

SternFA

Stern/Bally MPU based on FPGA

Software Version x.04

user manual

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Important remark

By using SternFA it is possible to damage your pinball machine. As this is a private project with NO commercial interest the author accepts no liability for any damage that may arise by using SternFA!

1. Introduction

SternFA use a (low cost) FPGA which emulates the hardware of a Stern MPU

SternFA is a 100% hobby project. This makes the solution cheap, depending on where you buy your components it is possible to create your Stern replacement MPU for less than 80€.

What do you need?

- Basic soldering skills (SMD components can be ordered pre-assembled I most shops)
- Possibility to read/write micro SD cards
- A PC with an USB port in order to be able to program the FPGA

2. Quickstart

1. Download latest versions of the SD card Image and the FPGA program from lisy.dev
2. Write the image to a SD card
3. Program the FPGA
 - a. 2.xx for Cyclone IV v3
 - b. 3.xx for Cyclone IV v4
 - c. 4.xx for Cyclone 10
4. Configure switch 'game select' according to your pinball (Appendix A)
5. Replace your original Stern MPU with SternFA
6. Switch the Game ON
7. Enjoy

Documentation on how to program your board for the first time can be found on my website.

3. Installation

SternFA boards have the same connectors and same mounting holes as the original Bally/Stern MPUs, so replacing of the board can be done in seconds.

4. Dip Switch Settings

4.1. DIP Switch S1: game select

Here you can select what game SternFA should run. This depends on the roms placed on the SD card. See Appendix A for a full list and Chapter 'SD card' for an explanation of the structure of the SD card content.

4.2. DIP Switch S2: options

Default setting is all 'OFF'

4.2.1. S2-Dip1 -> Zero Cross Emulator

Bally MPU need to have a 'Zero Cross' signal in order to work properly, this signal is coming from the 12Volt power supply. The existence of this signal is checked during boot. With dip 1 to 'ON' SternFA will emulate this signal, so for testing on the bench you only need 5 Volt supply. Note that timing is different with emulated zero cross!

4.2.2. S2-Dip2 -> Save nvram content to eeprom

SternFA does use an eeprom to save the nvram content (e.g. Highscores and extended settings). Each game has its own area on the eeprom. For bench testing dip2 can be set momentarily to ON, which results in SternFA saving the current nvram content to eeprom. During normal gameplay nvram content is saved automatically by test switch, game over realy and credit button.

4.2.3. S2-Dip3 -> force Bally game

With SternFA you can also run all games running on BallyFA by using the BallyFA rom SD image. Set this option to ON in this case (otherwise all games with a game number <32 will run with double CPU clock speed). **The Stern SD image provided do include Stern and Bally games, for this you do not need to activate this option.** See Appendix or pdf file provided for a list of game numbers.

4.2.4. S2-Dip4 -> anti Flicker for games with LEDs

With dip4 to 'ON' SternFA changes the timing of the Zero Cross signal. Bally games are known for 'flickering' LEDs; usually each LED needs a resistor in parallel to solve this. With this option LEDs will be 'flicker free' without the additional resistors.

4.2.5. S2-Dip5 -> not used

Not implemented yet.

4.2.6. S2-Dip6 -> init nvram

With dip6 to 'ON' SternFA during boot will initialize the nvram ram for the selected game to zero. This is useful if you want to reset ALL ram content.

5. boot sequence

5.1. phase 1: init

Immediately after switching on the pinball with SternFA inserted you will see the following output on the display of your pinball machine

Player 1: version of the FPGA program running

Player 2: value of selected game on S1 (with a leading '2' in case a game with MPU200 is selected)

Player 3: lisy.dev unique identifier for FPGA based MPUs

Player 4: show the value of the option DIP bank

Credit Display: counter, counts down from 5 ... 1

5.2. phase 2: SD card read

SternFA tries to read the SD card content, if this fails the red LED 'SD card error' will go ON. **The first digit of status display will then show the error reason.** '1' means CRC error with data read; '2' means that there is a general problem with the SD card (no data read)

5.3. phase 3: program execution

The code indicated by the Dip switch 'game select' is read from the SD card and executed. This starts the normal Bally boot sequence by blinking the green 'Bally' LED. If the code runs (regular interrupts are seen) the green 'ON' LED will go ON.

