User's Manual

RA2E3 Group

Fast Prototyping Board for RA2E3 Microcontroller Group
FPB-RA2E3 v1
User's Manual

Renesas RA Family
RA2 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

   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-RA2E3 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
JTAG	Joint Test Action Group
LDO	Low Dropout
LED	Light Emitting Diode
LFQFP	Lead Free Quad Flat Pack
MCU	Micro Controller Unit
MISO	Master In Slave Out
MOSI	Master Out Slave In
NC	Not Connected
Pmod™	Peripheral Module
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-RA2E3, a Fast Prototyping Board for the RA2E3 MCU Group, enables users to seamlessly evaluate the features of the RA2E3 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-RA2E3 board are categorized in two groups (consistent with the architecture of the board) as follows:

MCU Native Pin Access

- R7FA2E3073CFL MCU (referred to as RA MCU)
- 48 MHz, Arm® Cortex®-M23 core
- 64 KB Code Flash, 2 KB Data Flash, 16 KB SRAM
- 48-pin, LFQFP package
- Native pin access through 2 x 24-pin male headers
- MCU current measurement point for precision current consumption measurement
- Multiple clock sources - Low-precision (~1%) clocks are available internal to the RA MCU. RA MCU oscillator and sub-clock oscillator crystals, providing precision 20.000 MHz and 32,768 Hz reference clocks can be fitted to the board

System Control and Ecosystem Access

- Two 5 V input sources
  - USB (Debug, Full Speed)
  - External power supply (using 2-pin header) (not fitted)
- Built-in SEGGER J-Link On-Board programmer/debugger (SWD, JTAG and SWO)
- User LEDs and buttons
  - Two User LEDs (green)
  - Power LED (green) indicating availability of regulated power
  - Debug LED (yellow) indicating the debug connection
  - One User button
  - One Reset button
- Two popular ecosystem expansions
  - Two Digilent Pmod™ (SPI, UART, I^{2}C) connectors
  - Arduino™ (UNO R3) connector
- MCU boot configuration jumper (not fitted)

