X6-ORN

Edge AI Compact Fanless Embedded System

User's Manual

Copyright

Trademarks

FCC and DOC Statement on Class A

This equipment has been tested and found to comply with the limits for a Class A 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 retrieved 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 arises 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.

About this 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 X6-ORN System Unit

Note: The items are subject to change in the developing stage.
The product 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.

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 Precautions

- Use the correct DC / AC input voltage range.
- Unplug the power cord before removing the system chassis cover for installation or servicing. After installation or servicing, cover the system chassis before plugging in the power cord.
- There is danger of explosion if battery incorrectly replaced.
- Replace only with the same or equivalent specifications of batteries recommend by the manufacturer.
- Dispose of used batteries according to local ordinance.
- Keep this system away from humid environments.
- Make sure the system is placed or mounted correctly and stably to prevent the chance of dropping or falling may cause damage.
- The openings on the system shall not be blocked and shall be kept in distance from other objects to make sure of proper air ventilation to protect the system from overheating.
- Dress the cables, especially the power cord, so they will not be stepped on, in contact with high temperature surfaces, or cause any tripping hazards.
- Do not place anything on top of the power cord. Use a power cord that has been approved for use with the system and is compliant with the voltage and current ranges required by the system's electrical specifications.
- If the system is to be unused or stored for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
- If one of the following occurs, consult a service personnel:
  - The power cord or plug is damaged.
  - Liquid has penetrated the system.
  - The system has been exposed to moisture.
  - The system is not working properly.
  - The system is physically damaged.
- The unit uses a three-wire ground cable which is equipped with a third pin to ground the unit and prevent electric shock. Do not defeat the purpose of this pin. If your outlet does not support this kind of plug, contact your electrician to replace the outlet.
- Disconnect the system from the electricity outlet before cleaning. Use a damp cloth for cleaning the surface. Do not use liquid or spray detergents for cleaning.
- Before connecting, make sure that the power supply voltage is correct. The device is connected to a power outlet which should be grounded connection.

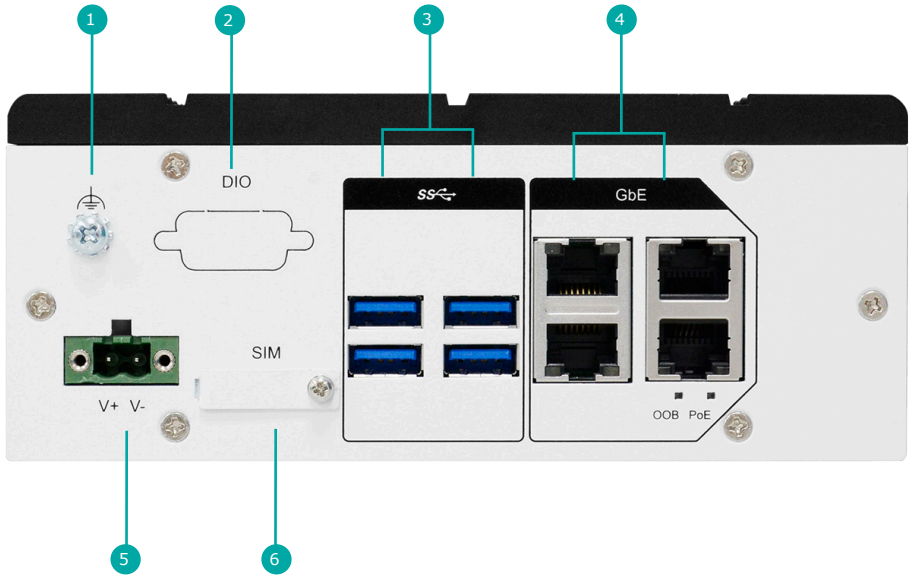
The system may burn fingers while running.

Wait for 30 minutes to handle electronic parts after power off.

