

OpenOCD 使用指南

发布版本：1.0

作者邮箱：jason.zhu@rock-chips.com

日期：2019.06

文件密级：内部资料

前言

概述

OpenOCD 使用指南。

读者对象

本文档（本指南）主要适用于以下工程师：

技术支持工程师

软件开发工程师

产品版本

修订记录

| 日期 | 版本 | 作者 | 修改说明 |
|------------|------|-----------|------|
| 2019-06-04 | V1.0 | Jason Zhu | 初始版本 |

OpenOCD 使用指南

- 1 引用参考
 - 2 术语
 - 3 测试平台
 - 4 简介
 - 5 驱动安装
 - 5.1 FT2232HL Windows 驱动安装
 - 5.2 FT2232HL Linux 驱动安装
 - 6 FT2232HL Windows 调试
 - 7 FT2232HL Linux 调试
 - 7.1 程序下载
 - 7.2 结合 telnet 调试
 - 7.3 结合 gdb 调试程序
 - 8 J-Link 支持
 - 9 OpenOCD 命令
 - 10 eclips 支持
 - 11 Rockchip 芯片支持
-

1 引用参考

[1] <https://blog.csdn.net/zhengyangliu123/article/details/54934719>

[2] [《Open On-Chip Debugger: OpenOCD User's Guide》](#)

2 术语

OpenOCD : OpenOCD 是一个用于 JTAG 调试的软件，可以用于不同调试器和 CPU，还可以与 GDB 配合，开源。

FT2232HL : FTDI 生产的芯片，它可以实现 USB 到两个串行 UART、FIFO、Bit-Bang IO 接口，并且还可以配成 MPSSE，I2C，JTAG 及 SPI 总线。

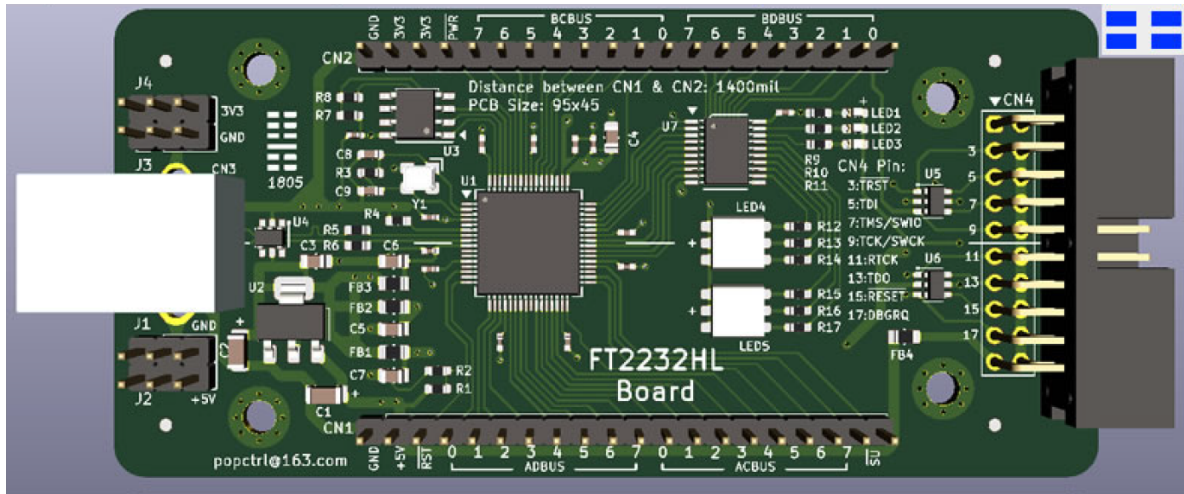
J-Link : SEGGER 公司为支持仿真 ARM 内核芯片推出的 JTAG 仿真器。

