RENESAS

RA2A2 Group

Evaluation Kit for RA2A2 Microcontroller Group
EK-RA2A2 v1
User's Manual

Renesas RA Family
RA2 Series

Renesas Electronics
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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 Evaluation 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 Evaluation 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

EK-RA2A2 v1

Contents

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1. Kit Overview

The EK-RA2A2, an Evaluation Kit for RA2A2 MCU Group, enables users to seamlessly evaluate the features of the RA2A2 MCU group and develop embedded systems applications using Flexible Software Package (FSP) and e^2 studio IDE. The users can use rich on-board features along with their choice of popular ecosystems add-ons to bring their big ideas to life.

The key features of the EK-RA2A2 board are categorized in three groups (consistent with the architecture of the kit) as follows:

MCU Native Pin Access

- R7FA2A2AD3CFP MCU (referred to as RA MCU)
- 48 MHz, Arm® Cortex®-M23 core
- 512 KB Code Flash, 48 KB SRAM
- 100 pins, LQFP package
- Native pin access through 3 x 20-pin and 1 x 40-pin male headers
- MCU current measurement points for precision current consumption measurement
- Multiple clock sources - RA MCU oscillator and sub-clock oscillator crystals, providing precision 32.768 kHz reference clock. Additional low-precision clocks (48MHz, 8MHz, 32.768kHz) are available internal to the RA MCU

System Control and Ecosystem Access

- Two 5 V input sources
  - USB (Debug)
  - External power supply (using surface mount clamp test points and power input vias)
- Three Debug modes
  - Debug on-board (SWD)
  - Debug in (SWD)
  - Debug out (JTAG, SWD)
- User LEDs and buttons
  - Three User LEDs (red, blue, green)
  - Power LED (white) indicating availability of regulated power
  - Debug LED (yellow) indicating the debug connection
  - Two User buttons
  - One Reset button
- Five most popular ecosystems expansions
  - 2 Seeed Grove system (I^{2}C/Analog) connectors
  - SparkFun Qwiic® connector
  - 2 Digilent Pmod^{TM} (SPI and I^{2}C) connectors
  - Arduino^{TM} (Uno R3) connector
  - MikroElektronika mikroBUS^{TM} connector
- MCU boot configuration jumper

Grove and Qwiic Connectors

mikroBus Connector

Arduino Uno Connectors (Analog and Power)

Arduino Uno Connectors (Digital)

+5 V Test Points

+3.3 V Test Points

Pmod 1 Connector

Pmod 2 Connector

Reset Switch

User Switches

Debug (JTAG/SWD) Connectors

User LEDs

Power Regulation

MCU Current Measurement Points

Debug LED and USB Connector

Breakout Pin Header J3

Breakout Pin Header J4

Breakout Pin Header J2

J1RA4E2 MCUMCU

MCU Clock Crystals/ Select

Breakout Pin Header J1

Figure 1.   EK-RA2A2 Board Top Side
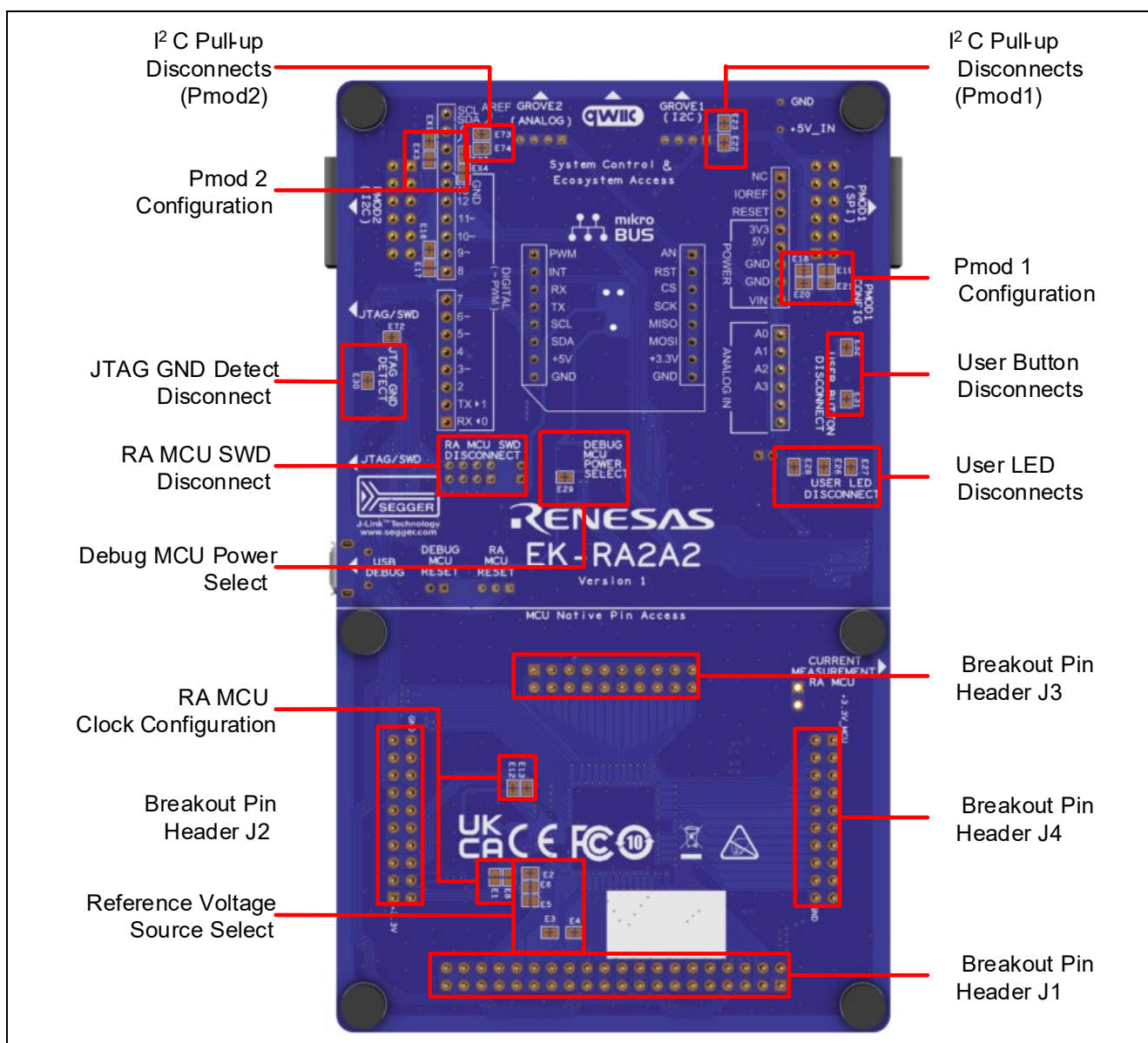
Figure 2.   EK-RA2A2 Board Bottom Side

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 *EK-RA2A2 Quick Start Guide* to get acquainted with the kit and the Quick Start example project that EK-RA2A2 board comes pre-programmed with.
3. Flexible Software Package (FSP) and Integrated Development Environment (IDE) such as e² studio is required to develop embedded applications on EK-RA2A2 kit.
4. Instructions to download and install software, import example projects, build them and program the EK-RA2A2 board are provided in the quick start guide.
5. The MCU fitted to the EK board may not contain the latest version of the on-chip boot firmware.

2. Kit Contents

The following components are included in the kit:

1. EK-RA2A2 v1 board
2. Micro USB device cable (type-A male to micro-B male)
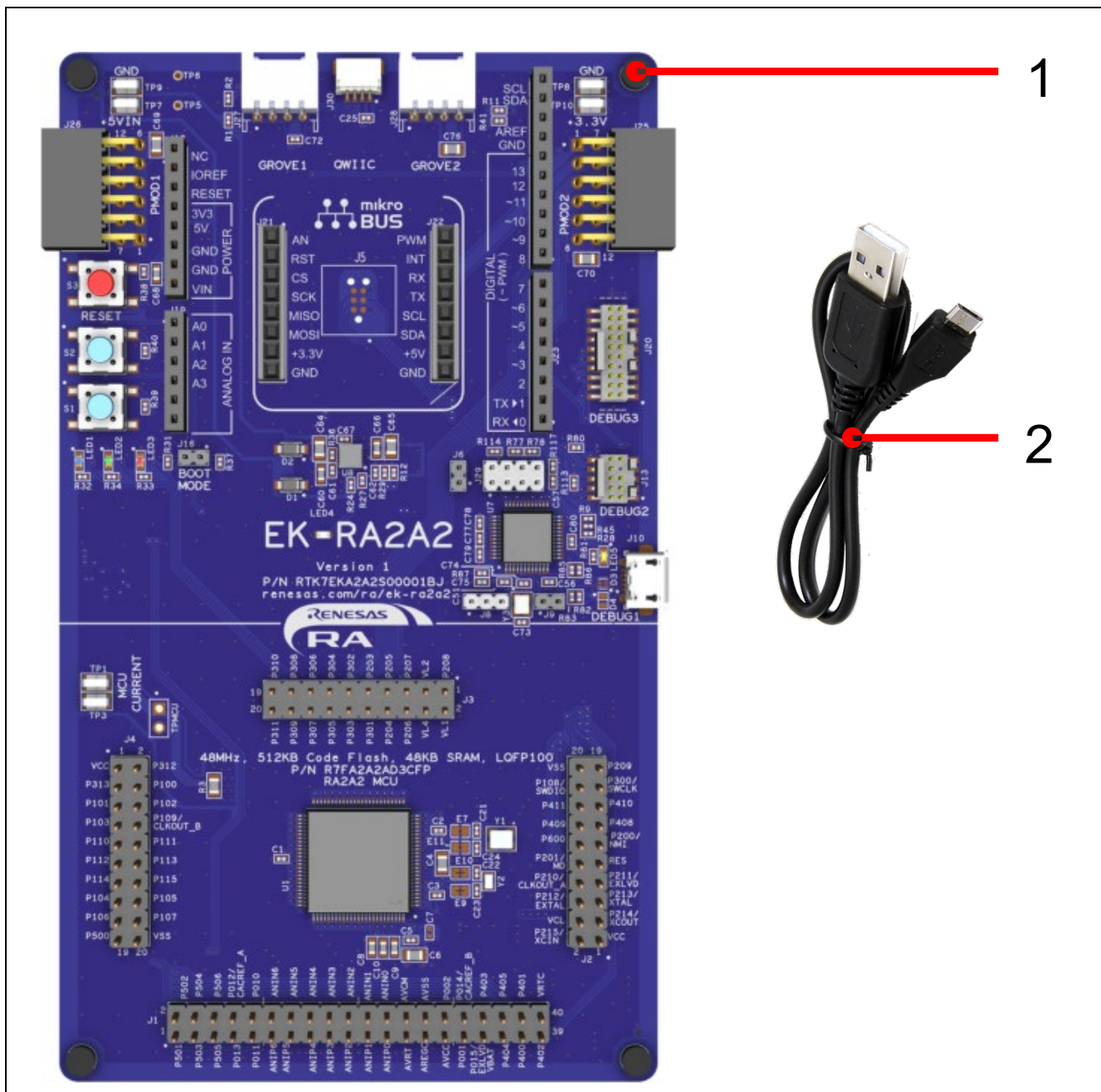
Figure 3.   EK-RA2A2 Kit Contents

3. Ordering Information

- EK-RA2A2 v1 kit orderable part number: RTK7EKA2A2S00001BJ

    Note: The underlined character in the orderable part number represents the kit version.

- EK-RA2A2 board dimensions: 80 mm (width) x 138 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Kit Architecture

The EK-RA2A2 board is designed with three sections or areas to help shorten the learning curve of the users and maximize the design and knowledge reuse among similar kits. The contents of these three areas are conceptually standardized among similar kits.

Table 1. Kit Architecture

Kit area	Area features	Area present on all similar kits	Functionality is:
MCU Native Pin Access Area	RA MCU, breakout pin headers for all MCU I/O and power, current measurement	Yes	MCU dependent
Special Feature Access Area	MCU special features: None	Optional	MCU dependent
System Control and Ecosystem Access Area	Power, Debug MCU, User LED and buttons, reset, ecosystem connectors, USB Full Speed, Boot configuration	Yes	Same or similar across similar kits
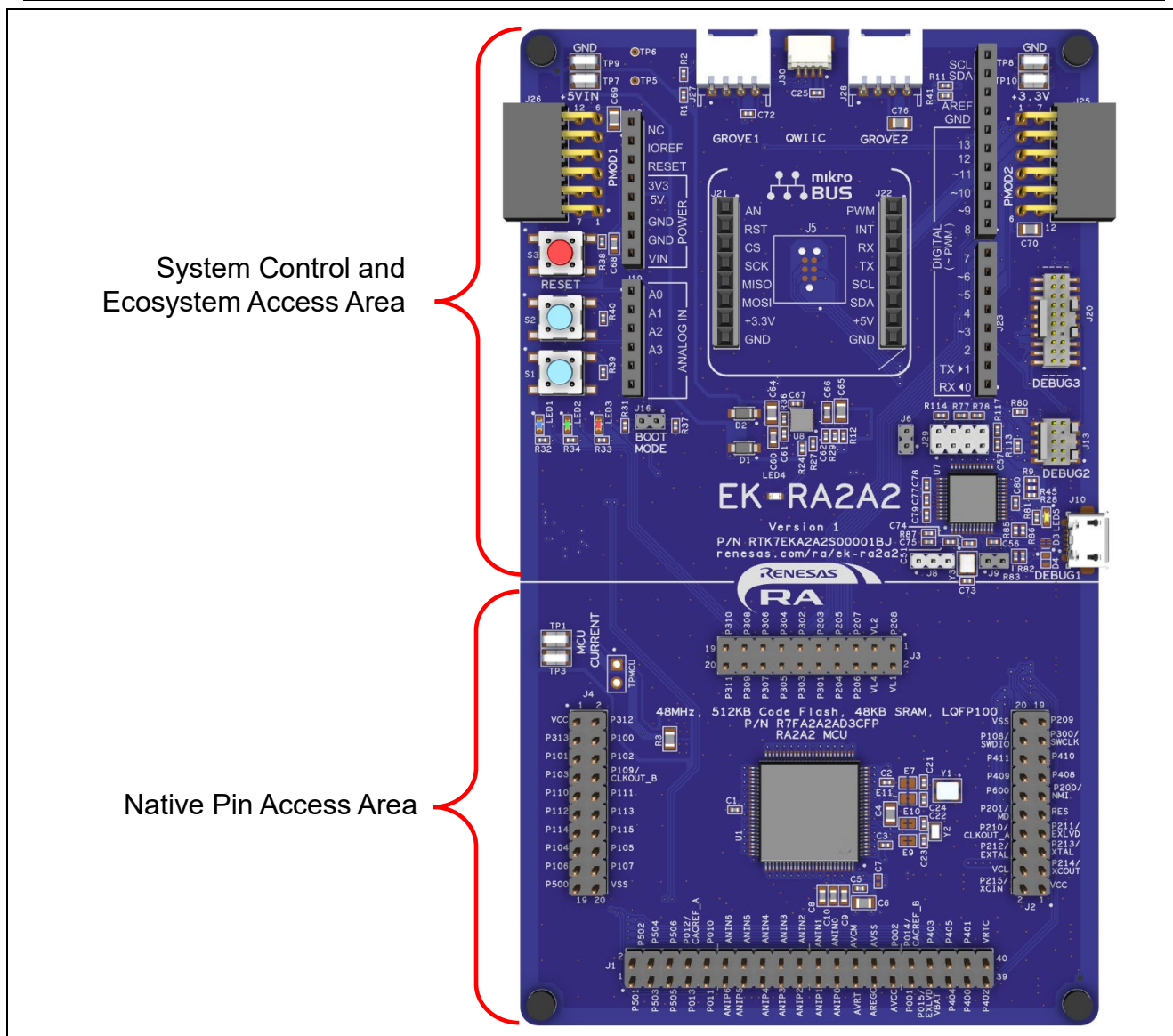
Figure 4. EK-RA2A2 Board Functional Area Definitions

