BOXER-8651AI-Plus

AI@Edge Compact Fanless Embedded
AI System with NVIDIA® Jetson Orin™ NX

User's Manual 1st Ed

Copyright Notice

Acknowledgements

Packing List

Before setting up your product, please make sure the following items have been shipped:

Item	Quantity
● BOXER-8651AI-Plus	1
● Wallmount Bracket	2
● Screw Package	1

If any of these items are missing or damaged, please contact your distributor or sales representative immediately.

About this Document

This User's Manual contains all the essential information, such as detailed descriptions and explanations on the product's hardware and software features (if any), its specifications, dimensions, jumper/connector settings/definitions, and driver installation instructions (if any), to facilitate users in setting up their product.

Users may refer to the product page at AAEON.com for the latest version of this document.

Safety Precautions

Please read the following safety instructions carefully. It is advised that you keep this manual for future references

1.   All cautions and warnings on the device should be noted.
2.   All cables and adapters supplied by AAEON are certified and in accordance with the material safety laws and regulations of the country of sale. Do not use any cables or adapters not supplied by AAEON to prevent system malfunction or fires.
3.   Make sure the power source matches the power rating of the device.
4.   Position the power cord so that people cannot step on it. Do not place anything over the power cord.
5.   Always completely disconnect the power before working on the system's hardware.
6.   No connections should be made when the system is powered as a sudden rush of power may damage sensitive electronic components.
7.   If the device is not to be used for a long time, disconnect it from the power supply to avoid damage by transient over-voltage.
8.   Always disconnect this device from any power supply before cleaning.
9.   While cleaning, use a damp cloth instead of liquid or spray detergents.
10.   Make sure the device is installed near a power outlet and is easily accessible.
11.   Keep this device away from humidity.
12.   Place the device on a solid surface during installation to prevent falls
13.   Do not cover the openings on the device to ensure optimal heat dissipation.
14.   Watch out for high temperatures when the system is running.
15.   Do not touch the heat sink or heat spreader when the system is running
16.   Never pour any liquid into the openings. This could cause fire or electric shock.

17.   As most electronic components are sensitive to static electrical charge, be sure to ground yourself to prevent static charge when installing the internal components. Use a grounding wrist strap and contain all electronic components in any static-shielded containers.

18.   If any of the following situations arises, please the contact our service personnel:

    i.   Damaged power cord or plug

    ii.   Liquid intrusion to the device

    iii.   Exposure to moisture

    iv.   Device is not working as expected or in a manner as described in this manual

    v.   The device is dropped or damaged

    vi.   Any obvious signs of damage displayed on the device

19.   **DO NOT LEAVE THIS DEVICE IN AN UNCONTROLLED ENVIRONMENT WITH TEMPERATURES BEYOND THE DEVICE'S PERMITTED STORAGE TEMPERATURES (SEE CHAPTER 1) TO PREVENT DAMAGE.**

FCC Statement

Warning!

This device complies with Part 15 FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received including interference that may cause undesired operation.

Caution:

There is a danger of explosion if the battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions and your local government's recycling or disposal directives.

Attention:

Il y a un risque d'explosion si la batterie est remplacée de façon incorrecte.
Ne la remplacer qu'avec le même modèle ou équivalent recommandé par le constructeur.
Recycler les batteries usées en accord avec les instructions du fabricant et les directives gouvernementales de recyclage.

China RoHS Requirements (CN)

产品中有毒有害物质或元素名称及含量

AAEON System   QO4-381 Rev.A2

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板 及其电子组件	×	○	○	○	○	○
外部信号 连接器及线材	×	○	○	○	○	○
外壳	○	○	○	○	○	○
中央处理器 与内存	×	○	○	○	○	○
硬盘	×	○	○	○	○	○
液晶模块	×	○	○	○	○	○
光驱	×	○	○	○	○	○
触控模块	×	○	○	○	○	○
电源	×	○	○	○	○	○
电池	×	○	○	○	○	○

本表格依据 SJ/T 11364 的规定编制。
○：表示该有毒有害物质在该部件所有均质材料中的含量均在 GB/T 26572 标准规定
　　的限量要求以下。
×：表示该有害物质的某一均质材料超出了 GB/T 26572 的限量要求，然而该部件仍
　　符合欧盟指令 2011/65/EU 的规范。
环保使用期限(EFUP (Environmental Friendly Use Period)) : 10 年
备注：
一、此产品所标示之环保使用期限，系指在一般正常使用状况下。
二、上述部件物质中央处理器、内存、硬盘、光驱、电源为选购品。
三、上述部件物质液晶模块、触控模块仅一体机产品适用。

China RoHS Requirement (EN)

Name and content of hazardous substances in product

AAEON System   QO4-381 Rev.A2

Part Name	Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
PCB Assemblies	×	○	○	○	○	○
Connector and Cable	×	○	○	○	○	○
Chassis	○	○	○	○	○	○
CPU and Memory	×	○	○	○	○	○
Hard Disk	×	○	○	○	○	○
LCD Modules	×	○	○	○	○	○
CD-ROM/DVD-ROM	×	○	○	○	○	○
Touch Modules	×	○	○	○	○	○
Power	×	○	○	○	○	○
Battery	×	○	○	○	○	○

The table is prepared in accordance with the provisions of SJ/T 11364.

○：Indicates that said hazardous substance contained in all of the homogenous materials for this product is below the limit requirement of GB/T 26572.

×：Indicates that said hazardous substance contained in at least one of the homogenous materials used for this part is above the limit requirement of GB/T 26572. But this product still be compliance with 2011/65/EU Directive (allowed with 2011/65/EU Annex III of RoHS exemption with number 6(c),7(a),7(c)-1).

