R-IN32M3 Module (RY9012A0)

Industrial Ethernet Module

1. Description

1.1 overview

The Renesas R-IN32M3 Module is currently available and ready for use. It is certified as a dual-port Ethernet module solution for the PROFINET, EtherNet/IP™, and EtherCAT® real-time protocols, and includes a 2-port Ethernet switch for various network topologies. Example applications are available.

The R-IN32M3 Module includes a Renesas R-IN32M3-EC running a protocol library which supports various kinds of real-time industrial Ethernet communication protocols. A well-documented generic application programming interface (API) allows for simple access to the protocol library by an application processor in order to exchange real-time network data with a user application via a lean SPI module interface.

The generic API is an abstraction platform for real-time communications offering scalable multi-protocol solutions such as PROFINET RT, EtherNet/IP, and EtherCAT. The external application processor has full control of the protocol stacks running on the module's CPU without interfering with the modules' real-time communications or wasting the CPU performance of the host processor.

The implementations of the currently available industrial Ethernet protocols, PROFINET RT, EtherNet/IP, and EtherCAT, comply with the latest specification releases. An extensive tool chain, covering an evaluation board (module and application processor), API source code, and host application examples including extensive documentation, eases integration into your target application environment. All this enables users to set up a lean and independent connection to existing or new applications, products, and networks while accelerating times to market.

1.2 Product Features

- Support for the PROFINET, EtherNet/IP™, and EtherCAT® real-time communication standards *
- All-in-one and compact body with 2-port Ethernet interface including Ethernet PHY and RJ45 connector.
- Ethernet ports supporting 10 Mbits per second and 100 Mbits per second with auto negotiation

Comprehensive tool support and application examples in the form of source code for the Renesas RA, RX, Synergy and RL78
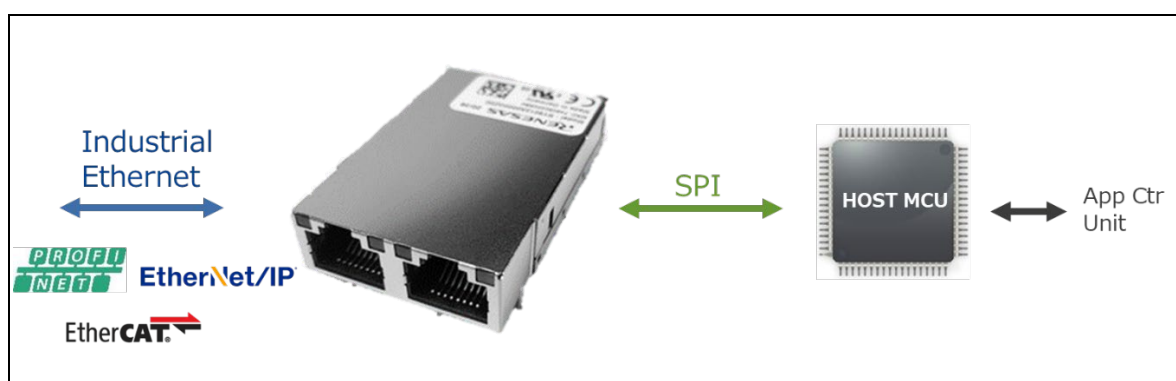
*ModbusTCP is also supported by host MCU control

Figure 1.1 usage configuration

1.3 Protocol Features

R-IN32M3 Module supports the following features in a condition of firmware Ver2.1.0.0 or later.

PROFINET

- PROFINET IO Conformance Class B

- Minimum Cycle time 1ms

- Maximum read/write 1434 Byte process data **(*1)**

- Supports LLDP, SNMP

- Supports MRP(Media Redundancy Protocol)

- Supports Alarm Queue

- Supports web browser and http

EtherNet/IP

- Minimum Cycle time 1ms

- Maximum connection size 495 Bytes (*1)

- Supports DLR (Device Level Ring)

- Supports QoS

- Supports ACD

- Supports web browser and http

- Object support

    - Identity Object
    - Message Router Object
    - Assembly Object
    - Connection Manager Object
    - TCP/IP Object
    - Ethernet Link Object
    - DLR (Ring Node only)
    - QoS Parameter Objects

EtherCAT

- EtherCAT communication profile

    CAN application protocol over EtherCAT (CoE)

    Ethernet over EtherCAT (EoE)

    File Access over EtherCAT (FoE)

- Supports Explicit Device ID

- Supports; Free-Run, Sync Manager and Distributed Clocks (DC)

- Maximum PDO 1408 Byte (*1)

(*1) The size of cyclic process data limits communication period.

