User's Manual

# RA6M3 Group

## Evaluation Kit for RA6M3 Microcontroller Group
## EK-RA6M3 v1
## User's Manual

Renesas RA Family
RA6 Series



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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 Microcontrollers

# EK-RA6M3 v1

## Contents

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# 1. Kit Overview

The EK-RA6M3, Evaluation Kit for RA6M3 Group, enables users to seamlessly evaluate the features of the RA6M3 MCU group and develop embedded systems applications using Flexible Software Package (FSP) and e$^2$ 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-RA6M3 are categorized in three groups (consistent with the architecture of the kit) as follows:

**MCU Native Pin Access Area**

- R7FA6M3AH3CFC MCU (referred to as RA MCU)
- 120 MHz, Arm® Cortex®-M4 core
- 2 MB Code Flash, 640 KB SRAM
- 176 pins, LQFP package
- Native pin access through 4 x 40-pin male headers
- MCU and USB current measurement points for precision current consumption measurement
- Multiple clock sources - Main 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 Area**

- 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
- Four most popular ecosystems expansions
  - 2 SeeedGrove® system (I2C) connectors
  - 2 Digilent Pmod™ (SPI and UART) connectors
  - Arduino™ (Uno R3) connector
  - MikroElektronika™ mikroBUS connector
- MCU boot configuration jumper

**Interface Function Area**

- Ethernet (RJ 45 RMII interface)
- USB High Speed Host and Device (micro AB connector)
- 32 MB (256 Mb) External QSPI Flash

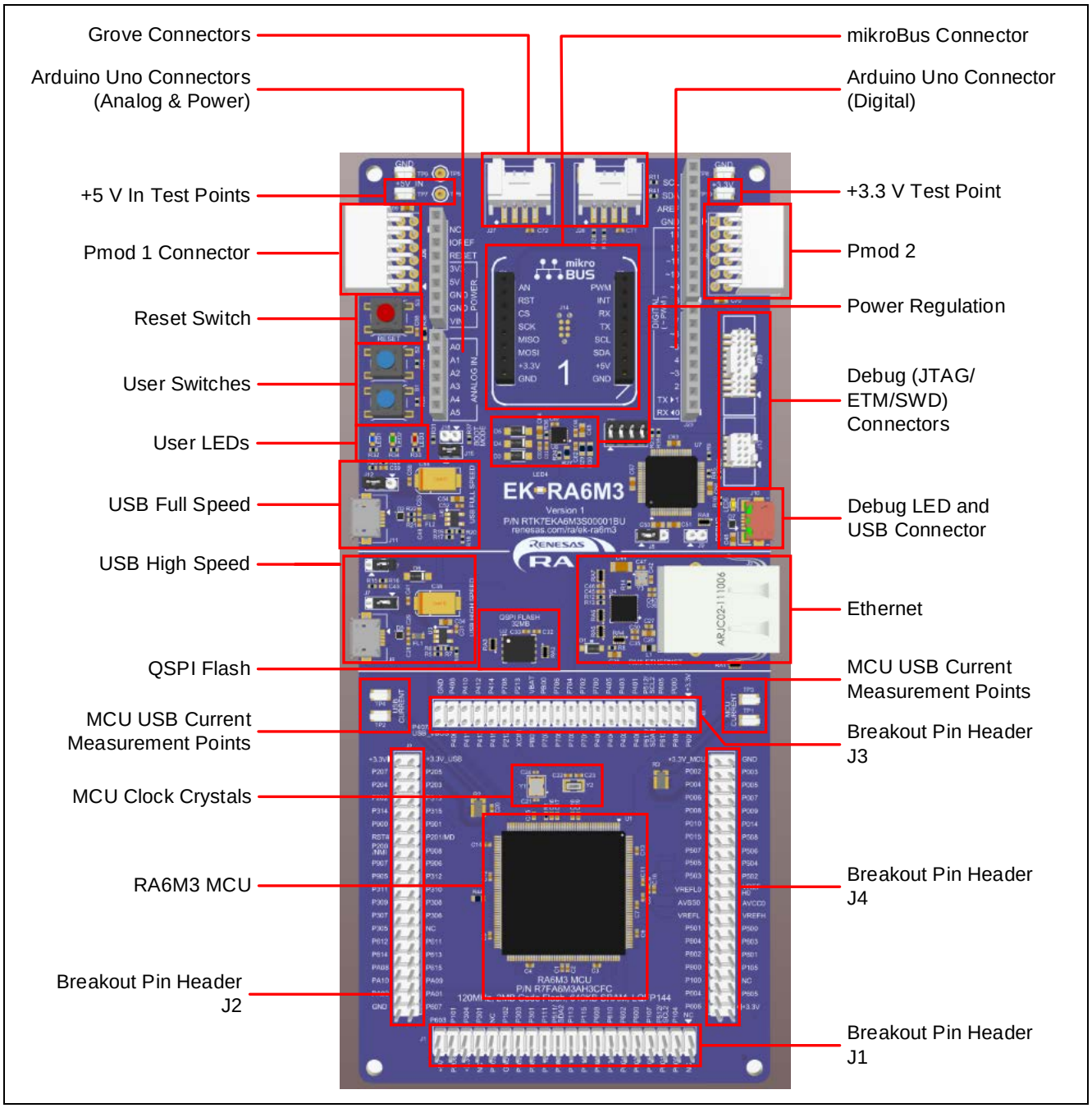


**Figure 1. EK-RA6M3 Top Side**

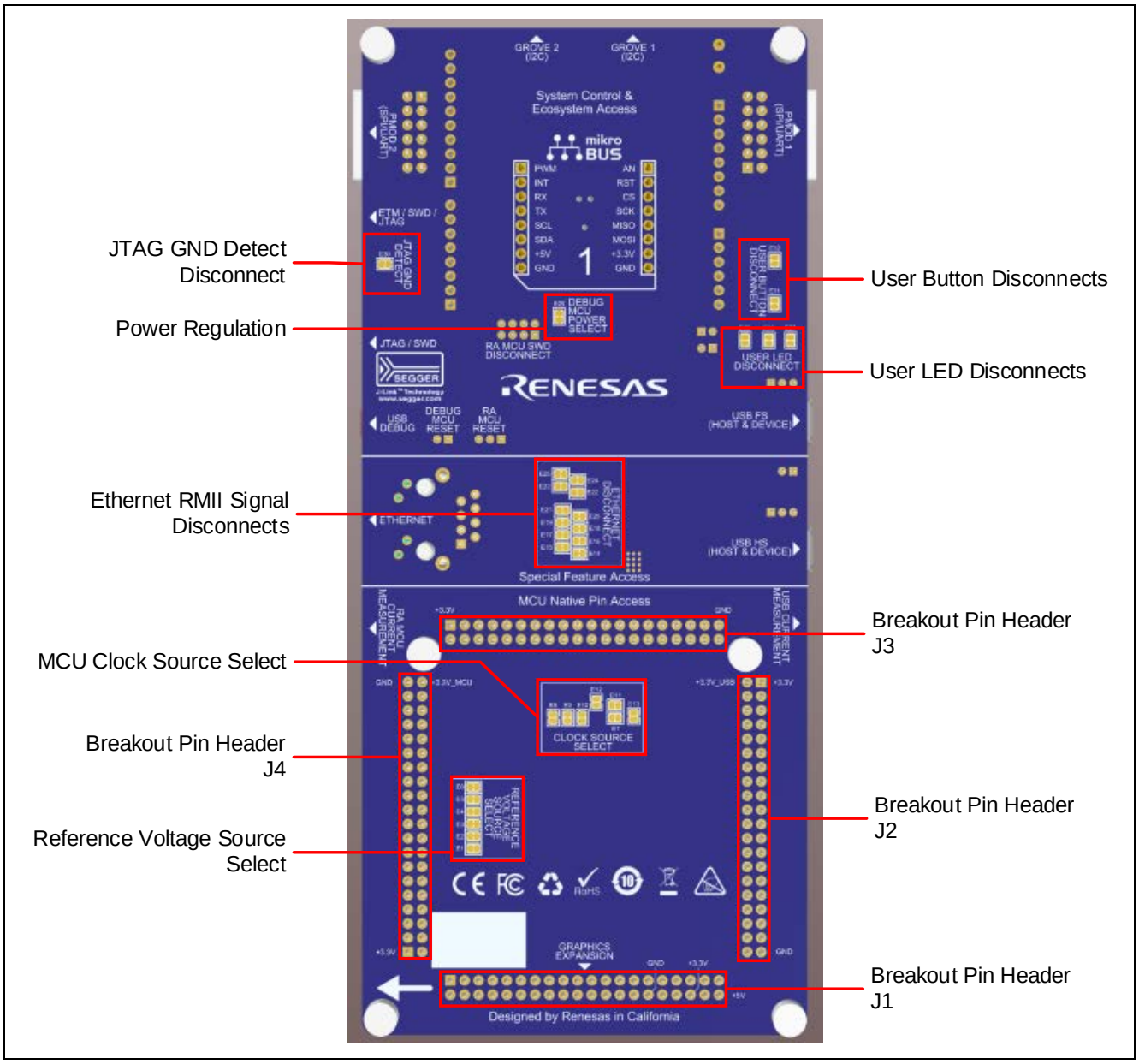


**Figure 2. EK-RA6M3 Bottom Side**

## 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-RA6M3 Quick Start Guide* to get acquainted with the kit and the Quick Start example project that EK-RA6M3 comes pre-programmed with.
3. Flexible Software Package (FSP) and Integrated Development Environment (IDE) such as e$^2$ studio are required to develop embedded applications on EK-RA6M3.
4. Instructions to download and install software, import example projects, build them and program the EK-RA6M3 are provided in the quick start guide.

