

RA0E1 Group

Fast Prototyping Board for RA0E1 Microcontroller
Group
FPB-RA0E1 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.).

7. Prohibition of access to reserved addresses

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8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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This Fast Prototyping Board 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 fulfil the regulatory standards for an end product.

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Renesas RA Family

FPB-RA0E1 v1
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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
LQFP	Lead Free Quad Flat Pack
MCU	Micro Controller Unit
MISO	SPI Master In Slave Out
MOSI	SPI Master Out Slave In
NC	Not Connected
PMOD™	Peripheral Module
RXD	UART Receive Data
SAU	Serial Array Unit
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	UART Transmit Data
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus

1. Board Overview

The FPB-RA0E1, a Fast Prototyping Board for the RA0E1 MCU Group, enables users to seamlessly evaluate the features of the RA0E1 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-RA0E1 board are categorized in two groups (consistent with the architecture of the board) as follows:

MCU and MCU Native Pin Access

- R7FA0E1073CFJ MCU (referred to as RA MCU)
 - 32 MHz, Arm® Cortex®-M23 core
 - 64 KB Code Flash, 12 KB SRAM, 1 KB Data Flash
 - 32-pin, LQFP package
 - Native pin access through 2 x 16-pin male headers (not fitted)
 - MCU's VCC current measurement point for precision current consumption measurement
- Multiple clock sources – Oscillators for high-speed, medium-speed, and low-speed on-chip clock signals are available in the RA MCU. Signals from crystal oscillators at 20.000 MHz (not fitted) and 32.768 kHz can also be used for the main clock and the sub-clock, respectively.

System Control and Ecosystem Access

- USB Full Speed Device (USB 2.0 Type-C™ connector)
- Two 5 V input sources
 - USB (Debug, Full Speed)
 - External power supply (using 2-pin header) (not fitted)
- On-board debugger (SWD)
- User LEDs and buttons
 - User LEDs (green) x 2
 - Power LED (green) indicating availability of regulated power
 - Debug/power LED (yellow) indicating power and the debug connection
 - User button x 1
 - Reset button x 1
- Two popular ecosystem expansions
 - Digilent Pmod™ (SPI, UART, and I²C) connectors x 2
 - Arduino® (Uno R3) connectors

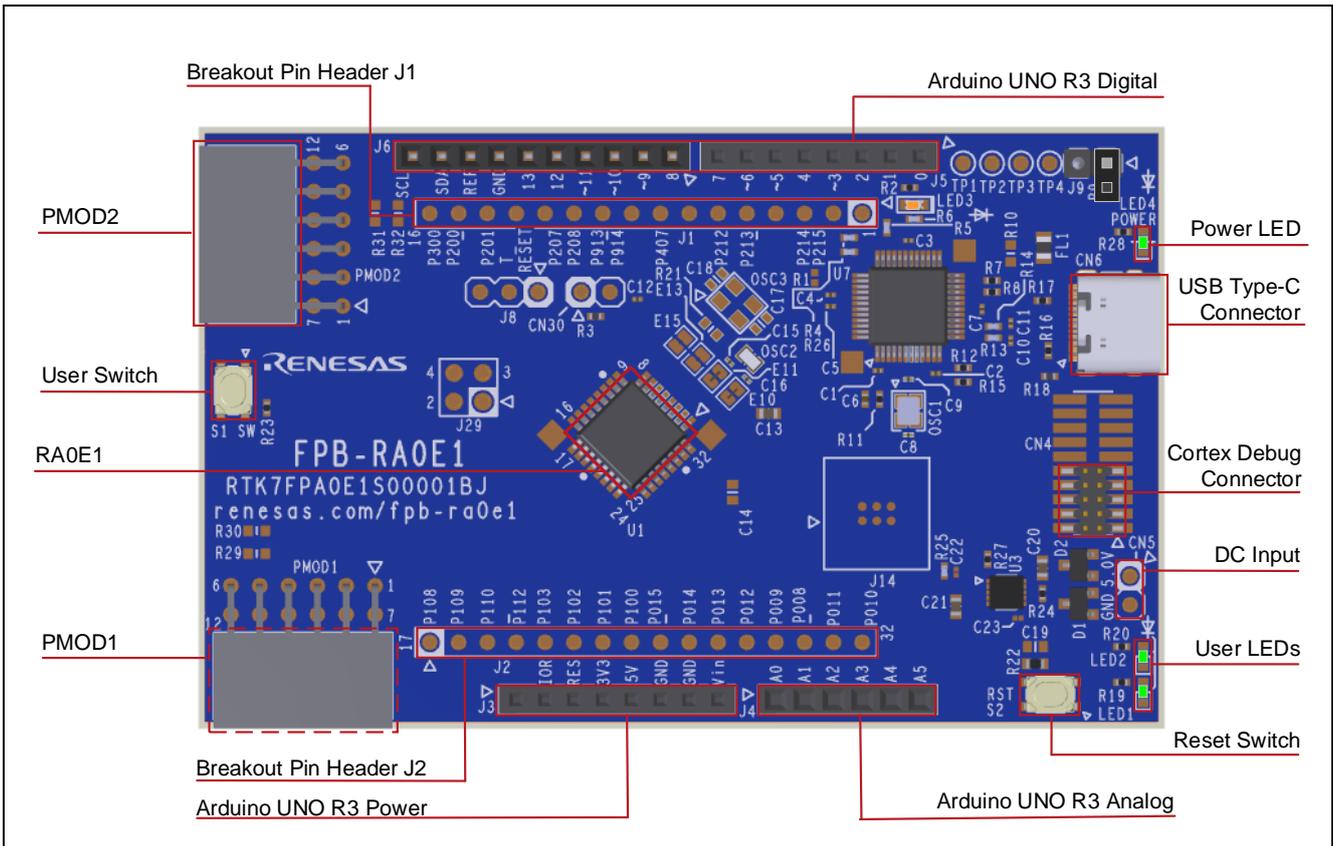


Figure 1. FPB-RA0E1 Board Top Side

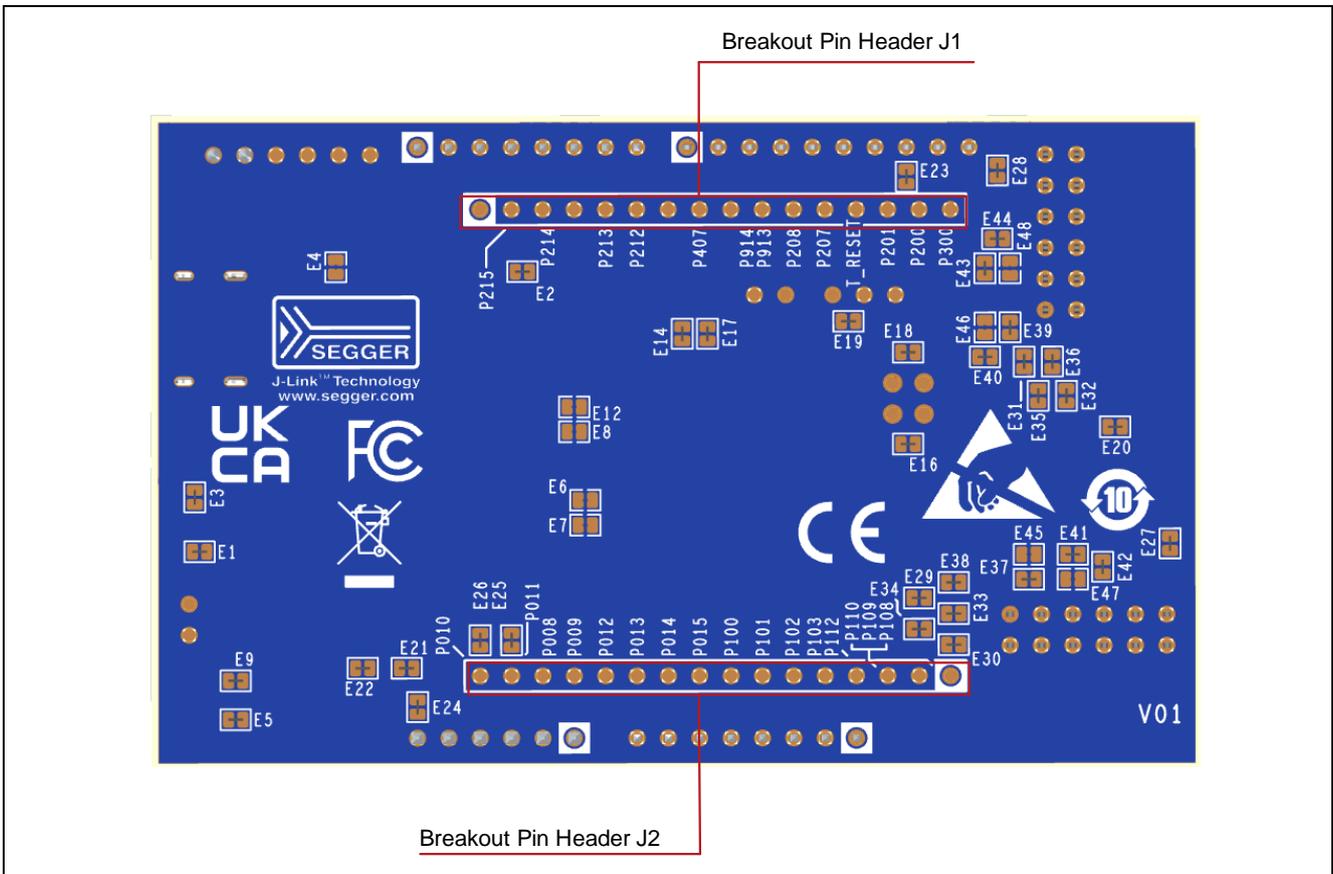


Figure 2. FPB-RA0E1 Board Bottom Side

1.1 Assumptions and Advisory Notes

- (1) It is assumed that the user has a basic understanding of microcontrollers and embedded systems hardware.
- (2) It is recommended that the user refers to the *FPB-RA0E1 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-RA0E1 board.
- (4) Instructions to download and install software, import example projects, build them and program the FPB-RA0E1 board are provided in the [FPB-RA0E1 tutorial](#) and [Getting Started with Fast Prototyping Board for RA Family](#).
- (5) The MCU fitted to the FPB-RA0E1 board may not contain the latest version of the firmware.

2. Box Contents

The following components are included in the box:

- (1) FPB-RA0E1 v1 board
- (2) Printed Quick Start Guide
- (3) China RoHS document
- (4) USB 2.0 Type-C™ cable (Type-A male to Type-C male): S.Lot 000000001~0000002700
 USB 2.0 Type-C™ cable (Type-C male to Type-C male): After S.Lot 0000003001

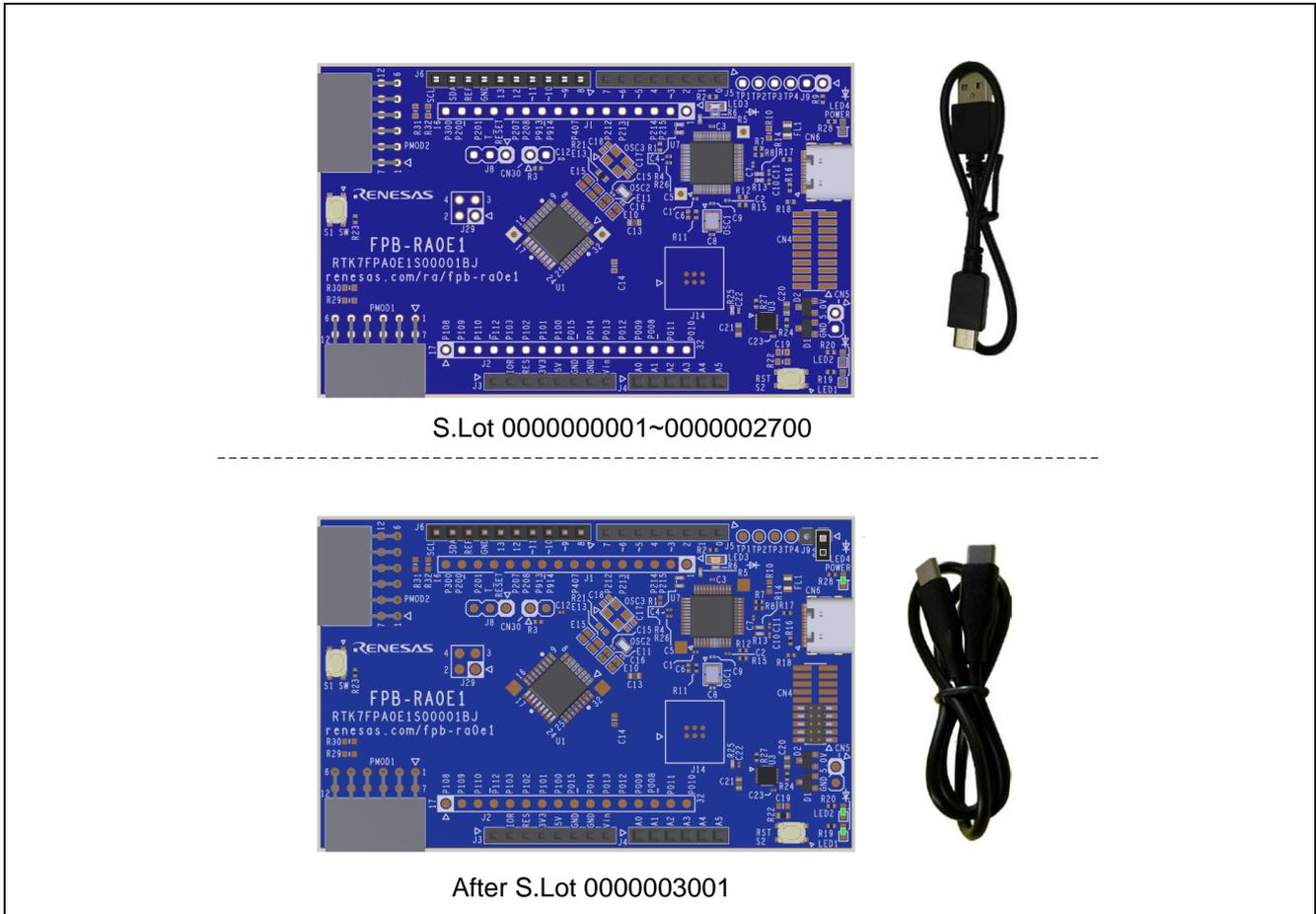


Figure 3. Configuration of the FPB-RA0E1 v1 Evaluation Kit

3. Ordering Information

- FPB-RA0E1 v1 orderable part number: RTK7FPA0E1S00001BJ

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

- FPB-RA0E1 board dimensions: 53.34 mm (width) x 85.00 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Board Architecture

