User's Manual

RA0E2 Group

Fast Prototyping Board for RA0E2 Microcontroller Group
FPB-RA0E2 v1
User's Manual

Renesas RA Family
RA0 Series

Renesas Electronics
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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

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

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

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This 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.

Proprietary Notice

Renesas RA Family

FPB-RA0E2 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^2C (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
RWM	Pulse Width Modulation
RXD	Receive Data
SAU	Serial Array Unit
SCI	Serial Clock Line
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-RA0E2, a Fast Prototyping Board for the RA0E2 MCU Group, enables users to seamlessly evaluate the features of the RA0E2 MCU group and develop embedded systems applications using Flexible Software Package (FSP) and the e^2 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-RA0E2 board are categorized in two groups (consistent with the architecture of the board) as follows:

MCU and MCU Native Pin Access

- R7FA0E2094CFM MCU (referred to as RA MCU)
- 32 MHz, Arm® Cortex®-M23 core
- 128 KB Code Flash, 16 KB SRAM, 2 KB Data Flash
- 64-pin, LQFP package
- Native pin access through 32 x 2-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.

* Fitted on the prototype board socket version only

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 I^{2}C) connectors x 2
  — Arduino® (UNO R3) connectors

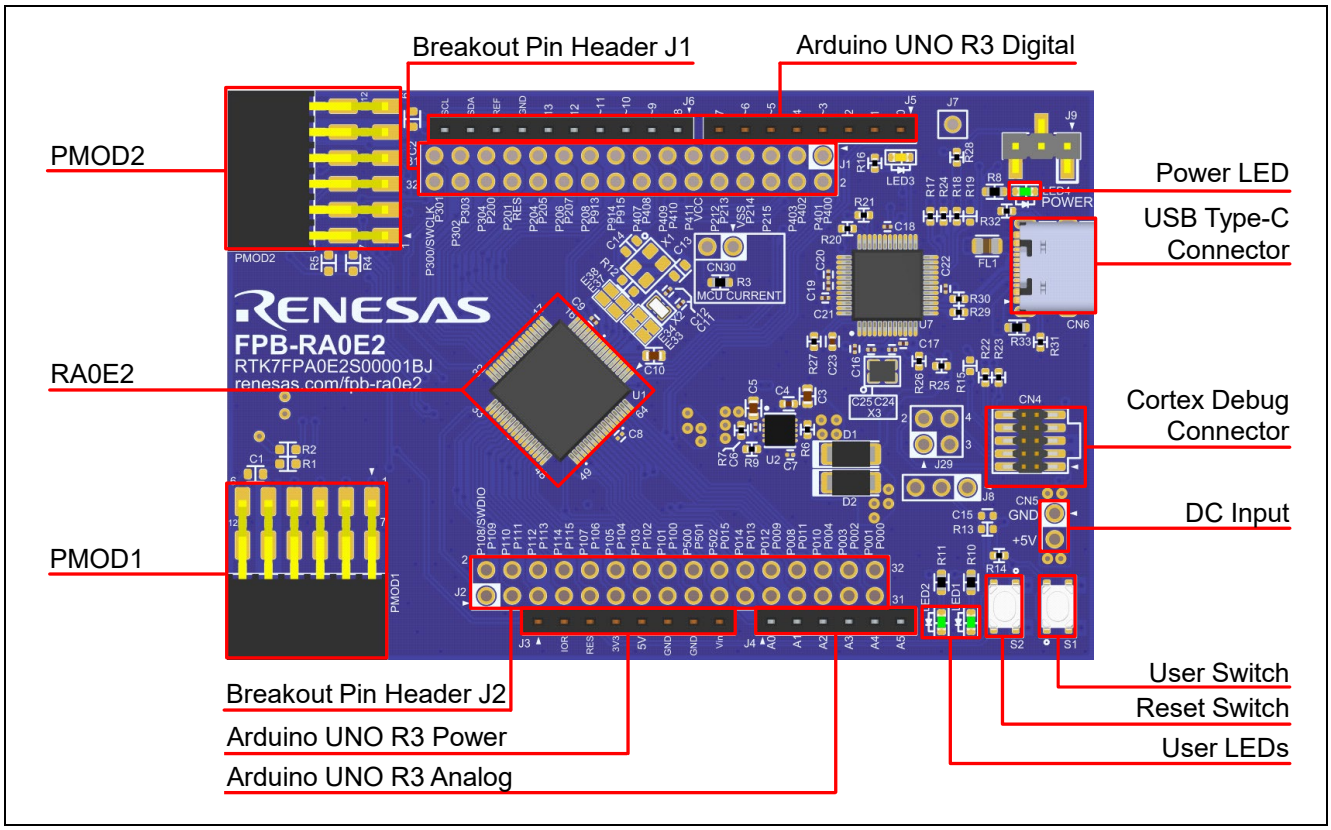

Figure 1. FPB-RA0E2 Board (Top view)

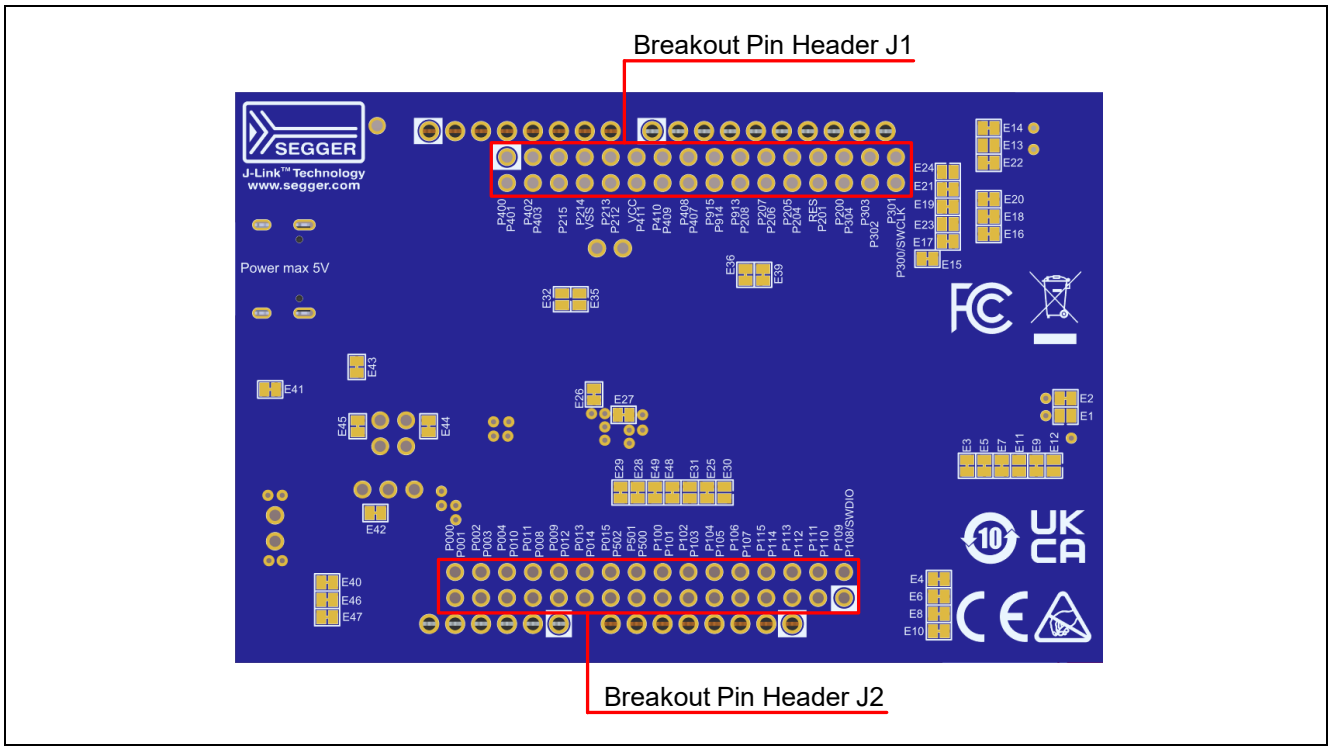

Figure 2. FPB-RA0E2 Board (Bottom view)

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-RA0E2 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-RA0E2 board.

(4) Instructions to download and install software, create example projects, build them and program the FPB-RA0E2 board can be found in the FPB-RA0E1 tutorial and Getting Started with Fast Prototyping Board for RA Family.

(5) The MCU fitted to the FPB-RA0E2 board may not contain the latest version of the firmware.

2. Box Contents

The following components are included in the box.

