

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.).

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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 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 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
 - Two User LEDs (green)
 - Power LED (green) indicating availability of regulated power
 - Debug/power LED (yellow) indicating power and the debug connection
 - One user button
 - One reset button
- Two popular ecosystem expansions
 - Two Digilent Pmod™ (SPI, UART, and I²C) connectors
 - Arduino® (Uno R3) connectors

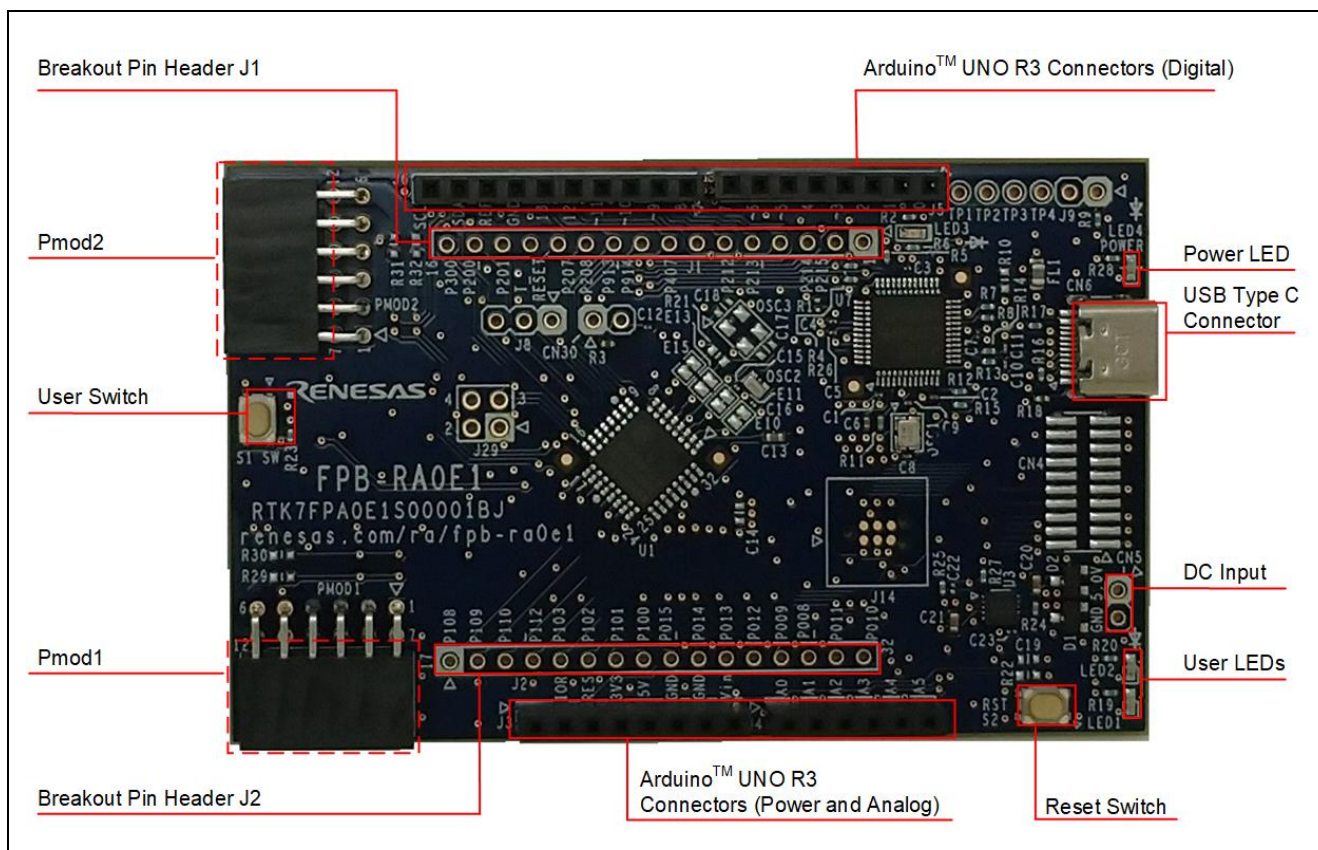


