GottFA1

Gottlieb System1 MPU based on FPGA

Software Version 0.98

user manual

ralf@lisy.dev

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Important remark

By using GottFA1 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 GottFA1!

1. Introduction

- GottFA1 is a 100% hobby project. This makes the solution cheap, depending on where you buy your components it is possible to create your Gottlieb replacement MPU for less than 50€.

What do you need?

- Basic soldering skills
- Possibility to read/write micro SD cards
- A PC with an USB port in order to be able to program the FPGA
- Gottlieb rom images (not included due to Copyright limitation)

2. Soldering

On my website I do provide all information that you can order your preassembled board at JLCPCB. You only need to add some ICs (no soldering, just place them in the sockets) and to solder the headers to your Cyclone II FPGA board.

Note: You need to solder an additional 2-pin connection on the FPGA and a 2-Pin socket on the PCB. With this connection GottFA will supply 5 Volt to the FPGA, no additional power supply needed!
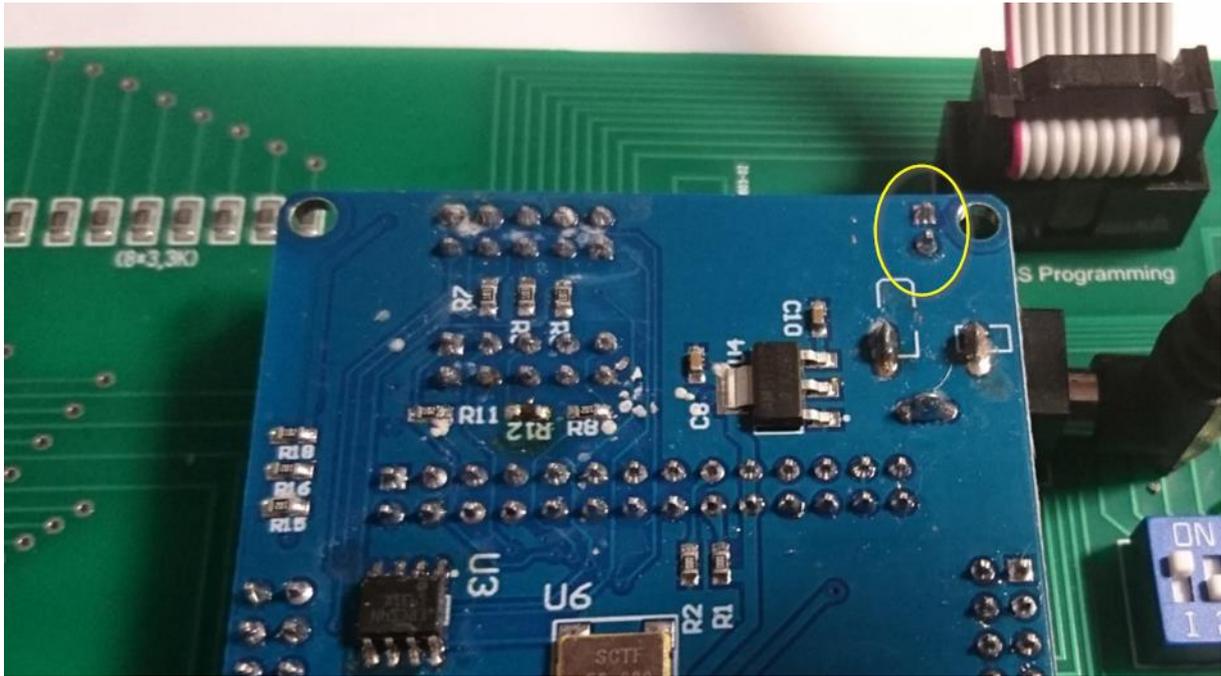
Do solder the 2-pin connector here

3. 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. Add Gottlieb roms
4. Program the FPGA
5. Configure switch 'game select' according to your pinball
6. Replace your original System1 MPU with GottFA1
7. Init the GottFA1 internal nvram for your game
8. Switch the Game ON
9. Enjoy

4. Put the GottFA1 Image to the SD card

On my website you will find the latest version of GottFA1 an (zipped) image file. After unpacking the image can be put on a SD card. I do recommend using Win32DiskImager for doing that.