GDB : [The GNU Project Debugger](#)，GNU 开源组织发布的一个强大的 UNIX 下的程序调试工具。

3 测试平台

STM32F103 开发板

FT2232HL 仿真器



J-Link 仿真器

4 简介

本文介绍如何通过 OpenOCD 调试开发板，仿真器包括 FT2232HL 仿真器与 J-Link。

5 驱动安装

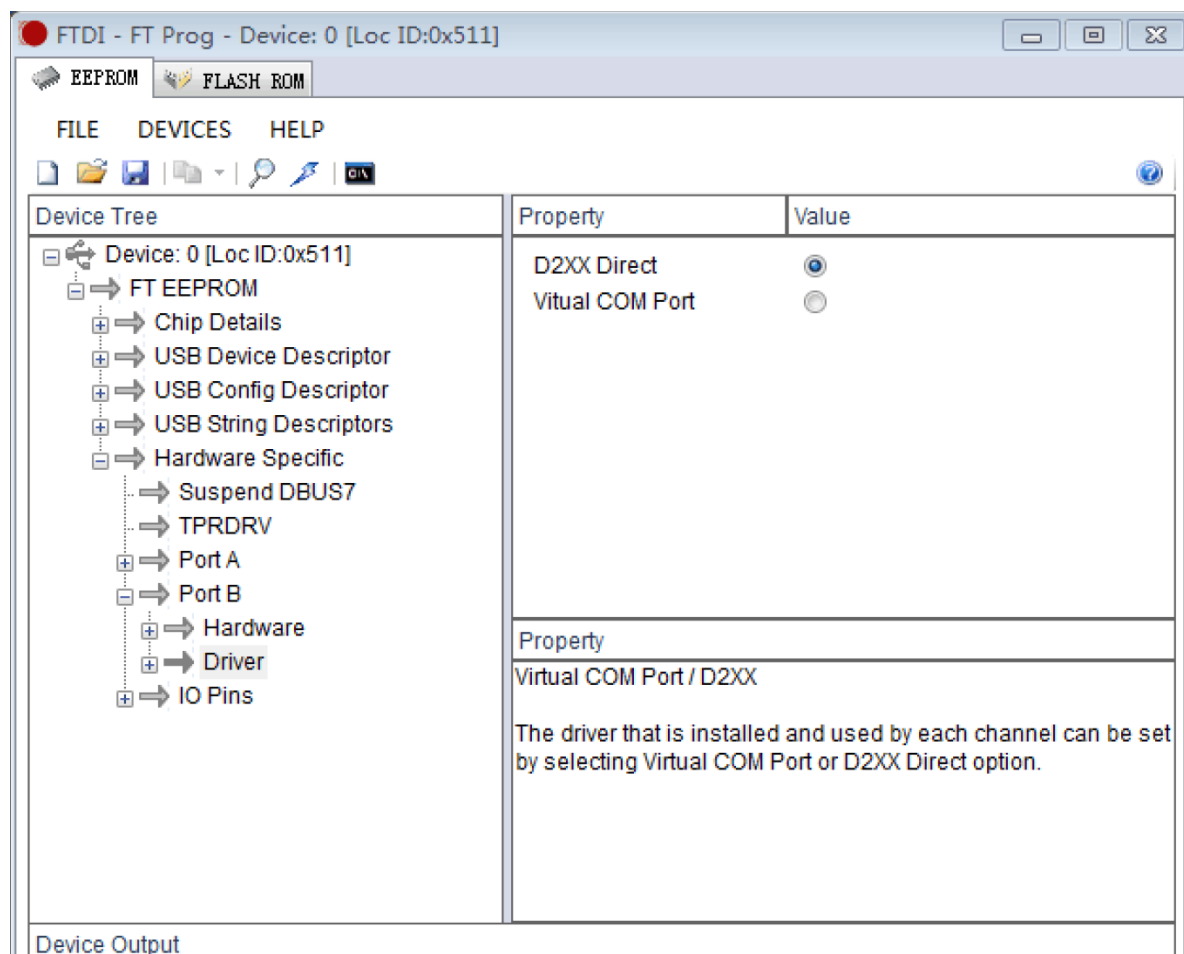
5.1 FT2232HL Windows 驱动安装

1. FT2232HL 调试板与电脑连接，会显示如下两个串口：



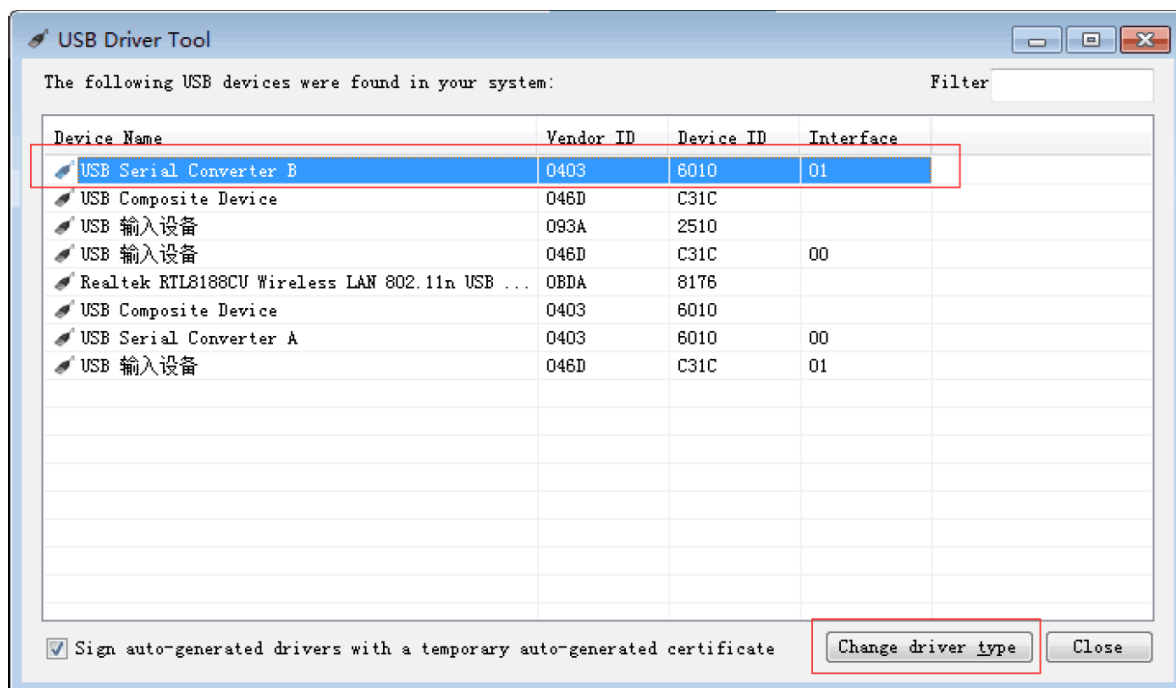
如果未出现可以[FTDI](#)官网下载对应驱动。

2. 安装 FT_Prog.exe 并运行：

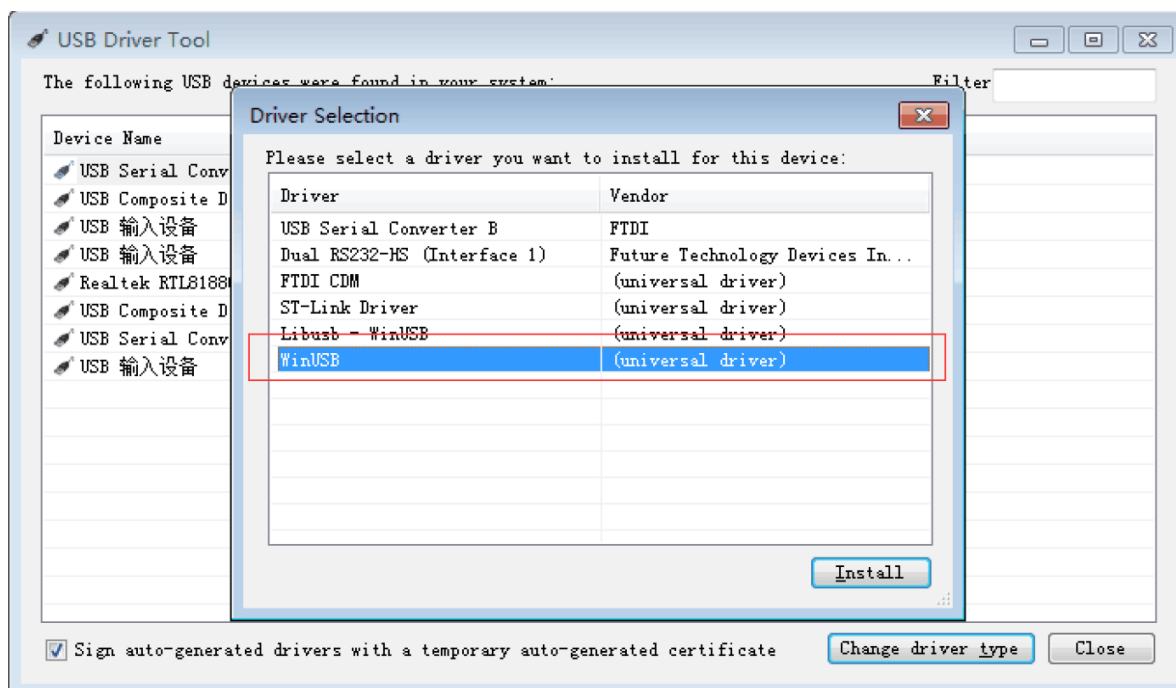


如上选择后，下载固件到 FT2232HL 调试板。

3. 运行 UsbDriverTool.exe (可以网上下载)：



选择 USB Serial Converter B，双击会弹出如下显示框：



安装 WinUSB 驱动。

5.2 FT2232HL Linux 驱动安装

新建文件 99-openocd.rules，写入如下内容：

```
SUBSYSTEM=="tty", ATTRS{idVendor}=="0403",ATTRS{idProduct}=="6010", MODE="664",
GROUP="plugdev"
SUBSYSTEM=="tty", ATTRS{idVendor}=="15ba",ATTRS{idProduct}=="002a", MODE="664",
GROUP="plugdev"
SUBSYSTEM=="usb", ATTR{idVendor}=="0403",ATTR{idProduct}=="6010", MODE="664",
GROUP="plugdev"
SUBSYSTEM=="usb", ATTR{idVendor}=="15ba",ATTR{idProduct}=="002a", MODE="664",
GROUP="plugdev"
```

把该文件拷贝到/etc/udev/rules.d/目录下。

6 FT2232HL Windows 调试

在 PowerShell 下输入：

```
openocd -f ftdi.cfg -f stm32f1x.cfg -c "halt" -c "flash write_image erase u-boot.bin 0x08000000 bin" -c "reset"
```

log 如下：

```
PS D:\openocd-0.10.0\bin-x64> .\openocd.exe -f .\ftdi.cfg -f .\stm32f1x.cfg -c init -c "halt" -c "flash write_image erase u-boot.bin 0x08000000 bin" -c "reset"
Open On-Chip Debugger 0.10.0
