EAORA04F-D Datasheet

Revision History

Date	Version	Detail	Reviser	Approved by
05/2022	V1.0	First Version	Terry Xu	Jason Du

Contact us

Web: www.ecotron.ai

Email: info@ecotron.ai

support@ecotron.ai

Address: 13115 Barton Road, Ste H,

Whittier, CA, 90605, USA

Telephone: +1 562-758-3039

Fax: +1 562-352-0552

Catalogue

1. Summary

EAORA04-D is an intelligent computing platform developed by Ecotron, for machine-learning based robotic systems using NVIDIA Jetson Orin chip and Infineon TC297. Using the supporting basic software and development tools, developers can build autonomous robotic system in a safe, convenient, and efficient manner.

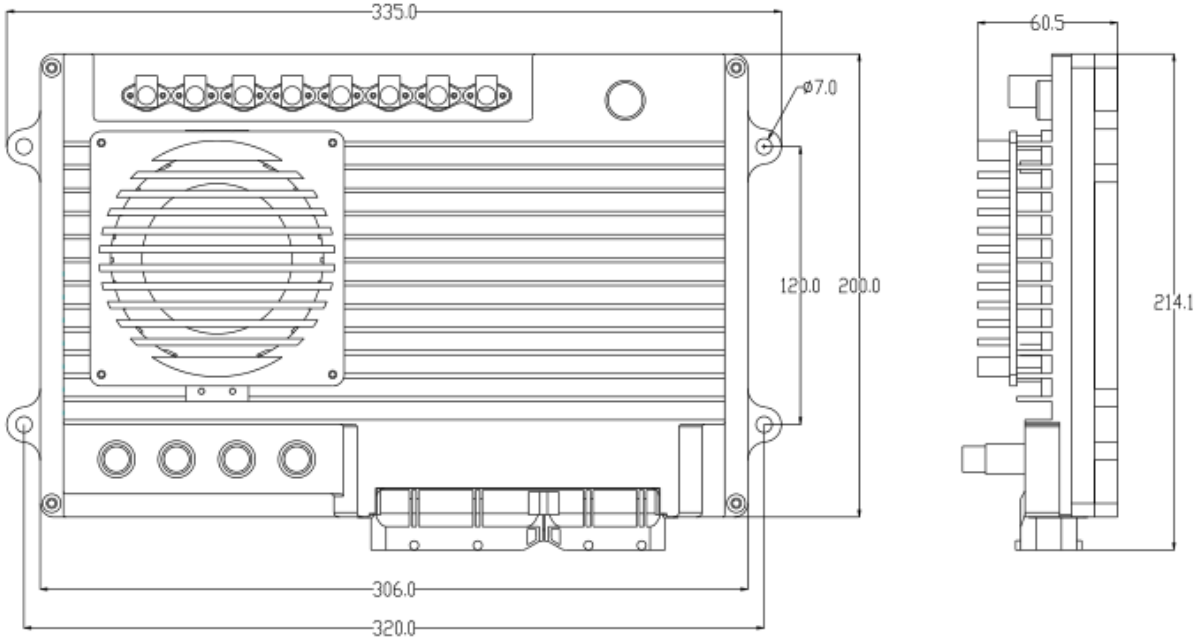
NVIDIA Jetson Orin is designed for embedded intelligent which can be used to implement computer vision features such as sensor fusion, environment perception, and path planning, etc. Infineon TC297 is based on TriCore™ architecture with a 300MHz operating frequency and an ECC (Error Correction Code) protected RAM with 728KB + 8MB capacity. Developers can develop and deploy robotic control and functional safety related strategies based on the MCU.

2. Interface

Interface type	Number	Function	Chip	Connector
M.2 KEY M	1	Extended storage	SOC	Internal
Camera interface	8	FPDlink III	SOC	Water-proof FAKRA
Gigabit Normal Ethernet	2	100BASE-T/1000BASE-T standard	Switch	2* Aviation plug
Gigabit Automotive Ethernet	3	100Base-T1/1000Base-T1,	Switch	1* Aviation plug
Video Output	1	1 channel HDMI	SOC	
USB	1	1 channel USBHost support USB2.0、US3.0、USB3.1	SOC	
RS232	4	1 channel used for Debugging	SOC	121PIN-CMC
RS485	1		SOC	
CAN	2		SOC	
PPS_IN	1	Support 3.3v-16v, hardware configuration	SOC	
PPS_OUT	4	2 channels 5V or 3.3V output, 2 channels 12V output	SOC	
CANFD	6	2 channels with specific frame wake-up	MCU	
LIN	4	No wake-up function is required	MCU	
KEYON	3	One channel is for SOC and two channels are for MCU		
Digital Input	6	Default configuration, 4 channels are active-high, 2 channels are active-low	MCU	
Analog Input	6	Default configuration: 2 channels are 5V voltage type, 2 channels are 36V voltage type and 2 channels are resistance type	MCU	
Digital Low-side output	8	8 channels @250mA	MCU	
Digital High-side output	4	4 channels @1A	MCU	
5V Sensor power	2	Maximum Current 100mA	MCU	
Power Positive	4			
Power Ground	4			
Signal Ground	8			

3. Mechanical

3.1 Dimensions



3.2 Connector

The connectors used by EAORA04-D are qualified for industrial robots. The connector types are as follows:

#	Connector	Name	Type	Supplier	Link
1	121P	PCB needle	1746979-1	TE	--
2		81P sheath	1473244-1	TE	http://www.digikey.com/products/en?keywords=1473244-1
3		40P sheath	1473252-1	TE	http://www.digikey.com/products/en?keywords=1473252-1
4		Large Terminal	964273-2	TE	http://www.digikey.com/products/en?keywords=964273-2%20

5		Small Terminal	968220-1	TE	http://www.digikey.com/products/en?keywords=968220-1
6		81P Back	1473247-1	TE	http://www.digikey.com/products/en?keywords=1473247-1
7		40P Back	1473255-1	TE	http://www.digikey.com/products/en?keywords=1473255-1
8		81P Retainer	368382-1	TE	http://www.digikey.com/products/en?keywords=368382-1
9		40P Retainer	368388-1	TE	http://www.digikey.com/products/en?keywords=368388-1
10	FAKRA	FAKRA needle Z Type	smbf-fkm1-3gt30g-50	Amphenol	
11	Aviation plug	Board-side	EEG.1K.308.CLN	JX	
12		Harness-side	FGG.1K.308.CLAC	JX	
13		Board-side	EEG.1K.306.CLN	JX	
14		Harness-side	FGG.1K.306.CLAC	JX	

4. Quick Start

4.1 Prepare in Advance

Before using this device, please prepare the following items:

- Stable power supply, 12V DC/ 5A min or 24V DC/ 5A min
- USB to RS-232 adapter
- Laptop

4.2 Basic Knowledge

If you are a Linux beginner, it is helpful to learn how to use Linux command line tools. Here is a good Linux tutorial: tutorial.

4.3 Get Started

1. Connection

   Connect the positive and negative of the RCU to a DC power source, and then connect the RS232-1 of the device to the computer through the USB to RS-232 adapter. Please make sure that the computer can use the serial port normally.

2. Configuration

   Configure serial port:

   Baud rate: 115200

   8 data bits

   No parity checks

   1 stop bit

   Please use Putty or Minicom to open the serial port.

3. Start RCU

Turn on the RCU KeyOn switch first and turn on the device power. The device first starts U-Boot, then runs the Linux system.

If you see the following information shown below in the serial terminal window, it indicates that the system starts normally.

User name: *nvidia* **Password: *nvidia***

5. Hardware

The hardware circuit of the computing platform is designed according to the application requirements of the autonomous robotic system. The electrical parameters meet the requirements of the robotic industry regulations and has a variety of data transmission interfaces to meet the needs of multi-sensor fusion of the autonomous robotic system. The main chip contains a variety of high-performance computing units to adapt to the computation-intense characteristics of autonomous robotic, including sequential and parallel computing.