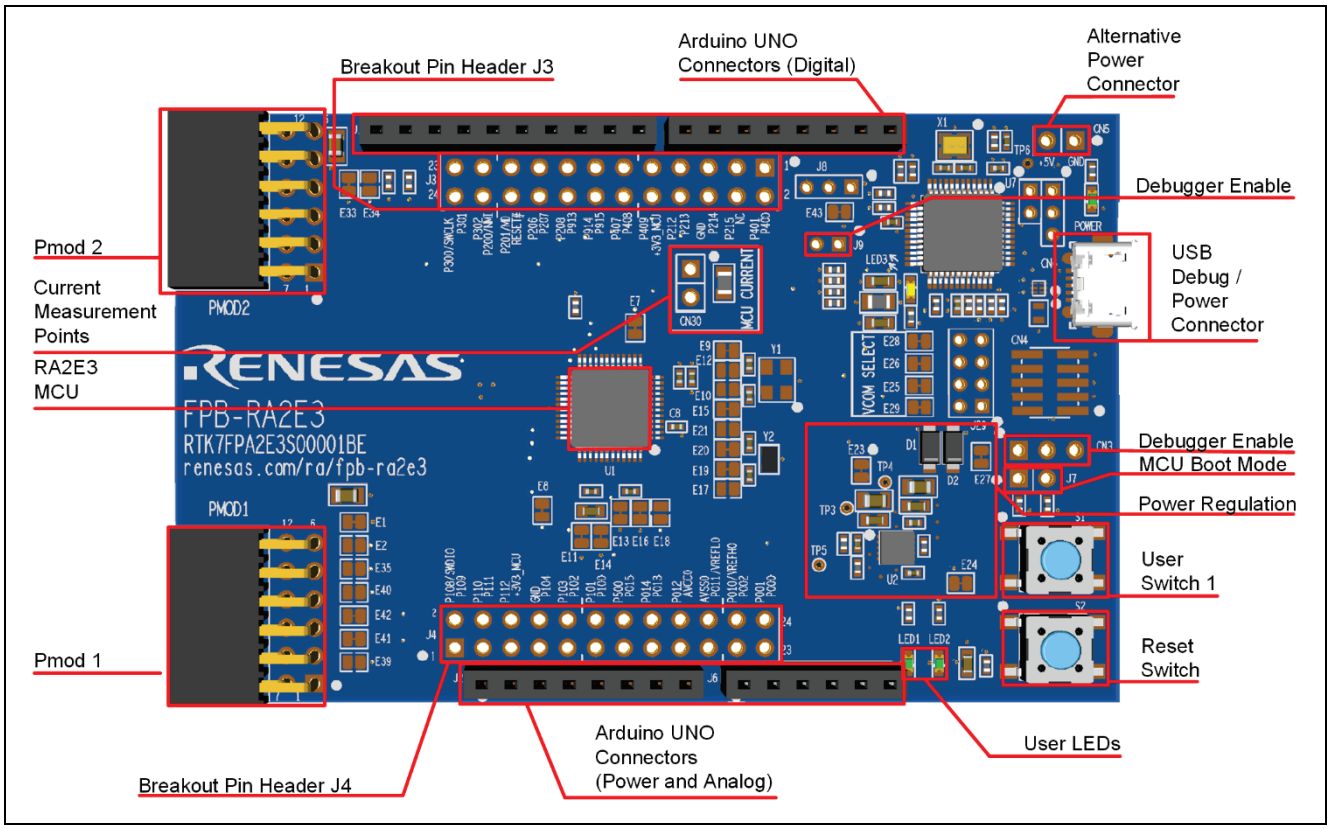

Figure 1. FPB-RA2E3 Board Top Side

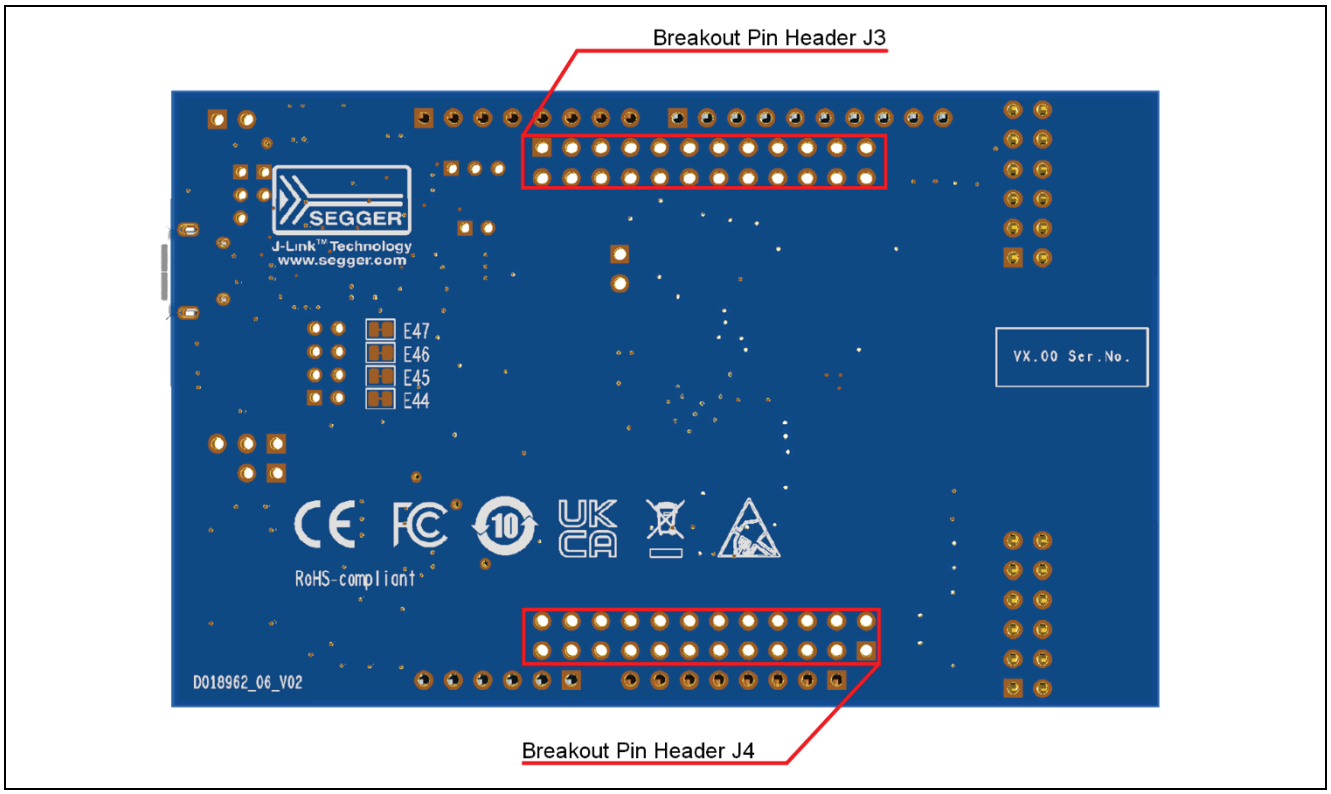

Figure 2. FPB-RA2E3 Board Bottom Side

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-RA2E3 Quick Start Guide* to get acquainted with the board.
3. Flexible Software Package (FSP) and Integrated Development Environment (IDE) such as e^2 studio are required to develop embedded applications on FPB-RA2E3 board.
4. Instructions to download and install software, import example projects, build them and program the FPB-RA2E3 board are provided in the tutorial manual.
5. The MCU fitted to the FPB 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-RA2E3 v1 board
2. Printed Quick Start Guide
3. China RoHS document

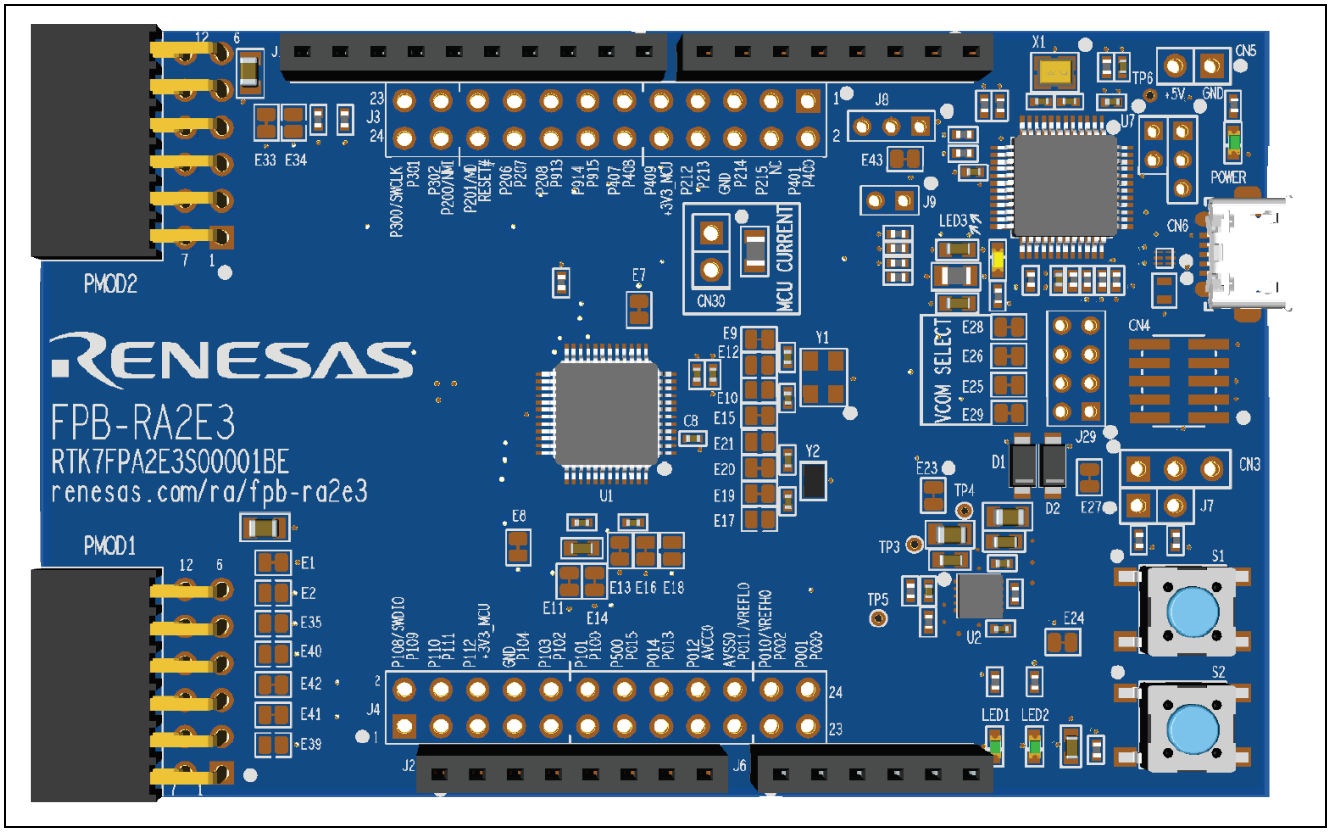

Figure 3. FPB-RA2E3 Board

3. Ordering Information

- FPB-RA2E3 v1 orderable part number: RTK7FPA2E3S00001BE

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

- FPB-RA2E3 board dimensions: 53 mm (width) x 85 mm (length) x 11.5 mm (thickness)