4.2 System Block Diagram
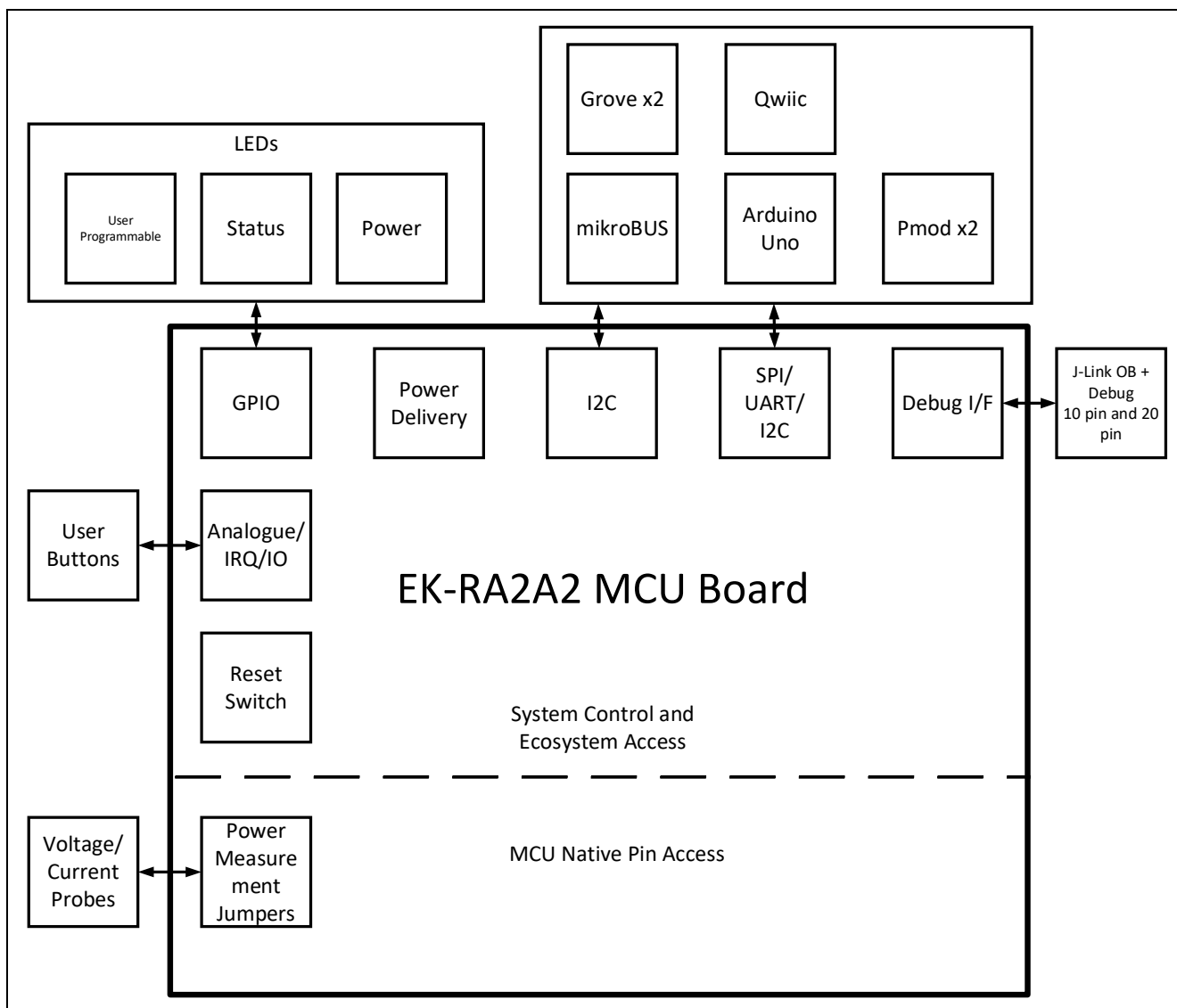
Figure 5. EK-RA2A2 Board Block Diagram

4.3   Jumper Settings

Two types of jumpers are provided on the EK-RA2A2 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.

4.3.1   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 by one of three methods:

* 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, inch 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 6.   Copper Jumpers

4.3.2   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 EK-RA2A2 board are 2 mm pitch headers and require compatible 2 mm shunt jumpers.

4.3.3   Default Jumper Configuration

The following table describes the default settings for each jumper on the EK-RA2A2 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 kits.

Table 2.   Default Jumper Settings

Location	Circuit Group	Default Open/Closed	Function
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	Enables the on-board debugger
J16	MCU boot mode	Open	Configures the MCU for normal boot mode

Location	Circuit Group	Default Open/Closed	Function
J29	J-Link OB	Jumper on pins 1-2 Jumper on pins 3-4 Jumper on pins 5-6 Jumper on pins 7-8	Connects the J-Link OB debugger to the RA MCU
E1	MCU Clock	Open	Connects P214/XCOUT pin to pin header J2 pin 3
E2	MCU Power	Closed	Connects VRTC to +3.3 V
E3	MCU Power	Closed	Connects AVCC to +3.3 V
E4	MCU Power	Closed	Connects AVSS to GND
E5	MCU Power	Open	Connects REFL0 to GND
E6	MCU Power	Open	Connects VREFH0 to +3.3 V
E7	MCU Clock	Open	Connects P212/EXTAL pin to 20 MHz crystal
E8	MCU Clock	Closed	Connects P215/XCIN pin to pin header J2 pin 2
E9	MCU Clock	Closed	Connects P215/XCIN pin to 32.768 kHz crystal
E10	MCU Clock	Closed	Connects P214/XCOUT pin to 32.768 kHz crystal
E11	MCU Clock	Open	Connects P213/XTAL pin to 20MHz crystal
E12	MCU Clock	Closed	Connects P213/XTAL pin to pin header J2 pin 5
E13	MCU Clock	Closed	Connects P212/EXTAL pin to pin header J2 pin 6
E16	Pmod 2	Closed	Connects +3.3 V to Pmod 2 pin 6 and pin 12
E17	Pmod 2	Open	Connects +5.0 V to Pmod 2 pin 6 and pin 12
E18	Pmod 1	Open	Connects P012 (SCL1) to Pmod 1 pin 3
E19	Pmod 1	Open	Connects P013 (SDA1) to Pmod 1 pin 4
E20	Pmod 1	Closed	Connects P403 (MISOA) to Pmod 1 pin 3
E21	Pmod 1	Closed	Connects P405 (RSPCKA) to Pmod 1 pin 4
E22	I²C	Closed	Connects P012 (SCL1) to Pull-up
E23	I²C	Closed	Connects P013 (SDA1) to Pull-up
E26	User LED	Closed	Connects P308 to user LED2
E27	User LED	Closed	Connects P307 to user LED1
E28	User LED	Closed	Connects P309 to user LED3
E29	Debug MCU Power	Closed	Connects the debug MCU power to +3.3 V
E30	JTAG	Closed	Connects the JTAG GND detect pin on J20 and J13 to GND
E31	User Switch	Closed	Connects P200 to user switch S1
E32	User Switch	Closed	Connects P306 to user switch S2
E72	J-Link OB	Closed	Enables debugger TRST signal
E73	I²C	Closed	Connects P411 (SCL0) to Pull-up
E74	I²C	Closed	Connects P410 (SDA0) to Pull-up
EX1	Pmod 2	Closed	Connects P411 (SCL0) to Pmod 2 pin 3
EX2	Pmod 2	Closed	Connects P410 (SDA0) to Pmod 2 pin 4
EX3	Pmod 2	Open	Connects P500 (RXD3/MISO3) to Pmod 2 pin 3
EX4	Pmod 2	Open	Connects P502 (SCK3) to Pmod 2 pin 4

5.   System Control and Ecosystem Access Area

The following figure shows the System Control and Ecosystem Access area on the EK-RA2A2 board. Subsequent sections detail the features and functionality provided in this area.
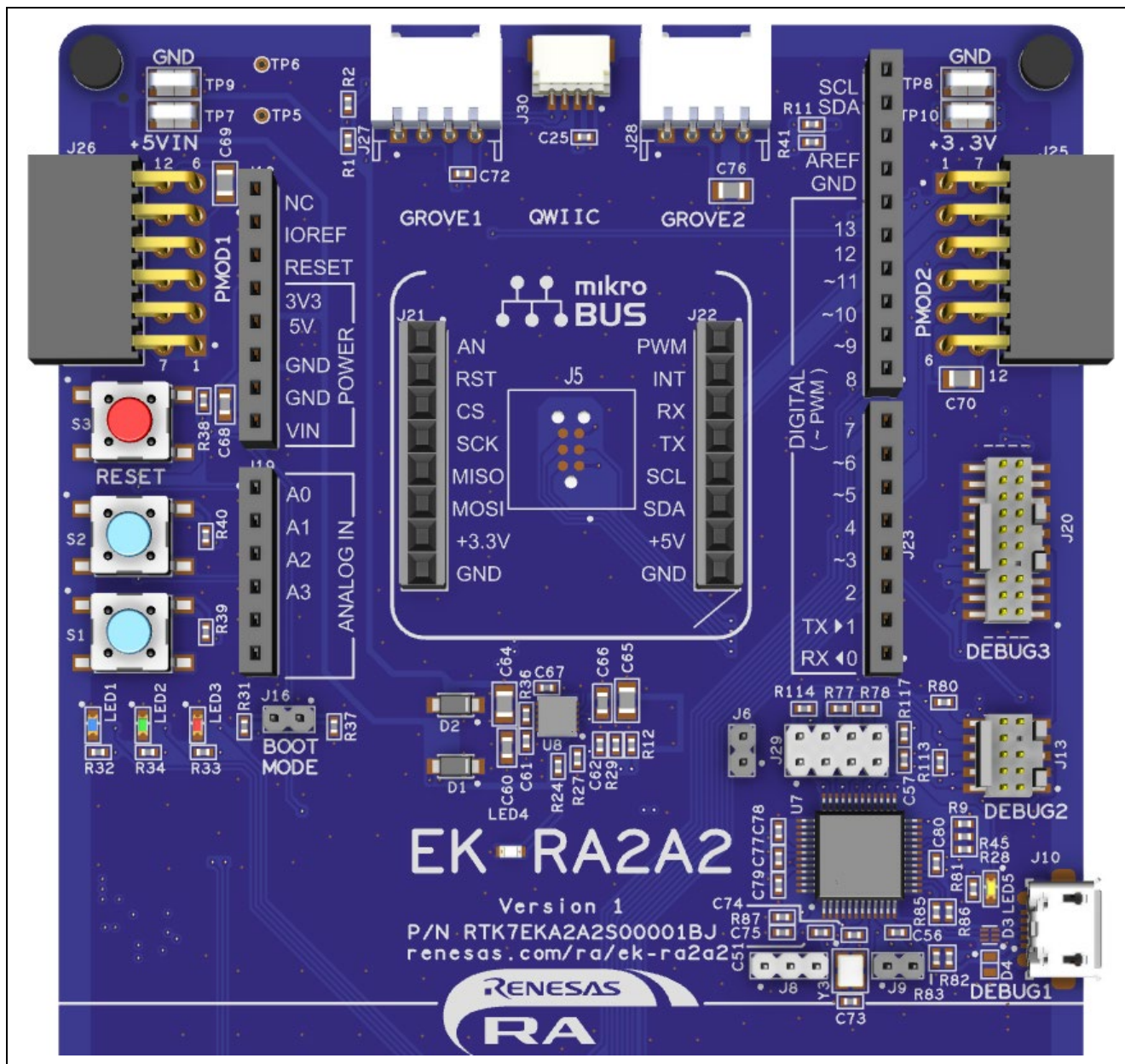
Figure 7.   System Control and Ecosystem Access Area

