DFI

QCS051

2.5" Pico-ITX Motherboard
User's Manual

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FCC and DOC Statement on Class B

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio TV technician for help.

Notice:

1. The changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
2. Shielded interface cables must be used in order to comply with the emission limits.

Table of Contents

About this Manual

This manual can be downloaded from the website.

The manual is subject to change and update without notice, and may be based on editions that do not resemble your actual products. Please visit our website or contact our sales representatives for the latest editions.

Warranty

1. Warranty does not cover damages or failures that occur from misuse of the product, inability to use the product, unauthorized replacement or alteration of components and product specifications.

2. The warranty is void if the product has been subjected to physical abuse, improper installation, modification, accidents or unauthorized repair of the product.

3. Unless otherwise instructed in this user's manual, the user may not, under any circumstances, attempt to perform service, adjustments or repairs on the product, whether in or out of warranty. It must be returned to the purchase point, factory or authorized service agency for all such work.

4. We will not be liable for any indirect, special, incidental or consequential damages to the product that has been modified or altered.

Static Electricity Precautions

It is quite easy to inadvertently damage your PC, system board, components or devices even before installing them in your system unit. Static electrical discharge can damage computer components without causing any signs of physical damage. You must take extra care in handling them to ensure against electrostatic build-up.

1. To prevent electrostatic build-up, leave the system board in its anti-static bag until you are ready to install it.

2. Wear an antistatic wrist strap.

3. Do all preparation work on a static-free surface.

4. Hold the device only by its edges. Be careful not to touch any of the components, contacts or connections.

5. Avoid touching the pins or contacts on all modules and connectors. Hold modules or connectors by their ends.

Important:
Electrostatic discharge (ESD) can damage your processor, disk drive and other components. Perform the upgrade instruction procedures described at an ESD workstation only. If such a station is not available, you can provide some ESD protection by wearing an antistatic wrist strap and attaching it to a metal part of the system chassis. If a wrist strap is unavailable, establish and maintain contact with the system chassis throughout any procedures requiring ESD protection.

Safety Measures

- To avoid damage to the system, use the correct AC input voltage range.

- To reduce the risk of electric shock, unplug the power cord before removing the system chassis cover for installation or servicing. After installation or servicing, cover the system chassis before plugging the power cord.

About the Package

The package contains the following items. If any of these items are missing or damaged, please contact your dealer or sales representative for assistance.

- 1 QCS051 Motherboard
- Heat spreader for (Height: 7mm)

The board and accessories in the package may not come similar to the information listed above. This may differ in accordance with the sales region or models in which it was sold. For more information about the standard package in your region, please contact your dealer or sales representative.

Before Using the System Board

When installing the system board in a new system, you will need at least the following internal components.

- Power supply

External system peripherals may also be required for navigation and display, including at least a keyboard, a mouse and a video display monitor.

Chapter 1 - Introduction

▶ Specifications

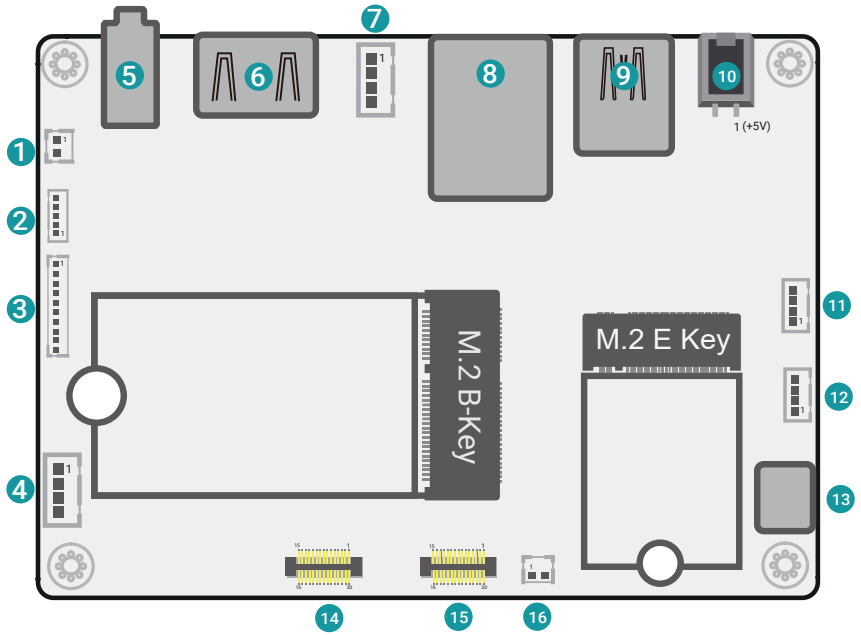
SYSTEM	Processor	QCS6490 Qualcomm® Kryo™ 670, 8 cores, up to 2.7 GHz, 12 TOPS (INT8) QCS5430 (FP1) Qualcomm® Kryo™ 670, 6 cores, up to 2.1 GHz, 3.5 TOPS (INT8)
	Memory	LPDDR5x, 4/8GB
GRAPHICS	Controller	Qualcomm® Adreno™ 643L GPU
	Feature	OpenGL ES 3.2
	Display	1 x HDMI Type A, w/o audio. 1080P support on Linux.
	Single Display	HDMI
STORAGE	UFS	Support UFS 3.1, default 128GB
EXPENSION	Interface	1 x M.2 B key 3052 (USB 3.1/ Opt. USB 2.0) reference RM502Q-AE Quectel *Optional USB 2.0 signal with UBJ4
		1 x Nano SIM slot
		1 x M.2 E key 2230 (PCIe x1) reference ENL-Q6856M2 Wifi module
AUDIO	Audio Codec	Audio codec WCD9385
ETHERNET	Controller	AX88179A USB3 to GbE controller
REAR I/O	Ethernet	1 x GbE (RJ-45)
	USB	2 x USB 3.1 Gen1 Type A
	Display	1 x HDMI 1.4
	Audio	1 x Line out/Mic in audio jack
	Debug	1 x Micro USB debug UART
INTERNAL I/O	Serial	1 x RS-232 (COM1, 1x5P/1.00mm)
	USB	3 x USB 2.0 (UBJ1/2/4, 1x4P/1.25mm), UBJ4 could option to M.2 B key 1 x USB Type C (Download only)
	DIO	1 x 8-bit DIO
	CANBus	1 x CAN FD
	SD	1 x uSD3.0 card
	Camera	2 x MIPI-CSI2 for 4-lanes camera, reference to IMX577
	Other I/O	1 x Ext. IO (1*12P/1.25mm), 1 x Power LED, 1 x System LED, 1 x Front Panel 1 x Fan connector (upon request)