1.4 Factory firmware version

Firmware version can be recognized as below combination with the upper right number of product label.

    20/**   Firmware Ver.1.1.9

    21/**   Firmware Ver.1.1.9

    22/**   Firmware Ver.2.1.4

For details of product label, please refer to User's Manual: Hardware (R19UH0122ED****) 『9. Marking Specifications』

Figure 1.2 Factory FW version

1.5 Ordering Information

Part No.	Application	Package
RY9012A0000GZ00#001	Dual-port Industrial Ethernet module	30-piece tray package
RY9012A0000GZ00#002	Dual-port Industrial Ethernet module	1-piece sample package

Note: The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
Not all products and/or types are available in every country. Please check with our sales representative for availability and additional information.

2. Pin Description

The module pins consist of those for Ethernet, power supply, SPI, and synchronization. The SPI is a slave interface.

2.1 Ethernet Port

The Ethernet ports comply with IEEE 802.3 10BASE-T / 100BASE-TX, half/full duplex and have the following pin assignment as listed in Table 2.1.

Table 2.1 Ethernet Port

Pin	Signal	I/O	Description
1	TX+	O	Transmit signal positive
2	TX-	O	Transmit signal negative
3	RX+	I	Receive signal positive
4	Not used		Drain wire
5	Not used		Drain wire
6	RX-	I	Receive signal negative
7	Not used		Drain wire
8	Not used		Drain wire

2.2 Application Interface

The module pins interface with power supply and SPI. The SPI is a slave interface.

Table 2.2 Application Interface

Pin	Signal	I/O	Description
1	Vcc		3.3V ±0.15V DC power supply
2	GND		Ground
3	/SS	I	Slave select: Active low to enable the slave device
4	/RESET	I	Reset of the whole R-IN32M3 Module: Active low
5	MISO	O	Master in slave out: Data from slave to master
6	MOSI	I	Master out slave in: Data from master to slave
7	SCLK	I	Serial clock: The master provides the clock to time shifting of the data
8	SYNC0	O	EtherCAT sync signal for distributed clocks
9	SYNC1	O	EtherCAT sync signal for distributed clocks

Note: Pin 8 and pin 9 EtherCAT sync signals for distributed clocks are only used for the EtherCAT protocol. They operate according to the EtherCAT specification.

2.2.1 SPI Operation

The SPI of the R-IN32M3 Module is intended to interface the module to the external application processor.

For independence of the module clock from the clock of the external application processor, serial transfer through the SPI interface is in asynchronous mode and handled by the following four pins of the module.

— MOSI (master out, slave in)
— MISO (master in, slave out)
— SCLK (RSPI clock) signals
— SS (slave select)

The application controller as SPI master determines the mode of SPI communications. The SPI data format is MSB-first, and the number of bits in each transfer is 8 bits. A 128-byte transfer buffer allows the transport of multiple requests.

Communications are based on a cyclic scheme, where process data can be transmitted cyclically in response to each request from the application controller. The same transport system is used for both real-time and non-real-time communications (RPC). However, processing for this is decoupled from that for real-time communications. Thus, real-time data can be exchanged independently of calls of the API functions.