## 2. Kit Contents

The following components are included in the kit:

1. EK-RA6M3 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

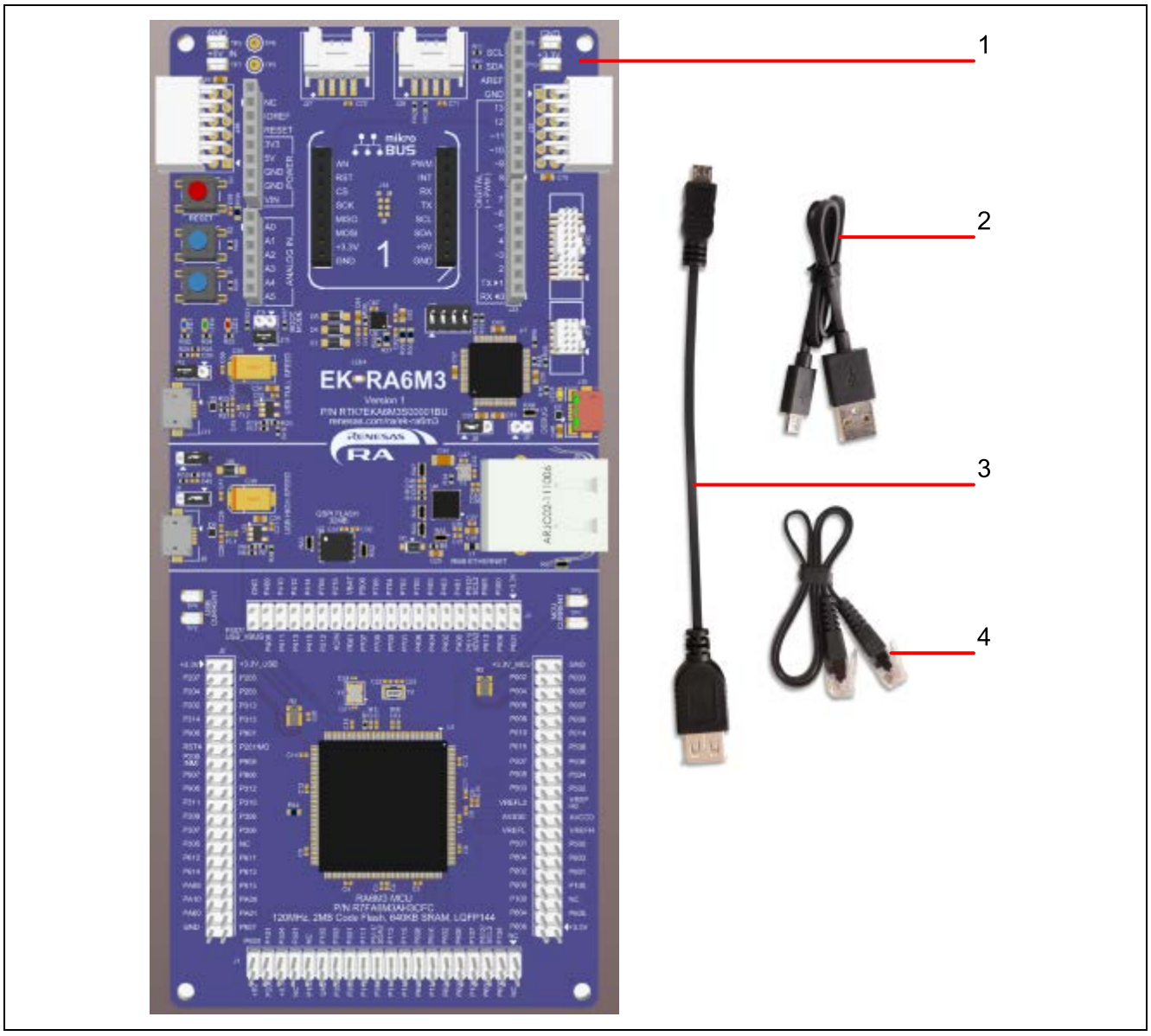


**Figure 3. Kit Contents**

## 3. Ordering Information

- EK-RA6M3 v1 orderable part number: RTK7EKA6M3S00001BU

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

- PCB dimensions: 80 mm (width) x 180 mm (length)

# 4. Hardware Architecture and Default Configuration

## 4.1 Kit Architecture

EK-RA6M3 is designed with three sections or areas to help shorten the learning curve for 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 |
| Interface Function Area | MCU interface functions: Ethernet, USB High Speed Host and Device, QSPI | 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 |