Chapter 1 - Introduction

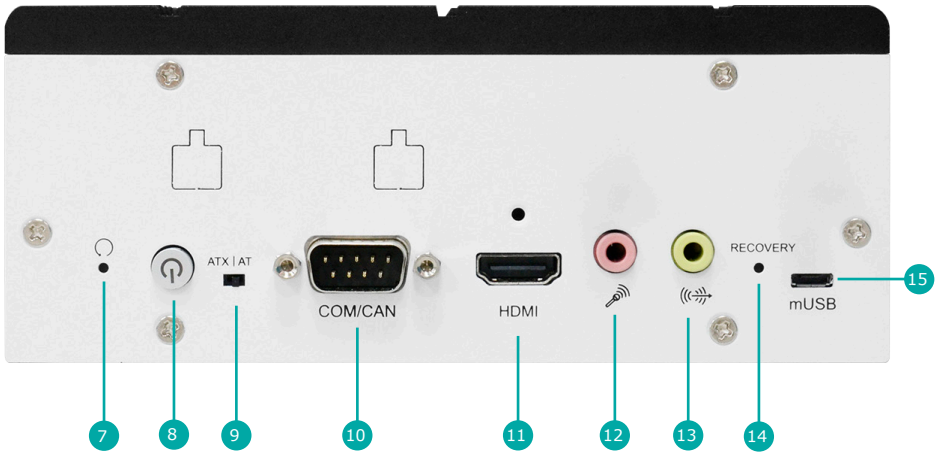
▶ Overview

Front View



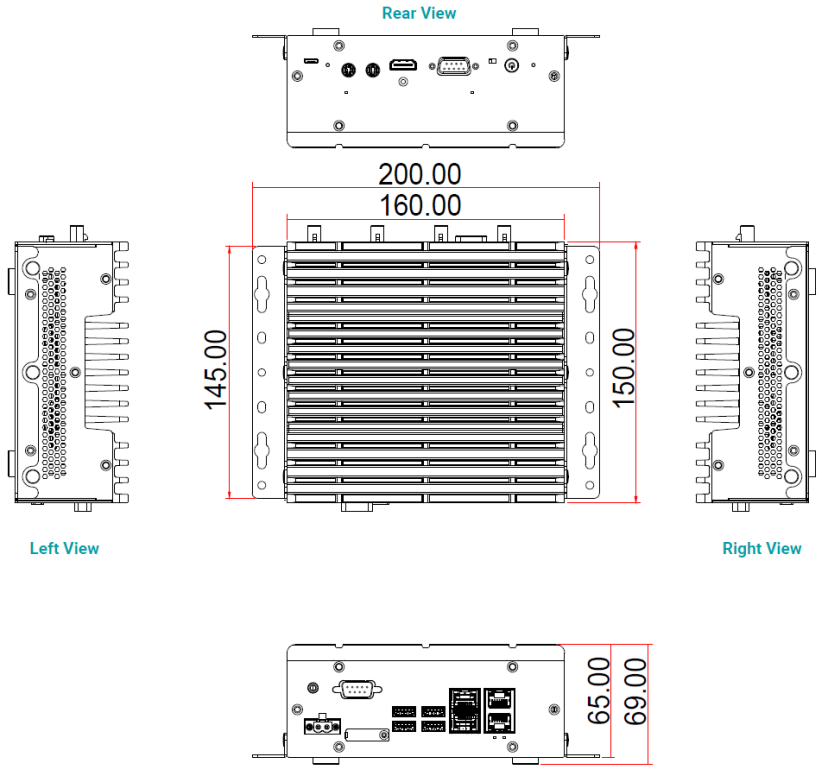
1	Grounding
2	DIO
3	USB 3.2 Gen1
4	RJ45 GbE Ports
5	2-Pin Power Terminal Block
6	Nano SIM Slot

Rear View



7	Reset Button
8	Power Button
9	ATX/AT Switch
10	CAN bus/ COM
11	HDMI
12	Mic-In
13	Line-Out
14	Recovery Button
15	Micro USB

▶ Dimensions



▶ Key Features

Nvidia Edge AI engine
NVIDIA® Jetson Orin Nano™ or NX

Multi GbE ports with PoE
Four RJ45 GbE ports and optional 2x PoE

OOB Support
Optional OOB (out-of-band) support

Multiple Expansions
1 M.2 2230 E-Key, 1 M.2 2280 M-Key
1 M.2 3042/3052 B-Key

Rich I/O
Audio, RS232/485, CAN bus, 4 USB 3.2, DIO, HDMI

▶ Specifications

SYSTEM	SOM	NVIDIA® Jetson Orin Nano™ 4GB, 7-10W NVIDIA® Jetson Orin Nano™ 8GB, 7-15W NVIDIA® Jetson Orin NX 8GB, 10-20W NVIDIA® Jetson Orin NX 16GB, 10-25W
	Processor	6/8-core Arm® Cortex®-A78AE v8.2 64-bit CPU
	GPU	1024-core NVIDIA Ampere architecture GPU with 32 Tensor Cores for Jetson Orin Nano™ 8GB and Orin NX 8/16GB, 40 TOPS 512-core NVIDIA Ampere architecture GPU with 16 Tensor Cores for Jetson Orin Nano™ 4GB, 20 TOPS
	Memory	8GB 128-bit LPDDR5 68 GB/s for Orin Nano™ 8GB 4GB 64-bit LPDDR5 34 GB/s for Orin Nano™ 4GB
		16GB 128-bit LPDDR5 102.4GB/s for Orin NX 16GB 8GB 128-bit LPDDR5 102.4GB for Orin NX 8GB
WATCHDOG TIMER	Watchdog Timer	Built-in NVIDIA® Jetson Orin™
GRAPHICS	Display	HDMI
STORAGE	Internal	M.2 2242/2280 M key (PCIe x4)
EXPANSION	Onboard	1 x M.2 Key E 2230 slot (USB 2 +PCIex1 signal) for Wi-Fi 6E 1 x M.2 Key B 3042/3052 slot (USB3 signal) for 5G/LTE with Nano SIM
ETHERNET	Controller	Four RJ45 GbE ports from 4x Intel i210 Supports 2x 15W PoE ports upon request
LED	Indicators	1 x PoE 1 x OOB
FRONT I/O	Ethernet	4 x RJ45 GbE connectors
	USB	4 x USB 3.2 Gen1 1 x micro USB for OS Flash
	SIM	accessible Nano SIM slot (covered by bracket)
	DC in	1 x 2-pin power terminal block
REAR I/O	CAN bus/ COM	1 x DB-9 for 1 RS232/485 and 1 CAN bus
	DIO	1 DB-9 for 4 DI/ 4 DO
	Audio	Mic-in, Line-out
	Display	1 x HDMI

