

RA8M1 Group

Evaluation Kit for RA8M1 Microcontroller Group
EK-RA8M1 v1
User's Manual

Renesas RA Family
RA8 Series

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2. Processing at power-on

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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

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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-RA8M1 v1
Contents

1.	Kit Overview	4
1.1	Assumptions and Advisory Notes.....	7
2.	Kit Contents	8
3.	Ordering Information.....	8
4.	Hardware Architecture and Default Configuration	9
4.1	Kit Architecture	9
4.2	System Block Diagram	11
4.3	Jumper Configuration	12
4.3.1	Copper Jumpers	12
4.3.2	Traditional Pin Header Jumpers.....	12
4.3.3	Default Jumper Configuration.....	13
5.	System Control and Ecosystem Access Area	15
5.1	Power	16
5.1.1	Power Supply Options.....	16
5.1.2	Power Supply Considerations	17
5.1.3	Power-up Behavior	17
5.2	Debug and Trace.....	17
5.2.1	Debug On-Board	18
5.2.2	Debug In	19
5.2.3	Debug Out	20
5.3	Ecosystem	20
5.3.1	Seeed Grove® Connectors	20
5.3.2	SparkFun® Qwiic Connector.....	21
5.3.3	Digilent Pmod™ Connectors.....	21
5.3.4	Arduino™ Connector	23
5.3.5	MikroElektronika™ mikroBUS Connector	25
5.4	Connectivity	26
5.4.1	USB Full Speed	26
5.4.2	I3C	26
5.5	Miscellaneous.....	27
5.5.1	User and Power LEDs.....	27
5.5.2	User and Reset Switches	27
5.5.3	MCU Boot Mode	28

5.5.4	Crystals.....	28
6.	Special Feature Access Area.....	29
6.1	CAN FD Bus.....	29
6.2	Ethernet.....	30
6.3	USB High Speed.....	31
6.4	Octo-SPI Flash.....	32
7.	MCU Native Pin Access Area.....	33
7.1	Breakout Pin Headers.....	33
7.2	MCU and USB Current Measurement.....	34
8.	Certifications.....	35
8.1	EMC/EMI Standards.....	35
8.2	Material Selection, Waste, Recycling and Disposal Standards.....	35
8.3	Safety Standards.....	35
9.	Design and Manufacturing Information.....	36
10.	Website and Support.....	36
	Revision History.....	37

Figures

Figure 1.	EK-RA8M1 Board Top Side.....	5
Figure 2.	EK-RA8M1 Board Bottom Side.....	6
Figure 3.	EK-RA8M1 Kit Contents.....	8
Figure 4.	EK-RA8M1 Board Functional Area Definitions.....	10
Figure 5.	EK-RA8M1 Board Block Diagram.....	11
Figure 6.	Copper Jumpers.....	12
Figure 7.	System Control and Ecosystem Access Area.....	15
Figure 8.	Power Supply Options.....	16
Figure 9.	Test Point Location.....	17
Figure 10.	EK-RA8M1 Debug Interface.....	18
Figure 11.	Seeed Grove and SparkFun Qwiic® Connectors.....	21
Figure 12.	Pmod 1 Connector.....	22
Figure 13.	Pmod 2 Connector.....	23
Figure 14.	Arduino Uno Connectors.....	24
Figure 15.	mikroBUS Connection.....	25
Figure 16.	USB Full Speed Connector.....	26
Figure 17.	User LEDs.....	27
Figure 18.	Power LED.....	27
Figure 19.	Reset and User Switches.....	28

Figure 20. Boot Mode	28
Figure 21. Special Feature Access Area	29
Figure 22. CAN FD Bus	29
Figure 23. Ethernet Connector	30
Figure 24. USB High Speed Connector.....	31
Figure 25. Octo-SPI Flash.....	32
Figure 26. Native Pin Access Area.....	33
Figure 27. RA USB Current Measurement Circuit.....	34
Figure 28. RA +3.3 V Current Measurement Circuit.....	34
Figure 29. RA MCU and USB Current Measurement.....	34

Tables

Table 1. Kit Architecture	9
Table 2. Default Jumper Configuration.....	13
Table 3. Debug Modes	17
Table 4. Jumper Connection Summary for Different Debug Modes	18
Table 5. Debug USB Port Assignments	18
Table 6. Debug On-Board Jumper Configuration.....	18
Table 7. Debug In Mode Jumper Configuration	19
Table 8. JTAG/SWD/ETM Debug Port Assignments	19
Table 9. JTAG/SWD Debug Port Assignments	19
Table 10. Debug Out Jumper Configuration	20
Table 11. Grove 1 Port Assignments	20
Table 12. Grove 2 Port Assignments	21
Table 13. Qwiic Port Assignments	21
Table 14. Pmod 1 Port Assignments	22
Table 15. Pmod 2 Port Assignments	23
Table 16. Arduino Uno Port Assignments.....	23
Table 17. mikroBUS Assignments	25
Table 18. USB Full Speed Port Assignments	26
Table 19. I ² C/I ³ C Pullup Configuration	26
Table 20. EK-RA8M1 Board LED Functions.....	27
Table 21. EK-RA8M1 Board Switches	27
Table 22. Main 20 MHz Crystal Configuration	28
Table 23. CAN FD bus connections between U21 and RA8M1	29
Table 24. CAN FD Port Assignments	29
Table 25. Ethernet Port Assignments	30
Table 26. Ethernet Components	30
Table 27. USB High Speed Port Assignments	31
Table 28. Octo-SPI Flash Port Assignments	32

Table 29. EK-RA8M1 Board Design Package Contents.....	36
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1. Kit Overview

The EK-RA8M1, an Evaluation Kit for RA8M1 MCU Group, enables users to seamlessly evaluate the features of the RA8M1 MCU group and develop embedded systems applications using Flexible Software Package (FSP) and e² studio IDE. The users can utilize 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-RA8M1 board are categorized in three groups (consistent with the architecture of the kit, with one exception) as follows:

MCU Native Pin Access

- R7FA8M1AHECBD MCU (referred to as RA MCU)
- 480 MHz, Arm® Cortex®-M85 core
- 2 MB Code Flash, 1 MB SRAM
- 224 pins, BGA package
- Native pin access through 2 x 50-pin, and 2 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 20.000 MHz and 32,768 Hz reference clocks. Additional low-precision clocks are available internal to the RA MCU

System Control and Ecosystem Access

- USB Full Speed Host and Device (micro-AB connector)
- Four 5 V input sources
 - USB (Debug, Full Speed, High Speed)
 - External power supply (using surface mount clamp test points and power input vias)
- Three Debug modes
 - Debug on-board (SWD)
 - Debug in (ETM, SWD and JTAG)
 - Debug out (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
 - Two Seeed Grove® system (I²C/I³C) connectors
 - One SparkFun Qwiic® connector
 - Two Digilent Pmod™ (SPI, UART and I²C/I³C) connectors
 - Arduino™ (Uno R3) connector
 - MikroElektronika™ mikroBUS connector
- MCU boot configuration jumper

Special Feature Access

- Ethernet (RJ45 RMII interface)
- USB High Speed Host and Device (micro-AB connector)
- 512 Mb (64 MB) External Octo-SPI Flash (present in the MCU Native Pin Access area of the EK-RA8M1 board)
- CAN FD (3-pin header)

