

**GottFA80\_PLuS**

**Gottlieb System80 MPU based on FPGA**

**Software Version 0.98**

**user manual**

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## **Important remark**

By using GottFA80\_PLuS 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 GottFA80\_PLuS!

## **1. Introduction**

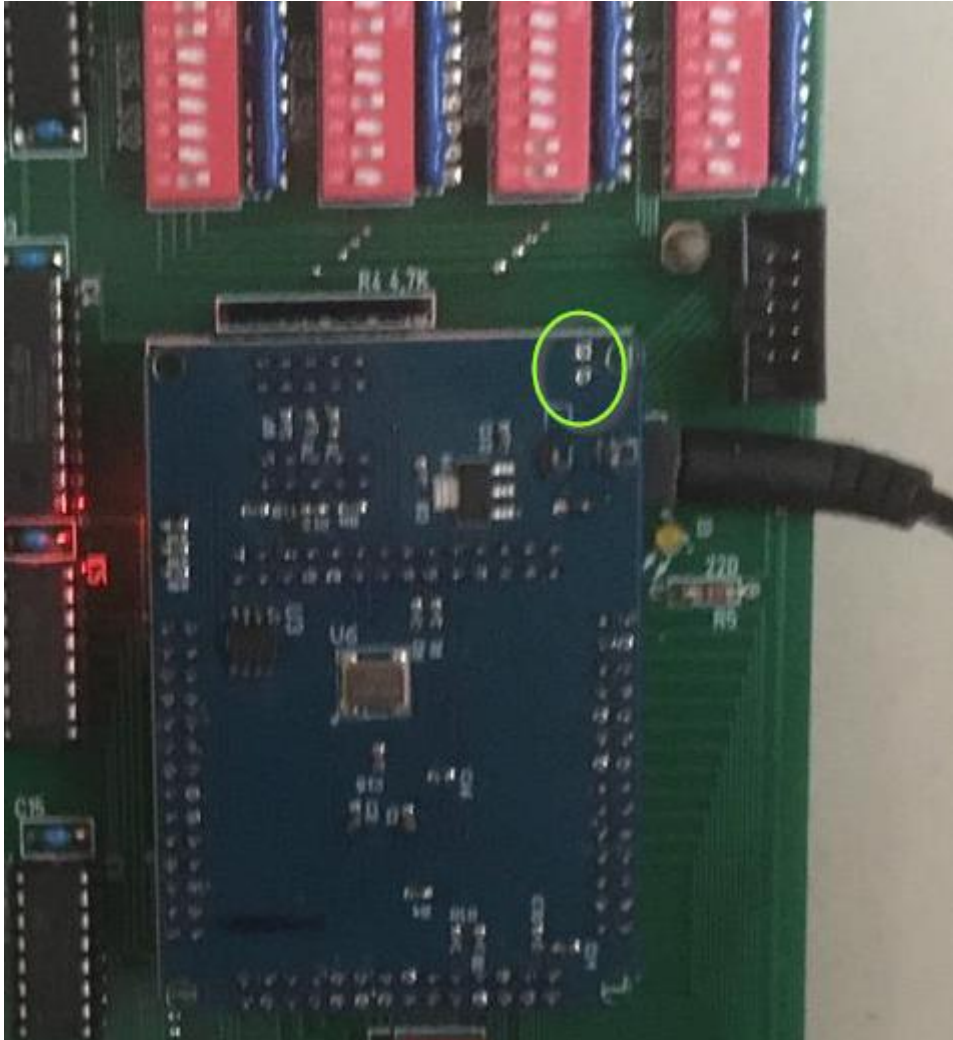
- GottFA80\_PLuS is a 100% hobby project. This makes the solution cheap, depending on where you buy your components it is possible to create your Gottlieb replacement MPU for less than 50€.

### **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

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 (missing on the picture)

### 3. Quickstart

1. Download latest versions of the SD card Image and the FPGA program from [lisy.dev](http://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. Please refer to "Appendix A example Gamelist" at the end of this document.
6. For **Gottlieb 80 and 80A**, replace your original System **80/80A** MPU, Driver board, and Power supply with GottFA80\_PLuS.

For **Gottlieb 80B**, replace your original System **80B** MPU, Driver board with GottFA80\_Plus.