The FPB-RA0E1 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 breakout pin headers for power and current measurement	Yes	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 series

4.2 Block Diagram

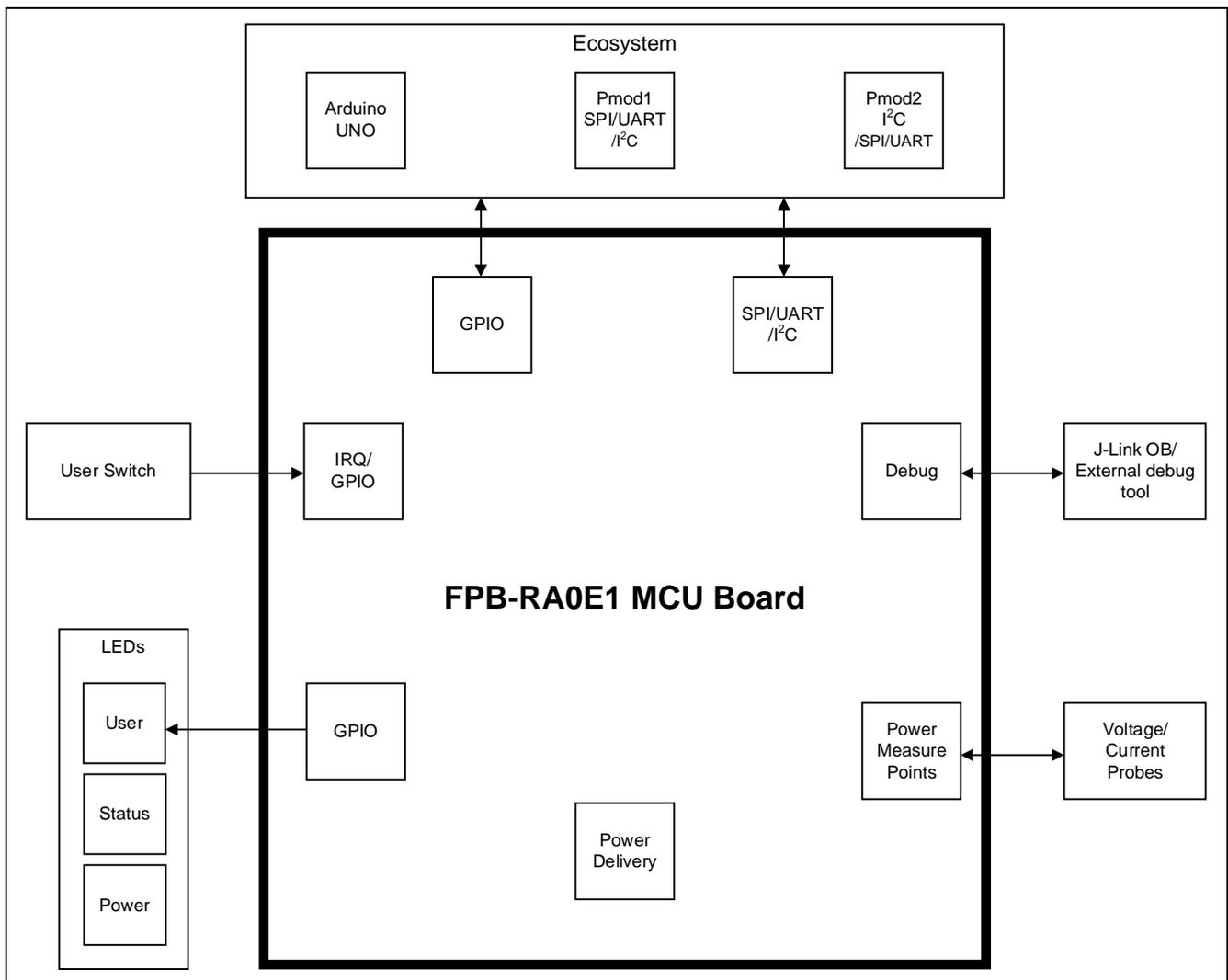


Figure 4. FPB-RA0E1 Board Block Diagram

4.3 Jumper Settings

Two types of jumpers are provided on the FPB-RA0E1 board.

- (1) Copper jumpers (Jumper Trace Cut and Jumper Solder Bridge)
- (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 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). The connection is considered **open** if there is no electrical connection between the pads (default for the Jumper Solder Bridge).

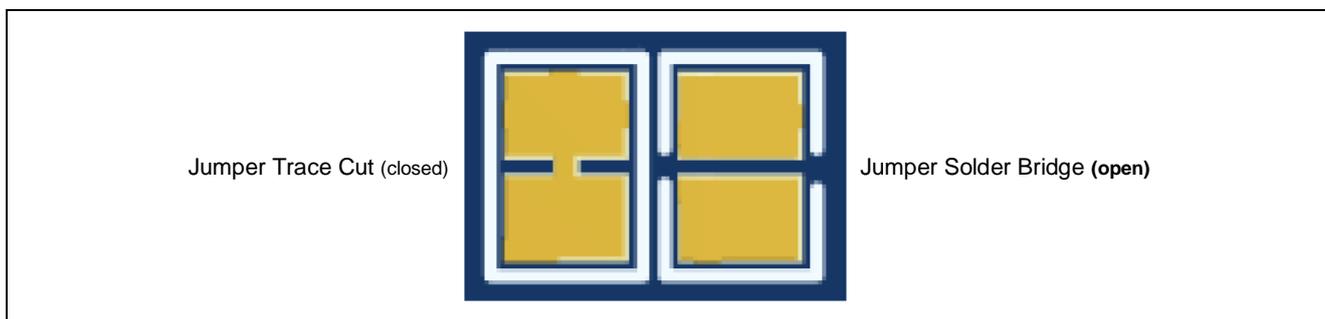


Figure 5. Copper Jumpers

4.3.2 Traditional Pin Header Jumpers

These pin header jumpers are traditional small pitch jumpers that require an external shunt to open/close them. The traditional pin header jumpers on the FPB-RA0E1 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-RA0E1 board. This includes copper jumpers (Ex) and traditional pin header jumpers (Jx).

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 Open/Closed	Function
E1	Debugger	Closed	Connects CN4-1 to VCC.
E2	Debugger	Closed	Connects CN4-6 to U7-36.
E3	Debugger	Closed	Connects CN4-9 to GND.
E4	Debugger	Open	Connects U7-23 to P208/TXDA_A. *1
E5	LED1	Closed	Connects LED1 to P008.
E6	MCU Power	Open	Connects P010/VREFH0 to VCC.
E7	MCU Power	Open	Connects P011/VREFL0 to GND.
E8	MCU Clock	Open	Connects U1-2 (P215/XCIN) to P215 of J1-2.
E9	LED2	Closed	Connects LED2 to P009.
E10	MCU Clock	Closed	Connects OSC2 to U1-2 (P215/XCIN).
E11	MCU Clock	Closed	Connects OSC2 to U1-3 (P214/XCOUT).
E12	MCU Clock	Open	Connects U1-3 (P214/XOUT) to P214 of J1-3.
E13	MCU Clock	Open	Connects OSC3 to U1-5 (P213/X2/EXCLK).
E14	MCU Clock	Closed	Connects U1-5 (P213/X2/EXCLK) to P213/SO11_A.
E15	MCU Clock	Open	Connects OSC3 to U1-6 (P212/X1).
E16	Debugger	Closed	Connects U1-17 (P108/SWDIO) to SWDIO.
E17	MCU Clock	Closed	Connects U1-6 (P212/X1) to P212/SI11_A.
E18	Debugger	Closed	Connects U1-16 (P300/SWCLK) to SWCLK.
E19	MCU Reset	Closed	Connects U1-13 (RES/P206) to RESET#.
E20	Switch S1	Closed	Connects S1 to P200/IRQ0.
E21	Power	Closed	Connects 3V3 to +3V3JLOB.
E22	Power	Closed	Connects 3V3 to VCC.
E23	MCU Power	Closed	Connects J6-8 to P010/VREFH0/AN000.
E24	MCU Power	Closed	Connects J4-6 to P011/VREFL0/AN001.
E25	MCU Power	Closed	Connects J2-31 to P011/VREFL0/AN001.
E26	MCU Power	Closed	Connects J2-32 to P010/VREFH0/AN000.
E27	PMOD1	Closed	Connects VCC to Pmod1_VCC.
E28	PMOD2	Closed	Connects VCC to Pmod2_VCC.
E29	PMOD1	Closed	Connects PMOD1-1 to P103/SSI00_A.
E30	PMOD1	Closed	Connects PMOD1-7 to P201/IRQ5_B/TO05_B.
E31	PMOD2	Closed	Connects PMOD2-1 to P015/IRQ1_A.
E32	PMOD2	Closed	Connects PMOD2-7 to P407/SCK11_A.
E33	PMOD1	Closed	Connects PMOD1-2 to P101/TXD0_A/SO00_A/TO07_A.
E34	PMOD1	Closed	Connects PMOD1-8 to P013/AN005.
E35	PMOD2	Closed	Connects PMOD2-2 to P109/TXD2_A/SO20_A.
E36	PMOD2	Closed	Connects PMOD2-8 to P014/AN006.
E37	PMOD1	Closed	Connects PMOD1-3 to P100/RxD0_A/SI00_A/SDA00_A.
E38	PMOD1	Closed	Connects PMOD1-9 to P012/AN004.
E39	PMOD2	Closed	Connects PMOD2-3 to P112/SCL20_A/SCK20_A/TO03_A.
E40	PMOD2	Closed	Connects PMOD2-9 to P914/SCLA0_A.
E41	PMOD1	Closed	Connects PMOD1-4 to P102/SCK00_A/SCL00_A/TO06_A.
E42	PMOD1	Closed	Connects PMOD1-10 to P009/AN003.
E43	PMOD2	Closed	Connects PMOD2-4 to P110/SDA20_A/RXD2_A/SI20_A/TO01_A.
E44	PMOD2	Closed	Connects PMOD2-10 to P913/SDAA0_A.
E45	PMOD1	Open	Connects PMOD1-3 to P102/SCK00_A/SCL00_A/TO06_A.

Location	Circuit Group	Default Open/Closed	Function
E46	PMOD2	Open	Connects PMOD2-3 to P110/SDA20_A/RXD2_A/SI20_A/TO01_A.
E47	PMOD1	Open	Connects PMOD1-4 to P100/RxD0_A/SI00_A/SDA00_A.
E48	PMOD2	Open	Connects PMOD2-4 to P112/SCL20_A/SCK20_A/TO03_A.
J9	Debugger	Open	Connects JLOB_RES# to GND.
R3	MCU Power	Fitted	Connects VCC to VCC_MCU. Remove this when testing current drawn by the MCU.
R10	Debugger	Not fitted	Connects U7-22 to P207/RXDA_A.*1

*1 COM port (JLink CDC UART port)

5. System Control and Ecosystem Access

The FPB-RA0E1 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-RA0E1 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-RA0E1 board can be powered.