5.1 Specifications

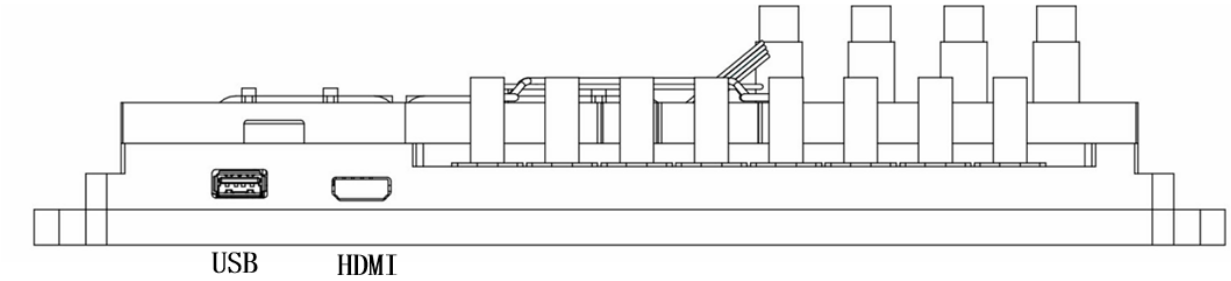
Item	Parameter
Operating voltage	DC 9-32V
Calculate performance	200 Tops
Operation memory	32GB
Storage memory	64GB, support extra SSD
Operating temperature	-25 to 70 °C
Operating humidity	0 - 95%, no condensation
Storage temperature	-40 to 85 °C
Dimensions	335mm*214mm*60mm

Weight	≤3000g
Protection level	IP5X

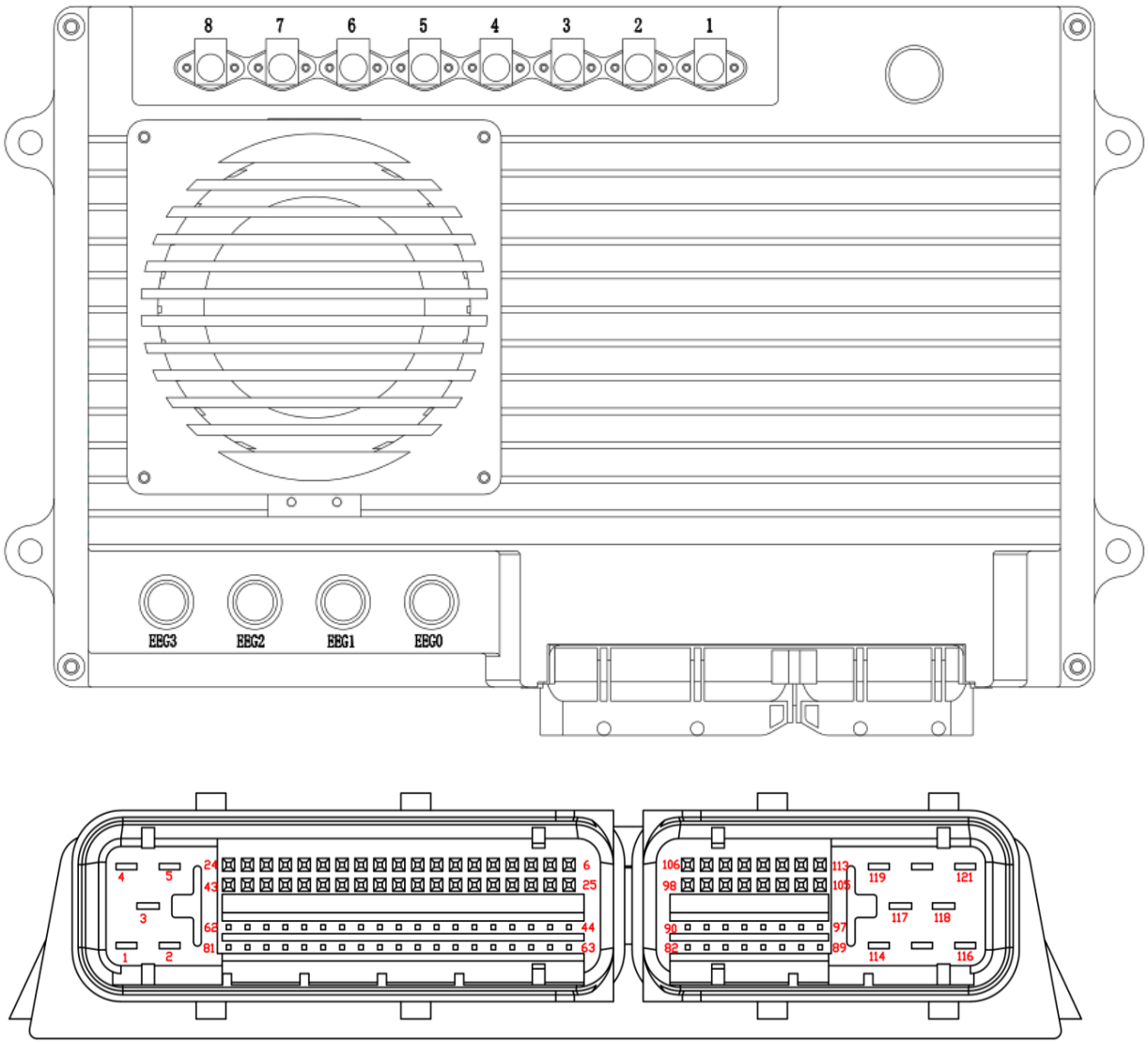
5.2 Device Ports

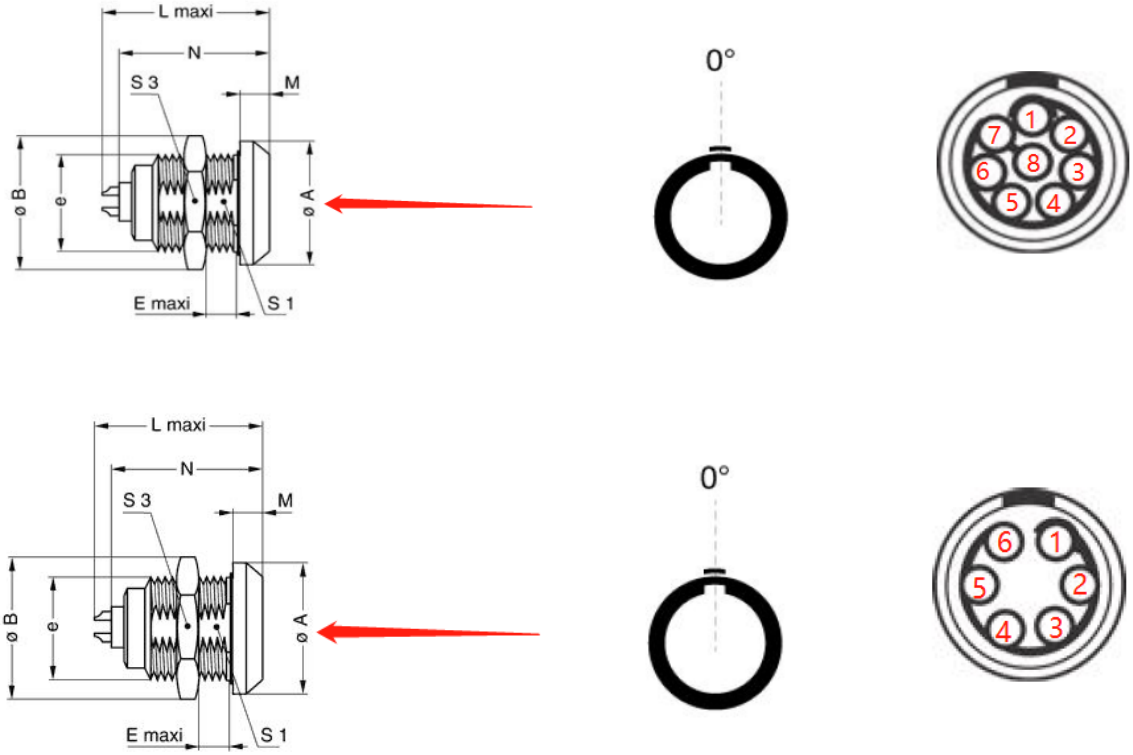
5.2.1 Port Placement

The distribution of input and output ports of the RCU is shown in the figure below. All the figures are front view.