5.1   Power

The EK-RA2A2 kit is designed for +5 V operation. An on-board Low Dropout Regulator (LDO) 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.

5.1.1   Power Supply Options

This section describes the different ways in which EK-RA2A2 kit can be powered.
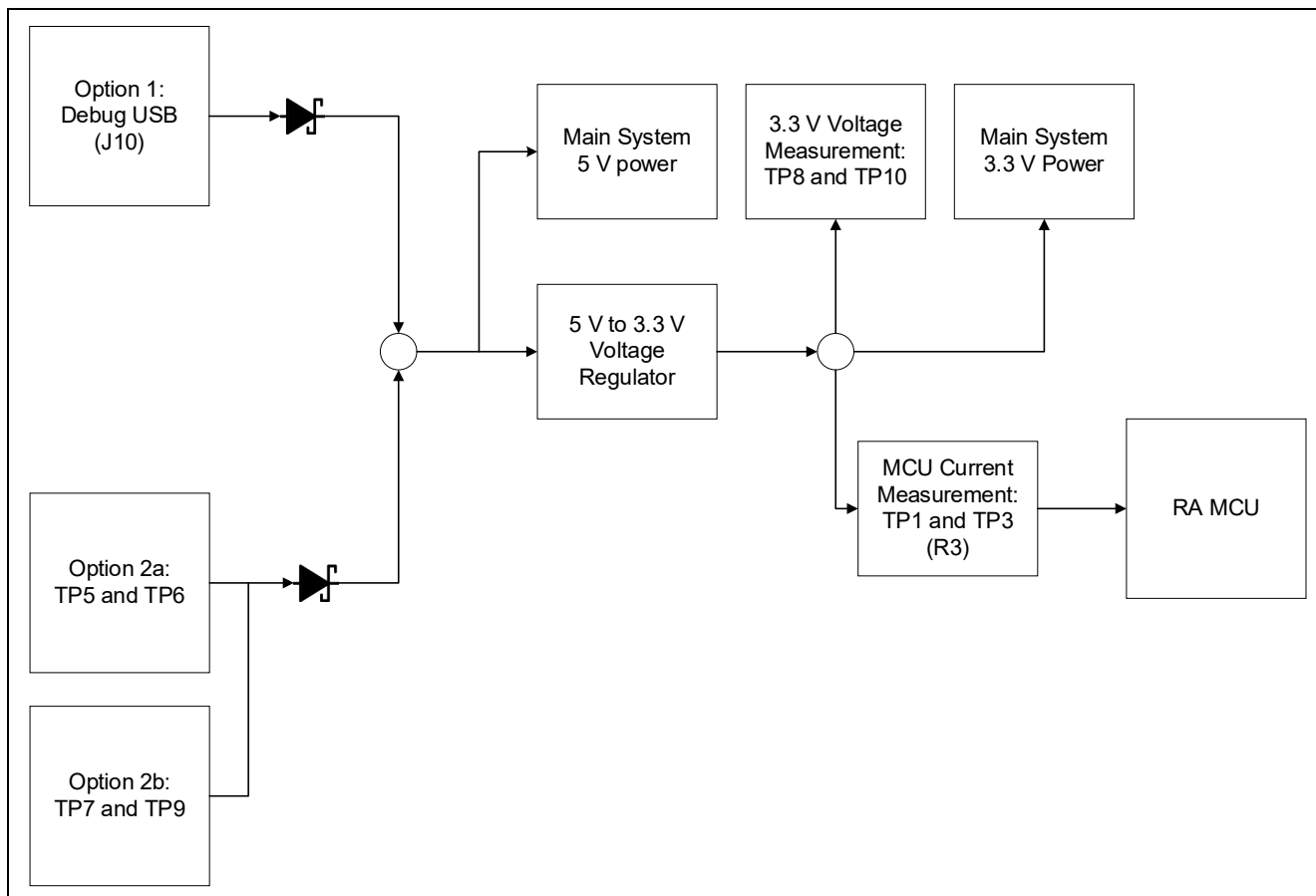
Figure 8.   Power Supply Options

5.1.1.1   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.

5.1.1.2   Option 2: 5 V Input Test Points

5 V may be supplied from an external power supply to test points on the board. TP7 (5 V) and TP9 (GND) are loop-style test points, and TP5 (5 V) and TP6 (GND) are through hole test points. The two types of test points are electrically equivalent, and both are provided for user convenience. 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. These test points can be found at the top left of the board above Pmod 1.

Figure 9.   Test Point Location

5.1.2 Power Supply Considerations

The on-board LDO regulator which supplies +3.3 V has a built-in current limit of 2.0 A. Make sure the total current required by the RA MCU, any active on-board features, and any connected peripheral devices 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.

5.1.3 Power-up Behavior

When powered, the white LED near the center of the board (the "dash" in the EK-RA2A2 name) will light up. For more details on initial power up behavior, see the *EK-RA2A2 Quick Start Guide*.

5.2 Debug

The EK-RA2A2 board supports the following three debug modes.

Table 3. Debug Modes

Debug Modes	Debug MCU (the device that connects to the IDE on your PC)	Target MCU (the device that is being debugged)	Debugging Interface/Protocol	Connector Used
Debug on-board	RA4M2 (on-board)	RA2A2 (on-board)	SWD	Micro USB (J10)
Debug in	External debugging tools	RA2A2 (on-board)	SWD	20-pin connector (J20) or 10-pin connector (J13)
Debug out	RA4M2 (on-board)	Any external RA MCU	SWD, JTAG	Micro USB (J10) plus either 20-pin connector (J20) or 10-pin connector (J13)

Notes:
- See Table 5 for the Debug USB connector pin definitions.
- See Table 8 for the 20-pin JTAG/SWD connector pin definitions.
- See Table 9 for the 10-pin JTAG/SWD connector pin definitions.

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

Table 4. Jumper Connection Summary for Different Debug Modes

Debug Modes	J6	J8	J9	J29
Debug on-board	Closed	Jumper on pins 1-2	Open	Jumpers on pins 1-2, 3-4, 5-6, 7-8
Debug in	Closed	Jumper on pins 1-2	Closed	Jumpers on pins 1-2, 3-4, 5-6, 7-8
Debug out	Open	Jumper on pins 2-3	Open	All pins open

5.2.1 Debug On-Board

The on-board debug functionality is provided using Renesas RA4M2 Debug MCU and SEGGER J-Link® firmware. Debug USB micro-B connector (J10) connects the RA4M2 Debug MCU 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 EK-RA2A2 board.

The RA4M2 debug MCU connects to the target RA MCU using the SWD interface.

Table 5.   Debug USB Connector

Debug USB Connector		EK-RA2A2
Pin	Description	Signal/Bus
J10-1	+5VDC	+5V_USB_DBG
J10-2	Data-	USB_DM (U7 pin 14)
J10-3	Data+	USB_DP (U7 pin 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 EK-RA2A2 board is powered on, and LED5 is blinking, it indicates that the RA4M2 debug MCU is not connected to a programming host. When LED5 is on solid, it indicates that the RA4M2 debug MCU is connected to a programming interface.

To configure the EK-RA2A2 board to use the Debug On-Board mode, configure the jumpers using the following table.

Table 6.   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 nRESET signal
J9	Open	RA4M2 debug MCU in normal operation mode
J29	Jumpers on pins 1-2, 3-4, 5-6, 7-8	Target RA MCU debug signals connected to the debug interface

Figure 10.   EK-RA2A2 Debug Interface

5.2.2   Debug In

One 20-pin Cortex® Debug Connector at J20 supports JTAG and SWD debug. One 10-pin Cortex® Debug Connector at J13 supports JTAG and SWD. Either of these connectors may be used for external debug of the target RA MCU.