(1) FPB-RA0E2 v1 board
(2) Printed Quick Start Guide
(3) China RoHS document
(4) USB 2.0 Type-C™ cable (Type-C male to Type-C male)

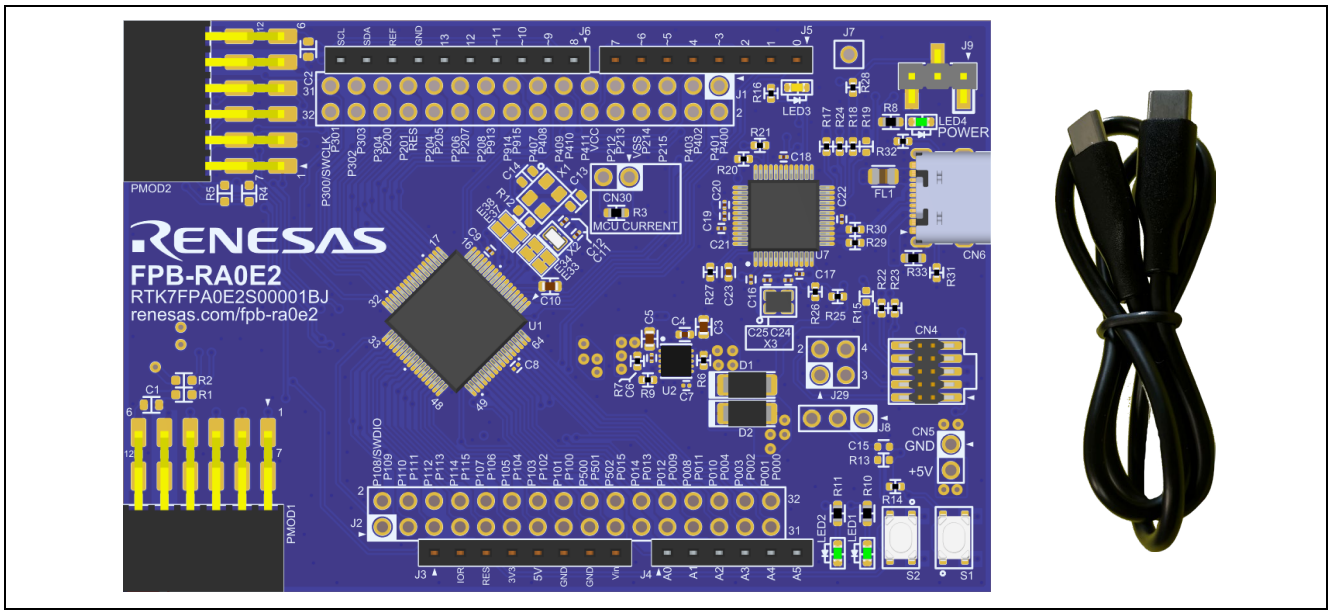

Figure 3. Configuration of the FPB-RA0E2 v1 Evaluation Kit

3. Ordering Information

- FPB-RA0E2 v1 orderable part number: RTK7FPA0E2S00001BJ

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

- FPB-RA0E2 board dimensions: 55.88 mm (width) x 85.00 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Board Architecture

The FPB-RA0E2 board is designed with a similar architecture 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 headers, 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

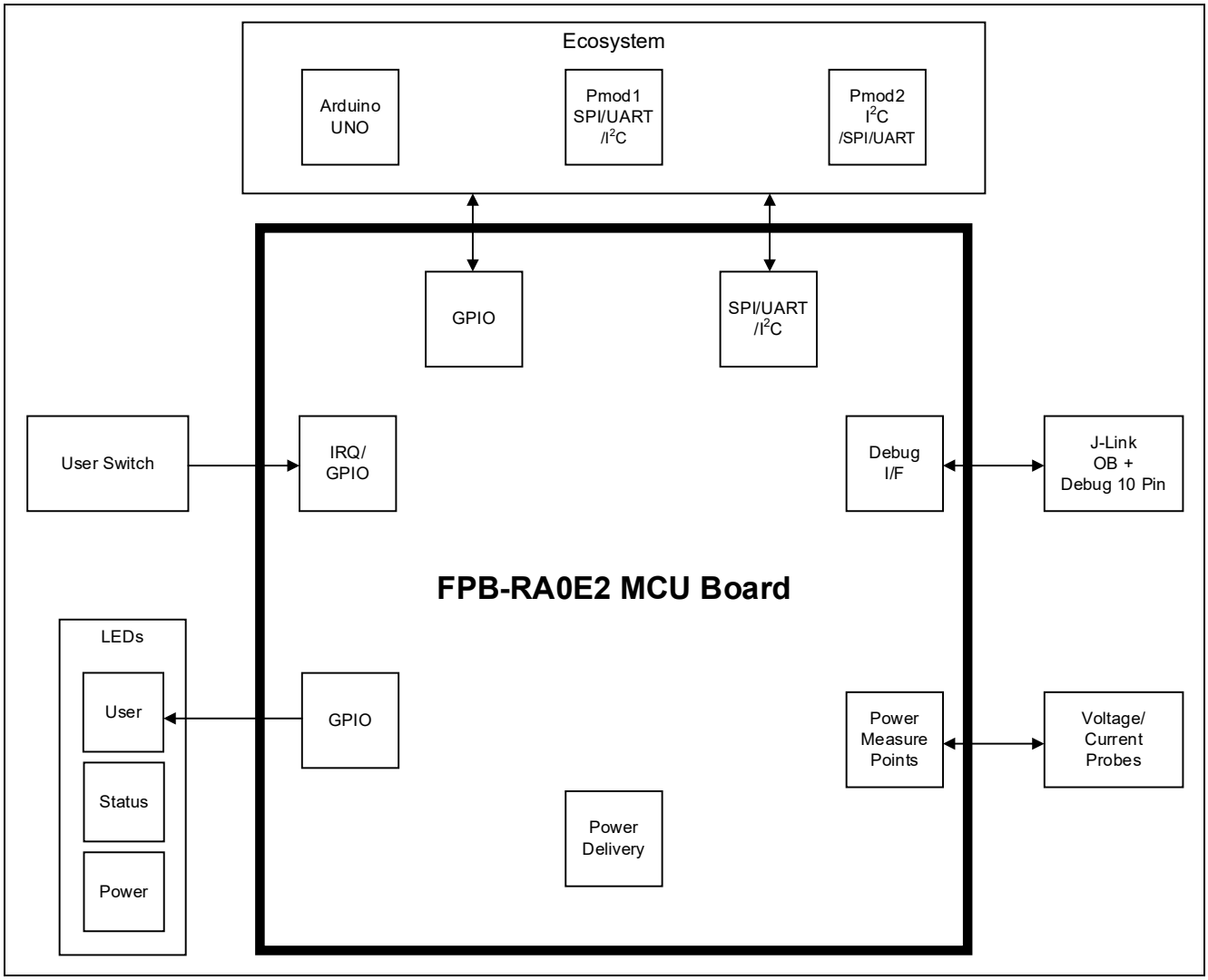

Figure 4. FPB-RA0E2 Board Block Diagram

4.3 Jumper Settings

Two types of jumpers are provided on the FPB-RA0E2 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 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 **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).