3. Internal Block Diagram

3.1 Block Diagram: Hardware

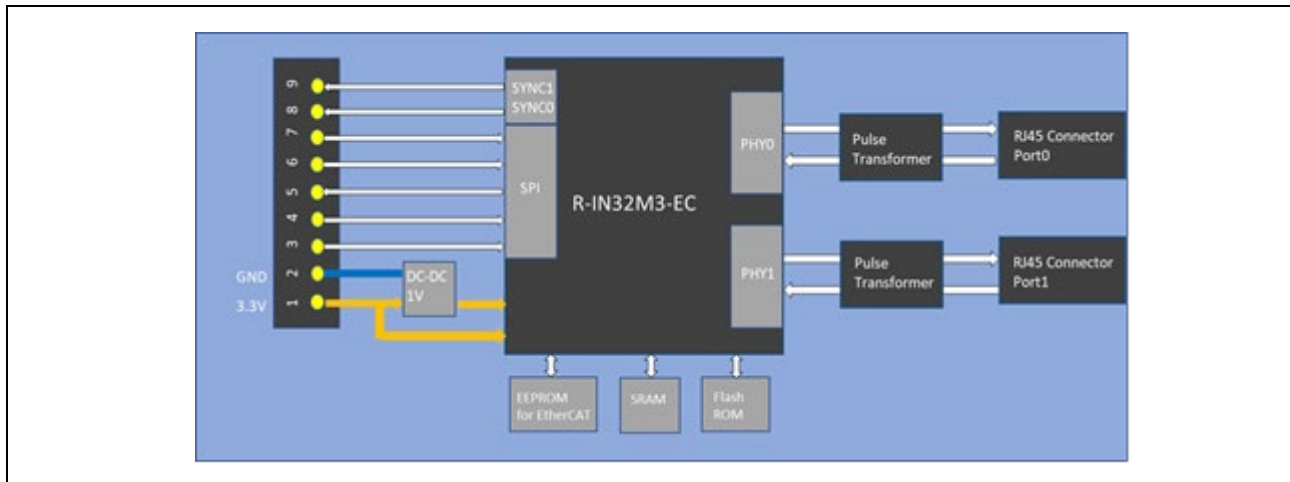Figure 3.1 shows the internal hardware blocks of the R-IN32M3 Module.

Figure 3.1 Internal Hardware Blocks

3.2   Block Diagram: Software

Figure 3.2 shows the software blocks of the R-IN32M3 Module and how they are connected with the application processor.
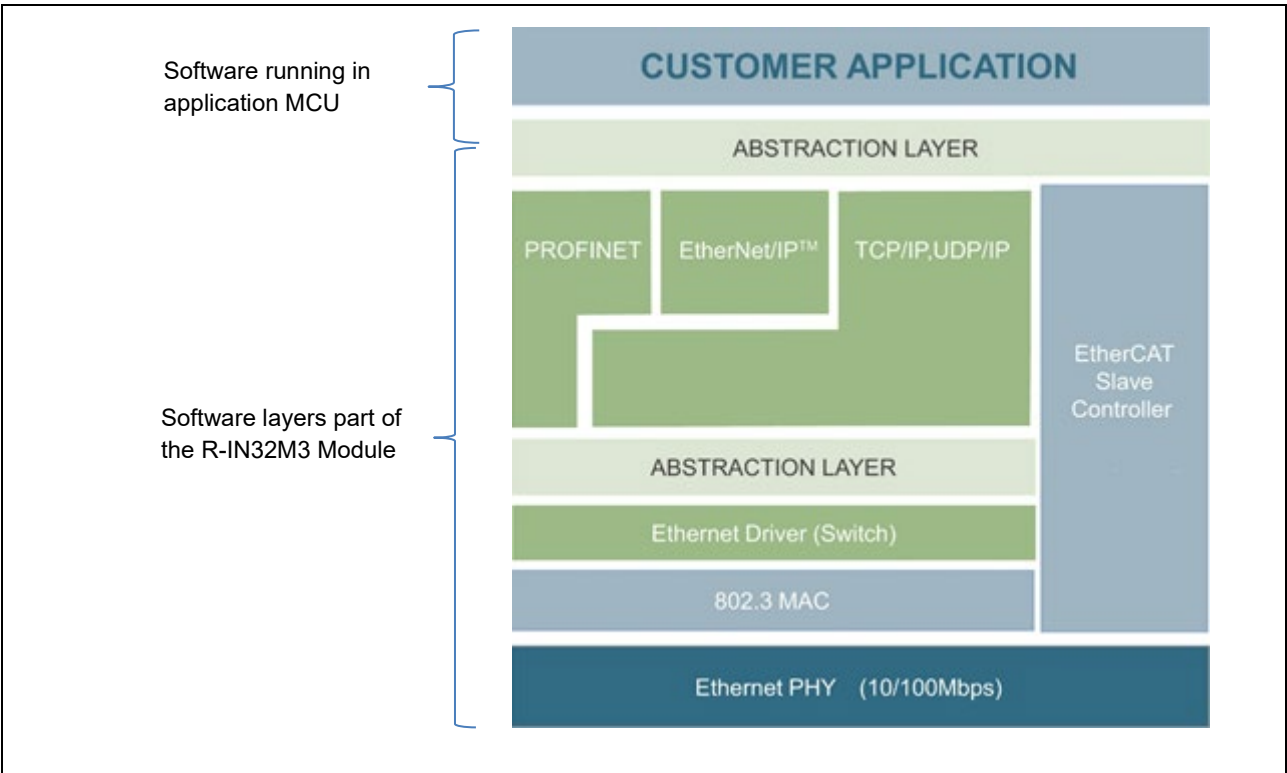

