

WillFA7

Williams MPU based on FPGA

Hardware version v0.5

Software Version 0.13

user manual

ralf@lisy.dev

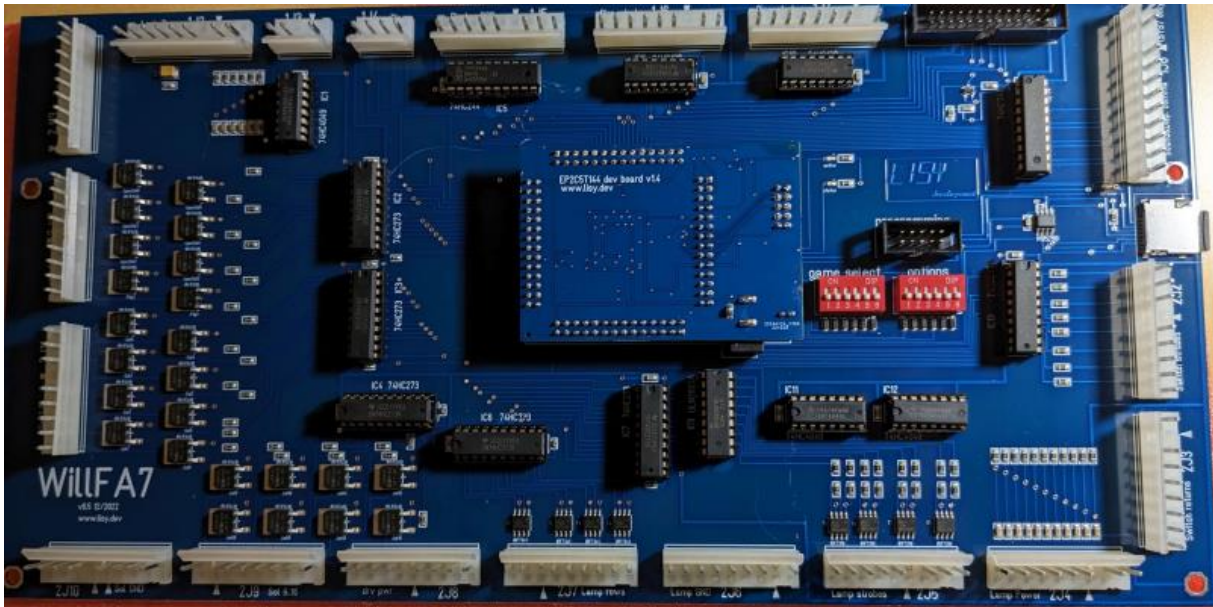
v1.0 09.01.2023

Table of contents

Important remark.....	3
1. Introduction.....	3
2. Quickstart	4
3. Put the WillFA7 Image to the SD card	5
Win32DiskImager	5
4. Installation.....	6
5. Dip Switch Settings	6
5.1. DIP Switch S1: game select.....	6
5.2. DIP Switch S2: options	6
5.2.1. S2-Dip1 -> init nvram.....	6
5.2.2. S2-Dip2 -> not used	6
5.2.3. S2-Dip3 -> not used	6
5.2.4. S2-Dip4 -> not used	6
5.2.5. S2-Dip5 -> not used	6
5.2.6. S2-Dip6 -> diag switch	6
6. boot sequence.....	7
6.1. phase 1: init	7
6.2. phase 2: SD card read.....	7
6.3. phase 3: program execution.....	7
7. programming the FPGA	8
7.1. programmer software	8
7.2. install the driver for your USB Blaster	8
7.3. program your FPGA	9
8. structure of SD card.....	12
8.1. WillFA7 image.....	12
8.2. use your own roms	12
Appendix A 'game select'	13

Important remark

By using WillFA7 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 BallyFA7!



1. Introduction

WillFA7 use a (low cost) FPGA which emulates the hardware of a Williams MPU type SYS3 up to SYS7; the driverboard is integrated on the PCB.

At the moment WillFA7 supports 30 games, see Appendix A for a complete list.

Note: Due to memory restrictions of the used FPGA YS7 games 'Defender# 6 #Star Light' are not supported!

What do you need?

- 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
4. Configure switch 'game select' according to your pinball (Appendix A)
5. Replace your original Williams MPU and Driverboard with WillFA7
6. Switch the Game ON
7. Enjoy

3. Put the WillFA7 Image to the SD card

On my website you will find the latest version of WillFA7 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](#)

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.