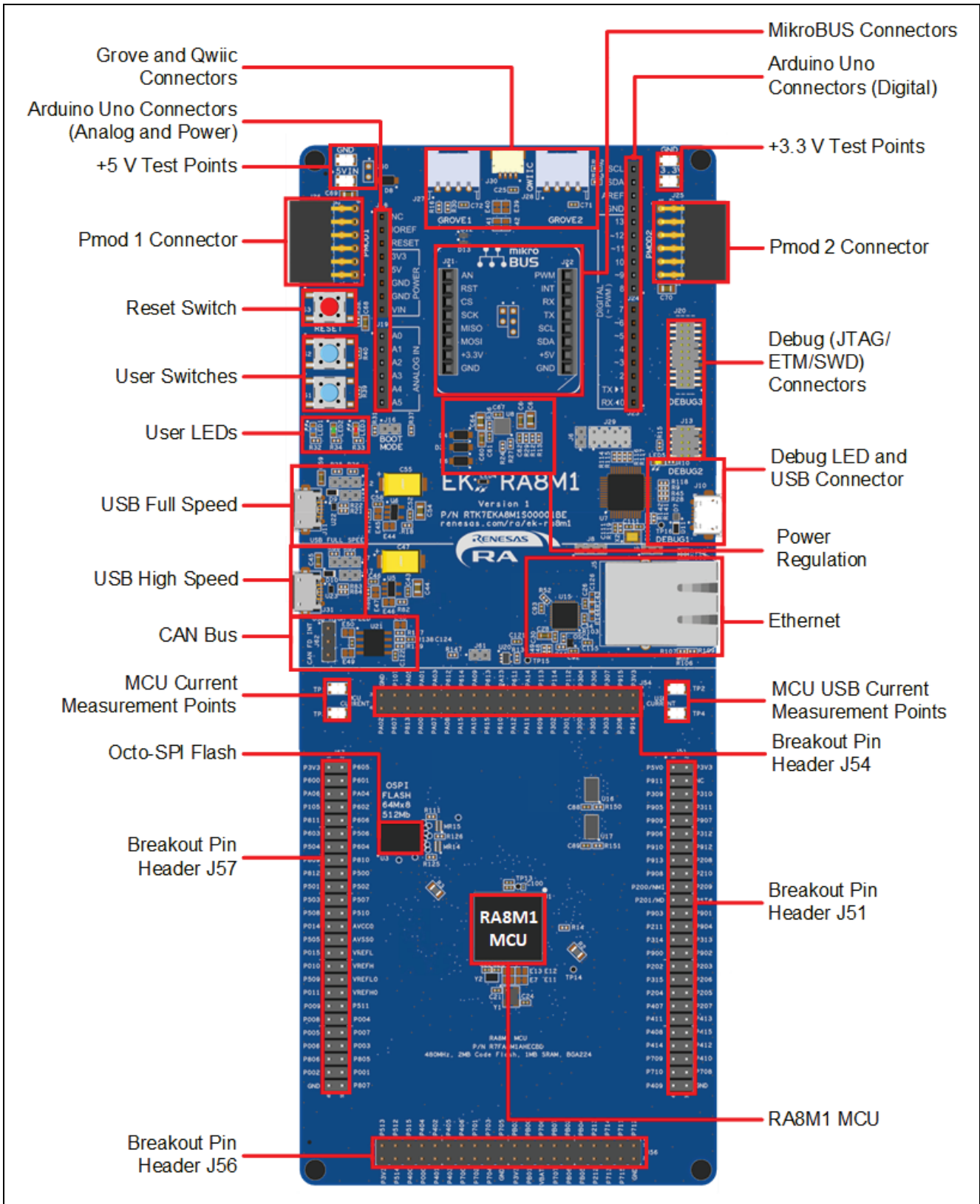


Figure 1. EK-RA8M1 Board Top Side

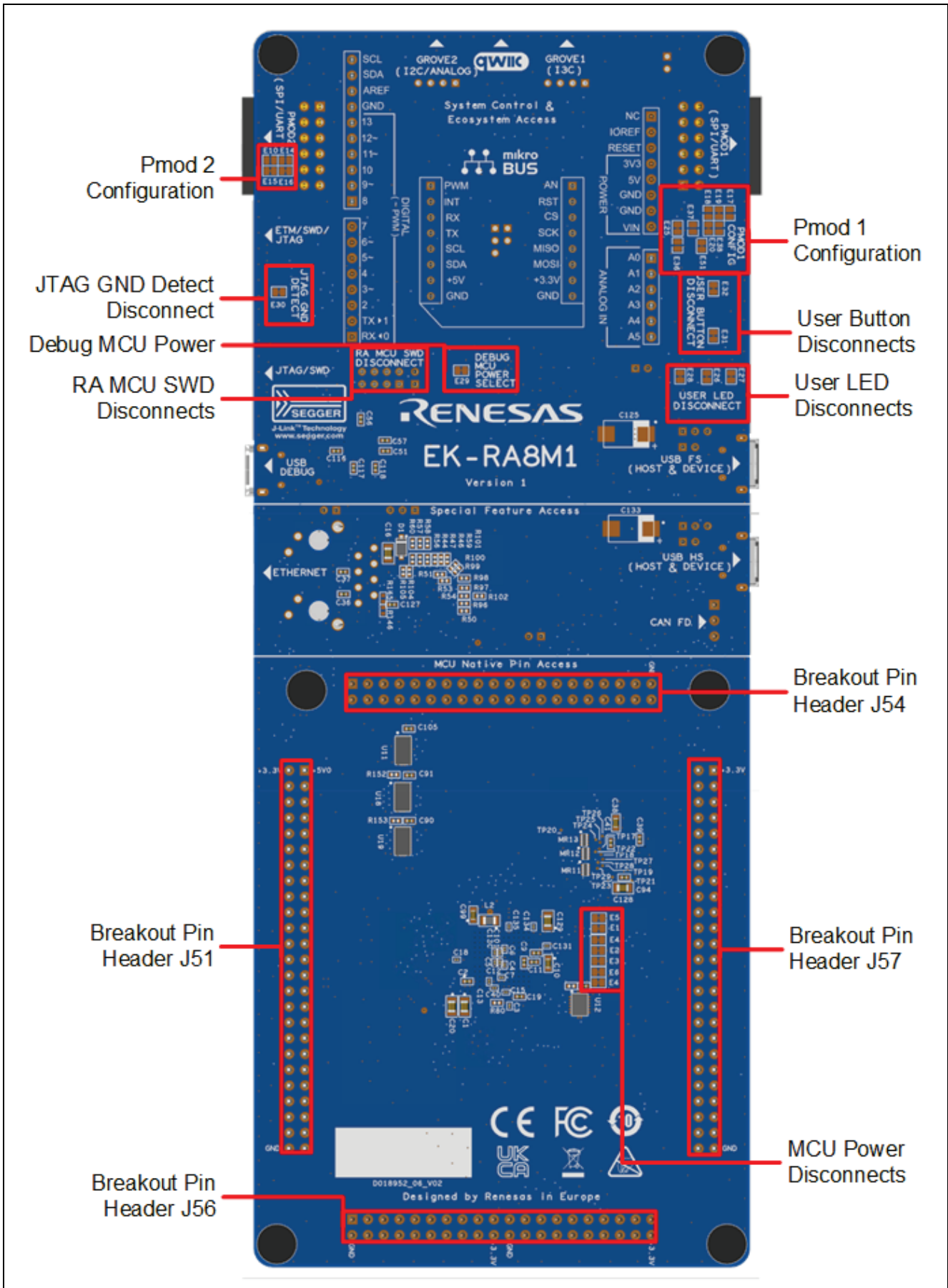


Figure 2. EK-RA8M1 Board Bottom Side

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-RA8M1 Quick Start Guide* to get acquainted with the kit and the Quick Start example project that EK-RA8M1 board comes pre-programmed with.
3. Flexible Software Package (FSP) and Integrated Development Environment (IDE) such as e² studio are required to develop embedded applications on EK-RA8M1 kit.
4. Instructions to download and install software, import example projects, build them and program the EK-RA8M1 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-RA8M1 v1 board
2. Micro USB device cable (type-A male to micro-B male)
3. Micro USB host cable (type-A female to micro-B male)
4. Ethernet patch cable

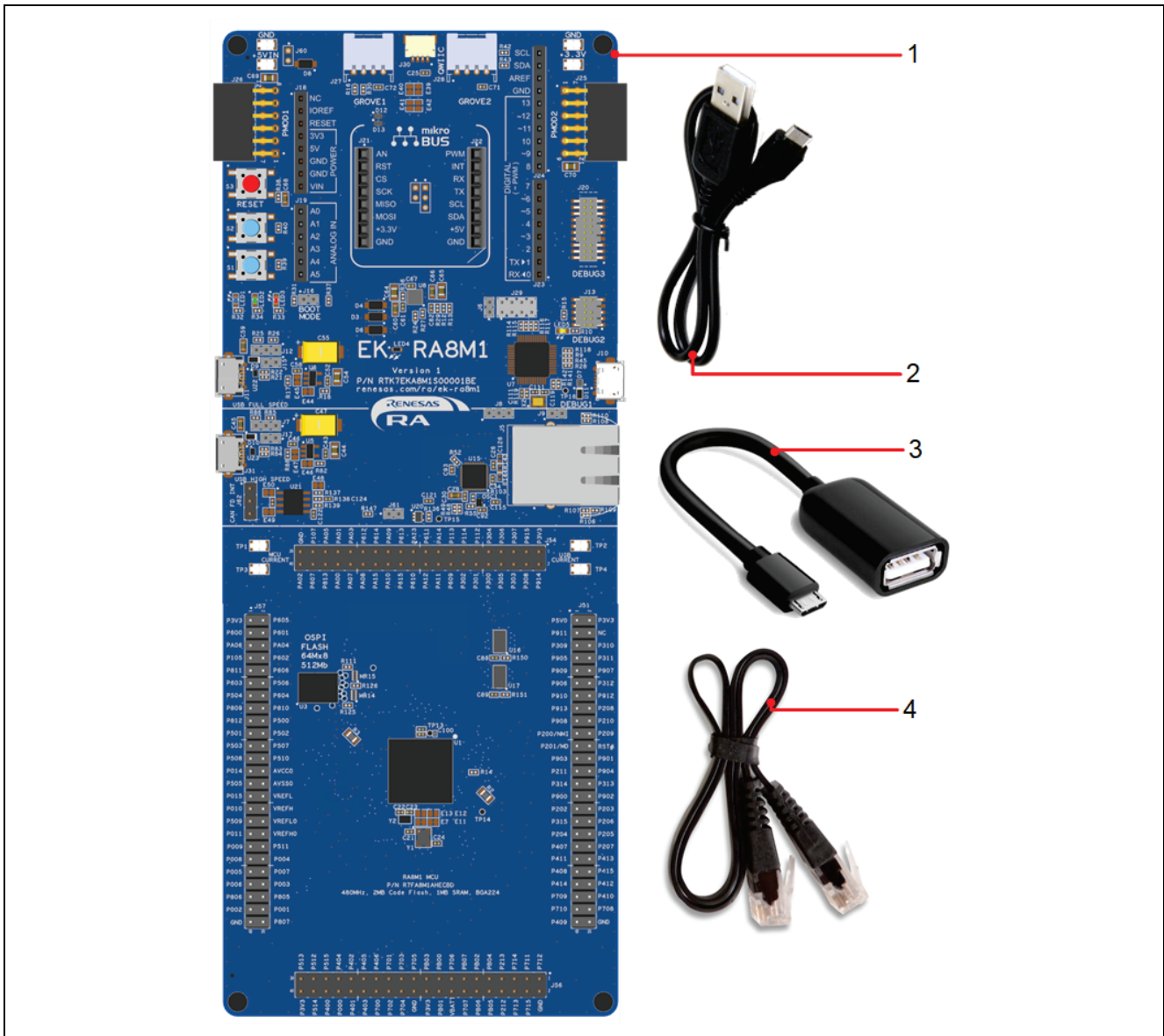


Figure 3. EK-RA8M1 Kit Contents

3. Ordering Information

- EK-RA8M1 v1 kit orderable part number: RTK7EKA8M1S00001BE

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

- EK-RA8M1 board dimensions: 80 mm (width) x 200 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Kit Architecture

The EK-RA8M1 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, and Octo-SPI Flash	Yes	MCU dependent
Special Feature Access Area	MCU special features: Ethernet, USB High Speed Host and Device, and CAN FD	Optional	MCU dependent
System Control and Ecosystem Access Area	Power, Debug MCU, User LED and buttons, reset, ecosystem connectors, USB Full Speed Host and Device, and Boot configuration	Yes	Same or similar across similar kits

Note: The Octo-SPI Flash is among the Special Feature Access features. Normally, it would be in Special Feature Access Area, however, to optimize the layout, routing, and performance, it is placed in the MCU Native Pin Access area.

