RAC-1000/1100 USER Manual

NVIDIA® Jetson AGX Orin™ Rugged AI Computing System
6 GigE LAN with 4 PoE+, 8 GMSL2, 1 PCIe x8, -25°C to 70°C Operation

Vecow

1.0.0 Edition 20241022

Record of Revision

Version	Date	Page	Description	Remark
1.00	2024/10/22	All	Official Release	

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Order Information

Part Number	Description
RAC-1000-R64	RAC-1000, on-board 64GB RAM, 2 LAN, 2 USB 3.1, 2 COM RS-232/422/485, 2 Isolated CAN Bus, 8 Fakra-Z connectors for GMSL 1/2 automotive cameras
RAC-1000-R32	RAC-1000, on-board 32GB RAM, 2 LAN, 2 USB 3.1, 2 COM RS-232/422/485, 2 Isolated CAN Bus, 8 Fakra-Z connectors for GMSL 1/2 automotive cameras
RAC-1100-R64	RAC-1100, on-board 64GB RAM, 6 LAN with 4 PoE+, 2 USB 3.1, 2 COM RS-232/422/485, 2 Isolated CAN Bus
RAC-1100-R32	RAC-1100, on-board 32GB RAM, 6 LAN with 4 PoE+, 2 USB 3.1, 2 COM RS-232/422/485, 2 Isolated CAN Bus

Optional Accessories

Part Number	Description
PWA-160WB-WT	160W, 24V, 85V AC to 264V AC Power Adapter with 3-pin Terminal Block, Wide Temperature -30°C to +70°C
PWA-180WB	180W, 24V, 90V AC to 264V AC Power Adapter with 3-pin Terminal Block
PWA-280WB-WT	280W, 24V, 85V AC to 264V AC Power Adapter with 3-pin Terminal Block, Wide Temperature -30°C to +70°C
GMSL Camera Kit	GMSL Camera with Fakra-Z connector
M.2 Storage Module	M.2 Key M/Key B PCIe Storage Module
5G Module	5G Module with Antenna
4G Module	4G/GPS Module with Antenna
WiFi & Bluetooth	WiFi & Bluetooth Module with Antenna

Table of Contents

1

GENERAL INTRODUCTION

1.1 Overview

The Vecow RAC-1000/1100 is an Arm-based rugged AI computing system powered by the NVIDIA$^®$ Jetson AGX Orin™ system-on-module. With up to 275 TOPS of AI performance, this system excels in demanding industrial and outdoor applications, including automated agricultural machinery, outdoor mobile robots, and construction automation.

Designed for harsh environments, the RAC-1000/1100 features an IP67-rated, anti-dust and waterproof chassis. It includes eight GMSL 1/2 automotive cameras connected via rugged FAKRA-Z connectors, ensuring reliable operation in extreme conditions. The system features extensive I/O options with rugged M12 connectors, including USB, COM, GigE LAN, HDMI, and CAN Bus, along with a PCIe Gen3 x8 expansion slot, providing seamless integration and customization capabilities.

The RAC-1000/1100 supports operating temperatures from -25°C to 70°C and a wide DC input range of 9V to 50V, making it versatile for various power configurations. Its compatibility with GMSL1/GMSL2 automotive cameras via MAXIM MAX9296 and FAKRA-Z connectors further enhances its adaptability. Meeting stringent industrial-grade requirements, the Vecow RAC-1000/1100 is a reliable, high-performance AI computing solution for edge AI applications.

1.2 Features

- Advanced NVIDIA® Jetson AGX Orin™ platform delivers up to 275 TOPS AI performance

- The latest NVIDIA Ampere™ architecture, featuring with 2048 NVIDIA® CUDA® cores and 64 Tensor cores

- Supports 8 GMSL 1/2 automotive cameras with Fakra-Z connectors

- IP67 Anti-dust and Waterproof Chassis design

- 1 PCIe Gen3 x8 expansion slot supports optional multiple 10GigE/PoE LAN/USB connections (by request)

- 2 Isolated CAN-FD, 2 COM RS-232/422/485

- 6 GigE LAN with 4 PoE+, 2 USB 3.1, 1 Digital Display supports 4K60

- DC 9V to 50V wide range power input

1.3 Product Specification

1.3.1 Specifications of RAC-1000

System	
Processor	NVIDIA® Jetson AGX Orin™ System-On-Module • 12-core Arm® Cortex®-A78AE v8.2 64-bit CPU • 2048-core NVIDIA Ampere™ architecture GPU with 64 Tensor Cores
Memory	• R32 : 1 32GB LPDDR5 DRAM • R64 : 1 64GB LPDDR5 DRAM • IND : 1 64GB LPDDR5 DRAM
Storage	eMMC 5.1, 64 GB
Software Support	• Linux • NVIDIA JetPack SDK
Graphics	
Interface	1 Digital Display, up to 4K60
Video Encode	• R32 : 1x 4K @60, 3x 4K @30, 6x 1080p @60, 12x 1080p @30 (HEVC) • R64 : 2x 4K @60, 4x 4K @30, 8x 1080p @60, 16x 1080p @30 (HEVC)
Video Decode	• R32 : 1x 8K @30, 2x 4K @60, 4x 4K @30, 9x 1080p @60, 18x 1080p @30 (HEVC) • R64 : 1x 8K @30, 3x 4K @60, 7x 4K @30, 11x 1080p @60, 22x 1080p @30 (HEVC)
Ethernet	
LAN 1 to LAN 2	10/100/1000Base-T Ethernet GigE LAN, X-coded M12 Connector
Camera	
GMSL	8 Fakra-Z connectors for GMSL 1/2 automotive cameras
I/O Interface	
USB	2 USB 3.1 (M12)
Serial	2 COM RS-232/422/485 (M12 A-coded)
LAN	2 GigE LAN (M12 X-coded)
HDMI	1 HDMI 2.1 (M12)
CAN Bus	2 Isolated CAN Bus support CAN FD (M12 A-coded)
Flash	1 Micro USB OS flash port
Button	• 1 Power Button with LED • 1 Recovery button
Expansion	
PCIe	1 PCIe x8 Slot (by request)
M.2	• 1 M.2 Key B Socket (3042/3052) • 1 M.2 Key E Socket (2230)