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
adapter speed: 1000 kHz
adapter_nsrst_delay: 100
jtag_ntrst_delay: 100
none separate
cortex_m reset_config sysresetreq
Error: libusb_open() failed with LIBUSB_ERROR_NOT_SUPPORTED
Info : clock speed 1000 kHz
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020 (STMicroelectronics), part: 0x6414, ver: 0x0)
Info : stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
auto erase enabled
Info : device id = 0x10036414
Info : flash size = 512kbytes
wrote 229376 bytes from file u-boot.bin in 9.517824s (23.535 KiB/s)
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020 (STMicroelectronics), part: 0x6414, ver: 0x0)
target halted due to breakpoint, current mode: Thread
xPSR: 0x61000000 pc: 0x2000003a msp: 0x1000f010
```

表示能够正常连接设备。

7 FT2232HL Linux 调试

7.1 程序下载

在 shell 输入：

```
openocd -f ftdi.cfg -f stm32f1x.cfg -c init -c "halt" -c "flash write_image erase u-boot.bin 0x08000000 bin" -c "reset"
```

log 如下：

```
zzz@zzz:~/code/flsdcv-openocd-0.10.0-2019.02.0-x86_64-linux-ubuntu14/bin$ ./openocd -f ftdi.cfg -f stm32f1x.cfg -c init -c "halt" -c "flash write_image erase u-boot.bin 0x08000000 bin" -c "reset"
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
adapter speed: 1000 kHz
adapter_nsrst_delay: 100
jtag_ntrst_delay: 100
none separate
cortex_m reset_config sysresetreq
Info : clock speed 1000 kHz
