

RA0E3 Group

Fast Prototyping Board for RA0E3 Microcontroller
Group
FPB-RA0E3 v1
User's Manual

Renesas RA Family
RA0 Series

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1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

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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 fulfil the regulatory standards for an end product.

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Renesas RA Family

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Glossary

Table 1. List of Abbreviations and Acronyms

BoM	Bill of Materials
FPB	Fast Prototyping Board
FSP	Flexible Software Package
GPIO	General Purpose Input Output
I ² C (or IIC)	Inter-Integrated Circuit
IDE	Integrated Development Environment
I/O	Input/Output
IRQ	Interrupt Request
LDO	Low Dropout
LED	Light Emitting Diode
TSSOP	Thin Shrink Small Outline Plastic Package
MCU	Micro Controller Unit
MISO	SPI Master In Slave Out
MOSI	SPI Master Out Slave In
NC	Not Connected
PWM	Pulse Width Modulation
RXD	Receive Data
SCI	Serial Communications Interface
SCL	Serial Clock Line
SDA	Serial Data Line
SMD	Surface Mount Device
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SWD	Serial Wire Debug
TXD	Transmit Data
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus

1. Board Overview

The FPB-RA0E3, a Fast Prototyping Board for the RA0E3 MCU Group, enables users to seamlessly evaluate the features of the RA0E3 MCU group and develop embedded systems applications using Flexible Software Package (FSP) and the e² studio IDE. Users can use on-board features along with their choice of popular ecosystems add-ons to bring their big ideas to life.

The key features of the FPB-RA0E3 board are categorized in two groups (consistent with the architecture of the board) as follows:

MCU and MCU Native Pin Access

- R7FA0E3034ZSD MCU (referred to as RA MCU)
- 32 MHz, Arm® Cortex®-M23 core
- 16 KB Code Flash, 2 KB SRAM
- 20-pin TSSOP package
- Native pin access through 2 x 10-pin male headers (not fitted)
- MCU's VCC current measurement point for precision current consumption measurement
- Multiple clock sources - the high-speed on-chip oscillator (HOCO) / low-speed on-chip oscillator (LOCO) inside the RA MCU are available.

System Control and Ecosystem Access

- USB Full Speed Device (USB 2.0 Type-C™ connector)
- 5 V input sources x 2
 - USB (Debug, Full Speed)
 - External power supply (using 2-pin header) (not fitted)
- On-board debugger (SWD)
- User LEDs and switches
 - User LED (green) x 2
 - Power LED (green) indicating availability of regulated power
 - Debug/power LED (yellow) indicating power and the debug connection
 - User switch
 - Reset switch
- Popular ecosystem expansions x 2
 - Digilent Pmod™ (I²C, SPI, and UART) connector
 - Arduino® (Uno R3) connectors

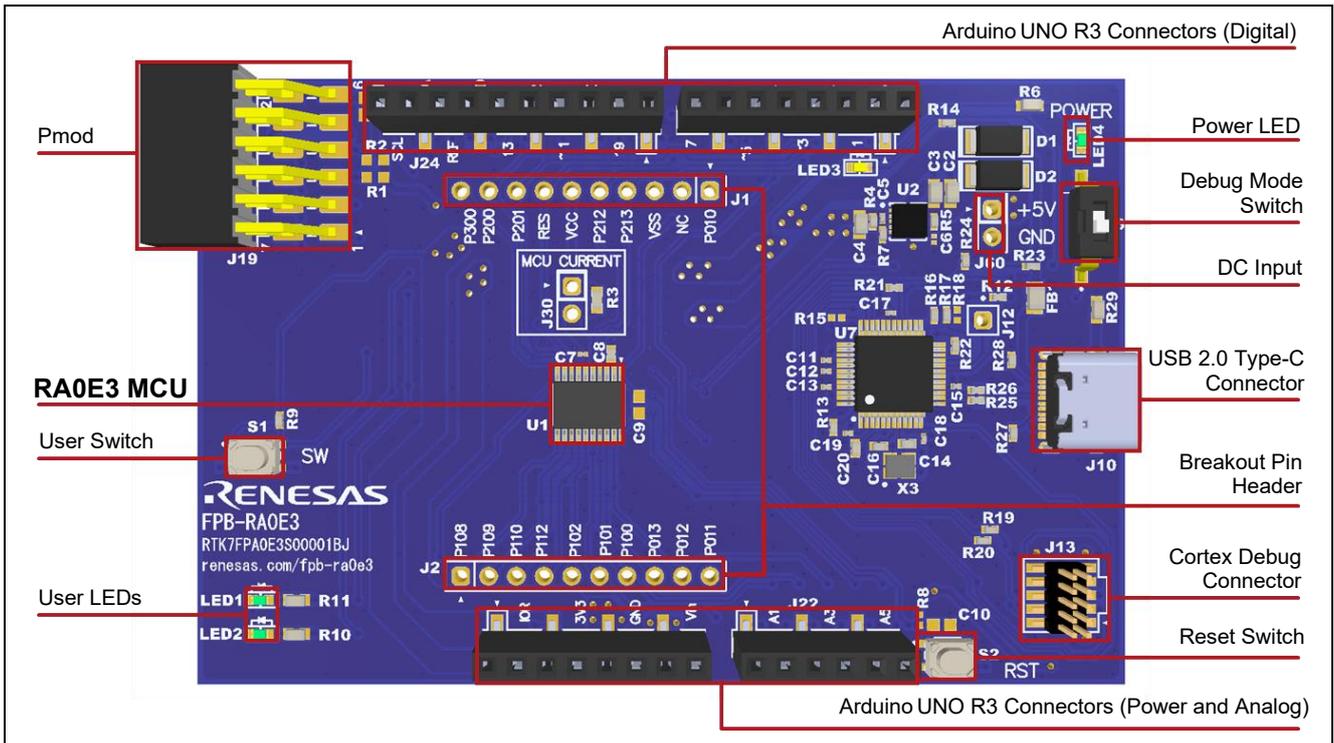


Figure 1. FPB-RA0E3 Board Top View

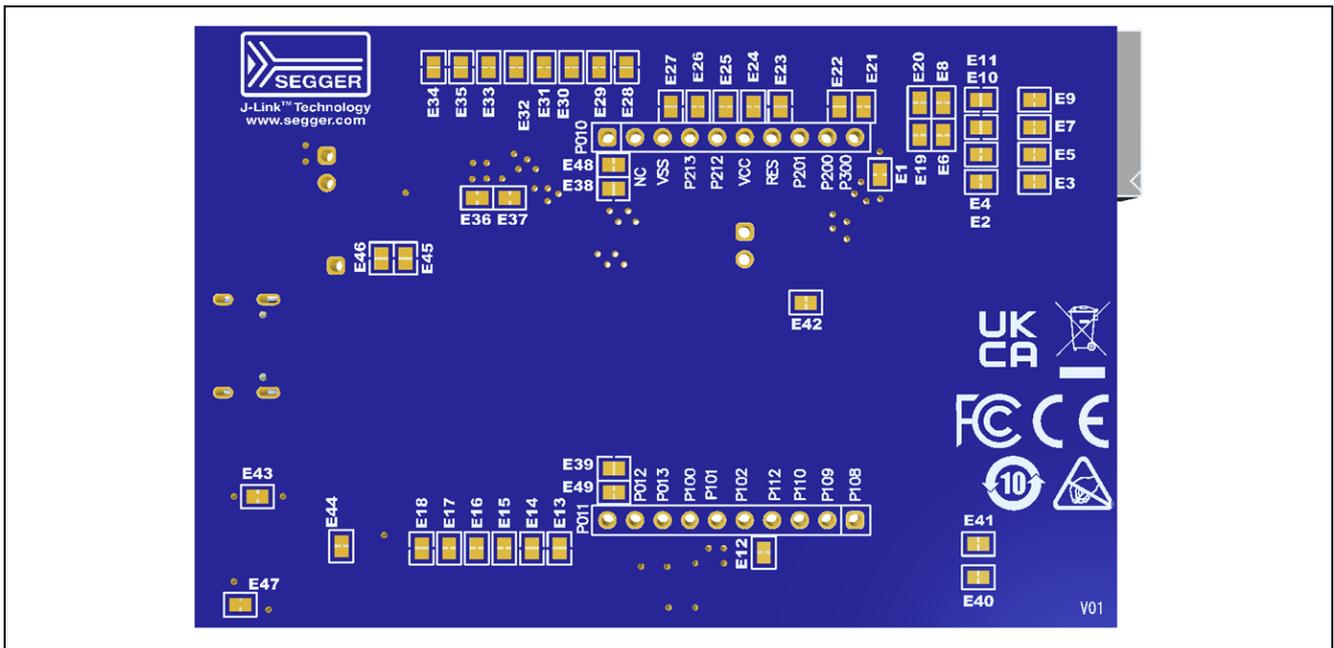


Figure 2. FPB-RA0E3 Board Bottom View

1.1 Assumptions and Advisory Notes

1. It is assumed that the user has a basic understanding of microcontrollers and embedded systems hardware.
2. It is recommended that the user refers to the *FPB-RA0E3 Quick Start Guide* to get acquainted with the board.
3. [Flexible Software Package \(FSP\)](#) and Integrated Development Environment (IDE) such as [e² studio](#) are required to develop embedded applications on FPB-RA0E3 board.
4. Instructions to download and install software, import example projects, build them and program the FPB-RA0E3 board are provided in the [FPB-RA0E1 tutorial](#) and the [Getting Started with Fast Prototyping Board for RA Family](#).
5. The RA MCU fitted to the FPB-RA0E3 board may not contain the latest version of the on-chip boot firmware.

2. Box Contents

The following components are included in the box.

