

RA6M5 Group

Evaluation Kit for RA6M5 Microcontroller Group
EK-RA6M5 v1
User's Manual

Renesas RA Family
RA6 Series

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
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1. Precaution against Electrostatic Discharge (ESD)

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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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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-RA6M5 v1
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1. Kit Overview

The EK-RA6M5, an Evaluation Kit for RA6M5 MCU Group, enables users to seamlessly evaluate the features of the RA6M5 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-RA6M5 board are categorized in three groups (consistent with the architecture of the kit) as follows:

MCU Native Pin Access

- R7FA6M5BH3CFC MCU (referred to as RA MCU)
- 200 MHz, Arm® Cortex®-M33 core
- 2 MB Code Flash, 512 kB SRAM
- 176 pins, LQFP package
- Native pin access through 4 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 24.000 MHz and 32,768 Hz reference clock. 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
 - 2 Seeed Grove® system (I2C/Analog) connectors
 - SparkFun® Qwiic® connector
 - 2 Digilent Pmod™ (SPI and UART) connectors
 - Arduino™ (Uno R3) connector
 - MikroElektronika™ mikroBUS connector
- MCU boot configuration jumper

Special Feature Access

- Ethernet (RJ 45 RMII interface)
- USB High Speed Host and Device (micro AB connector)
- 32 MB (256 Mb) External Quad-SPI Flash
- 64 MB (512 Mb) External Octo-SPI Flash
- CAN (3-pin header)

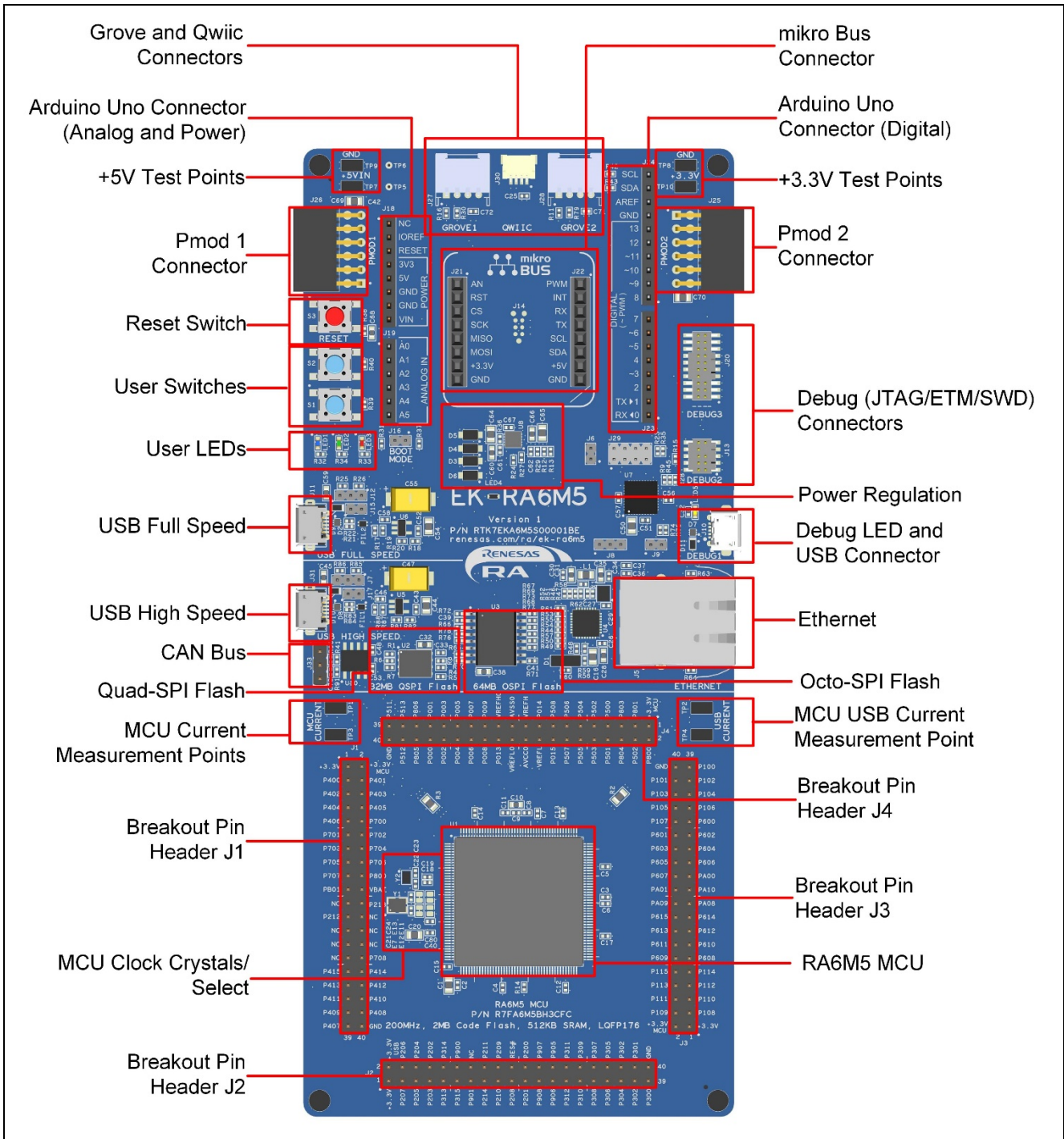


Figure 1. EK-RA6M5 Board Top Side

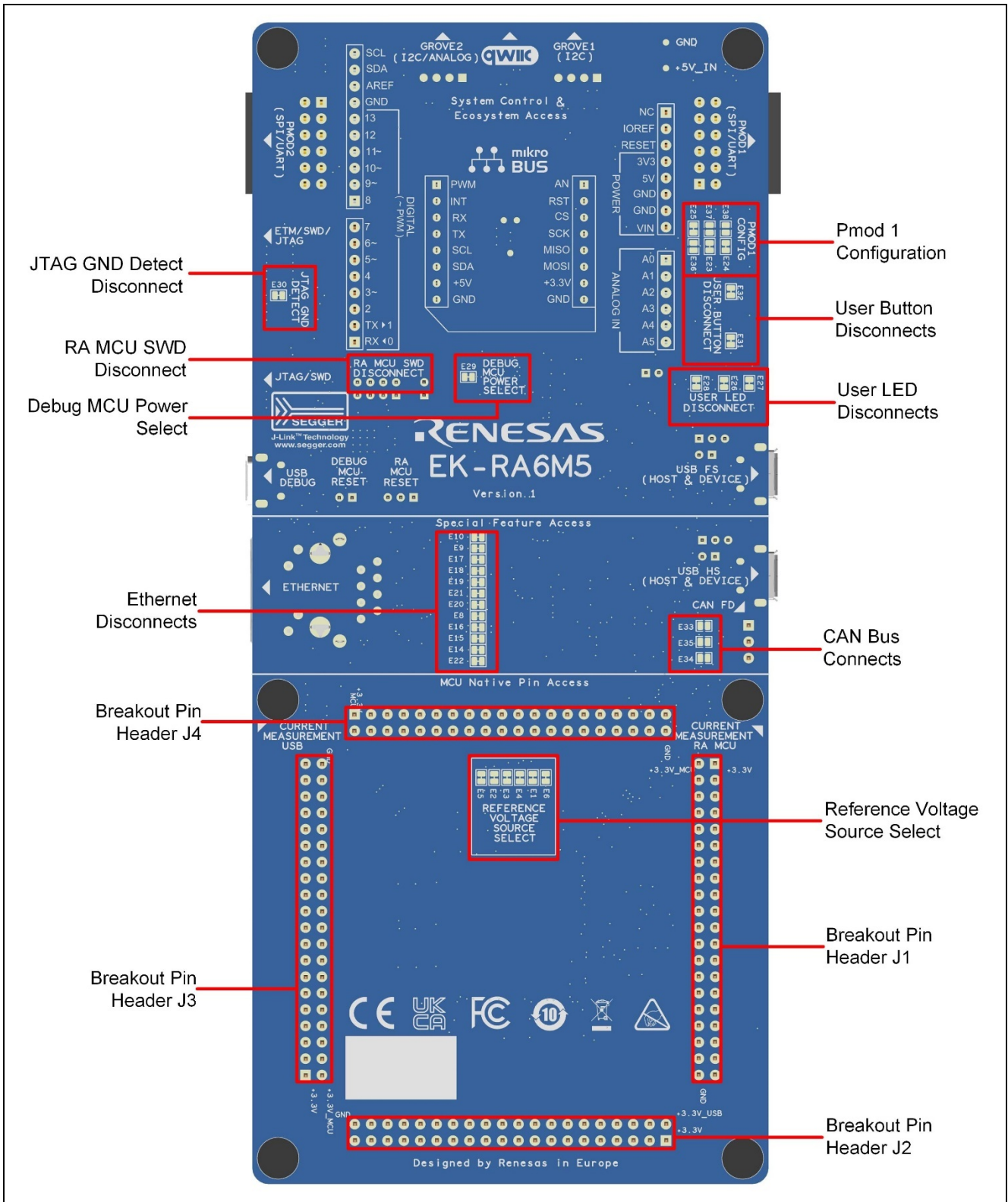


Figure 2. EK-RA6M5 Board Bottom Side

1.1 Assumptions and Advisory Notes

1. It is assumed that the user has basic understanding of microcontrollers and embedded systems hardware.
2. It is recommended that the user refers to the *EK-RA6M5 Quick Start Guide* to get acquainted with the kit and the Quick Start example project that EK-RA6M5 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-RA6M5 kit.
4. Instructions to download and install software, import example projects, build them and program the EK-RA6M5 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-RA6M5 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

