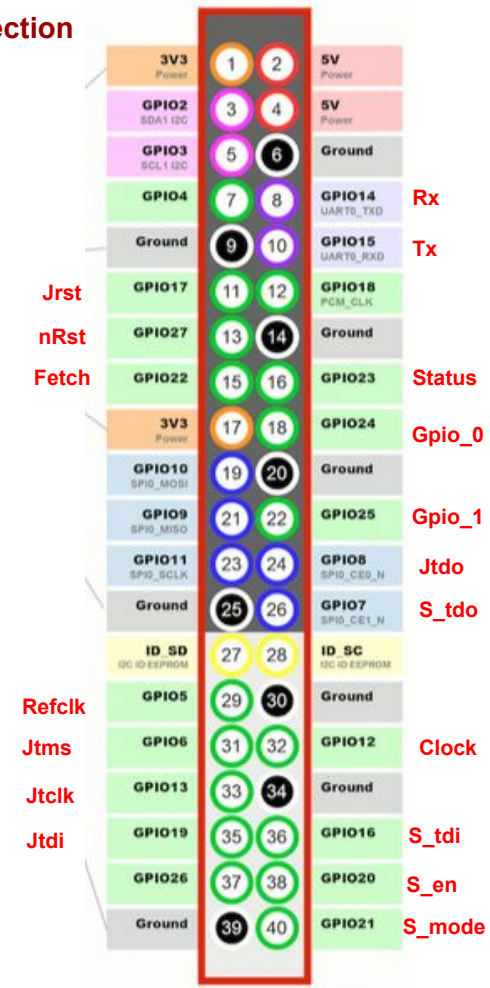
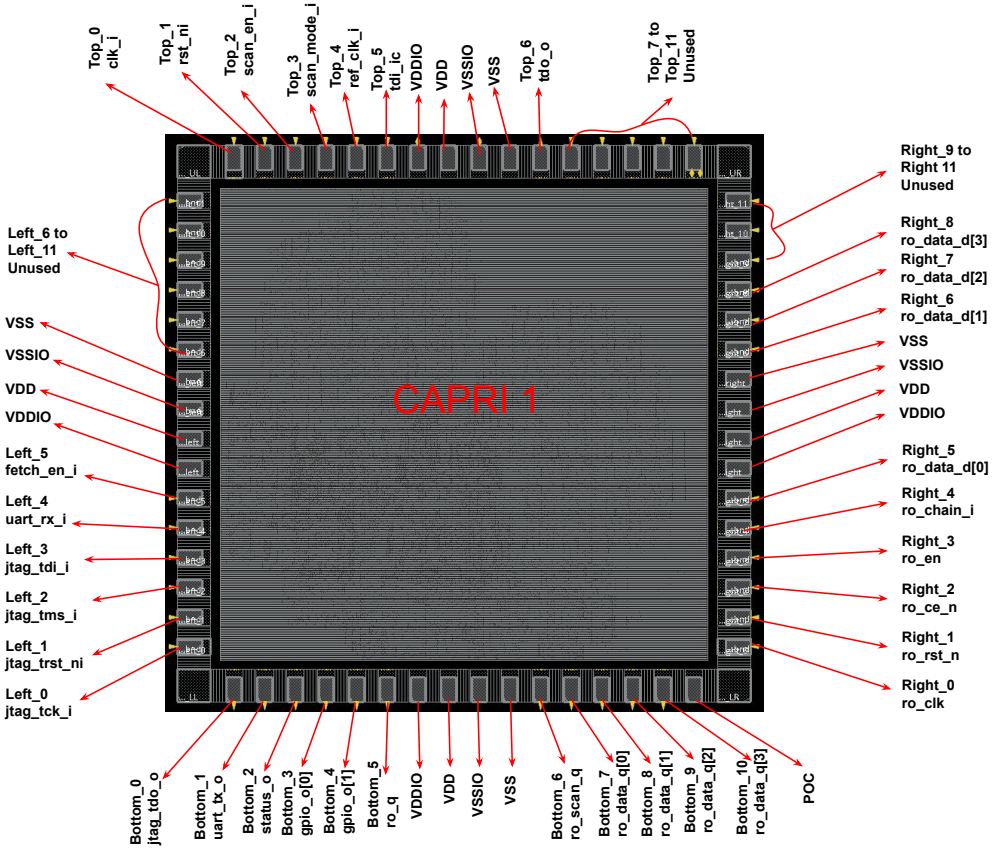