Storage	
M.2	2 M.2 Key M Socket (2280)
eMMC	1 eMMC 5.1, 64GB
Power	
Power Input	DC 9V to 50V
Power Interface	4-pin K-Code M12 connector
Mechanical	
Dimensions	260 mm x 330 mm x 80 mm (10.23" x 13" x 3.14")
Weight	7 kg (15.43 lb)
Mounting	Wallmount
Environment	
Operating Temperature	30W TDP Mode : -25°C to 70°C (-13°F to 158°F), with 0.63 m/s air flow 50W TDP Mode : -25°C to 55°C (-13°F to 131°F), with 0.63 m/s air flow
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Humidity	5% to 95% Humidity, non-condensing
Relative Humidity	95% at 70°C
Shock	Operating, MIL-STD-810G, Method 516.7, Procedure I
Vibration	Operating, MIL-STD-810G, Method 514.6, Procedure I, Category 4
EMC	CE, FCC, EN50155, EN50121-3-2, IP67

## 1.3.2 Specifications of RAC-1100

System	
Processor	NVIDIA® Jetson AGX Orin™ System-On-Module • 12-core Arm® Cortex®-A78AE v8.2 64-bit CPU • 2048-core NVIDIA Ampere™ architecture GPU with 64 Tensor Cores
Memory	• R32 : 1 32GB LPDDR5 DRAM • R64 : 1 64GB LPDDR5 DRAM • IND : 1 64GB LPDDR5 DRAM
Storage	eMMC 5.1, 64 GB
Software Support	• Linux • NVIDIA JetPack SDK
Graphics	
Interface	1 Digital Display, up to 4K60
Video Encode	• R32 : 1x 4K @60, 3x 4K @30, 6x 1080p @60, 12x 1080p @30 (HEVC) • R64 : 2x 4K @60, 4x 4K @30, 8x 1080p @60, 16x 1080p @30 (HEVC)
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Ethernet	
LAN 1 to LAN 2	10/100/1000Base-T Ethernet GigE LAN, X-coded M12 Connector
PoE+	
LAN 3 to LAN 6	IEEE 802.3at (25.5W/48V) GigE PoE+ LAN, X-coded M12 Connector
I/O Interface	
USB	2 USB 3.1 (M12)
Serial	2 COM RS-232/422/485 (M12 A-coded)
LAN	2 GigE LAN (M12 X-coded)
HDMI	1 HDMI 2.1 (M12)
CAN Bus	2 Isolated CAN Bus support CAN FD (M12 A-coded)
Flash	1 Micro USB OS flash port
Button	• 1 Power Button with LED • 1 Recovery button
Expansion	
PCIe	1 PCIe x8 Slot (by request)
M.2	• 1 M.2 Key B Socket (3042/3052) • 1 M.2 Key E Socket (2230)

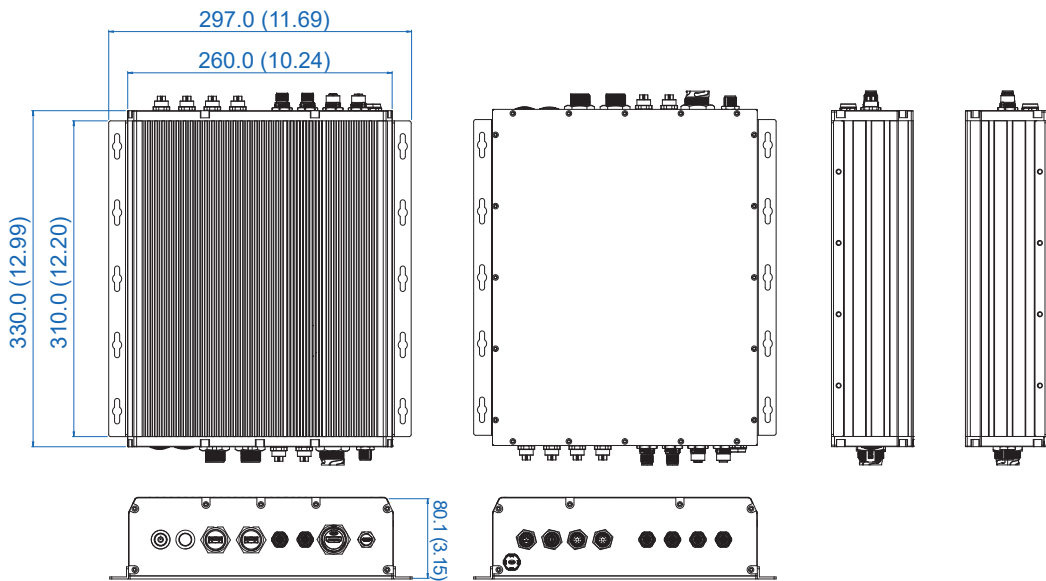| Storage	
M.2	2 M.2 Key M Socket (2280)
eMMC	1 eMMC 5.1, 64GB
Power	
Power Input	DC 9V to 50V
Power Interface	4-pin K-Code M12 connector
Mechanical	
Dimensions	260 mm x 330 mm x 80 mm (10.23'' x 13'' x 3.14'')
Weight	7 kg (15.43 lb)
Mounting	Wallmount
Environment	
Operating Temperature	30W TDP Mode : -25°C to 70°C (-13°F to 158°F), with 0.63 m/s air flow 50W TDP Mode : -25°C to 55°C (-13°F to 131°F), with 0.63 m/s air flow
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Humidity	5% to 95% Humidity, non-condensing
Relative Humidity	95% at 70°C
Shock	Operating, MIL-STD-810G, Method 516.7, Procedure I
Vibration	Operating, MIL-STD-810G, Method 514.6, Procedure I, Category 4
EMC	CE, FCC, EN50155, EN50121-3-2, IP67