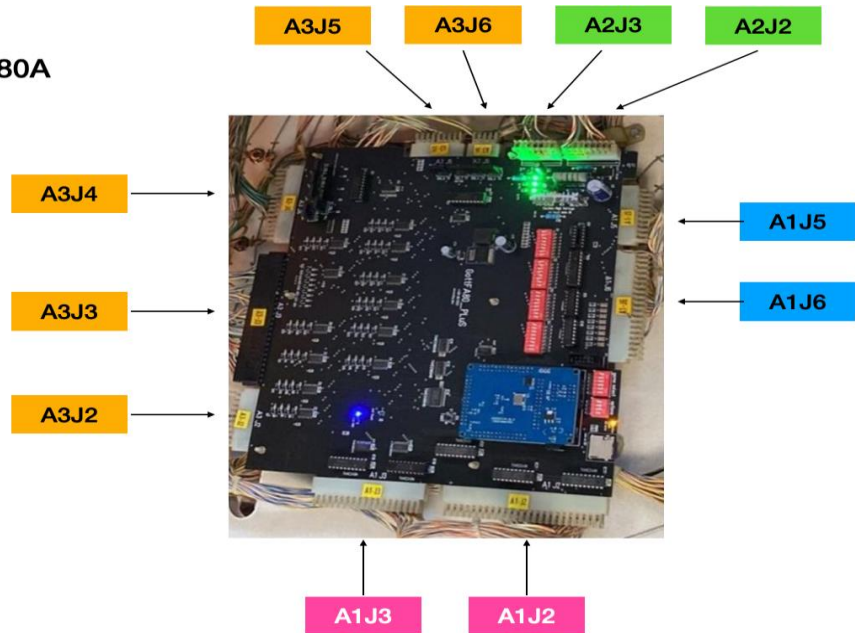
See "Board wiring" section below.

7. Switch the Game ON
8. Enjoy

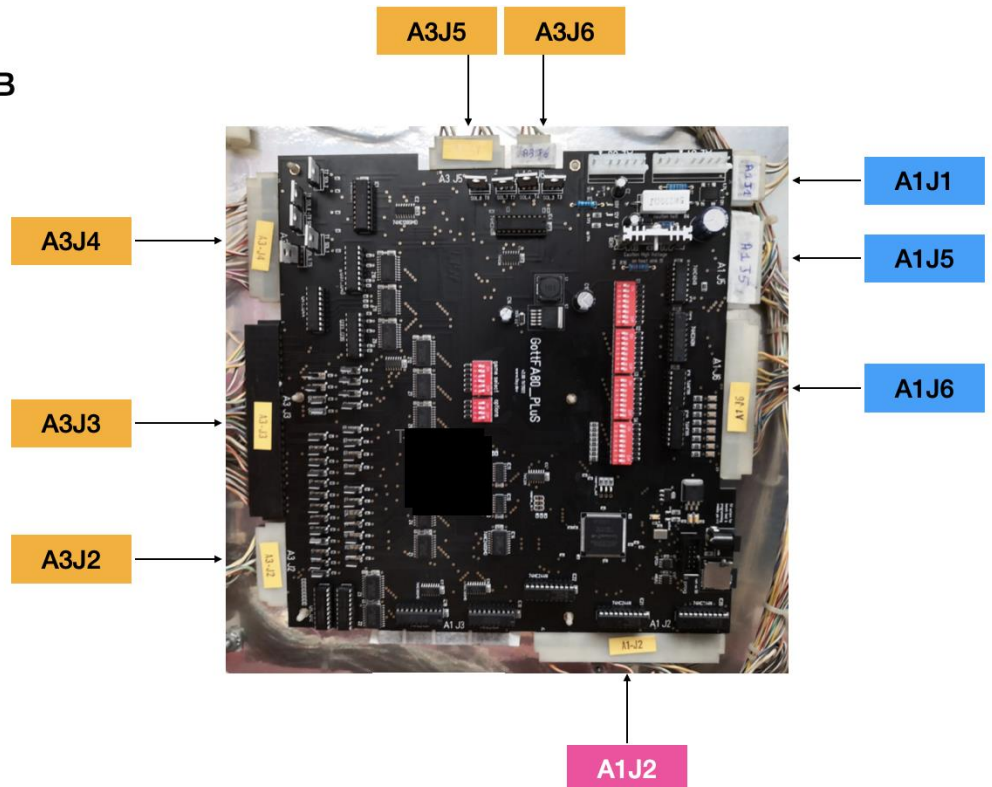
## 4. Board wiring

GottFA80 comes with the same connectors as the original Gottlieb CPU, so replacing is straight forward. Note that for System80B A1J3 will be left unconnected.

