaucerLightsAndMiniPlayfieldRollovers()
                                        ;
7413: BD 89 9B    JSR   $899B           ; SpawnInBankedFunction()
7416: 74 B0 36                          ;  $74b0,36, LampShow_AdventureLights()
                                        ;
7419: BD 89 9B    JSR   $899B           ; SpawnInBankedFunction()
741C: 74 D1 36                          ;  $74d1,36, LampShow_PlaneLights()
                                        ;
741F: BD 89 9B    JSR   $899B           ; SpawnInBankedFunction()
7422: 74 DC 36                          ;  $74dc,36, LampShow_IndyAndModeLights()
                                        ;
7425: BD 89 9B    JSR   $899B           ; SpawnInBankedFunction()
7428: 75 06 36                          ;  $7506,36, LampShow_FriendsBonusXArc()
                                        ;
742B: BD 89 9B    JSR   $899B           ; SpawnInBankedFunction()
742E: 75 28 36                          ;  $7528,36, LampShow_JackpotLights()
                                        ;
7431: 86 0F       LDA   #$0F            ;--\
7433: 34 02       PSHS  A               ;  |--\
7435: BD 86 CC    JSR   $86CC           ;  |  | WaitForDMDSequence() <lamps do random blinkys>
7438: 03 84                             ;  |  |
743A: C6 1B       LDB   #$1B            ;  |  | \
```

```
743C: 8E 00 14    LDX   #$0014          ;  |  |  > lamp effects: center-out, out-center
743F: CE 00 30    LDU   #$0030          ;  |  | /
7442: BD 75 37    JSR   $7537           ;  |  | DoLampWipeEffect()
7445: BD 86 CC    JSR   $86CC           ;  |  | WaitForDMDSequence()
7448: 03 84                             ;  |  |
744A: C6 1C       LDB   #$1C            ;  |  | \
744C: 8E 00 14    LDX   #$0014          ;  |  |  > lamp effects: diagonal bottom-left to top-right and back
744F: CE 00 2D    LDU   #$002D          ;  |  | /
7452: BD 75 37    JSR   $7537           ;  |  | DoLampWipeEffect()
7455: BD 86 CC    JSR   $86CC           ;  |  | WaitForDMDSequence()
7458: 03 84                             ;  |  |
745A: C6 1D       LDB   #$1D            ;  |  | \
745C: 8E 00 14    LDX   #$0014          ;  |  |  > lamp effects: diagonal bottom-right to top-left and back
745F: CE 00 2D    LDU   #$002D          ;  |  | /
7462: BD 75 37    JSR   $7537           ;  |  | DoLampWipeEffect()
7465: BD 86 CC    JSR   $86CC           ;  |  | WaitForDMDSequence()
7468: 03 84                             ;  |  |
746A: C6 0F       LDB   #$0F            ;  |  | \
746C: 8E 00 14    LDX   #$0014          ;  |  |  > lamp effects: bottom-top, top-bottom
746F: CE 00 30    LDU   #$0030          ;  |  | /
7472: BD 75 37    JSR   $7537           ;  |  | DoLampWipeEffect()
7475: BD 86 CC    JSR   $86CC           ;  |  | WaitForDMDSequence()
7478: 03 84                             ;  |  |
747A: C6 10       LDB   #$10            ;  |  | \
747C: 8E 00 14    LDX   #$0014          ;  |  |  > lamp effects: left-right, right-left
747F: CE 00 2D    LDU   #$002D          ;  |  | /
7482: BD 75 37    JSR   $7537           ;  |  | DoLampWipeEffect()
7485: 35 02       PULS  A               ;  |  |
7487: 4A          DECA                  ;  |  | Decrement the 0x0f counter
7488: 26 A9       BNE   $7433           ;  |--/
                                        ;  |
748A: BD 75 BA    JSR   $75BA           ;  | PlayIJThemeMusic()
748D: 20 A2       BRA   $7431           ;--/
                                        ;
;---------------------------------------;-------------------------------------
                                        ;

;
; LampShow_SaucerLightsAndMiniPlayfieldRollovers()
;
; Spawned at start of lamp show.
```

```
;
748F: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
7492: 03                               ;  Lamp 0x03, Eject Extra Ball
                                       ;
7493: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
7496: 32                               ;  Lamp 0x32, Mini Top Right
                                       ;
7497: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
749A: 3B                               ;  Lamp 0x3B, Mini Bottom Left
                                       ;
749B: BD 83 99    JSR   $8399           ;--\ Sleep()
749E: 0A                               ;  |
749F: BD FE 1C    JSR   $FE1C           ;  |
74A2: 13 00                            ;  | 0x13, AttractModeLightShowData13[], Saucer Lights
                                       ;  | 0x00, Lamp bank 0x00
74A4: BD FE 2E    JSR   $FE2E           ;  |
74A7: 14 00                            ;  | 0x14, AttractModeLightShowData14[], Mini Playfield Lights, Left Rollovers
                                       ;  | 0x00, Lamp bank 0x00
74A9: BD FE 1C    JSR   $FE1C           ;  |
74AC: 15 00                            ;  | 0x15, AttractModeLightShowData15[], Mini Playfield Lights, Right
Rollovers
                                       ;  | 0x00, Lamp bank 0x00
74AE: 20 EB       BRA $749F            ;--/
                                       ;
;--------------------------------------;--------------------------------------
                                       ;
;
; LampShow_AdventureLights()
;
; Spawned at start of lamp show.
;
74B0: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74B3: 06                               ;  Lamp 0x06, (A)dventure Light
                                       ;
74B4: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74B7: 24                               ;  Lamp 0x24, Advent(u)re Light
                                       ;
74B8: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74BB: 0B                               ;  Lamp 0x0B, Adv(e)nture Light
                                       ;
```

```
74BC: BD 83 99    JSR   $8399           ;--\ Sleep()
74BF: 0C                                ;  |
74C0: BD FE 2E    JSR   $FE2E           ;  |
74C3: 06 00                             ;  | 0x06, AttractModeLightShowData06[], (Adv)enture Lights
                                        ;  | 0x00, Lamp bank 0x00
74C5: BD FE 1C    JSR   $FE1C           ;  |
74C8: 05 00                             ;  | 0x05, AttractModeLightShowData05[], Advent(ure) Lights
                                        ;  | 0x00, Lamp bank 0x00
74CA: BD FE 1C    JSR   $FE1C           ;  |
74CD: 03 00                             ;  | 0x03, AttractModeLightShowData03[], Adv(ent)ure Lights
                                        ;  | 0x00, Lamp bank 0x00
74CF: 20 EB       BRA   $74BC           ;--/
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; LampShow_PlaneLights()
;
; Spawned at start of lamp show.
;
74D1: BD FE 64    JSR   $FE64           ;--\ LampDataToggleScheduler()
74D4: 0A 00                             ;  |  0x0A, AttractModeLightShowData0A[], Plane Lights
                                        ;  |
74D6: BD 83 99    JSR   $8399           ;  | Sleep()
74D9: 08                                ;  |
74DA: 20 F5       BRA   $74D1           ;--/
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; LampShow_IndyAndModeLights()
;
; Spawned at start of lamp show.
;
74DC: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74DF: 29                                ;  Lamp 0x29, (I)ndy
                                        ;
74E0: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74E3: 08                                ;  Lamp 0x08, Get The Idol
                                        ;
```

```
74E4: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74E7: 14                                ;  Lamp 0x14, Monkey Brains
                                        ;
74E8: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
74EB: 12                                ;  Lamp 0x12, Castle Grunewald
                                        ;
74EC: BD 83 99    JSR   $8399           ;--\ Sleep()
74EF: 0C                                ;  |
74F0: BD FE 1C    JSR   $FE1C           ;  |
74F3: 04 00                             ;  | 0x04, AttractModeLightShowData04[], (Indy) Lights
                                        ;  | 0x00, Lamp bank 0x00
74F5: BD FE 1C    JSR   $FE1C           ;  |
74F8: 19 00                             ;  | 0x19, AttractModeLightShowData19[], Mode Lights, Movie: Last Crusade
                                        ;  | 0x00, Lamp bank 0x00
74FA: BD FE 1C    JSR   $FE1C           ;  |
74FD: 18 00                             ;  | 0x18, AttractModeLightShowData18[], Mode Lights, Movie: Temple of Doom
                                        ;  | 0x00, Lamp bank 0x00
74FF: BD FE 1C    JSR   $FE1C           ;  |
7502: 17 00                             ;  | 0x17, AttractModeLightShowData17[], Mode Lights, Movie: Raiders of the
Lost Ark
                                        ;  | 0x00, Lamp bank 0x00
7504: 20 E6       BRA   $74EC           ;--/
                                        ;
;---------------------------------------;---------------------------------------
                                        ;

;
; LampShow_FriendsBonusXArc()
;
; Spawned at start of lamp show.
;
; This takes care of the lamps as they go back and forth at the arc near the flippers.
;
7506: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
7509: 2F                                ;  Lamp 0x2F, Shorty
                                        ;
750A: 86 08       LDA   #$08            ;--\
750C: BD 83 99    JSR   $8399           ;  |--\ Sleep()
750F: 06                                ;  |  |
7510: BD FE 1C    JSR   $FE1C           ;  |  |
7513: 16 00                             ;  |  | 0x16, AttractModeLightShowData16[], Friends and Bonus X Lights
```