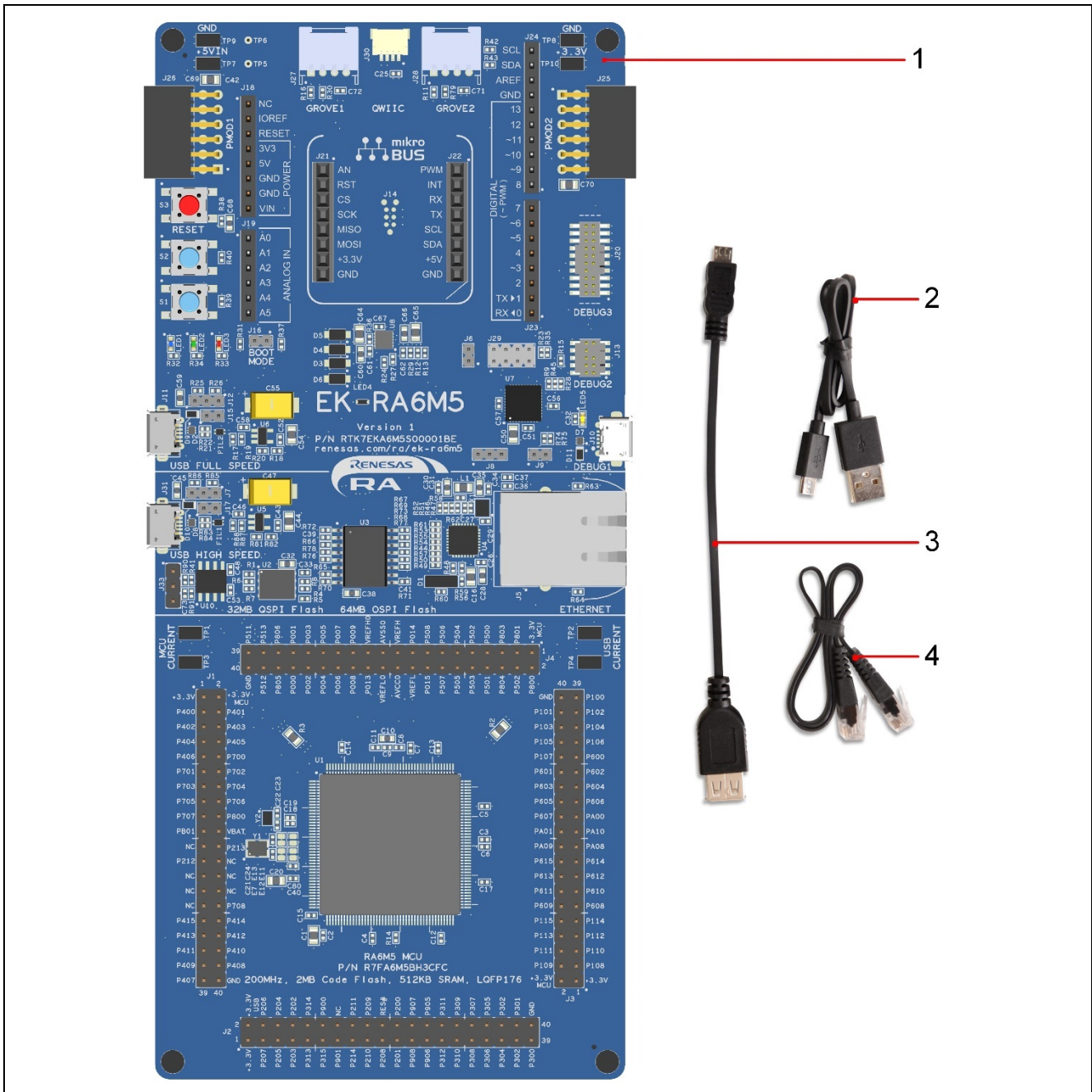


Figure 3. EK-RA6M5 Kit Contents

3. Ordering Information

- EK-RA6M5 v1 kit orderable part number: RTK7EKA6M5S00001BE

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

- EK-RA6M5 board dimensions: 80 mm (width) x 180 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Kit Architecture

The EK-RA6M5 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.

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: Ethernet, USB High Speed Host and Device, Quad-SPI, Octo-SPI, CAN	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, Boot configuration	Yes	Same or similar across similar kits

4.2 System Block Diagram

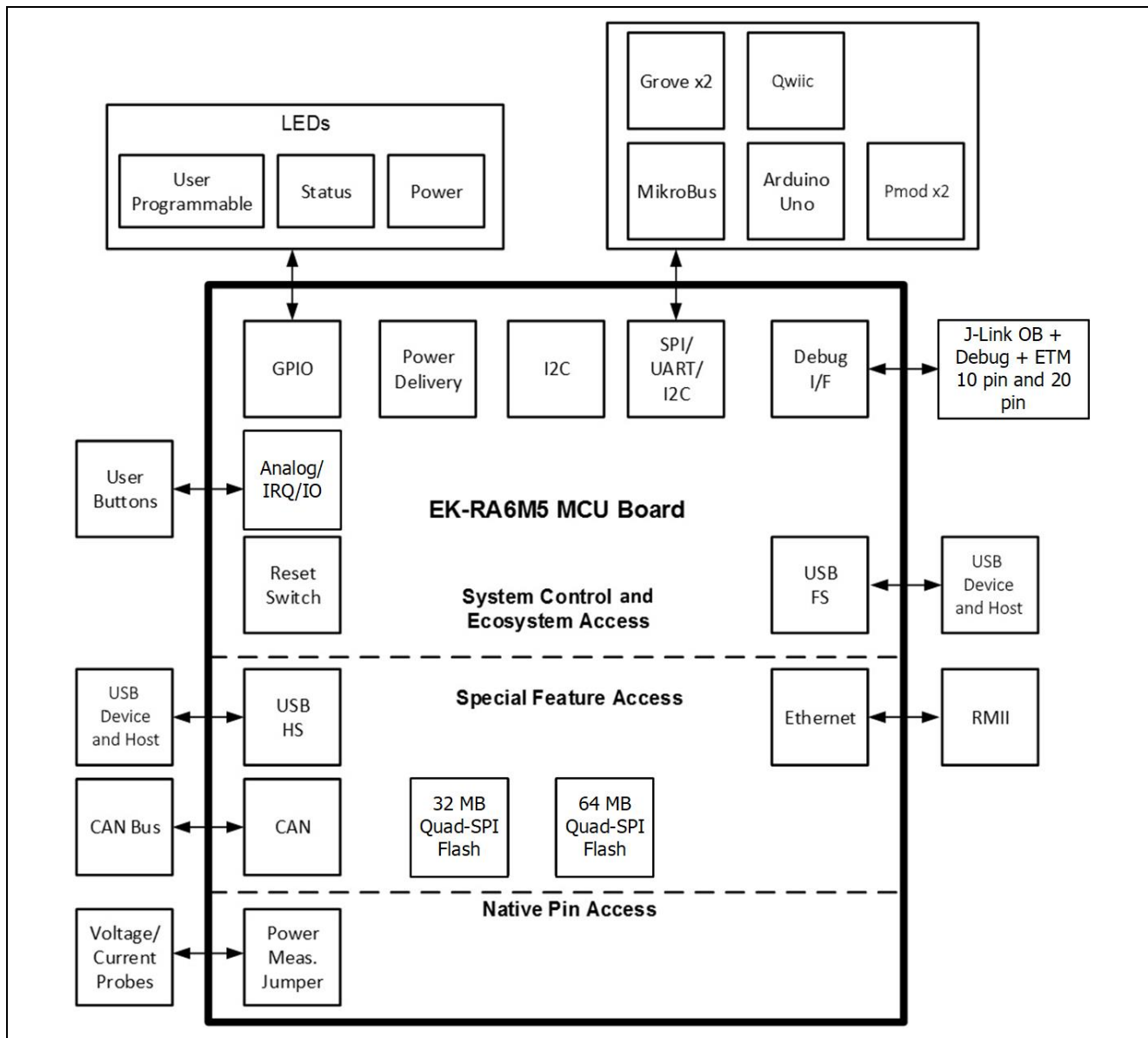


Figure 5. EK-RA6M5 Board Block Diagram

4.3 Jumper Settings

Two types of jumpers are provided on the EK-RA6M5 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.)

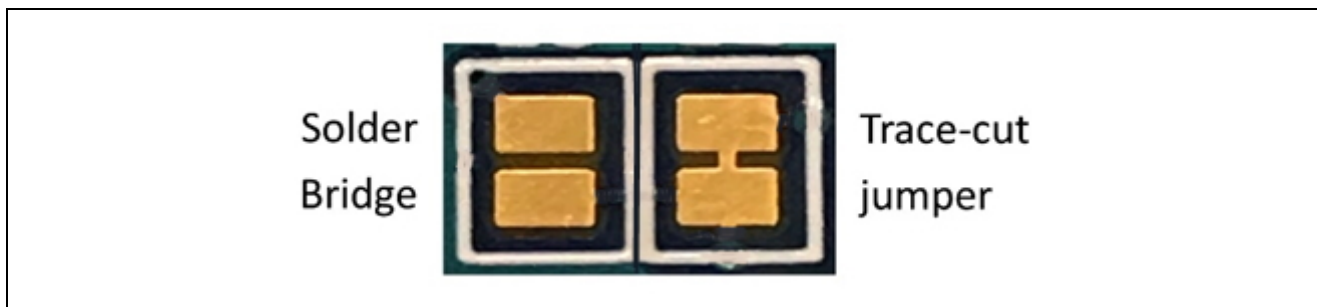


Figure 6. Copper Jumpers

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-RA6M5 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-RA6M5 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 1. 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	Configures 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	Jumper on pins 1-2	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	Jumper on pins 1-2	Connects micro-USB power to system power
E1	MCU Power	Closed	Connects VREFL 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 VREFL0 to GND
E6	MCU Power	Closed	Connects VREFH0 to +3.3 V
E7	MCU Clock	Closed	Connects P212/EXTAL to 24 MHz crystal
E11	MCU Clock	Closed	Connects P213/XTAL to 24 MHz crystal
E12	MCU Clock	Open	Connects P213/XTAL pin to pin headers

Location	Circuit Group	Default Open/Closed	Function
E13	MCU Clock	Open	Connects P212/EXTAL pin to pin headers
E8	Ethernet	Closed	Connects P706 (IRQ7) to Ethernet IRQ
E9	Ethernet	Closed	Connects P401 to Ethernet MDC
E10	Ethernet	Closed	Connects P402 to Ethernet MDIO
E14	Ethernet	Closed	Connects P406 to Ethernet TXD1
E15	Ethernet	Closed	Connects P700 to Ethernet TXD0
E16	Ethernet	Closed	Connects P405 to Ethernet TXD_EN
E17	Ethernet	Closed	Connects P703 to Ethernet RXD1
E18	Ethernet	Closed	Connects P702 to Ethernet RXD0
E19	Ethernet	Closed	Connects P705 to Ethernet CRS_DV
E20	Ethernet	Closed	Connects P704 to Ethernet RX_ER
E21	Ethernet	Closed	Connects P701 to Ethernet REF50CK0
E22	Ethernet	Closed	Connects P403 to Ethernet RST#
E23	Pmod1	Open	Connects P415 (SCL2) to Pmod1
E24	Pmod1	Open	Connects P414 (SDA2) to Pmod1
E25	Pmod1	Open	Connects +5.0 V to Pmod1
E36	Pmod1	Closed	Connects P301 (SSLA2) to Pmod1
E37	Pmod1	Closed	Connects P302 (SSLA3) to Pmod1
E38	Pmod1	Closed	Connects +3.3 V to Pmod1
E26	User LED	Closed	Connects P007 to User LED2
E27	User LED	Closed	Connects P006 to User LED1
E28	User LED	Closed	Connects P008 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 P005 to User Switch S1
E32	User Switch	Closed	Connects P004 to User Switch S2
E33	CAN	Open	Connects P611 to CAN Standby
E34	CAN	Open	Connects P610 to CAN RXD
E35	CAN	Open	Connects P609 to CAN TXD
E39	Pmod2	Open	Connects P512 (SCL1) to Pmod2
E40	Pmod2	Open	Connects P511 (SDA1) to Pmod2
E41	Pmod2	Open	Connects +5.0 V to Pmod2
E42	Pmod2	Closed	Connects P708 (SSLB3) to Pmod2
E43	Pmod2	Closed	Connects P408 (GPIO) to Pmod2
E44	Pmod2	Closed	Connects +3.3 V to Pmod2

5. System Control and Ecosystem Access Area

The following figure shows the System Control and Ecosystem Access area on the EK-RA6M5 board. Subsequent sections detail the features and functionality provided in the area.