Gottlieb System 80 & 80A



Gottlieb System 80B



## 5. Put the GottFA80 Image to the SD card

On my website you will find the latest version of GottFA80 as a (zipped) image file. After unpacking the image can be put on a SD card. I do recommend using Win32DiskImager for doing that.

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*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](#)*

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### 5.1. 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.

## 6. Installation

GottFA80 boards have the same connectors and same mounting holes as the original Gottlieb System80 MPUs, so replacing of the board can be done in seconds.

## 7. Dip Switch Settings

### 7.1. S1 Dips 1...6 : game select

Here you can select what game GottFA80 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.

### 7.2. S2

#### 7.2.1. S2-Dip1 -> Freeplay

With set 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.

#### 7.2.2. S2-Dip2 -> init nvram

With set 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)

#### 7.2.3. S2-Dip3 -> slam contact open

With set to ,ON' the slam will be simulated as 'open' (needed for late 80B games)

#### 7.2.4. S2-Dip4 -> slam contact closed

Most System80 games need the Slam contact to be closed and will not boot in case the slam contact is open. With set to ,ON' the slam will be simulated as 'closed' independent of the real status.



## 8. boot sequence

### 8.1. phase 1: init (not implemented yet!)

Immediately after switching on the pinball with GottFA80 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)

### 8.2. phase 2: SD card read

GottFA80 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.

### 8.3. phase 3: program execution

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

## 9. programming the FPGA

To program the FPGA you need the Quartus Programmer.

### 9.1. programmer software

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

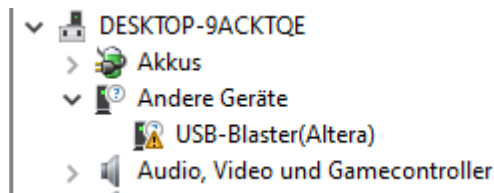
<https://fpgasoftware.intel.com/13.0sp1/?edition=web>

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.

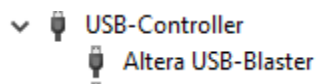
### 9.2. install the driver for your USB Blaster

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.

