User's Manual

RA6M5 Group

Cloud Kit Base Board for RA6M5 Microcontroller Group
CK-RA6M5 v2
User's Manual

Renesas RA Family
RA6 Series

Renesas Electronics
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Rev. 1.00 Sep 2023

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(Rev.5.0-1 October 2020)

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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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Precautions

This Cloud Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area, or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

• Ensure attached cables do not lie across the equipment.

• Reorient the receiving antenna.

• Increase the distance between the equipment and the receiver.

• Connect the equipment into an outlet on a circuit different from that which the receiver is connected.

• Power down the equipment when not in use.

• Consult the dealer or an experienced radio/TV technician for help.

Note: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken:

• The user is advised that mobile phones should not be used within 10 m of the product when in use.

• The user is advised to take ESD precautions when handling the equipment.

The Cloud Kit does not represent an ideal reference design for an end product and does not fulfill the regulatory standards for an end product.

Renesas RA Family

CK-RA6M5 v2

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Glossary

Table 1. List of Abbreviations and Acronyms

BoM	Bill of Materials
CK	Cloud Kit
ETM	Embedded Trace Module
FSP	Flexible Software Package
GPIO	General Purpose Input Output
I^2C (or IIC)	Inter-Integrated Circuit
IDE	Integrated Development Environment
I/O	Input/Output
IRQ	Interrupt Request
LDO	Low Dropout
LED	Light Emitting Diode
LQFP	Low-profile Quad Flat Pack
MCU	Micro Controller Unit
MEMS	Micro-Electromechanical Systems
MISO	Master In Slave Out
MOSI	Master Out Slave In
NC	Not Connected
Pmod™	Peripheral Module
PWM	Pulse Width Modulation
RXD	Receive Data
SCI	Serial Communications Interface
SCL	Serial Clock Line
SDA	Serial Data Line
SMD	Surface Mount Device
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SWD	Serial Wire Debug
TXD	Transmit Data
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus

1. CK Base Board Overview

The CK-RA6M5 v2, Cloud Kit for RA6M5 MCU Group, enables users to experience the cloud connectivity options available from Renesas and Renesas Partners. A broad array of sensors on the CK-RA6M5 v2 provide multiple options for observing user interaction with the Cloud Kit. By selecting from a choice of add-on devices, multiple cloud connectivity options are available.

MCU Features

- R7FA6M5BH3CFC MCU (referred to as RA MCU)
- 200 MHz, Arm® Cortex®-M33 core
- 2 MB Code Flash, 8 kB data flash, 512 kB SRAM
- 176 pins, LQFP package
- MCU and Pmod current measurement points for precision current consumption measurement
- Multiple clock sources - RA MCU oscillator and sub-clock oscillator crystals, providing precision 24.000 MHz and 32,768 Hz reference clock. Additional low-precision clocks are available internal to the RA MCU

Ecosystem Access and Connectivity

- USB Full Speed Host and Device (micro AB connector)
- USB-C Power Only Connector
- Four 5 V input sources
  - USB (Debug, Full Speed)
  - USB-C Power Only Connector
  - External power supply (using traditional pin jumpers)
- Debug modes
  - Debug on-board (SWD)
  - Debug in (SWD and JTAG)
- User LEDs and buttons
  - Four User LEDs (red, blue, green, RGB)
  - Power LED (white) indicating availability of regulated power
  - Debug LED (yellow) indicating the debug connection
  - One User button
  - One Reset button
- Two of the most popular ecosystems expansions
  - 2 Digilent Pmod™ (SPI, UART and I²C) connectors
  - Arduino™ (Uno R3) connector
- MCU boot configuration jumper
- Ethernet (RJ45 RMII interface)

Sensors

- Renesas HS3001 Humidity and Temperature sensor
- Renesas ZMOD4410 Indoor Air Quality Index sensor
- Renesas ZMOD4510 Outdoor Air Quality Index sensor
- Renesas OB1203 Biometric sensor
- TDK ICP-20100 Barometric Pressure sensor
- TDK ICM-42605 6 Axis sensor (Gyroscope, Accelerometer)
- Knowles SPH0645LM4H-B MEMS Microphones in stereo configuration