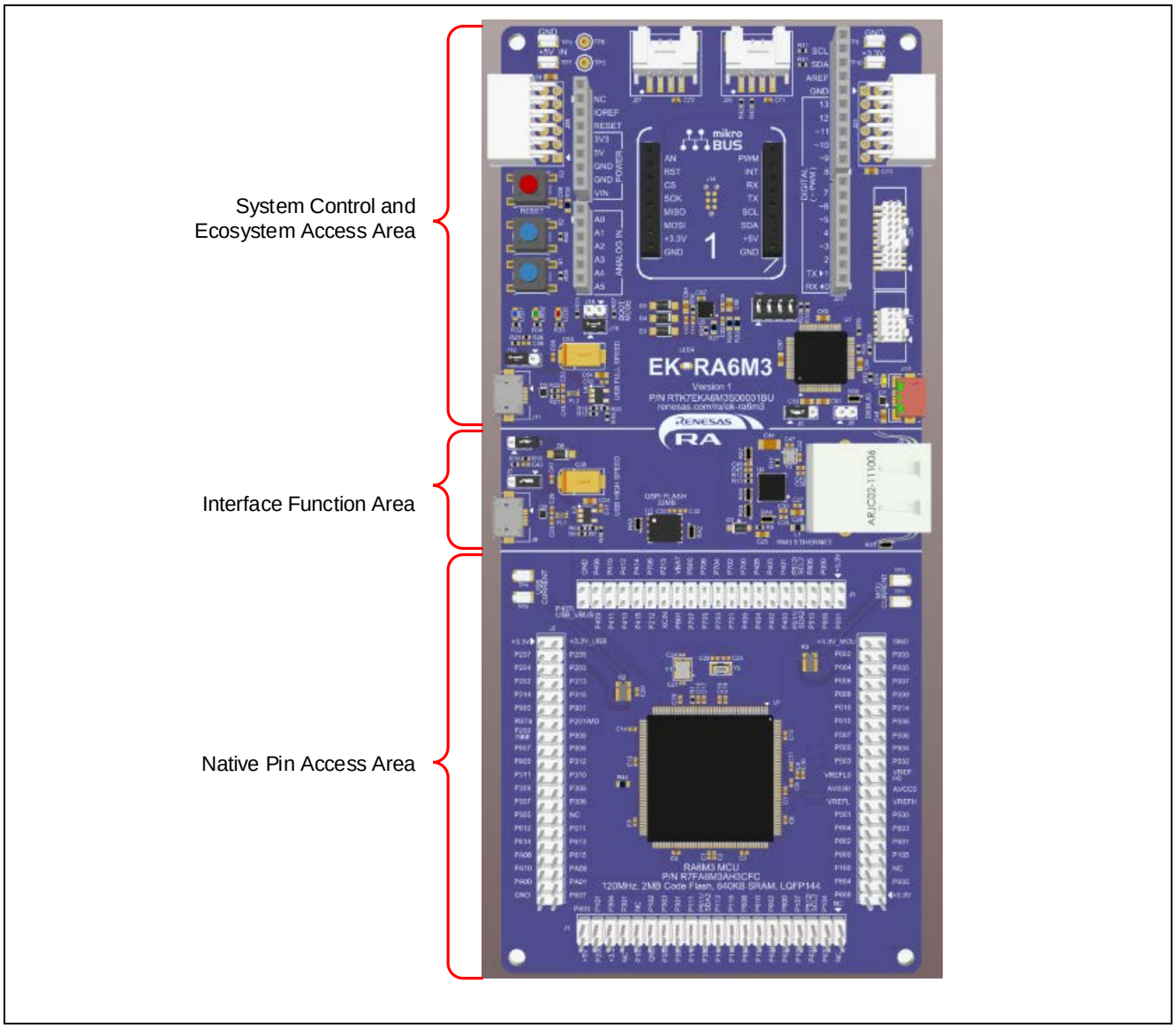


**Figure 4. Functional Area Definitions**

## 4.2 System Block Diagram

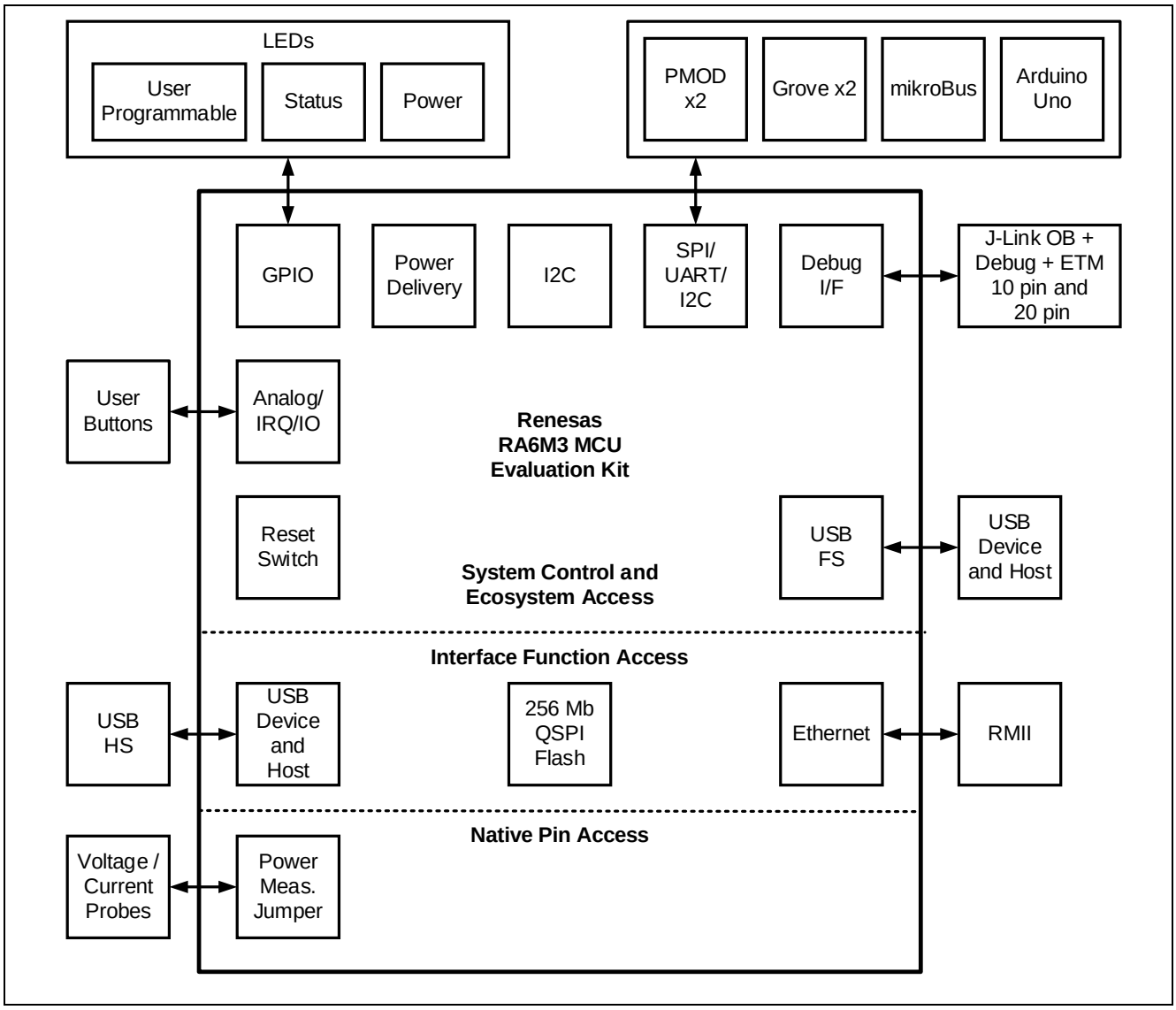


**Figure 5. EK-RA6M3 Block Diagram**

## 4.3 Jumper Settings

Two types of jumpers are provided on EK-RA6M3.

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.

The silk screen overlay printing around a solder-bridge jumper is a box with a gap in the lines adjacent to the isolation region between the pads.

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.)

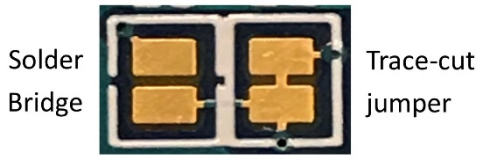


**Figure 6. Copper Jumpers**

### 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 EK-RA6M3 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-RA6M3. 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 |
|---|---|---|---|
| J7 | USB HS | Jumper on pins 1-2 | Sets USB power to host mode |
| J8 | J-Link OB | Jumper on pins 1-2 | Configures J-Link OB as the on-board debugger |
| J9 | J-Link OB | Open | Configures Reset# for on-board debugger mode |
| J12 | USB FS | Jumper on pins 2-3 | Sets USB power to device mode |
| J15 | USB FS | Jumper on pins 1-2 | Connects micro-USB power to system power |
| J16 | MCU Boot Mode | Open | Configures the MCU for normal boot mode |
| J17 | USB HS | Open | Connects micro-USB power to system power |
| J29 | J-Link OB | Jumper on pins 1-2<br>Jumper on pins 3-4<br>Jumper on pins 5-6<br>Jumper on pins 7-8 | Connects the J-Link OB debugger to the RA MCU |
| 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 24 MHz crystal to MCU EXTAL pin |
| E8 | MCU Clock | Open | Connects MCU XCIN pin to pin headers |
| E9 | MCU Clock | Closed | Connects 32.768 kHz crystal to MCU XCIN pin |
| E10 | MCU Clock | Closed | Connects 32.768 kHz crystal to MCU XCOUT pin |
| E11 | MCU Clock | Closed | Connects 24 MHz crystal to MCU XTAL pin |
| E12 | MCU Clock | Open | Connects MCU P213/XTAL pin to pin headers |
| E13 | MCU Clock | Open | Connects MCU P212/EXTAL pin to pin headers |
| E14 | Ethernet | Closed | Connects Ethernet RESET# to MCU P404 |
| E15 | Ethernet | Closed | Connects Ethernet TXD1 to MCU P406 |
| E16 | Ethernet | Closed | Connects Ethernet TXD0 to MCU P700 |
| E17 | Ethernet | Closed | Connects Ethernet TXD_EN to MCU P405 |
| E18 | Ethernet | Closed | Connects Ethernet IRQ to MCU P706 (IRQ7) |
| E19 | Ethernet | Closed | Connects Ethernet RX_ER to MCU P704 |
| E20 | Ethernet | Closed | Connects Ethernet CRS_DV to MCU P705 |
| E21 | Ethernet | Closed | Connects Ethernet REF50CK0 to MCU P701 |
| E22 | Ethernet | Closed | Connects Ethernet RXD0 to MCU P702 |
| E23 | Ethernet | Closed | Connects Ethernet RXD1 to MCU P703 |
| E24 | Ethernet | Closed | Connects Ethernet MDC to MCU P401 |
| E25 | Ethernet | Closed | Connects Ethernet MDIO to MCU P402 |
| E26 | User LED | Closed | Connects User LED2 to MCU P400 |
| E27 | User LED | Closed | Connects User LED1 to MCU P403 |
| E28 | User LED | Closed | Connects User LED3 to MCU P100 |
| 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 |

| Location | Circuit Group | Default Open/Closed | Function |
|---|---|---|---|
| E31 | User Switch | Closed | Connects User Switch S1 to MCU P009 |
| E32 | User Switch | Closed | Connects User Switch S2 to MCU P008 |

## 5. System Control and Ecosystem Access Area

The following figure shows the System Control and Ecosystem Access Area on the EK-RA6M3. Subsequent sections detail the features and functionality provided in the area.