EFUP (Environment Friendly Use Period) value: 10 years.

Notes：

1. This product defined period of use is under normal condition.

2. In above part, CPU/Memory/ Hard Disk/CD-ROM/DVD-ROM/ Power are optional.

3. In above part, LCD Modules/ Touch Modules are for all-in-one product model.

Table of Contents

Chapter 1

Product Specifications

1.1   Specifications

System	
AI Accelerator	NVIDIA® Jetson Orin NX™ with Super Mode
CPU	8GB SKU: 6-core Arm® Cortex®-A78AE v8.2 64-bit CPU
	16GB SKU: 8-core Arm® Cortex®-A78AE v8.2 64-bit CPU
System Memory	8GB/16GB LPDDR5 (Dependent on AI Accelerator Module)
Storage Device	M.2 3052 B-Key x 1 for M.2 2242 B+M Key SSD (Default Storage)
	M.2 2230 E-Key x 1 (Optional)
Display Interface	HDMI 1.2 (Type-A) x 1, up to 1920 x 1080 @60Hz
Ethernet	RJ-45 x 1 for GbE LAN
I/O	USB 3.2 Gen 2 (Type-A) x 4
	DB-9 for RS-232 (Rx/Tx/CTS/RTS) & CANBus FD x 1
	10-Pin header for DIO x 8
	Micro USB x 1 for OS Flash
	Recovery Button x 1
	Antenna x 6
Expansion	M.2 3042/3052 B Key x 1 (4G/5G/M.2 2242 B+M-Key storage)
	M.2 2230 E Key x 1 (Wi-Fi/BT)
	SIM Slot x 1
Indicator	Power LED x 1
OS Support	Linux (NVIDIA Jetpack™ 6.2 and above)

Power Supply

Power Requirement	12VDC ~ 24VDC via 2-pin Terminal Block

Mechanical

Mounting	Wall mount kit
Dimensions (W x D x H)	4.92 " x 3.54 " x 2.2" (125mm x 90mm x 56mm)
Gross Weight	3.13 lb. (1.42Kg)
Net Weight	1.85 lb. (0.84Kg)