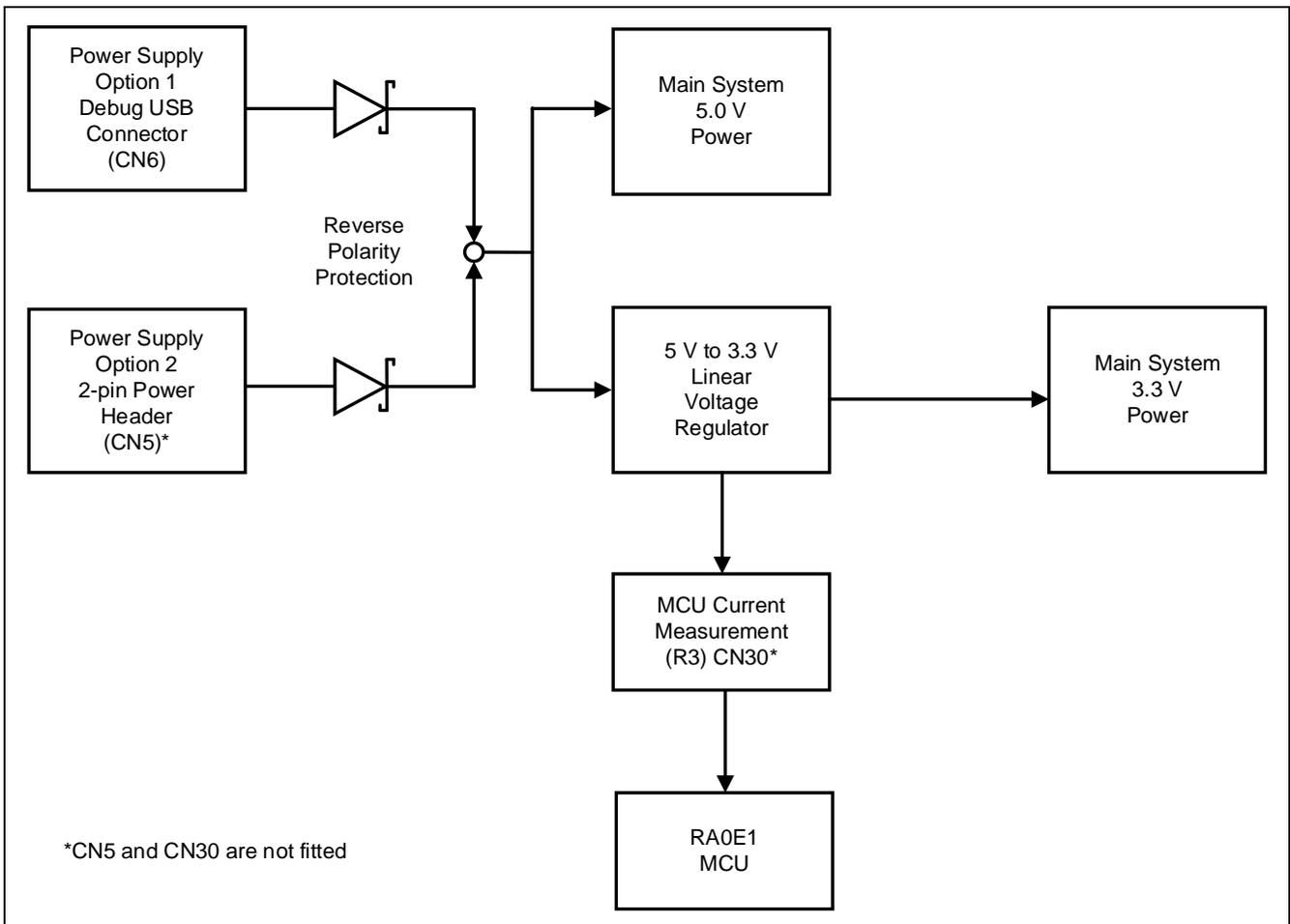


Figure 6. Power Supply Options

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 (CN6). 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 CN5

5 V may be supplied from an external power supply to test points on the board. CN5 (not fitted) provides large via style test points 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 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 Behavior When Power is Supplied

When powered, the green LED marked POWER will illuminate. The yellow DEBUG LED will also illuminate.

5.2 Debug

The FPB-RA0E1 board can be programmed and debugged using the built-in SEGGER J-Link® Emulator On-Board debugger and supports the following two debug modes.

Table 4. Debug Modes

Debug Mode	Debugger	Debug Interface	Connector Used
On-board debug	RA4M2 (J-Link OB)	SWD	USB 2.0 Type-C™ connector (CN6)
Debug in	External debug tools	SWD	Debug connector (CN4)

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

Table 5. Jumper Configurations for Each of the Debug Modes

Debug Mode	J9
On-board debug	Open
Debug in	1-2

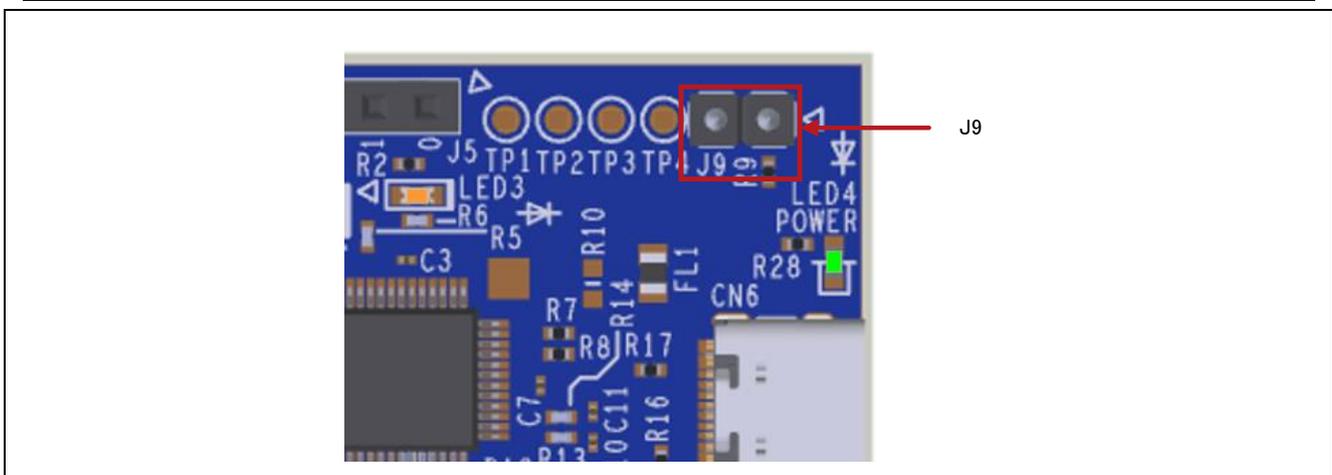


Figure 7. Pin Header Jumpers for Debug Modes

5.2.1 On-Board Debug

The on-board debug functionality is provided using Renesas RA4M2 (J-Link OB) and SEGGER J-Link® firmware.

Debug USB 2.0 Type-C™ connector (CN6) connects the RA4M2 (J-Link OB) 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 FPB-RA0E1 board.

The RA4M2 (J-Link OB) connects to the target RA MCU using the SWD interface.

Table 6. Debug USB Connector

Debug USB Connector CN6		FPB-RA0E1
Pin	Description	Signal/Bus
A4, B4, A9, B9	+5VDC	+5V_USB_DBG
A7, B7	Data-	JLOB_USB_DM (U7 pin 14)
A6, B6	Data+	JLOB_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	GND

Signal/Bus names are shown on the board schematic (available in the design package) and are compliant with that.

A yellow indicator LED3 shows the visual status of the debug interface. When the FPB-RA0E1 board is powered on, and the LED3 is blinking, it indicates that the RA4M2 (J-Link OB) is not connected to a host PC. When the LED3 is on solid, it indicates that it is connected to the host PC. When the LED3 is flickering, it indicates that data is being transferred between the RA4M2 (J-Link OB) and the host PC.

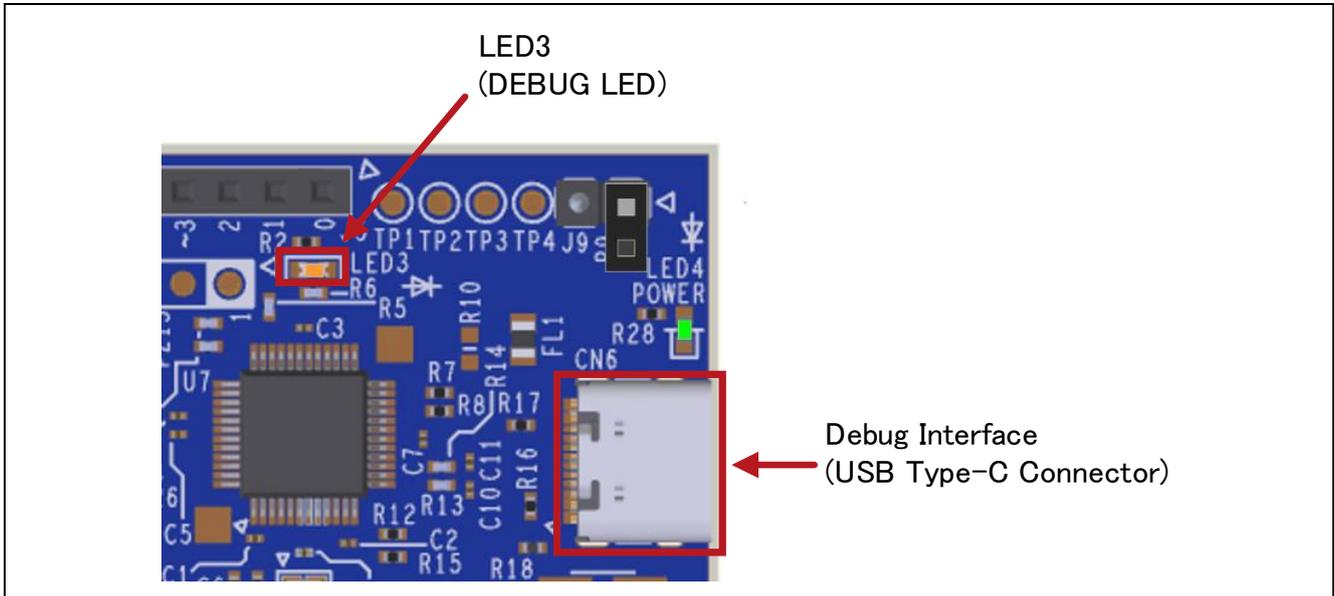


Figure 8. FPB-RA0E1 Debug Interface

5.2.2 Debug In

The 10-pin Cortex® debug connector at CN4^{*1} supports the SWD interface. An external debug tool can be used with CN4 for debugging of the target RA0E1.

To configure the FPB-RA0E1 board to use the Debug in mode, configure the jumpers as stated in Table 5.

Table 7. SWD Port Assignments

Debug Connector CN4		FPB-RA0E1
Pin	SWD Pin Name	Signal/Bus
CN4-1	VTREF	VCC
CN4-2	TMS / SWDIO	P108 / SWDIO
CN4-3	GND	VSS
CN4-4	TCK / SWCLK	P300 / SWCLK
CN4-5	GND	VSS
CN4-6	TDO / SWO	NC
CN4-7	KEY (NC)	NC
CN4-8	TDI	NC
CN4-9	GND Detect	VSS
CN4-10	nSRST	RES

*1: S.Lot 0000000001 ~ 0000002700, the connector is not fitted.
After S.Lot 0000003001, the connector is fitted.

5.2.3 Debugger Settings in e² studio

Figure 9 shows the settings for e² studio when creating a new project for the FPB-RA0E1 Fast Prototyping Board.

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

[Target Device]: Select [R7FA0E107].