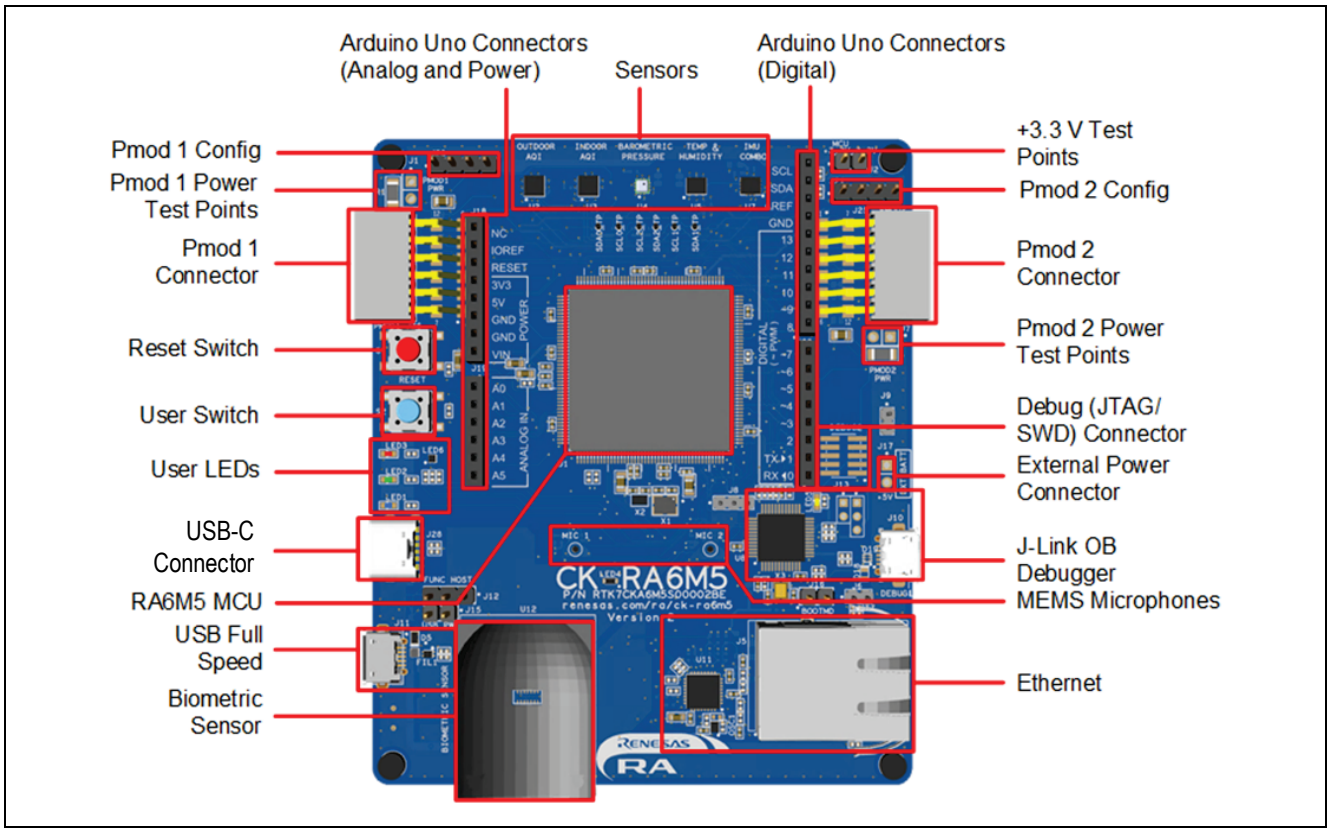

Figure 1. CK-RA6M5 v2 Board Top Side

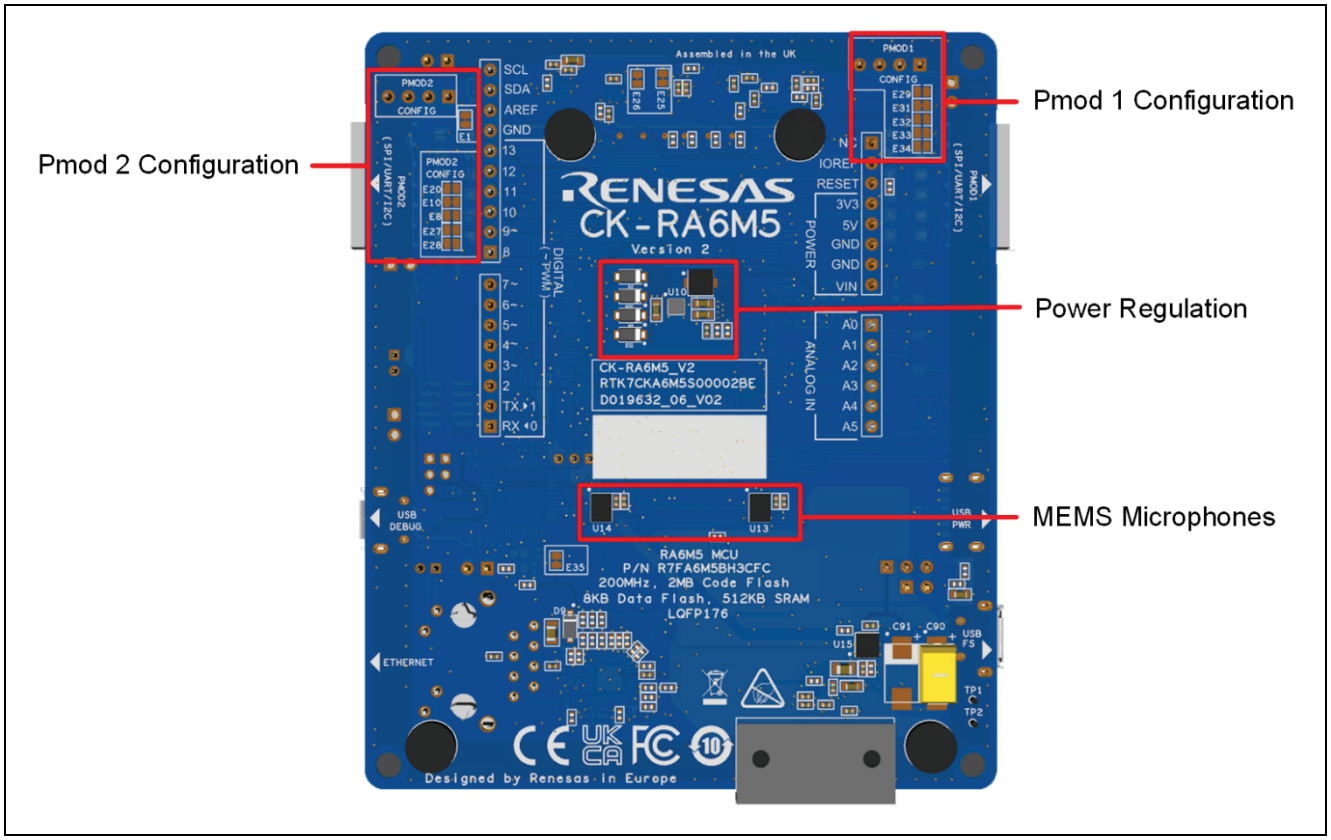

Figure 2. CK-RA6M5 v2 Board Bottom Side

1.1 Assumptions and Advisory Notes

1. It is assumed that the user has a basic understanding of microcontrollers and embedded systems hardware.
2. It is recommended that the user refers to the *CK-RA6M5 v2 Quick Start Guide* to get acquainted with the kit and the Quick Start example project that the CK-RA6M5 v2 board comes pre-programmed with.
3. Flexible Software Package (FSP) and an Integrated Development Environment (IDE) such as e^2 studio are required to develop embedded applications on the CK-RA6M5 v2 kit.
4. Instructions to download and install software, import example projects, build them and program the CK-RA6M5 v2 board are provided in the quick start guide.
5. The MCU fitted to the CK board may not contain the latest version of the on-chip boot firmware.

2. Ordering Information

For details of the ordering codes, additional kit contents and connectivity please see the manual related to the specific kit.

3. Hardware Architecture and Default Configuration

3.1 Kit Architecture

The CK-RA6M5 v2 board is designed to demonstrate many options available to connect the RA6M5 MCU to various cloud services. The board includes the RA6M5 MCU, multiple environmental sensors and connectivity options such as USB, Ethernet, and Pmod connections for use with add-on wireless connectivity devices, as well as support for Arduino Uno R3 shields. The board also includes an on-board debugger and all required hardware needed to power, program, and debug software running on the MCU. The board also has LED indicators and a push-button available for user interaction with the board.

Most of the on-board sensors are connected to the MCU using I^{2}C. The on-board microphones use the SSIE peripheral on the RA6M5 MCU.

Table 2. Kit Architecture

Board Functionality	Area Features	Function present on all similar kits	Functionality is:
MCU Native Access	RA MCU, power / current measurement	Yes	MCU dependent
System Control and Ecosystem Access	Power, Debug MCU, User LED and buttons, reset, ecosystem connectors, USB Full Speed, Boot configuration, Ethernet.	Yes	Same or similar across similar kits

3.2 System Block Diagram

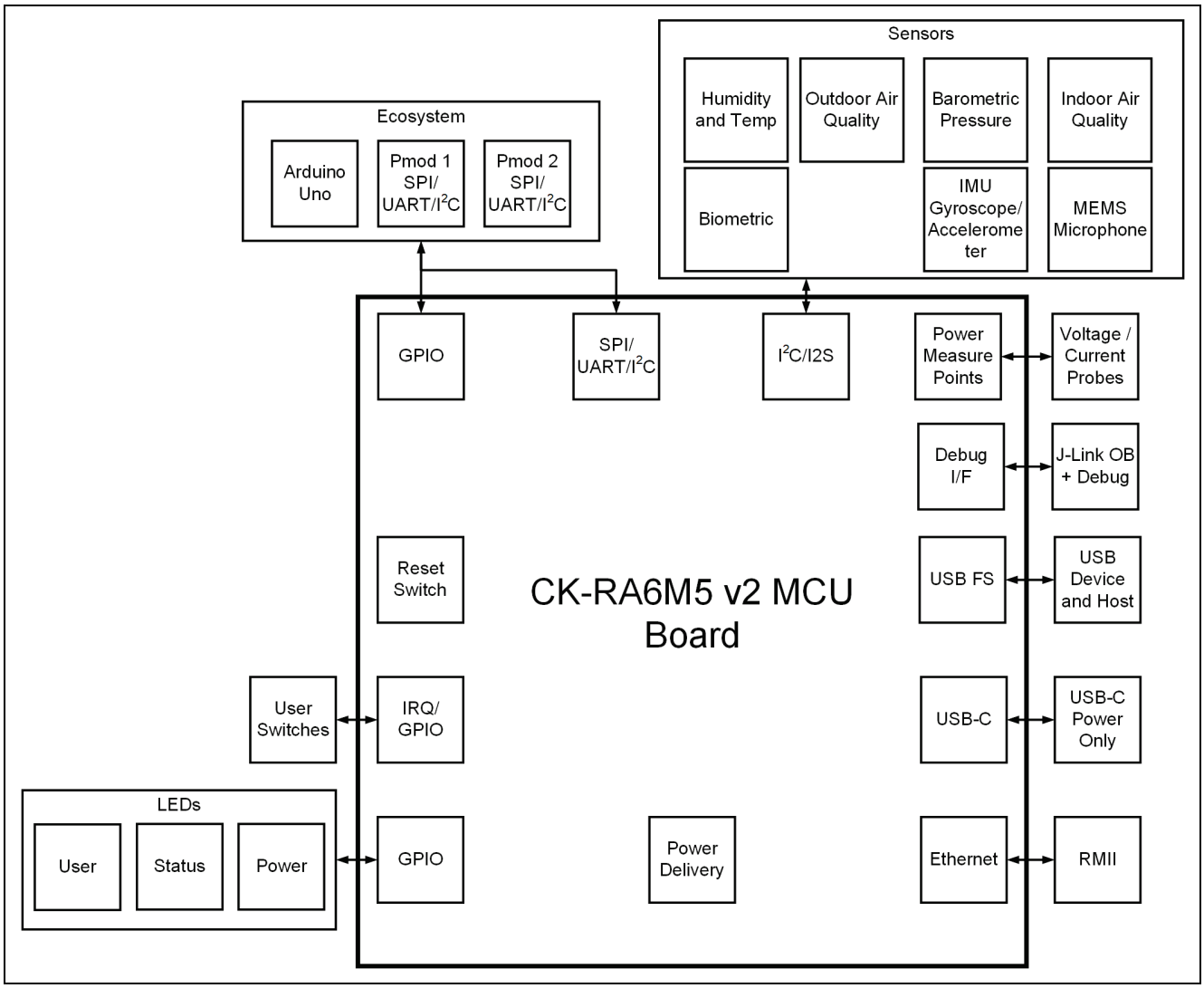

Figure 3. CK-RA6M5 v2 Board Block Diagram

3.3 Jumper Settings

Two types of jumpers are provided on the CK-RA6M5 v2 board.

1. Copper jumpers (trace-cut type and solder bridge type)
2. Traditional pin header jumpers

The following sections describe each type and their default configuration.