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

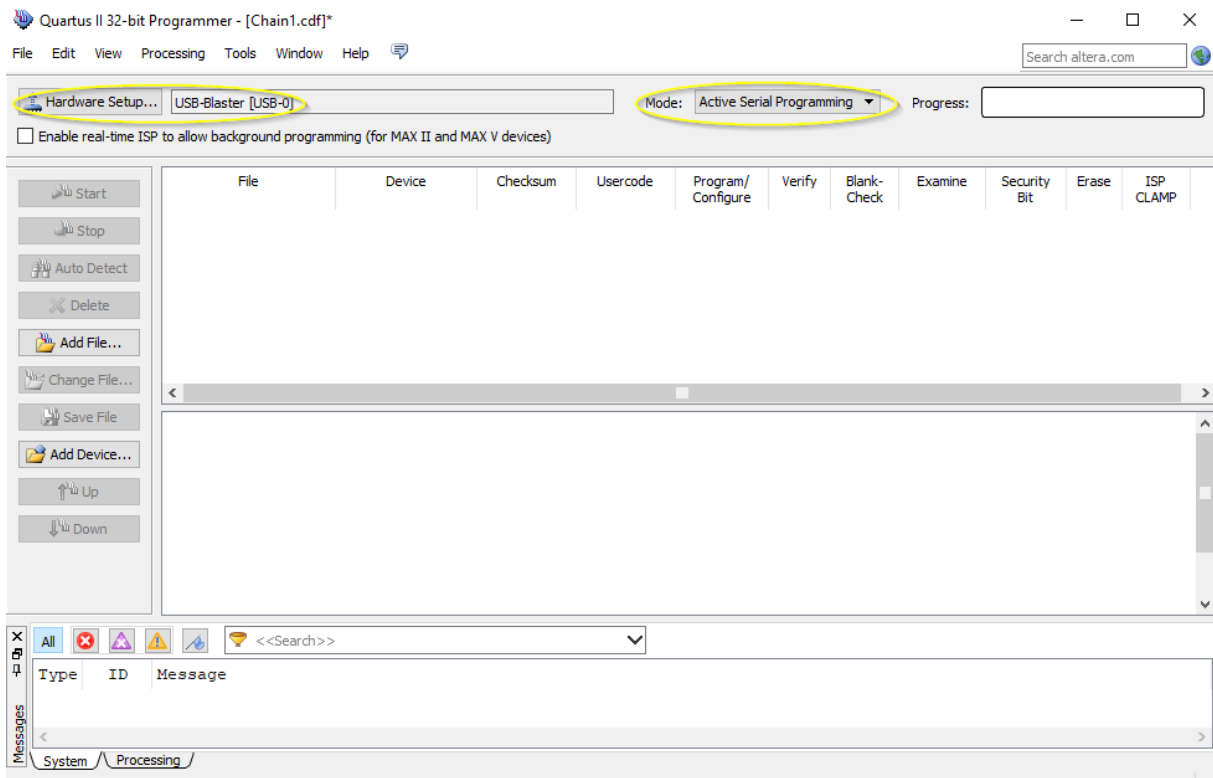


### 9.3. program your FPGA

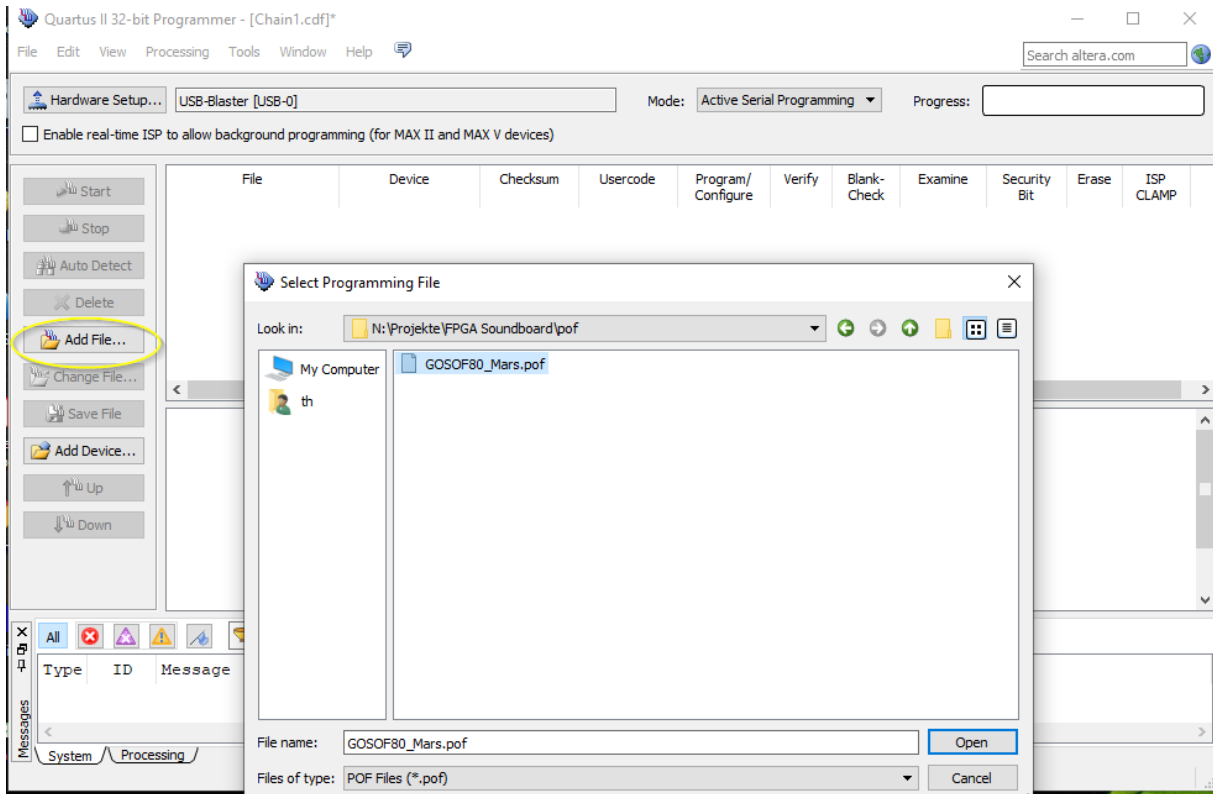
- 1) Connect the USB Blaster to the PC



- 2) Start the programmer, make sure in the Hardware setup ,USB-Blaster' is visible and set the Mode to ,Activeserial Programming'