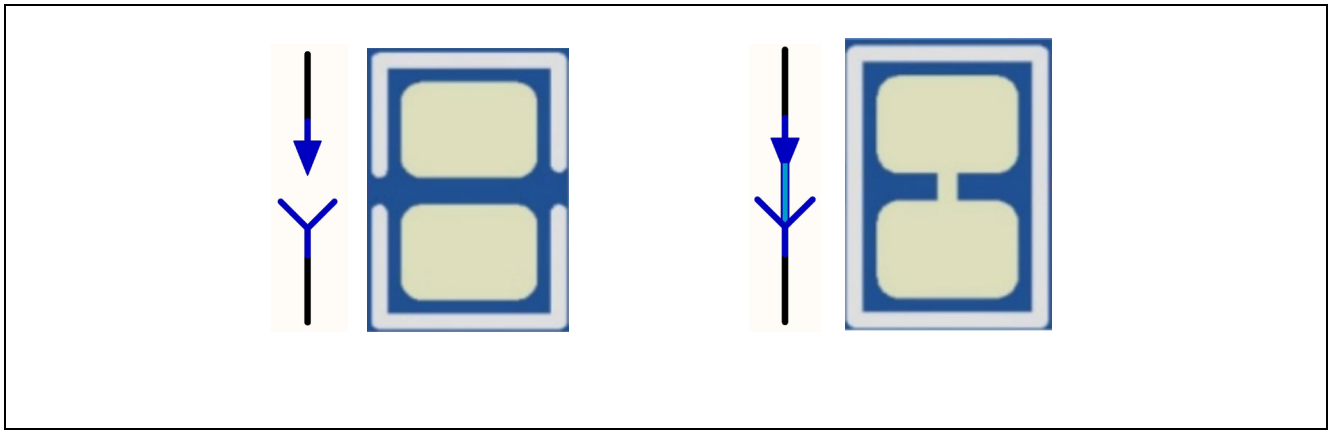

Figure 5. Copper Jumpers

4.3.2 Traditional Pin Header Jumpers

These jumpers are traditional small pitch jumpers that require an external shunt to open/close them. The traditional pin header jumpers on the FPB-RA0E2 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-RA0E2 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	PMOD1	Open	Connects Pmod1-6,12 to 5.0V
E2	PMOD1	Closed	Connects Pmod1-6,12 to VCC
E3	PMOD1	Closed	Connects PMOD1-1 to P207/IRQ2
E4	PMOD1	Closed	Connects PMOD1-7 to P107/IRQ7
E5	PMOD1	Closed	Connects PMOD1-2 to P206/SO01_A/TXDA1
E6	PMOD1	Closed	Connects PMOD1-8 to P114
E7	PMOD1	Closed	Connects PMOD1-3 to P205/SI01_A/RXDA1
E8	PMOD1	Closed	Connects PMOD1-9 to P113
E9	PMOD1	Closed	Connects PMOD1-4 to P204/SCK01_A
E10	PMOD1	Closed	Connects PMOD1-10 to P112
E11	PMOD1	Open	Connects P914/SCLA0_A to PMOD1-3
E12	PMOD1	Open	Connects P913/SDAA0_A to PMOD1-4
E13	PMOD2	Open	Connects Pmod2-6,12 to 5.0V
E14	PMOD2	Closed	Connects Pmod2-6,12 to VCC
E15	PMOD2	Closed	Connects PMOD2-1 to P302/IRQ0
E16	PMOD2	Closed	Connects PMOD2-7 to P111/IRQ3
E17	PMOD2	Closed	Connects PMOD2-2 to P402/SO20_B/TXDA0_F/TXD2_B
E18	PMOD2	Closed	Connects PMOD2-8 to P208
E19	PMOD2	Closed	Connects PMOD2-3 to P400/SCLA1_D
E20	PMOD2	Closed	Connects PMOD2-9 to P915
E21	PMOD2	Closed	Connects PMOD2-4 to P401/SDAA1_D
E22	PMOD2	Closed	Connects PMOD2-10 to P407
E23	PMOD2	Open	Connects PMOD2-3 to P403/SI20_B/RXDA0_F/RXD2_B
E24	PMOD2	Open	Connects PMOD2-4 to P410/SCK20_B
E25	MCU Power	Closed	Connects J6-8(Arduino AREF) to P010/VREFH0/AN000
E26	Power	Closed	Connects 3.3V to +3V3JLOB
E27	Power	Closed	Connects 3.3V to VCC
E28	LED1	Closed	Connects LED1 to P103
E29	LED2	Closed	Connects LED2 to P102
E30	MCU Power	Open	Connects P010/VREFH0 to VCC
E31	MCU Power	Open	Connects P011/VREFL0 to GND
E32	MCU Clock	Open	Connects U1-6(P215/XCIN) to J1-6(P215)
E33	MCU Clock	Closed	Connects 32.768 kHz oscillator to P215/XCIN
E34	MCU Clock	Closed	Connects 32.768 kHz oscillator to P214/XCOUT

Location	Circuit Group	Default Open/Closed	Function
E35	MCU Clock	Open	Connects U1-7(P214/XCOUT) to J1-7(P214)
E36	MCU Clock	Closed	Connects U1-9(P213/X2/EXCLK) to J1-9
E37	MCU Clock	Open	Connects 20 MHz oscillator to U1-9(P213/X2/EXCLK)
E38	MCU Clock	Open	Connects 20 MHz oscillator to U1-10(P212/X1)
E39	MCU Clock	Closed	Connects U1-10(P212/X1) to J1-10
E40	Switch S1	Closed	Connects S1 to U1-27(P200)
E41	Debugger	Closed	Connects CN4-9 to GND
E42	Debugger	Closed	Connects CN4-10(nSRST) to RES
E43	Debugger	Closed	Connects CN4-6 to U7-36
E44	Debugger	Closed	Connects CN4-2(TMS/SWDIO) to U1-33(P108/SWDIO)
E45	Debugger	Closed	Connects CN4-4(TCK/SWCLK) to U1-32(P300/SWCLK)
E46	Debugger	Closed	Connects U7-23(P301) to U1-47(P101/TXDA0[*1])
E47	Debugger	Closed	Connects U7-22(P302) to U1-48(P100/RXDA0[*1])
E48	MCU Power	Closed	Connects J2-26 to U1-58(P011/VREFL0)
E49	MCU Power	Closed	Connects J2-27 to U1-59(P010/VREFH0)
J7	Debugger	TP	Connects to U7-20(P201/MD)
J8	Debugger	1-2 Short (Not fitted)	1-2: Connect U1-25 (RES) and U7-29 (RST control by J-Link OB) 2-3: Connect U1-25 (RES) to GND (cut E42)
J9	Debugger	1-2 Short	1-2: Pull up U7-19 2-3: Connect U7-19 (JLOB_RES) to GND
J29	Debugger	1-2, 3-4 Short (Not fitted)	Connect U1 debug signal to debug interface
R3	MCU Power	Fitted	Connects VCC to VCC_MCU. Remove when measure the current consumed.

[*1] COM port (JLink CDC UART Port)

5. System Control and Ecosystem Access

The FPB-RA0E2 board 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-RA0E2 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-RA0E2 board can be powered.

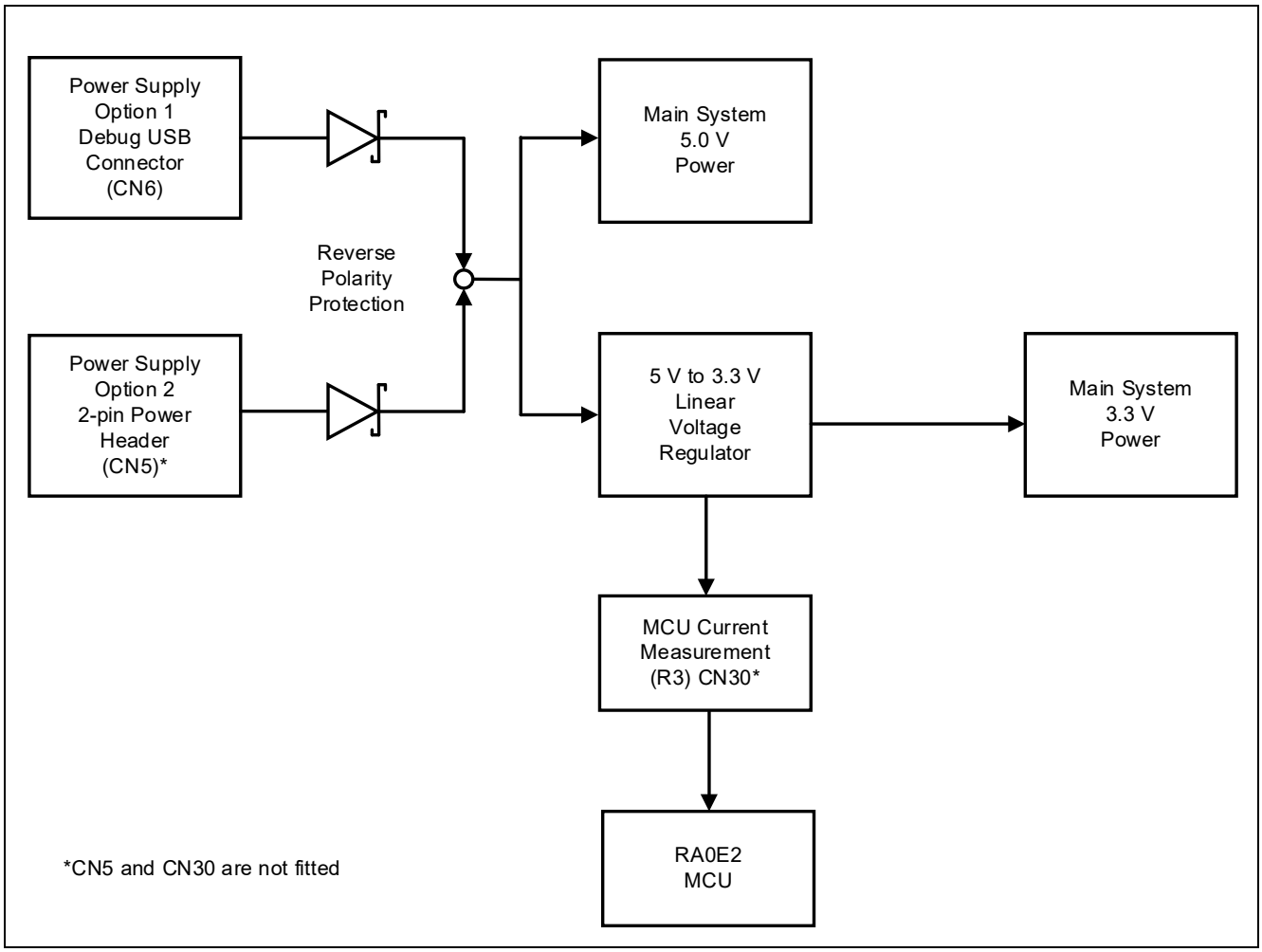

Figure 6. Power Supply Options

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 supply.