4. Hardware Architecture and Default Configurations

4.1 Board Architecture

The FPB-RA2E3 board is designed with an architecture similar to other boards in the FPB series. Alongside the MCU there is an on-board programmer, pin headers for access to all the pins on the 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, breakout pin headers for all MCU I/O and power, current measurement	Yes	MCU dependent
System Control and Ecosystem Access	Power, debugger, user LEDs and switches, reset switch, ecosystem connectors, boot configuration	Yes	Same or similar across other FPB boards

4.2 Block Diagram

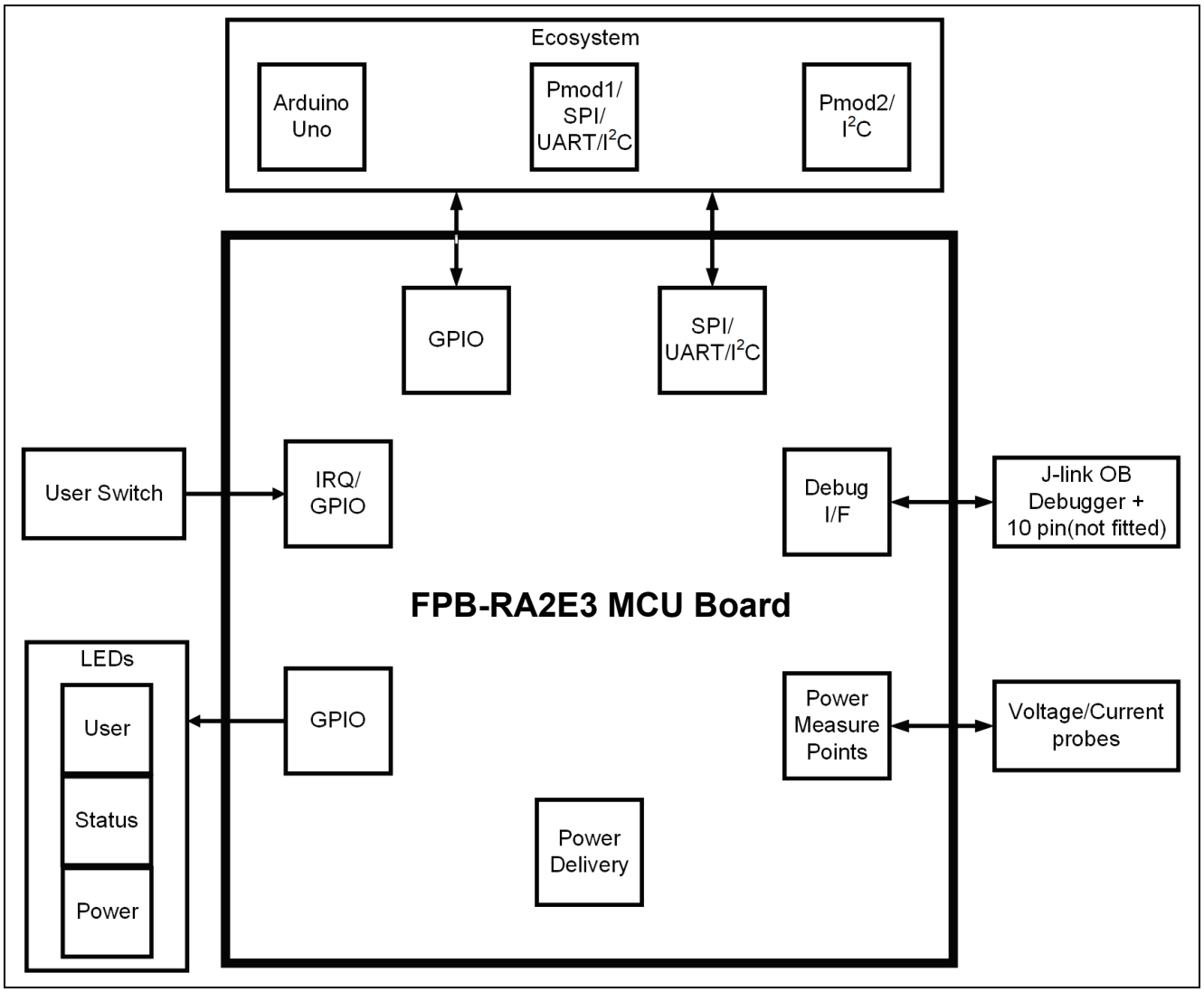

Figure 4. FPB-RA2E3 Board Block Diagram

4.3 Jumper Configurations

Two types of jumpers are provided on the FPB-RA2E3 board.

1. Copper jumpers (trace-cut type and solder bridge type)
2. Traditional pin header jumpers

The following sections describe each type and their default configuration.

4.3.1 Copper Jumpers

Copper jumpers are of two types, designated **trace-cut** and **solder-bridge**.

A **trace-cut jumper** is provided with a narrow copper trace connecting its pads. The silk screen overlay printing around a trace-cut jumper is a solid box. To isolate the pads, cut the trace between pads adjacent to each pad, then remove the connecting copper foil either mechanically or with the assistance of heat. Once the etched copper trace is removed, the trace-cut jumper is turned into a solder-bridge jumper for any later changes.

A **solder-bridge** jumper is provided with two isolated pads that may be joined together by one of three methods:

- Solder may be applied to both pads to develop a bulge on each and the bulges joined by touching a soldering iron across the two pads.
- A small wire may be placed across the two pads and soldered in place.
- A SMD resistor, size 0805, 0603 or 0402, may be placed across the two pads and soldered in place. A zero-ohm resistor shorts the pads together.

For any copper jumper, the connection is considered **closed** if there is an electrical connection between the pads (default for trace-cut jumpers). The connection is considered **open** if there is no electrical connection between the pads (default for the solder-bridge jumpers).

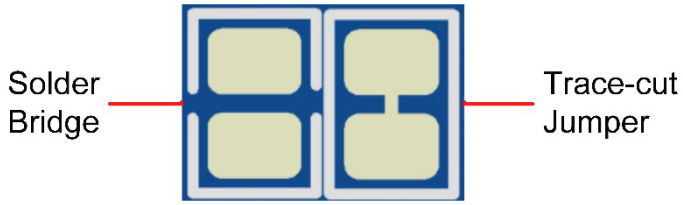

Figure 5. Copper Jumpers

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-RA2E3 board are 0.1” (2.54 mm) pitch headers and require compatible 2.54 mm shunt jumpers.