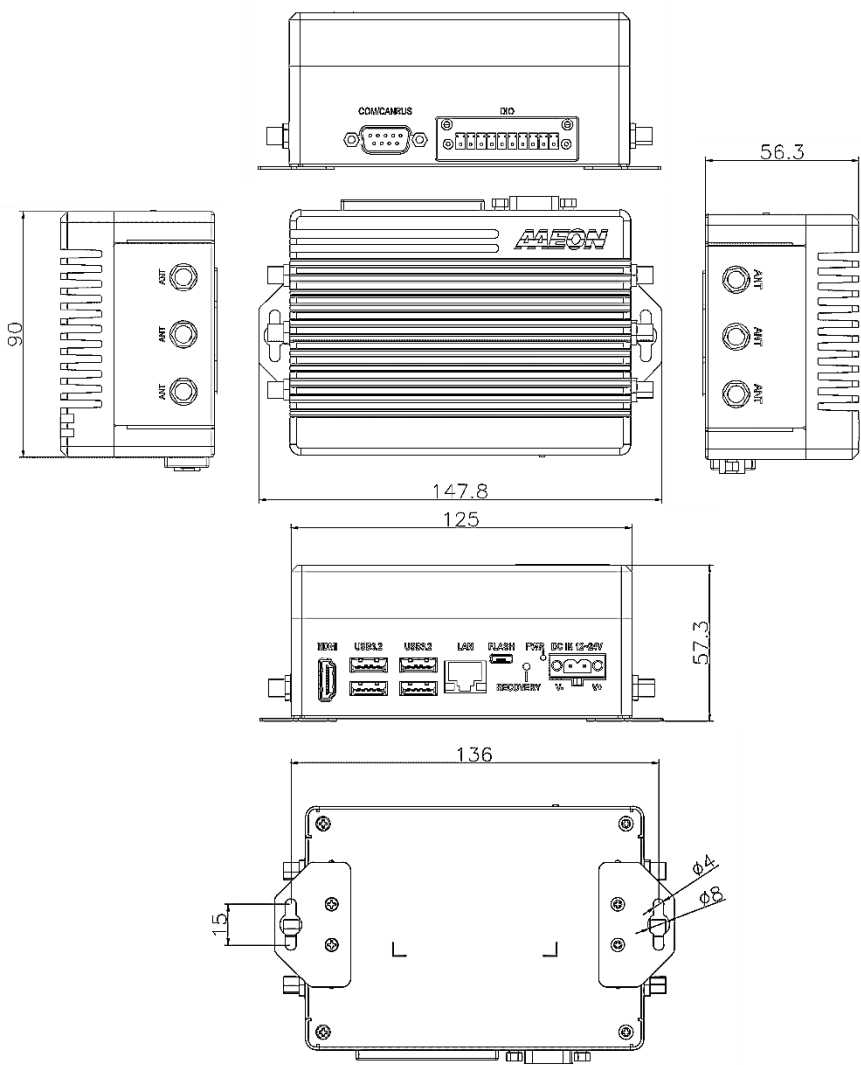## Environmental

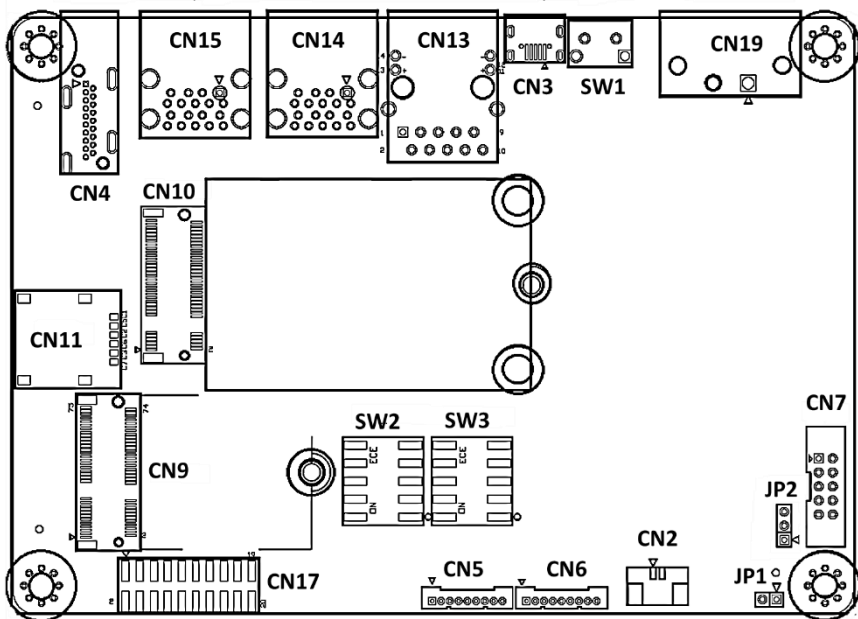|	
Operating Temperature	-13°F ~ 131°F (-25°C ~ 55°C with 0.7m/s airflow)
Storage Temperature	-40°F ~ 185°F (-40°C ~ 85°C)
Storage Humidity	5 ~ 95% @ 40°C, non-condensing
Anti-Vibration	3.5 Grms, 5~500Hz with SSD
Anti-Shock	50G peak acceleration
Certification	CE/FCC Class A

Chapter 2

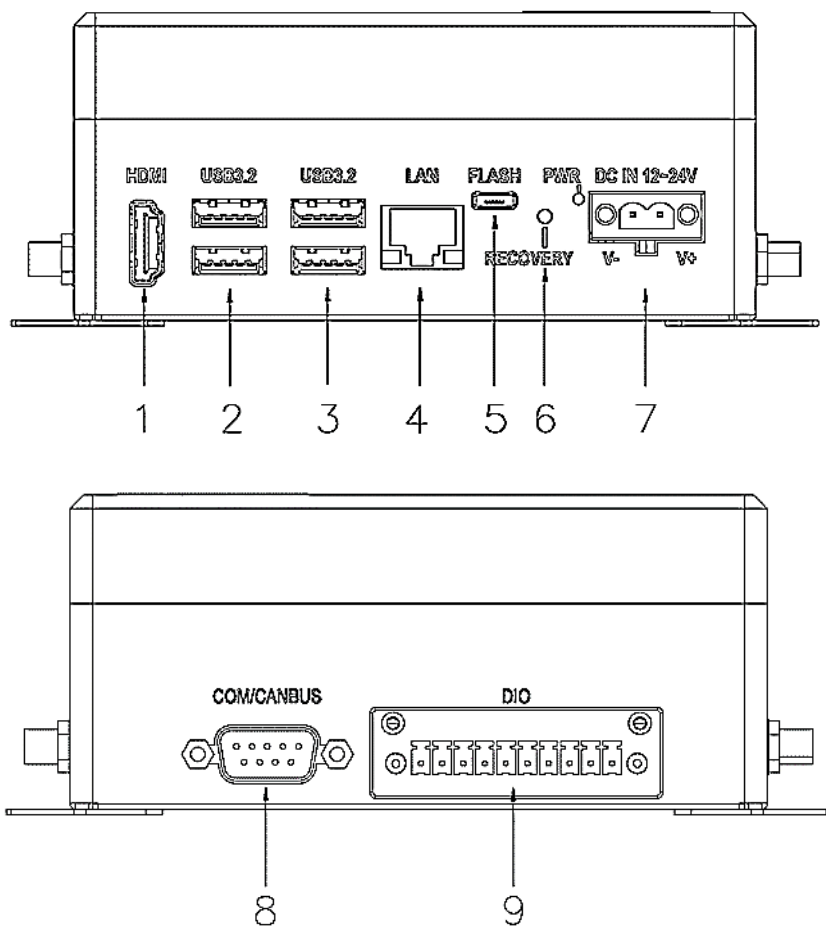Hardware Information

2.1 Dimensions

2.2   Jumpers and Connectors

Board Connectors

System Ports

2.3   List of Jumpers

The board has a number of jumpers that allow you to configure your system to suit your application.

The table below shows the function of each of the board's jumpers

Label	Function
JP1	AT/ATX Select
JP2	DIO Power Level Selection

2.3.1   Jumper Settings

You configure your card to match the needs of your application by setting jumpers. A jumper is the simplest kind of electric switch. It consists of two metal pins and a small metal clip (often protected by a plastic cover) that slides over the pins to connect them. To "close" a jumper you connect the pins with the clip.

To "open" a jumper you remove the clip. Sometimes a jumper will have three pins, labeled 1, 2 and 3. In this case you would connect either pins 1 and 2 or 2 and 3.

Open   **Closed**   **Closed 2-3**
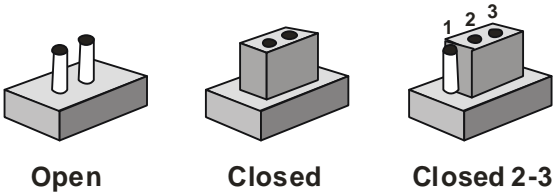
A pair of needle-nose pliers may be helpful when working with jumpers.

If you have any doubts about the best hardware configuration for your application, contact your local distributor or sales representative before you make any change.

Generally, you simply need a standard cable to make most connections.