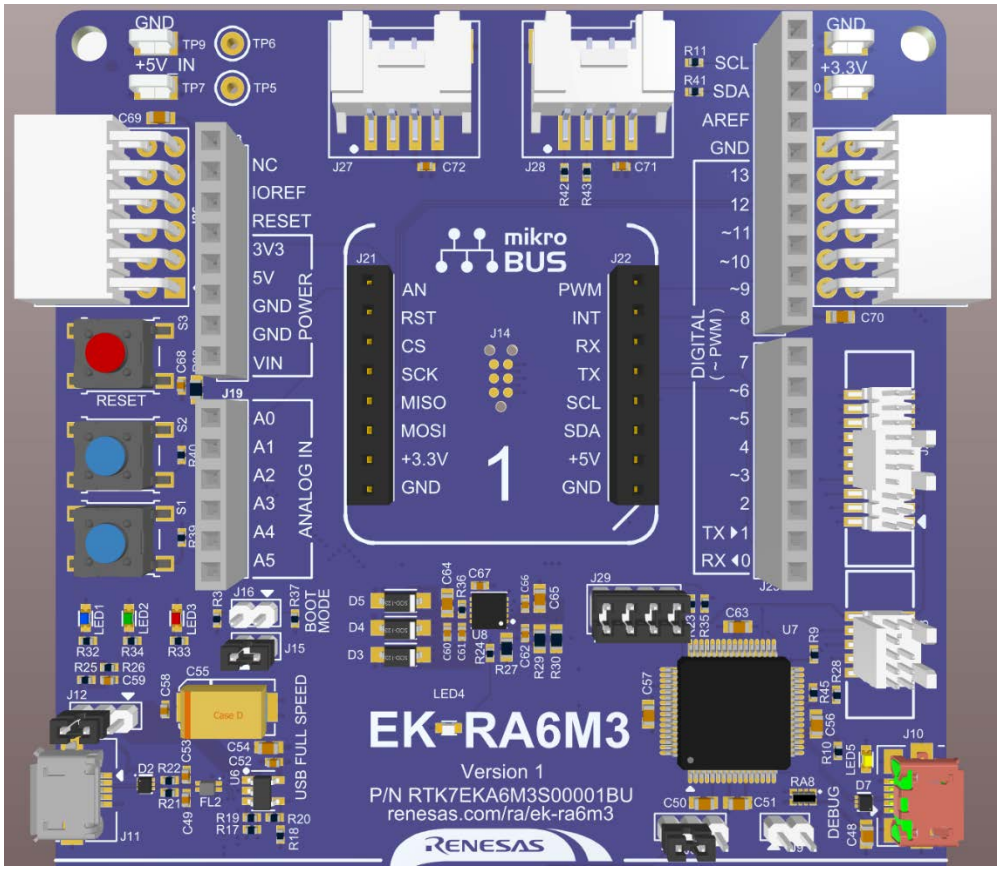


**Figure 7. System Control and Ecosystem Access Area**

### 5.1 Power

EK-RA6M3 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 main MCU and many of the EK-RA6M3 peripheral features.

#### 5.1.1 Power Supply Options

This section describes the different ways in which EK-RA6M3 kit can be powered.

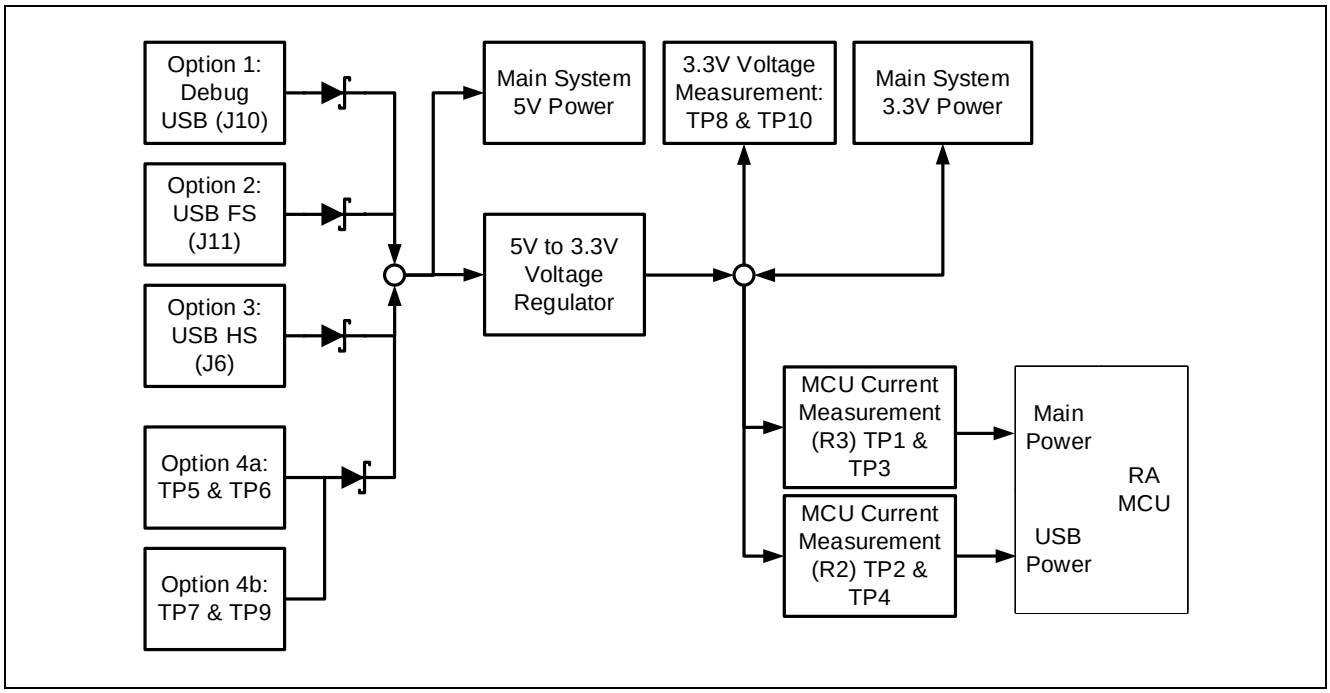


**Figure 8. Power Supply Options**

#### 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 the Main System 5 V Power. Reverse current protection is provided between this connector and the Main System 5 V Power.

#### 5.1.1.2 Option 2: 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 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 3: USB High Speed

5 V may be supplied from an external USB host to the USB High Speed connector (J6) labelled USB HIGH SPEED on the board. Power from this source is connected the Main System 5 V Power. Reverse current protection is provided between this connector and the Main System 5 V Power.

#### 5.1.1.4 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) & 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 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-RA6M3 name) will light up. For more details on initial power up behavior, see the *EK-RA6M3 Quick Start Guide*.

## 5.2 Debug and Trace

The EK-RA6M3 supports the following three debug modes:

**Table 2. Debug Modes**

| Debug Modes | Debugger 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) | RA6M3 (on-board) | SWD | Micro USB (J10) |
| Debug in | External debugging tools | RA6M3 (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 | J8 | J9 | J29 |
|---|---|---|---|
| Debug on-board | Jumper on pins 1-2 | Open | Jumpers on pins 1-2, 3-4, 5-6, 7-8 |
| Debug in | Jumper on pins 1-2 | Jumper on pins 1-2 | Jumpers on pins 1-2, 3-4, 5-6, 7-8 |
| Debug out | 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 EK-RA6M3.

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

**Table 4. Debug USB Connector**

| Debug USB Connector | | EK-RA6M3 |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J34-1 | +5VDC | +5V_JUSB |
| J34-2 | Data- | U2 USB_DM (U2-18) |
| J34-3 | Data+ | U2 USB_DP (U2-19) |
| J34-4 | USB ID, jack internal switch, cable inserted | N.C. |
| J34-5 | Ground | GND |

A yellow indicator, LED5, shows the visual status of the debug interface. When the EK-RA6M3 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 the S124 Debug MCU is connected to a programming interface.

