Neousys Technology Inc.

NRU Series

User Manual

Revision 1.3

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To the extent permitted by applicable laws, Neousys Technology Inc. shall NOT be responsible for any interoperability or compatibility issues that may arise when (1) products, software, or options not certified and supported; (2) configurations not certified and supported are used; (3) parts intended for one system is installed in another system of different make or model.

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Declaration of Conformity

FCC	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 commercial environment. 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. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.
CE	The product(s) described in this manual complies with all applicable European Union (CE) directives if it has a CE marking. For computer systems to remain CE compliant, only CE-compliant parts may be used. Maintaining CE compliance also requires proper cable and cabling techniques.

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Safety Precautions

- Read these instructions carefully before you install, operate, or transport the system.
- Install the system or DIN rail associated with, at a sturdy location
- Install the power socket outlet near the system where it is easily accessible
- Secure each system module(s) using its retaining screws
- Place power cords and other connection cables away from foot traffic. Do not place items over power cords and make sure they do not rest against data cables
- Shutdown, disconnect all cables from the system and ground yourself before touching internal modules
- Ensure that the correct power range is being used before powering the device
- Should a module fail, arrange for a replacement as soon as possible to minimize down-time
- By means of a power cord connected to a socket-outlet with earthing connection
- This product is intended to be supplied by a Listed Power Adapter or DC power source, rated up to 5000m altitude operation. If further assistance is required, please contact Neousys Technology
- If the system is not going to be used for a long time, disconnect it from mains (power socket) to avoid transient over-voltage

Battery Warning

- Batteries are at risk of exploding if incorrectly installed.
- Do not attempt to recharge, force open, or heat the battery.
- Replace the battery only with the same or equivalent type recommended by the manufacturer.

Service and Maintenance

- ONLY qualified personnel should service the system
- Shutdown the system, disconnect the power cord and all other connections before servicing the system
- When replacing/ installing additional components (expansion card, memory module, etc.), insert them as gently as possible while assuring proper connector engagement

ESD Precautions

- Handle add-on module, motherboard by their retention screws or the module's frame/ heat sink. Avoid touching the PCB circuit board or add-on module connector pins
- Use a grounded wrist strap and an anti-static work pad to discharge static electricity when installing or maintaining the system
- Avoid dust, debris, carpets, plastic, vinyl and 8tyrofoam in your work area.
- Do not remove any module or component from its anti-static bag before installation

Restricted Access Location

The controller is intended for installation only in certain environments where both of the following conditions apply:

- Access can only be gained by QUALIFIED SERVICE PERSONNEL who have been instructed on the reasons for restrictions applied to the location and any precautions that shall be taken
- Access is through the use of a TOOL, lock and key, or other means of security, and is controlled by the authority responsible for the location

About This Manual

This manual introduces and demonstrates installation procedures of Neousys NRU series systems featuring NVIDIA Jetson AGX Xavier platform. The manual also demonstrates the system's general installation procedures.

Revision History

Version	Date	Description
1.0	Jan. 2021	Initial release
1.1	Mar. 2021	Updated Safety Precaution rating specifications
1.2	May. 2021	Updated front accessible 2.5" tray installation procedures
1.3	May. 2022	Updated installation/ disassembly instructions

1 Introduction

NRU series is a low-power edge AI computing platform that supports automotive cameras. It is a turnkey solution that includes computing core, on-board GMSL deserializers, and a pre-installed board support package (BSP) to support selected cameras. Powered by NVIDIA® Jetson AGX Xavier™, NRU systems offer up to 11 TFLOPS FP16 or 22 TOPS INT8 GPU computing with 30W power consumption. The power-efficient design not only extends operation time for battery-powered machines, such as autonomous mobile robots (AMR), but also reduces operating costs for mass deployed applications, such as intelligent V2X.

NRU-110V

NRU-120S

Taking advantages of commercial off the shelf (COTS) automotive cameras that feature water-proof ability, high dynamic range, auto white balance, to LED flickering mitigation for high-quality images regardless of lighting conditions, from rainy, bright sunny days, to pitch-black nights, ideal for roadside unit deployment. The NRU series also has built-in camera driver for selected automotive camera sensor, On Semi AR0147. With the unique onboard trigger system, it can simultaneously capture images from eight GMSL cameras within millisecond channel-to-channel skew.

With the gradual development of AI, the demand for image computing is increasing and in the process promoted the development of edge computing for roadside applications. Neousys NRU series is an efficient fanless Edge AI inference platform that can deliver an equivalent of 120W GPU performances in under 30W of power consumption. NRU series can be tasked to perform video recording/ transcoding or real-time inference at the edge. It is ideal for applications that require intelligent video analytics, autonomous robots, industrial inspections, vehicle-to-Infrastructure, embedded IoT edge devices, etc.

1.1 NRU-110V Specifications

System Core	
Processor	Supporting NVIDIA® Jetson AGX Xavier™ System-on-Module, comprising NVIDIA® Volta GPU and Carmel CPU
Memory	On board 32GB LPDDR4x @ 2133 MHz on SoM
eMMC	32GB eMMC 5.1 on SoM
I/O Interface	
Ethernet port	1x 10GBASE-T 10G Ethernet port by Intel® X550-AT controller
CAN	1x isolated CAN 2.0 port
Isolated DIO	1x GPS PPS input, 3-CH isolated DI and 4-CH isolated DO
USB	3x USB 3.1 Gen1 (5 Gbps) ports
Video Port	2x DisplayPort, supporting 3840x2160 at 60Hz
Serial Port	1x RS-232 port with flow control
Storage Interface	
M.2 NVMe	1x M.2 2280 M key socket (PCIe Gen3 x2) for NVMe SSD
Internal Expansion Bus	
Mini PCI Express	1x full-size mini PCI Express socket with internal SIM socket for WiFi or 4G Module
Power Supply	
DC Input	1x 3-pin pluggable terminal block for 8V to 35V DC input (IGN/ GND/ V+)
Mechanical	
Dimension	230 mm (W) x 173 mm (D) x 66 mm (H)
Weight	2.7 kg (excluding damping bracket)
Mounting	Neousys' patented damping bracket (standard)
Environmental	
Operating Temperature	**-25°C ~ 50°C with passive cooling (MAX TDP mode) *** **-25°C ~ 70°C with passive cooling (30W TDP mode) *** **-25°C ~ 70°C with optional fan kit (all modes) ***
Storage Temperature	-40°C ~ 85°C
Humidity	10% ~ 90% , non-condensing
Vibration	Operating, MIL-STD-810G, Method 514.7, Category 4
Shock	Operating, MIL-STD-810G, Method 516.7, Procedure I
EMC	CE/FCC Class A, according to EN 55032 & EN 55035

** For sub-zero and over 60°C operating temperature, a wide temperature Solid State Disk (SSD) is required.*

1.2 NRU-120S Specifications

System Core	
Processor	Supporting NVIDIA® Jetson AGX Xavier™ system-on-module, comprising of NVIDIA® Volta GPU and Carmel CPU
Memory	Onboard 32GB LPDDR4x @ 2133 MHz
eMMC	32GB eMMC 5.1 on module
I/O Interface	
PoE+	4x IEEE 802.3at (25.5W) Gigabit PoE+ ports by Intel® I350
CAN	1x isolated CAN 2.0 port
Isolated DIO	1x PPS input. 3-CH isolated DI and 4-CH isolated DO
USB	3x USB 3.1 Gen1 (5 Gbps) ports
Video Port	2x DisplayPort, supporting 3840x2160 at 60Hz
Serial Port	1x RS-232 port with flow control
Storage Interface	
SATA HDD	2x front-accessible HDD tray for 2.5” HDD/SSD (up to 9.5mm height)
M.2 NVMe	1x M.2 2280 M key socket (PCIe Gen3 x2) for NVMe SSD
Internal Expansion Bus	
Mini PCI Express	1x full-size mini PCI Express socket with internal SIM socket for WiFi or 4G Module
Power Supply	
DC Input	1x 3-pin pluggable terminal block for 8~35V DC input (IGN/ GND/ V+)
Mechanical	
Dimension	230 mm (W) x 173 mm (D) x 66 mm (H)
Weight	2.7 kg (excluding damping bracket)
Mounting	Neousys’ patented damping bracket (standard)
Environmental	
Operating Temperature	**-25°C ~ 50°C with passive cooling (MAX TDP mode) *** **-25°C ~ 70°C with passive cooling (30W TDP mode) *** **-25°C ~ 70°C with optional fan kit (all modes) ***
Storage Temperature	-40°C ~ 85°C
Humidity	10% ~ 90%, non-condensing
Vibration	Operating, MIL-STD-810G, Method 514.7
Shock	Operating, MIL-STD-810G, Method 516.7
EMC	CE/FCC Class A, according to EN 55032 & EN 55035

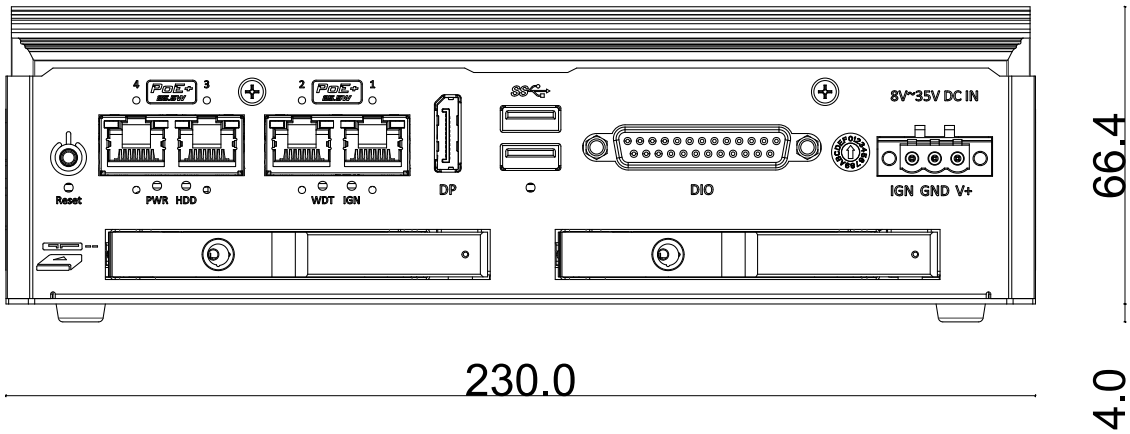
** For sub-zero and over 60°C operating temperature, a wide temperature HDD or Solid State Disk (SSD) is required.*

1.3 Dimension of NRU Series

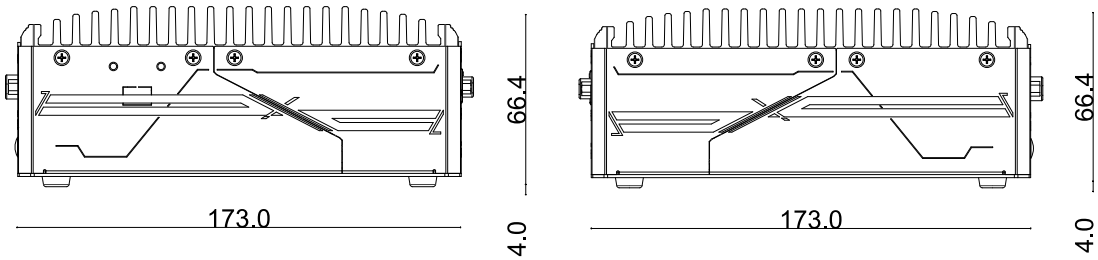
> NOTE
>
> *All measurements are in millimeters (mm).*

The NRU-110V and NRU-120S share the same dimensions.

1.3.1 Front Panel View

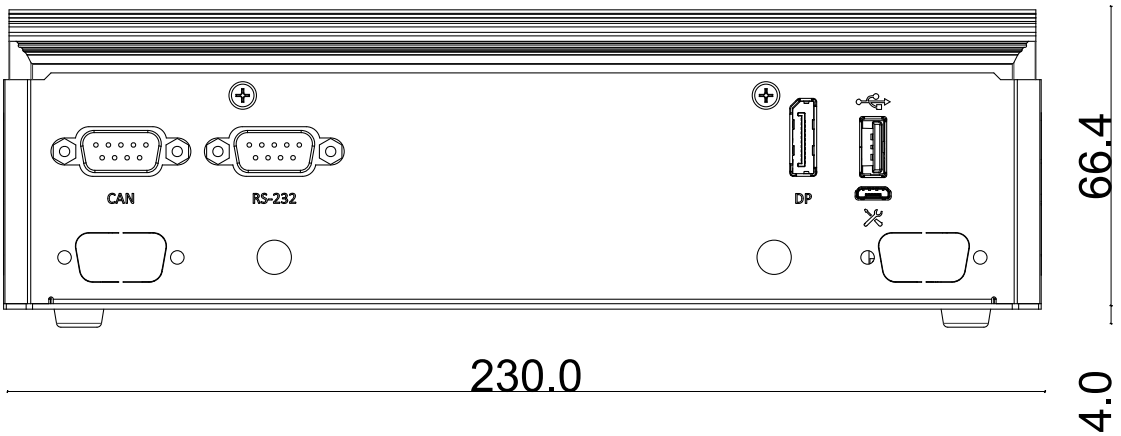


1.3.2 Side Panel Views

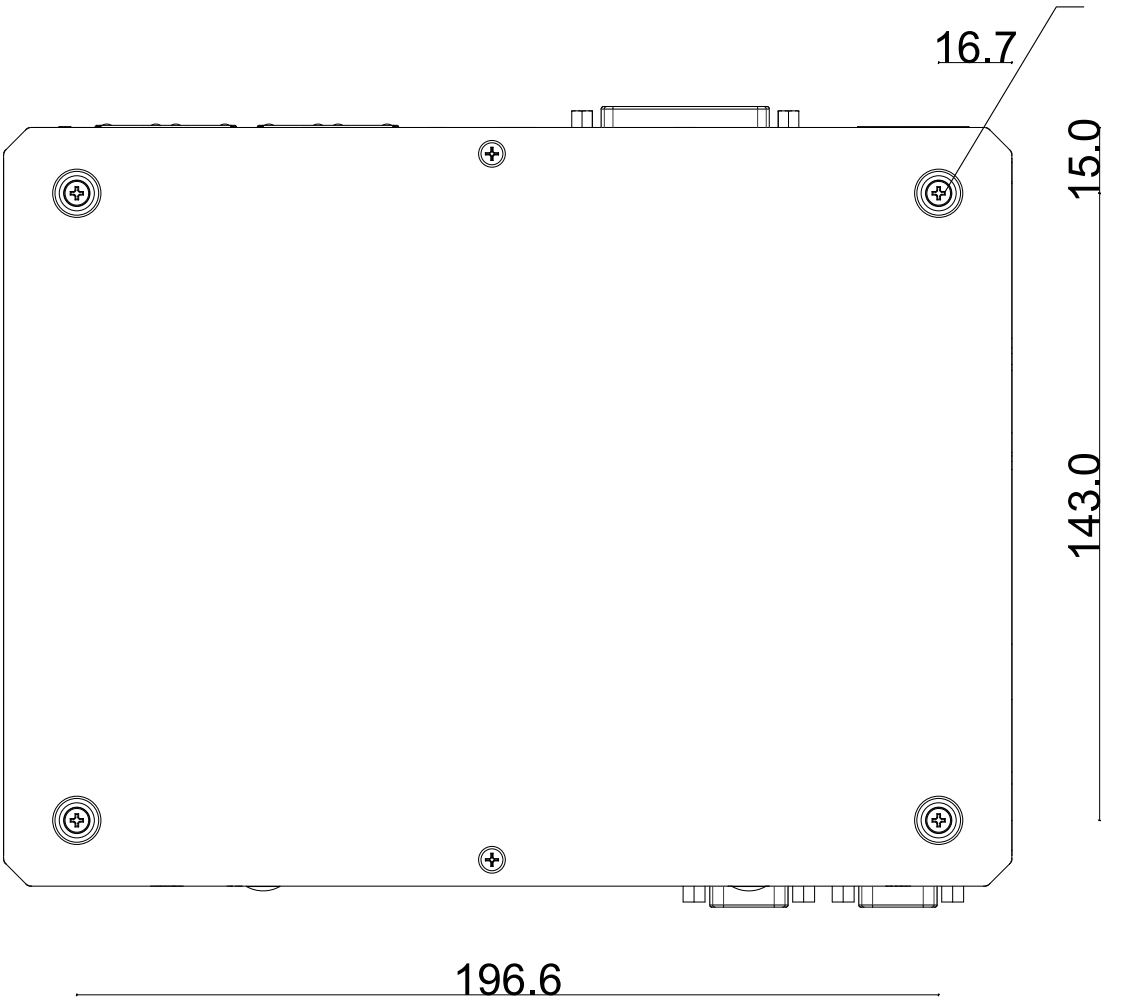


Left **Right**

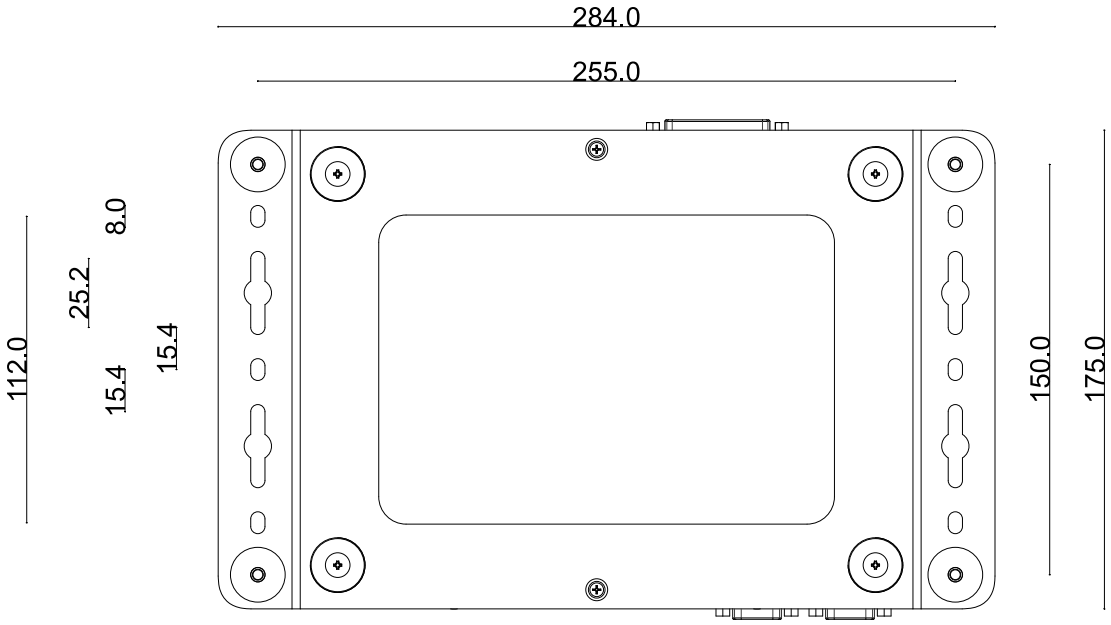
1.3.3 Rear Panel View



1.3.4 Bottom View



1.3.5 Anti-vibration Mount Dimensions



2 System Overview

Upon receiving and unpacking your NRU series systems, please check immediately if the package contains all the items listed in the following table. If any item(s) are missing or damaged, please contact your local dealer or Neousys Technology.