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 green LED marked POWER will illuminate. The yellow DEBUG LED will also illuminate.

5.2 Debug

The FPB-RA0E2 board can be programmed and debugged using the built-in SEGGER J-Link® On-Board debugger and supports the following three debug modes.

Table 4. Debug Modes

Debug mode	Debug MCU*	Target MCU (MCU that debug target)	Debugging Interface	Connector Used
On-Board Debug	RA4M2 (on-board)	RA0E2 (on-board)	SWD	USB 2.0 Type-C™ connector (CN6)
Debug In	External debugging tools	RA0E2 (on-board)	SWD	10-pin connector (CN4)

* MCU that connect to IDE on PC

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

Table 5. Debug Modes

Debug mode *1	**J8** *2	**J9**	**J29**
On-Board Debug	1-2	1-2	1-2, 3-4
Debug In	1-2	2-3	1-2, 3-4

*1 When using the on-board debug mode, J8 and J29 do not need to be installed (they are connected by E42, E44, and E45).
*2 J8 requires components to be mounted. Cut E42 when mount J8.

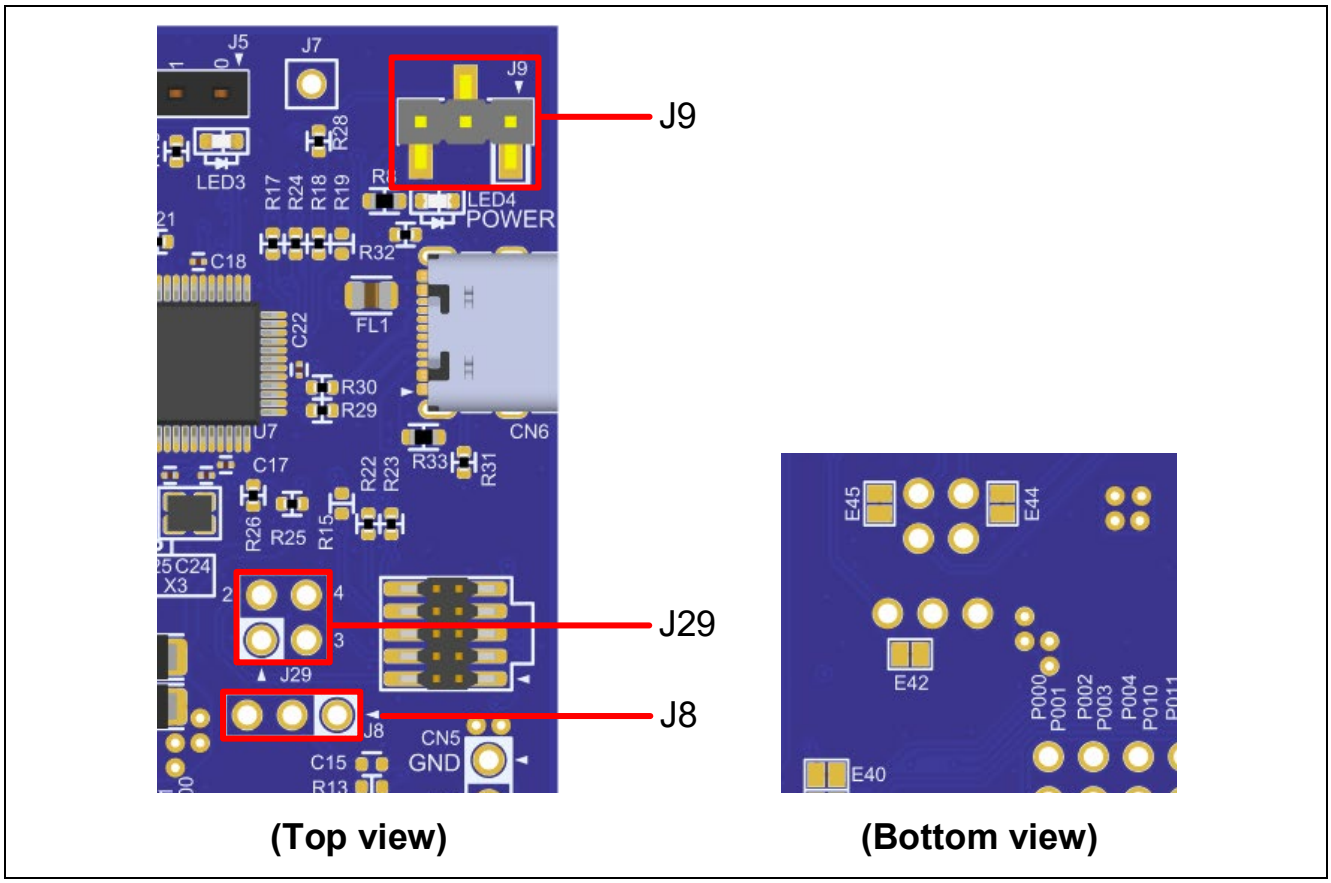

Figure 7. Jumper for Debug mode

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-RA0E2 board.
The Debug RA4M2 (J-Link OB) connects to the target RA MCU using the SWD interface.

Table 6. Debug USB Connector

Debug USB Connector CN6		**FPB-RA0E2**
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	VSS

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

The yellow indicator LED3 shows the status of the debug interface. When the FPB-RA0E2 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 lit, it indicates that the RA4M2 (J-Link OB) is connected to the host PC.
When LED3 is blinking while connected to the host PC, it indicates that data is being transferred between the RA4M2 (J-Link OB) and the host PC.

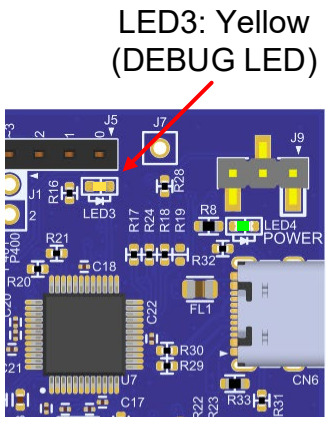

Figure 8. FPB-RA0E2 board Debug Interface (Top view)

5.2.2 Debug In

The 10-pin Cortex® debug connector CN4 supports the SWD (Serial Wire Debug) interface, allowing debugging of the target RA0E2 using an external debug tool.

To configure the FPB-RA0E2 board to use the Debug In mode, configure the jumpers using Table 5.

Table 7. SWD port Assignments

Debug Connector CN4		**FPB-RA0E2 (U1)**
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

5.2.3 Debugger Settings in e² studio

Figure 9 shows the settings for e² studio when creating a new project for the FPB-RA0E2 Fast Prototyping Board.

