RISC-V MCU development boards

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Introduction

"How do I get my feet wet with RISC-V?" is a very common question, which is often answered "Buy a RISC-V development board, and practice bare metal development."

This document provides guidance on part selection, as well as pointers to useful resources. It is not a comprehensive guide of RISC-V MCU, but rather a short list of easily approachable parts. To be listed in this guide, parts **must** meet several criteria:

- have decent English documentation,
- have open-source or freely downloadable supporting software,
- be easily available from anywhere in the world, e.g. through AliExpress or LCSC,
- have cheap development boards as easily available as the chips,
- not require a Chinese mobile phone number to download software or documentation.

License

Manufacturer selection

MCU manufacturers have different product strategies, leading to different product ranges. An easy and efficient method is to select a manufacturer whose strategy matches your needs, and then see which of their parts best suits your project.

Manufacturer	*Wide supply voltage range*	*Wide package choice*	*64-bit*	*Lots of I/O pins*	*WiFi*	*BLE*	*802.15.4*
BouffaloLab			x		x	x	x
CVITEK			x				
Espressif					x	x	x
GigaDevice				x			
WCH	x	x		x		x	

Note: manufacturers are sorted in alphabetical order.

Better stay clear: Bluetrum, Canaan, domestic-only.

BouffaloLab

Chinese name: 博流智能 (or just 博流) – pinyin: bó liú zhìnéng – https://en.bouffalolab.com/

BouffaloLab only manufactures RISC-V chips, so they're undoubtedly committed to this platform. They have a wide range of IoT-oriented MCU, some with SiFive IP, others with T-Head IP. The documentation is good, but their SDK and code examples are a bit chaotic.

2023-06-27: note that this situation is improving as BouffaloLab is working on a unified SDK (bouffalo_sdk) to replace the old bl_mcu_sdk and bl_iot_sdk.

The following table presents the main differences between BouffaloLab's RISC-V SoC (not the modules):

Part	*MHz*	*RAM*	*CPU*	*Core IP*	*WiFi*	*BT*	*BLE*	*802.15.4*	*USB*	*Ethernet*	*Camera*	*AI NPU*
BL602/ BL604	192	276K	RV32IMAFC	SiFive E24	b/g/n	-	yes	-	-	-	-	-
BL702	144	132K	RV32IMAFC	SiFive E24	-	-	yes	yes	yes	-	-	-
BL704	144	132K	RV32IMAFC	SiFive E24	-	-	yes	yes	yes	yes	-	-
BL706	144	132K	RV32IMAFC	SiFive E24	-	-	yes	yes	yes	yes	yes	-
BL616/ BL618 *	320	480K	RV32IMAFCP	T-Head E907	b/g/n/ax	yes	yes	yes	yes	yes	yes	-
BL808	480	64M	RV32IMAFCP+ RV64GCV+ RV32EMC	T-Head E907 + C906 + E902	b/g/n	yes	yes	yes	yes	yes	yes	yes

***: the BL616 and BL618 are ultra-low-power wireless MCU.*

I chose to include the BL808 because it is exceedingly powerful for an MCU, but very limited for a Linux-capable SoC, so it makes sense to include it in both documents.

I didn't include the BL606P because as of 2023-06-27, BouffaloLab provides no technical documentation about it, and neither chips, nor development boards are available for purchase.

Finally, the BL604, is a higher pin count version of the BL602, and the BL618, a higher pin count version of the BL616.

Clones

The BL602 is so successful that it has clones, the LF686 (= BL602) and LF688 (= BL604) by LeapFive, and the TG7100C (= BL602) by T-Head (developed for Tmall).

Advice to beginners

Pine64 has released a well-documented development board (PineCone) and a module (PineNut), both based on the BL602 MCU, and Lee Lup Yuen has produced excellent training material for this board, so this is what you want to use for your first steps.

Energy efficiency

Since the early days of the BL602, BouffaloLab has always paid attention to energy efficiency. This commitment is confirmed today by the priority they give to the BL616/618, their ultra-low-power MCU. If they meet your needs, these are the MCU you want to focus on.

Compute power & embedded AI

The BL808 is a great choice for applications that need significant compute power while staying energy efficient, and for applications incorporating AI-based features.

Documentation, SDK and tools

Data sheets & reference manuals: https://github.com/bouffalolab/bl_docs

SDK:

- https://github.com/bouffalolab/bouffalo_sdk (newer SDK)
- https://github.com/bouffalolab/bl_iot_sdk (older SDK)
  Note: the older SDK may still be needed until the newer has full peripheral coverage (e.g. to use WiFi on the BL808).
- https://dev.bouffalolab.com/download

Flashing tool (BlDevCube): https://github.com/bouffalolab/flash_tools

GitHub: https://github.com/bouffalolab

Developer forum: https://bbs.bouffalolab.com/t/english-forum

OpenBouffalo wiki, covers many practical details: https://openbouffalo.org/

Interesting information not found in BouffaloLab documents: https://github.com/pine64/

BL602

Third-party development board: PineCone

Purchase link: https://pine64.com/product/pinecone-bl602-evaluation-board/

Documentation: https://wiki.pine64.org/wiki/PineCone

Review: https://lupyuen.github.io/articles/pinecone

Tutorials: https://lupyuen.github.io/articles/book

Third-party development board: Ai-WB2 series

Purchase links (Ai-WB2-12F-Kit: 11 I/O):

