User's Manual

RA2T1 Group

Fast Prototyping Board for RA2T1 Microcontroller Group
FPB-RA2T1 v1
User's Manual

Renesas RA Family
RA2 Series

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1. Precaution against Electrostatic Discharge (ESD)

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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.
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   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-RA2T1 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
PWM	Pulse Width Modulation
RXD	UART 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	UART Transmit Data
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus

1. Board Overview

The FPB-RA2T1, a Fast Prototyping Board for the RA2T1 MCU Group, enables users to seamlessly evaluate the features of the RA2T1 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-RA2T1 board are categorized in two groups (consistent with the architecture of the board) as follows:

MCU and MCU Native Pin Access

- R7FA2T1074CFL MCU (referred to as RA MCU)
- 64 MHz, Arm® Cortex®-M23 core
- 64 KB Code Flash, 8 KB SRAM, 2 KB Data Flash
- 48-pin, LFQFP package
- Native pin access through 2 x 24-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) can also be used for the main clock.

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
  - Digilent Pmod™ (SPI, UART, and I^{2}C) connector x 2
  - Arduino® (Uno R3) connectors
- MCU boot configuration jumper (not fitted)

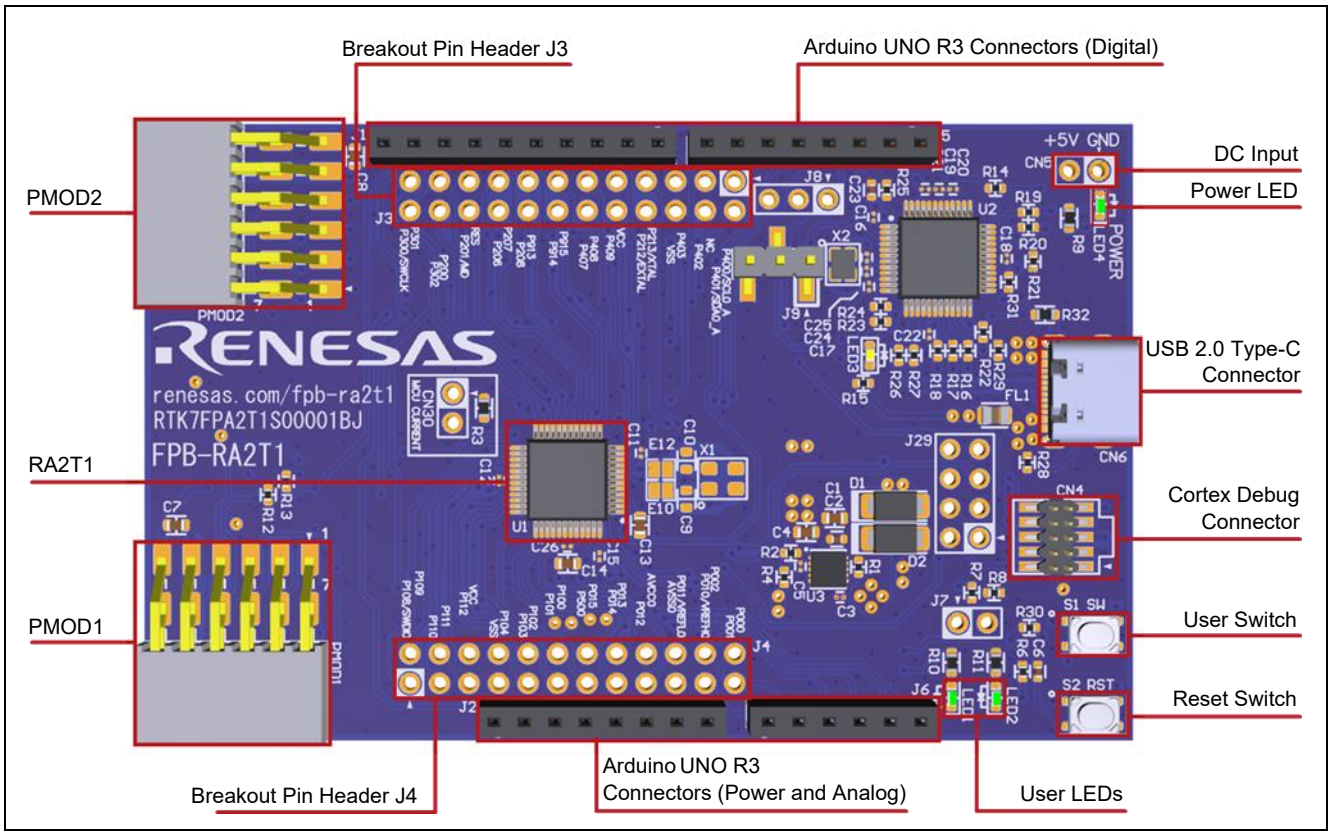

Figure 1. FPB-RA2T1 Board Top View

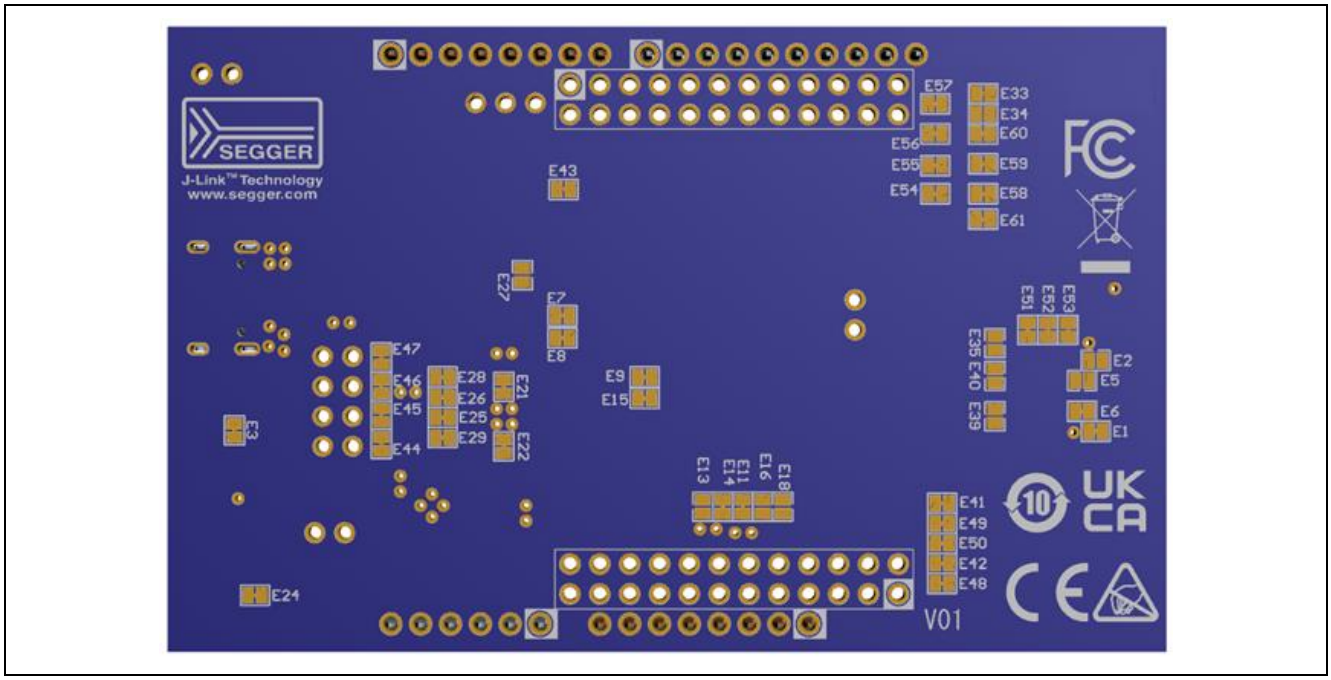

Figure 2. FPB-RA2T1 Board Bottom View

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-RA2T1 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-RA2T1 board.
4. Instructions to download and install software, import example projects, build them and program the FPB-RA2T1 board are provided in the FPB-RA0E1 tutorial and the Getting Started with Fast Prototyping Board for RA Family.
5. The RA MCU fitted to the FPB-RA2T1 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-RA2T1 v1 board
(2) USB cable (Type-C male to Type-C male)
(3) Printed Quick Start Guide
(4) China RoHS document