2.1 NRU-110V Packing List

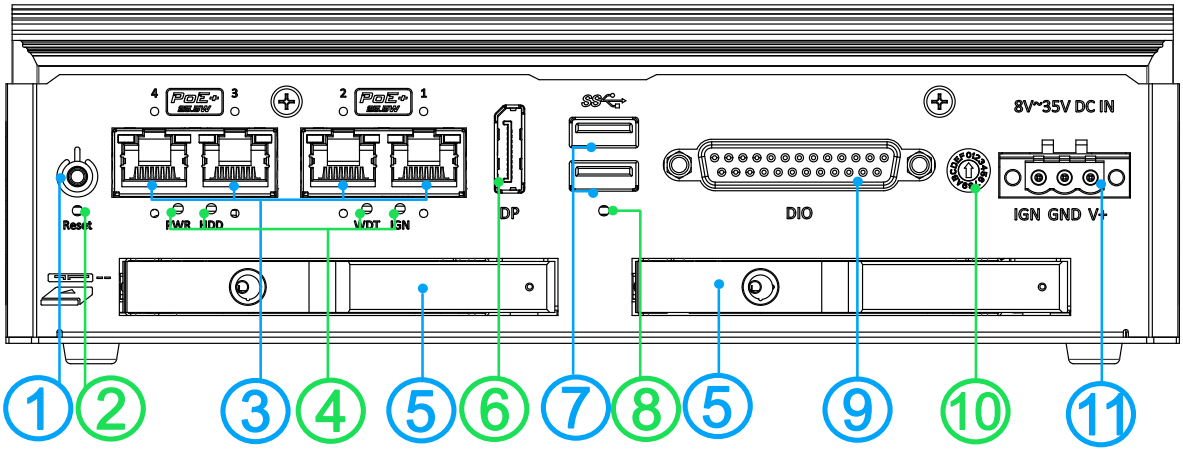
Item	Description	Qty
1	NRU-110V (If you ordered SSD/ HDD or add-on module, please verify these items)	1
2	Accessory box, which contains ● NRU damping bracket for mobile deployment ● Shock-absorbing grommet ● 3-pin power terminal block ● Screw pack	 1 8 1 1

2.2 NRU-120S Packing List

Item	Description	Qty
1	NRU-120S (If you ordered SSD/ HDD or add-on module, please verify these items)	1
2	Accessory box, which contains ● NRU damping bracket for mobile deployment ● Shock-absorbing grommet ● 3-pin power terminal block ● Screw pack ● 7mm to 9.5mm spacer for 2.5” SATA SSD/HDD	 1 8 1 1 8

2.3 NRU Series Front Panel

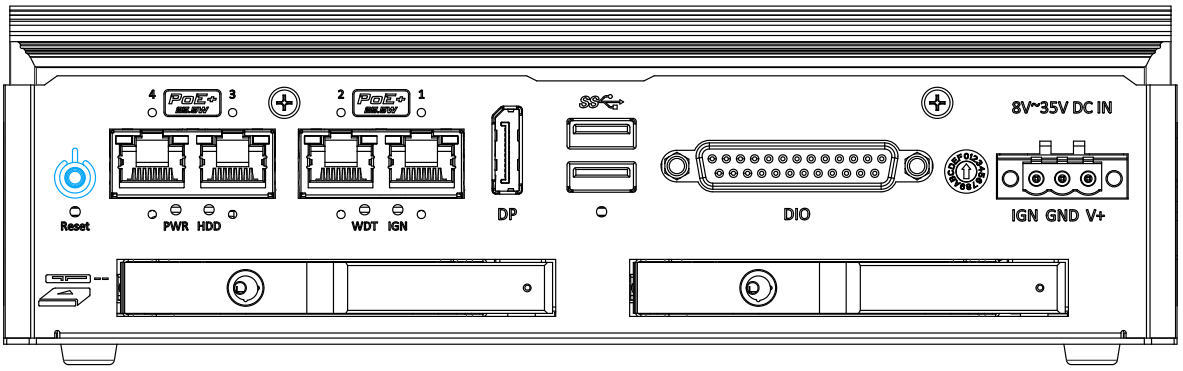
The front panel of NRU series feature rich I/O ports, it has four PoE+ Gigabit Ethernet ports, two USB 3.1 Gen1 ports, one DisplayPort, one digital I/O (1x GPS PPS input, 3-CH isolated DI and 4-CH isolated DO), ignition control switch and 3-pin terminal block for DC input. There are also two front accessible 2.5" hard drive slots.



No.	Item	Description
1	Power button	Use this button to turn on or shutdown the system.
2	Reset button	Use this button to manually reset the system.
3	Gigabit PoE+ ports	Gigabit Power over Ethernet (PoE) port can provide both data and electric power to devices. Available on NRU-120S only
4	System status LED	Four system LEDs, power (PWR), hard disk drive (HDD), Watchdog Timer (WDT), and ignition control (IGN).
5	2.5" HDD/ SSD tray	Two front-accessible 2.5" HDD/ SSD trays Available on NRU-120S only.
6	DisplayPort output	The DisplayPort is a high-resolution graphics output supporting up to 3840 x 2160 @ 30Hz.
7	USB 3.1 Gen1 port	USB 3.1 Gen1 port, up to 5 Gbit/s data transfer bandwidth.
8	Force recovery button	Use for system recovery or system reflash purposes.
9	DIO port	The DIO port provides 1x GPS PPS input, 3-CH isolated DI and 4-CH isolated DO

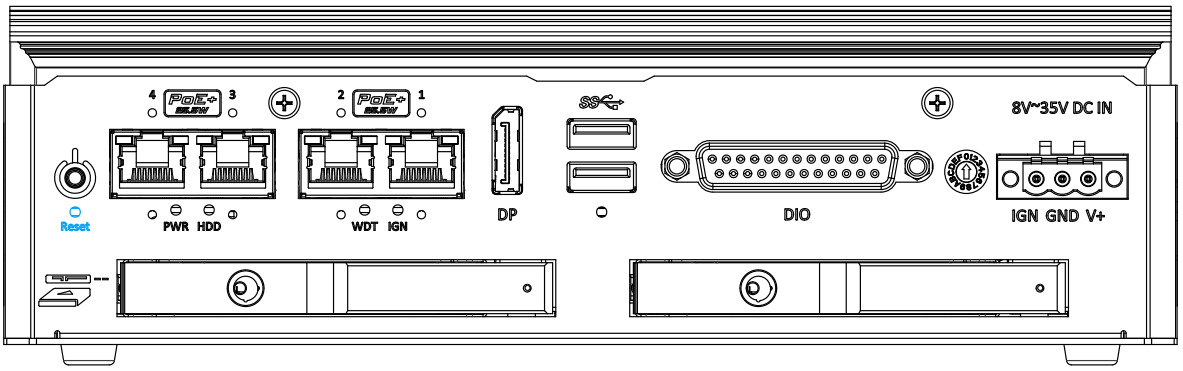
10	Ignition control switch	The switch allows for the configuration of ignition power on/ off delay by adjusting switch position.
11	3-pin terminal block (DC/ ignition control)	Compatible with DC power input from 8~35V, the terminal block is also used for ignition signal input.

2.3.1 Power Button



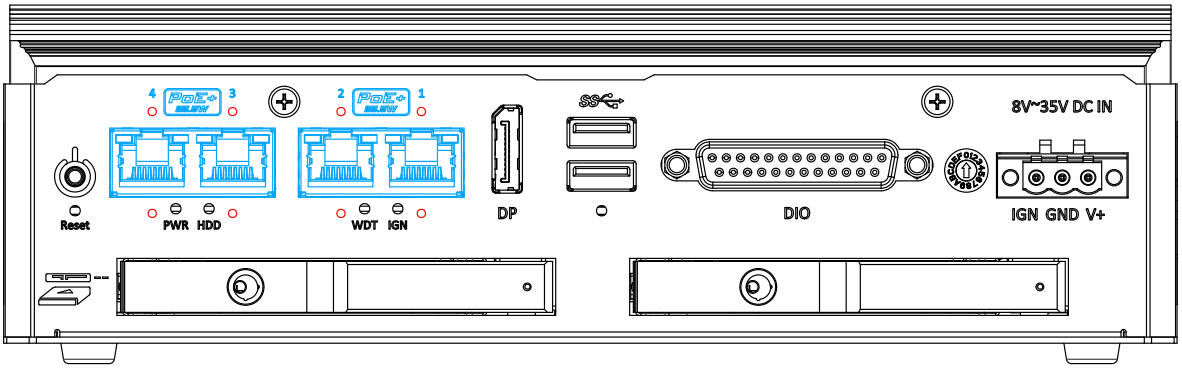
The power button is a non-latched switch for ATX mode on/off operation. Press to turn on the system, PWR LED should light up and to turn off, you can either issue a shutdown command in the OS, or just press the power button. In case of system halts, you can press and hold the power button for 5 seconds to force-shutdown the system. Please note that there is a 5 seconds interval between two on/off operations (i.e. once turning off the system, you will need to wait for 5 seconds to initiate another power-on operation).

2.3.2 Reset Button



The reset button is used to manually reset the system in case of system halt or malfunction. To avoid unexpected reset, the button is purposely placed behind the panel. To reset, please use a pin-like object (eg. tip of a pen) to access the button.

2.3.3 IEEE 802.3at Power over Ethernet Port (NRU-120S Only)



The Gigabit Power over Ethernet (PoE) port supply power and data on a standard CAT-5/CAT-6 Ethernet cable. Acting as a PSE (Power Sourcing Equipment), compliant with IEEE 802.3at, each port delivers up to 25W to a Powered Device (PD). PoE automatically detects and determine if the connected device is PoE PD or not before supplying power, making it compatible with standard Ethernet devices as well. There are screw-lock holes (indicated in **red**) for each port to ensure cables are tightly secured

Active/Link LED (Right)

LED Color	Status	Description
Green	Off	Ethernet port is disconnected
	On	Ethernet port is connected and no data transmission
	Flashing	Ethernet port is connected and data is transmitting/receiving

Speed LED (Left)

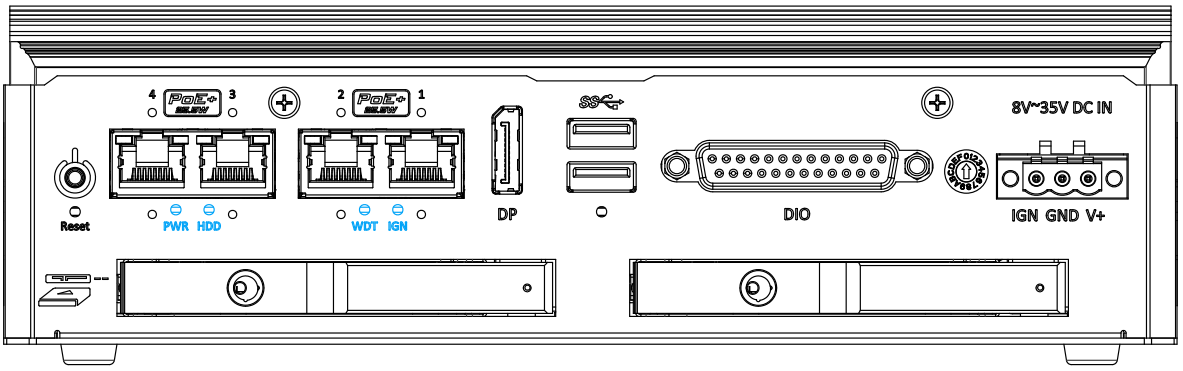
LED Color	Status	Description
Green or Orange	Off	10 Mbps
	Green	100 Mbps
	Orange	1000 Mbps

NOTE

At 70°C ambient, with the GPU under full load and USB with 20W load, the total power supply of PoE+ ports will reduce from 100W to 68W.

To increase the stability of NRU series, we have design an over current protection of 16A. In other words, if you expect to max out the power supply from PoE+ ports, please supply NRU series more than 12V.

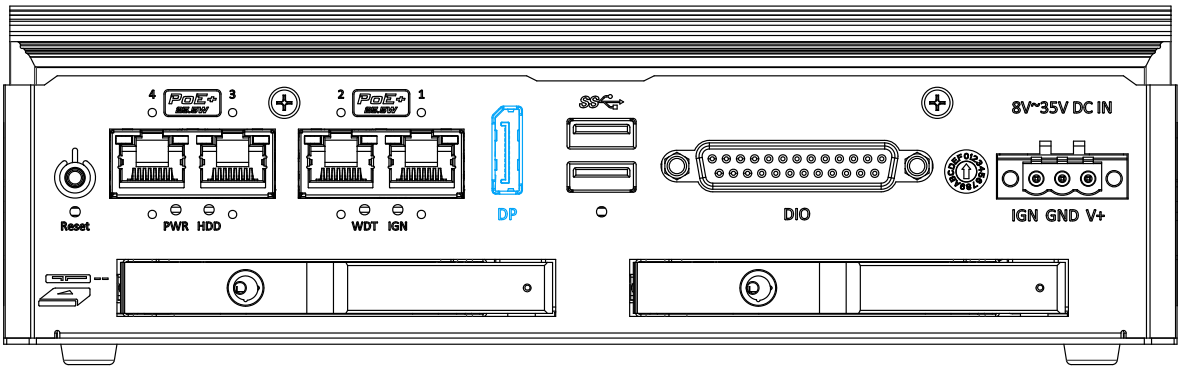
2.3.4 System Status LED



There are four LED indicators on the front panel: PWR, HDD and IGN. The descriptions of these four LEDs are listed in the following table.

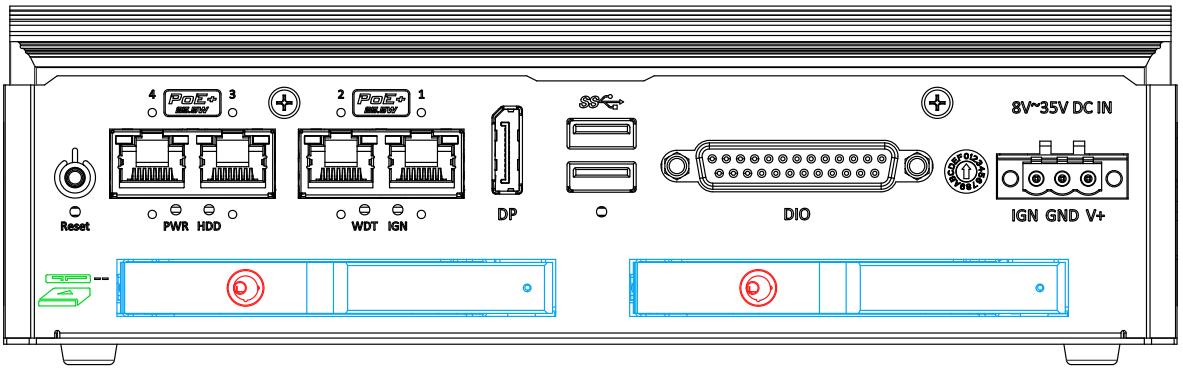
Indicator	Color	Description
PWR	Green	Power indicator, lid when system is on
HDD	Red	Hard drive indicator, flashing when SATA HDD is active
IGN	Yellow	Ignition power control, lid when IGN signal is applied.

2.3.5 DisplayPort



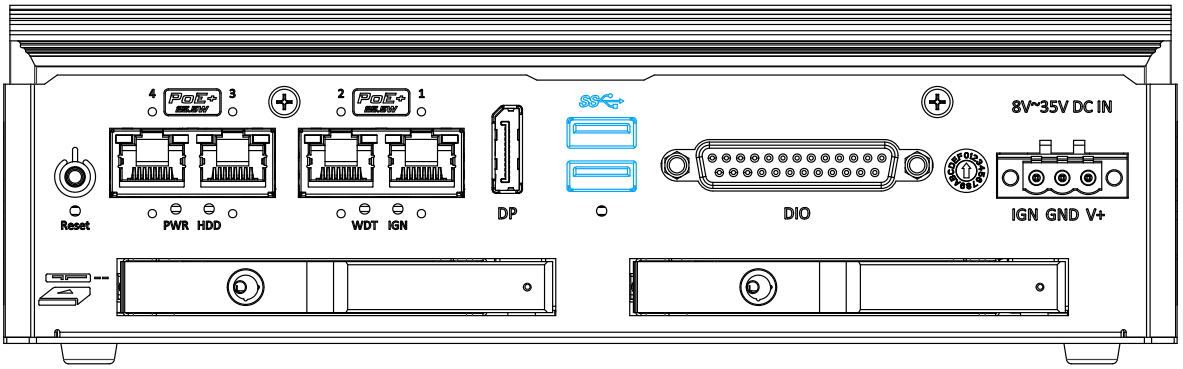
The system has a DisplayPort (DP) output which is a digital display interface that mainly connect video source and carry audio to a display device. When connecting a DP, it can deliver up to 4K UHD (3840 x 2160 @ 30Hz) in resolution. The system is designed to support active DP adapter/ cable from NVIDIA's recommended display adapters. You may refer to NVIDIA's page to find more information
(https://nvidia.custhelp.com/app/answers/detail/a_id/4449/~/nvidia-recommended-display-adapters)

2.3.6 2.5” HDD/ SSD Front-accessible Tray (NRU-120S Only)



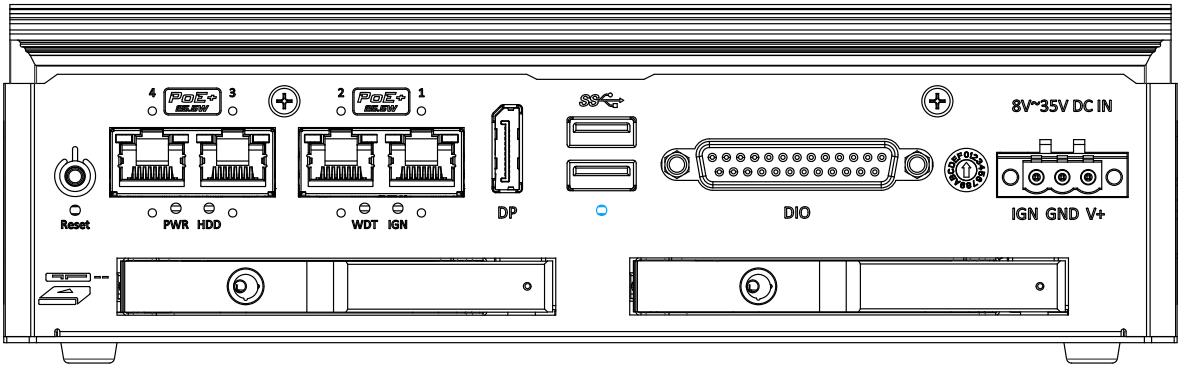
The system supports two external 2.5” HDD/ SSD via front-accessible trays. Designed for easy access, the HDD trays are secured by a lock (indicated in **red**) and together. There is a disk connector insertion orientation (indicated in **green**) to avoid damaging the connectors during installation.