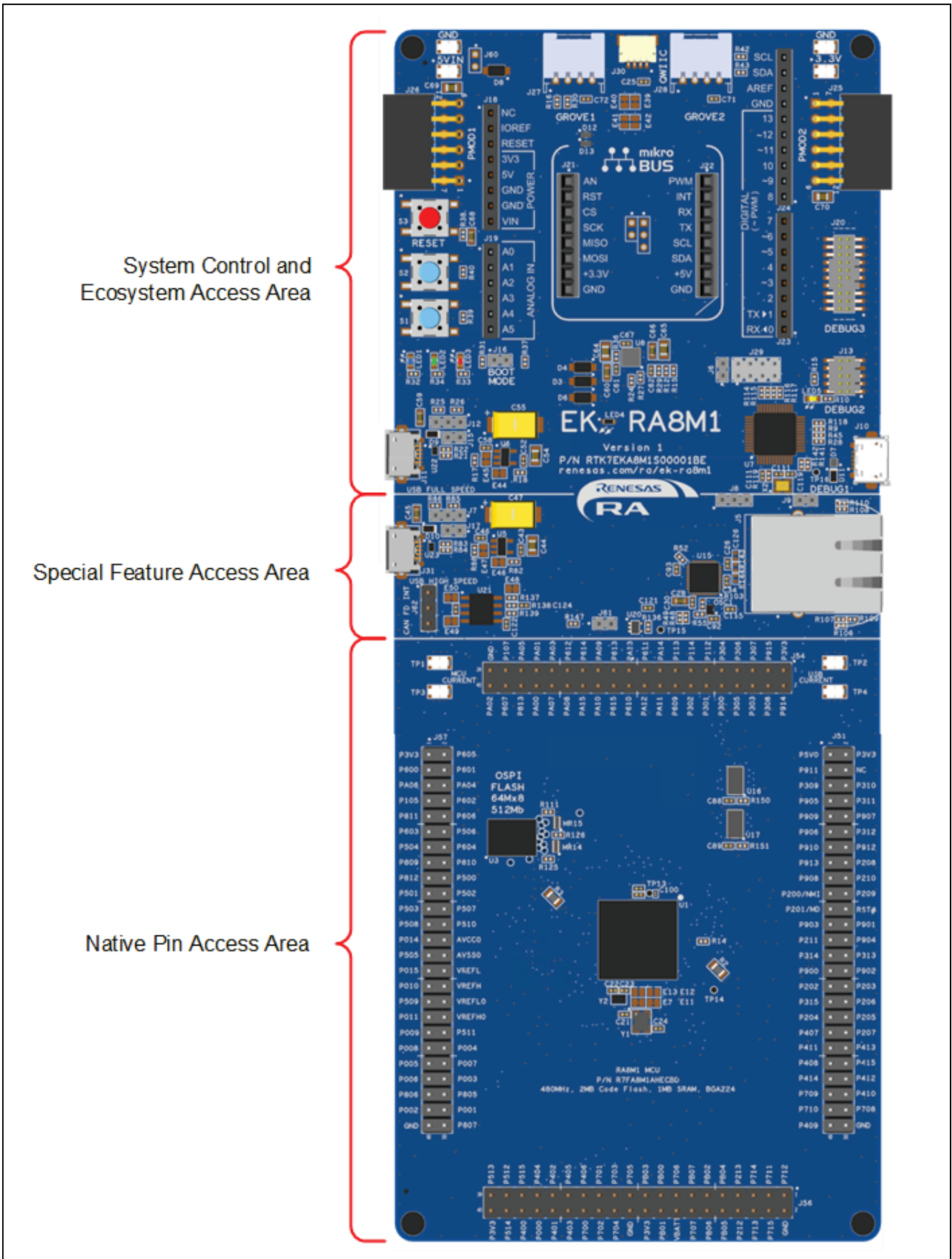


Figure 4. EK-RA8M1 Board Functional Area Definitions

4.2 System Block Diagram

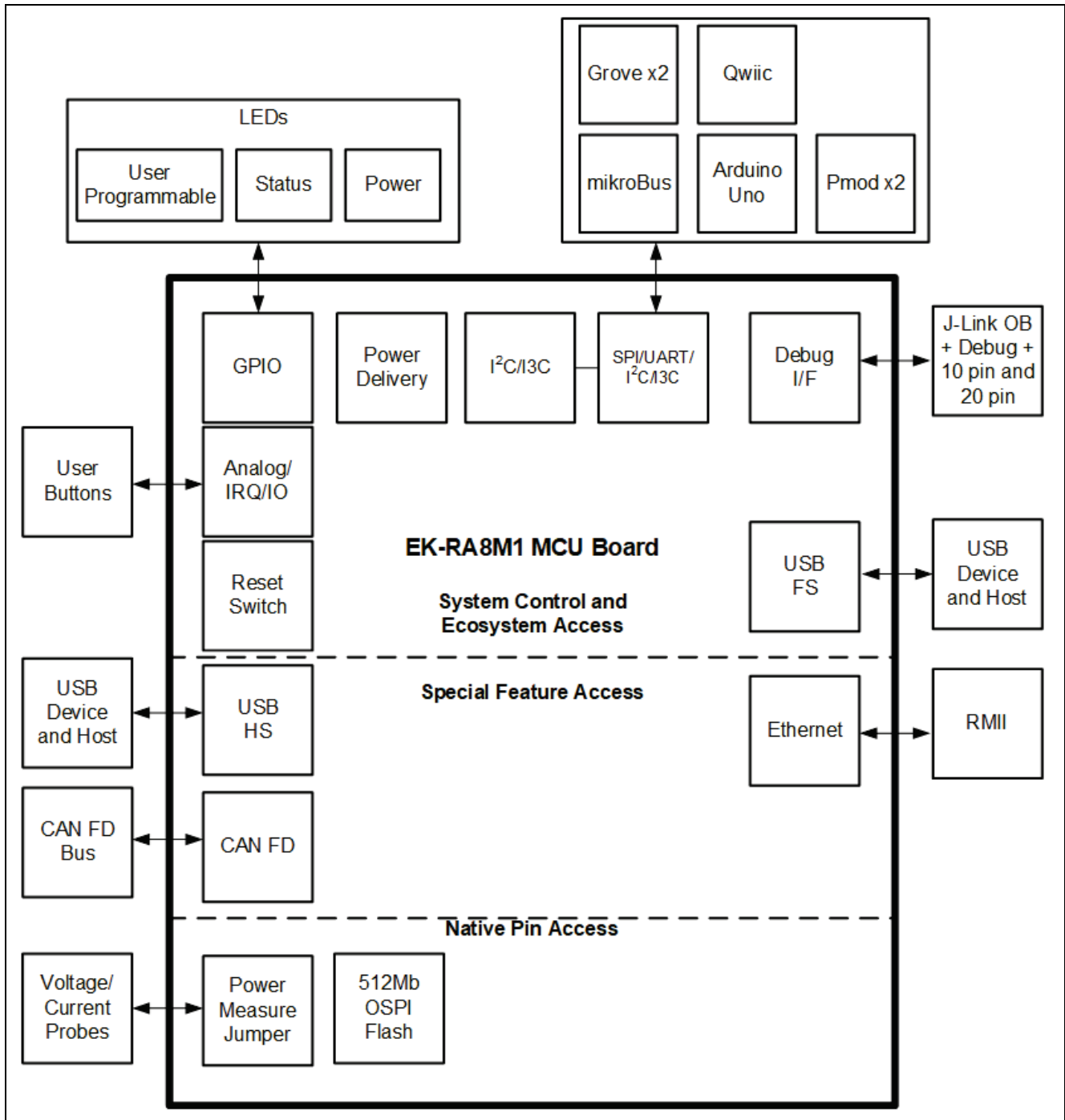


Figure 5. EK-RA8M1 Board Block Diagram

4.3 Jumper Configuration

Two types of jumpers are provided on the EK-RA8M1 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, 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.)

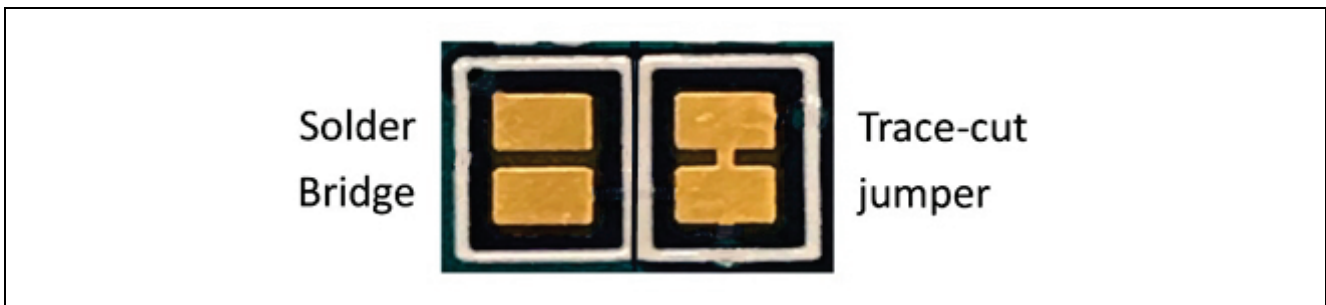


Figure 6. Copper Jumpers

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-RA8M1 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 configuration for each jumper on the EK-RA8M1 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 Configuration

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	Configures JLOB_RESET# for on-board debugger mode
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
J16	MCU Boot Mode	Open	Configures the MCU for normal boot 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
J7	USB HS	Jumper on pins 2-3	Sets USB HS power to device mode
J17	USB HS	Closed	Connects micro-USB power to system power
J61	I3C	Closed	Connects PB00 and P711 for control of the I3C/I ² C SDA pull-up (active when PB00 and P711 is driven high)
E1	MCU Power	Closed	Connects VREFL0 to GND
E2	MCU Power	Closed	Connects VREFH to +3.3 V
E3	MCU Power	Closed	Connects AVCC0 to +3.3 V
E4	MCU Power	Closed	Connects AVSS0 to GND
E5	MCU Power	Closed	Connects VREFL to GND
E6	MCU Power	Closed	Connects VREFH0 to +3.3 V
E7	MCU Clock	Closed	Connects P212/EXTAL to 20 MHz crystal
E11	MCU Clock	Closed	Connects P213/XTAL to 20 MHz crystal
E12	MCU Clock	Open	Connects P213/XTAL pin to pin headers
E13	MCU Clock	Open	Connects P212/EXTAL pin to pin headers
E10	Pmod2	Open	Connects PA06 (CTS2) to Pmod 2 pin 1
E14	Pmod2	Open	Connects PA05 (RTS2) to Pmod 2 pin 4
E15	Pmod2	Closed	Connects PA05 (SSL2) to Pmod 2 pin 1
E16	Pmod2	Closed	Connects PA04 (SCK2) to Pmod 2 pin 4
E17	Pmod1	Open	Connects P613 (CTS0) to Pmod 1 pin 1
E18	Pmod1	Open	Connects P612 (RTS0) to Pmod 1 pin 4
E19	Pmod1	Closed	Connects P612 (SSL0) to Pmod 1 pin 1
E20	Pmod1	Closed	Connects P611 (SCK0) to Pmod 1 pin 4
E25	Pmod1	Closed	Connects +3.3 V to Pmod 1
E36	Pmod1	Open	Connects +5.0 V to Pmod 1
E37	Pmod1	Open	Connects P400 (I3C_SCL0) to Pmod 1 pin 3
E38	Pmod1	Open	Connects P401 (I3C_SDA0) to Pmod 1 pin 4
E51	Pmod1	Closed	Connects P610 (MISO0/RXD0) to Pmod 1 pin 3
E26	User LED	Closed	Connects P414 to User LED2
E27	User LED	Closed	Connects P600 to User LED1
E28	User LED	Closed	Connects P107 to User LED3

Location	Circuit Group	Default Open/Closed	Function
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 P009 to User Switch S1
E32	User Switch	Closed	Connects P008 to User Switch S2
E39	Grove 2	Closed	Connects P512 (I ² C/SCL1) to Grove 2
E40	Grove 2	Closed	Connects P511 (I ² C/SDA1) to Grove 2
E41	Grove 2	Open	Connects P002 (AN102) to Grove 2
E42	Grove 2	Open	Connects P005 (AN001) to Grove 2
E43	Arduino	Closed	Connects VREFH to the Arduino AREF pin
E44	USBFS	Closed	Connects P500 to the VBUS power supply enable pin for USB Full Speed
E45	USBFS	Closed	Connects P501 to the USB VBUS Fault signal for USB Full Speed
E46	USBHS	Closed	Connects P408 to the VBUS power supply enable pin for USB High Speed
E47	USBHS	Closed	Connects P409 to the USB OVRCURA for USB High Speed
E48	CAN FD	Closed	Connects P207 STB to CAN-FD Interface
E49	CAN FD	Closed	Connects P311 RXD to CAN-FD Interface
E50	CAN FD	Closed	Connects P312 TXD to CAN-FD Interface

5.1 Power

The EK-RA8M1 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-RA8M1 kit can be powered.

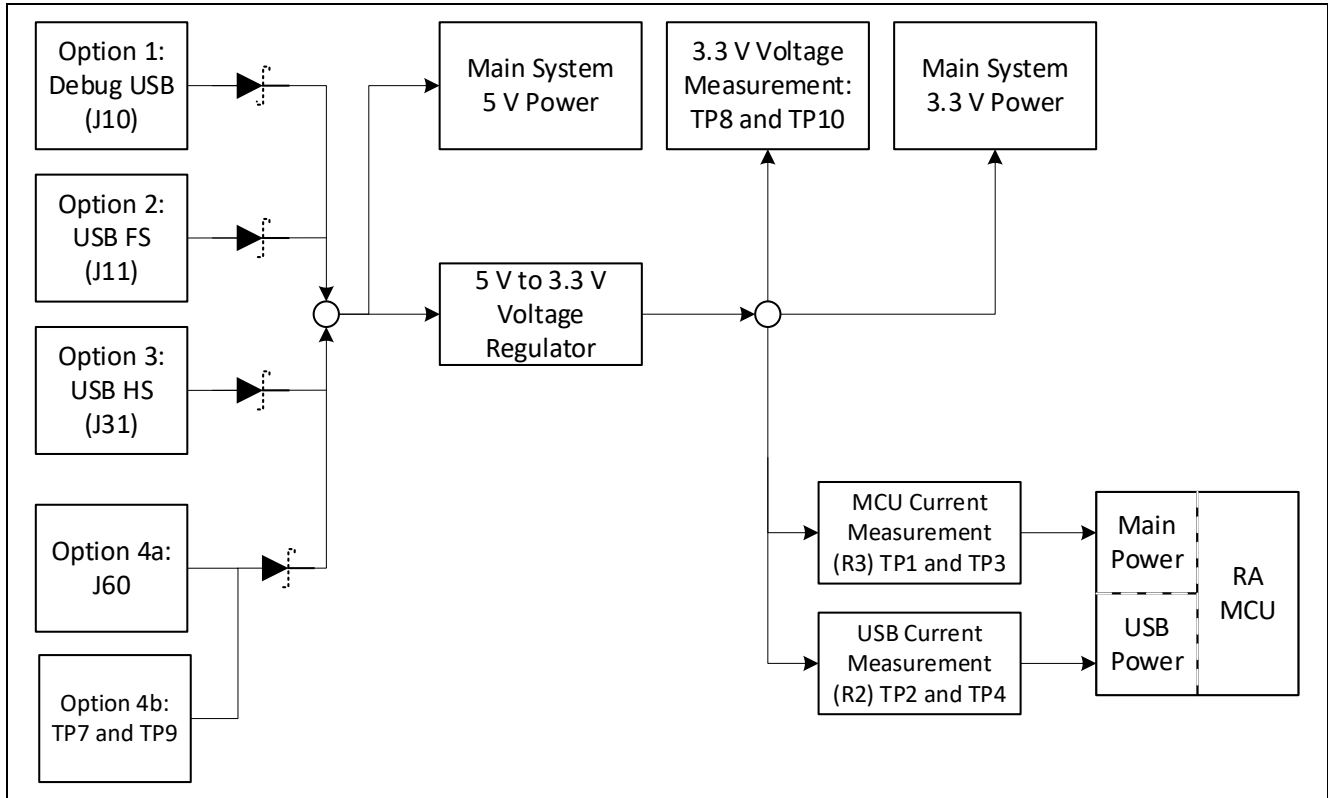


Figure 8. Power Supply Options

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.