(1) (2)

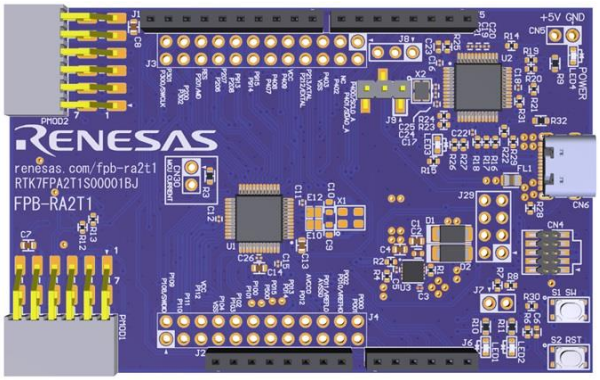

Figure 3. Configuration of the FPB-RA2T1 v1 Evaluation Kit

3. Ordering Information

- FPB-RA2T1 v1 orderable part number: RTK7FPA2T1S00001BJ

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

- FPB-RA2T1 board dimensions: 53.00 mm (width) x 85.00 mm (length)

4. Hardware Architecture and Default Configuration

4.1 Board Architecture

The FPB-RA2T1 board is designed with an architecture similar to other boards in the FPB series. Alongside the RA MCU there is an on-board programmer, pin headers for access to all the pins on the RA MCU, a power supply regulator, some LEDs and switches, and several ecosystem I/O connectors (Pmod and Arduino).

Table 2. Kit Architecture

Board Functionality	Features	Function present on all similar boards	Functionality is:
MCU Native Pin Access	RA MCU, all MCU I/Os and power, Breakout Pin Header for Current measurement	Yes	RA MCU dependent
System Control and Ecosystem Access	Power, Debugger, User LEDs and switches, Reset switch, and Ecosystem connectors	Yes	Same or similar across other FPB boards