To configure EK-RA6M3 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 |
|---|---|---|
| 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 |

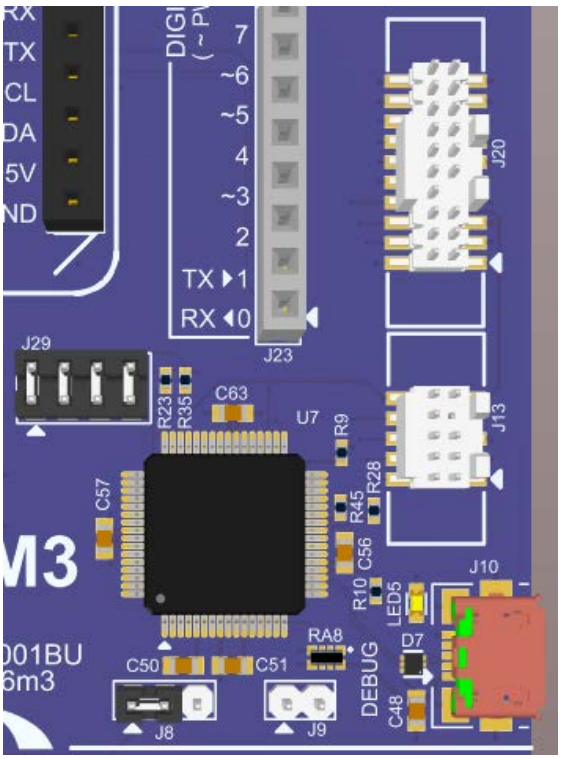


**Figure 9. EK-RA6M3 Debug Interface**

### 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 EK-RA6M3 to use the External Debug mode, configure the jumpers using the following table:

**Table 6. External Debug Jumper Configuration**

| Location | Default Open/Closed | Function |
|---|---|---|
| J8 | Jumper on pins 1-2 | Target RA MCU RESET# connected to debug RESET# |
| J9 | Jumper on pins 1-2 | 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-RA6M3 |
|---|---|---|---|---|
| **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 (U1-89) |
| J20-3 | GND | GND | GND | GND |
| J20-4 | TCK | SWCLK | N/A | P300/SWCLK (U1-88) |
| J20-5 | GND | GND | GND | GND |
| J20-6 | TDO | SWO | N/A | P109/TDO (U1-90) |
| J20-7 | Key | Key | Key | N.C. |
| J20-8 | TDI | NC/EXTb | N/A | P110/TDI (U1-91) |
| J20-9 | GNDDetect | GNDDetect | GNDDetect | GND (cut E30 to open) |
| J20-10 | nSRST | nSRST | nSRST | RESET# |
| J20-11 | N/A | N/A | N/A | N.C. |
| J20-12 | N/A | N/A | TCLK | P214/TCLK (U1-62) |
| J20-13 | N/A | N/A | N/A | N.C. |
| J20-14 | N/A | N/A | TDATA0 | P211/TDATA0 (U1-63) |
| J20-15 | N/A | N/A | GND | GND |
| J20-16 | N/A | N/A | TDATA1 | P210/TDATA1 (U1-64) |
| J20-17 | N/A | N/A | GND | GND |
| J20-18 | N/A | N/A | TDATA2 | P209/TDATA2 (U1-65) |
| J20-19 | N/A | N/A | GND | GND |
| J20-20 | N/A | N/A | TDATA3 | P208/TDATA3 (U1-66) |

**Table 8. JTAG/SWD Connector**

| JTAG Connector | | | | EK-RA6M3 |
|---|---|---|---|---|
| **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 (U1-89) |
| J13-3 | GND | GND | GND | GND |
| J13-4 | TCK | SWCLK | N/A | P300/SWCLK (U1-88) |
| J13-5 | GND | GND | GND | GND |
| J13-6 | TDO | SWO | N/A | P109/TDO (U1-90) |
| J13-7 | Key | Key | Key | N.C. |
| J13-8 | TDI | NC/EXTb | N/A | P110/TDI (U1-91) |
| J13-9 | GNDDetect | GNDDetect | GNDDetect | GND (cut E30 to open) |
| J13-10 | nSRST | nSRST | nSRST | RESET# |

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

### 5.2.3 Debug Out

The EK-RA6M3 Debug Interface 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 EK-RA6M3 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 EK-RA6M3 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 |
|---|---|---|
| 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. Two Digilent Pmod™ (SPI and UART) connectors
3. Arduino™ (Uno R3) connector
4. MikroElektronika™ mikroBUS connector

### 5.3.1 SeeedGrove® Connectors

#### 5.3.1.1 Grove 1

A SeeedGrove I2C connector is provided at J27. The Main 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-RA6M3 |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J27-1 | SCL | P408 (SCL3) |
| J27-2 | SDA | P409 (SDA3) |
| J27-3 | VCC | +3.3 V |
| J27-4 | GND | GND |

#### 5.3.1.2 Grove 2

A SeeedGrove I2C connector is provided at J28. The Main MCU acts as a two-wire serial master, and a connected module acts as a two-wire serial slave.

**Table 11. Grove 2 Connector**

| Grove 2 Connector | | EK-RA6M3 |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J28-1 | SCL | P408 (SCL3) |
| J28-2 | SDA | P409 (SDA3) |
| J28-3 | VCC | +3.3 V |
| J28-4 | GND | GND |

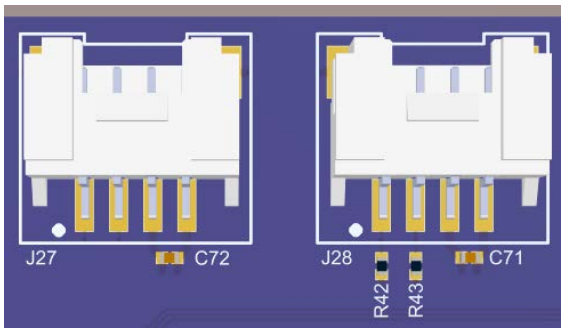


**Figure 10. Seeed Grove Connectors**

### 5.3.2 Digilent Pmod™ Connectors

#### 5.3.2.1 PMOD 1

A 12-pin PMOD Type-2A connector is provided at PMOD 1. The Main MCU acts as the SPI master, and the connected module acts as an SPI slave device. This interface may additionally be re-configured in firmware as several other PMOD types.

This PMOD interface supports +3.3 V devices. Please ensure that any PMOD device installed is compatible with a +3.3 V supply.

**Table 12. PMOD 1 Connector**

| **PMOD 1 Connector** | | **EK-RA6M3** |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J26-1 | SS/CTS_RTS | P205 (SSLB0_A/SS9/CTS_RTS9) |
| J26-2 | MOSI/TXD | P203 (MOSIB_A/MOSI9/TXD9/SDA9) |
| J26-3 | MISO/RXD | P202 (MISOB_A/MISO9/RXD9/SCL9) |
| J26-4 | SCK | P204 (RSPCKB_A/SCK9) |
| J26-5 | GND | GND |
| J26-6 | VCC | +3.3 V |
| J26-7 | INT (slave to master) | P004 (IRQ9) |
| J26-8 | RESET (master to slave) | P800 (GPIO) |
| J26-9 | Not Specified (GPIO) | P801 (GPIO) |
| J26-10 | Not Specified (GPIO) | P802 (GPIO) |
| J26-11 | GND | GND |
| J26-12 | VCC | +3.3 V |

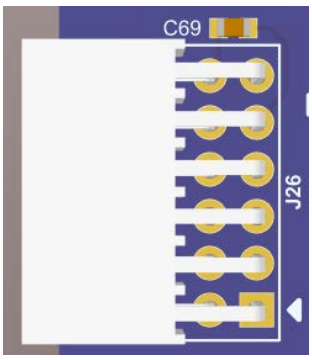


**Figure 11. PMOD 1**

#### 5.3.2.2 PMOD 2

A 12-pin PMOD Type-2A connector is provided at PMOD 2. The Main MCU acts as the SPI master, and the connected module acts as an SPI slave device. This interface may additionally be re-configured in firmware as several other PMOD types.

This PMOD interface supports +3.3 V devices. Please ensure that any PMOD device installed is compatible with a +3.3 V supply.

**Table 13. PMOD 2 Connector**

| **PMOD 2 Connector** | | **EK-RA6M3** |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J25-1 | SS/CTS_RTS | P107 (SS8/CTS8) |
| J25-2 | MOSI/TXD | P105 (MOSI8/TXD8/SDA8) |
| J25-3 | MISO/RXD | P104 (MISO8/RXD8/SCL8) |
| J25-4 | SCK | P106 (SCK8) |
| J25-5 | GND | GND |
| J25-6 | VCC | +3.3 V |
| J25-7 | INT (slave to master) | P708 (IRQ11) |
| J25-8 | RESET (master to slave) | P803 (GPIO) |
| J25-9 | Not Specified (GPIO) | P804 (GPIO) |
| J25-10 | Not Specified (GPIO) | P805 (GPIO) |
| J25-11 | GND | GND |
| J25-12 | VCC | +3.3 V |