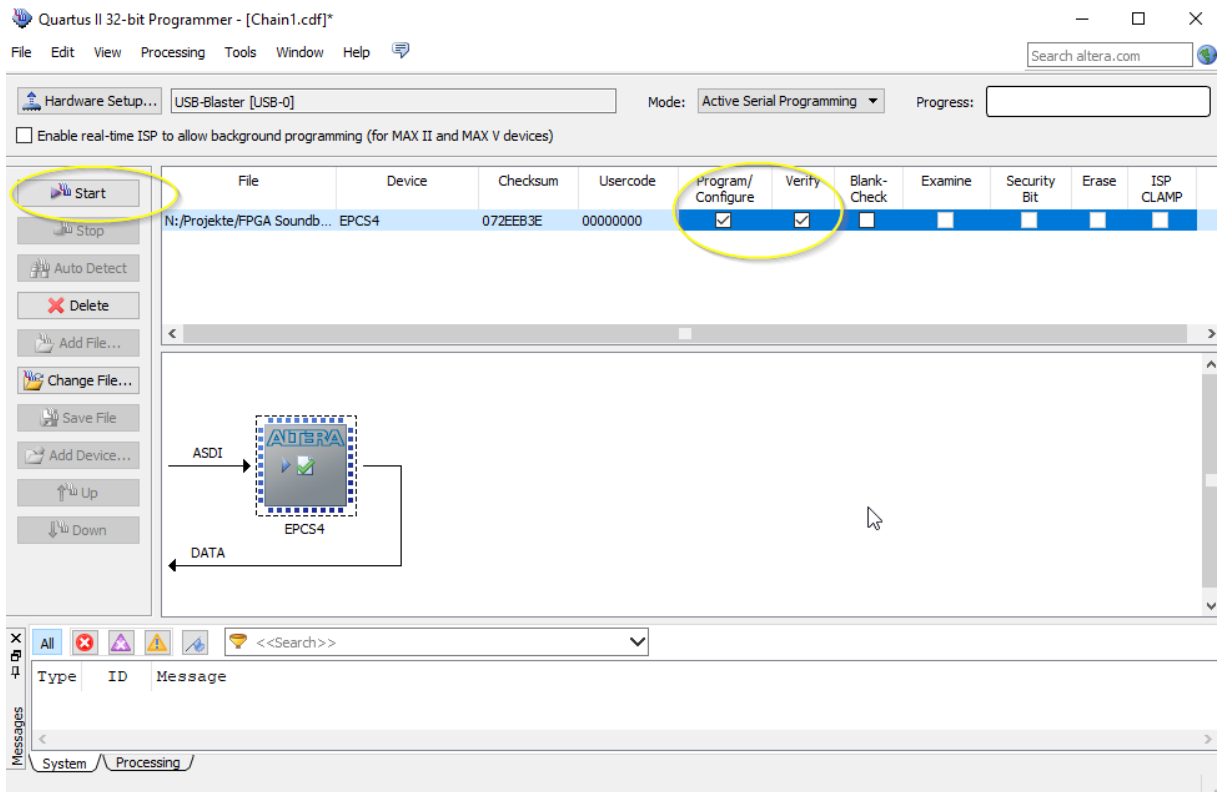
- 3) Select ,Add File' and choose the right ,pof' file for your game