2.3.7 USB 3.1 Gen1 Port



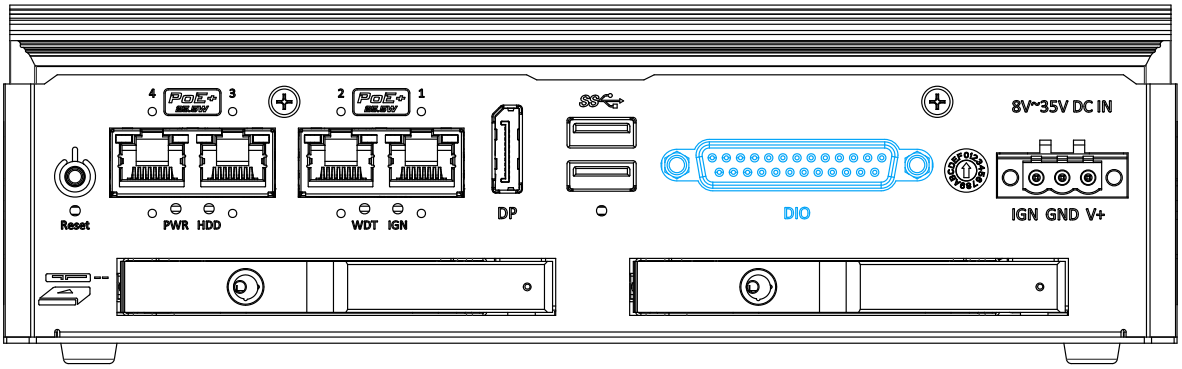
The system offers two USB 3.1 Gen1 (SuperSpeed USB) ports on its front panel. They are backward compatible with USB 2.0, USB 1.1 and USB 1.0 devices.

2.3.8 Force Recovery Button

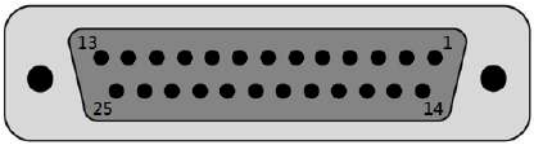


The force recovery button is reserved for engineering or system reflash purposes.

2.3.9 DIO Port



The system provides 1x GPS PPS input, 3-CH isolated DI and 4-CH isolated DO output channels. The DO is followed by open-drain design, i.e., the output voltage is decided by the external power source. And we recommended to design the external power source between 5V to 24V. The DI treat 0 to 1.5V voltage input as 0, and treat 5 to 40V voltage input as 1. In Linux, each GPIO is mapped to a virtual folder. And the PPS0 is defined in our official device tree. Please refer to **the following table** for information on wiring and programming the isolated DIO channels.



Pin No.	Definition	I/O	GPIO in Linux	Description
1	ISO_DI3H	I	gpio326	Digital input channel 3
2	ISO_DI2H	I	gpio331	Digital input channel 2
3	ISO_DI1H	I	gpio325	Digital input channel 1
4	ISO_DI0H	I	pps0	GPS PPS input
5	ISO_DO3	O	gpio323	Digital output channel 3
6	ISO_DO2	O	gpio322	Digital output channel 2
7	ISO_DO1	O	gpio321	Digital output channel 1
8	ISO_DO0	O	gpio320	Digital output channel 0
9	Reserved	-	-	Reserved pin. Keep unconnected
10				
11				
12				
13				
14	ISO_DI3L	-	-	Digital input channel 3
15	ISO_DI2L	-	-	Digital input channel 2
16	ISO_DI1L	-	-	Digital input channel 1
17	ISO_DI0L	-	-	Digital input channel 0
18	EOGND	-	-	Digital output GND
19	EOGND	-	-	Digital output GND
20	EOGND	-	-	Digital output GND
21	EOGND	-	-	Digital output GND
22	Reserved	-	-	Reserved pin. Keep

23				unconnected
24				
25				

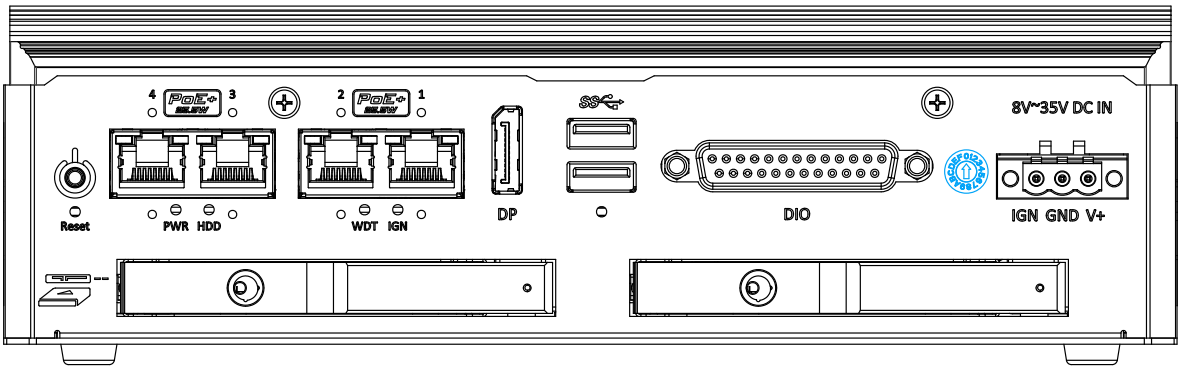
DIO Script Sample

In the following sample bash script, you can see how to access the DIO in Linux.

```
# DIO GPIO Pin
DO0=320
DO1=321
DO2=322
DO3=323
DI1=325
DI2=331
DI3=326

function exposeDI() {
    ## Expose DI to User Space
    echo $1 >/sys/class/gpio/export 2>/dev/null
    echo in >/sys/class/gpio/gpio$1/direction
}

function exposeDO() {
    echo $1 >/sys/class/gpio/export 2>/dev/null
    echo out >/sys/class/gpio/gpio$1/direction
}

function setDO() {
    echo $2 >/sys/class/gpio/gpio$1/value
}

function getDO() {
    cat /sys/class/gpio/gpio$1/value
}

### Initial DI
exposeDI $DI1
exposeDI $DI2
```

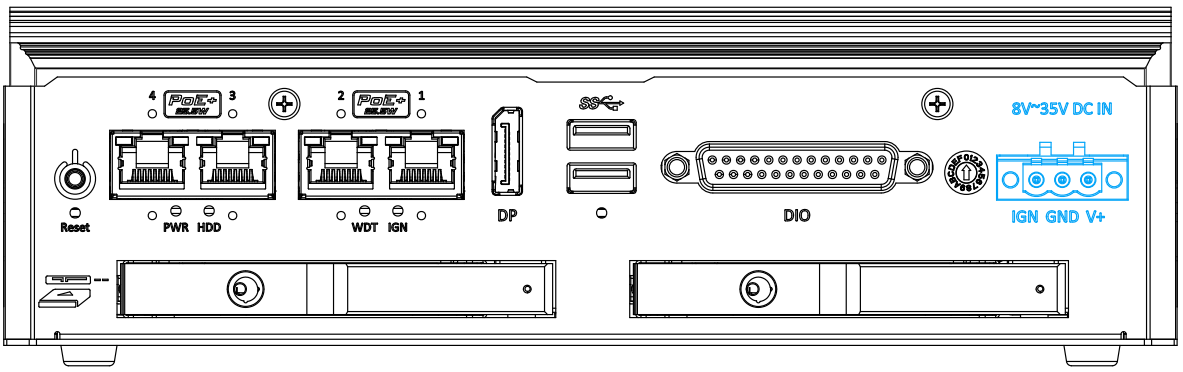
```
exposeDI $DI3

### Initial DO
exposeDO $DO0
exposeDO $DO1
exposeDO $DO2
exposeDO $DO3

### Set DO1 = 1
setDO $DO1 1

### Set DO1 = 0
setDO $DO1 0

### Save DI1 Value to DI_VALUE
DI_VALUE=$(getDI $DI1)
```

2.3.10 Ignition Control Switch



The ignition power control switch features multiple modes for pre and post ignition settings. Please refer to the section Ignition Power Control for details.

2.3.11 3-pin Terminal Block for DC and Ignition Control



The system allows an 8 to 35V DC power input from via a 3-pin pluggable terminal block. The screw clamping mechanism is a reliable way to wire DC power. In addition to DC power, this terminal block also accepts ignition signal input (IGN).

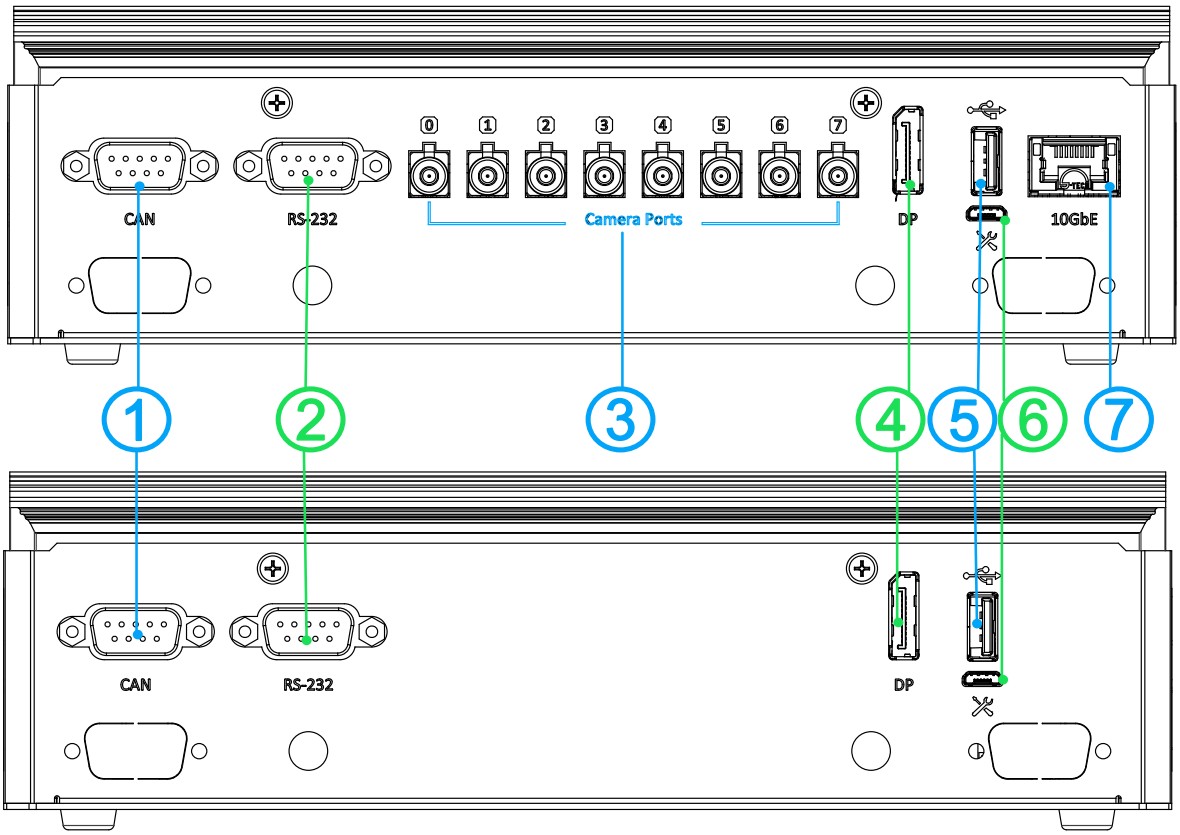
WARNING

Please make sure the voltage of DC power is correct before you connect it to the system. Supplying a voltage over 35V will damage the system.

2.4 NRU Series Rear Panel

The rear panel of NRU systems feature a CAN bus, RS-232, DisplayPort, USB2.0 and a reserved micro-USB OTG port. The camera and 10GbE ports are only available on NRU-110V systems only. For demonstration purposes, NRU-110V will be used for most illustrations.

NRU-110V

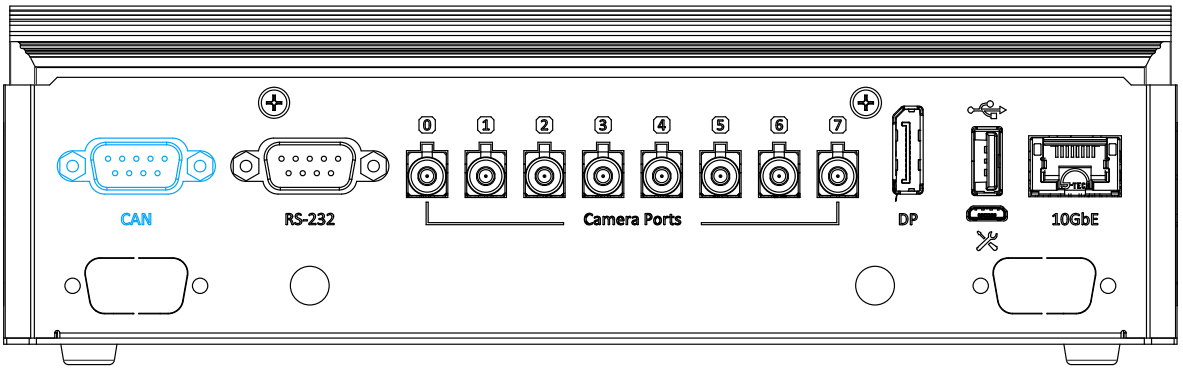


NRU-120S

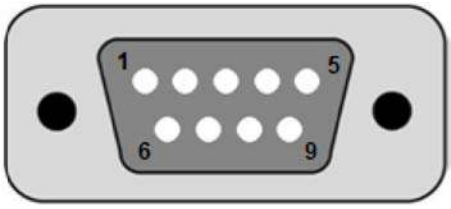
No.	Item	Description
1	CAN bus port	Allows controller to communicate with other in-vehicle CAN device(s).
2	RS-232 port	There is a RS-232 COM port for communicating with external devices.
3	Camera port	The camera ports support automotive camera sensor, On Semi AR0147. Available on NRU-110V only.
4	DisplayPort	The DisplayPort is a high-resolution graphics output supporting up to 3840 x 2160 @ 30Hz.
5	USB 3.1 Gen1 port	USB 3.1 Gen1 port, up to 5 Gbit/s data transfer bandwidth.
6	micro-USB	The micro-USB port is reserved for system reflashing

	port	only..
7	10GbE Ethernet port	10GBASE-T 10G Ethernet port by Intel® X550-AT controller. Available on NRU-110V only

2.4.1 CAN bus Port

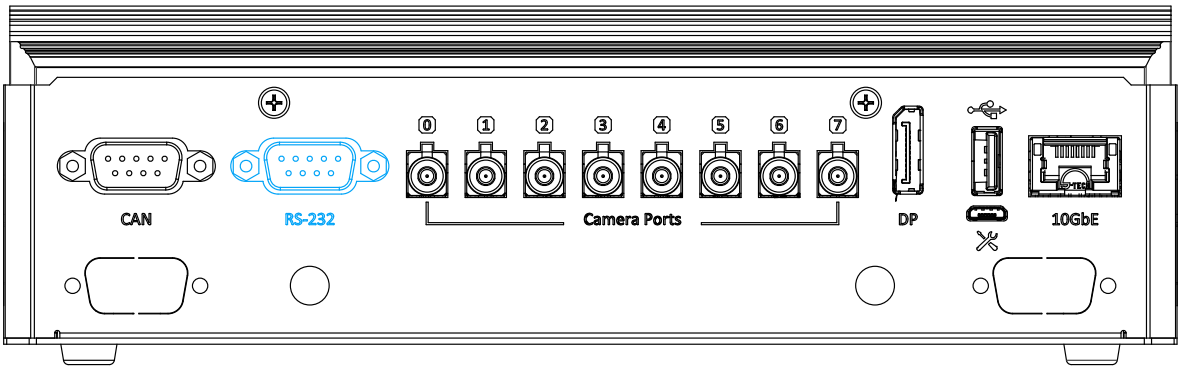


CAN bus is a robust industrial bus with a pair of differential signals and is commonly used in various industrial and in-vehicles applications. The system is equipped with a CAN bus DB9 port that is compatible with both industrial and in-vehicle applications. The CAN bus port supports CAN2.0A and CAN2.0B up to 1Mbps.

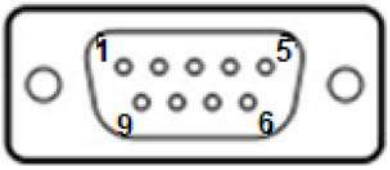


Pin No.	Definition	I/O	Description
1	GND	-	GND
2	Reserved	-	Reserved pin. Keep unconnected
3	CAN_H	I/O	CAN Bus High-level voltage
4	Reserved	-	Reserved pin. Keep unconnected
5	CAN_L	I/O	CAN Bus Low-level voltage
6	Reserved	-	Reserved pin. Keep unconnected
7	Reserved	-	Reserved pin. Keep unconnected
8	Reserved	-	Reserved pin. Keep unconnected
9	Reserved	-	Reserved pin. Keep unconnected

2.4.2 RS-232 Port

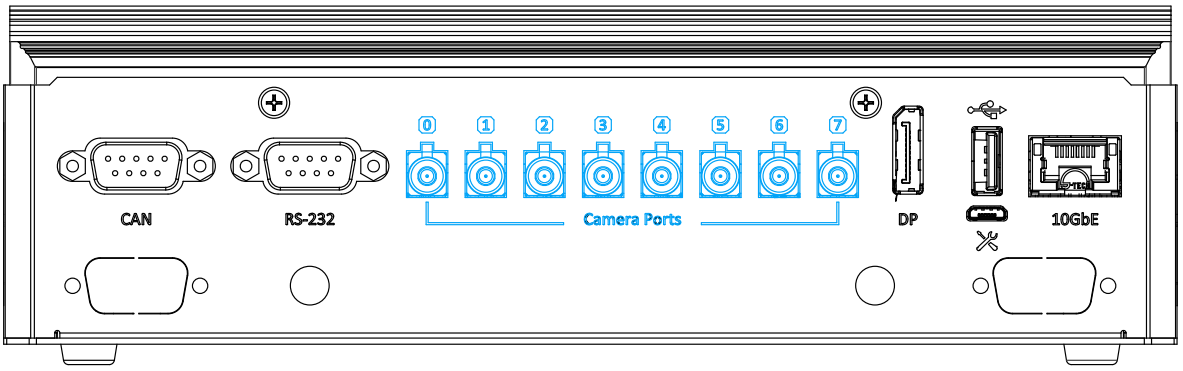


The system has a RS-232 COM port for communicating with external devices. The port can be located on the rear panel via 9-pin D-Sub male connectors.