[Debug hardware]: Select [J-Link (ARM)]
[Target Device]: Select [R7FA0E209]

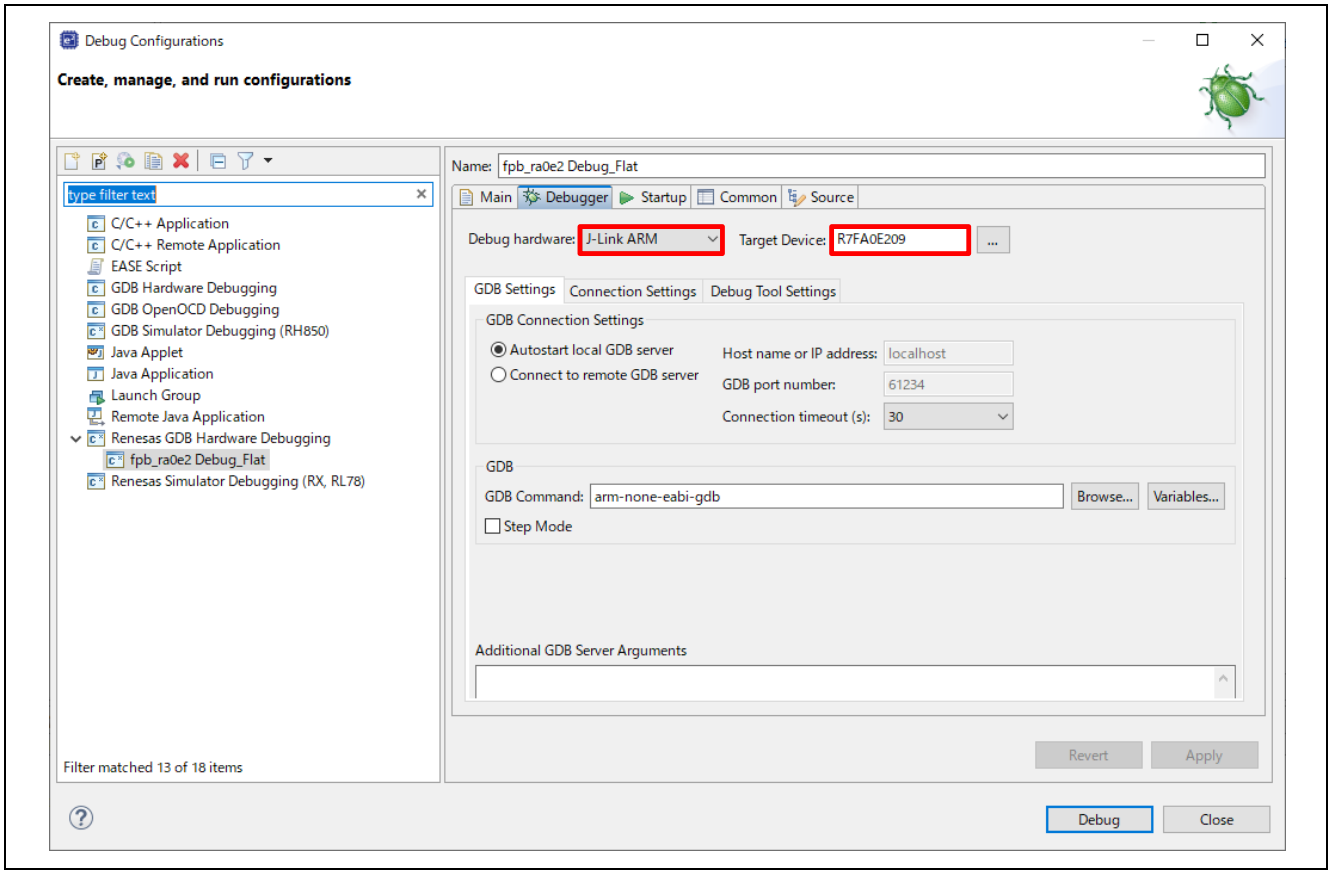

Figure 9. e² studio Debugger Settings

5.2.4 VCOM port

The FPB-RA0E2 board can perform USB-UART conversion using the onboard debugger MCU (RA4M2). It is recognized by the host as the COM port (JLink CDC UART Port). It is connected to the RA0E2 UART using the FPB-RA0E2 board (refer to Table 8).

TXDA0/RXDA0 function is also used in Arduino, Pmod2. if TXDA0/RXDA0 function is not used in Arduino, Pmod2, TXDA0/RXDA0 function can be used in VCOM.

Table 8. UART Assignments

RA0E2 Pin	RA0E2 Signal
U1-48	P100/RXD0_A/RXDA0_D
U1-47	P101/TXD0_A/TXDA0_D

5.3 Ecosystem

The Ecosystem connectors allow users 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-RA0E2 board also provides jumpers so the 12-pin connector of Pmod 1 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 “Simplified SPI” mode and so do not offer the full functionality of the SPI. Please see the hardware manual for full details of the SAU “Simplified 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 designation). This interface may additionally be re-configured in firmware as several other Pmod types.

Table 9. Pmod 1 Connector

Pmod 1 Connector			**FPB-RA0E2**	**Pmod 1 Configuration**	
Pin	**Option Type 2A / 3A (Default)**	**Option Type 6A**	**Signal/Bus**	**Short**	**Open**
PMOD1-1	CS/CTS	INT	P207/IRQ2	E3	
PMOD1-2	MOSI/TXD	RESET	P206/SO01_A/TXDA1	E5	
PMOD1-3	MISO/RXD	-	P205/SI01_A/RXDA1	E7	E11
	-	SCL	P914/SCLA0_A	E11	E7
PMOD1-4	SCK/RTS	-	P204/SCK01_A	E9	E12
	-	SDA	P913/SDAA0_A	E12	E9
PMOD1-5	GND		VSS		
PMOD1-6	VCC		VCC	E2	E1
			5.0 V	E1	E2
PMOD1-7	INT	GPIO	P107/IRQ7	E4	
PMOD1-8	RESET	GPIO	P114	E6	
PMOD1-9	CS2	GPIO	P113	E8	
PMOD1-10	CS3	GPIO	P112	E10	
PMOD1-11	GND		VSS		
PMOD1-12	VCC		VCC	E2	E1
			5.0 V	E1	E2

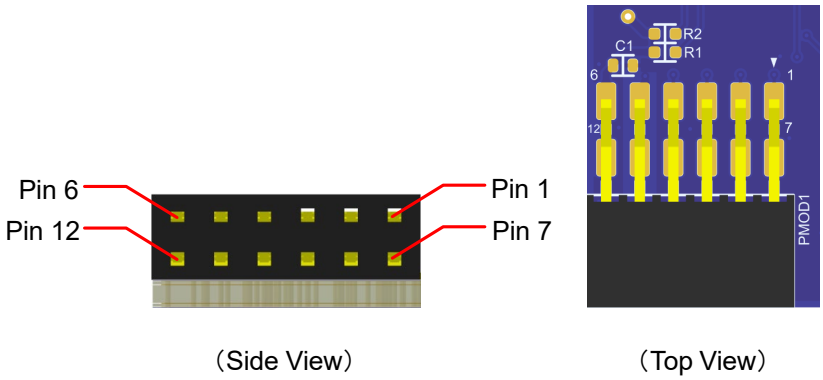

Figure 10. Pmod 1 Connector

The default setting of the Pmod 1 interface supports 3.3 V devices. Please ensure that any Pmod device installed is compatible with a 3.3 V supply.

Pmod Type 6A Operation
Pmod 1 can be configured to support proposed Pmod Type 6A connector specification supporting I^2C connections. There is also an alternative 5 V power source option. In order to configure Pmod 1 for Type 6A operation, modify the copper Jumpers as described in Table 9. The copper Jumpers (Jumper Solder Bridge and Jumper Trace Cut) are shown in Figure 11. P914/SCLA0_A and P913/SDAA0_A are 5.0 V tolerant ports, but other ports must be disconnected when supporting 5.0 V power.

Note: Exercise caution while modifying power source copper jumpers E1, E2. Permanent damage to the FPB-RA0E2 board and/or connected modules may result.

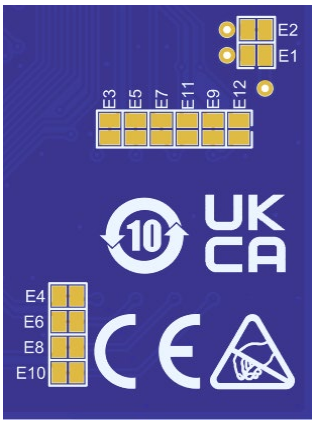

Figure 11. Pmod 1 Copper Jumpers (Bottom view)

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 designation). This interface may additionally be re-configured in firmware as several other Pmod types.