Figure 3.2   Software Blocks of the R-IN32M3 Module Solution

4. Electrical Characteristics

4.1 Absolute Maximum Ratings

Stress exceeding the maximum ratings even for short time may damage the R-IN32M3 Module. Functional operation above the recommended operating conditions is not guaranteed. Extended exposure to stress above the recommended operating conditions may affect device reliability.

Table 4.1   Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	-0.2 to +3.6	V
I/O voltage	VI/Vo	-0.3 to +3.6	V
Output current	Io	15	mA
Storage temperature	T_{stg}	-40 to +85	°C

Remark: Tests performed IEC 60512-11-4 (-40°C/125°C), IEC 60512-11-9 (125°C), IEC 60512-11-10 (-40°C), IEC 60512-11-3 (40°C /85%RH), IEC 60512-11-12

Caution:	Product quality may suffer if any absolute maximum rating is even momentarily exceeded. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that these ratings are not exceeded.

Remark:	3.3 V must be applied to the I/O pins only after applying the power supply voltage.

4.2 Operating Conditions

Table 4.2   Operating Conditions

| Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply	Vcc	3.15	3.3	3.45	V
Power consumption	P		1.3	2.0	W
Input voltage high	VIH	2.0		Vcc + 0.3	V
Input voltage low	VIL	-0.3		0.8	V
Input voltage high (/RESET)	VIH_{RESET}	2.2		Vcc	V
Input voltage low (/RESET)	VIL_{RESET}	-0.2		0.3	V
Output voltage high	VOH	Vcc - 0.1			V
Output voltage low	VOL			0.1	V
Output current low	IOL	6			mA
Output current high	IOH	-6			mA
Operating temperature	T_a	-40		70	°C

All further specifications and statements of timing assume the application of the operating conditions listed in Table 4.2.