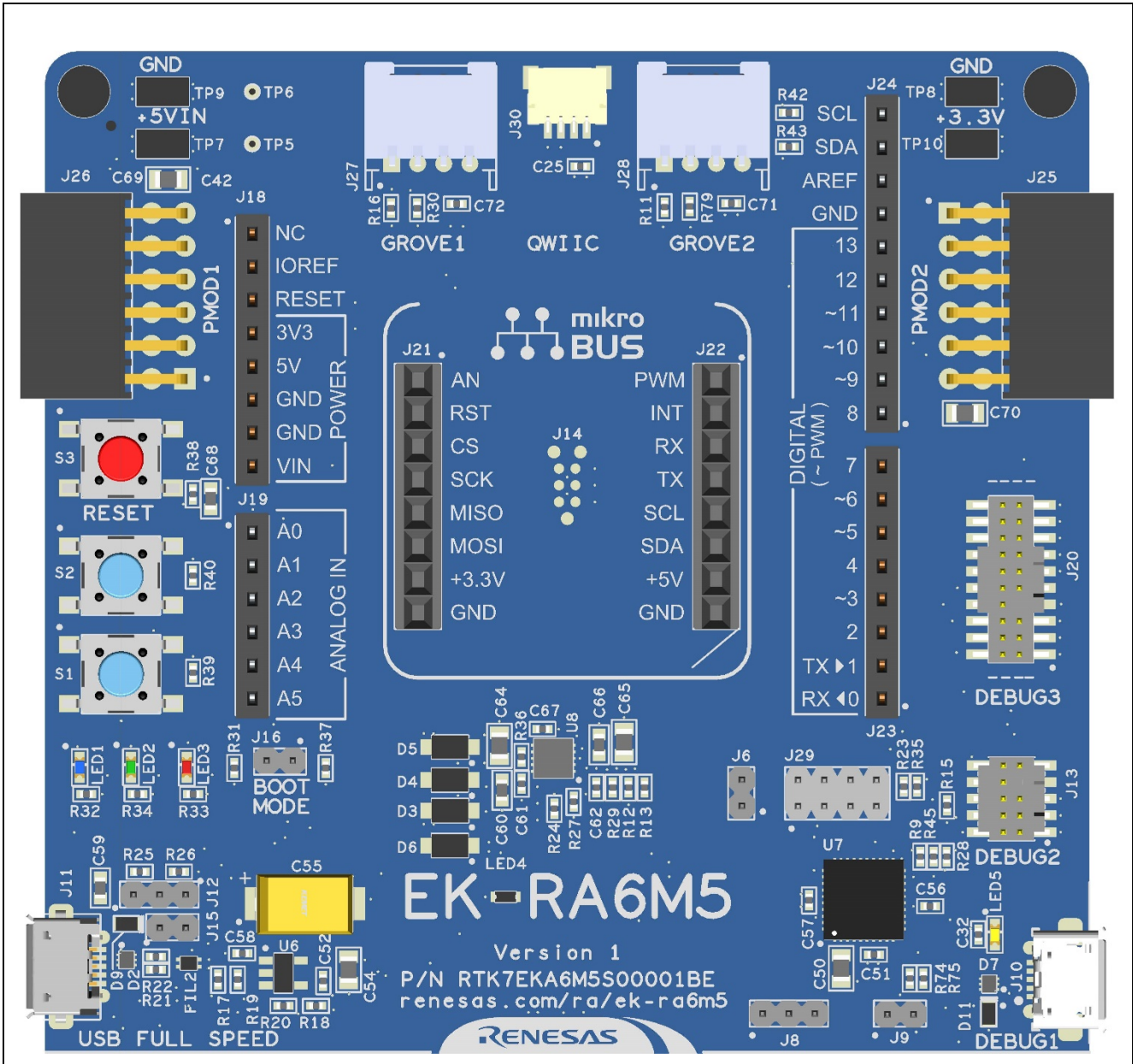


Figure 7. System Control and Ecosystem Access Area

5.1 Power

The EK-RA6M5 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-RA6M5 kit can be powered.

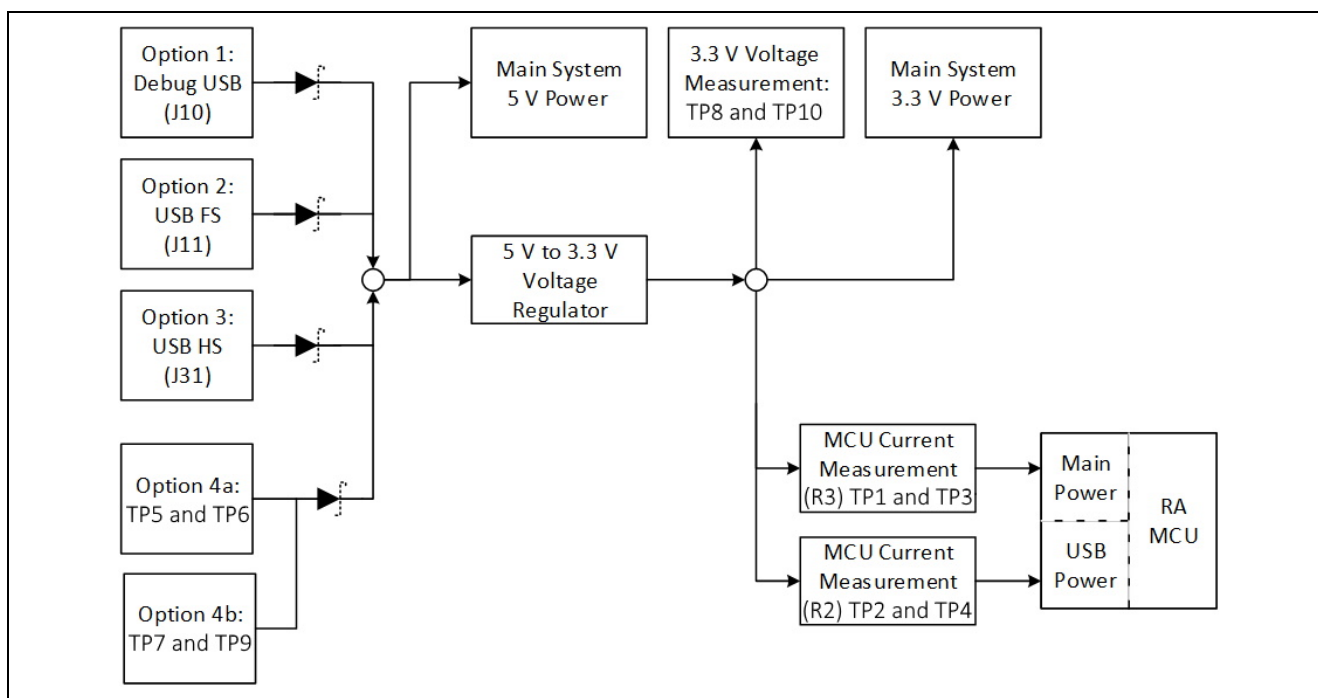


Figure 8. Power Supply Options

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 DEBUG 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 TP5 (5 V) and TP6 (GND) are large via style 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.

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-RA6M5 name) will light up. For more details on initial power up behavior, see the *EK-RA6M5 Quick Start Guide*.

5.2 Debug and Trace

The EK-RA6M5 board supports the following three debug modes.

Table 2. Debug Modes

Debug Modes	Debug MCU (one that connects to the IDE on PC)	Target MCU (one that is being debugged)	Debugging Interface/Protocol	Connector Used
Debug on-board	S124 (on-board)	RA6M5 (on-board)	SWD	Micro USB (J10)
Debug in	External debugging tools	RA6M5 (on-board)	SWD, ETM, JTAG	20-pin connector (J20) or 10-pin connector (J13)
Debug out	S124 (on-board)	Any external RA MCU	SWD	Micro USB (J10) plus either 20-pin connector (J20) or 10-pin connector (J13)

Notes:

- See Table 4 for the Debug USB connector pin definition.
- See Table 7 for the 20-pin JTAG connector pin definition.
- See Table 8 for the 10-pin JTAG connector pin definition.

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

Table 3. 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 S124 Debug MCU and SEGGER J-Link® firmware. Debug USB Micro-B connector (J10) connects the S124 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-RA6M5 board.

The S124 Debug MCU connects to the target RA MCU using the SWD interface.

Table 4. Debug USB Connector

Debug USB Connector		EK-RA6M5
Pin	Description	Signal/Bus
J10-1	+5VDC	+5V_USB_DBG
J10-2	Data-	USB_DM (U7-12)
J10-3	Data+	USB_DP (U7-13)
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-RA6M5 board is powered on, and LED5 is blinking, it indicates that the S124 Debug MCU is not connected to a programming host. When LED5 is on solid, it indicates that the S124 Debug MCU is connected to a programming interface.