Table 10. Pmod 2 Connector

Pmod 2 Connector			FPB-RA0E2	Pmod 2 Configuration	
Pin	Option Type 6A (Default)	Option Type 2A/3A	Signal/Bus	Short	Open
PMOD2-1	INT	CS/CTS	P302/IRQ0	E15	
PMOD2-2	RESET	MOSI/TXD	P402/SO20_B/TXD2_B/TXDA0_F	E17	
PMOD2-3	SCL	-	P400/SCLA1_D	E19	E23
	-	MISO/RXD	P403/SI20_B/RXD2_B/RXDA0_F	E23	E19
PMOD2-4	SDA	-	P401/SDAA1_D	E21	E24
	-	SCK/RTS	P410/SCK20_B	E24	E21

Pmod 2 Connector			FPB-RA0E2	Pmod 2 Configuration	
Pin	Option Type 6A (Default)	Option Type 2A/3A	Signal/Bus	Short	Open
PMOD2-5	GND		VSS		
PMOD2-6	VCC		VCC	E14	E13
			5.0 V	E13	E14
PMOD2-7	GPIO	INT	P111/IRQ3	E16	
PMOD2-8	GPIO	RESET	P208	E18	
PMOD2-9	GPIO	CS2	P915	E20	
PMOD2-10	GPIO	CS3	P407	E22	
PMOD2-11	GND		VSS		
PMOD2-12	VCC		VCC	E14	E13
			5.0 V	E13	E14

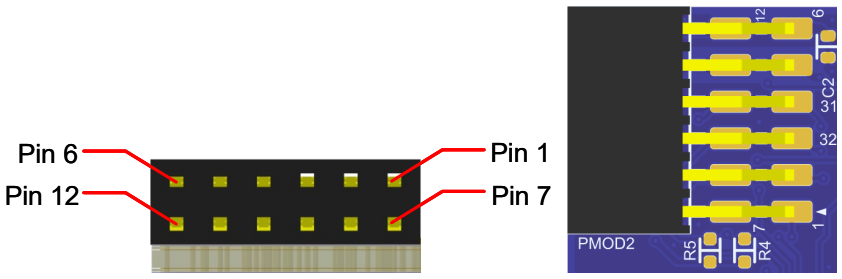

Figure 12. Pmod 2 Connector

This Pmod 2 interface supports 3.3 V devices. Please ensure that any Pmod device installed is compatible with a 3.3 V supply. There is also a 5.0 V option. In order to configure the Pmod to 5.0 V, modify the copper jumpers as described in Table 10. The copper Jumpers (Jumper Solder Bridge and Jumper Trace Cut) are shown in Figure 13. P400/SCLA1_D and P401/SDAA1_D are 5.0 V tolerant ports, but other ports must be disconnected when supporting 5.0 V power.

Note: Exercise caution while modifying power source copper jumpers E13, E14. Permanent damage to the FPB-RA0E2 board and/or connected modules may result.

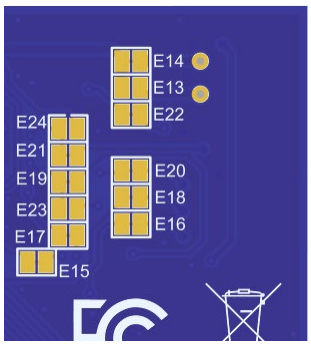

Figure 13. Pmod 2 Copper Jumper (Bottom view)

5.3.2 Arduino® Connector

An Arduino® Uno R3 compatible connector interface is provided.

Table 11. Arduino® Connector

Arduino® Connector		**FPB-RA0E2**
Pin	**Description**	**Signal/Bus**
J3-1	NC	NC
J3-2	IOREF	VCC
J3-3	RESET	RES
J3-4	3V3	3.3 V
J3-5	5V	5.0 V
J3-6	GND	VSS
J3-7	GND	VSS
J3-8	VIN	NC
J4-1	A0	P015/AN007
J4-2	A1	P014/AN006
J4-3	A2	P013/AN005
J4-4	A3	P012/AN004
J4-5	A4	P009/AN003
J4-6	A5	P008/AN002
J5-1	RX/0	P110/RXDA0_C/RXD2_A
J5-2	TX/1	P109/TXDA0_C/TXD2_A
J5-3	2	P411/IRQ3
J5-4	~3	P409/IRQ6/TO03
J5-5	4	P408
J5-6	~5	P201/TO05
J5-7	~6	P301/TO06
J5-8	7	P115
J6-1	8	P106
J6-2	~9	P105/TO01
J6-3	~10	P104/TO02
J6-4	~11	P501/SO00/TO04
J6-5	12	P502/SI00
J6-6	13	P500/SCK00
J6-7	GND	VSS
J6-8	AREF	P010/VREFH0
J6-9	SDA	P913/SDAA0_A
J6-10	SCL	P914/SCLA0_A

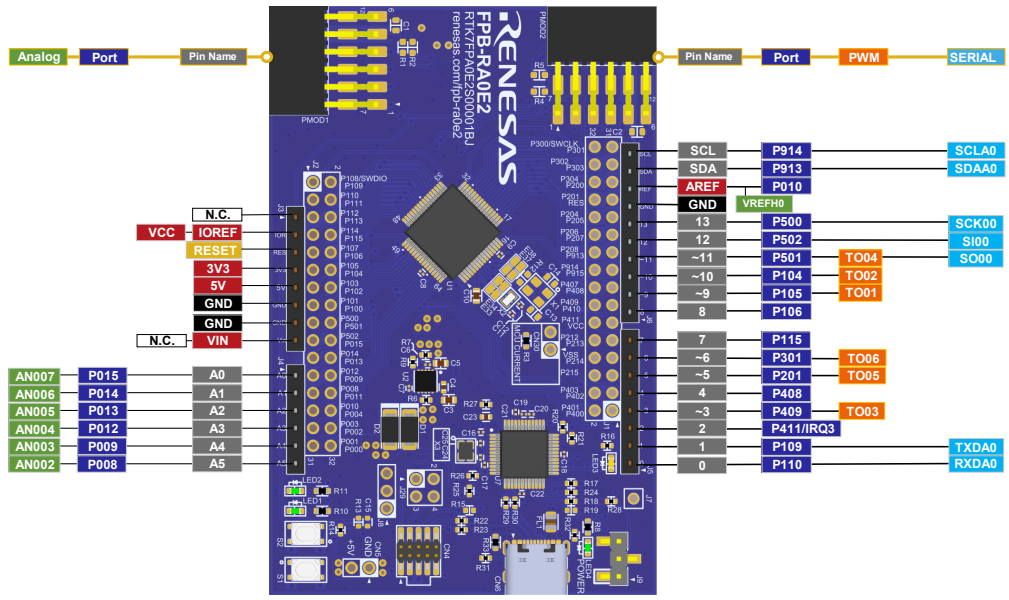

Figure 14. Arduino Uno Connectors (Top view)

5.4 Miscellaneous

5.4.1 User and Power LEDs

Four LEDs are provided on the FPB-RA0E2 board.
Behavior of the LEDs on the FPB-RA0E2 board is described in the following table.

Table 12. FPB-RA0E2 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Green	User LED	P103
LED2	Green	User LED	P102
LED3	Yellow	Debug LED	Renesas RA4M2 Debug MCU
LED4	Green	Power on indicator	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 P103, Jumper Trace Cut E28 must be open. To disconnect LED2 from P102, Jumper Trace Cut E29 must be open.

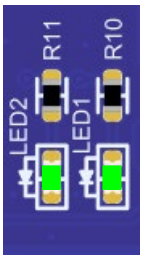

Figure 15. User LEDs (Top view)

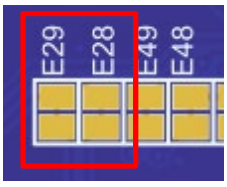

Figure 16. Jumper for User LEDs (Bottom view)

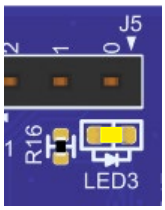

Figure 17. Power LED (Top view)

Figure 18. Debug LED (Top view)

5.4.2 User and Reset Switches

Two miniature, momentary, mechanical push-button type SMD switches are mounted on the FPB-RA0E2 board.
Pressing the reset switch (S2) generates a reset signal to restart the RA MCU.

Table 13. FPB-RA0E2 Board Switches

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

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, trace cut jumper E40 must be open.

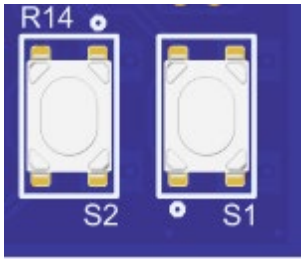

Figure 19. User Switch (S1) and Reset Switch (S2) (Top view)

Figure 20. Jumper for User Switch (S1) (Bottom view)

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. The option has also been provided to fit an RA MCU oscillator crystal, providing a precision 20.000 MHz reference clock. When installing the main clock oscillator circuit components, short E37 and E38 of Jumper Solder Bridge (open) and, cat E36 and E39 of Jumper Trace Cut (short).

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.