To configure the EK-RA2A2 board to use the Debug In mode, configure the jumpers using the following table.

Table 7.   Debug In Mode Jumper Configuration

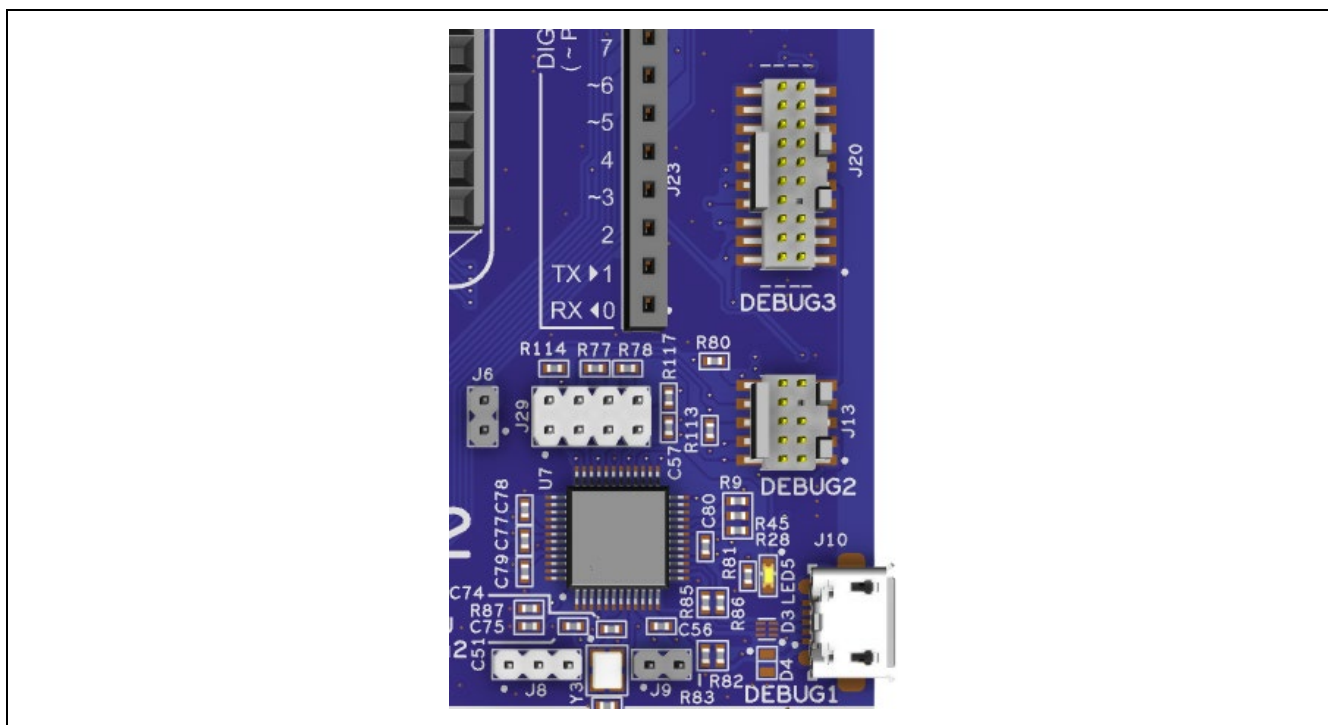| Location	Default Open/Closed	Function
J6	Closed	Target RA MCU MD connected to debug
J8	Jumper on pins 1-2	Target RA MCU RESET# connected to nRESET signal
J9	Closed	RA4M2 debug MCU is held in RESET
J29	Jumpers on pins 1-2, 3-4, 5-6, 7-8	Target RA MCU debug signals connected to the debug interface

Table 8.   JTAG/SWD Connector (J20)

JTAG Connector			EK-RA2A2
Pin	**JTAG Pin Name**	**SWD Pin Name**	**Signal/Bus**
J20-1	Vtref	Vtref	+3V3
J20-2	TMS	SWDIO	P108/SWDIO
J20-3	GND	GND	GND
J20-4	TCK	SWCLK	P300/SWCLK
J20-5	GND	GND	GND
J20-6	TDO	SWO	P109/TXD9
J20-7	Key	Key	NC
J20-8	TDI	NC/EXTb	P110/RXD9
J20-9	GNDDetect	GNDDetect	GND (cut E30 to open)
J20-10	nSRST	nSRST	RESET# (via J8)
J20-11	N/A	N/A	GND
J20-12	N/A	N/A	NC
J20-13	N/A	N/A	GND
J20-14	N/A	N/A	NC
J20-15	N/A	N/A	GND
J20-16	N/A	N/A	TRST
J20-17	N/A	N/A	GND
J20-18	N/A	N/A	NC
J20-19	N/A	N/A	GND
J20-20	N/A	N/A	NC

Table 9.   JTAG/SWD Connector (J13)

JTAG Connector			EK-RA2A2
Pin	**JTAG Pin Name**	**SWD Pin Name**	**Signal/Bus**
J13-1	Vtref	Vtref	+3V3
J13-2	TMS	SWDIO	P108/SWDIO
J13-3	GND	GND	GND
J13-4	TCK	SWCLK	P300/SWCLK
J13-5	GND	GND	GND
J13-6	TDO	SWO	P109
J13-7	Key	Key	NC
J13-8	TDI	NC/EXTb	P110
J13-9	GNDDetect	GNDDetect	GND (cut E30 to open)
J13-10	nSRST	nSRST	RESET# (via J8)

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

5.2.3   Debug Out

The EK-RA2A2 board can be configured to use the RA4M2 debug MCU to debug target RA MCU on an external board.

A yellow indicator, LED5, shows the visual status of the debug interface. When the EK-RA2A2 board is powered on, and LED5 is blinking, this indicates that the RA4M2 debug MCU is not connected to a programming host. When LED5 is on solid, this indicates that the RA4M2 debug MCU is connected to a programming interface.

To configure the EK-RA2A2 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	RA4M2 debug MCU in normal operation mode
J29	All jumpers removed	Disconnects the on-board RA MCU debug signals from the debug interface

5.3 Ecosystem

The System Control and Ecosystem area provides users the option to simultaneously connect several third-party add-on modules compatible with five most popular ecosystems using the following connectors:

1. Two Seeed Grove system (I^{2}C/ANALOG) connectors
2. SparkFun Qwiic® connector
3. Two Digilent Pmod™ (SPI and I^{2}C) connectors
4. Arduino™ (Uno R3) connector
5. MikroElektronika™ mikroBUS connector

5.3.1 Seeed Grove Connectors

5.3.1.1 Grove 1

A Seeed Grove I^{2}C connector is provided at J27. The RA MCU acts as a two-wire serial master, and a connected module acts as a two-wire serial slave.

Table 11. Grove 1 Connector

Grove 1 Connector		EK-RA2A2
Pin	Description	Signal/Bus
J27-1	SCL / AN	P012 (SCL)
J27-2	SDA / AN	P013 (SDA)
J27-3	VCC	+3.3 V
J27-4	GND	GND

5.3.1.2 Grove 2

A Seeed Grove ANALOG connector is provided at J28. The RA MCU acts as two analog (ADC) inputs.

Table 12. Grove 2 Connector

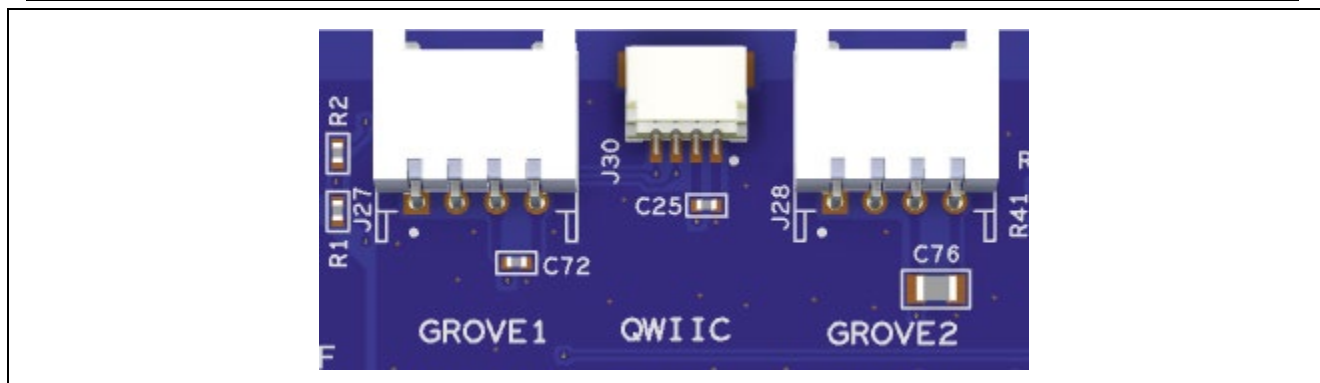| Grove 2 Connector		EK-RA2A2
Pin	Description	Signal/Bus
J28-1	An	P014 (AN000)
J28-2	An+1	P001 (AN001)
J28-3	VCC	+3.3 V
J28-4	GND	GND

Figure 11.   Seeed Grove and SparkFun Qwiic® Connectors

5.3.2 SparkFun Qwiic® Connector

A SparkFun Qwiic® connector is provided at J30. The main MCU acts as a two-wire serial master, and a connected module acts as a two-wire serial slave (data lines are shared with Grove 1).