POWER	Type	5VDC
	Connector	2 pin Power Jack
	Consumption	Typical: QCS6490: 5V @ 0.6A (3.0Watt) Max.: QCS6490: 5V @ 1.45A (7.25Watt)
	RTC Battery	CR2032 Coin Cell
OS SUPPORT	Linux	Default: Yocto (Linux Kernel 6.6.x) Upon request: Ubuntu 20.04 (Linux Kernel 5.4.x)
ENVIRONMENT	Temperature	Operating: 0°C~60°C, -25°C~75°C Storage: -40 to 85°C
	Humidity	Operating: 5 to 90% RH Storage: 5 to 90% RH
MECHANISM	Dimensions	2.5" Pico-ITX Form Factor: 100mm (3.94") x 72mm (2.83")
	Height	PCB: 1mm Top Side: 16.44mm, Bottom Side: 3.45mm
STANDARDS AND CERTIFICATIONS	Certifications	CE, FCC, RoHS, UKCA

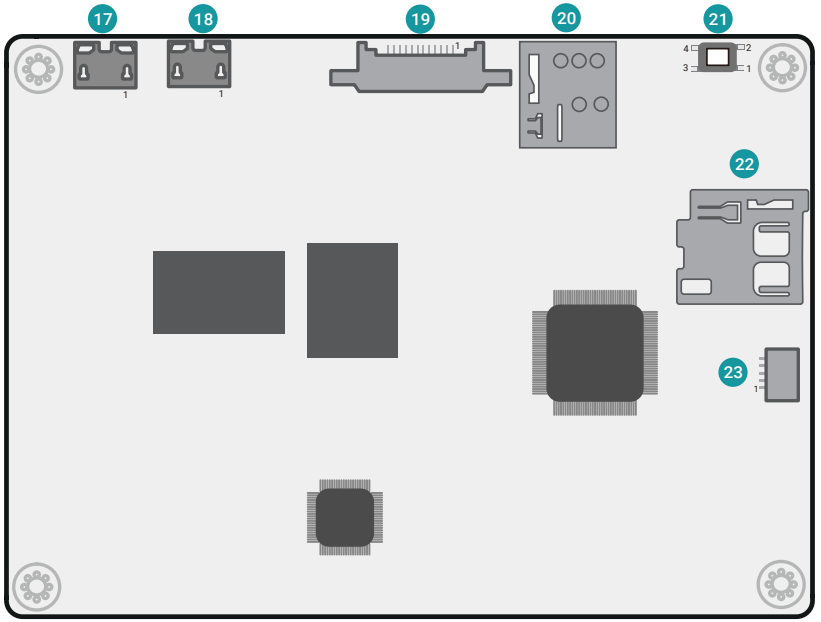
Chapter 2 - Hardware Installation

▶ Board Layout

Top View



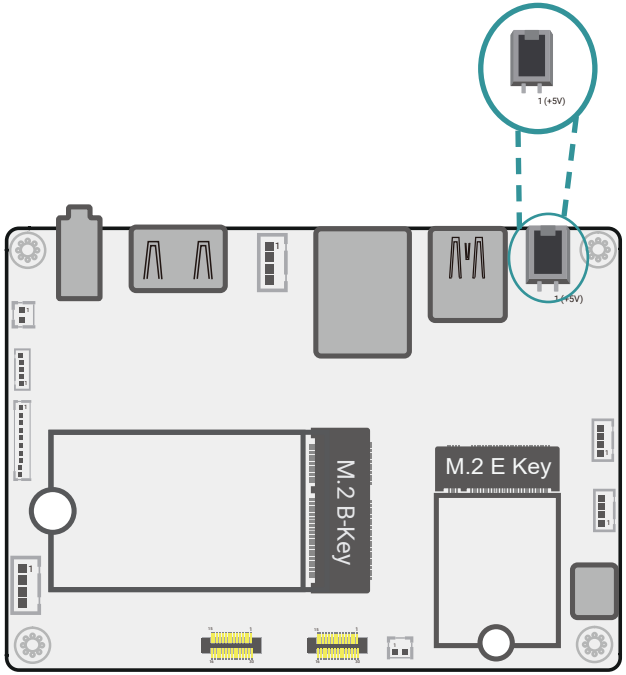
Bottom View



1. Battery
2. COM1
3. DIO 8-bits
4. CAN FD
5. Audio
6. HDMI
7. USB2.0_4
8. LAN
9. 2 x USB 3.1 Gen1 Type A
10. DC-IN
11. USB2.0_2
12. USB2.0_1
13. USB Type C (Download only)
14. Camera1
(4-lanes, MIPI-CSI2, reference model: IMX577)
15. Camera2
(4-lanes, MIPI-CSI2, reference model: IMX577)
16. Force USB Boot
17. USB2.0_Debug/Console
18. USB2.0_ADB
19. SPI/I2C/GPIO
20. SIM Slot
21. USB Boot (SW1)
22. uSD Slot
23. Front Panel

