

RA6M3 Group

Graphics Evaluation Kit for RA6M3 Microcontroller Group
EK-RA6M3G v1
User's Manual

Renesas RA Family
RA6 Series

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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

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1. Kit Overview

The EK-RA6M3G, Graphics Evaluation Kit for RA6M3 MCU Group, enables users to seamlessly evaluate the features of the RA6M3 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 EK-RA6M3G kit consists of two boards: the EK-RA6M3 board featuring the RA6M3 MCU with on-chip Graphics LCD Controller and the Graphics Expansion Board featuring a 4.3 inch TFT color LCD with capacitive touch overlay.

The key features of the EK-RA6M3 board are categorized in three groups (consistent with the architecture of the kit) as follows:

MCU Native Pin Access

- 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 - 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
- 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

Special Feature Access

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

The key features of the Graphics Expansion Board are as follows:

- 4.3 inch TFT color LCD
 - 480 x 272 resolution
 - Capacitive touch overlay with controller
- Back light controller

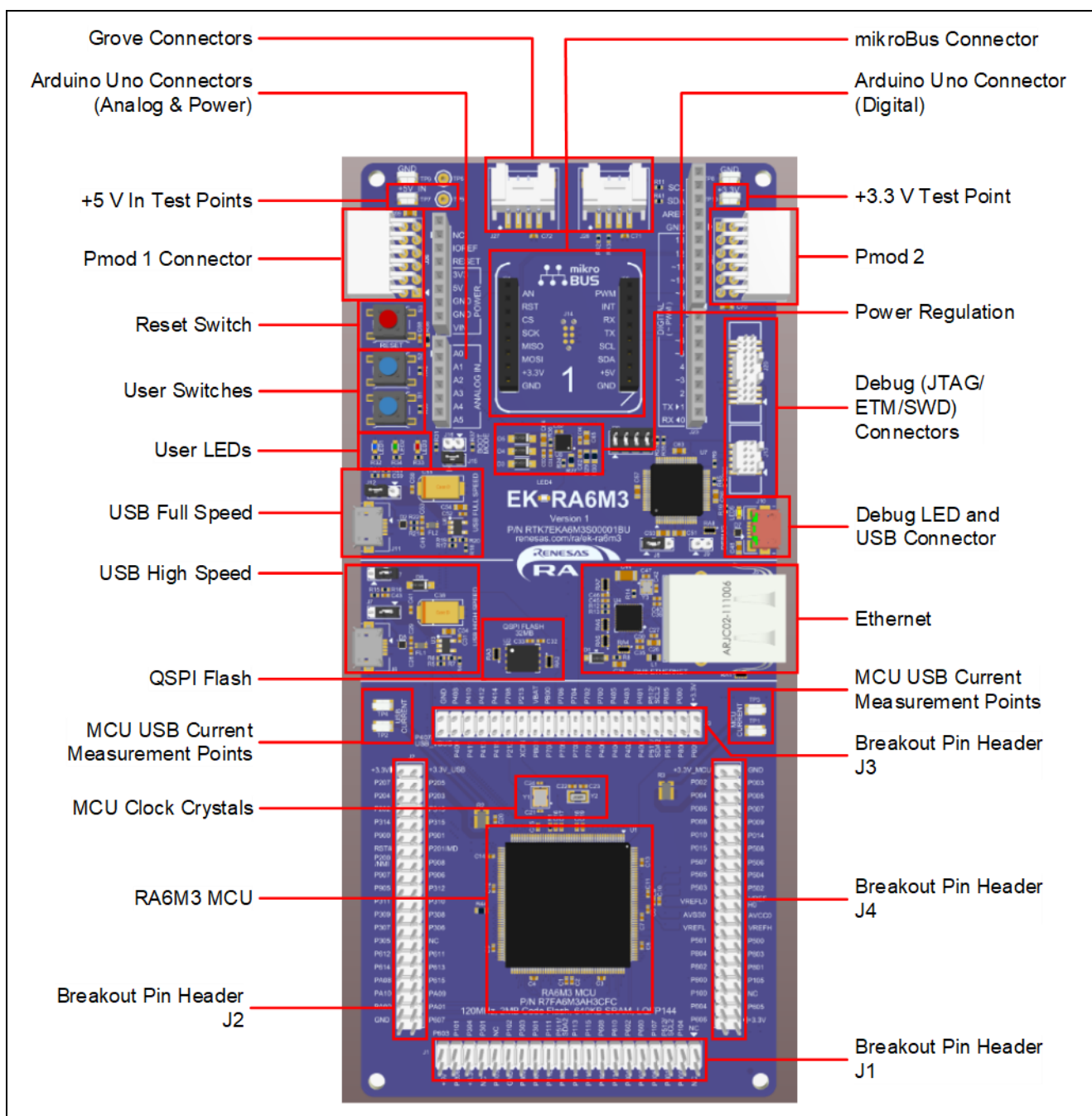


Figure 1. EK-RA6M3 Board Top Side

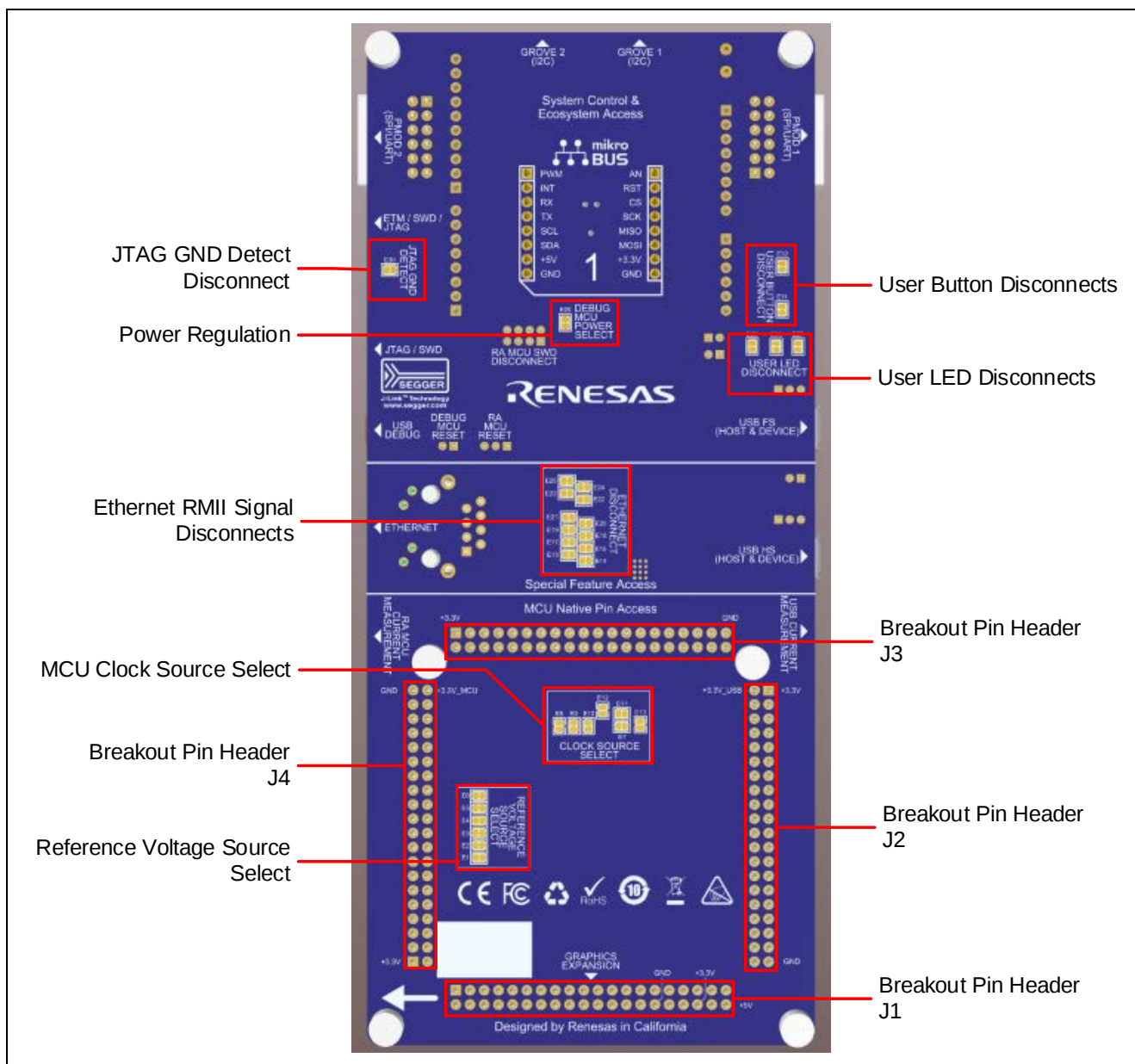


Figure 2. EK-RA6M3 Board Bottom Side

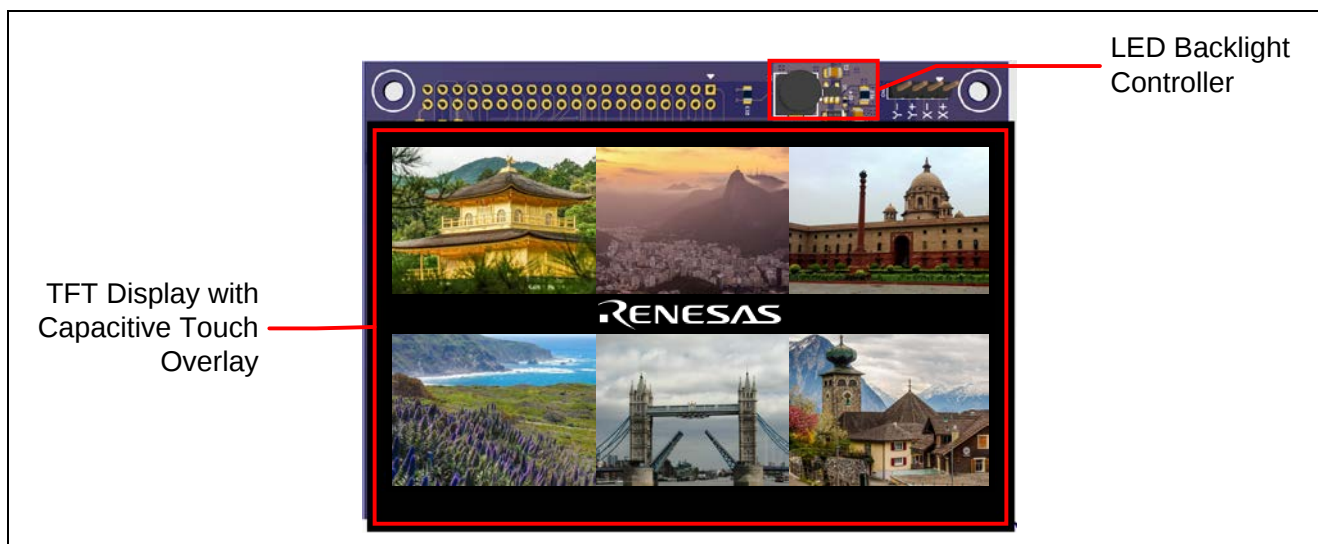


Figure 3. Graphics Expansion Board Top Side