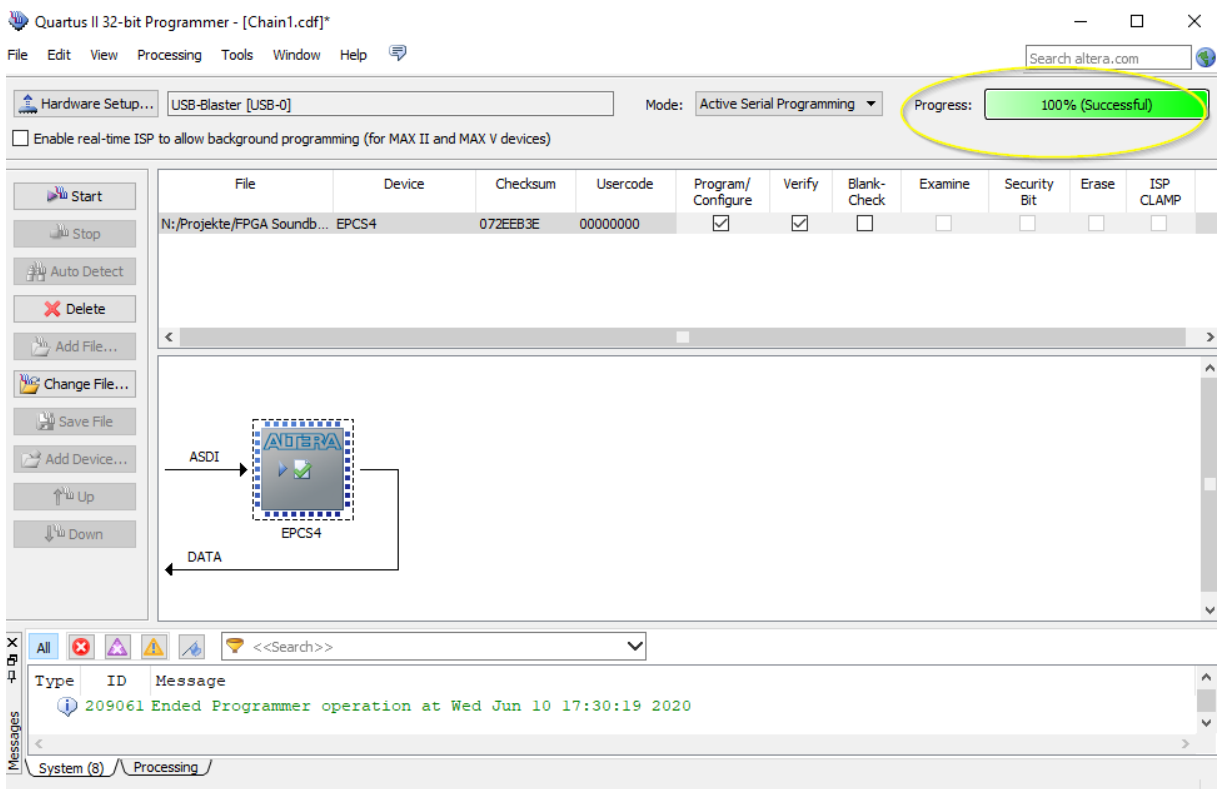
- 4) Power the FPGA with 5 Volt ( middle pin ,+‘, outer pin ,-‘) and connect the USB Blaster to the ,AS programming‘ connector on the GottFA PCB



- 5) Select ,Program/Configure‘ and ,Verify‘



6) Push start, wait for progress 100%



That's it!

## 10. 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!

### 10.1. rom file structure for GottFA80

Each rom file has a size of 16Kbyte and must have the 'game rom' within the first 8 Kbyte and the 'System rom' in the second 8 Kbyte. All Gottlieb Games have a 8Kbyte system rom while the size of the game roms depends on the game. Early Gottlieb games ( Panthera, Spiderman, Circus, Counterforce and Star Race) will come with a game rom of only 1Kbyte. Games as James Bond and later will come with a 2Kbyte game rom. Late System80B ( Excalibur, Bad Girls, Big House, Hot Shots Bone Buster and Night Moves ) come with a 4Kbyte game rom.

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.

### 10.2. game selection

The game selection aims to choose the proper project "image" for running the game. The "image" here means the combination of game ROM + system ROM. Depending on the fact you wanna build a multi-system game SD card or not, there are two case:

- 1) Your SD card is intended to run a single pinball game. In that case, you just need to "merged" this game ROM and system ROM in a single image file (see examples below) and put it on the SD card. Because you have only a single image, the proper configuration for game select DIP switch is all switches set to '0' (OFF).
- 2) You have several game + system ROM mostly because the same SD card is used in several pinballs or you have a set of game + system roms for all the pinballs supported by this board. In that case, you also have to create several "merged" image files containing game + system ROM and to copy them on the SD card (see examples below). The copy order will determined the game selection index.