1.4 Mechanical Dimension

1.4.1 Dimensions of RAC-1000

Unit : mm (inch)

297.0 (11.69)
260.0 (10.24)
330.0 (12.99)
310.0 (12.20)
80.1 (3.15)
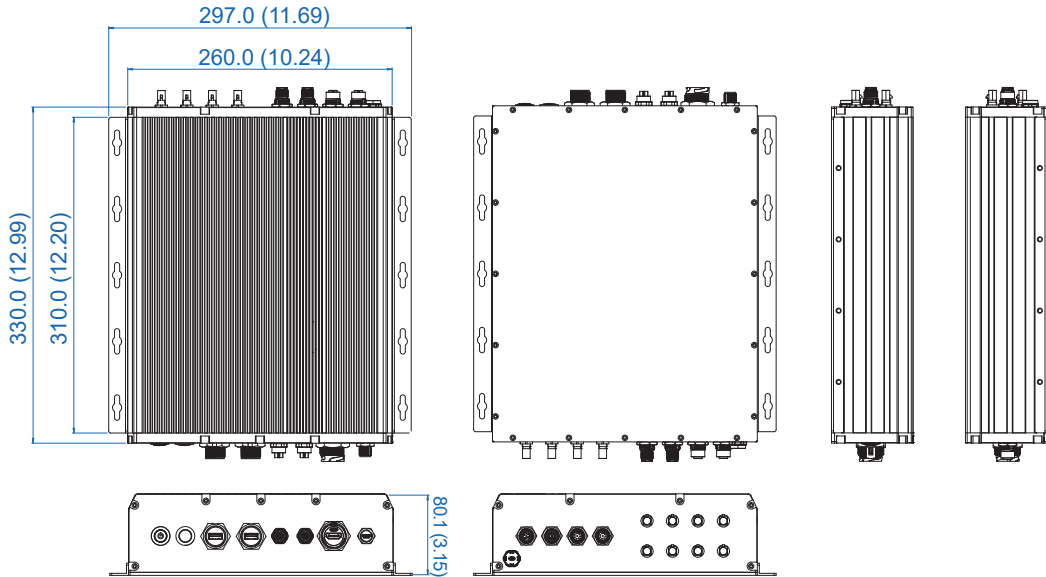
1.4.2 Dimensions of RAC-1100

Unit : mm (inch)

297.0 (11.69)
260.0 (10.24)
330.0 (12.99)
310.0 (12.20)
80.1 (3.15)

2

GETTING TO KNOW YOUR RAC-1000/1100

2.1 RAC-1000/1100 Packing List

| Item	Description	Qty
1	RAC-1000/RAC-1100 Edge AI Computing System (According to the configuration of your order, RAC-1000/RAC-1100 series may contain micro SD and M.2 modules. Please verify these items if necessary.)	1

Item	Description	Outlook	Usage	P/N	Qty
1	PHILLIPS#10-32x6L,Ni		Wall Mount	53-I000510-000	8
2	Wall Mount Bracket RAC-1000		Mount	62-04P1636-30A	2
3	M12 DC Cable With IGN		DC/IGN	61-1CB0204-014	1

2.2 Front Panel I/O & Functions

2.2.1 Functions of RAC-1000/1100 series

In Vecow RAC-1000/1100 series, Most of the I/O connectors are located on the front panels. Most of the general connections to computer devices, such as Power Button, Force Recovery button, USB, LAN, Digital Display Port, Flash Port are placed on the front panel.
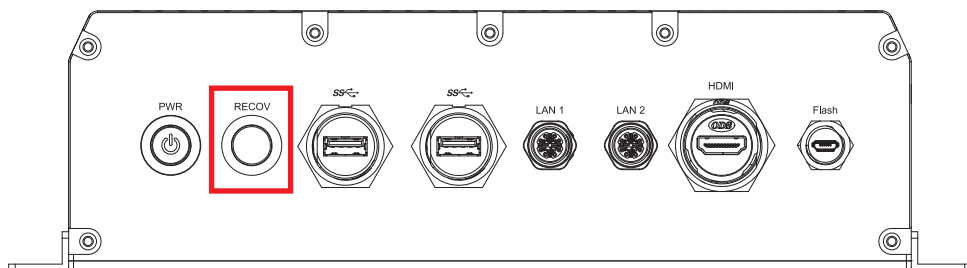
2.2.2 Power Button
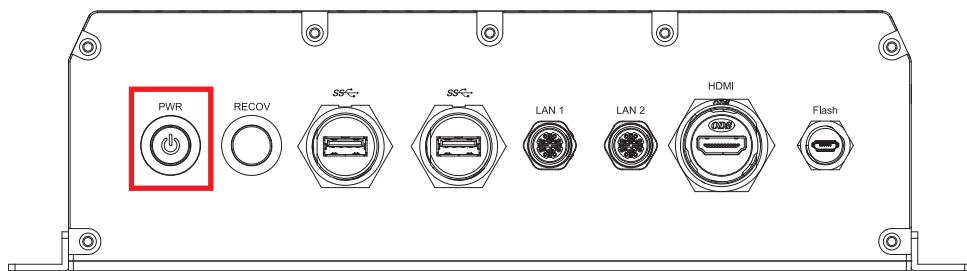
The Power Button is a non-latched switch with LED indication.