FAKRA


8 7 6 5 4 3 2 1
EBG3
EBG2
EBG1
EBG0
4 5 3 1 2
24 43 62 81 6 25 44 63
106 98 90 82 113 105 97 89
119 121 117 118 114 116



5.2.2 Pinout

Signal Name	PIN	Description	Note
Automotive Ethernet			
ENet0_N	EEG1-3	Automotive Ethernet 0	1000Base-T1/100Base-T1
ENet0_P	EEG1-4		
ENet1_N	EEG1-5	Automotive Ethernet 1	1000Base-T1/100Base-T1
ENet1_P	EEG1-6		
ENet2_N	EEG1-1	Automotive Ethernet 2	1000Base-T1/100Base-T1
ENet2_P	EEG1-2		
Standard Ethernet			
NPort3_BI_DD+	EEG2-1	Standard Ethernet 3	100BASE-TX/1000BASE-T
NPort3_BI_DD-	EEG2-2		
NPort3_BI_DC+	EEG2-3		
NPort3_BI_DC-	EEG2-4		
NPort3_BI_DB+	EEG2-5		
NPort3_BI_DB-	EEG2-6		

NPort3_BI_DA+	EEG2-7		
NPort3_BI_DA-	EEG2-8		
NPort4_BI_DD+	EEG3-1	Standard Ethernet 4	100BASE-TX/1000BASE-T
NPort4_BI_DD-	EEG3-2		
NPort4_BI_DC+	EEG3-3		
NPort4_BI_DC-	EEG3-4		
NPort4_BI_DB+	EEG3-5		
NPort4_BI_DB-	EEG3-6		
NPort4_BI_DA+	EEG3-7		
NPort4_BI_DA-	EEG3-8		
Camera			
Camera-1	FAKRA-1	FPD-Link III Serial Camera Interface 1	Z Type
Camera-2	FAKRA-2	FPD-Link III Serial Camera Interface 2	Z Type
Camera-3	FAKRA-3	FPD-Link III Serial Camera Interface 3	Z Type
Camera-4	FAKRA-4	FPD-Link III Serial Camera Interface 4	Z Type
Camera-5	FAKRA-5	FPD-Link III Serial Camera Interface 5	Z Type
Camera-6	FAKRA-6	FPD-Link III Serial Camera Interface 6	Z Type
Camera-7	FAKRA-7	FPD-Link III Serial Camera Interface 7	Z Type
Camera-8	FAKRA-8	FPD-Link III Serial Camera Interface 8	Z Type
Display			
HDMI	HDMI	HDMI display interface	
USB			
USB Host	USB	USB	Support USB2.0、USB3.0、USB3.1
Power			
BATT	121P-1	Power Positive	
	121P-3		
	121P-116		
	121P-118		
	121P-121		
Power Ground			
PGND	121P-2	Power Ground	
	121P-4		
	121P-5		

	121P-117		
	121P-119		
	121P-120		
Signal Ground			
GND	121P-36	Signal ground	Ground for 5V sensor power supply
	121P-45		
	121P-57		
	121P-59		
	121P-63		
	121P-65		
	121P-82		
	121P-87		
Sensor Power Supply (5V)			
5V-1	121P-83	5V-1 Sensor Power Supply	Max current: 100mA
5V-2	121P-86	5V-2 Sensor Power Supply	Max current: 100mA
Wakeup Signal			
KEYON1	121P-44	KEYON1	Effective-High, control Orin power on, High level trigger
KEYON2	121P-56	KEYON2	Effective-High, control TC297 power on, Rising edge triggering
KEYON3	121P-39	KEYON3	Effective-High, control TC297 power on, High level trigger
Analog Input			
AI01	121P-42	Analog Input 0~5V (Voltage type)	12-bit resolution
AI02	121P-60	Analog Input 0~5V (Voltage type)	12-bit resolution
AI03	121P-43	Analog Input (Resistance type)	12-bit resolution
AI04	121P-24	Analog Input (Resistance type)	12-bit resolution
AI13	121P-62	Analog Input 0~36V (Voltage type)	12-bit resolution
AI14	121P-40	Analog Input 0~36V (Voltage type)	12-bit resolution
Digital Input			
DI01	121P-20	Digital Input 0~BATT	Active High
DI02	121P-58	Digital Input 0~BATT	Active High
DI03	121P-77	Digital Input 0~BATT	Active Low
DI04	121P-38	Digital Input 0~BATT	Active Low
DI21	121P-74	Digital Input 0~BATT	Active High
DI22	121P-16	Digital Input 0~BATT	Active High
Output Signal			

HSO01	121P-88	Rated 0.5A，Maximum 1A	
HSO02	121P-89	Rated 0.5A，Maximum 1A	
HSO03	121P-97	Rated 1A，Maximum 1.5A	
HSO04	121P-96	Rated 1A，Maximum 1.5A	
LSO01	121P-101	Rated 250mA	
LSO02	121P-94	Rated 250mA	
LSO03	121P-90	Rated 250mA	
LSO04	121P-92	Rated 250mA	
LSO05	121P-110	Rated 250mA	
LSO06	121P-103	Rated 250mA	
LSO07	121P-109	Rated 250mA	
LSO08	121P-107	Rated 250mA	
Communication Port			
CAN_0_H	121P-31	With 120 Ω Terminal Resistor	Support CANFD, optional terminal resistor, corresponding to the CANA in EcoCoder
CAN_0_L	121P-32		
CAN_1_H	121P-11	With 120 Ω Terminal Resistor	Support CANFD, optional terminal resistor, corresponding to the CANB in EcoCoder
CAN_1_L	121P-12		
CAN_2_H	121P-29	With 120 Ω Terminal Resistor	Support CANFD, optional terminal resistor, corresponding to the CANC in EcoCoder
CAN_2_L	121P-30		
CAN_3_H	121P-13	With 120 Ω Terminal Resistor	Support CANFD, optional terminal resistor, corresponding to the CAND in EcoCoder
CAN_3_L	121P-14		
CAN_R0_H	121P-27	Without 120 Ω Terminal Resistor	Support wakeup by user-defined message ID. Optional terminal resistor, corresponding to the CANE in EcoCoder
CAN_R0_L	121P-28		
CAN_R1_H	121P-9	Without 120 Ω Terminal Resistor	Support wakeup by user-defined message ID. Optional terminal resistor, corresponding to the CANF in EcoCoder
CAN_R1_L	121P-10		
CAN_X0_H	121P-47	With 120 Ω Terminal Resistor	

CAN_X0_L	121P-66		Optional termination resistor, corresponding to CAN0 in Orin
CAN_X1_H	121P-48	With 120 Ω Terminal Resistor	Optional termination resistor, corresponding to CAN1 in Orin
CAN_X1_L	121P-67		
CAN_SHILD-1	121P-46	CAN Shield	
CAN_SHILD-2	121P-8	CAN Shield	
LIN0	121P-6	LIN0 bus	
LIN1	121P-26	LIN1 bus	
LIN2	121P-7	LIN2 bus	
LIN3	121P-25	LIN3 bus	
RS232_1_TXD	121P-52	RS-232 interface 1	Orin *ttyTHS0*
RS232_1_RXD	121P-71		
RS232_2_TXD	121P-69	RS-232 interface 2	Orin *ttyTHS1*
RS232_2_RXD	121P-50		
RS232_3_TXD	121P-51	RS-232 interface 3	Orin ttyTCU0, used by default for Debug
RS232_3_RXD	121P-70		
RS232_4_TXD	121P-68	RS-232 interface 4	Orin *ttyTHS6*
RS232_4_RXD	121P-49		
RS485_A	121P-34	RS485	Orin *ttyTHS4*
RS485_B	121P-33		
Others			
PPS_IN	121P-23	Second pulse synchronization input signal	Orin, support 3.3V-16V, hardware configuration
PPS_OUT1	121P-81	Second pulse synchronization output signal	Orin, 12V output
PPS_OUT2	121P-80	Second pulse synchronization output signal	Orin, 12V output
PPS_OUT3	121P-79	Second pulse synchronization output signal	Orin, 3.3V or 5V output
PPS_OUT4	121P-78	Second pulse synchronization output signal	Orin, 3.3V or 5V output

5.3 System Main Chip

The main chip of EAORA04 is NVIDIA Jetson Orin which is designed specifically for embedded robot control systems. The computing performance of different internal processors are listed below.

AI performance: 200 INT8 Sparse TOPs

CPU: 8 core Cortex A78 ARM 64-bit CPU, 2 clusters (4x 256KB L2 + 2MB L3) + 4MB L4