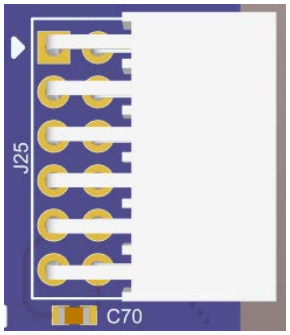


**Figure 12. PMOD 2**

### 5.3.3 Arduino™ Connector

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

**Table 14. Arduino Uno Connections**

| Arduino Compatible Connector | | | EK-RA6M3 |
|---|---|---|---|
| **Pin** | **Description** | **Signal Group** | **Signal/Bus** |
| J18-1 | NC | NC | NC |
| J18-2 | IOREF | Power | +3.3 V |
| J18-3 | RESET# | Power | P413 (Arduino RESET#) |
| J18-4 | +3.3 V | Power | +3.3 V |
| J18-5 | +5 V | Power | +5 V |
| J18-6 | GND | Power | GND |
| J18-7 | GND | Power | GND |
| J18-8 | NC ($V_{in}$) | NC | NC |
| J19-1 | AN0 | Analog | P000 (AN000) |
| J19-2 | AN1 | Analog | P001 (AN001) |
| J19-3 | AN2 | Analog | P002 (AN002) |
| J19-4 | AN3 | Analog | P507 (AN119) |
| J19-5 | AN4 | Analog | P508 (AN020) |
| J19-6 | AN5 | Analog | P014 (AN005) |
| J23-1 | RXD | Digital | P614 (RXD7) |
| J23-2 | TXD | Digital | P613 (TXD7) |
| J23-3 | INT0 | Digital | P506 (IRQ15 / AN019) |
| J23-4 | INT1 | Digital | P505 (IRQ14 / PWM(GTIOC13B) / AN118) |
| J23-5 | T0 | Digital | P908 (GPIO / PWM(GTIOC12A)) |
| J23-6 | T1 | Digital | P907 (GPIO / PWM(GTIOC12B)) |
| J23-7 | AIN0 | Digital | P504 (GPIO / AN018 / PWM(GTIOC13A)) |
| J23-8 | AIN1 | Digital | P503 (GPIO / AN117) |
| J24-1 | CLK0 | Digital | P611 (GPIO / CLKOUT) |
| J24-2 | GPIO | Digital | P415 (GPIO / PWM(GTIOC0A)) |
| J24-3 | SPI SS | Digital | P414 (SSLA1 / PWM(GTIOC0B)) |
| J24-4 | SPI MOSI | Digital | P411 (MOSIA / PWM(GTIOC9A)) |
| J24-5 | SPI MISO | Digital | P410 (MISOA) |
| J24-6 | SPI SCK | Digital | P412 (RSPCKA) |
| J24-7 | GND | Power | GND |
| J24-8 | AREF | | +3.3 V |
| J24-9 | I2C SDA | | P511 (SDA2) |
| J24-10 | I2C SCL | | P512 (SCL2) |

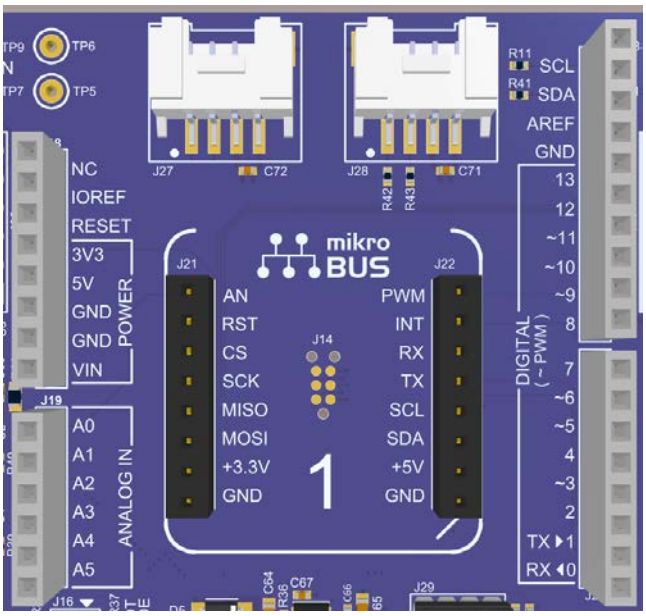


**Figure 13. Arduino Uno Connectors**

### 5.3.4 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 15. mikroBus Connections**

| **mikroBus Connector** | | **EK-RA6M3** |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J21-1 | Analog (AN) | P000 (AN000) |
| J21-2 | Reset (RST) | P413 (mikroBus RESET#) |
| J21-3 | SPI Chip Select (CS) | P414 (SSLA1) |
| J21-4 | SPI Clock (SCK) | P412 (RSPCKA) |
| J21-5 | SPI MISO | P410 (MISOA) |
| J21-6 | SPI MOSI | P411 (MOSIA) |
| J21-7 | +3.3 V | +3.3 V |
| J21-8 | GND | GND |
| J22-1 | PWM | P415 (GTIOC0A) |
| J22-2 | Hardware Interrupt (INT) | P505 (IRQ14) |
| J22-3 | UART RX | P614 (RXD7) |
| J22-4 | UART TX | P613 (TXD7) |
| J22-5 | I2C Clock (SCL) | P512 (SCL2) |
| J22-6 | I2C Data (SDA) | P511 (SDA2) |
| J22-7 | +5 V | +5 V |
| J22-8 | GND | GND |

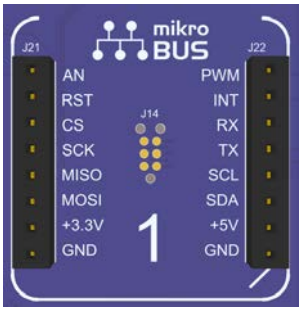


**Figure 14. mikroBus Connection**

## 5.4 Connectivity

### 5.4.1 USB Full Speed

The USB Micro-AB connection jack (J11) connects the Main MCU USB Full Speed interface to an external USB interface, allowing communications for testing and use of the Main 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 Main 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 EK-RA6M3.

For a USB Host configuration, set Jumper J12 to pins 1-2, remove the jumper from J15, and configure the Main 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 EK-RA6M3 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 16. USB Full Speed Connector**

| USB Full Speed Connector | | EK-RA6M3 |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J11-1 | +5VDC | +5VUSB (Host Mode)<br>P407/USBFS_VBUS = 2/3 of +5VUSB at J11 |
| 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 |

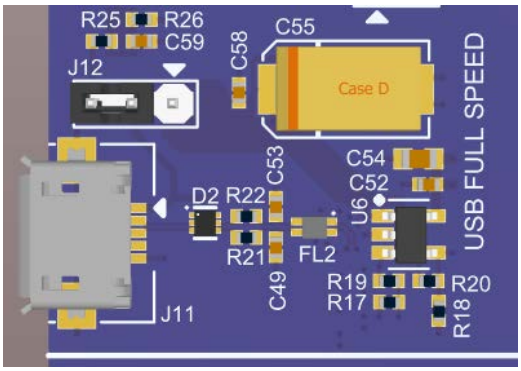


**Figure 15. USB Full Speed Connector**

## 5.5 Miscellaneous

### 5.5.1 User and Power LEDs

There are 5 LEDs provided on the EK-RA6M3. In addition, the Ethernet connector has built-in link status and link speed LEDs.

The behavior of the LEDs on the EK-RA6M3 is described in the following table.

**Table 17. EK-RA6M3 LED Functions**

| Designator | Color | Function | MCU Control Port |
|---|---|---|---|
| LED1 | Blue | User LED | P403 |
| LED2 | Green | User LED | P400 |
| LED3 | Red | User LED | P100 |
| LED4 | White | Power on indicator | +3.3 V |
| LED5 | Yellow | J-Link OB Status | 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 P403, Trace Cut Jumper E27 must be open. To separate LED2 from P400, Trace Cut Jumper E26 must be open. To separate LED3 from P100, 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 EK-RA6M3.

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

**Table 18. EK-RA6M3 Switches**

| Designator | Function | MCU Control Port | Button Color |
|---|---|---|---|
| S3 | MCU Reset Switch | RESET# | Red |
| S1 | User Switch | P009 (IRQ13-DS) | Blue |
| S2 | User Switch | P008 (IRQ12-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.

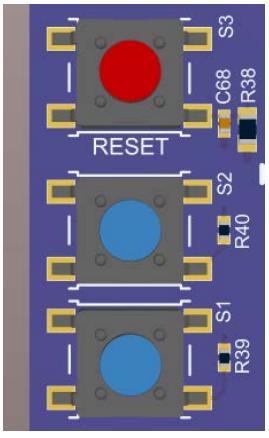


**Figure 18. Reset and User Switches**

### 5.5.3 MCU Boot Mode

A two-pin header (J16) is provided to select the Boot Mode of the 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.

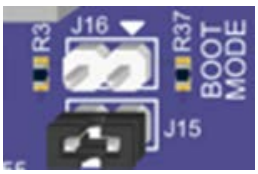


**Figure 19. Boot Mode**

## 6. Interface Function Area

The interface function area provides features specific to the RA6M3 MCU group such as Ethernet MAC controller, USB High Speed (Host and Device) and QSPI.