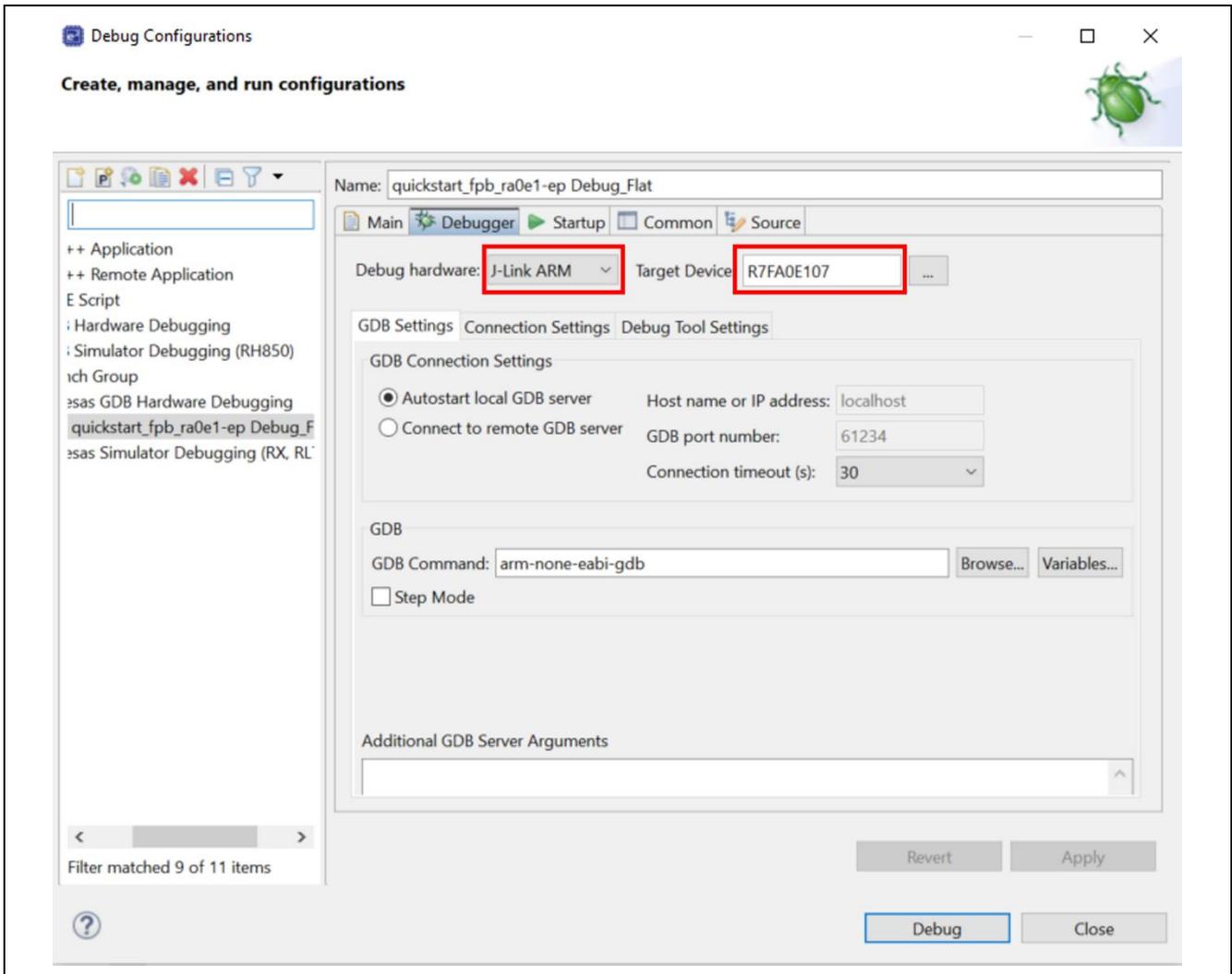


Figure 9. e² Studio Debugger Settings

5.2.4 VCOM Port

The FPB-RA0E1 board can perform USB-UART conversion by using the RA4M2 (J-Link OB). It is recognized by the host as a VCOM port (JLink CDC UART port) and connected to the UART for RA0E1 by using the FPB-RA0E1 board (refer to Table 8). To use USB-UART, Jumper Solder Bridge E4 must be closed and R10 must be fitted.

The TXDA0/RXDA0 function is also used by Arduino. If you do not use the TXDA0/RXDA0 function in Arduino, you can use the TXDA0/RXDA0 function for VCOM.

Table 8. UART Assignments

RA0E1 Pin	RA0E1 Signal
U1-11	P208/TXDA0_A
U1-12	P207/RXDA0_A

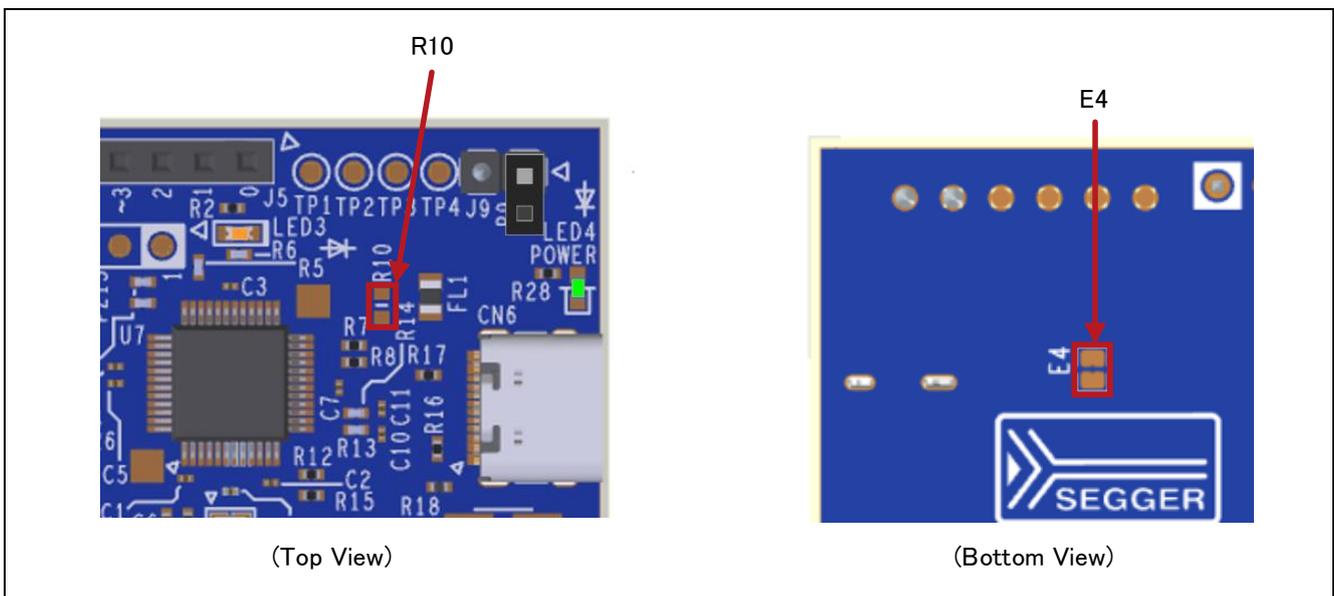


Figure 10. Setting for VCOM

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

5.3.1 Digilent Pmod™ Connectors

Two 12-pin connectors are provided to support Pmod modules where the RA MCU acts as the master, and the connected module acts as a slave device.

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

The FPB-RA0E1 board also provides jumpers so the 12-pin connector may alternatively be used for Pmod Type 6A (expanded I²C).

The default 12-pin Pmod interface supports +3.3 V devices. Please ensure that any Pmod device installed is compatible with a +3.3 V supply.

Note that both Pmods use the SAU peripheral in “Simple SPI” mode, and so do 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 1

A 12-pin right angle connector is fitted at Pmod 1. The connections support Pmod Type 2A (expanded SPI) and Type 3A (expanded UART) and Type 6A (expanded I²C). Type 2A and Type 3A are used for the connections by default. Type 6A can be used by changing copper jumper settings (Ex). This interface may additionally be re-configured in firmware as several other Pmod types.

Note: P009 is shared with LED2. When LED2 is in use, this pin is not available.

Table 9. Pmod 1 Connector

Pmod 1 Connector			FPB-RA0E1	Pmod 1 Configuration	
Pin	Option Type 2A/3A (Default)	Option Type 6A	Signal/Bus	Short	Open
PMOD1-1	CS/CTS	INT	P103/SSI00_A	E29	
PMOD1-2	MOSI/TXD	RESET	P101/TXD0_A/SO00_A/TO07_A	E33	
PMOD1-3	MISO/RXD		P100/RxD0_A/SI00_A/SDA00_A	E37	E45
		SCL	P102/SCK00_A/SCL00_A/TO06_A	E45	E37
PMOD1-4	SCK/RTS		P102/SCK00_A/SCL00_A/TO06_A	E41	E47
		SDA	P100/RxD0_A/SI00_A/SDA00_A	E47	E41
PMOD1-5	GND		GND		
PMOD1-6	VCC		Pmod1_VCC	E27	
PMOD1-7	INT/GPIO	GPIO	P201/IRQ5_B/TO05_B	E30	
PMOD1-8	RESET/GPIO	GPIO	P013/AN005	E34	
PMOD1-9	CS2/GPIO	GPIO	P012/AN004	E38	
PMOD1-10	CS3/GPIO	GPIO	P009/AN003	E42	
PMOD1-11	GND		GND		
PMOD1-12	VCC		Pmod1_VCC	E27	

Signal/Bus names are shown on the board schematic (available in the design package) and are compliant with that.

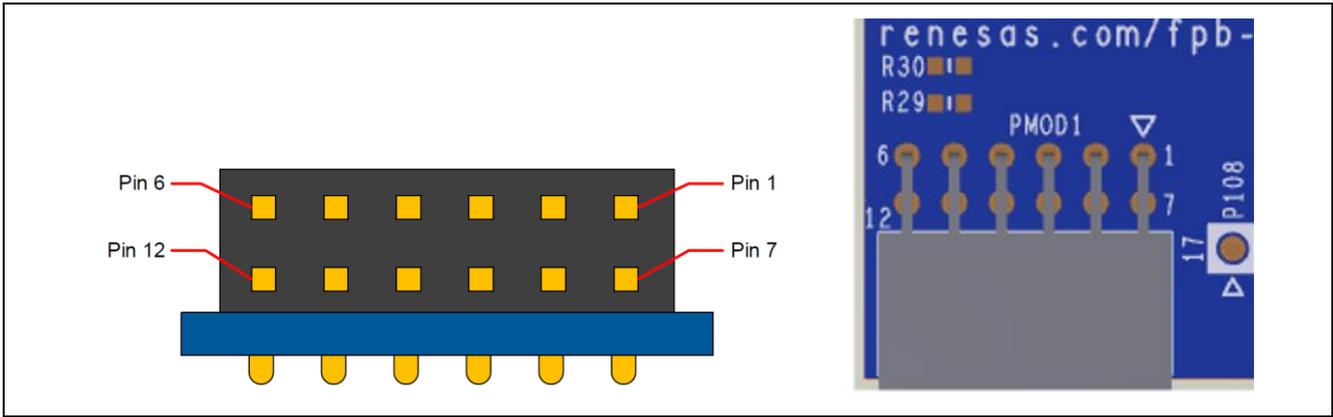
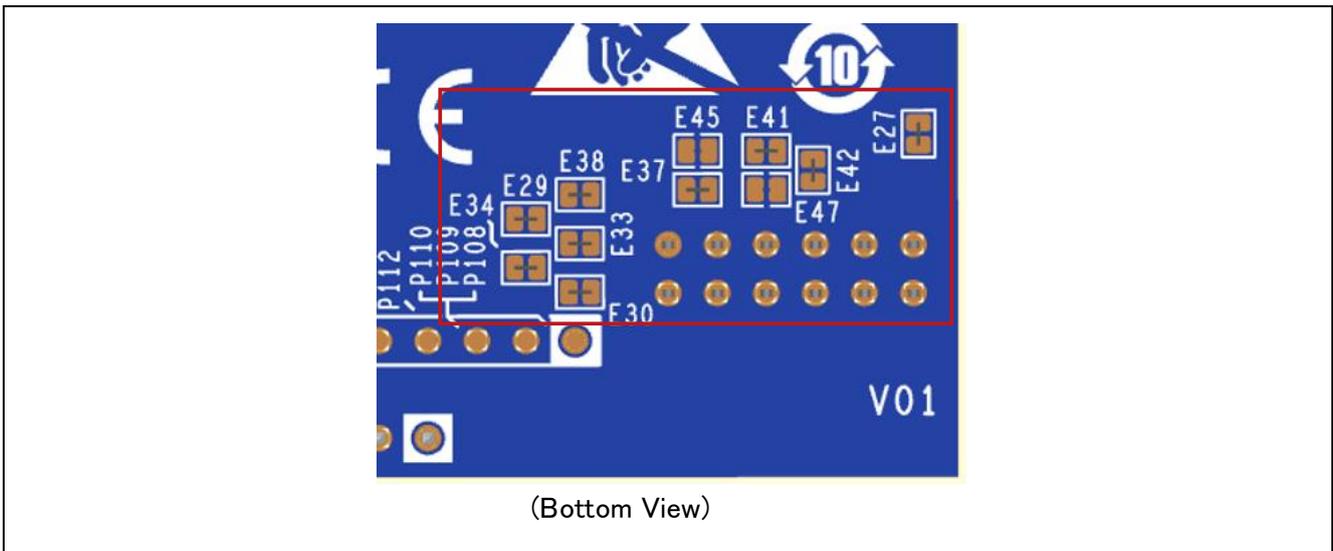


Figure 11. Pmod 1 Connector



(Bottom View)

Figure 12. Pmod 1 Solder Bridge and Jumper Trace Cut (closed)s

5.3.1.2 Pmod 2

A 12-pin right angle connector is fitted at Pmod 2. Type 6A is used for the connections by default. Type 2A and Type 3A can be used by changing copper jumper settings (Ex). This interface may additionally be re-configured in firmware as several other Pmod types.