4.3.3 Default Jumper Configurations

The following table describes the default configurations for each jumper on the FPB-RA2E3 board. This includes copper jumpers (Ex designation) and traditional pin jumpers (Jx or CNx 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 Configuration

Location	Circuit Group	Default Open/Closed	Function
CN3 (not fitted)	Debugger	1-2 (via E27)	Normal debug operation
CN5 (not fitted)	Power	Not fitted	Pin headers used for alternative 5 V power source
CN30 (not fitted)	Power	Closed (via R3)	MCU current measurement

Location	Circuit Group	Default Open/Closed	Function
R3	Power	Fitted	Connects +3.3 V to MCU. Remove when testing MCU current draw
E1	Pmod1 Power	Closed	Connects +3.3 V to Pmod 1 pins 6 and 12
E2	Pmod1 Power	Open	Connects +5.0 V to Pmod 1 pins 6 and 12
E7	User LED2	Closed	Connects LED2 to P914
E8	User LED1	Closed	Connects LED1 to P213
E9	MCU Clock	Closed	Connects P212 net to MCU pin 8 (P212/EXTAL)
E10	MCU Clock	Open	Connects 20MHz crystal to MCU pin 7
E11	MCU Power	Closed	Connects AVCC0 (MCU pin 42) to +3.3 V
E12	MCU Clock	Open	Connects 20MHz crystal to MCU pin 8
E13	MCU Power	Closed	Connects P011/VREFL0 (MCU pin 44) to GND
E14	MCU Power	Closed	Connects AVSS0 (MCU pin 43) to GND
E15	MCU Clock	Closed	Connects P213 net to MCU pin 7 (P213/XTAL)
E16	MCU Power	Closed	Connects P010/VREFH0 (MCU pin 45) to +3.3 V
E17	MCU Clock	Open	Connects P215 net to MCU pin 4 (P215/XCIN)
E18	MCU Power	Open	Connects J1 pin 8 (Arduino™) to MCU pin 45 (P010/VREFH0)
E19	MCU Clock	Closed	Connects 32,768 Hz crystal to MCU pin 4 (P215/XCIN)
E20	MCU Clock	Closed	Connects 32,768 Hz crystal to MCU pin 5 (P214/XCOUT)
E21	MCU Clock	Open	Connects P214 net to MCU pin 5 (P214/XCOUT)
E23	Debugger Power	Closed	Connects debugger power to the +3.3 V regulator
E24	User Switch 1	Closed	Connects S1 to P200/NMI
E25	Debug	Closed	Connects Debug P301 to J29, E46, E29
E26	Debug	Closed	Connects JTAG_TDI (debug pin 33) to J29, E47, E28
E27	Debugger	Closed	Normal debug operation (bypassing CN3)
E28	Debugger	Closed	Connects Debug P302 to J29, E47, E26
E29	Debugger	Closed	Connects JTAG_TDO (debug pin 36) to J29, E46, E25
E33	Pmod2 Power	Closed	Connects +3.3 V to Pmod 2 pins 6 and 12
E34	Pmod2 Power	Open	Connects +5.0 V to Pmod 2 pins 6 and 12
E35	Pmod1 UART	Open	Connects Pmod 1 Pin4 to RTS (P407)
E39	Pmod1 IIC	Open	Connects Pmod 1 Pin3 to SCL (P400)
E40	Pmod1 IIC	Open	Connects Pmod 1 Pin4 to SDA (P401)
E41	Pmod1 SPI/UART	Closed	Connects Pmod 1 Pin3 to MISO/RXD (P100)
E42	Pmod1 SPI	Closed	Connects Pmod 1 Pin4 to SCK (P102)
E43	Debug	Closed	Debug input/output select (bypassing J8)
E44	Debug	Closed	VCOM select. Links SWDIO (P108) to JTAG_TMS
E45	Debug	Closed	VCOM select. Links SWCLK (P300) to JTAG_TCK
E46	Debug	Closed	VCOM select. Links P109 to JTAG_TDO and debug RXD
E47	Debug	Closed	VCOM select. Links P110 to JTAG TDI and debug TXD
J7 (not fitted)	MCU Boot Mode	Open	Configures the MCU for Single-chip mode
J8 (not fitted)	Debug	1-2 (via E43)	Selects between debug input and output
J9 (not fitted)	Debug	Open	Selects between internal debugger and external debugger

5. System Control and Ecosystem Access

The FPB-RA2E3 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-RA2E3 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-RA2E3 board can be powered.

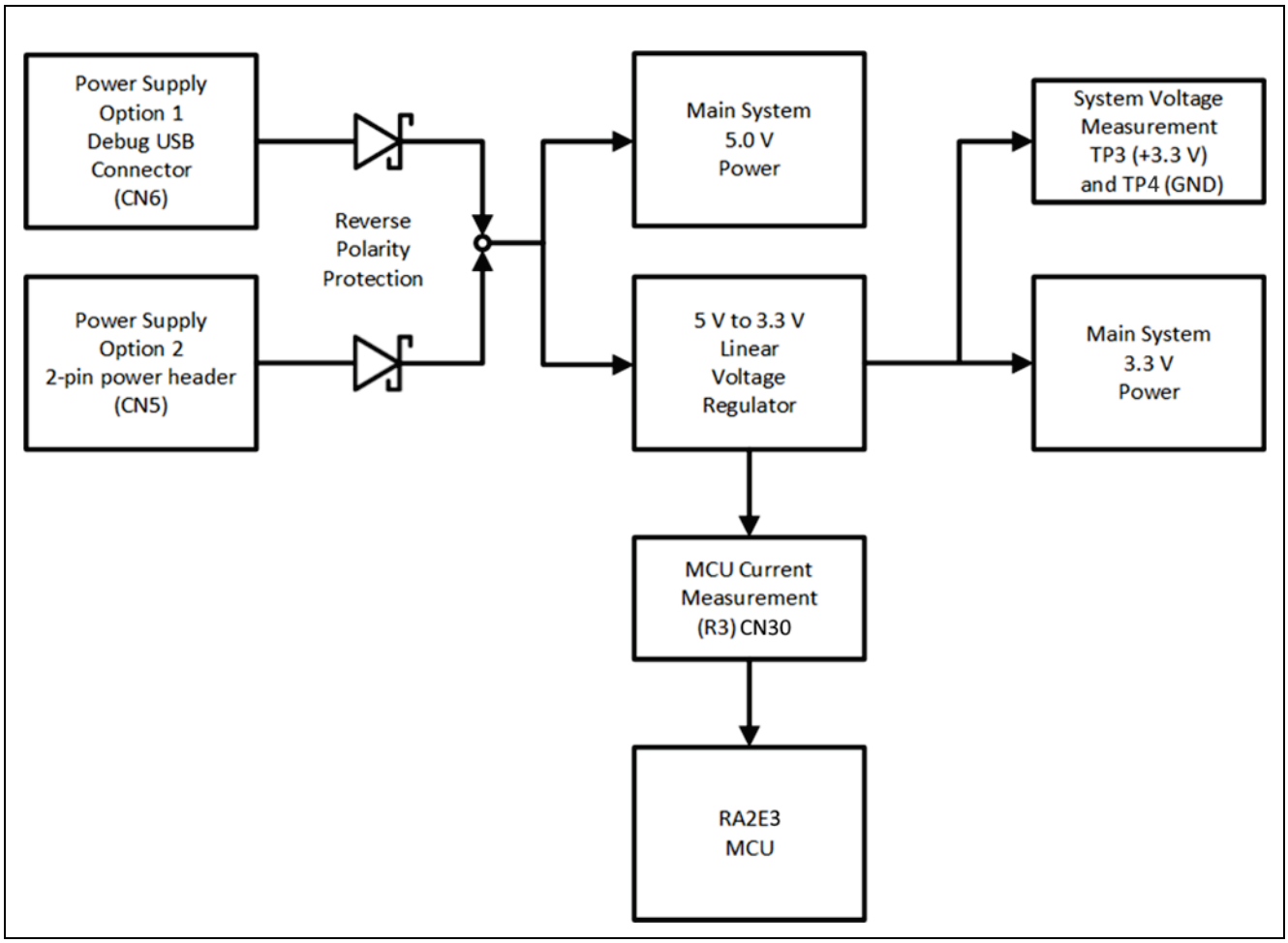

Figure 6. Power Supply Options

The MCU can be operated at a lower voltage than 3.3 V by removing the current measurement resistor and powering the MCU via CN30.