Figure 1. FPB-RA0E1 Board Top Side

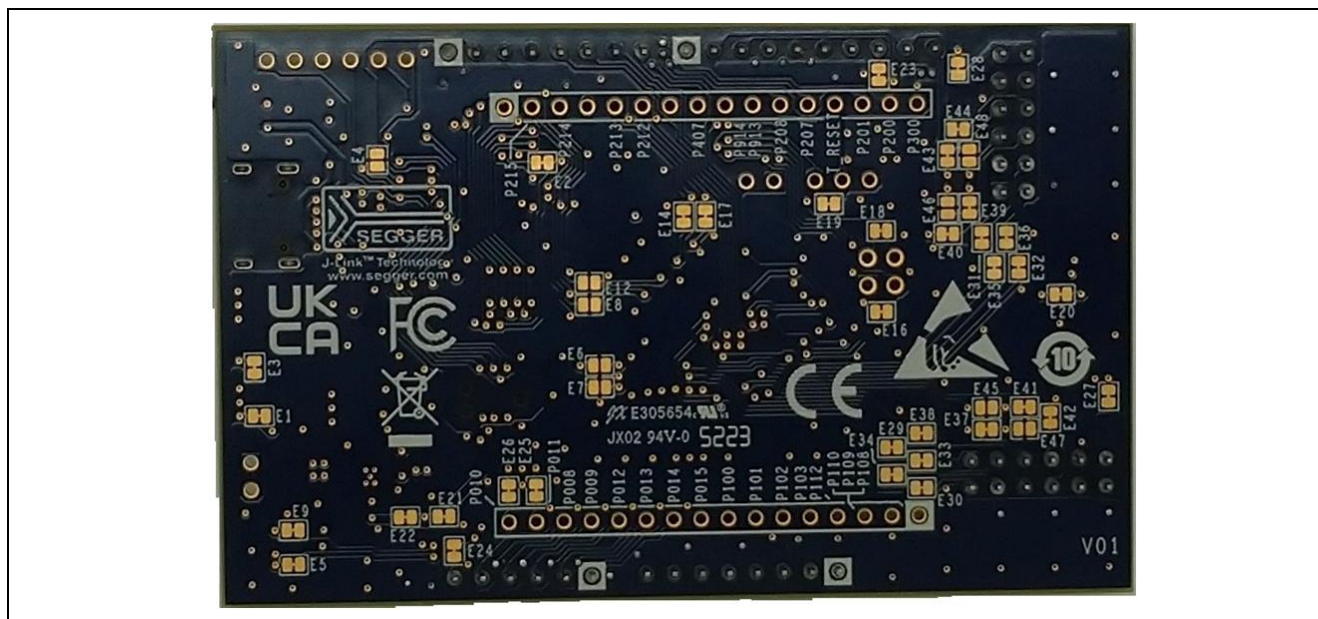


Figure 2. FPB-RA0E1 Board Bottom Side

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 tutorial manual.
- (5) The MCU fitted to the FPB-RA0E1 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-RA0E1 v1 board
- (2) Printed Quick Start Guide
- (3) China RoHS document
- (4) USB Type-A to Type-C cable

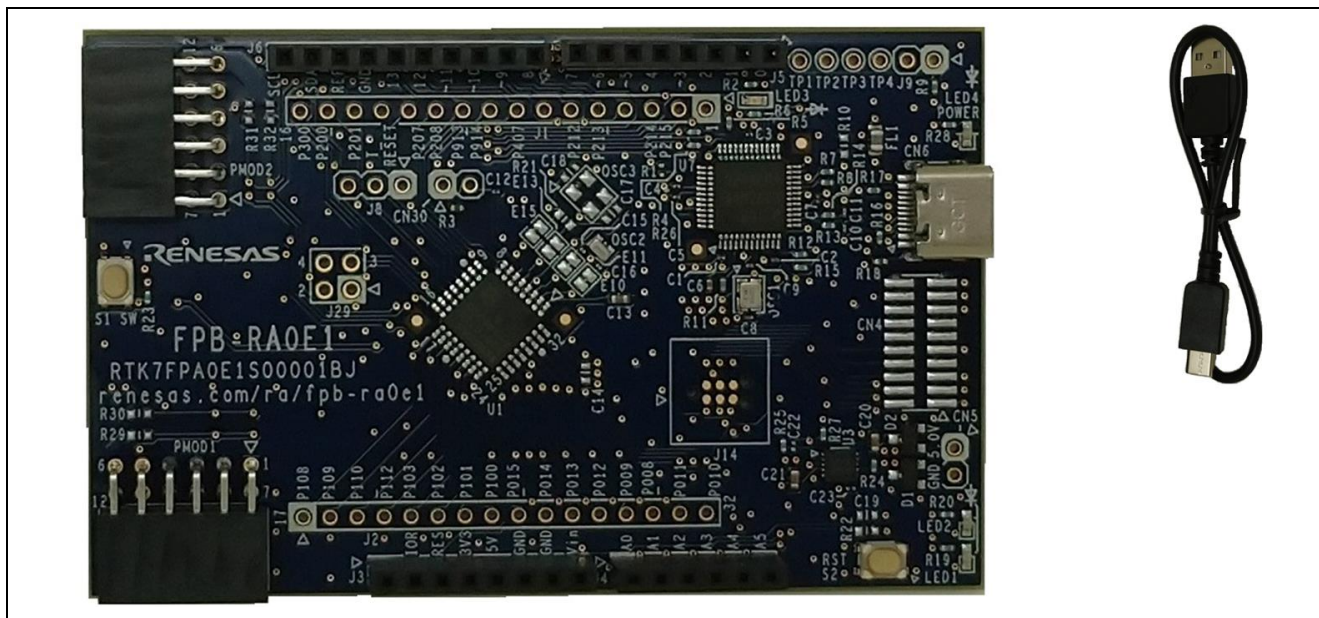


Figure 3. Configuration of the FPB-RA0E1 v1 Evaluation Kit

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 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, 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 boards |