To power on the system, press the power button and then the blue LED is lightened. To power off the system, you can either command shutdown by OS operation, or just simply press the power button.
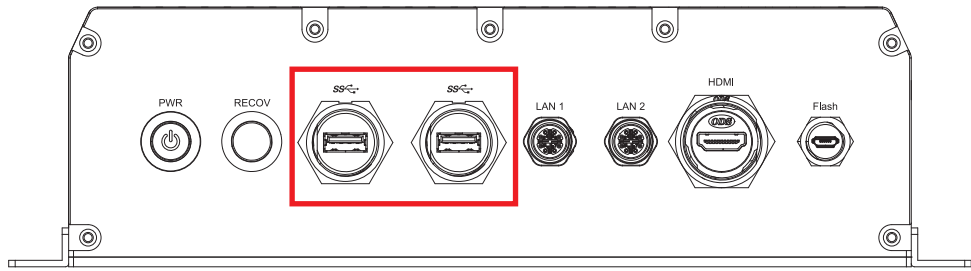
2.2.3 Force Recovery Button

Used to enter Force Recovery Mode. Button is held down while either system is first powered on, or by pressing & releasing reset button while Recovery button is pressed.
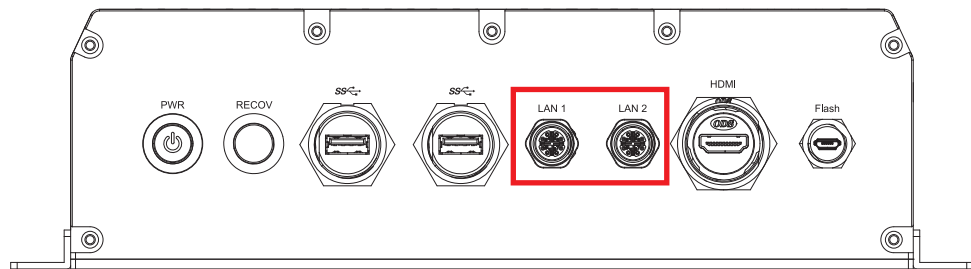
2.2.4 USB 3.2 Gen1

There are 2 USB 3.2 Gen1 connections available supporting up to 5Gb per second data rate in the front panel of RAC-1000/1100 series. It is also compliant with the requirements of Speed (SS), High Speed (HS), Full Speed (FS) and Low Speed (LS).

2.2.5 Ethernet Port

There are two LAN ports supporting 10/100/1000 Mbps Ethernet connections on the front side of RAC-1000/1100 series.

LAN Chip	Function	Connector
RTL8211_LAN1	RJ-45(10/100/1000)	LAN1
I210_LAN2	RJ-45(10/100/1000)	LAN2

The pin define of LAN 1 & LAN 2 are listed as follows:

Pin Define	Pin No.	100MBps	1000MBps
	1	TX-	MDI0_N
	2	TX+	MDI0_P
	3	RX-	MDI1_N
	4	RX+	MDI1_P
	5	-----	MDI2_N
	6	-----	MDI2_P
	7	-----	MDI3_N
	8	-----	MDI3_P

2.2.6 Digital Display Port
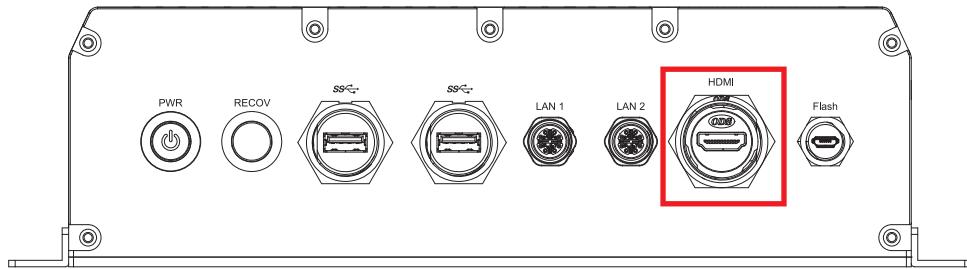
Onboard HDMI Ports support HDMI V2.1 interface, connection supports up to Up to 3840 x 2160 @60Hz.

2.2.7 Flash Port
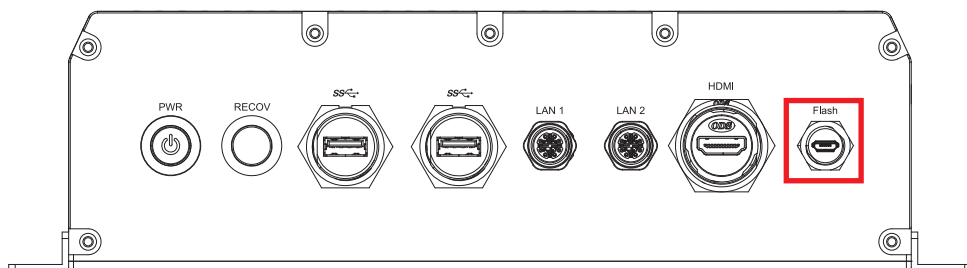
The RAC-1000/1100 USB Recovery mode provides an alternate boot device (USB). In this mode, the system is connected to a host system and boots over USB. This is used when a new image needs to be flashed. USB0 must be available to use as USB Device for USB Recovery Mode.