5.1.1.1 Option 2: USB Full Speed

5 V may be supplied from an external USB host to the USB Full Speed connector (J11) labelled USB FULL SPEED 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 3: USB High Speed

5 V may be supplied from an external USB host to the USB High Speed connector (J31) labelled USB HIGH SPEED 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.

5.1.1.3 Option 4: 5V 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 J60 provides large via style test points that can accommodate a 0.1" pin header or connector. 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. TP7 (5 V), TP9 (GND) and J60 can be found at the top left of the board above Pmod1.

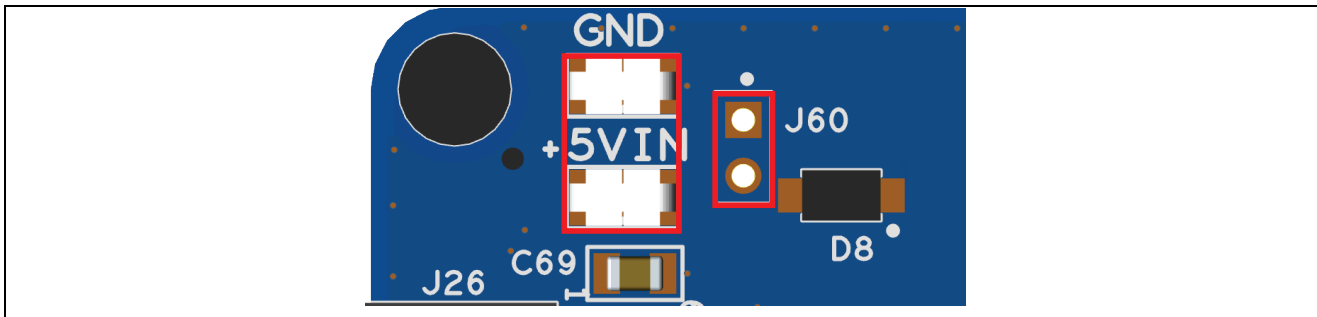


Figure 9. Test Point Location

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 enumerated 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-RA8M1 name) will light up. For more details on initial power up behavior, see the *EK-RA8M1 Quick Start Guide*.

5.2 Debug and Trace

The EK-RA8M1 board supports the following three debug modes.

Table 3. Debug Modes

Debug Modes	Debug MCU (the device that connects to the IDE on PC)	Target MCU (the device that is being debugged)	Debugging Interface/Protocol	Connector Used
Debug on-board	J-Link On Board (on-board)	RA8M1 (on-board)	SWD	Micro USB (J10)
Debug in	External debugging tools	RA8M1 (on-board)	SWD, ETM, JTAG	20-pin connector (J20) or 10-pin connector (J13)
Debug out	J-Link On Board (on-board)	Any external RA MCU	SWD	Micro USB (J10) plus either 20-pin connector (J20) or 10-pin connector (J13)

Notes:

- See Table 5 for the Debug USB connector pin definition.
- See Table 8 for the 20-pin JTAG connector pin definition.
- See Table 9 for the 10-pin JTAG connector pin definition.

The following table summarizes the jumper configuration 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 J-Link On Board Debug MCU and SEGGER J-Link® firmware. Debug USB micro-B connector (J10) connects the J-Link On Board 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-RA8M1 board.

The J-Link On Board Debug MCU connects to the target RA MCU using the SWD interface.

Table 5. Debug USB Port Assignments

Debug USB Connector		EK-RA8M1
Pin	Description	Signal/Bus
J10-1	+5 VDC	+5V_USB_DBG
J10-2	Data-	USB_JLOB_N (U7-14)
J10-3	Data+	USB_JLOB_P (U7-15)
J10-4	USB ID, jack internal switch, cable inserted	N.C.
J10-5	Ground	GND

A yellow indicator, LED5, shows the visual status of the debug interface. When the EK-RA8M1 board is powered on, and LED5 is blinking, it indicates that the J-Link On Board Debug MCU is not connected to a programming host. When LED5 is on solid, it indicates that the J-Link On Board Debug MCU is connected to a programming interface.

To configure the EK-RA8M1 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 debug RESET#
J9	Open	J-Link On Board 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

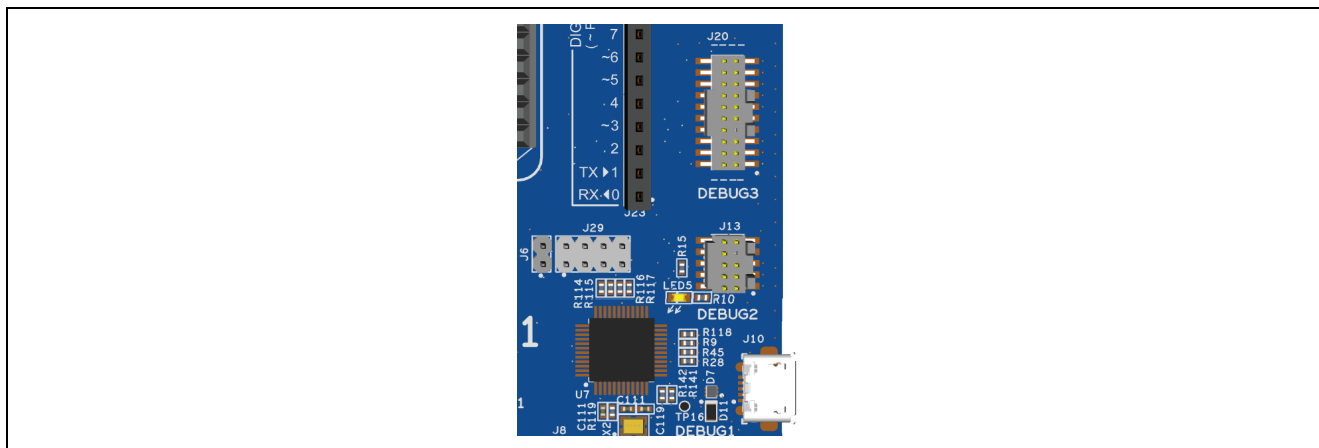


Figure 10. EK-RA8M1 Debug Interface

5.2.2 Debug In

One 20-pin Cortex® Debug Connector at J20 supports JTAG, SWD and ETM (TRACE) 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-RA8M1 board to use the Debug In mode, configure the jumpers as shown in Table 7.

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 debug RESET#
J9	Closed	J-Link On Board 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/ETM Debug Port Assignments

JTAG Connector				EK-RA8M1
Pin	JTAG Pin Name	SWD Pin Name	ETM Pin Name	Signal/Bus
J20-1	Vtref	Vtref	Vtref	+3.3 V
J20-2	TMS	SWDIO	TMS / SWDIO	P210/SWDIO/TMS
J20-3	GND	GND	GND	GND
J20-4	TCK	SWCLK	TCK / SWCLK	P211/SWCLK/TCK
J20-5	GND	GND	GND	GND
J20-6	TDO	N/A	TDO / N/A	P209/TDO
J20-7	Key	Key	Key	N.C.
J20-8	TDI	N/A	TDI / N/A	P208/TDI
J20-9	GNDDetect	GNDDetect	GNDDetect	GND (cut E30 to open)
J20-10	nSRST	nSRST	nSRST	RESET#
J20-11	GND	GND	GND	GND
J20-12	N/A	N/A	TCLK	P308/TCLK*
J20-13	GND	GND	GND	GND
J20-14	N/A	N/A	TDATA0	P307/TDATA0*
J20-15	GND	GND	GND	GND
J20-16	N/A	N/A	TDATA1	P306/TDATA1*
J20-17	GND	GND	GND	GND
J20-18	N/A	N/A	TDATA2	P305/TDATA2*
J20-19	GND	GND	GND	GND
J20-20	N/A	N/A	TDATA3	P304/TDATA3*

* Option selection by J61 or P115. Please check section 5.4.2.

Table 9. JTAG/SWD Debug Port Assignments

JTAG Connector			EK-RA8M1
Pin	JTAG Pin Name	SWD Pin Name	Signal/Bus
J13-1	Vtref	Vtref	+3.3 V
J13-2	TMS	SWDIO	P210/TMS/SWDIO
J13-3	GND	GND	GND
J13-4	TCK	SWCLK	P211/TCK/SWCLK
J13-5	GND	GND	GND
J13-6	TDO	N/A	P209/TDO
J13-7	Key	Key	N.C.
J13-8	TDI	N/A	P208/TDI
J13-9	GNDDetect	GNDDetect	GND (cut E30 to open)
J13-10	nSRST	nSRST	RESET#

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

5.2.3 Debug Out

The EK-RA8M1 board can be configured to use the J-Link On Board 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-RA8M1 board is powered on, and LED5 is blinking, this indicates that the J-Link On Board Debug MCU is not connected to a programming host. When LED5 is on solid, this indicates that the J-Link On Board Debug MCU is connected to a programming interface. When the debug interface is actively in use, the LED will flicker randomly.

To configure the EK-RA8M1 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 On Board 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 (I²C and I³C) connectors
2. One SparkFun® Qwiic® connector
3. Two Digilent Pmod™ (SPI, UART and I²C/I³C) 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® I³C 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 Port Assignments

Grove 1 Connector		EK-RA8M1
Pin	Description	Signal/Bus
J27-1	I3C_SCL	P400 (I3C_SCL0)*
J27-2	I3C_SDA	P401 (I3C_SDA0)*
J27-3	VCC	+3.3 V
J27-4	GND	GND

* Option selection between I²C and I³C by J61 or P115. Please check section 5.4.2.

5.3.1.2 Grove 2

A Seeed Grove® I²C connector is provided at J28. The RA MCU acts as a two-wire serial master, and a connected module acts as a two-wire serial slave.

To configure for I²C function, complete links E39 and E40, and unlink E41 and E42.

To configure for analog function, unlink E39 and E40, and complete links E41 and E42.

Table 12. Grove 2 Port Assignments

Grove 2 Connector		EK-RA8M1	
Pin	Description	Signal/Bus	
J28-1	SCL1/AN	P512 (SCL1)	P005 (AN001)*
J28-2	SDA1/AN	P511 (SDA1)	P002 (AN102)*
J28-3	VCC	+3.3 V	
J28-4	GND	GND	

* Jumpers E39 and E40 are open, E41 and E42 are closed.