4.2 Block Diagram

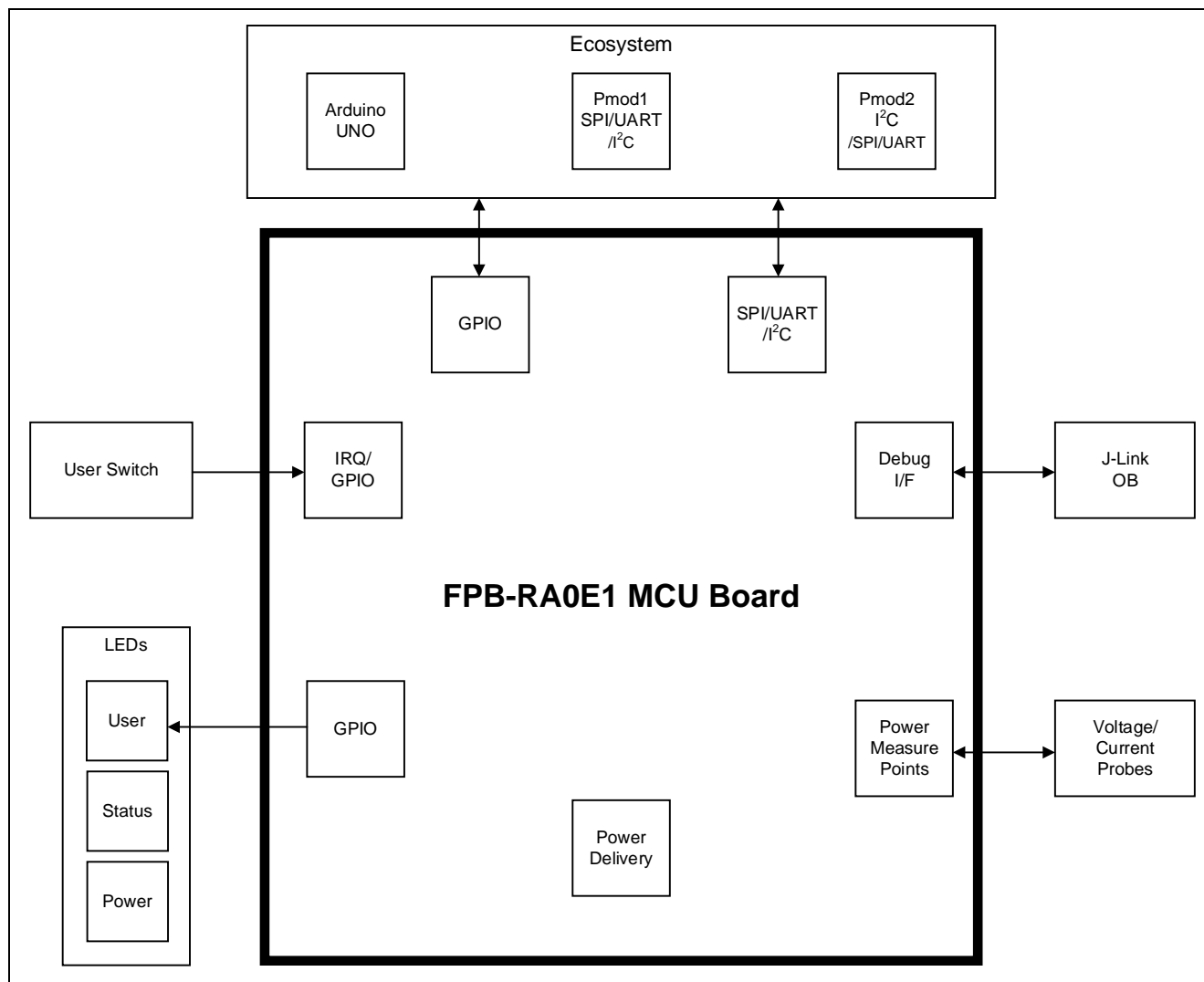


Figure 4. FPB-RA0E1 Board Block Diagram

4.3 Jumper Settings

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

- (1) Copper jumpers (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, 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 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 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 designation) and traditional pin header jumpers (Jx designation).

The circuit group for each jumper is the designation found in the board schematic (available in the Design Package). Functional details for many of the listed jumpers may be found in sections associated with each functional area of the kits.

Table 3. Default Jumper Settings

| Location | Circuit Group | Default 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. |
| 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. |

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.