Antenna	Antenna	6 x antenna holes
ON BOARD	On board	CPU fan header from EC Recovery switch for image update Reset button Power button
POWER	Type	9-36V DC
	Connector	1x 2-pin terminal block
	RTC Battery	CR2032
OS SUPPORT	Linux	Ubuntu 22.04
	Mounting	Wall mount (mounting brackets and screws) DIN mount by optional
	Dimensions (W x H x D)	Approx. 165 x 65 x 150 mm
	Weight	1.98kg
ENVIRONMENT	Operating Temperature	-20°C to 60°C
	Storage Temperature	-40°C to 85°C
	Relative Humidity	5 to 95% RH (non-condensing)
STANDARDS AND CERTIFICATIONS	Shock	**Operation** IEC 60068-2-27 Test Ea: Shock test Half-sine, 3G @ 11ms, 18 Shock ±X, ±Y, ±Z (each axis 3 times) **Non- Operation** IEC 60068-2-27 Test Ea: Shock test Half-sine, 5G @ 11ms, 18 Shock ±X, ±Y, ±Z (each axis 3 times)
	Vibration	**Operation** IEC 60068-2-64 Test Fh: Vibration board-band random test Random,2Grms @ 5~500 Hz, 30min. **Non- Operation** IEC 60068-2-6 Test Fc: Vibration Sinusoidal Test Sweep sine, 3Grms @ 10~500Hz, 30min.
	Certification	CE, FCC Class A, RoHS

Chapter 2 - Hardware Installations

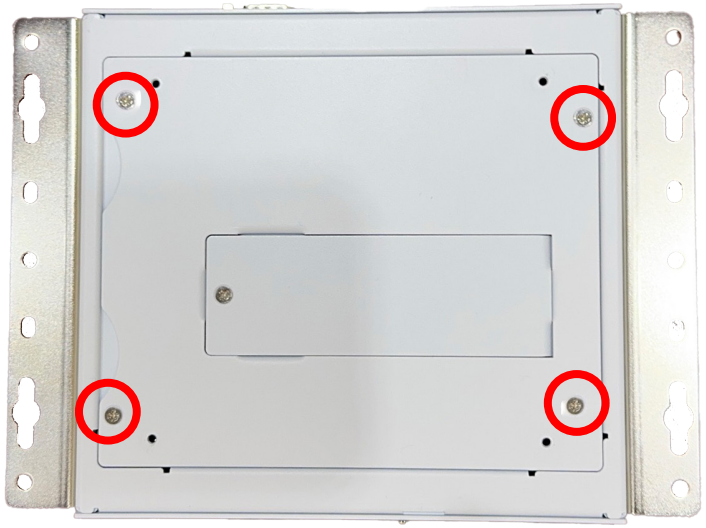
▶ Removing the Chassis Cover

Please observe the following guidelines and follow the instructions to open the system.

1. Make sure the system and all other peripheral devices connected to it have been powered off.

2. Disconnect all power cords and cables.

Step 1: Please remove 4 screws circled by red in each corner on the bottom of the system.



Step 2: Remove the bottom case. The board can be easily accessed after the chassis cover is removed.

▶ Installing an Antenna

Before installing the antenna, please make sure that the following safety cautions are wellattended.

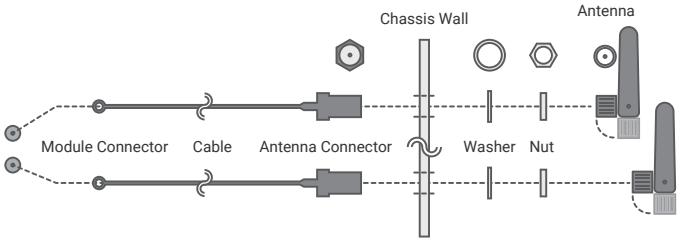
1. Make sure the PC and all other peripheral devices connected to it has been powered down.
2. Disconnect all power cords and cables.

Step 1:

There are antenna holes reserved on the left and the right side of the system and covered by rubber plugs. Please remove the plug prior to installing an antenna.

Step 2:

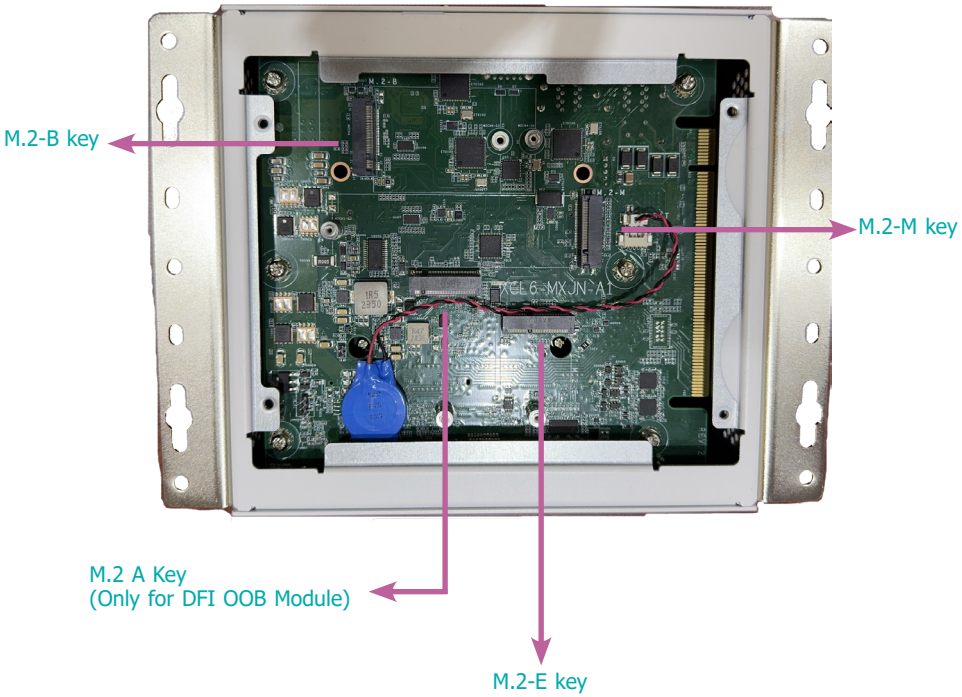
Connect the internal cable to the board's antenna connector, screw the antenna connector through the antenna hole with washers and nuts, and screw on the antenna as illustrated below.



▶ Installing a M.2 Module

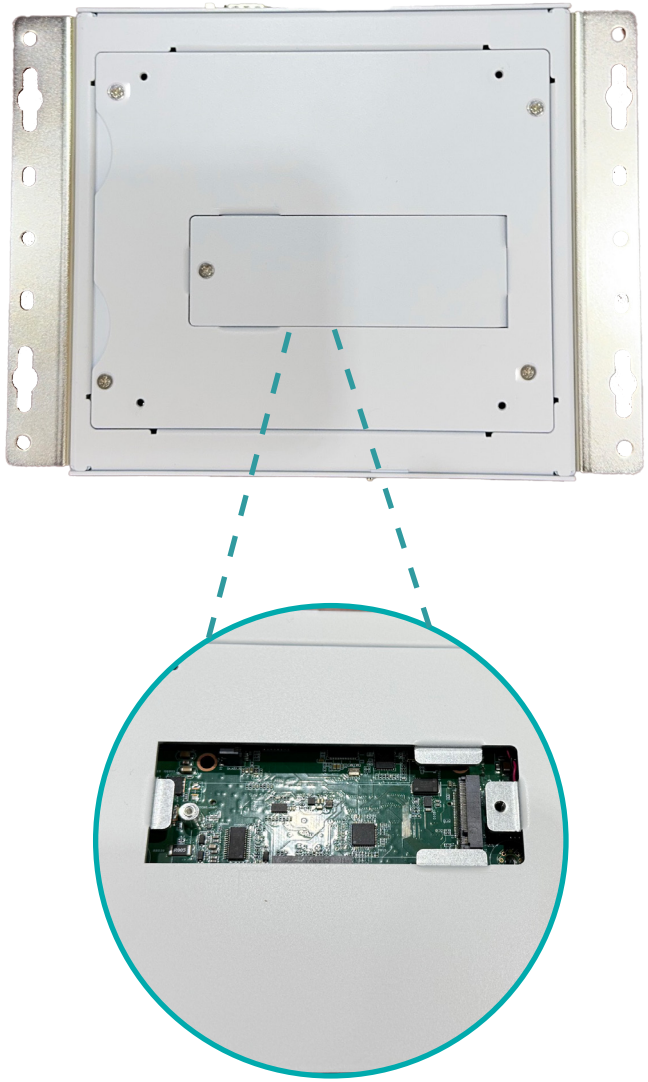
Before installing the M.2 module into the M.2 socket, please make sure that the following safety cautions are well-attended.

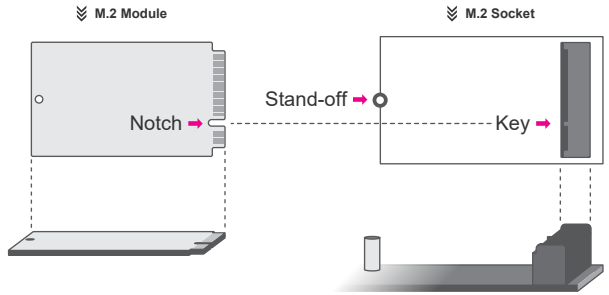
1. Make sure the PC and all other peripheral devices connected to it has been powered down.
2. Disconnect all power cords and cables.
3. Locate the M.2 socket on the system board
4. Make sure the notch on card is aligned to the key on the socket.
5. Make sure the standoff screw is removed from the standoff.



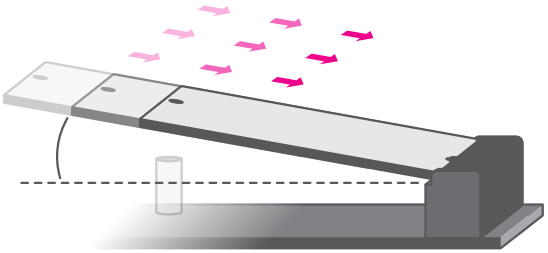
Installing a M.2-M Module

There is a screw on the bottom of the system.
Unlock the screw to access the M.2-M module without removing the chassis cover.