Table 10. Pmod 2 Connector

Pmod 2 Connector			FPB-RA0E1	Pmod 2 Configuration	
Pin	Option Type 2A/3A	Option Type 6A (Default)	Signal/Bus	Short	Open
PMOD2-1	CS/CTS	INT	P015/IRQ1_A	E31	
PMOD2-2	MOSI/TXD	RESET	P109/TXD2_A/SO20_A	E35	
PMOD2-3		SCL	P112/SCL20_A/SCK20_A/TO03_A	E39	E46
	MISO/RXD		P110/SDA20_A/RXD2_A/SI20_A/TO01_A	E46	E39
PMOD2-4		SDA	P110/SDA20_A/RXD2_A/SI20_A/TO01_A	E43	E48
	SCK/RTS		P112/SCL20_A/SCK20_A/TO03_A	E48	E43
PMOD2-5	GND		GND		
PMOD2-6	VCC		Pmod2_VCC	E28	
PMOD2-7	INT	GPIO	P407/SCK11_A	E32	
PMOD2-8	RESET	GPIO	P014/AN006	E36	
PMOD2-9	CS2	GPIO	P914/SCLA0_A	E40	
PMOD2-10	CS3	GPIO	P913/SDAA0_A	E44	
PMOD2-11	GND		GND		
PMOD2-12	VCC		Pmod2_VCC	E28	

Signal/Bus names are shown on the board schematic (available in the design package) and are compliant with that.

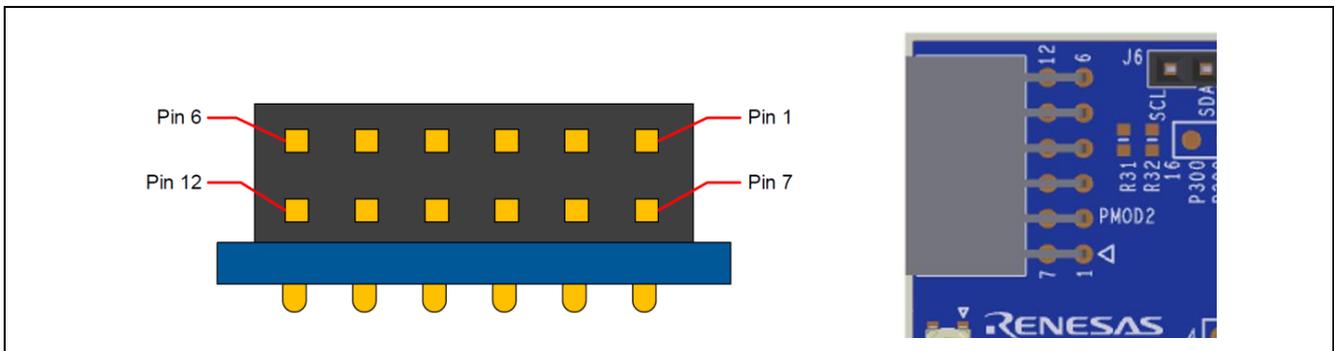


Figure 13. Pmod 2 Connector

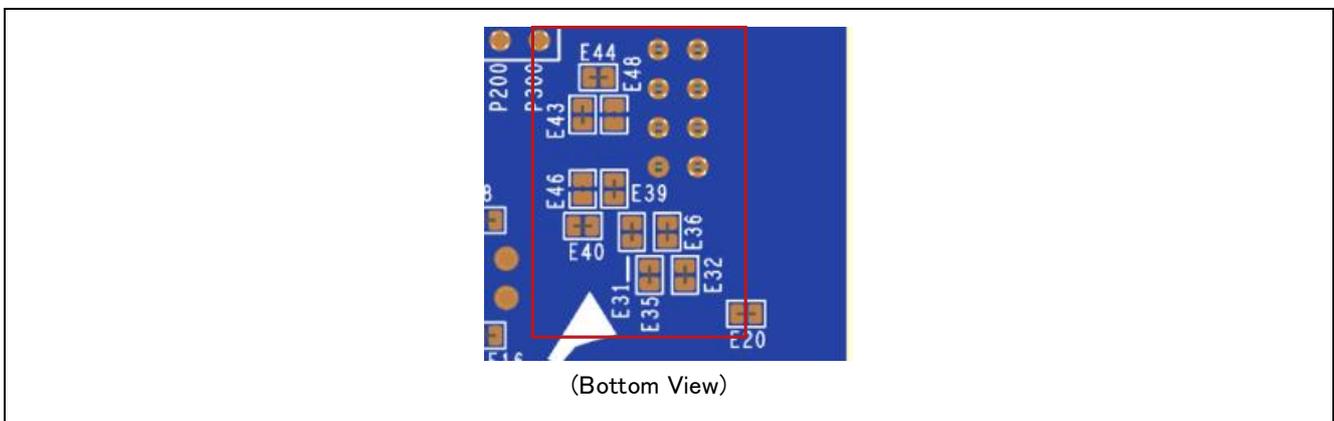


Figure 14. Pmod 2 Solder Bridge and Jumper Trace Cut (closed)s

5.3.2 Arduino® Connector

An Arduino Uno R3 compatible connector interface is provided.

Note: P212 and P213 are shared with the external crystal. If an external crystal is used these pins will be unavailable.

Note: P200/NMI/IRQ0 is shared with the user switch, S1.

Note: P001/VREFL0/ANI001 will be available as the reference voltage of – side.

Note: RE/P206 is shared with the reset switch, S2.

Table 11. Arduino Uno Connections

Arduino Compatible Connector		FPB-RA0E1
Pin	Description	Signal/Bus
J3-1	NC	NC
J3-2	IREF	VCC
J3-3	RESET	RES/P206/T_RESET
J3-4	3V3	3V3
J3-5	5 V	5V
J3-6	GND	GND
J3-7	GND	GND
J3-8	VIN	NC

J4-1	A0	P014/AN006
J4-2	A1	P013/AN005
J4-3	A2	P012/AN004
J4-4	A3	P009/AN003
J4-5	A4	P008/AN002
J4-6	A5	P011/VREFL0/AN001

J5-1	RX/D0	P207/RXDA_A
J5-2	TX/D1	P208/TXDA_A
J5-3	2	P200/NMI/IRQ0
J5-4	~3	P201/IRQ5_B/TO05_B
J5-5	4	P100/RxD0_A/SI00_A/SDA00_A
J5-6	~5	P101/TXD0_A/SO00_A/TO07_A
J5-7	~6	P102/SCK00_A/SCL00_A/TO06_A
J5-8	7	P103/SSI00_A

J6-1	8	P109/TXD2_A/SO20_A
J6-2	~9	P110/SDA20_A/RXD2_A/SI20_A/TO01_A
J6-3	~10	P112/SCL20_A/SCK20_A/TO03_A
J6-4	~11	P213/TI00_A/TI02_B/TO02_B
J6-5	12	P212/SI11_A
J6-6	13	P407/SCK11_A
J6-7	GND	GND
J6-8	AREF	P010/VREFH0/AN000
J6-9	SDA	P913/SDAA0_A
J6-10	SCL	P914/SCLA0_A

Signal/Bus names are shown on the board schematic (available in the design package) and are compliant with that.

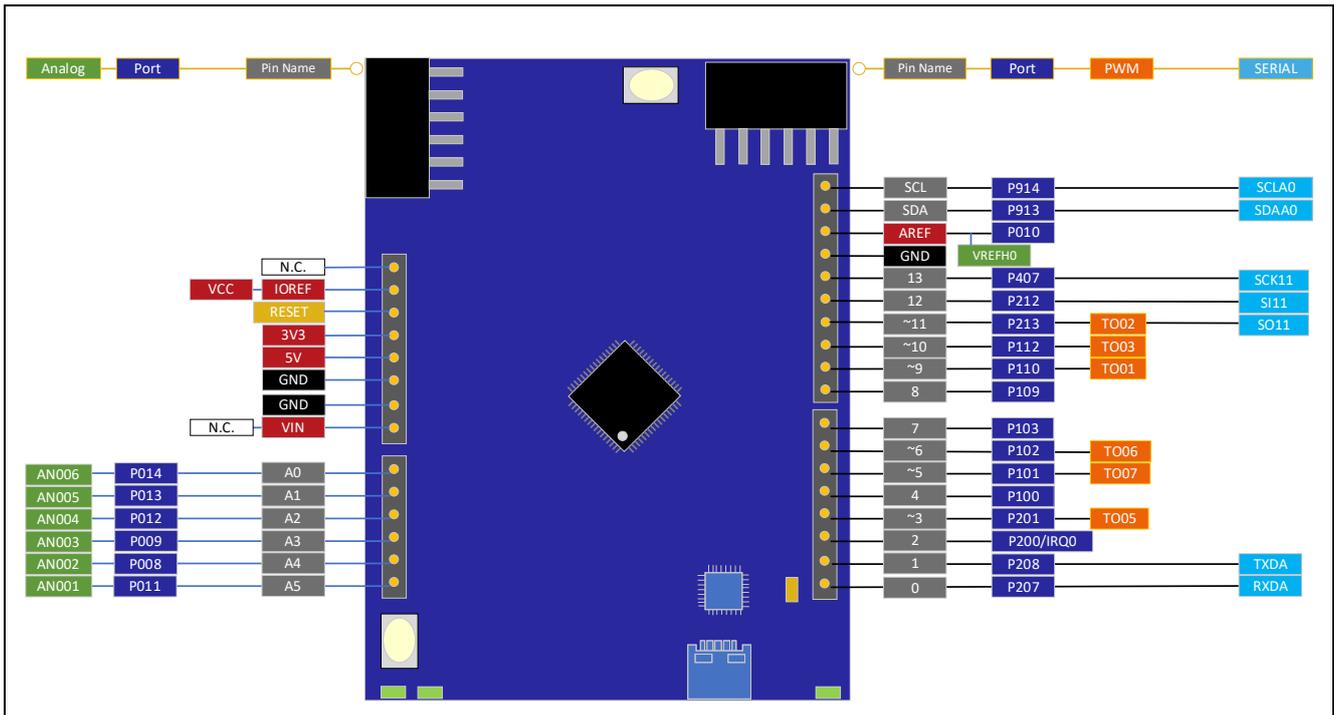


Figure 15. Arduino Uno Connectors

5.4 Miscellaneous

5.4.1 User and Power LEDs

Four LEDs are provided on the FPB-RA0E1 board.

Behavior of the LEDs on the FPB-RA0E1 board is described in the following table.

Table 12. FPB-RA0E1 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Green	User LED	P008
LED2	Green	User LED	P009
LED3	Yellow	Debug LED	RA4M2 (J-Link OB)
LED4	Green	Power on indicator	VCC

The User LEDs can be isolated from the main MCU so that the associated ports can be used for other purposes. To disconnect LED1 from P008, Jumper Trace Cut (closed) E5 must be open. To disconnect LED2 from P009, Jumper Trace Cut (closed) E9 must be open.