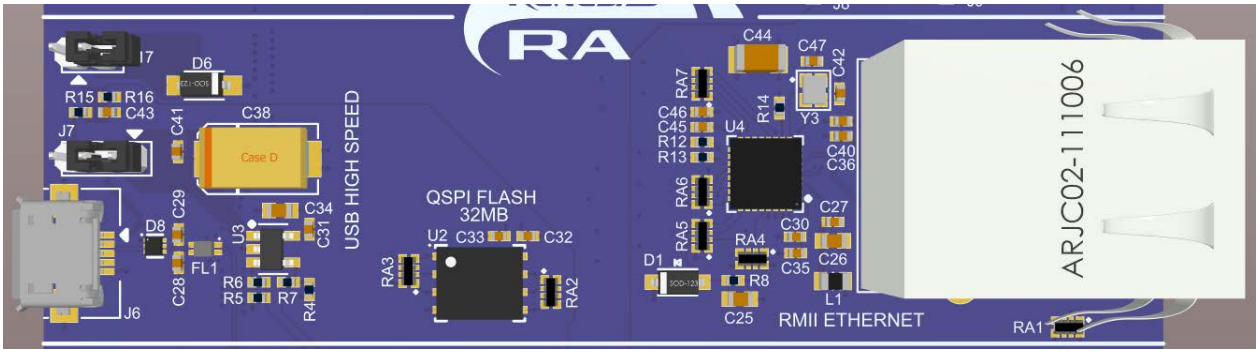


**Figure 20. Interface Function Area**

## 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 Main MCU through a set of Trace Cut Jumpers. To isolate the Ethernet PHY from the Main MCU, each of the RMII signal Trace Cut Jumpers must be OPEN.

**Table 19. Ethernet Port Assignments**

| Ethernet Signal Description | EK-RA6M3 Port | RMII Trace Cut Jumper |
|---|---|---|
| IRQ | P706 (IRQ7) | E18 |
| RESET# | P404 | E14 |
| MDC | P401 | E24 |
| MDIO | P402 | E25 |
| CRS_DV | P705 | E20 |
| TXD_EN | P405 | E17 |
| TXD0 | P700 | E16 |
| TXD1 | P406 | E15 |
| RXD1 | P703 | E23 |
| RXD0 | P702 | E22 |
| RX_ER | P704 | E19 |
| REF50CK | P701 | E21 |

**Table 20. Ethernet Components**

| Component | Manufacturer | Manufacturer Part Number |
|---|---|---|
| Ethernet PHY | Microchip | KSZ8091RNB |
| RJ-45 Connector | Abracon | ARJC02-111009D |
| 25 MHz Oscillator | TXC | 8Y-25.000MEEQ-T |

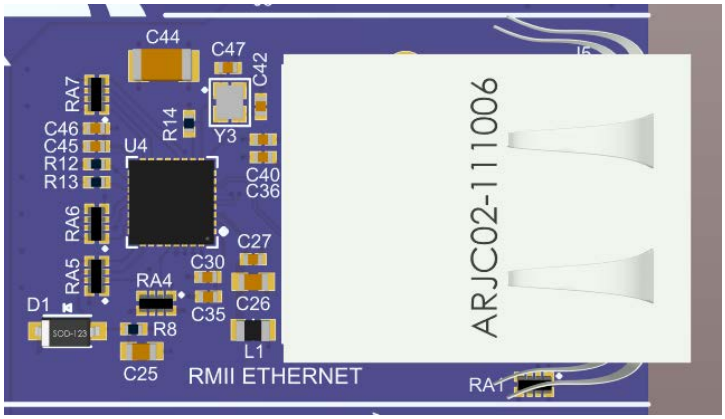


**Figure 21. Ethernet Connector**

## 6.2 USB High Speed

The USB Micro-AB connection jack (J6) connects the Main MCU USB High Speed interface to an external USB interface, allowing communications for testing and use of the Main 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 Main 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 EK-RA6M3.

For a USB Host configuration, set Jumper J7 to pins 1-2, remove the jumper from J17, and configure the Main MCU firmware to use the USB High Speed ports in host mode. In this configuration, power to J6 is supplied from U3. The total current available from U3 is 500 mA. Note that the input power sources must be configured with enough power for both EK-RA6M3 and the USB Full Speed port in host mode. Connect the included USB Type-A female to micro-B male cable to J6. USB device cables or devices can be connected to the USB High Speed port using this cable.

**Table 21. USB High Speed Connector**

| **USB High Speed Connector** | | **EK-RA6M3** |
|---|---|---|
| **Pin** | **Description** | **Signal/Bus** |
| J6-1 | +5VDC | +5VUSB (Host Mode)<br>PB01/USBHS_VBUS = 2/3 of +5VUSB at J6 |
| J6-2 | Data- | USBHS_DM |
| J6-3 | Data+ | USBHS_DP |
| J6-4 | USB ID, jack internal switch, cable inserted | N.C. |
| J6-5 | Ground | GND |

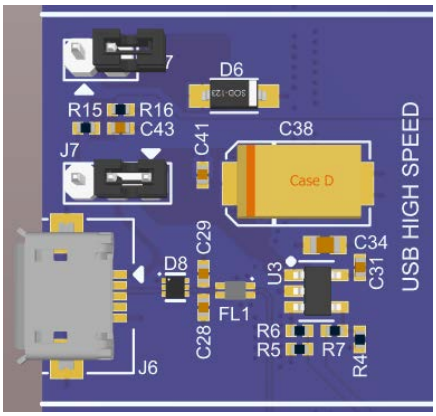


**Figure 22. USB High Speed Connector**

## 6.3 QSPI Flash

Included on EK-RA6M3 is a Macronix 256 Mb (32 MB) serial flash QSPI memory (MX25L25645G). The QSPI serial flash device (U2) connects to the QSPI peripheral on the Main MCU and defaults to standard SPI mode initially. The flash memory is enabled for XIP (Execute-in-place) mode directly after power-on.

**Table 22. QSPI Flash Port Assignments**

| QSPI Signal Description | EK-RA6M3 Port |
|---|---|
| QSPI CS# | P306 |
| QSPI CLK | P305 |
| QSPI DQ0 | P307 |
| QSPI DQ1 | P308 |
| QSPI DQ2 | P309 |
| QSPI DQ3 | P310 |