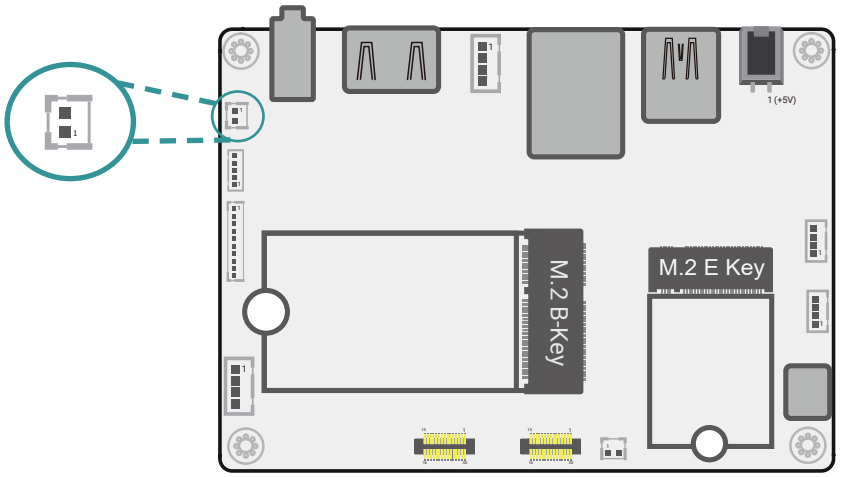
▶ Pin Assignment

DC-IN (DCCN1)



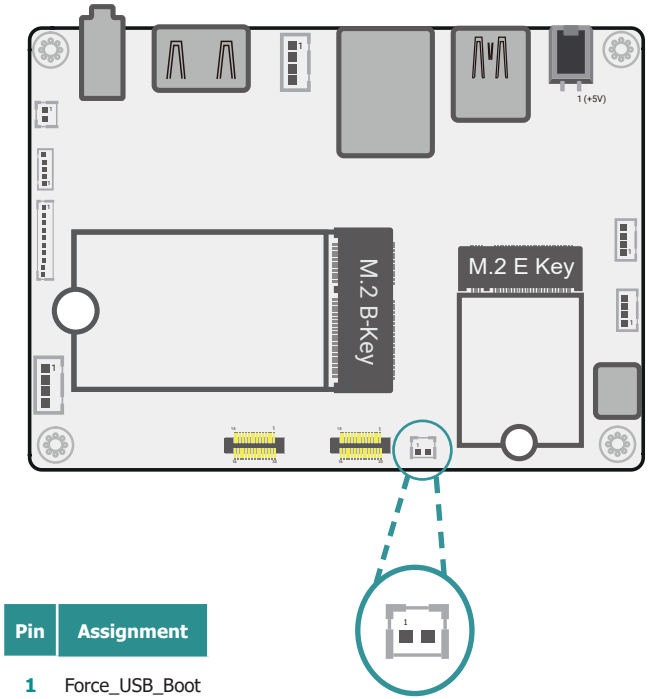
Pin	Assignment
1	+5V
2	GND

Battery (BTJ1)



Pin	Assignment
1	+VBAT
2	GND

Force USB Boot (SWJ1)

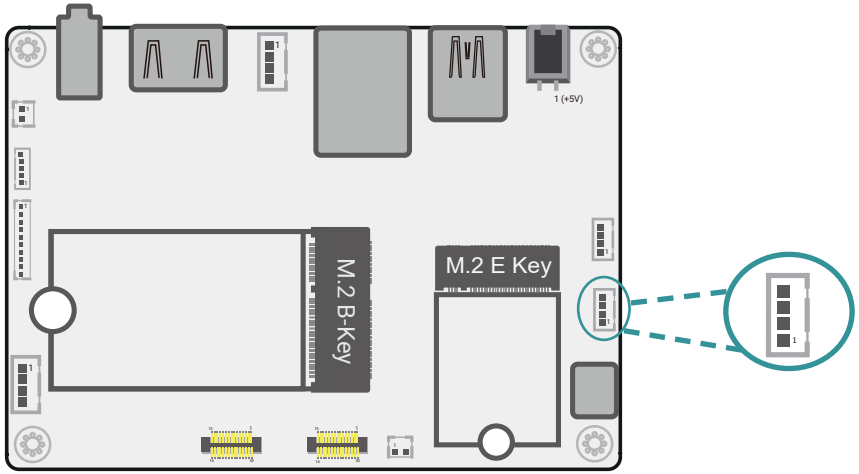


Pin	Assignment
1	Force_USB_Boot
2	SW1_PU_1P8

Note:

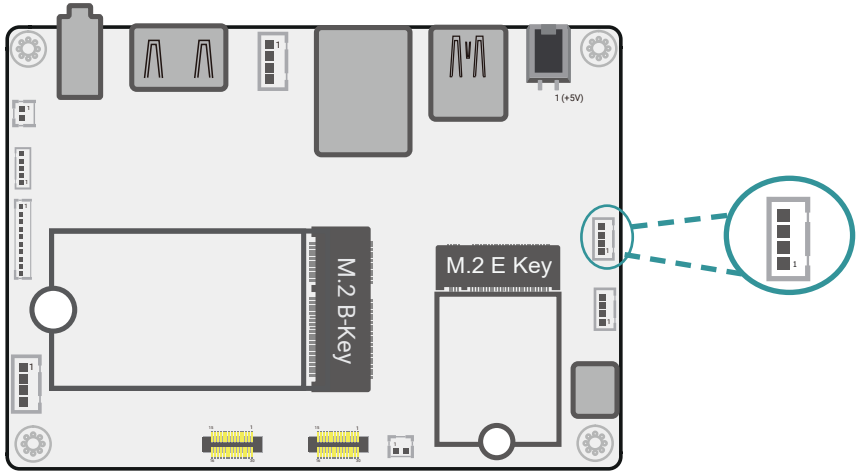
SWJ1, internal wafer, is saved for system integration. Same function as SW1.
To enter the download mode (USB Boot), you can just press SW1 or have SWJ1 two pins short-circuted.