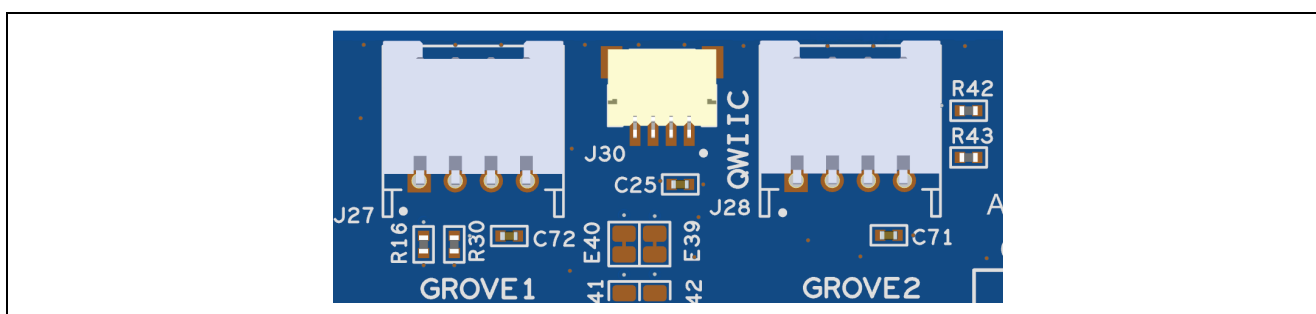


Figure 11. Seed Grove and SparkFun Qwiic® Connectors

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 shared with Grove 1).

Table 13. Qwiic Port Assignments

Qwiic Connector		EK-RA8M1	
Pin	Description	Signal/Bus	
J30-1	GND	GND	
J30-2	VCC	+3.3 V	
J30-3	I3C_SCL	P400 (SCL0)*	
J30-4	I3C_SDA	P401 (SDA0)*	

* Option selection between I²C and I3C by J61 or P115. Please check section 5.4.2.

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-RA8M1 board also provides jumpers so the 12-pin connector may alternatively be used for Pmod Type-6A (I²C).

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 6-pin Pmod interface option for Type-6 (I²C) may also support +5.0 V devices. Please ensure that only 6-pin modules are used when this option is selected.

Note: Both Pmods use the SCI peripheral in “Simple SPI” mode, and so do not offer the full functionality of the SPI peripheral. Please see the hardware manual for full details of the SCI “Simple SPI” mode.

5.3.3.1 Pmod 1

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

This Pmod connector is controlled by a jumper option (J61) or P115. Please check section 5.4.2. as the signals needed are shared with the Ethernet-B. Pmod 1 option type-6A and Ethernet-B cannot be used concurrently.

Table 14. Pmod 1 Port Assignments

Pmod 1 Connector				EK-RA8M1 Signal/Bus	Pmod 1 Configuration	
Pin	Option Type-2A (SPI)	Option Type-3A (UART)	Option Type-6A (I ² C/I3C)*		Short	Open
J26-1	SSL			P612 (SSL0)	E19	E17
		CTS		P613 (CTS0)	E17	E19
J26-2	MOSI	TXD		P609 (MOSI0/TXD0)		
J26-3	MISO	RXD		P610 (MISO0/RXD0)	E51	E37
				SCL	P400 (SCL0)*	E37
J26-4	SCK			P611 (SCK0)	E20	E18, E38
		RTS		P612 (RTS0)	E18	E20, E38
			SDA	P401 (SDA0)*	E38	E18, E20
J26-5	GND			GND		
J26-6	VCC			+3.3 V	E25	E36
				+5.0 V	E36	E25
J26-7	IRQ			P006 (IRQ11)		
J26-8	RESET (master to slave)			PA08		
J26-9	GPIO			P614		
J26-10	GPIO			P615		
J26-11	GND			GND		
J26-12	VCC			+3.3 V	E25	E36
				+5.0 V	E36	E25

* Option selection between I²C and I3C by J61 or P115. Please check section 5.4.2.

Caution: 5 V optional supply is provided (J26-6 and J26-12), however the interface must only be driven with 3.3 V signals from the Pmod. The EK-RA8M1 will only provide 3.3 V signal levels to the Pmod.

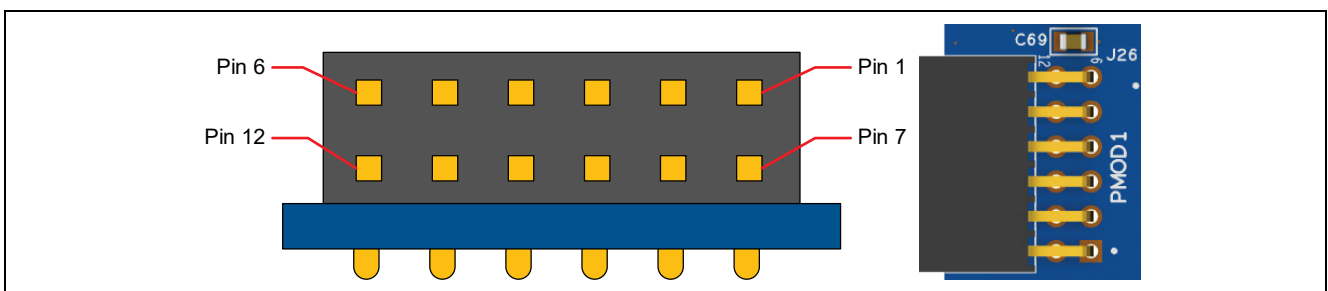


Figure 12. Pmod 1 Connector

5.3.3.2 Pmod 2

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

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

Note: Both Pmods use the SCI peripheral in “Simple SPI” mode, and so do not offer the full functionality of the SPI peripheral. Please see the hardware manual for full details of the SCI “Simple SPI” mode.

Table 15. Pmod 2 Port Assignments

Pmod 2 Connector			EK-RA8M1	Pmod 2 Configuration	
Pin	Option Type-2A (SPI)	Option Type-3A (UART)	Signal/Bus	Short	Open
J25-1	SSL		PA05 (SSL2)	E15	E10
J25-1		CTS	PA06 (CTS2)	E10	E15
J25-2	MOSI	TXD	PA03 (TXD2/MOSI2)		
J25-3	MISO	RXD	PA02 (RXD2/MISO2)		
J25-4	SCK		PA04 (SCK2)	E16	E14
J25-4		RTS	PA05 (RTS2)	E14	E16
J25-5	GND		GND		
J25-6	VCC		+3.3 V		
J25-7	IRQ		P508 (IRQ1)		
J25-8	RESET (master to slave)		P809		
J25-9	GPIO		P810		
J25-10	GPIO		P811		
J25-11	GND		GND		
J25-12	VCC		+3.3 V		

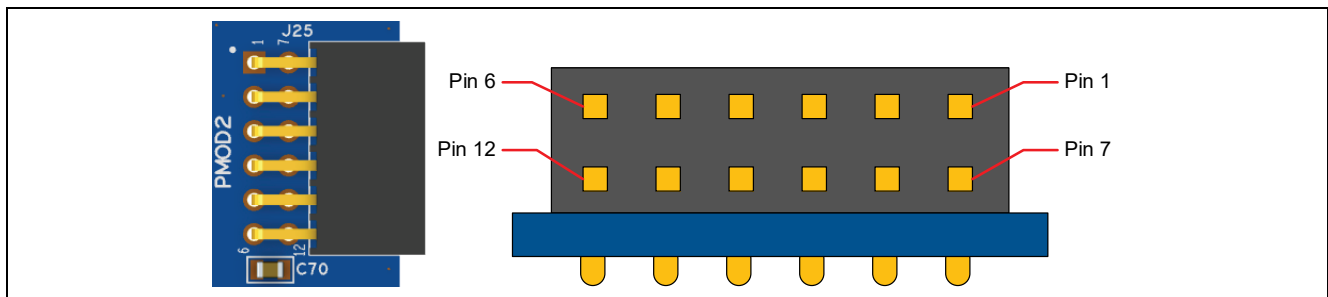


Figure 13. Pmod 2 Connector

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 Port Assignments

Arduino Compatible Connector		EK-RA8M1
Pin	Description	Signal/Bus
J18-1	N.C.	N.C.
J18-2	IOREF	+3.3 V
J18-3	RESET	P812
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	N.C.

Arduino Compatible Connector		EK-RA8M1		
Pin	Description	Signal/Bus		
J19-1	A0	P004 (AN000)		
J19-2	A1	P003 (AN104)		
J19-3	A2	P007 (AN004)		
J19-4	A3	P001 (AN101)		
J19-5	A4	P014 (AN007/DA0)		
J19-6	A5	P015 (AN105/DA1)		
J23-1	D0	RXD	P309 (GPIO/RXD3)	
J23-2	D1	TXD	P310 (GPIO/TXD3)	
J23-3	D2	INT0	P906 (GPIO/IRQ9)	
J23-4	D3	INT1	PWM	P907 (GPIO/IRQ10/GTIOC13A)
J23-5	D4		P905 (GPIO)	
J23-6	D5		PWM	P601 (GPIO/GTIOC6A)
J23-7	D6		PWM	P602 (GPIO/GTIOC7B)
J23-8	D7		P908 (GPIO)	
J24-1	D8		P909 (GPIO)	
J24-2	D9		PWM	P603 (GPIO/GTIOC7A)
J24-3	D10	SPI_SS	P413 (GPIO/SSLB0)	
J24-4	D11	SPI_MOSI	PWM	P411 (GPIO/MOSIB/GTIOC9A)
J24-5	D12	SPI_MISO	PWM	P410 (GPIO/MISOB/GTIOC9B)
J24-6	D13	SPI_SCK	P412 (GPIO/RSPCKB)	
J24-7	GND		GND	
J24-8	AREF		ARDUINO_AREF (linked to VREFH via E43)	
J24-9	SDA		P401 (I3C_SDA0)*	
J24-10	SCL		P400 (I3C_SCL0)*	

* Option selection between I²C and I3C by J61 or P115. Please check section 5.4.2.

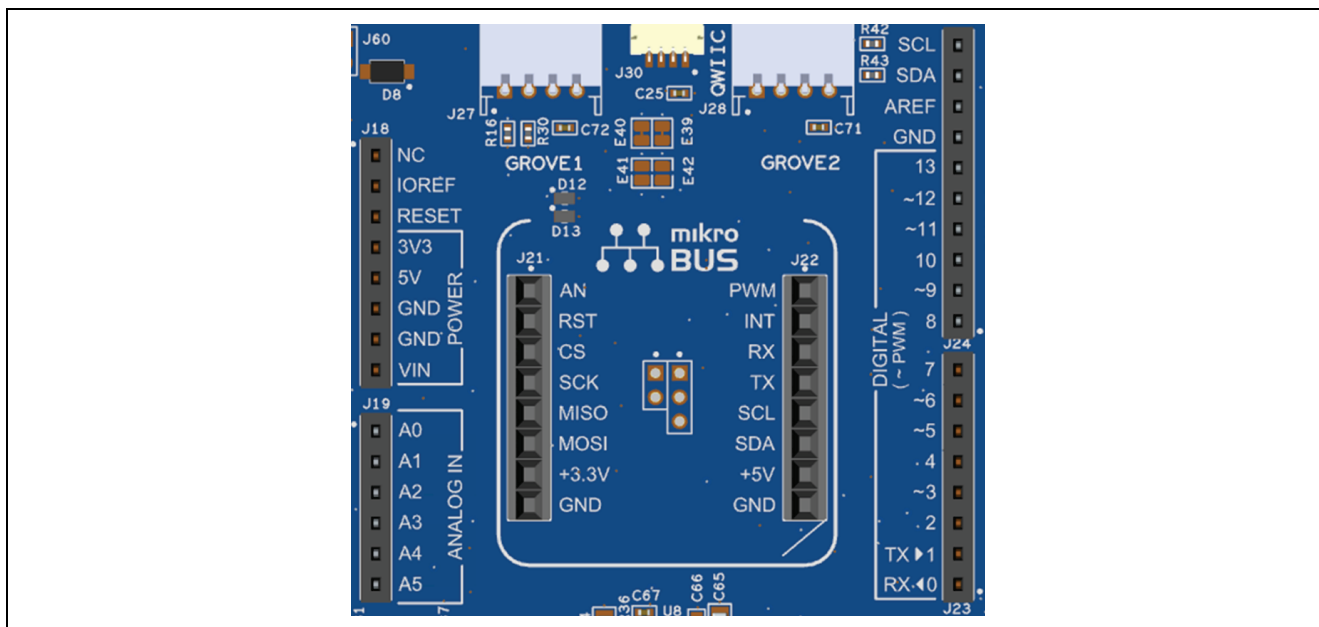


Figure 14. Arduino Uno Connectors

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 Assignments

mikroBUS Connector		EK-RA8M1
Pin	Description	Signal/Bus
J21-1	AN (Analog)	P004 (AN000)
J21-2	RST (Reset)	P502
J21-3	CS (SPI Chip Select)	P413 (SSLB0)
J21-4	SCK (SPI Clock)	P412 (RSPCKB)
J21-5	MISO	P410 (MISOB)
J21-6	MOSI	P411 (MOSIB)
J21-7	+3.3 V	+3.3 V
J21-8	GND	GND
J22-1	PWM	P907 (GTIOC13A)
J22-2	INT (Hardware Interrupt)	P010 (IRQ14)
J22-3	RX (UART Receive)	P309 (RXD3)
J22-4	TX (UART Transmit)	P310 (TXD3)
J22-5	SCL (I ² C Clock)	P400 (SCL0)*
J22-6	SDA (I ² C Data)	P401 (SDA0)*
J22-7	+5 V	+5 V
J22-8	GND	GND

* Option selection between I²C and I³C by J61 or P115. Please check section 5.4.2.