Appendix A 'game select'

| No | game select (v098) | | | | | | | | Game | Remark |
|----|--------------------|-----|-----|-----|-----|-----|-----|-----|--------------|------------------------|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | | |
| 0 | off | off | off | off | off | off | off | off | Meteor | Stern MPU-200 |
| 1 | on | off | Galaxy | Stern MPU-200 |
| 2 | off | on | off | off | off | off | off | off | Ali | Stern MPU-200 |
| 3 | on | on | off | off | off | off | off | off | Big Game | Stern MPU-200 |
| 4 | off | off | on | off | off | off | off | off | Seawitch | Stern MPU-200 |
| 5 | on | off | on | off | off | off | off | off | Cheetah | Stern MPU-200 |
| 6 | off | on | on | off | off | off | off | off | Quicksilver | Stern MPU-200 |
| 7 | on | on | on | off | off | off | off | off | Stargazer | Stern MPU-200 |
| 8 | off | off | off | on | off | off | off | off | Nine Ball | Stern MPU-200 |
| 9 | on | off | off | on | off | off | off | off | Iron Maiden | Stern MPU-200 |
| 10 | off | on | off | on | off | off | off | off | Viper | Stern MPU-200 |
| 11 | on | on | off | on | off | off | off | off | Dragonfist | Stern MPU-200 |
| 12 | off | off | on | on | off | off | off | off | Cue | Stern MPU-200 |
| 13 | on | off | on | on | off | off | off | off | Flight 2000 | Stern MPU-200 |
| 14 | off | on | on | on | off | off | off | off | Freefall | Stern MPU-200 |
| 15 | on | on | on | on | off | off | off | off | Lightning | Stern MPU-200 |
| 16 | off | off | off | off | on | off | off | off | Split Second | Stern MPU-200 |
| 17 | on | off | off | off | on | off | off | off | Catacomb | Stern MPU-200 |
| 18 | off | on | off | off | on | off | off | off | Orbitor 1 | Stern MPU-200 |
| 19 | on | on | off | off | on | off | off | off | Meteor | Stern MPU-200 Freeplay |
| 20 | off | off | on | off | on | off | off | off | Galaxy | Stern MPU-200 Freeplay |
| 21 | on | off | on | off | on | off | off | off | Ali | Stern MPU-200 Freeplay |
| 22 | off | on | on | off | on | off | off | off | Big Game | Stern MPU-200 Freeplay |
| 23 | on | on | on | off | on | off | off | off | Seawitch | Stern MPU-200 Freeplay |
| 24 | off | off | off | on | on | off | off | off | Cheetah | Stern MPU-200 Freeplay |
| 25 | on | off | off | on | on | off | off | off | Quicksilver | Stern MPU-200 Freeplay |
| 26 | off | on | off | on | on | off | off | off | Stargazer | Stern MPU-200 Freeplay |
| 27 | on | on | off | on | on | off | off | off | Nine Ball | Stern MPU-200 Freeplay |
| 28 | off | off | on | on | on | off | off | off | Iron Maiden | Stern MPU-200 Freeplay |
| 29 | on | off | on | on | on | off | off | off | Viper | Stern MPU-200 Freeplay |
| 30 | off | on | on | on | on | off | off | off | Dragonfist | Stern MPU-200 Freeplay |
| 31 | on | on | on | on | on | off | off | off | Cue | Stern MPU-200 Freeplay |
| 32 | off | off | off | off | off | on | off | off | Flight 2000 | Stern MPU-200 Freeplay |
| 33 | on | off | off | off | off | on | off | off | Freefall | Stern MPU-200 Freeplay |
| 34 | off | on | off | off | off | on | off | off | Lightning | Stern MPU-200 Freeplay |
| 35 | on | on | off | off | off | on | off | off | Split Second | Stern MPU-200 Freeplay |

| | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----------------|------------------------|
| 36 | off | off | on | off | off | on | off | off | Catacomb | Stern MPU-200 Freeplay |
| 37 | on | off | on | off | off | on | off | off | Orbitor 1 | Stern MPU-200 Freeplay |
| 38 | off | on | on | off | off | on | off | off | NOT USED | |
| 39 | on | on | on | off | off | on | off | off | NOT USED | |
| 40 | off | off | off | on | off | on | off | off | NOT USED | |
| 41 | on | off | off | on | off | on | off | off | NOT USED | |
| 42 | off | on | off | on | off | on | off | off | NOT USED | |
| 43 | on | on | off | on | off | on | off | off | NOT USED | |
| 44 | off | off | on | on | off | on | off | off | NOT USED | |
| 45 | on | off | on | on | off | on | off | off | NOT USED | |
| 46 | off | on | on | on | off | on | off | off | NOT USED | |
| 47 | on | on | on | on | off | on | off | off | NOT USED | |
| 48 | off | off | off | off | on | on | off | off | NOT USED | |
| 49 | on | off | off | off | on | on | off | off | NOT USED | |
| 50 | off | on | off | off | on | on | off | off | NOT USED | |
| 51 | on | on | off | off | on | on | off | off | NOT USED | |
| 52 | off | off | on | off | on | on | off | off | NOT USED | |
| 53 | on | off | on | off | on | on | off | off | NOT USED | |
| 54 | off | on | on | off | on | on | off | off | NOT USED | |
| 55 | on | on | on | off | on | on | off | off | NOT USED | |
| 56 | off | off | off | on | on | on | off | off | NOT USED | |
| 57 | on | off | off | on | on | on | off | off | NOT USED | |
| 58 | off | on | off | on | on | on | off | off | NOT USED | |
| 59 | on | on | off | on | on | on | off | off | NOT USED | |
| 60 | off | off | on | on | on | on | off | off | NOT USED | |
| 61 | on | off | on | on | on | on | off | off | NOT USED | |
| 62 | off | on | on | on | on | on | off | off | NOT USED | |
| 63 | on | on | on | on | on | on | off | off | NOT USED | |
| 64 | off | off | off | off | off | off | on | off | Pinball | Stern |
| 65 | on | off | off | off | off | off | on | off | Stingray | Stern |
| 66 | off | on | off | off | off | off | on | off | Stars | Stern |
| 67 | on | on | off | off | off | off | on | off | Memory Lane | Stern |
| 68 | off | off | on | off | off | off | on | off | Lectronamo | Stern |
| 69 | on | off | on | off | off | off | on | off | Wild Fyre | Stern |
| 70 | off | on | on | off | off | off | on | off | Nugent | Stern |
| 71 | on | on | on | off | off | off | on | off | Dracula | Stern |
| 72 | off | off | off | on | off | off | on | off | Trident | Stern |
| 73 | on | off | off | on | off | off | on | off | Hot Hand | Stern |
| 74 | off | on | off | on | off | off | on | off | Magic | Stern |
| 75 | on | on | off | on | off | off | on | off | Cosmic Princess | Stern |
| 76 | off | off | on | on | off | off | on | off | Pinball | Stern Freeplay |
| 77 | on | off | on | on | off | off | on | off | Stingray | Stern Freeplay |

| | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|----|-----|-----------------|----------------|
| 78 | off | on | on | on | off | off | on | off | Stars | Stern Freeplay |
| 79 | on | on | on | on | off | off | on | off | Memory Lane | Stern Freeplay |
| 80 | off | off | off | off | on | off | on | off | Lectronamo | Stern Freeplay |
| 81 | on | off | off | off | on | off | on | off | Wild Fyre | Stern Freeplay |
| 82 | off | on | off | off | on | off | on | off | Nugent | Stern Freeplay |
| 83 | on | on | off | off | on | off | on | off | Dracula | Stern Freeplay |
| 84 | off | off | on | off | on | off | on | off | Trident | Stern Freeplay |
| 85 | on | off | on | off | on | off | on | off | Hot Hand | Stern Freeplay |
| 86 | off | on | on | off | on | off | on | off | Magic | Stern Freeplay |
| 87 | on | on | on | off | on | off | on | off | Cosmic Princess | Stern Freeplay |
| 88 | off | off | off | on | on | off | on | off | NOT USED | |
| 89 | on | off | off | on | on | off | on | off | NOT USED | |
| 90 | off | on | off | on | on | off | on | off | NOT USED | |
| 91 | on | on | off | on | on | off | on | off | NOT USED | |
| 92 | off | off | on | on | on | off | on | off | NOT USED | |
| 93 | on | off | on | on | on | off | on | off | NOT USED | |
| 94 | off | on | on | on | on | off | on | off | NOT USED | |
| 95 | on | on | on | on | on | off | on | off | NOT USED | |
| 96 | off | off | off | off | off | on | on | off | FREEDOM | Bally |
| 97 | on | off | off | off | off | on | on | off | NIGHTRIDER | Bally |
| 98 | off | on | off | off | off | on | on | off | EVELKNIEVEL | Bally |
| 99 | on | on | off | off | off | on | on | off | EIGHTBALL | Bally |
| 100 | off | off | on | off | off | on | on | off | POWERPLAY | Bally |
| 101 | on | off | on | off | off | on | on | off | MATAHARI | Bally |
| 102 | off | on | on | off | off | on | on | off | BLACKJACK | Bally |
| 103 | on | on | on | off | off | on | on | off | STRIKES_SPARES | Bally |
| 104 | off | off | off | on | off | on | on | off | LOSTWORLD | Bally |
| 105 | on | off | off | on | off | on | on | off | 6MILLIONMAN | Bally |
| 106 | off | on | off | on | off | on | on | off | PLAYBOY | Bally |
| 107 | on | on | off | on | off | on | on | off | VOLTAN | Bally |
| 108 | off | off | on | on | off | on | on | off | SUPERSONIC | Bally |
| 109 | on | off | on | on | off | on | on | off | STARTREK | Bally |
| 110 | off | on | on | on | off | on | on | off | KISS | Bally |
| 111 | on | on | on | on | off | on | on | off | PARAGON | Bally |
| 112 | off | off | off | off | on | on | on | off | HARLEMGLOBE | Bally |
| 113 | on | off | off | off | on | on | on | off | DOLLYPARTON | Bally |
| 114 | off | on | off | off | on | on | on | off | FUTURESPA | Bally |
| 115 | on | on | off | off | on | on | on | off | NITROGROUND | Bally |
| 116 | off | off | on | off | on | on | on | off | SILVERBALLMANIA | Bally |
| 117 | on | off | on | off | on | on | on | off | SPACEINVADERS | Bally |
| 118 | off | on | on | off | on | on | on | off | ROLLINGSTONES | Bally |
| 119 | on | on | on | off | on | on | on | off | MYSTIC | Bally |

| | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------------|----------------|
| 120 | off | off | off | on | on | on | on | off | HOTDOGGIN | Bally |
| 121 | on | off | off | on | on | on | on | off | VIKING | Bally |
| 122 | off | on | off | on | on | on | on | off | SKATEBALL | Bally |
| 123 | on | on | off | on | on | on | on | off | FRONTIER | Bally |
| 124 | off | off | on | on | on | on | on | off | XENON | Bally |
| 125 | on | off | on | on | on | on | on | off | FLASHGORDON | Bally |
| 126 | off | on | on | on | on | on | on | off | 8BALLDELUXE | Bally |
| 127 | on | off | FIREBALLII | Bally |
| 128 | off | on | EMRYRON | Bally |
| 129 | on | off | off | off | off | off | off | on | FATHOM | Bally |
| 130 | off | on | off | off | off | off | off | on | MEDUSA | Bally |
| 131 | on | on | off | off | off | off | off | on | CENTAUR | Bally |
| 132 | off | off | on | off | off | off | off | on | ELEKTRA | Bally |
| 133 | on | off | on | off | off | off | off | on | VECTOR | Bally |
| 134 | off | on | on | off | off | off | off | on | MR_MRSPACMAN | Bally |
| 135 | on | on | on | off | off | off | off | on | SPECTRUM | Bally |
| 136 | off | off | off | on | off | off | off | on | SPEAKEASY | Bally |
| 137 | on | off | off | on | off | off | off | on | BMX | Bally |
| 138 | off | on | off | on | off | off | off | on | GRANDSLAM | Bally 2 player |
| 139 | on | on | off | on | off | off | off | on | GOLDBALL | Bally |
| 140 | off | off | on | on | off | off | off | on | XandOs | Bally |
| 141 | on | off | on | on | off | off | off | on | SPYHUNTER | Bally |
| 142 | off | on | on | on | off | off | off | on | KINGSOFSTEEL | Bally |
| 143 | on | on | on | on | off | off | off | on | BLACKPYRAMID | Bally |
| 144 | off | off | off | off | on | off | off | on | FIREBALCLASSIC | Bally |
| 145 | on | off | off | off | on | off | off | on | CYBERNAUT | Bally |
| 146 | off | on | off | off | on | off | off | on | NIGHTRIDER | Bally Freeplay |
| 147 | on | on | off | off | on | off | off | on | EVELKNIEVEL | Bally Freeplay |
| 148 | off | off | on | off | on | off | off | on | EIGHTBALL | Bally Freeplay |
| 149 | on | off | on | off | on | off | off | on | POWERPLAY | Bally Freeplay |
| 150 | off | on | on | off | on | off | off | on | MATAHARI | Bally Freeplay |
| 151 | on | on | on | off | on | off | off | on | BLACKJACK | Bally Freeplay |
| 152 | off | off | off | on | on | off | off | on | STRIKES_SPARES | Bally Freeplay |
| 153 | on | off | off | on | on | off | off | on | LOSTWORLD | Bally Freeplay |
| 154 | off | on | off | on | on | off | off | on | 6MILLIONMAN | Bally Freeplay |
| 155 | on | on | off | on | on | off | off | on | PLAYBOY | Bally Freeplay |
| 156 | off | off | on | on | on | off | off | on | VOLTAN | Bally Freeplay |
| 157 | on | off | on | on | on | off | off | on | SUPERSONIC | Bally Freeplay |
| 158 | off | on | on | on | on | off | off | on | STARTREK | Bally Freeplay |
| 159 | on | on | on | on | on | off | off | on | KISS | Bally Freeplay |
| 160 | off | off | off | off | off | on | off | on | PARAGON | Bally Freeplay |
| 161 | on | off | off | off | off | on | off | on | HARLEMGLOBE | Bally Freeplay |

| | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----------------|------------------|
| 162 | off | on | off | off | off | on | off | on | DOLLYPARTON | Bally Freeplay |
| 163 | on | on | off | off | off | on | off | on | FUTURESPA | Bally Freeplay |
| 164 | off | off | on | off | off | on | off | on | NITROGROUND | Bally Freeplay |
| 165 | on | off | on | off | off | on | off | on | SILVERBALLMANIA | Bally Freeplay |
| 166 | off | on | on | off | off | on | off | on | SPACEINVADERS | Bally Freeplay |
| 167 | on | on | on | off | off | on | off | on | ROLLINGSTONES | Bally Freeplay |
| 168 | off | off | off | on | off | on | off | on | MYSTIC | Bally Freeplay |
| 169 | on | off | off | on | off | on | off | on | HOTDOGGIN | Bally Freeplay |
| 170 | off | on | off | on | off | on | off | on | VIKING | Bally Freeplay |
| 171 | on | on | off | on | off | on | off | on | SKATEBALL | Bally Freeplay |
| 172 | off | off | on | on | off | on | off | on | FRONTIER | Bally Freeplay |
| 173 | on | off | on | on | off | on | off | on | XENON | Bally Freeplay |
| 174 | off | on | on | on | off | on | off | on | FLASHGORDON | Bally Freeplay |
| 175 | on | on | on | on | off | on | off | on | 8BALLDELUXE | Bally Freeplay |
| 176 | off | off | off | off | on | on | off | on | FIREBALLII | Bally Freeplay |
| 177 | on | off | off | off | on | on | off | on | EMRYRON | Bally Freeplay |
| 178 | off | on | off | off | on | on | off | on | FATHOM | Bally Freeplay |
| 179 | on | on | off | off | on | on | off | on | MEDUSA | Bally Freeplay |
| 180 | off | off | on | off | on | on | off | on | CENTAUR | Bally Freeplay |
| 181 | on | off | on | off | on | on | off | on | ELEKTRA | Bally Freeplay |
| 182 | off | on | on | off | on | on | off | on | VECTOR | Bally Freeplay |
| 183 | on | on | on | off | on | on | off | on | MR_MRSPACMAN | Bally Freeplay |
| 184 | off | off | off | on | on | on | off | on | SPECTRUM | Bally Freeplay |
| 185 | on | off | off | on | on | on | off | on | SPEAKEASY | Bally Freeplay |
| 186 | off | on | off | on | on | on | off | on | BMX | Bally Freeplay |
| 187 | on | on | off | on | on | on | off | on | GOLDBALL | Bally Freeplay |
| 188 | off | off | on | on | on | on | on | off | XandOs | Bally Freeplay |
| 189 | on | off | on | on | on | on | off | on | SPYHUNTER | Bally Freeplay |
| 190 | off | on | on | on | on | on | off | on | KINGSOFSTEEL | Bally Freeplay |
| 191 | on | on | on | on | on | on | off | on | BLACKPYRAMID | Bally Freeplay |
| 192 | off | on | FIREBALCLASSIC | Bally Freeplay |
| 193 | on | off | off | off | off | off | on | on | CYBERNAUT | Bally Freeplay |
| 194 | off | on | off | off | off | off | on | on | 6MILLIONMAN | Bally 7digit mod |
| 195 | on | on | off | off | off | off | on | on | PLAYBOY | Bally 7digit mod |
| 196 | off | off | on | off | off | off | on | on | VOLTAN | Bally 7digit mod |
| 197 | on | off | on | off | off | off | on | on | SUPERSONIC | Bally 7digit mod |
| 198 | off | on | on | off | off | off | on | on | STARTREK | Bally 7digit mod |
| 199 | on | on | on | off | off | off | on | on | KISS | Bally 7digit mod |
| 200 | off | off | off | on | off | off | on | on | PARAGON | Bally 7digit mod |
| 201 | on | off | off | on | off | off | on | on | HARLEMGLOBE | Bally 7digit mod |
| 202 | off | on | off | on | off | off | on | on | DOLLYPARTON | Bally 7digit mod |
| 203 | on | on | off | on | off | off | on | on | FUTURESPA | Bally 7digit mod |

| | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|----|----|-------------------|-------------------------|
| 204 | off | off | on | on | off | off | on | on | NITROGROUND | Bally 7digit mod |
| 205 | on | off | on | on | off | off | on | on | SILVERBALLMANIA | Bally 7digit mod |
| 206 | off | on | on | on | off | off | on | on | SPACEINVADERS | Bally 7digit mod |
| 207 | on | on | on | on | off | off | on | on | ROLLINGSTONES | Bally 7digit mod |
| 208 | off | off | off | off | on | off | on | on | MYSTIC | Bally 7digit mod |
| 209 | on | off | off | off | on | off | on | on | HOTDOGGIN | Bally 7digit mod |
| 210 | off | on | off | off | on | off | on | on | VIKING | Bally 7digit mod |
| 211 | on | on | off | off | on | off | on | on | 8BALLDELUXE | Special |
| 212 | off | off | on | off | on | off | on | on | EMBRYON | Special |
| 213 | on | off | on | off | on | off | on | on | VECTOR | Special |
| 214 | off | on | on | off | on | off | on | on | FATHOM | Special |
| 215 | on | on | on | off | on | off | on | on | NITROGROUND | Special w. Sirene Patch |
| 216 | off | off | off | on | on | off | on | on | Pinball | Stern |
| 217 | on | off | off | on | on | off | on | on | Stingray | Stern |
| 218 | off | on | off | on | on | off | on | on | Stars | Stern |
| 219 | on | on | off | on | on | off | on | on | Memory Lane | Stern |
| 220 | off | off | on | on | on | off | on | on | Pinball | Stern Freeplay |
| 221 | on | off | on | on | on | off | on | on | Stingray | Stern Freeplay |
| 222 | off | on | on | on | on | off | on | on | Stars | Stern Freeplay |
| 223 | on | on | on | on | on | off | on | on | Memory Lane | Stern Freeplay |
| 224 | off | off | off | off | off | on | on | on | Tigerrag | Bell Games |
| 225 | on | off | off | off | off | on | on | on | 8BALLDELUXE | V32 |
| 226 | off | on | off | off | off | on | on | on | SPEAKEASY 4Player | |
| 227 | on | on | off | off | off | on | on | on | SPEAKEASY 4Player | Freeplay |
| 228 | off | off | on | off | off | on | on | on | Saturn2 | Bell Games |
| 229 | on | off | on | off | off | on | on | on | Lectronamo | Stern |
| 230 | off | on | on | off | off | on | on | on | Lectronamo | Stern Freeplay |
| 231 | on | on | on | off | off | on | on | on | World Defender | Bell Games |
| 232 | off | off | off | on | off | on | on | on | World Defender | Bell Games Freeplay |
| 233 | on | off | off | on | off | on | on | on | Baby Pacman | |
| 234 | off | on | off | on | off | on | on | on | Baby Pacman | Okaegi version |
| 235 | on | on | off | on | off | on | on | on | GRANDSLAM | 4 player |
| 236 | off | off | on | on | off | on | on | on | GRANDSLAM | 2 player freeplay |
| 237 | on | off | on | on | off | on | on | on | GRANDSLAM | 4 player freeplay |