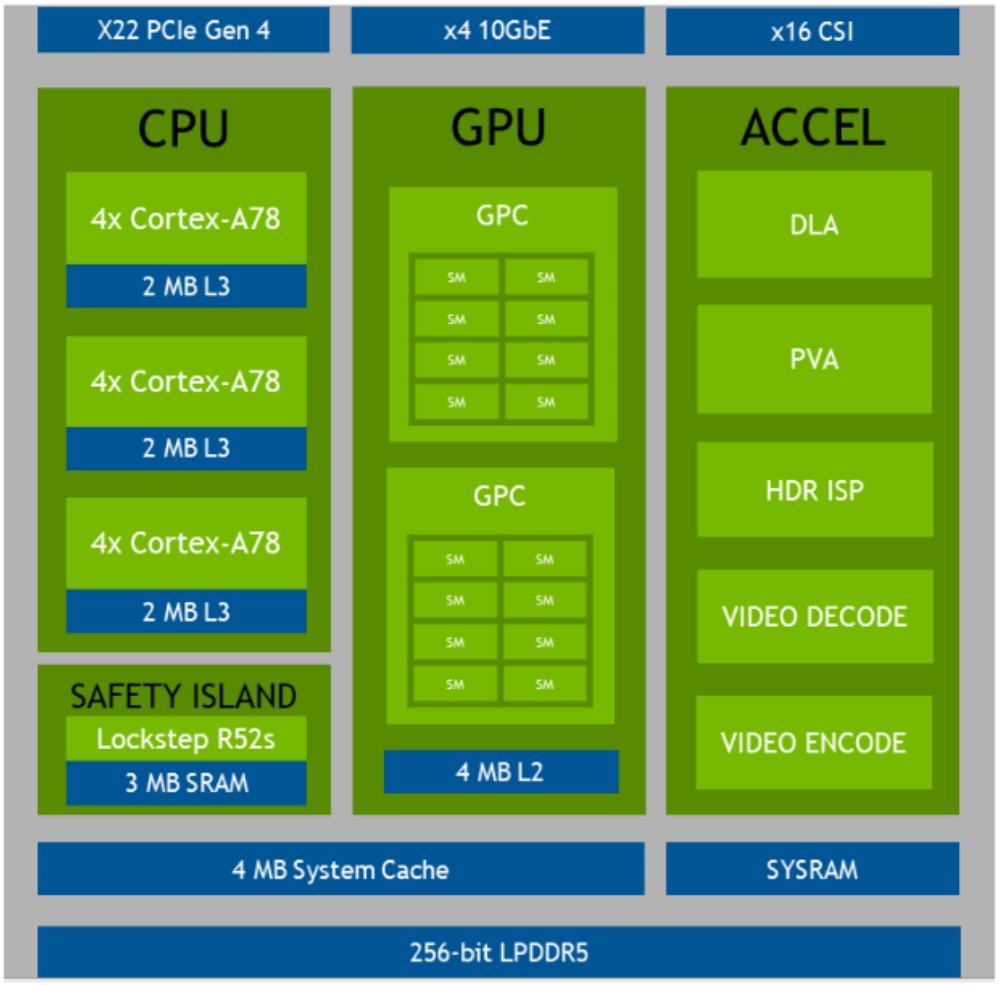
Deep Learning Accelerator (DLA)： 2x NVDLA 2.0 Engines (48 TOPs each)

GPU: NVIDIA Ampere Architecture with 2048 NVIDIA ® CUDA ® cores and 64 Tensor Cores. (108 Sparse INT8 TOPs)

Vision accelerator： 1x PVA v2

Image Signal Processor (ISP)： 1.85 Giga Pixels/s

The internal structure of the chip is shown below:

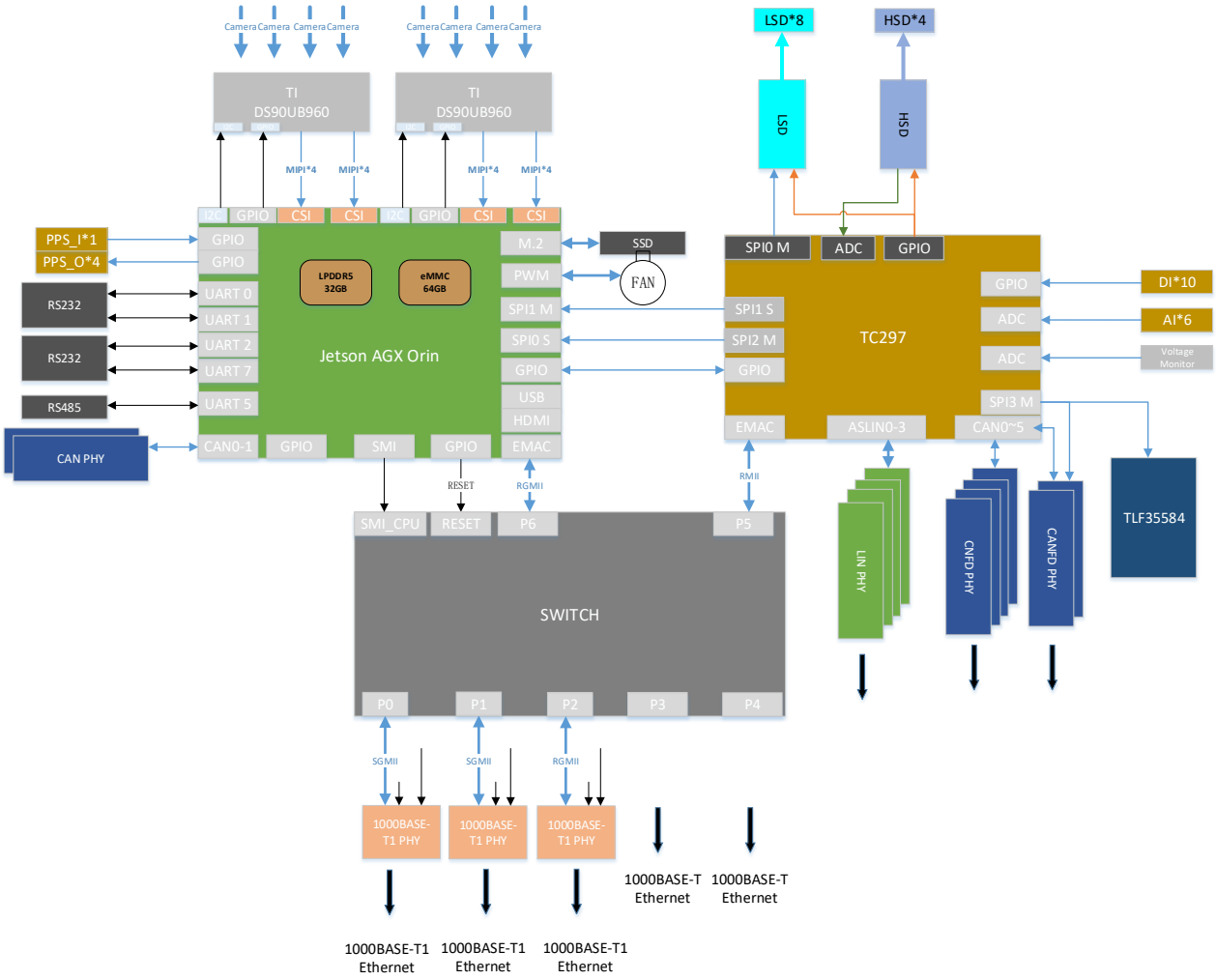


The microcontroller used in EAXORA04 is Infineon TC297 which has a TriCore™ architecture, working at 300MHz and has an ECC (Error Correction Code) protected RAM with a capacity of up to 728KB + 8MB, designed based on ISO26262, supporting up to ASIL-D. By working with a system basic chip (SBC), a hardware core security architecture design is achieved. The resources of the chip are as follows:

Feature	**Detail**
Micro Control Core	32-bit Infineon TC297TP
Maximum Frequency	300MHz
Flash	8M
SRAM	728K
EEPROM	128K
Float Point Capability	Yes
SBC	TLF35584

5.4 Circuit Structure

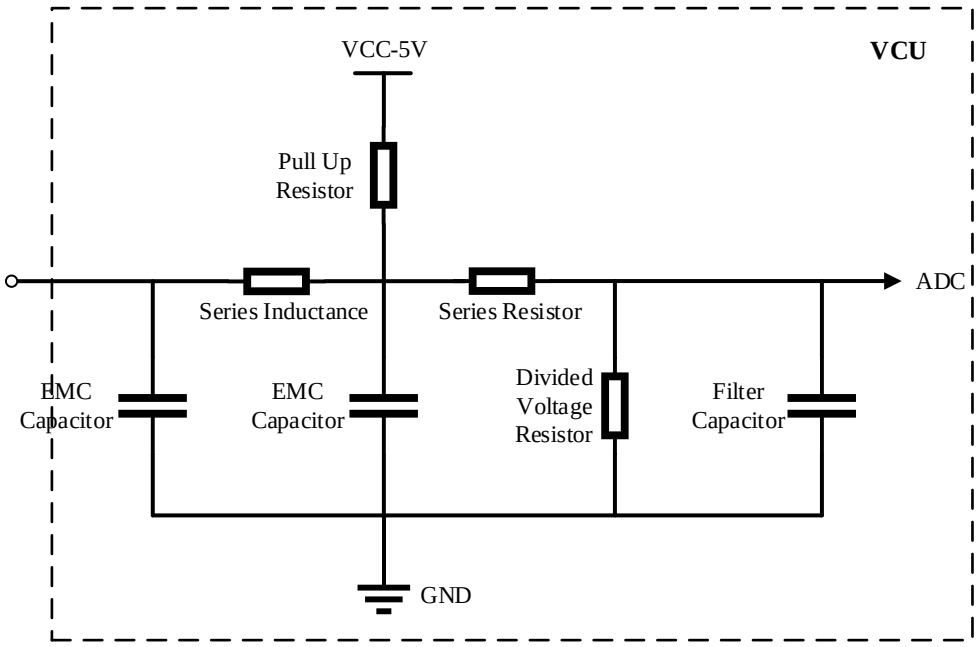
The internal circuit structure of EAORA04-D is shown below:



5.5 Circuit Description

5.5.1 Analog Input

The analog input channel circuit has the same structure, the circuit schematic and circuit details are shown below:

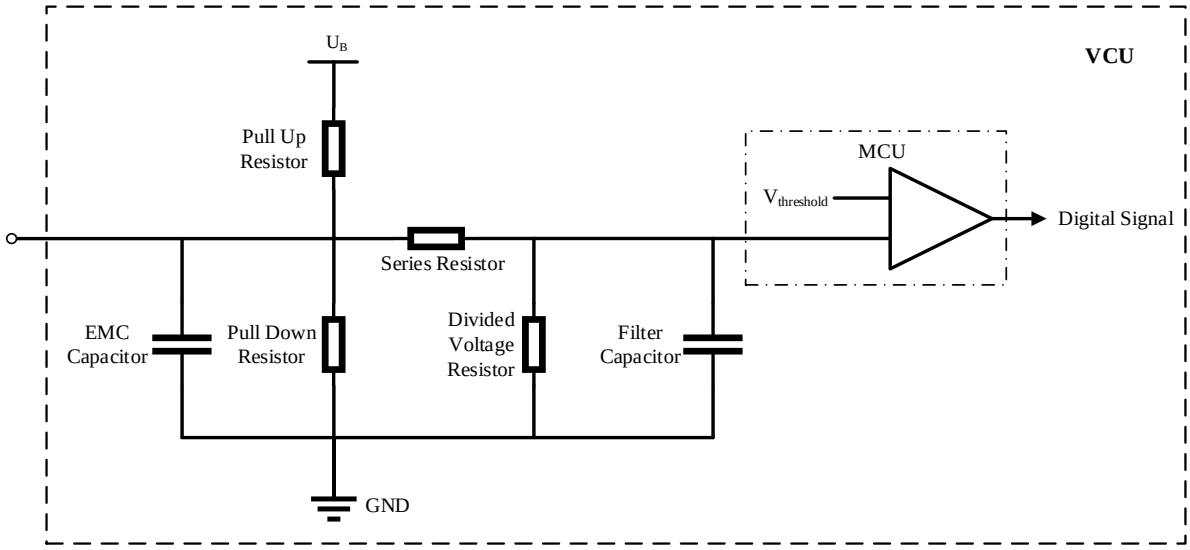


Note: 1. "--" means not soldered; 2. UB means power supply BATT voltage; 3. AI28 collects BATT voltage signal.

Pin #	AI	EMC Capacitor	Pull Up Resistor	Series Resistor	Divided Voltage Resistor	Filter Capacitor	Input Range		Conditions / Remarks
		(F)	to 5V (Ohm)	(Ohm)	(Ohm)	(F)	Min	Max	
42	AI01	100n	--	22k	--	1n	0V	5V	
60	AI02	100n	--	22k	--	1n	0V	5V	
43	AI03	100n	10k	22k	--	1n	--	--	Resistance type
24	AI04	100n	10k	22k	--	1n	--	--	Resistance type
62	AI13	100n	--	22k	3.48k	1n	0V	32V	
40	AI14	100n	--	22k	3.48k	1n	0V	32V	
--	AI28	100n	--	22k	3.48k	1n	0V	32V	BATT

5.5.2 Digital Input

The digital input channel circuit has the same structure, the circuit schematic and circuit details are shown below:



Note: 1. "--" means not welded. 2. UB represents the power supply BATT voltage. 3. KEYON and DC_WAKE only make hard-wire wake-up signal.

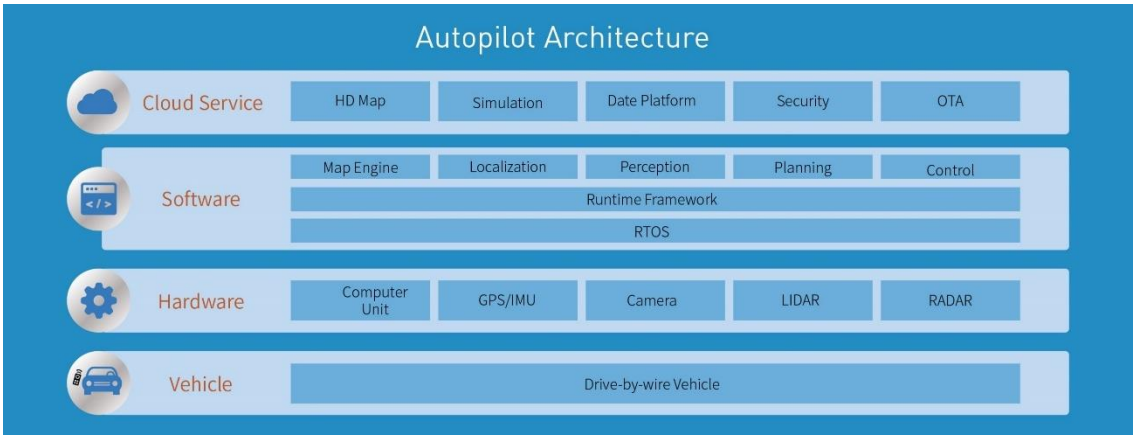
Pin #	DI	Pull Up Resistor	Pull Down Resistor	Operation Threshold for Input Signal		Input Range		Conditions/ Remarks
		to U_B(Ohm)	(Ohm)	V_{low}	V_{high}	Min	Max	
20	DI01	--	10k	3V	8.5V	0V	U_B	Active High
58	DI02	--	10k	3V	8.5V	0V	U_B	Active High
77	DI03	10k	--	3V	8.5V	0V	U_B	Active Low
38	DI04	10k	--	3V	8.5V	0V	U_B	Active Low
74	DI21	--	10k	3V	8.5V	0V	U_B	Active High
16	DI22	--	10k	3V	8.5V	0V	U_B	Active High

6. Soc Basic Software

The SOC software system of the computing platform is customized for robotic systems. A typical framework of autonomous robotic system is shown below. The SoC software system of

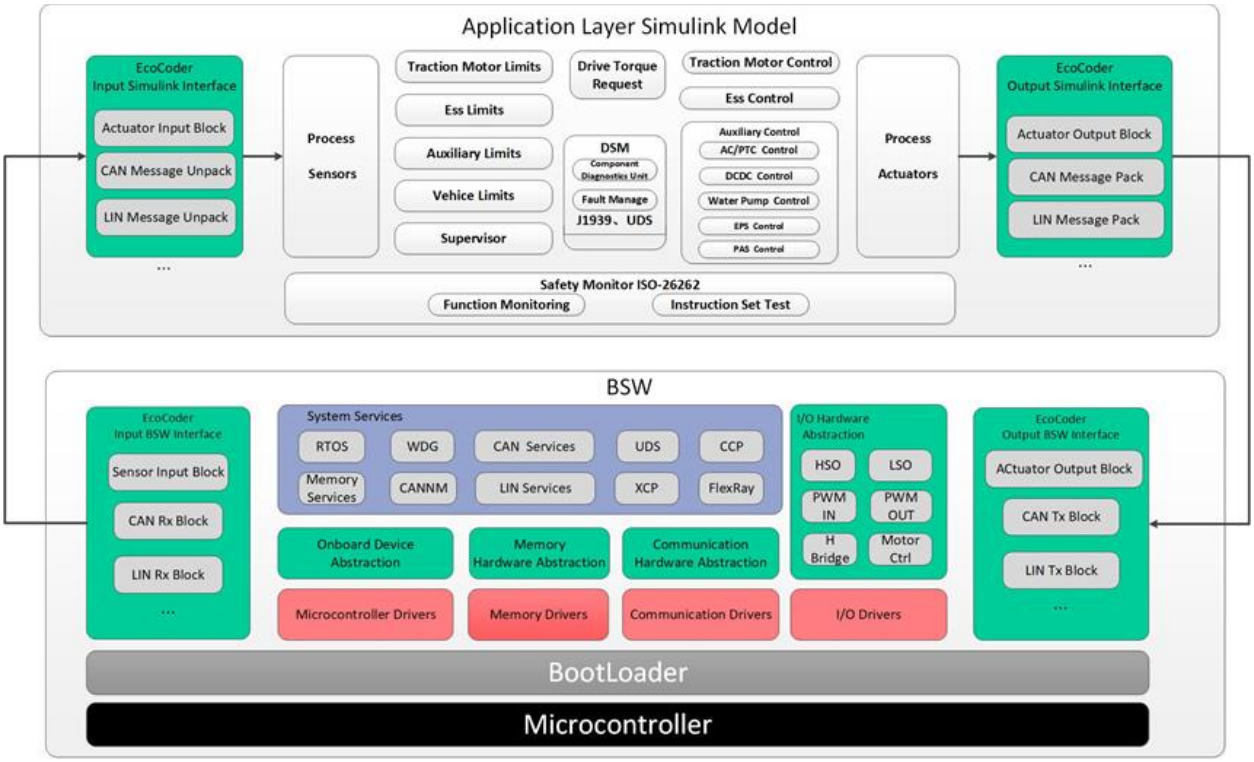
EAORA04 consists of RTOS and Runtime Framework. RTOS is a Linux operating system. Runtime Framework is ROS (Robot Operating System) Melodic.