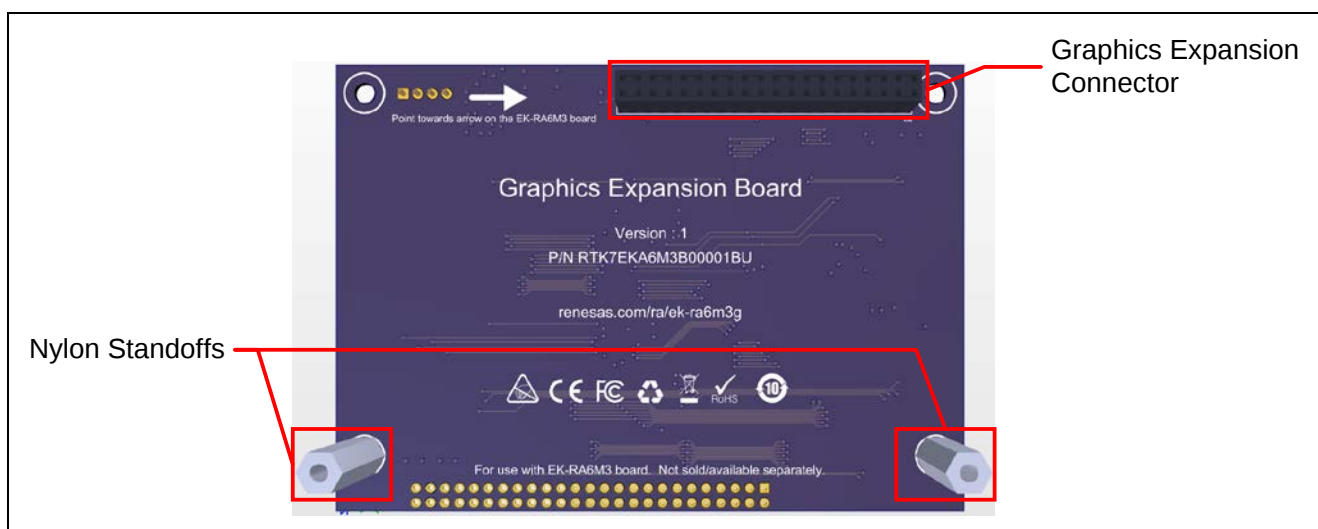


Figure 4. Graphics Expansion Board Bottom Side

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-RA6M3G Quick Start Guide* to get acquainted with the kit and the Quick Start example project that the EK-RA6M3 board comes pre-programmed with.
3. Flexible Software Package (FSP) and IDE such as e² studio are required to develop embedded applications on the EK-RA6M3G kit.
4. Instructions to download and install software, import example projects, build them and program the EK-RA6M3G kit are provided in the quick start guide.

2. Kit Contents

The following components are included in the kit:

1. EK-RA6M3 v1 board
2. Graphics Expansion Board
3. Micro USB device cable (type-A male to micro-B male)
4. Micro USB host cable (type-A female to micro-B male)
5. Ethernet patch cable

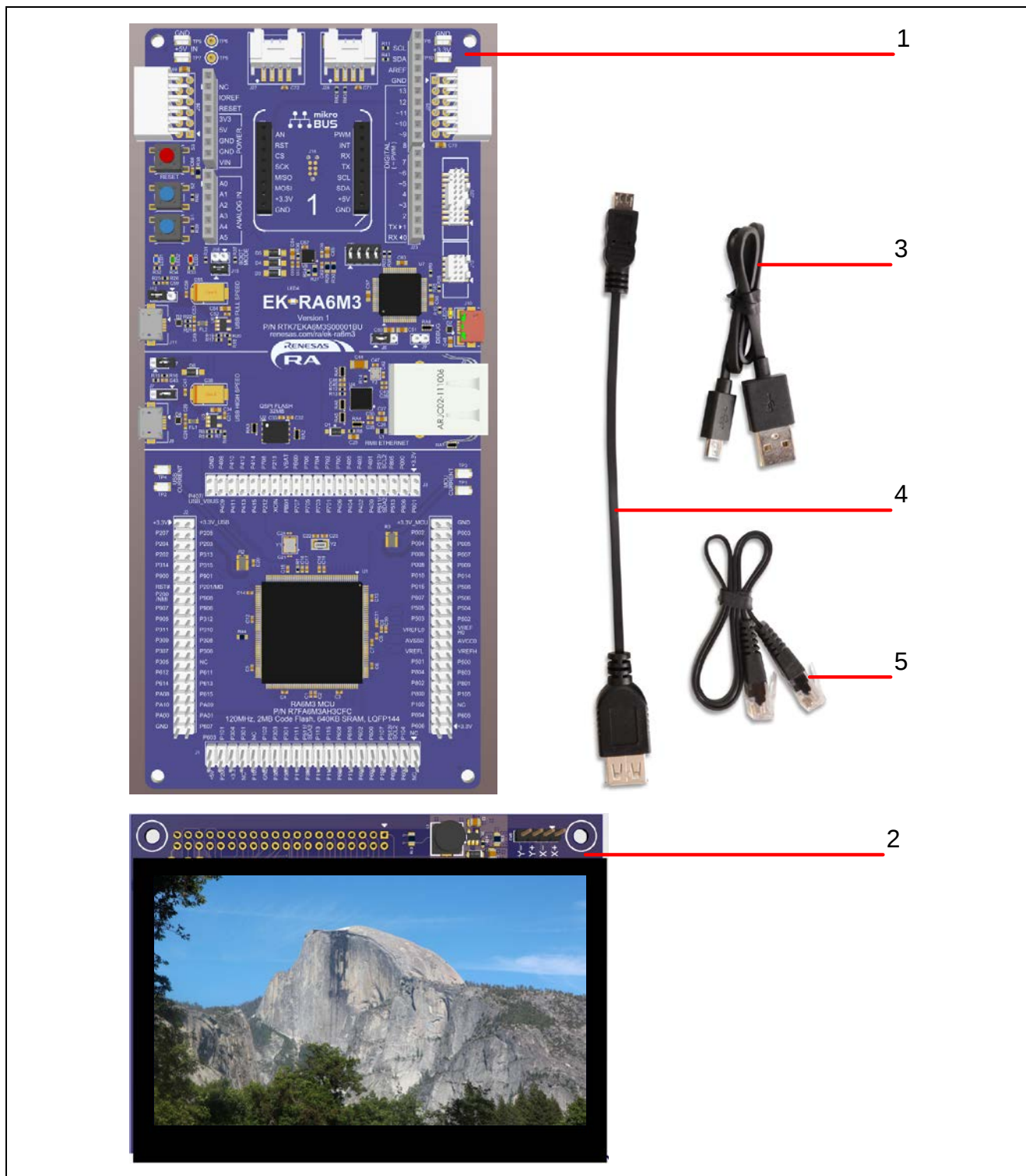


Figure 5. EK-RA6M3G Kit Contents

3. Ordering Information

- EK-RA6M3G v1 kit orderable part number: RTK7EKA6M3S01001BU
Note: The underlined character in the orderable part number represents the kit version.
- EK-RA6M3 board dimensions: 80 mm (width) x 180 mm (length)
- Graphics Expansion Board dimensions: 110 mm (width) x 78.3 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Kit Architecture

The EK-RA6M3G kit consists of two boards: the EK-RA6M3 board and the Graphics Expansion Board. The Graphics Expansion Board plugs on to the graphics expansion header (J1) on the EK-RA6M3 board. The architecture of each of the two boards is described in the following sections.