4.2 Block Diagram

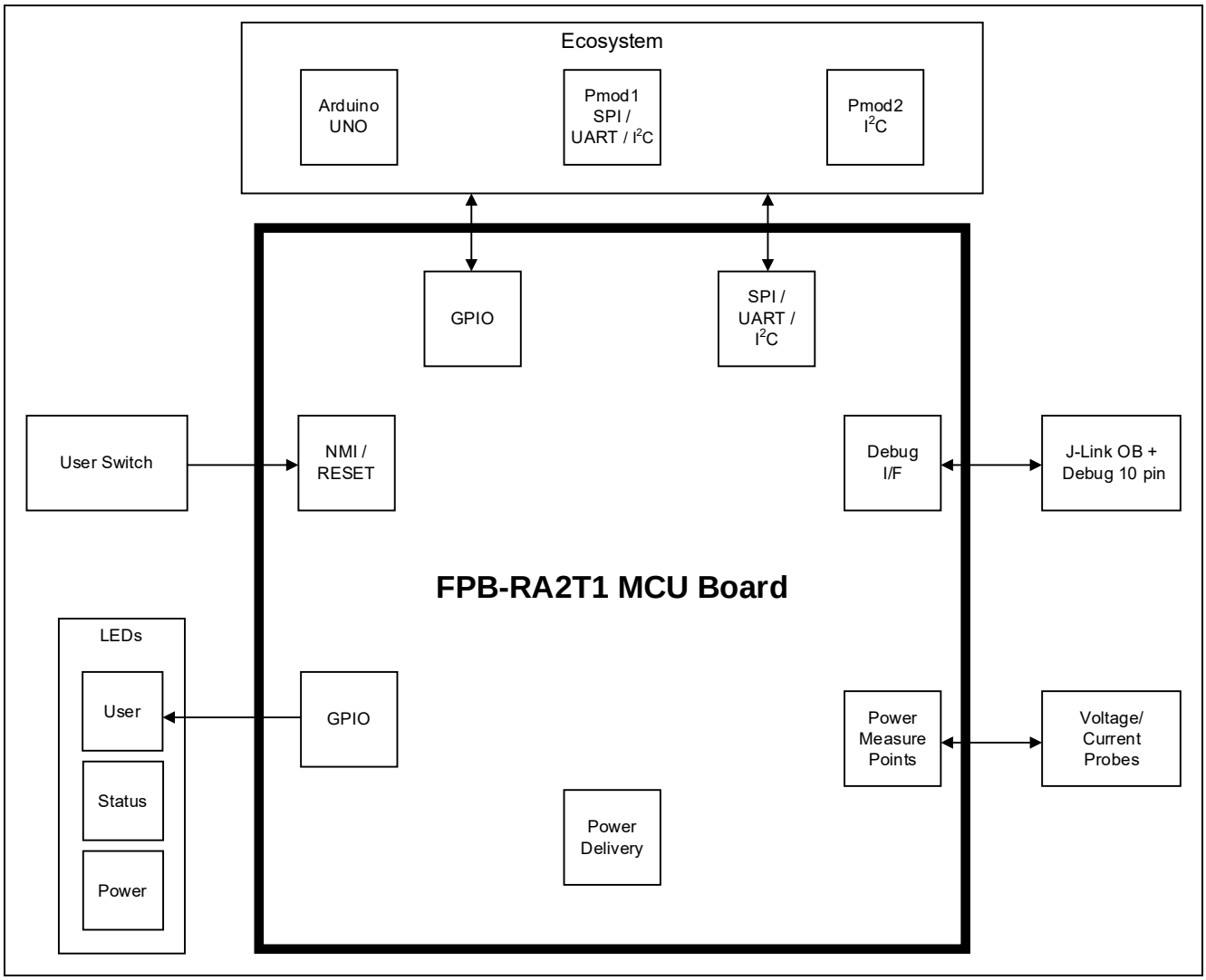

Figure 4. FPB-RA2T1 Board Block Diagram

4.3 Jumper Settings

Two types of jumpers are provided on the FPB-RA2T1 board.

(1) Copper jumpers (Jumper Trace Cut (closed) and Jumper Solder Bridge (open))
(2) Traditional pin header jumpers

The following sections describe each type and their default configuration.

4.3.1 Copper Jumpers

Copper jumpers are of two types, designated **Jumper Trace Cut (closed)** and **Jumper Solder Bridge (open)**.

A **Jumper Trace Cut (closed)** is provided with a narrow copper trace connecting its pads. The silk screen overlay printing around a Jumper Trace Cut (closed) is a solid box. To isolate the pads, cut the trace between pads adjacent to each pad, then remove the connecting copper foil either mechanically or with the assistance of heat. Once the etched copper trace is removed, the Jumper Trace Cut (closed) is turned into a Jumper Solder Bridge (open) for any later changes.

A **Jumper Solder Bridge (open)** is provided with two isolated pads that may be joined together by one of three methods:

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

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

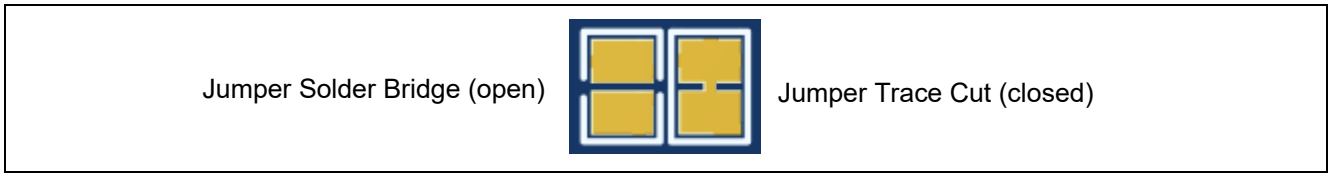

Figure 5. Copper Jumpers

4.3.2 Traditional Pin Header Jumpers

These jumpers are traditional small pitch jumpers that require an external shunt to open/close them. The traditional pin jumpers on the FPB-RA2T1 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-RA2T1 board. This includes copper jumpers (Ex designation) and traditional pin jumpers (Jx designation).

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

Table 3. Default Jumper Settings

Location	Circuit Group	Default Open/Closed	Function
CN30	Power	Open (not fitted)	Pin header for measuring current from VCC for the RA MCU. Remove R3 when VCC current drawn by the RA MCU is to be measured.
E1	PMOD1	Closed	Connects PMOD1-6 and PMOD1-12 to 3.3 V.
E2	PMOD1	Open	Connects PMOD1-6 and PMOD1-12 to 5.0 V[*1].
E3	Debugger	Closed	Connects CN4-9 to GND.
E5	PMOD1, PMOD2	Open	Connects pull-up resistors for P400/SCL0_A and P401/SDA0_A to 5.0 V[*1].
E6	PMOD1, PMOD2	Closed	Connects pull-up resistors for P400/SCL0_A and P401/SDA0_A to 3.3 V.
E7	LED2	Closed	Connects LED2 to P914.
E8	LED1	Closed	Connects LED1 to P213/XTAL.
E9	MCU Clock	Closed	Connects the P212/EXTAL net to pin 8 (P212/EXTAL) of the RA MCU.
E10	MCU Clock	Open	Connects the 20-MHz crystal oscillator to pin 7 (P213/XTAL) of the RA MCU[*1].
E11	MCU Power	Closed	Connects AVCC0 to 3.3 V.
E12	MCU Clock	Open	Connects the 20-MHz crystal oscillator to pin 8 (P212/EXTAL) of the RA MCU[*1].
E13	MCU Power	Open	Connects P011/VREFL0 to GND[*1].
E14	MCU Power	Closed	Connects AVSS0 to GND.
E15	MCU Clock	Closed	Connects the P213/XTAL net to pin 7 (P213/XTAL) of the RA MCU.
E16	MCU Power	Open	Connects P010/VREFH0 to 3.3 V[*1].
E18	MCU Power	Open	Connects J1-8 (Arduino AREF) to P010/VREFH0[*1].
E21	Power	Closed	Connects 3.3 V (VCC_3.3V) to +3V3JLOB.
E22	Power	Closed	Connects 3.3 V (VCC_3.3V) to VCC (3.3 V).
E24	Switch S1	Closed	Connects S1 to P200/NMI.
E25	Debugger	Closed	Connects U2-23 (P301) to J29-6, E46, and E29[*2].
E26	Debugger	Closed	Connects U2-33 (P103) and CN4-8 to J29-8, E47, and E28.
E27	Debugger	Open	Connects P201/MD to E45 and J29-3.
E28	Debugger	Closed	Connects U2-22 (P302) to J29-8, E47, and E26[*2].
E29	Debugger	Closed	Connects U2-36 (P100) and CN4-6 to J29-6, E46, and E25.
E33	PMOD2	Closed	Connects PMOD2-6 and PMOD2-12 to 3.3 V.
E34	PMOD2	Open	Connects PMOD2-6 and PMOD2-12 to 5.0 V[*1].
E35	PMOD1	Open	Connects P407/CTS0_RTS0_D to PMOD1-4 (RTS)[*1].
E39	PMOD1	Open	Connects P400/SCL0_A to PMOD1-3[*1].
E40	PMOD1	Open	Connects P401/SDA0_A to PMOD1-4[*1].
E41	PMOD1	Closed	Connects P100/MISOA_A to PMOD1-3 and E39.
E42	PMOD1	Closed	Connects P102/SCK0_A to PMOD1-4, E35, and E40.
E43	Debugger	Closed	Connects RES to U2-29 and CN4-10 (bypassing J8).
E44	Debugger	Closed	Connects P108/SWDIO to U2-35 and CN4-2 (bypassing J29).
E45	Debugger	Closed	Connects P300/SWCLK and E27 to U2-34 and CN4-4 (bypassing J29).
E46	Debugger	Closed	Connects P109/TXD9_B to E25 and E29 (bypassing J29).