- (1) FPB-RA0E3 v1 board
- (2) Printed Quick Start Guide and China RoHS document

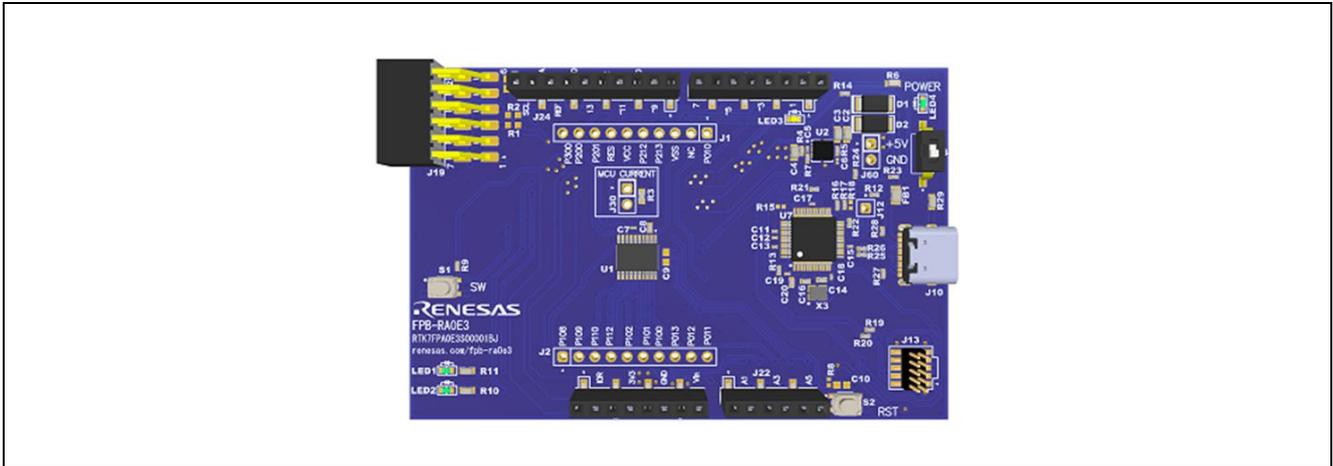


Figure 3. Configuration of the FPB-RA0E3 v1 Evaluation Kit

3. Ordering Information

- FPB-RA0E3 v1 orderable part number: RTK7FPA0E3S00001BJ
Note: The underlined character in the orderable part number represents the kit version.
- FPB-RA0E3 board dimensions: 55.88 mm (width) x 85.00 mm (length) (Connector protrusions not included)

4. Hardware Architecture and Default Configuration

4.1 Kit Architecture

The FPB-RA0E3 board is designed with an architecture similar to other boards in the FPB series. Alongside the RA MCU there is an on-board programmer, pin headers for access to all the pins on the RA MCU, a power supply regulator, some LEDs and switches, and several ecosystem I/O connectors (Pmod and Arduino).

Table 2. Kit Architecture

Board Functionality	Features	Function present on all similar boards	Functionality is:
MCU Native Pin Access	RA MCU, all MCU I/Os and power, breakout pin header for current measurement	Yes	RA MCU dependent
System Control and Ecosystem Access	Power, debugger, user LEDs and switches, reset switch, and ecosystem connectors	Yes	Same or similar across other FPB boards

4.2 Block Diagram

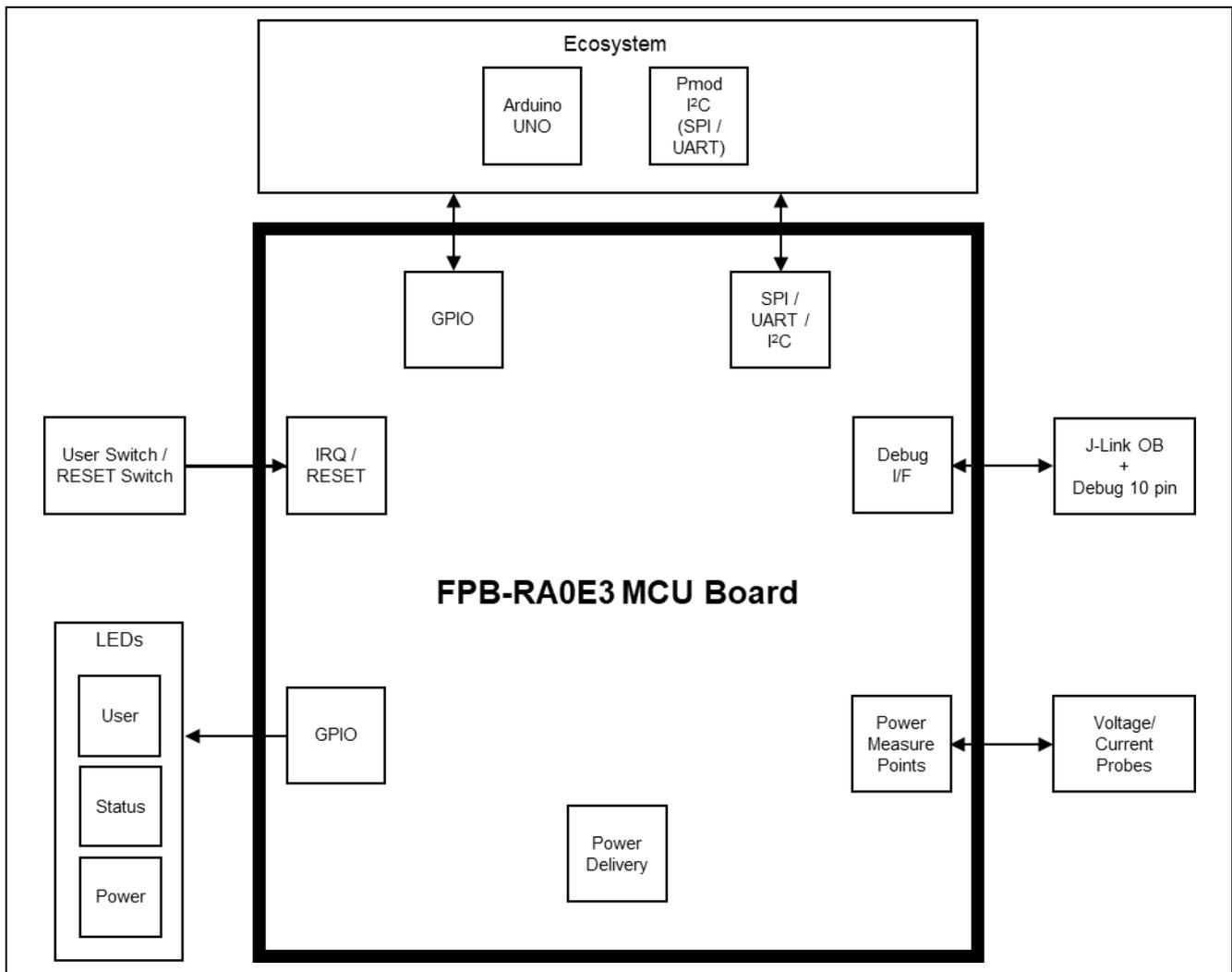


Figure 4. FPB-RA0E3 Board Block Diagram

4.3 Jumper Settings

Two types of jumpers are provided on the FPB-RA0E3 board.

- (1) Copper jumpers (Jumper Trace Cut (closed) and Jumper Solder Bridge (open))
- (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 **Jumper Trace Cut (closed)** and **Jumper Solder Bridge (open)**.

A **Jumper Trace Cut (closed)** is provided with a narrow copper trace connecting its pads. The silk screen overlay printing around a Jumper Trace Cut (closed) 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 Jumper Trace Cut (closed) is turned into a Jumper Solder Bridge (open) for any later changes.

A **Jumper Solder Bridge (open)** 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 SMD zero-ohm resistor, inch size 0805, 0603, or 0402, may be placed across the two pads and soldered in place. A zero-ohm resistor shorts the pads together.

For any copper jumper, the connection is considered **closed** if there is an electrical connection between the pads (default for Jumper Trace Cut (closed)). The connection is considered **open** if there is no electrical connection between the pads (default for Jumper Solder Bridge (open)).

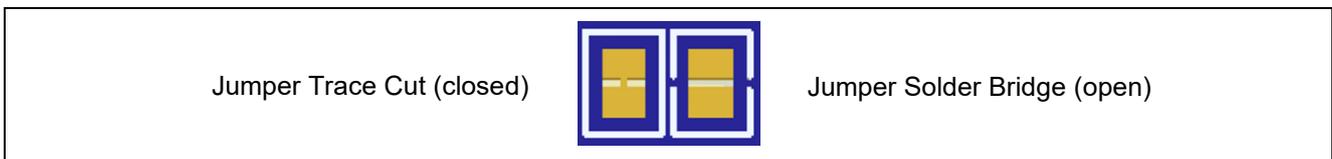


Figure 5. Copper Jumpers

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 FPB-RA0E3 board are 0.1" (2.54 mm) pitch headers and require compatible 2.54 mm shunt jumpers.