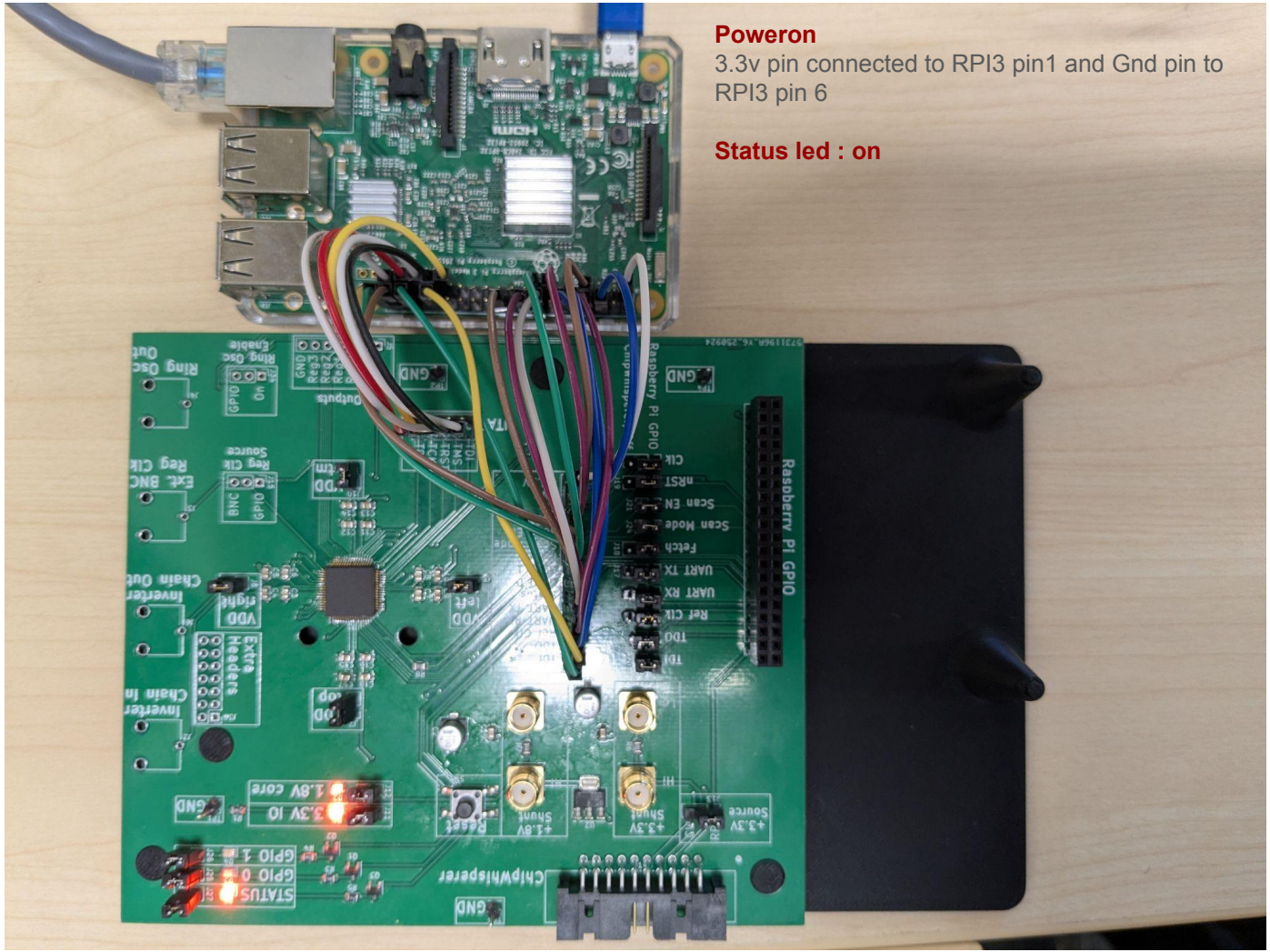
Pin connection details