4. Installation

WillFA7 boards have the same connectors and same mounting holes as the original Williams MPUs, so replacing of the board can be done in seconds. The board need to be placed at the former location of the Williams driverboard.

5. Dip Switch Settings

5.1. DIP Switch S1: game select

Here you can select what game WillFA7 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.

5.2. DIP Switch S2: options

Default setting is all ,OFF'

5.2.1. S2-Dip1 -> init nvram

With dip1 to ,ON' WillFa7 during boot will initialize the nvram ram for the selected game to zero. This is useful if you want to reset ALL ram content.

5.2.2. S2-Dip2 -> not used

Not implemented yet.

5.2.3. S2-Dip3 -> not used

Not implemented yet.

5.2.4. S2-Dip4 -> not used

Not implemented yet.

5.2.5. S2-Dip5 -> not used

5.2.6. S2-Dip6 -> diag switch

With dip6 to ,ON' the 'Advance Switch' in the coin door will have the functionality of the 'Diagnostic Switch'. This is needed because I forgot to implement the diag switch on the PCB with HW v0.5

6. boot sequence

6.1. phase 1: init

Immediately after switching on the pinball with WillFA7 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 (game select)

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

Player 4: blank

Credit Display: value of selected game on S2 (game options)

6.2. phase 2: SD card read

WillFA7 tries to read the SD card content, if this fails the red LED 'SD card error' will go ON and '56' will be shown at display 4.

6.3. 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 display strobes are present) the yellow 'status' LED will go ON.

7. programming the FPGA

To program the FPGA you need the Quartus Programmer.

7.1. programmer software

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

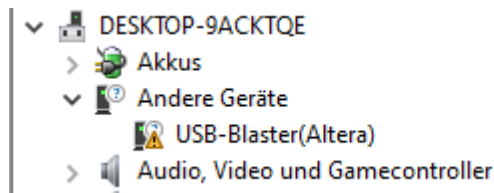
<https://fpgasoftware.intel.com/13.0sp1/?edition=web>

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.

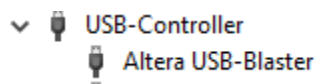
7.2. install the driver for your USB Blaster

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'