```
                                        ;  |  | 0x00, Lamp bank 0x00
7515: 4A          DECA                  ;  |  |
7516: 26 F4       BNE   $750C           ;  |--/
                                        ;  |
7518: 86 08       LDA   #$08            ;  |
751A: BD 83 99    JSR   $8399           ;  |--\ Sleep()
751D: 06                                ;  |  |
751E: BD FE 2E    JSR   $FE2E           ;  |  |
7521: 16 00                             ;  |  | 0x16, AttractModeLightShowData16[], Friends and Bonus X Lights
                                        ;  |  | 0x00, Lamp bank 0x00
7523: 4A          DECA                  ;  |  |
7524: 26 F4       BNE   $751A           ;  |--/
                                        ;  |
7526: 20 E2       BRA   $750A           ;--/
                                        ;
;---------------------------------------;-------------------------------------
                                        ;

;
; LampShow_JackpotLights()
;
; Spawned at start of lamp show.
;
7528: BD 84 6F    JSR   $846F           ; SetSingleLampBank00()
752B: 0E                                ;  Lamp 0x0E, Grail Jackpot
                                        ;
752C: BD 83 99    JSR   $8399           ;--\ Sleep()
752D: 10                                ;  |
7530: BD FE 2E    JSR   $FE2E           ;  |
7533: 0C 00                             ;  | 0x0C, AttractModeLightShowData0C[], Jackpot Lights
7535: 20 F5       BRA   $752C           ;--/
                                        ;
;---------------------------------------;-------------------------------------
                                        ;

;
; DoLampWipeEffect()
;
; Wipe              B        X        U
; -------------------------------------
; Center-out     0x1B   0x0014   0x0030
; Diag BL-TR     0x1C   0x0014   0x002D
```

```
; Diag BR-TL      0x1D   0x0014   0x002D
; Horizontal      0x0F   0x0014   0x0030
; Vertical        0x10   0x0014   0x002D
;
                                        ;-------------------------------------------------------------------------
                                        ; The following sets all 64 bits at lamp plane +10 to turn off the normal
                                        ; attract mode lamp show which is still happening in the background, updating
                                        ; the +08 memory.
                                        ;-------------------------------------------------------------------------
7537: BD 88 04    JSR   $8804           ; ApplyLightShowData2ParamBytes() Set all bits in the +10 lamp plane
753A: 01                                ; 0x01 == Use AttractModeLightShowData01[] $62f7,20, process all 64 lamps
753B: 10                                ; 0x10 == Lamp matrix plane to update.  00 main, 08=lamps-on 10=lamps-off
                                        ;
                                        ;-------------------------------------------------------------------------
                                        ; The following removes the start-button lamp from the +10 bits so that it is
                                        ; not forced off by this wipe pattern.
                                        ;-------------------------------------------------------------------------
753C: BD 87 75    JSR   $8775           ; SetSingleLamp2ParamBytes()
753F: 40                                ; 0x40 == start-button lamp index
7540: 10                                ; 0x10 == Lamp matrix plane to update.  00 main, 08=lamps-on 10=lamps-off
                                        ;-------------------------------------------------------------------------
7541: BD AD C0    JSR   $ADC0           ; Set10BitAt59_5APtrPlus2E()  // flagging something
7544: 86 28       LDA   #$28            ; A = 0x28
7546: BD AD 8E    JSR   $AD8E           ; StoreAto59_5APtrPlus2D()
7549: 34 02       PSHS  A               ;
754B: 1F 98       TFR   B,A             ; Store wipe-pattern code into A
754D: C6 10       LDB   #$10            ; B gets 0x10, lamp plane for this wipe pattern
754F: BD AE 0C    JSR   $AE0C
7552: 10 8E 00 06 LDY   #$0006          ; Loop the wipe 6 times
                                        ;
7556: C6 18       LDB   #$18            ;--\
7558: BD AE 0C    JSR   $AE0C           ;  |
755B: 9F 61       STX   $61             ;  |
755D: BD 98 24    JSR   $9824           ;  |
7560: BD AE 2D    JSR   $AE2D           ;  |
7563: DF 61       STU   $61             ;  |
7565: BD 98 24    JSR   $9824           ;  |
7568: BD AE 1C    JSR   $AE1C           ;  |
756B: 9F 61       STX   $61             ;  |
```

```
756D: BD 98 24    JSR   $9824           ;  |
7570: BD AE 4E    JSR   $AE4E           ;  |
7573: DF 61       STU   $61             ;  |
7575: BD 98 24    JSR   $9824           ;  |
7578: 30 1F       LEAX  $FFFF,X         ;  |
757A: 33 5C       LEAU  $FFFC,U         ;  |
757C: E6 E4       LDB   ,S              ;  |
757E: C0 06       SUBB  #$06            ;  |
7580: E7 E4       STB   ,S              ;  |
7582: 1F 89       TFR   A,B             ;  |
7584: A6 E4       LDA   ,S              ;  |
7586: BD AD 8E    JSR   $AD8E           ;  |
7589: 1F 98       TFR   B,A             ;  |
758B: 31 3F       LEAY  $FFFF,Y         ;  |
758D: 26 C7       BNE   $7556           ;--/
                                        ;
                                        ; Continue the "random" blinky effect
758F: BD AD CF    JSR   $ADCF           ;
7592: C6 18       LDB   #$18            ;
7594: BD AE 0C    JSR   $AE0C           ;
7597: DF 61       STU   $61             ;
7599: BD 98 24    JSR   $9824           ;
759C: 34 02       PSHS  A               ;
759E: 86 20       LDA   #$20            ;
75A0: BD AD 8E    JSR   $AD8E           ;
75A3: 35 02       PULS  A               ;
75A5: C6 10       LDB   #$10            ;
75A7: BD AE 2D    JSR   $AE2D           ;
75AA: BD 83 99    JSR   $8399           ; Sleep()
75AD: 08                                ;
75AE: BD 88 11    JSR   $8811           ;
75B1: 01 18                             ;
75B3: BD 88 11    JSR   $8811           ;
75B6: 01 10                             ;
75B8: 35 82       PULS  A,PC            ; Done. RTS.
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; PlayIJThemeMusic()
```

```
;
; Once in awhile during attract mode play the IJ theme song.
;
75BA: BD 86 AE    JSR   $86AE            ; LookupGameAdjustmentParameter1andCheckIfEqualsParameter2()
75BD: 1D 01                              ;  TableEntry1D, Adjustments, Feature Adjustments, Attract Mode Sounds
75BF: 25 1B       BCS   $75DC
75C1: 86 00       LDA   #$00             ; A=0x00=Stop playing
75C3: BD C1 A8    JSR   $C1A8            ; PlaySoundIndexRegisterAIfNotPlaying()
75C6: 86 01       LDA   #$01             ; A=0x01=IJ Theme, End of Game music
75C8: BD C1 A8    JSR   $C1A8            ; PlaySoundIndexRegisterAIfNotPlaying()
75CB: BD 89 48    JSR   $8948            ; CallPagedFunctionPreserve_U_A_B_CC()
75CE: 68 5D 20                           ;
75D1: BD 86 CC    JSR   $86CC            ; WaitForDMDSequence()
75D4: 01 E0                              ;
75D6: BD 89 48    JSR   $8948            ; CallPagedFunctionPreserve_U_A_B_CC()
75D9: 68 49 20                           ;
75DC: 39          RTS                    ;
                                         ;
;----------------------------------------;---------------------------------------
                                         ;
```

Attract Mode Data, "random" effects

As implied in the attract-mode code (above), there is a data table that defines different groups of lamps. The "random" blinky code is achieved by "spawned" functions which loop indefinitely and independently update the LampBank+08 with their own lamp data. The WPC architecture allows this multi-threaded approach to give the appearance of multiple functions running at the same time. The random functions each handle the following data table entries

LampShow_SaucerLightsAndMiniPlayfieldRollovers()

- AttractModeLightShowData13[], Saucer Lights
- AttractModeLightShowData14[], Mini Playfield Lights, Left Rollovers
- AttractModeLightShowData15[], Mini Playfield Lights, Right Rollovers

LampShow_AdventureLights()

- AttractModeLightShowData06[], (Adv)enture Lights
- AttractModeLightShowData05[], Advent(ure) Lights
- AttractModeLightShowData03[], Adv(ent)ure Lights

LampShow_PlaneLights()

- AttractModeLightShowData0A[], Plane Lights

LampShow_IndyAndModeLights()

- AttractModeLightShowData04[], (Indy) Lights
- AttractModeLightShowData19[], Mode Lights, Movie: Last Crusade
- AttractModeLightShowData18[], Mode Lights, Movie: Temple of Doom
- AttractModeLightShowData17[], Mode Lights, Movie: Raiders of the Lost Ark

LampShow_FriendsBonusXArc()

- AttractModeLightShowData16[], Friends and Bonus X Lights

LampShow_JackpotLights()

- AttractModeLightShowData0C[], Jackpot Lights

Attract Mode Data, data handling functions

The function "LampShow_FriendsBonusXArc()" also reveals that the same data structure is used to illuminate a group of lamps in two different directions. The data and functions allow the lamps start at the end, and work to the first lamp (in the data table entry) and they can also allow data to be read at the first lamp and then work towards the last lamp.

This effect is also more obvious with the wipe-mode patterns. First they illuminate in one direction to "wipe-on" the lamps, and then they work in the opposite direction when they "wipe-off" the lamps. However this effect with wipe-modes is different from the Indy's Friends in that Indy's friends quickly illuminates each lamp back and forth, which is subtly different than the wipe. This also highlights a previous statement about the abundance of functions to perform different actions with lamp data.

Functions for handling lamp data do things such as:

- Handle lamp data in a particular direction (top to bottom or bottom to top)
- For each lamp, just blink it on and off
- For each lamp, just leave it on
- For each lamp, just turn it off
- etc…

In fact the WPC architecture allows any group of lamp data to be processed through a callback function, and that callback function can do any variety of things with each lamp. The actual address of the callback function is passed along when a lamp-data entry is processed. Sometimes the callback functions are in the main un-switched bank ($8000-$FFFF) or the callback function could be in banked rom ($4000-$7fff) along with the ROM bank. Below is an example of such callback code. The following function is what gets called from the $FE1C function which is called to start the Indy's Friends arch light effect:

```
733A: 34 36       PSHS  Y,X,B,A          ; A has next AttractModeLightShowData[]
733C: 1F 01       TFR   D,X              ;
733E: 10 8E 73 5C LDY   #$735C           ; & of callback function (it must pulse the lamp)
7342: 86 3B       LDA   #$3B             ; 0x3B Bank corresponding to $735C function.
7344: C6 0C       LDB   #$0C             ;
7346: BD AE EB    JSR   $AEEB            ; SetupAndCallAttractModeLightShowNext()
7349: 35 B6       PULS  A,B,X,Y,PC       ; Done. RTS.
```

Attract Mode Data, data handling functions (continued)

The previous code snippet is what gets called from LampShow_FriendsBonusXArc() when it wants to start the blinky of each light around Indy's face. As indicated in code above, this function passed in index 0x16 which I labeled "AttractModeLightShowData16[], Friends and Bonus X Lights". The code sets up a callback to $735C,3B. The function at $735C,3B is called once for every lamp defined in AttractModeLightShowData16. And as implied, it seems that the function at $735C,3B must simply blink each lamp (and not leave it on).

The last function that gets called, I named "SetupAndCallAttractModeLightShowNext()" which will take care of the details involved with running through all of the lamps (specified in AttractModeLightShowData16[]) and passing each lamp index into function at $735C,3B.

At this time the details of AttractModeLightShowNext() function are not provided in this document. However, it is important to understand that AttractModeLightShowNext() will need to look up the lamp data, in this example, AttractModeLightShowData16[]. It does this by calling a function I named "LoadAttractModeLightShowDataIndexA()". This function is shown below so you can find similar function in your ROM in order to derive the address of the LightShowDataTable[].

```
;
; LoadAttractModeLightShowDataIndexA()
;
B02C: 34 20       PSHS  Y
B02E: 8E 81 DD    LDX   #$81DD          ; At $81DD is $62B3,20, AttractModeLightShowData[]
B031: BD AC F3    JSR   $ACF3           ; GetPageAndLoadTableEntryPointerIndexAIntoXandY()
B034: 24 04       BCC   $B03A           ;
B036: BD 82 E4    JSR   $82E4           ; ThrowGenError(18)
B039: 18                                ;
B03A: BD 90 52    JSR   $9052           ; LoadTableEntryAdvanceX()
B03D: 30 A4       LEAX  ,Y              ;
B03F: 35 A0       PULS  Y,PC            ; Done. RTS.
```

As you can see, the above function derives the address of the LightShowDataTable[] by using, in this case 0x81DD pointer. At $81DD is the address $62B3,20. At $62B3,20 is the actual LightShowDataTable[] which will be described next. If the above isn't enough detail to allow you to find same code in your ROM, let me know, I'll help you find this function in your ROM. (remember, addresses will be different in other games).

Attract Mode Data, LightShowDataTable

In IJ_L7, the LightShowDataTable[] is located at address $62B3,20. It is a typical WPC type of table, in this case, the main table has 2-byte entries. Each entry is just an address to the table entry usually immediately following the main table. Below is the entire table, and all table entries:

```
;-------------------------------------;-------------------------------------
                                      ;
;
; TablePointer06, AttractModeLightShowData[]
;
62B3: 00 1E                           ; Table entries: 0x1E == 30
62B5: 02                              ; Entry length: 2 bytes
                                      ;
62B6: 62 F3                           ; AttractModeLightShowData00[], NULL
62B8: 62 F7                           ; AttractModeLightShowData01[], Process all 64 lamps.
62BA: 62 FF                           ; AttractModeLightShowData02[]. NULL
62BC: 63 03                           ; AttractModeLightShowData03[], Adv(ent)ure Lights
62BE: 63 0A                           ; AttractModeLightShowData04[], (Indy) Lights
62C0: 63 12                           ; AttractModeLightShowData05[], Advent(ure) Lights
62C2: 63 19                           ; AttractModeLightShowData06[], (Adv)enture Lights
62C4: 63 20                           ; AttractModeLightShowData07[], (Adventure) Lights
62C6: 63 2D                           ; AttractModeLightShowData08[], Friends Lights
62C8: 63 36                           ; AttractModeLightShowData09[], Bonus X Lights
62CA: 63 3E                           ; AttractModeLightShowData0A[], Plane Lights
62CC: 63 48                           ; AttractModeLightShowData0B[], Mode Lights, All
62CE: 63 58                           ; AttractModeLightShowData0C[], Jackpot Lights
62D0: 63 5F                           ; AttractModeLightShowData0D[], Mini Playfield Lights, All
62D2: 63 68                           ; AttractModeLightShowData0E[], Mini Playfield Lights, Rollover
62D4: 63 74                           ; AttractModeLightShowData0F[], Wipe effect: Horizontal
62D6: 63 C2                           ; AttractModeLightShowData10[], Wipe effect: Vertical
62D8: 64 0C                           ; AttractModeLightShowData11[], Indirect Callback to Wipe effect: Vertical
62DA: 64 13                           ; AttractModeLightShowData12[], Misc Award Lights 1
62DC: 64 1F                           ; AttractModeLightShowData13[], Saucer Lights
62DE: 64 26                           ; AttractModeLightShowData14[], Mini Playfield Lights, Left Rollovers
62E0: 64 2E                           ; AttractModeLightShowData15[], Mini Playfield Lights, Right Rollovers
62E2: 64 36                           ; AttractModeLightShowData16[], Friends and Bonus X Lights
62E4: 64 43                           ; AttractModeLightShowData17[], Mode Lights, Movie: Raiders of the Lost Ark
62E6: 64 4B                           ; AttractModeLightShowData18[], Mode Lights, Movie: Temple of Doom
62E8: 64 53                           ; AttractModeLightShowData19[], Mode Lights, Movie: Last Crusade
62EA: 64 5B                           ; AttractModeLightShowData1A[], Misc Award Lights 2
62EC: 64 6C                           ; AttractModeLightShowData1B[], Wipe effect: Center-out
62EE: 64 B0                           ; AttractModeLightShowData1C[], Wipe effect: Diag BL-TR
62F0: 64 F5                           ; AttractModeLightShowData1D[], Wipe effect: BR-TL
```

```
62F2: 00                                ; End of table marker?
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData00[], NULL
;
62F3: 62 F7                             ; Pointer to next AttractModeLightShowData[]
62F5: FA                                ; 0xFA start of lamp show data
62F6: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData01[], Process all 64 lamps.
;
62F7: 62 FF                             ; Pointer to next AttractModeLightShowData[]
62F9: FA                                ; 0xFA start of lamp show data
                                        ;
62FA: 85 01 40 85                       ; LampDataByteLookupTable05, Process range of lamps.
                                        ;  0x01, first lamp number (0x00 is invalid)
                                        ;  0x40, last lamp number
                                        ;
62FE: FA                                ; 0xFA end of lamp show data
                                        ;
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData02[]. NULL
;
62FF: 63 03                             ; Pointer to next AttractModeLightShowData[]
6301: FA                                ; 0xFA start of lamp show data
6302: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData03[], Adv(ent)ure Lights
;
6303: 63 0A                             ; Pointer to next AttractModeLightShowData[]
6305: FA                                ; 0xFA start of lamp show data
                                        ;
6306: 0B                                ; Lamp 0x0B, Adv(e)nture Light
6307: 0C                                ; Lamp 0x0C, Adve(n)ture Light
```

```
6308: 0A                                ; Lamp 0x0A, Adven(t)ure Light
                                        ;
6309: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData04[], (Indy) Lights
;
630A: 63 12                             ; Pointer to next AttractModeLightShowData[]
630C: FA                                ; 0xFA start of lamp show data
                                        ;
630D: 29                                ; Lamp 0x29, (I)ndy
630E: 2A                                ; Lamp 0x2A, I(n)dy
630F: 2B                                ; Lamp 0x2B, In(d)y
6310: 2C                                ; Lamp 0x2C, Ind(y)
                                        ;
6311: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData05[], Advent(ure) Lights
;
6312: 63 19                             ; Pointer to next AttractModeLightShowData[]
6314: FA                                ; 0xFA start of lamp show data
                                        ;
6315: 24                                ; Lamp 0x24, Advent(u)re Light
6316: 25                                ; Lamp 0x25, Adventu(r)e Light
6317: 26                                ; Lamp 0x26, Adventur(e) Light
                                        ;
6318: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData06[], (Adv)enture Lights
;
6319: 63 20                             ; Pointer to next AttractModeLightShowData[]
631B: FA                                ; 0xFA start of lamp show data
                                        ;
631C: 04                                ; Lamp 0x04, Ad(v)enture Light
631D: 05                                ; Lamp 0x05, A(d)venture Light
631E: 06                                ; Lamp 0x06, (A)dventure Light
                                        ;
```