Table 13. Qwiic Connector

Qwiic Connector		EK-RA2A2
Pin	Description	Signal/Bus
J30-1	GND	GND
J30-2	VCC	+3.3V
J30-3	SDA	P013 (SDA)
J30-4	SCL	P012 (SCL)

5.3.3 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) and Type-3A (expanded UART).

The EK-RA2A2 board also provides jumpers so the 12-pin connector may alternatively be used for Pmod Type-6A (I^2C).

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.

The Pmod interface option for Type-6A (expanded I^2C) may also support +5.0 V devices. Please ensure that only 5 V capable modules are used when this option is selected.

5.3.3.1 Pmod 1

A 12-pin Pmod Type-2A (expanded SPI) and Type-6A (expanded I^2C) connector is provided at J26, Pmod 1. The RA MCU acts as the SPI master, and the connected module acts as an SPI slave device. This interface may additionally be re-configured in firmware as several other Pmod types.

Table 14. Pmod 1 Connector

| Pmod 1 Connector			EK-RA2A2	Pmod 1 Configuration	
Pin	Default Type-2A (SPI)	Option Type-6A (I^2C)	Signal/Bus	Short	Open
J26-1	SS	(INT)	P408 (SSLA0)		
J26-2	MOSI	(RESET)	P404 (MOSIA)		
J26-3	MISO	NC	P403 (MISOA)	E20	E18
	NC	SCL	P100 (SCL)	E18	E20
J26-4	SCK	NC	P405 (RSPCKA)	E21	E19
	NC	SDA	P101 (SDA)	E19	E21
J26-5	GND		GND		
J26-6	VCC		+3.3 V		
J26-7	GPIO / INT (slave to master)		P400*(IRQ9)		
J26-8	GPIO / RESET (master to slave)		P401*		
J26-9	GPIO		P112		
J26-10	GPIO		P103		
J26-11	GND		GND		
J26-12	VCC		+3.3 V		

*: N-ch open drain
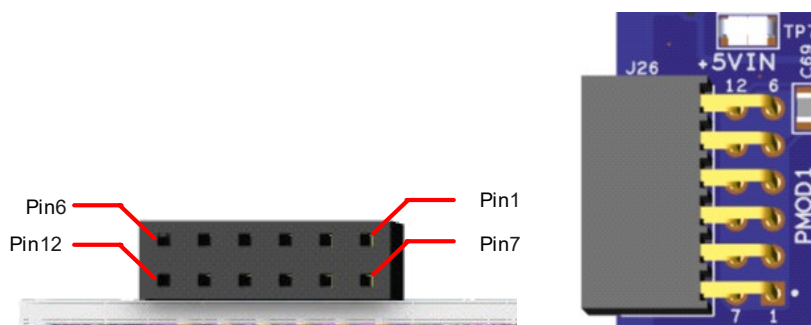
Figure 12. Pmod 1 Connector

5.3.3.2 Pmod 2

A 12-pin Pmod Type-6A (enhanced I^{2}C), Type-2A (enhanced SPI) and Type-3A (enhanced UART) connectors is provided at J25, Pmod 2. This Pmod interface can supply +5.0V by changing the Solder-Bridge/Trace-Cut jumpers(E16 and E17).

Exercise caution while modifying power source Solder-Bridge/Trace-Cut jumpers, E16 and E17. Permanent damage to the EK-RA2A2 board and/or connected modules may result.

Table 15. Pmod 2 Connector

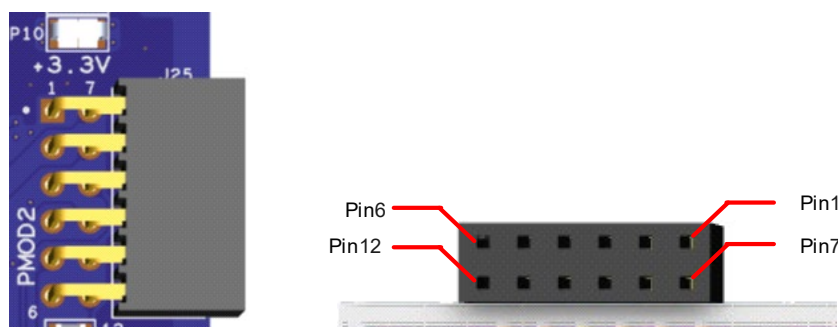| Pmod 2 Connector				EK-RA2A2	Pmod 2 Configuration	
Pin	Option Type-2A (SPI)	Option Type-3A (UART)	Default Type-6A (I^{2}C)	Signal/Bus	Short	Open
J25-1	CS	CTS	NC(INT)	P503(IRQ7/CTS3_RTS3/SS3)		
J25-2	MOSI	TXD	NC(RESET)	P501(TXD3/MOSI3)		
J25-3	MISO	RXD	NC	P500(RXD3/MISO3)	Ex3	Ex1
	NC	NC	SCL	P411(SCL0)	Ex1	Ex3
J25-4	SCK	RTS*	NC	P502(SCK3)	Ex4	Ex2
	NC	NC	SDA	P410(SDA0)	Ex2	Ex4
J25-5	GND			GND		
J25-6	VCC			+3.3V	E16	E17
				+5.0V	E17	E16
J25-7	GPIO(INT)		GPIO	P310(IRQ4)		
J25-8	GPIO(RESET)		GPIO	P203		.
J25-9	GPIO			P204		
J25-10	GPIO			P205		
J25-11	GND			GND		
J25-12	VCC			+3.3V	E16	E17
				+5.0V	E17	E16

Figure 13. Pmod 2 Connector

5.3.4 Arduino™ Connector

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

Table 16. Arduino Uno Connections

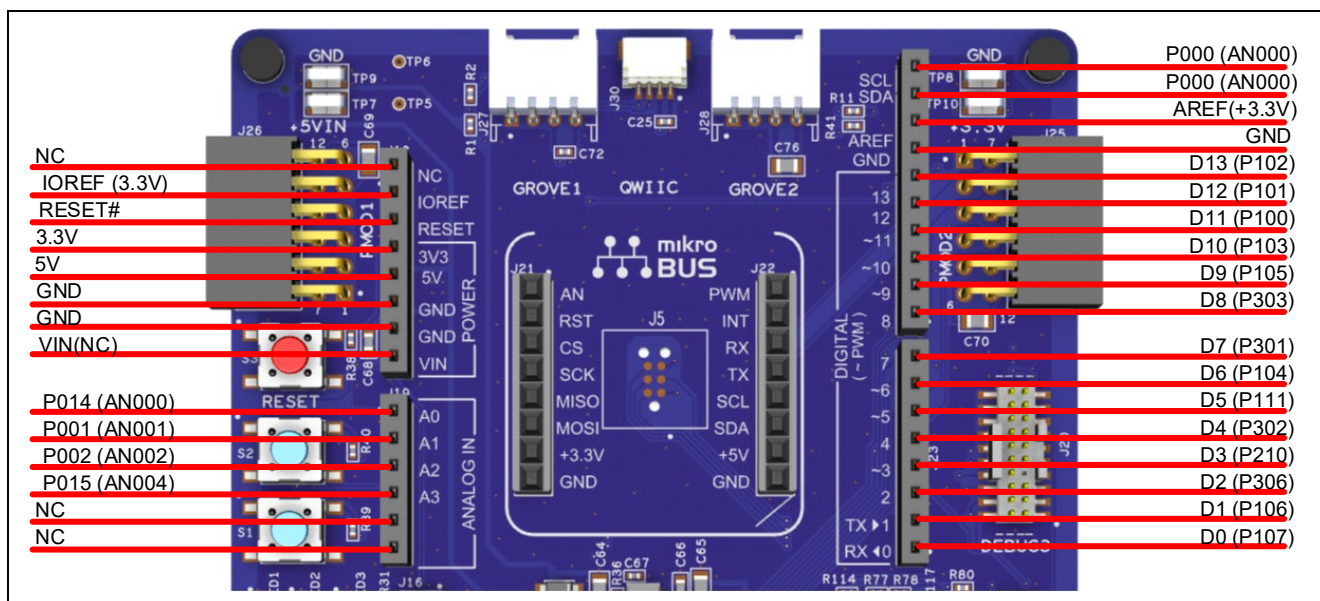| Arduino Compatible Connector				EK-RA2A2
Pin	Description			Signal/Bus
J18-1	NC			NC
J18-2	IOREF			+3.3V
J18-3	RESET			RESET#
J18-4	3.3V			+3.3V
J18-5	5 V			+5V
J18-6	GND			GND
J18-7	GND			GND
J18-8	VIN			NC
J19-1	A0			P014 (AN000)
J19-2	A1			P001 (AN001)
J19-3	A2			P002 (AN002)
J19-4	A3			P015 (AN004)
J19-5	A4			NC
J19-6	A5			NC
J23-1	D0	RXD		P107 (GPIO/RXD2)
J23-2	D1	TXD		P106 (GPIO/TXD2)
J23-3	D2	INT0		P306 (GPIO/IRQ0)
J23-4	D3	INT1	PWM	P210 (GPIO/IRQ8/GTIOC5B)
J23-5	D4			P302 (GPIO)
J23-6	D5		PWM	P111 (GPIO/GTIOC5A)
J23-7	D6		PWM	P104 (GPIO/GTIOC8A)
J23-8	D7			P301 (GPIO)
J24-1	D8			P303 (GPIO)
J24-2	D9		PWM	P105 (GPIO/GTIOC8B)
J24-3	D10	SPI_SS	PWM	P103 (GPIO/SS0/GTIOC6B)
J24-4	D11	SPI_MOSI	PWM	P100 (GPIO/MOSI0/GTIOC8A)
J24-5	D12	SPI_MISO		P101 (GPIO/MISO0)
J24-6	D13	SPI_SCK		P102 (GPIO/SCK0)
J24-7	GND			GND
J24-8	AREF			+3.3V
J24-9	SDA			P410 (SDA0)
J24-10	SCL			P411 (SCL0)