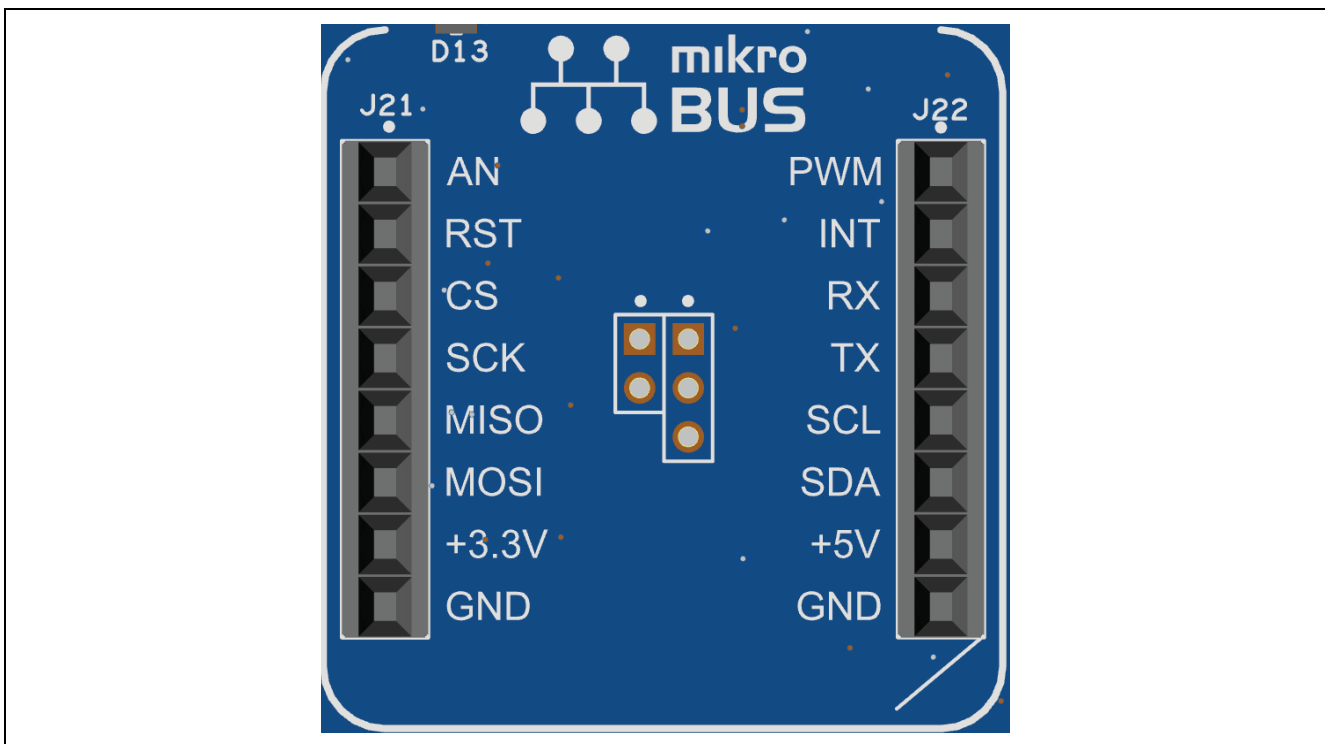


Figure 15. mikroBUS Connection

5.4 Connectivity

5.4.1 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 EK-RA8M1 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 U6. The total current available from U6 is 500 mA. Note that the input power sources must be configured with enough power for both the EK-RA8M1 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 18. USB Full Speed Port Assignments

USB Full Speed Connector		EK-RA8M1
Pin	Description	Signal/Bus
J11-1	+5 VDC	+5V_USBFS (Host Mode)*1 P407/USB_VBUS = 2/3 of +5V_USBFS at J11*2
J11-2	Data-	USBF_N
J11-3	Data+	USBF_P
J11-4	USB ID, jack internal switch, cable inserted	N.C.
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 closed

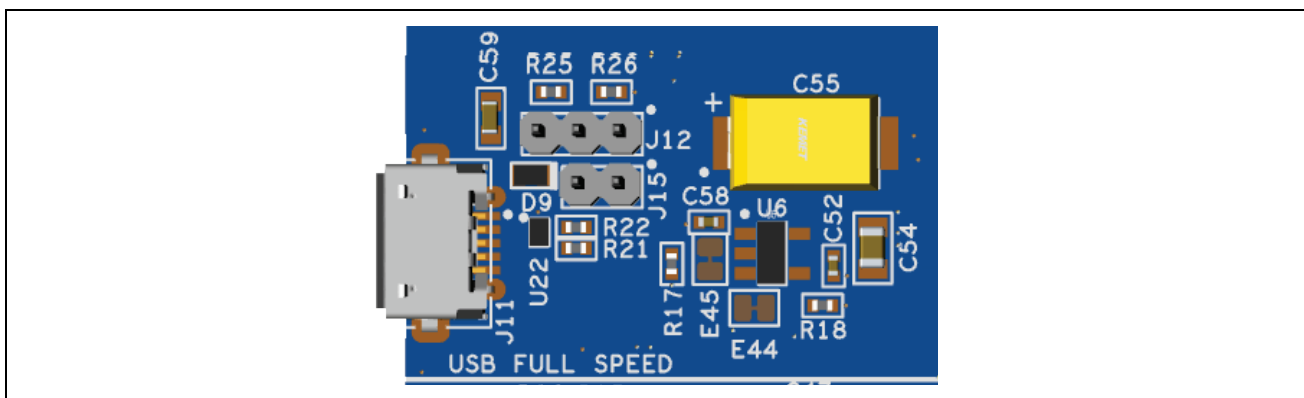


Figure 16. USB Full Speed Connector

5.4.2 I3C

The Arduino, mikroBUS, Grove 1, Qwiic, and Pmod 1 connectors connect the RA MCU I3C interface to external I3C or I²C devices, allowing communications between devices.

Please ensure that J61 or P115 set correctly. Set signal high to Port PB00 and P711 when I3C is in use or set signal low for I²C. The required configurations can be seen in Table 19 where “x” means the setting does not matter.

Table 19. I²C/I3C Pullup Configuration

I ² C/I3C	J61	P115	PB00/P711
I3C	Closed	Pin disable	High
I ² C	Open	Pin disable	Low
I ² C	x	High	High
I3C	x	Low	Low

5.5 Miscellaneous

5.5.1 User and Power LEDs

Five LEDs are provided on the EK-RA8M1 board. In addition, the Ethernet connector has built-in link status and link speed LEDs.

Behavior of the LEDs on the EK-RA8M1 board is described in the following table.

Table 20. EK-RA8M1 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Blue	User LED	P600
LED2	Green	User LED	P414
LED3	Red	User LED	P107
LED4	White	Power on indicator	+3.3 V
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 P600, trace-cut jumper E27 must be open. To separate LED2 from P414, trace-cut jumper E26 must be open. To separate LED3 from P107, trace-cut jumper E28 must be open.

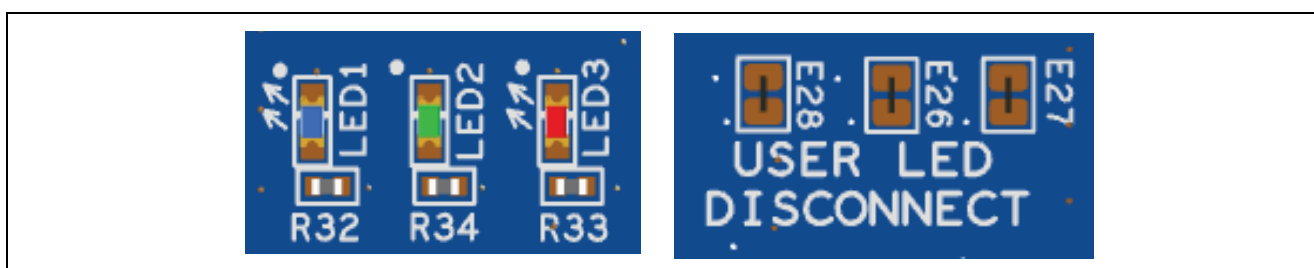


Figure 17. User LEDs



Figure 18. Power LED

5.5.2 User and Reset Switches

Three miniature, momentary, mechanical push-button type SMT switches are mounted on the EK-RA8M1 board.

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

Table 21. EK-RA8M1 Board Switches

Designator	Function	MCU Control Port	Button Color
S3	MCU Reset Switch	RESET#	Red
S2	User Switch	P008 (IRQ12-DS)	Blue
S1	User Switch	P009 (IRQ13-DS)	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 P009, trace cut jumper E31 must be open. To separate S2 from P008, trace cut jumper E32 must be open.

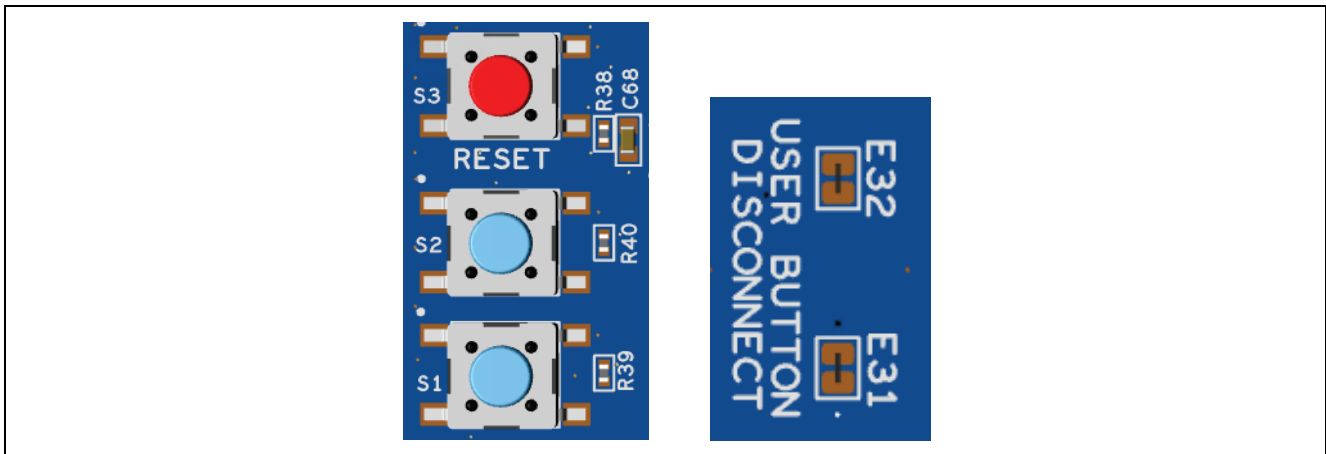


Figure 19. Reset and User Switches

5.5.3 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.