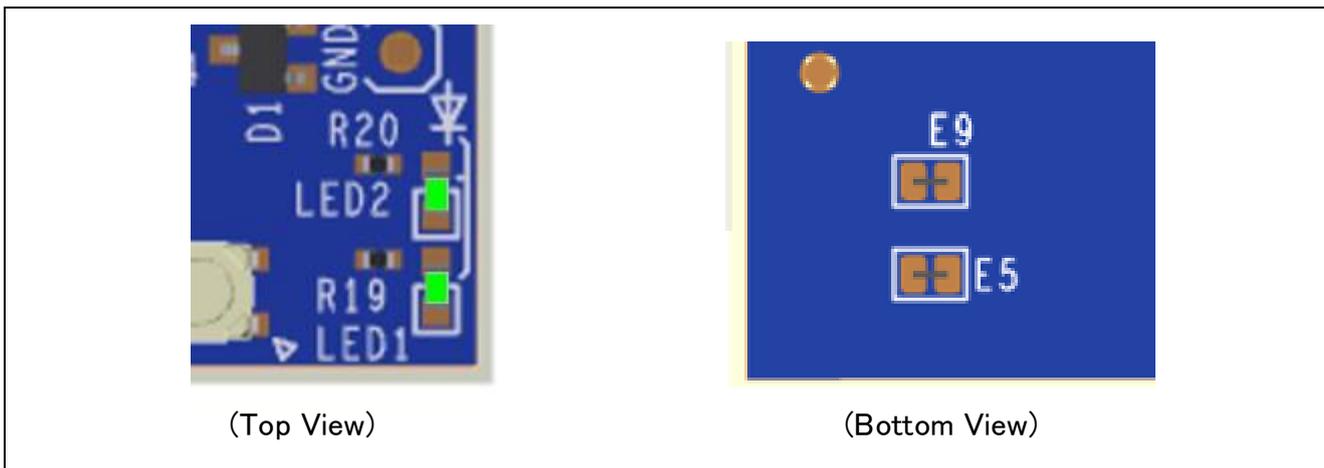


Figure 16. User LEDs

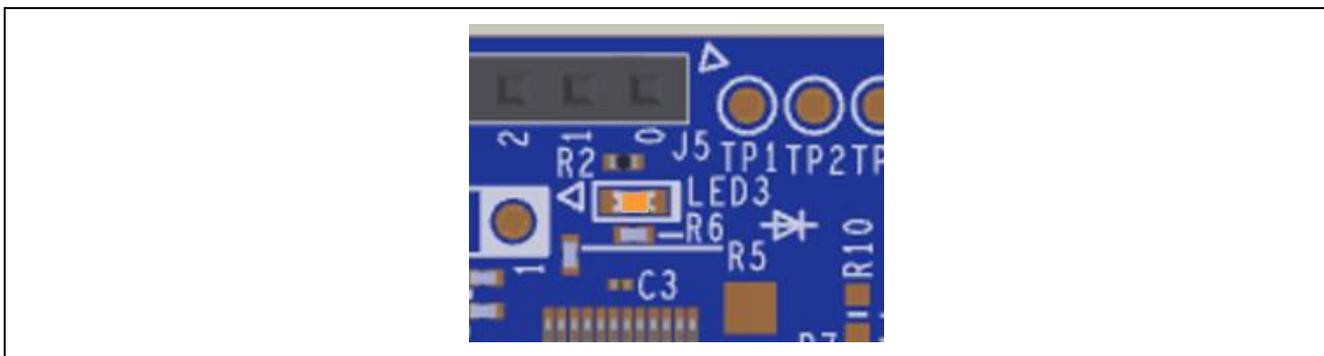


Figure 17. Debug LED

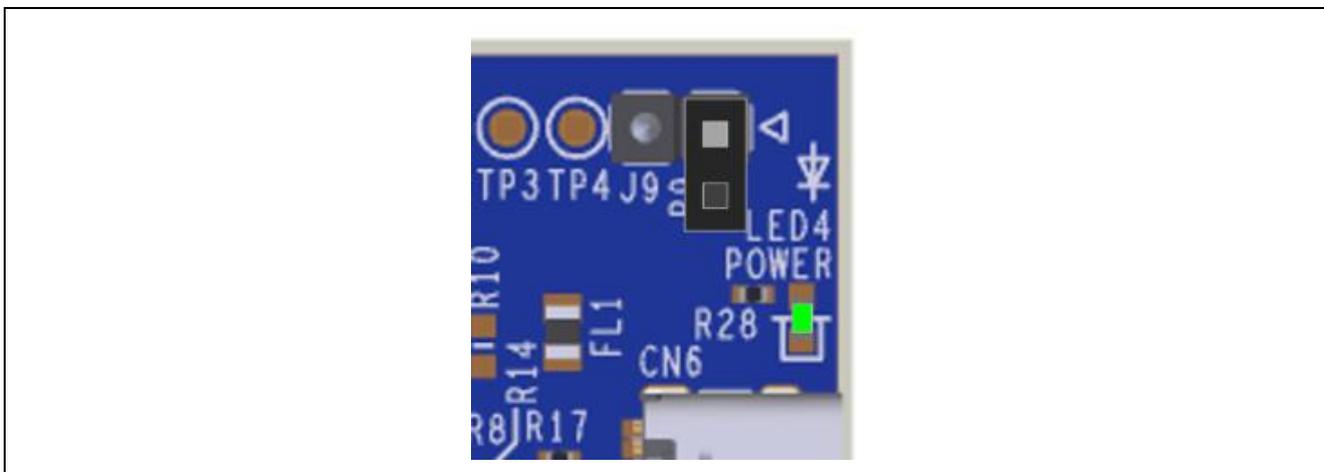


Figure 18. Power LED

5.4.2 User and Reset Switches

Two miniature, momentary, mechanical push-button type SMD switches are mounted on the FPB-RA0E1 board.

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

Table 13. FPB-RA0E1 Board Switches

Designator	Function	MCU Control Port
S1	User Switch	P200/NMI/IRQ0
S2	MCU Reset Switch	RES/P206

User switch S1 may be isolated from the MCU, so that the associated port can be used for other purposes. To disconnect S1 from P200, Jumper Trace Cut (closed) E20 must be open.

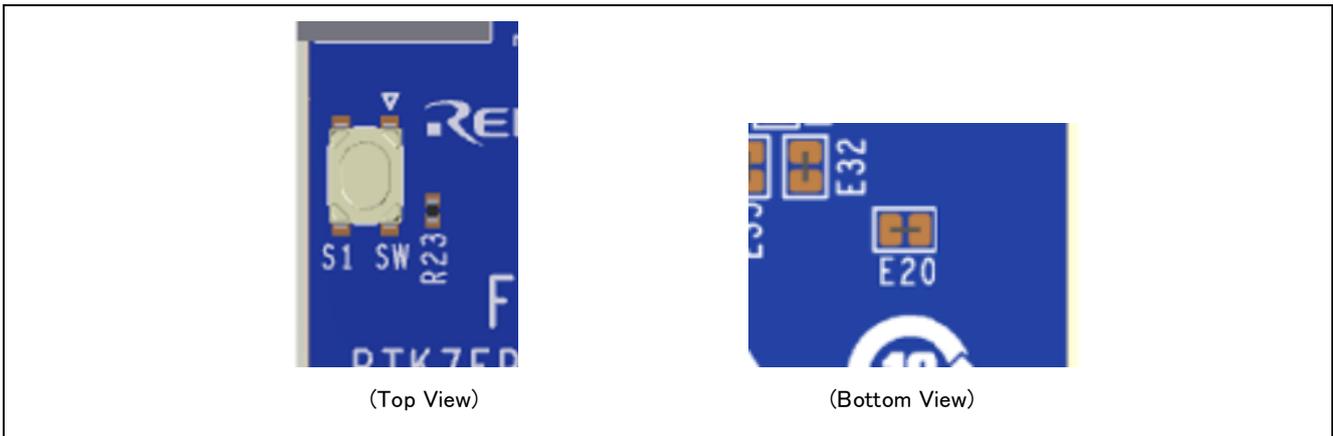


Figure 19. User Switch (S1) and jumper

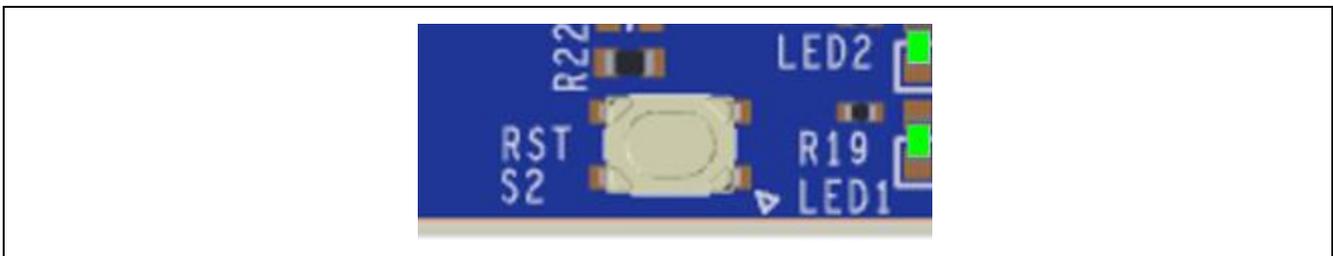


Figure 20. Reset Switch (S2)

5.4.3 MCU Clocks

The board is fitted with a RA MCU sub clock oscillator crystal, providing a precision 32.768 kHz reference clock. It is possible to provide a precision 20.000-MHz reference clock by fitting components of the main-clock oscillation circuit and short-circuiting E13 and E15 of Jumper Trace Cut, and cut E14 and E 17 of Jumper Solder Bridge . The ABRACON ABM8-20.000MHZ-10-B1U-T is a recommended part.

Note: The sub clock cannot be used with SODRV[1:0] bits set to 1 1: Low power mode 3.

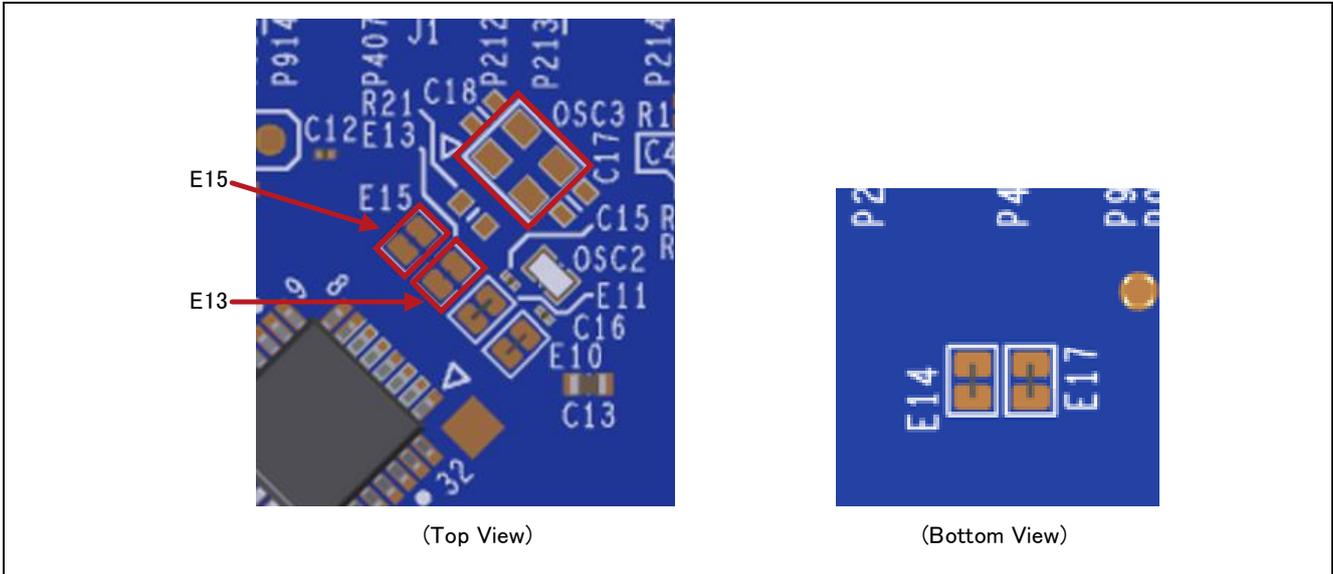


Figure 21. Main clock Oscillation Circuit and jumpers

6. MCU Native Pin Access

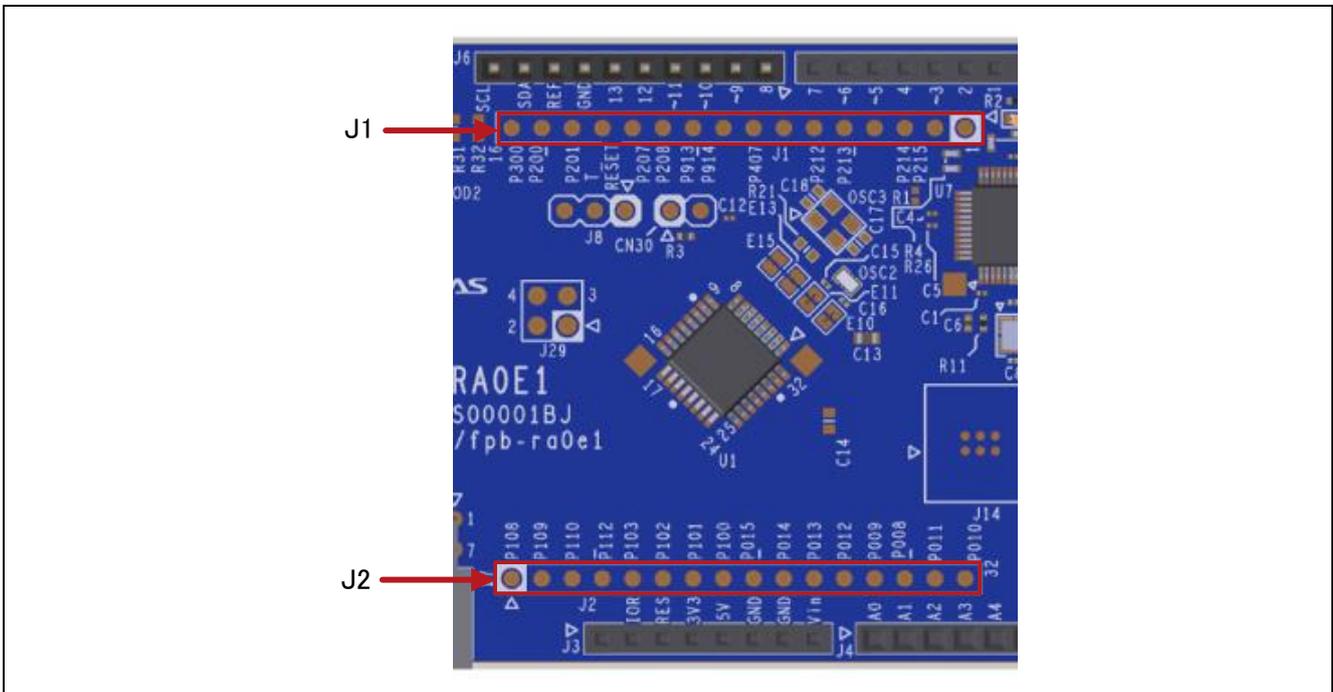


Figure 22. Native Pin Access J1 and J2

6.1 Breakout Pin Headers

The FPB-RA0E1 board pin headers, J1 (not fitted) and J2 (not fitted), provide access to all RA MCU interface signals, and to voltages for all RA MCU power ports. Each header pin is labelled with the voltage or port connected to that pin. Refer to the RA0E1 MCU Group User's Manual for details of each port function, and the FPB-RA0E1 board schematic for pin header port assignments.