3.3.1 Copper Jumpers

Copper jumpers are of two types, designated **trace-cut** and **solder-bridge**.

A **trace-cut jumper** is provided with a narrow copper trace connecting its pads. The silk screen overlay printing around a trace-cut jumper is a solid box. To isolate the pads, cut the trace between pads adjacent to each pad, then remove the connecting copper foil either mechanically or with the assistance of heat. Once the etched copper trace is removed, the trace-cut jumper is turned into a solder-bridge jumper for any later changes.

A **solder-bridge** jumper is provided with two isolated pads that may be joined together. The silkscreen overlay printed around a solder-bridge jumper has gaps in the surround. Three methods can be used for joining:

- Solder may be applied to both pads to develop a bulge on each and the bulges joined by touching a soldering iron across the two pads.

- A small wire may be placed across the two pads and soldered in place.
- A SMT resistor, size 0805, 0603, or 0402, may be placed across the two pads and soldered in place. A zero-ohm resistor shorts the pads together.

For any copper jumper, the connection is considered **closed** if there is an electrical connection between the pads (default for trace-cut jumpers.) The connection is considered **open** if there is no electrical connection between the pads (default for the solder-bridge jumpers.)

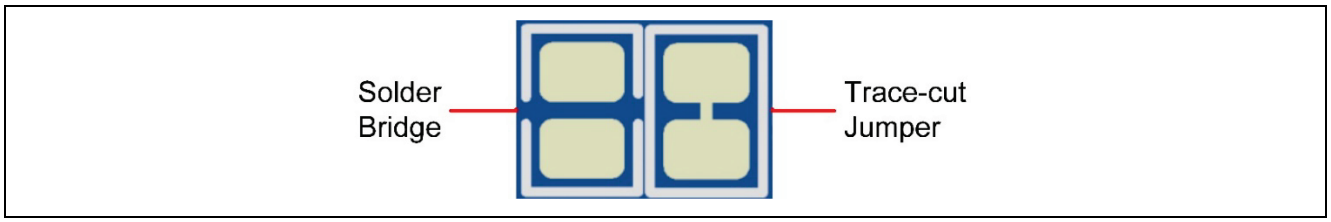

Figure 4. Copper Jumpers

3.3.2 Traditional Pin Header Jumpers

These jumpers are traditional small pitch jumpers that require an external shunt to open/close them. The traditional pin jumpers on the CK-RA6M5 v2 board are 2.54 mm pitch headers and require compatible 2.54 mm shunt jumpers.

3.3.3 Default Jumper Configuration

The following table describes the default settings for each jumper on the CK-RA6M5 v2 board. This includes copper jumpers (Ex designation) and traditional pin jumpers (Jx designation.)

The Circuit Group for each jumper is the designation found in the board schematic (available in the Design Package). Functional details for many of the listed jumpers may be found in sections associated with each functional area of the kit.

Table 3. Default Jumper Configuration

Location	Circuit Group	Default Open/Closed	Function
J2	MCU Power	Closed	Current Measurement point for MCU
J6	J-Link OB	Closed	Configures J-Link OB connection to MCU mode
J8	J-Link OB	Jumper on pins 1-2	Configures the MCU for normal operation
J9	J-Link OB	Open	Configures RESET# for on-board debugger mode
J12	USB FS	Jumper on pins 2-3	Sets USB FS power to device mode
J15	USB FS	Closed	Connects micro-USB power to system power
J16	MCU Boot Mode	Open	Configures the MCU for normal boot mode
J20	Pmod 1	Jumper on pins 1-2 Jumper on pins 3-4	Connects P205 (CTS9_RTS9) to Pmod 1 Pin 4 and P604 (CTS9) to Pmod 1 Pin 1
J21	Pmod 2	Jumper on pins 1-2 Jumper on pins 3-4	Connects P413 (CTS0_RTS0) to Pmod 2 Pin 4 and P800 (CTS0) to Pmod 2 Pin 1
E1	MCU Power	Closed	Connects AREF to +3.3 V
E25	Pressure Sensor	Closed	Connects U4 AD0 pin to GND
E26	Motion Sensor	Closed	Connects U7 AP_SDO/AP_AD0 pin to GND
E8	Pmod 2	Open	Connects P412 (RSPCKB) to Pmod 2 Pin 4
E10	Pmod 2	Closed	Connects P100 (MISOB/RXD0) to Pmod 2 Pin 3
E20	Pmod 2	Open	Connects P413 (SSLB0/CTS0_RTS0) to Pmod 2 Pin 1
E27	Pmod 2	Open	Connects P410 (SCL2) to Pmod 2 Pin 3
E28	Pmod 2	Open	Connects P409 (SDA2) to Pmod 2 Pin 4
E29	Pmod 1	Open	Connects P205 (SSLA0/CTS9_RTS9) to Pmod 1 Pin 1
E31	Pmod 1	Closed	Connects P202 (MISOA/RXD9) to Pmod 1 Pin 3
E32	Pmod 1	Open	Connects P204 (RSPCKA) to Pmod 1 Pin 4
E33	Pmod 1	Open	Connects P512 (SCL1) to Pmod 1 Pin 3

Location	Circuit Group	Default Open/Closed	Function
E34	Pmod 1	Open	Connects P511 (SDA1) to Pmod 1 Pin 4
E35	Debug Power	Closed	Connects J-Link OB debugger to +3.3 V

4. System Control and Ecosystem Access

The CK-RA6M5 v2 provides a power supply regulator, an on-board debugger, simple I/O (switches and LEDs), and popular I/O ecosystem connectors. These are all described in detail below.

4.1 Power

The CK-RA6M5 v2 kit is designed for +5 V operation. An on-board switching voltage regulator (ISL8002IRZ) is used to convert the 5 V supply to a 3.3 V supply. The 3.3 V supply is used to power the RA MCU and other peripheral features as well as some of the sensors.

4.1.1 Power Supply Options

This section describes the different ways in which CK-RA6M5 v2 kit can be powered.

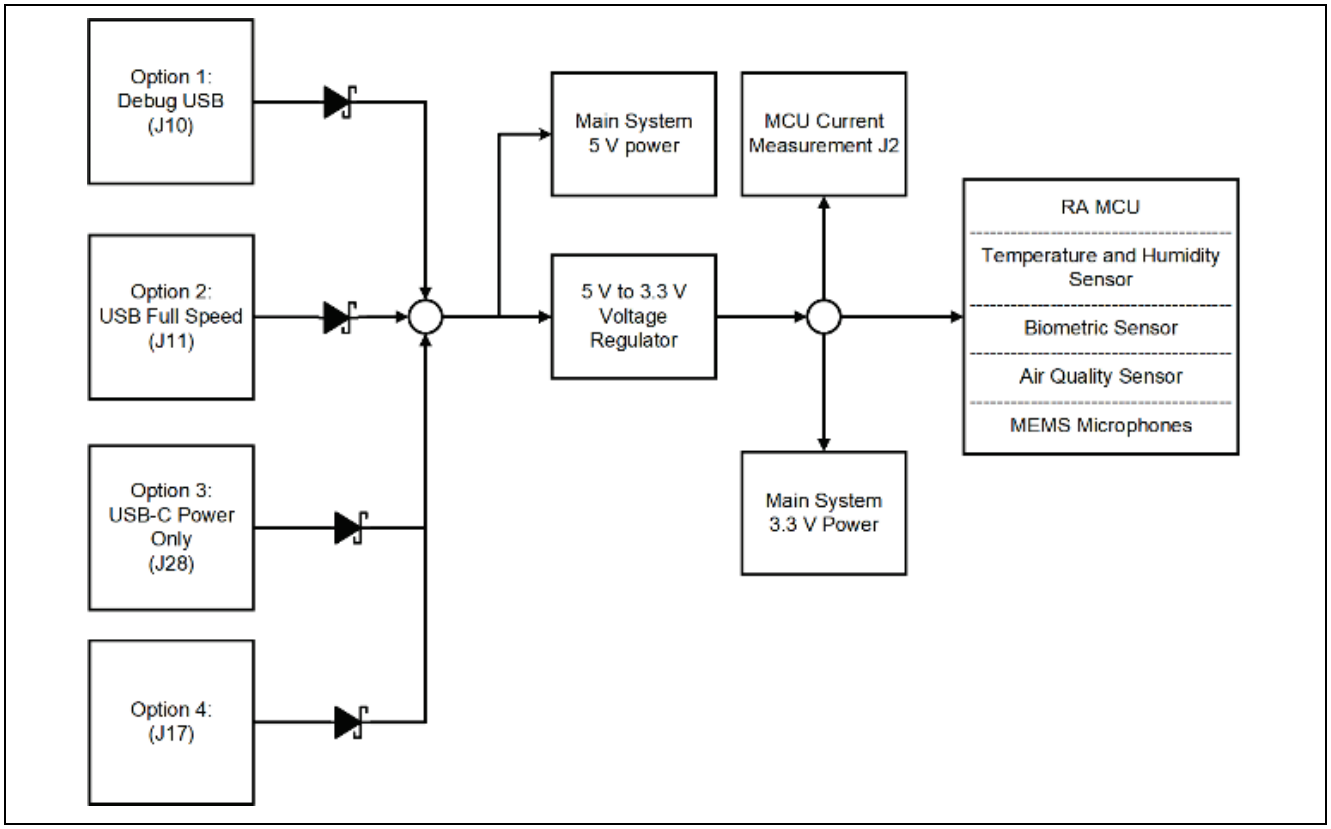

Figure 5. Power Supply Options

4.1.1.1 Option 1: Debug USB

5 V may be supplied from an external USB host to the USB Debug connector (J10) labelled DEBUG1 on the board. Power from this source is connected to the Main System 5 V Power. Reverse current protection is provided between this connector and the Main System 5 V Power.