Note: Other changes to the circuit where interfaces or pull-up resistors are used may also need to be removed. Please review the schematic carefully before making these changes.

5.1.1.1 Option 1: Debug USB

5 V may be supplied from an external USB host to the USB debug connector (CN6) labelled POWER on the board. Power from this source is connected to the main system 5 V power. Reverse current protection is provided between this connector and the main system 5 V power.

5.1.1.2 Option 2: Header Connector CN5

5 V may be supplied from an external power supply to connector CN5. CN5 is a standard 2-pin header on a 0.1” (2.54 mm) pitch. Pin 1 is GND, and pin 2 is +5 V. Power from this source is connected to the main system 5 V power. Reverse current protection is provided between CN5 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 100 mA before enumeration, and 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.

5.2 Debug and Trace

The FPB-RA2E3 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 Modes	Debug MCU (the device that connects to the IDE on PC)	Target MCU (the device that is being debugged)	Debugging Interface/ Protocol	Connector Used
Debug on-board	RA4M2 (on-board)	RA2E3 (on-board)	SWD	Micro USB (CN6)
Debug in	External debugging tools	RA2E3 (on-board)	SWD	10-pin connector (CN4)
Debug out	RA4M2 (on-board)	Any external RA MCU	SWD, JTAG, SWO	Micro USB (CN6) plus 10-pin connector (CN4)

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

Table 5. Jumper Connection Summary for Different Debug Modes

Debug Modes	CN3	J8	J9	J29
Debug on-board	1-2	1-2	Open	J29 not fitted, link E44, E45, E46, E47
Debug in	1-2	1-2	Closed	J29 not fitted, link E44, E45, E46, E47
Debug out	2-3	2-3	Open	J29 not fitted, cut E44, E45, E46, E47

Note: J8 is not fitted to the board by default and is shorted by E43. If J8 needs to be fitted, cut E43.

Note: CN3 is not fitted to the board by default and is shorted by E27. If CN3 needs to be fitted, cut E27.

5.2.1 On-Board Debug

Debug USB micro-B connector (CN6) connects the SEGGER J-Link On-Board debugger to an external USB full speed host, allowing re-programming and debugging of the target RA MCU firmware.
The J-Link On-Board debugger connects to the target RA MCU using the SWD interface.

Table 6. Debug USB Port Assignments

Debug USB Connector		FPB-RA2E3
Pin	**Description**	**Signal/Bus**
CN6-1	+5VDC	+5V_USB_DBG
CN6-2	Data-	SEGGER J-Link On-Board Data-
CN6-3	Data+	SEGGER J-Link On-Board Data+
CN6-4	USB ID, jack internal switch, cable inserted	NC
CN6-5	Ground	GND

A yellow indicator, LED3, shows the visual status of the debug interface. When the FPB-RA2E3 board is powered on, and LED3 is blinking, it indicates that the SEGGER J-Link On-Board debugger is not connected to a programming host. When LED3 is on solid, it indicates that it is connected to a programming interface. When LED3 is flickering, it indicates that data is being transferred between the SEGGER J-Link On-Board debugger and the programming host.

To configure the FPB-RA2E3 board to use the Debug On-Board mode, configure the jumpers using the following table.

Table 7. Debug On-Board Jumper Configurations

Location	Open/Closed	Function
CN3 (not fitted)	Link 1-2 (or E27 linked)	Target RA MCU MD connected to debug
J8 (not fitted)	Link 1-2 (or E43 linked)	Target RA MCU RESET# connected to debug RESET#
J9 (not fitted)	Open	RA4M2 Debug MCU in normal operation mode
J29 (not fitted)	Jumpers on pins 1-2, 3-4, 5-6, 7-8 or E44, E45, E46, E47 linked	Target RA MCU debug signals connected to the Debug Interface

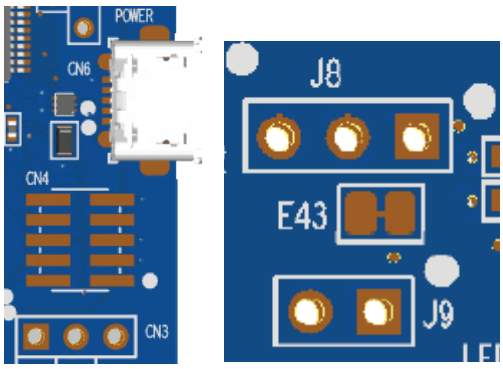

Figure 7. FPB-RA2E3 Debug Interface

5.2.2 Debug In

The 10-pin Cortex® Debug Connector at CN4 supports SWD, JTAG and SWO. This connector may be used for external debug of a target RA MCU.

To configure the FPB-RA2E3 board to use the Debug In mode, configure the jumpers using the following table.

Table 8. Debug In Mode Jumper Configurations

Location	Open/Closed	Function
CN3 (not fitted)	Link 1-2 (or E27 linked)	Target RA MCU MD connected to debug
J8 (not fitted)	Link 1-2 (or E43 linked)	Target RA MCU RESET# connected to debug RESET#
J9 (not fitted)	Closed	J-Link OB Debug MCU is held in RESET
J29 (not fitted)	Jumpers on pins 1-2, 3-4, 5-6, 7-8 or E44, E45, E46, E47 linked	Target RA MCU debug signals connected to the Debug Interface

Table 9. JTAG/SWD Port Assignments

JTAG/SWD Connector			FPB-RA2E3
Pin	**JTAG Pin Name**	**SWD Pin Name**	**Signal/Bus**
CN4-1	Vtref	Vtref	+3.3 V
CN4-2	TMS	SWDIO	P108/SWDIO
CN4-3	GND	GND	GND
CN4-4	TCK	SWCLK	P300/SWCLK
CN4-5	GND	GND	GND
CN4-6	TDO	SWO	P109
CN4-7	Key	Key	NC
CN4-8	TDI	NC/EXTb	P110
CN4-9	GNDDetect	GNDDetect	GND
CN4-10	nSRST	nSRST	RESET#

5.2.3 Debug Out

The FPB-RA2E3 board can be configured to use the RA4M2 Debug MCU to debug target RA MCU on an external board.

