

Programming ICE6502 on the EEPIZZA FPGA Board using openocd_0.11.0~rc2-1_arm64.deb and a Pi4B with 64bit OS 2022-01- 28-raspios-bullseye-arm64

Introduction

This page contains notes on programming the EEPIZZA FPGA board using a 64bit Raspberry Pi4B running a 64bit OS image, version 2022-01-28-raspios-bullseye-arm64. (See notes at the end for other Pi Models)

https://downloads.raspberrypi.org/raspios_arm64/images/raspios_arm64-2022-01-28/2022-01-28-raspios-bullseye-arm64.zip

Start by logged in as the pi user and open a Terminal Window.
The command “cat /etc/os-release” reports

```
PRETTY_NAME="Debian GNU/Linux 11 (bullseye)"
NAME="Debian GNU/Linux"
VERSION_ID="11"
VERSION="11 (bullseye)"
VERSION_CODENAME=bullseye
ID=debian
HOME_URL="https://www.debian.org/"
SUPPORT_URL="https://www.debian.org/support"
BUG_REPORT_URL=https://bugs.debian.org/
```

After the install use the command “uname -m” reports aarch64

```
uname -m
aarch64
```

Once the Pi was up and running I ran updates and upgrades.

```
sudo apt-get update
sudo apt-get upgrade
```

Install OpenOCD

(I'm using openocd_0.11.0~rc2-1_arm64.deb)
sudo apt-get install openocd=0.11.0~rc2-1

Create a local configuration file

Create a file in the current directory called "local.cfg" with the following contents:
adapter speed 50

Connect the Pi to the FPGA Board

```
FPGA board:      Pi GPIO Header:
Pin 1 (TMS) <=> Pin 22 (GPIO 25)
Pin 2 (TDI) <=> Pin 19 (GPIO 10)
Pin 3 (TDO) <=> Pin 21 (GPIO 9)
Pin 4 (TCK) <=> Pin 23 (GPIO 11)
Pin 5 (0V) <=> Pin 20 (0V)
Pin 6 (3V3)      NOT CONNECTED
```

On the FPGA board, pin 1 of the JTAG connector has a square pad.

[Here](#) is a the pin numbering of the Pi GPIO connector.

IMPORTANT: DO NOT CONNECT PIN 6 (3V3)

IMPORTANT: If you are doing this "hot" (i.e. with both boards powered), connect the 0V wire first.

Example: Programming the ice6502.bit file into FPGA "RAM"

Download the Release 5 .zip file with all the supported ICE targets into your local pi folder.

```
wget
https://github.com/hoglet67/AtomBusMon/releases/download/release\_5/ice\_20210921\_1232\_0994.zip
```

Unzip the ice_20210921_1232_0994.zip file

Copy the ice6502.bit to your pi user local directory

```
cp ice_20210921_1232_0994/lx9_dave/ice6502/ice6502.bit /home/pi/ice6502.bit
```

As root/su modify the /usr/share/openocd/scripts/interface/raspberrypi-native.cfg file for the Pi4B specifics.

Remark out:

```
# bcm2835gpio_peripheral_base 0x20000000
# bcm2835gpio_speed_coeffs 113714 28
# cm2835gpio_swd_nums 11 25
```

And add:

```
bcm2835gpio_peripheral_base 0xFE000000  
bcm2835gpio_speed_coeffs 236181 60  
bcm2835gpio_jtag_nums 11 25 10 9
```

```
sudo nano /usr/share/openocd/scripts/interface/raspberrypi-native.cfg
```

Run openocd with the following options:

```
sudo openocd -f local.cfg -f /usr/share/openocd/scripts/interface/raspberrypi-  
native.cfg -f /usr/share/openocd/scripts/cpld/xilinx-xc6s.cfg -c "init; xc6s_program  
xc6s.tap; pld load 0 ice6502.bit; exit"
```

When the ice6502.bit file is being uploaded to the EEPIZZA FPGA RAM you should only see blue LEDs.