4.3.3 Default Jumper Configuration

The following table describes the default settings for each jumper on the FPB-RA0E3 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 3. Default Jumper Settings

Location	Circuit Group	Default Setting	Function
E1	Pmod	Closed	Connects R1 (not fitted), R2 (not fitted), J19-6, and J19-12 to VCC.
E2	Pmod	Closed	Connects J19-1 to U1-8 (P201/IRQ5_B).
E3	Pmod	Closed	Connects J19-7 to U1-14 (P112/IRQ2_B).
E4	Pmod	Closed	Connects J19-2 to U1-16 (P101/SO00_A/TXD0_A).
E5	Pmod	Closed	Connects J19-8 to U1-19 (P012).
E6	Pmod	Closed	Connects J19-3 to U1-5 (P212/SCLA0_B).
E7	Pmod	Closed	Connects J19-9 to U1-18 (P013).
E8	Pmod	Closed	Connects J19-4 to U1-4 (P213/SDAA0_B).
E9	Pmod	Closed	Connects J19-10 to U1-12 (P109).
E10	Pmod	Open	Connects J19-3 to U1-17 (P100/SI00_A/RXD0_A).
E11	Pmod	Open	Connects J19-4 to U1-15 (P102/SCK00_A).
E12	Arduino	Closed	Connects J21-3 to U1-7 (RES/P206).
E13	Arduino	Open	Connects J22-1 to U1-16 (P101/AN021/TO07_A).
E14	Arduino	Open	Connects J22-2 to U1-17 (P100/AN022/TO04_A).
E15	Arduino	Closed	Connects J22-3 to U1-18 (P013/AN005).
E16	Arduino	Closed	Connects J22-4 to U1-19 (P012/AN004).
E17	Arduino	Closed	Connects J22-5 to U1-20 (P011/AN001).
E18	Arduino	Open	Connects J22-6 to U1-1 (P010/AN000/VREFH0).
E19	Arduino	Closed	Connects J24-10 to U1-5 (P212/SCLA0_B/RXD1_A).
E20	Arduino	Closed	Connects J24-9 to U1-4 (P213/SDAA0_B/TXD1_A).
E21	Arduino	Closed	Connects J24-8 to U1-1 (P010/AN000/VREFH0).
E22	Arduino	Open	Connects J24-6 to U1-20 (P011/AN001).
E23	Arduino	Open	Connects J24-5 to U1-19 (P012/AN004).
E24	Arduino	Closed	Connects J24-4 to U1-17 (P100/AN022/TO04_A).
E25	Arduino	Closed	Connects J24-3 to U1-16 (P101/AN021/TO07_A).
E26	Arduino	Closed	Connects J24-2 to U1-15 (P102/TO06_A).
E27	Arduino	Open	Connects J24-1 to U1-18 (P013/AN005).
E28	Arduino	Open	Connects J23-8 to U1-7 (RES/P206).
E29	Arduino	Closed	Connects J23-7 to U1-14 (P112/TO03_A).
E30	Arduino	Closed	Connects J23-6 to U1-13 (P110/TO01_A).
E31	Arduino	Closed	Connects J23-5 to U1-12 (P109).
E32	Arduino	Closed	Connects J23-4 to U1-8 (P201/TO05_B).
E33	Arduino	Closed	Connects J23-3 to U1-9 (P200).
E34	Arduino	Open	Connects J23-2 to U1-4 (P213/SDAA0_B/TXD1_A).
E35	Arduino	Open	Connects J23-1 to U1-5 (P212/SCLA0_B/RXD1_A).
E36	MCU Power	Closed	Connects 3.3 V to +3V3JLOB.
E37	MCU Power	Closed	Connects 3.3 V to VCC.
E38	RA0E3 MCU	Open	Connects U1-1 (P010/VREFH0) to VCC.
E39	RA0E3 MCU	Open	Connects U1-20 (P011/VREFL0) to VSS.
E40	User LED2	Closed	Connects LED2 to U1-20 (P011) (via R10).
E41	User LED1	Closed	Connects LED1 to U1-1 (P010) (via R11).
E42	User Switch	Closed	Connects S1 to U1-9 (P200/IRQ0_A/NMI).
E43	Debugger	Closed	Connects J13-9 to VSS.
E44	Debugger	Closed	Connects J13-10 and U7-29 (P112) (via R21) to U1-7 (RES/P206).
E45	Debugger	Open	Connects U7-23 (P301) to U1-16 (P101/TXD0_A) (connection to the VOM port (J-Link CDC UART port)).
E46	Debugger	Open	Connects U7-22 (P302) to U1-17 (P100/RXD0_A) (connection to the VOM port (J-Link CDC UART port)).

Location	Circuit Group	Default Setting	Function
E47	Debugger	Closed	Connects J13-1 to VCC.
E48	Breakout Pin Header	Closed	Connects J1-1 to U1-1.
E49	Breakout Pin Header	Closed	Connects J2-10 to U1-20.
J30	Debugger	Open (Not fitted)	Pin header for measuring current from VCC for the RA MCU. Remove R3 when VCC current drawn by the RA MCU is to be measured.
R3	Debugger	Closed (Fitted)	Connects VCC to the RA MCU. Remove this when current drawn by the RA MCU is to be measured by using J30.
S3	Power	OFF	ON: Debug In / MCU simple substance OFF: On-board debug

Note: J1 and J2: Breakout Pin Header

J13: Debug connector

J19: Pmod connector

U1: RA0E3

U7: RA4M2 (J-Link OB)

5. System Control and Ecosystem Access

The FPB-RA0E3 provides a power supply regulator, an on-board debugger, simple I/O (switches and LEDs), and popular I/O ecosystem connectors. These are all described in detail below.

5.1 Power

The FPB-RA0E3 board is designed for +5 V operation. An on-board Low Dropout (LDO) regulator 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 FPB-RA0E3 board can be powered.

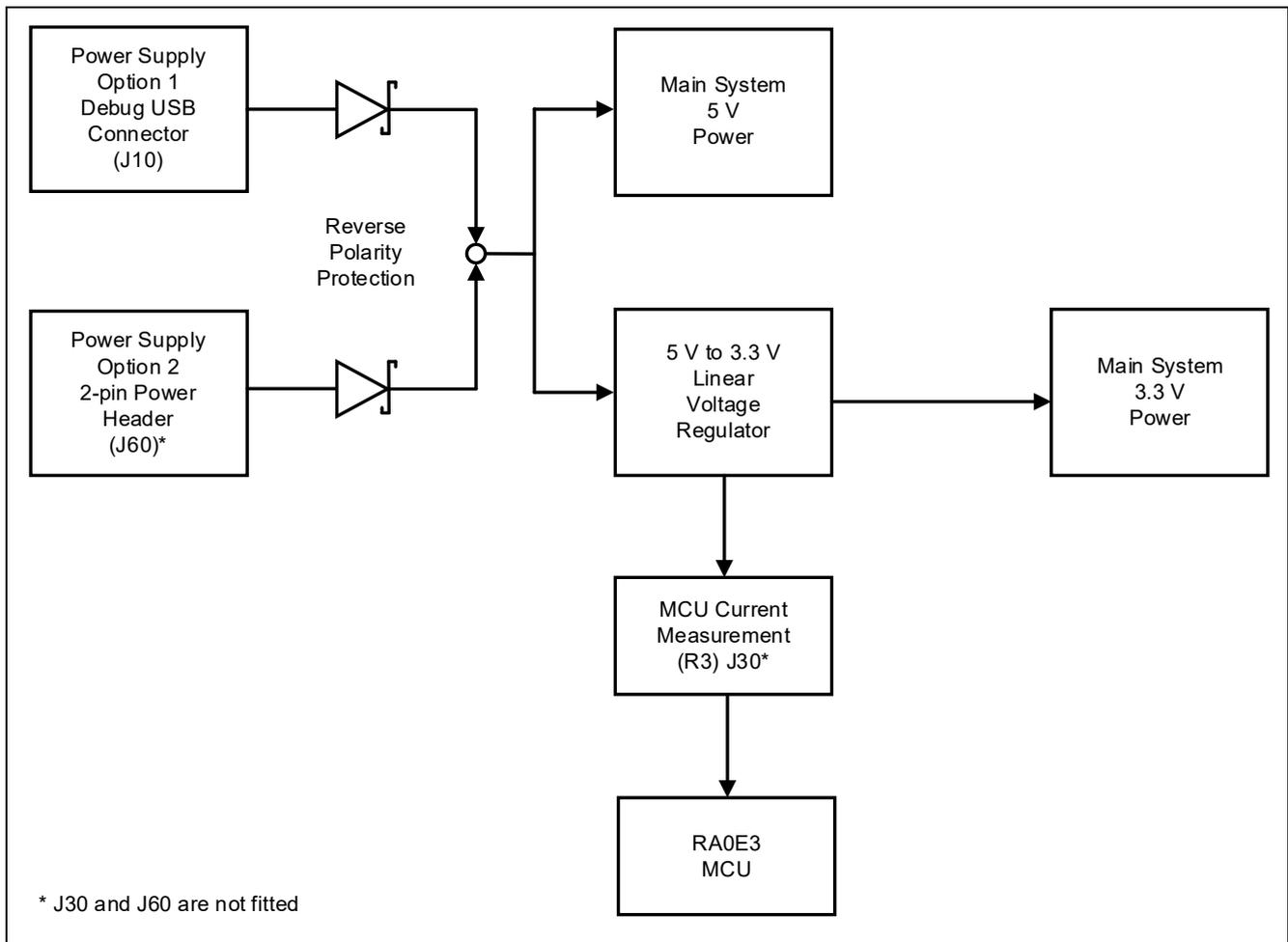


Figure 6. Power Supply Options

5.1.1.1 Option 1: Debug USB (Default Setting)

5 V may be supplied from an external USB host to the USB debug connector (J10). 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: Header Connector J60

5 V may be supplied from an external power supply to header connector (J60) on the board. J60 (not fitted) is the 2-pin through holes that can accommodate a 0.1" (2.54 mm) pin header or connector. Power from this source is connected to the main system 5 V power. Reverse current protection is provided between the 5 V header connector and the main system 5 V power.

5.1.2 Power Supply Considerations

The FPB-RA0E3 specification places a limit of 1.0 A on current. 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 power is supplied, green LED4 marked POWER will illuminate. Yellow LED3 (DEBUG LED) will also illuminate.

5.2 Debug

The FPB-RA0E3 board can be programmed and debugged by using the built-in SEGGER J-Link® on-board debugger and can support the two debug modes listed below.