A yellow indicator, LED3, shows the visual status of the debug interface. When the FPB-RA2E3 board is powered on, and LED3 is blinking, this indicates that the RA4M2 Debug MCU is not connected to a programming host. When LED3 is on solid, this indicates that the RA4M2 Debug MCU is connected to a programming interface.

To configure the FPB-RA2E3 board to use the Debug Out mode, configure the jumpers according to the following table.

Table 10. Debug Out Jumper Configurations

Location	Open/Closed	Function
CN3 (not fitted)	Link 2-3 (and cut E27)	No connection to RA MCU
J8 (not fitted)	Link 2-3 (and cut E43)	On-board RA MCU is held in RESET
J9 (not fitted)	Open	J-Link OB Debug MCU in normal operation mode
J29 (not fitted)	All Jumpers removed E44, E45, E46, E47 cut	Disconnects the on-board RA MCU debug signals from the Debug Interface

5.2.4 Debugger configurations in e² studio

Figure 8 shows the configurations for e² studio when creating a new project for the FPB-RA2E3 Fast Prototyping Board.

[Debug hardware]: Select [J-Link ARM]

[Target Device]: Select [R7FA2E307]

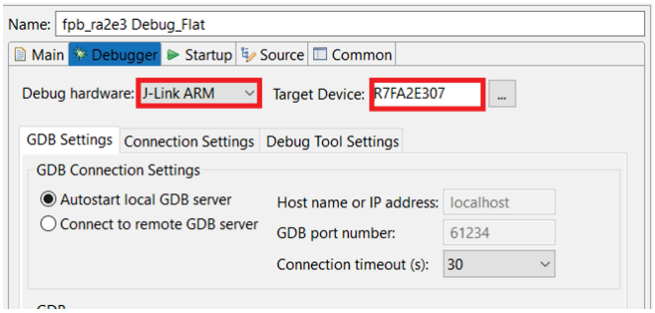

Figure 8. e² Studio Debugger Configurations

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. Two Digilent Pmod™ (SPI , I²C and UART [Pmod 1] and I²C [Pmod 2]) connectors
2. Arduino™ (UNO R3) connectors

5.3.1 Digilent Pmod™ Connectors

5.3.1.1 Pmod 1

A 12-pin Pmod Type-2A / Type-3A / Type-6A connector is provided at connector Pmod 1. The RA MCU acts as the SPI master, and the connected module acts as an SPI slave device.

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

Table 11. Pmod 1 Port Assignments

Pmod 1 Connector			FPB-RA2E3	Pmod 1 Configurations	
Pin	**Description**	**Option Type 6A**	**Signal/Bus**	**Short**	**Open**
Pmod 1-1	SS / CTS	NC/INT	P103 (SS0/CTS0)		
Pmod 1-2	MOSI / TXD	NC/RESET	P101 (MOSI0/TXD0)		
Pmod 1-3	MISO / RXD		P100 (MISO0/RXD0)	E41	E39
		SCL	P400 (SCL0)	E39	E41
Pmod 1-4	SCK		P102 (SCK0)	E42	E40, E35
	RTS		P407 (RTS0)	E35	E40, E42
		SDA	P401 (SDA0)	E40	E42, E35
Pmod 1-5	GND		GND		
Pmod 1-6	VCC		+3.3 V	E1	E2
			+5.0 V	E2	E1
Pmod 1-7	GPIO / INT (slave to master)		P015 (IRQ7)		
Pmod 1-8	GPIO / RESET (master to slave)		P915		
Pmod 1-9	GPIO		P914 (GPIO)		
Pmod 1-10	GPIO		P913 (GPIO)		
Pmod 1-11	GND		GND		
Pmod 1-12	VCC		+3.3 V	E1	E2
			+5.0 V	E2	E1

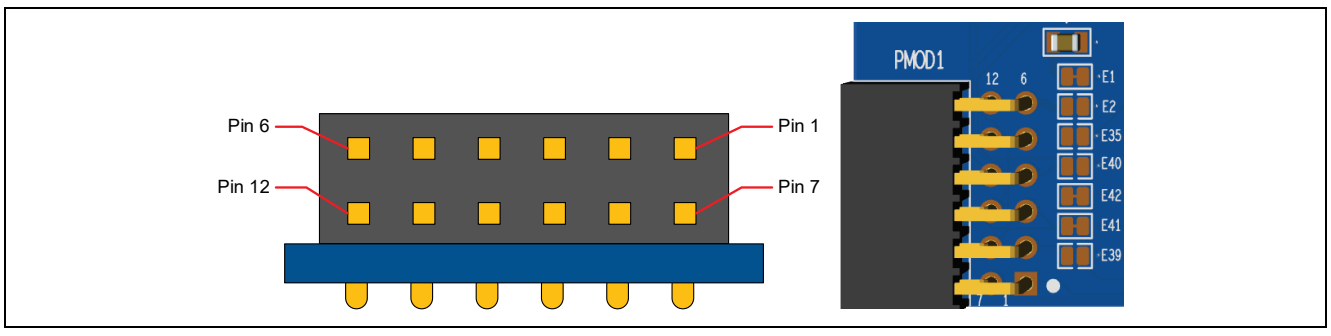

Figure 9. Pmod 1 Connector

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 I²C connections. There is also an alternative 5 V power source option. In order to configure Pmod 1 for Type 6A operation, modify the trace cut jumpers as described in Table 11.Pmod 1 Port Assignments. The trace cut jumpers are shown in Figure 10.

Note: Exercise caution while modifying power source trace jumpers, E1 and E2. Permanent damage to the FPB-RA2E3 board and/or connected modules may result.

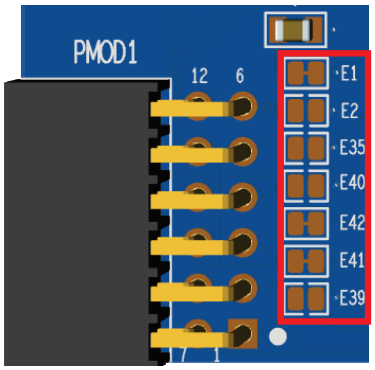

Figure 10. Pmod 1 Trace Cut Jumpers

5.3.1.2 Pmod 2

A 12-pin Pmod type-6A connector is provided at connector Pmod 2. The RA MCU acts as the I²C master, and the connected module acts as an I²C slave device.

This Pmod 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 trace cut jumpers as described in Table 12.