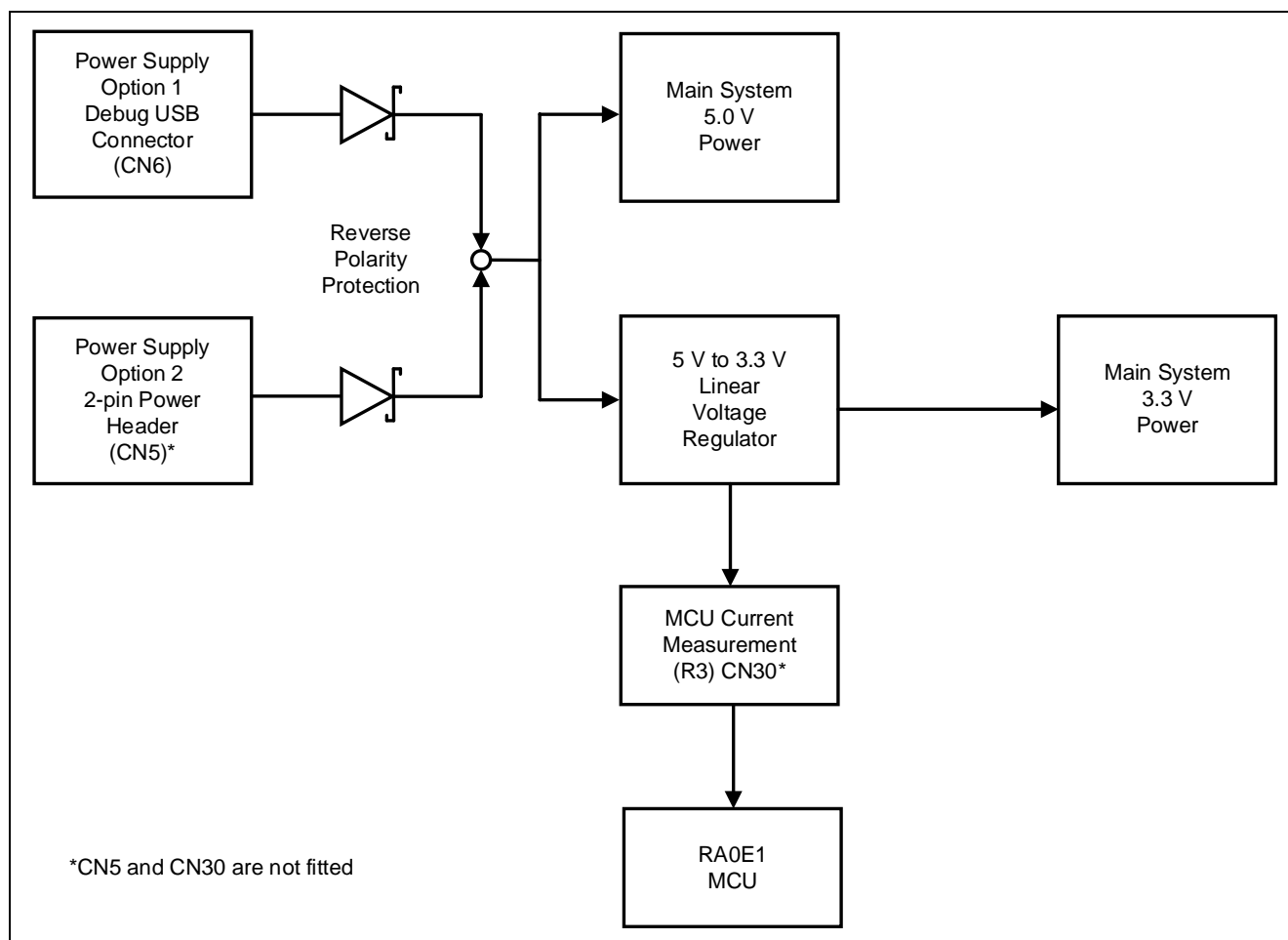


Figure 6. Power Supply Options

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 Power-up Behavior

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

5.2 Debug and Trace

The FPB-RA0E1 board can be programmed and debugged using the built-in SEGGER J-Link Emulator On-Board debugger.

5.2.1 On-Board Debug

The on-board debug functionality is provided using Renesas RA4M2 Debug MCU and SEGGER J-Link® firmware.

Debug USB 2.0 Type-C™ connector (CN6) connects the RA4M2 Debug MCU to an external USB full speed host, allowing re-programming and debugging of the target RA MCU firmware. This connection is the default debug mode for the FPB-RA0E1 board.

The RA4M2 Debug MCU connects to the target RA MCU using the SWD interface.

Table 4. Debug USB Connector

| Debug USB Connector | | FPB-RA0E1 |
|-----------------------------------|--|-------------------------|
| Pin | Description | Signal/Bus |
| CN6: A4, B4, A9, B9 | +5VDC | +5V_USB_DBG |
| CN6: A7, B7 | Data- | JLOB_USB_DM (U7 pin 14) |
| CN6: A6, B6 | Data+ | JLOB_USB_DP (U7 pin 15) |
| CN6: CC1, CC2, SH1, SH2, SH3, SH4 | USB ID, jack internal switch, cable inserted | NC |
| CN6: 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), DEBUG LED, shows the visual status of the debug interface. When the FPB-RA0E1 board is powered on, and the DEBUG LED is blinking, it indicates that the RA4M2 Debug MCU is not connected to a programming host. When the DEBUG LED is on solid, it indicates that it is connected to a programming interface. When the DEBUG LED is flickering, it indicates that data is being transferred between the RA4M2 Debug MCU and the programming host.

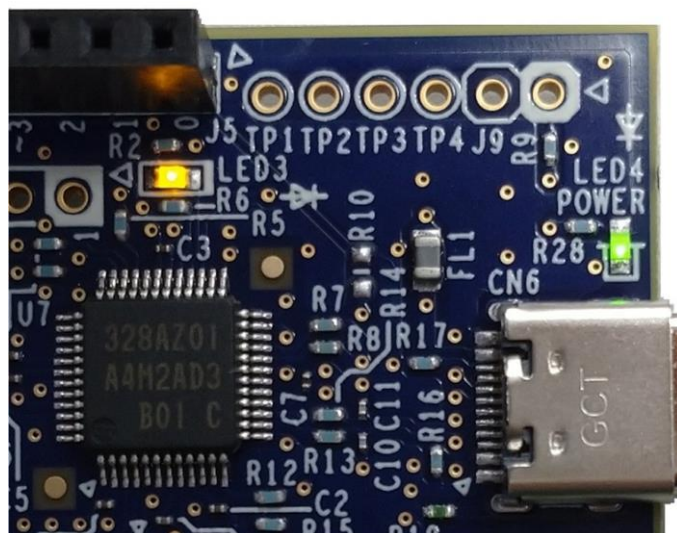


Figure 7. FPB-RA0E1 Debug Interface

5.2.2 Debugger Settings in e² studio

Figure 8 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].