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020 (STMicroelectronics), part: 0x6414, ver: 0x0)
Info : stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
Info : Listening on port 3333 for gdb connections
auto erase enabled
Info : device id = 0x10036414
Info : flash size = 512kbytes
^Cwrote 229376 bytes from file u-boot.bin in 11.798333s (18.986 KiB/s)
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020 (STMicroelectronics), part: 0x6414, ver: 0x0)
target halted due to breakpoint, current mode: Thread
xPSR: 0x61000000 pc: 0x2000003a msp: 0x1000f010
Info : Listening on port 6666 for tcl connections
Info : Listening on port 4444 for telnet connections
shutdown command invoked
```

7.2 结合 telnet 调试

在 shell 内输入：

```
=> openocd -f ftdi.cfg -f stm32f1x.cfg
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
adapter speed: 1000 kHz
adapter_nsrst_delay: 100
jtag_ntrst_delay: 100
```

```
none separate
cortex_m reset_config sysresetreq
Info : Listening on port 6666 for tcl connections
Info : Listening on port 4444 for telnet connections
Info : clock speed 1000 khz
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM
Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020
(STMicroelectronics), part: 0x6414, ver: 0x0)
Info : stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
Info : Listening on port 3333 for gdb connections
Info : accepting 'telnet' connection on tcp/4444
```