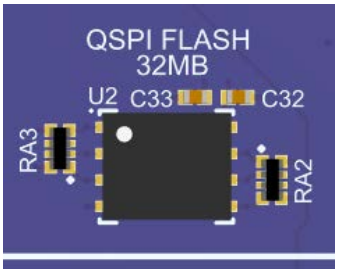


**Figure 23. QSPI Flash**

# 7. MCU Native Pin Access Area

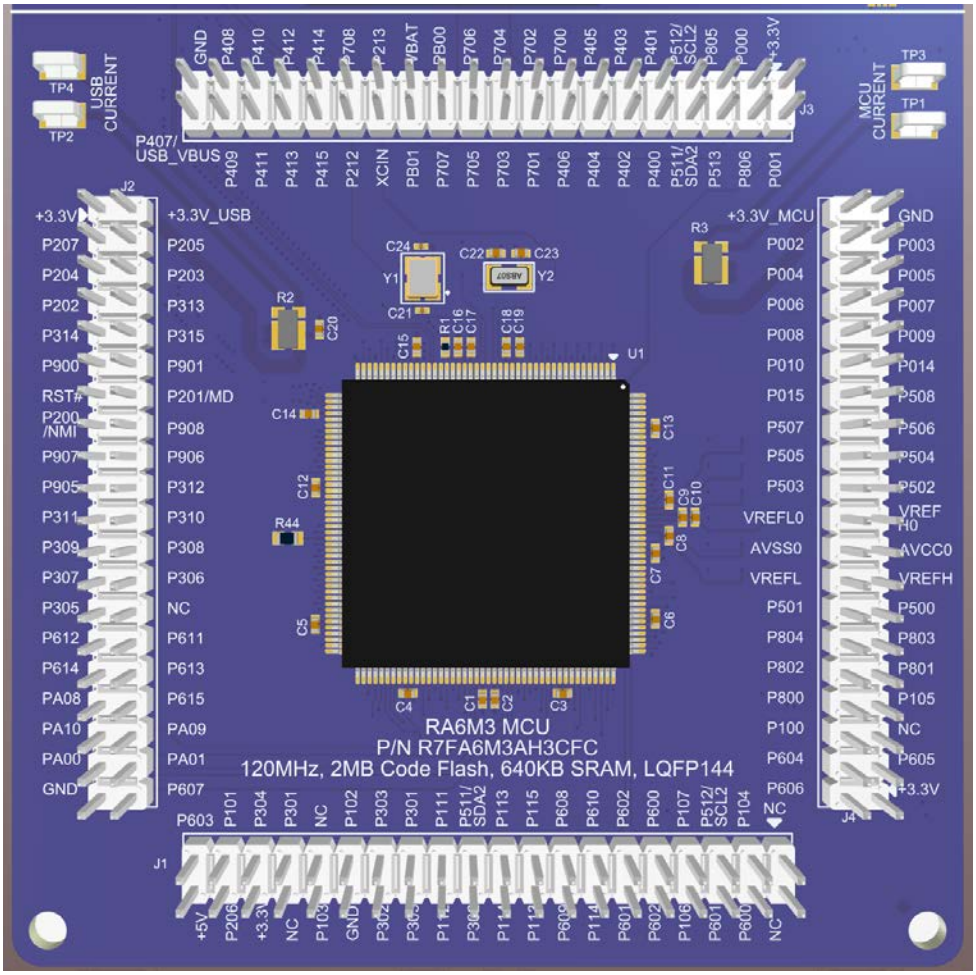


**Figure 24. Native Pin Access Area**

## 7.1 Breakout Pin Headers

The EK-RA6M3 pin headers, J1, J2, J3 and J4, provide access to all Main MCU interface signals, and to voltages for all Main MCU power ports. Each pin is labeled with the voltage or port connected to that pin.

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 RA6M3 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.

EK-RA6M3 provides precision 5 mΩ resistors (Yageo, part number PS0612FKE070R005L) 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 27 for the location of TP1, TP3, TP2 and TP4.

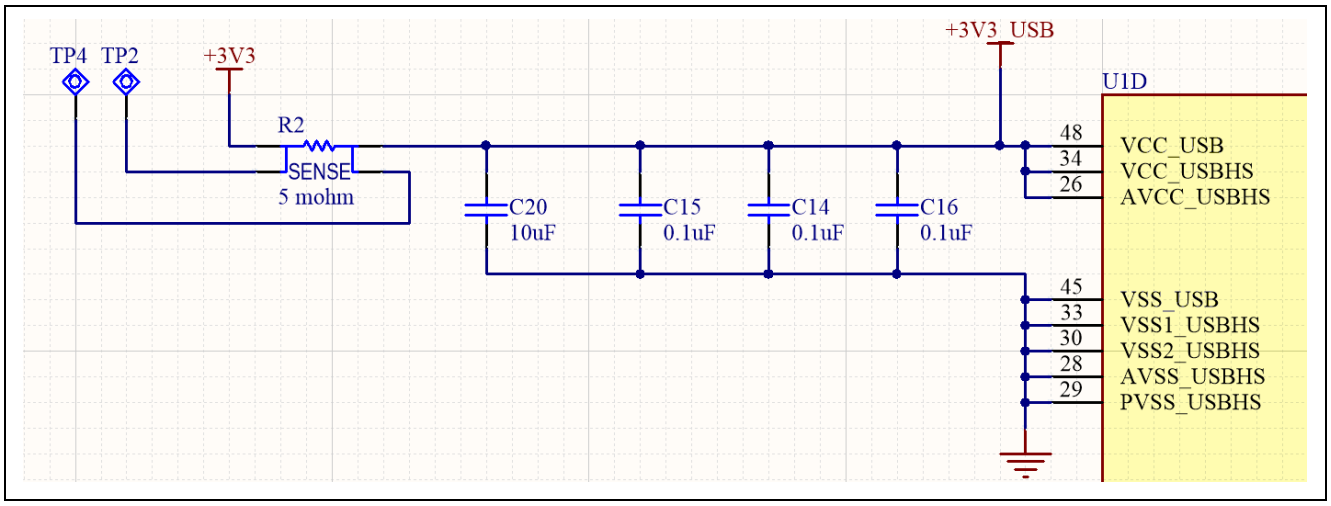


**Figure 25. MCU USB Current Measurement Circuit**

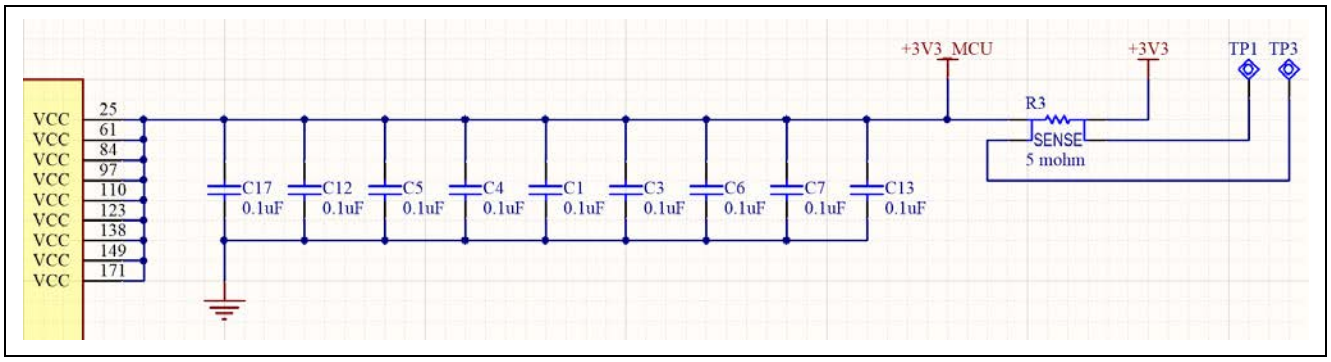


**Figure 26. MCU +3.3V Current Measurement Circuit**

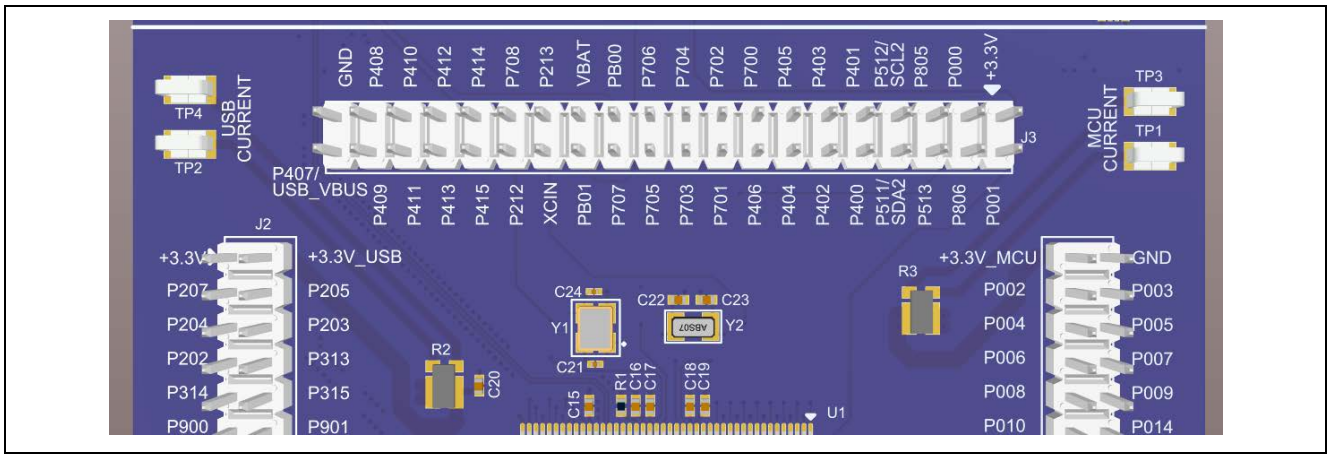


**Figure 27. MCU Current Measurement**

# 8. Certifications

The EK-RA6M3 v1 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 requirmeents set out in the Council Directives on the Approximation of the laws of the Member States relating to electromagnetic Compatibility Directive 2004/108/EEC.

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

## 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-RA6M3 v1 board is available in the "EK-RA6M3v1 Design Package" available on renesas.com/ra/ek-ra6m3.

- Design package file name: ek-ra6m3-v1-designpackage.zip
- Design package contents

| File Type | Content | File/Folder Name |
|---|---|---|
| File (PDF) | Schematics | ek-ra6m3-v1-schematics |
| File (PDF) | Mechanical Drawing | ek-ra6m3-v1-mechdwg |
| File (PDF) | 3D Drawing | ek-ra6m3-v1-3d |
| File (PDF) | BOM | ek-ra6m3-v1-bom |
| Folder | Manufacturing Files | Manufacturing Files |
| Folder | Design Files | Design Files-Altium |

## 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-RA6M3 Resources | renesas.com/ra/ek-ra6m3 |
| 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 | Oct.02.19 | — | Initial release |

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