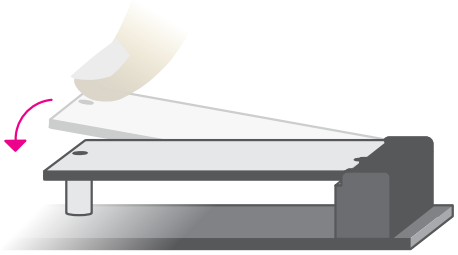




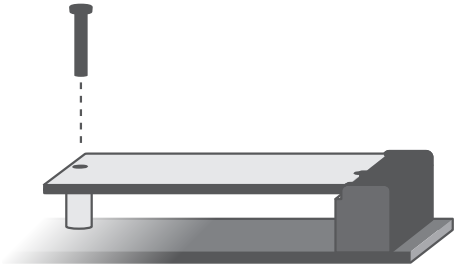
Please follow the steps below to install the card into the socket.



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



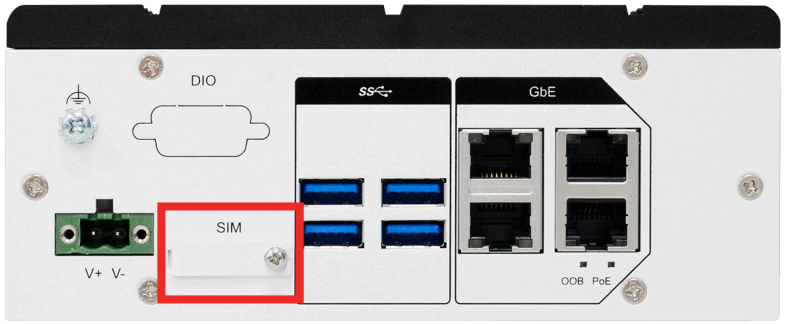
Step 2:
Press the end of the card far from the socket down until against the stand-off.



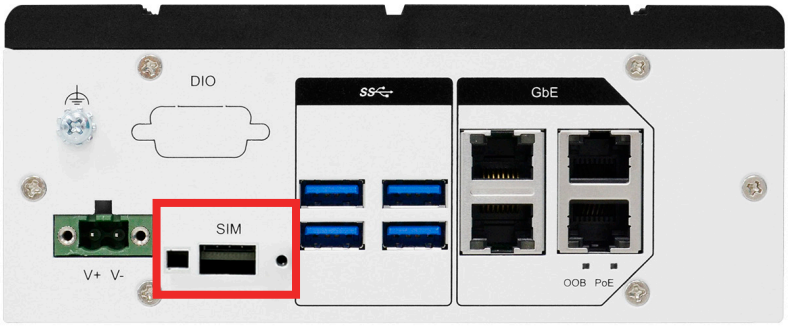
Step 3:
Screw tight the card onto the stand-off with a screw driver and a stand-off screw until the gap between the card and the stand-off closes up. The card should be lying parallel to the board when it's correctly mounted.

▶ Installing a Nano SIM Card

Step 1:
Please first remove the screw to disassemble the bracket.

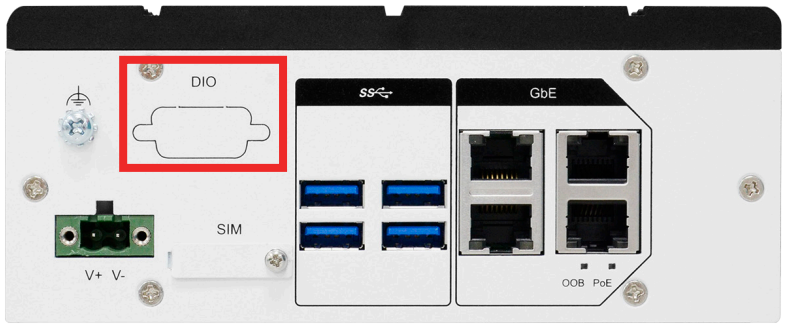


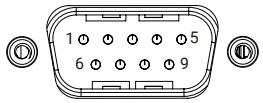
Step 2:
There is a slot for Nano SIM card.