RPI3



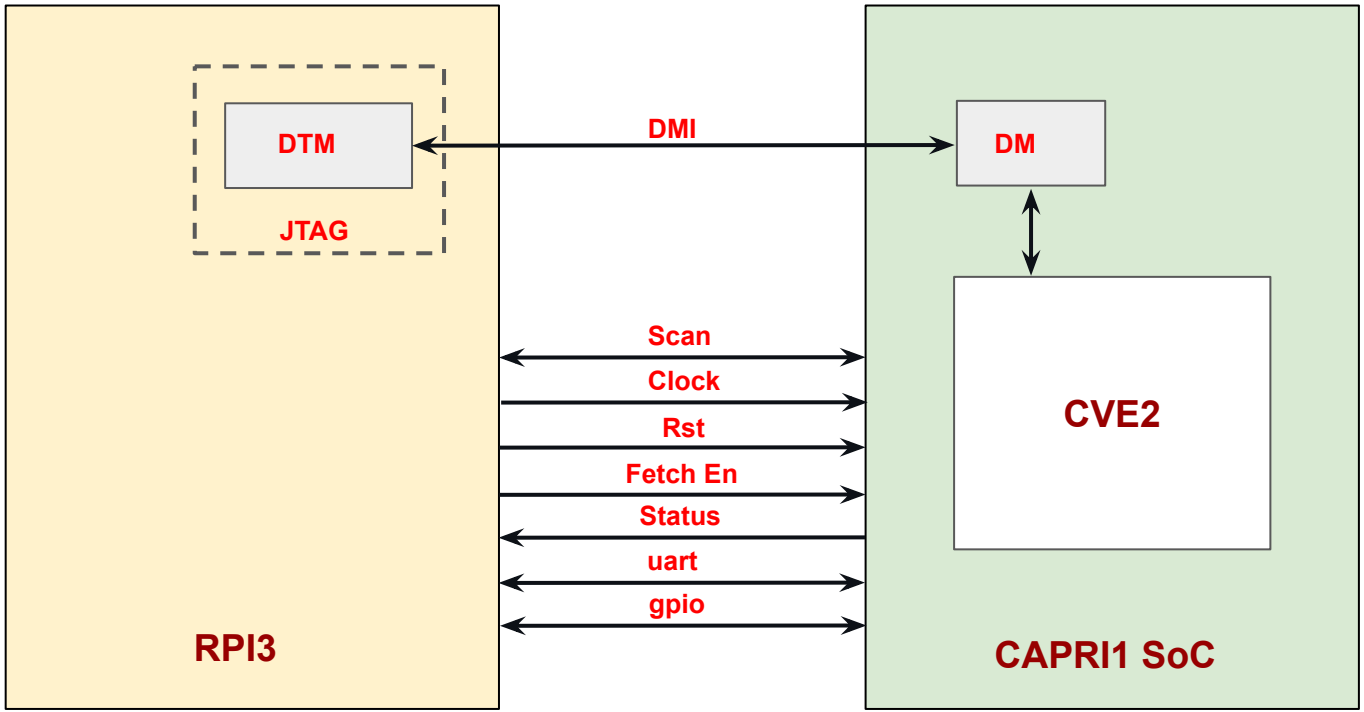
VDDIO = 3.3V
VDD = 1.8V
VSSIO / VSS = GND



Poweron

3.3v pin connected to RPI3 pin1 and Gnd pin to RPI3 pin 6

Status led : on



gpio12 : clk
gpio27 : nRst
gpio17 : Jrst
gpio22 : Fetchen
gpio6 : Jmts
gpio13 : Jclk
gpio19 : Jtdi
gpio8 : Jtdo
gpio21 : S_mode
gpio20 : S_en
gpio16 : S_tdi
gpio7 : S_tdo
gpio25 : led1(gpio1)
gpio24 : led0(gpio0)
gpio23 : Status
gpio14 : Rx
gpio15 : Tx

Configuration

1. ./prep_pins.sh
2. openocd -f rpi3_gpio.cfg -f capri1_target.cfg; init; reset halt;
3. reset.tcl(when DM halt hart fails to responded)