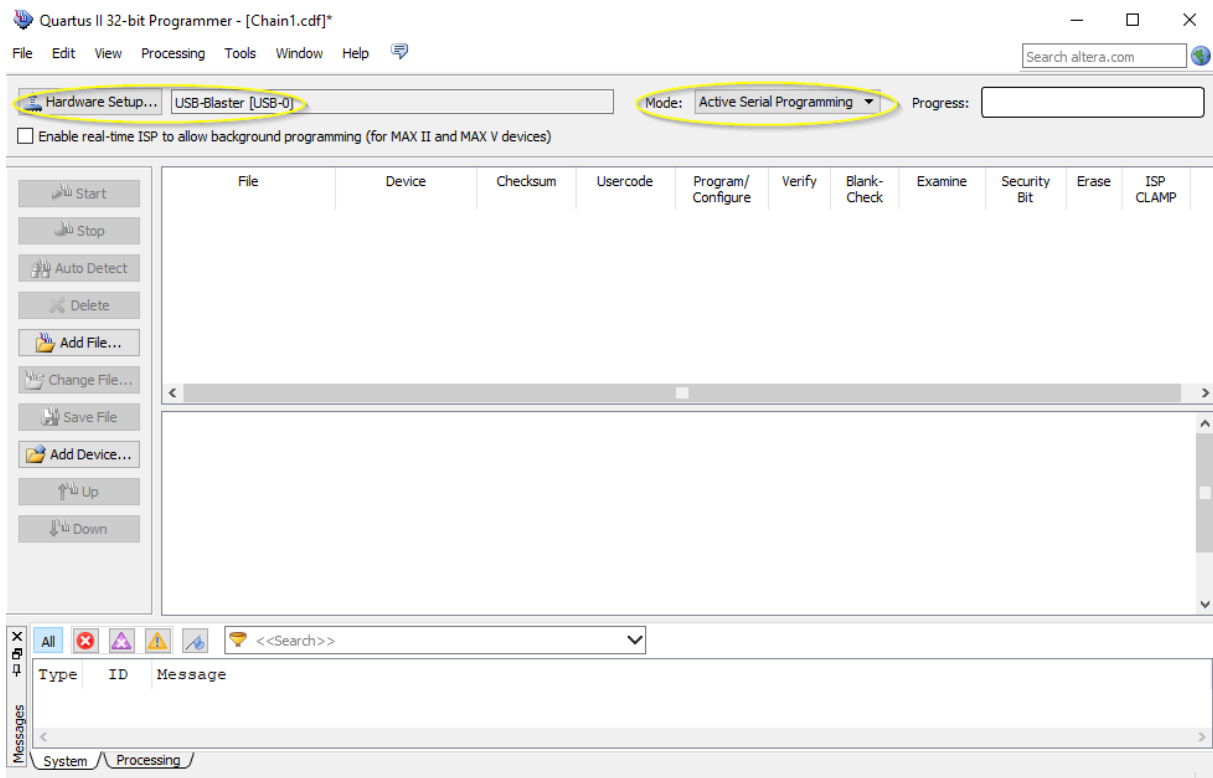


7.3. program your FPGA

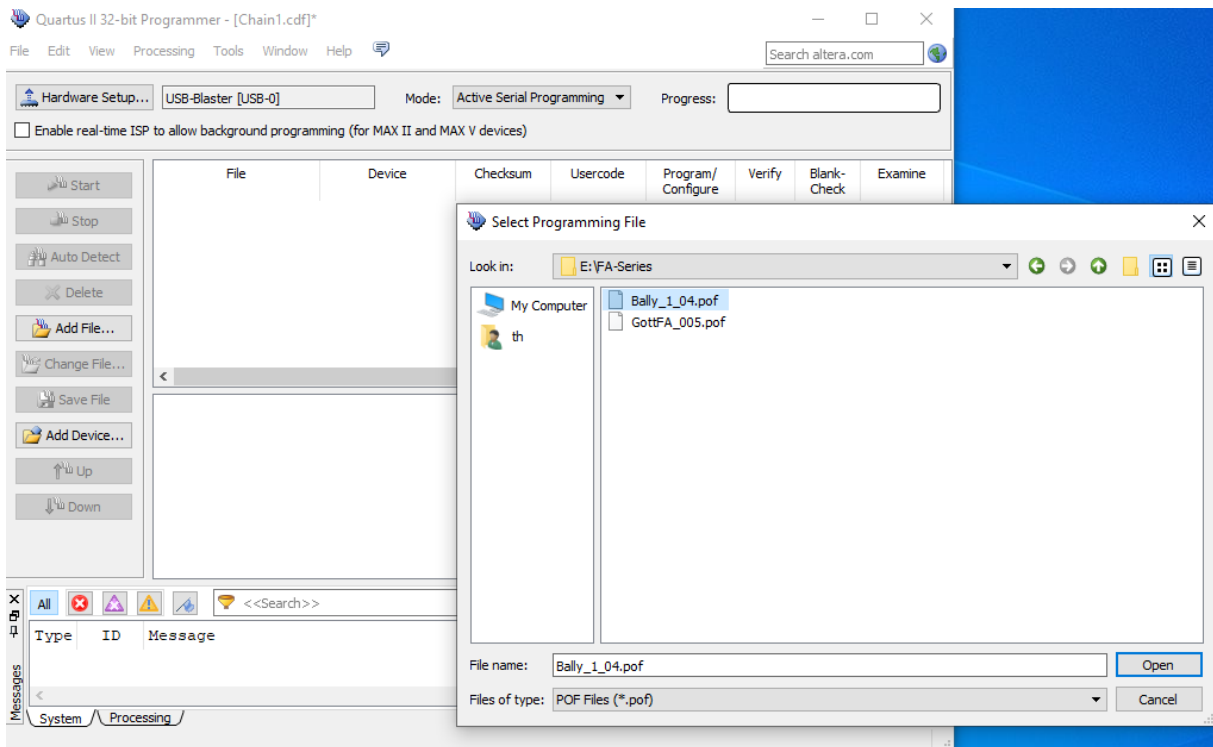
- 1) Connect the USB Blaster to the PC