- https://www.aliexpress.com/item/1005004911487557.html
- https://www.aliexpress.com/item/1005005287884896.html
- https://www.aliexpress.com/item/1005005742607807.html
- https://www.aliexpress.com/item/1005005256873547.html

Purchase links (Ai-WB2-13-Kit: 11 I/O):

- https://www.aliexpress.com/item/1005004911837141.html
- https://www.aliexpress.com/item/1005005287884896.html
- https://www.aliexpress.com/item/1005005256844150.html
- https://www.aliexpress.com/item/1005005699841474.html

Purchase links (Ai-WB2-32S-Kit: 15 I/O):

- https://www.aliexpress.com/item/1005004911645385.html
- https://www.aliexpress.com/item/1005005287884896.html
- https://www.aliexpress.com/item/1005005256875832.html
- https://www.aliexpress.com/item/1005005697279606.html

Documentation: https://docs.ai-thinker.com/en/wb2

GitHub: https://github.com/Ai-Thinker-Open/Ai-Thinker-WB2

Third-party development board: DT-BL10 or XT-BL12

Purchase links:

- https://www.aliexpress.com/item/1005005083839351.html
- https://www.aliexpress.com/item/1005001762587381.html
- https://www.aliexpress.com/item/1005003695650307.html
- https://www.aliexpress.com/item/1005004477041228.html

Documentation: https://xzrnllk27j.k.topthink.com/@xgr3x6lrjy/BL602.html

BL702

Third-party development board: M0 Sense

Purchase links:

- https://www.aliexpress.com/item/1005005373072135.html
- https://www.aliexpress.com/item/1005005686395980.html
- https://www.aliexpress.com/item/1005005363184503.html
- https://www.aliexpress.com/item/1005005372923816.html
- https://www.aliexpress.com/item/1005005012406688.html

Documentation: https://dl.sipeed.com/shareURL/Maix-Zero/M0sense

GitHub: https://github.com/sipeed/M0sense_BL702_example

Third-party development board: XT-ZB1

Purchase links:

- https://www.aliexpress.com/item/1005004477055377.html
- https://www.aliexpress.com/item/1005003695882418.html
- https://www.aliexpress.com/item/1005003747200098.html
- https://www.aliexpress.com/item/1005004134568356.html
- https://www.aliexpress.com/item/1005004705201239.html

Documentation: https://xzrnllk27j.k.topthink.com/@xgr3x6lrjy/BL702.html

BL616

Third-party development board: M0S Dock

Purchase links:

- https://www.aliexpress.com/item/1005005373075939.html
- https://www.aliexpress.com/item/1005005286453236.html
- https://www.aliexpress.com/item/1005005261055758.html
- https://www.aliexpress.com/item/1005005743601410.html
- https://www.aliexpress.com/item/1005005142466936.html

Documentation: https://dl.sipeed.com/shareURL/Maix-Zero/M0S

GitHub: https://github.com/sipeed/M0S_BL616_example

Third-party development board: Ai-M62-12F

Purchase links:

- https://www.aliexpress.com/item/1005005553858124.html
- https://www.aliexpress.com/item/1005005742683460.html
- https://www.aliexpress.com/item/1005005407942430.html
- https://www.aliexpress.com/item/1005005438854506.html

Documentation: https://docs.ai-thinker.com/en/ai_m62

GitHub: https://github.com/Ai-Thinker-Open/aithinker_Ai-M6X_SDK

BL618

Third-party development board: M0P Dock

Purchase links:

- https://www.aliexpress.com/item/1005005505353135.html
- https://www.aliexpress.com/item/1005005505242737.html
- https://www.aliexpress.com/item/1005005434411547.html
- https://www.aliexpress.com/item/1005005461103465.html

Documentation: https://dl.sipeed.com/shareURL/Maix-Zero/M0P

GitHub: https://github.com/sipeed/M0P_BL618_examples

Third-party development board: Ai-M61-32S

Purchase links:

https://www.aliexpress.com/item/1005004486335583.html
https://www.aliexpress.com/item/1005005525538426.html
https://www.aliexpress.com/item/1005005407539968.html
https://www.aliexpress.com/item/1005005407935386.html

Documentation: https://docs.ai-thinker.com/en/ai_m61

GitHub: https://github.com/Ai-Thinker-Open/aithinker_Ai-M6X_SDK

BL808

Third-party development board: Ox64

Purchase link: https://pine64.com/product-category/ox64/

Documentation: https://wiki.pine64.org/wiki/Ox64

Third-party development board: M1S Dock

Purchase links:

https://www.aliexpress.com/item/1005004996572935.html
https://www.aliexpress.com/item/1005004996668405.html
https://www.aliexpress.com/item/1005004996731092.html
https://www.aliexpress.com/item/1005004970779483.html

Documentation: https://dl.sipeed.com/shareURL/MAIX/M1s

GitHub:

https://github.com/sipeed/M1s_BL808_example
https://github.com/sipeed/M1s_BL808_SDK
https://github.com/sipeed/M1s_BL808_Linux_SDK

CVITEK

Chinese name: 晶视智能 – Pinyin: jīng shì zhìnéng

CV1800B

Third-party development board: Milk-V Duo

Being Linux-capable, the Milk-V Duo is comparable to some extent to the Ox64, including price-wise. The CV1800B includes two C906 cores, one fully-fledged, the other stripped down (no V extension, 700MHz instead of 1GHz), meaning no SMP (Symmetric Multi-Processing).

This design decision both greatly limits its interest as a Linux platform, and prevents its use in low-power applications (which the BL808 is suitable for). However, it might still be useful in applications where the compute power of two 64-bit cores is required but can accommodate limited memory (64MB).