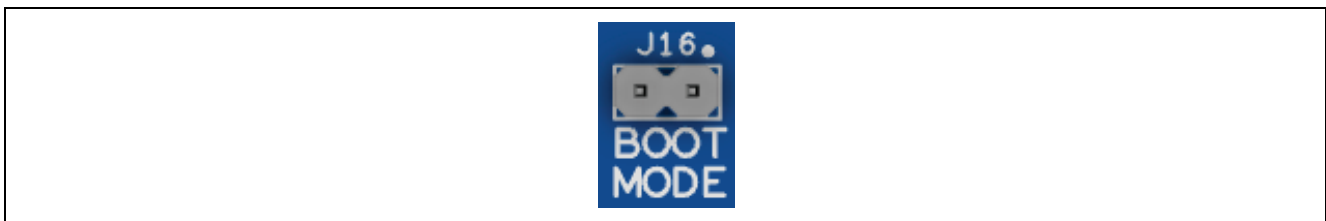


Figure 20. Boot Mode

5.5.4 Crystals

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

Table 22. Main 20 MHz Crystal Configuration

20MHz Crystal Oscillator	Configuration
Required	E7 and E11 closed, E12 and E13 open
Not required	E7 and E11 open, E12 and E13 closed. P212 and P213 are available for other purposes.

6. Special Feature Access Area

The Special Feature Access area provides features specific to the RA8M1 MCU group such as Ethernet MAC controller, USB High Speed (host and device) and CAN FD Bus.

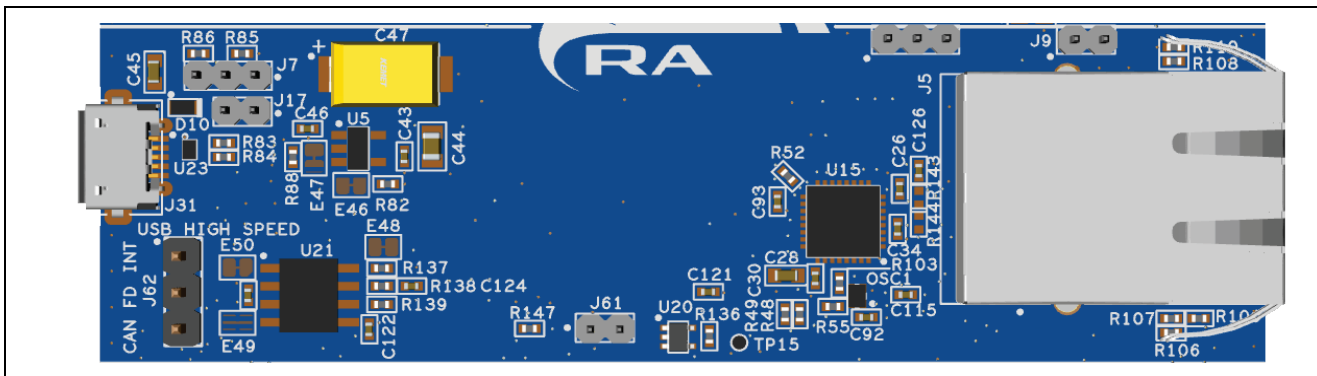


Figure 21. Special Feature Access Area

6.1 CAN FD Bus

The EK-RA8M1 board provides a CAN FD bus transceiver (TJA1042T) that is connected directly to the RA MCU. External connection to the CAN FD bus is made using the 0.1" pitch 3-pin male header J62.

Table 23. CAN FD bus connections between U21 and RA8M1

CAN FD Signal Description	EK-RA8M1 Port
RXD	P311
TXD	P312
STB	P207

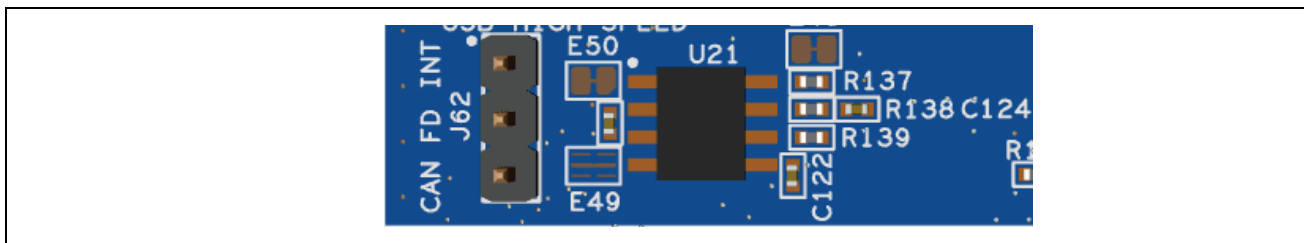


Figure 22. CAN FD Bus

Table 24. CAN FD Port Assignments

J62 Pin	Function
1	CANH
2	CANL
3	GND

6.2 Ethernet

The Ethernet interface uses an RMII Ethernet Physical Layer Transceiver (PHY) (U15), 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 oscillator connected directly to the Ethernet PHY.

The RMII signals used for the Ethernet port are connected from the RA MCU through two sets of bus switches. This is to allow different feature sets of the RA8M1 device to be evaluated, that would otherwise become unavailable. The Jumper J61 and P115 control the peripheral interface option used to communicate with the Ethernet PHY device.

Table 25. Ethernet Port Assignments

Ethernet Signal Description	RA8M1 MCU Port J61 is Open* or P115 is High	RA8M1 MCU Port J61 is Closed* or P115 is Low
INT	P000	P000
MDC	P308	P401
MDIO	P307	P402
TXD1	P305	P406
TXD0	P304	P700
TXD_EN	P306	P405
RXD1	P301	P703
RXD0	P302	P702
RMII/RXDV	P112	P705
RX_ER	P300	P704
REF50CK	P303	P701
RESET#	P404	P404
LINKSTA	P114	P403

*P115 must be set to high impedance setting, if you intend to use J61.

Table 26. Ethernet Components

Component	Manufacturer	Manufacturer Part Number
Ethernet PHY	Renesas	ICS1894-32
RJ45 Connector	Pulse	J0011D21BNL
50 MHz Oscillator	ECS Inc International	ECS-1612MV

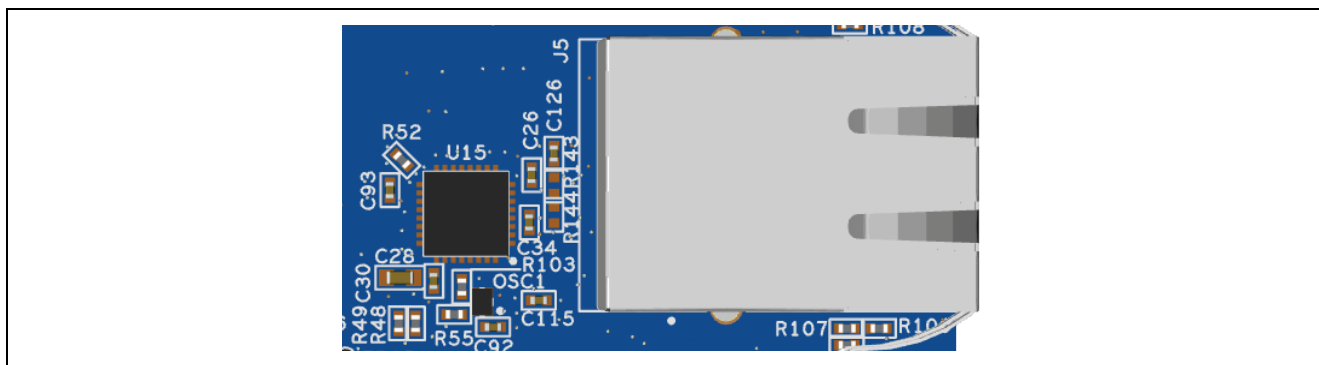


Figure 23. Ethernet Connector

6.3 USB High Speed

The USB micro-AB connection jack (J31) connects the RA MCU USB High 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 J7 to pins 2-3, install a jumper on J17 pins 1-2, and configure the RA MCU firmware to use the USB High Speed ports in device mode. Power from an external USB host on this connection can be used to provide power to the EK-RA8M1 board.

For a USB host configuration, set jumper J7 to pins 1-2, remove the jumper from J17, and configure the RA MCU firmware to use the USB High Speed ports in host mode. In this configuration, power to J7 is supplied from U5. The total current available from U5 is 500 mA. Note that the input power sources must be configured with enough power for both the EK-RA8M1 board and the USB High Speed port in host mode. Connect the included USB type-A female to micro-B male cable to J31. USB device cables or devices can be connected to the USB High Speed port using this cable.

Table 27. USB High Speed Port Assignments

USB High Speed Connector		EK-RA8M1
Pin	Description	Signal/Bus
J31-1	+5 VDC	+5V_USBHS (Host Mode)*1 PB01/USBHS_VBUS = 2/3 of +5V_USBHS at J31*2
J31-2	Data-	USBH_N
J31-3	Data+	USBH_P
J31-4	USB ID, jack internal switch, cable inserted	N.C.
J31-5	Ground	GND

*1 When J7 is linked 1-2 and J17 is open

*2 When J7 is linked 2-3 and J17 is closed

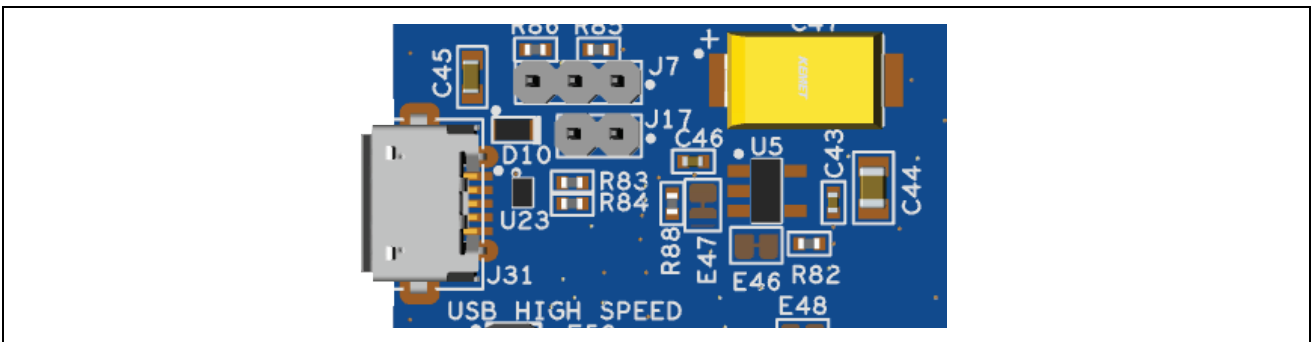


Figure 24. USB High Speed Connector

6.4 Octo-SPI Flash

Included on the EK-RA8M1 board is a 512 Mb (64 MB) Octo-serial flash memory (S28HL512TFPBHI010). The Octo-SPI serial flash device (U3) connects to the Octo-SPI peripheral on the RA MCU and defaults to standard SPI mode initially. The flash memory is enabled for XIP (Execute-In-Place) mode directly after power-on.

The Octo-SPI signals are not provided on an external pin header due to the high speed of this interface.