Figure 14.   Arduino Uno Connectors

5.3.5   MikroElektronika mikroBUS™ Connector

In the center of the System Control and Ecosystem Access area is a mikroBUS compatible connector interface. This interface is compliant with mikroBUS Standard Specifications revision 2.00.

Table 17. mikroBUS Connections

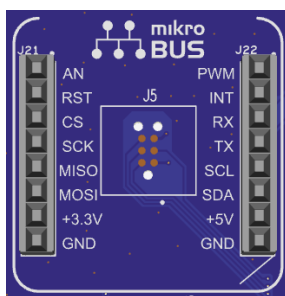| mikroBUS Connector		EK-RA2A2
Pin	**Description**	**Signal/Bus**
J21-1	AN (Analog)	P014 (AN000)
J21-2	RST (Reset)	P313
J21-3	CS (SPI Chip Select)	P408 (SSLA0)
J21-4	SCK (SPI Clock)	P405 (RSPCKA)
J21-5	MISO	P403 (MISOA)
J21-6	MOSI	P404 (MOSIA)
J21-7	+3.3 V	+3.3V
J21-8	GND	GND
J22-1	PWM	P409 (GTIOC9B)
J22-2	INT (Hardware Interrupt)	P402* (IRQ11)
J22-3	RX (UART Receive)	P101 (RXD0)
J22-4	TX (UART Transmit)	P100 (TXD0)
J22-5	SCL (I2C Clock)	P012 (SCL1)
J22-6	SDA(I2C Data)	P013 (SDA1)
J22-7	+5 V	+5V
J22-8	GND	GND

*: N-ch open drain

Figure 15.   mikroBUS Connection

5.4 Miscellaneous

5.4.1 User and Power LEDs

Five LEDs are provided on the EK-RA2A2 board.

Behavior of the LEDs on the EK-RA2A2 board is described in the following table.

Table 18. EK-RA2A2 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Blue	User LED	P307
LED2	Green	User LED	P308
LED3	Red	User LED	P309
LED4	White	Power on indicator	+3.3V
LED5	Yellow	Debug LED	J-Link OB MCU

The user LEDs may be isolated from the main MCU so the associated ports can be used for other purposes. To separate LED1 from P307, trace-cut jumper E27 must be open. To separate LED2 from P308, trace-cut jumper E26 must be open. To separate LED3 from P309, trace-cut jumper E28 must be open.
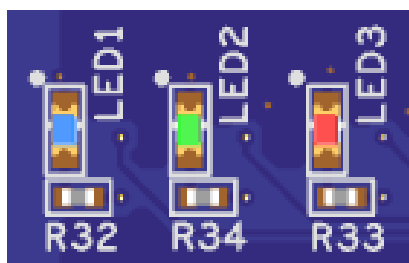

Figure 16.   User LEDs

Figure 17.   Power LED

5.4.2 User and Reset Switches

Three miniature, momentary, mechanical push-button type SMT switches are mounted on the EK-RA2A2 board.

Pressing the reset switch (S3) generates a reset signal to restart the RA MCU.

Table 19. EK-RA2A2 Board Switches

Designator	Function	MCU Control Port	Button Color
S3	MCU Reset Switch	RESET#	Red
S2	User Switch	P306 (IRQ3)	Blue
S1	User Switch	P200 (NMI)	Blue

The User Switches S1 and S2 may be isolated from the main MCU, so the associated ports can be used for other purposes. To separate S1 from P200, trace-cut jumper E31 must be open. To separate S2 from P306, trace-cut jumper E32 must be open.
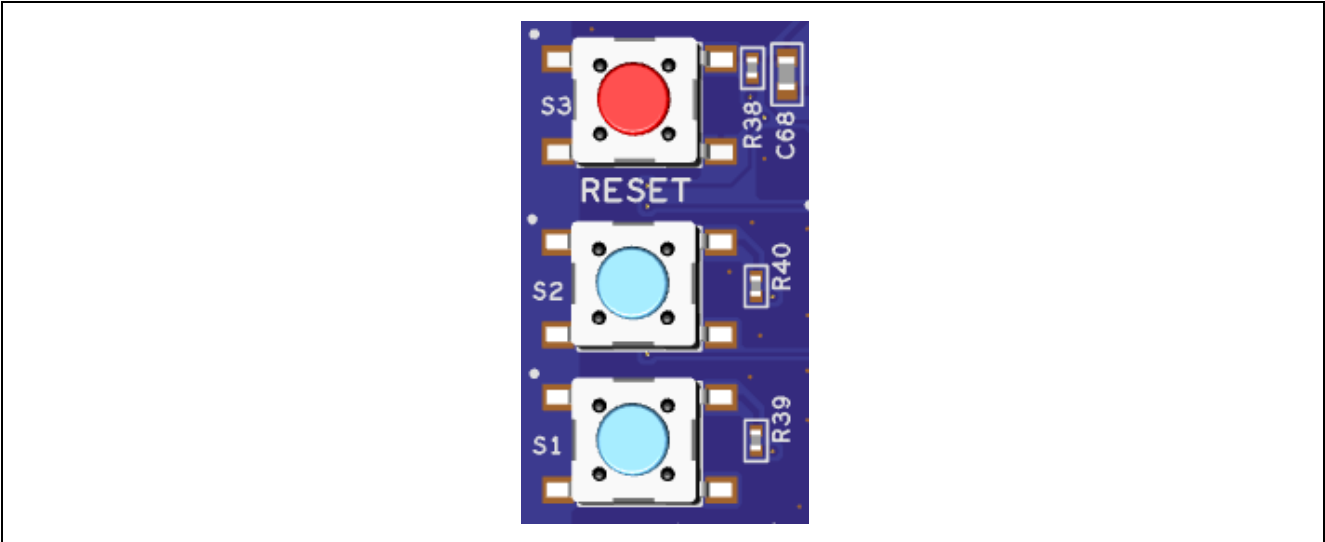
Figure 18. Reset and User Switches

5.4.3 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, place a jumper on J16.

Figure 19. Boot Mode

Note: The RA MCU fitted to the EK-RA2A2 board may not contain the latest version of the on-chip boot firmware.

5.4.4 Crystals

If the sub high-precision crystal oscillator (32.768 kHz) is not needed, then the ports that it is connected to can be used for other purposes.