4.1.1.2 Option 2: USB Full Speed

5 V may be supplied from an external USB host to the USB Full Speed connector (J11) labelled USB FS on the board. Power from this source is connected to the Main System 5 V Power. Reverse current protection is provided between this connector and the Main System 5 V Power.

4.1.1.3 Option 3: USB-C Power Input

5 V may be supplied from an external USB host to the USB-C Power connector (J28) labelled USB PWR on the board. Power from this source is connected to the Main System 5 V Power. Reverse current protection is provided between this connector and the Main System 5 V Power.

4.1.1.4 Option 4: External Power Input

5 V may be supplied from an external power supply or battery to 2 pin header J17. Polarity is J17-2 (5 V) and J17-1 (GND) pin headers. Power from this source is connected to the Main System 5 V Power. Reverse current protection is provided between the 5 V test points and the Main System 5 V Power.

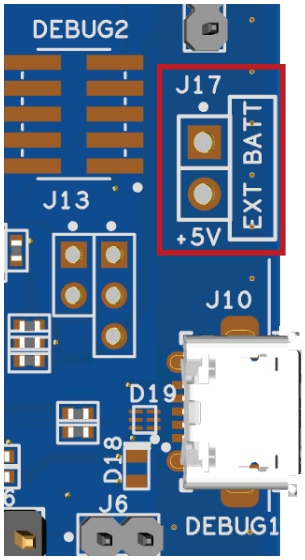

Figure 6. Test Point Location

4.1.2 Power Supply Considerations

The on-board regulator which supplies +3.3 V has a built-in current limit of 2.0 A. Make sure that the total current required by the RA MCU, any active on-board features, and any connected peripheral device does not exceed this limit.

Note: The total current available from a typical USB host is 500 mA maximum. Depending on the configuration of the kit, multiple power sources may be required.

4.1.3 Power-up Behavior

When powered, the white LED near the center of the board (the “dash” in the CK-RA6M5 name) will light up. For more details on initial power up behavior, see the *CK-RA6M5 v2 Quick Start Guide*.

4.2 Debug and Trace

The CK-RA6M5 v2 board supports the following three debug modes.

Table 4. Debug Modes

Debug Modes	Debug MCU (one that connects to the IDE on PC)	Target MCU (one that is being debugged)	Debugging Interface/Protocol	Connector Used
Debug on-board	J-Link (on-board)	RA6M5 (on-board)	SWD	Micro USB (J10)
Debug in	External debugging tools	RA6M5 (on-board)	SWD, JTAG	10-pin connector (J13)
Debug out	J-Link (on-board)	Any external RA MCU	SWD	Micro USB (J10) plus 10-pin connector (J13)

Notes:

- See Table 6 for the Debug USB connector pin definition.
- See Table 9 for the 10-pin JTAG connector pin definition.

The following table summarizes the jumper setting for each of the debug modes.

Table 5. Jumper Connection Summary for Different Debug Modes

Debug Modes	J6	J8	J9
Debug on-board	Closed	Jumper on pins 1-2	Open
Debug in	Closed	Jumper on pins 1-2	Closed
Debug out	Open	Jumper on pins 2-3	Open

4.2.1 Debug On-Board

The on-board debug functionality is provided using Renesas J-Link OB debugger and SEGGER J-Link® firmware. Debug USB Micro B connector (J10) connects the J-Link OB debugger to an external USB Full Speed Host, allowing re-programming and debugging of the target RA MCU firmware. This connection is the default debug mode for the CK-RA6M5 v2 board.

The J-Link OB debugger connects to the target RA MCU using the SWD interface.

Table 6. Debug USB Port Assignments

Debug USB Connector		CK-RA6M5 v2
Pin	**Description**	**Signal/Bus**
J10-1	+5VDC	+5V_USB_DBG
J10-2	Data-	USB_JLOB_DM (U8-14)
J10-3	Data+	USB_JLOB_DP (U8-15)
J10-4	USB ID, jack internal switch, cable inserted	NC
J10-5	Ground	GND

A yellow indicator, LED5, shows the visual status of the debug interface. When the CK-RA6M5 v2 board is powered on, and LED5 is blinking, it indicates that the J-Link OB debugger is not connected to a programming host. When LED5 is on solid, it indicates that the J-Link OB debugger is connected to a programming interface. When LED5 is flickering it indicates that there is active communication between the debugger and the host PC.

To configure the CK-RA6M5 v2 board to use the Debug On-Board mode, configure the jumpers using the following table.

Table 7. Debug On-Board Jumper Configuration

Location	Default Open/Closed	Function
J6	Closed	Target RA MCU MD connected to debug
J8	Jumper on pins 1-2	Target RA MCU RESET# connected to debug RESET#
J9	Open	J-Link OB debugger in normal operation mode

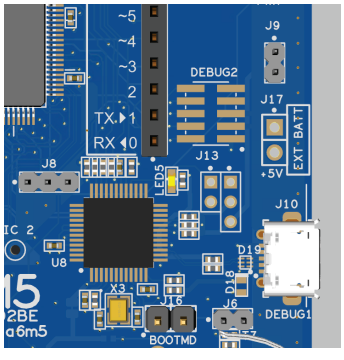

Figure 7. CK-RA6M5 v2 Debug Interface

4.2.2 Debug In

One 10-pin Cortex® Debug Connector at J13 supports JTAG and SWD. The connector may be used for external debug of the target RA MCU.

To configure the CK-RA6M5 v2 board to use the Debug In mode, configure the jumpers using the following table.

Table 8. Debug In Mode Jumper Configuration

Location	Default Open/Closed	Function
J6	Closed	Target RA MCU MD connected to debug
J8	Jumper on pins 1-2	Target RA MCU RESET# connected to debug RESET#
J9	Closed	J-Link OB debugger is held in RESET

Table 9. JTAG/SWD Port Assignments

JTAG Connector			CK-RA6M5 v2
Pin	**JTAG Pin Name**	**SWD Pin Name**	**Signal/Bus**
J13-1	Vtref	Vtref	+3.3 V
J13-2	TMS	SWDIO	P108/TMS/SWDIO
J13-3	GND	GND	GND
J13-4	TCK	SWCLK	P300/TCK/SWCLK
J13-5	GND	GND	GND
J13-6	TDO	N/A	P109/TDO
J13-7	NC	NC	N.C.
J13-8	TDI	N/A	P110/TDI
J13-9	GNDDetect	GNDDetect	N.C.
J13-10	nSRST	nSRST	RESET# (Via J8)

Note: The Cortex® Debug Connector is fully described in the Arm® CoreSight™ Architecture Specification

4.2.3 Debug Out

The CK-RA6M5 v2 board can be configured to use the J-Link OB debugger to debug target RA MCU on an external board.

A yellow indicator, LED5, shows the visual status of the debug interface. When the CK-RA6M5 v2 board is powered on, and LED5 is blinking, this indicates that the J-Link OB debugger is not connected to a programming host. When LED5 is on solid, this indicates that the J-Link OB debugger is connected to a programming interface.

To configure the CK-RA6M5 v2 board to use the Debug Out mode, configure the jumpers according to the following table.

Table 10. Debug Out Jumper Configuration

Location	Default Open/Closed	Function
J6	Open	No connection to RA MCU
J8	Jumper on pins 2-3	On-board RA MCU is held in RESET
J9	Open	J-Link OB debugger in normal operation mode

Ecosystem

The Ecosystem connectors provide users the option to simultaneously connect several third-party add-on modules compatible with two popular ecosystems using the following connectors:

1. Two Digilent Pmod™ (SPI, UART and I^2C) connectors
2. Arduino™ (Uno R3) connectors

4.2.4 Digilent Pmod™ Connectors

Two 12-pin connectors are provided to support Pmod modules where the RA MCU acts as the master, and the connected module acts as a slave device.