Table 28. Octo-SPI Flash Port Assignments

Octo-SPI Signal Description	EK-RA8M1 Port
OSPI_RESET#	P106
OSPI_INT#	P105
OSPI_SCLK	P808
OSPI_CS#	P104
OSPI_DS	P801
OSPI_DQ0	P100
OSPI_DQ1	P803
OSPI_DQ2	P103
OSPI_DQ3	P101
OSPI_DQ4	P102
OSPI_DQ5	P800
OSPI_DQ6	P802
OSPI_DQ7	P804

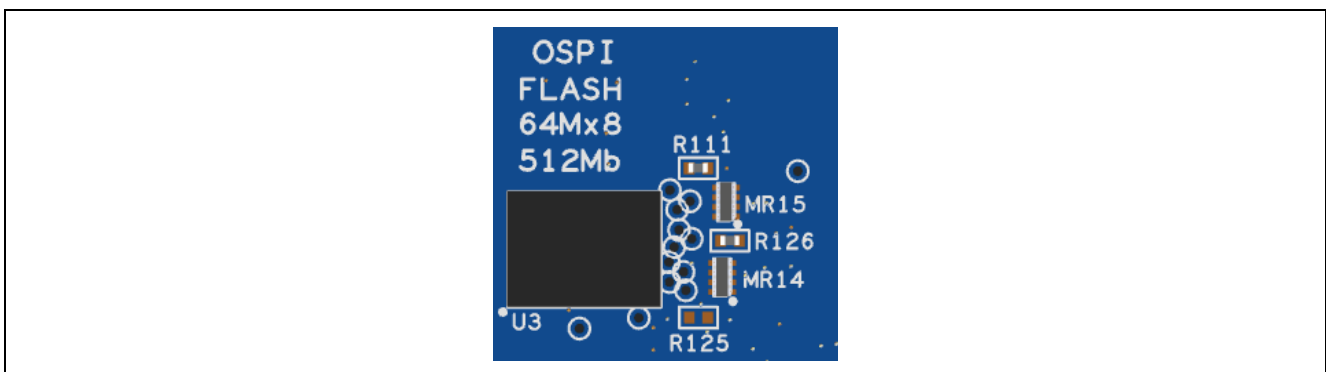


Figure 25. Octo-SPI Flash

Note: The Octo-SPI Flash is among the Special Feature Access features. Normally, it would be in Special Feature Access Area, however, to optimize the layout, routing, and performance, it is placed in the MCU Native Pin Access area.

7. MCU Native Pin Access Area

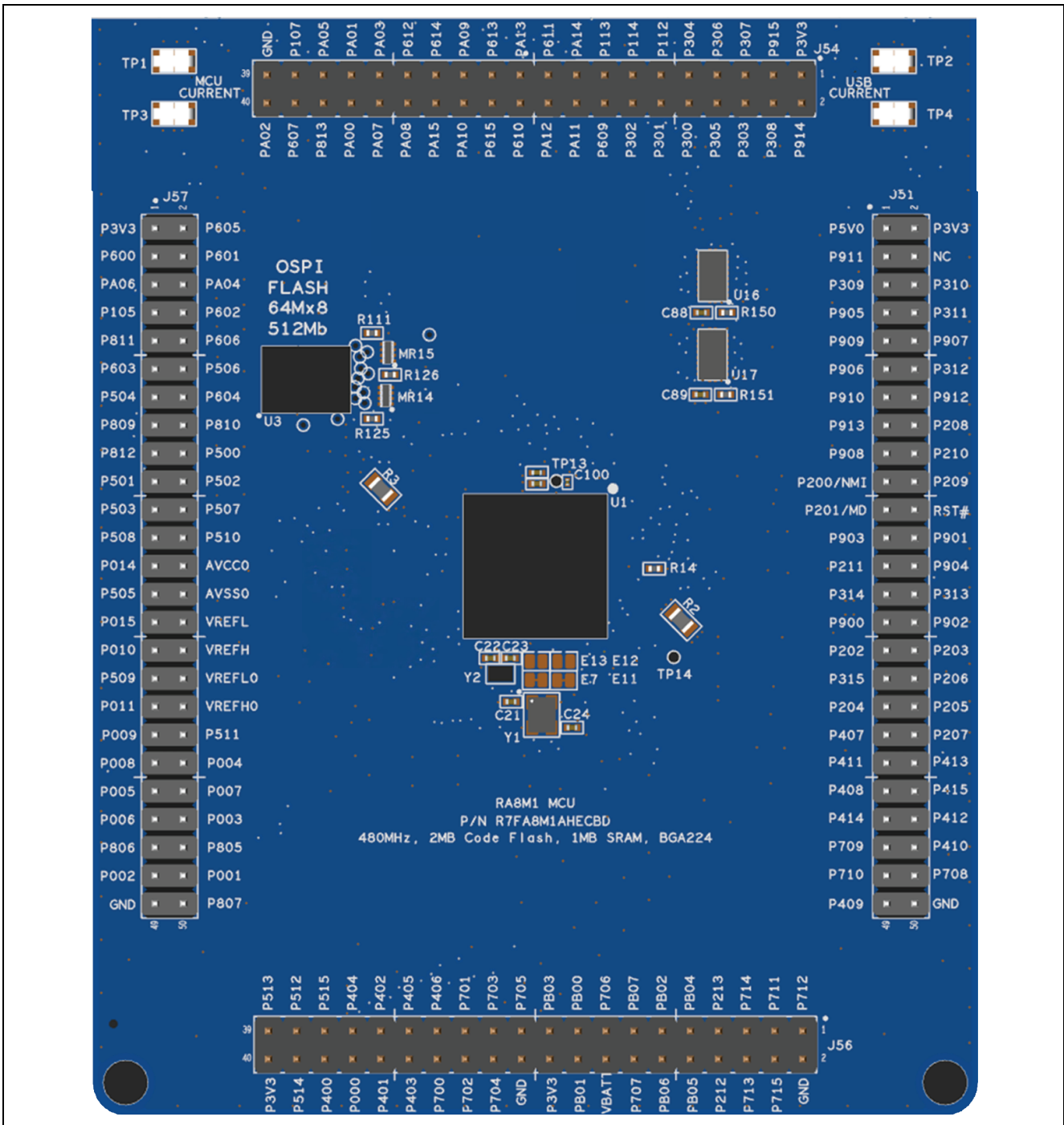


Figure 26. Native Pin Access Area

7.1 Breakout Pin Headers

The EK-RA8M1 board pin headers, J51, J54, J56 and J57 provide access to nearly all RA MCU interface signals, and to voltages for all RA MCU power ports. Each header pin is labelled with the voltage or port connected to that pin. Refer to the RA8M1 MCU Group User's Manual for details of each port function, and the EK-RA8M1 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 pin headers simultaneously. This can be used for prototyping and testing of custom circuitry for use with the RA8M1 MCU.

7.2 MCU and USB Current Measurement

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

The EK-RA8M1 board provides precision 5 mΩ resistors (Vishay, part number WSLP08055L000FEA18) for current measurement of the main 3.3 V MCU power and the 3.3 V USB 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, and TP2 and TP4 are provided to measure the 3.3 V USB MCU power. See Figure 29 for the location of TP1, TP2, TP3 and TP4.

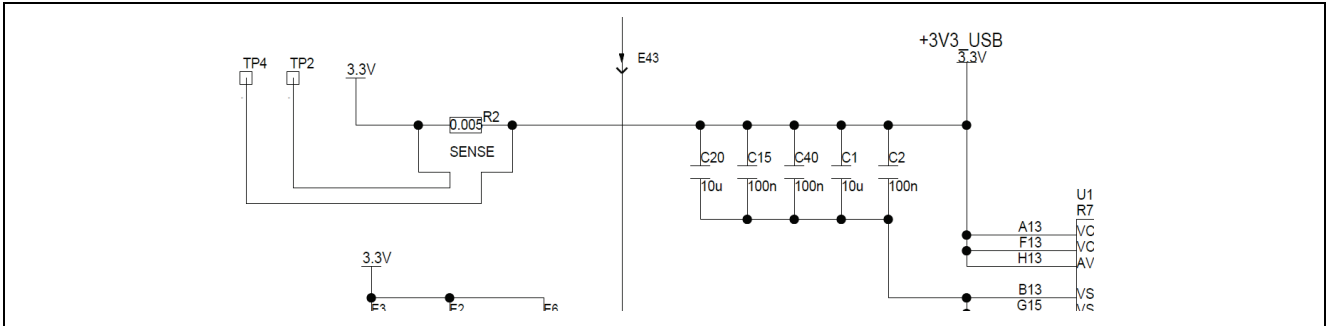


Figure 27. RA USB Current Measurement Circuit

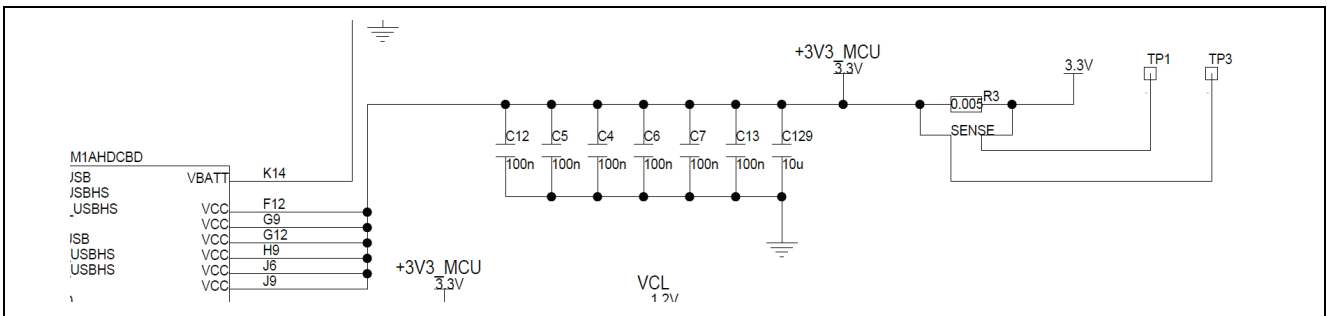


Figure 28. RA +3.3 V Current Measurement Circuit

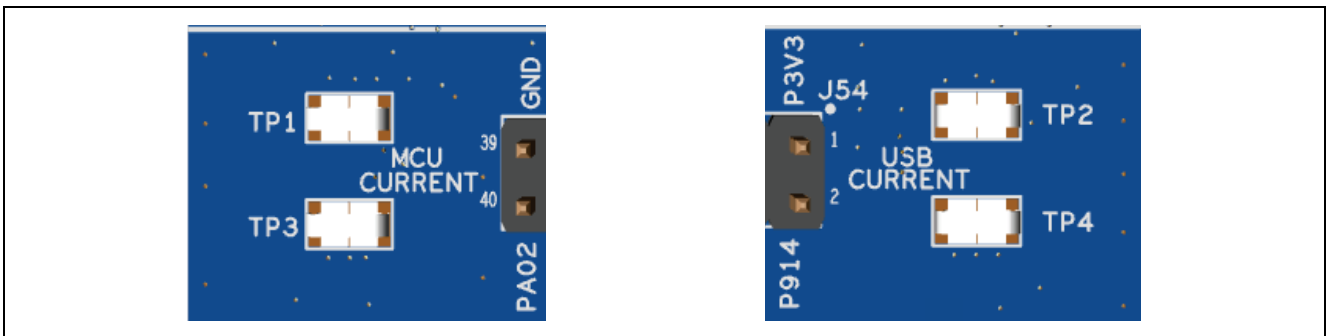


Figure 29. RA MCU and USB Current Measurement

8. Certifications

The EK-RA8M1 v1 kit meets the following certifications/standards. See page 3 of this user's manual for the disclaimer and precautions.

8.1 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 required 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 required 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

8.2 Material Selection, Waste, Recycling and Disposal Standards

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

8.3 Safety Standards

- UL 94V-0

9. Design and Manufacturing Information

The design and manufacturing information for the EK-RA8M1 v1 kit is available in the “EK-RA8M1 v1 Design Package” available on renesas.com/ra/ek-ra8m1.

- Design package file name: ek-ra8m1-v1-designpackage.zip
- Design package contents

Table 29. EK-RA8M1 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	ek-ra8m1-v1-schematics
File (PDF)	Mechanical Drawing	ek-ra8m1-v1-mechdwg
File (PDF)	3D Drawing	ek-ra8m1-v1-3d
File (PDF)	BOM	ek-ra8m1-v1-bom
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files-Cadence Allegro

10. 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-RA8M1 Resources	renesas.com/ra/ek-ra8m1
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
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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
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