Linux is a bridge connecting the hardware and the users, providing functions such as Process Management, Memory Management, File System, Network, Security, User Interface, and Device Drivers. Users can enter commands through the user interface of the operating system. The operating system interprets the commands, drives the hardware devices, and implements user requirements. ROS provides some standard operating system services, such as Hardware Abstraction, Low-Level Device Control, Inter-Process Messaging, and Message Packet Management. ROS is built on a graph architecture, various nodes can publish, subscribe and aggregate all kinds of information, e.g. sensing, control, status, planning.



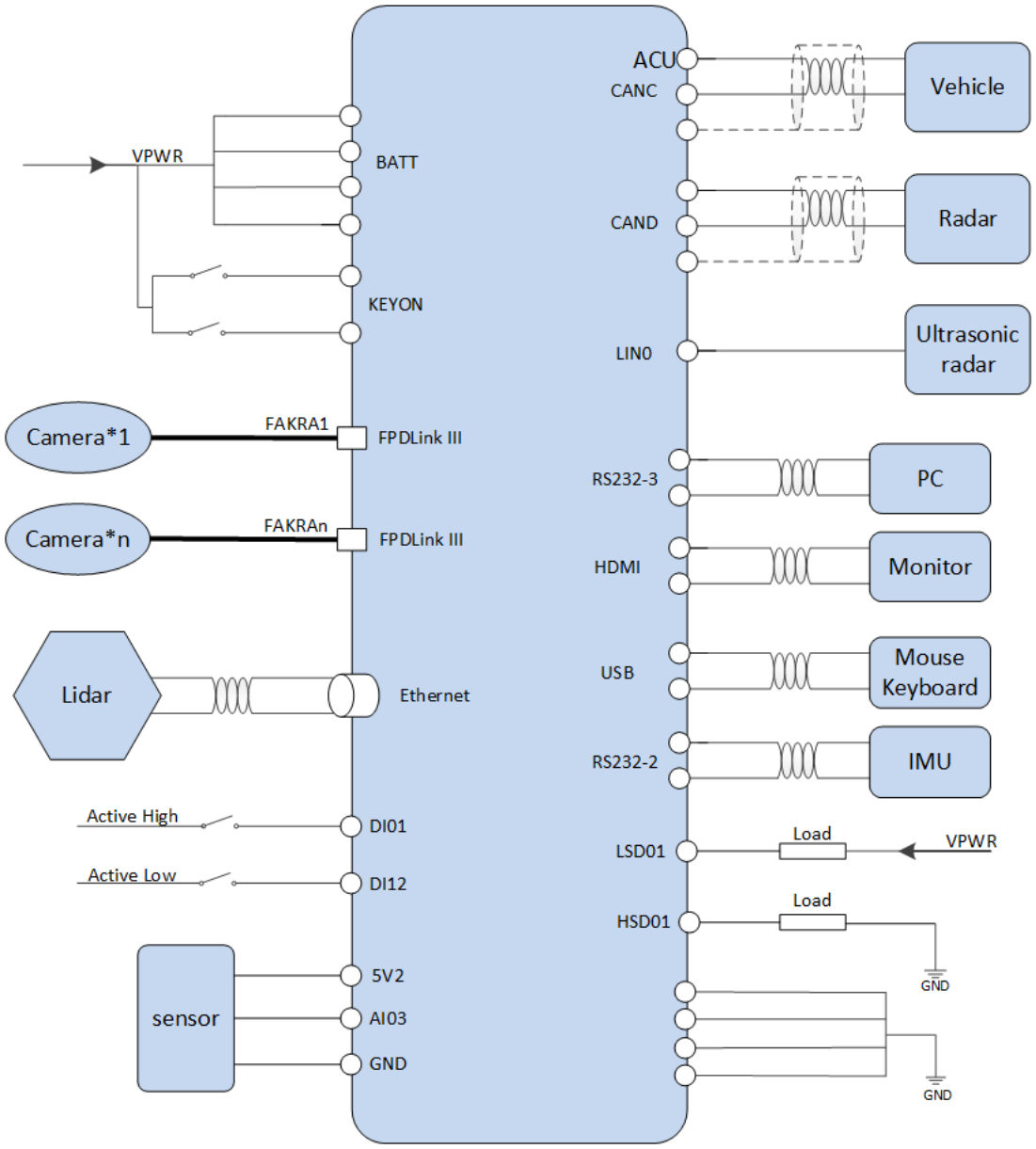
The software architecture of the MCU inside EAORA04-D is designed according to AUTOSAR, which is divided into Application Software Layer and Basic Software Layer. Basic Software Layer consists of a microcontroller abstraction layer, an ECU abstraction layer, a service layer, and a complex driver. Application software and basic software are connected and integrated through EcoCoder. EcoCoder encapsulates the low-level software interfaces into the Simulink library via s-functions. Application developers can use Simulink to build the model and generate executable program files for TC297 via Simulink by just one click.

The basic software interfaces that EcoCoder encapsulates can read digital and analog input signals, control high and low side outputs, support .dbc file interpretation, implement CCP and UDS protocols, and define the measurement, calibration and NVM variables. MCU application development is implemented with the calibration software EcoCAL and the flashing software EcoFlash.



7. Demo Application

A demo for a robotic hardware platform is shown below, which consists of EAORA04-D and sensors.

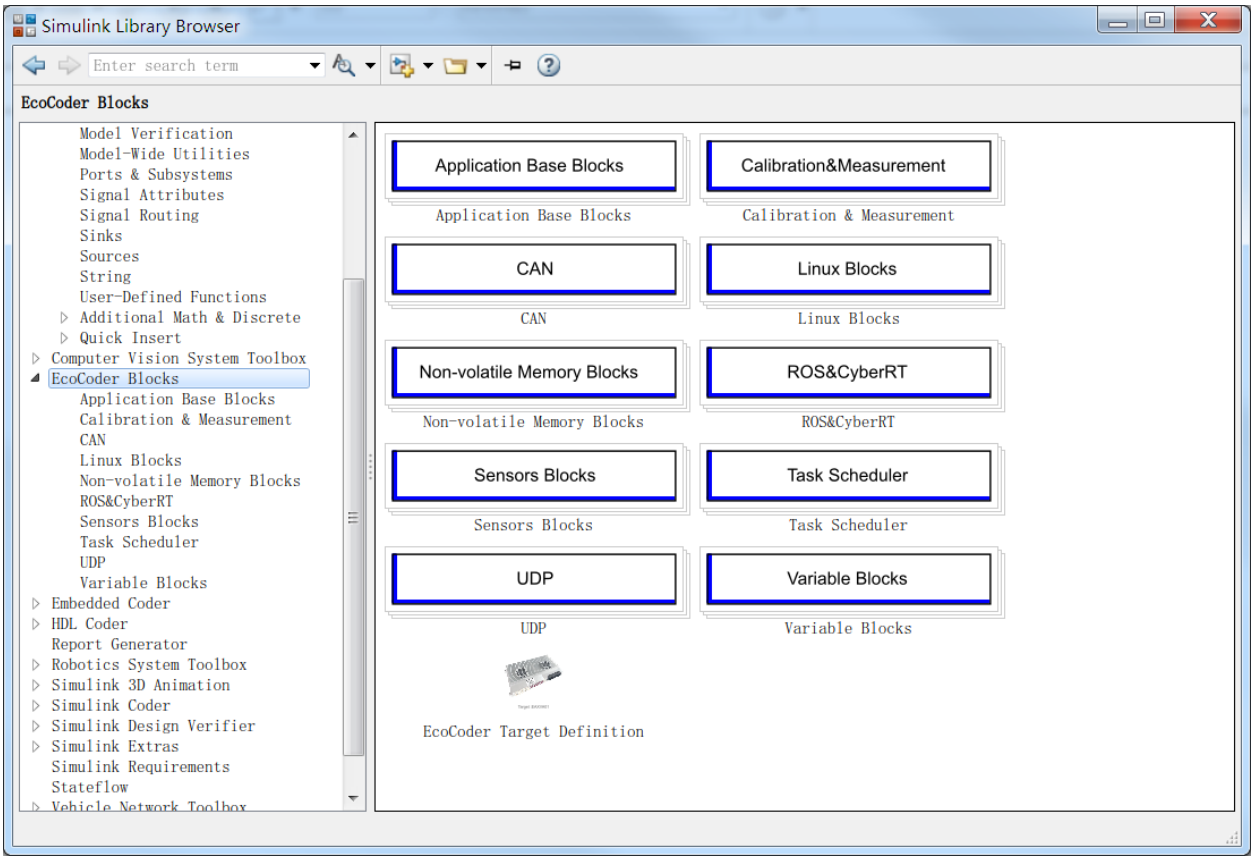


8. Development Tool

A combination of hardware, operating system stacks, and runtime environments along are not capable enough for modern robotic systems, therefore, users need to develop software that can perform specific functionality and deploy them to EAORA04-D. For Orin, development tool is provided: EcoCoder-AI. For MCU Infineon TC297, three development tools are provided: EcoCoder, EcoCAL, and EcoFlash. Developers can select the tools they need.