4.2 EK-RA6M3 Board Architecture

The EK-RA6M3 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, 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

System Control and
Ecosystem Access Area

Special Features Access
Area

Native Pin Access Area

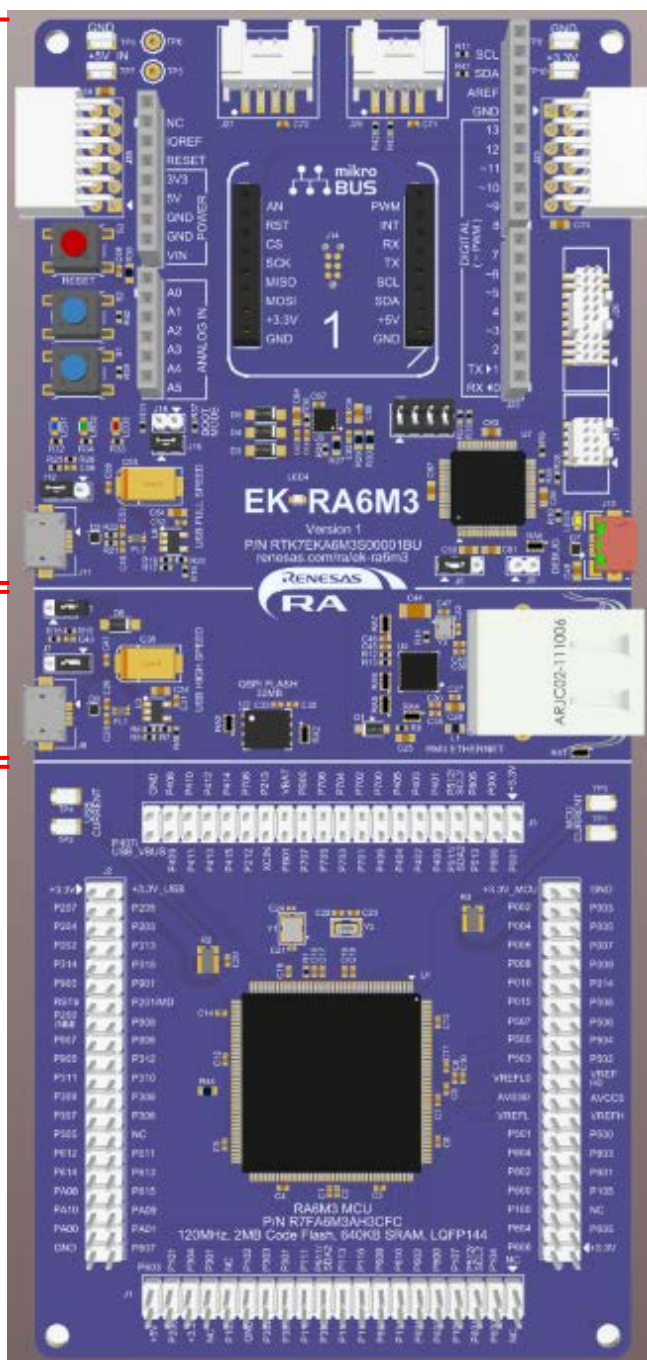


Figure 6. EK-RA6M3 Board Functional Area Definitions

4.3 Graphics Expansion Board Architecture

The Graphics Expansion Board provides connectivity for 4.3-inch TFT color LCD with a capacitive touch overlay. The Graphics Expansion Board includes a backlight controller to drive the LED backlight on the LCD.

The Graphics Expansion Board has no configurable jumpers or settings on the board. All control of the LCD is driven by the RA MCU on EK-RA6M3.

4.4 System Block Diagram

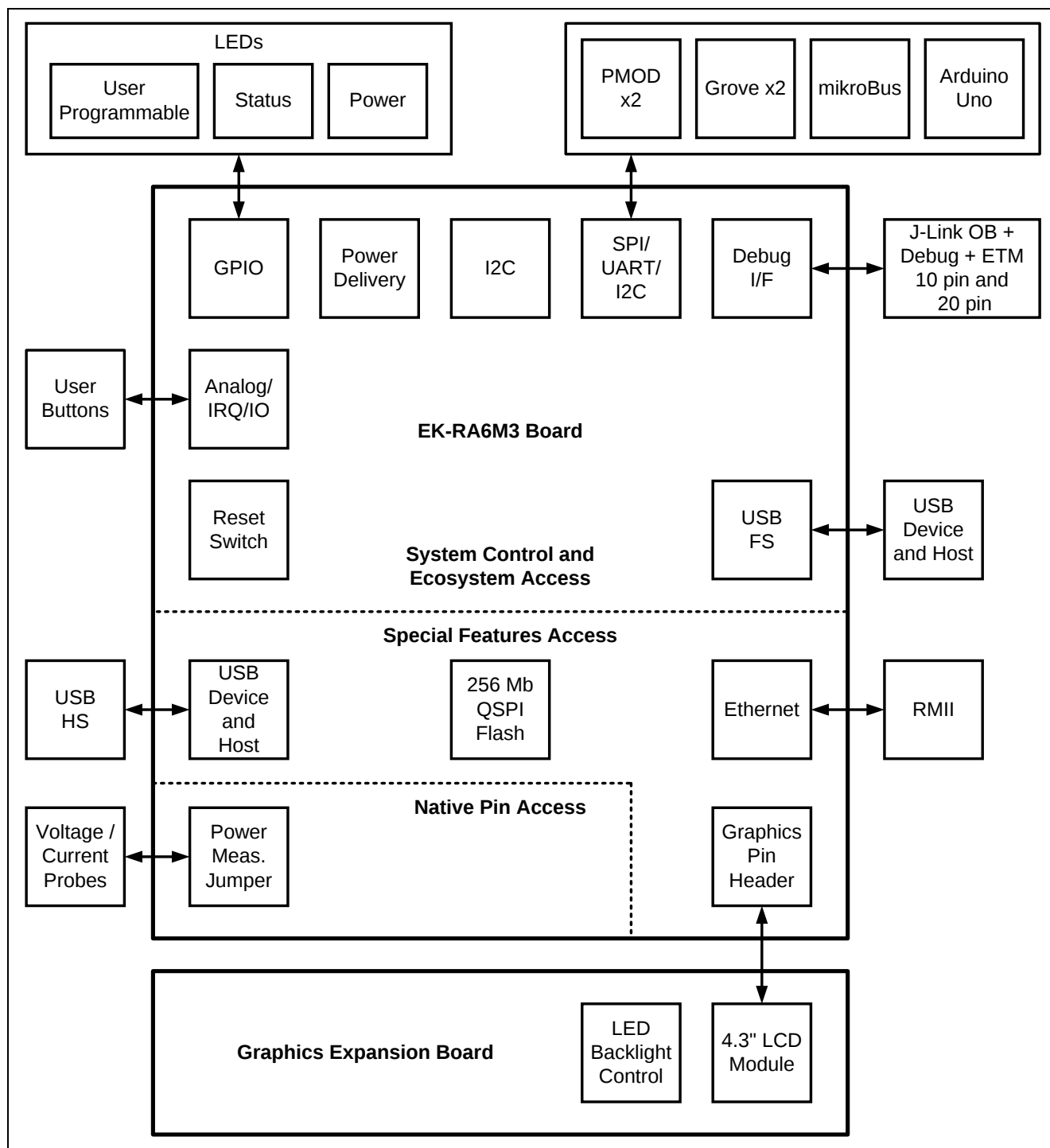


Figure 7. EK-RA6M3G Kit Block Diagram

4.5 Jumper Settings

Two types of jumpers are provided on the EK-RA6M3 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.

4.5.1 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.)

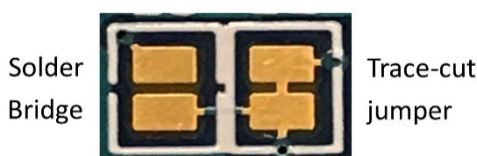


Figure 8. Copper Jumpers

4.5.2 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-RA6M3 board are 2 mm pitch headers and require compatible 2 mm shunt jumpers.