```
631F: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData07[], (Adventure) Lights
;
6320: 63 2D                             ; Pointer to next AttractModeLightShowData[]
6322: FA                                ; 0xFA start of lamp show data
                                        ;
6323: 81 06 81                          ; AttractModeLightShowData06[], (Adv)enture Lights
6326: 81 05 81                          ; AttractModeLightShowData05[], Advent(ure) Lights
6329: 81 03 81                          ; AttractModeLightShowData03[], Adv(ent)ure Lights
                                        ;
632C: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData08[], Friends Lights
;
632D: 63 36                             ; Pointer to next AttractModeLightShowData[]
632F: FA                                ; 0xFA start of lamp show data
                                        ;
6330: 2F                                ; Lamp 0x2F, Shorty
6331: 2D                                ; Lamp 0x2D, Willie
6332: 16                                ; Lamp 0x16, Sallah
6333: 36                                ; Lamp 0x36, Marion
6334: 38                                ; Lamp 0x38, Dr. Jones
                                        ;
6335: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData09[], Bonus X Lights
;
6336: 63 3E                             ; Pointer to next AttractModeLightShowData[]
6338: FA                                ; 0xFA start of lamp show data
                                        ;
6339: 2E                                ; Lamp 0x2E, Bonus 2X
633A: 17                                ; Lamp 0x17, Bonus 4X
633B: 1D                                ; Lamp 0x1D, Bonus 6X
633C: 37                                ; Lamp 0x37, Bonus 8X
                                        ;
```

```
633D: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-----------------------------------
                                        ;
;
; AttractModeLightShowData0A[], Plane Lights
;
633E: 63 48                             ; Pointer to next AttractModeLightShowData[]
6340: FA                                ; 0xFA start of lamp show data
                                        ;
6341: 13                                ; Lamp 0x13, Left Plane Top
6342: 22                                ; Lamp 0x22, Right Plane Top
6343: 15                                ; Lamp 0x15, Left Plane Middle
6344: 1C                                ; Lamp 0x1C, Right Plane Middle
6345: 18                                ; Lamp 0x18, Left Plane Bottom
6346: 1E                                ; Lamp 0x1E, Right Plane Middle
                                        ;
6347: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-----------------------------------
                                        ;
;
; AttractModeLightShowData0B[], Mode Lights, All
;
6348: 63 58                             ; Pointer to next AttractModeLightShowData[]
634A: FA                                ; 0xFA start of lamp show data
                                        ;
634B: 08                                ; Lamp 0x08, Get The Idol
634C: 0F                                ; Lamp 0x0F, Streets Of Cairo
634D: 1F                                ; Lamp 0x1F, Well Of Souls
634E: 1B                                ; Lamp 0x1B, Raven Bar
634F: 14                                ; Lamp 0x14, Monkey Brains
6350: 0D                                ; Lamp 0x0D, Steal The Stones
6351: 19                                ; Lamp 0x19, Mine Cart
6352: 23                                ; Lamp 0x23, Rope Bridge
6353: 12                                ; Lamp 0x12, Castle Grunewald
6354: 09                                ; Lamp 0x09, Tank Chase
6355: 27                                ; Lamp 0x27, The 3 Challenges
6356: 21                                ; Lamp 0x21, Choose Wisely
                                        ;
6357: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-----------------------------------
                                        ;
;
```

```
; AttractModeLightShowData0C[], Jackpot Lights
;
6358: 63 5F                         ; Pointer to next AttractModeLightShowData[]
635A: FA                            ; 0xFA start of lamp show data
                                    ;
635B: 1A                            ; Lamp 0x1A, Ark Jackpot
635C: 10                            ; Lamp 0x10, Stones Jackpot
635D: 0E                            ; Lamp 0x0E, Grail Jackpot
                                    ;
635E: FA                            ; 0xFA end of lamp show data
                                    ;
;-------------------------------------;-------------------------------------
                                    ;
;
; AttractModeLightShowData0D[], Mini Playfield Lights, All
;
635F: 63 68                         ; Pointer to next AttractModeLightShowData[]
6361: FA                            ; 0xFA start of lamp show data
                                    ;
6362: 81 0E 81                      ; AttractModeLightShowData0E[], Mini Playfield Lights, Rollover
6365: 3D                            ; Lamp 0x3D, Mini Bottom Arrow
6366: 35                            ; Lamp 0x35, Mini Top Arrow
                                    ;
6367: FA                            ; 0xFA end of lamp show data
                                    ;
;-------------------------------------;-------------------------------------
                                    ;
;
; AttractModeLightShowData0E[], Mini Playfield Lights, Rollover
;
6368: 63 74                         ; Pointer to next AttractModeLightShowData[]
636A: FA                            ; 0xFA start of lamp show data
                                    ;
636B: 31                            ; Lamp 0x31, Mini Top Left
636C: 32                            ; Lamp 0x32, Mini Top Right
636D: 33                            ; Lamp 0x33, Mini Middle Top Left
636E: 34                            ; Lamp 0x34, Mini Middle Top Right
636F: 39                            ; Lamp 0x39, Mini Middle Bottom Left
6370: 3A                            ; Lamp 0x3A, Mini Middle Bottom Right
6371: 3B                            ; Lamp 0x3B, Mini Bottom Left
6372: 3C                            ; Lamp 0x3C, Mini Bottom Right
                                    ;
6373: FA                            ; 0xFA end of lamp show data
                                    ;
;-------------------------------------;-------------------------------------
```

```
                                        ;
;
; AttractModeLightShowData0F[], Wipe effect: Horizontal
;
6374: 63 C2                             ; Pointer to next AttractModeLightShowData[]
6376: FA                                ; 0xFA start of lamp show data
                                        ;
6377: 2F                                ; Lamp 0x2F, Shorty
6378: 38                                ; Lamp 0x38, Dr. Jones
6379: 2E                                ; Lamp 0x2E, Bonus 2X
637A: 37                                ; Lamp 0x37, Bonus 8X
637B: 80                                ; <flush>
637C: 17                                ; Lamp 0x17, Bonus 4X
637D: 1D                                ; Lamp 0x1D, Bonus 6X
637E: 16                                ; Lamp 0x16, Sallah
637F: 2D                                ; Lamp 0x2D, Willie
6380: 36                                ; Lamp 0x36, Marion
6381: 80                                ; <flush>
6382: 08                                ; Lamp 0x08, Get The Idol
6383: 1B                                ; Lamp 0x1B, Raven Bar
6384: 1A                                ; Lamp 0x1A, Ark Jackpot
6385: 18                                ; Lamp 0x18, Left Plane Bottom
6386: 1E                                ; Lamp 0x1E, Right Plane Bottom
6387: 80                                ; <flush>
6388: 0F                                ; Lamp 0x0F, Streets Of Cairo
6389: 1F                                ; Lamp 0x1F, Well Of Souls
638A: 15                                ; Lamp 0x15, Left Plane Middle
638B: 1C                                ; Lamp 0x1C, Right Plane Middle
638C: 07                                ; Lamp 0x07, Shoot Again
638D: 80                                ; <flush>
638E: 10                                ; Lamp 0x10, Stones Jackpot
638F: 14                                ; Lamp 0x14, Monkey Brains
6390: 23                                ; Lamp 0x23, Rope Bridge
6391: 06                                ; Lamp 0x06, (A)dventure Light
6392: 26                                ; Lamp 0x26, Adventur(e) Light
6393: 25                                ; Lamp 0x25, Adventu(r)e Light
6394: 80                                ; <flush>
6395: 0D                                ; Lamp 0x0D, Steal The Stones
6396: 19                                ; Lamp 0x19, Mine Cart
6397: 05                                ; Lamp 0x05, A(d)venture Light
6398: 24                                ; Lamp 0x24, Advent(u)re Light
6399: 13                                ; Lamp 0x13, Left Plane Top
639A: 22                                ; Lamp 0x22, Right Plane Top
639B: 80                                ; <flush>
639C: 04                                ; Lamp 0x04, Ad(v)enture Light
```

```
639D: 0E                                ; Lamp 0x0E, Grail Jackpot
639E: 12                                ; Lamp 0x12, Castle Grunewald
639F: 21                                ; Lamp 0x21, Choose Wisely
63A0: 80                                ; <flush>
63A1: 09                                ; Lamp 0x09, Tank Chase
63A2: 27                                ; Lamp 0x27, The 3 Challenges
63A3: 28                                ; Lamp 0x28, Right Loop
63A4: 03                                ; Lamp 0x03, Eject Extra Ball
63A5: 30                                ; Lamp 0x30, Right Ramp Arrow
63A6: 80                                ; <flush>
63A7: 20                                ; Lamp 0x20, Left Loop
63A8: 02                                ; Lamp 0x02, Hand Of Fate
63A9: 11                                ; Lamp 0x11, Left Ramp Arrow
63AA: 0C                                ; Lamp 0x0C, Adve(n)ture Light
63AB: 0A                                ; Lamp 0x0A, Adven(t)ure Light
63AC: 80                                ; <flush>
63AD: 01                                ; Lamp 0x01, Mode Start
63AE: 0B                                ; Lamp 0x0B, Adv(e)nture Light
63AF: 3F                                ; Lamp 0x3F, Center Lock
63B0: 3B                                ; Lamp 0x3B, Mini Bottom
63B1: 3C                                ; Lamp 0x3C, Mini Bottom Right
63B2: 3D                                ; Lamp 0x3D, Mini Bottom Arrow
63B3: 39                                ; Lamp 0x39, Mini Middle Bottom Left
63B4: 3A                                ; Lamp 0x3A, Mini Middle Bottom Right
63B5: 80                                ; <flush>
63B6: 33                                ; Lamp 0x33, Mini Middle Top Left
63B7: 34                                ; Lamp 0x34, Mini Middle Top Right
63B8: 31                                ; Lamp 0x31, Mini Top Left
63B9: 32                                ; Lamp 0x32, Mini Top Right
63BA: 35                                ; Lamp 0x35, Mini Top Arrow
63BB: 3E                                ; Lamp 0x3E, Totem Top Arrow
63BC: 80                                ; <flush>
63BD: 29                                ; Lamp 0x29, (I)ndy
63BE: 2A                                ; Lamp 0x2A, I(n)dy
63BF: 2B                                ; Lamp 0x2B, In(d)y
63C0: 2C                                ; Lamp 0x2C, Ind(y)
                                        ;
63C1: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;---------------------------------------
                                        ;