Table 12. Pmod 2 Port Assignments

Pmod 2 Connector		**FPB-RA2E3**	**Pmod 2 configurations**	
Pin	**Description**	**Signal/Bus**	**Short**	**Open**
Pmod 2-1	INT	P408 (IRQ7)		
Pmod 2-2	RESET	P212 (GPIO)		
Pmod 2-3	SCL	P400 (SCL0)		
Pmod 2-4	SDA	P401 (SDA0)		
Pmod 2-5	GND	GND		
Pmod 2-6	VCC	+3.3 V	E33	E34
		+5.0 V	E34	E33
Pmod 2-7	GPIO	P208		
Pmod 2-8	GPIO	P207		
Pmod 2-9	GPIO	P206		
Pmod 2-10	GPIO	P301		
Pmod 2-11	GND	GND		
Pmod 2-12	VCC	+3.3 V	E33	E34
		+5.0 V	E34	E33

Note: Exercise caution while modifying power source trace jumpers, E33 and E34. Permanent damage to the FPB-RA2E3 board and/or connected modules may result.

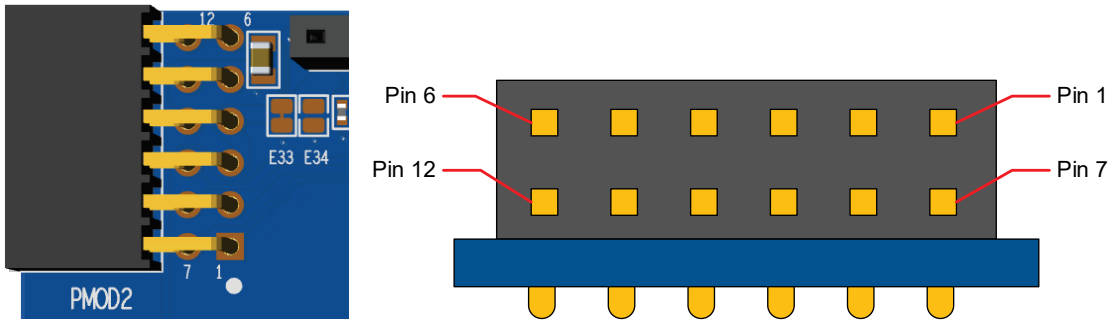

Figure 11. Pmod 2 Connector

5.3.2 Arduino™ Connector

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

Table 13. Arduino™ UNO Port Assignments

Arduino™ Compatible Connector		**FPB-RA2E3**
Pin	**Description**	**Signal/Bus**
J2-1	NC	NC
J2-2	IOREF	+3.3 V
J2-3	RESET	RESET#
J2-4	3.3 V	+3.3 V
J2-5	5 V	+5.0 V
J2-6	GND	GND
J2-7	GND	GND
J2-8	VIN	NC
J6-1	A0	P000 (AN000)
J6-2	A1	P001 (AN001)
J6-3	A2	P002 (AN002)
J6-4	A3	P012 (AN007)
J6-5	A4	P013 (AN008)
J6-6	A5	P014 (AN009)
J5-1	D0 / RXD	P110 (GPIO/RXD9)
J5-2	D1 / TXD	P109 (GPIO/TXD9)
J5-3	D2 / INT0	P409 (GPIO/IRQ6)
J5-4	D3 / INT1 / PWM	P111 (GPIO/IRQ4/GTIOC6A)
J5-5	D4	P301 (GPIO)
J5-6	D5 / PWM	P302 (GPIO/GTIOC7A)
J5-7	D6 / PWM	P500 (GPIO/GTIOC5A)
J5-8	D7	P206 (GPIO)
J1-1	D8	P112 (GPIO)
J1-2	D9 / PWM	P104 (GPIO/GTIOC4B)
J1-3	D10 / SPI_SS / PWM	P103 (GPIO/SS0/GTIOC5A)
J1-4	D11 / SPI_MOSI / PWM	P101 (GPIO/MOSI0/GTIOC8A)
J1-5	D12 / SPI_MISO	P100 (GPIO/MISO0)
J1-6	D13 / SPI_SCK	P102 (GPIO/SCK0)
J1-7	GND	GND
J1-8	AREF	CON_P010/VREFH0
J1-9	I^2C SDA	P401 (SDA0)
J1-10	I^2C SCL	P400 (SCL0)

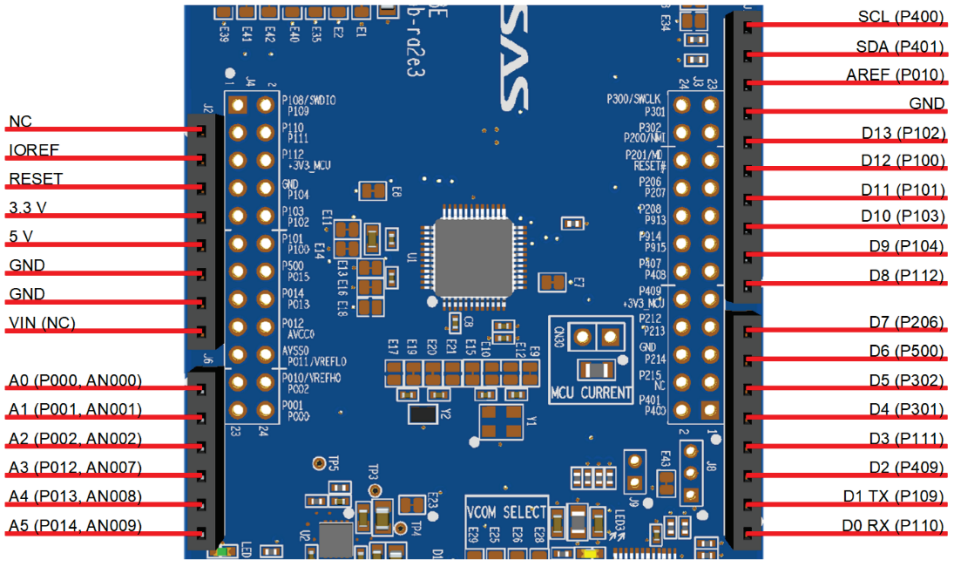

Figure 12. Arduino™ UNO Connectors

5.4 Miscellaneous

5.4.1 User and Power LEDs

Four LEDs are provided on the FPB-RA2E3 board.

Behavior of the LEDs on the FPB-RA2E3 board is described in the following table.

Table 14. FPB-RA2E3 Board LED Functions

Designator	Color	Function	MCU Control Port
LED1	Green	User LED	P213
LED2	Green	User LED	P914
POWER	Green	Power on indicator	+3.3 V
LED3	Yellow	Debug LED	SEGGER J-Link On-Board Debugger MCU

The User LEDs may be isolated from the main MCU so that the associated ports can be used for other purposes. To disconnect LED1 from P213, trace cut jumper E8 must be open. To disconnect LED2 from P914, trace cut jumper E7 must be open.