4.5.3 Default Jumper Configuration

The following table describes the default settings for each jumper on the EK-RA6M3 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
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 Jumper on pins 3-4 Jumper on pins 5-6 Jumper on pins 7-8	Connects the J-Link OB debugger to the RA MCU
E1	MCU 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

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

5. EK-RA6M3 Board System Control and Ecosystem Access Area

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

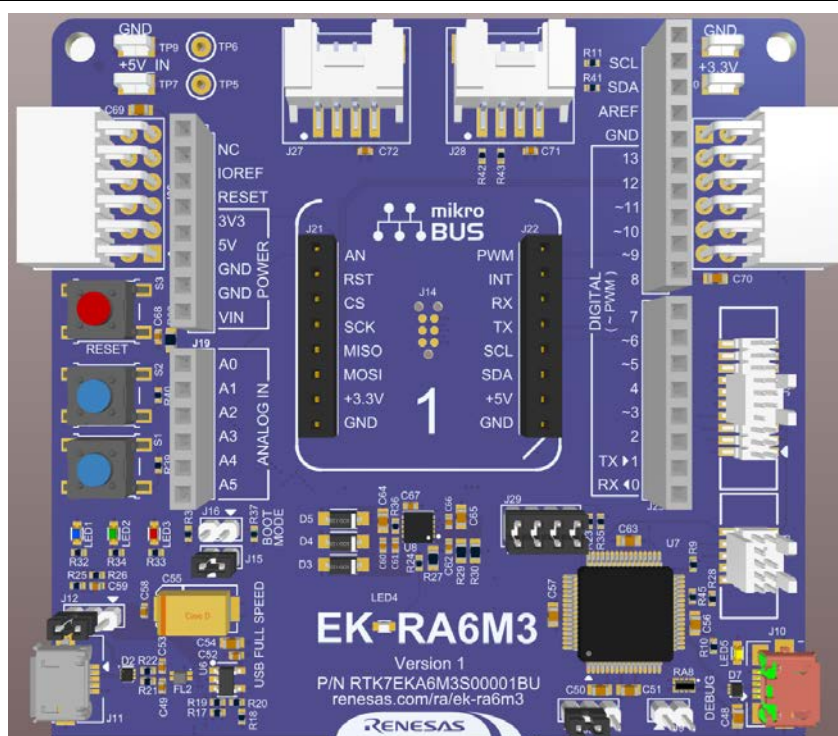


Figure 9. System Control and Ecosystem Access Area

5.1 Power

The EK-RA6M3G 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-RA6MG kit can be powered.

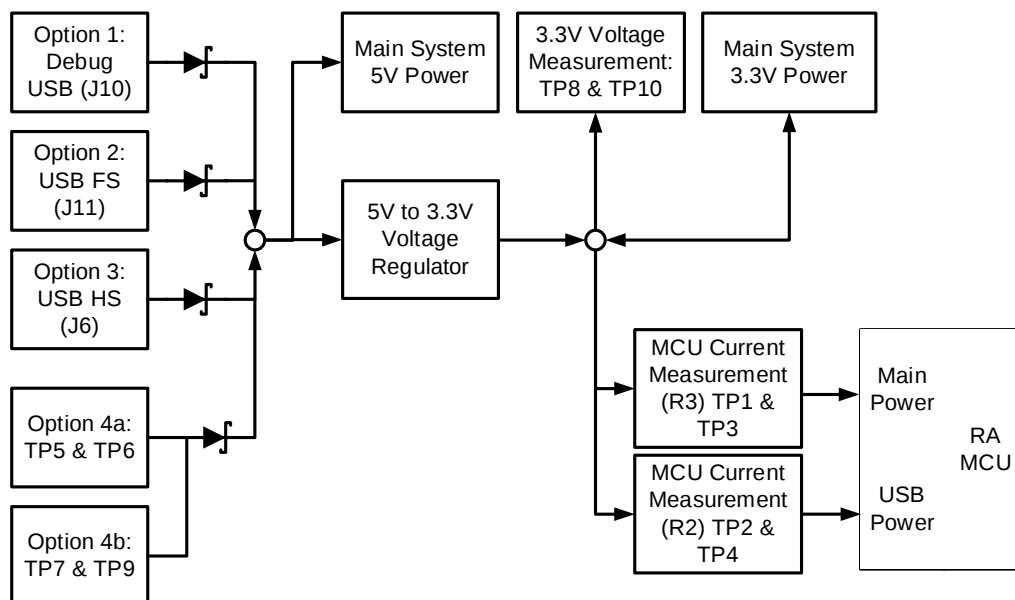


Figure 10. Power Supply Options

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.

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

5.1.1.4 Option 4: 5V Test Points

5 V may be supplied from an external power supply to test points on the board. TP7 (5V) 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-RA6M3 name) will light up. For more details on initial power up behavior, see the *EK-RA6M3G Quick Start Guide*.

5.2 Debug and Trace

The EK-RA6M3 board 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 the EK-RA6M3 board.

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 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-RA6M3 board to use the Debug on-board mode, configure the jumpers using the following table.

Table 5. Debug On-Board Mode 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

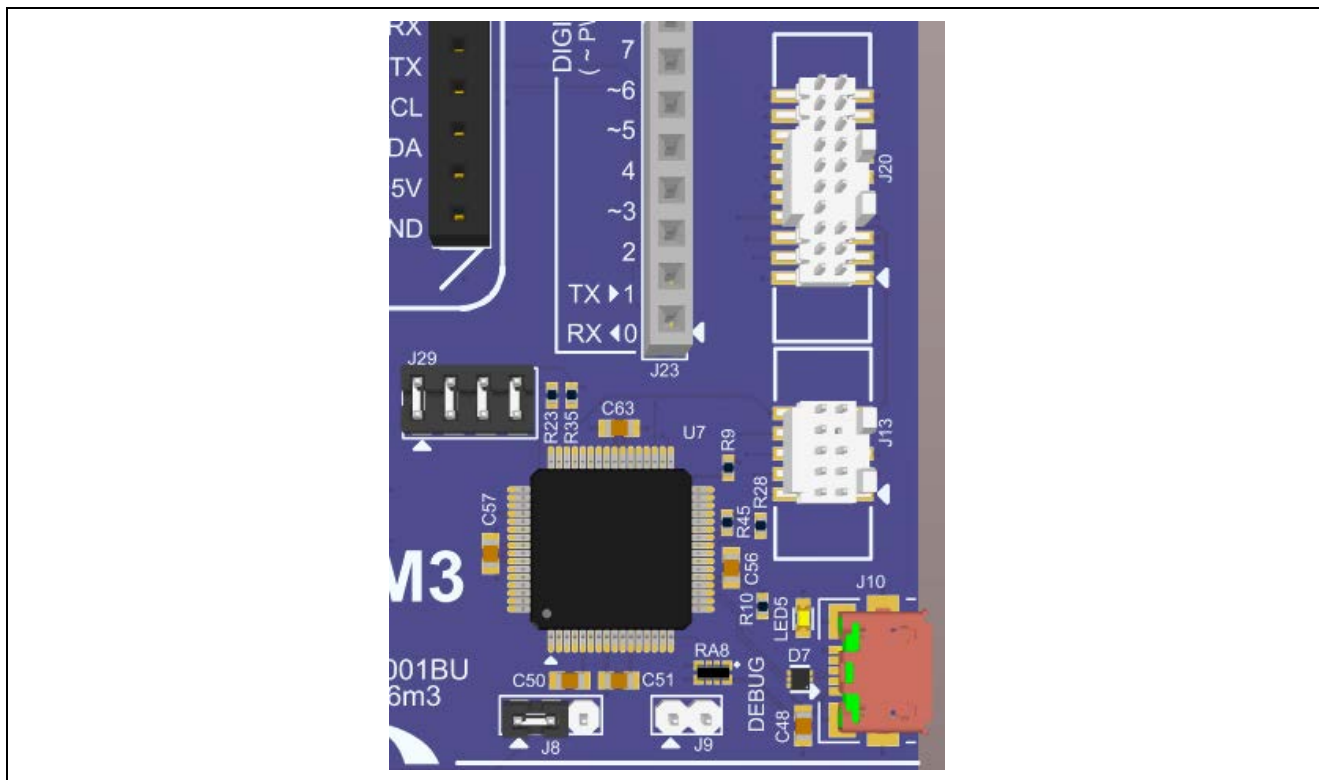


Figure 11. EK-RA6M3 Board Debug Interface

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-RA6M3 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
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.

JTAG Connector				EK-RA6M3
Pin	JTAG Pin Name	SWD Pin Name	ETM Pin Name	Signal/Bus
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 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-RA6M3 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-RA6M3 board to use the Debug out mode, configure the jumpers according to the following table.

Table 9. Debug Out Mode 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 & UART) connectors
3. Arduino™ (Uno R3) connector
4. 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-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 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.