▶ PIN Assignment

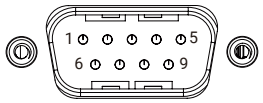
DIO





Pin	Assignment
1	GPI0
2	GPI1
3	GPI2
4	GPI3
5	GND
6	GPO0
7	GPO1
8	GPO2
9	GPO3

COM/CAN

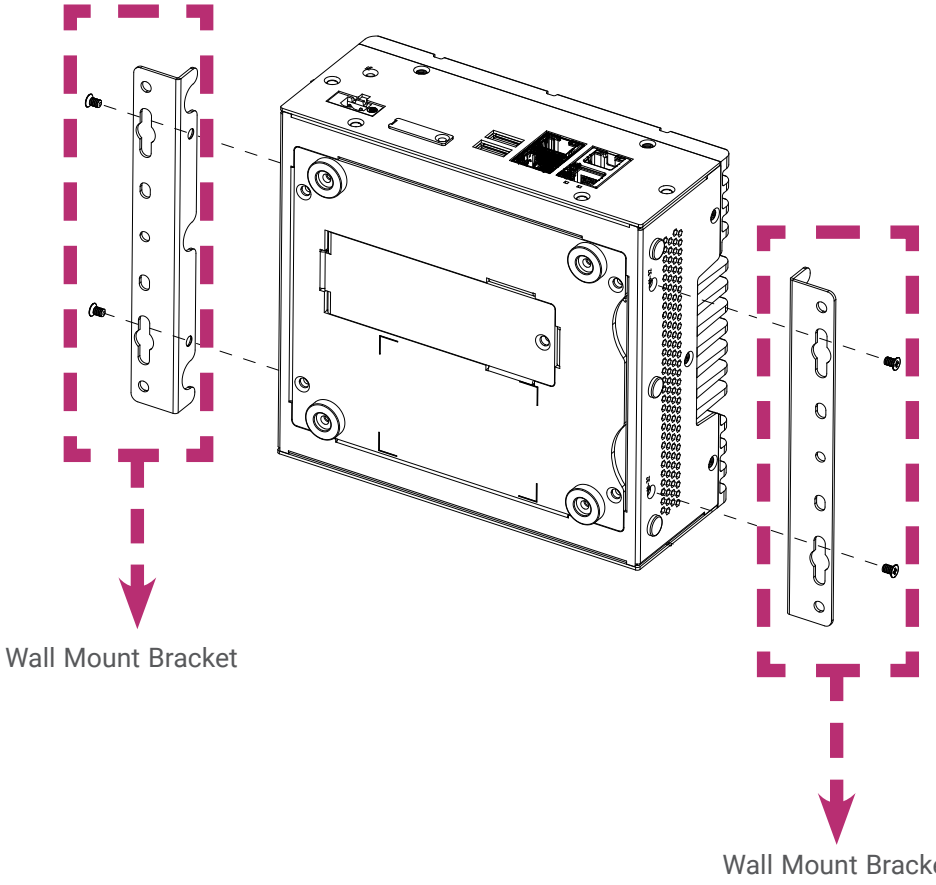


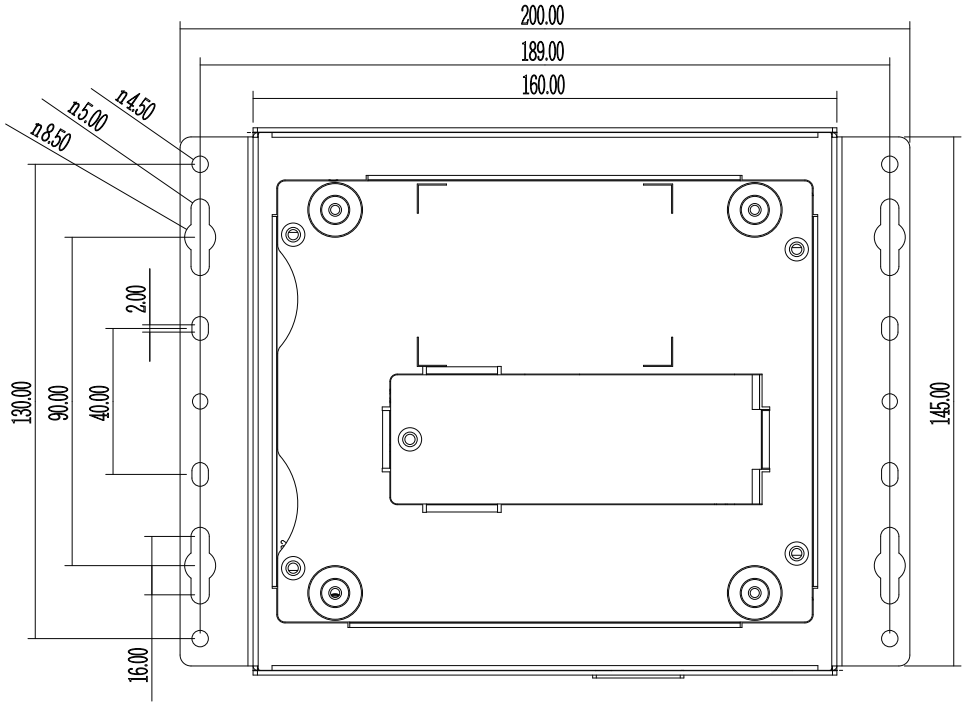
Pin	Assignment
1	---
2	RX
3	TX
4	---
5	GND
6	CAN_H
7	---
8	---
9	CAN_L

▶ Mounting Options

Wall Mount

The wall mount kit containing two mounting brackets can be attached to the bottom of the system for mounting onto desired locations, such as walls, stands, or shelves. Locate the mounting holes on the bottom of the system as shown in the photo. Screw on the two brackets onto the system with six screws as illustrated below.