Location	Circuit Group	Default Open/Closed	Function
E47	Debugger	Closed	Connects P110/RXD9_B to E26 and E28 (bypassing J29).
E48	PMOD1	Closed	Connects PMOD1-1 to P103/SSLA0_A/GTIOC2A_A.
E49	PMOD1	Closed	Connects PMOD1-2 to P101/MOSIA_A/GTIOC1A_B.
E50	PMOD1	Closed	Connects PMOD1-7 to P015/AN002.
E51	PMOD1	Closed	Connects PMOD1-8 to P915.
E52	PMOD1	Closed	Connects PMOD1-9 to P914.
E53	PMOD1	Closed	Connects PMOD1-10 to P913/GTIOC1B_A.
E54	PMOD2	Closed	Connects PMOD2-1 to P408.
E55	PMOD2	Closed	Connects PMOD2-2 to P212/EXTAL.
E56	PMOD2	Closed	Connects PMOD2-3 to P400/SCL0_A.
E57	PMOD2	Closed	Connects PMOD2-4 to P401/SDA0_A.
E58	PMOD2	Closed	Connects PMOD2-7 to P208.
E59	PMOD2	Closed	Connects PMOD2-8 to P207.
E60	PMOD2	Closed	Connects PMOD2-9 to P206.
E61	PMOD2	Closed	Connects PMOD2-10 to P301/RXD2_A.
J7	MCU Boot Mode	Open (Not fitted)	Sets the RA MCU to SCI boot mode. (The single-chip mode is set by default.)
J8	Debugger	1-2 Short (Not fitted)	1-2: Connects U1-19 (RES) and U2-29. (Reset control by J-Link OB) 2-3: Connects U1-19 (RES) to GND.
J9	Debugger	1-2 Short	1-2: Pull up U2-19. 2-3: Connects U2-19 to GND.
J29	Debugger	Open (Not fitted)	Connects debug signals of the RA MCU to the debug interface[*1].
R3	Power	Closed (Fitted)	Connects 3.3 V to the RA MCU. Remove this when current drawn by the RA MCU is to be measured by using CN30.

Notes: 1. The signal is not connected by default.
2. VCOM port (J-Link CDC UART port)

5. System Control and Ecosystem Access

The FPB-RA2T1 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-RA2T1 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-RA2T1 board can be powered.