2.3.2 DIO Power Level Selection (JP2)
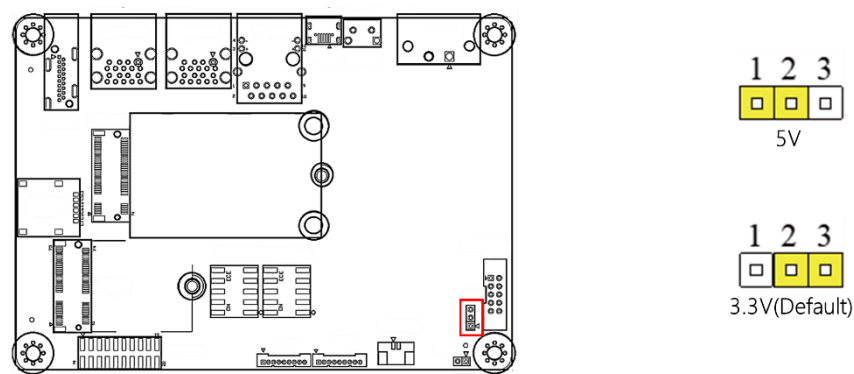
JP2 Pin	Function
1-2	5V
2-3	3.3V (Default)

2.3.3 AT/ATX Mode Selection (JP1)

JP1 Pin	Function
1-2	Open AT
1-2	Close ATX (Default)

2.4   List of Ports

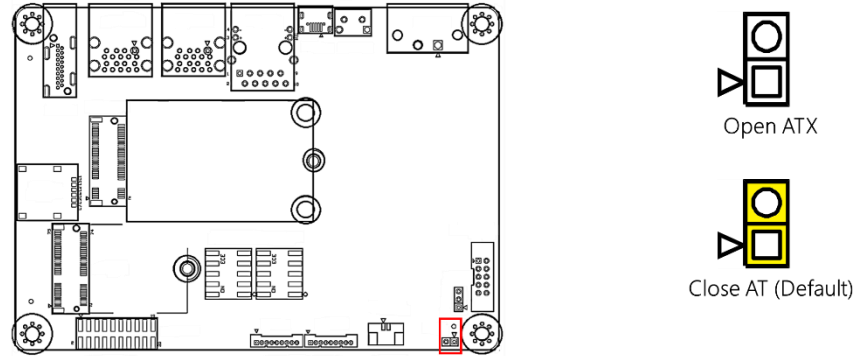The system has a number of ports that allow you to configure your system to suit your application.

The table below shows the function of each of the board's connectors

Label	Function
1	HDMI Port
2	USB 3.2 Gen 2 Type-A Port
3	USB 3.2 Gen 2 Type-A Port
4	RJ-45 Port
5	Micro USB for Flash Image Use
6	Recovery Button
7	12V~24V DC Power Input
8	RS-232/422/485 + CANBus Port
9	DIO Port
JP1	AT/ATX Select
JP2	DIO Power Level Select

2.4.1   HDMI Port (1)
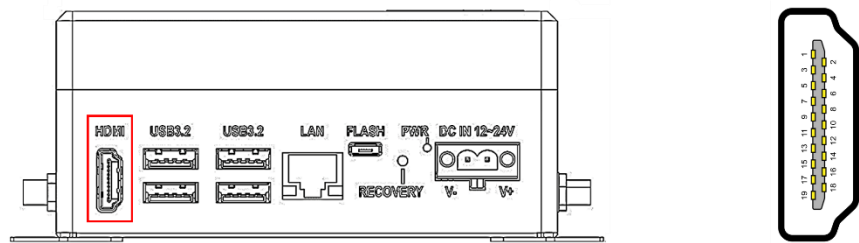
Pin	Signal	Pin	Signal
1	HDMI_DATA2_P	2	GND
3	HDMI_DATA2_N	4	HDMI_DATA1_P
5	GND	6	HDMI_DATA1_N
7	HDMI_DATA0_P	8	GND
9	HDMI_DATA0_N	10	HDMI_CLK_P
11	GND	12	HDMI_CLK_N
13	NC	14	NC
15	HDMI_SCL	16	HDMI_SDA
17	GND	18	HDMI_PWR
19	HDMI_HDP		

2.4.2   USB 3.2 Gen 2 Type-A Port (2/3)
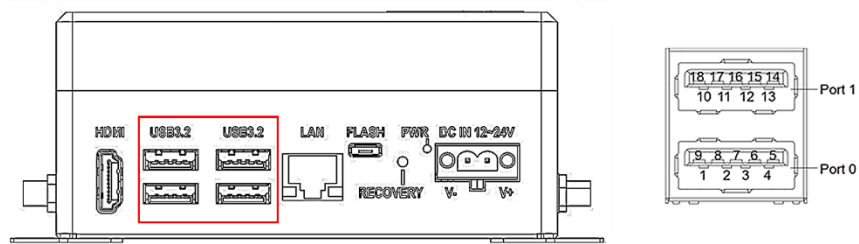
Pin	Signal	Pin	Signal
U1	VBUS_1	U10	VBUS_2
U2	(A)D-	U11	(B)D-
U3	(A)D+	U12	(B)D+
U4	GND	U13	GND
U5	(A)SSRX-	U14	(B)SSRX-
U6	(A)SSRX+	U15	(B)SSRX+

Pin	Signal	Pin	Signal
U7	GND	U16	GND
U8	(A)SSTX-	U17	(B)SSTX-
U9	(A)SSTX+	U18	(B)SSTX+