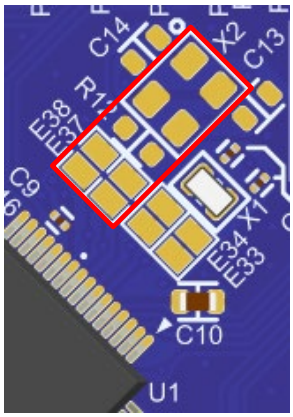

Figure 21. Main Clock Oscillation Circuit (Top view)

Figure 22. Jumper for main clock oscillation circuit (Bottom view)

6. MCU Native Pin Access

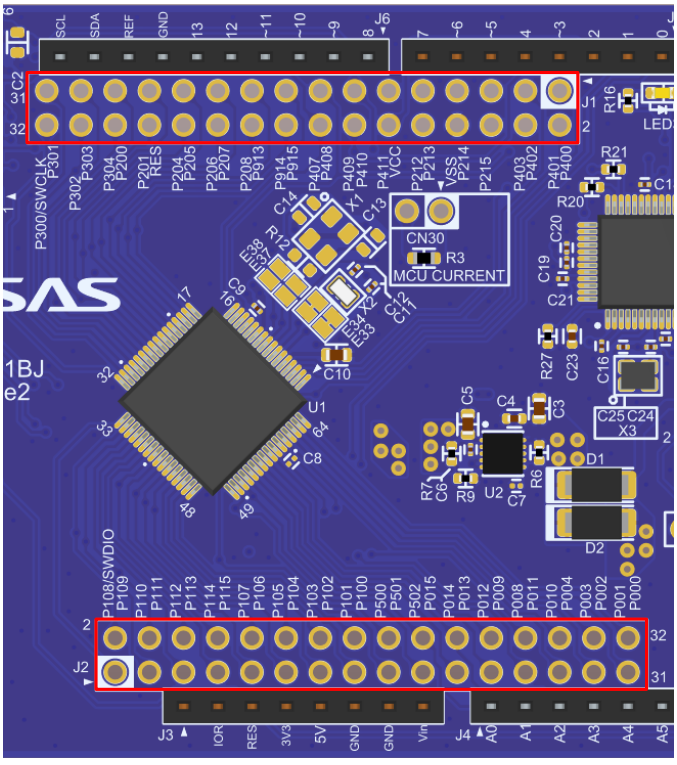

Figure 23. Native Pin Access (Breakout Pin Header J1 and J2) (Top view)

6.1 Breakout Pin Headers

The FPB-RA0E2 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 RA0E2 Group User's Manual for details of each port function, and the FPB-RA0E2 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

No. (J1)	Circuit Net Name	RA0E2 (U1)	No. (J1)	Circuit Net Name	RA0E2 (U1)
1	P400/SCLA1_D	1	2	P401/SDAA1_D	2
3	P402/SO20_B/TXDA0_F/TXD2_B	3	4	P403/SI20_B/RXDA0_F/RXD2_B	4
5	N.C.	5	6	P215	6
7	P214	7	8	GND	8
9	P213	9	10	P212	10
11	VCC	11	12	P411/IRQ3	12
13	P410/SCK20_B	13	14	P409/IRQ6/TO03	14
15	P408	15	16	P407	16
17	P915	17	18	P914/SCLA0_A	18
19	P913/SDAA0_A	19	20	P208	20
21	P207/IRQ2	21	22	P206/SO01_A/TXDA1	22
23	P205/SI01_A/RXDA1	23	24	P204/SCK01_A	24
25	RES	25	26	P201/TO05	26
27	P200/IRQ0/NMI	27	28	P304	28
29	P303	29	30	P302/IRQ0	30
31	P301/TO06	31	32	P300/SWCLK	32

Table 15. Breakout Pin Header J2

No. (J2)	Circuit Net Name	RA0E2 (U1)	No. (J2)	Circuit Net Name	RA0E2 (U1)
1	P108/SWDIO	33	2	P109/TXDA0/TXD2_A	34
3	P110/RXDA0_C/RXD2_A	35	4	P111/IRQ3	36
5	P112	37	6	P113	38
7	P114	39	8	P115	40
9	P107/IRQ7	41	10	P106	42
11	P105/TO01	43	12	P104/TO02	44
13	P103	45	14	P102	46
15	P101/TXDA0_A/TXDA0_D	47	16	P100/RXDA0_A/RXDA0_D	48
17	P500/SCK00	49	18	P501/SO00/TO04	50
19	P502/SI00	51	20	P015/AN007	52
21	P014/AN006	53	22	P013/AN005	54
23	P012/AN004	55	24	P009/AN003	56
25	P008/AN002	57	26	P011/VREFL0	58
27	P010/VREFH0	59	28	P004	60
29	P003	61	30	P002	62
31	P001	63	32	P000	64

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 0805) 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 RA MCU can then be calculated using Ohm's Law.

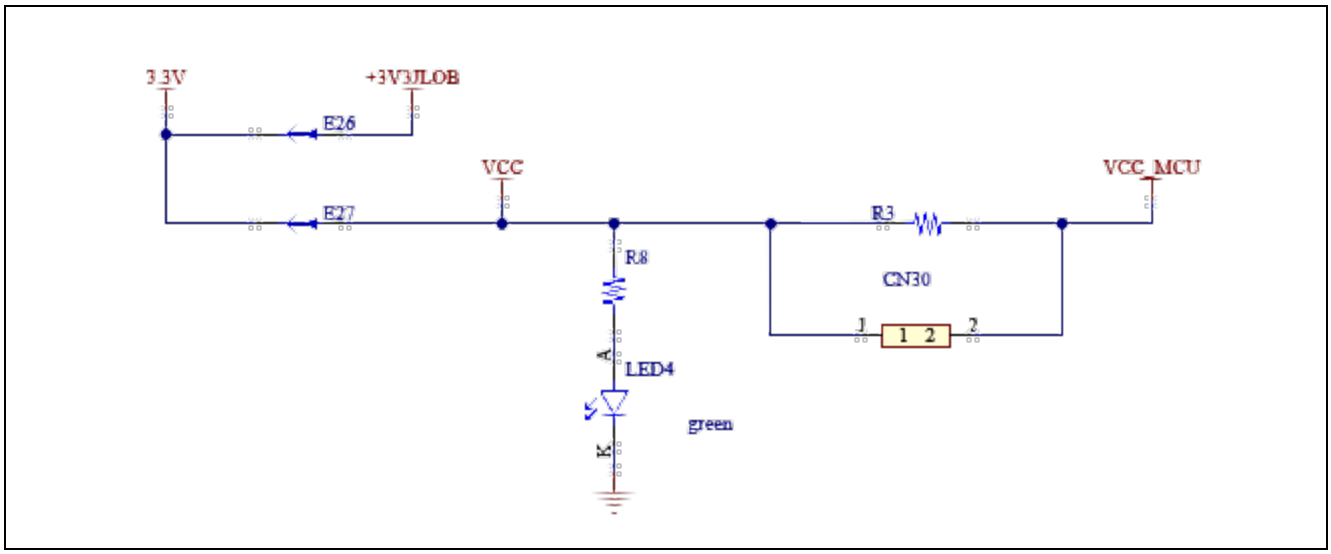

Figure 24. RA MCU VCC Current Measurement Circuit

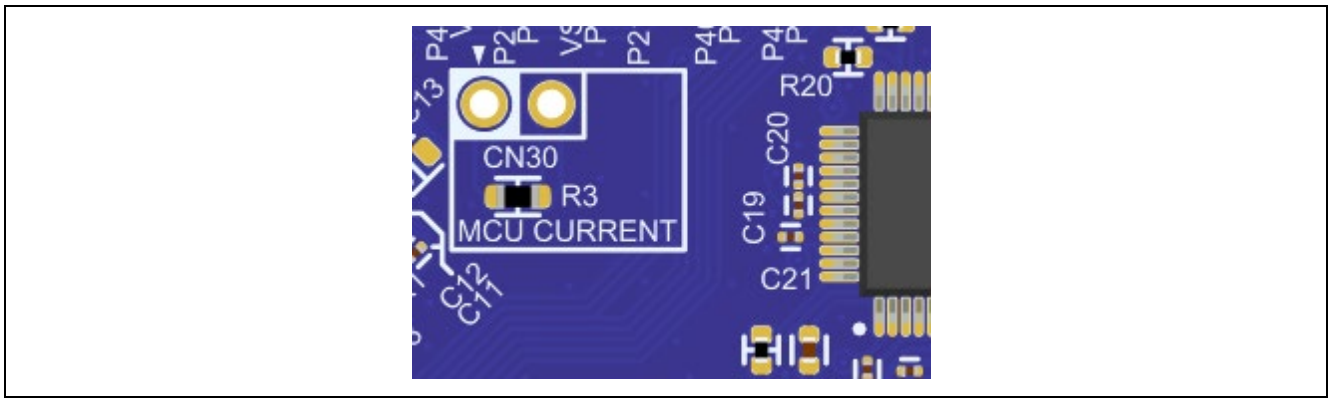

Figure 25. RA MCU VCC Current Measurement Point (CN30) and R3 (Top view)

7. Recommended Parts

Table 16 lists recommended part numbers for optional components that can be fitted as required.