This article uses content from the eLinux wiki page RPi_Easy_SD_Card_Setup, which is shared under the Creative Commons Attribution-ShareAlike 3.0 Unported license

4.1.Win32DiskImager

- Insert the SD card into your SD card reader. You can use the SD card slot if you have one, or an SD adapter in a USB port. Note the drive letter assigned to the SD card. You can see the drive letter in the left hand column of Windows Explorer, for example **E:**
- Download the Win32DiskImager utility from the Sourceforge Project page as an installer file, and run it to install the software.
- Run the `Win32DiskImager` utility from your desktop or menu.
- Select the LISY image file you extracted earlier.
- In the device box, select the drive letter of the SD card. Be careful to select the correct drive: if you choose the wrong drive you could destroy the data on your computer's hard disk! If you are using an SD card slot in your computer, and can't see the drive in the Win32DiskImager window, try using an external SD adapter.
- Click 'Write' and wait for the write to complete.
- Exit the imager and eject the SD card.

5. Installation

GottFA1 boards have the same connectors and same mounting holes as the original Gottlieb System1 MPUs, so replacing of the board can be done in seconds.

6. Dip Switch Settings

6.1. S1 game select

Here you can select what game GottFA1 should run. This depends on the roms placed on the SD card. See chapter 9 for an explanation of the structure of the SD card content and Appendix A for a possible arrangement on your SD card

6.2. S2 options

6.2.1. S2-Dip1 -> Init nvram

With dip1 to ‚ON' GottFa will initialize the nvram ram during boot for the selected game to zero. This is useful if you want to reset ALL ram content. (recommended for the first start of the game)

6.2.2. S2-Dip2 -> Freeplay

With dip2 to ‚ON' GottFa will enable 'Freeplay'. By 'press and hold' the credit button for more than two seconds a coin insert for the left coin chute is simulated.

6.2.3. S2-Dip3 -> LED displays

With dip2 to ‚ON' the timing for refreshing the displays is optimized for LEDs. With the timing for the original 'tube' displays the LED displays shows sometimes flickering, where with the 'LED' timing the 'tubes' show 'ghosting.

6.2.4. S2-Dip4 -> Slam

With dip4 to ‚ON' GottFa will disable the Gottlieb Slam detection. (recommended)

6.3. Gottlieb DIP Banks

Here you have the same settings as with an original MPU. Consult the Manual for your pinball to see how they do affect the game behavior. For a 'smooth start' I recommend the following settings:

S1...S8: all OFF

S9…S16: all ON

S17…S24: DIP19&24 OFF, all other ON

7. boot sequence

7.1. phase 1: init (not implemented yet!)

Immediately after switching on the pinball with GottFA1 inserted you will see the following output on the display of your pinball machine

Player 1: 'GottFA'

Player 2…4: welcome message

Status Display: 'S1' and current setting (decimal) of S1

7.2. phase 2: SD card read

Player 1: 'GottFA'

Player 2: version of the FPGA program running

Player 3: 'readSD'

Player 4: nothing or 'Error'

Status Display: 'S1' and current setting (decimal) of S1

GottFA1 tries to read the SD card content, if this fails the red LED 'SD card errror' will go ON and display 4 will show 'Error'.

7.3. phase 3: program execution

The code indicated by the Dip switch 'game select' is red from the SD card and executed. If the code runs (regular interrupts are seen) the 'active' LED will go ON.

8. programming the FPGA

To program the FPGA you need the Quartus Programmer.

8.1. programmer software

It can be downloaded from the Intel Website for free. You just need to create a user account.

https://fpgasoftware.intel.com/13.0sp1/?edition=web

Go to Additional Software and Download **Quartus II Programmer and SignalTap II**

Note: Intel has discontinued support for Cyclone II by end of 2021 and will eventually remove version 13.0sp1 from the download section (the used FPGA for BallyFA is quite old ,and therefor cheap.) I have tested latest version (v21.4) which worked also, but I recommend to use 13.0sp1 if available.

8.2. install the driver for your USB Blaster

When connecting your USB Blaster the first time it will not be recognized correctly by Windows.

You also need to install the driver for your USB Blaster. The driver comes together with the installation of the programmer and is located in the 'driver' subdirectory.