USB2.0_1 (UBJ1)



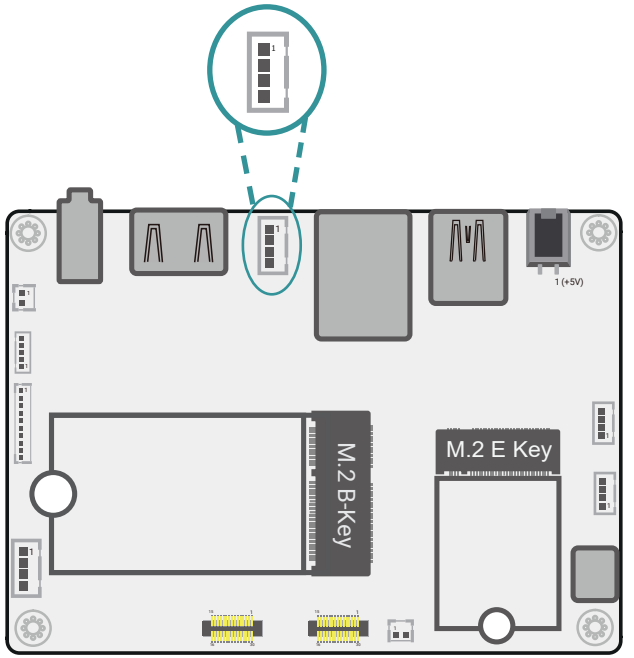
Pin	Assignment
1	+5V
2	USB-DN
3	USB-DP
4	GND

USB2.0_2 (UBJ2)



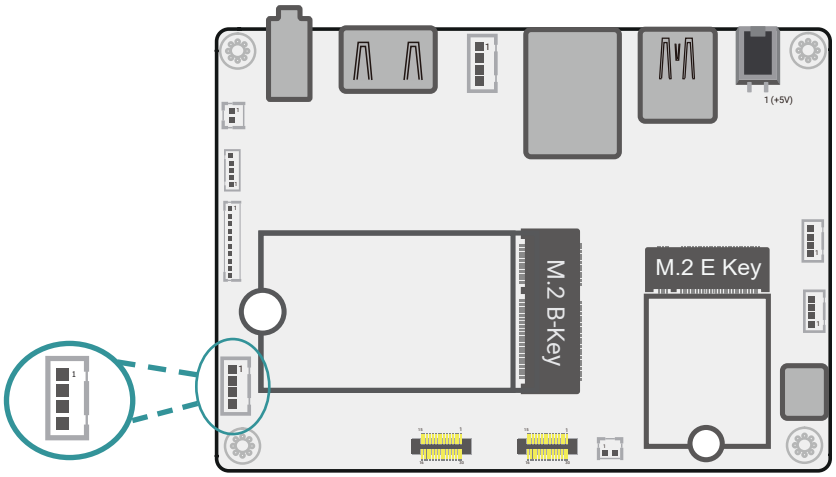
Pin	Assignment
1	+5V
2	USB-DN
3	USB-DP
4	GND

USB2.0_4 (UBJ4)



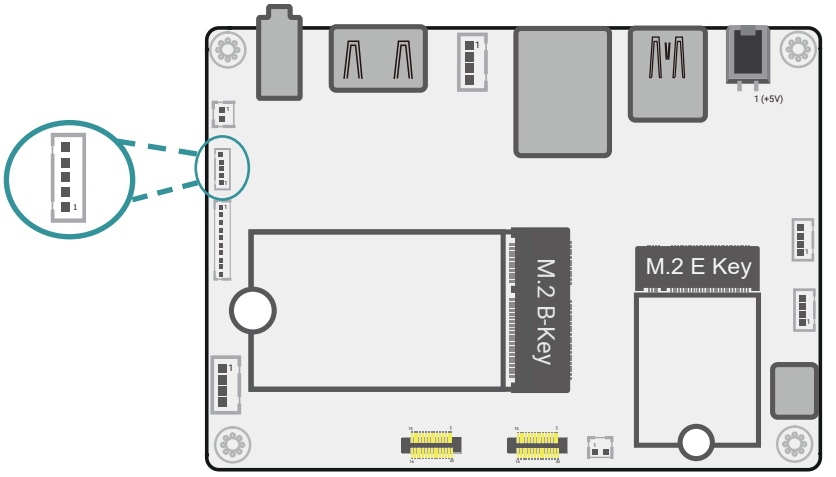
Pin	Assignment
1	+5V
2	USB-DN
3	USB-DP
4	GND

CAN FD (CBJ1)



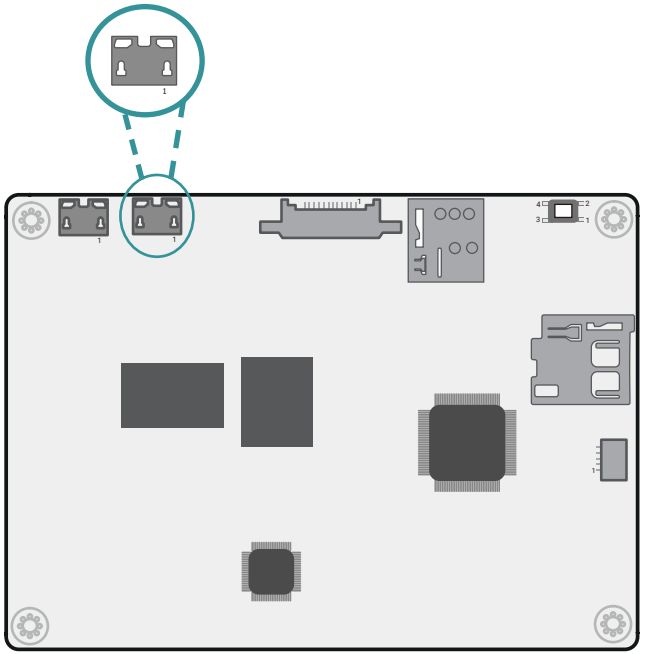
Pin	Assignment
1	+VDD_CAN
2	CAN1H
3	CAN1L
4	GND

