

# RISC-V MCU development boards

## Table of contents

Introduction.....	4
License.....	4
Manufacturer selection.....	4
BouffaloLab.....	5
Clones.....	5
Advice to beginners.....	5
Energy efficiency.....	6
Compute power & embedded AI.....	6
Documentation, SDK and tools.....	6
BL602.....	6
Third-party development board: PineCone.....	6
Third-party development board: Ai-WB2 series.....	6
Third-party development board: DT-BL10 or XT-BL12.....	7
BL702.....	7
Third-party development board: M0 Sense.....	7
Third-party development board: XT-ZB1.....	8
BL616.....	8
Third-party development board: M0S Dock.....	8
Third-party development board: Ai-M62-12F.....	8
BL618.....	8
Third-party development board: M0P Dock.....	8
Third-party development board: Ai-M61-32S.....	9
BL808.....	9
Third-party development board: Ox64.....	9
Third-party development board: M1S Dock.....	9
Espressif.....	10
ESP8684 (ESP32-C2).....	10
Official development board: ESP8684-DevKitM-1.....	10
Official development board: ESP8684-DevKitC-02.....	10
Third-party development board: ESPC2-12.....	10
Documentation.....	11
ESP32-C3 and ESP8685.....	11
Official development board: ESP32-C3-DevKitM-1.....	11
Official development board: ESP32-C3-DevKitC-02.....	11
Third-party development board: ESP32-C3FH4.....	11
Third-party development board: nanoESP32-C3.....	11
Third-party development board: YD-ESP32-C3.....	11
Third-party development board: XIAO ESP32C3.....	11
Third-party development board: ESP32C3-MINI-DK.....	12
Third-party development board: ESP32-C3 Mini.....	12
Third-party development board: 01Space ESP32-C3FH4-RGB.....	12
Documentation.....	12
ESP32-C6.....	12
Official development board: ESP32-C6-DevKitM-1.....	12
Official development board: ESP32-C6-DevKitC-1.....	13
Third-party development board: WeAct ESP32-C6-A.....	13
Third-party development board: nanoESP32-C6.....	13
Documentation.....	13
ESP32-H2.....	13
Official development board: ESP32-H2-DevKitM-1.....	13

Documentation.....	13
GigaDevice.....	14
Official development board: GD32VF103C-START .....	14
Third-party development board: Longan Nano.....	14
Documentation, SDK and tools.....	14
WCH.....	15
Programmer / debugger.....	16
Working mode.....	16
Flashing utility.....	16
Notes to Linux users.....	17
MounRiver IDE.....	17
Stand alone tool chain.....	17
Alternatives to WCH tools.....	17
CH32V003.....	18
Official development board.....	18
Third-party development board: CR-CH32VXX.....	18
Third-party development board: nanoCH32V003.....	18
Third-party development board: QSZNTEC CH32V003.....	18
Documentation and SDK.....	18
CH32V103.....	18
Official development board.....	18
Third-party development board: CH32V103C_MINI = 303CH32VC02.....	19
Third-party development board: CH32V103R_MINI = 303CH32MI01.....	19
Documentation and SDK.....	19
CH32V203.....	19
Official development boards.....	19
Third-party development board: BluePill+ CH32V203.....	19
Third-party development board: nanoCH32V203.....	19
Documentation and SDK.....	20
CH32V208.....	20
Official development board.....	20
Documentation and SDK.....	20
CH32V303.....	20
Official development board.....	20
Documentation and SDK.....	20
CH32V305.....	20
Third-party development board: nanoCH32V305.....	20
Documentation and SDK.....	21
CH32V307.....	21
Official development board.....	21
Third-party development board: YD-CH32V307VC.....	21
Third-party development board: YD-CH32V307RC.....	21
Third-party development board: CH32V307RC-MINI.....	21
Documentation and SDK.....	21
CH32X035.....	21
Official development board.....	21
Documentation and SDK.....	22
CH565.....	22
Official development board.....	22
Documentation and SDK.....	22
CH569.....	22
Official development board.....	22
Documentation and SDK.....	22
CH582 / CH583.....	22
Official development board.....	22
Third-party development board: YD-CH58x.....	23
Third-party development board: 303CH582M01.....	23

Documentation and SDK.....	23
CH592 / CH591.....	23
Official development board.....	23
Documentation and SDK.....	23
BLUETRUM.....	24
AB5301A.....	24
Official development board: AB32VG1 "blue board" (aka. prougen).....	24
Third-party development board: AB32VG1 "green board".....	24
Common description.....	24
CVITEK.....	25
CV1800B.....	25
Third-party development board: Milk-V Duo.....	25

# 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

This document is (c) 2023 Vincent DEFERT and is licensed under the Creative Commons Attribution 4.0 International License.