Capture : map and group

4. scan_chain_capture_10cc.py
5. map_and_group_script.py

Configuration : GPIO pins on RPI3

./prep_pins.sh

```
pschaumont@raspberrypi:~/capri1/scripts/9oct/test/v1 $ ./prep_pins.sh
[prep] ensure pigpiod is running
GPIO 12: level=1 fsel=4 alt=0 func=PWM0
[prep] status:
GPIO17: GPIO 17: level=1 fsel=1 func=OUTPUT
GPIO27: GPIO 27: level=1 fsel=1 func=OUTPUT
GPIO12: GPIO 12: level=1 fsel=4 alt=0 func=PWM0
GPIO22: GPIO 22: level=0 fsel=1 func=OUTPUT
GPIO6 : GPIO 6: level=1 fsel=1 func=OUTPUT
GPIO13: GPIO 13: level=0 fsel=1 func=OUTPUT
GPIO19: GPIO 19: level=0 fsel=1 func=OUTPUT
GPIO8 : GPIO 8: level=0 fsel=0 func=INPUT
GPIO21: GPIO 21: level=0 fsel=1 func=OUTPUT
GPIO20: GPIO 20: level=0 fsel=1 func=OUTPUT
GPIO16: GPIO 16: level=0 fsel=1 func=OUTPUT
GPIO7 : GPIO 7: level=0 fsel=0 func=INPUT
GPIO25: GPIO 25: level=0 fsel=0 func=INPUT
GPIO24: GPIO 24: level=0 fsel=0 func=INPUT
GPIO23: GPIO 23: level=1 fsel=0 func=INPUT
GPIO14: GPIO 14: level=0 fsel=1 func=OUTPUT
GPIO15: GPIO 15: level=1 fsel=0 func=INPUT
[prep] Clock is now on GPIO12 (PWM0). Wire CAPRI1 clk_i to GPIO12.
```

Configuration : openocd

openocd -f rpi3_gpio.cfg -f capri1_target.cfg

```
pschaumont@raspberrypi:~/capri1/scripts/9oct/test/v1 $ openocd -f rpi3_gpio.cfg -f capri1_target.cfg
Open On-Chip Debugger 0.12.0
Licensed under GNU GPL v2
For bug reports, read
        http://openocd.org/doc/doxygen/bugs.html
adapter speed: 100 kHz

Warn : Transport "jtag" was already selected
0
Info : Listening on port 6666 for tcl connections
Info : Listening on port 4444 for telnet connections
Info : BCM2835 GPIO JTAG/SWD bitbang driver
Info : clock speed 100 kHz
Info : JTAG tap: capri1.cpu tap/device found: 0x0c0c5db3 (mfg: 0x6d9 (PULP Platform), part: 0xc0c5, ver: 0x0)
Info : datacount=2 progbufsize=8
Info : Examined RISC-V core; found 1 harts
Info :  hart 0: XLEN=32, misa=0x40100104
Info : starting gdb server for capri1.cpu on 3333
Info : Listening on port 3333 for gdb connections
```

Reset

reset.tcl (when DM halt hart fails to responded)

```
init
riscv dmi_write 0x10 0x00000001       ;# dmactive=1
riscv dmi_write 0x38 0x20040C07       ;# SBA: 32-bit, autoinc, read-on-data
riscv dmi_write 0x37 0x00000000
riscv dmi_write 0x39 0x03000004       ;# FETCHEN
riscv dmi_write 0x3C 0x00000001       ;# FETCHEN=1

riscv dmi_write 0x10 0x04000003       ;# setresethaltreq|ndmreset|dmactive
sleep 20
riscv dmi_write 0x10 0x04000001       ;# release reset (resethaltreq still set)
sleep 20
riscv dmi_write 0x10 0x02000001       ;# clrresethaltreq
riscv dmi_read  0x11
```

Load_image

```
mww 0x10000000 0x0 256
mdw 0x10000000 256

halt
load_image /home/pschaumont/capri1/scripts/9oct/test/v1/verifyPIN_0/verifyPIN_0_opt.bin
0x10000000 bin
shutdown
```

Capture : scan chain values

scan_chain_capture_10cc.py (capture 10cc scan chain values)
map_and_group_script.py (map and group bits)

```
pschaumont@raspberrypi:~/capri1/scripts/9oct/test/v1/verifyPIN_0 $ ls
frame_0.txt      frame_5          frame_9_map.out
frame_1          frame_5_map.out  frame_9.txt
frame_1_map.out  frame_5.txt      group.py
frame_1.txt      frame_6          map_and_group_script.py
frame_2          frame_6_map.out  map.out
frame_2_map.out  frame_6.txt      map.py
frame_2.txt      frame_7          out
frame_3          frame_7_map.out  reset.tcl
frame_3_map.out  frame_7.txt      scan_chain_capture_10cc.py
frame_3.txt      frame_8          scan_dump_bits_12756_17oct_c8_v2_verifypin0.txt
frame_4          frame_8_map.out  scan_layout_z_removed.txt
frame_4_map.out  frame_8.txt      verifyPIN_0_opt.bin
frame_4.txt      frame_9
pschaumont@raspberrypi:~/capri1/scripts/9oct/test/v1/verifyPIN_0 $
```