- o Right click on the entry in the device manager and choose 'update driver' (Treiber aktualisieren)
- o Choose 'search for driver on this PC' (auf dem Computer nach Treibersoftware suchen)
- o For a default installation select 'C:\altera\13.0sp1\qprogrammer\drivers
- o Confirm installation
- o Now the Altera USB Blaster should be visible und 'USB-Controller'
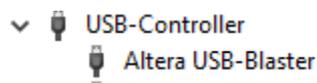
8.3. program your FPGA

1) Connect the USB Blaster to the PC

2) Start the programmer, make sure in the Hardware setup ‚USB-Blaster' is visible and set the Mode to ‚Activeserial Programming'
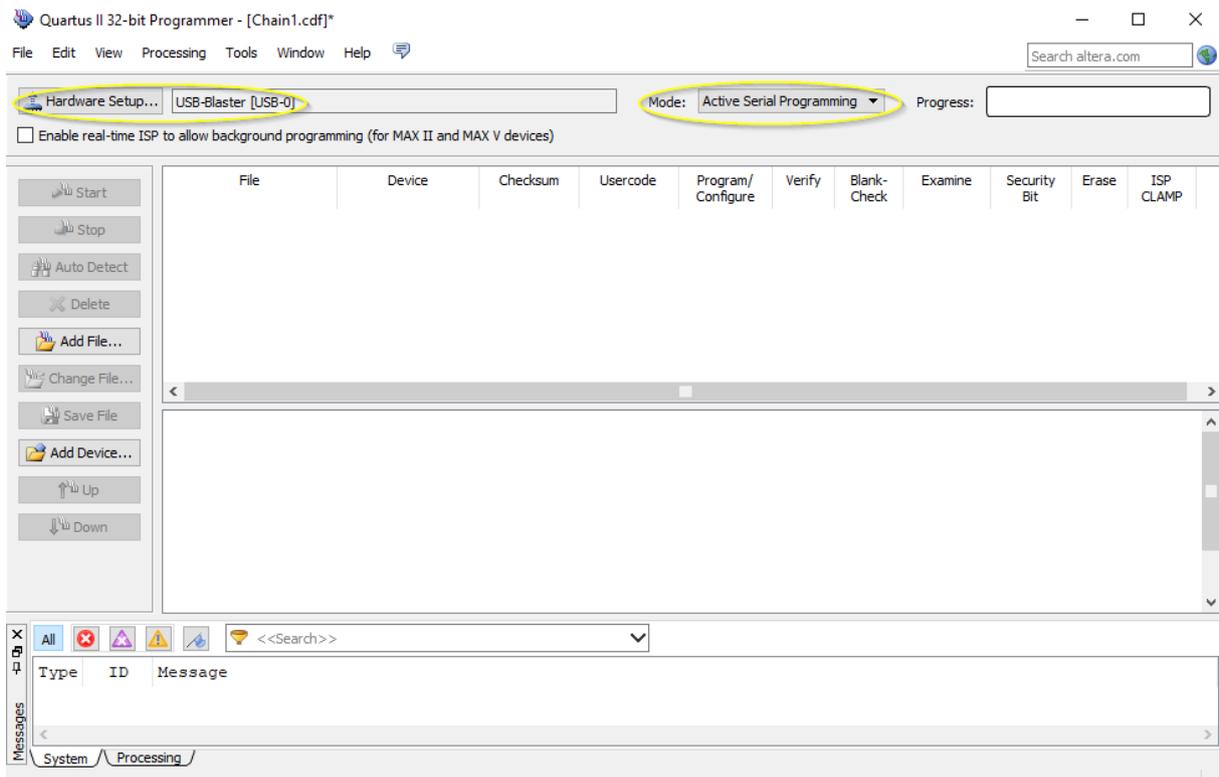
3) Select ‚Add File' and choose the right ‚pof' file for your game
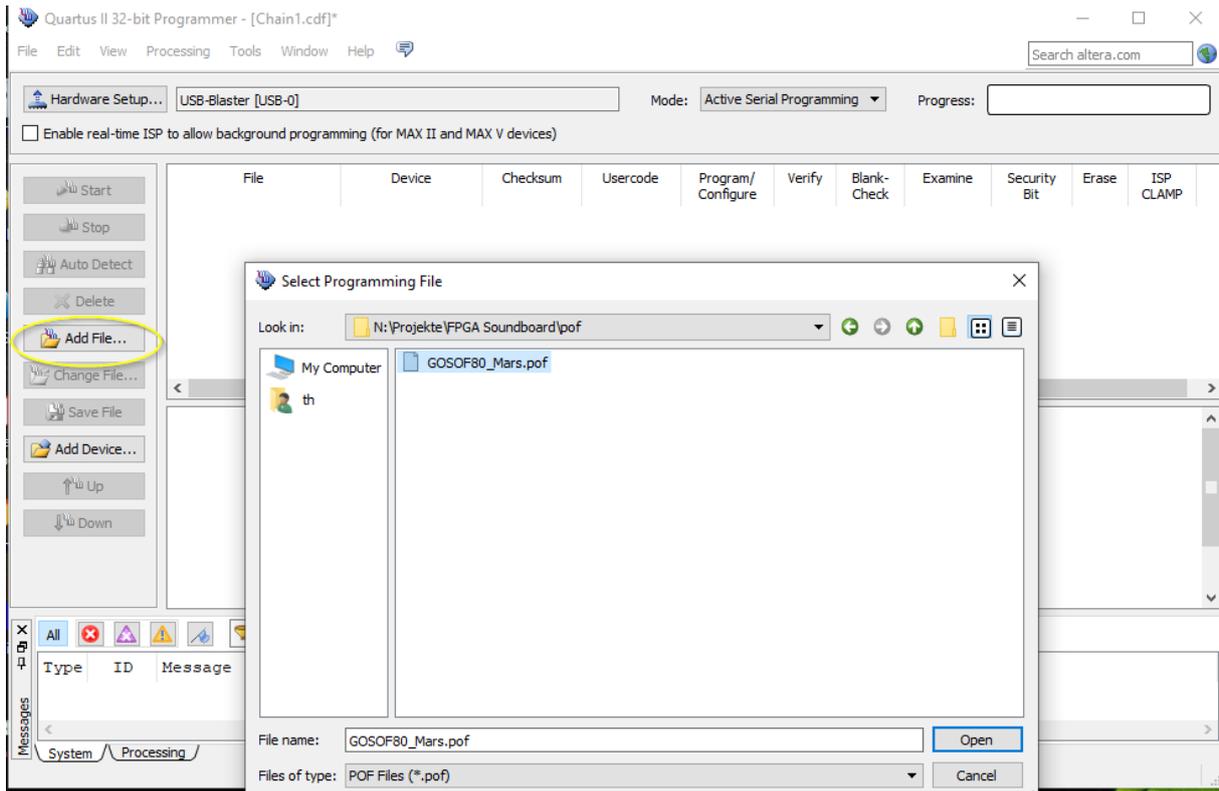
4) Power the FPGA with 5 Volt (middle pin ‚+‘, outer pin ‚-,) and connect the USB