Table 4. Debug Modes

Debug Mode	Debug MCU*	Target MCU (MCU to be Debugged)	Debug Interface	Connector Used
On-board debug	RA4M2 (on-board)	RA0E3 (on-board)	SWD	USB 2.0 Type-C™ connector (J10)
Debug In	External debug tools	RA0E3 (on-board)	SWD	10-pin connector (J13)

Note: MCU to be connected to an IDE running on a PC

The following table summarizes the switch configurations for each of the debug modes.

Table 5. Switch Configurations for Each of the Debug Modes

Debug Mode	S3
On-board debug	OFF (default setting)
Debug In	ON

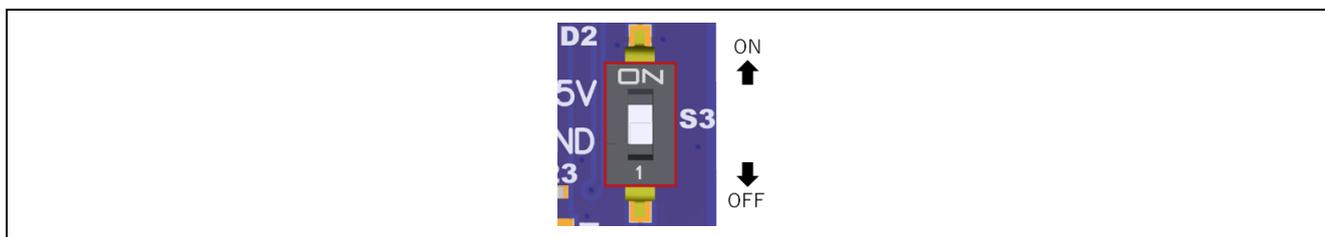


Figure 7. Switch for Debug Mode (Top View)

5.2.1 On-Board Debug

The on-board debug functionality is provided using the RA4M2 (J-Link OB) and SEGGER J-Link® firmware. The USB debug connector (J10) for the USB 2.0 Type-C™ connector connects the RA4M2 (J-Link OB) to an external USB full-speed host, allowing programming and debugging of the target MCU.

The RA4M2 (J-Link OB) is connected to the target MCU through the SWD interface.

Table 6. Debug USB Connector

Debug USB Connector J10		FPB-RA0E3
Pin	Description	Signal/Bus
A4, B4, A9, B9	+5VDC	+5V_USB_DBG
A7, B7	Data-	J-Link OB: USB_DM (U7 pin 14)
A6, B6	Data+	J-Link OB: USB_DP (U7 pin 15)
CC1, CC2	USB ID, jack internal switch, cable inserted	Pull down
SH1, SH2, SH3, SH4	Shell	VSS
A1, B1, A12, B12	Ground	VSS

Signal/Bus names are shown on the board schematic (available in the FPB-RA0E3 v1 Design Package) and are compliant with that.

Yellow indicator LED3 shows the visual status of the debug interface. When the FPB-RA0E3 board is powered on and LED3 is blinking, it indicates that the RA4M2 (J-Link OB) is not connected to the host PC. When LED3 is on solid, it indicates that the RA4M2 (J-Link OB) is connected to the host PC. When LED3 is flickering during the connection of the debugger, it indicates that data are being transferred between the RA4M2 (J-Link OB) and the host PC.

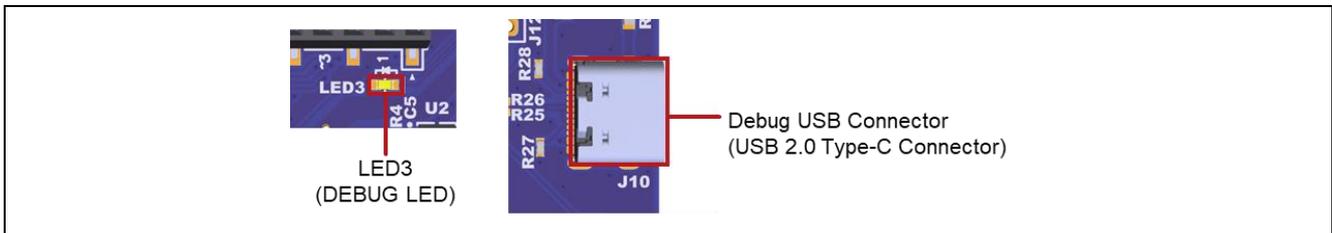


Figure 8. FPB-RA0E3 Debug Interface (Top View)

5.2.2 Debug In

The 10-pin Cortex® debug connector at J13 supports the SWD (Serial Wire Debug) interface, allowing debugging of the target MCU using an external debug tool.

To configure the FPB-RA0E3 board to use the Debug In mode, configure the jumpers as stated in Table 5.

Table 7. Debug In Port Assignments

Debug Connector J13		FPB-RA0E3
Pin	SWD Pin Name	RA0E3 Signal/Bus
J13-1	Vtref	VCC
J13-2	SWDIO	P108/SWDIO
J13-3	GND	VSS
J13-4	SWCLK	P300/SWCLK
J13-5	GND	VSS
J13-6	-	NC
J13-7	Key	NC
J13-8	-	NC
J13-9	GND Detect	VSS
J13-10	nRESET (nSRST)	RES/P206

5.2.3 Debugger Settings in e² studio

Figure 9 shows the settings for e² studio when creating a new project for the FPB-RA0E3 board.

[Debug hardware]: Select [J-Link (ARM)].

[Target Device]: Select [R7FA0E303].

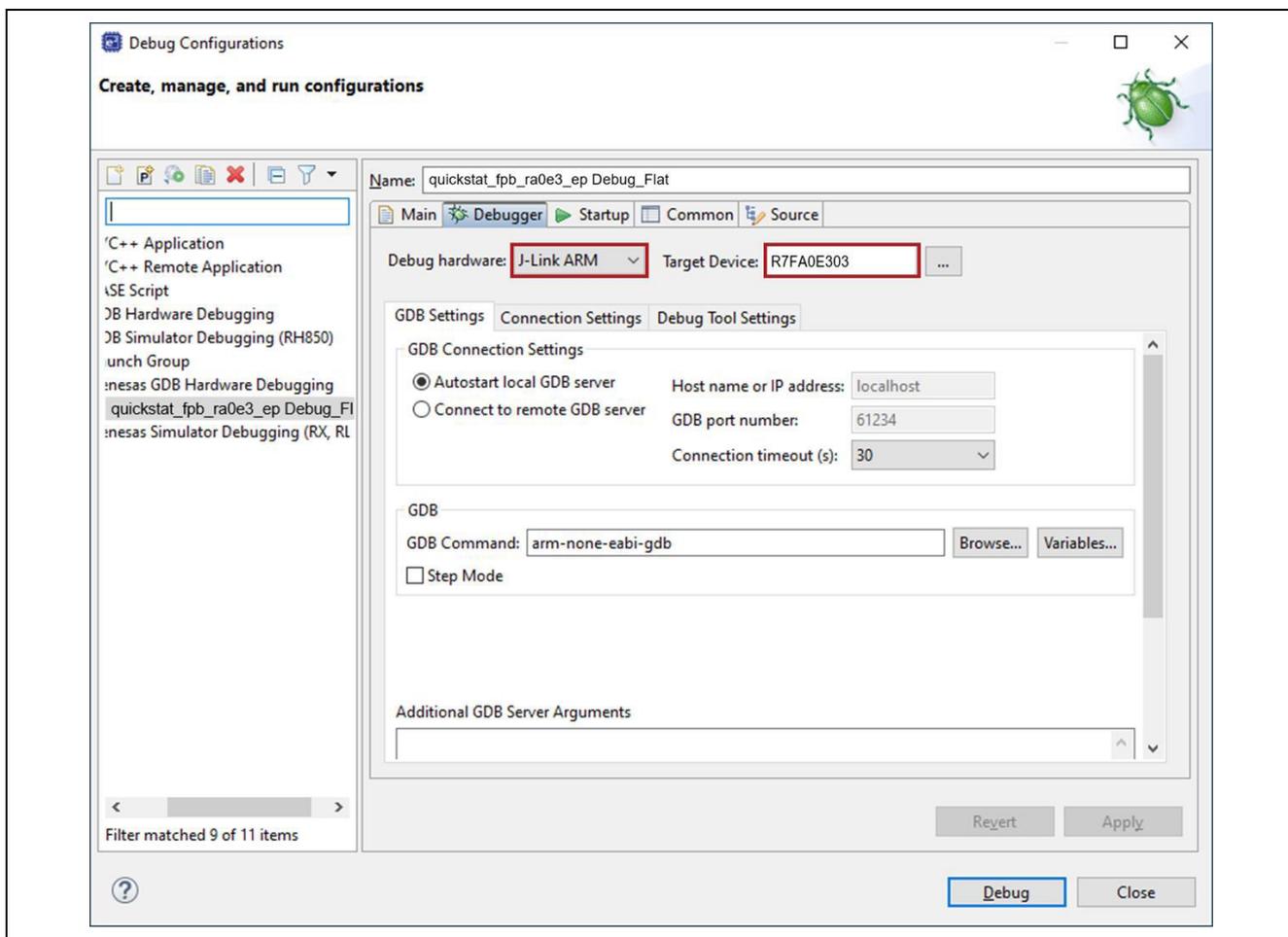


Figure 9. e² studio Debugger Settings

5.2.4 VCOM Port

The FPB-RA0E3 board can perform USB-UART conversion by using the RA4M2 (J-Link OB). It is recognized by the host as a VCOM port (J-Link CDC UART port) and connected to the UART of the RA0E3 on the FPB-RA0E3 board via copper jumpers (refer to Table 8). When the UART is to be used, close the E45 and E46 copper jumpers (Jumper Solder Bridge (open)).

Table 8. UART Assignments

RA0E3 Pin	RA0E3 Signal/Bus	Copper Jumper	
		Part Number	Default Setting
U1-16	P101/TXD0_A	E45	Open
U1-17	P100/RXD0_A	E46	Open

When both of the following conditions are satisfied, reset the RA4M2 (turn S3 on).