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



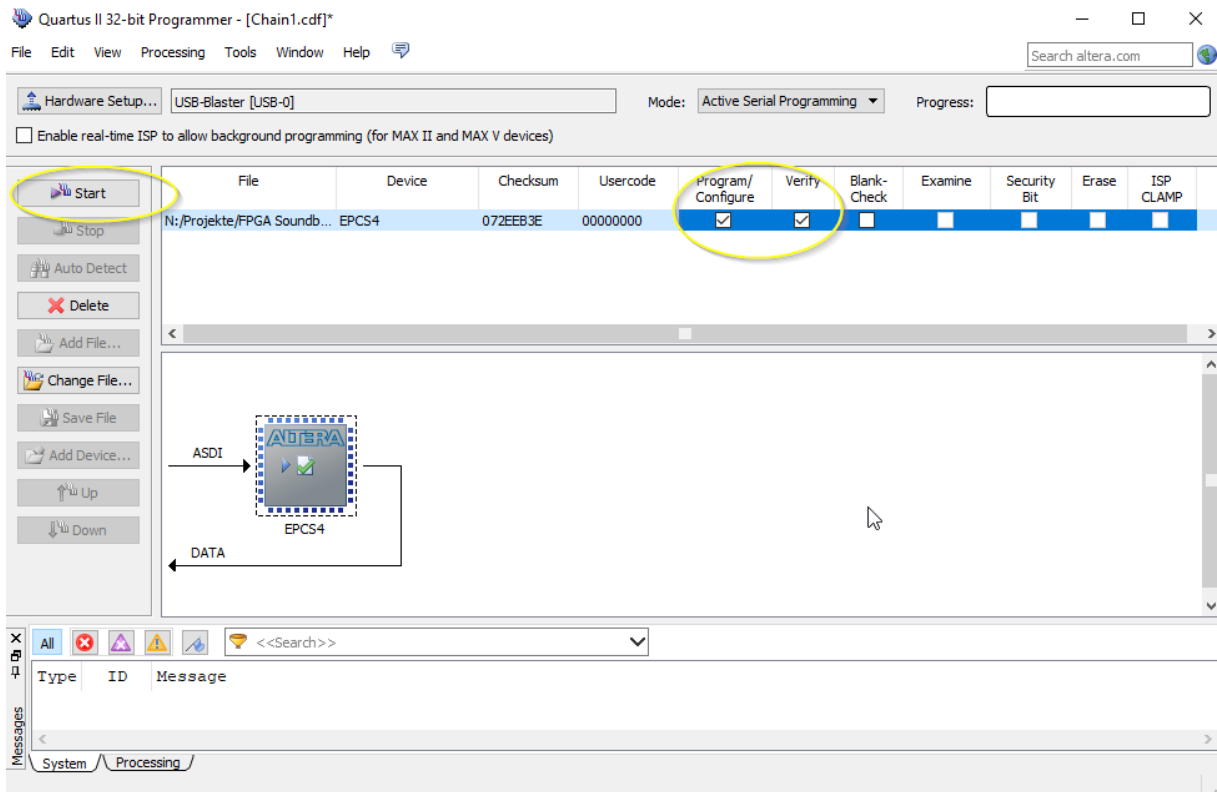
- 3) Select ,Add File' and choose the right ,pof' file for your game