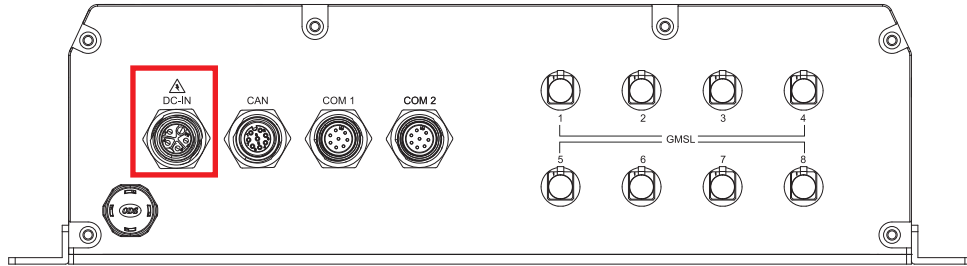## 2.3 Rear Panel I/O & Functions

2.3.1 Functions of RAC-1000 series

In Vecow RAC-1000 series, Some of the I/O connectors are located on the rear panels. Such as Power input, CAN Port, COM Port, GMSL Camera are placed on the rear panel.

2.3.2 Power Connector

RAC-1000/RAC-1100 series supports 9V to 50V DC wide range power input by DC-IN connector in the rear side.

And the pin define is as below table:

Pin Define	Pin No.	Definition
	1	V-
	2	V-
	3	V+
	4	V+

2.3.3 CAN Port
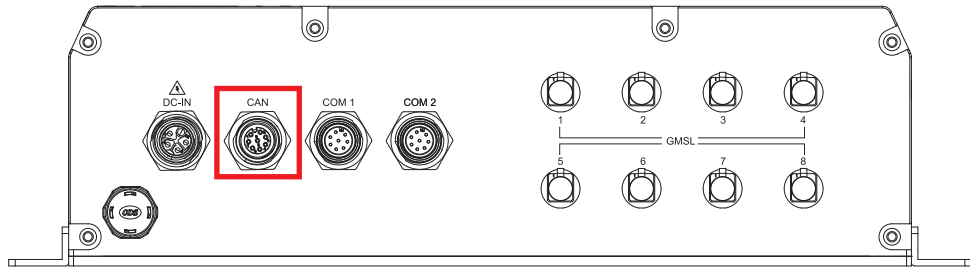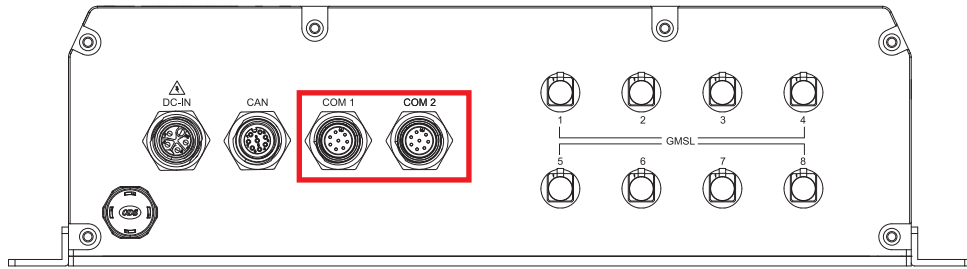

RAC-1000/RAC-1100 series supports CAN Bus by CAN connector in the rear side.

The pin define of CAN 1 & CAN 2 are listed as follows:

Pin Define	Pin No.	Definition
	1	CAN1_H
	2	CAN1_L
	3	GND1
	4	NC
	5	CAN2_H
	6	CAN2_L
	7	GND2
	8	NC

2.3.4 COM Port

The COM 1, 2 can be configured for RS-232, RS-422, or RS-485 with auto flow control communication. The default definition of COM 1 and COM2 is RS-232; if you want to use RS-422 or RS-485, you must select the desired COM mode through GPIO.

The pin define of COM 1 & COM 2 are listed as follows:

Pin Define	Pin No.	Definition
	1	DCD
	2	RXD
	3	TXD
	4	DTR
	5	NC
	6	RTS
	7	CTS
	8	GND

2.3.5 GMSL Camera Port
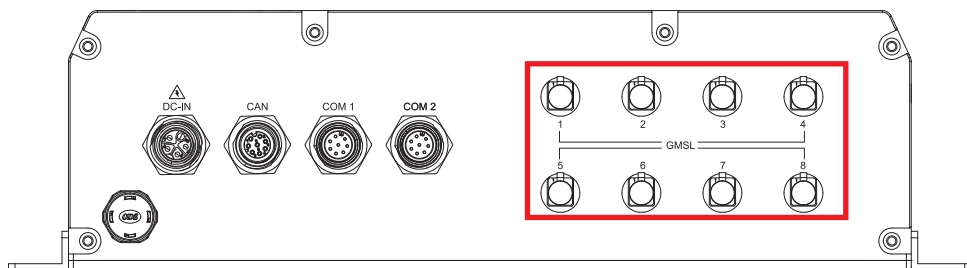
There are eight FAKRA connectors in the rear side of RAC-1000. Each camera connects to the RAC-1000 through a single coax cable. Using GMSL2 (Gigabit Multimedia Serial Link) connections, the cameras are connected to a two-port deserializer. The output of the deserializer is MIPI CSI-2.

2.3.6 Functions of RAC-1100
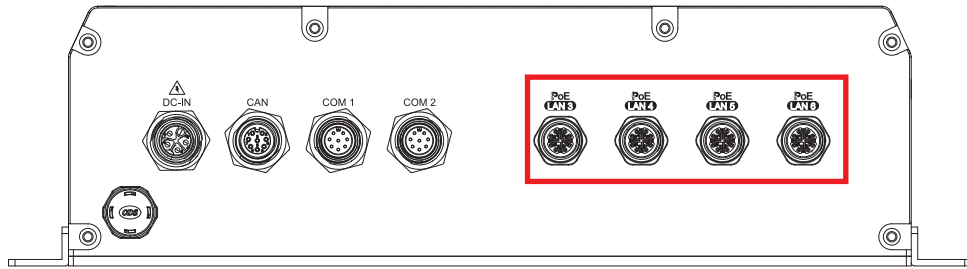
There are 4 LAN connectors in the rear side of RAC-1100. It supports IEEE 802.3at (PoE+) Power over Ethernet (PoE) connection delivering up to 25W/54V per port and 1000BASE-T gigabit data signals over standard Ethernet Cat 5/Cat 6 cable.