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

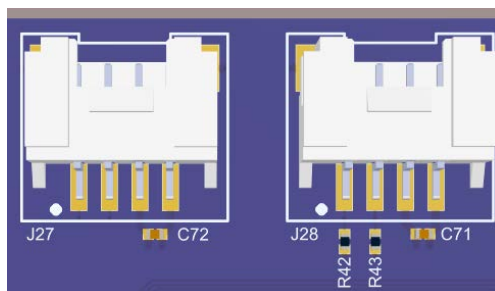


Figure 12. Seeed Grove Connectors

5.3.2 Digilent Pmod™ Connectors

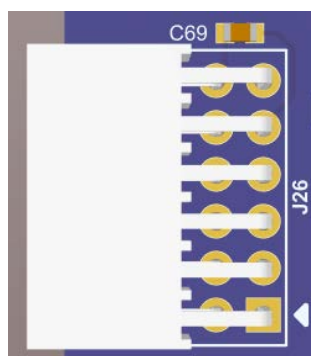
5.3.2.1 PMOD 1

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

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 13. PMOD 1**

5.3.2.2 PMOD 2

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

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

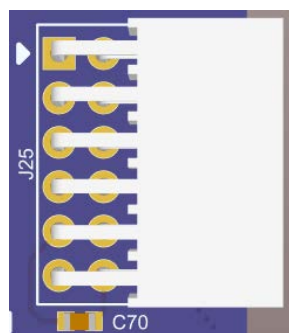


Figure 14. PMOD 2

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	N/A	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 (VIN)	Power	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	N/A	GND
J24-8	AREF	N/A	+3.3 V
J24-9	I2C SDA	N/A	P511 (SDA2)

Arduino Compatible Connector			EK-RA6M3
Pin	Description	Signal Group	Signal/Bus
J24-10	I2C SCL	N/A	P512 (SCL2)

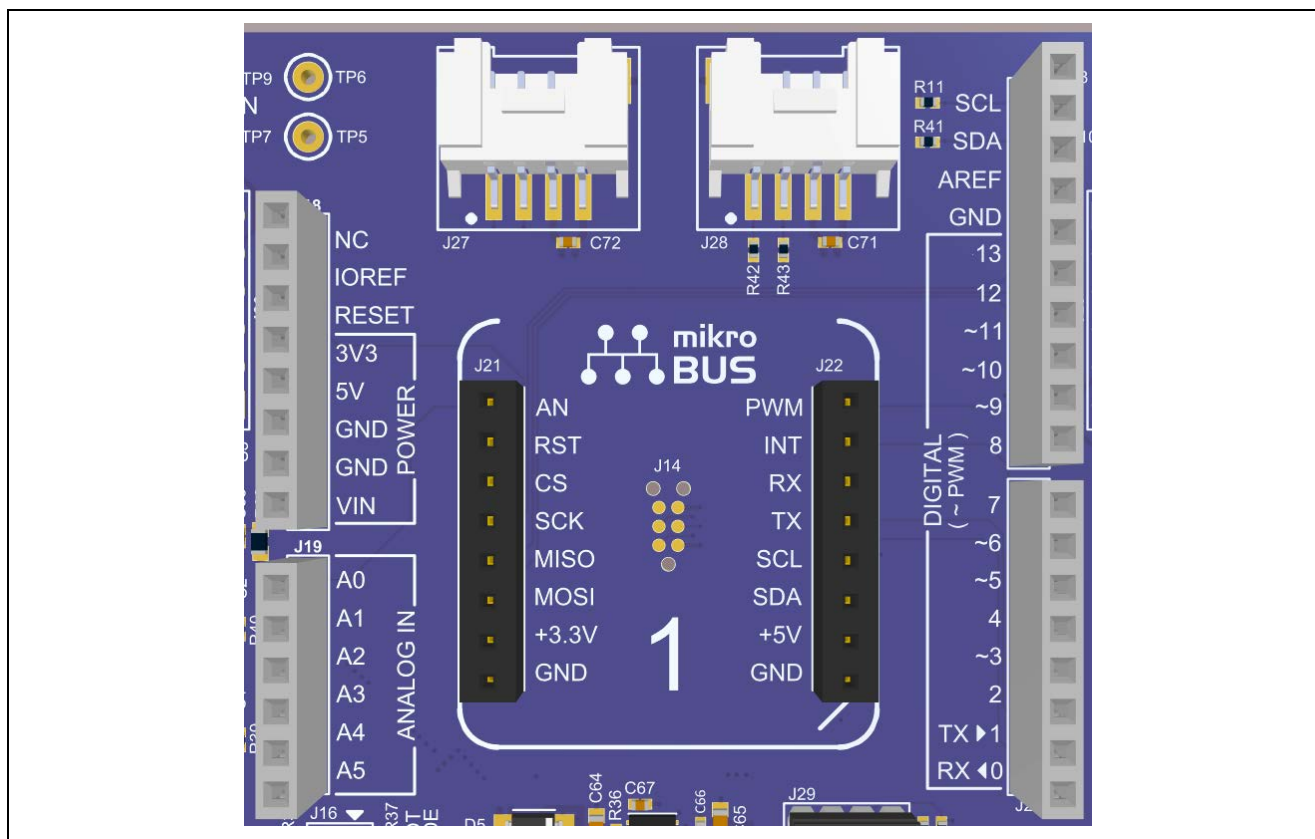


Figure 15. Arduino Uno Connectors

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	AN (Analog)	P000 (AN000)
J21-2	RST (Reset)	P413 (mikroBus RESET#)
J21-3	CS (SPI Chip Select)	P414 (SSLA1)
J21-4	SCK (SPI Clock)	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	INT (Hardware Interrupt)	P505 (IRQ14)
J22-3	UART RX	P614 (RXD7)
J22-4	UART TX	P613 (TXD7)
J22-5	SCL (I2C Clock)	P512 (SCL2)
J22-6	SDA (I2C Data)	P511 (SDA2)
J22-7	+5 V	+5 V
J22-8	GND	GND

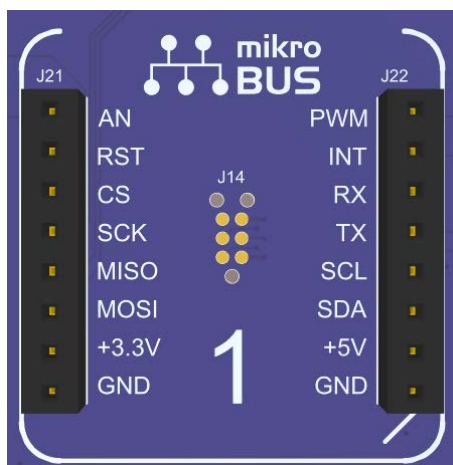


Figure 16. mikroBus Connection

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-RA6M3 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 the EK-RA6M3 board and the USB device connected to the host port. 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) 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

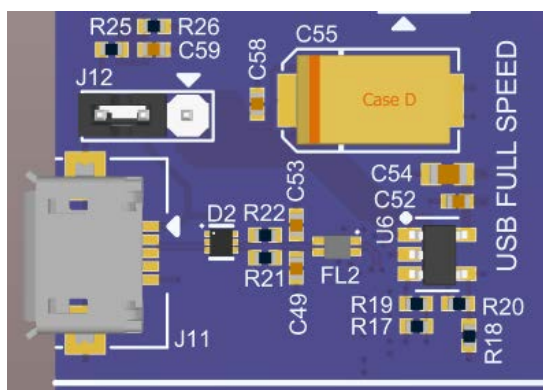


Figure 17. USB Full Speed Connector

5.5 Miscellaneous

5.5.1 User and Power LEDs

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

Behavior of the LEDs on the EK-RA6M3 board is described in the following table.

Table 17. EK-RA6M3 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Blue	User LED 1	P403
LED2	Green	User LED 2	P400
LED3	Red	User LED 3	P100
LED4	White	Power LED	+3.3 V
LED5	Orange	Debug LED	J-Link OB MCU

The User LEDs may be isolated from the RA 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 18. User LEDs

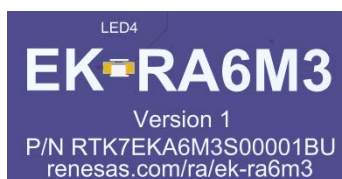


Figure 19. Power LED

5.5.2 User and Reset Switches

Three miniature, momentary, mechanical push-button type SMT switches are mounted on the EK-RA6M3 board.

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

Table 18. EK-RA6M3 Board 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 RA 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.

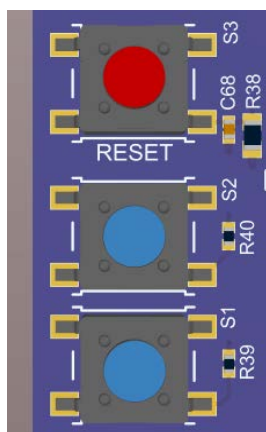


Figure 20. Reset and User Switches

5.5.3 MCU Boot Mode

A two-pin header (J16) is provided to select the Boot mode 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, then press the MCU Reset switch (S3) or remove power from the board and re-apply power.



Figure 21. Boot Mode

6. EK-RA6M3 Board Special Feature Access Area

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

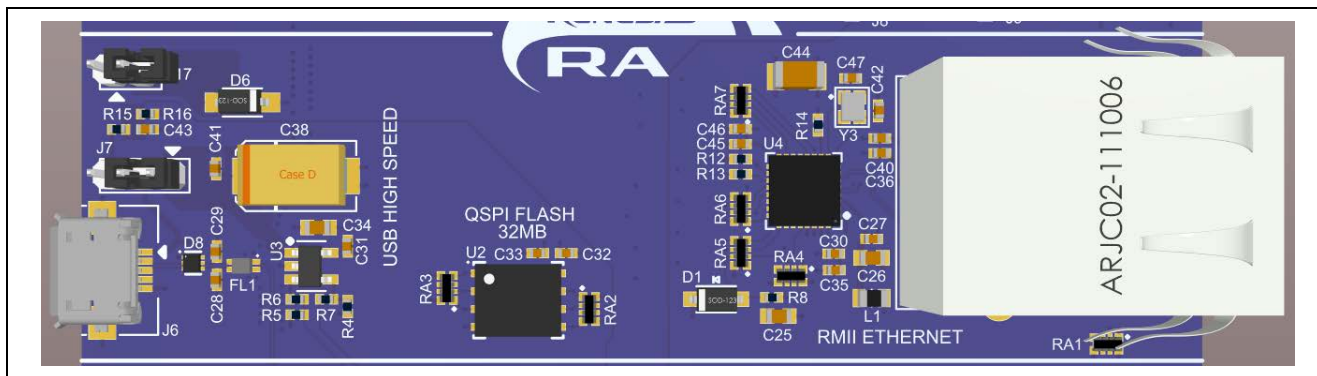


Figure 22. Special Features Access Area

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.