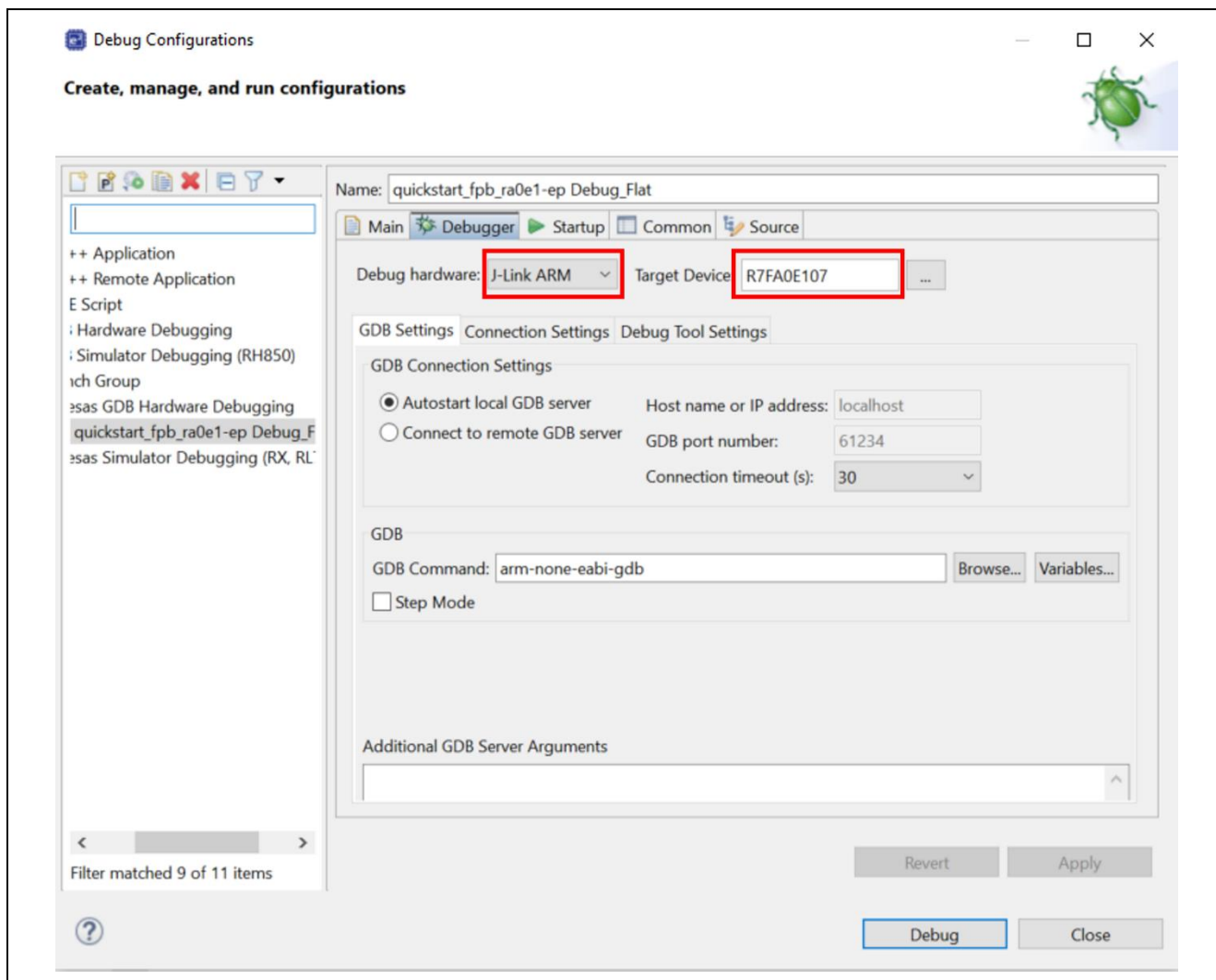


Figure 8. e² Studio Debugger Settings

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, UART and I²C) connectors
- (2) Arduino® (Uno R3) connectors

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 designation). 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 5. 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.