Each PoE connection is powered by Intel® I350 Gigabit Ethernet controller and independent PCI express interface to connect with multi-core processor for network and data transmit optimization.

PS. Suggest to use PoE function when power input is over 24V.

The pin define of LAN 3 & LAN 6 are listed as follows:

Serial Port	Pin No.	10/100 Mbps	1000 Mbps	PoE
	1	TX-	MDI0_N	PoE+
	2	TX+	MDI0_P	PoE+
	3	RX-	MDI1_N	PoE-
	4	RX+	MDI1_P	PoE-
	5	-----	MDI2_N	-----
	6	-----	MDI2_P	-----
	7	-----	MDI3_N	-----
	8	-----	MDI3_P	-----

3

SYSTEM SETUP

3.1 How to Open Your RAC-1000

3.1.1 DC-IN/CAN/COM/USB/LAN/HDMI/Flash

Step 1 Remove waterproof cap.

Step 2 Confirm connector pin defined. (Example LAN).

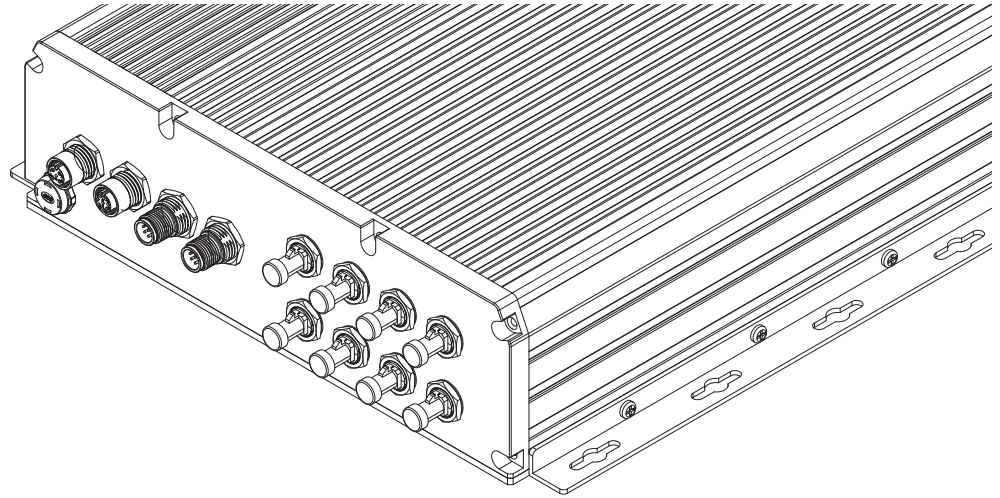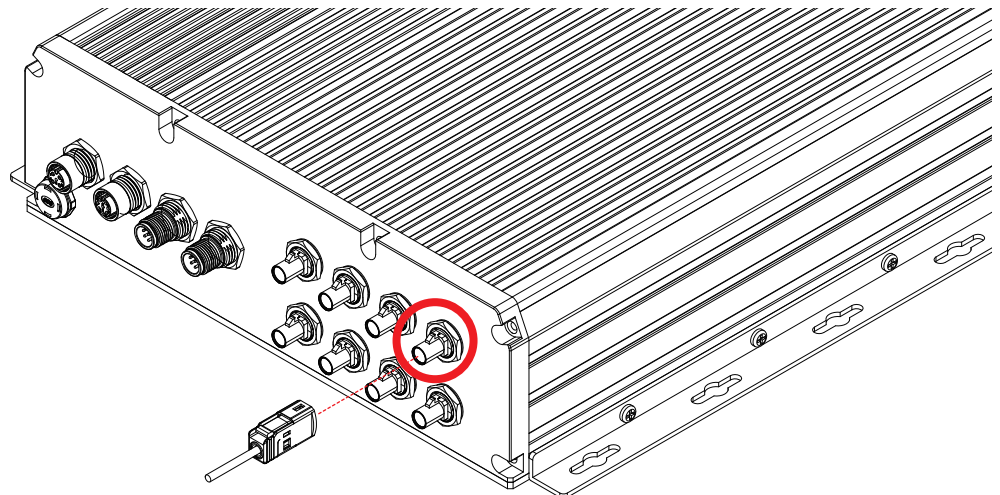**Step 3** Confirm wire.

Step 4 Locked.

3.1.2 GMSL

Step 1 Remove the GMSL rubber corks on connector.

Step 2 Install plug.

Step 3 Finish.
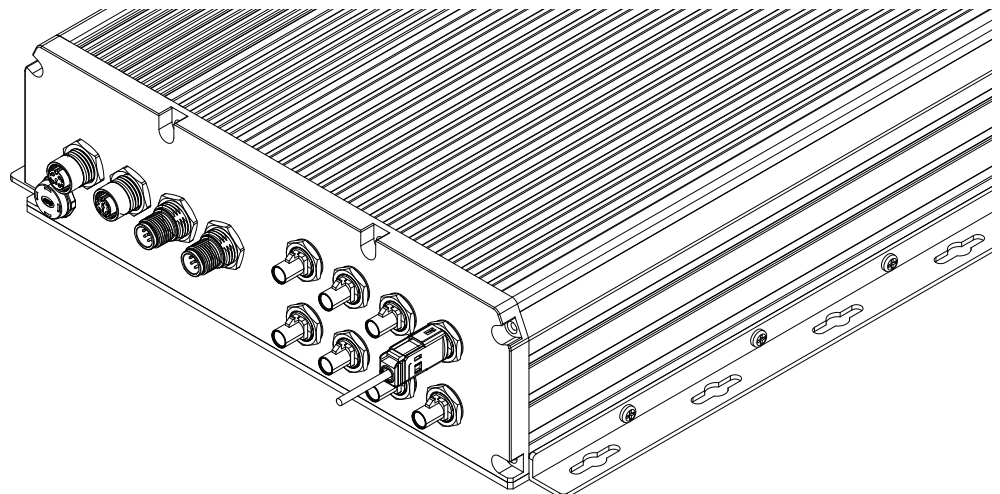
3.2 Mounting Your RAC-1000/RAC-1100