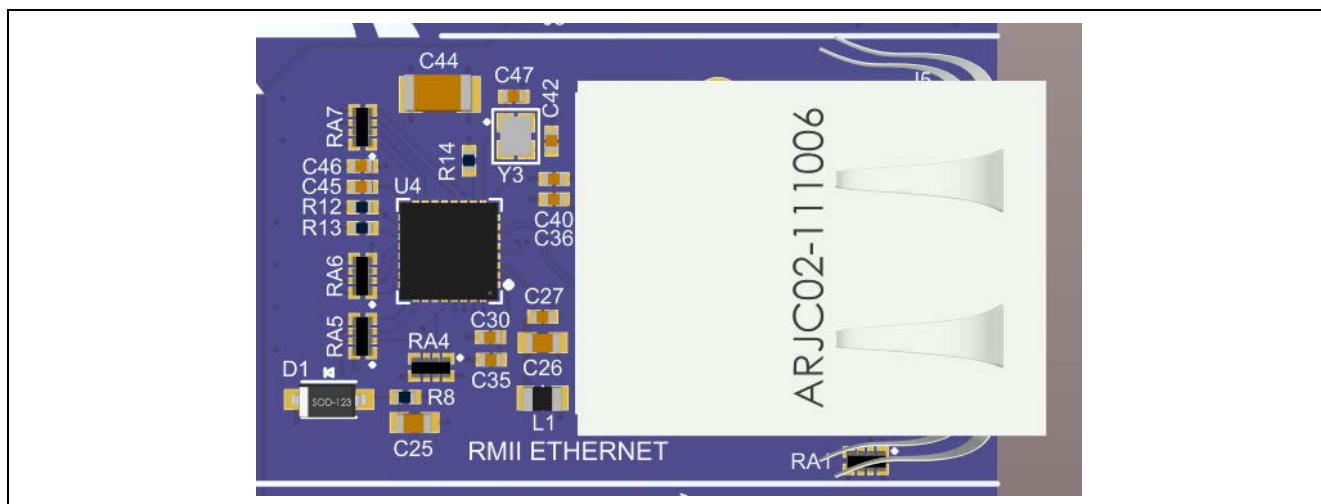
The RMII signals used for the Ethernet port are connected from the RA MCU through a set of Trace Cut Jumpers. To isolate the Ethernet PHY from the RA MCU, each of the RMII signal Trace Cut Jumpers must be OPEN.

Table 19. Ethernet Port Assignments

Ethernet Signal Description	RA6M3 MCU 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 23. Ethernet Connector**

6.2 USB High Speed

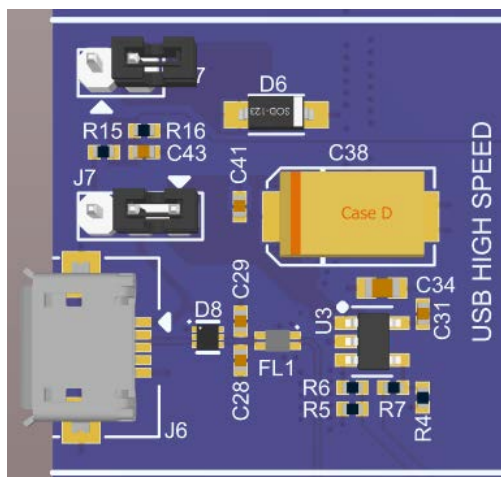
The USB Micro-AB connection jack (J6) connects the RA MCU USB High Speed interface to an external USB interface, allowing communications for testing and use of the RA MCU firmware. This connection can be configured as either a USB Device or a USB Host interface.

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-RA6M3 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 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 the EK-RA6M3 board and the USB device connected to the host port. 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	+5 VDC	+5 VUSB (Host Mode) 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

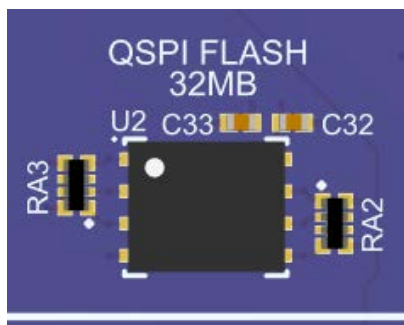
**Figure 24. USB High Speed Connector**

6.3 QSPI Flash

Included on the EK-RA6M3 board 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 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 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 25. QSPI Flash**

7. EK-RA6M3 Board MCU Native Pin Access Area

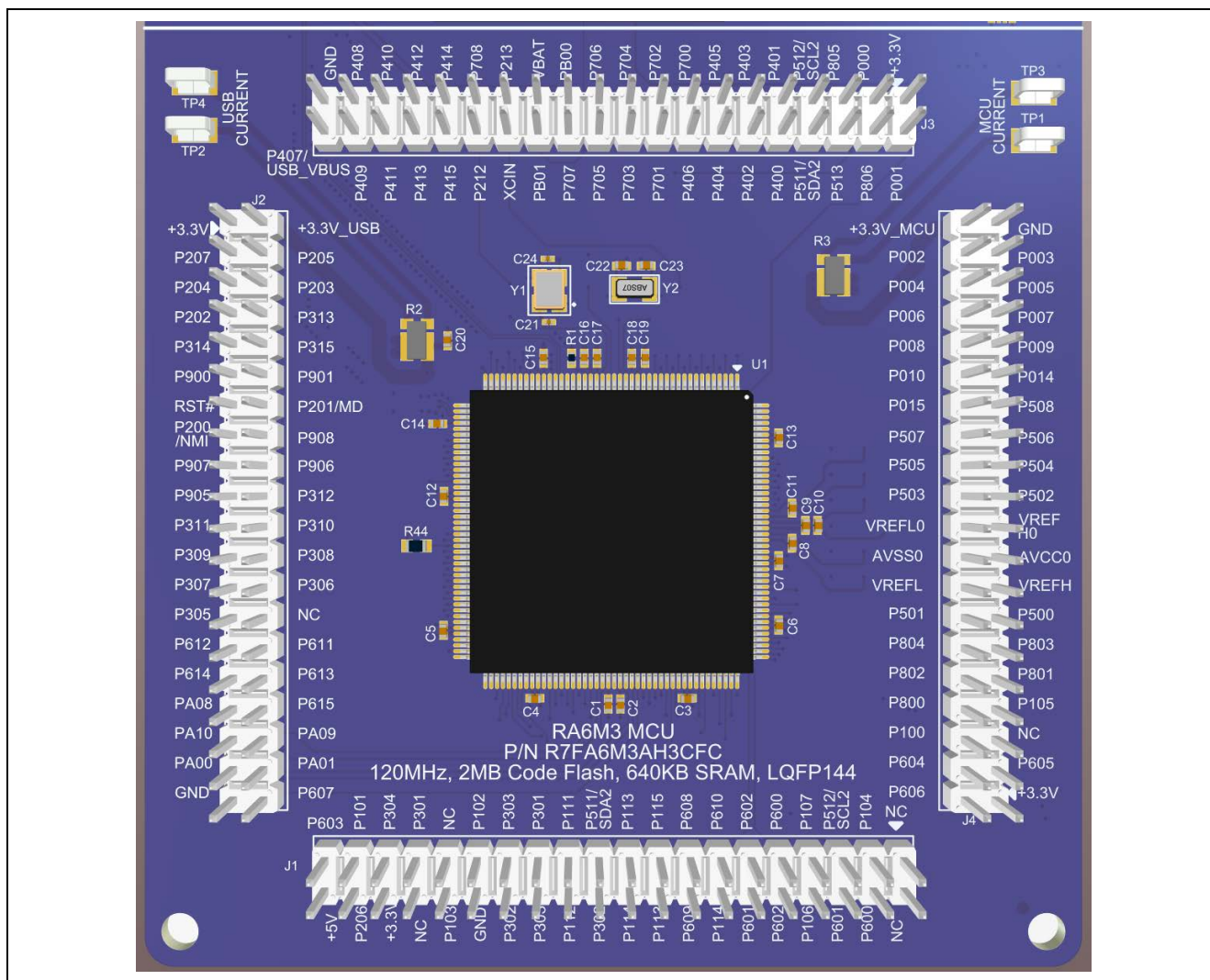


Figure 26. Native Pin Access Area

7.1 Breakout Pin Headers

The EK-RA6M3 board pin headers, J1, J2, J3 and J4, provide access to all RA MCU interface signals, and to voltages for all RA MCU power terminals. Each header pin is labeled with the voltage or port connected to that pin. Refer to the RA6M3 MCU Group User's Manual for details of each port function, and the EK-RA6M3 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 RA6M3 MCU.