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

Table 5. 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	S124 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

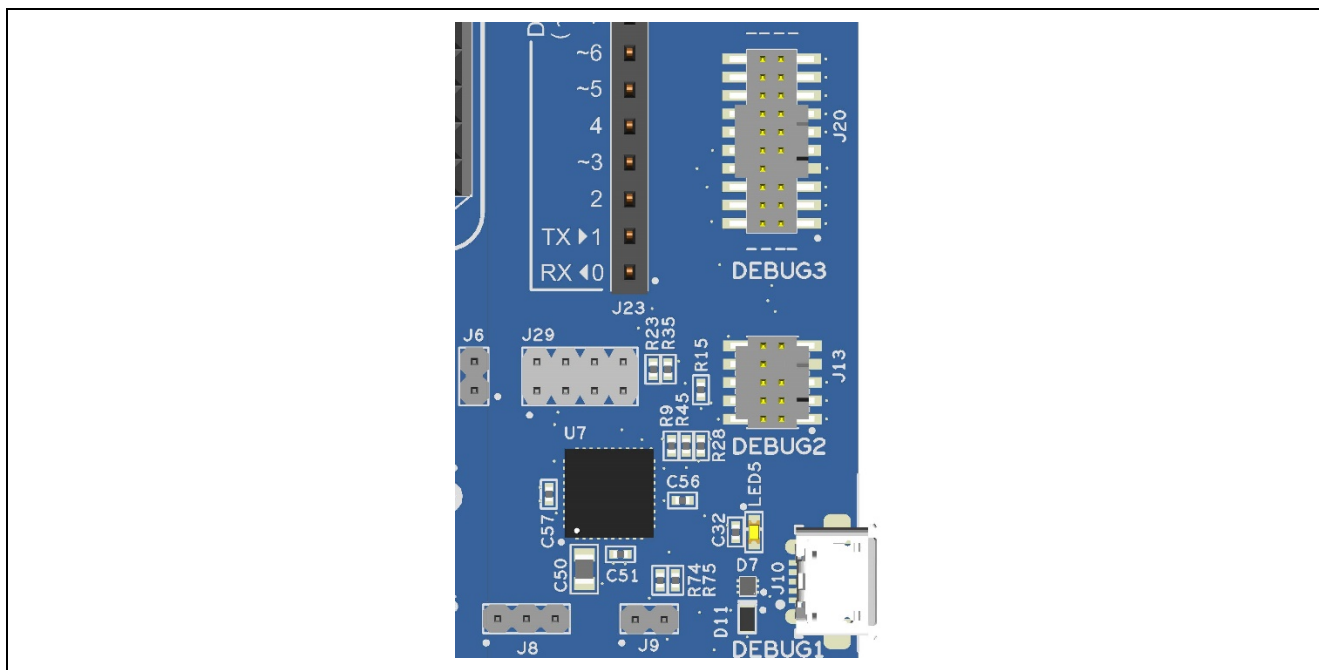


Figure 9. EK-RA6M5 Debug Interface

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

Table 6. 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	S124 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 7. JTAG/SWD/TRACE Connector

JTAG Connector				EK-RA6M5
Pin	JTAG Pin Name	SWD Pin Name	ETM Pin Name	Signal/Bus
J20-1	Vtref	Vtref	Vtref	+3V3
J20-2	TMS	SWDIO	N/A	P108/SWDIO
J20-3	GND	GND	GND	GND
J20-4	TCK	SWCLK	N/A	P300/SWCLK

JTAG Connector				EK-RA6M5
Pin	JTAG Pin Name	SWD Pin Name	ETM Pin Name	Signal/Bus
J20-5	GND	GND	GND	GND
J20-6	TDO	SWO	N/A	P109/TDO
J20-7	Key	Key	Key	N.C.
J20-8	TDI	NC/EXTb	N/A	P110/TDI
J20-9	GNDDetect	GNDDetect	GNDDetect	GND (cut E30 to open)
J20-10	nSRST	nSRST	nSRST	RESET# (Via J8)
J20-11	N/A	N/A	N/A	GND
J20-12	N/A	N/A	TCLK	P214/TCLK
J20-13	N/A	N/A	N/A	GND
J20-14	N/A	N/A	TDATA0	P211/TDATA0
J20-15	N/A	N/A	GND	GND
J20-16	N/A	N/A	TDATA1	P210/TDATA1
J20-17	N/A	N/A	GND	GND
J20-18	N/A	N/A	TDATA2	P209/TDATA2
J20-19	N/A	N/A	GND	GND
J20-20	N/A	N/A	TDATA3	P208/TDATA3

Table 8. JTAG/SWD Connector

JTAG Connector				EK-RA6M5
Pin	JTAG Pin Name	SWD Pin Name	ETM Pin Name	Signal/Bus
J13-1	Vtref	Vtref	Vtref	+3V3
J13-2	TMS	SWDIO	N/A	P108/SWDIO
J13-3	GND	GND	GND	GND
J13-4	TCK	SWCLK	N/A	P300/SWCLK
J13-5	GND	GND	GND	GND
J13-6	TDO	SWO	N/A	P109/TDO
J13-7	Key	Key	Key	N.C.
J13-8	TDI	NC/EXTb	N/A	P110/TDI
J13-9	GNDDetect	GNDDetect	GNDDetect	GND (cut E30 to open)
J13-10	nSRST	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-RA6M5 board can be configured to use the S124 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-RA6M5 board is powered on, and LED5 is blinking, this indicates that the S124 Debug MCU is not connected to a programming host. When LED5 is on solid, this indicates that the S124 Debug MCU is connected to a programming interface.

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

Table 9. 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	S124 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 3rd party add-on modules compatible with four most popular ecosystems using the following connectors:

1. Two Seeed Grove® system (I2C) connectors
2. SparkFun® Qwiic® connector
3. Two Digilent Pmod™ (SPI and UART) 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 I2C 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 10. Grove 1 Connector

Grove 1 Connector		EK-RA6M5
Pin	Description	Signal/Bus
J27-1	SCL	P415 (SCL2)
J27-2	SDA	P414 (SDA2)
J27-3	VCC	+3.3 V
J27-4	GND	GND

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. Alternatively, this port can be configured to support two analog (ADC) inputs.

The pull-up resistors, R11 and R79, must be fitted when using I2C and removed when using as analog.

Table 11. Grove 2 Connector

Grove 2 Connector		EK-RA6M5
Pin	Description	Signal/Bus
J28-1	SCL / AN	P505 (SCL6/AN121)
J28-2	SDA / AN	P506 (SDA6/AN121)
J28-3	VCC	+3.3 V
J28-4	GND	GND

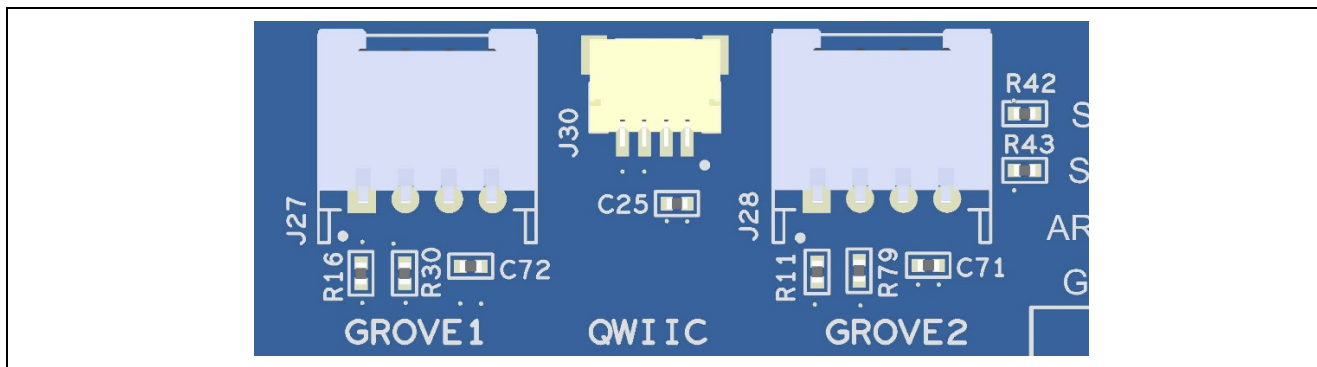


Figure 10. Seeed Grove and SparkFun® Qwiic Connectors

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 shared with Grove 1.)

Table 12. Qwiic Connector

Qwiic Connector		EK-RA6M5
Pin	Description	Signal/Bus
J30-1	GND	GND
J30-2	VCC	+3.3V
J30-3	SDA	P414 (SDA2)
J30-4	SCL	P415 (SCL2)

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-RA6M5 board also provides jumpers so the 12-pin connector may alternatively be used for 2 independent 6-pin Pmod devices where the top row supports Pmod Type-2 (SPI) and Type-3 (UART) while the bottom row supports Pmod Type-6 (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.

5.3.3.1 Pmod 1

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

Table 13. Pmod 1 Connector

Pmod 1 Connector Default			EK-RA6M5	Pmod 1 Configuration	
Pin	Description	Option Type 6A	Signal/Bus	Short	Open
J26-1	SS / CTS	NC	P206 (SSLA1/CTS9)		
J26-2	MOSI / TXD	NC	P203 (MOSIA/TXD9)		
J26-3	MISO / RXD		P202 (MISOA/RXD9)	E23	E37
		SCL	P415 (SCL2)	E37	E23
J26-4	SCK		P204 (RSPCKA/SCK9)	E24	E38
		SDA	P414 (SDA2)	E38	E24
J26-5	GND		GND		
J26-6	VCC		+3.3 V	E25	E36
			+5.0 V	E36	E25
J26-7	GPIO / INT (slave to master)		P905 (IRQ8)		
J26-8	GPIO / RESET (master to slave)		P905 (IRQ8)		
J26-9	GPIO / CS2		P301 (SSLA2)		
J26-10	GPIO / CS3		P302 (SSLA3)		
J26-11	GND		GND		
J26-12	VCC		+3.3 V	E25	E36
			+5.0 V	E36	E25

Note: Exercise caution while modifying power source trace jumpers, E25 and E36. Permanent damage to the EK-RA6M5 board and/or connected modules may result.