Blaster to the ‚AS programming‘ connector on the GottFA PCB
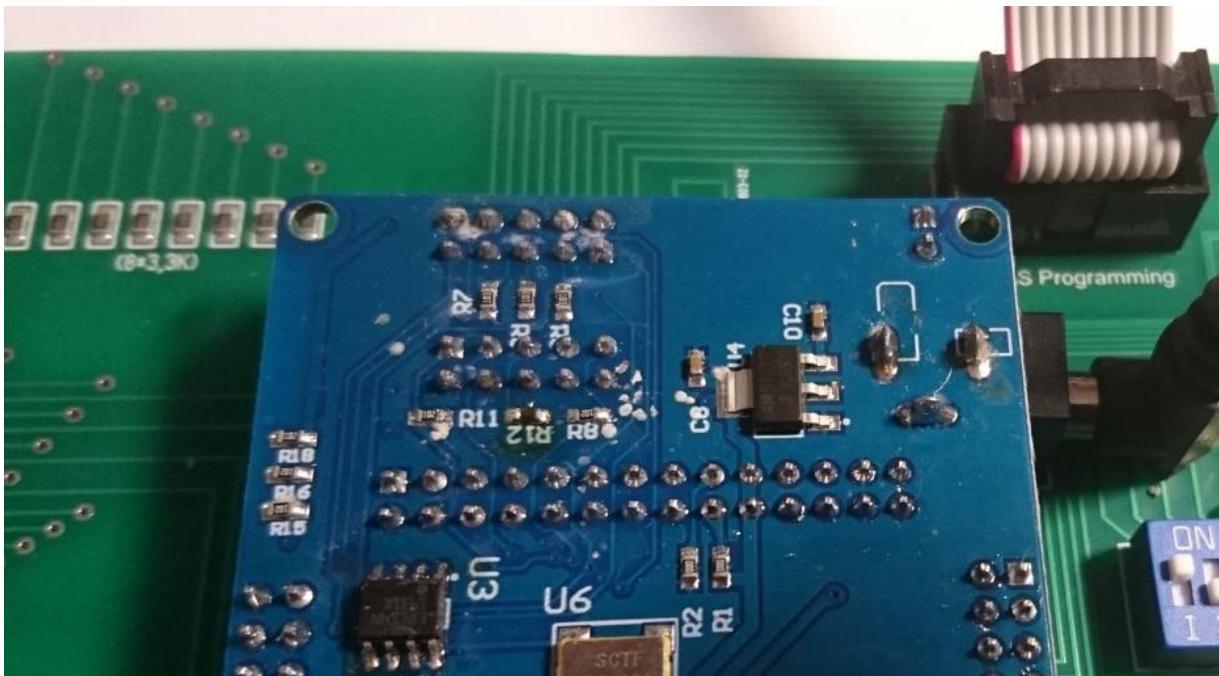
5) Select ‚Program/Configure‘ and ‚ Verify‘
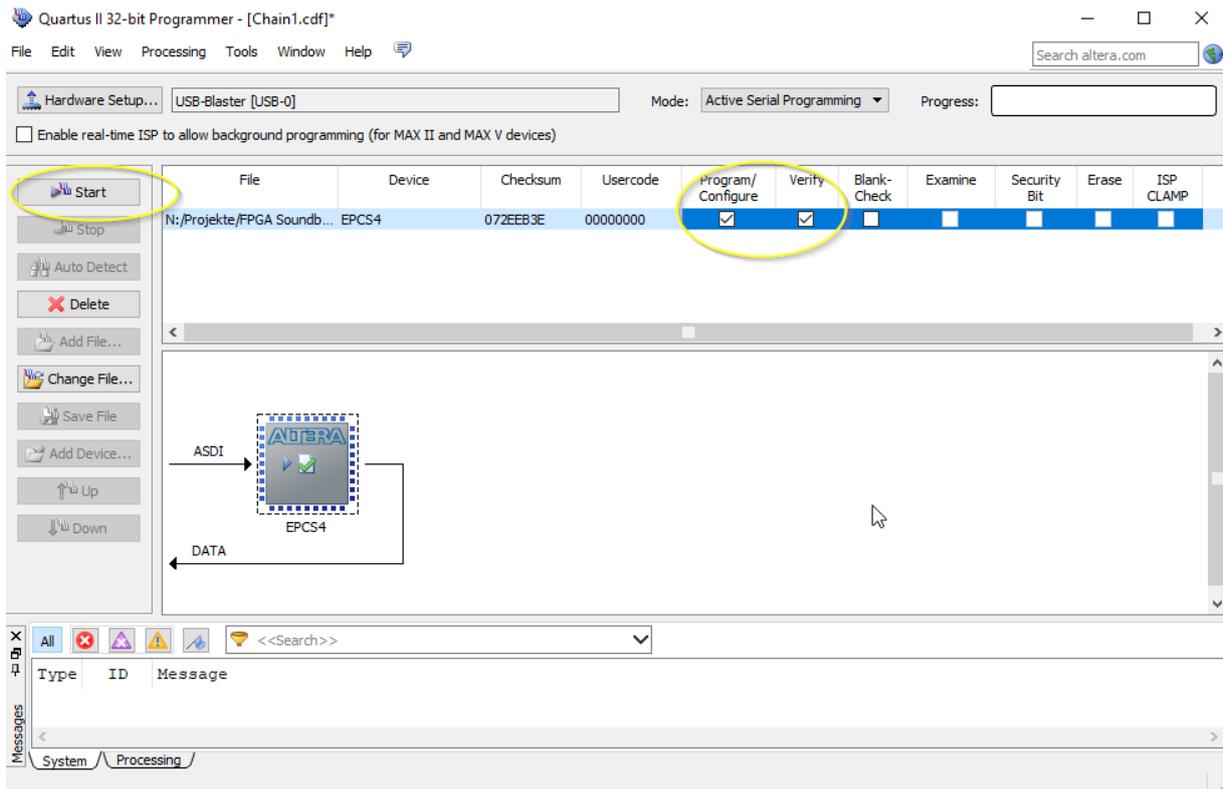
6) Push start, wait for progress 100%
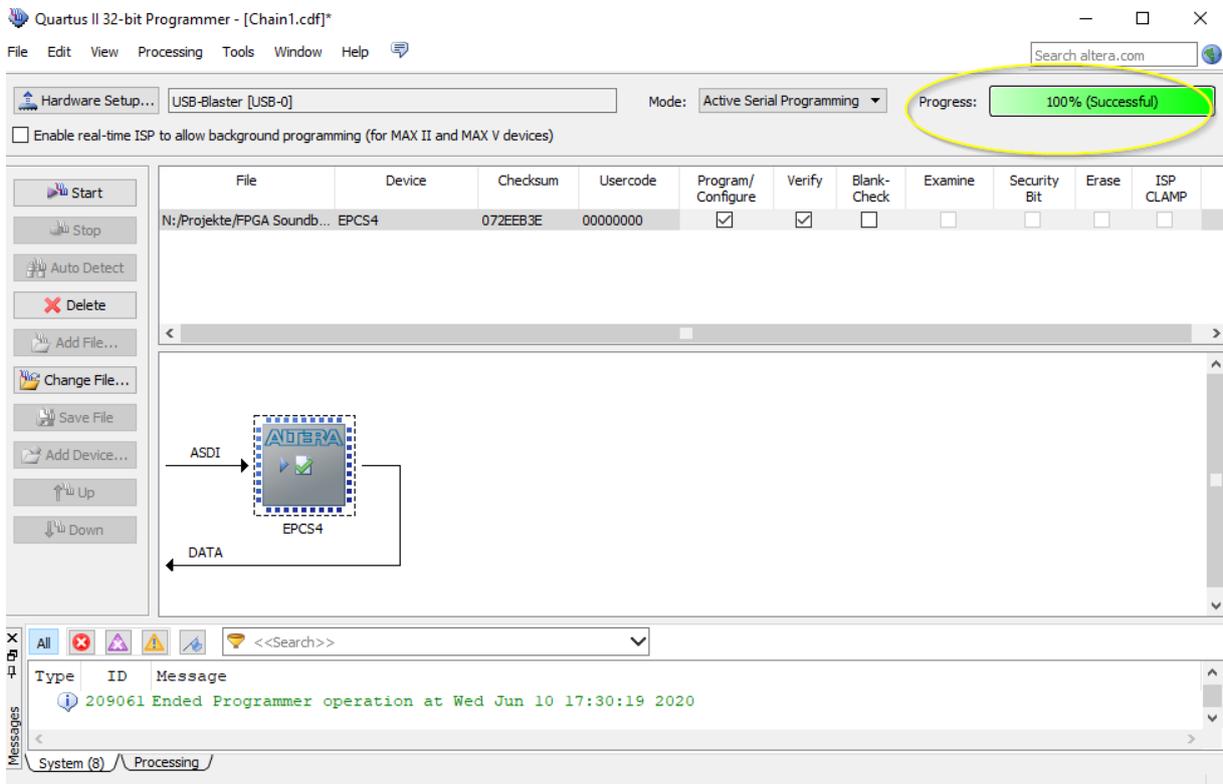
Thats it!