在另一个 shell 输入：

```
=> telnet localhost 4444
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
Open On-Chip Debugger
>
```

输入 help，可以查看支持命令帮助：

```
> help
adapter
  adapter command group (command valid any time)
adapter usb
  usb adapter command group (command valid any time)
  adapter usb location <bus>-port[.port]...
    set the USB bus location of the USB device (configuration
    command)
adapter_khz [khz]
  with an argument, change to the specified maximum jtag speed. For
  JTAG, 0 KHz signifies adaptive clocking. with or without argument,
  display current setting. (command valid any time)
adapter_name
  Returns the name of the currently selected adapter (driver) (command
  valid any time)
adapter_nsrst_assert_width [milliseconds]
  delay after asserting SRST in ms (command valid any time)
adapter_nsrst_delay [milliseconds]
  delay after deasserting SRST in ms (command valid any time)
add_help_text command_name helptext_string
  Add new command help text; Command can be multiple tokens. (command
  valid any time)
add_script_search_dir <directory>
  dir to search for config files and scripts (command valid any time)
add_usage_text command_name usage_string
  Add new command usage text; command can be multiple tokens. (command
  valid any time)
```

7.3 结合 gdb 调试程序

在 shell 内输入：

```
=> openocd -f ftdi.cfg -f stm32f1x.cfg
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
adapter speed: 1000 kHz
adapter_nsrst_delay: 100
jtag_ntrst_delay: 100
none separate
cortex_m reset_config sysresetreq
Info : Listening on port 6666 for tcl connections
Info : Listening on port 4444 for telnet connections
Info : clock speed 1000 kHz
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM
Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020
(STMicroelectronics), part: 0x6414, ver: 0x0)
Info : stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
Info : Listening on port 3333 for gdb connections
Info : accepting 'telnet' connection on tcp/4444
```

在另一个 shell 输入：

```
=> arm-none-eabi-gdb LED_project.elf
GNU gdb (Linaro GDB 2017.01) 7.12.1.20170126-git
Copyright (C) 2017 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law. Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=x86_64-unknown-linux-gnu --target=arm-none-
eabi".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from LED_project.elf...done.
(gdb)
```

输入 target remote localhost:3333：

```
(gdb) target remote localhost:3333
Remote debugging using localhost:3333
0x00554e46 in ?? ()
(gdb)
```

下载程序：

```
(gdb) monitor reset
JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.),
part: 0xba00, ver: 0x3)
```

```
JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020
(STMicroelectronics), part: 0x6414, ver: 0x0)
stm32f1x.cpu -- clearing lockup after double fault
target halted due to debug-request, current mode: Handler HardFault
xPSR: 0x01000003 pc: 0x00554e46 msp: 0xffffffffe4
Polling target stm32f1x.cpu failed, trying to reexamine
stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
(gdb) monitor halt
(gdb) load
Loading section .note.gnu.build-id, size 0x24 lma 0x8000000
Loading section .isr_vector, size 0x134 lma 0x8000024
Loading section .text, size 0x14c8 lma 0x8000158
Loading section .init_array, size 0x4 lma 0x8001620
Loading section .fini_array, size 0x4 lma 0x8001624
Loading section .data, size 0x28 lma 0x8001628
Loading section .co_stack, size 0x400 lma 0x8001650
Start address 0x80015a0, load size 6736
Transfer rate: 4 KB/sec, 962 bytes/write.
(gdb)
```

gdb 调试 :

```
(gdb)c
Continuing.
Program received signal SIGINT, Interrupt.
0x080015b2 in Default_Reset_Handler () at USER/CoIDE_startup.c:228
228     *(pulDest++) = *(pulSrc++);
(gdb) s
226   for(pulDest = &_sdata; pulDest < &_edata; )
(gdb)
```

