

SternFA

Stern/Bally MPU based on FPGA

Software Version x.01

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).

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 know 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

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

Player 4: version of image on inserted SD card (not implemented yet)

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. On success the current version of the SD card image is shown at display 4.

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 (v097)								Game	Remark
	S1	S2	S3	S4	S5	S6	S7	S8		
0	off	off	off	off	off	off	off	off	Pinball	Stern
1	on	off	off	off	off	off	off	off	Stingray	Stern
2	off	on	off	off	off	off	off	off	Stars	Stern
3	on	on	off	off	off	off	off	off	Memory Lane	Stern
4	off	off	on	off	off	off	off	off	Lectronamo	Stern
5	on	off	on	off	off	off	off	off	Wild Fyre	Stern
6	off	on	on	off	off	off	off	off	Nugent	Stern
7	on	on	on	off	off	off	off	off	Dracula	Stern
8	off	off	off	on	off	off	off	off	Trident	Stern
9	on	off	off	on	off	off	off	off	Hot Hand	Stern
10	off	on	off	on	off	off	off	off	Magic	Stern
11	on	on	off	on	off	off	off	off	Cosmic Princess	Stern
12	off	off	on	on	off	off	off	off	Pinball	Stern Freeplay
13	on	off	on	on	off	off	off	off	Stingray	Stern Freeplay
14	off	on	on	on	off	off	off	off	Stars	Stern Freeplay
15	on	on	on	on	off	off	off	off	Memory Lane	Stern Freeplay
16	off	off	off	off	on	off	off	off	Lectronamo	Stern Freeplay
17	on	off	off	off	on	off	off	off	Wild Fyre	Stern Freeplay
18	off	on	off	off	on	off	off	off	Nugent	Stern Freeplay
19	on	on	off	off	on	off	off	off	Dracula	Stern Freeplay
20	off	off	on	off	on	off	off	off	Trident	Stern Freeplay
21	on	off	on	off	on	off	off	off	Hot Hand	Stern Freeplay
22	off	on	on	off	on	off	off	off	Magic	Stern Freeplay
23	on	on	on	off	on	off	off	off	Cosmic Princess	Stern Freeplay
24	off	off	off	on	on	off	off	off	NOT USED	
25	on	off	off	on	on	off	off	off	NOT USED	
26	off	on	off	on	on	off	off	off	NOT USED	
27	on	on	off	on	on	off	off	off	NOT USED	
28	off	off	on	on	on	off	off	off	NOT USED	
29	on	off	on	on	on	off	off	off	NOT USED	
30	off	on	on	on	on	off	off	off	NOT USED	
31	on	on	on	on	on	off	off	off	NOT USED	
32	off	off	off	off	off	on	off	off	Meteor	Stern MPU-200
33	on	off	off	off	off	on	off	off	Galaxy	Stern MPU-200
34	off	on	off	off	off	on	off	off	Ali	Stern MPU-200
35	on	on	off	off	off	on	off	off	Big Game	Stern MPU-200

36	off	off	on	off	off	on	off	off	Seawitch	Stern MPU-200
37	on	off	on	off	off	on	off	off	Cheetah	Stern MPU-200
38	off	on	on	off	off	on	off	off	Quicksilver	Stern MPU-200
39	on	on	on	off	off	on	off	off	Stargazer	Stern MPU-200
40	off	off	off	on	off	on	off	off	Nine Ball	Stern MPU-200
41	on	off	off	on	off	on	off	off	Iron Maiden	Stern MPU-200
42	off	on	off	on	off	on	off	off	Viper	Stern MPU-200
43	on	on	off	on	off	on	off	off	Dragonfist	Stern MPU-200
44	off	off	on	on	off	on	off	off	Cue	Stern MPU-200
45	on	off	on	on	off	on	off	off	Flight 2000	Stern MPU-200
46	off	on	on	on	off	on	off	off	Freefall	Stern MPU-200
47	on	on	on	on	off	on	off	off	Lightning	Stern MPU-200
48	off	off	off	off	on	on	off	off	Split Second	Stern MPU-200
49	on	off	off	off	on	on	off	off	Catacomb	Stern MPU-200
50	off	on	off	off	on	on	off	off	Orbitor 1	Stern MPU-200
51	on	on	off	off	on	on	off	off	Meteor	Stern MPU-200 Freeplay
52	off	off	on	off	on	on	off	off	Galaxy	Stern MPU-200 Freeplay
53	on	off	on	off	on	on	off	off	Ali	Stern MPU-200 Freeplay
54	off	on	on	off	on	on	off	off	Big Game	Stern MPU-200 Freeplay
55	on	on	on	off	on	on	off	off	Seawitch	Stern MPU-200 Freeplay
56	off	off	off	on	on	on	off	off	Cheetah	Stern MPU-200 Freeplay
57	on	off	off	on	on	on	off	off	Quicksilver	Stern MPU-200 Freeplay
58	off	on	off	on	on	on	off	off	Stargazer	Stern MPU-200 Freeplay
59	on	on	off	on	on	on	off	off	Nine Ball	Stern MPU-200 Freeplay
60	off	off	on	on	on	on	off	off	Iron Maiden	Stern MPU-200 Freeplay
61	on	off	on	on	on	on	off	off	Viper	Stern MPU-200 Freeplay
62	off	on	on	on	on	on	off	off	Dragonfist	Stern MPU-200 Freeplay
63	on	on	on	on	on	on	off	off	Cue	Stern MPU-200 Freeplay
64	off	off	off	off	off	off	on	off	Flight 2000	Stern MPU-200 Freeplay
65	on	off	off	off	off	off	on	off	Freefall	Stern MPU-200 Freeplay
66	off	on	off	off	off	off	on	off	Lightning	Stern MPU-200 Freeplay
67	on	on	off	off	off	off	on	off	Split Second	Stern MPU-200 Freeplay
68	off	off	on	off	off	off	on	off	Catacomb	Stern MPU-200 Freeplay
69	on	off	on	off	off	off	on	off	Orbitor 1	Stern MPU-200 Freeplay