2.4.3   RJ-45 Port (4)
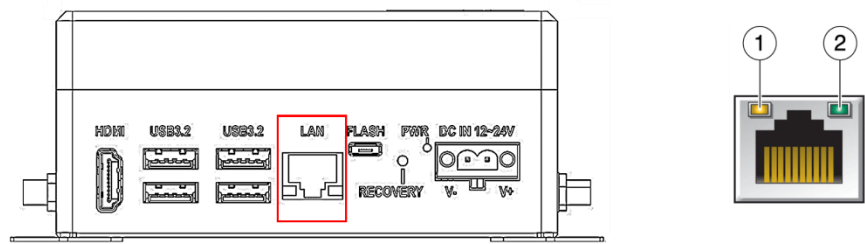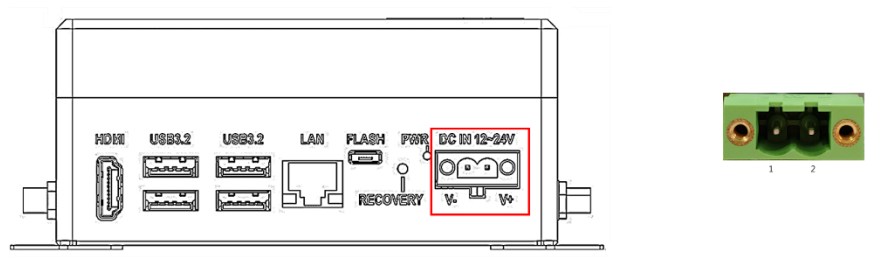
Pin	Signal	Pin	Signal
1	MDI0+	2	MDI0-
3	MDI1+	4	MDI1-
5	MDI2+	6	MDI2-
7	MDI3+	8	MDI3-
1	Active LED	2	Speed LED
Orange	Blinking	Green	100Mbps
		Orange	1Gbps

2.4.4   Micro USB (Flash OS) (5)
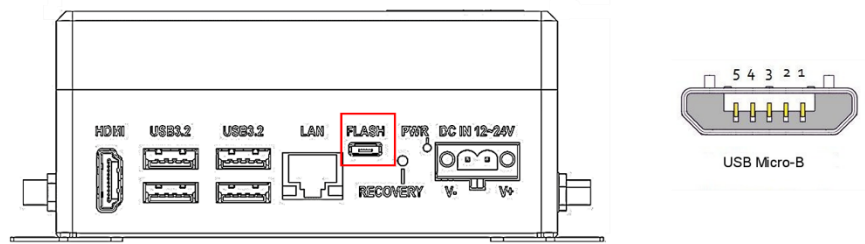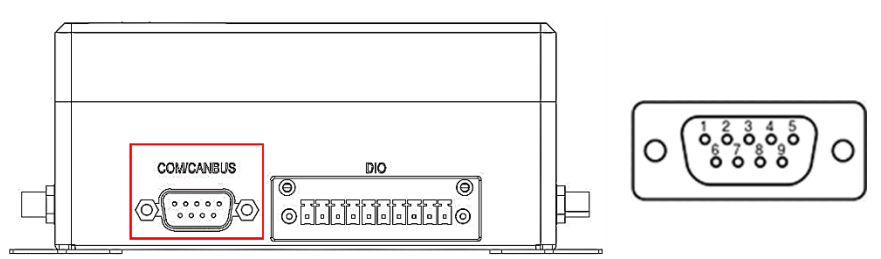
Pin	Signal	Pin	Signal
1	+5V	2	USB1-
3	USB1+	4	
5	GND		

2.4.5   12V~24V DC Power Input (7)

Pin	Signal	Pin	Signal
1	DC Positive	2	DC Negative

2.4.6   RS-232/422/485 + CANBus Port (8/SW2)

Pin	RS-232	RS-422	RS-485
1		TX-	D-
2	RXD	TX+	D+
3	TXD	RX+	
4		RX-	
5	GND	GND	GND
6	CAN L	CAN L	CAN L
7	RTS#	RTS#	RTS#
8	CTS#	CTS#	CTS#
9	CAN H	CAN H	CAN H

2.4.7   RS-232/422/485 Select (SW2)
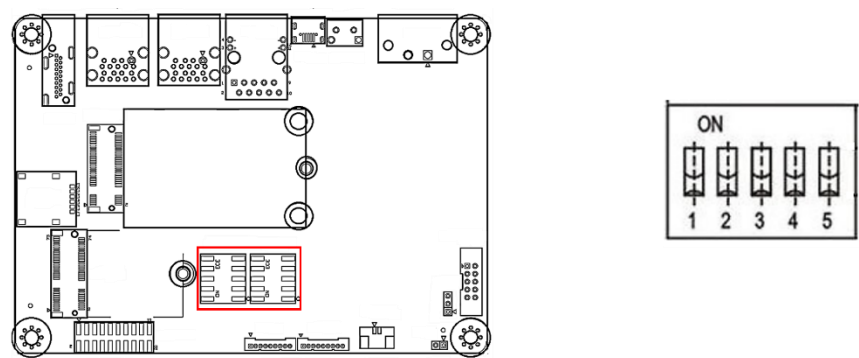
Mode	S-1	S-2	S-3	S-4
2T/2R RS-232	On	On	On	
1T/1R RS-422 Full Duplex w/o RTS#,TX always enable	On	On	Off	
1T/1R RS-422 Full Duplex TX enable low active with auto sensing	On	Off	On	
1T/1R RS-422 Full Duplex TX enable when RTS# is low.	On	Off	Off	
1T/1R RS-485 Half Duplex TX enable low active with auto sensing	Off	On	On	
1T/1R RS-485 Half Duplex TX enable when RTS# is low.	Off	On	Off	
Low power shutdown	Off	Off	On	
250kbps for RS-232 and RS-485				On
RS-232 to 3Mbps and RS-485 to 20Mbps				Off
Enable RS-485 bias and termination resistors.			On	
Disable RS-485 bias and termination resistors.			Off	