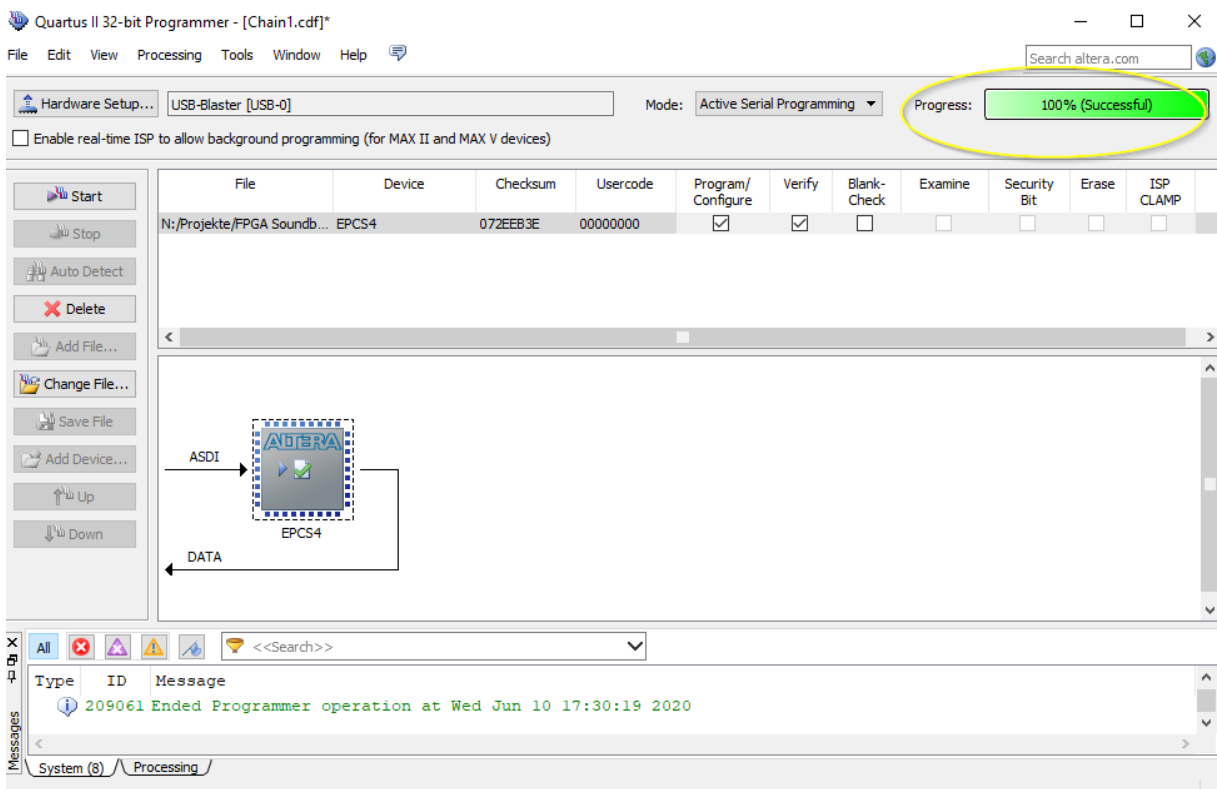
- 4) Power the FPGA with 5 Volt (middle pin ,+‘, outer pin ,-,) and connect the USB Blaster to the ,AS programming‘ connector on the BallyFA PCB



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



6) Push start, wait for progress 100%



That's it!

8. 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.

With game select all '0' WillFa will try to read the first rom image at sector number 660. With my 128MB BallyFa image this is the location of the first file you write to an empty SD card.

8.1. WillFA7 image

My WillFA SD card image has almost all available roms 'on board'. See appendix A for a gamelist

8.2. use your own roms

todo

Appendix A 'game select'

No	S1	S2	S3	S4	S5	S6	type	Name
0	off	off	off	off	off	off	SYS3	Hot Tip
1	on	off	off	off	off	off	SYS3	Lucky Seven
2	off	on	off	off	off	off	SYS3	World Cup
3	on	on	off	off	off	off	SYS3	Contact
4	off	off	on	off	off	off	SYS3	Disco Fever
5	on	off	on	off	off	off	SYS4	Pokerino
6	off	on	on	off	off	off	SYS4	Phoenix
7	on	on	on	off	off	off	SYS4	Flash
8	off	off	off	on	off	off	SYS4	Stellar Wars
9	on	off	off	on	off	off	SYS6	Tri Zone
10	off	on	off	on	off	off	SYS6	Time Warp
11	on	on	off	on	off	off	SYS6	Gorgar
12	off	off	on	on	off	off	SYS6	Laser Ball
13	on	off	on	on	off	off	SYS6	Firepower
14	off	on	on	on	off	off	SYS6	Blackout
15	on	on	on	on	off	off	SYS6	Scorpion
16	off	off	off	off	on	off	SYS6A	Algar
17	on	off	off	off	on	off	SYS6A	Alien Poker
18	off	on	off	off	on	off	SYS7	Black Knight
19	on	on	off	off	on	off	SYS7	Jungle Lord
20	off	off	on	off	on	off	SYS7	Pharaoh
21	on	off	on	off	on	off	SYS7	Solar Fire
22	off	on	on	off	on	off	SYS7	Barracora
23	on	on	on	off	on	off	SYS7	Cosmic Gunfight
24	off	off	off	on	on	off	SYS7	Varkon
25	on	off	off	on	on	off	SYS7	Warlok
26	off	on	off	on	on	off	SYS7	Time Fanatsy
27	on	on	off	on	on	off	SYS7	Joust
28	off	off	on	on	on	off	SYS7	Firepower II
29	on	off	on	on	on	off	SYS7	Laser Cue