Step 1 Fasten eight PHILLIPS #10-32 screws.
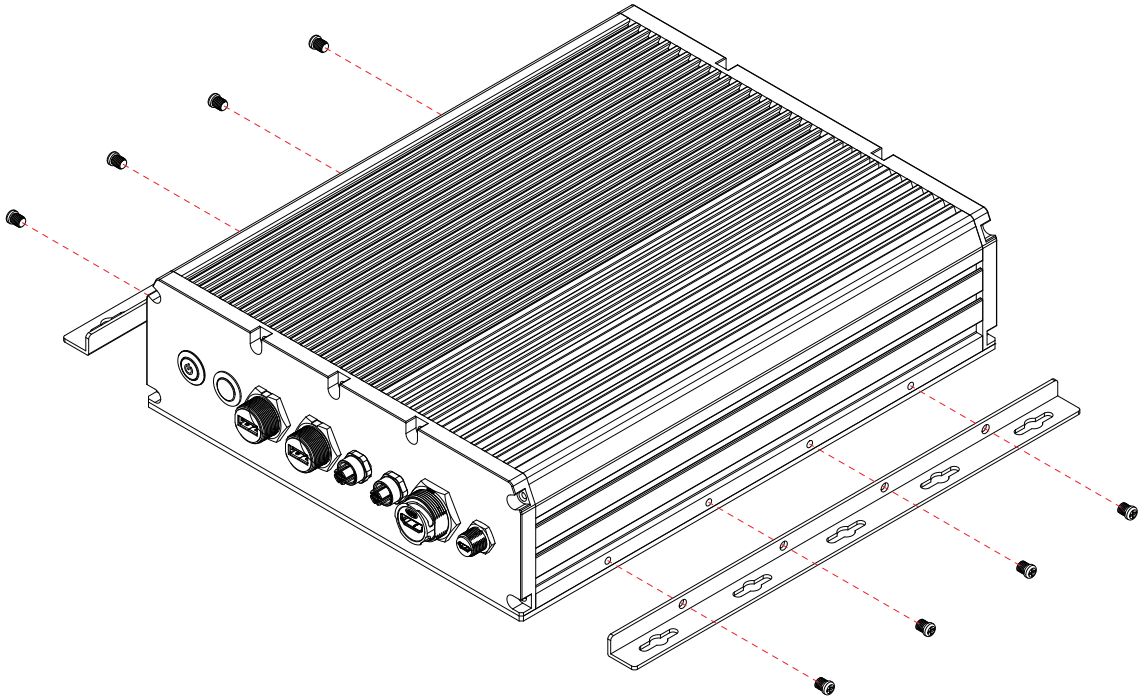
Step 2 Finish.
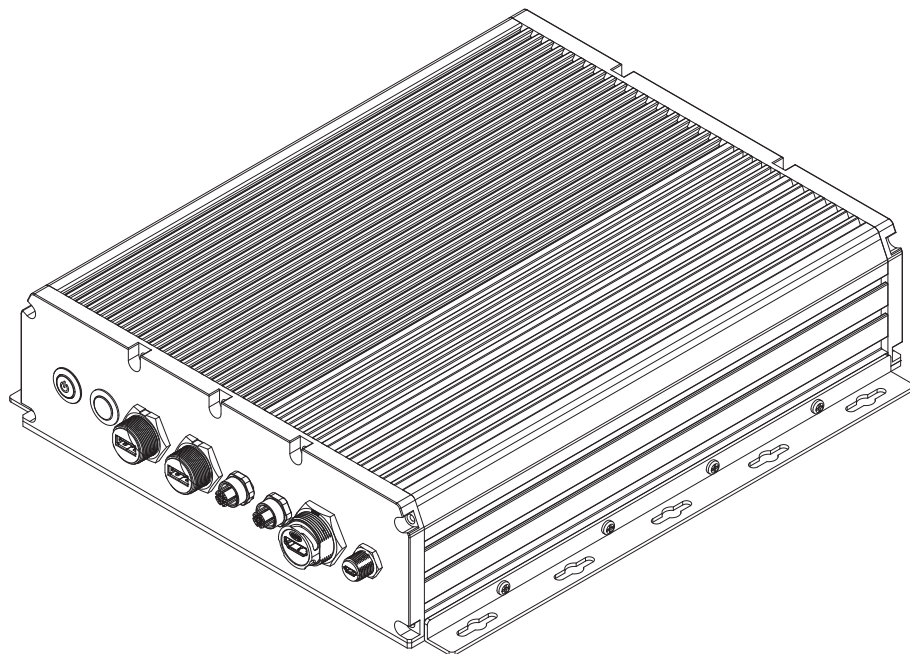
4

SOFTWARE SETUP

4.1 Peripheral Interface Guide

For I/O support and example please follow this link:

https://github.com/VecowSoftware/RAC-1000_IO_Sample

4.2 Flash image to Your RAC-1000/RAC-1100

Before starting the flashing process, be sure the RAC-1000 is turned off and disconnected from the power. You also need to prepare a host computer running Ubuntu 20.04 or later.