Ex, you have the game+system ROM for Black Hole, Raven and Bad Girls:

You copy on the SD card first Black Hole image, then Raven image then Bad Girls. The proper game select DIP configuration is 0 for select Black Home game, 1 for Raven game, 2 for Bad Girls and so on. To determine the All the decimal value is encoded in binary here, so:

0 -> switches 1 to 6 to 0 (OFF)

1 -> switch. 1 to 1 (ON) and 2 to 6 to 0 (OFF)

2 -> switch. 1 to 0 (OFF) and 2 to 1 (ON) and 3 to 6 to 0 (OFF)

## 10.3. examples

### 10.3.1. Black Hole

Gottlieb Black Hole has a 2Kbyte game.rom (668-4.cpu) and two systems roms 4Kbyte each ( U2\_80.bin & U3\_80.bin). To create a rom file for GottFa (GottFA80\_BH.img) you can use the following command on a windows system:

```
Copy /b 668-4.cpu + 668-4.cpu + 668-4.cpu + 668-4.cpu + U2_80.bin + U3_80.bin GottFA80_BH.img
```

The multiple copies of 668-4.cpu are just to fill the 6Kbyte gap between the game rom and the system rom.

### 10.3.2. Raven

Gottlieb Raven ( System80B) has a 2Kbyte game.rom (prom2.cpu) and a 8Kbyte system.rom (prom1.cpu). To create a rom file for GottFa (GottFA80\_Raven.img) you can use the following command on a windows system:

```
Copy /b prom2.cpu + prom2.cpu + prom2.cpu + prom2.cpu + prom1.cpu GottFA80_Raven.img
```

### 10.3.3. Bad Girls

Gottlieb Raven ( System80B) has a 4Kbyte game.rom (prom2.cpu) and a 8Kbyte system.rom (prom1.cpu). To create a rom file for GottFa (GottFA80\_BadGirls.img) you can use the following command on a windows system:

```
Copy /b prom2.cpu + prom2.cpu + prom1.cpu GottFA80_BadGirls.img
```

### 10.3.4. Rock

( also valid for Bounty Hunter, Chicago Cubs Triple Play, Rock Encore )

Gottlieb Rock ( System80B) has a 8Kbyte system.rom (prom1.cpu) and **no separate game.rom**. To create a rom file for GottFa (GottFA80\_Rock.img) you can use the following command on a windows system:

```
Copy /b prom1.cpu + prom1.cpu GottFA80_Rock.img
```

## Appendix A example ,Gamelist'

| No | game select |     |     |     |     |     | Game                        |                          |
|----|-------------|-----|-----|-----|-----|-----|-----------------------------|--------------------------|
|    | S1          | S2  | S3  | S4  | S5  | S6  |                             |                          |
| 0  | off         | off | off | off | off | off | Panthera                    | fits :-)                 |
| 1  | on          | off | off | off | off | off | Spiderman                   | should fit               |
| 2  | off         | on  | off | off | off | off | Circus                      | should fit               |
| 3  | on          | on  | off | off | off | off | Counterforce                | should fit               |
| 4  | off         | off | on  | off | off | off | Star Race                   | should fit               |
| 5  | on          | off | on  | off | off | off | James Bond Timed Play       | should fit               |
| 6  | off         | on  | on  | off | off | off | James Bond 3/5-Ball         | should fit               |
| 7  | on          | on  | on  | off | off | off | Time Line                   | should fit               |
| 8  | off         | off | off | on  | off | off | Force II                    | should fit               |
| 9  | on          | off | off | on  | off | off | Pink Panther                | should fit               |
| 10 | off         | on  | off | on  | off | off | Mars - God of War Speech    | should fit               |
| 11 | on          | on  | off | on  | off | off | Mars - God of War Soundonly | should fit               |
| 12 | off         | off | on  | on  | off | off | Volcano speech rev4         | should fit               |
| 13 | on          | off | on  | on  | off | off | Volcano Soundonly           | should fit               |
| 14 | off         | on  | on  | on  | off | off | Black Hole                  | should fit               |
| 15 | on          | on  | on  | on  | off | off | Black Hole Soundonly        | should fit               |
| 16 | off         | off | off | off | on  | off | Haunted House               | should fit               |
| 17 | on          | off | off | off | on  | off | Eclipse                     | should fit               |
| 18 | off         | on  | off | off | on  | off | Devils DareSpeech           | should fit               |
| 19 | on          | on  | off | off | on  | off | Devils Dare Soundonly       | should fit               |
| 20 | off         | off | on  | off | on  | off | Rocky                       | should fit               |
| 21 | on          | off | on  | off | on  | off | Spirit                      | should fit, to be tested |
| 22 | off         | on  | on  | off | on  | off | Punk                        | should fit, to be tested |
| 23 | on          | on  | on  | off | on  | off | Striker                     | should fit, to be tested |
| 24 | off         | off | off | on  | on  | off | Krull                       | should fit, to be tested |
| 25 | on          | off | off | on  | on  | off | Q*Bert's Quest              | should fit, to be tested |
| 26 | off         | on  | off | on  | on  | off | Super Orbit                 | should fit, to be tested |
| 27 | on          | on  | off | on  | on  | off | Royal Flush Deluxe          | should fit, to be tested |
| 28 | off         | off | on  | on  | on  | off | Goin' Nuts                  | should fit, to be tested |
| 29 | on          | off | on  | on  | on  | off | Amazon Hunt                 | should fit, to be tested |
| 30 | off         | on  | on  | on  | on  | off | Rack 'Em Up                 | should fit, to be tested |
| 31 | on          | on  | on  | on  | on  | off | Ready...Aim...Fire!         | should fit, to be tested |
| 32 | off         | off | off | off | off | on  | Jacks To Open               | should fit, to be tested |
| 33 | on          | off | off | off | off | on  | Touchdown                   | should fit, to be tested |
| 34 | off         | on  | off | off | off | on  | Alien Star                  | should fit, to be tested |
| 35 | on          | on  | off | off | off | on  | The Games                   | should fit, to be tested |
| 36 | off         | off | on  | off | off | on  | El Dorado City of Gold      | should fit, to be tested |