COM1 (TSJ1)



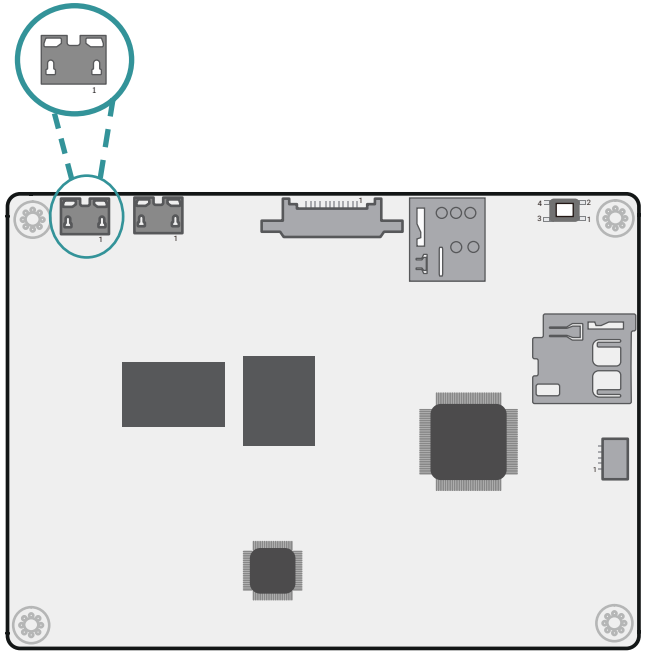
Pin	Assignment
1	COM1_RX
2	COM1_TX
3	COM1_CTS
4	COM1_RTS
5	GND

USB2.0_ADB (UBCN4)



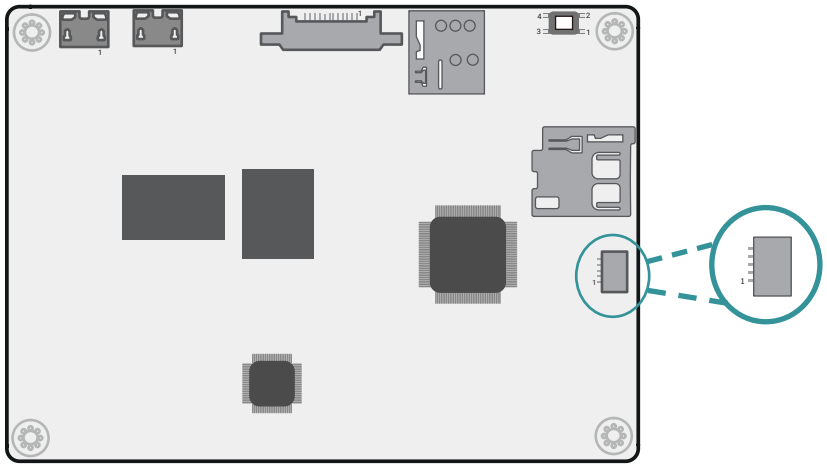
Pin	Assignment
1	+5V
2	USB-DN
3	USB-DP
4	NC
5	GND

USB2.0_Debug/Console (DUCN1)



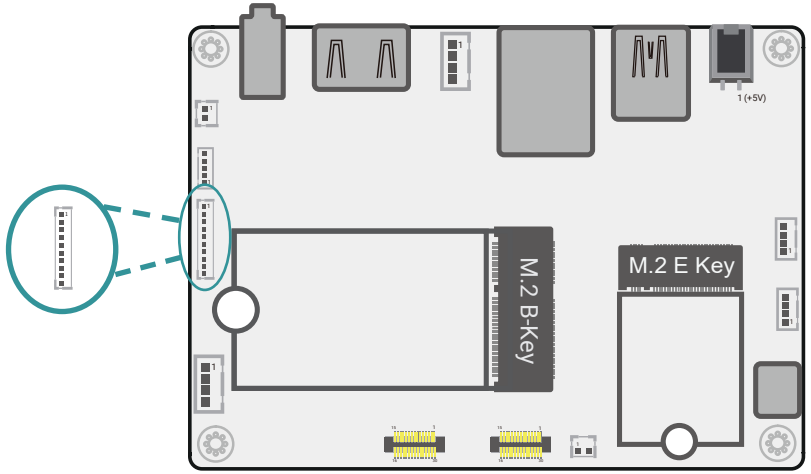
Pin	Assignment
1	+5V
2	USB-DN
3	USB-DP
4	NC
5	GND

Front Panel (FPJ1)



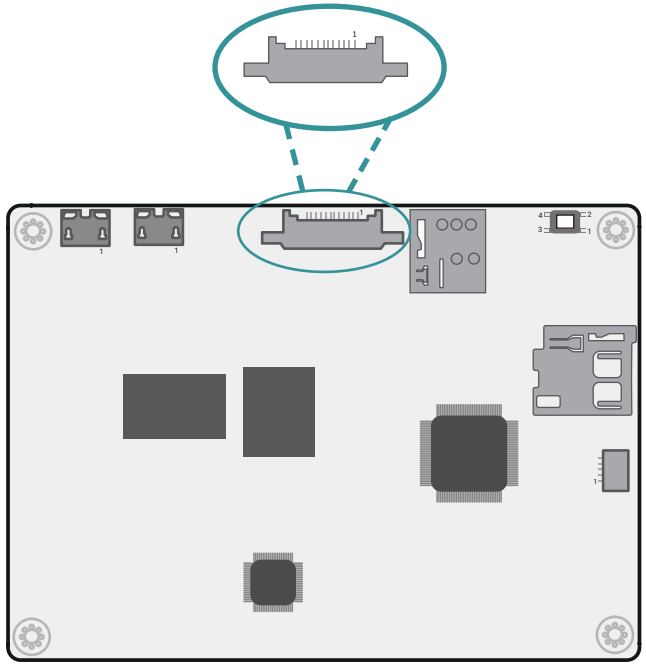
Pin	Assignment
1	GND
2	Volume-_Button#
3	Volume+_Button#
4	PWR_Button#
5	LED_3.3V