;
; AttractModeLightShowData10[], Wipe effect: Vertical
;
63C2: 64 0C                             ; Pointer to next AttractModeLightShowData[]
```

```
63C4: FA                        ; 0xFA start of lamp show data
                                ;
63C5: 31                        ; Lamp 0x31, Mini Top Left
65C6: 35                        ; Lamp 0x35, Mini Top Arrow
63C7: 33                        ; Lamp 0x33, Mini Middle Top Left
63C8: 39                        ; Lamp 0x39, Mini Middle Bottom Left
63C9: 3B                        ; Lamp 0x3B, Mini Bottom Left
63CA: 3D                        ; Lamp 0x3D, Mini Bottom Arrow
63CB: 80                        ; <flush>
63CC: 32                        ; Lamp 0x32, Mini Top Right
63CD: 34                        ; Lamp 0x34, Mini Middle Top Right
63CE: 20                        ; Lamp 0x20, Left Loop
63CF: 3A                        ; Lamp 0x3A, Mini Middle Bottom Right
63D0: 3C                        ; Lamp 0x3C, Mini Bottom Right
63D1: 07                        ; Lamp 0x07, Shoot Again
63D2: 04                        ; Lamp 0x04, Ad(v)enture Light
63D3: 05                        ; Lamp 0x05, A(d)venture Light
63D4: 06                        ; Lamp 0x06, (A)dventure Light
63D5: 2D                        ; Lamp 0x2D, Willie
63D6: 80                        ; <flush>
63D7: 01                        ; Lamp 0x01, Mode Start
63D8: 02                        ; Lamp 0x02, Hand of Fate
63D9: 12                        ; Lamp 0x12, Castle Grunewald
63DA: 03                        ; Lamp 0x03, Eject Extra Ball
63DB: 13                        ; Lamp 0x13, Left Plane Top
63DC: 15                        ; Lamp 0x15, Left Plane Middle
63DD: 18                        ; Lamp 0x18, Left Plane Bottom
63DE: 14                        ; Lamp 0x14, Monkey Brains
63DF: 08                        ; Lamp 0x08, Get The Idol
63E0: 2F                        ; Lamp 0x2F, Shorty
63E1: 2E                        ; Lamp 0x2E, Bonus 2X
63E2: 80                        ; <flush>
63E3: 29                        ; Lamp 0x29, (I)ndy
63E4: 11                        ; Lamp 0x11, Left Ramp Arrow
63E5: 09                        ; Lamp 0x09, Tank Chase
63E6: 0D                        ; Lamp 0x0D, Steal The Stones
63E7: 0F                        ; Lamp 0x0F, Streets of Cairo
63E8: 17                        ; Lamp 0x17, Bonus 4X
63E9: 0B                        ; Lamp 0x0B, Adve(n)ture Light
63EA: 80                        ; <flush>
63EB: 2A                        ; Lamp 0x2A, I(n)dy
63EC: 0C                        ; Lamp 0x0C, Adve(n)ture Light
63ED: 0E                        ; Lamp 0x0E, Grail Jackpot
63EE: 10                        ; Lamp 0x10, Stones Jackpot
63EF: 1A                        ; Lamp 0x1A, Ark Jackpot
```

```
63F0: 16                                ; Lamp 0x16, Sallah
63F1: 80                                ; <flush>
63F2: 2B                                ; Lamp 0x2B, In(d)y
63F3: 3F                                ; Lamp 0x3F, Center Lock
63F4: 0A                                ; Lamp 0x0A, Adven(t)ure
63F5: 27                                ; Lamp 0x27, The 3 Challenges
63F6: 19                                ; Lamp 0x19, Mine Cart
63F7: 1F                                ; Lamp 0x1F, Well Of Souls
63F8: 1D                                ; Lamp 0x1D, Bonus 6X
63F9: 36                                ; Lamp 0x36, Marion
63FA: 37                                ; Lamp 0x37, Bonux 8X
63FB: 38                                ; Lamp 0x38, Dr. Jones
63FC: 80                                ; <flush>
63FD: 3E                                ; Lamp 0x3E, Totem Top Arrow
63FE: 21                                ; Lamp 0x21, Choose Wisely
63FF: 23                                ; Lamp 0x23, Rope Bridge
6400: 1B                                ; Lamp 0x1B, Raven Bar
6401: 2C                                ; Lamp 0x2C, Ind(y)
6402: 22                                ; Lamp 0x22, Right Plane Top
6403: 1C                                ; Lamp 0x1C, Right Plane Middle
6404: 1E                                ; Lamp 0x1E, Right Plane Bottom
6405: 30                                ; Lamp 0x30, Right Ramp Arrow
6406: 80                                ; <flush>
6407: 24                                ; Lamp 0x24, Advent(u)re
6408: 25                                ; Lamp 0x25, Adventu(r)e
6409: 26                                ; Lamp 0x26, Adventur(e)
640A: 28                                ; Lamp 0x28, Right Loop
                                        ;
640B: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;---------------------------------------
                                        ;
;
; AttractModeLightShowData11[], Indirect Callback to Wipe effect: Vertical
;
640C: 64 13                             ; Pointer to next AttractModeLightShowData[]
630E: FA                                ; 0xFA start of lamp show data
                                        ;
640F: 81 10 81                          ; AttractModeLightShowData10[], Wipe effect: Vertical
                                        ;
6412: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;---------------------------------------
                                        ;
;
```

```
; AttractModeLightShowData12[], Misc Award Lights 1
;
6413: 64 1F                         ; Pointer to next AttractModeLightShowData[]
6415: FA                            ; 0xFA start of lamp show data
                                    ;
6416: 07                            ; Lamp 0x07, Shoot Again
6417: 03                            ; Lamp 0x03, Eject Extra Ball
6418: 40                            ; Lamp 0x40, Start Button
6419: 3D                            ; Lamp 0x3D, Mini Bottom Arrow
641A: 35                            ; Lamp 0x35, Mini Top Arrow
641B: 81 04 81                      ; AttractModeLightShowData04[], (Indy) Lights
                                    ;
641E: FA                            ; 0xFA end of lamp show data
                                    ;
;-------------------------------------;-------------------------------------
                                    ;
;
; AttractModeLightShowData13[], Saucer Lights
;
641F: 64 26                         ; Pointer to next AttractModeLightShowData[]
6421: FA                            ; 0xFA start of lamp show data
                                    ;
6422: 03                            ; Lamp 0x03, Eject Extra Ball
6423: 02                            ; Lamp 0x02, Hand Of Fate
6424: 01                            ; Lamp 0x01, Mode Start
                                    ;
6425: FA                            ; 0xFA end of lamp show data
                                    ;
;-------------------------------------;-------------------------------------
                                    ;
;
; AttractModeLightShowData14[], Mini Playfield Lights, Left Rollovers
;
6426: 64 2E                         ; Pointer to next AttractModeLightShowData[]
6428: FA                            ; 0xFA start of lamp show data
                                    ;
6429: 31                            ; Lamp 0x31, Mini Top Left
642A: 33                            ; Lamp 0x33, Mini Middle Top Left
642B: 39                            ; Lamp 0x39, Mini Middle Bottom Left
642C: 3B                            ; Lamp 0x3B, Mini Bottom Left
                                    ;
642D: FA                            ; 0xFA end of lamp show data
                                    ;
;-------------------------------------;-------------------------------------
                                    ;
```

```
;
; AttractModeLightShowData15[], Mini Playfield Lights, Right Rollovers
;
642E: 64 36                             ; Pointer to next AttractModeLightShowData[]
6430: FA                                ; 0xFA start of lamp show data
                                        ;
6431: 32                                ; Lamp 0x32, Mini Top Right
6432: 34                                ; Lamp 0x34, Mini Middle Top Right
6433: 3A                                ; Lamp 0x3A, Mini Middle Bottom Right
6434: 3C                                ; Lamp 0x3C, Mini Bottom Right
                                        ;
6435: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData16[], Friends and Bonus X Lights
;
6436: 64 43                             ; Pointer to next AttractModeLightShowData[]
6438: FA                                ; 0xFA start of lamp show data
                                        ;
6439: 2F                                ; Lamp 0x2F, Shorty
643A: 2E                                ; Lamp 0x2E, Bonus 2X
643B: 2D                                ; Lamp 0x2D, Willie
643C: 17                                ; Lamp 0x17, Bonus 4X
643D: 16                                ; Lamp 0x16, Sallah
643E: 1D                                ; Lamp 0x1D, Bonus 6X
643F: 36                                ; Lamp 0x36, Marion
6440: 37                                ; Lamp 0x37, Bonus 8X
6441: 38                                ; Lamp 0x38, Dr. Jones
                                        ;
6442: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData17[], Mode Lights, Movie: Raiders of the Lost Ark
;
6443: 64 4B                             ; Pointer to next AttractModeLightShowData[]
6445: FA                                ; 0xFA start of lamp show data
                                        ;
6446: 08                                ; Lamp 0x08, Get The Idol
6447: 0F                                ; Lamp 0x0F, Streets Of Cairo
6448: 1F                                ; Lamp 0x1F, Well Of Souls
6449: 1B                                ; Lamp 0x1B, Raven Bar
```