2.4.8   DIO Port (9)
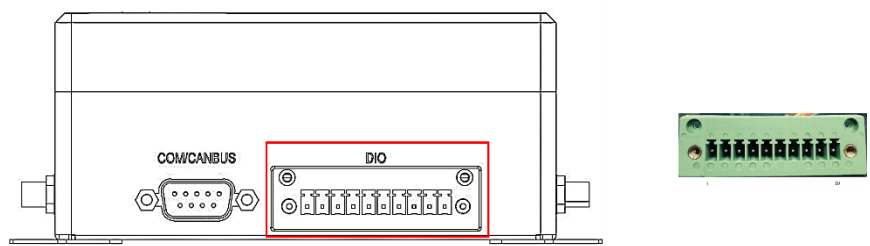
Pin	Signal	Pin	Signal
1	PH.07	2	PQ.05
3	PI.00	4	PAC.06
5	PI.01	6	PQ.06
7	PI.02	8	PH.00
9	GND	10	DIO POWER

2.5   Hardware Installation

2.5.1   Expansion Module Installation

Turn the BOXER-8651AI-Plus system over so the bottom is facing up. Install each
module by first inserting at an angle (approx. 30°), then gently pressing down and
securing.
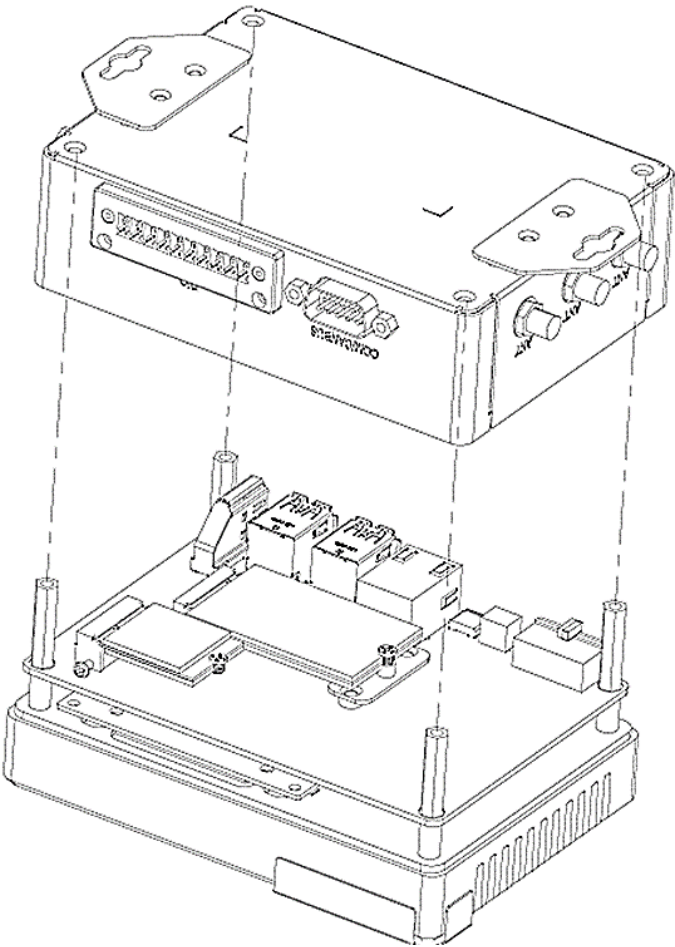
2.5.2   Wall Mount Installation

Turn the BOXER-8651AI-Plus system over so the bottom is facing up. Install each

bracket using two (2) screws to affix them to the bottom of the chassis, as below.
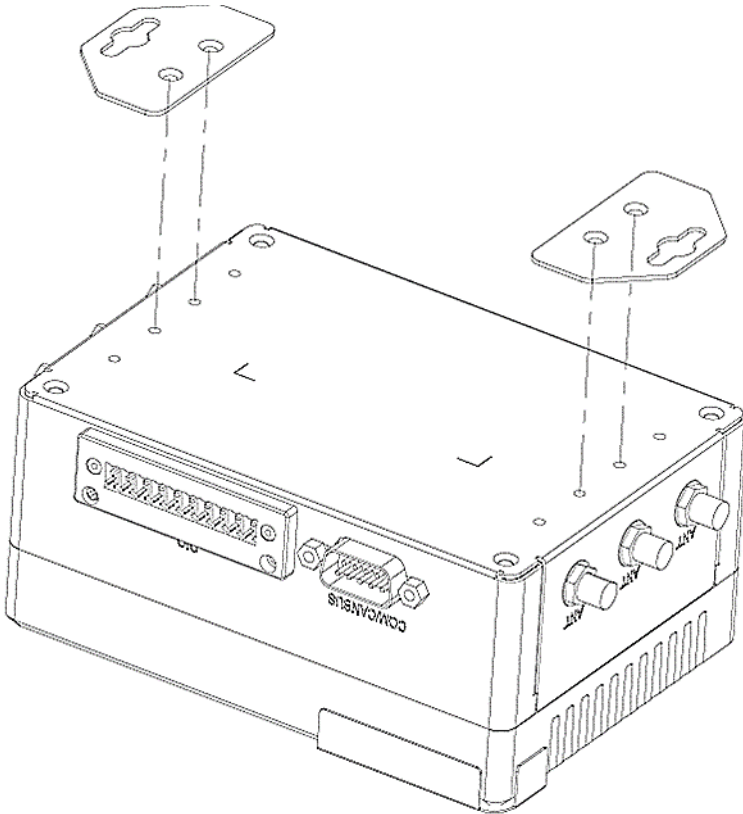
Chapter 3

BSP Flash Guide

3.1   Before Installation

Before starting the process make sure your BOXER-8651AI-Plus system is turned off and the power is disconnected. You will need a Host PC running Ubuntu 20.04, and make sure the NVIDIA® Jetson Orin™ NX module is installed onto the BOXER-8651AI-Plus carrier board system.