|    |     |     |     |     |     |    |                          |                          |
|----|-----|-----|-----|-----|-----|----|--------------------------|--------------------------|
| 37 | on  | off | on  | off | off | on | Ice Fever                | should fit, to be tested |
| 38 | off | on  | on  | off | off | on | Caveman                  | should fit, to be tested |
| 39 | on  | on  | on  | off | off | on | notused1                 | should fit, to be tested |
| 40 | off | off | off | on  | off | on | Bounty Hunter            | bottom display           |
| 41 | on  | off | off | on  | off | on | Chicago Cubs Triple Play | bottom display           |
| 42 | off | on  | off | on  | off | on | Tag Team                 | bottom display           |
| 43 | on  | on  | off | on  | off | on | Rock                     | bottom display           |
| 44 | off | off | on  | on  | off | on | Raven                    | bottom display           |
| 45 | on  | off | on  | on  | off | on | Rock Encore              | bottom display           |
| 46 | off | on  | on  | on  | off | on | Hollywood Heat           | bottom display           |
| 47 | on  | on  | on  | on  | off | on | Genesis                  | bottom display           |
| 48 | off | off | off | off | on  | on | Gold Wings               | bottom display           |
| 49 | on  | off | off | off | on  | on | Monte Carlo              | bottom display           |
| 50 | off | on  | off | off | on  | on | Spring Break             | bottom display           |
| 51 | on  | on  | off | off | on  | on | Arena                    | bottom display           |
| 52 | off | off | on  | off | on  | on | Victory                  | bottom display           |
| 53 | on  | off | on  | off | on  | on | Diamond Lady             | Display on top           |
| 54 | off | on  | on  | off | on  | on | TX Sector                | Display on top           |
| 55 | on  | on  | on  | off | on  | on | Robo War                 | Display on top           |
| 56 | off | off | off | on  | on  | on | Excalibur                | Display on top           |
| 57 | on  | off | off | on  | on  | on | Bad Girls                | Rom too big              |
| 58 | off | on  | off | on  | on  | on | Big House                | Rom too big              |
| 59 | on  | on  | off | on  | on  | on | Hot Shots                | Rom too big              |
| 60 | off | off | on  | on  | on  | on | Bone Busters Inc.        | Rom too big              |
| 61 | on  | off | on  | on  | on  | on | Night Moves              | Rom too big              |
| 62 | off | on  | on  | on  | on  | on | notused3                 |                          |
| 63 | on  | on  | on  | on  | on  | on | notused4                 |                          |