4.3 SPI Specification

Table 4.3 SPI Specification

Vcc = 3.3±0.15 V, Ta = -40 to +70°C

Parameter	Symbol	Conditions	Min.	Max.	Unit
SCLK input cycle	tCSISSCK	-	60	-	ns
SCLK output high level width	tWSKH	-	tCSIMSCK × 0.5 - 5.0	-	ns
SCLK output low level width	tWSKL	-	tCSIMSCK × 0.5 - 5.0	-	ns
MOSI input setup time (to CSISCKn↑)	tSSSI	-	10	-	ns
MOSI input setup time (to CSISCKn↓)	tSSSI	-	10	-	ns
MOSI input hold time (from CSISCKn↑)	tHSSI	-	15	-	ns
MOSI input hold time (from CSISCKn↓)	tHSSI	-	15	-	ns
MISO output delay time (from CSISCKn↑)	tDSSO	C_L = 15 pF	-	10	ns
MISO output delay time (from CSISCKn↓)	tDSSO		-	10	ns
MISO output hold time (from CSISCKn↑)	tHSSO		tCSISSCK × 0.5 - 5.0	-	ns
MISO output hold time (from CSISCKn↓)	tHSSO		tCSISSCK × 0.5 - 5.0	-	ns
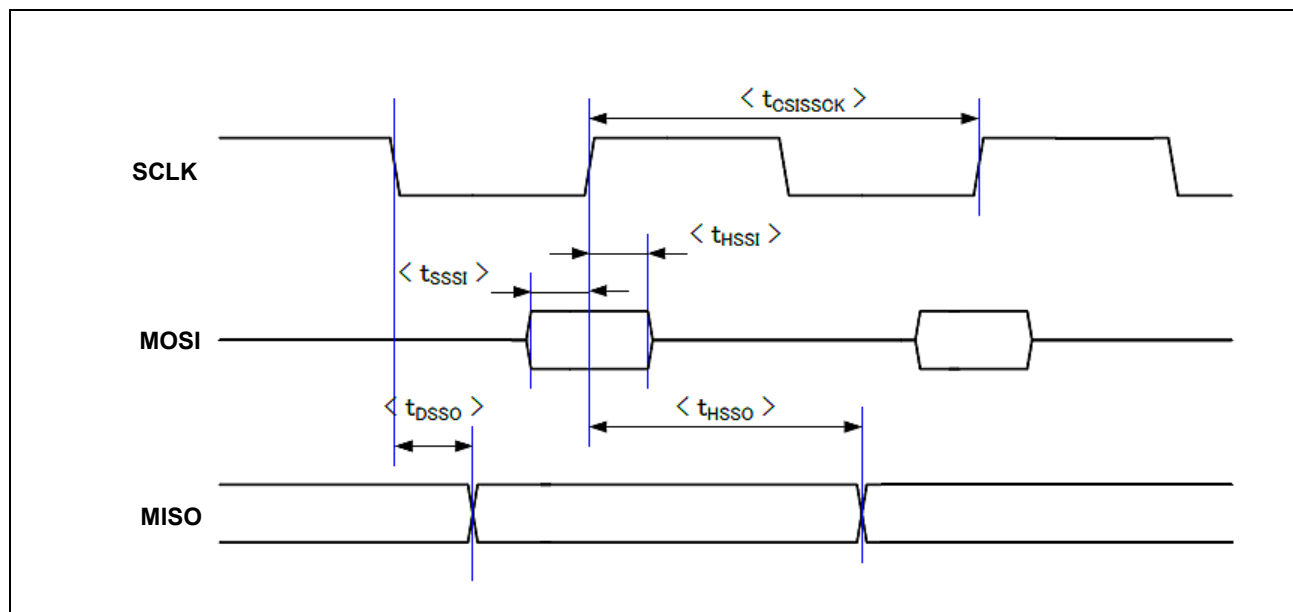
Figure 4.1 SPI Access Timing Chart

5. Applicable Standards

The R-IN32M3 Module complies with the following standards:

CE marking・UKCA marking

Emission EN61000-6-4

- ✓ EN55016-2-3   Radiated emission
- ✓ EN55022   Conducted emission

Immunity EN61000-6-2

- ✓ EN61000-4-2   Electrostatic Discharge immunity test
- ✓ EN61000-4-3   Immunity to radiated radio frequencies
- ✓ EN61000-4-4   Electrical fast transient / burst immunity test
- ✓ EN61000-4-5   Surge immunity test
- ✓ EN61000-4-6   Immunity to conducted disturbances, induced by radio-frequency fields

RoHS / REACH

UL

- ✓ **UL 61010-1, 3rd Edition and UL 61010-2-201, 2nd Edition**
- ✓ **CAN/CSA C22.2 No. 61010-1, 3rd Edition and CAN/CSA C22.2 No. 61010-2-201:18**