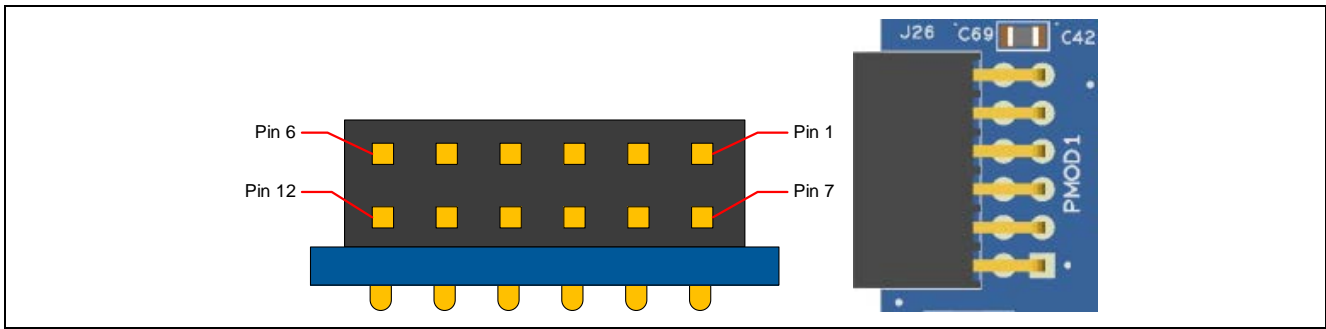


Figure 11. Pmod 1

5.3.3.2 Pmod 2

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

Table 14. Pmod 2 Connector

Pmod 2 Connector		EK-RA6M5
Pin	Description	Signal/Bus
J25-1	CS	P413 (CTS0_RTS0/SSLB0)
J25-2	MOSI	P411 (TXD0/MOSIB)
J25-3	MISO	P410 (RXD0/MISOB)
J25-4	SCK	P412 (SCK0/RSPCKB)
J25-5	GND	GND
J25-6	VCC	+3.3V
J25-7	GPIO / INT (slave to master)	P400 (IRQ0)
J25-8	GPIO / RESET (master to slave)	P404
J25-9	GPIO / CS2	P708 (SSLB3)
J25-10	GPIO / CS3	P408
J25-11	GND	GND
J25-12	VCC	+3.3V

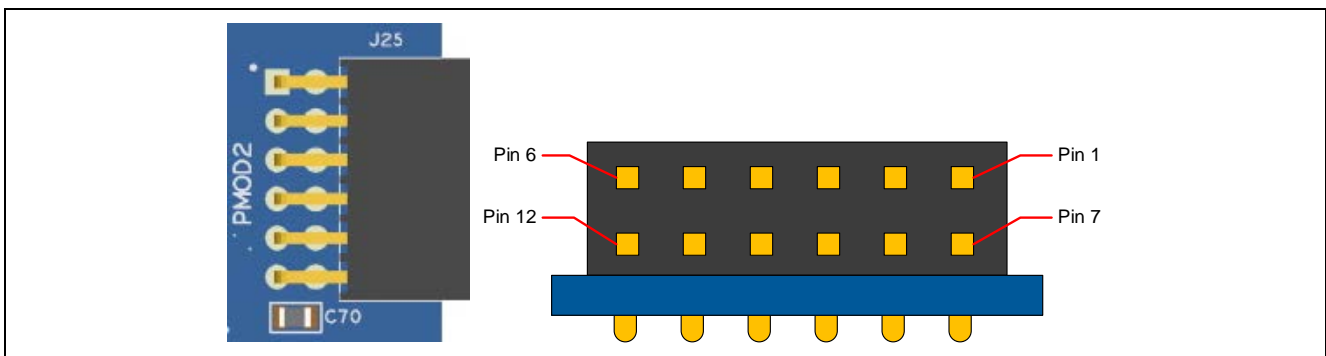


Figure 12. Pmod 2

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 15. Arduino Uno Connections

Arduino Compatible Connector		EK-RA6M5
Pin	Description	Signal/Bus
J18-1	NC	NC
J18-2	IOREF	+3.3V
J18-3	RESET	P303

	Arduino Compatible Connector		EK-RA6M5
Pin	Description		Signal/Bus
J18-4	3.3 V		+3.3V
J18-5	5 V		+5V
J18-6	GND		GND
J18-7	GND		GND
J18-8	VIN		NC
J19-1	A0		P000 (AN000)
J19-2	A1		P001 (AN001)
J19-3	A2		P002 (AN002)
J19-4	A3		P003 (AN003)
J19-5	A4		P014 (AN012)
J19-6	A5		P015 (AN013)
J23-1	D0	RXD	P614 (RXD7)
J23-2	D1	TXD	P613 (TXD7)
J23-3	D2	INT0	P409 (IRQ6)
J23-4	D3	INT1	P111 (IRQ4/GTIOC3A)
J23-5	D4		P112
J23-6	D5		P113 (GTIOC2A)
J23-7	D6		P114 (GTIOC2B)
J23-8	D7		P608
J24-1	D8		P207
J24-2	D9		P115 (GTIOC4A)
J24-3	D10	SPI_SS	P205 (/SSLA0/GTIOC4A)
J24-4	D11	SPI_MOSI	P203 (MOSIA/GTIOC5A)
J24-5	D12	SPI_MISO	P202 (MISOA)
J24-6	D13	SPI_SCK	P204 (RSPCKA)
J24-7	GND		GND
J24-8	AREF		+3.3V
J24-9	I2C_SDA		P511 (SDA1)
J24-10	I2C_SCL		P512 (SCL1)

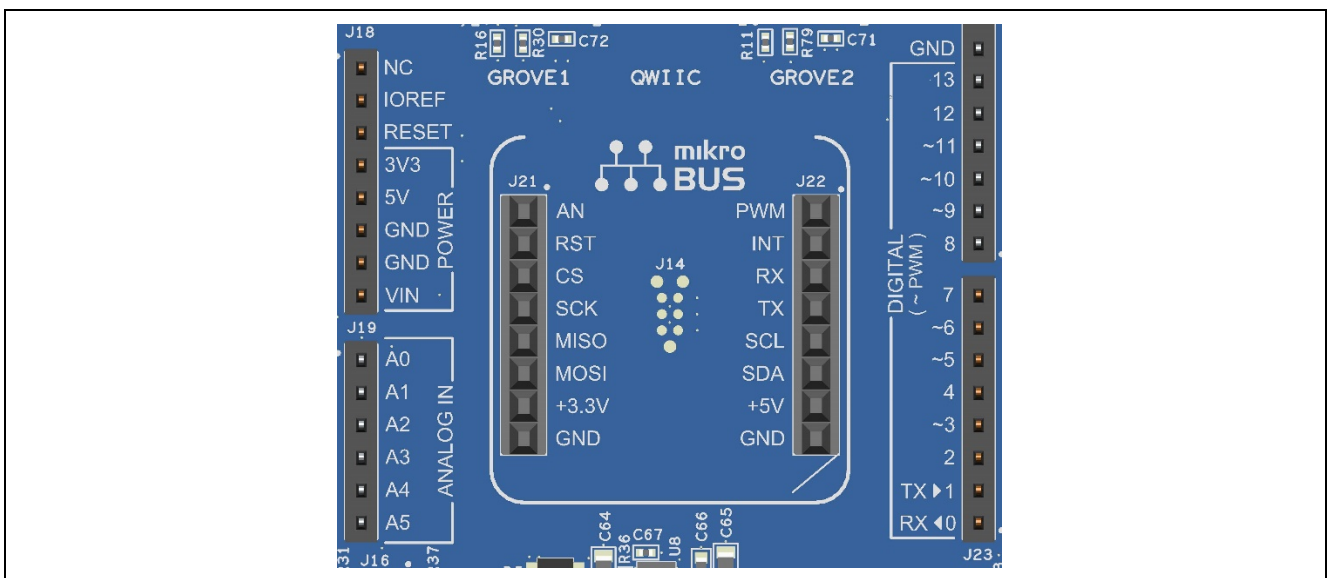


Figure 13. Arduino Uno Connectors

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 16. mikroBUS Connections

mikroBUS Connector		EK-RA6M5
Pin	Description	Signal/Bus
J21-1	AN (Analog)	P000 (AN000)
J21-2	RST (Reset)	P303
J21-3	CS (SPI Chip Select)	P205 (SSLA0)
J21-4	SCK (SPI Clock)	P204 (RSPCKA)
J21-5	MISO	P202 (MISOA)
J21-6	MOSI	P203 (MOSIA)
J21-7	+3.3 V	+3.3V
J21-8	GND	GND
J22-1	PWM	P111 (GTIOC3A)
J22-2	INT (Hardware Interrupt)	P409 (IRQ6)
J22-3	RX (UART Receive)	P614 (RXD7)
J22-4	TX (UART Transmit)	P613 (TXD7)
J22-5	SCL (I2C Clock)	P512 (SCL1)
J22-6	SDA (I2C Data)	P511 (SDA1)
J22-7	+5 V	+5V
J22-8	GND	GND

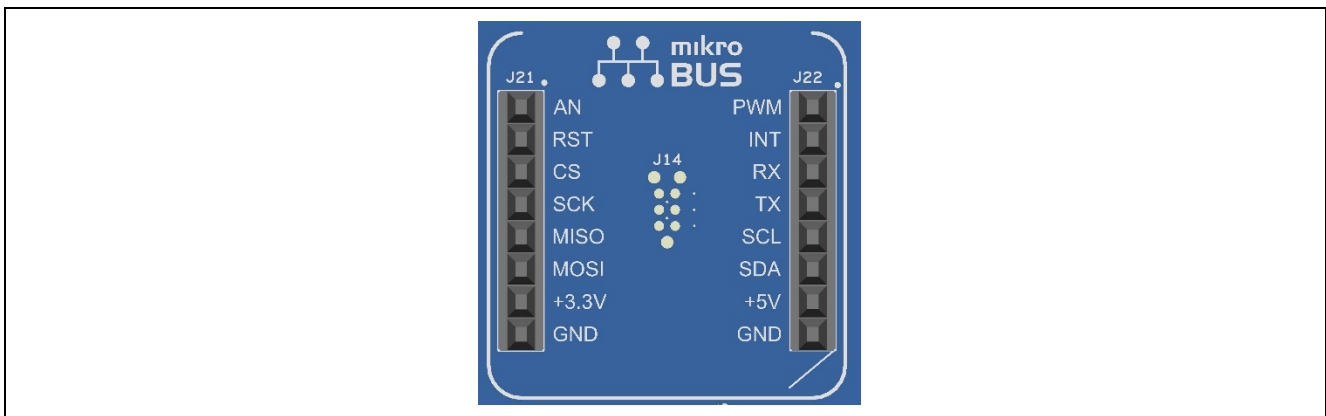


Figure 14. mikroBUS Connection

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-RA6M5 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-RA6M5 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 17. USB Full Speed Connector

USB Full Speed Connector		EK-RA6M5
Pin	Description	Signal/Bus
J11-1	+5 VDC	+5VUSB (Host Mode) *1 P407/USBFS_VBUS = 2/3 of +5VUSB at J11 *2
J11-2	Data-	USB_DM
J11-3	Data+	USB_DP
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 open