Table 20. Sub 32.768 kHz Crystal Selection

32.768 kHz **Crystal Oscillator**	Setting
Required	E9 and E10 closed, E1 and E8 open
Not required	E9 and E10 open, E1 and E8 closed. P214 and P215 are available for other purposes

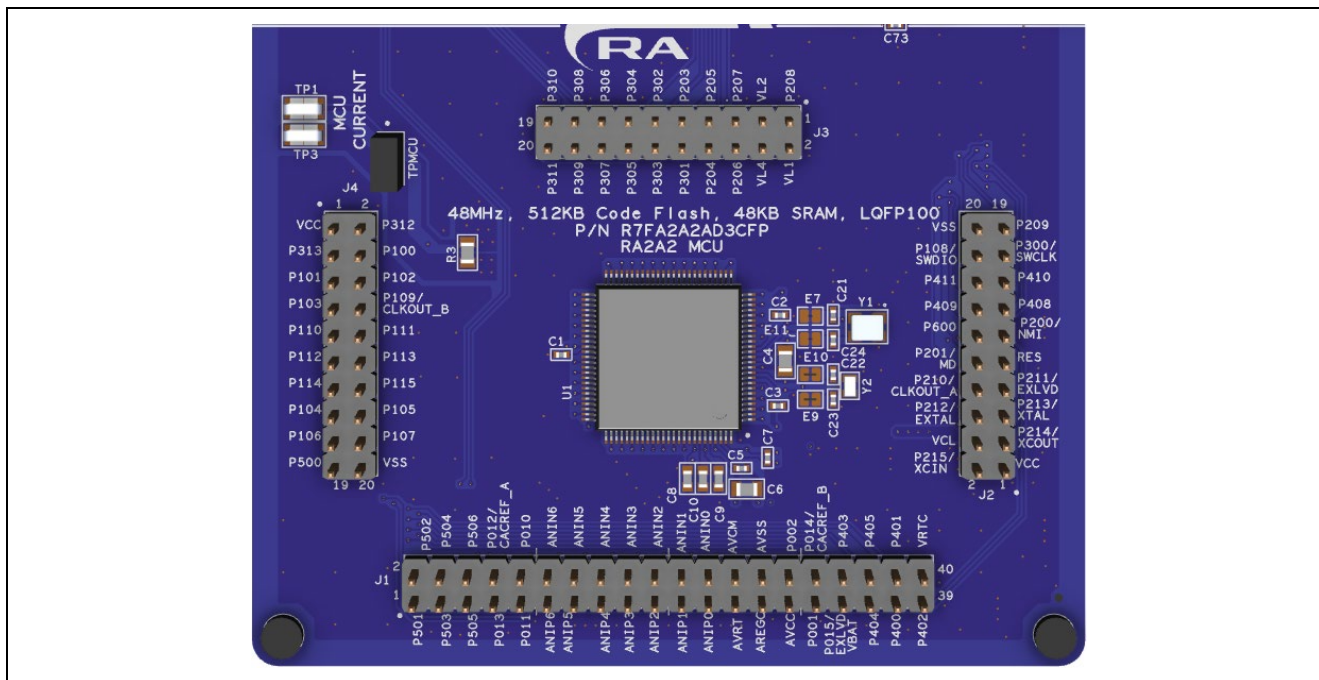## 6. MCU Native Pin Access Area

Figure 20.   MCU Native Pin Access Area

6.1   Breakout Pin Headers

The EK-RA2A2 board pin headers, J1, J2, J3 and J4, provide access to all RA MCU interface signals, and to voltages for all RA MCU power ports. Each header pin is labeled with the voltage or port connected to that pin. Refer to the RA2A2 MCU Group User's Manual for details of each port function, and the EK-RA2A2 board schematic for pin header port assignments.

The placement of the breakout pin headers allows for a standard 2.54 mm (0.100") center breadboard to be placed on all four pin headers simultaneously. This can be used for prototyping and testing of custom circuitry for use with the RA2A2 MCU.

6.2   Current Measurement

Included in the MCU Native Pin Access area is a current measurement resistor and test points to measure the MCU core power current.

The EK-RA2A2 board provides a precision 5 mΩ resistor (Vishay, part number WSLP08055L000FEA18) for current measurement of the main 3.3 V MCU power. Measure the voltage drop across these resistors and use Ohm's Law to calculate the current. For convenience, TP1 and TP3 are provided to measure the main 3.3 V MCU power. See Figure 22 for the location of TP1 and TP3.
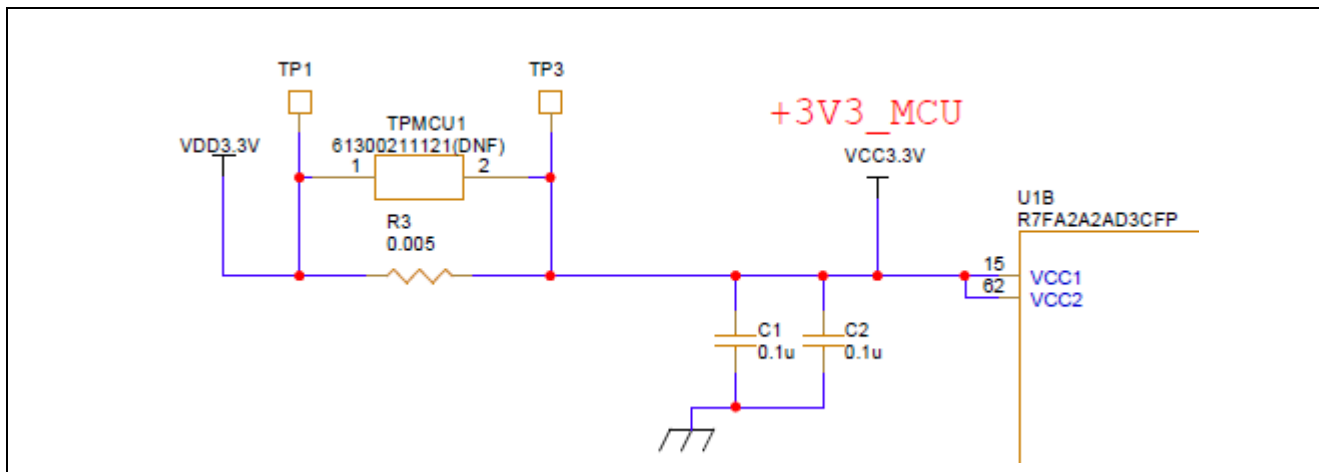

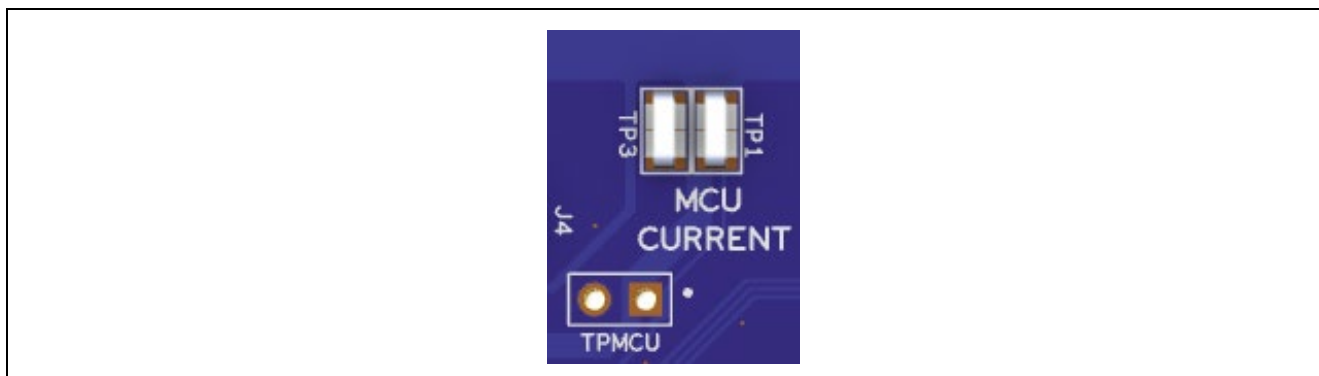**Figure 21.   RA +3.3 V Current Measurement Circuit**

Figure 22.   RA MCU Current Measurement

7. Certifications

The EK-RA2A2 v1 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
- China SJ/T 113642014, 10-year environmental protection use period.
- WEEE Directive (2012/19/EU) & The Waste Electrical and Electronic Equipment Regulations 2013

The WEEE (Waste Electrical and Electronic Equipment) regulations put responsibilities on producers for the collection and recycling or disposal of electrical and electronic waste. Return of WEEE under these regulations is applicable in the UK and European Union.

 This equipment (including all accessories) is not intended for household use. After use the equipment cannot be disposed of as household waste, and the WEEE must be treated, recycled and disposed of in an environmentally sound manner.

Renesas Electronics Europe GmbH can take back end of life equipment. Register for this service at;
https://www.renesas.com/eu/en/support/regional-customer-support/weee

7.3   Safety Standards

- UL 94V-0

8.   Design and Manufacturing Information

The design and manufacturing information for the EK-RA2A2 v1 kit is available in the "EK-RA2A2 v1 Design Package" available on renesas.com/ra/ek-ra2a2.

- Design package file name: ek-ra2a2-v1-designpackage.zip
- Design package contents

Table 21. EK-RA2A2 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	ek-ra2a2-v1-schematics
File (PDF)	Mechanical Drawing	ek-ra2a2-v1-mechdwg
File (PDF)	3D Drawing	ek-ra2a2-v1-3d
File (PDF)	BOM	ek-ra2a2-v1-bom
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files - OrCAD_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.

EK-RA2A2 Resources	renesas.com/ra/ek-ra2a2
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

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

		Description	
Rev.	Date	Page	Summary
1.00	Feb.20.24	—	Initial release

EK-RA2A2 v1 – User's Manual

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