- E45 is closed and used other than for the J-Link UART.
- Pulling up on the J-Link OB (RA4M2) side affects P101/TXD0_A.

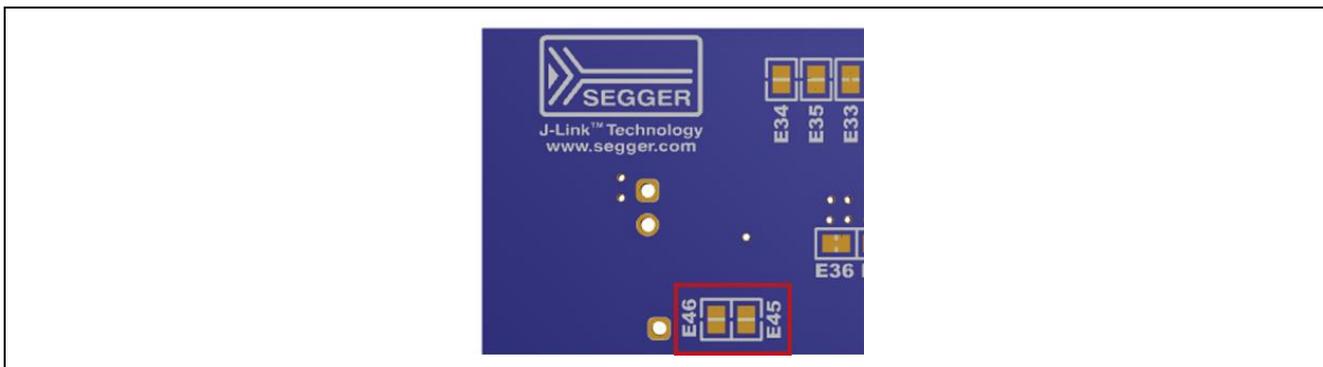


Figure 10. Copper Jumper for VCOM (Bottom View)

5.3 Ecosystem

The Ecosystem connectors provide users the option to simultaneously connect several third-party add-on modules compatible with two popular ecosystems using the following connectors:

- (1) Digilent Pmod™ (I²C, SPI, and UART) connector
- (2) Arduino® (Uno R3) connectors

5.3.1 Digilent Pmod™ Connector

The 12-pin connector (J19) is provided to support Pmod modules where the RA MCU acts as the master, and the connected module acts as a slave device.

The interface supports Pmod Type 6A (expanded I²C), Type 2A (expanded SPI), and Type 3A (expanded UART).

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.

Note that the FPB-RA0E3 board's Pmod Type 2A uses the SAU peripheral in “Simple SPI” mode, and so does not offer the full functionality of the SPI. Please see the hardware manual for full details of the SAU “Simple SPI” mode.

5.3.1.1 Pmod

A 12-pin right angle connector is fitted at J19. The interface supports Pmod Type 6A (expanded with I²C), Type 2A (expanded with SPI), and Type 3A (expanded with UART). Type 6A is used by default. If the Pmod module operation as a slave device does not have pull-ups on SCL and SDA, the FPB-RA0E3 board can be populated with pull-up resistor components R1 for SCL and R2 for SDA. Type 2A or Type 3A can be used by changing copper jumper settings (Ex designation).

Table 9. Pmod Connector (Type 6A)

Pmod Connector	Type 6A (Default Setting)	RA0E3 Signal/Bus	RA0E3 Pin	Pmod Configuration (Default Setting)	
				Closed	Open
J19-1	INT	IRQ5_B	U1-8	E2	-
J19-2	RESET	P101	U1-16	E4	-
J19-3	SCL	SCLA0_B	U1-5	E6	E10
J19-4	SDA	SDAA0_B	U1-4	E8	E11
J19-5	GND	VSS	-	-	-
J19-6	VCC	VCC (3.3 V)	-	-	-
J19-7	GPIO	P112	U1-14	E3	-
J19-8	GPIO	P012	U1-19	E5	-
J19-9	GPIO	P013	U1-18	E7	-
J19-10	GPIO	P109	U1-12	E9	-
J19-11	GND	VSS	-	-	-
J19-12	VCC	VCC (3.3 V)	-	-	-

Table 10. Pmod Connector (Type 2A/3A)

Pmod Connector	Type 2A/3A	RA0E3 Signal/Bus	RA0E3 Pin	Pmod Configuration	
				Closed	Open
J19-1	CS/CTS	P201	U1-8	E2	-
J19-2	MOSI/TXD	SO00_A/TXD0_A	U1-16	E4	-
J19-3	MISO/RXD	SI00_A/RXD0_A	U1-17	E10	E6
J19-4	SCK/RTS	SCK00_A/P102	U1-15	E11	E8
J19-5	GND	VSS	-	-	-
J19-6	VCC	VCC (3.3 V)	-	-	-
J19-7	INT	IRQ2_B	U1-14	E3	-
J19-8	RESET	P012	U1-19	E5	-
J19-9	CS2	P013	U1-18	E7	-
J19-10	CS3	P109	U1-12	E9	-
J19-11	GND	VSS	-	-	-
J19-12	VCC	VCC (3.3 V)	-	-	-

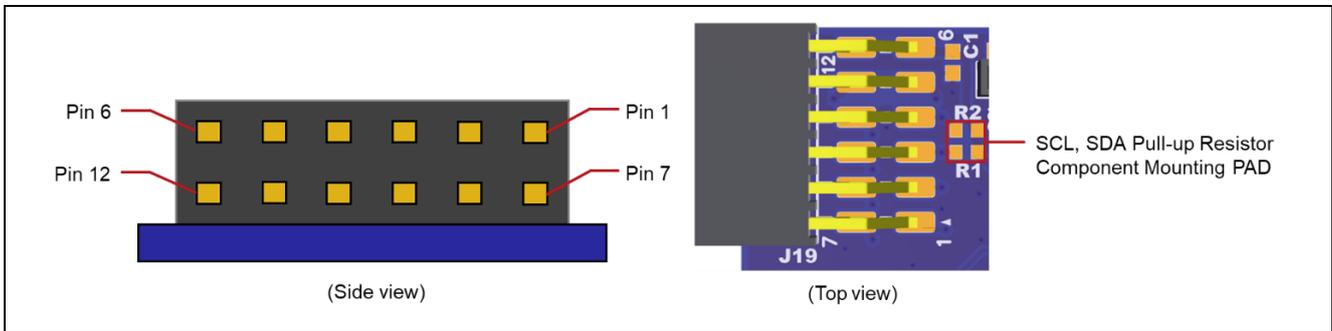


Figure 11. Pmod Connector Pin Layout

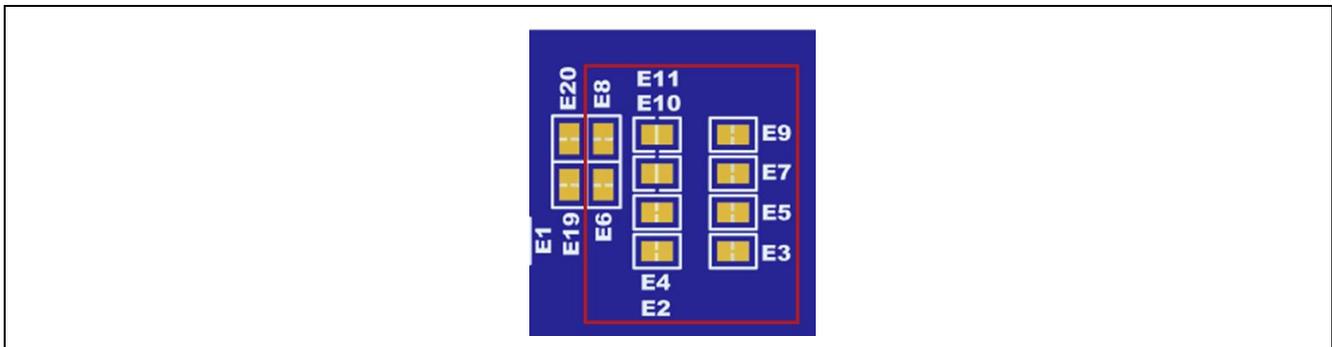


Figure 12. Pmod Copper Jumpers (Bottom View)

5.3.2 Arduino® Connector

An Arduino® UNO R3 compatible connector interface is provided.

However, we do not guarantee connection to all types of the Arduino® shield. Confirm the specifications of this product against any Arduino® shield you intend to use.

Table 11. Arduino® Connector

Arduino® Connector		Signal/Bus	Copper Jumper	
			Part Number	Default Setting
J21-1	NC	NC	-	-
J21-2	IOREF	3.3 V	-	-
J21-3	RESET	RES /P206	E12	Closed
J21-4	3V3	3.3 V	-	-
J21-5	5V	5.0 V	-	-
J21-6	GND	VSS	-	-
J21-7	GND	VSS	-	-
J21-8	VIN	NC	-	-
J22-1	A0	P101/ AN021 /TO07_A *	E13	Open
J22-2	A1	P100/ AN022 /TO04_A *	E14	Open
J22-3	A2	P013/ AN005	E15	Closed
J22-4	A3	P012/ AN004	E16	Closed
J22-5	A4	P011/ AN001	E17	Closed
J22-6	A5	P010/ AN000 /VREFH0 *	E18	Open
J23-1	RX/0	P212/ SCLA0_B/RXD1_A *	E35	Open
J23-2	TX/1	P213/ SDAA0_B/TXD1_A *	E34	Open
J23-3	2	P200	E33	Closed
J23-4	~3	P201/TO05_B	E32	Closed
J23-5	4	P109	E31	Closed
J23-6	~5	P110/TO01_A	E30	Closed
J23-7	~6	P112/TO03_A *	E29	Open
J23-8	7	NC	-	-
J24-1	8	P013/AN005 *	E27	Open
J24-2	~9	P102/TO06_A	E26	Closed
J24-3	~10	P101/AN021/TO07_A	E25	Closed
J24-4	~11	P100/AN022/TO04_A	E24	Closed
J24-5	12	P012/AN004 *	E23	Open
J24-6	13	P011/AN001 *	E22	Open
J24-7	GND	VSS	-	-
J24-8	AREF	P010/ AN000/VREFH0	E21	Closed
J24-9	SDA	P213/ SDAA0_B/TXD1_A	E20	Closed
J24-10	SCL	P212/ SCLA0_B/RXD1_A	E19	Closed

Note: Close the copper jumper (Jumper Solder Bridge (open)).