You should see the following output:

```
Open On-Chip Debugger 0.11.0-rc2  
Licensed under GNU GPL v2  
For bug reports, read  
    http://openocd.org/doc/doxygen/bugs.html  
adapter speed: 50 kHz
```

```
BCM2835 GPIO config: tck = 11, tms = 25, tdi = 10, tdo = 9
```

```
Info : auto-selecting first available session transport "jtag". To override use  
'transport select <transport>'.  
xc6s_print_dna  
Info : BCM2835 GPIO JTAG/SWD bitbang driver  
Info : clock speed 50 kHz  
Info : JTAG tap: xc6s.tap tap/device found: 0x24001093 (mfg: 0x049 (Xilinx), part:  
0x4001, ver: 0x2)  
Warn : gdb services need one or more targets defined
```

At the end of this process only the blue LD9 PWR and yellow LD10 Done LEDs should be on indicating a successful upload to the EEPIZZA FPGA RAM and the FPGA should be running the new bitstream.

NOTE: The RAM on the EEPIZZA is volatile so if you lose power the EEPIZZA FPGA RAM content is not saved and WILL BE LOST.

The following procedure will write the content to the EEPIZZA FLASH. If you lose power the EEPIZZA FPGA FLASH content is saved and WILL NOT BE LOST.

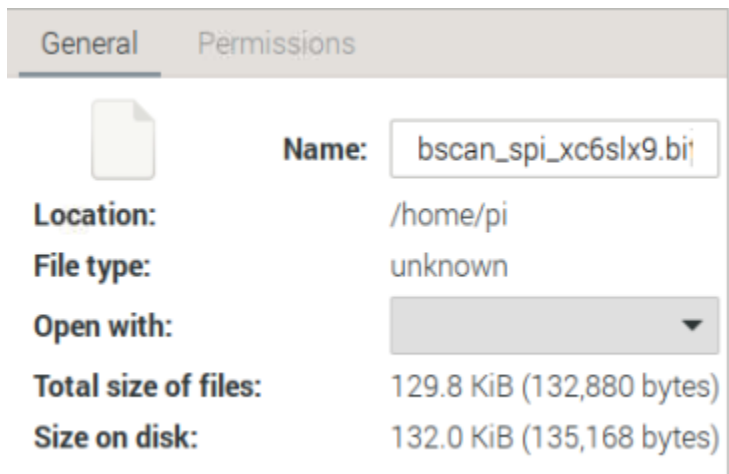
Example 2: Programming ice6502.bin file into FLASH

For later versions of OpenOCD including version openocd_0.11.0~rc2-1_arm64.deb , a special bscan file is required.

The bscan file version from the master branch (not the single-tap branch) should be used:

wget https://github.com/quartiq/bscan_spi_bitstreams/raw/master/bscan_spi_xc6slx9.bit

You can verify that you are using the correct new bscan file by referencing the below size and installation path.



Copy the ice6502.bin to your pi user local directory

```
cp ice_20210921_1232_0994/lx9_dave/ice6502/ice6502.bin /home/pi/ice6502.bin
```

Run openocd with the following options:

```
sudo openocd -f local.cfg -f /usr/share/openocd/scripts/interface/raspberrypi-native.cfg -f /usr/share/openocd/scripts/cpld/xilinx-xc6s.cfg -f /usr/share/openocd/scripts/cpld/jtagspi.cfg -c "init; jtagspi_init 0 bscan_spi_xc6slx9.bit; jtagspi_program ice6502.bin 0; xc6s_program xc6s.tap; shutdown"
```

Be patient. This step may take a while to complete.