The Milk-V Duo also comes with FreeRTOS support (included in duo-buildroot-sdk).

Note: as of 2023-08-03, a significant documentation effort has been made, including English versions, which bodes well for the future, including for other Milk-V products.

Purchase links:

- https://www.aliexpress.com/item/1005005699023966.html
- https://www.aliexpress.com/item/1005005699176591.html
- https://www.aliexpress.com/item/1005005699215618.html
- https://www.aliexpress.com/item/1005005866947535.html
- https://www.aliexpress.com/item/1005005963211206.html

Documentation & SDK:

- https://milkv.io/docs/duo (start here)
- https://milkv.io/duo (see pinout at bottom of page)
- https://github.com/milkv-duo (duo-files, hardware, duo-buildroot-sdk)
- https://github.com/milk-v (cvitek-host-tools)
- https://community.milkv.io/c/duo/5 (forum)

Espressif

Chinese name: 乐鑫科技 – Pinyin: lè xīn kējì – https://www.espressif.com/

Espressif is famous for their Xtensa-based ESP32 and ESP32-S3 modules, but they also announced their new developments would be made on RISC-V, so interesting things are to be expected from them. Like BouffaloLab, they focus on IoT-oriented MCU.

Their current RISC-V product range includes the ESP32-C2/ESP8684, ESP32-C3/ESP8685, ESP32-C6, and ESP32-H2.

The following table presents the main differences between Espressif's RISC-V SoC (not the modules):

Part	*Pins*	*CPU*	*MHz*	*RAM*	*Max. flash*	*WiFi*	*BLE*	*802.15.4*	*Notes*
ESP8684	24	RV32IMC	120	272K	4M	b/g/n	yes	-	Aka. ESP32-C2
ESP32-C3	32	RV32IMC	160	400K	4M	b/g/n	yes	-	
ESP8685	28	RV32IMC	160	400K	4M	b/g/n	yes	-	
ESP32-C6	40	RV32IMAC	160	512K	4M	b/g/n/ax	yes	yes	Has 2 CPU (one low power)
ESP32-H2	32	RV32IMAC	96	320K	4M	-	yes	yes	Low-power applications

GitHub: https://github.com/espressif

The SDK for all Espressif products is called **ESP-IDF**. It is available from GitHub, or can be downloaded from there: https://www.espressif.com/en/support/download/all?keys=&field_type_tid%5B%5D=785

ESP8684 (ESP32-C2)

Official development board: ESP8684-DevKitM-1

Purchase link: https://www.aliexpress.com/item/1005004436990376.html

Documentation: https://docs.espressif.com/projects/espressif-esp-dev-kits/en/latest/esp8684/esp8684-devkitm-1/index.html

Official development board: ESP8684-DevKitC-02

Purchase link: https://www.aliexpress.com/item/1005004693162839.html

Documentation: https://docs.espressif.com/projects/espressif-esp-dev-kits/en/latest/esp8684/esp8684-devkitc-02/index.html

Third-party development board: ESPC2-12

Purchase links:

https://www.aliexpress.com/item/1005004861021167.html
https://www.aliexpress.com/item/1005004708803007.html

Documentation: http://bbs.doit.am/forum.php?mod=viewthread&tid=489&extra=page%3D1

Documentation

https://www.espressif.com/en/support/documents/technical-documents?keys=&field_type_tid%5B%5D=956

Relevant documents are *ESP8684 Datasheet*, *ESP8684 Technical Reference Manual, and ESP32-C2 Series SoC Errata*.

ESP32-C3 and ESP8685

Official development board: ESP32-C3-DevKitM-1

Purchase link: https://www.aliexpress.com/item/1005003989099547.html

Documentation: https://docs.espressif.com/projects/esp-idf/en/latest/esp32c3/hw-reference/esp32c3/user-guide-devkitm-1.html

Official development board: ESP32-C3-DevKitC-02

Purchase link: https://www.aliexpress.com/item/1005004443594655.html

Documentation: https://docs.espressif.com/projects/esp-idf/en/latest/esp32c3/hw-reference/esp32c3/user-guide-devkitc-02.html

Third-party development board: ESP32-C3FH4

Purchase link: https://www.aliexpress.com/item/1005004960064227.html

Documentation: https://github.com/WeActStudio/WeActStudio.ESP32C3CoreBoard

Third-party development board: nanoESP32-C3

Purchase link: https://www.aliexpress.com/item/1005003081928629.html

Documentation: https://github.com/wuxx/nanoESP32-C3

Third-party development board: YD-ESP32-C3

Purchase links:

https://www.aliexpress.com/item/1005004639250865.html
https://www.aliexpress.com/item/1005003613170790.html

Documentation: http://www.vcc-gnd.com/

Breaks the ESP32-C3's USB interface out and provides a separate USB-to-serial interface.

Third-party development board: XIAO ESP32C3

Purchase link: https://www.aliexpress.com/item/33011482127.html

Documentation: https://wiki.seeedstudio.com/XIAO_ESP32C3_Getting_Started/

Third-party development board: ESP32C3-MINI-DK

Purchase links:

- https://www.aliexpress.com/item/1005004994621831.html
- https://www.aliexpress.com/i/1005004945580114.html
- https://www.aliexpress.com/item/1005004945500567.html

Has similar features as the ESP32-C3-DevKitC-02 except uses ESP32-C3-MINI-1 instead of ESP32-C3-WROOM-02 and CH340 instead of CP2102, and costs half the price.