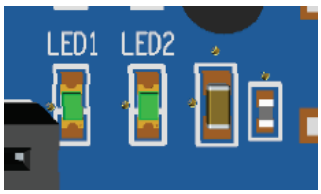

Figure 13. User LEDs

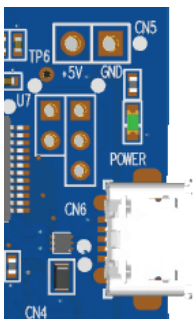

Figure 14. Power LED

5.4.2 User and Reset Switches

Two miniature, momentary, mechanical push-button type SMD switches are mounted on the FPB-RA2E3 board.

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

Table 15. FPB-RA2E3 Board Switches

Designator	Function	MCU Control Port
S1	User Switch	P200 (NMI)
S2	MCU Reset Switch	RESET#

The 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, trace cut jumper E24 must be open.

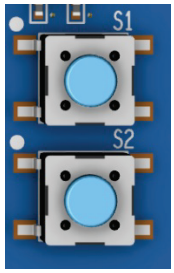

Figure 15. Reset (S2) and User Switch (S1)

5.4.3 MCU Boot Mode

A two-pin header (J7) and a three-pin header (CN3) can be fitted to select the boot mode (P201) of the target RA MCU. For normal operation (single-chip mode), leave J7 open, CN3 open and E27 closed. To enable SCI boot mode, place a jumper on J7 or CN3 pins 2-3 and cut E27.

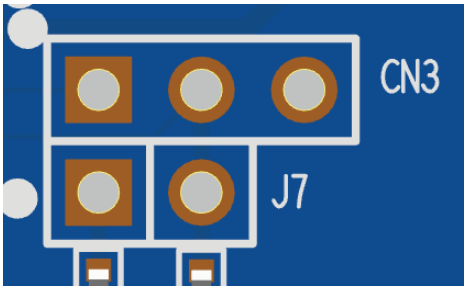

Figure 16. Boot Mode Jumper (J7 and CN3)

5.4.4 MCU Clocks

The board is fitted with a RA MCU sub-clock oscillator crystal, providing a precision 32,768 Hz reference clock. The option has also been provided to fit an RA MCU oscillator crystal, providing a precision 20.000 MHz reference clock. A recommended part is the ABRACON ABM8-20.000MHZ-10-B1U-T.

Table 16. Clock Crystal Part Numbers

Clock	Schematic Reference	Manufacturer and Part Number
20.000 MHz	Y1	ABRACON ABM8-20.000MHZ-10-B1U-T
32,768 Hz	Y2	ABRACON ABS06-32.768KHZ-1-T

6. MCU Native Pin Access Area

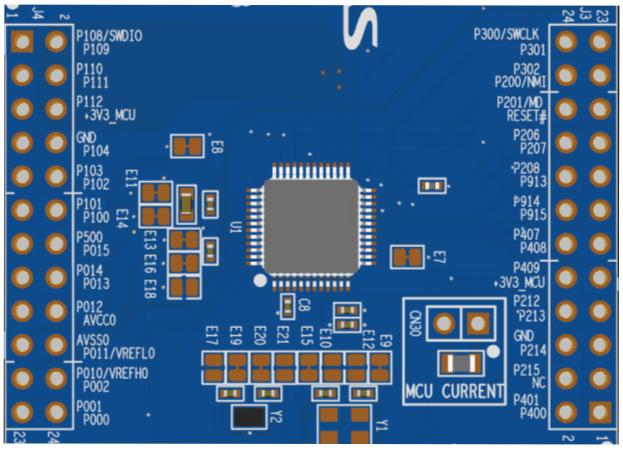

Figure 17. Native Pin Access Area J3 and J4

6.1 Breakout Pin Headers

The FPB-RA2E3 board pin headers (not fitted), J3 and J4, 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 RA2E3 MCU Group User's Manual for details of each port function, and the FPB-RA2E3 board schematic for pin header port assignments.

The placement of the breakout pin headers allows for a standard 2.54 mm (0.1") 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 RA2E3 MCU.

6.2 MCU Current Measurement

Included near the RA MCU is resistor R3 and test point CN30 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 across CN30.

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 across CN30. The current drawn by the MCU can then be calculated using Ohm's Law.

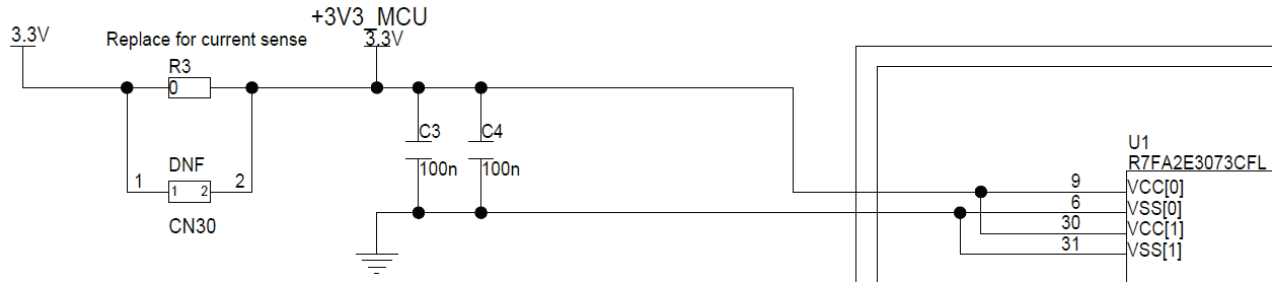

Figure 18. RA +3.3 V Current Measurement Circuit

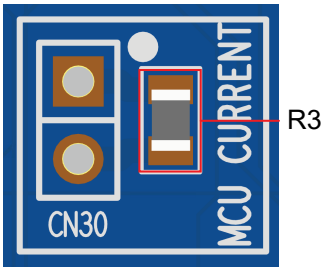

Figure 19. RA MCU +3.3 V Current Measurement Test Point and R3

7. Certifications

The FPB-RA2E3 v1 board meets the following certifications/standards. See page 4 of this user's manual for the disclaimer and precautions.

7.1 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

7.2 Material Selection, Waste, Recycling and Disposal Standards

- EU RoHS
- WEEE
- China SJ/T 113642014, 10-year environmental protection use period.

7.3 Safety Standards

- UL 94V-0

8. Design and Manufacturing Information

The design and manufacturing information for the FPB-RA2E3 v1 kit is available in the “FPB-RA2E3 v1 Design Package” available on renesas.com/ra/fpb-ra2e3.

- Design package file name: fpb-ra2e3-v1-designpackage.zip
- Design package contents

Table 17. FPB-RA2E3 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	fpb-ra2e3-v1-schematics
File (PDF)	Mechanical Drawing	fpb-ra2e3-v1-mechdwg
File (PDF)	3D Drawing	fpb-ra2e3-v1-3d
File (PDF)	BoM	fpb-ra2e3-v1-bom
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files-Cadence Allegro

9. 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-RA2E3 Resources	renesas.com/ra/fpb-ra2e3
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
RA Kit Feedback and Feature Request	renesas.com/ra/kitfeedback
Renesas Support	renesas.com/support

Revision History

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		Page	Summary
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