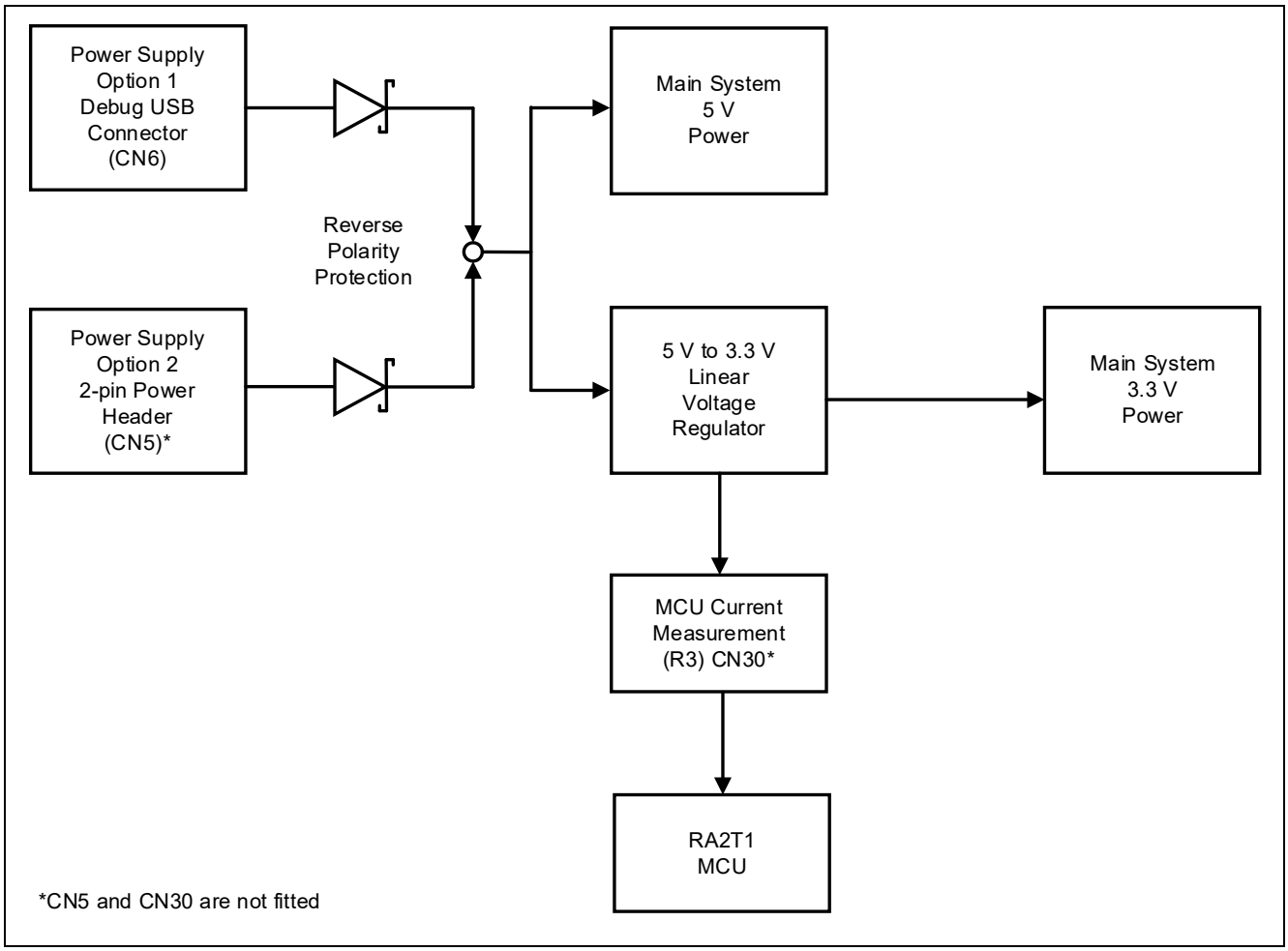

Figure 6. Power Supply Options

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 power is supplied, green LED4 marked POWER will illuminate. Yellow LED3 (DEBUG LED) will also illuminate.

5.2 Debug

The FPB-RA2T1 board can be programmed and debugged by using the built-in SEGGER J-Link® on-board debugger and can support the two debug modes listed below.

Table 4. Debug Modes

Debug Mode	Debug MCU*	Target MCU (MCU to be Debugged)	Debug Interface	Connector Used
On-board debug	RA4M2 (on-board)	RA2T1 (on-board)	SWD	USB 2.0 Type-C™ connector (CN6)
Debug In	External debug tools	RA2T1 (on-board)	SWD	10-pin connector (CN4)

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

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

Table 5. Jumper Configurations for Each of the Debug Modes

Debug Mode	J9	E43, E44, E45, E46, and E47*1
On-board debug	1-2 or no setting	All closed
Debug In	2-3	All closed

Notes: 1. If E43 to E47 are cut (open), it is possible to fit J29 for use as closed (short-circuit) or open.