Third-party development board: ESP32-C3 Mini

Purchase links:

- https://www.aliexpress.com/item/1005005780121305.html
- https://www.aliexpress.com/item/1005005757810089.html
- https://www.aliexpress.com/item/1005005692188666.html

Ultra-miniature development board with 16 pins and a ceramic antenna.

Third-party development board: 01Space ESP32-C3FH4-RGB

Purchase links:

- https://www.aliexpress.com/item/1005005608527939.html
- https://www.aliexpress.com/item/1005005872253063.html
- https://www.aliexpress.com/item/1005005686520654.html
- https://www.aliexpress.com/item/1005005037654381.html
- https://www.aliexpress.com/item/1005005377159331.html

Ultra-miniature development board with ceramic antenna and 25 x WS2812 on the back.

GitHub: https://github.com/01Space/ESP32-C3FH4-RGB

Documentation

https://www.espressif.com/en/support/documents/technical-documents?keys=&field_type_tid%5B%5D=785

Relevant documents are *ESP32-C3 Datasheet*, *ESP32-C3 Technical Reference Manual*, and *ESP32-C3 Series SoC Errata*.

ESP32-C6

Official development board: ESP32-C6-DevKitM-1

Purchase link: https://www.aliexpress.com/item/1005005087127863.html

Documentation: https://docs.espressif.com/projects/espressif-esp-dev-kits/en/latest/esp32c6/esp32-c6-devkitm-1/index.html

Official development board: ESP32-C6-DevKitC-1

Purchase link: https://www.aliexpress.com/item/1005005087160183.html

Documentation: https://docs.espressif.com/projects/espressif-esp-dev-kits/en/latest/esp32c6/esp32-c6-devkitc-1/index.html

Third-party development board: WeAct ESP32-C6-A

Purchase link: https://www.aliexpress.com/item/1005005569520224.html

Compatible with ESP32-C6-DevKitC-1.

GitHub: https://github.com/WeActStudio/WeActStudio.ESP32-C6-A

Third-party development board: nanoESP32-C6

Purchase link: https://www.aliexpress.com/item/1005005508686571.html

GitHub: https://github.com/wuxx/nanoESP32-C6

Documentation

Data sheets & reference manuals:
https://www.espressif.com/en/support/documents/technical-documents?keys=&field_type_tid%5B%5D=1177

Relevant documents are *ESP32-C6 Datasheet*, *ESP32-C6 Technical Reference Manual*.

ESP32-H2

Official development board: ESP32-H2-DevKitM-1

Purchase link: https://www.aliexpress.com/item/1005005252175587.html

Documentation: https://docs.espressif.com/projects/espressif-esp-dev-kits/en/latest/esp32h2/esp32-h2-devkitm-1/index.html

Documentation

https://www.espressif.com/en/support/documents/technical-documents?keys=&field_type_tid%5B%5D=1211

Relevant documents are *ESP32-H2 Datasheet*, and *ESP32-H3 Technical Reference Manual*.

GigaDevice

Chinese name: 兆易创新 – Pinyin: zhào yì chuàngxīn – https://www.gd32mcu.com/en

While GigaDevice have largely developed their ARM MCU portfolio in the past years, the GD32VF103 is still their only one RISC-V MCU. It's a very interesting part, but unfortunately out-of-stock to date (June 2023), and GigaDevice not being committed to RISC-V doesn't bode well of its future. Anyway, there are still development boards available for the GD32VF103 and plenty of articles and tutorials can be found on the web, so you might want to give it a try.

The GD32VF103 is based on the Nuclei N200 "Bumblebee" core.

Official development board: GD32VF103C-START

Purchase link: https://www.lcsc.com/product-detail/C432220.html

Note: this evaluation board includes GigaDevice's GDLink programmer.

Third-party development board: Longan Nano

Purchase links:

https://www.aliexpress.com/item/1005002542610332.html
https://www.aliexpress.com/item/1005003467064600.html

Documentation: https://github.com/sipeed/Longan-DOC

Downloads: https://dl.sipeed.com/shareURL/LONGAN/Nano

Note: an additional JTAG adapter is needed to program the chip. If you don't already have one (e.g. JLink), you can buy Sipeed's USB-JTAG/TTL.

Purchase link: https://www.aliexpress.com/item/1005002714665888.html

Documentation, SDK and tools

Download URL: https://www.gd32mcu.com/en/download?kw=GD32VF1

Data sheets & reference manuals: relevant documents are *GD32VF103xx Datasheet* and *GD32VF103 User Manual*.

SDK: relevant archive is *GD32VF103 Firmware Library*.

WCH

Chinese name: 南京沁恒 (or just 沁恒) – Pinyin: nánjīng qìn héng – https://wch-ic.com/

WCH provides a much wider range of RISC-V MCU than any other manufacturer. For this reason, each chip has its own section below.

WCH's offer is divided in 2 families, the general purpose CH32V*xxx* series, which are the RISC-V equivalents of their ARM CH32F*xxx* series, and the more specialised CH*xxx* series, which use a slightly different peripheral set.

An interesting thing to note is the CH32V003 doesn't have an ARM equivalent, which could be a hint that, like Espressif, WCH will continue to concentrate their efforts on their RISC-V products.