```
                                        ;
644A: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData18[], Mode Lights, Movie: Temple of Doom
;
644B: 64 53                             ; Pointer to next AttractModeLightShowData[]
644D: FA                                ; 0xFA start of lamp show data
                                        ;
644E: 14                                ; Lamp 0x14, Monkey Brains
644F: 0D                                ; Lamp 0x0D, Steal The Stones
6450: 19                                ; Lamp 0x19, Mine Cart
6451: 23                                ; Lamp 0x
                                        ;
6452: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData19[], Mode Lights, Movie: Last Crusade
;
6453: 64 5B                             ; Pointer to next AttractModeLightShowData[]
6455: FA                                ; 0xFA start of lamp show data
                                        ;
6456: 12                                ; Lamp 0x12, Castle Grunewald
6457: 09                                ; Lamp 0x09, Tank Chase
6458: 27                                ; Lamp 0x27, The 3 Challenges
6459: 21                                ; Lamp 0x21, Choose Wisely
                                        ;
645A: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData1A[], Misc Award Lights 2
;
645B: 64 6C                             ; Pointer to next AttractModeLightShowData[]
645D: FA                                ; 0xFA start of lamp show data
                                        ;
645E: 81 04 81                          ; AttractModeLightShowData04[], (Indy) Lights
6461: 81 07 81                          ; AttractModeLightShowData07[], (Adventure) Lights
6464: 20                                ; Lamp 0x20, Left Loop
6465: 28                                ; Lamp 0x38, Dr. Jones
```

```
6466: 30                                ; Lamp 0x30, Right Ramp Arrow
6567: 11                                ; Lamp 0x11, Left Ramp Arrow
6468: 3E                                ; Lamp 0x3E, Totem Top Arrow
6469: 3F                                ; Lamp 0x3F, Center Lock
646A: 01                                ; Lamp 0x01, Mode Start
                                        ;
646B: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData1B[], Wipe effect: Center-out
;
646C: 64 B0                             ; Pointer to next AttractModeLightShowData[]
646E: FA                                ; 0xFA start of lamp show data
                                        ;
646F: 0D                                ; Lamp 0x0D, Steal The Stones
6470: 19                                ; Lamp 0x19, Mine cart
6471: 10                                ; Lamp 0x10, Stones Jackpot
6472: 80                                ; <flush>
6473: 14                                ; Lamp 0x14, Monkey Brains
6474: 0E                                ; Lamp 0x0E, Grail Jackpot
6475: 23                                ; Lamp 0x23, Rope Bridge
6476: 0F                                ; Lamp 0x0F, Streets Of Cairo
6477: 1F                                ; Lamp 0x1F, Well Of Souls
6478: 80                                ; <flush>
6479: 1A                                ; Lamp 0x1A, Ark Jackpot
647A: 15                                ; Lamp 0x15, Left Plane Middle
647B: 14                                ; Lamp 0x14, Monkey Brains
647C: 13                                ; Lamp 0x13, Left Plane Top
647D: 09                                ; Lamp 0x09, Tank Chase
647E: 27                                ; Lamp 0x27, The 3 Challenges
647F: 22                                ; Lamp 0x22, Right Plane Top
6480: 1C                                ; Lamp 0x1C, Right Plane Middle
6481: 80                                ; <flush>
6482: 12                                ; Lamp 0x12, Castle Grunewald
6483: 08                                ; Lamp 0x08, Get The Idol
6484: 1B                                ; Lamp 0x1B, Raven Bar
6485: 21                                ; Lamp 0x21, Choose Wisely
6486: 80                                ; <flush>
6487: 18                                ; Lamp 0x18, Left Plane Bottom
6488: 17                                ; Lamp 0x17, Bonus 4X
6489: 16                                ; Lamp 0x16, Sallah
648A: 1D                                ; Lamp 0x1D, Bonus 6X
648B: 1E                                ; Lamp 0x1E, Right Plane Bottom
```

```
648C: 02                                ; Lamp 0x02, Hand Of Fate
648D: 11                                ; Lamp 0x11, Left Ramp Arrow
648E: 0C                                ; Lamp 0x0C, Adve(n)ture Light
648F: 0A                                ; Lamp 0x0A, Adven(t)ure Light
6490: 30                                ; Lamp 0x30, Right Ramp Arrow
6491: 80                                ; <flush>
6492: 2D                                ; Lamp 0x2D, Willie
6493: 36                                ; Lamp 0x36, Marion
6494: 28                                ; Lamp 0x28, Right Loop
6495: 20                                ; Lamp 0x20, Left Loop
6496: 01                                ; Lamp 0x01, Mode Start
6497: 0B                                ; Lamp 0x0B, Adv(e)nture
6498: 81 06 81                          ; AttractModeLightShowData06[], (Adv)enture Lights
649B: 81 05 81                          ; AttractModeLightShowData05[], Advent(ure) Lights
649E: 80                                ; <flush>
649F: 2E                                ; Lamp 0x2E, Bonus 2X
64A0: 37                                ; Lamp 0x37, Bonus 8X
64A1: 3F                                ; Lamp 0x3F, Center Lock
64A2: 3E                                ; Lamp 0x3E, Totem Top Arrow
64A3: 3B                                ; Lamp 0x3B, Mini Bottom Left
64A4: 3C                                ; Lamp 0x3C, Mini Bottom Right
64A5: 3A                                ; Lamp 0x3A, Mini Middle Bottom Right
64A6: 39                                ; Lamp 0x39, Mini MIddle Bottom Left
64A7: 80                                ; <flush>
64A8: 33                                ; Lamp 0x33, Mini Middle Top Left
64A9: 34                                ; Lamp 0x34, Mini MIddle Top Right
64AA: 31                                ; Lamp 0x31, Mini Top Left
64AB: 32                                ; Lamp 0x32, Mini Top Right
64AC: 81 04 81                          ; AttractModeLightShowData04[], (Indy) Lights
                                        ;
64AF: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-------------------------------------
                                        ;
;
; AttractModeLightShowData1C[], Wipe effect: Diag BL-TR
;
64B0: 64 F5                             ; Pointer to next AttractModeLightShowData[]
64B2: FA                                ; 0xFA start of lamp show data
                                        ;
64B3: 2F                                ; Lamp 0x2F, Shorty
64B4: 2E                                ; Lamp 0x2E, Bonus 2X
64B5: 2D                                ; Lamp 0x2D, Willie
64B6: 80                                ; <flush>
64B7: 38                                ; Lamp 0x38, Dr. Jones
```

```
64B8: 17                        ; Lamp 0x17, Bonus 4X
64B9: 37                        ; Lamp 0x37, Bonus 8X
64BA: 18                        ; Lamp 0x18, Left Plane Bottom
64BB: 1D                        ; Lamp 0x1D, Bonus 6X
64BC: 16                        ; Lamp 0x16, Sallah
64BD: 36                        ; Lamp 0x36, Marion
64BE: 08                        ; Lamp 0x08, Get The Idol
64BF: 06                        ; Lamp 0x06, (A)dventure Light
64C0: 80                        ; <flush>
64C1: 1E                        ; Lamp 0x1E, Right Plane Bottom
64C2: 1A                        ; Lamp 0x1A, Ark Jackpot
64C3: 0F                        ; Lamp 0x0F, Streets Of Cairo
64C4: 14                        ; Lamp 0x14, Monkey Brains
64C5: 15                        ; Lamp 0x15, Left Plane Middle
64C6: 05                        ; Lamp 0x05, A(d)venture Light
64C7: 04                        ; Lamp 0x04, Ad(v)enture Light
64C8: 80                        ; <flush>
64C9: 20                        ; Lamp 0x20, Left Loop
64CA: 12                        ; Lamp 0x12, Castle Grunewald
64CB: 13                        ; Lamp 0x13, Left Plane Top
64CC: 0D                        ; Lamp 0x0D, Steal The Stones
64CD: 1F                        ; Lamp 0x1F, Well Of Souls
64CE: 1B                        ; Lamp 0x1B, Raven Bar
64CF: 10                        ; Lamp 0x10, Stones Jackpot
64D0: 80                        ; <flush>
64D1: 1C                        ; Lamp 0x1C, Right Plane Middle
64D2: 26                        ; Lamp 0x26, Adventur(e) Light
64D3: 23                        ; Lamp 0x23, Rope Bridge
64D4: 19                        ; Lamp 0x19, Mine Cart
64D5: 0E                        ; Lamp 0x0E, Grail Jackpot
64D6: 02                        ; Lamp 0x02, Hand Of Fate
64D7: 09                        ; Lamp 0x09, Tank Chase
64D8: 80                        ; <flush>
64D9: 27                        ; Lamp 0x27, The 3 challenges
64DA: 21                        ; Lamp 0x21, Choose wisely
64DB: 22                        ; Lamp 0x22, Right Plane Top
64DC: 11                        ; Lamp 0x11, Left Ramp Arrow
64DD: 24                        ; Lamp 0x24, Advent(u)re Light
64DE: 25                        ; Lamp 0x25, Adventu(r)e Light
64DF: 01                        ; Lamp 0x01, Mode Start
64E0: 39                        ; Lamp 0x39, Mini Middle Bottom Left
64E1: 3B                        ; Lamp 0x3B, Mini Bottom Left
64E2: 3C                        ; Lamp 0x3C, Mini Bottom Right
64E3: 81 03 81                  ; AttractModeLightShowData03[], Adv(ent)ure Lights
64E6: 80                        ; <flush>
```

```
64E7: 33                                ; Lamp 0x33, Mini Middle Top Left
64E8: 34                                ; Lamp 0x34, Mini Middle Top Right
64E9: 31                                ; Lamp 0x31, Mini Top Left
64EA: 3A                                ; Lamp 0x3A, Mini Mmiddle Bottom Right
64EB: 3F                                ; Lamp 0x3F, Center Lock
64EC: 30                                ; Lamp 0x30, Right Ramp Arrow
64ED: 28                                ; Lamp 0x28, Right Loop
64EE: 80                                ; <flush>
64EF: 32                                ; Lamp 0x32, Mini Top Right
64F0: 3E                                ; Lamp 0x3E, Totem Top Arrow
64F1: 81 04 81                          ; AttractModeLightShowData04[], (Indy) Lights
                                        ;
64F4: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;-----------------------------------
                                        ;