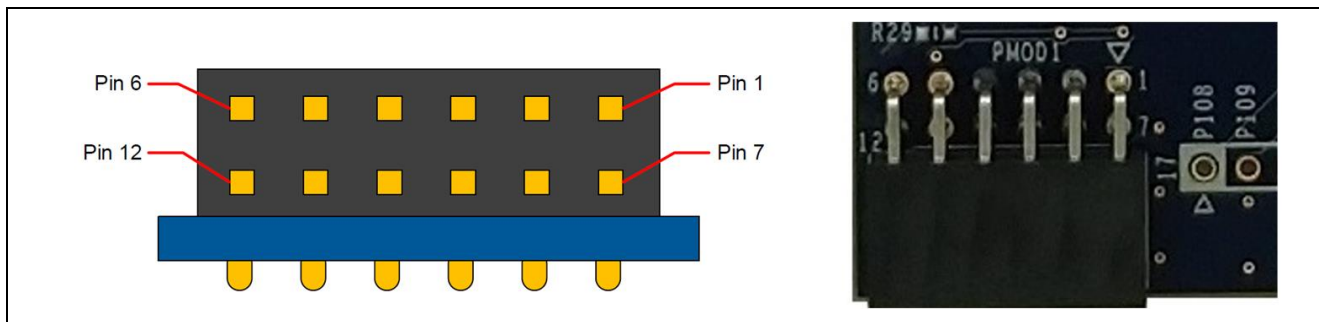


Figure 9. Pmod 1 Connector

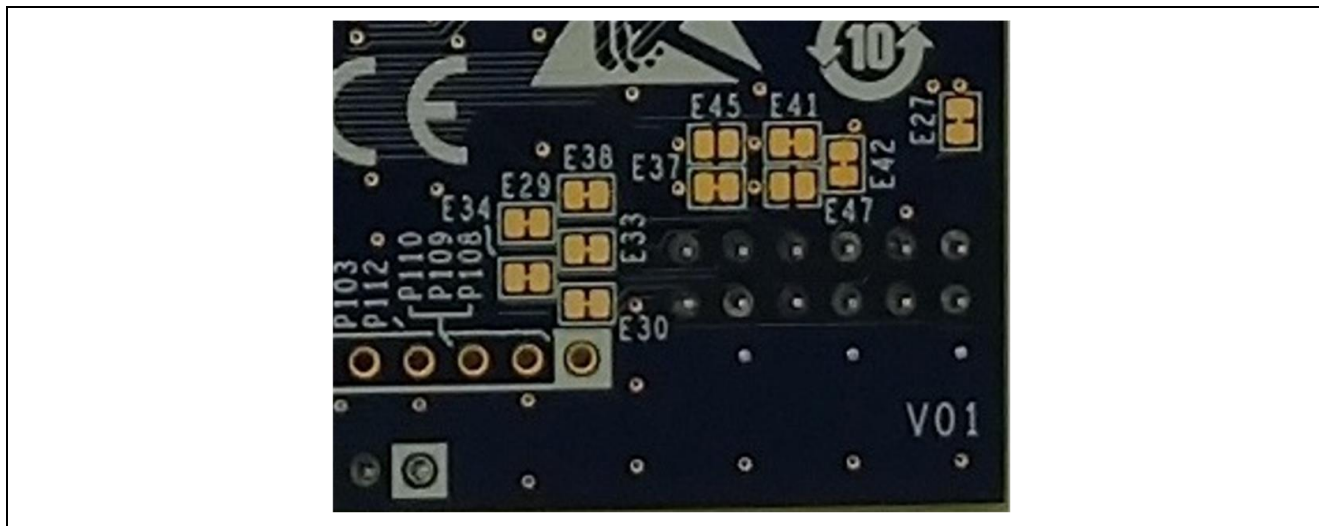


Figure 10. Pmod 1 Solder Bridge and Trace Cut Jumpers

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 6. 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.

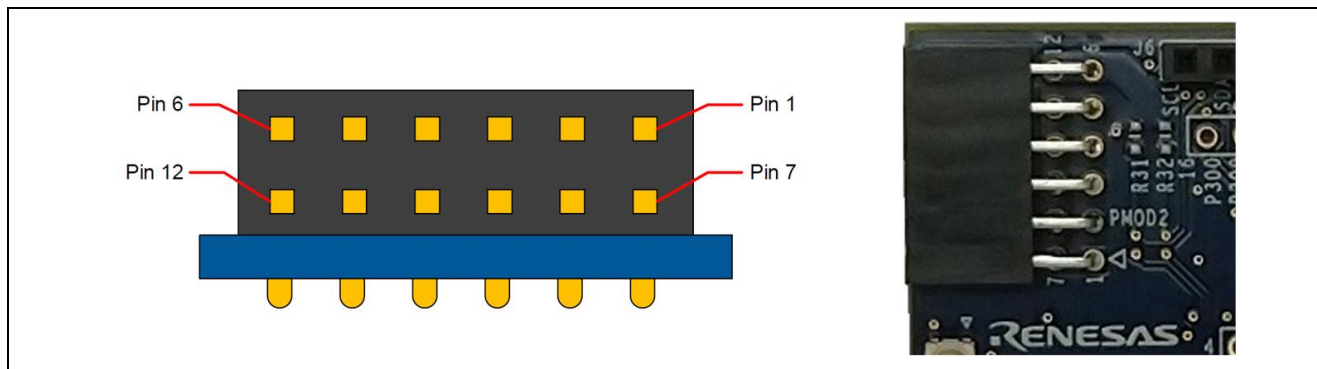


Figure 11. Pmod 2 Connector

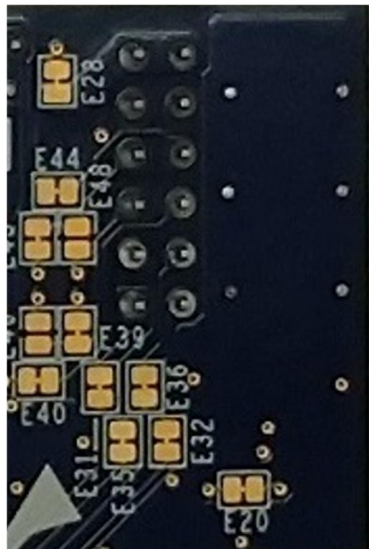


Figure 12. Pmod 2 Solder Bridge and Trace Cut Jumpers

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 7. Arduino Uno Connections

| Arduino Compatible Connector | | FPB-RA0E1 |
|------------------------------|-------------|------------------|
| Pin | Description | Signal/Bus |
| J3-1 | NC | NC |
| J3-2 | IOREF | 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.