The following table presents the main differences between WCH's RISC-V MCU:

Part+GitHub	*CPU*	*Core*	*MHz*	*Flash*	*RAM*	*Voltage*	*Notes*
CH32V003	RV32EC	V2A	48	16K	2K	2.7-5.5V	Low pin count (8, 16, 20)
CH32X035	RV32IMAC	V4C	48	62K	20K	2.0-5.5V	USB PD, PIOC, OpAmp / PGA / comp.
CH32V103	RV32IMAC	V3A	80	64K	20K	2.7-5.5V	
CH32L103	RV32IMAC	V4C	96	64K	20K	2.4-3.6V	USB PD, OpAmp / PGA / comp.
CH32V203	RV32IMAC	V4B	144	128K	64K	2.4-3.6V	LQFP-64 has Ethernet
CH32V208	RV32IMAC	V4C	144	128K	64K	2.4-3.6V	BLE + Ethernet
CH32V303	RV32IMAFC	V4F	144	256K	64K	2.4-3.6V	
CH32V305	RV32IMAFC	V4F	144	128K	32K	2.4-3.6V	
CH32V307	RV32IMAFC	V4F	144	256K	64K	2.4-3.6V	Has Ethernet. LQFP-100 has DVP & FSMC
CH565	RV32IMAC	V3A	120	448K	96K	2.3-3.6V	USB 3.0, Gb Ethernet, EMMC, DVP
CH569	RV32IMAC	V3A	120	448K	96K	2.3-3.6V	USB 3.0, Gb Ethernet, EMMC, HSPI
CH573/571	RV32IMAC	V3A	60	448K	16K	2.3-3.6V	Superseded by the CH582
CH583/582	RV32IMAC	V4A	80	448K	30K	2.3-3.6V	BLE, ultra low power
CH592/591	RV32IMAC	V4C	80	448K	24K	2.3-3.6V	BLE, ultra low power, LCD controller
CH643	RV32IMAC	V4C	48	62K	20K	2.0-5.5V	USB PD, PIOC, RGB LED PWM

PIOC: programmable I/O protocol controller / PGA: programmable gain amplifier

Note: Development boards for the CH643 are not available yet as of 2023-08-03.
Development boards for the CH573 have intentionally been omitted.

For further details, here is a selection table covering the whole WCH offer:
https://special.wch.cn/en/mcu/

Note: all WCH MCU SDK include the schematics of the official evaluation boards as reference design.

GitHub: https://github.com/openwch

Programmer / debugger

A proprietary programmer / debugger is needed to flash WCH chips, the WCH-LinkE. It includes both the programmer/debugger, and a USB-to-serial adapter, eliminating the need for a separate device.

Purchase links:

https://www.aliexpress.com/item/1005004881582037.html
https://www.aliexpress.com/item/1005004964197577.html
https://www.aliexpress.com/item/1005005244468643.html

One is already included with the CH32V003 evaluation kit, and the CH32V003 + CH32V203 evaluation kit combo from WCH.

Note: you may also come across the WCH-Link (without final E) on AliExpress. It is the predecessor of the WCH-LinkE and does not support the CH32V003/CH32X035/CH643.

Documentation:

User manual: https://www.wch-ic.com/downloads/WCH-LinkUserManual_PDF.html
Schematic diagram: https://www.wch.cn/downloads/WCH-LinkSCH_PDF.html
JTAG upgrade utility for WCH-LinkE-R0-1v3:
https://www.wch.cn/downloads/WCHLinkEJtagUpdTool_ZIP.html

Working mode

The WCH-LinkE and WCH-Link have 2 distinct working modes, ARM and RISC-V. When the blue LED is on, the device is in ARM mode and cannot be used with RISC-V MCU.

The WCH-LinkE has a "ModeS" push button to toggle the working mode. Remove the transparent plastic case, and hold "ModeS" down while plugging the device in a USB port, this will change the working mode and save it so you don't have to repeat the operation the next time you use it.

Older WCH-Link don't have this button. To toggle the working mode, you need to short TX to GND while plugging the device in a USB port. The new mode will also be saved.

Flashing utility

WCH provides 3 flashing tools, WCHISPTool (Windows application, recommended), WCHISPTool_CMD (multi-platform command-line tool), and WCH-LinkUtility (Windows application). MounRiver Studio includes its own flashing utility, which looks a lot like WCH-LinkUtility.

Download links:

https://www.wch.cn/downloads/WCHISPTool_Setup_exe.html
https://www.wch.cn/downloads/WCHISPTool_CMD_ZIP.html
https://www.wch.cn/downloads/WCH-LinkUtility_ZIP.html

Notes to Linux users

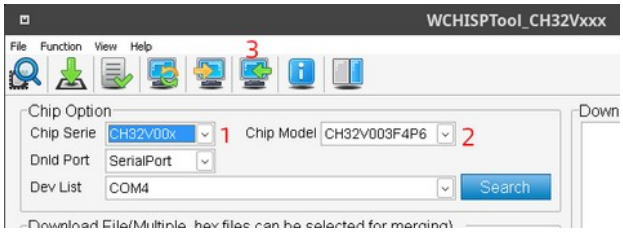
WCHISPTool's main executable is unusable under Wine, but independent executables for each MCU series are provided under its installation directory and those work quite well.

To run it, let's say you installed WCHISPTool in ~/.wine/drive_c/WCHISPTool and you want to flash a CH582M, open a terminal window and type:

```
cd ~/.wine/drive_c/WCHISPTool
wine WCHISPTool_CH57x-59x/WCHISPTool_CH57x-59x.exe
```

Alternatively, you can add ~/.wine/drive_c/WCHISPTool to the Windows PATH and directly run the appropriate executable with Wine.