Pin header J1 is configured to support the Graphics Expansion Module. See Section 8 for more details on the Graphics Expansion Board.

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-RA6M3 board 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 29 for the location of TP1, TP3, TP2 and TP4.

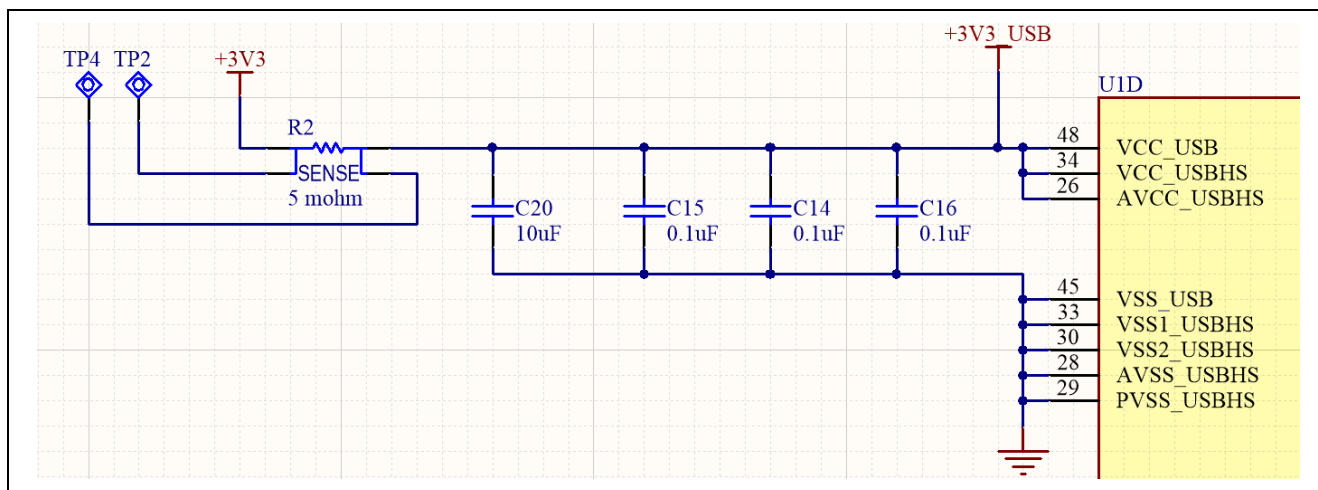


Figure 27. RA MCU USB Current Measurement Circuit

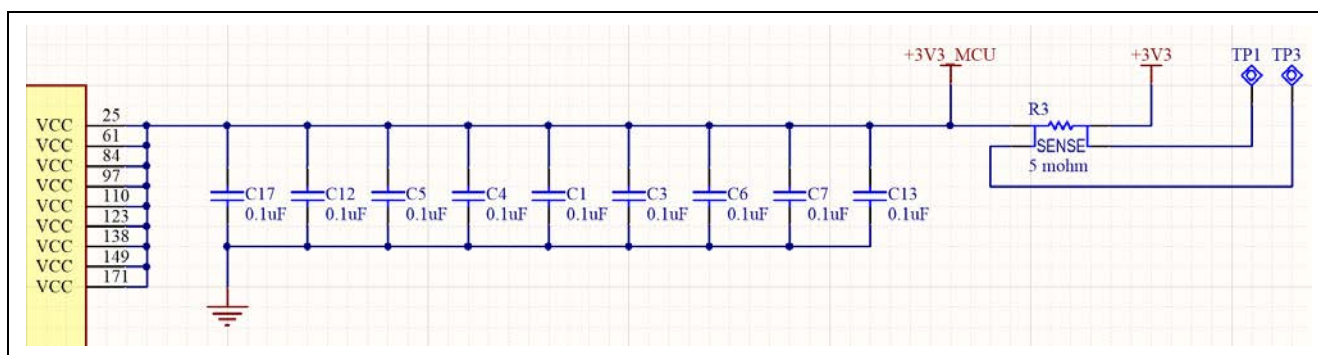


Figure 28. RA MCU +3.3 V Current Measurement Circuit

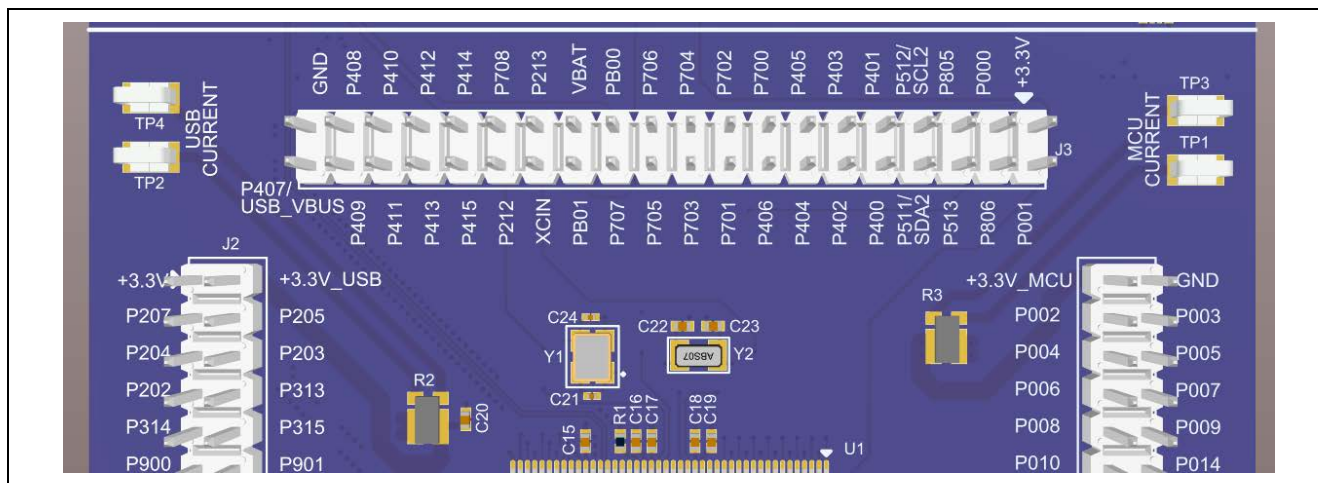


Figure 29. RA MCU Current Measurement

8. Graphics Expansion Board

The Graphics Expansion Board includes a 4.3-inch 480 x 272 pixel TFT color LCD with a capacitive touch overlay. The LED backlight in the TFT display is driven by a backlight controller circuit on the Graphics Expansion Board. The port driving the backlight controller is capable of PWM output, so the intensity of the LED backlight can be adjusted by the RA MCU.

8.1 Connecting the Graphics Expansion Board on to EK-RA6M3 Board

The Graphics Expansion Board can be connected to the EK-RA6M3 board using the connector CN1 on the Graphics Expansion Board and pin header J1 on the EK-RA6M3 board.

Alignment arrows are printed on each board to assist with correct alignment and connection. Use the alignment arrows to ensure that all of the pins between CN1 and J1 are connected correctly.

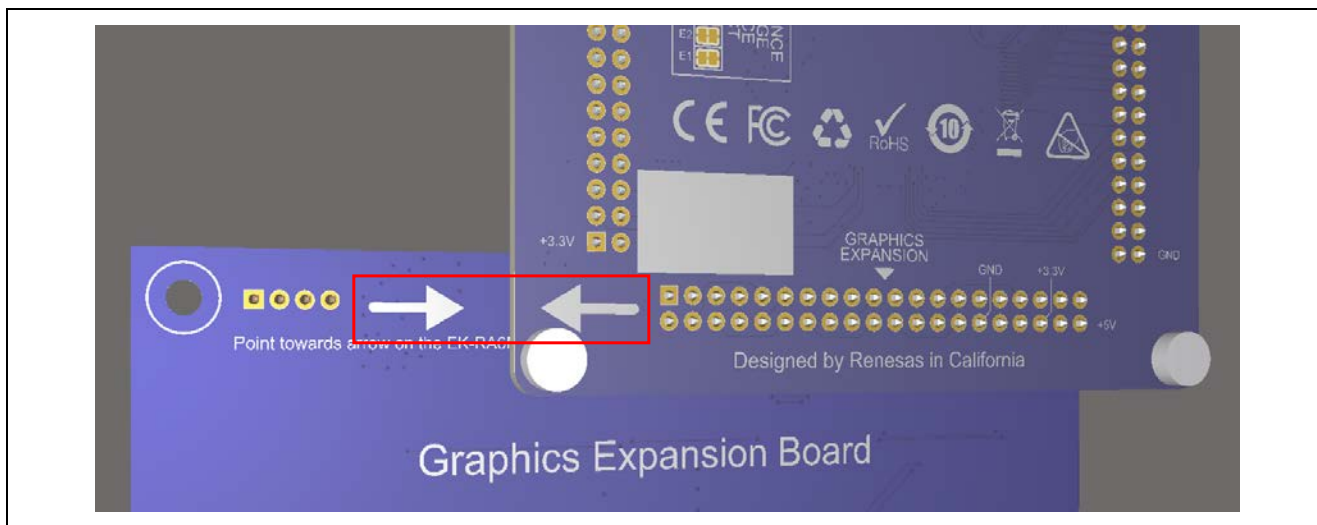


Figure 30. Aligning Graphics Expansion Board and the EK-RA6M3 Board Using the Alignment Arrows Printed on the Bottom of Each Board