9. structure of SD card

Due to limitations of the SD card read routine in the FPGA (it does read fix sector numbers instead of looking for filenames) it is necessary to use my SD-card image (128 Mbyte). You can write the image to a SD-card of your choice, any size equal or bigger than 128 Mbyte will work.

Note: 'Sandisk' SD cards can not be used with GottFA!

9.1. rom file structure for GottFA1

Each GottFA1 rom file has a size of 16Kbyte and must have the 'u5_cf system rom' within the first Kbyte and the 'u4_ce system rom' in the second Kbyte. Followed by the game specific rom and a 11 Kbyte 'Gap' as for each game GottFA read a 16Kbyte block from the SD card, so you need to fill the gaps depending on the game you are using.

9.2. game selection

The first image you copy on the SD card will be selected with setting game select to '0' (all OFF) the second with '1' (all OFF except Dip1) and so on ...

As the FPGA just reads fix sector numbers the filename is not relevant, you can choose whatever filename you want. It just needs to be placed at the right position on the SD card afterwards. You can 'select' the position of the rom-image on the SD card with the order of your file copy.

9.3. Example Charlies Angels

For Charlies Angels you need (as for all other system1 games) the two system roms 'u5cf.bin'; 'u4_ce.bin' and the game specific rom '425.cpu' in this case. To create a rom file for GottFa (Charlies.img) you can use the following command on a windows system:

copy /b u5_cf.bin + u4_ce.bin + 425.cpu + 4K + 7K Charlies.img

The files '4k' and '7k' do not contain any data and just exist to fill the gap to the next image. They can be downloaded from my software repository on lisy.dev.

To add attract mode commands you need the converted 'bin' file (see next chapter). The command for creating the rom with attract included for Charlies.img is

copy /b u5_cf.bin + u4_ce.bin + 425.cpu + 7K + 005_attract.bin Charlies.img

10. GottFA1 Attract Mode for System1

With GottFa1 SW version 0.98 or higher GottFA1 supports Attract Mode for System1. **Attract mode for GottFA1 is activated/deactivated with Gottlieb DIP switch #24.**

The attract mode actions can be self-defined in a csv configuration file which has to be converted and the result '.bin' file to be integrated in the rom on the Sd card (details see example in last chapter).

I have created a basic set of configuration files which can be downloaded from my repository server. Links can be found on my website www.lisy.dev

10.1. syntax for configuration file

During attract mode the csv file will be scanned and the commands in there will be executed. If the scan reaches the end of the configuration file it will start at the beginning again. The syntax for GottFA1 is compatible to the LISY1 syntax, with the limitation that only the commands 'lamp' and 'time' are supported.

10.1.1. time <wait time> <s | ms >

Wait 'wait time' in seconds or milliseconds before executing the next command. Only integer values are supported!

10.1.2. lamp <lamp number> <on | off >

Switch the lamp 'lamp number' (1..36) to ON or OFF

10.2. converter tool 'attractcsv2bin.exe'

You find the tool on my repository server (windows executable). It converts a csv file with attract mode commands to a bin file (fix size 4Kbyte) which can be integrated into the rom on the SD card.

Example converting 005_attract.csv to 005_attract.bin:

attractcsv2bin 005_attract

opening input file: 005_attract.csv

creating output file: 005_attract.bin

csv contained 34 commands

22 lamp commands written

12 time commands written

wrote 121 of possible 4096 bytes

Appendix A example ‚Gamelist‘

No	Dip Switch S1				Short Name	Long Name
	S1	S2	S3	S4		
0	off	off	off	off	cleoptra	Cleopatra
1	on	off	off	off	sinbad	Sinbad
2	off	on	off	off	jokrpokr	Joker Poker
3	on	on	off	off	dragon	Dragon
4	off	off	on	off	closeenc	Close Encounters of the Third Kind
5	on	off	on	off	charlies	Charlie's Angels
6	off	on	on	off	solaride	Solar Ride
7	on	on	on	off	countdwn	Count-Down
8	off	off	off	on	pinpool	Pinball Pool
9	on	off	off	on	totem	Totem
10	off	on	off	on	hulk	The Incredible Hulk
11	on	on	off	on	genie	Genie
12	off	off	on	on	buckrgrs	Buck Rogers
13	on	off	on	on	torch	Torch
14	off	on	on	on	roldisco	Roller Disco
15	on	on	on	on	astannie	Asteroid Annie and the Aliens