WCHISPTool_CMD, the multi-platform command-line tool, uses configuration files generated by WCHISPTool. To create one, start the WCHISPTool variant matching your MCU series, select the chip series (1), the chip model (2), click the "Save UI config" button (3) and save it in your project's source folder.



You can also flash your MCU with OpenOCD, but you must first unlock the flash write protection using the WCHISPTool matching its series.

Finally, WCH-LinkUtility runs correctly under Wine.

MounRiver IDE

MounRiver Community Edition is an Eclipse-based IDE supporting all RISC-V and ARM WCH MCU, available for Windows, Linux and Mac.

Download link: http://www.mounriver.com/download

Stand alone tool chain

WCH provides modified versions of OpenOCD and GCC to support their MCU's specific features. These are included with MounRiver, but can also be downloaded separately through MounRiver's download page, e.g. for installation on a continuous integration server.

Alternatives to WCH tools

If you would like to use mainstream GCC instead of WCH's, or to try an open-source flashing tool, the following Reddit threads will be of interest to you:

https://www.reddit.com/r/RISCV/comments/115u6i9/comment/j94xvpq/
https://www.reddit.com/r/RISCV/comments/126262j/

CH32V003

Official development board

Purchase link: https://www.aliexpress.com/item/1005004895791296.html

Third-party development board: CR-CH32VXX

Purchase links:

- https://www.aliexpress.com/item/1005005878452720.html
- https://www.aliexpress.com/item/1005005879547898.html
- https://www.aliexpress.com/item/1005005870406150.html
- https://www.aliexpress.com/item/1005005871348984.html
- https://www.aliexpress.com/item/1005005910184015.html

Note: unlike other boards, this one doesn't have a crystal, so **all GPIO pins are available**.

Third-party development board: nanoCH32V003

Purchase links:

- https://www.aliexpress.com/item/1005005221751705.html
- https://www.aliexpress.com/item/1005005222228477.html

Documentation: https://github.com/wuxx/nanoCH32V003

Third-party development board: QSZNTEC CH32V003

Purchase links:

- https://www.aliexpress.com/item/1005004964355080.html
- https://www.aliexpress.com/item/1005005137124754.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V003DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32V003RM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV2_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V003EVT_ZIP.html

CH32V103

Official development board

Purchase links:

- https://www.lcsc.com/product-detail/C2943983.html (C8T6)
- https://www.lcsc.com/product-detail/C2943982.html (R8T6)
- https://www.aliexpress.com/item/1005004607642695.html (C8T6, R8T6)

Third-party development board: CH32V103C_MINI = 303CH32VC02

Purchase links:

- https://www.aliexpress.com/item/1005005246058814.html
- https://www.aliexpress.com/item/1005005245923411.html
- https://www.aliexpress.com/item/1005005239569091.html
- https://www.aliexpress.com/item/1005005226811776.html
- https://www.aliexpress.com/item/1005005138899141.html

Third-party development board: CH32V103R_MINI = 303CH32MI01

Purchase links:

- https://www.aliexpress.com/item/1005005768751075.html
- https://www.aliexpress.com/item/1005005804959082.html
- https://www.aliexpress.com/item/1005004569522706.html
- https://www.aliexpress.com/item/1005005786828189.html
- https://www.aliexpress.com/item/1005005845811065.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V103DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32xRM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV3_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V103EVT_ZIP.html

CH32V203

Official development boards

Purchase links:

- https://www.aliexpress.com/item/1005004493040662.html (CH32V203C8T6)
- https://www.aliexpress.com/item/1005005335685988.html (F6P6, F8P6, G6U6, G8R6)

Third-party development board: BluePill+ CH32V203

Purchase link: https://www.aliexpress.com/item/1005001474741936.html

Documentation: https://github.com/WeActStudio/WeActStudio.BluePill-Plus-CH32

Note: this board initially shipped with a CH32V103C8T6, but now uses a CH32V203C8T6.

Third-party development board: nanoCH32V203

Purchase link: https://www.aliexpress.com/item/1005004908206775.html

Documentation: https://github.com/wuxx/nanoCH32V203

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V203DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V20XEVT_ZIP.html

CH32V208

Official development board

Purchase link: https://www.aliexpress.com/item/1005004924242063.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V208DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V20XEVT_ZIP.html

CH32V303

Official development board

Purchase link: https://www.aliexpress.com/item/1005005444077007.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V307DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V307EVT_ZIP.html

CH32V305

Third-party development board: nanoCH32V305

Purchase links:

https://www.aliexpress.com/item/1005005033298927.html
https://www.aliexpress.com/item/1005005705171817.html
https://www.aliexpress.com/item/1005005180667965.html

Documentation: https://github.com/wuxx/nanoCH32V305

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V307DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V307EVT_ZIP.html

CH32V307

Official development board

Purchase links:

https://www.aliexpress.com/item/1005004329125620.html
https://www.lcsc.com/product-detail/C2943980.html

Third-party development board: YD-CH32V307VC

Purchase links:

https://www.aliexpress.com/item/1005004367173443.html
https://www.aliexpress.com/item/1005005882943775.html
https://www.aliexpress.com/item/1005005871739964.html
https://www.aliexpress.com/item/1005005887620227.html
https://www.aliexpress.com/item/1005005933803835.html

Documentation: http://www.vcc-gnd.com/

Third-party development board: YD-CH32V307RC

Purchase link: https://www.aliexpress.com/item/1005005175711704.html

Third-party development board: CH32V307RC-MINI

Purchase link: https://www.aliexpress.com/item/1005005175678285.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32V307DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32V307EVT_ZIP.html

CH32X035

Official development board

Purchase link: https://www.aliexpress.com/item/1005005718558442.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH32X035DS0_PDF.html

Reference manual: http://wch-ic.com/downloads/CH32X035RM_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH32X035EVT_ZIP.html

CH565

Official development board

Purchase link: https://www.aliexpress.com/item/1005004346104186.html

Documentation and SDK

Same as CH569.