;
; AttractModeLightShowData1D[], Wipe effect: BR-TL
;
64F5: 65 3B                             ; Pointer to next AttractModeLightShowData[] *** INVALID POINTER ***
64F7: FA                                ; 0xFA start of lamp show data
                                        ;
64F8: 38                                ; Lamp 0x38, Dr. Jones
64F9: 37                                ; Lamp 0x37, Bonus 8X
64FA: 36                                ; Lamp 0x36, Marion
64FB: 80                                ; <flush>
64FC: 1E                                ; Lamp 0x1E, Right Plane Bottom
64FD: 2F                                ; Lamp 0x2F, Shorty
64FE: 1D                                ; Lamp 0x1D, Bonus 6X
64FF: 1B                                ; Lamp 0x1B, Raven Bar
6500: 2E                                ; Lamp 0x2E, Bonus 2X
6501: 17                                ; Lamp 0x17, Bonus 4X
6502: 16                                ; Lamp 0x16, Sallah
6503: 2D                                ; Lamp 0x2D, Willie
6504: 26                                ; Lamp 0x26, Adventur(e) Light
6505: 80                                ; <flush>
6506: 18                                ; Lamp 0x18, Left Plane Bottom
6507: 1C                                ; Lamp 0x1C, Right Plane Middle
6508: 1A                                ; Lamp 0x1A, Ark Jackpot
6509: 1F                                ; Lamp 0x1F, Will Of Souls
650A: 23                                ; Lamp 0x23, Rope Bridge
650B: 24                                ; Lamp 0x24, Advent(u)re Light
650C: 25                                ; Lamp 0x25, Adventu(r)e Light
650D: 80                                ; <flush>
650E: 28                                ; Lamp 0x28, Right Loop
```

```
650F: 21                                ; Lamp 0x21, Choose Wisely
6510: 08                                ; Lamp 0x08, Get The Idol
6511: 0F                                ; Lamp 0x0F, Streets Of Cairo
6512: 19                                ; Lamp 0x19, Mine Cart
6513: 22                                ; Lamp 0x22, Right Plane Top
6514: 10                                ; Lamp 0x10, Stones Jackpot
6515: 80                                ; <flush>
6516: 14                                ; Lamp 0x14, Monkey Brains
6517: 0D                                ; Lamp 0x0D, Steal The Stones
6518: 27                                ; Lamp 0x27, The 3 Challenges
6519: 0E                                ; Lamp 0x0E, Grail Jackpot
651A: 15                                ; Lamp 0x15, Left Plane Middle
651B: 30                                ; Lamp 0x30, Right Ramp Arrow
651C: 06                                ; Lamp 0x06, (A)dventure Light
651D: 80                                ; <flush>
651E: 04                                ; Lamp 0x04, Ad(v)enture Light
651F: 05                                ; Lamp 0x05, A(d)venture Light
6520: 13                                ; Lamp 0x13, Left Plane Top
6521: 12                                ; Lamp 0x12, Castle Grunewald
6522: 09                                ; Lamp 0x09, Tank Chase
6523: 0A                                ; Lamp 0x0A, Adven(t)ure Light
6524: 80                                ; <flush>
6525: 20                                ; Lamp 0x20, Left Loop
6526: 01                                ; Lamp 0x01, Mode Start
6527: 02                                ; Lamp 0x02, Hand Of Fate
6528: 11                                ; Lamp 0x11, Left Ramp Arrow
6529: 3F                                ; Lamp 0x3F, Center Lock
652A: 0B                                ; Lamp 0x0B, Adv(e)nture Light
652B: 0C                                ; Lamp 0x0C, Adve(n)ture Light
652C: 80                                ; <flush>
652D: 3E                                ; Lamp 0x3E, Totem Top Arrow
652E: 3B                                ; Lamp 0x3B, Mini Bottom Left
652F: 3C                                ; Lamp 0x3C, Mini Bottom Right
6530: 3A                                ; Lamp 0x3A, Mini Middle Bottom Right
6531: 80                                ; <flush>
6532: 39                                ; Lamp 0x39, Mini Middle Bottom Left
6533: 33                                ; Lamp 0x33, Mini Middle Top Left
6534: 34                                ; Lamp 0x34, Mini Middle Top Right
6535: 31                                ; Lamp 0x31, Mini Top Left
6536: 32                                ; Lamp 0x32, Mini Top Right
6537: 81 04 81                          ; AttractModeLightShowData04[], (Indy) Lights
                                        ;
653A: FA                                ; 0xFA end of lamp show data
                                        ;
;---------------------------------------;------------------------------------------------------
```

Attract Mode Data, LightShowDataTable Entry

As you can see, each light table entry starts and ends with 0xFA. This is the start/end marker byte. It is also important to realize that the special marker bytes are at the beginning AND end of data bytes. This is because of the way some lamp modes start at the LAST byte and work to the FIRST byte. So by wrapping the special bytes around their data, it allows code to find the special byte when reading the table starting from the first or starting from the last byte.

Control Characters:

- 0xFA, start/end marker for entire light data table entry
- 0xF8, unknown, not present in IJ_L7 light data but recognized in the lamp handling code for something.
- 0x80, <flush> I inferred from the code, but didn't 100% confirm, 0x80 byte is used to flush out the data to the playfield lamps before the next lamp in the data table entry is processed. This can help achieve certain effects such as having a left/right wipe ensure an entire "line" of lights on the playfield illuminates before the next one.
- 0x81, Used to insert/wedge another LightShowDataTableEntry[] into the current table. This will be used in the format of 0x81 0xYY 0x81 (as mentioned, the control byte appears at beginning <and> and of its data). The 0xYY is the number of another table to include. This allows a single table entry to include lamps from other table entries.
- 0x85, Used to insert a range of lamps in numerically sequential order. Used in the format of 0x85 0xXX 0xYY 0x85. The 0xXX is the first lamp number and 0xYY is the last lamp number. This is only used in IJ_L7 for table entry "AttractModeLightShowData01[]" which is used to update all 64 lamps by specifying a range of 0x01 to 0x40. Again, the 0x85 appear on both sides so the lamps can be processed in reverse order.

As you can see, any lamp data byte with 0x80 bit set is considered a control character. The lamp matrix handling code will have problems if it encounters a byte with 0x80 bit set, however such byte isn't explicitly handled in the code. As I mentioned the 0xF8 byte is handled in the code in a special manner (but I haven't traced it through since IJ_L7 doesn't appear to use it for lamp data).

Also there is a special series of control characters with 0x8y high nibble '8' with low nibble specifying an index into a handler table. As indicated above 0x80 is used to lookup handler table index 0 which is "<flush>". 0x81 is used to look up index 1 which calls handler to insert another table. 0x85 is used to call handler which processes the range of lamps. In IJ_L7 there are additional 0x8y index callback handlers which don't appear to be used since there are no other 0x8y values used in the lamp data table entries. Next we'll see how to fine these handlers.

Attract Mode Data, LightShowDataTable Control Character 0x8y Handlers

Below is the table from IJ_L7 used to lookup a handler whenever lamp data contain a 0x8y control character. Since IJ_L7 only uses 0x80, 0x81, and 0x85, the other handlers haven't been annotated and I'm not certain what behavior they might perform. Other games might use these other control characters so it may be important to understand how these characters affect the processing of light show data bytes.

```
;--------------------------------------;-----------------------------------------
                                       ;
;
; LampDataByteLookupTable[]
;
; When processing lamp show data bytes, when a data byte has 0x80 bit set
; and it's not 0xFA or 0xF8, then the byte is used as an index into this table with 0x80
; bit stripped.
;
B0FF: 00 B1 3E                         ; LampDataByteLookupTable00(), 0x80, flush out lamp bits to the playfield.
B102: 02 B1 1D                         ; LampDataByteLookupTable01(), 0x81, Load lamp data from different LightShowData table
B105: 02 B1 29                         ; LampDataByteLookupTable02(), 0x82,
B108: 02 B1 3A                         ; LampDataByteLookupTable03(), 0x83,
B10B: 02 B1 68                         ; LampDataByteLookupTable04(), 0x84,
B10E: 03 B1 6D                         ; LampDataByteLookupTable05(), 0x85, Process range of lamps.
B111: 03 B1 CF                         ; LampDataByteLookupTable06(), 0x86,
B114: 04 B1 D8                         ; LampDataByteLookupTable07(), 0x87,
B117: 05 B1 E7                         ; LampDataByteLookupTable08(), 0x88,
B11A: 05 B1 96                         ; LampDataByteLookupTable09(), 0x89,
                                       ;
;--------------------------------------;-----------------------------------------
                                       ;
;
; LampDataByteLookupTable01(), 0x81, Load lamp data from different LightShowData table
;
; 2 Data bytes
;
B11D: A6 84       LDA   ,X             ; Get the lamp data byte following the 0x81 byte into A
B11F: BD B0 2C    JSR   $B02C          ; LoadAttractModeLightShowDataIndexA()
B122: BD B0 41    JSR   $B041          ; AdvanceLightShowDataPointerXPastHeader()
B125: BD AF 9B    JSR   $AF9B          ; ProcessAttractModeLightShowData()
B128: 39          RTS                  ;
                                       ;
;--------------------------------------;-----------------------------------------
```