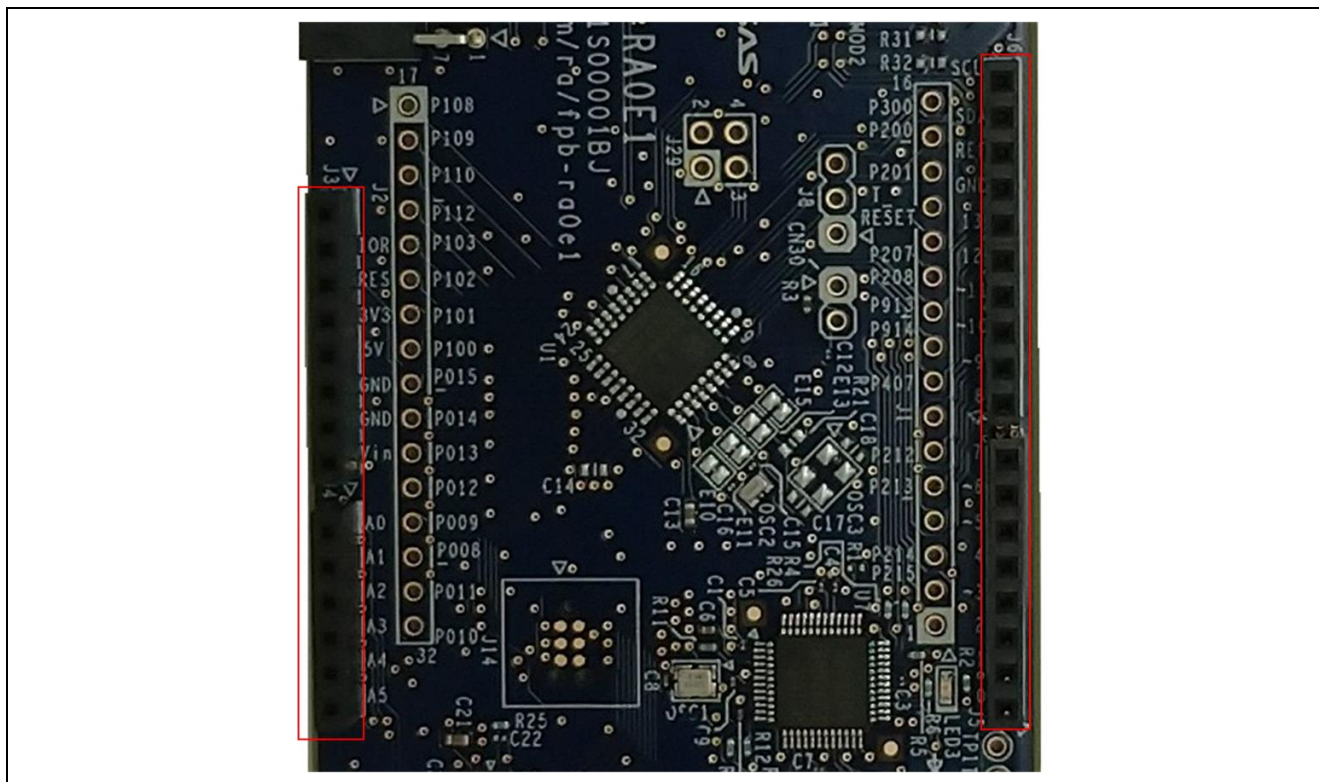


Figure 13. Arduino Uno Connectors

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 8. 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 | Renesas RA4M2 Debug MCU |
| 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, trace cut jumper E5 must be open. To disconnect LED2 from P009, trace cut jumper E9 must be open.

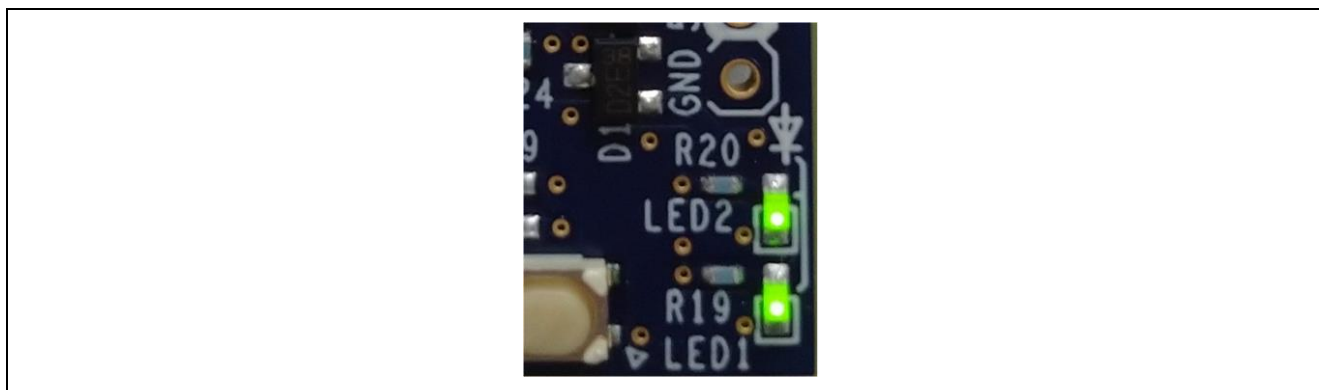


Figure 14. User LEDs



Figure 15. Power LED



Figure 16. Debug 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 9. 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, trace cut jumper E20 must be open.



Figure 17. Reset Switch (S2) and User Switch (S1)

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. The ABRACON ABM8-20.000MHZ-10-B1U-T is a recommended part.