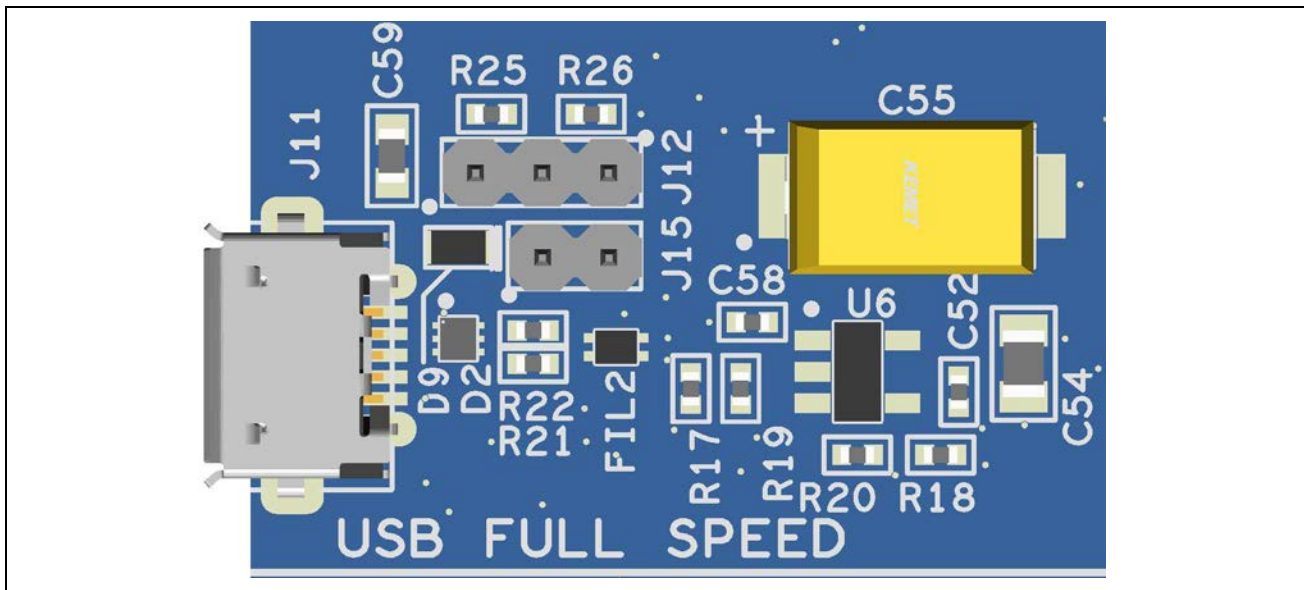


Figure 15. USB Full Speed Connector

5.5 Miscellaneous

5.5.1 User and Power LEDs

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

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

Table 18. EK-RA6M5 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Blue	User LED	P006
LED2	Green	User LED	P007
LED3	Red	User LED	P008
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 P006, Trace Cut Jumper E27 must be open. To separate LED2 from P007, Trace Cut Jumper E26 must be open. To separate LED3 from P008, Trace Cut Jumper E28 must be open.

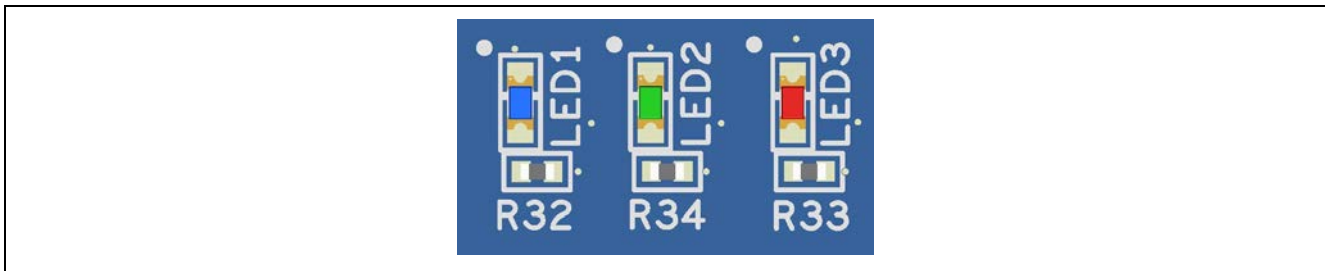


Figure 16. User LEDs



Figure 17. Power LED

5.5.2 User and Reset Switches

Three miniature, momentary, mechanical push-button type SMT switches are mounted on the EK-RA6M5 board.

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

Table 19. EK-RA6M5 Board Switches

Designator	Function	MCU Control Port	Button Color
S3	MCU Reset Switch	RESET#	Red
S2	User Switch	P004 (IRQ9-DS)	Blue
S1	User Switch	P005 (IRQ10-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 P005, Trace Cut Jumper E31 must be open. To separate S2 from P004, Trace Cut Jumper E32 must be open.

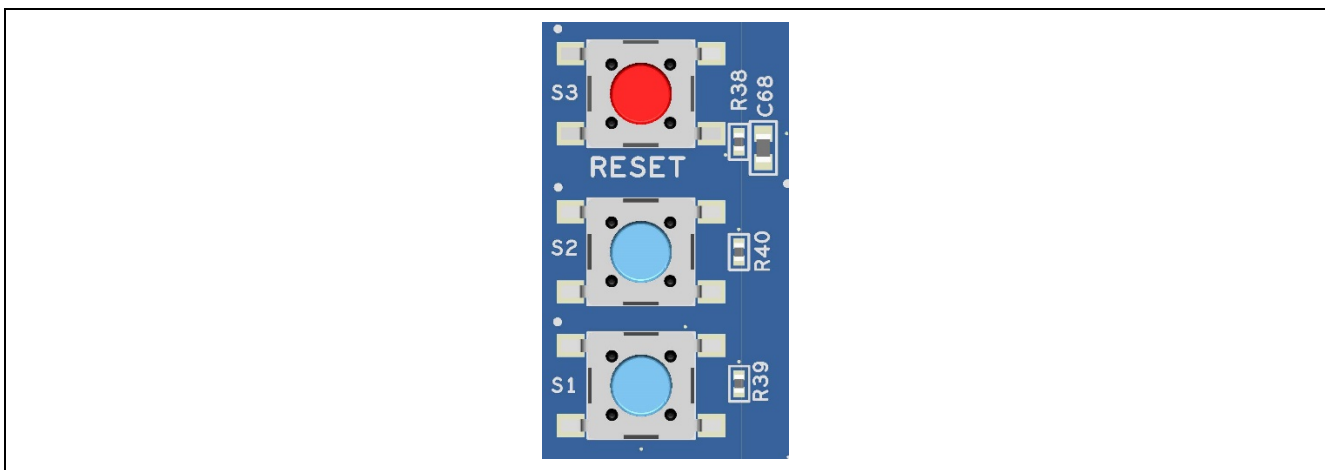


Figure 18. Reset and User Switches

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.

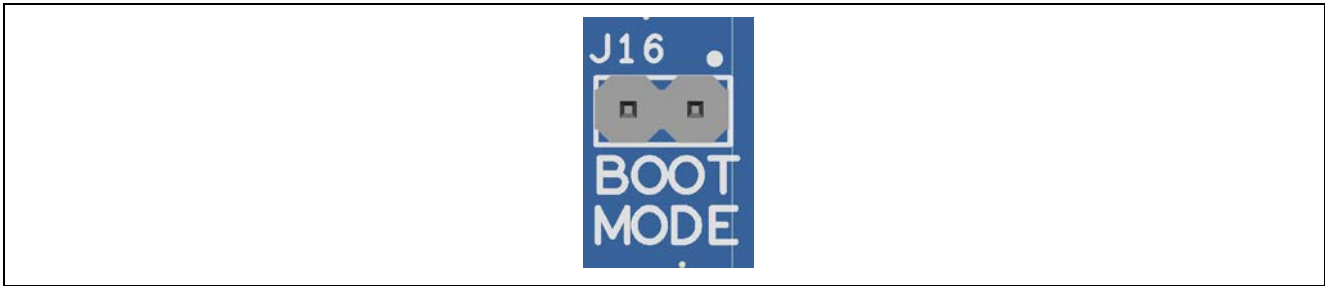


Figure 19. Boot Mode

Note: The RA MCU fitted to the EK-RA6M5 board may not contain the latest version of the on-chip boot firmware.

6. Special Feature Access Area

The Special Feature Access area provides features specific to the RA6M5 MCU group such as Ethernet MAC controller, USB High Speed (Host and Device), Quad-SPI, Octo-SPI and CAN.

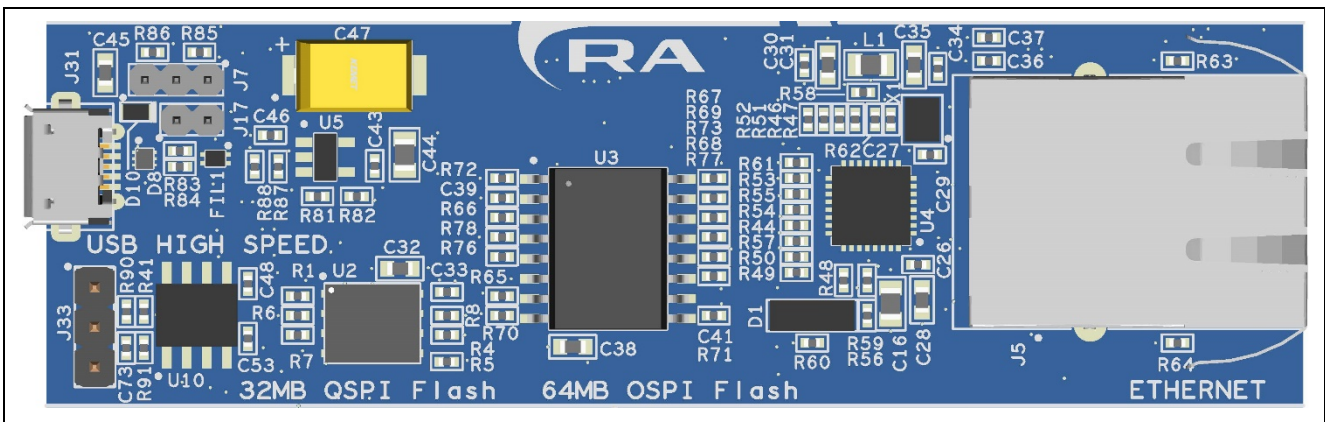


Figure 20. Special Feature Access Area

6.1 Ethernet

The Ethernet interface uses an RMII Ethernet Physical Layer Transceiver (PHY) (U4), connected to an RJ45 standard Ethernet connector (J5) with integrated magnetics and status indicators. The Ethernet clock is sourced from a precision 25 MHz clock crystal connected directly to the Ethernet PHY.