CH569

Official development board

Purchase links:

https://www.lcsc.com/product-detail/C3001176.html
https://www.aliexpress.com/item/1005004328816871.html

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH569DS1_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV3_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH569EVT_ZIP.html

CH582 / CH583

Official development board

Purchase links:

https://www.lcsc.com/product-detail/C2943981.html (CH582M)
https://www.aliexpress.com/item/1005005060737000.html (CH582M and CH583M)
https://www.aliexpress.com/item/1005005493310632.html (CH583M)
https://www.aliexpress.com/item/1005004346585597.html (CH582F)

Third-party development board: YD-CH58x

Purchase links:

https://www.aliexpress.com/item/1005005305938011.html
https://www.aliexpress.com/item/1005004787513484.html
https://www.aliexpress.com/item/1005004794466027.html

Documentation: http://www.vcc-gnd.com/

Can be programmed and debugged using OpenOCD and a WCH-Link or WCH-LinkE programmer, so is suitable for use with Linux.

Third-party development board: 303CH582M01

Purchase links:

https://www.aliexpress.com/item/1005005488527985.html
https://www.aliexpress.com/item/1005005457754241.html
https://www.aliexpress.com/item/1005005458836770.html
https://www.aliexpress.com/item/1005005467071580.html
https://www.aliexpress.com/item/1005005456987838.html

Similar to YD-CH58x. After ordering, ask the seller for schematic diagram. Uses the USB C connector for programming, which at the moment only works under Windows.

Documentation and SDK

Data sheet: http://wch-ic.com/downloads/CH583DS1_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH583EVT_ZIP.html

CH592 / CH591

Official development board

Purchase link: https://www.aliexpress.com/item/1005005884261132.html

Documentation and SDK

Data sheet: https://wch-ic.com/downloads/CH592DS1_PDF.html

Processor manual: http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html

SDK: https://www.wch.cn/downloads/CH592EVT_ZIP.html

BLUETRUM

Chinese name: 中科蓝讯 – Pinyin: zhōng kē lán xùn – https://www.bluetrum.com/

AB5301A

Official development board: AB32VG1 "blue board" (aka. prougen)

Purchase links:

- https://www.aliexpress.com/item/1005003476403583.html
- https://www.aliexpress.com/item/1005003569918832.html
- https://www.aliexpress.com/item/1005003124829942.html

Third-party development board: AB32VG1 "green board"

Purchase links:

- https://www.aliexpress.com/item/1005003547381454.html
- https://www.aliexpress.com/item/1005003700027776.html
- https://www.aliexpress.com/item/1005003547529433.html
- https://www.aliexpress.com/item/1005003619461823.html
- https://www.aliexpress.com/item/1005003594401351.html

Common description

The only difference between the two boards is the PCB layout, all the rest is identical. The green version has the advantage of being much cheaper and more easily available than the blue version.

These boards are available through AliExpress, but their documentation is only partially available in English, and they are supported by the RT-Thread RTOS.

This means that these boards are not for beginners, and you must be willing to Google Translate some Chinese documents and/or blog posts, but provided you have a first experience with another Bluetooth MCU, you should not hit major roadblocks.

Documentation & SDK:

- https://github.com/BLUETRUM
- https://gitee.com/bluetrum/bluetrum_sdk
- https://www.cnx-software.com/2021/09/12/getting-started-with-bluetrum-ab32vg1-risc-v-bluetooth-audio-board-using-rt-thread/
- https://ab32vg1-example.readthedocs.io/zh/latest/
- https://docs.qq.com/doc/DTVVWWXpLRVl6cER2

Canaan

Chinese name: 嘉楠科技 – Pinyin: jiā nán kējì – https://www.canaan.io/

Canaan produces the Kendryte series, 64-bit RISC-V MCU intended for edge AI.

Canaan has the detestable habit of been quite shy about their products, so you won't be able to find a proper data sheet and technical reference manual, which all other silicon vendors proudly offer on their web sites.

They have a developer forum, but it hasn't seen a new message in the last 12 months: https://developer.canaan.io/

Their GitHub account offers downloads (IDE, SDK), but no decent documentation: https://github.com/kendryte

A cursory look at GitHub reveals that many people have played with their chips, so you may possibly get the information you need by browsing their repositories.

Before you buy a development board, it is wise to ask the seller if they can provide you with documentation. Most of the time, supporting material is made available on Baidu, which cannot be used outside China. Some sellers provide these materials on download sites accessible from the rest of the world, but not all do.

Some board manufacturers have a web site, so can also ask them directly.

K210

The K210 features 2 RV64IMAFDC cores running at 400MHz, 8MB SRAM, a neural network processor, and an audio processor. It was released in 2018, so it's a bit old now (2023), but development boards are still available.