Information about the license can be found at: <http://creativecommons.org/licenses/by/4.0/>

## 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.

<i>Manufacturer</i>	<i>Wide supply voltage range</i>	<i>Wide package choice</i>	<i>Lots of I/O pins</i>	<i>WiFi</i>	<i>BLE</i>	<i>802.15.4</i>
BouffaloLab				X	X	X
Espressif				X	X	X
GigaDevice			X			
WCH	X	X	X		X	

*Note: manufacturers are sorted in alphabetical order.*

# BouffaloLab

Chinese name: 博流智能 (or just 博流) – pinyin: bó liú zhìnéng

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	RV32IMAFRC	SiFive <a href="#">E24</a>	b/g/n	-	yes	-	-	-	-	-
BL702	144	132K	RV32IMAFRC	SiFive <a href="#">E24</a>	-	-	yes	yes	yes	-	-	-
BL704	144	132K	RV32IMAFRC	SiFive <a href="#">E24</a>	-	-	yes	yes	yes	yes	-	-
BL706	144	132K	RV32IMAFRC	SiFive <a href="#">E24</a>	-	-	yes	yes	yes	yes	yes	-
BL616/ BL618 *	320	480K	RV32IMAFRC	T-Head <a href="#">E907</a>	b/g/n/ax	yes	yes	yes	yes	yes	yes	-
BL808	480	64M	RV32IMAFRC+ RV64GCV+ RV32EMC	T-Head <a href="#">E907</a> + <a href="#">C906</a> + <a href="#">E902</a>	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](https://github.com/bouffalolab/bl_docs)

SDK:

[https://github.com/bouffalolab/bouffalo\\_sdk](https://github.com/bouffalolab/bouffalo_sdk) (newer SDK)

[https://github.com/bouffalolab/bl\\_iot\\_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 (BIDevCube): [https://github.com/bouffalolab/flash\\_tools](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](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://xzrnlk27j.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](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](https://docs.ai-thinker.com/en/ai_m62)

GitHub: [https://github.com/Ai-Thinker-Open/aithinker\\_Ai-M6X\\_SDK](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](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](https://docs.ai-thinker.com/en/ai_m61)

GitHub: [https://github.com/Ai-Thinker-Open/aithinker\\_Ai-M6X\\_SDK](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_example)

[https://github.com/sipeed/M1s\\_BL808\\_SDK](https://github.com/sipeed/M1s_BL808_SDK)

[https://github.com/sipeed/M1s\\_BL808\\_Linux\\_SDK](https://github.com/sipeed/M1s_BL808_Linux_SDK)

# Espressif

Chinese name: 乐鑫科技 – Pinyin: lè xīn kējì

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](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](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/](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](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](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](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

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

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 CH32Vxxx series, which are the RISC-V equivalents of their ARM CH32Fxxx series, and the more specialised CHxxx 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
<a href="#">CH32V003</a>	RV32EC	<a href="#">V2A</a>	48	16K	2K	2.7-5.5V	Low pin count (8, 16, 20)
<a href="#">CH32X035</a>	RV32IMAC	<a href="#">V4C</a>	48	62K	20K	2.0-5.5V	USB PD, PIOC, OpAmp / PGA / comp.
<a href="#">CH32V103</a>	RV32IMAC	<a href="#">V3A</a>	80	64K	20K	2.7-5.5V	
CH32L103	RV32IMAC	<a href="#">V4C</a>	96	64K	20K	2.4-3.6V	USB PD, OpAmp / PGA / comp.
<a href="#">CH32V203</a>	RV32IMAC	<a href="#">V4B</a>	144	128K	64K	2.4-3.6V	LQFP-64 has Ethernet
<a href="#">CH32V208</a>	RV32IMAC	<a href="#">V4C</a>	144	128K	64K	2.4-3.6V	BLE + Ethernet
CH32V303	RV32IMAFC	<a href="#">V4F</a>	144	256K	64K	2.4-3.6V	
CH32V305	RV32IMAFC	<a href="#">V4F</a>	144	128K	32K	2.4-3.6V	
<a href="#">CH32V307</a>	RV32IMAFC	<a href="#">V4F</a>	144	256K	64K	2.4-3.6V	Has Ethernet. LQFP-100 has DVP & FSMC
<a href="#">CH565</a>	RV32IMAC	<a href="#">V3A</a>	120	448K	96K	2.3-3.6V	USB 3.0, Gb Ethernet, EMMC, DVP
<a href="#">CH569</a>	RV32IMAC	<a href="#">V3A</a>	120	448K	96K	2.3-3.6V	USB 3.0, Gb Ethernet, EMMC, HSPI
CH573/571	RV32IMAC	<a href="#">V3A</a>	60	448K	16K	2.3-3.6V	Superseded by the CH582
<a href="#">CH583/582</a>	RV32IMAC	<a href="#">V4A</a>	80	448K	30K	2.3-3.6V	BLE, ultra low power
CH592/591	RV32IMAC	<a href="#">V4C</a>	80	448K	24K	2.3-3.6V	BLE, ultra low power, LCD controller
<a href="#">CH643</a>	RV32IMAC	<a href="#">V4C</a>	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](https://www.wch-ic.com/downloads/WCH-LinkUserManual_PDF.html)