Chapter 3 - Software Specification

▶ Software Components

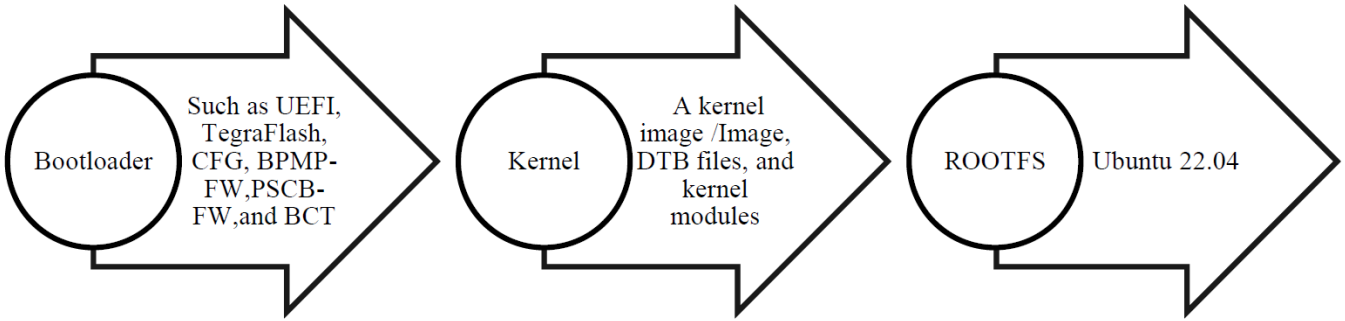
Introduction

This chapter details the Linux operation on Ubuntu 22.04 OS. The OS is an embedded system with Linux kernel 5.15. It contains all system-required shell commands and drivers ready.
You can evaluate and develop under Ubuntu 22.04 environment.

Boot flow is the sequence of operations that the Bootloader performs to initialize the SoC and boot NVIDIA® Jetson™ Linux. Here are the major operations that the Bootloader performs:

- Initializing the storage devices, memory controller (MC), external memory controller (EMC), and CPU.
- Setting up security parameters.
- Loading and authenticating firmware components.
- Maintaining the chain of trust.
- Creating memory carveouts for various firmware components.
- Flashing the storage device.
- Booting to the operating system.

The following diagram shows the flow of control in the boot software.



Develop Environment

Ubuntu 22.04 kernel 5.15 image for X6-ORN project was built with Ubuntu20.04 docker image and follow : Welcome — NVIDIA Jetson Linux Developer Guide released by **NVIDIA**.

General Support

(*) is depended on the NVIDIA support.

Components	Name	Base-Line Feature
General	OS Support	Ubuntu 22.04 (Default Preloaded on NVMe SSD), Kernel 5.15
Tools	Firmware Upgrade(*)	l4t_initrd_flash.sh update tool
	Utilities(*)	Jetson Power GUI

Linux AP/API support

(*) is depended on the NVIDIA support.

Component	Description	Detail	Release Schedule
Linux	Kernel 5.15	NVIDIA Jetson Linux Driver Package is the board support package for Jetson. It includes Linux Kernel, UEFI bootloader, NVIDIA drivers, flashing utilities, sample file system based on Ubuntu, and more for the Jetson platform.	2025 Q4
Linux AP/API	NVIDIA BSP Support X Window	All library and utility should support (*). Source code package (support by request).	2025 Q4
	Support I2C,CAN,GPIO	Provide support console for NVIDIA Jetson platform. i2ctools, can-utils, gpioget, gpioset	2025 Q4

Ubuntu Support List

(*) is depended on the NVIDIA support.

Component	Support Status
Ubuntu Version	22.04
Jetpack Version	6.2
Kernel version	5.15
Window System	X Window System
NVMe Drive	Support NVMe SSD boot by default, Linux EXT4 file system
Ethernet LAN1/2/3/4	Support "ping", "ifconfig" console commands verify, static IP/DHCP Dynamic IP

Audio	1. Support system sound output to LINE OUT Connector.
	2. Support music app for test play WAV file
	Select Settings -> Sound -> Output -> Output Device -> Audio Output
	Audio Adapter
	3. Support sound recorder app for test recording OGG file with MIC_IN
	$ sudo add-apt-repository ppa:audio-recorder/ppa
	$ sudo add-apt-repository ppa:ubuntuhandbook1/audio-recorder
	$ sudo apt install audio-recorder
	Run audio-recorder app record audio from system's sound card

I2C	Support "i2cdetect" console command for detect I2C device.
USB1/2/3/4	1. Support USB HID Keyboard and Mouse Device. 2. Support USB Mass Storage by "mount" console command, EXT3/EXT4/FAT filesystem.
CAN Bus	CAN Bus Support "cansend", "candump" console commands for test send/read data.
USB OTG	For connect to PC to update image by update firmware tool only.
HDMI Video	1. Support max display resolution of 1080p60. 2. Support single display function.
OOB (optional)	Support DFI M.2 OOB module remote power on/off/reset
M.2 B key	1. Support "lspci" console command for check PCIe card status. 2. Support 5G module: Quectel RM520N-GL 3. Support 4G LTE module: Quectel EM06 Insert the SIM card. Click the network icon on the top-right panel. Select Mobile Broadband Settings, Set APN name and enable mobile data. Check connection status
M.2 E key	1. Support "lspci" console command for check PCIe card status. 2. Support Wi-Fi/BT module : RTL8822BE,ENL8852 Wi-Fi: Select the available Wi-Fi AP from the Wi-Fi Settings list. Click connect and enter the password. Wait until the connection status shows connected BT: Select the available BT devices from the Bluetooth Settings list and transfer files between them.
COM Port(RS232/ RS422/RS485)	RS232: Support Loopback test, (need DFI Linux user space utility). RS422: Use minicom test TX/RX RS485: Use minicom test TX/RX
GPIO	Support read input high/low status, set output voltage high/low status, control by Linux device node, 8 pins.
Debug serial port	Support read Linux kernel debug message by serial port, use PC serial terminal tool (ex. PuTTY), BR 115200.
Play Video	Support play MPEG4 (play by Ubuntu tool).
RTC	Support Linux "date -s"and "hwclock -w" console commands to set system time.
GMSL2 Camera	APO imx415 OTO 271isp Use gst-launch-1.0 to test preview function
Power saving feature (suspend/ resume)*	Not support.
Watchdog	Support /proc/sysrq-trigger to test watchdog reboot function.
OTA	use l4t_generate_ota_package.sh create OTA image use nv_ota_start.sh to update OS image
Secure boot	Optional by request
Benchmark	Please refer to the link : GitHub - NVIDIA-AI-IOT/jetson_benchmarks:Jetson Benchmark and perform the benchmark test