另一个 shell 的打印 :

```
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
  http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
adapter speed: 1000 kHz
adapter_nsrst_delay: 100
jtag_ntrst_delay: 100
none separate
cortex_m reset_config sysresetreq
Info : Listening on port 6666 for tcl connections
Info : Listening on port 4444 for telnet connections
Info : clock speed 1000 kHz
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM
Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020
(STMicroelectronics), part: 0x6414, ver: 0x0)
Info : stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
Error: stm32f1x.cpu -- clearing lockup after double fault
Polling target stm32f1x.cpu failed, trying to reexamine
Info : stm32f1x.cpu: hardware has 6 breakpoints, 4 watchpoints
Info : Listening on port 3333 for gdb connections
Info : accepting 'gdb' connection on tcp/3333
```



```
zzz@zzz:~/code/rtscv-openocd-0.10.0-2019.02.0-x86_64-linux-ubuntu4/bin$ ./openocd -f jlink.cfg -f stm32f1x.cfg -c intt -c "halt" -c "flash write_image erase u-boot.bin 0x08000000 b1n" -c "reset"
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
Info : auto-selecting first available session transport "jtag". To override use 'transport select <transport>'.
adapter speed: 1000 kHz
adapter_nsrst_delay: 100
jtag_ntrst_delay: 100
none separate
cortex_m reset config sysresetreq
Info : J-Link ARM V8 compiled Nov 28 2014 13:44:46
Info : Hardware version: 8.00
Info : WTarget = 3.287 V
Info : clock speed 1000 kHz
Info : JTAG tap: stm32f1x.cpu tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: stm32f1x.bs tap/device found: 0x06414041 (mfg: 0x020 (STMicroelectronics), part: 0x6414, ver: 0x0)
Info : stm32f1x.cpu: hardware has 0 breakpoints, 4 watchpoints
Error: stm32f1x.cpu -- clearing lockup after double fault
Polling target stm32f1x.cpu failed, trying to reexamine
Info : stm32f1x.cpu: hardware has 0 breakpoints, 4 watchpoints
Info : listening on port 3333 for gdb connections
auto erase enabled
Info : device id = 0x10036414
Info : flash size = 512Kbytes
```

其他命令操作同章节 7 FT2232HL Linux 调试。

9 OpenOCD 命令

shell 下输入 `openocd --help`，查看支持的命令，log 如下：

```
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
Open On-Chip Debugger
Licensed under GNU GPL v2
--help      | -h      display this help
--version   | -v      display openOCD version
--file      | -f      use configuration file <name>
--search    | -s      dir to search for config files and scripts
--debug     | -d      set debug level to 3
            | -d<n>   set debug level to <level>
--log_output | -l      redirect log output to file <name>
--command   | -c      run <command>
```

1. -h

查看 OpenOCD 的命令帮助。

2. -v

查看 OpenOCD 的版本，例：

```
=> openocd -v
Open On-Chip Debugger 0.10.0+dev-g672ef66-dirty (2019-03-06-06:00)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
```

3. -f

后面跟随配置文件，可以用于探测是否有板子连接，例：

连接测试板 log：

```
PS D:\openocd-0.10.0\bin-x64> .\openocd.exe -f .\ftdi.cfg
Open On-Chip Debugger 0.10.0
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
Error: libusb_open() failed with LIBUSB_ERROR_NOT_SUPPORTED
Info : clock speed 1000 kHz
Warn : There are no enabled taps. AUTO PROBING MIGHT NOT WORK!!
Info : JTAG tap: auto0.tap tap/device found: 0x3ba00477 (mfg: 0x23b (ARM Ltd.), part: 0xba00, ver: 0x3)
Info : JTAG tap: auto1.tap tap/device found: 0x06414041 (mfg: 0x020 (STMicroelectronics), part: 0x6414, ver: 0x0)
Warn : AUTO auto0.tap - use "jtag newtap auto0 tap -irlen 4 -expected-id 0x3ba00477"
Warn : AUTO auto1.tap - use "jtag newtap auto1 tap -irlen 5 -expected-id 0x06414041"
Warn : gdb services need one or more targets defined
```

未连接测试板 log :

```
PS D:\openocd-0.10.0\bin-x64> .\openocd.exe -f .\ftdi.cfg
Open On-Chip Debugger 0.10.0
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
adapter speed: 1000 kHz
Error: libusb_open() failed with LIBUSB_ERROR_NOT_SUPPORTED
Info : clock speed 1000 kHz
Warn : There are no enabled taps.  AUTO PROBING MIGHT NOT WORK!!
Error: JTAG scan chain interrogation failed: all ones
Error: Check JTAG interface, timings, target power, etc.
Error: Trying to use configured scan chain anyway...
Warn : Bypassing JTAG setup events due to errors
Warn : gdb services need one or more targets defined
```

4. -d

设置调试级别。

5. -l

后面跟随 log 输出文件。

6. -c

跟随命令，例：

```
openocd -f jlink.cfg -f stm32f1x.cfg -c init -c "halt" -c "flash write_image
erase u-boot.bin 0x08000000 bin" -c "reset"
```

10 eclips 支持

to-do

11 Rockchip 芯片支持

to-do