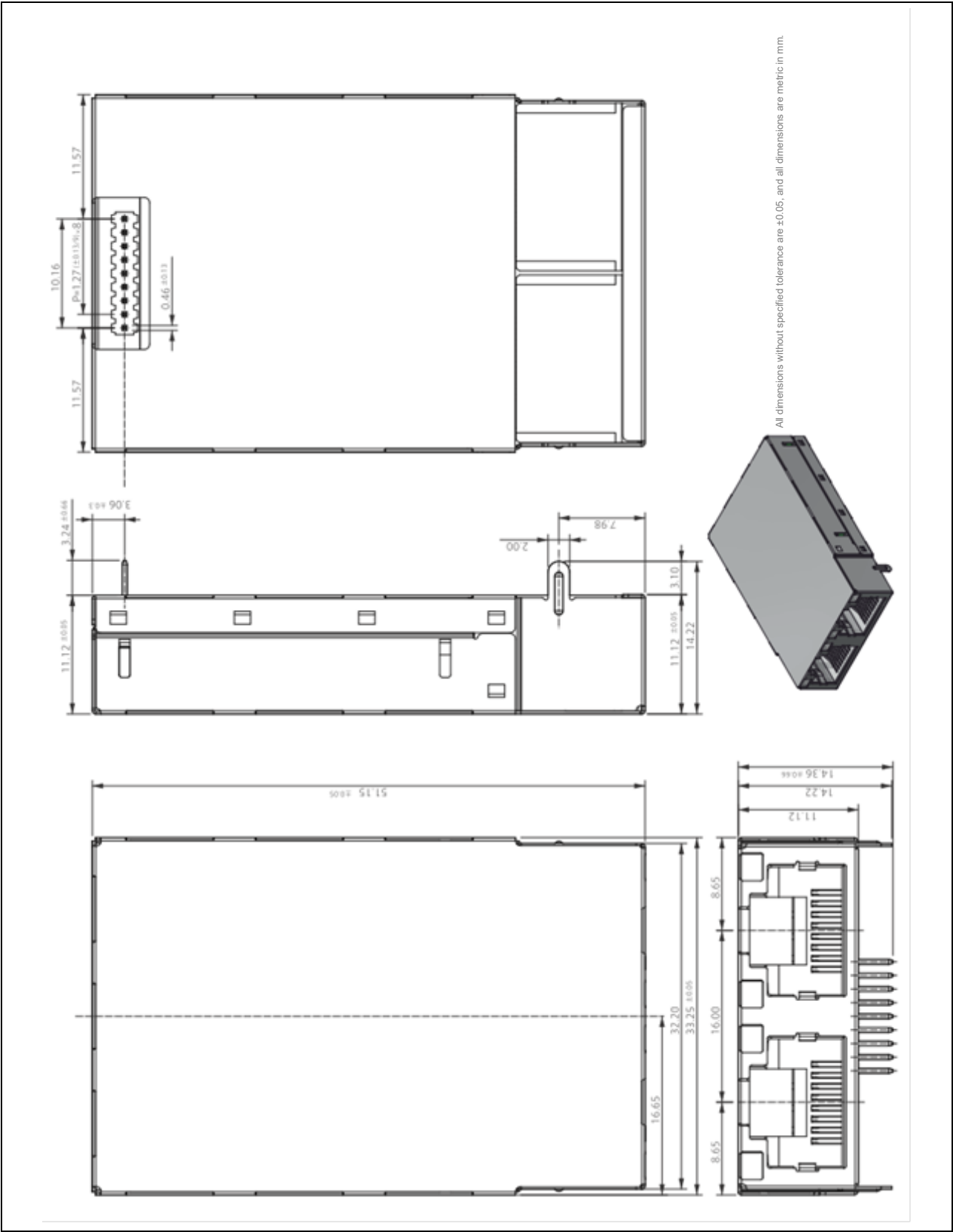# 6. Package Dimensions

Figure 6.1   Package Dimensions

7. Related Products

R-IN32M3 module solution kit supports evaluation and development effortlessly.

For more information, please visit Renesas website.

■ R-IN32M3 Module adapter board [YCONNECT-IT-I-RJ4501]

Connect with existing MCU evaluation boards via Arduino™ or P-mod interface.