X6-ORN BSP base on JetPack SDK | NVIDIA Developer , Jetpack 6.2, build (Builds Ubuntu 22.04).

Refer from Welcome — NVIDIA Jetson Linux Developer Guide

If using a 1TB NVMe SSD, the file system will have:

Used space: ~55 GB

Avail space: ~882 GB

UEFI Function Available List

a. Booting: NVMe SSD

b. UART Console Debug

▶ System Recovery

X6-ORN Flash Image Method

Step 1:

You have a X6-ORN system and a separate Linux (Ubuntu 20.04) X86 host system.

Step 2:

Download X6-ORN OS image from DFI NAS

Step 3:

Plug in Micro-USB cable (X86 <- -> X6-ORN)

Step 4:

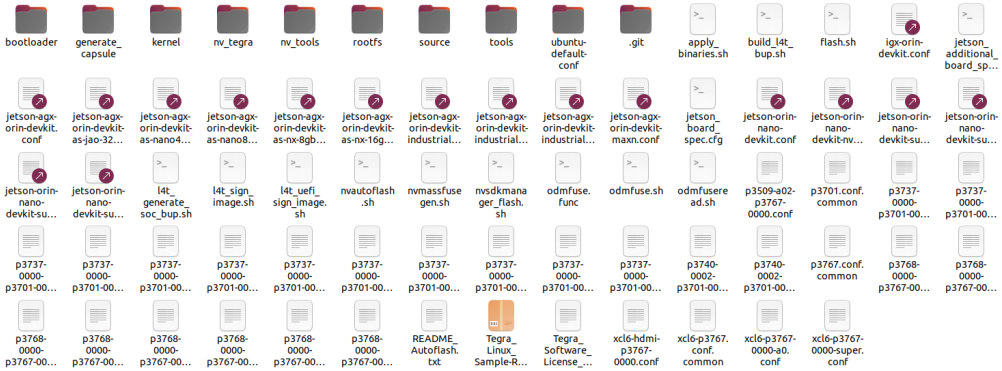
Plug in power cable (No power coming in)

Step 5:

Unzip X6-ORN OS image to home folder. Please refer to the following commands and pictures.

$ sudo tar –jxvf OS_Ubuntu2204_K5.15.148_R2_DVT_X6-ORN_ORIN_JP62_20250313_14.tar.bz2

$ cd Linux_for_Tegra



Step 6:

Create a programming environment. Please refer to the following commands.

$ sudo tar -xpf Tegra_Linux_Sample-Root-Filesystem_R36.4.3_aarch64.tbz2 -C rootfs

$ sudo ./tools/l4t_flash_prerequisites.sh

$ sudo ./apply_binaries.sh

$ sudo tools/l4t_create_default_user.sh -u x6-orin -p DFI -a --accept-license

Step 7:

Press Recovery button

Step 8:

Power on

Step 9:

Release Recovey button

CAUTION:

Your X86 host must be able to connect to a wide network (Internet), because the next step is to download the necessary package for flashing via the internet.

Step 10:

Enter the lsusb command on the X86 system. You will see 0955:7523 USB ID displayed in the terminal. Please refer to the figure below.

```
(base) jason@jason-Veriton-M4680G:~$ lsusb
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 003 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 002 Device 003: ID 0461:0010 Primax Electronics, Ltd HP PR1101U / Primax PMX-KPR1101U Keyboard
Bus 002 Device 029: ID 0403:6015 Future Technology Devices International, Ltd Bridge(I2C/SPI/UART/FIFO)
Bus 002 Device 002: ID 0c76:1694 JMTek, LLC. USB Audio Device
Bus 002 Device 031: ID 0955:7523 NVIDIA Corp. APX
Bus 002 Device 004: ID 0461:4e2a Primax Electronics, Ltd USB Optical Mouse
Bus 002 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
(base) jason@jason-Veriton-M4680G:~$
```

Step 11:

Enter the following command to flash OS image into NVME

$ sudo ./tools/kernel_flash/l4t_initrd_flash.sh --external-device nvme0n1p1 -c tools/kernel_flash/flash_l4t_t234_nvme.xml -p "-c bootloader/generic/cfg/flash_t234_qspi.xml" --showlogs --network usb0 xcl6-p3767-0000-super internal

Step 12:

Wait about 10 minutes.

Step 13:

After programming is completed, the X6-ORN will automatically reboot into the Ubuntu OS.

Step 14:

If you see the following screen on the HDMI monitor, it indicates that the system has been flashed successfully.