Pin #	RS-232 Port
1	Reserved
2	RX
3	TX
4	Reserved
5	GND
6	Reserved
7	RTS
8	CTS
9	Reserved

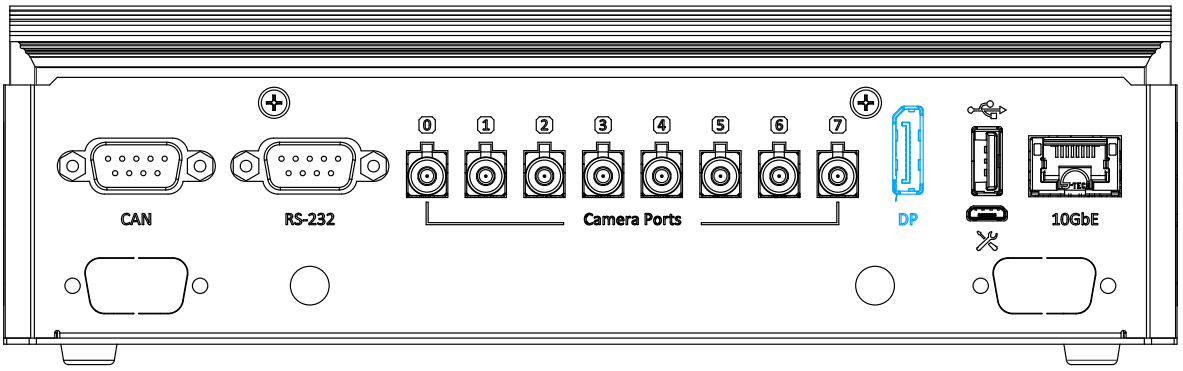
2.4.3 Camera Ports (NRU-110V Only)



The NRU-110V system features eight FAKRA Z male camera connection ports that support automotive camera sensors. Coupled with the unique onboard trigger system, it can simultaneously capture images from eight GMSL cameras within millisecond channel-to-channel skew.

If you are using 7m FAKRA cable from Neousys, please remember to connect blue water color end on the NRU-110V, and connect the black end on the camera side. The black end of FAKRA cable has an extra O-ring to give better water proof protection.

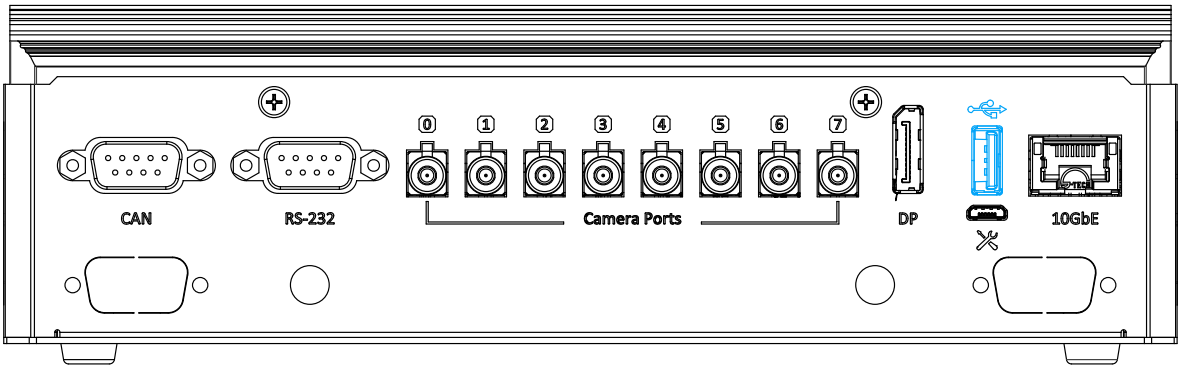
2.4.4 DisplayPort



The system has a DisplayPort (DP) output which is a digital display interface that mainly connect video source and carry audio to a display device. Please use cable length within 1.8 meters when connecting a DP, the port can deliver up to 4K UHD (3840 x 2160 @ 30Hz) in resolution.

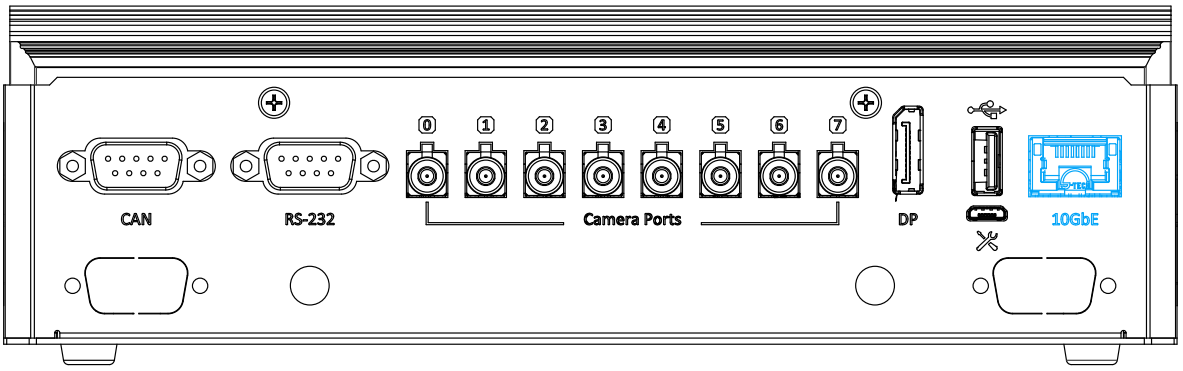
The system is designed to support active DP adapter/ cable from NVIDIA's recommended display adapters. You may refer to NVIDIA's page to find more information
(https://nvidia.custhelp.com/app/answers/detail/a_id/4449/~/nvidia-recommended-display-adapters)

2.4.5 USB 3.1 Gen1 Port



The system offers two USB 3.1 Gen1 (SuperSpeed USB) ports on its front panel. They are backward compatible with USB 2.0, USB 1.1 and USB 1.0 devices.

2.4.6 10GbE Ethernet Port (NRU-110V Only)



Utilizing Intel's X550-AT2 controller, the RJ45 10GBAST-T connector offers up to 10Gb bandwidth throughput over a maximum distance of 100 meters using Cat 6a or 55 meters using Cat 6 cables. It is ideal as a camera hub to deliver real-time image or video to other computers.

Item	Description
10Gbit PoE+ Ethernet port	The two 10Gbit Ethernet ports are implemented via Intel® X550-AT2 controller that supports 15.5K jumbo frame, teaming and IEEE 1588

Active/Link LED (Right)

LED Color	Status	Description
Green	Off	Ethernet port is disconnected
	On	Ethernet port is connected and no data transmission
	Flashing	Ethernet port is connected and data is transmitting/receiving

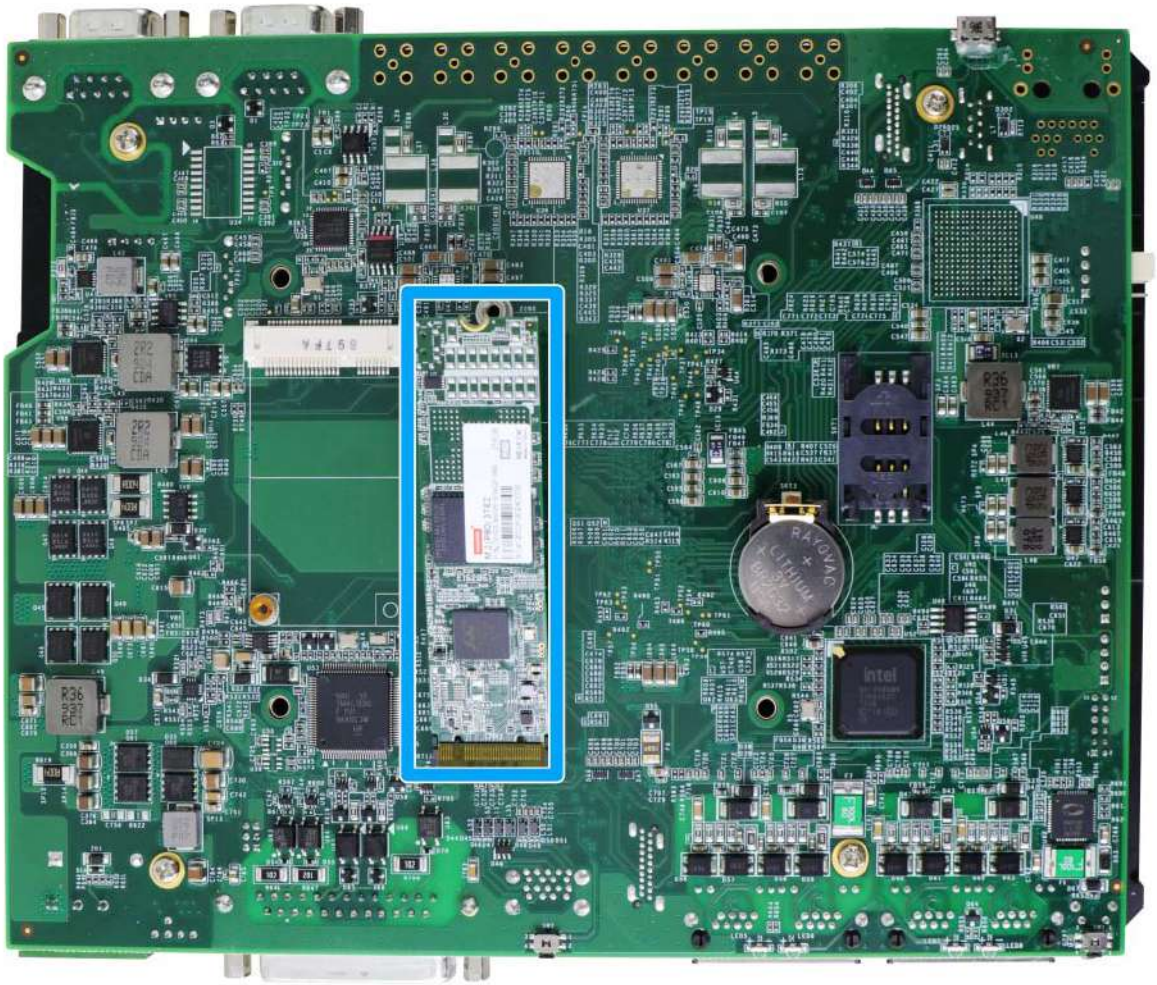
Speed LED (Left)

LED Color	Status	Description
Green or Orange	Off	100 Mbps
	Orange	1000 Mbps
	Green	10 Gbps

2.5 Internal I/O

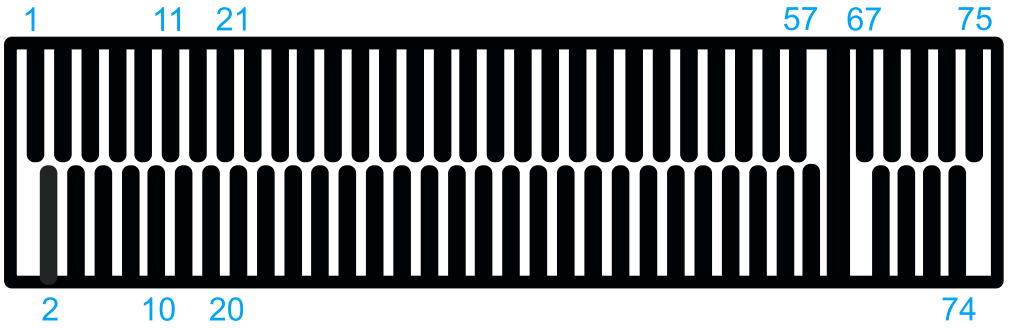
The system's internal I/O connectors consist of an M.2 slot for NVMe SSD, mini PCIe slot and corresponding SIM slot.

2.5.1 M.2 2280 (M Key) Slot for NVMe SSD



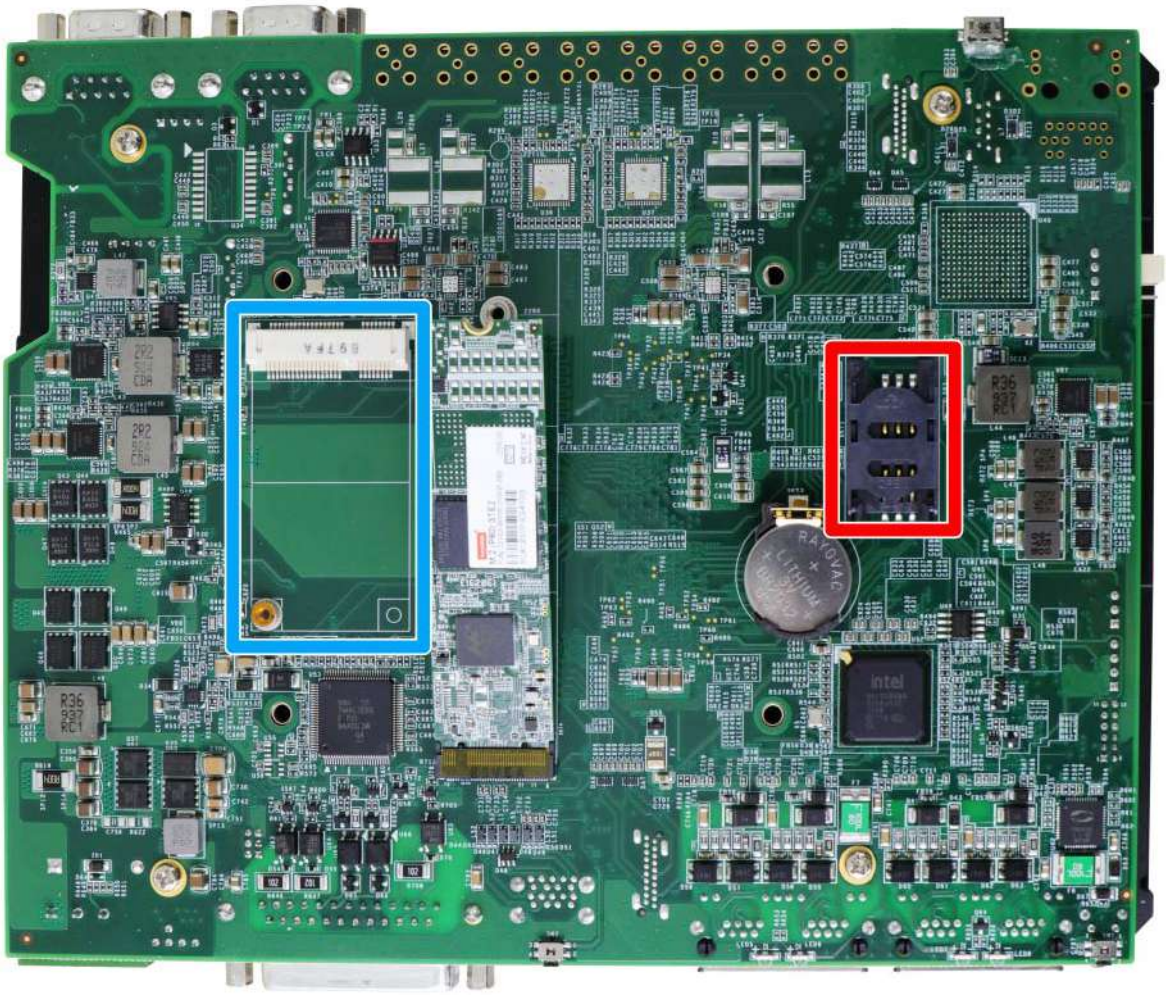
The system has an M.2 2280 slot (M key PCIe Gen3 x2) to install an NVMe SSD for the ultimate disk read/ write performance. An NVMe SSD offers significantly more disk read/ write speed performances over 2.5" SSDs.

M.2 (M Key) Slot Pin Definition



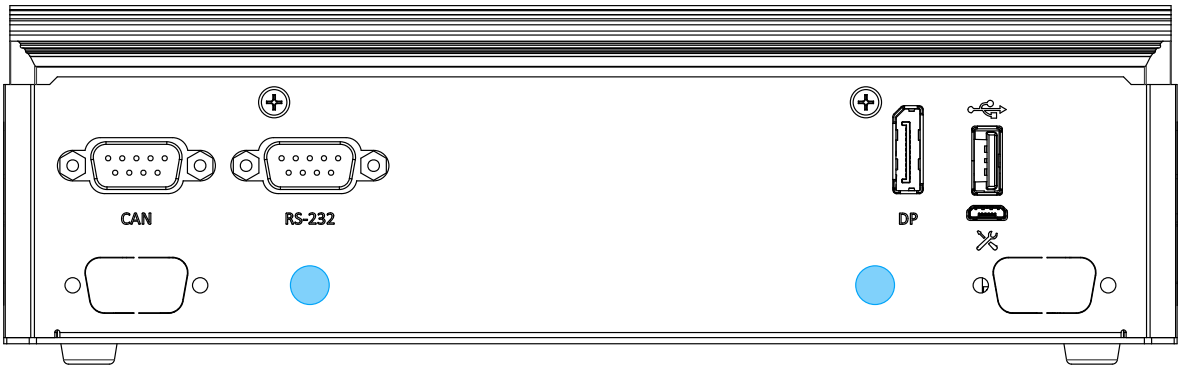
Pin #	Signal	Pin #	Signal
1	GND	**2**	+3V3
3	GND	**4**	+3V3
5	-	**6**	-
7	-	**8**	-
9	GND	**10**	DAS/DSS_N
11	-	**12**	+3V3
13	-	**14**	+3V3
15	GND	**16**	+3V3
17	-	**18**	+3V3
19	-	**20**	-
21	GND	**22**	-
23	-	**24**	-
25	-	**26**	-
27	GND	**28**	-
29	PERN1	**30**	-
31	PERP1	**32**	-
33	GND	**34**	-
35	PETN1	**36**	-
37	PETP1	**38**	-
39	GND	**40**	-
41	PERn0 +	**42**	-
43	PERp0 -	**44**	-
45	GND	**46**	-
47	PETn0 -	**48**	-
49	PETp0 +	**50**	PERST_N
51	GND	**52**	-
53	REFCLKN	**54**	-
55	REFCLKP	**56**	-
57	GND	**58**	-
Mechanical Key			
67	-	**68**	SUSCLK
69	PEDET	**70**	+3V3
71	GND	**72**	+3V3
73	GND	**74**	+3V3
75	GND		

2.5.2 mini-PCIe & SIM Slot

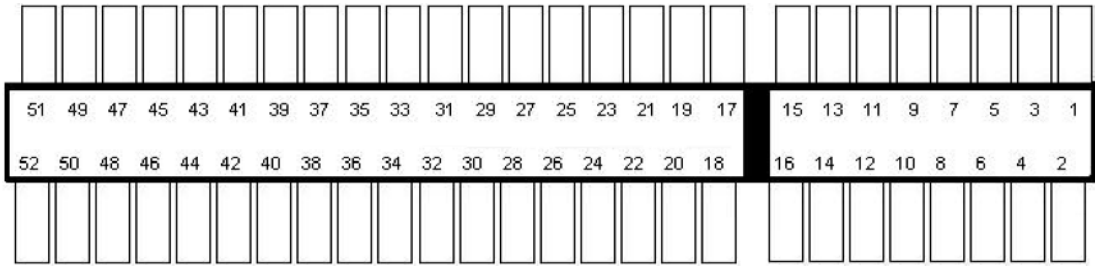


This mini-PCIe socket works (indicated in **blue**) in cooperation with the SIM slot (indicated in **red**). By installing a mini-PCIe module, you can add additional features to your system such as WIFI, GPS, CAN bus, analog frame grabber, etc. You can also install a 3G/4G module and SIM card for internet via your service provider's 3G/4G network.