DIO 8-bits (IOJ1)



Pin	Assignment
1	DIO0
2	DIO1
3	DIO2
4	DIO3
5	DIO4
6	DIO5
7	DIO6
8	DIO7
9	+VPWR_3.3V
10	GND

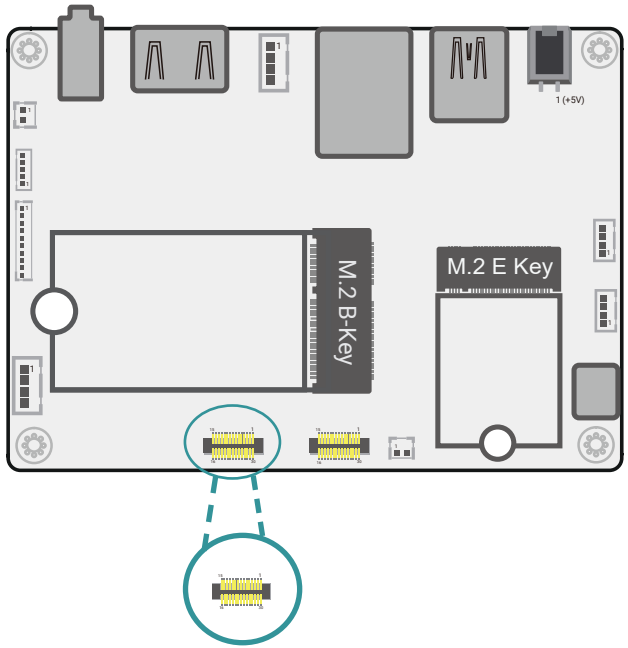
SPI/I2C/GPIO (IOJ2)



Pin	Assignment
1	+VCC_3.3V
2	SPI_MISO_3V3
3	SPI_MOSI_3V3
4	SPI_CLK_3V3
5	SPI_CS#_3V3
6	I2C_SCL_3V3
7	I2C_SDA_3V3
8	GPIOA_3V3
9	GPIOB_3V3
10	GPIOC_3V3
11	GND
12	GND

Camera 1 (CMJ1)

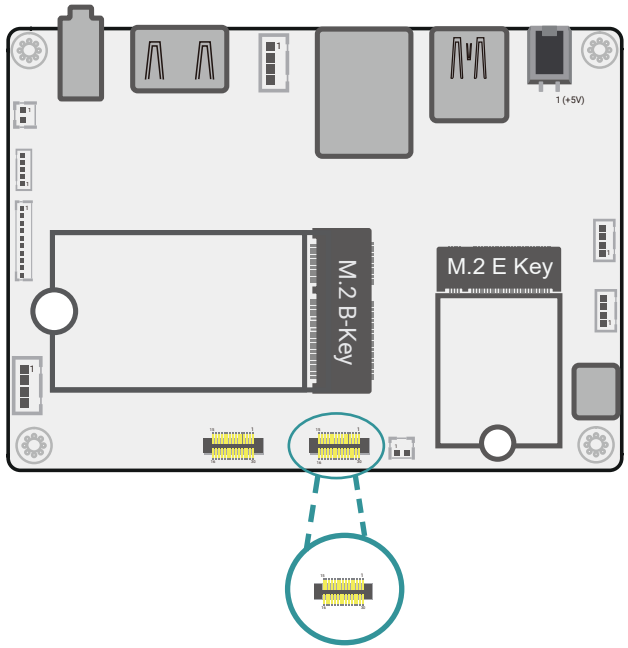
* (4-lanes, MIPI-CSI2, reference model: IMX577)



Pin	Assignment	Pin	Assignment
1	CAM2_Strobe/ GPIO	2	CAM2_SPI-CLK
3	+2.8V	4	CAM2_SPI-MOSI
5	CAM2_RESET#	6	GND
7	CAM2_CSI_D2P	8	CAM2_CSI_D2M
9	GND	10	CAM2_CSI_D0P
11	CAM2_CSI_D0M	12	GND
13	CAM2_CSI_D3P	14	CAM2_CSI_D3M
15	Reserved	16	GND
17	CAM2_CSI_D1M	18	CAM2_CSI_D1P
19	GND	20	CAM2_CSI_CKM
21	CAM2_CSI_CKP	22	GND
23	CAM2_CSI_MCLK	24	GND
25	CAM2_I2C-SCL	26	CAM2_I2C-SDA
27	CAM2_SPI-CS#	28	+1.8V
29	CAM2_SPI-MISO	30	+1.1V

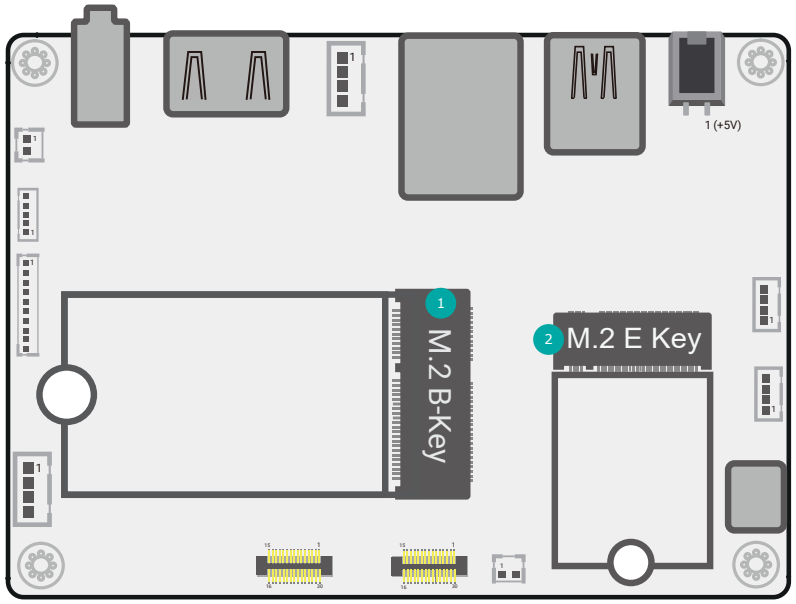
Camera 2 (CMJ2)