When the ice6502.bin file is being programmed into the EEPIZZA FPGA FLASH you should see blue LEDs LD9 PWR and LD01-LD08 along with the yellow LD10 Done LED. You should see the following output:

```
Open On-Chip Debugger 0.11.0-rc2
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 50 kHz
```

```
BCM2835 GPIO config: tck = 11, tms = 25, tdi = 10, tdo = 9
```

```
Info : auto-selecting first available session transport "jtag". To override use
'transport select <transport>'.
xc6s_print_dna
jtagspi_program
Info : BCM2835 GPIO JTAG/SWD bitbang driver
Info : clock speed 50 kHz
Info : JTAG tap: xc6s.tap tap/device found: 0x24001093 (mfg: 0x049 (Xilinx), part:
0x4001, ver: 0x2)
Info : JTAG tap: xc6s.tap tap/device found: 0x24001093 (mfg: 0x049 (Xilinx), part:
0x4001, ver: 0x2)
Info : Found flash device 'win w25q32fv/jv' (ID 0x001640ef)
Info : Found flash device 'win w25q32fv/jv' (ID 0x001640ef)
Info : Found flash device 'win w25q32fv/jv' (ID 0x001640ef)
Info : Found flash device 'win w25q32fv/jv' (ID 0x001640ef)
Info : sector 0 took 116 ms
Info : sector 1 took 111 ms
Info : sector 2 took 113 ms
Info : sector 3 took 110 ms
Info : sector 4 took 111 ms
Info : sector 5 took 111 ms
Info : Found flash device 'win w25q32fv/jv' (ID 0x001640ef)
shutdown command invoked
```

At the end of this process only the blue LD9 PWR and yellow LD10 Done LEDs should be on indicating a successful programming of the EEPIZZA FPGA FLASH and the FPGA should be running the new bitstream.

At the end of this process, the EEPIZZA FPGA should be reconfigured and be running the new bitstream.

If you get the following error, then you have a mismatch between openocd and the bscan file.

```
Error: Unknown flash device (ID 0x00ffffff)
```

If you connect the EEPIZZA USB port to your computer and run Putty configured with a serial connection at 115200 baud, you should see the below each time you press the EEPIZZA reset button.

```
8 watches/breakpoints implemented
Tracing every 1 instructions while single stepping
*** missing clock ***
CPU free running...
```

Using other Pi Models

For the Pi0 or Pi1, use the following config file:

```
/usr/share/openocd/scripts/interface/raspberrypi-native.cfg
```

For the Pi 2, use the following config file:

```
/usr/share/openocd/scripts/interface/raspberrypi2-native.cfg
```

For the Pi 3, you could try using the config file for the Pi 2.

For the Pi 4, you need to copy the one of the above files, and change the following lines:

```
bcm2835gpio_peripheral_base 0xFE000000  
bcm2835gpio_speed_coeffs 236181 60
```

(I've only tested a Pi1B and Pi4B myself)

Changes to the raspberrypi-native.cfg interface script.

Timings are different between the between models.

RPI 1A/A+/B/B+ with 700 MHz base clock

```
bcm2835gpio_peripheral_base 0x20000000  
bcm2835gpio_speed_coeffs 113714 28
```

RPI 2B with 900 MHz base clock

```
bcm2835gpio_peripheral_base 0x3E000000  
bcm2835gpio_speed_coeffs 146203 36
```

RPI 3B with 1200 MHz base clock

```
bcm2835gpio_peripheral_base 0x3E000000  
bcm2835gpio_speed_coeffs 194938 48
```

RPI 3B+ with 1400 MHz base clock (despite the higher clock seems to be the same as RPI 3B)

```
bcm2835gpio_peripheral_base 0x3E000000  
bcm2835gpio_speed_coeffs 194938 48
```

RPI 4 with 1500 MHz base clock

```
bcm2835gpio_peripheral_base 0xFE000000  
bcm2835gpio_speed_coeffs 236181 60
```

Later versions of OpenOCD

For later versions of Open OCD including version `openocd_0.11.0~rc2-1_arm64.deb`, a couple of things are different:

- a different bscan file is needed
- the `local.cfg` file contents are different

The bscan file version from the master branch (not the single-tap branch) should be used:

wget https://github.com/quartiq/bscan_spi_bitstreams/raw/master/bscan_spi_xc6slx9.bit

The `local.cfg` file needs to contain just a single line:

```
adapter speed 50
```

Note, I experienced different errors and failure when the speed was not set at 50 KHz using version `openocd_0.11.0~rc2-1_arm64.deb`.