For wireless (WIFI/ 3G/ 4G) communication, multiple SMA antenna apertures can be located on the rear panel.



mini-PCIe Pin Definition



Pin #	Signal	Pin #	Signal
1	WAKE#	2	+3.3Vaux
3	COEX1	4	GND
5	COEX2	6	+1.5V
7	CLKREQ#	8	UIM_PWR
9	GND	10	UIM_DATA
11	REFCLK-	12	UIM_CLK
13	REFCLK+	14	UIM_RESET
15	GND	16	UIM_VPP
Mechanical Key			
17	Reserved* (UIM_C8)	18	GND
19	Reserved* (UIM_C4)	20	W_DISABLE#
21	GND	22	PERST#
23	PERn0	24	+3.3Vaux
25	PERp0	26	GND
27	GND	28	+1.5V
29	GND	30	SMB_CLK
31	PETn0	32	SMB_DATA
33	PETp0	34	GND
35	GND	36	USB_D-
37	GND	38	USB_D+
39	+3.3Vaux	40	GND
41	+3.3Vaux	42	LED_WWAN#
43	GND	44	LED_WLAN#
45	Reserved	46	LED_WPAN#
47	Reserved	48	+1.5V
49	Reserved	50	GND
51	Reserved	52	+3.3Vaux

WARNING

Some off-the-shelf mini-PCIe 4G modules are not compliant to standard mini-PCIe interface. They use 1.8V I/O signals instead of standard 3.3V I/O and may have signal conflict. Please consult with Neousys for compatibility when in doubt!

Installing an incompatible 4G module may damage the system or the module itself may be damaged.

3 System Installation

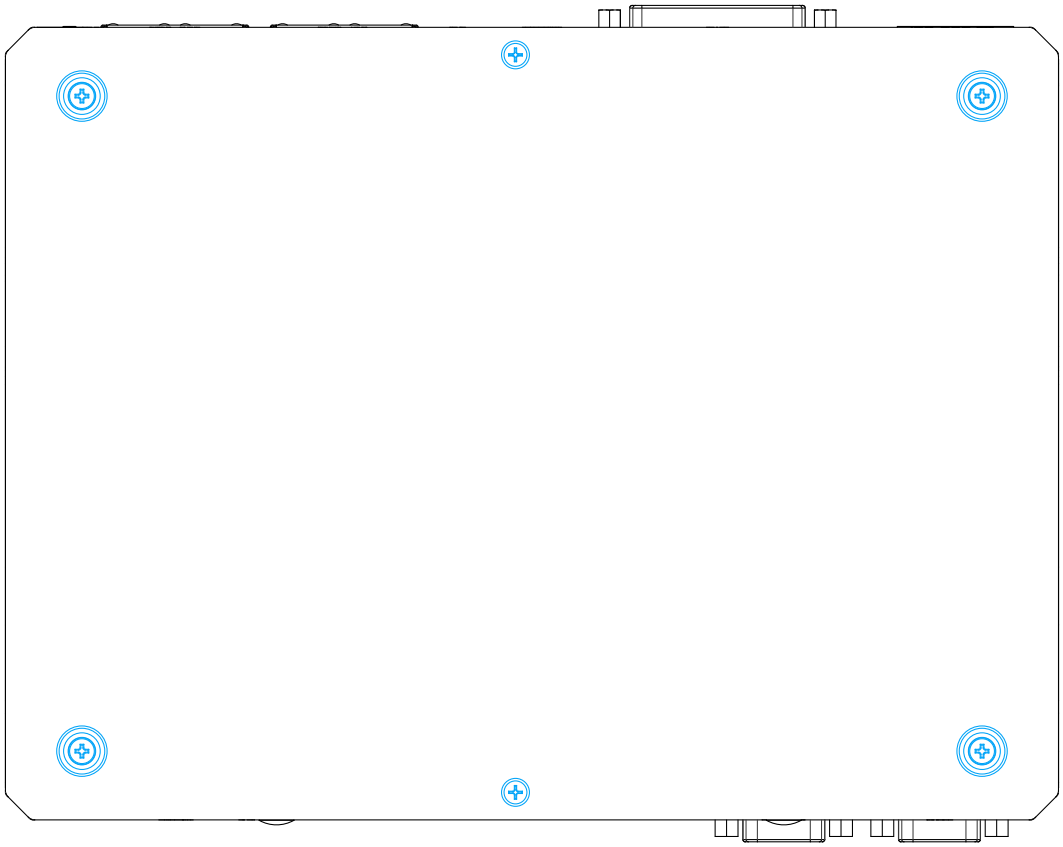
Before disassembling the system enclosure and installing components and modules, please make sure you have done the following:

- It is recommended that only qualified service personnel should install and service this product to avoid injury or damage to the system.
- Please observe all ESD procedures at all times to avoid damaging the equipment.
- Before disassembling your system, please make sure you have the module/ component you wish to install at hand and have all the necessary tools.
- Before disassembling your system, please make sure the system has powered off, all cables and antenna (power, video, data, etc.) are disconnected.
- Place the system on a flat and sturdy surface (remove from mounts or out of server cabinets) before proceeding with the installation/ replacement procedure.

3.1 Disassembling the System Enclosure

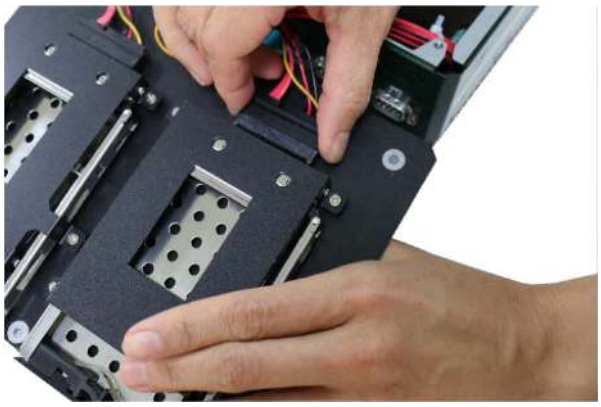
To install internal components such as M.2 SSD or mini-PCIe module, you need to disassemble the system enclosure. Please refer to the following procedure:

1. Turn the system upside-down and remove the six screws indicated.

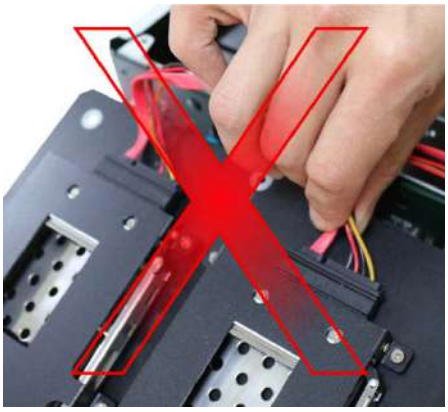


2. Gently lift the bottom panel open

3. To separate the bottom panel, you will need to disconnect the SATA connectors. When disconnecting, please pull by placing your fingers on the connector, and **DO NOT** pull on the cable.

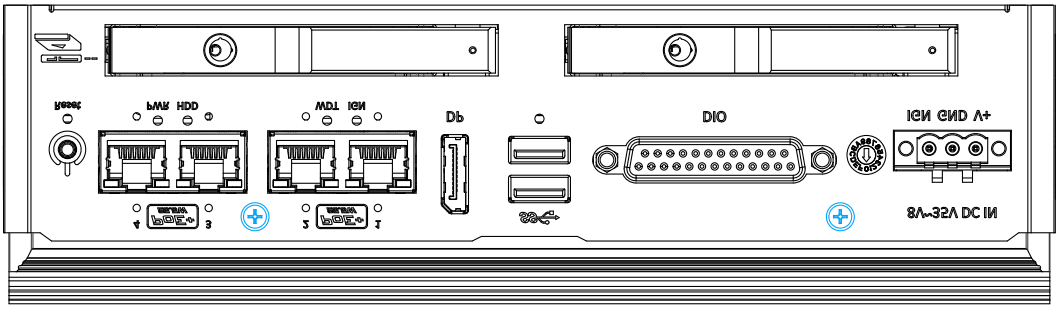


Pull to disconnect by placing fingers on the connector

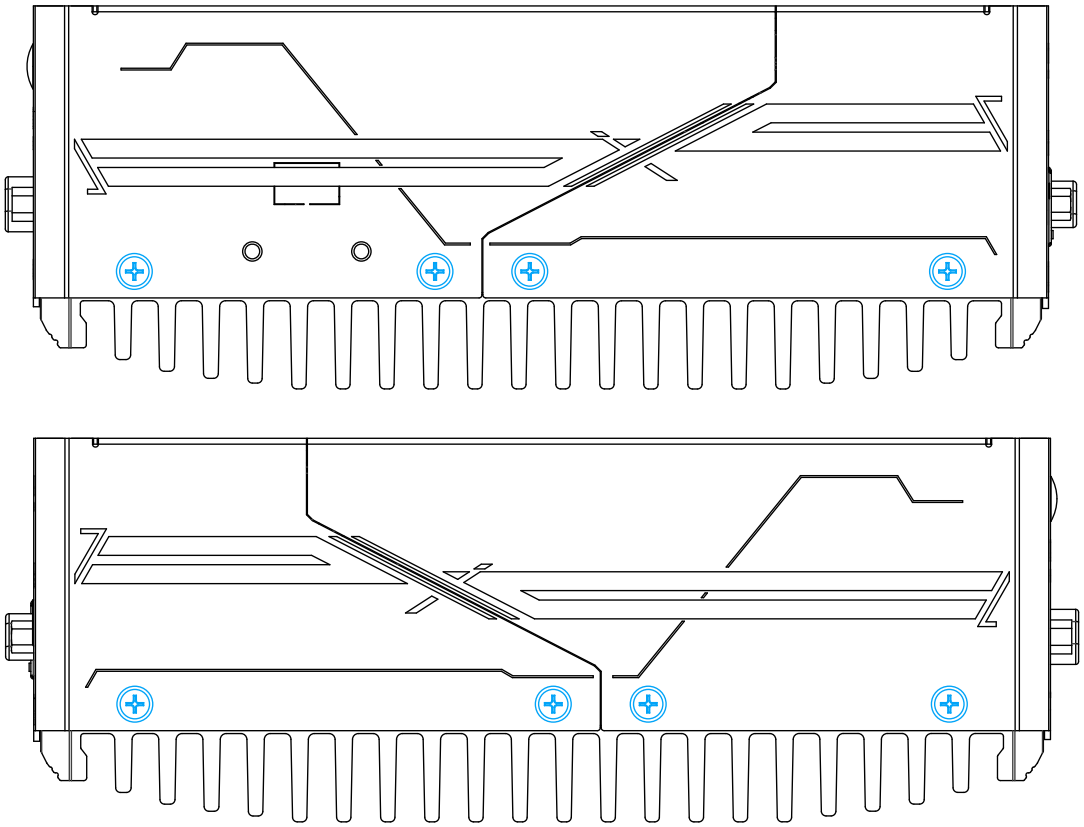


DO NOT pull on the cable

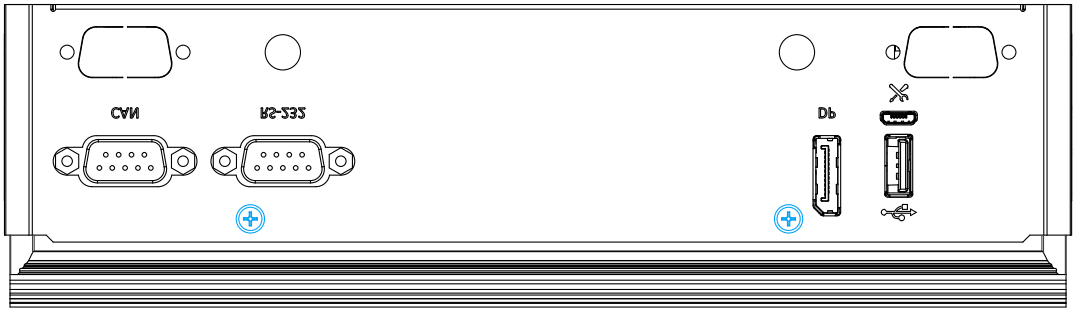
4. With the system remaining upside-down, remove the two screws indicated on the front panel.



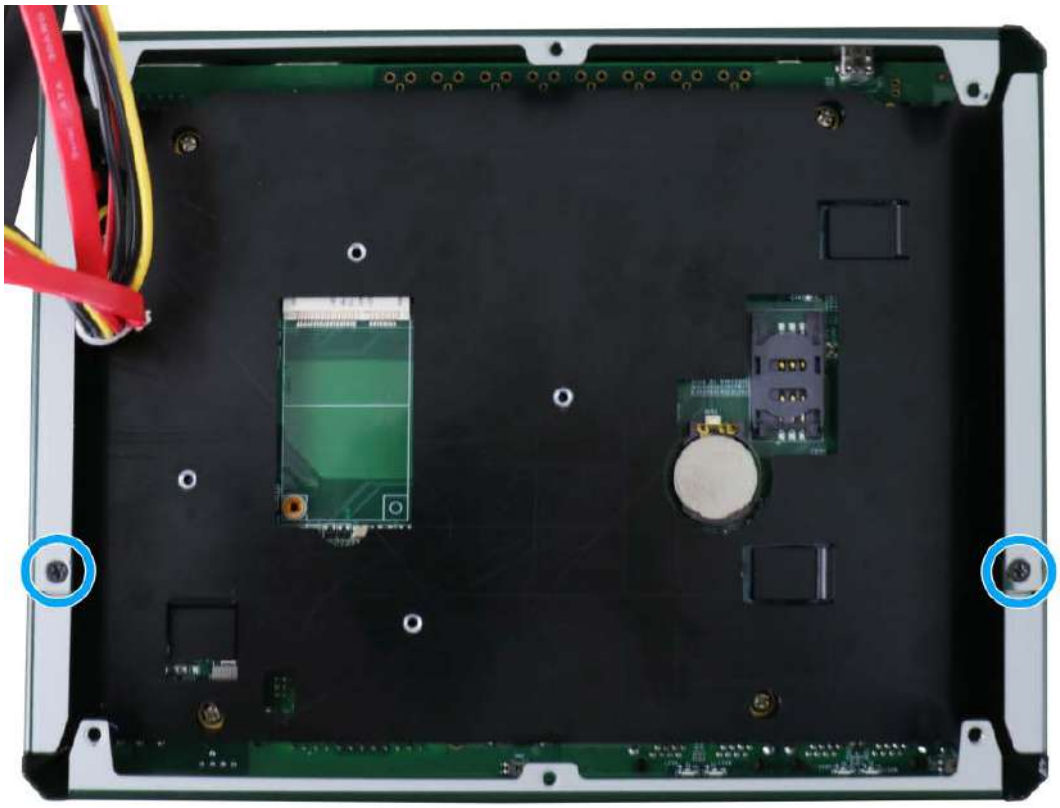
5. Remove the eight screws (4 per side) indicated on both sides of the system.



6. Remove the two screws indicated on the rear panel.



7. *Remove the two screws indicated.*



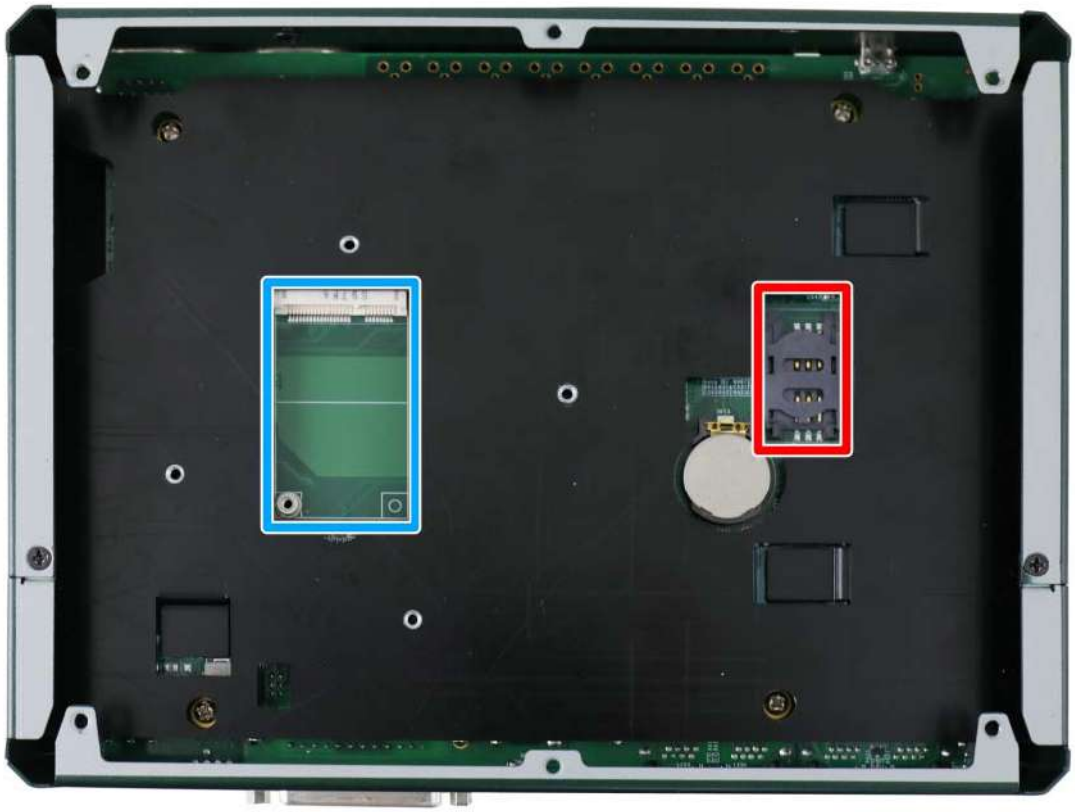
8. Gently pull apart the enclosure.

3.2 Installing Internal Components

3.2.1 mini-PCIe and SIM Card Installation

There is one mini-PCIe and a SIM card slot on the main board. Please follow the procedures for installation.

1. Disassembling the system enclosure.
2. Locate the mini-PCIe slot indicated in blue and the SIM card slot indicated in red on the motherboard shown below.

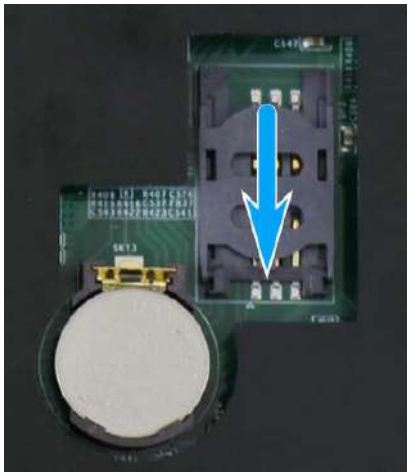


3. To install, insert the gold finger end of the mini-PCIe card on a 45 degree angle into the slot, gently push the other end of the mini-PCIe onto the motherboard and secure it with two screws.

45 degree angle insert

Secure the card with a screw

4. To install the SIM card, you need to push the SIM card slot in the direction of the battery and flip open the SIM card holder.