* (4-lanes, MIPI-CSI2, reference model: IMX577)



Pin	Assignment	Pin	Assignment
1	CAM0_Strobe/ GPIO	2	CAM0_RSV#1
3	+2.8V	4	CAM0_RSV#2
5	CAM0_RESET#	6	GND
7	CAM0_CSI_D2P	8	CAM0_CSI_D2M
9	GND	10	CAM0_CSI_D0P
11	CAM0_CSI_D0M	12	GND
13	CAM0_CSI_D3P	14	CAM0_CSI_D3M
15	Reserved	16	GND
17	CAM0_CSI_D1M	18	CAM0_CSI_D1P
19	GND	20	CAM0_CSI_CKM
21	CAM0_CSI_CKP	22	GND
23	CAM0_CSI_MCLK	24	GND
25	CAM0_I2C-SCL	26	CAM0_I2C-SDA
27	CAM0_RSV#4	28	+1.8V
29	CAM0_RSV#3	30	+1.1V

▶ Expansion Slots



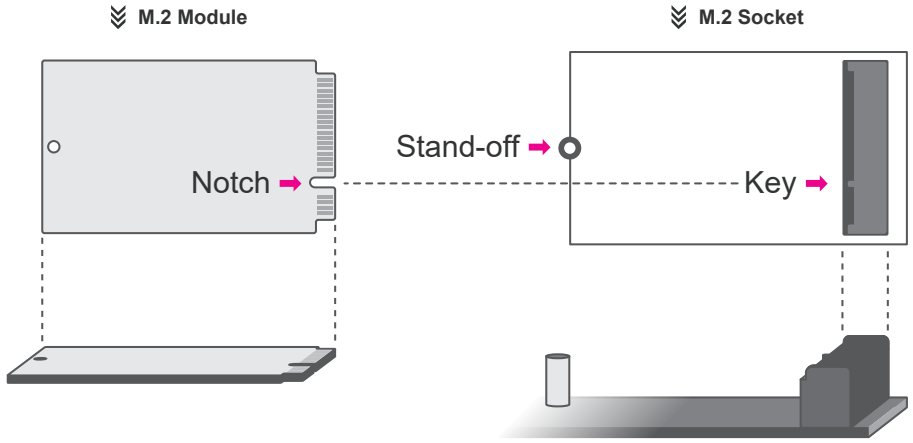
1 M.2 B-Key

2 M.2 E-Key

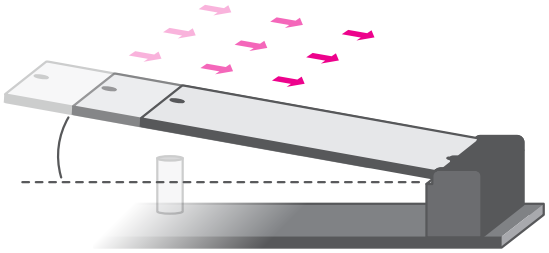
Installing the M.2 Module

Before installing the M.2 module into the M.2 socket, please make sure that the following safety cautions are well-attended.

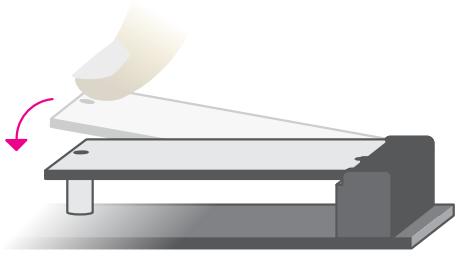
1. Make sure the PC and all other peripheral devices connected to it has been powered down.
2. Disconnect all power cords and cables.
3. Locate the M.2 socket on the system board
4. Make sure the notch on card is aligned to the key on the socket.
5. Make sure the standoff screw is removed from the standoff.



Please follow the steps below to install the card into the socket.



Step 1:
Insert the card into the socket at an angle while making sure the notch and key are perfectly aligned.



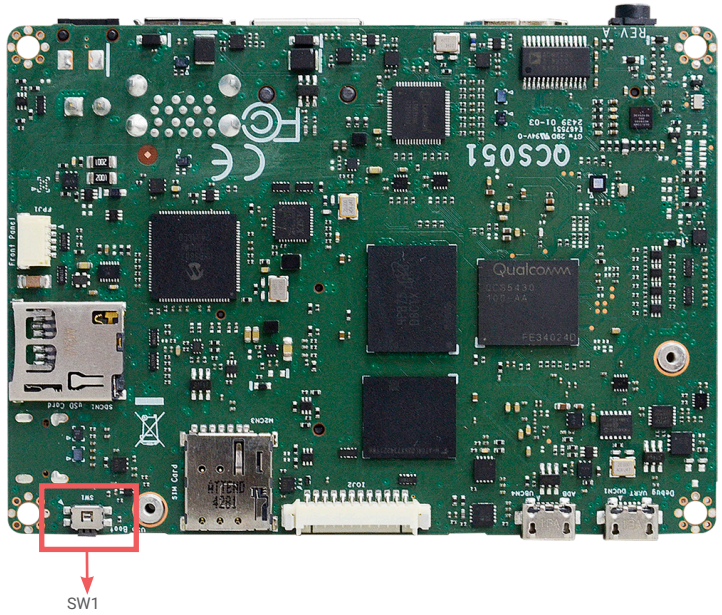
Step 2:
Press the end of the card far from the socket down until against the stand-off.

Step 3:
Screw tight the card onto the stand-off with a screw driver and a stand-off screw until the gap between the card and the stand-off closes up. The card should be lying parallel to the board when it's correctly mounted.