```
                                        ;
;
; LampDataByteLookupTable02(), 0x82,
;
; 2 Data bytes
;
B129: A6 C8 10    LDA   $10,U
B12C: 85 04       BITA  #$04
B12E: 26 09       BNE   $B139
B130: 85 01       BITA  #$01
B132: 26 05       BNE   $B139
B134: A6 84       LDA   ,X
B136: BD AA 68    JSR   $AA68
B139: 39          RTS
                                        ;
;---------------------------------------;-----------------------------------------
                                        ;
;
; LampDataByteLookupTable03(), 0x83,
;
; 2 Data bytes
;
B13A: E6 84       LDB   ,X
B13C: 20 09       BRA   $B147
                                        ;
;---------------------------------------;-----------------------------------------
                                        ;
;
; LampDataByteLookupTable00(), 0x80, flush out lamp bits to the playfield.
;
; 0 Data bytes
;
;
B13E: E6 C8 10    LDB   $10,U           ; B gets U[10]
B141: C5 20       BITB  #$20            ; Check if 0x20 bit is set
B143: 26 22       BNE   $B167           ; If 0x20 bit IS set, branch to the end
                                        ; else, 0x20 bit is NOT set....
                                        ;
B145: E6 41       LDB   $0001,U         ; B gets U[1]
B147: A6 C8 10    LDA   $10,U           ; A gets U[10]
B14A: 85 04       BITA  #$04            ; Check if 0x04 bit is set
B14C: 26 19       BNE   $B167           ; if 0x04 bit IS set, branch to the end
                                        ; else, 0x04 bit is NOT set....
                                        ;
```

```
B14E: A6 49       LDA   $0009,U          ; A gets U[9]
B150: 81 FF       CMPA  #$FF             ; Is A 0xFF?
B152: 26 05       BNE   $B159            ; if (A == 0xFF)
B154: 1F 98       TFR   B,A              ;  A gets B
B156: 5F          CLRB                   ;  B gets 0x00
B157: 20 01       BRA   $B15A            ; else
B159: 3D          MUL                    ;  D = A * B
B15A: EB 42       ADDB  $0002,U          ;
B15C: E7 42       STB   $0002,U          ; U[2] += B
B15E: 89 00       ADCA  #$00             ;
B160: 27 05       BEQ   $B167            ;
B162: 97 62       STA   $62              ;
B164: BD 98 22    JSR   $9822            ; CycleUPointerforDMDUpdatesB
B167: 39          RTS                    ;
                                         ;
;--------------------------------------;-----------------------------------------
                                         ;
;
; LampDataByteLookupTable04(), 0x84,
;
; 2 Data bytes
;
B168: A6 84       LDA   ,X
B16A: A7 41       STA   $0001,U
B16C: 39          RTS
                                         ;
;--------------------------------------;-----------------------------------------
                                         ;
;
; LampDataByteLookupTable05(), 0x85, Process range of lamps.
;
; 3 Data bytes
;
; Lamp data has 0x85 0xXX 0xYY 0x85
;  0xXX is starting lamp index
;  0xYY is ending lamp index
;
;
B16D: EC 84       LDD   ,X               ; D gets first 2 data bytes following the 0x85 data byte
B16F: E1 84       CMPB  ,X               ; C-bit set if first data byte was == 0x00. (should never happen)
                                         ; C-bit clr if first data byte was != 0x00. (should always be the case)
B171: 24 04       BCC   $B177            ; Skip over error handler when first data byte after 0x85 isn't 0x00
B173: BD 82 BC    JSR   $82BC            ; ErrorHandler82BC(1B)
B176: 1B                                 ;
B177: 6D 45       TST   $0005,U          ; Look at U[5], wipe-on/wipe-off indicator.  (00==wipe-on)
```

```
B179: 26 0C       BNE   $B187           ;
                                        ;-------------------------------------------------------------------
                                        ; U[5] == 0x00, Process range of lamps, 1st byte up to 2nd byte
                                        ;-------------------------------------------------------------------
                                        ;
B17B: BD B0 00    JSR   $B000           ;--\ ProcessLampShowDataByteA()
B17E: 25 15       BCS   $B195           ;  | C-bit set? Skip to the end
B180: A1 01       CMPA  $0001,X         ;  | See if A has incremented to 2nd of the data bytes
B182: 24 11       BCC   $B195           ;  | If we processed every lamp number in the range, skip to the end.
B184: 4C          INCA                  ;  | Increment current lamp number
B185: 20 F4       BRA   $B17B           ;--/ Loop
                                        ;
                                        ;-------------------------------------------------------------------
                                        ; U[5] != 0x00, Process range of lamps, 2nd byte down to 1st byte
                                        ;-------------------------------------------------------------------
B187: 1F 98       TFR   B,A             ;
B189: BD B0 00    JSR   $B000           ;--\ ProcessLampShowDataByteA()
B18C: 25 07       BCS   $B195           ;  | C-bit set? Skip to the end
B18E: A1 84       CMPA  ,X              ;  |
B190: 23 03       BLS   $B195           ;  |
B192: 4A          DECA                  ;  |
B193: 20 F4       BRA   $B189           ;--/
B195: 39          RTS                   ;
                                        ;
;---------------------------------------;-----------------------------------------
                                        ;
;
; LampDataByteLookupTable09(), 0x89,
;
; 5 Data bytes
;
B196: EC 84       LDD   ,X
B198: E1 84       CMPB  ,X
B19A: 24 04       BCC   $B1A0
B19C: BD 82 BC    JSR   $82BC           ; ErrorHandler82BC(1B)
B19F: 1B
B1A0: 10 AE 02    LDY   $0002,X
B1A3: 6D 45       TST   $0005,U
B1A5: 26 0B       BNE   $B1B2
B1A7: 8D 17       BSR   $B1C0
B1A9: 25 14       BCS   $B1BF
B1AB: A1 01       CMPA  $0001,X
B1AD: 24 10       BCC   $B1BF
B1AF: 4C          INCA
B1B0: 20 F5       BRA   $B1A7
```

```
B1B2: 1F 98       TFR   B,A
B1B4: 8D 0A       BSR   $B1C0
B1B6: 25 07       BCS   $B1BF
B1B8: A1 84       CMPA  ,X
B1BA: 23 03       BLS   $B1BF
B1BC: 4A          DECA
B1BD: 20 F5       BRA   $B1B4
B1BF: 39          RTS
B1C0: 34 24       PSHS  Y,B
B1C2: A1 A4       CMPA  ,Y
B1C4: 27 07       BEQ   $B1CD
B1C6: E6 A0       LDB   ,Y+
B1C8: 26 F8       BNE   $B1C2
B1CA: BD B0 00    JSR   $B000           ; ProcessLampShowDataByteA()
B1CD: 35 A4       PULS  B,Y,PC ; (PUL? PC=RTS)
                                        ;
;---------------------------------------;-----------------------------------------
                                        ;
;
; LampDataByteLookupTable06(), 0x86,
;
; 3 Data bytes
;
B1CF: AE 84       LDX   ,X
B1D1: BD B0 41    JSR   $B041           ; AdvanceLightShowDataPointerXPastHeader()
B1D4: BD AF 9B    JSR   $AF9B           ; ProcessAttractModeLightShowData()
B1D7: 39          RTS
                                        ;
;---------------------------------------;-----------------------------------------
                                        ;
;
; LampDataByteLookupTable07(), 0x87,
;
; 4 Data bytes
;
B1D8: A6 C8 10    LDA   $10,U
B1DB: 85 04       BITA  #$04
B1DD: 26 07       BNE   $B1E6
B1DF: A6 4B       LDA   $000B,U
B1E1: E6 4A       LDB   $000A,U
B1E3: BD 90 09    JSR   $9009           ; CallPagedFunctionInXPointer()
B1E6: 39          RTS
                                        ;
;---------------------------------------;-----------------------------------------
                                        ;
```

```
;
; LampDataByteLookupTable08(), 0x88,
;
; 5 Data bytes
;
B1E7: A6 C8 10    LDA   $10,U
B1EA: 85 04       BITA  #$04
B1EC: 26 07       BNE   $B1F5
B1EE: E6 4A       LDB   $000A,U
B1F0: A6 03       LDA   $0003,X
B1F2: BD 90 09    JSR   $9009           ; CallPagedFunctionInXPointer()
B1F5: 39          RTS
                                        ;
;---------------------------------------;-----------------------------------------
```

Note, some of the comments have labeled functions with names including “DMD”. Those are old labels when I first went through the code several years ago I assumed those functions were specific to DMD code however since they are called from lamp processing this is not likely the case. Until I rename those functions throughout all the disassembly, I just leave the legacy naming convention.

Using the information in this document

If you want to observe the lamp matrix ram, first I'd find the ISR code in your ROM and see what the base RAM address is for your pin. In IJ_L7 the LampBank+00 is at $280 but it could be different for your pin. If you can match up the data pattern in your ROM and find the code that corresponds to IJ_L7:

```
DD39: 8E 02 80    LDX   #$0280          ; X gets 0x0280, starting RAM address of lamp matrix data
```

Then you will have your base address. Next you can then use pinmame with debug mode and hit the ` key to break execution and observe the memory window with your lamp matrix ram in place. You should be able to see how each block of 64-bits is used to update the lamps on your playfield. You can also experiment, for example, with setting your LampBank+30 to all 0xFFs. That should override the other banks, making all of your lamps turn off. Then you can manually set bits in LampBank+0x38 and see how they illuminate on the playfield (note it's possible other WPC code will kick in and overwrite your changes immediately upon resuming execution with 'esc' key).

You can also experiment with modifying the attract-mode code (shown earlier in this document) so it does the wipe patterns in different ordering. This statement assumes other ROMs have similar loops as IJ_L7 which seems likely. If you cannot find the attract mode code in your ROM, let me know and I'll take a look at your game to see if/how it's different from IJ_L7.

You can also experiment with modifying the LightData[] structs so they blink differently. You can even come up with your own wipe-mode patterns. If there's enough spare room at the end of your LightShowData bank, you can make the table point to your new entry at the end of the bank where you put in your own ordering of lamps.

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