4.2.1 Prepare the host computer

Step 1 Open a terminal on host computer and disable the automount of new external storage devices temporarily. On most distributions of Debian-based Linux, you can do this using the following command:

```
$ sudo systemctl stop udisks2.service
```

Step 2 Run the following script to ensure that the host computer has the "nfs-kernel-server" service running:

```
$ sudo service nfs-kernel-server start
```

4.2.2 Download the OS image file to the host computer

Step 1 Download the OS image package file. The file name will be similar to:

RAC-1000_64GB_EMMC-BOOT_JetPack5.1.1_230731.tbz2

Step 2 Check the MD5 Checksum of the OS image package

$ sudo md5sum -c ./ RAC-1000_64GB_EMMC-BOOT_JetPack5.1.1_230731.tbz2.md5

Step 3 Open a Linux terminal on host computer and issue the following command to extract compressed image files:

$ sudo tar xvf RAC-1000_64GB_EMMC-BOOT_JetPack5.1.1_230731.tbz2 --use-compress-program=lbzip2

4.2.3 Connect RAC-1000 to the host computer

Step 1 Connect the power adapter to the RAC-1000. Connect the Micro USB cable to the "Flash" Port on RAC-1000 and the other end to an available USB port on the host PC. Make sure you have only ONE RAC-1000 device in recovery mode plugged in the host.

Step 2 Press and hold the "RECOV" button.

Step 3   While holding the "RECOV" button, power on the system. Continue to hold the "RECOV" button for two seconds, and release.

Step 4   Now that the device is in recovery mode, issue "lsusb" command on host PC to find a new USB device:

BUS 003 Device 005: ID 0955:7e19 Nvidia Corp.

4.2.4 Flash image to the RAC-1000

Step 1   Open a terminal on host PC, then access the package folder you extracted in step 4.2.2-3.

Step 2   Run the following script to install the right dependencies:

$ sudo ./l4t_flash_prerequisites.sh

Step 3   Run this command from the decompressed folder to flash the image:

$ sudo ./RAC-1000_flash.sh

Step 4   Once the process finished, you should see the following log:

```
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
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Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
Ongoing processes: 11873
```

A

APPENDIX A : GMSL Camera Guide (RAC-1000 Only)

Before you start

Please connect the camera cable to GMSL port before power on the RAC-1000.

To initialize the GMSL camera, you can access the following path

`$ cd /usr/src/tools/RAC-1000/camera/`

Or

https://github.com/VecowSoftware/RAC-1000_IO_Sample/tree/master/camera

to find the camera initial scripts.

B

APPENDIX B : Power Consumption

B.1 RAC-1000

Testing Board	RAC-1000
RAM	32 GB 256-bit LPDDR5
USB-1	USB Microsoft Wired Keyboard 600
USB-2	USB Mouse HP G1K28AA
Storage	64 GB eMMC 5.1
LAN 1	1.0 Gbps
LAN 2	1.0 Gbps
Camera	GMSL Camera 8pcs
Graphics Output	HDMI
Power Plan	30W/60W TDP
Power Source	Chroma 62006P-100-25
Test Program	Stress-ng Test

B.2 12-core ArmR CortexR-A78AE v8.2 64-bit CPU, up to 2 GHz 2048-core NVIDIA Ampere™ GPU with 64 Tensor Cores (30W)

CPU	Power Input	Ubuntu 20.04 LTS 64bit			
		idle status CPU		Run BurnInTest/Stress-ng Test	
		Max Current	Max Consumption	Max Current	Max Consumption
12-core Arm® Cortex®-A78AE v8.2 64-bit CPU, up to 2 GHz	9V	2.461A	22.14W	5.050A	45.45W
	12V	1.829A	21.94W	3.782A	45.39W
	24V	0.995A	23.88W	1.885A	45.24W
	36V	0.705A	25.39W	1.357A	48.85W
	50V	0.505A	25.26W	0.049A	52.45W

B.3 12-core ArmR CortexR-A78AE v8.2 64-bit CPU, up to 2 GHz 2048-core NVIDIA Ampere™ GPU with 64 Tensor Cores (50W)

CPU	Power Input	Ubuntu 20.04 LTS 64bit			
		idle status CPU		Run BurnInTest/Stress-ng Test	
		Max Current	Max Consumption	Max Current	Max Consumption
12-core Arm® Cortex®-A78AE v8.2 64-bit CPU, up to 2 GHz	9V	1.475A	13.28W	6.320A	56.88W
	12V	1.097A	13.16W	4.549A	54.59W
	24V	0.622A	14.92W	2.266A	54.38W
	36V	0.474A	17.05W	1.556A	56.02W
	50V	0.394A	19.68W	1.136A	56.82W

C

APPENDIX C : Supported Expansion Module List

C.1 Supported 5G/4G/GPS List

Type	Model	Support Standard
M.2 KEY B	Quectel EM060K	LTE Category 6 Worldwide LTE and UMTS/HSPA+ Coverage
M.2 KEY B	Telit LN920A6	LTE Category 6 Worldwide LTE-A and 3G/HSPA+ Coverage
M.2 KEY B	Quectel RM520N	5G sub-6GHz Worldwide 5G and LTE-A coverage
M.2 KEY B	CINTERION Thales_MV31-W	5G sub-6GHz Global 5G coverage and LTE Cat. 20 fallback
M.2 KEY B	CINTERION Telit_MV32-W	5G sub-6GHz Global 5G coverage and LTE Cat. 20 and 3G fallback

C.2 Supported Wi-Fi/Bluetooth List

Type	Model	Support Standard
M.2 KEY E	SparkLAN_WNFT-237ACN(BT)	IEEE 802.11ac/a/b/g/n BT5.0
M.2 KEY E	jjPlus JWW6051	IEEE 802.11ac/a/b/g/n (2T2R) BT5.0
M.2 KEY E	Intel 8265NGW	IEEE 802.11a/b/g/n/ac BT5.2

** If more help is needed, please contact Vecow Technical Support.

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For further support information, please visit www.vecow.com