When closing the copper jumper, be careful regarding connections with other connectors.

J23-8 is NC according to specifications of the FPB-RA0E3 board.

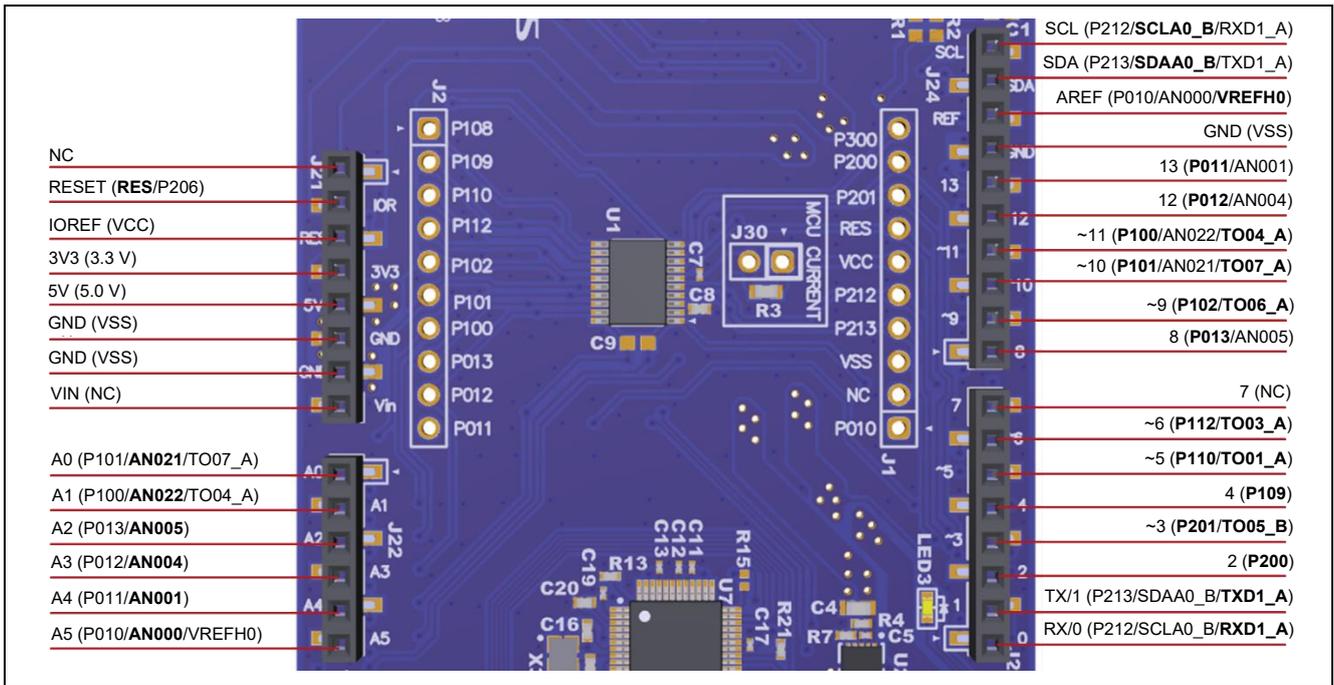


Figure 13. Arduino® Connectors (Top View)

5.4 Miscellaneous

5.4.1 User and Power LEDs

Four LEDs are provided on the FPB-RA0E3 board.

Behavior of the LEDs on the FPB-RA0E3 board is described in the following table.

Table 12. FPB-RA0E3 Board LED Functions

Designator	Color	Function	RA MCU Control Port
LED1	Green	User LED	P010 (illuminated by the high level)
LED2	Green	User LED	P011 (illuminated by the high level)
LED3	Yellow	Debug LED	Port for the RA4M2 (J-Link OB)
LED4	Green	Power LED	VCC

The user LEDs can be isolated from the RA MCU so that the associated ports can be used for other purposes. To disconnect LED1 from P010, Jumper Trace Cut (closed) E41 must be open. To disconnect LED2 from P011, Jumper Trace Cut (closed) E40 must be open.

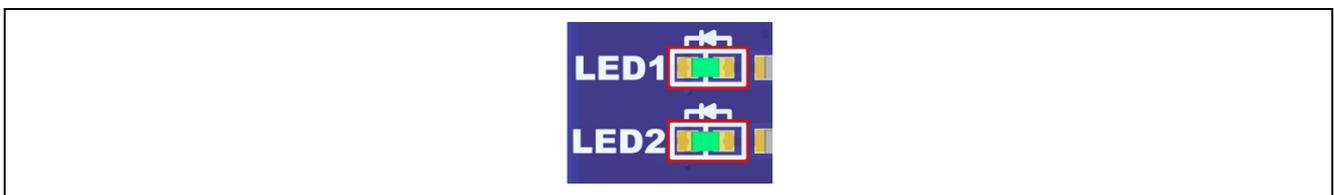


Figure 14. User LEDs (Top View)

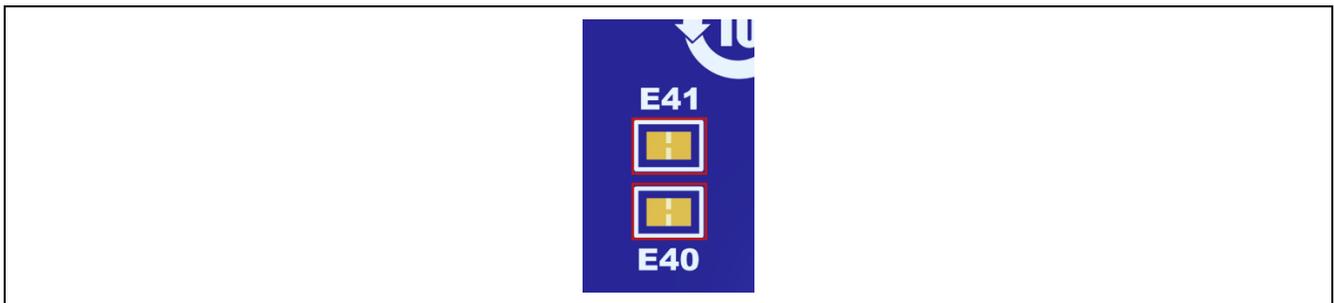


Figure 15. Jumper Trace Cut (Closed) for User LEDs (Bottom View)

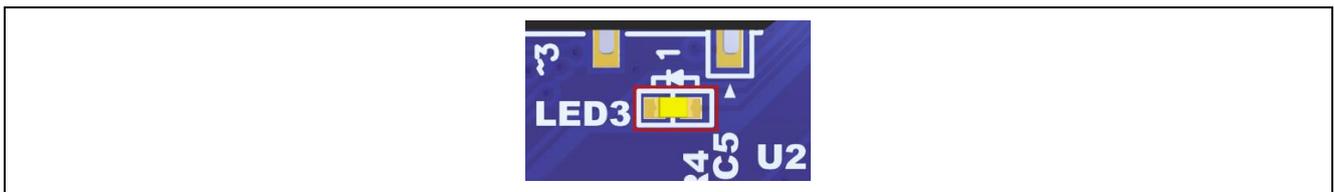


Figure 16. Debug LED (Top View)

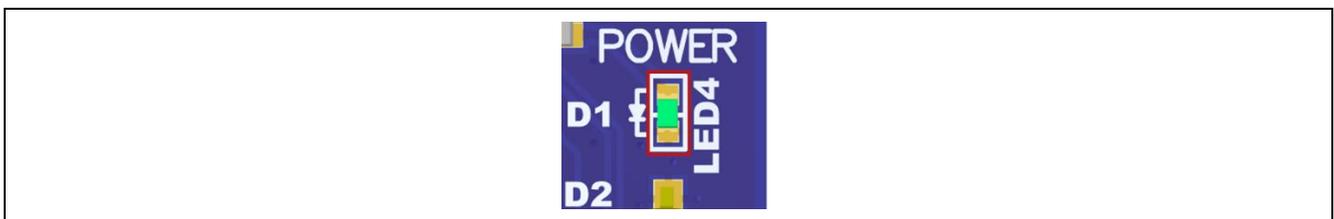


Figure 17. Power LED (Top View)

5.4.2 User and Reset Switches

Two miniature, momentary, mechanical push-button type SMD switches are mounted on the FPB-RA0E3 board.

Pressing the reset switch (S2) generates a reset signal to restart the RA MCU.

Table 13. FPB-RA0E3 Board Switches

Designator	Function	RA MCU Control Port
S1	User Switch	P200/NMI/IRQ0_A
S2	RA MCU Reset Switch	RES/P206

User switch S1 may be isolated from the RA MCU, so that the associated port can be used for other purposes. To disconnect S1 from P200, Jumper Trace Cut (closed) E42 must be open.