8.1 EcoCoder-AI

EcoCoder-AI is a powerful automatic code generation library based on Matlab / Simulink that links directly to the target controller. EcoCoder-AI integrates code generation, compilation and one-click generation of executable files. In addition, the control model based on Simulink can be directly converted into an ROS-based executable program suitable for the target controller and downloaded to the target controller. For details, please refer to EcoCoder-AI Manual.



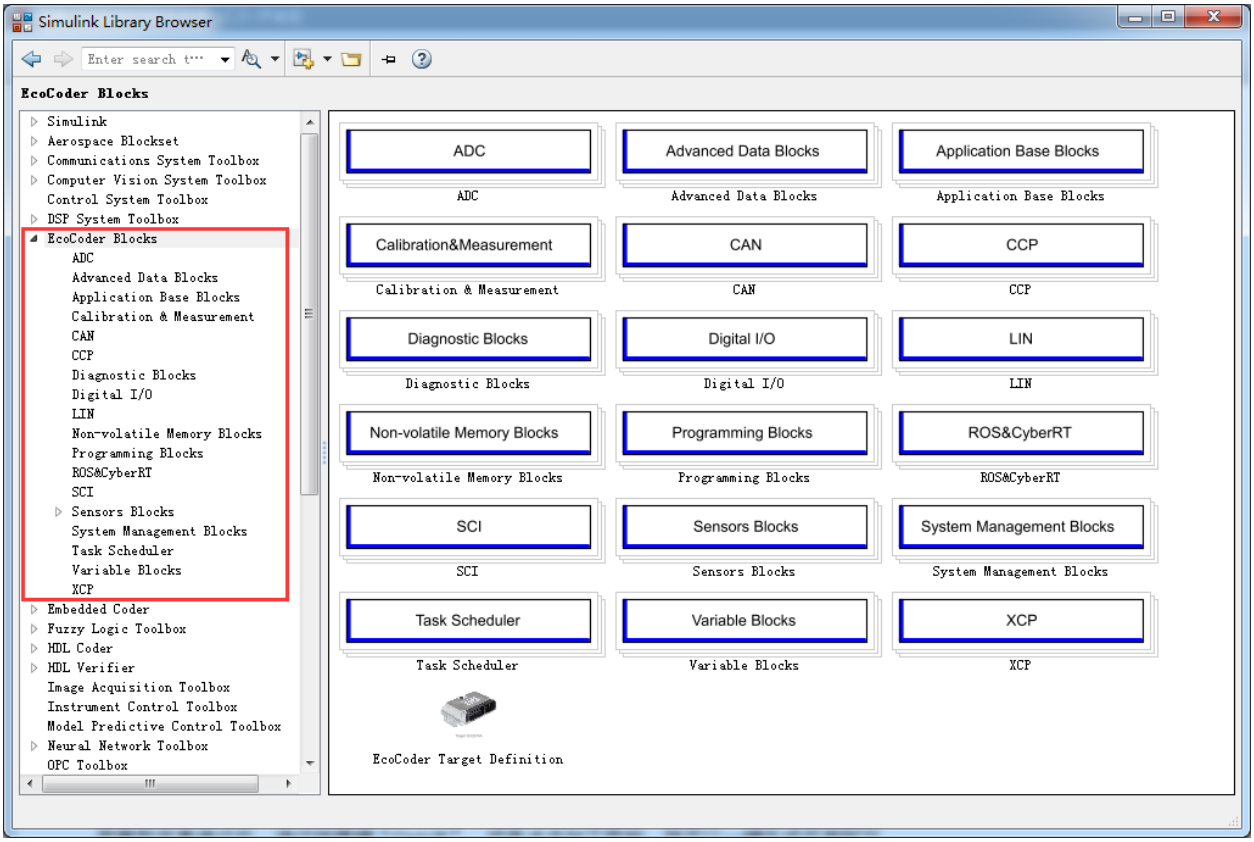
8.2 EcoCoder

EcoCoder is an application development tool for the control system, which makes it easier for users to develop embedded application software in the Simulink environment. It expands the resources of Simulink and Real-Time Workshop embedded encoders to generate the necessary code module and automatically configures and optimizes code generation. By encapsulating the low-level software library to s-functions, EcoCoder allows developers to use low-level software interfaces by model-based-design method and configure basic parameters. It can generate executable files and data description files with one click and provide .a2l file address update tool.

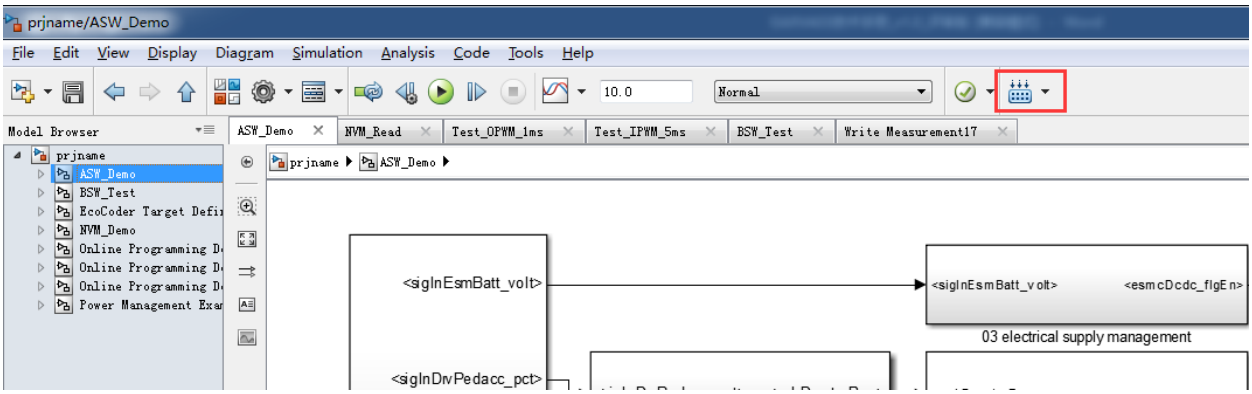
Features:

- Users develop embedded application software in the Simulink environment.

- Application developers can focus on control strategy development without knowing all the information about hardware.
- By encapsulating the low-level software library to s-functions, EcoCoder enables developers to use the low-level software interfaces and configure parameters using the model-based-design method.
- Executable file and data description file can be generated by one click, and a .a2l file address update tool is provided. During the generation, the code generated by the model is integrated with the low-level software automatically in the background, then makefile is used to call the compiler to generate executables.