These interfaces may be configured in firmware to support several Pmod types such as Type-2A (expanded SPI), Type-3A (expanded UART) and Type-6A (I^2C).

The CK-RA6M5 v2 board also provides jumpers to select the desired operation mode, with the default being UART with full flow control. Modes SPI and I^2C configurations are shown below.

The default 12-pin Pmod interface supports +3.3 V devices. Please ensure that any Pmod device installed is compatible with a +3.3 V supply.

4.2.4.1 Pmod 1 Connector

A 12-pin Pmod connector is provided at J26, Pmod 1.

Table 11. Pmod 1 Port Assignments

Pmod 1 Connector Default				**CK-RA6M5 v2**	**Pmod 1 Configuration**	
Pin	**Option Type-2A (SPI)**	**Option Type-3A (UART)**	**Option Type-6A (I^2C)**	**Signal/Bus**	**Short**	**Open**
J26-1	SS			P205 (SSLA0)	E29	J20 Open 3-4
		CTS		P604 (CTS9)	J20 Link 3-4	E29
J26-2	MOSI	TXD		P203 (MOSIA/TXD9)		
J26-3	MISO	RXD		P202 (MISOA/RXD9)	E31	E33
			SCL	P512 (SCL1)	E33	E31
J26-4	SCK			P204 (RSPCKA)	E32	E34, J20 Open 1-2
		RTS		P205 (CTS_RTS9)	J20 Link 1-2	E34, E32
			SDA	P511 (SDA1)	E34	E32, J20 Open 1-2
J26-5	GND			GND		
J26-6	VCC			+3.3 V		
J26-7	GPIO / INT (slave to master)			P005 (IRQ10-DS)		
J26-8	GPIO / RESET (master to slave)			P311		
J26-9	GPIO / SSLA1			P206		
J26-10	GPIO / SSLA2			P207		
J26-11	GND			GND		
J26-12	VCC			+3.3 V		

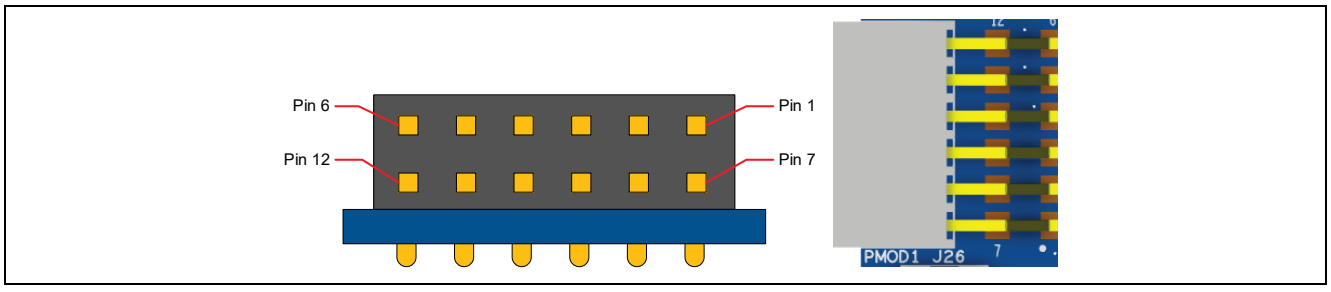

Figure 8. Pmod 1 Connector

4.2.4.2 Pmod 2 Connector

A 12-pin Pmod connector is provided at J25, Pmod 2.

Table 12. Pmod 2 Port Assignments

Pmod 2 Connector Default				CK-RA6M5 v2	Pmod 2 Configuration	
Pin	**Option Type-2A (SPI)**	**Option Type-3A (UART)**	**Option Type-6A (I^2C)**	**Signal/Bus**	**Short**	**Open**
J25-1	SS			P413 (SSLB0)	E20	J21 Open 3-4
		CTS		P800 (CTS0)	J21 Link 3-4	E20
J25-2	MOSI	TXD		P411 (MOSIB/TXD0)		
J25-3	MISO	RXD		P100 (MISOB/RXD0)	E10	E27
			SCL	P410 (SCL2)	E27	E10
J25-4	SCK			P412 (RSPCKB)	E8	E28, J21 Open 1-2
		RTS		P413 (CTS_RTS0)	J21 Link 1-2	E8, E28
			SDA	P409 (SDA2)	E28	E8, J21 Open 1-2
J25-5	GND			GND		
J25-6	VCC			+3.3 V		
J25-7	GPIO / INT (slave to master)			P004 (IRQ9-DS)		
J25-8	GPIO / RESET (master to slave)			P101		
J25-9	GPIO / SSLB1			P414		
J25-10	GPIO / SSLB3			P708		
J25-11	GND			GND		
J25-12	VCC			+3.3 V		

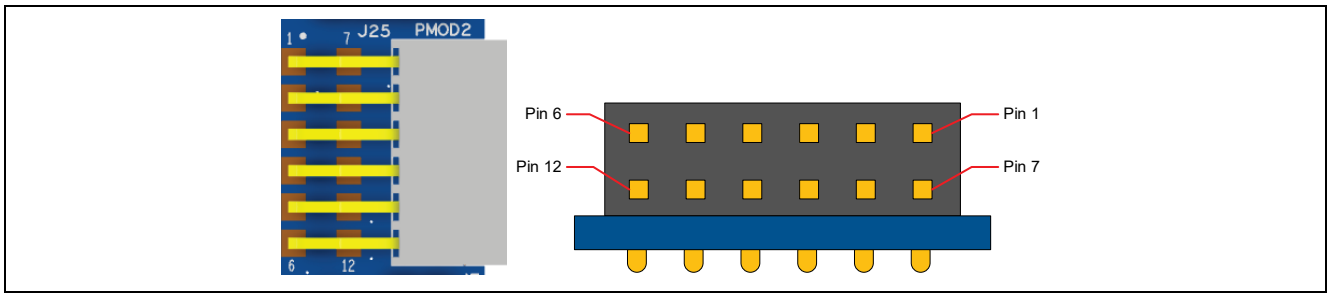

Figure 9. Pmod 2 Connector

4.2.5 Arduino™ Connector

Near the center of the System Control and Ecosystem Access area is an Arduino Uno R3 compatible connector interface.

Table 13. Arduino Uno Port Assignments

Arduino Uno Compatible Connector		CK-RA6M5 v2
Pin	**Description**	**Signal/Bus**
J18-1	NC	NC
J18-2	IOREF	+3.3 V
J18-3	RESET	P303
J18-4	3.3 V	+3.3 V
J18-5	5 V	+5 V
J18-6	GND	GND
J18-7	GND	GND
J18-8	VIN	NC
J19-1	A0	P000 (AN000)
J19-2	A1	P001 (AN001)
J19-3	A2	P002 (AN002)
J19-4	A3	P003 (AN003)

Arduino Uno Compatible Connector				CK-RA6M5 v2
Pin	**Description**			**Signal/Bus**
J19-5	A4			P014 (AN012/DA0)
J19-6	A5			P015 (AN013/DA1)
J23-1	D0	RXD		P706 (RXD3)
J23-2	D1	TXD		P707 (TXD3)
J23-3	D2	INT0		P006 (IRQ11)
J23-4	D3	INT1	PWM	P111 (IRQ4/GTIOC3A)
J23-5	D4		PWM	P415 (GTIOC0A)
J23-6	D5		PWM	P105 (GTIOC1A)
J23-7	D6		PWM	P104 (GTIOC1B)
J23-8	D7		PWM	P115 (GTIOC4A)
J24-1	D8			P611
J24-2	D9		PWM	P608 (GTIOC4B)
J24-3	D10	SPI_SS		P503 (SSL6)
J24-4	D11	SPI_MOSI		P506 (MOSI6)
J24-5	D12	SPI_MISO		P505 (MISO6)
J24-6	D13	SPI_SCK		P504 (SCK6)
J24-7	GND			GND
J24-8	AREF			+3.3 V
J24-9	I2C_SDA			P511 (SDA1)
J24-10	I2C_SCL			P512 (SCL1)