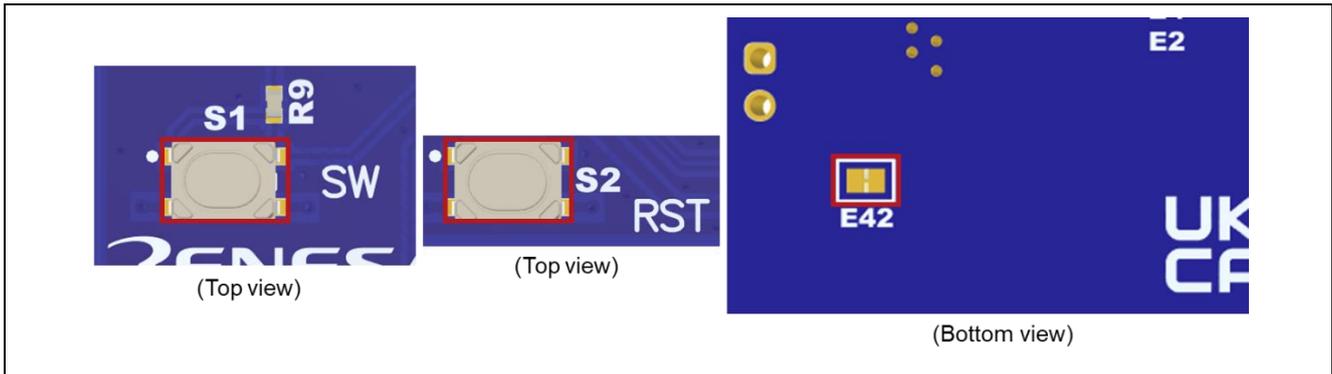


Figure 18. User Switch (S1), Reset Switch (S2), and Jumper Trace Cut (Closed) (E42)

6. MCU Native Pin Access

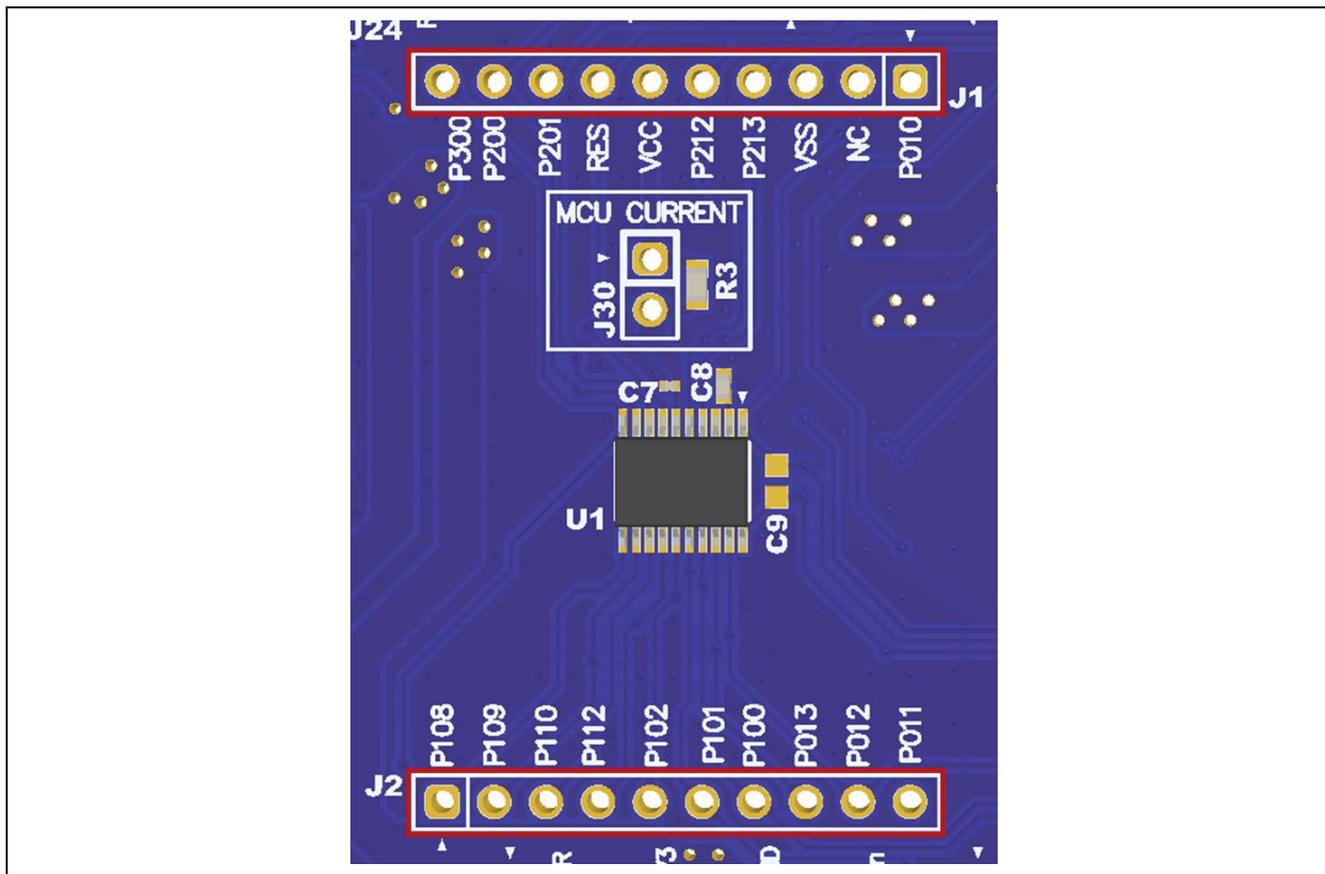


Figure 19. Native Pin Access (Breakout Pin Headers J1 and J2) (Top View)

6.1 Breakout Pin Headers

The FPB-RA0E3 board pin headers, J1 (not fitted) and J2 (not fitted), provide access to all RA0E3 MCU interface signals, and to voltages for all RA0E3 MCU power ports. Each header pin is labelled with the voltage or port connected to that pin. Refer to the RA0E3 MCU Group User’s Manual for details of each port function, and the FPB-RA0E3 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 both pin headers simultaneously. This can be used for prototyping and testing custom circuitry for use with the RA0E3 MCU.

Table 14. Breakout Pin Headers J1 and J2

J1 Pin No.	RA0E3 Signal/Bus	RA0E3 MCU	J2 Pin No.	RA0E3 Signal/Bus	RA0E3 MCU
1	P010/AN000/VREFH0	U1-1	1	P108/SWDIO	U1-11
2	NC	—	2	P109	U1-12
3	VSS	U1-3	3	P110	U1-13
4	P213/SDAA0_B	U1-4	4	P112/IRQ2_B	U1-14
5	P212/SCLA0_B	U1-5	5	P102/SCK00_A	U1-15
6	VCC	U1-6	6	P101/AN021/SO00_A/TXD0_A	U1-16
7	RES/P206	U1-7	7	P100/AN022/SI00_A/RXD0_A	U1-17
8	P201/IRQ5_B	U1-8	8	P013/AN005	U1-18
9	P200/IRQ0_A/NMI	U1-9	9	P012/AN004	U1-19
10	P300/SWCLK	U1-10	10	P011/AN001/VREFL0	U1-20

6.2 MCU Current Measurement

Included near the RA0E3 is resistor R3 and test connector J30 (not fitted) to measure the VCC current of the RA0E3.

Resistor R3 is 0 Ω (SMD 0603). It should be removed in order to measure the current consumption using an ammeter connected between J30 (not fitted) pins 1 and 2.

Alternatively, it could be removed and replaced with a suitable low value resistor, and then a voltmeter used to measure the voltage between J30 pins 1 and 2. The current drawn by RA0E3 can then be calculated using Ohm's Law.

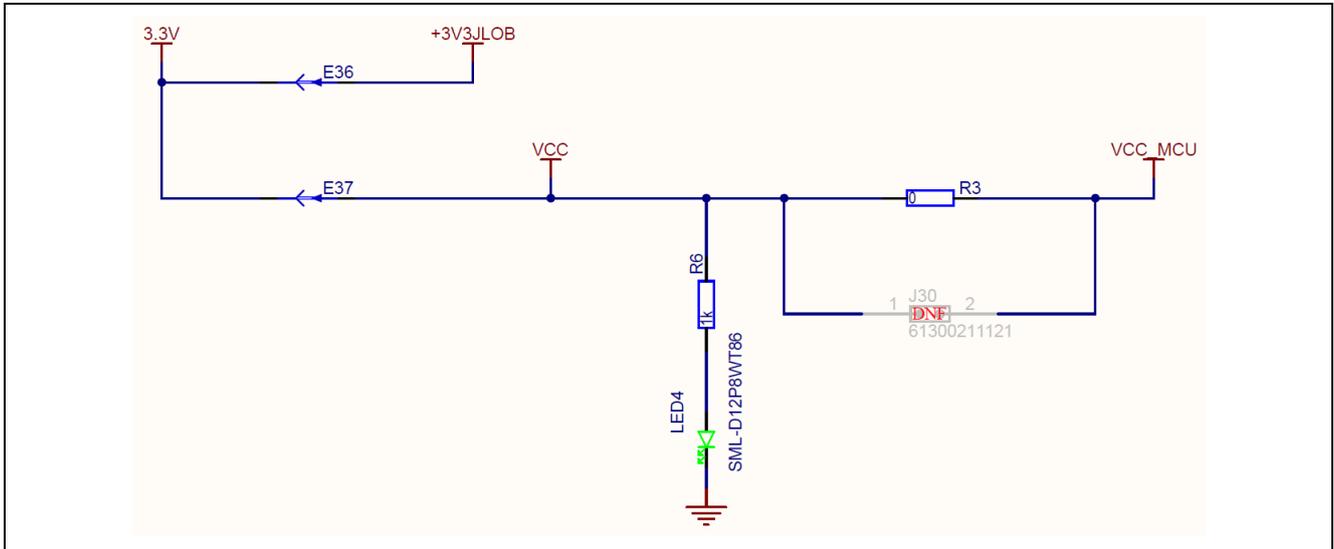


Figure 20. RA0E3 VCC Current Measurement Circuit

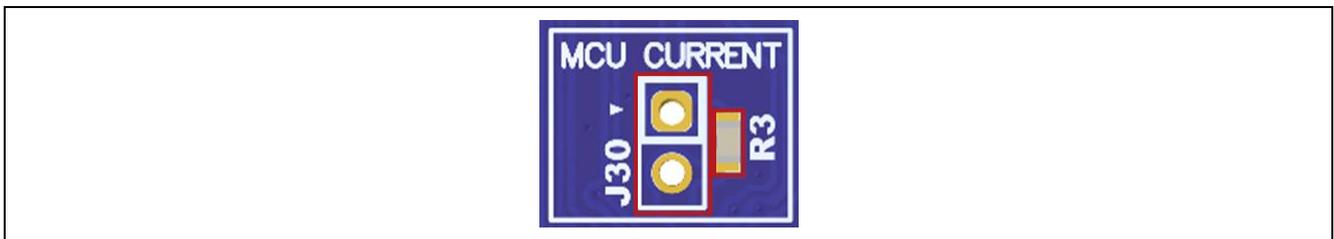


Figure 21. RA0E3 VCC Current Measurement Point J30 and R3 (Top View)

7. Recommended Parts

The following table lists the specifications of optional components that can be fitted as required.