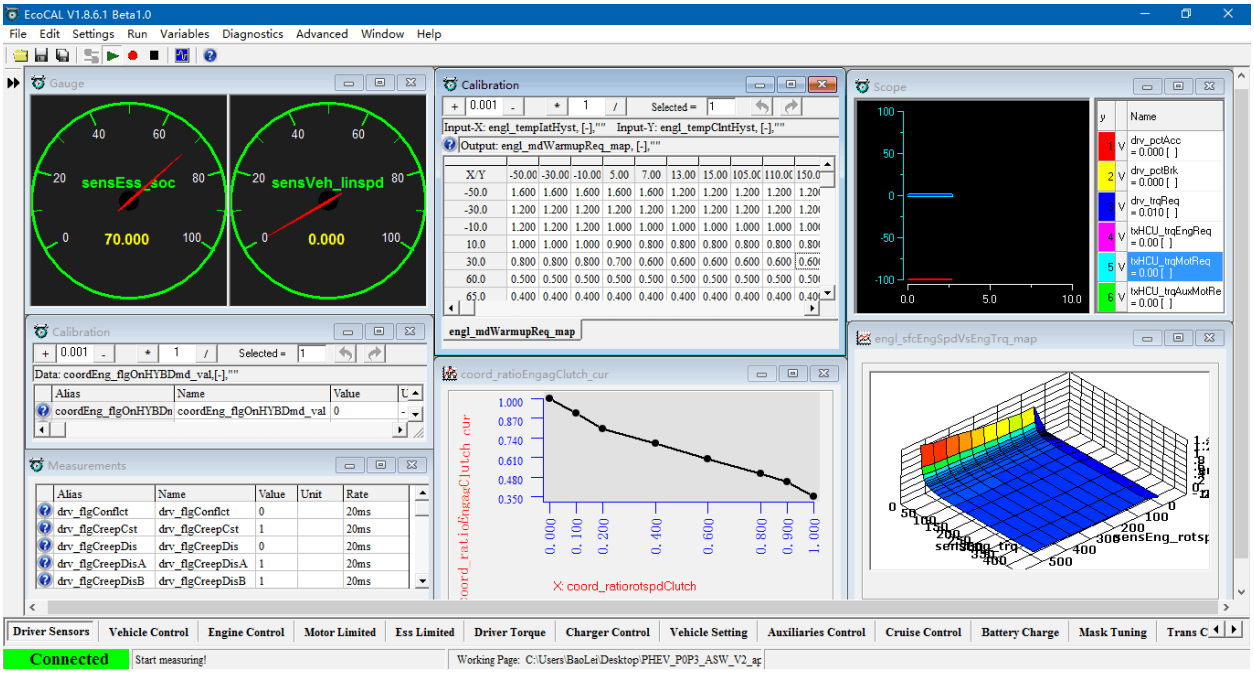
After compilation of the model, use the shortcut “Ctrl + B” or click the button shown below, the files ready to be flashed will be generated.



Developers can use EcoCoder to develop application software for MCU in EAORA04. Please refer to EcoCoder User Manual.

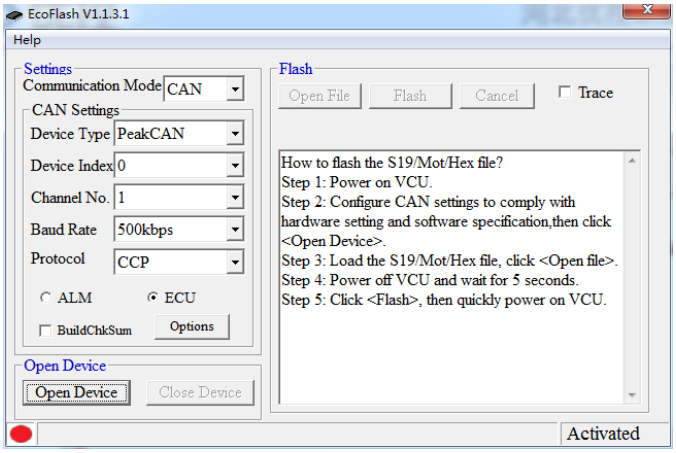
8.3 EcoCAL

EcoCAL is a PC-side calibration software based on the CCP protocol. By loading .a2l and .hex files, real-time observation of the measurable variables and on-the-fly calibration can be achieved. It can assist control strategy development engineers to debug and calibrate application software. Please refer to EcoCAL User Manual for more details.



8.4 EcoFlash

EcoFlash is PC-side software working with BootLoader to flash target program files. The CAN communication uses CCP/UDS protocol, and .s19, .mot and .hex files are supported.



9. Installation Requirements

It is recommended to install the ADCU in the cockpit. If the OEM wants to assemble the RCU in another location, the corresponding installation location should be evaluated by Ecotron's engineers and the OEM's engineers.

The precautions for RCU installation are as follows:

1. The installation of RCU and wiring harness should be firm and reliable, and there should be no looseness. Avoid supporting the wiring harness by RCU. At the same time, the arrangement of RCU wiring harness should prevent and protect all wires in the wiring harness from damage due to wear and overheating.
2. Try to avoid installing in places where dust is easy to gather, a large amount of dust accumulation will affect the reliability of RCU work.
3. RCU should be kept away from the location where the temperature of the shell itself may exceed 70°C. At the same time, it is necessary to prevent the surrounding parts from

releasing heat to the RCU.

4. Avoid installing the RCU in locations where oil, moisture, and water droplets are likely to splash on it.
5. Avoid the possibility of additional mechanical shock and external impact due to the installation position and fixing method of the RCU and avoid installing the RCU at the resonance point of the car body.
6. Avoid installing the RCU where it may come into contact with the battery or other parts that are prone to seepage of acid and alkaline solutions, and near the RCU power terminal.
7. Avoid installing the RCU where it may come into contact with the positive terminal of Battery and the ignition power terminal.
8. RCU should be installed in the horizontal and vertical position according to the connector downwards and maintain a certain angle to prevent water from entering the connector. In the horizontal direction, the recommended installation angle is -170° to -10°, as shown in Figure below. In the vertical direction, the recommended installation angle is -170°~ -10°, as shown in Figure below.

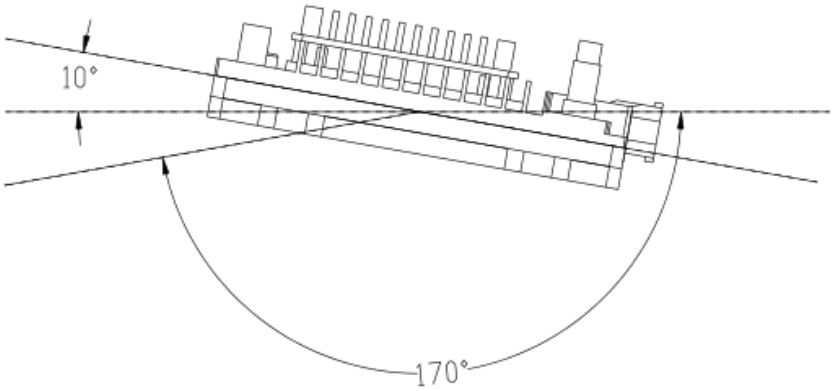
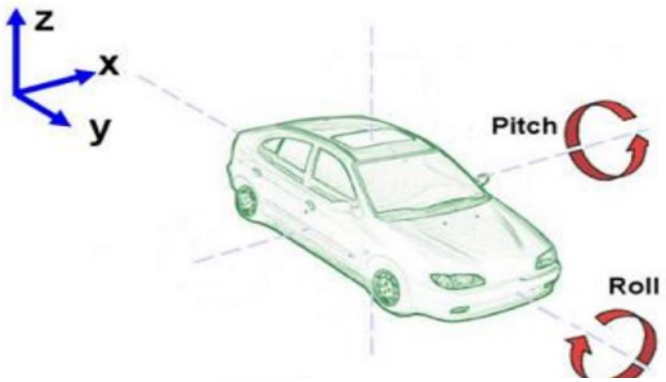


Figure: Horizontal Installation Angle



Z Axis: Vertical Direction

X Y Axes: Horizontal Direction

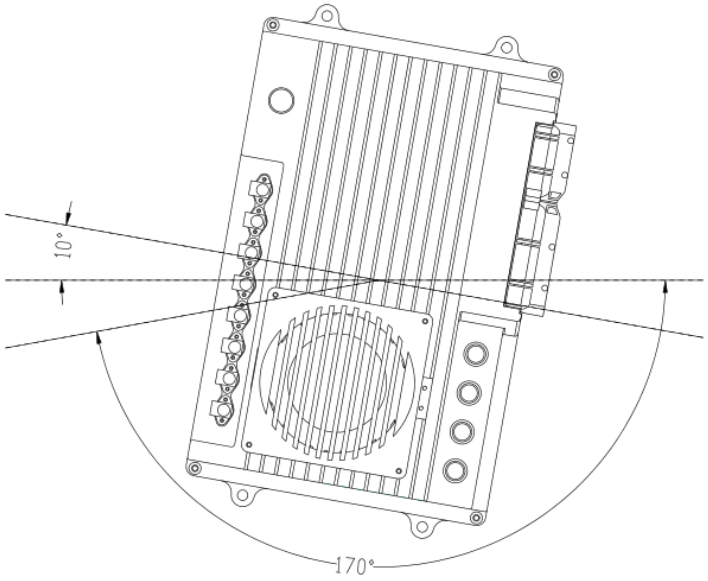


Figure: Vertical Installation Angle

Ecotron recommends using the 4 installation points on the RCU for installation and fixation. It is recommended to use metal materials such as aluminum alloy for the mounting bracket, and the housing should have a reliable electrical connection with the robotic body through the

bracket. If other materials are used, the customer must ensure that it can meet the requirements of RCU for vibration, heat dissipation, temperature, EMC, etc. If there is any deviation, it needs to be confirmed with Ecotron.

9. High-speed signal lines such as harness installation, network cables, video cables, etc. should keep away from areas of high voltage, radiation interference such as motors, battery packs, DCs as far as possible.