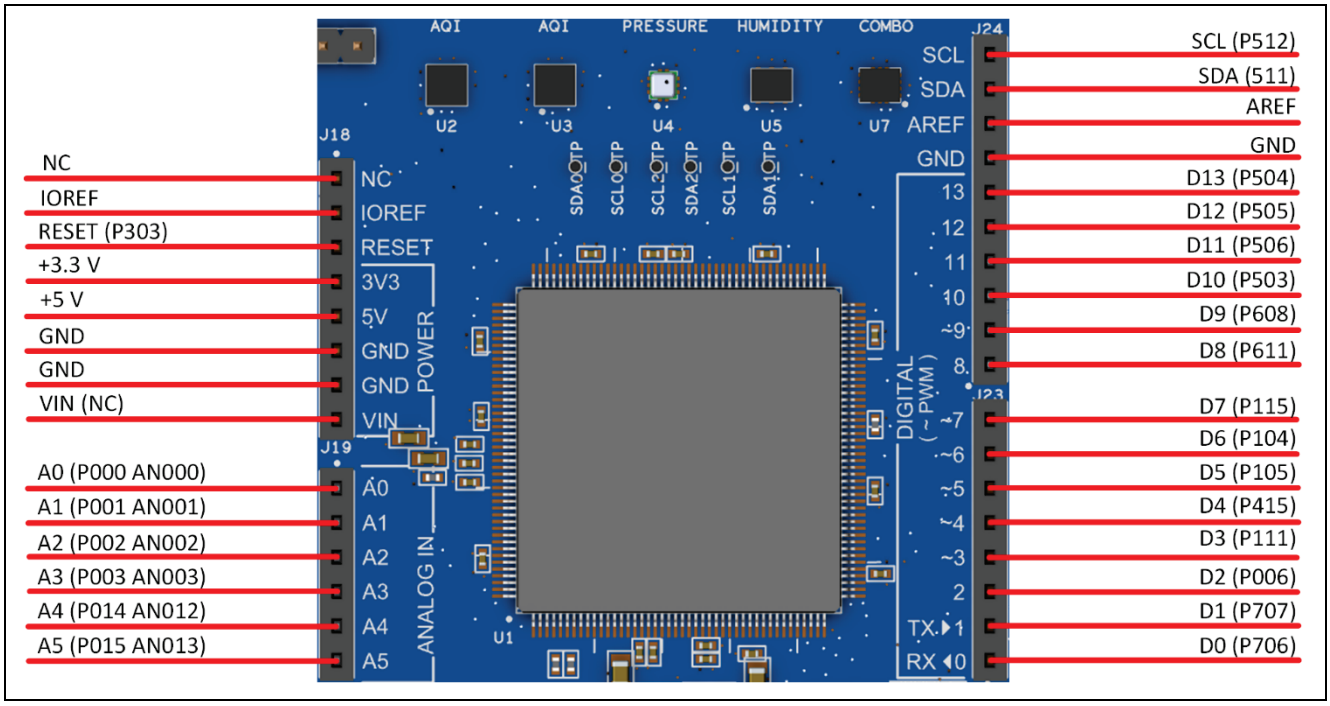

Figure 10. Arduino Uno Connectors

4.3 Connectivity

4.3.1 USB Full Speed

The USB Micro-AB connection jack (J11) connects the RA MCU USB Full Speed interface to an external USB interface, allowing communications for testing and use of the RA MCU firmware. This connection can be configured as either a USB Device or a USB Host interface.

For a USB Device configuration, set jumper J12 to pins 2-3, install a jumper on J15 pins 1-2, and configure the RA MCU firmware to use the USB Full Speed ports in device mode. Power from an external USB Host on this connection can be used to provide power to the CK-RA6M5 v2 board.

For a USB Host configuration, set jumper J12 to pins 1-2, remove the jumper from J15, and configure the RA MCU firmware to use the USB Full Speed ports in host mode. In this configuration, power to J11 is supplied from U15. The total current available from U15 is 500 mA. Note that the input power sources must be configured with enough power for both the CK-RA6M5 v2 board and the USB Full Speed port in host mode. Connect the included USB type-A female to micro B male cable to J11. USB device cables or devices can be connected to the USB Full Speed port using this cable.

Table 14. USB Full Speed Port Assignments

USB Full Speed Connector		**CK-RA6M5 v2**
Pin	**Description**	**Signal/Bus**
J11-1	+5 VDC	+5VUSB (Host Mode) *1 P407/USBFS_VBUS = 2/3 of +5VUSB at J11 *2
J11-2	Data-	USBF_N
J11-3	Data+	USBF_P
J11-4	USB ID, jack internal switch, cable inserted	NC
J11-5	Ground	GND

*1 When J12 is linked 1-2 and J15 is open
*2 When J12 is linked 2-3 and J15 is open

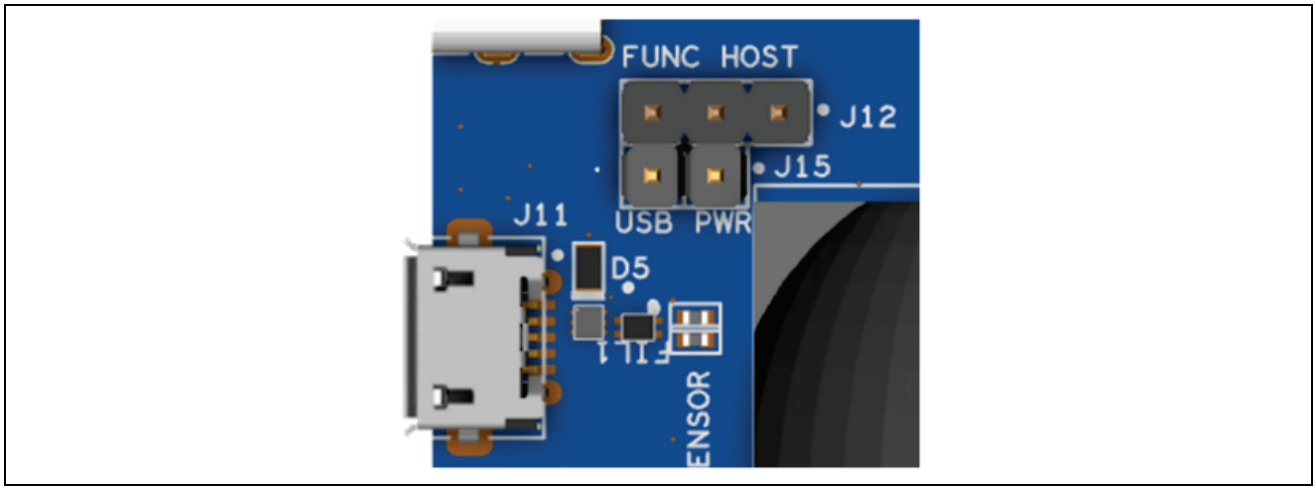

Figure 11. USB Full Speed Connector

4.4 Miscellaneous

4.4.1 User and Power LEDs

6 LEDs are provided on the CK-RA6M5 v2 board. In addition, the Ethernet connector has built-in link status and link speed LEDs.

Behavior of the LEDs on the CK-RA6M5 v2 board is described in the following table.

Table 15. CK-RA6M5 v2 Board LED Functions

Designator	**Color**	**Function**	**MCU Control Port**
LED1	Blue	User LED	P601
LED2	Green	User LED	P609
LED3	Red	User LED	P610
LED4	White	Power Indicator	Power
LED5	Yellow	Debug LED	J-Link OB MCU
LED6	RGB	User LED	R: P602, G:P603, B:P605

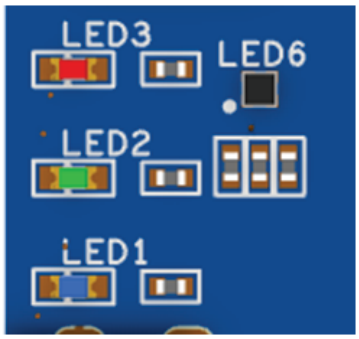

Figure 12. User LEDs

Figure 13. Power LED

4.4.2 User and Reset Switches

Two miniature, momentary, mechanical push-button type SMT switches are mounted on the CK-RA6M5 v2 board.

Pressing the Reset switch (S1) generates a reset signal to restart the RA MCU.

Table 16. CK-RA6M5 v2 Board Switches

Designator	Function	MCU Control Port	Button Color
S1	MCU Reset Switch	RESET#	Red
S2	User Switch	P804 (IRQ01)	Blue

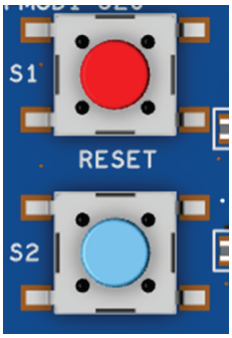

Figure 14. Reset and User Switches

4.4.3 MCU Boot Mode

A two-pin header (J16) is provided to select the Boot mode (P201) of the RA MCU. For normal operation, or Single-Chip mode, leave J16 open. To enter SCI Boot mode or USB Boot mode, place a jumper on J16.

Figure 15. Boot Mode

4.5 Ethernet

The Ethernet interface uses an RMII Ethernet Physical Layer Transceiver (PHY) (U11), connected to an RJ45 standard Ethernet connector (J5) with integrated magnetics and status indicators. The Ethernet clock is sourced from a precision 50 MHz clock crystal connected directly to the Ethernet PHY.