Schematic diagram: [https://www.wch.cn/downloads/WCH-LinkSCH\\_PDF.html](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](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_Setup_exe.html)

[https://www.wch.cn/downloads/WCHISPTool\\_CMD\\_ZIP.html](https://www.wch.cn/downloads/WCHISPTool_CMD_ZIP.html)

[https://www.wch.cn/downloads/WCH-LinkUtility\\_ZIP.html](https://www.wch.cn/downloads/WCH-LinkUtility_ZIP.html)



## Notes to Linux users

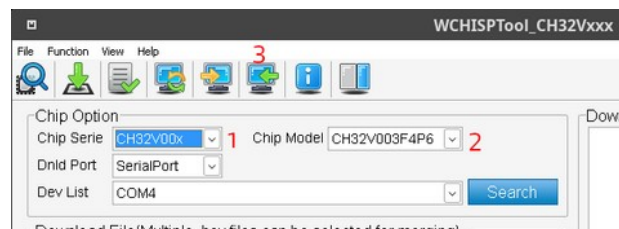
WCHISPTool's main executable is unusable under Wine, but independent executables for each MCU series are provided under its installation directory and those work quite well.

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](http://wch-ic.com/downloads/CH32V003DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32V003RM\\_PDF.html](http://wch-ic.com/downloads/CH32V003RM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV2\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV2_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V003EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32V103DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32xRM\\_PDF.html](http://wch-ic.com/downloads/CH32xRM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV3\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV3_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V103EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32V203DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32FV2x\\_V3xRM\\_PDF.html](http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V20XEVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32V208DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32FV2x\\_V3xRM\\_PDF.html](http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V20XEVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32V307DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32FV2x\\_V3xRM\\_PDF.html](http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V307EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32V307DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32FV2x\\_V3xRM\\_PDF.html](http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V307EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32V307DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32FV2x\\_V3xRM\\_PDF.html](http://wch-ic.com/downloads/CH32FV2x_V3xRM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32V307EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH32X035DS0_PDF.html)

Reference manual: [http://wch-ic.com/downloads/CH32X035RM\\_PDF.html](http://wch-ic.com/downloads/CH32X035RM_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH32X035EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH569DS1_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV3\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV3_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH569EVT\\_ZIP.html](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](http://wch-ic.com/downloads/CH583DS1_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH583EVT\\_ZIP.html](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](https://wch-ic.com/downloads/CH592DS1_PDF.html)

Processor manual: [http://wch-ic.com/downloads/QingKeV4\\_Processor\\_Manual\\_PDF.html](http://wch-ic.com/downloads/QingKeV4_Processor_Manual_PDF.html)

SDK: [https://www.wch.cn/downloads/CH592EVT\\_ZIP.html](https://www.wch.cn/downloads/CH592EVT_ZIP.html)

# BLUETRUM

Chinese name: 中科蓝讯 – Pinyin: zhōng kē lán xùn

## 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/1005003594401351.html>

## Common description

These boards are easily available, 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://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>



# CVITEK

Chinese name: 晶视智能 – Pinyin: jīng shì zhì néng

## 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)