Note: Do not use a virtual machine as a host PC, as some virtual machines may have unstable USB connections which can cause the flash procedure to fail.

Download the compressed BSP image file:

"**BOXER-8651AI-B1_J6.2_A00_1.0.0_20250226.tar.gz**" into the Host Ubuntu 20.04 PC directory.

Note: No spaces, special characters, or non-English characters can be used for the name of the folder where the file is stored, or its parent folder.

Ensure the language settings of Ubuntu 20.04 are set to English, and the format setting is the United States, to prevent flash failure.
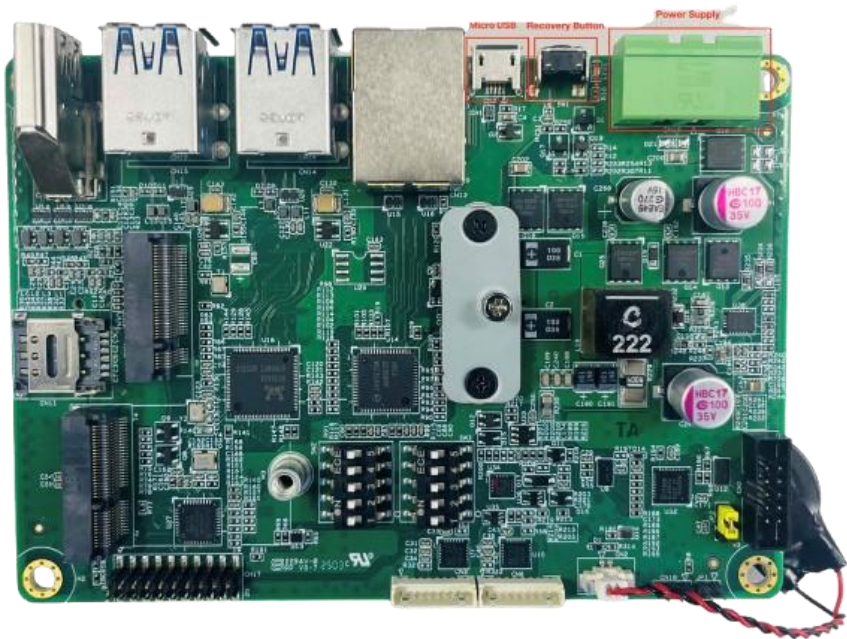
3.2　Connecting to PC/Force Recovery Mode

Step 1:

On the Host computer, open Linux terminal and enter the following command to

extract the compressed BSP image files (BSP file name may vary):

$ sudo tar -zxvf BOXER-8651AI-B1_J6.2_A00_1.0.0_20250226.tar.gz.tar.gz

Note: Do not decompress the file using a Windows OS. BSP should only be

decompressed in a Linux EXT3/4 file system.

Step 2:

Perform the following actions to force the system to start in USB Recovery Mode:

1.　Connect the Micro-USB plug on the USB cable to the Recovery Port on the

BOXER-8651AI-Plus and the other end to an available USB port on the Host PC.

2.　Connect the BOXER-8651AI-Plus power supply.

3.   Press and hold the recovery key button. While holding the recovery key button, power on the system, and continue to hold the recovery key button for two seconds, then release. The BOXER-8651AI-Plus should then enter recovery mode.

4.   To check if device is in recovery mode, enter the **lsusb** command in the terminal on the Host PC.

$ lsusb | grep "0955:7523"

If successful, the command will return "0955:7523 Nvidia Corp"

Bus 001 Device 018: ID 0955:7523 NVidia Corp.

Note: Recovery mode cannot be initiated if the NVIDIA® Jetson Orin™ NX module is disassembled. Ensure the NVIDIA® Jetson Orin™ NX module is installed and refer to the image below to perform the steps:

3.3   Flash Image to Board

Use the following steps to flash the OS to the BOXER-8651AI-Plus.

1)   Open terminal on the Ubuntu Host PC, then access the folder you extracted in

the previous section.

2)   Enter the following command in terminal to flash the image:

`$ ./flashboxer.sh -s 62517420 nvme`

3)   Wait until the image is installed. Once finished you should see the following:

```
writing item=16, 9:0:secondary_gpt, 32008902144, 16896, gpt_secondary_9_0.bin, 16896, fixed-<reserved>-0, 59012273e727e6a457684ff7805a26ed6cf1c4fa
[ 389]: l4t_flash_from_kernel: Successfully flash the external device
[ 389]: l4t_flash_from_kernel: Flashing success
[ 389]: l4t_flash_from_kernel: The device size indicated in the partition layout xml is smaller than the actual size. This utility will try to fix the GPT.
Flash is successful
Reboot device
Cleaning up...
```

From the second time onwards, you can flash 10 images once at most, using the flash

command as follows:

`$ ./flashboxer.sh -m nvme`

3.4   Check BSP Version

Once the flash image is successfully installed, the BOXER-8651AI will reboot automatically, then check the BSP version to see if the system is flashing the correct version of BSP.

Open a Terminal, and type command "cat /proc/product"

You will see the product name with version and date

BOXER-8651AI-B1_J6.2_A00_1.0.0_20250226

{PJ_IF}_{JPV_IF}_A00_{IMGV_IF}_{BD_IF}

For example:

BOXER-8651AI-B1_J6.2_A00_1.0.0_20250226

Note: Filename may differ from this example.