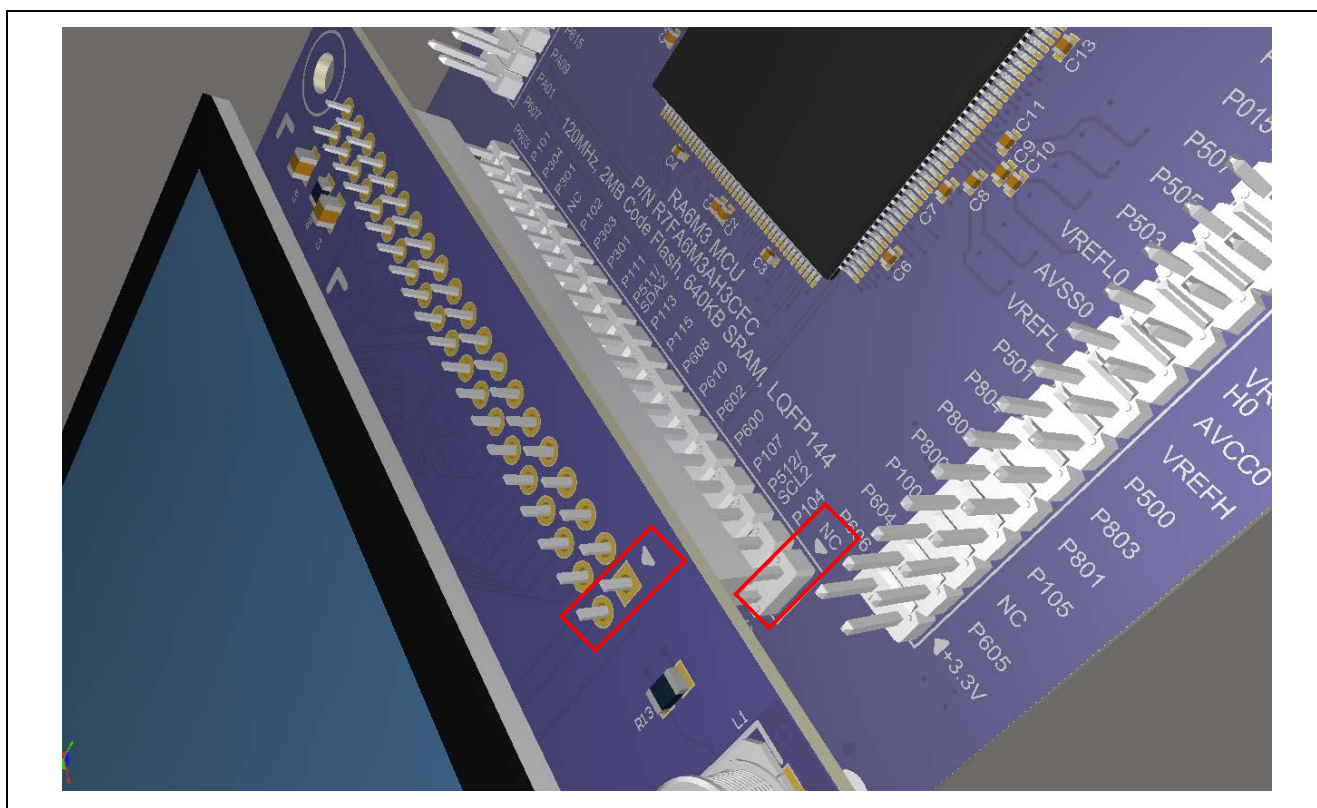


Figure 31. Aligning Graphics Expansion Board and the EK-RA6M3 Board Using the Alignment Triangles Printed on the Top of Each Board

8.2 Signal Assignment

The RA MCU GLCD ports are configured for a 5-6-5 color depth. Table 23 shows the GLCD port assignments and signal names between the EK-RA6M3 board and the Graphics Expansion Board.

Note that P206, which is used as the interrupt for the capacitive touch portion of the LCD, must have the internal pull-up feature enabled in the RA6M3 MCU configuration. This will ensure proper responsiveness of the LCD capacitive touch overlay.

Some ports used for the Graphics Expansion Board are also used by PMOD 2. To ensure correct operation, do not use the Graphics Expansion Board and PMOD 2 at the same time. Other ecosystem connections, including PMOD 1, are available to use while the Graphics Expansion Board is in use.

Table 23. Graphics Expansion Connector Signals

EK-RA6M3 Board				Graphics Expansion Board	
J1 Pin Number	RA MCU Port	RA MCU GLCD Signal	RGB Signal	Graphics Module Signal	CN1 Pin Number
J1-1	N.C.	N.C.	N.C.	DITH	CN1-1
J1-2	N.C.	N.C.	N.C.	MODE	CN1-2
J1-3	P104	TCON2	DE	RGB_EN	CN1-3
J1-4	P600	DATA2	B0	B0	CN1-4
J1-5	P512	SCL2	SCL	SCL	CN1-5
J1-6	P601	DATA3	B1	B1	CN1-6
J1-7	P107	DATA1	B4	B4	CN1-7
J1-8	P106	DATA0	B3	B3	CN1-8
J1-9	P600	DATA2	B5	B5	CN1-9
J1-10	P602	DATA4	B2	B2	CN1-10
J1-11	P602	DATA4	B7	B7	CN1-11
J1-12	P601	DATA3	B6	B6	CN1-12
J1-13	P610	DATA5	G2	G2	CN1-13
J1-14	P114	DATA9	G0	G0	CN1-14
J1-15	P608	DATA7	G4	G4	CN1-15
J1-16	P609	DATA6	G3	G3	CN1-16
J1-17	P115	DATA8	G5	G5	CN1-17
J1-18	P113	DATA10	G1	G1	CN1-18
J1-19	P113	DATA10	G7	G7	CN1-19
J1-20	P114	DATA9	G6	G6	CN1-20
J1-21	P511	SDA	SDA	SDA	CN1-21
J1-22	P302	DATA14	R1	R1	CN1-22
J1-23	P111	DATA12	R4	R4	CN1-23
J1-24	P112	DATA11	R3	R3	CN1-24
J1-25	P301	DATA13	R5	R5	CN1-25
J1-26	P303	DATA15	R2	R2	CN1-26
J1-27	P303	DATA15	R7	R7	CN1-27
J1-28	P302	DATA14	R6	R6	CN1-28
J1-29	P102	TCON0	HSYNC	HSYNC	CN1-29
J1-30	GND	GND	GND	GND	CN1-30
J1-31	N.C.	N.C.	N.C.	LR_INV	CN1-31
J1-32	P103	TCON1	VSNC	VSNC	CN1-32
J1-33	P301	DATA13	R0	R0	CN1-33
J1-34	N.C.	N.C.	N.C.	UD_INV	CN1-34
J1-35	P304	RST	RST	RESET#	CN1-35
J1-36	+3.3 V	+3.3 V	+3.3 V	+3.3 V	CN1-36
J1-37	P101	CLK	CLK	CLK	CN1-37
J1-38	P206	IRQ0	IRQ	INTP	CN1-38
J1-39	P603	GTIOC7A	BLEN	BLEN	CN1-39
J1-40	+5 V	+5 V	+5 V	+5 V	CN1-40

9. Certifications

The EK-RA6M3G v1 kit meets the following certifications/standards. See page 3 of this user's manual for disclaimer and precautions.

9.1 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 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 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

9.2 Material Selection, Waste, Recycling and Disposal Standards

- EU RoHS
- China SJ/T 11364:2014, 10-year environmental protection use period.

9.3 Safety Standards

- UL 94V-0

10. Design and Manufacturing Information

The design and manufacturing information for the EK-RA6M3G v1 kit is available in the “EK-RA6M3Gv1 Design Package” available on renesas.com/ra/ek-ra6m3g.

- Design package file name: ek-ra6m3g-v1-designpackage.zip
- Design package contents:
 1. EK-RA6M3 Board design package: ek-ra6m3-v1-designpackage.zip
 2. Graphics Expansion Board design package: ek-ra6m3geb-v1-designpackage.zip

Table 24. EK-RA6M3 Board 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

Table 25. Graphics Expansion Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	ek-ra6m3geb-v1-schematics
File (PDF)	Mechanical Drawing	ek-ra6m3geb -v1-mechdwg
File (PDF)	3D Drawing	ek-ra6m3geb-v1-3d
File (PDF)	BOM	ek-ra6m3geb-v1-bom
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files-Altium

11. 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-RA6M3G Resources	renesas.com/ra/ek-ra6m3g
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
1.01	Jan.30.20	—	Second release

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