Table 17. Ethernet Port Assignments

Ethernet Signal Description	RA6M5 MCU Port
IRQ	P803 (IRQ02)
MDC	P214
MDIO	P211
TXD1	P406
TXD0	P700
TXD_EN	P405
RXD1	P703
RXD0	P702
CRS_DV	P705
RX_ER	P704
REF-50-CK	P701
RST#	P210
LINK_STATUS	P208

Table 18. Ethernet Components

Component	Manufacturer	Manufacturer Part Number
Ethernet PHY	Renesas	ICS1894-32
RJ45 Connector	Pulse	J0011D21BNL
50 MHz Oscillator	ECSInc	ECS-1612MV_1P6X1P2X0P6

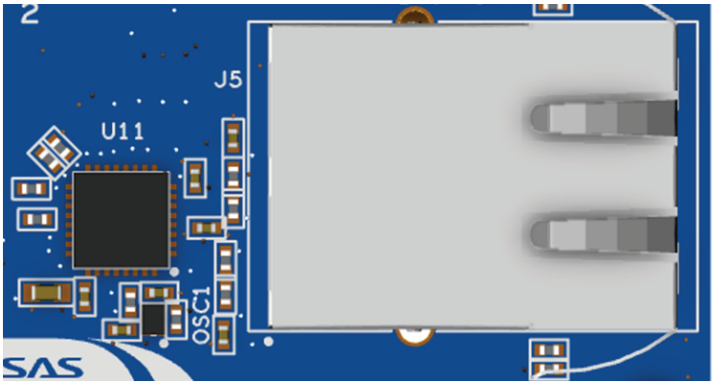

Figure 16. Ethernet Connector

4.6 Onboard Sensors

The CK-RA6M5 v2 is fitted with a number of onboard sensors, including a barometric pressure sensor, 6-axis MEMS motion tracking sensor, indoor air quality sensor, outdoor air quality sensor, biometric sensor, temperature, and humidity sensor.

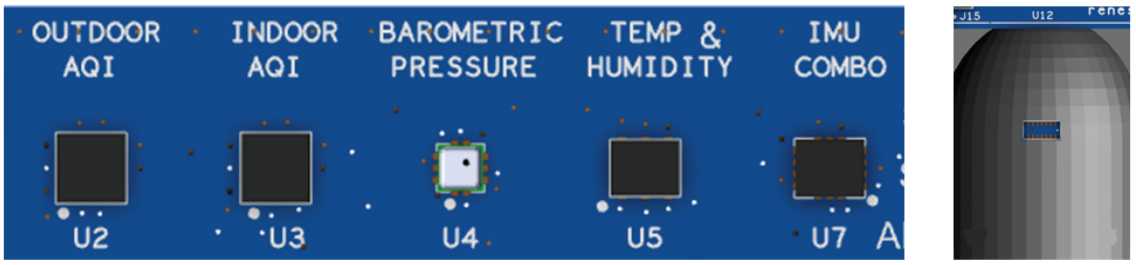

Figure 17. On Board Sensors

4.6.1 HS3001 Temperature and Humidity Sensor

An integrated calibration and temperature compensation logic provides fully corrected Relative Humidity and Temperature values via a standard I²C output. The measured data is internally corrected and compensated for accurate operation over a wide range of temperature and humidity levels.

Table 19. HS3001 Port Assignments

Pin Number	HS3001 Signal Description	RA6M5 MCU Port
1	SCL	P400 (SCL0)
2	SDA	P401 (SDA0)
3	VC	Connect a 0.1 µF decoupling capacitor from VC to ground
4	VDD	+3.3 V
5	NC	NC
6	VSS	GND

4.6.2 OB1203 Biometric Sensor

The OB1203 is a fully integrated optical sensing module for Pulse Oximetry (PPG – photoplethysmography), multi-channel Color Sensing (CS), Ambient Light Sensing (LS) and Proximity Sensing (PS). It can determine human heart rate, blood oxygen saturation (SpO2), respiration rate and heart rate variability (a measure of stress). The OB1203 integrates all light sources, drivers, and the sensor elements, in a single optically optimized package.

Table 20. OB1203 Port Assignments

Pin Number	OB1203 Signal Description	RA6M5 MCU Port
1	NC	NC
2	SCL	P512 (SCL1)
3	SDA	P511 (SDA1)
4	LGND	GND
5	LED1	TP1
6	LED2	TP2
7	LVDD	+3.3 V
8	LVDD	+3.3 V
9	LVDD	+3.3 V
10	LVDD	+3.3 V
11	VDD	+3.3 V
12	AGND	GND
13	INT	P403 (IRQ14)
14	NC	NC

4.6.3 ZMOD4510 Outdoor Air Quality Sensor

The ZMOD4510 gas sensor platform detects air quality in a variety of indoor and outdoor applications. The signal conditioner controls the sensor temperature and measures the MOx resistance, which is a function of the gas concentration. The device is ideal for monitoring and reporting Outdoor Air Quality (OAQ).

Table 21. ZMOD4510 Port Assignments

Pin Number	ZMOD4510 Signal Description	RA6M5 MCU Port
1	SCL	P410 (SCL2)
2	SDA	P409 (SDA2)
3	INT	P404 (IRQ15)
4	NC	NC
5	VDD	+3.3 V
6	VSS	GND
7	VSS	GND
8	NC	NC
9	VSS	GND
10	VDDH	+3.3 V
11	RES_N	P306 (ZMOD4510RESET)
12	VDDIO	+3.3 V

4.6.4 ZMOD4410 Indoor Air Quality Sensor

The ZMOD4410 Gas Sensor Module is designed for detecting total volatile organic compounds (TVOC) and monitoring indoor air quality (IAQ). The module's sense element consists of a heater element on a Si-based MEMS structure and a metal oxide (MOx) chemiresistor. The signal conditioner controls the sensor temperature and measures the MOx conductivity, which is a function of the gas concentration.

Table 22. ZMOD4410 Port Assignments

Pin Number	ZMOD4410 Signal Description	RA6M5 MCU Port
1	SCL	P410 (SCL2)
2	SDA	P409 (SDA2)
3	INT	P402 (IRQ4)
4	NC	NC
5	VDD	+3.3 V
6	VSS	GND
7	VSS	GND
8	NC	NC
9	VSS	GND
10	VDDH	+3.3 V
11	RES_N	P307 (ZMOD4410RESET)
12	VDDIO	+3.3 V

4.6.5 ICM-42605 6-Axis MEMS Motion Tracking Sensor

The ICM-42605 is a low power 6-axis motion tracking sensor with 3-axis gyroscope, 3-axis accelerometer, as well as Digital Motion Processor; offloading computation from the RA6M5 MCU improving system performance. Adding a resistor in space of R129 and removing link on E26 will change the I^2C address to 0x69 from 0x68.

Table 23. ICM-42605 Port Assignments

Pin number	ICM-42605 Signal Description	RA6M5 MCU Port
1	AP_SDO/AP_AD0	GND (Default) / +3.3 V (Cut E26, fit R129)
2	RESV	GND
3	RESV	GND
4	INT1/INT	P008 (IRQ12)

Pin number	ICM-42605 Signal Description	RA6M5 MCU Port
5	VDDIO	+3.3 V
6	GND	GND
7	RESV	GND
8	VDD	+3.3 V
9	INT2/FSYNC	P802 (IRQ3)
10	RESV	GND
11	RESV	GND
12	AP_CS	+3.3 V
13	AP_SCL/AP_SCLK	P400 (SCL0)
14	AP_SDA/AP_SDIO/AP_SDI	P401 (SDA0)

4.6.6 ICP-20100 Barometric Pressure Sensor

The ICP-20100 is based on MEMS capacitive technology which provides ultra-low noise at the lowest power, providing a high level of relative accuracy, sensor throughput, and temperature stability. Fitting a resistor to R128 and removing link E25 will change the address from 0x63 to 0x64.

Table 24. ICP-20100 Port Assignments

Pin Number	ICP-20100 Signal Description	RA6M5 MCU Port
1	CSB	+3.3 V
2	SCL	P400 (SCL0)
3	GND[0]	GND
4	SDA	P401 (SDA0)
5	VDD	+3.3 V
6	ADO	GND (Default) / +3.3 V (Cut E25, fit R128)
7	INT	P301 (IRQ6)
8	GND[1]	GND
9	GND[2]	GND
10	VDDIO	+3.3 V

4.6.7 SPH0645 MEMS Microphones

The SPH0645LM4H-B is a miniature, low power, bottom port microphone with an I^2S digital output. The solution consists of a high performance acoustic sensor, a serial Analog to Digital convertor, and an interface to condition the signal into an industry standard 24-bit I^2S format.