The RMII signals used for the Ethernet port are connected from the RA MCU through a set of Trace Cut Jumpers. To isolate the Ethernet PHY from the RA MCU, each of the RMII signal Trace Cut Jumpers must be OPEN.

Table 20. Ethernet Port Assignments

Ethernet Signal Description	RA6M5 MCU Port	RMII Trace Cut Jumper
IRQ	P706 (IRQ7)	E8
MDC	P401	E9
MDIO	P402	E10
TXD1	P406	E14
TXD0	P700	E15
TXD_EN	P405	E16
RXD1	P703	E17
RXD0	P702	E18
CRS_DV	P705	E19
RX_ER	P704	E20
REF50CK	P701	E21
RST#	P403	E22

Table 21. Ethernet Components

Component	Manufacturer	Manufacturer Part Number
Ethernet PHY	Microchip	KSZ8091RNB
RJ-45 Connector	Pulse	J0011D21BNL
25 MHz Oscillator	EuroQuarz	25.000 x22/30/30-40+85/12pF

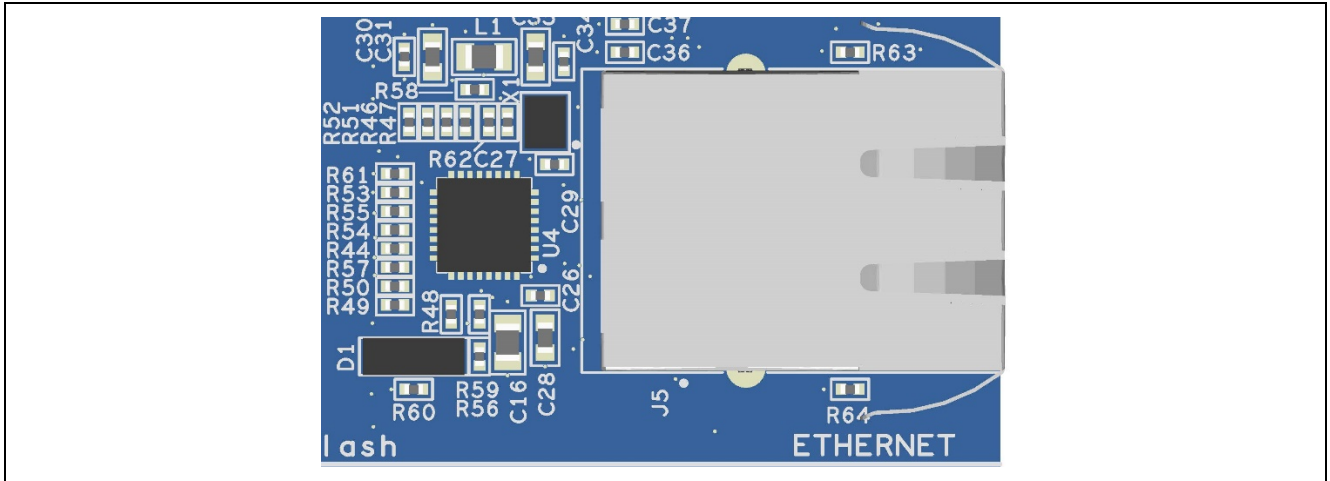


Figure 21. Ethernet Connector

6.2 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-RA6M5 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-RA6M5 board and the USB Full 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 22. USB High Speed Connector

USB High Speed Connector		EK-RA6M5
Pin	Description	Signal/Bus
J31-1	+5 VDC	+5VUSB (Host mode) PB01/USBHS_VBUS = 2/3 of +5VUSB at J31
J31-2	Data-	USBHS_DM
J31-3	Data+	USBHS_DP
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 open

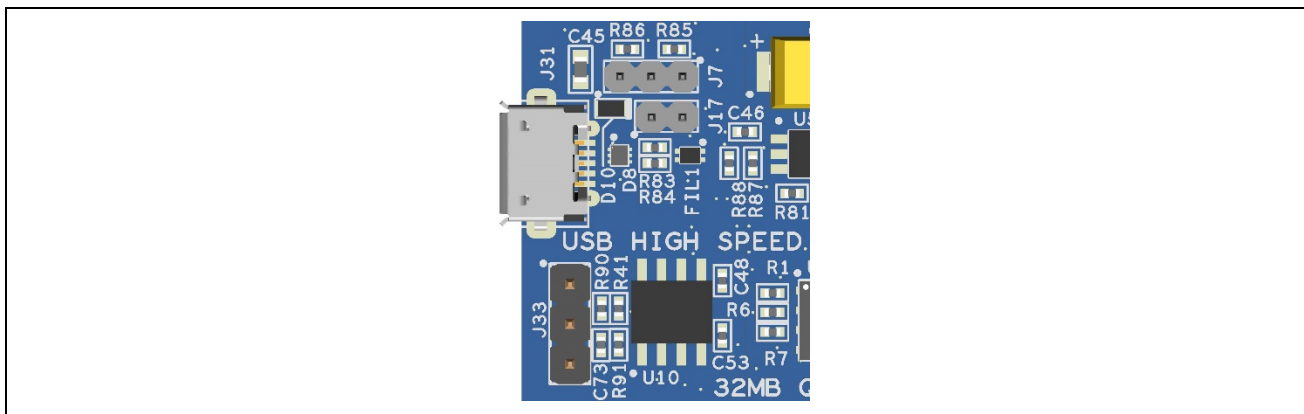


Figure 22. USB High Speed Connector

6.3 Quad-SPI Flash

Included on the EK-RA6M5 board is a Macronix 256 Mb (32 MB) serial flash Quad-SPI memory (MX25L25645G). The Quad-SPI serial flash device (U2) connects to the Quad-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.

Table 23. Quad-SPI Flash Port Assignments

Quad-SPI Signal Description	EK-RA6M5 Port
Quad-SPI CS#	P306
Quad-SPI CLK	P305
Quad-SPI DQ0	P307
Quad-SPI DQ1	P308
Quad-SPI DQ2	P309
Quad-SPI DQ3	P310

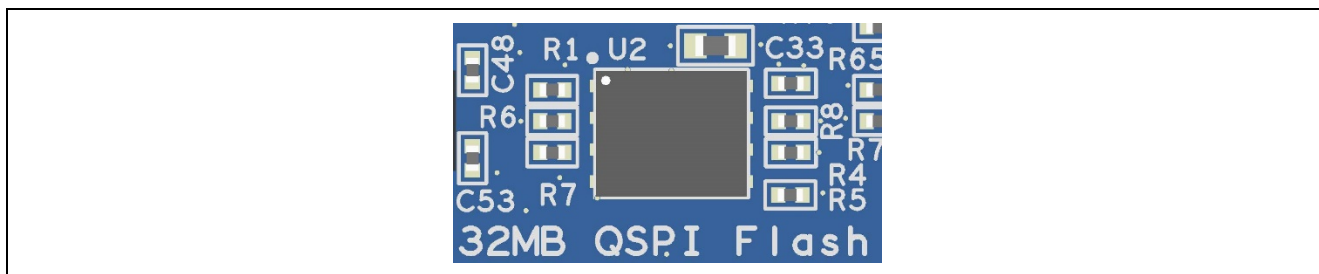


Figure 23. Quad-SPI Flash

6.4 Octo-SPI Flash

Included on the EK-RA6M5 board is a Macronix 512 Mb (64 MB) Octal serial flash memory (MX25LM51245GM). 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.

Table 24. Octo-SPI Flash Port Assignments

Quad-SPI Signal Description	EK-RA6M5 Port
Octo-SPI CS#	P602
Octo-SPI RESET#	P615
Octo-SPI SCLK	P100
Octo-SPI DQS	P104
Octo-SPI DQ0	P106
Octo-SPI DQ1	P102
Octo-SPI DQ2	P601

Octo-SPI DQ3	P107
Octo-SPI DQ4	P600
Octo-SPI DQ5	P105
Octo-SPI DQ6	P103
Octo-SPI DQ7	P101

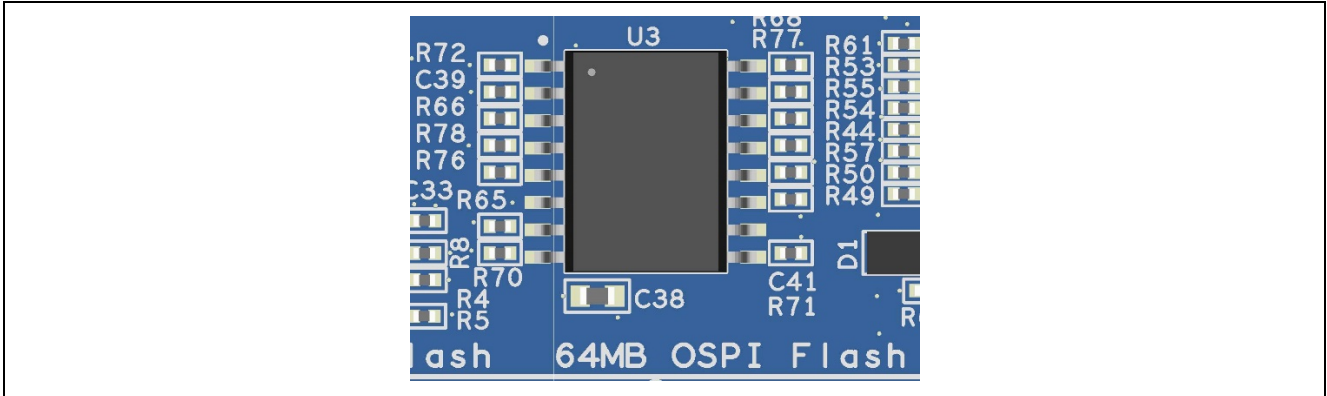


Figure 24. Octo-SPI Flash

6.5 CAN Bus

The EK-RA6M5 board provides a CAN bus transceiver (TJA1042T/3) that may be connected to the RA MCU, via jumper solder bridges. External connection to the CAN bus is made using a 3-pin header.