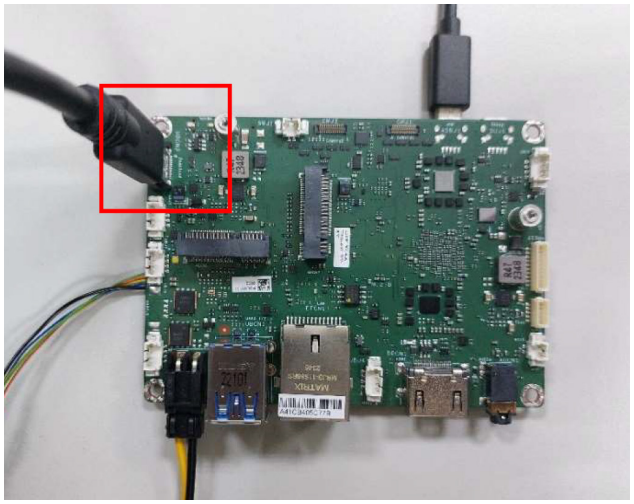
Chapter 3 - Software User Guide

Flash images with QDL

Step 1: Setup flash tool QDL environment
Ubuntu22.04
Install the following dependent packages:
$ sudo apt-get install libxml2-dev libusb-1.0-0-dev



Step 2: Flash images to the device
Force the device to enter download mode
Enter download mode with SW1 button:
1. Press and hold the SW1 button.
2. Connect the device to 5 V power supply.
3. Connect the device Download port (UBCN3) to the host machine via USB Type-C cable.



Flash with download mode
Follow these steps to flash with download mode:
1. Extract qcs051_yocto4.0_yyyymmdd_xx.zip
2. Flash image
   Enter download path
   $ cd <extract_folder>/qcs051-image/LE.QCLINUX.1.0.r1/build-qcom-wayland/tmp-glibc/deploy/images/qcs6490-rb3gen2-vision-kit/qcom-multimedia-image
   If not find, try below path.
   $ cd <extract_folder>/qcs051-image/LE.QCROBOTICS.1.0.r1/build-qcom-robotics-ros2-humble/tmp-glibc/deploy/images/qcs6490-rb3gen2-vision-kit/qcom-robotics-full-image
   flash command
   $ ./qdl prog_firehose_ddr.elf rawprogram*.xml patch*.xml

▶ Software Feature

Introduction

This chapter details the Linux operation on Yocto 4.0. The OS is an embedded system with Linux kernel 6.6.x. It contains all system-required shell commands and drivers ready. You can evaluate and develop under Ubuntu 22.04 environment.

Develop Environment

Yocto 4.0 kernel 6.6.x image for QCS051 project was built with PC Ubuntu environment.

General Support

(*) is depended on the Qualcomm support.

Component	Name	Base-Line Feature
General	OS Support	Yocto 4.0 (Default Preloaded on UFS), Kernel 6.6.x
Misc	Firmware Upgrade (*)	Qualcomm Device Loader (QDL)
	Utilities (*)	Hardware diagnostic utilities

Linux AP/API Support List

(*) is depended on the Qualcomm support.

Component	Description	Detail	Release Schedule
Linux	Yocto 4.0 - Kernel 6.6.x	It's an open-source project that delivers a set of tools that create operating system images for embedded Linux systems. Support wayland weston graphics Demo Image Only (*).	2025 Q1
Linux AP/API	Qualcomm Linux 1.2 BSP	All library and utility should support (*). Source code package (support by request).	2025 Q1
	Support GPIO	Provide support console for QCS051 platform.	2025 Q1

Yocto Support List

(*) is depended on the Qualcomm support.

Component	Support Status
Yocto Version	4.0
Kernel version	6.6.x
Window System	Weston Wayland
UFS 3.0	Support UFS boot by default, Linux EXT4 file system
Ethernet LAN	Support "ping", "ifconfig" console commands verify, static IP/DHCP Dynamic IP, writable MAC address store in Ethernet IC.
USB	1. Support USB HID Keyboard and Mouse Device. 2. Support USB Mass Storage by "mount" console command, EXT3/EXT4/FAT filesystem.
USB OTG	Support image download.
HDMI Video	Support max display resolution of 1080p60.
Micro SD Card (uSD card slot)	1. Support SD card boot, support SD storage by "mount" console command, FAT filesystem. 2. Support SD boot (select by boot switch). 3. Not support SDIO module.
GPIO	Support read input high/low status, set output voltage high/low status, controled by Linux device node, 8 pins.
I2C	Support "i2cdetect" console command for detect I2C device.
SPI	Support flash (by request)
DIO	Support control by Linux device node.
Micro USB debug	Support read Linux kernel debug message by serial port, use PC serial terminal tool (ex. PuTTY), BR 115200.
Play Video	Support play MPEG4(H.264) with GStreamer
Watch Dog	Support watch dog function.
CAN Bus	Support socket CAN TX/RX data.
RTC	Support Linux "date -s"and "hwclock -w" console commands to set system time.
Audio	1. Support system sound output to LINE OUT Connector. 2. Support GStreamer for test play MP3/WAV file. 3. Support sound recorder for test recording audio file.

M.2 B key	1. Support "lsusb" console command for check PCIe card status. 2. Support 5G module: Quectel RM502Q-AE
M.2 2230 E key	1. Support "lspci" console command for check PCIe card status. 2. Support WiFi module: Enli ENL-Q6856M2
MIPI-CSI 1/2 Camera	1. Support camera preview 2. Support camera module: IMX577, OV9282
Power saving feature (suspend/resume)*	Not support.
WiFi module	1. Support ENL-Q6856M2 module WiFi function only. 2. ENL-Q6856M2 WiFi: (1) Support Wifi STA Mode (connect Wifi AP) (2) Not support Soft AP Mode. 3. Not ready, wait for qualcomm bsp supports external WiFi module.
5G module	Support Quectel RM502Q-AE module 5G data-link function only.
Image Size	Around ~ 1.7GB (zip file)
Free storage size	Around ~100GB free space (/sysroot)