The placement of the breakout pin headers allows for a standard 0.100" (2.54 mm) center breadboard to be placed on both pin headers simultaneously. This can be used for prototyping and testing of custom circuitry for use with the RA MCU.

Table 14. Breakout Pin Header J1 J2

J1 Pin No.	Circuit Net Name	RA0E1 (U1)	J2 Pin No.	Circuit Net Name	RA0E1 (U1)
1	N.C.	-	17	P108/SWDIO	17
2	[P215]	[2]*1	18	P109/(TXD2_A/SO20_A)	18
3	[P214]	[3]*1	19	P110/SDA20_A/ [(RXD2_A/SI20_A)] /TO01_A	19
4	VSS	4	20	P112/SCL20_A/ [(SCK20_A)]/ TO03_A	20
5	P213/SO11_A	5	21	P103/SSI00_A	21
6	P212/SI11_A	6	22	P102/SCK00_A/ [(SCL00_A)]/ TO06_A	22
7	VCC	7	23	P101/TXD0_A/SO00_A/TO07_A	23
8	P407/SCK11_A	8	24	P100/RxD0_A/SI00_A/ [(SDA00_A)]	24
9	P914/SCLA0_A	9	25	P015/IRQ1_A	25
10	P913/SDAA0_A	10	26	P014/AN006	26
11	P208/TXDA_A	11	27	P013/AN005	27
12	P207/RXDA_A	12	28	P012/AN004	28
13	T_RESET	13	29	P009/AN003	29
14	P201/IRQ5_B/TO05_B	14	30	P008/AN002	30
15	P200/IRQ0_A	15	31	P011/VREFL0/AN001	31
16	P300/SWCLK	16	32	P010/VREFH0/AN000	32

*1 It is not connected to RA_MCU because it is used for XCIN and XCOU at default.
 When using as P214, short E12 of Jumper Solder Bridge and cut E11 of Jumper Trace Cut.
 When using as P215, short E8 of Jumper Solder Bridge and cut E10 of Jumper Trace Cut.

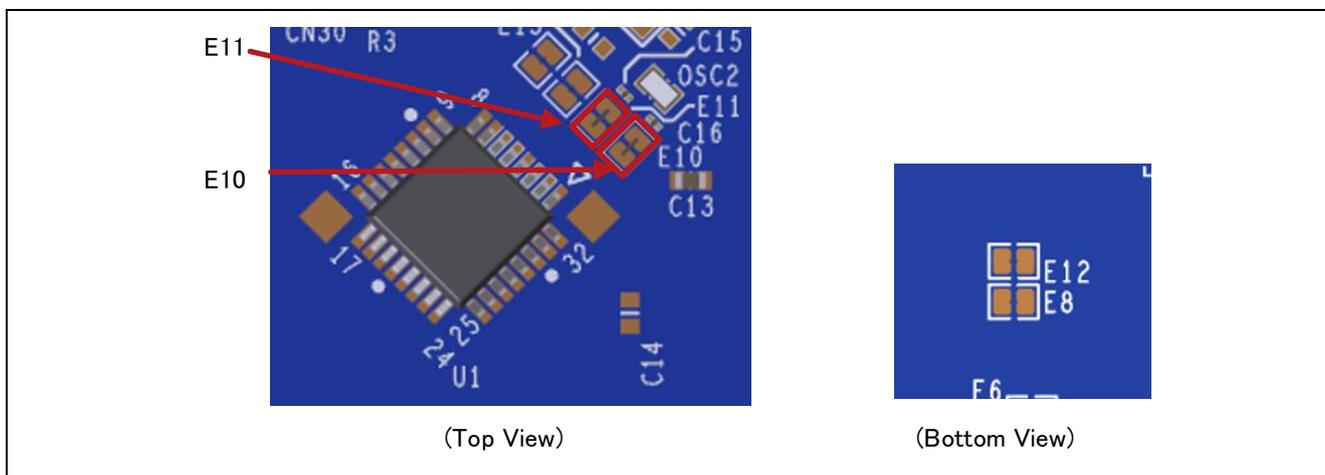


Figure 23. P214 P215 and jumpers

6.2 MCU Current Measurement

Included near the RA MCU is resistor R3 and test connector CN30 (not fitted) to measure the MCU core current.

Resistor R3 is 0 Ω (SMD 0402) as supplied. It should be removed in order to measure the current consumption using an ammeter connected between CN30 (not fitted) pins 1 and 2.

Alternatively, it could be removed and replaced with a suitable low value resistor (such as 100 mΩ), and then a voltmeter used to measure the voltage between CN30 pins 1 and 2. The current drawn by the MCU can then be calculated using Ohm's Law.

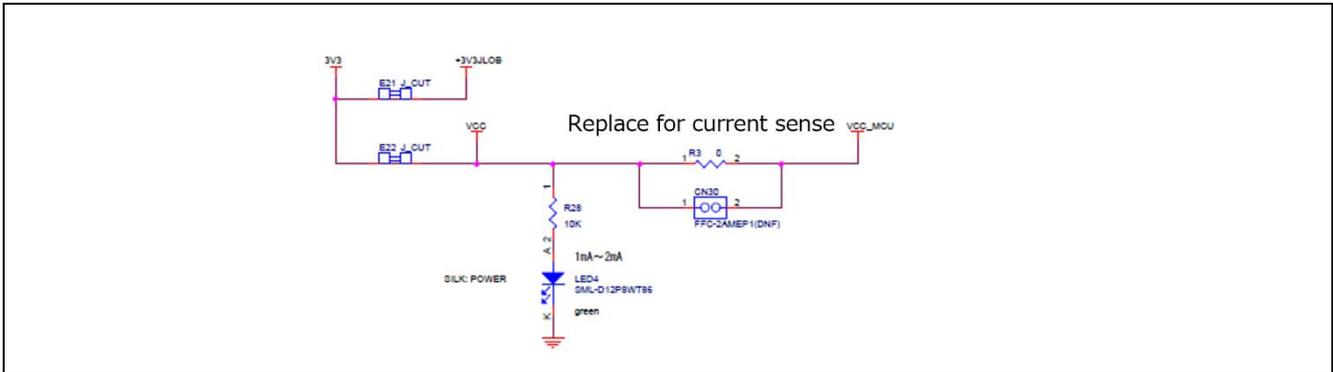


Figure 24. RA +3.3 V Current Measurement Circuit

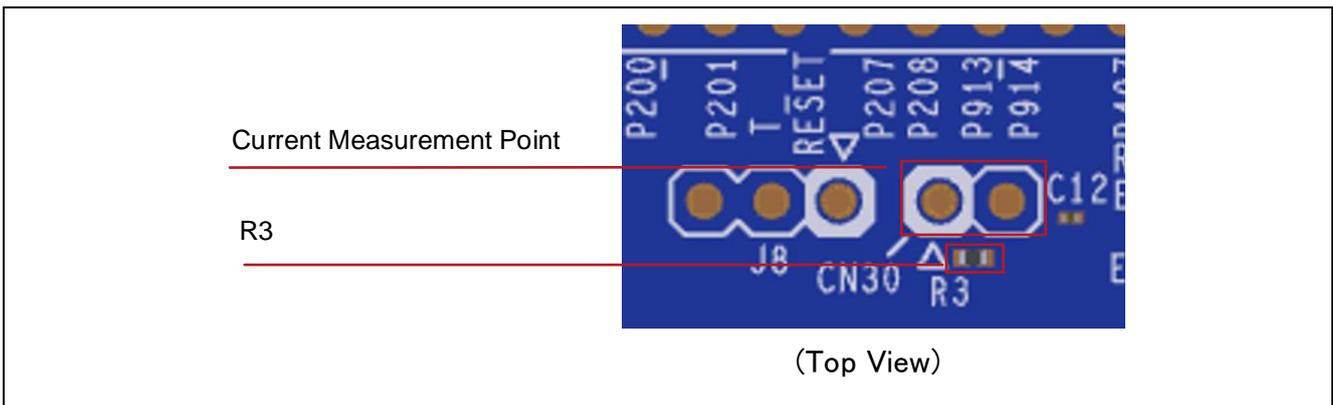


Figure 25. RA MCU +3.3 V Current Measurement Point (CN30) and R3

7. Recommended Parts

Table 15 lists recommended part numbers for optional components that can be fitted as required.

Table 15. Part Numbers

Designator(s)	Description	Manufacturer	Part Number
OSC3	20 MHz Crystal	ABRACON	ABM8-20.000MHZ-10-B1U-T
J1, J2	16-pin single male header	16 pins, 2.54 mm pitch, parts to fit 1.10 mm dia. holes on board	
CN5, CN30	2-pin male header	2 pins, 2.54 mm pitch, parts to fit 1.10 mm dia. holes on board	

8. Certifications

The FPB-RA0E1 v1 board meets the following certifications/standards. See the beginning of this user's manual for the disclaimer and precautions.

8.1 EMC/EMI Standards

- FCC Notice (Class A)



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

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

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

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

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

- CE Class A (EMC)



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

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

- UKCA Class A (EMC)



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

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

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

8.2 Material Selection, Waste, Recycling and Disposal Standards

- EU RoHS
- 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-RA0E1 v1 kit is available in the “FPB-RA0E1 v1 Design Package” available on renesas.com/ra/fpb-ra0e1.

- Design package file name: fpb-ra0e1-v1-designpackage.zip
- Design package contents

Table 16. FPB-RA0E1 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	fpb-ra0e1-v1-schematics
File (PDF)	Mechanical Drawing	fpb-ra0e1-v1-mechdwg
File (PDF)	BoM	fpb-ra0e1-v1-bom
File (PDF)	3D Drawing	fpb-ra0e1-v1-3d
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files – OrCAD_Allegro

10. Website and Support

Visit the following URLs to learn about the kit and the RA family of microcontrollers, download tools and documentation, and get support.

FPB-RA0E1 Resources	renesas.com/fpb-ra0e1
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 describes note on using the FPB-RA0E1 v1 board.

1. The RES pin of RA0E1 cannot be used as P206. Use PORTSELB (bit 15) in the OFS1 register to make the setting for the input of RES. If the setting is changed from that for RES to that for P206, J-Link OB will not be connectable to RA0E1.
2. When connecting an external debugger to CN4, check the position of pin 1 of the connector to be connected.

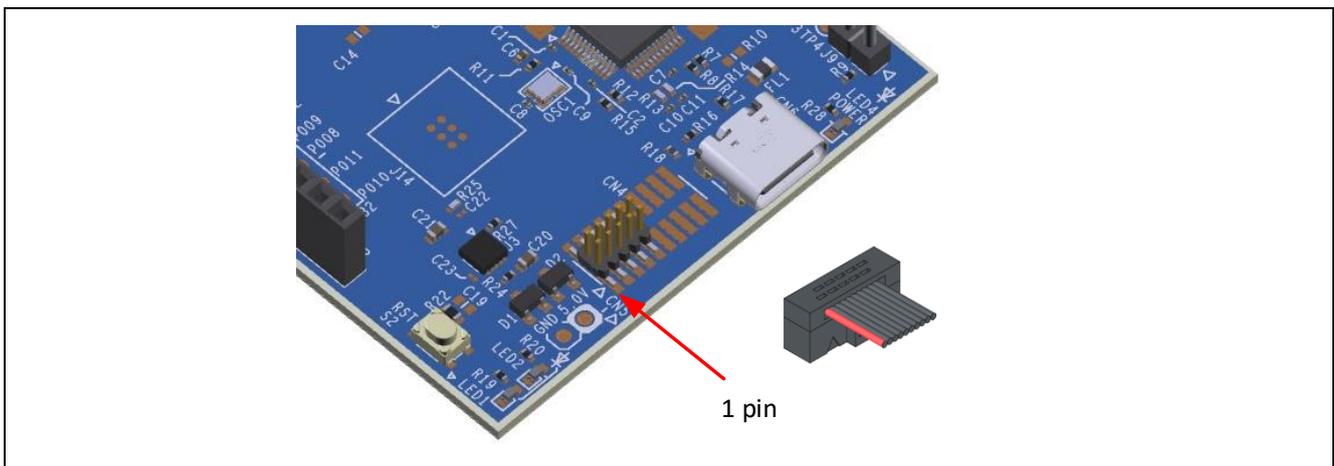


Figure 26. Position of CN4-1

12. Appendix

12.1 Dimensions for the FPB-RA0E1 Board

Dimensions are shown the following figure.