Table 25. SPH0645 Port Assignments

Pin Number	SPH0645 Signal Description	RA6M5 MCU Port
1	WS	P113 (SSIE0_WS)
2	SELECT	+3.3 V
3	GND	GND
4	BCLK	P112 (SSIE0_SCK)
5	VDD	+3.3 V
6	DATA-OUT	P114 (SSIE0_RXD)

5. MCU Native Access Area

5.1 MCU and Pmod Current Measurement

Included in the Native Pin Access area are current measurement resistors and test points to measure the MCU core power current and Pmod power current.

The CK-RA6M5 v2 board has pin header test points for current measurement of the main 3.3 V MCU power and for Pmod power. To measure current remove 0 Ohm resistor and install pin header. Alternatively use a resistor of known value and measure the voltage drop across the resistor and use Ohm's Law to calculate the current. J2 can be used to measure the MCU power, J1 can be used to measure Pmod 1 power, and J7 can be used to measure Pmod 2 power.

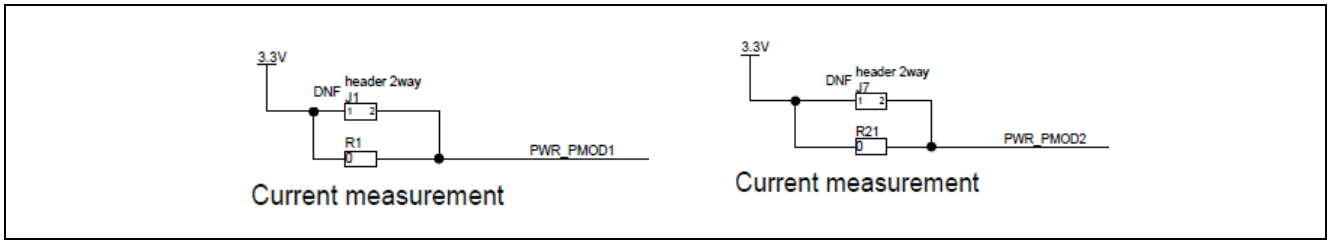

Figure 18. Pmod Current Measurement Circuit

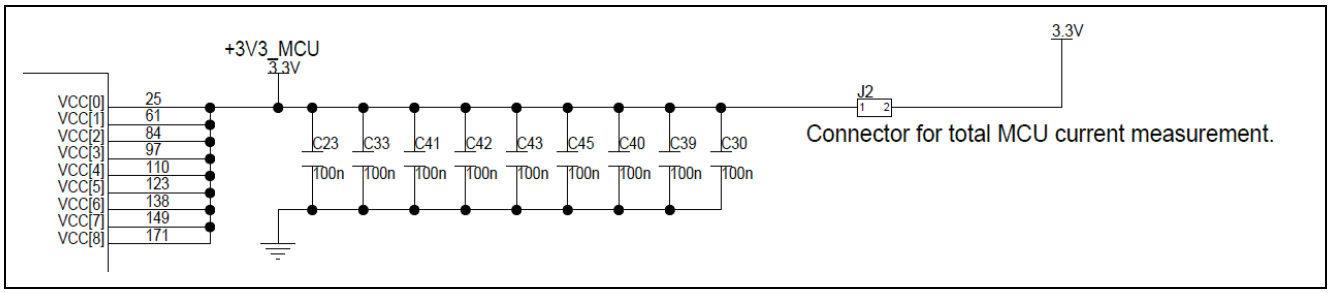

Figure 19. RA +3.3 V Current Measurement Circuit

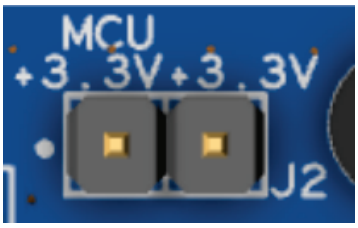

Figure 20. RA MCU Current Measurement

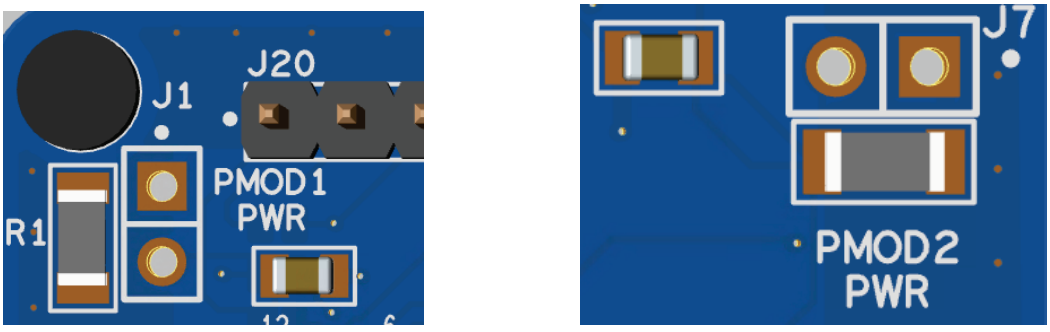

Figure 21. Pmod Current Measurement

6. Recommended Parts

The below table lists recommended part numbers for optional components that can be fitted as required.

Table 26. Part Numbers

Designator(s)	Description	Manufacturer	Part Number
J1, J7, J17	1 Row 2 Way header	Wuerth Elektronik	613 002 111 21
R128, R129	0R resistor 0402	YAGEO	RC0402JR-070RL

7. Certifications

The CK-RA6M5 v2 kit meets the following certifications/standards. See page 4 of this user's manual for the disclaimer and precautions.

7.1 EMC/EMI Standards

- FCC Notice (Class A)

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

  NOTE- 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 in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
  - Reorient or relocate the receiving antenna.
  - Increase the separation between the equipment and receiver.
  - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
  - Consult the dealer or an experienced radio/television technician for help.
- Innovation, Science and Economic Development Canada ICES-003 Compliance:
  CAN ICES-3 (A)/NMB-3(A)
- CE Class A (EMC)

  This product is herewith confirmed to comply with the requirements set out in the Council Directives on the Approximation of the laws of the Member States relating to Electromagnetic Compatibility Directive 2014/30/EU.

  Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be requried to take adequate measures to correct this interference.
- UKCA Class A (EMC)

  This product is in conformity with the following relevant UK Statutory Instrument(s) (and its amendments): 2016 No. 1091 Electromagnetic Compatibility Regulations 2016.

  Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be requried to take adequate measures to correct this interference.
- Taiwan: Chinese National Standard 13438, C6357 compliance, Class A limits
- Australia/New Zealand AS/NZS CISPR 32:2015, Class A

7.2 Material Selection, Waste, Recycling and Disposal Standards

- EU RoHS
- WEEE
- China SJ/T 113642014, 10-year environmental protection use period.

7.3 Safety Standards

- UL 94V-0

8. Design and Manufacturing Information

The design and manufacturing information for the CK-RA6M5 v2 kit is available in the “CK-RA6M5 v2 Design Package” available on renesas.com/ra/ck-ra6m5.

- Design package file name: ck-ra6m5-v2-designpackage.zip
- Design package contents

Table 27. CK-RA6M5 v2 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	ck-ra6m5-v2-schematics
File (PDF)	Mechanical Drawing	ck-ra6m5-v2-mechdwg
File (PDF)	3D Drawing	ck-ra6m5-v2-3d
File (PDF)	BOM	ck-ra6m5-v2-bom
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files-Cadence Allegro

9. Website and Support

Visit the following URLs to learn about the kit and the RA family of microcontrollers, download tools and documentation, and get support.

CK-RA6M5 v2 Resources	renesas.com/ra/ck-ra6m5
RA Kit Information	renesas.com/ra/kits
RA Product Information	renesas.com/ra
RA Product Support Forum	renesas.com/ra/forum
RA Videos	renesas.com/ra/videos
RA Kit Feedback and Feature Request	renesas.com/ra/kitfeedback
Renesas Support	renesas.com/support
IoT Cloud Solutions	renesas.com/cloudsolutions

Provide Feedback/Request a Feature

Renesas aims to provide the best microcontroller kit experience to help our customers jumpstart innovation and take products to market faster with the RA family of microcontrollers. The Renesas RA microcontroller kits have been designed with a lot of attention to detail and customer-centered thinking in every aspect of the design. Renesas aims to exceed customer expectation.

Renesas looks forward to hearing your feedback and learning how we can enhance your experience. Please share your feedback at renesas.com/ra/kitfeedback.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Sep.11.23	—	Initial release

CK-RA6M5 v2 – User’s Manual

Publication Date: Sep.11.23

Published by: Renesas Electronics Corporation

CK-RA6M5 v2 – User's Manual

Renesas Electronics Corporation

R20UT5265EG0100