5. Insert the SIM card and secure the holder by sliding the holder away from the battery.

Insert SIM card

Secure by sliding holder

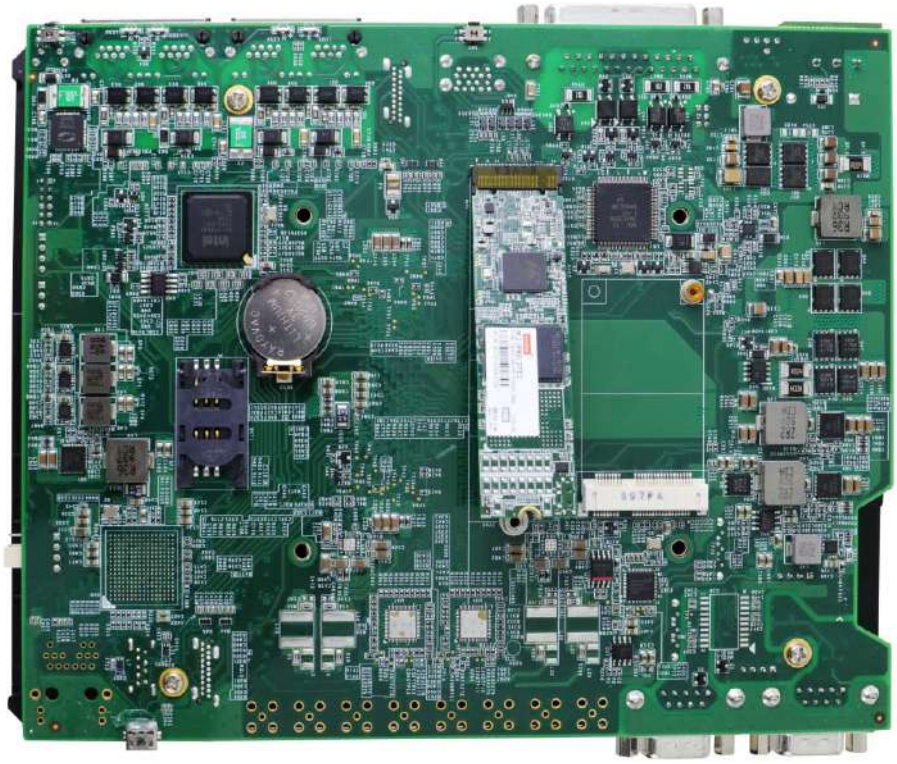
6. Reinstall the enclosure when done.

3.2.2 M.2 2880 M Key NVMe SSD Installation

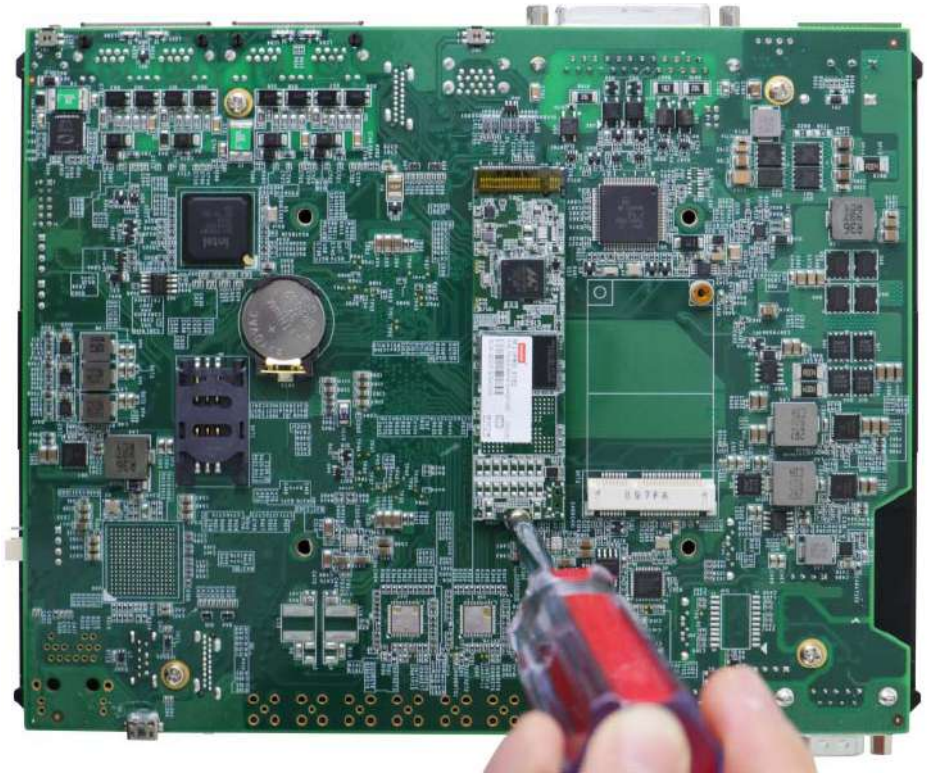
There is one M.2 2280 M Key slot (PCIe Gen3 x2) for you to install an NVMe SSD. Please follow the procedures below to install the M.2 module.

1. Disassemble the system enclosure.
2. Remove the internal panel/ heat spreader by unscrewing the screws on the sides.

3. Insert the NVMe SSD into the slot on a 45° angle.



4. Gently push it towards the motherboard and secure the NVMe SSD with the supplied screw.



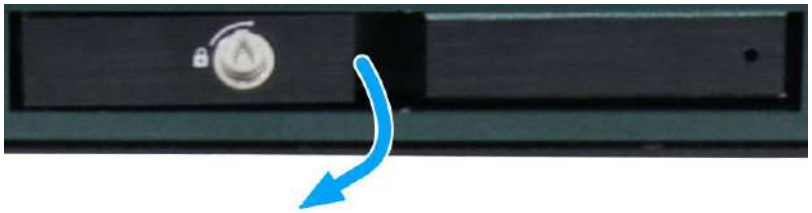
5. Once the NVMe SSD has been secured, reinstall the internal panel by securing the screws on both sides.

6. Reinstall the enclosure when done.

3.2.3 Front Accessible 2.5” HDD/ SSD Installation (NRU-120S Only)

The system has two front accessible 2.5” HDD/ SSD trays that can accept 2.5” HDD/ SSD up to 9.5mm. To install a HDD/ SSD into the tray, please refer to the following instructions.

1. Pull the lever to open the 2.5” front accessible HDD/ SSD tray.



2. Insert the HDD/ SSD with the label facing upwards, insert the SATA connector side into the slot first. You may feel resistance when the SATA connectors meet, push firmly until the drive is fully inserted into the slot.

Insert HDD/ SSD

Attach PORON if you are installing a 7mm HDD/ SSD

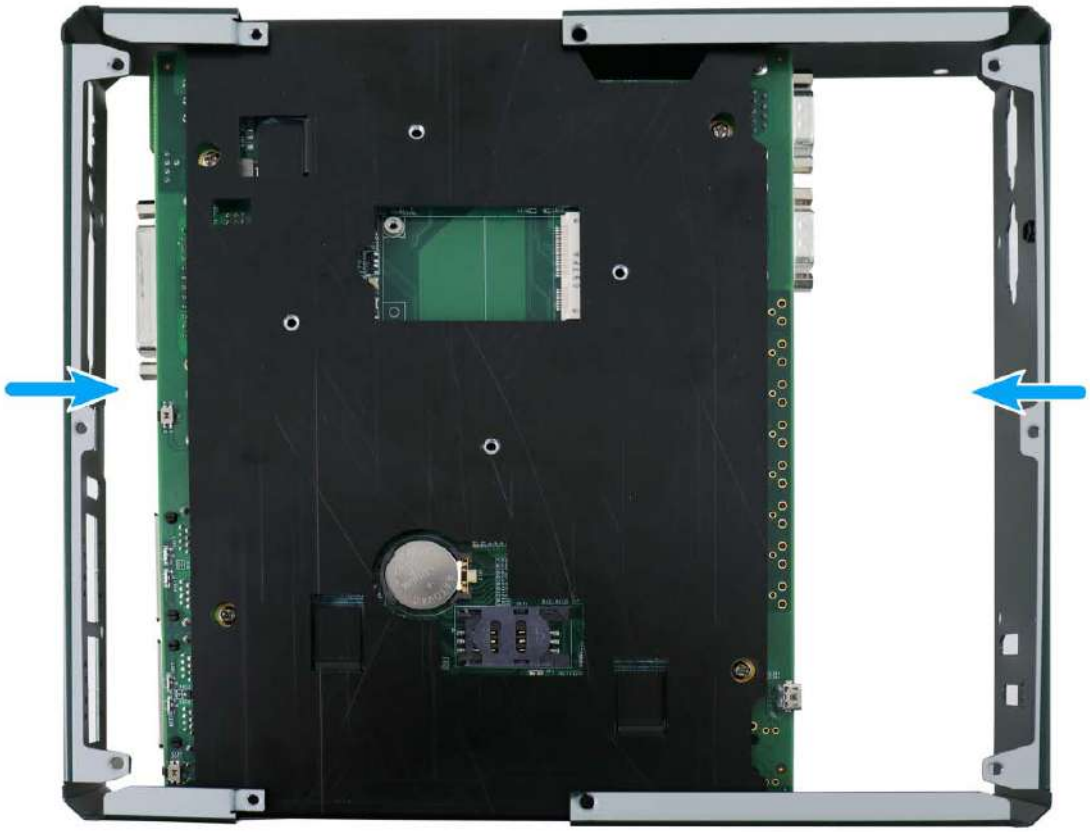
3. Push the lever into the 2.5” slot until it snaps into position. A key is provided (in accessory box) to lock the external slot.

Key in accessory box

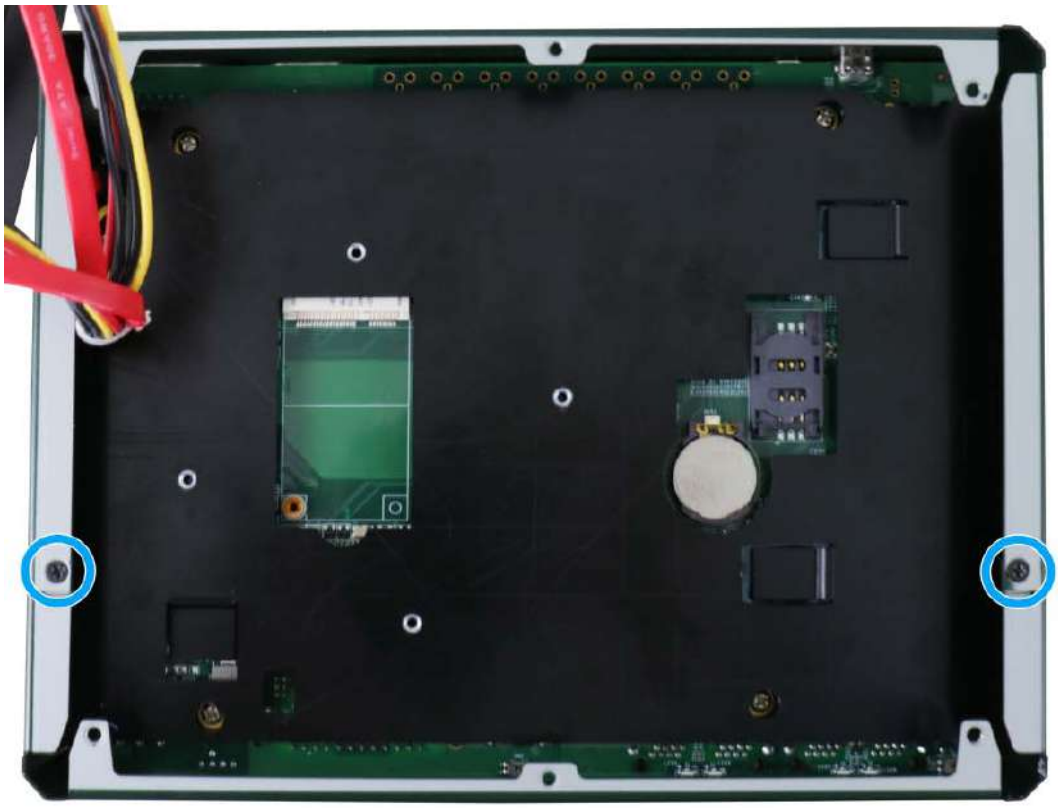
2.5” HDD/ SSD slot lock

3.3 Installing the System Enclosure

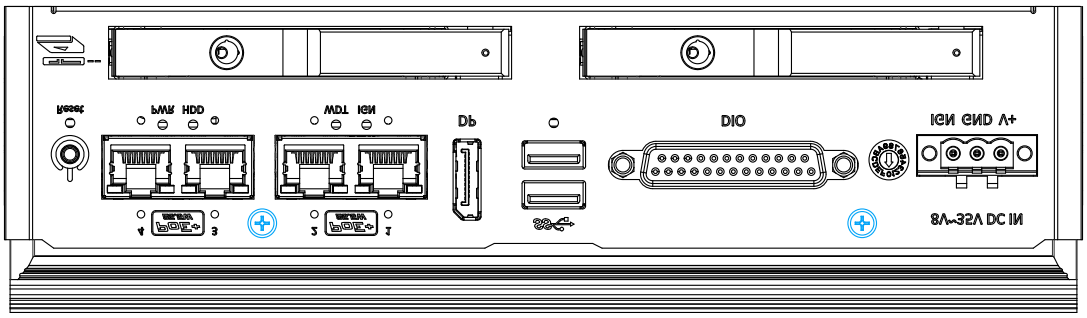
1. To reinstall the system enclosure, with system upside-down (the heatsink fins at the bottom). Merge the front and rear panel enclosures together while making sure the connection ports meet the front and rear openings.



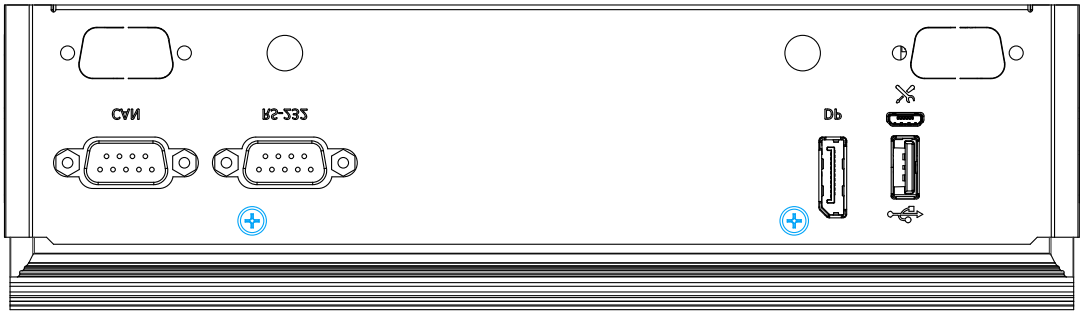
2. Secure the two screws that hold the front and rear enclosure panels together.



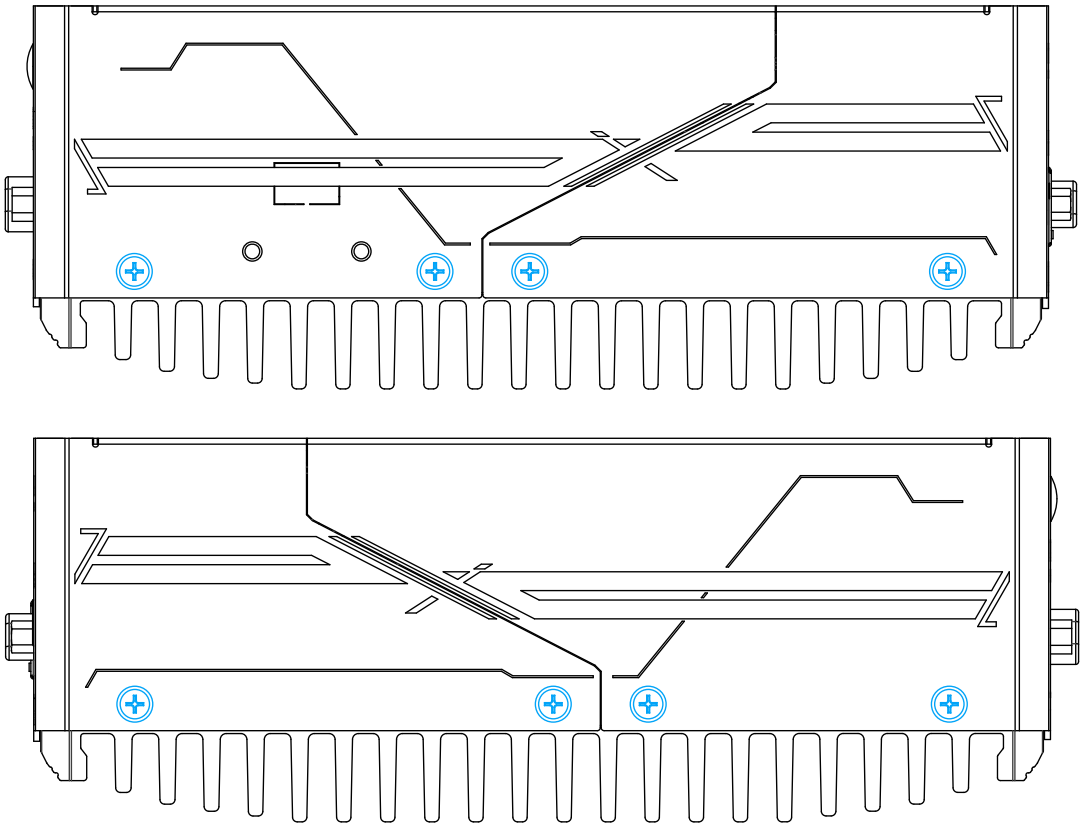
3. Secure the two screws indicated on the front panel.



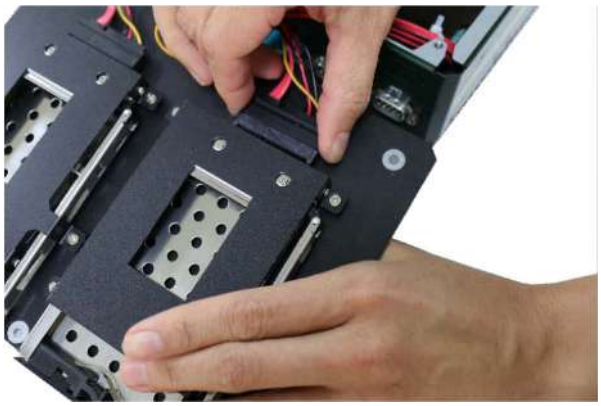
4. Secure the two screws indicated on the rear panel.



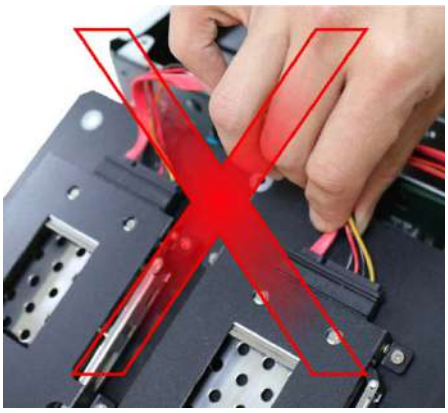
5. Secure the eight screws (4 per side) indicated on both sides of the system.



6. Connect the SATA connectors onto the slots on the bottom panel. Please connect it by holding onto the connector, and **DO NOT** push the connector while holding the cable.