verifyPIN_0

```
> load_image /home/pschaumont/capri1/scripts/9oct/test/v1/verifyPIN_0/verifyPIN_0_opt.bin 0x10000000 bin
327 bytes written at address 0x10000000
downloaded 327 bytes in 0.047467s (6.728 KiB/s)
```

SRAM : bank0, 79 words, 32 bits (program memory)

```
> mdw 0x10000000 256
0x10000000: 00000197 14118193 2bf18113 00000093 00000213 00000293 00000313 00000393
0x10000020: 00000413 00000493 00000513 00000593 00000613 00000693 00000713 00000793
0x10000040: 0dc000ef f3000297 fc428293 00a2a023 10500073 000182a3 00300793 00f18223
0x10000060: 000181a3 00008067 00000793 00c7c663 00100513 00008067 00f506b3 00f58733
0x10000080: 0006c683 00074703 00e69663 00178793 fddff06f 00000513 00008067 ff010113
0x100000a0: 00912223 000182a3 00418493 00812423 040307b7 00048403 00112623 20178793
0x100000c0: fff18713 ffb18593 00f72023 00f5a023 00000513 02805263 00400613 00070513
0x100000e0: f89ff0ef 00100793 02f51263 00300793 00f48023 00a182a3 00c12083 00812403
0x10000100: 00412483 01010113 00008067 fff40413 00848023 00000513 fe1ff06f ff010113
0x10000120: 00112623 f31ff0ef f75ff0ef 00c12083 00a03533 01010113 00008067 00000000
0x10000140: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000160: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000180: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100001a0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100001c0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100001e0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000200: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000220: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000240: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000260: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000280: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100002a0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100002c0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100002e0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000300: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000320: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000340: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000360: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000380: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100003a0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100003c0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100003e0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

```
> resume
> halt
> mdw 0x10000000 256
```

SRAM : bank1 (data memory)

```
0x10000000: 00000197 14118193 2bf18113 00000093 00000213 00000293 00000313 00000393
0x10000020: 00000413 00000493 00000513 00000593 00000613 00000693 00000713 00000793
0x10000040: 0dc000ef f3000297 fc428293 00a2a023 10500073 000182a3 00300793 00f18223
0x10000060: 000181a3 00008067 00000793 00c7c663 00100513 00008067 00f506b3 00f58733
0x10000080: 0006c683 00074703 00e69663 00178793 fddff06f 00000513 00008067 ff010113
0x100000a0: 00912223 000182a3 00418493 00812423 040307b7 00048403 00112623 20178793
0x100000c0: fff18713 ffb18593 00f72023 00f5a023 00000513 02805263 00400613 00070513
0x100000e0: f89ff0ef 00100793 02f51263 00300793 00f48023 00a182a3 00c12083 00812403
0x10000100: 00412483 01010113 00008067 fff40413 00848023 00000513 fe1ff06f ff010113
0x10000120: 00112623 f31ff0ef f75ff0ef 00c12083 00a03533 01010113 00008067 04030201
0x10000140: 04030201 00010300 00000000 00000000 00000000 00000000 00000000 00000000
0x10000160: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000180: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100001a0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100001c0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100001e0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000200: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000220: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000240: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000260: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000280: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100002a0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100002c0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100002e0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000300: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000320: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000340: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000360: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x10000380: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100003a0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100003c0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x100003e0: 00000000 00000000 00000000 1000012c 00000000 00000000 00000000 10000044
```

verifyPIN_0

```
10000000 <_start>:
10000000:       00000197                auipc   gp,0x0
10000004:       14118193                addi    gp,gp,321 # 10000141 <__global_pointer$>
10000008:       2bf18113                addi    sp,gp,703 # 10000400 <__stack_pointer$>
1000000c:       00000093                li      ra,0
10000010:       00000213                li      tp,0
10000014:       00000293                li      t0,0
10000018:       00000313                li      t1,0
1000001c:       00000393                li      t2,0
10000020:       00000413                li      s0,0
10000024:       00000493                li      s1,0
10000028:       00000513                li      a0,0
1000002c:       00000593                li      a1,0
10000030:       00000613                li      a2,0
10000034:       00000693                li      a3,0
10000038:       00000713                li      a4,0
1000003c:       00000793                li      a5,0
10000040:       0dc000ef                jal     ra,1000011c <main>