Superficial data sheet: https://github.com/kendryte/kendryte-doc-datasheet

Third-party development boards: Sipeed Maix series

Purchase links:

- https://www.aliexpress.com/item/1005002802675701.html (Maix Amigo)
- https://www.aliexpress.com/item/1005002624234145.html (Maix Cube)
- https://www.aliexpress.com/item/1005002569741906.html (Maix Dock)
- https://www.aliexpress.com/item/1005002547345797.html (Maix Duino)
- https://www.aliexpress.com/item/1005004131749651.html (Maix Nano)

GitHub: https://github.com/sipeed/

Documentation:
https://mega.nz/folder/A8g1Hb4J#WcuoqvbpasKlVB8-YEpWPA/folder/4wpEgIQZ

Third-party development board: pyAI-K210

Purchase link: https://www.aliexpress.com/item/1005001459205624.html

Third-party development boards: AI-Motion series

Purchase links:

- https://www.aliexpress.com/item/1005005475178374.html (K210 developer kit)
- https://www.aliexpress.com/item/1005005456612901.html (K210 visual recognition)

Manufacturer web site: https://www.yahboom.com/

Third-party development board: M5StickV

Purchase link: https://www.aliexpress.com/item/1005003299167263.html

Manufacturer web site: https://m5stack.com/

GitHub: https://github.com/m5stack/M5-StickV-UnitV

K510

The K510 is introduced by Canaan as the bigger brother of the K210, but as of the 2023-08-25, I haven't been able to find even a product brief about it...

Official development board: K510 CRB-KIT

Purchase links:

- https://www.aliexpress.com/item/1005005278496505.html
- https://www.aliexpress.com/item/1005004332478616.html
- https://www.aliexpress.com/item/1005004255412488.html
- https://www.aliexpress.com/item/1005004254339055.html

GitHub: https://github.com/kendryte (several repositories)

Third-party development board: DongshanPI-Vision

Purchase link: https://www.aliexpress.com/item/1005005648555879.html

GitHub: https://github.com/DongshanPI (several repositories)

Purely domestic Chinese RISC-V MCU

This chapter provides information about chips whose manufacturer consider domestic-only.

This means that you won't be able to download development tools and official documentation, which are hidden in developer portals for which registration requires a Chinese mobile phone. Anyway, the documentation is entirely in Chinese, so you probably don't want to translate hundreds of pages to use an MCU. You won't be able to purchase development boards from the manufacturer either.

At best, you're going to find blog posts on Chinese web sites providing guidance for your first steps. Translating them is manageable, but their informative content is limited compared to the unavailable official documentation.

You can purchase some of these chips from LCSC and/or find development boards on AliExpress, but that's all.

In other words, with all the MCU mentioned in this chapter, **you're completely on your own**. You've been warned.

HiSilicon

Chinese name: 海思 – Pinyin: hǎi sī – https://www.hisilicon.com/en

Hi3861

HiSilicon is a subsidiary of Huawei. Their chips are supported by HarmonyOS (鸿蒙, pinyin: hóngméng), an OS developed by Huawei using the LiteOS kernel.

The Hi3861 is comparable to the ESP32-C3 or the BL602. It exists in 2 models, the Hi3861V100 and the Hi3861LV100 (low power version).

Third-party development board: Hi-12F-Kit & Hi-12FL-Kit

The 12F is based on the Hi3861V100, and the 12FL on the Hi3861LV100.

Purchase links:

- https://www.aliexpress.com/item/1005005806328088.html
- https://www.aliexpress.com/item/1005004072457367.html
- https://www.aliexpress.com/item/1005004116773752.html
- https://www.aliexpress.com/item/1005005003338511.html
- https://www.aliexpress.com/item/1005005807889439.html

Documentation: https://docs.ai-thinker.com/en/hi

Third-party development board: Hi3861 = 303HI386101

This board is based on the Hi3861V100 and costs twice the price of the Hi-12F(L)-Kit.

Purchase links:

https://www.aliexpress.com/item/1005005239118476.html
https://www.aliexpress.com/item/1005003342277490.html
https://www.aliexpress.com/item/1005003355115819.html
https://www.aliexpress.com/item/1005003624801955.html
https://www.aliexpress.com/item/1005003624988141.html

Xinsheng Technology

Chinese name: 芯昇科技 – Pinyin: xīn shēng kējì – https://www.xinshengcmiot.cn/

Xinsheng Technology is a division of **China Mobile** (中国移动).

CM32M4xxR

There are 2 chips in this series, the CM32M431R and CM32M433R. The CM32M433R can be purchased from LCSC and development boards from AliExpress.

These chips are designed to compete with ARM Cortex-M3/M4/M4F and M33. They are built on an RV32IMAFDCP Nuclei N308 core. They can run at 144MHz, include up to 512KB Flash / 144KB SRAM, fast 12-bit ADC and DAC (5Mbps and 1Mbps respectively), and provide 2-wire/4-wire JTAG support.

Official development board: CM32R433R-START

Purchase link: https://www.aliexpress.com/item/1005004333840765.html

Nanjing Zhongke Micro

Chinese name: 南京中科微 – Pinyin: nánjīng zhōng kē wéi – https://www.njzkwiot.com/

Previously known as CSM (http://csm-ic.com/).

CSM32RV003

This low-power RV32IMAC MCU can run at 32MHz, support a wide supply voltage range (1.8~5.5V), include 32KB Flash / 4KB SRAM, a fast high-precision 16-bit ADC, and provide 2-wire cJTAG support (the 'c' before 'JTAG' is not a typo).

The name suggests this MCU intends to compete with WCH's famous CH32V003, but as of 2023-08-23, this chip is unavailable.

CSM32RV20

This MCU is very similar to the CSM32RV003 except that it has 40KB flash. It can be purchased from LCSC and AliExpress.