Table 25. CAN Bus Assignments

CAN Signal Description	EK-RA6M5 Port	Solder Bridge
STBY	P611	E33
RXD	P610	E34
TXD	P609	E35

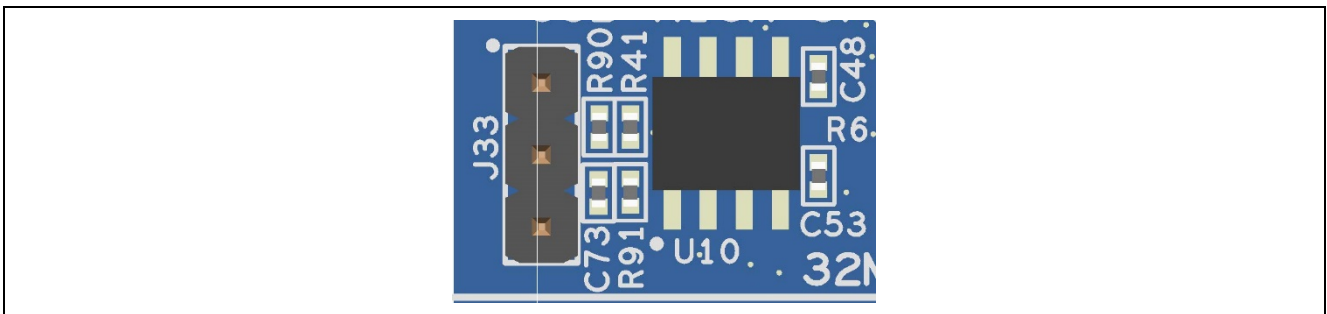


Figure 25. CAN Bus

7. MCU Native Pin Access Area

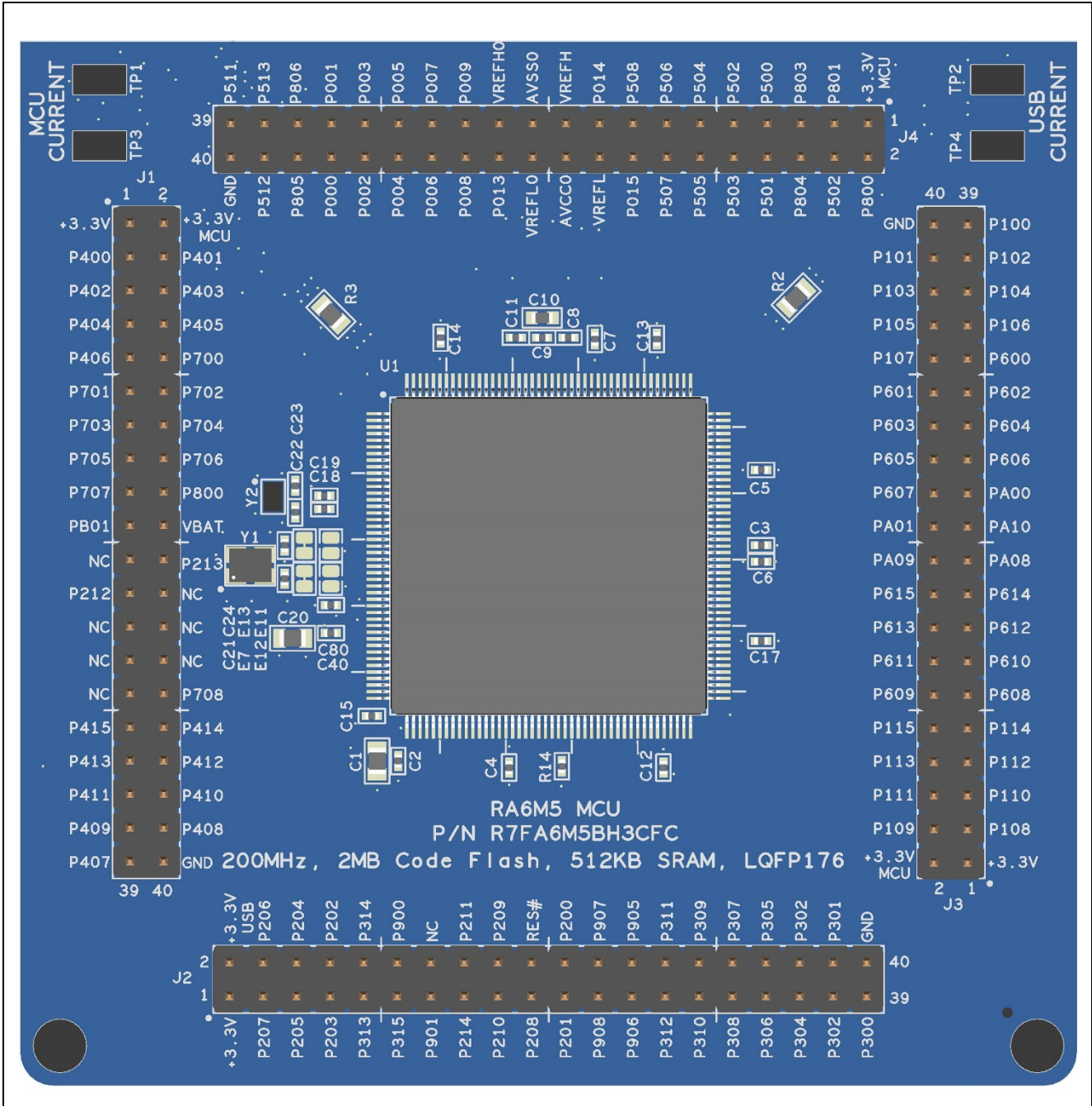


Figure 26. Native Pin Access Area

7.1 Breakout Pin Headers

The EK-RA6M5 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 RA6M5 MCU Group User's Manual for details of each port function, and the EK-RA6M5 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 RA6M5 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-RA6M5 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 and TP3.

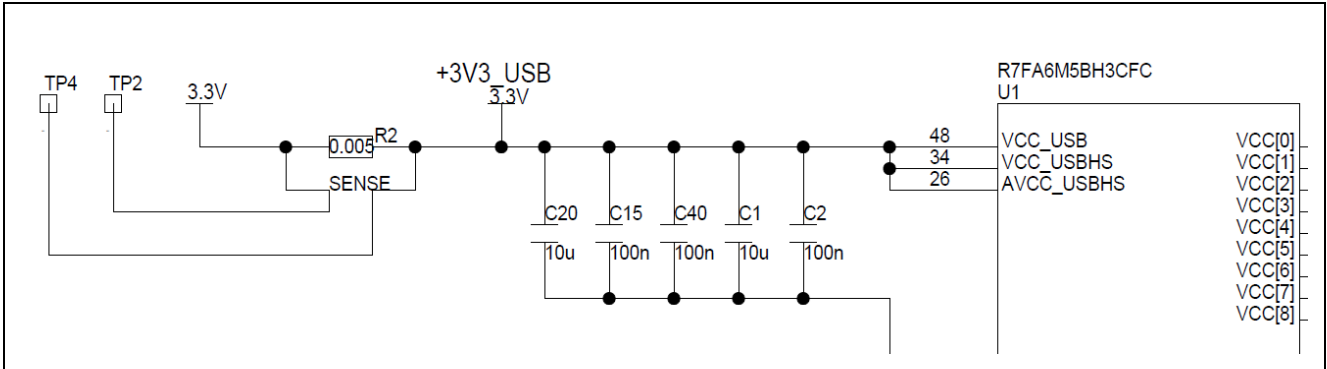


Figure 27. RA USB Current Measurement Circuit

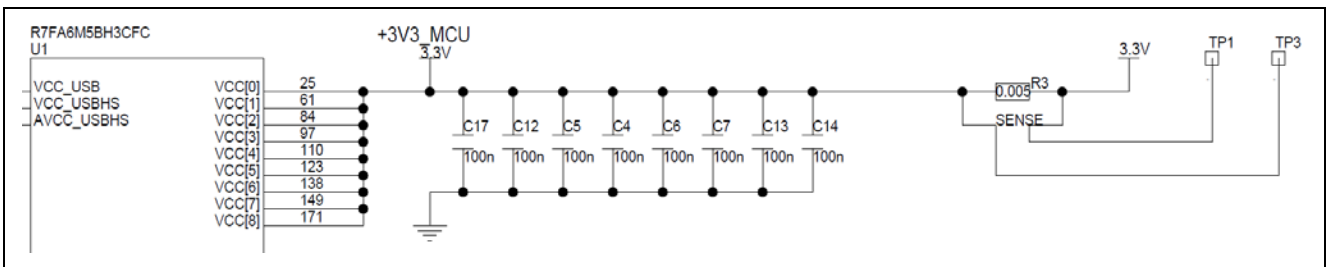


Figure 28. RA +3.3 V Current Measurement Circuit

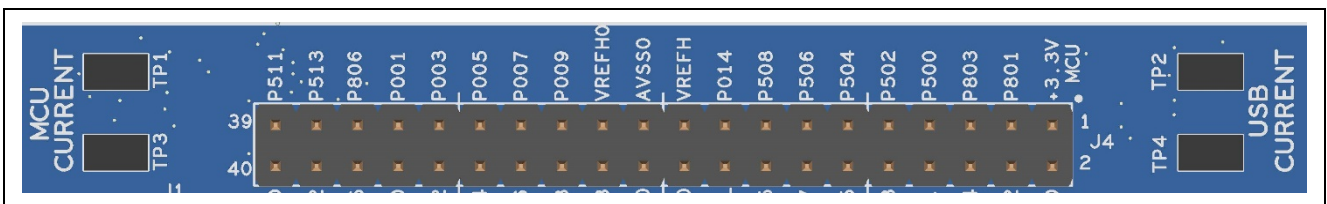


Figure 29. RA MCU Current Measurement

8. Certifications

The EK-RA6M5 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.

- 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
- 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-RA6M5 v1 kit is available in the “EK-RA6M5v1 Design Package” available on renesas.com/ra/ek-ra6m5.

- Design package file name: ek-ra6M5-v1-designpackage.zip
- Design package contents

Table 26. EK-RA6M5 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	ek-ra6m5-v1-schematics
File (PDF)	Mechanical Drawing	ek-ra6m5-v1-mechdwg
File (PDF)	3D Drawing	ek-ra6m5-v1-3d
File (PDF)	BOM	ek-ra6m5-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-RA6M5 Resources	renesas.com/ra/ek-ra6m5
RA Product Information	renesas.com/ra
RA Product Support Forum	renesas.com/ra/forum
Renesas Support	renesas.com/support

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Mar.15.21	—	Initial release

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