10000044 <_eoc>:
10000044:       f3000297                auipc   t0,0xf3000
10000048:       fc428293                addi    t0,t0,-60 # 3000008 <status>
1000004c:       00a2a023                sw      a0,0(t0)
10000050:       10500073                wfi

Disassembly of section .text:

10000054 <initialize>:
10000054:       000182a3                sb      zero,5(gp) # 10000146 <g_authenticated>
10000058:       00300793                li      a5,3
1000005c:       00f18223                sb      a5,4(gp) # 10000145 <g_ptc>
10000060:       000181a3                sb      zero,3(gp) # 10000144 <g_countermeasure>
10000064:       00008067                ret

10000068 <byteArrayCompare>:
10000068:       00000793                li      a5,0
1000006c:       00c7c663                blt     a5,a2,10000078 <byteArrayCompare+0x10>
10000070:       00100513                li      a0,1
10000074:       00008067                ret
10000078:       00f506b3                add     a3,a0,a5
1000007c:       00f58733                add     a4,a1,a5
10000080:       0006c683                lbu     a3,0(a3)
10000084:       00074703                lbu     a4,0(a4)
10000088:       00e69663                bne     a3,a4,10000094 <byteArrayCompare+0x2c>
1000008c:       00178793                addi    a5,a5,1
10000090:       fddff06f                j       1000006c <byteArrayCompare+0x4>
10000094:       00000513                li      a0,0
```

```
1000009c <verifyPIN>:
1000009c:       ff010113                addi    sp,sp,-16
100000a0:       00912223                sw      s1,4(sp)
100000a4:       000182a3                sb      zero,5(gp) # 10000146 <g_authenticated>
100000a8:       00418493                addi    s1,gp,4 # 10000145 <g_ptc>
100000ac:       00812423                sw      s0,8(sp)
100000b0:       040307b7                lui     a5,0x4030
100000b4:       00048403                lb      s0,0(s1)
100000b8:       00112623                sw      ra,12(sp)
100000bc:       20178793                addi    a5,a5,513 # 4030201 <status+0x10301f9>
100000c0:       fff18713                addi    a4,gp,-1 # 10000140 <g_userPin>
100000c4:       ffb18593                addi    a1,gp,-5 # 1000013c <g_cardPin>
100000c8:       00f72023                sw      a5,0(a4)
100000cc:       00f5a023                sw      a5,0(a1)
100000d0:       00000513                li      a0,0
100000d4:       02805263                blez    s0,100000f8 <verifyPIN+0x5c>
100000d8:       00400613                li      a2,4
100000dc:       00070513                mv      a0,a4
100000e0:       f89ff0ef                jal     ra,10000068 <byteArrayCompare>
100000e4:       00100793                li      a5,1
100000e8:       02f51263                bne     a0,a5,1000010c <verifyPIN+0x70>
100000ec:       00300793                li      a5,3
100000f0:       00f48023                sb      a5,0(s1)
100000f4:       00a182a3                sb      a0,5(gp) # 10000146 <g_authenticated>
100000f8:       00c12083                lw      ra,12(sp)
100000fc:       00812403                lw      s0,8(sp)
10000100:       00412483                lw      s1,4(sp)
10000104:       01010113                addi    sp,sp,16
10000108:       00008067                ret
1000010c:       fff40413                addi    s0,s0,-1
10000110:       00848023                sb      s0,0(s1)
10000114:       00000513                li      a0,0
10000118:       fe1ff06f                j       100000f8 <verifyPIN+0x5c>

1000011c <main>:
1000011c:       ff010113                addi    sp,sp,-16
10000120:       00112623                sw      ra,12(sp)
10000124:       f31ff0ef                jal     ra,10000054 <initialize>
10000128:       f75ff0ef                jal     ra,1000009c <verifyPIN>
1000012c:       00c12083                lw      ra,12(sp)
10000130:       00a03533                snez    a0,a0
10000134:       01010113                addi    sp,sp,16
10000138:       00008067                ret
```