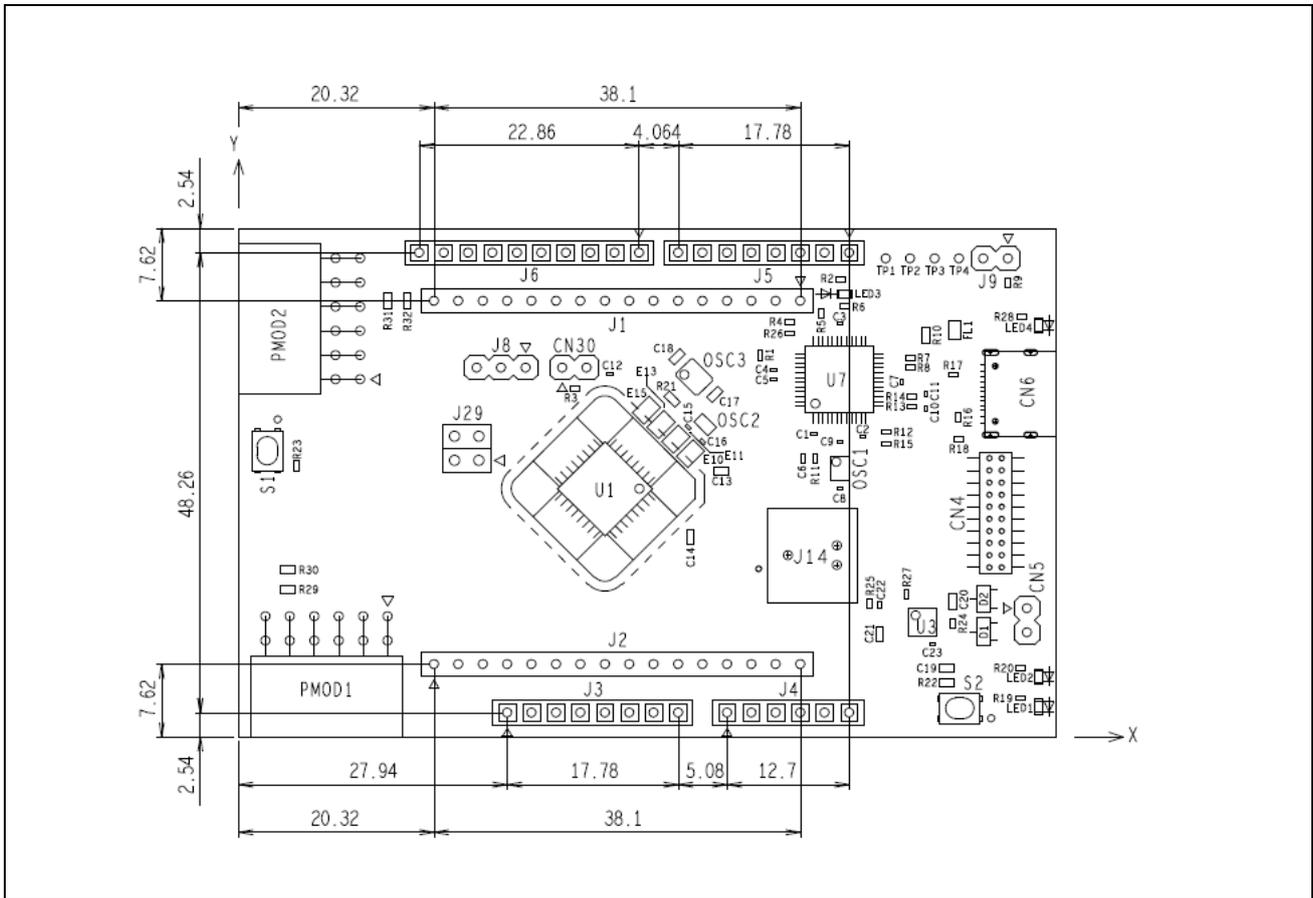


Figure 27. Dimensions

12.2 Components Layout Diagram for the FPB-RA0E1 Board (Top view)

The components layout diagram for the FPB-RA0E1 board (Top view) is shown in the following figure.

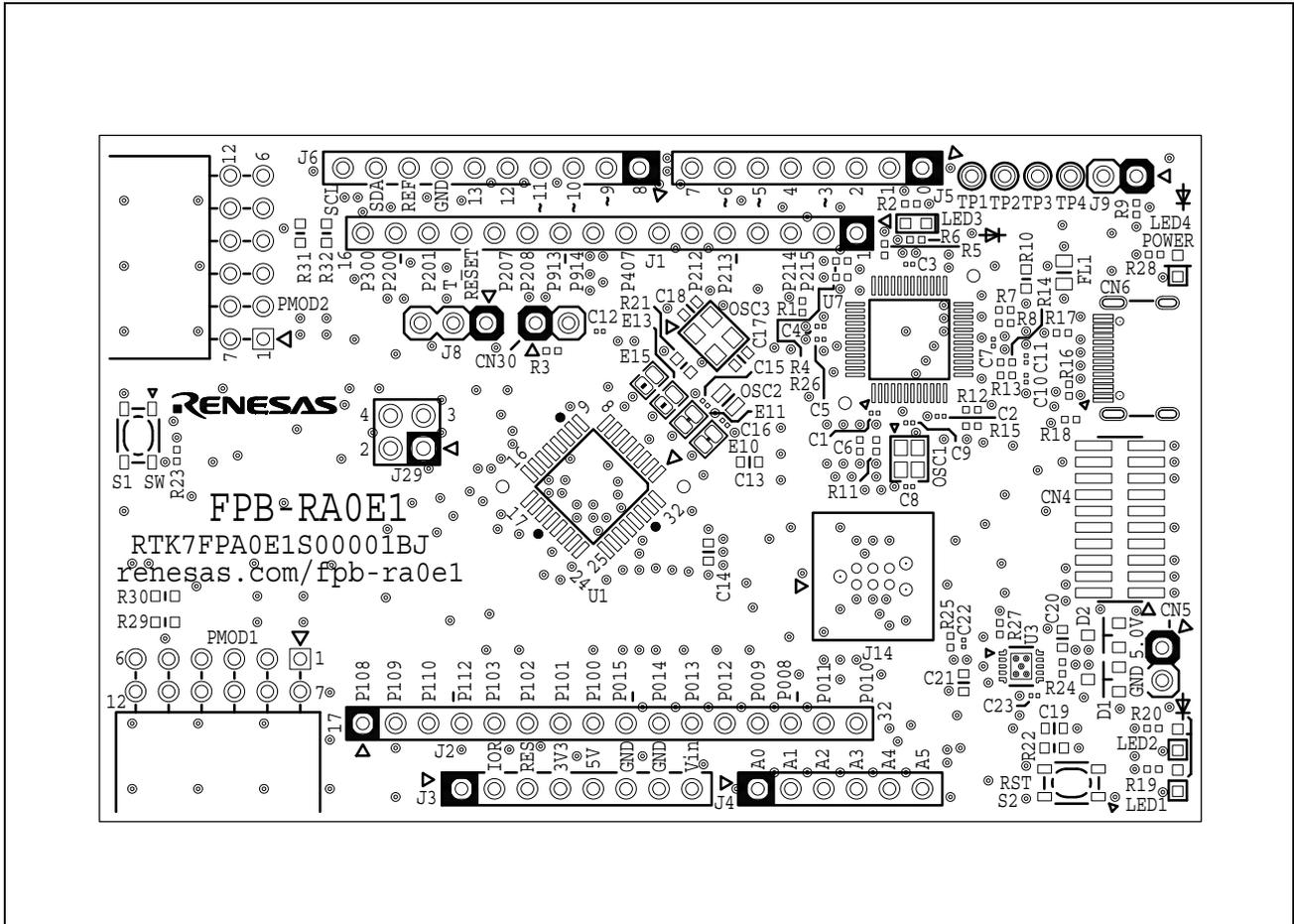


Figure 28. Components Layout Diagram (Top view).

12.3 Components Layout Diagram for the FPB-RA0E1 Board (Bottom view)

The components layout diagram for the FPB-RA0E1 board (Bottom view) is shown in the following figure.

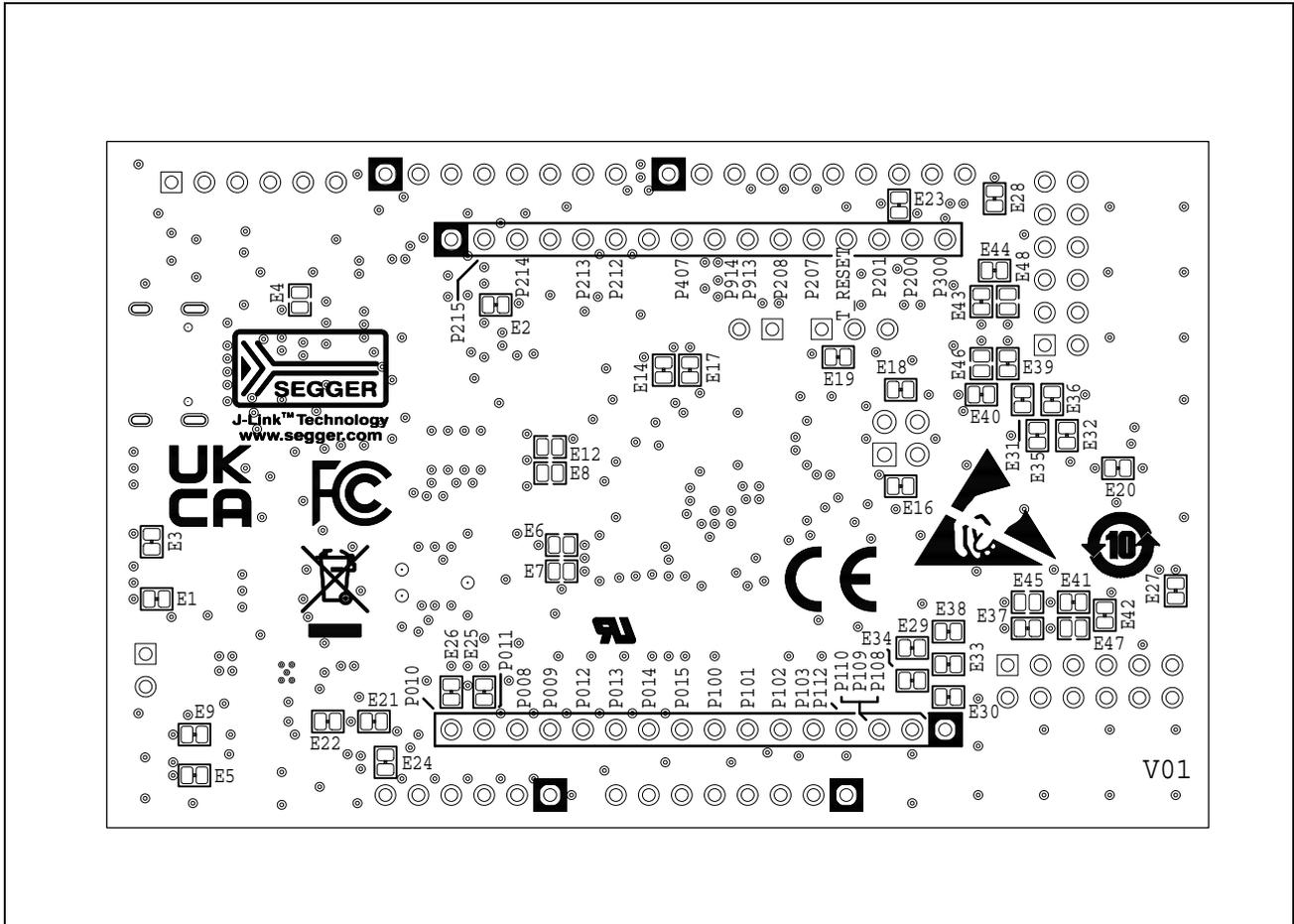


Figure 29. Components Layout Diagram (Bottom view).

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Mar.15.24	—	First Edition issued
1.10	Mar.05.25	7	Add links to the FSP and the tutorials
		8, 15	Add changes for each S.Lot number
		15	Add 5.2.2 Debug In
		17	Add 5.2.4 VCOM Port
		26	Add Table 14 Breakout Pin Header.
		30	Add Note for connecting external debugger
		31-33	Add appendix for dimensions and components diagram

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