6. MCU Native Pin Access

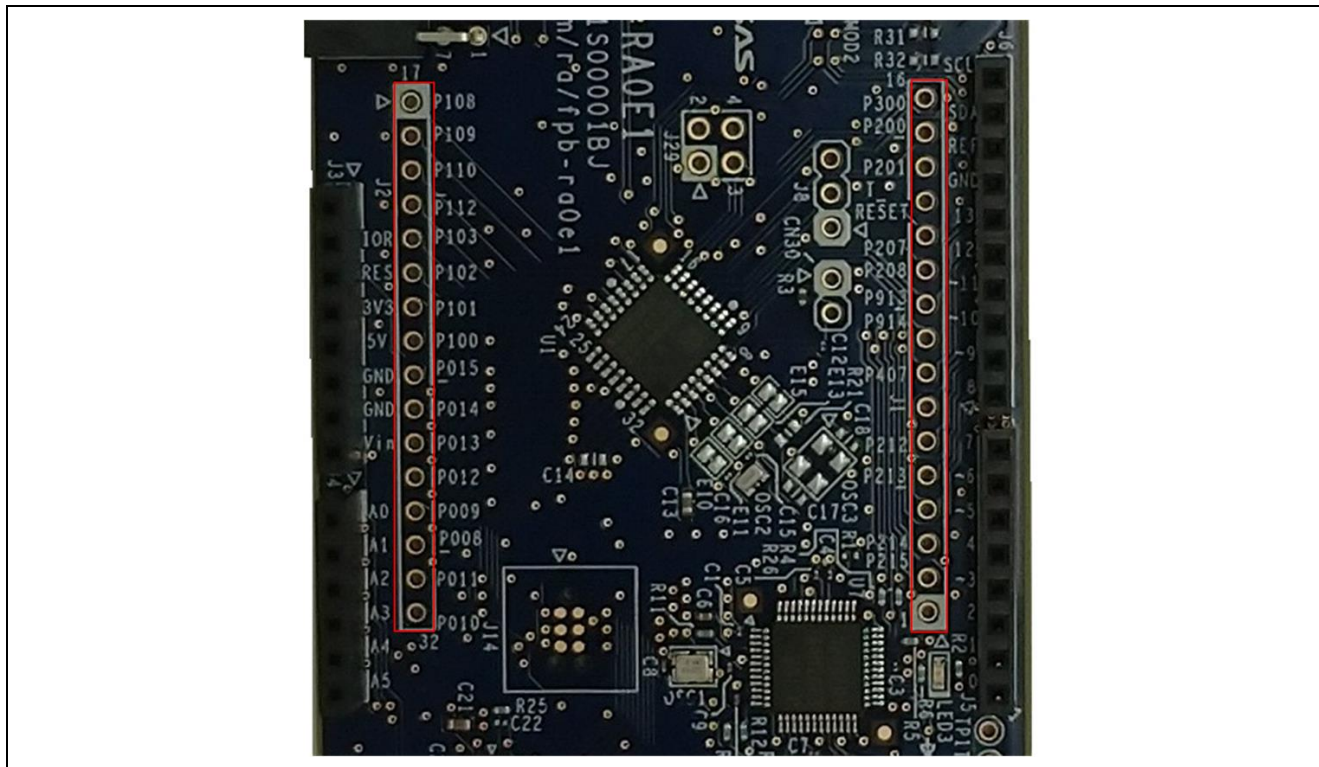


Figure 18. Native Pin Access J1 and J2

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 RA0E1 MCU.

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 m Ω), 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.

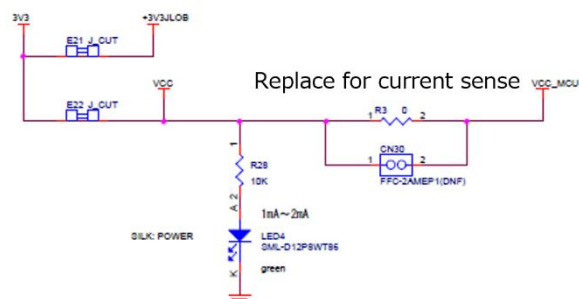


Figure 19. RA +3.3 V Current Measurement Circuit

Current Measurement Point

R3

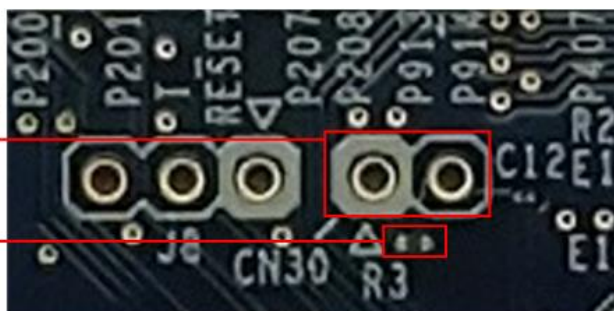


Figure 20. RA MCU +3.3 V Current Measurement Point (CN30) and R3

7. Recommended Parts

Table 10 lists recommended part numbers for optional components that can be fitted as required.

Table 10. Part Numbers

| Designator(s) | Description | Manufacturer | Part Number |
|---------------|--------------------|------------------|-------------------------|
| OSC3 | 20 MHz Crystal | ABRACON | ABM8-20.000MHZ-10-B1U-T |
| J1, J2 | 16-way male header | Würth Elektronik | 613 016 111 21 |
| CN5, CN30 | 2-way male header | Würth Elektronik | 613 002 111 21 |

8. Certifications

The FPB-RA0E1 v1 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-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 11. 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/ra/fpb-ra0e1 |
| 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 |

Provide Feedback/Request a Feature

Renesas aims to provide the best microcontroller kit experience to help our customers jumpstart innovation and take products to market faster with the RA family of microcontrollers. The Renesas RA microcontroller kits have been designed with a lot of attention to detail and customer-cantered thinking in every aspect of the design. Renesas aims to exceed customer expectation.

Renesas looks forward to hearing your feedback and learning how we can enhance your experience. Please share your feedback at renesas.com/ra/kitfeedback.

11. Note on Usage

This chapter describes note on using the FPB-RA0E1 v1 board.

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.

Revision History

| Rev. | Date | Description | |
|------|-----------|-------------|----------------------|
| | | Page | Summary |
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