Table 15. Specifications of Components

Designator	Description	Specification
J1, J2	1-row 10-pin male pin header	Parts with 10 x 1 pin and 2.54-mm pitch, which fit into the board holes with a diameter of 1.10 mm
J30, J60	1-row 2-pin male pin header	Parts with 2 x 1 pin and 2.54-mm pitch, which fit into the board holes with a diameter of 1.10 mm

8. Certifications

FPB-RA0E3 v1 meets the following certifications/standards. Please refer to the next page on the cover of this user's manual for notice and disclaimers.

8.1 EMC/EMI Standards

- FCC Notice (Class A)



This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE- This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

- Innovation, Science and Economic Development Canada ICES-003 Compliance:

CAN ICES-3 (A)/NMB-3(A)

- CE Class A (EMC)



This product is herewith confirmed to comply with the requirements set out in the Council Directives on the Approximation of the laws of the Member States relating to Electromagnetic Compatibility Directive 2014/30/EU.

Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures to correct this interference.

- UKCA Class A (EMC)



This product is in conformity with the following relevant UK Statutory Instrument(s) (and its amendments): 2016 No. 1091 Electromagnetic Compatibility Regulations 2016.

Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures to correct this interference.

- Taiwan: Chinese National Standard 13438, C6357 compliance, Class A limits
- Australia/New Zealand AS/NZS CISPR 32:2015, Class A

8.2 Material Selection, Waste, Recycling and Disposal Standards

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



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

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

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

8.3 Safety Standards

- UL 94V-0

9. Design and Manufacturing Information

The design and manufacturing information for the FPB-RA0E3 v1 board is available in the “FPB-RA0E3 v1 Design Package” available on renesas.com/fpb-ra0e3.

- FPB-RA0E3 v1 Design Package file name: fpb-ra0e3-v1-designpackage.zip
- FPB-RA0E3 v1 Design Package contents:

Table 16. FPB-RA0E3 v1 Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	fpb-ra0e3-v1-schematics
File (PDF)	Mechanical Drawing	fpb-ra0e3-v1-mechdwg
File (PDF)	BoM	fpb-ra0e3-v1-bom
File (PDF)	3D Drawing	fpb-ra0e3-v1-3d
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files - Altium

9.1 Supplementary Information

When hardware equipped with RA0E3 must meet the BISS Class-1 standard under the 150Ω method specified in IEC 61967-4, the conductive emission standard defined by the International Electrotechnical Commission (IEC), refer to the document below.

Table 17. Supplementary Materials

Document Title	Document Number
RA0E3 Group Supplement of EMI (Electromagnetic Interference) design	R01AN8120

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.

FPB-RA0E3 Resources	renesas.com/fpb-ra0e3
RA Kit Information	renesas.com/ra/kits
RA Product Information	renesas.com/ra
RA Product Support Forum	renesas.com/ra/forum
RA Videos	renesas.com/ra/videos
Renesas Support	renesas.com/support

11. Note on Usage

This chapter gives note on using the FPB-RA0E3 board.

1. When connecting an external debugger to J13, check the position of pin 1 of the connector to be connected.

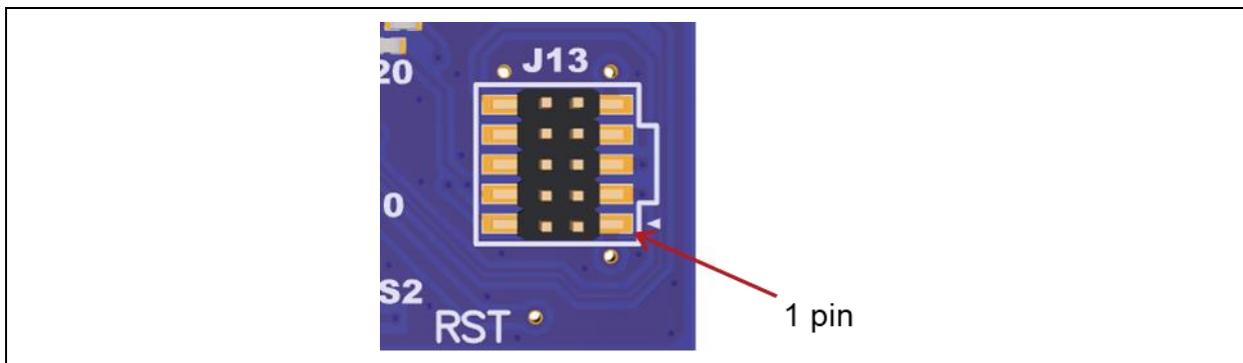


Figure 22. Position of J13-1 (Top View)

12. Appendix

12.1 Layout Diagram of Components on the FPB-RA0E3 Board

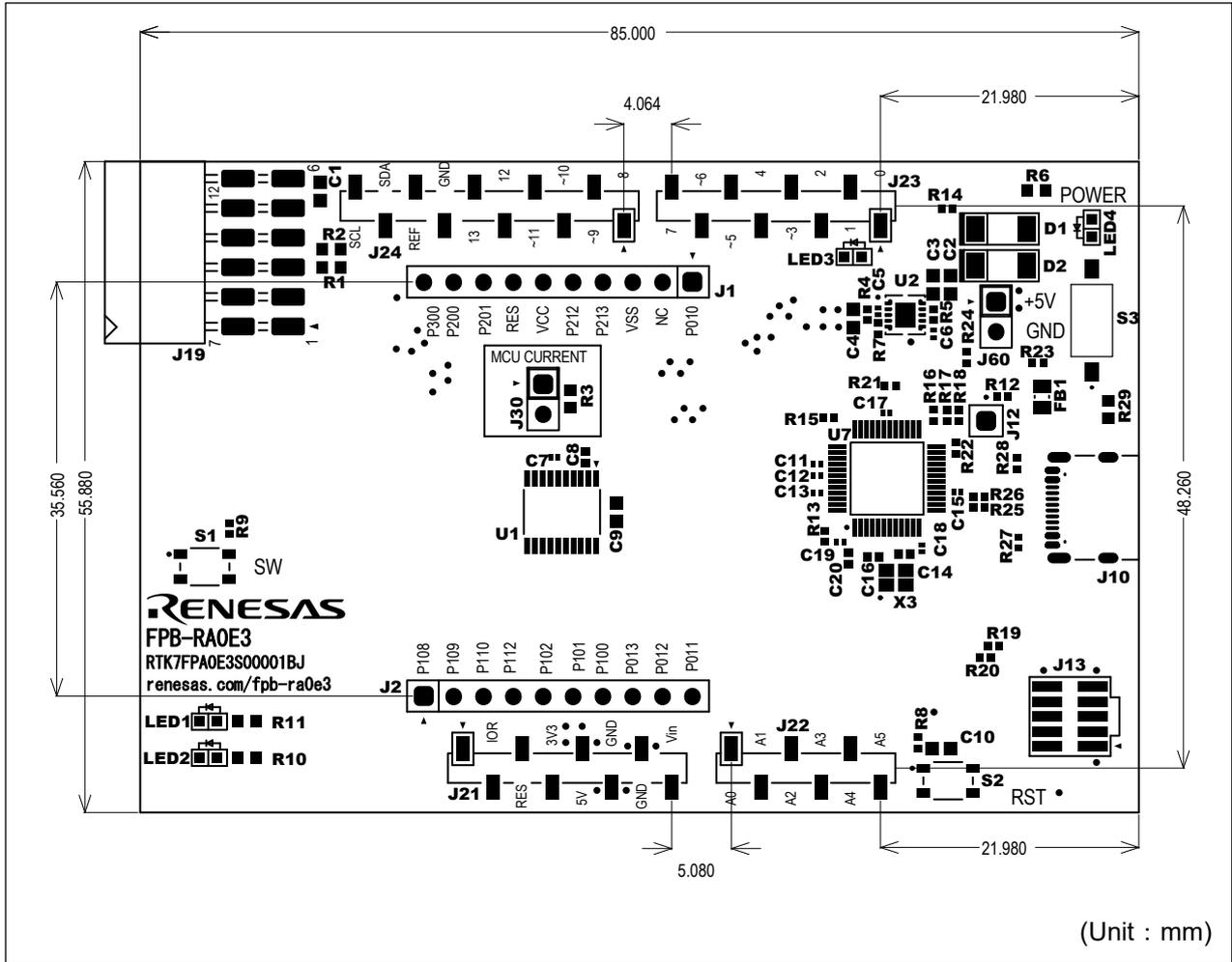


Figure 23. Layout Diagram of Components on the FPB-RA0E3 Board (Top View)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Nov.10.25	—	Newly created

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