Connect by placing fingers on the connector

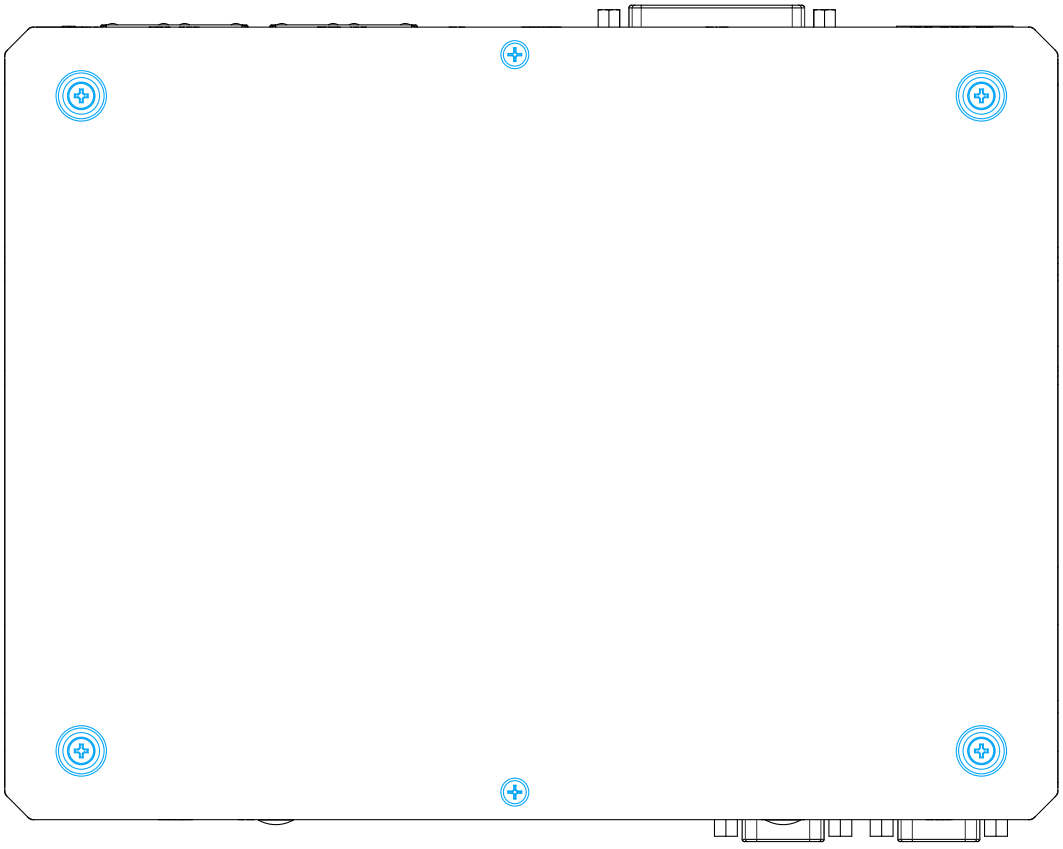


DO NOT push the connector while holding the cable

7. Gently slide the bottom panel into place.

With the connectors connected, hold the bottom panel perpendicular to the enclosure	Gently place the bottom panel onto the enclosure
Tuck the cables into the enclosure so the cables don’t protrude and cause resistance when placing the bottom panel onto the enclsoure	Slide the bottom panel to match the six screw holes

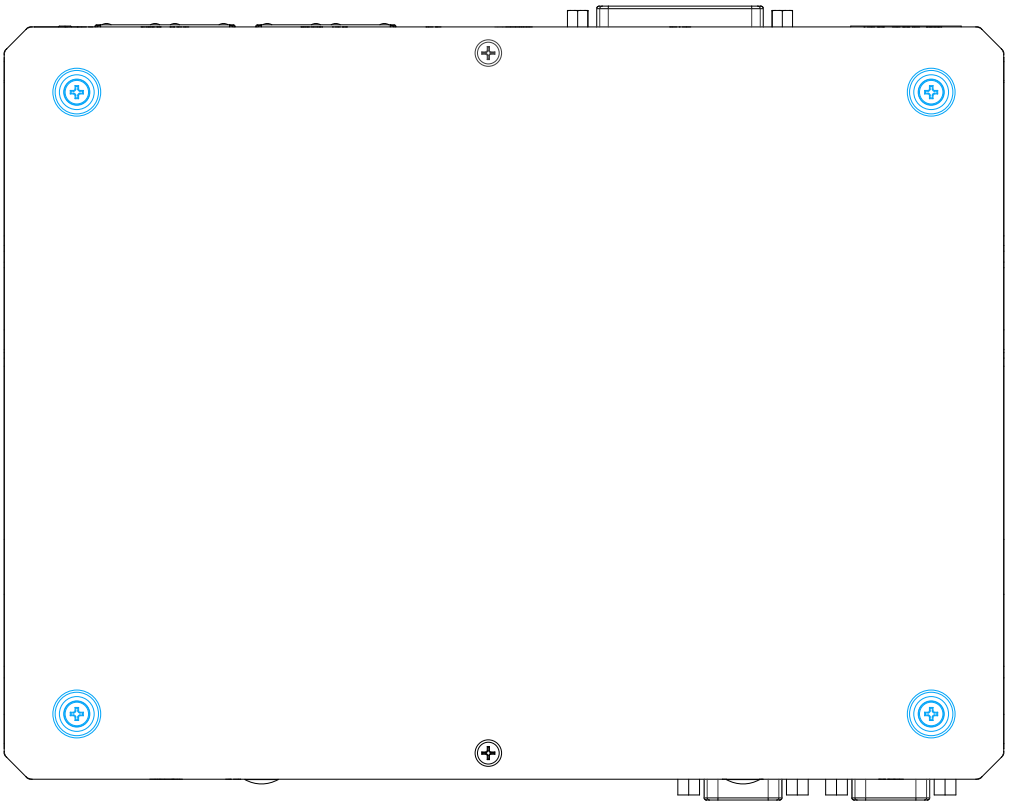
8. Secure the bottom panel with six screws (four screws secure the four rubber stands).



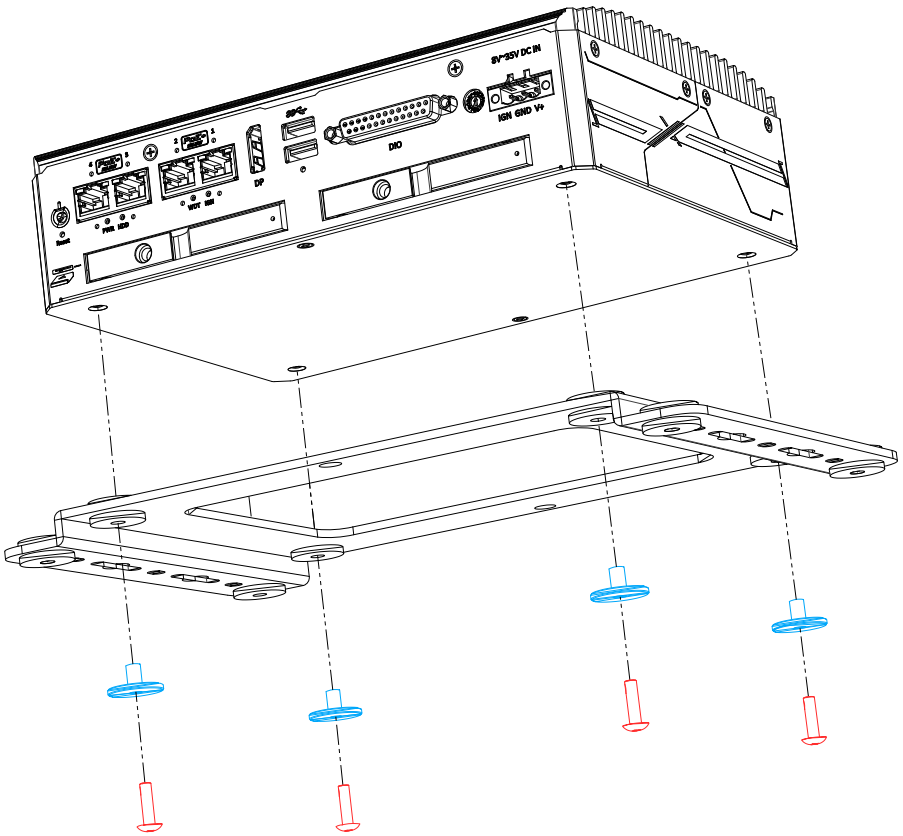
3.4 Anti-vibration Mount Installation

The system comes with an anti-vibration mount.

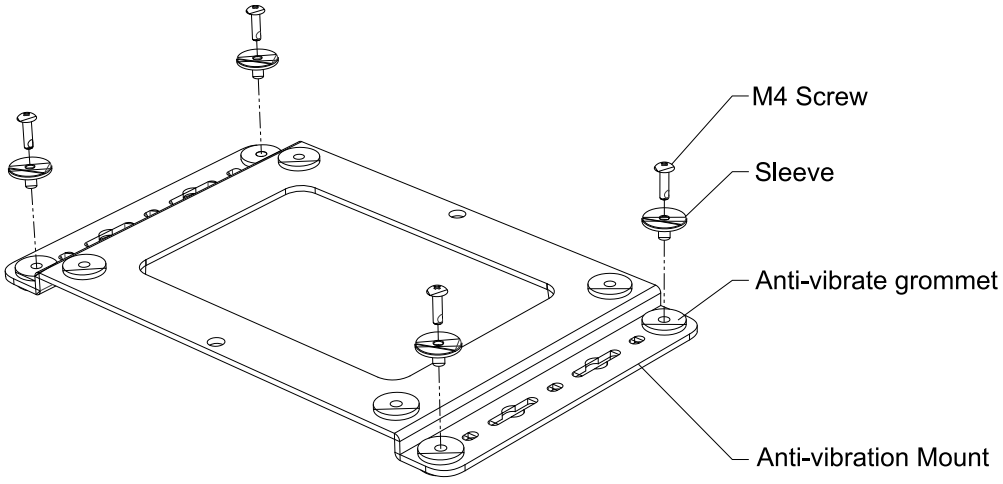
1. To install the anti-vibration mount, please remove the four rubber stands at the bottom of the enclosure.



2. To install, secure the anti-vibration mount to the bottom of the system enclosure using the provided M4 screws (indicated in **red**) and sleeves (indicated in **blue**).



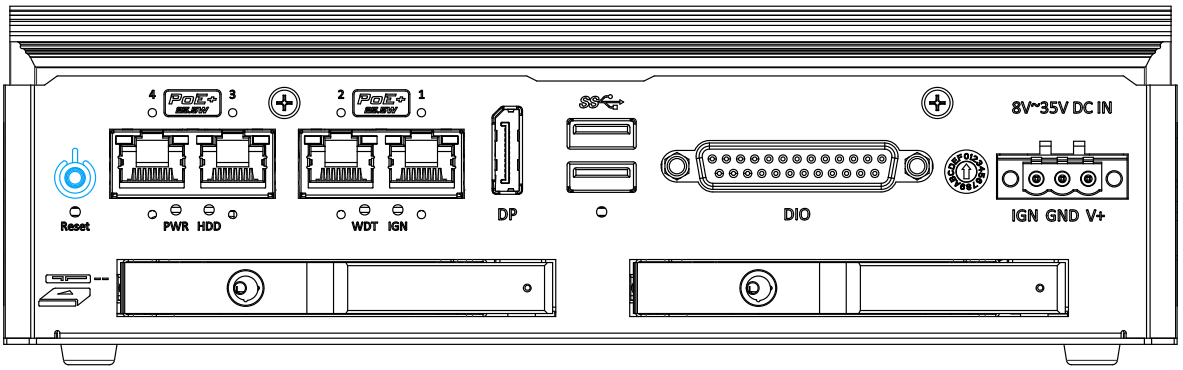
3. Make sure you secure the system on a flat surface. The illustration shows only the anti-vibration mount being secured.



3.5 Powering On the System

3.5.1 Powering On Using the Power Button

This is the simplest way to turn on your system. The power button on the side panel is a non-latched switch and behaves as the ATX-mode on/off control. With DC power connected, pushing the power button will turn on the system and the PWR LED indicator will light up. Pushing the button when system is on will turn off the system. If your operating system supports ATX power mode, pushing the power button while the system is in operation will result in a pre-defined system behavior, such as shutdown or hibernation.

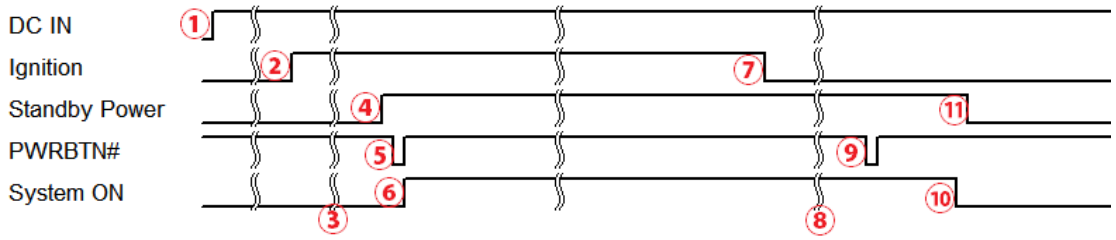


4 Ignition Power Control

The ignition power control module for in-vehicle applications is an MCU-based implementation that monitors the ignition signal and reacts to turn on/off the system according to predefined on/off delay. Its built-in algorithm supports other features such as ultra-low power standby, battery-low protection, system hard-off, etc. In this section, we'll illustrate the principle of ignition power control and operation modes.

4.1 Principles of Ignition Power Control

The basic concept of ignition power control module is to control the timing correlation between ignition signal and system power status. A typical timing correlation is described in following diagram.



1. When DC power is supplied to the system, MCU starts to periodically detect ignition signal. Note that only MCU is working at this moment and the overall power consumption is less than 2 mW.
2. Ignition signal is active (both 12VDC and 24VDC ignition signals are accepted).
3. MCU starts to count a pre-defined power-on delay.
4. Once power-on delay expired, MCU turns on necessary standby power for the system (3.3VSB & 5VSB).
5. A PWRBTN# pulse is then issued to turn on the system (equivalent to one pressing the power button on the front panel).
6. The system is booting and becomes operational.
7. After a period of time, the ignition signal becomes inactive.
8. MCU starts to count a pre-defined power-off delay.

9. Once power-off delay expired, another PWRBTN# pulse is issued to perform a soft-off for the system (ex. a normal shutdown process for Windows system).
10. The system is completely shut down.
11. As MCU detects system is off, it turns off the standby power for the system, and operates in low power mode again (< 2mW power consumption).

4.1.1 Additional Features of Ignition Power Control

In addition to the typical timing correlation, the ignition power control module offers additional features to provide additional reliability for in-vehicle applications.

- **Low battery detection**

  The ignition power control module continuously monitors the voltage of DC input when the system is operational. If input voltage is less than 9V (for 12VDC input) or less than 18V (for 24VDC input) over a 60-second duration, it will shut down the system automatically.

- **Guarded power-on/ power-off delay duration**

  If ignition signal goes inactive during the power-on delay duration, the ignition power control module will cancel the power-on delay process and go back to idle status. Likewise if ignition signal goes active during the power-off delay duration, the ignition power control module will cancel the power-off delay process and keep the system running.

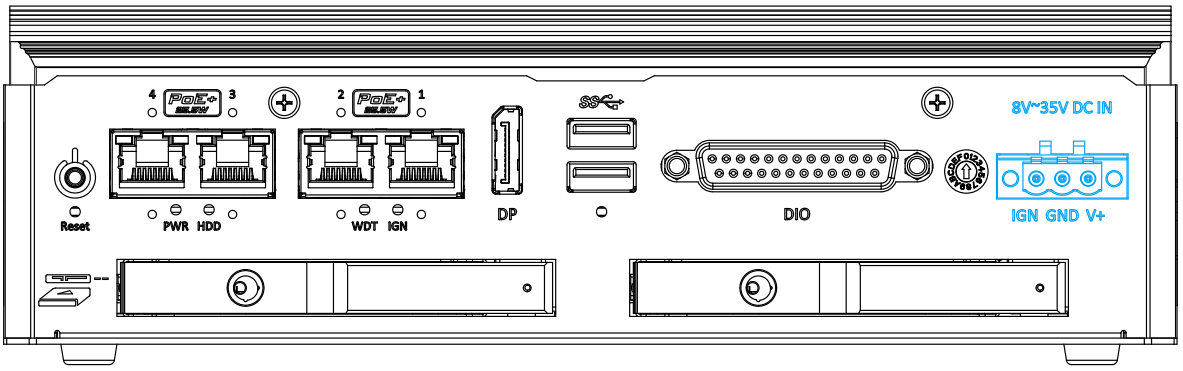
- **System hard-off**

  In some cases, system may fail to shutdown via a soft-off operation due to system/ application halts. The ignition power control module offers a mechanism called “hard-off” to handle this unexpected condition. By detecting the system status, it can determine whether the system is shutting down normally. If not, the ignition power control module will force cut-off the system power 10 minutes after the power-off delay duration.

- **Smart off-delay**

  The ignition power control module offers two modes (mode 6 & mode 7) which have very long power-off delay duration for applications require additional off-line time to process after the vehicle has stopped. In these two modes, the ignition power control module will automatically detect the system status during the power-off delay duration. If the system has shutdown (by the application software) prior to power-off delay expiring, it will cut off the system power immediately to prevent further battery consumption.

4.1.2 Wiring Ignition Signal



To have ignition power control for in-vehicle usage, you need to supply IGN signal to the system. The IGN input is located on the 3-pin pluggable terminal block (shared with DC power input). For in-vehicle ignition control wiring, please do the following:

1. Connect car Battery + line (12V for sedan, 24V for bus/ truck) to V+.
2. Connect car Battery -/ GND line to GND.
3. Connect ACC line to IGN.

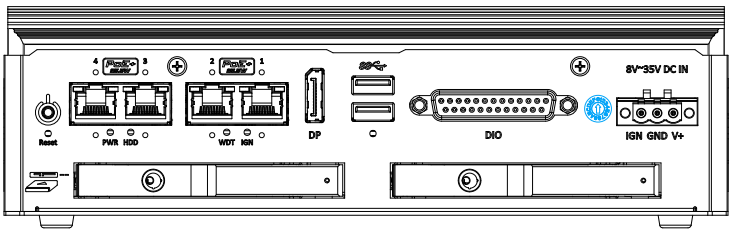
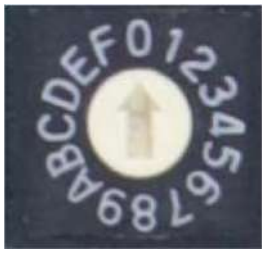
WARNING

Please make sure your DC power source and IGN signal share the same ground.

IGN input accepts 8~35VDC. Supplying a voltage higher than 35VDC may damage the system.

4.1.3 Operation Modes of Ignition Power Control

You can use the rotary switch to configure the operation mode. The system offers 16 (0~15) operation modes with different power-on/power-off delay configurations.

	
Ignition rotary switch location on the front panel	**Ignition rotary switch**

- **Mode 0**

  Mode 0 is the ATX mode without power-on and power-off delay. User can only use the power button on the front panel to turn on or turn off the system.

Mode	Power-on Delay	Power-off Delay	Hard-off Timeout
0	N/A	N/A	N/A

- **Mode 1**

  Mode 1 is AT mode without power-on and power-off delay. The system automatically turns on when DC power is applied. A retry mechanism is designed to repeat the power-on cycle if the system fails to boot up.