{PJ_IF} is Project Information; e.g. BOXER-8651AI-B1

{JPV_IF} is Jetpack Version; e.g. J6.2

{IMGV_IF} is Build Version; e.g. 1.0.0

{BD_IF} is Build Date; e.g. 20250226

Chapter 4

OS User Guide

4.1   Introduction

The BOXER-8651AI-Plus' OS, Ubuntu/Linux version, and preinstalled SDK components are as follows:

For **Jetpack 6.2 (l4t 36.4.3)**

1. Jetpack 6.2, L4T 36.4.3
    a. Ubuntu version: 22.04.5
    b. Kernel version: 5.15.148-tegra
    c. UEFI version: 36.4.3-gcid-38968081
2. Pre-installed NV components, Deepstream
    a. CUDA 12.6.10
    b. cuDNN 9.3.0
    c. TensorRT 10.3.0
    d. OpenCV 4.8
    e. Vulkan 1.3
    f. VPI 3.2
    g. NVIDIA Container Runtime 2.1
    h. Multimedia API 36.4
    i. Nsight Systems 2024.5
    j. Nsight Graphics 2024.2
    k. Nsight Perf SDK 2023.2
    l. Deepstream 7.1
3. Built-in Allxon DMS

    a. Please refer to https://www.allxon.com/solutions

Default login user/password is:

Account: **aaeon**

Password: **aaeon**

4.2   Update Note

Running **$** **sudo apt upgrade** command in terminal will overwrite the **Aaeon kernel device tree (.dtb)/kernel image(Image)/bootloader** in OS, which can lead to unexpected results including losing I/O ports.
**So Aaeon default disable Nvidia apt Repo for updating Nvidia apt package.**

AAEON maintains updated versions of BSP on the product page, which follow updates to the NVIDIA Jetpack software. Contact your AAEON representative or visit the product page to download the latest version of AAEON BSP for your system:
https://www.aaeon.com/en/

4.3　BOXER-8651AI-Plus Power Mode

NVIDIA® Jetson Orin™ NX power mode can be selected and monitored by GUI, please refer to the following picture:
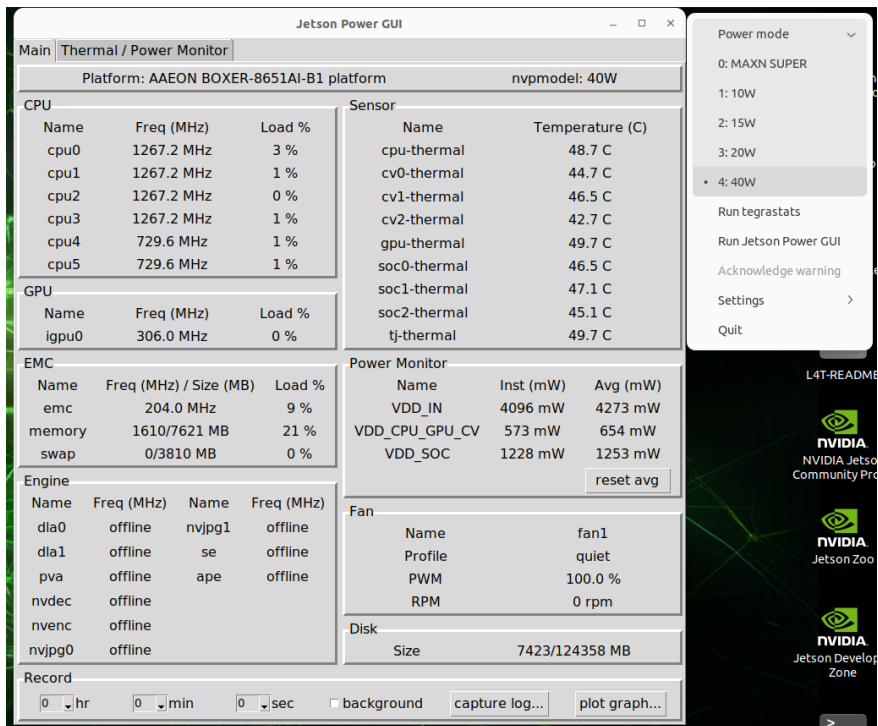
Note: Power mode is dependent on DRAM size. For more detailed information please visit https://developer.nvidia.com/embedded/jetson-modules

4.4   DIO/GPIO setting Command for BOXER-8651AI-Plus

This section provides example commands for testing and configuring GPIO and FAN PWM on the BOXER-8651AI-Plus system.

1.   GPIO Test Commands

Before proceeding, refer to the **Hardware DIO/GPIO** section for details on pin numbers and corresponding GPIO IDs. The following example demonstrates using PIN 2, which maps to GPIO ID: PQ.05 on connector CN7.

1.   Set GPIO to 0

$ sudo gpioset -m time -u 300000 -b $(sudo gpiofind "PQ.05")=0

2.   Read the input value of GPIO

$ sudo gpioget $(sudo gpiofind "PQ.05")

Note: For GPIOs on connector CN7, there is no need to manually export the GPIO or set its direction. When using gpioget, the direction is automatically set to input. Conversely, when using gpioset, it is automatically set to output.

2.   FAN PWM test command:

For customers who wish to use the FAN PWM interface as a standard PWM output for manual control, follow the steps below.

1.   Stop NV fan control daemon

$ sudo systemctl stop nvfancontrol

2.   Set PWM value

$ echo [PWM_duty_cycle] >

/sys/devices/platform/pwm-fan/hwmon/hwmon<x>/pwm1

Where: [PWM_duty_cycle] is a value in the range [0,255]. <x> is a kernel enumerated number for fan hwmon.