Table 16. Part Numbers

Designator(s)	Description	Manufacturer	Part Number
X1	20 MHz Crystal	ABRACON	ABM8-20.000MHZ-10-B1U-T
J1, J2	24-pin Dual pin header	32 x 2 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, fits into 1.10 mm dia. hole in board	

8. Certifications

The FPB-RA0E2 board meets the following certifications/standards. See page 4 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-RA0E2 board is available in the “FPB-RA0E2 v1 Design Package” available on renesas.com/fpb-ra0e2.

Design package file name: fpb-ra0e2-v1-designpackage.zip
Design package contents:

Table 17. FPB-RA0E2 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	fpb-ra0e2-v1-schematics
File (PDF)	Mechanical Drawing	fpb-ra0e2-v1-mechdwg
File (PDF)	BoM	fpb-ra0e2-v1-bom
File (PDF)	3D Drawing	fpb-ra0e2-v1-3d
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files

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-RA0E2 Board Resources	renesas.com/fpb-ra0e2
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

The FPB-RA0E2 board has the following notes.

1. When connecting an external debugger to CN4, check the position of pin 1 of the connector to be connected.

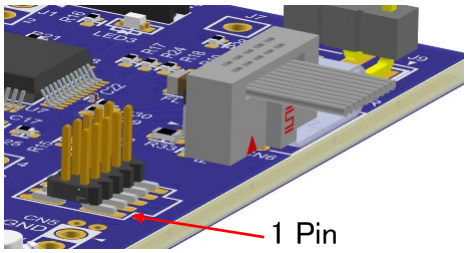

Figure 26. Position of CN4-1 (Top view)

2. P101/TXDA0 and P100/RXDA0 are connected to RA4M2 (J-Link OB). cut Jumper Trace Cut (short) E46, E47 if not used as J-Link virtual COM port (VCOM).

Figure 27. Jumper for VCOM (Bottom view)

12. Appendix

12.1 Component Layout Diagram for the FPB-RA0E2 Board (Top view)

The component layout diagram for the FPB-RA0E2 board (Top View) is shown below.

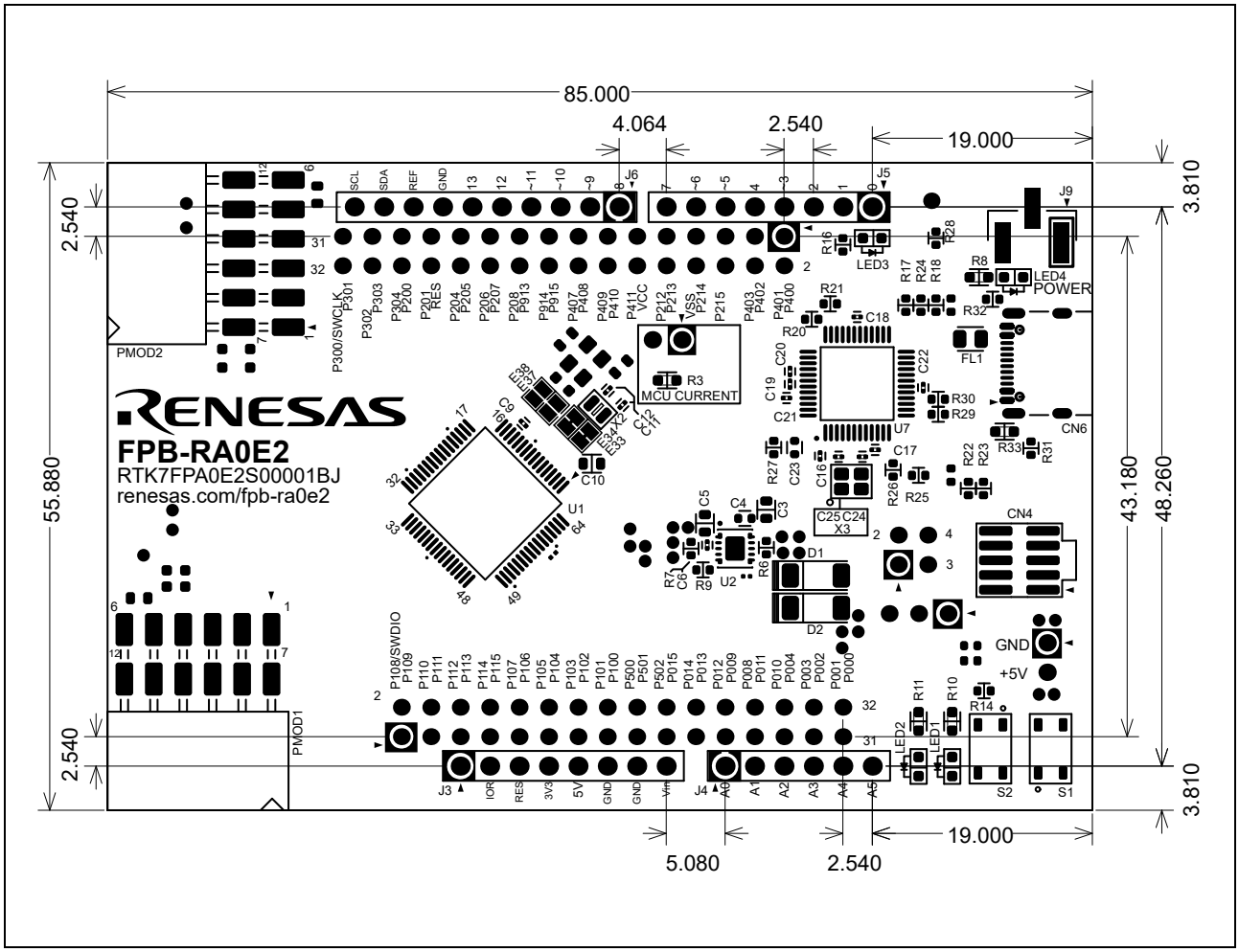

Figure 28. FPB-RA0E2 Board Parts Layout Diagram (Top view)

12.2 Component Layout Diagram for the FPB-RA0E2 Board (Bottom view)

The component layout diagram for the FPB-RA0E2 board (Bottom View) is shown below.

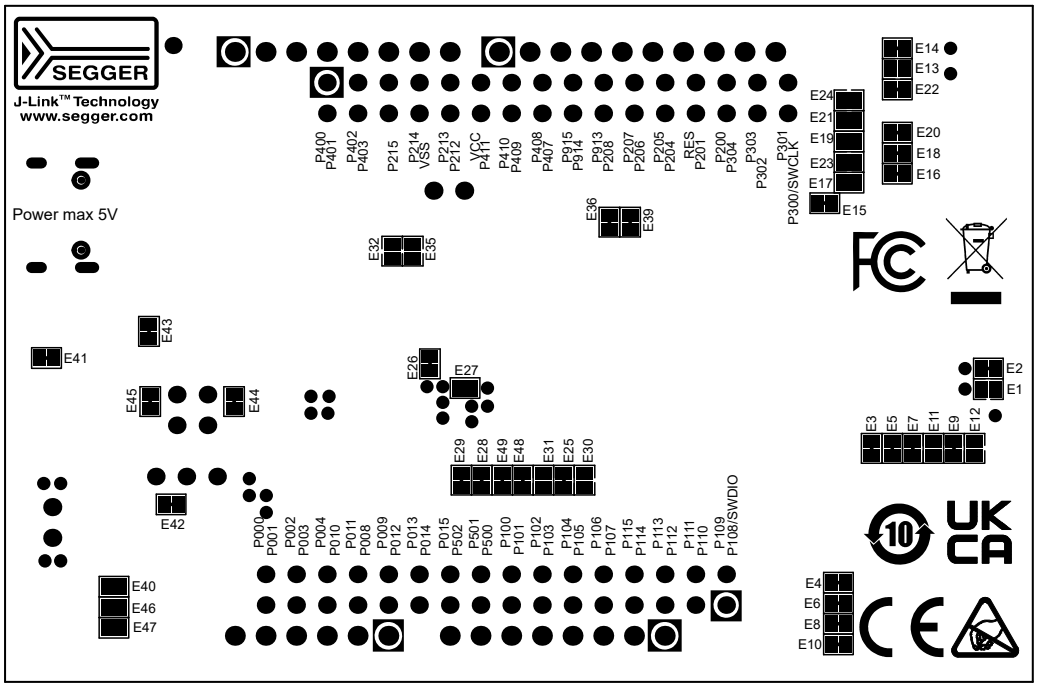

Figure 29. FPB-RA0E2 Board Parts Layout Diagram (Bottom view)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Mar.1, 2025	—	First Edition issued

FPB-RA0E2 v1 – User’s Manual

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