Mode	Power-on Delay	Power-off Delay	Hard-off Timeout
1	N/A	N/A	N/A

- **Mode 2**

  Mode 2 is designed to have a very minor power on/ off delay of 160ms for applications that requires the system to start up almost at the same as the rest of the equipment it is working in collaboration with.

Mode	Power-on Delay	Power-off Delay	Hard-off Timeout
2	160ms	160ms	10 minutes

- **Mode 3 ~ Mode 12**

  Mode 3 ~ Mode 12 have various power-on delay and power-off delay. Each mode supports a hard-off timeout of 10 minutes.

Mode	Power-on Delay	Power-off Delay	Hard-off Timeout
3	10 seconds	10 seconds	10 minutes
4	10 seconds	1 minute	10 minutes
5	10 seconds	5 minutes	10 minutes
6	30 seconds	1 minute	10 minutes
7	30 seconds	5 minutes	10 minutes
8	30 seconds	10 minutes	10 minutes
9	3 minutes	1 minute	10 minutes
10 (A)	3 minutes	10 minutes	10 minutes
11 (B)	3 minutes	30 minutes	10 minutes
12 (C)	10 minutes	30 minutes	10 minutes

- **Mode 13 (D) / Mode 14 (E)**

  Mode 13 and Mode 14 are ignition power control modes with very long power-off delay. Both modes support the feature of “smart off-delay”, which automatically detect system status during power-off delay duration and cut off system power if system is off in prior to power-off delay expired.

Mode	Power-on Delay	Power-off Delay	Hard-off Timeout
13 (D)	30 seconds	2 hours	10 minutes
14 (E)	3 minutes	2 hours	10 minutes

- **Mode 15 (F)**

  Mode 15 is reserved.

5 Reflashing the NRU System

NRU series is shipped with JetPack 4.4 installed as a turnkey solution. If you are familiar and experienced with the platform, you can skip this section and start your development.

This section will show you how to reflash the NRU series with either NVIDIA's official JetPack 4.4 or from the pre-built system image by Neousys.

To reflash the NRU system, you need a host system to reflash via a USB cable.

There are four types of files involved in the reflash process:

- Device Tree - It helps the Xavier module understand the hardware design.
- Kernel Image - The driver package
- Startup Scripts - Startup script to full support NRU hardware
- File System - A system image covers Jetson OS, kernel image, startup scripts..

5.2 NRU FTP

We put our latest released files on our **FTP**. Please contact your sales representative for the FTP info.

5.3 Prerequisites

Please have the following items ready before you start:

- **1x Host Machine with the following specifications**
  - Ubuntu 18.04.2 LTS
  - NVIDIA SDK manager with JetPack 4.4 for Xavier
  - Memory: 8G (minimal) or 16G+ (recommended)
  - Storage: 128G (minimal) or 256G+ (recommended)
  - Keyboard & Mouse
  - Wired Network Connection
  - Power Supply
- **1x USB Cable**
  - USB 2.0 Type A to Micro USB Type B Cable
- **1x USB Stick for bootable Ubuntu USB stick** (if you haven't installed Ubuntu on Host Machine)
  - Storage: 4GB (minimal)
- **1x NRU system with NVIDIA Jetson Xavier 32GB Module**
- **1x NRU Series barebone and power supply**

5.4 Prepare Host Machine for Reflash Process

1. Install Ubuntu 18.04.02 LTS [link].
2. Create a bootable USB stick and finish the Ubuntu 18.04.02 setup process [link].
3. Download [link] and install the Debian package of NVIDIA SDK manager by entering the following command.
   sudo apt install ./sdkmanager-[version].[build#].deb

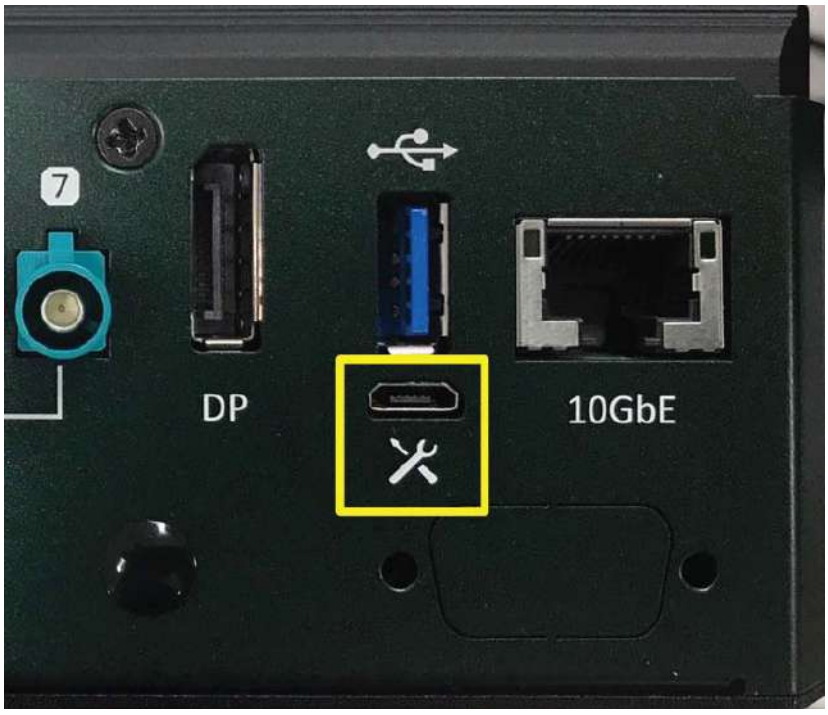
5.5 Prepare Target Machine for Reflash Process

To reflash your NRU system, please refer to the following steps:

1. Make sure you set the ignition switch to mode 0.

2. Connect the 3-pin terminal plug.

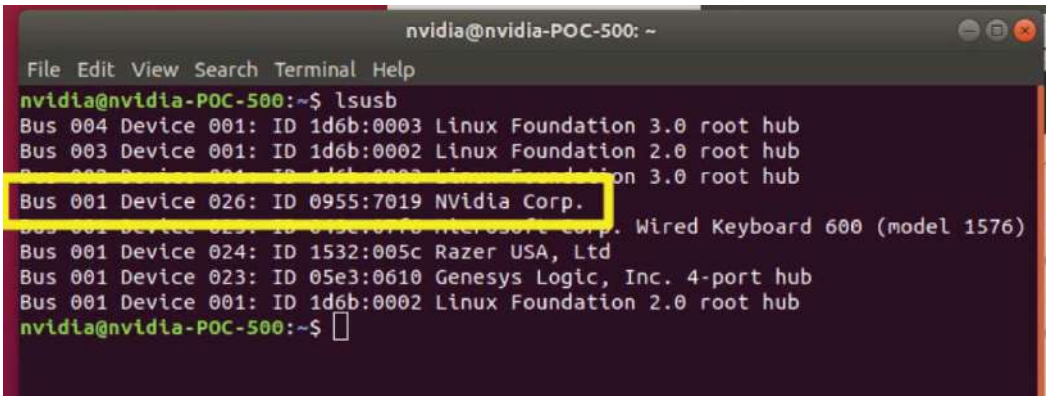
3. Connect the USB cable between the host and target machine.



4. Boot the target machine (NRU) in recovery mode:

   A. Make sure the NRU system is off.
   B. **Press the hold** the force recovery button
   C. Press the power button
   D. 5 seconds later, release the force recovery button

5. Confirm NRU is in recovery mode using lsusb on your host machine. If your system successfully booted into recovery mode, you should see NVIDIA Corp in one of the lsusb output.



5.6 Reflashing the NRU System

To beginning reflashing the NRU system, enter the following command in the terminal to update the package list on the host machine:

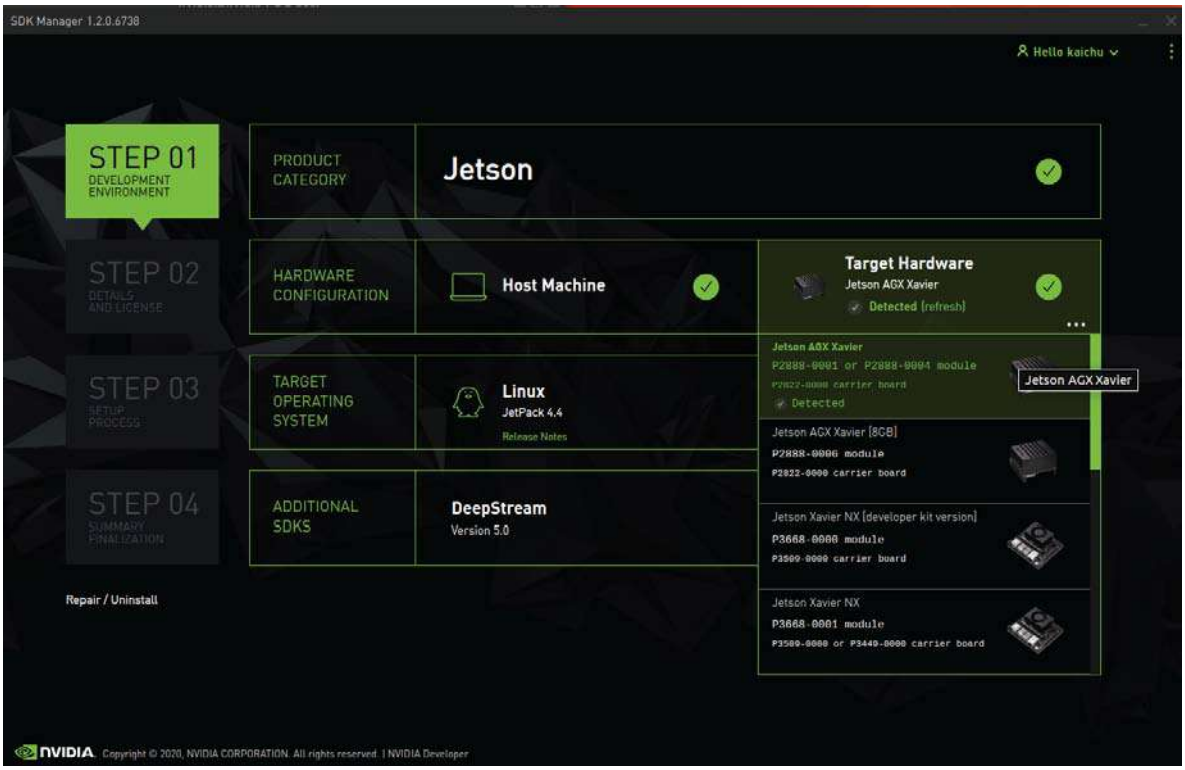
```
sudo apt-get update
```

We will flash a NRU series by **SDK Manager** once to finish necessary settings on **Host Machine.** After this session, you will get a **flash.sh** command-line tool. Run NVIDIA SDK Manager by the following command [link]

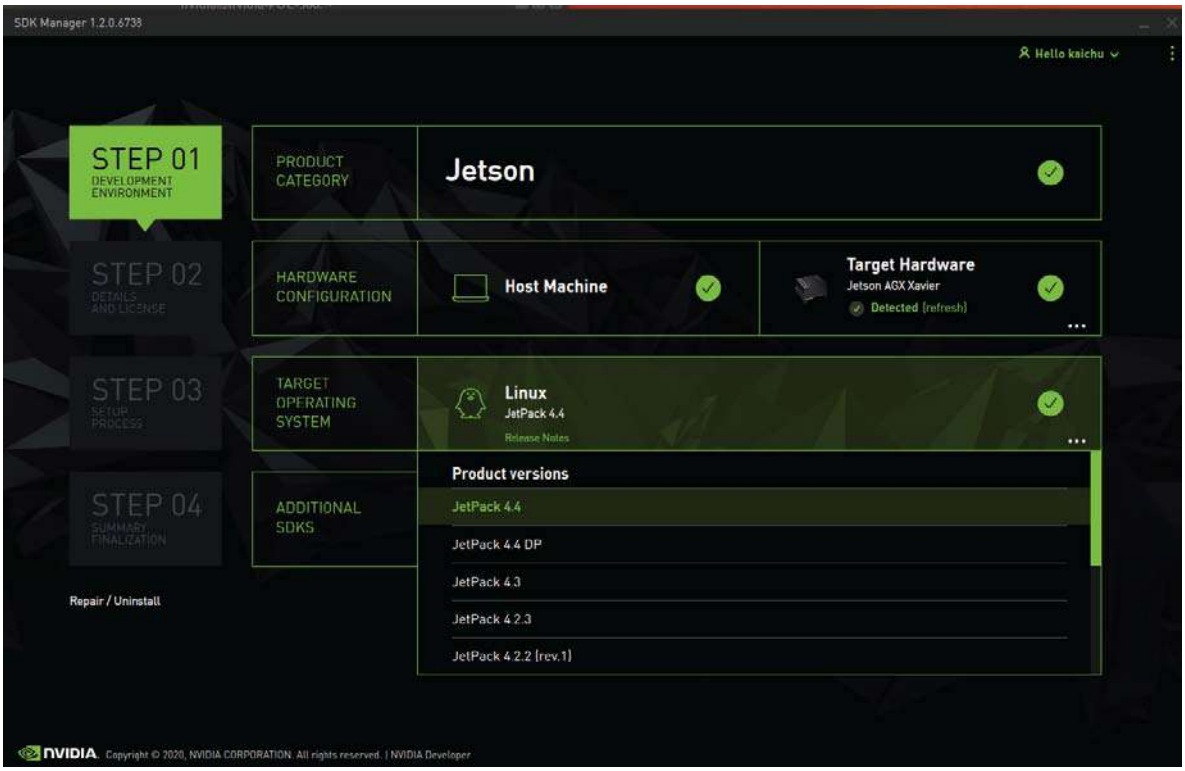
- sdkmanager
- You have to register an NVIDIA developer account first **(free)** to proceed

At STEP 01, please make sure you have prepared the **host machine**, target hardware **(Jetson AGX Xavier), JetPack 4.4** (Not JetPack 4.4 DP) and they are checked in the SDK manager window.

If the "**Detected**" is not shown under the Jetson AGX Xavier, you may need to refer to the previous step to put your NRU system into **Recovery Mode**.



JetPack 4.4 (NOT JetPack 4.4 DP)



At STEP 02, click on the **Jetson OS**, and the "I accept the terms ..." in the bottom of SDK Manager and press continue.

The flash process may take a while and when complete, you will find a signed "**flash.sh"** under your **L4T** path.

The **L4T** varies due to different SDK Manager versions. The **L4T** path in this demonstration's host machine is ~/nvidia/nvidia_sdk/JetPack_4.4_Linux_JETSON_AGX_XAVIER/Linux_for_Tegra

5.7 Reflash Neousys' Pre-built System Image

Flash via this method if you wish to reset your NRU system to the original factory settings.

1. Download .dtb and .img files from NRU FTP.
2. Boot your NRU system into recovery mode (click here for details)
3. Put .dtb under you **L4T** folder. You **L4T** folder will be similar to ~/nvidia/nvidia_sdk/JetPack_4.4_Linux_JETSON_AGX_XAVIER/Linux_for_Tegra
4. Put .img under **L4T/bootloader**, and rename it as **system.img**

```
# Example Code
# Please Update Variables based on Your Settings

export
L4T_ROOT_J4_4=/home/nvidia/nvidia/nvidia_sdk/JetPack_4.4_Linux_JETSON_AGX_XAVIER/Linux_for_Tegra
export SYS_IMG=NRU-100_20201222

sudo cp $SYS_IMG $L4T_ROOT_J4_4/bootloader/system.img
```

5. Flash File System and Device Tree

```
# Example Code
# Please Update Variables based on Your Settings

export
L4T_ROOT_J4_4=/home/nvidia/nvidia/nvidia_sdk/JetPack_4.4_Linux_JETSON_AGX_XAVIER/Linux_for_Tegra
export NRU_DTS=NRU_JetPack4.4_v0.8

cd $L4T_ROOT_J4_4
sudo ./flash.sh -r -d $NRU_DTS.dtb jetson-xavier mmcblk0p1
```

5.8 Reflash NRU System Using NVIDIA’s SDK Manager

NVIDIA constantly upgrades JetPack. I would highly recommend you to use **Neousys' Pre-built System Image** as a stable basis. Please port your applications to **Neousys' Pre-built System Image.**

1. We only recommended advanced developers to re-build the whole NRU development.

   Download Relevant Files on NRU FTP

   You will need to download .dtb .img .sh
2. Flash your System with JetPack 4.4 using SDK Manager

   After the GUI process, you will find your NRU without display output signal. This is because the official NVIDIA dtb doesn't 100% fit the hardware design of NRU series.

- Device Tree - It helps the Xavier module understand the hardware design.
- Kernel Image - The driver package
- Startup Scripts - Startup script to full support NRU hardware
- File System - A huge system image covers Jetson OS, kernel image, startup scripts. The device tree is the only file excluded.

5.9 Backup Your File System Image

As an edge AI platform, if you have made yourself a stable NRU development environment. We would recommend you to make your own **File System Image** as your backup.

By following steps, you can create your own System Image on your Host machine.

1. On target machine, clone RAW image from target to host machine via Ethernet

```
# Example Code
# Please Update Variables based on Your Settings

sudo su

export HOST_IP=192.168.1.144 # Kaichu's Host Machine
export SYS_IMG_RAW=NRU-100_0930

# Stop File System
echo u > /proc/sysrq-trigger

# Low Level Backup of Target Raw (Raw Image will be stored under ~/
Folder of Host Machine)
dd if=/dev/mmcblk0p1 | ssh nvidia@$HOST_IP dd
of=$SYS_IMG_RAW.raw status=progress
```

2. On the host machine, convert RAW image to sparse system image

```
# Example Code
# Please Update Variables based on Your Settings

sudo -s

export HOST_IP=192.168.1.144
export
L4T_ROOT_J4_4=/home/nvidia/nvidia/nvidia_sdk/JetPack_4.4_Linux_
JETSON_AGX_XAVIER/Linux_for_Tegra
export SYS_IMG_RAW=NRU-100_0930
```

```
# Move Raw Image to L4T/bootloader
cd $L4T_ROOT_J4_4/bootloader
mv ~/$SYS_IMG_RAW.raw .

# Make Sparase Image
./mksparse -v --fillpattern=0 $SYS_IMG_RAW.raw
$SYS_IMG_RAW.img

# System Image is Ready, and replace for the default path for File
System Flash!
cp $SYS_IMG_RAW.img system.img
```

3. Refer to "Reflash Neousys' Pre-built System Image" to Finish the Flash Steps

6 Software Reminder

In this section, we would like to introduce our built-in camera driver (NRU-110V) only, and some usage and feedback from our early adopters.

6.1 GMSL Camera Driver and Utility (NRU-110V Only)

We have put two demo folders on the pre-installed system image.

“Demo AR0147” is a shortcut that includes camera bring up script and camera driver, then open the camera with GStreamer.

“Camera Trigger PPS” is a utility need root permission for advanced developers who want to:
- Change the FPS of camera trigger by MCU
- Make camera trigger from MCU synchronized with GPS PPS.

6.2 Before calling “sudo apt upgrade”

NVIDIA tries to design a OTA mechanism to update the Jetson Xavier Computer from remote. However, as far as we tested, the OTA mechanism might damage the boot loader files and make NRU can’t boot anymore.

Please make sure to call “sudo apt-mark hold nvidia-l4t-bootloader” before any software or system update.