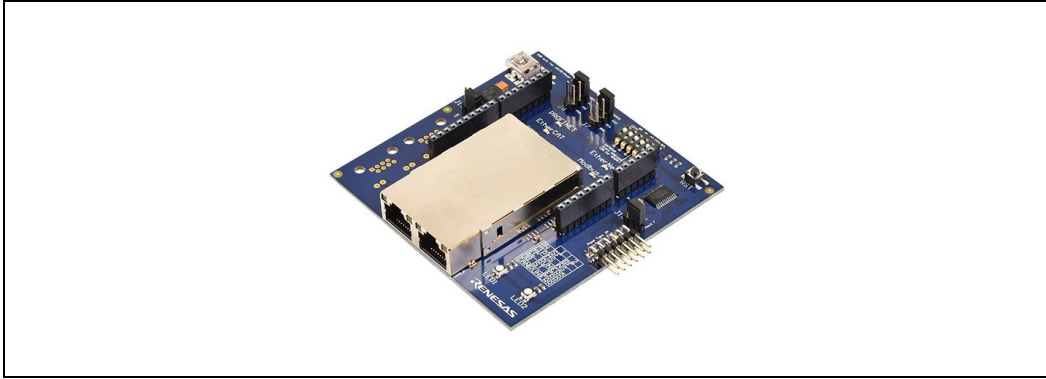Sample Software available: EK-RA6M4 / EK-RA6M3 (RA), RL78/G14 and SK-S7G2(Synergy)

Figure 7.1   Adapter board

■ R-IN32M3 Module CPU card [SEMB1320]

R-IN32M3 Module and RX66T CPU card integrated.

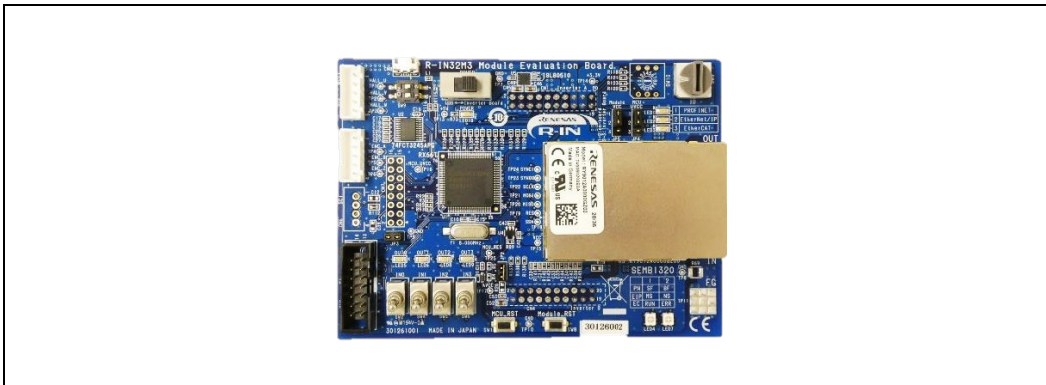Sample Software available: SEMB1320 (RX66T)

Figure 7.2   CPU card

SEMB1320 is a product of Shimafuji Electric Co., Ltd.

Revision History		R-IN32M3 Module (RY9012A0) Datasheet		

		Description		
Rev.	**Date**	**Page**	**Summary**	
1.00	Aug 03, 2020	-	First Edition issued	
2.00	Nov 06, 2020	1	Update to Industrial Communication Explorer	
2.01	Jun 14, 2021	2	Add support protocol functions	
2.02	Oct 15,2021	1	Change description in chapter 1.1 and 1.3	
		2	Update features according to FW 2.1.0	
		10	Add description of UL	
2.03	Aug 5,2022	-	Modified chapter structure	
		3	chapter 1.4. add factory initial firmware version	
		10	chapter 5. add UKCA marking	
		12	chapter 7. add SEMB1320	
2.04	May 31, 2023	1	chapter 1.2. add ModbusTCP	
		-	Minor correction	

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

    A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

    The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

    Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

    Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

    After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

    Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

    Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

    Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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