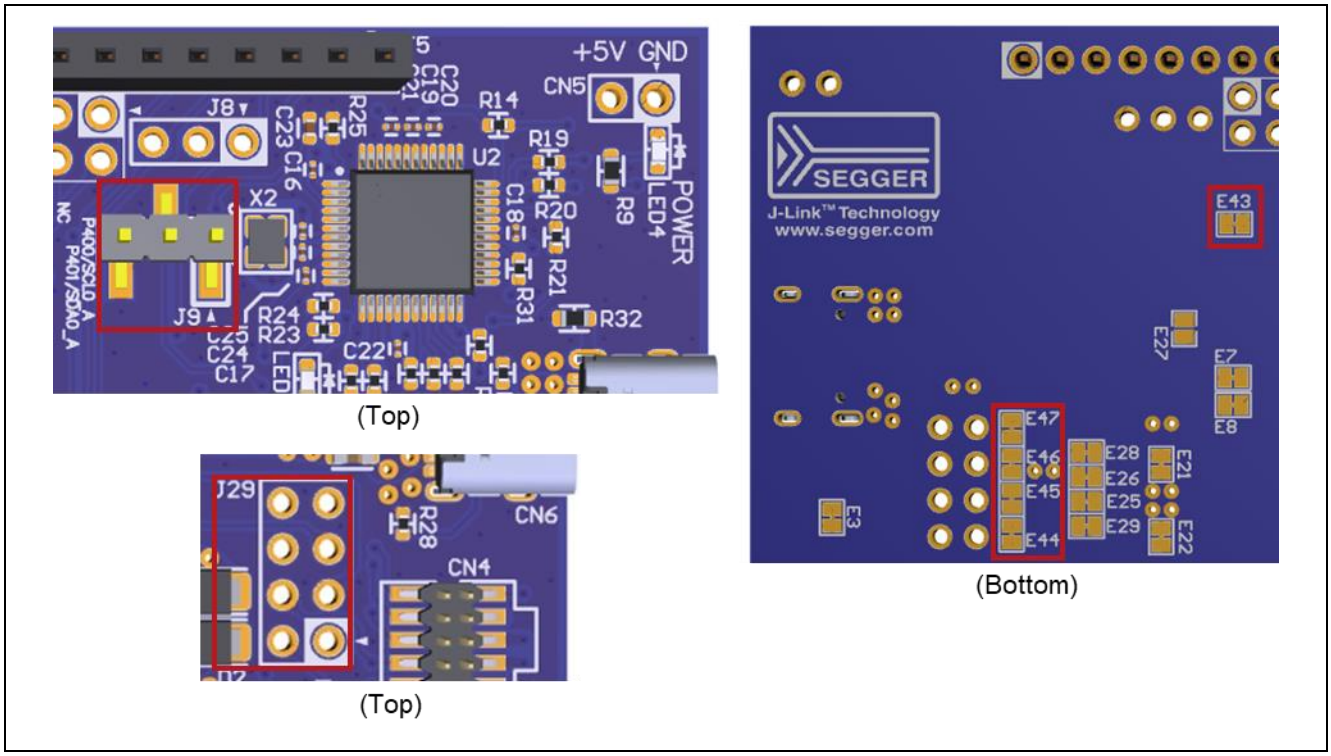

Figure 7. Jumpers for Debug Modes

5.2.1 On-Board Debug

The on-board debug functionality is provided using the RA4M2 (J-Link OB) and SEGGER J-Link® firmware. The USB 2.0 Type C™ connector (CN6) for debugging connects the RA4M2 (J-Link OB) to an external USB full-speed host, allowing programming and debugging of the target MCU.

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

Table 6. Debug USB Connector

Debug USB Connector CN6		FPB-RA2T1
Pin	**Description**	**Signal/Bus**
A4, B4, A9, B9	+5VDC	+5V_USB_DBG
A7, B7	Data-	J-Link OB: USB_DM (U2 pin 14)
A6, B6	Data+	J-Link OB: USB_DP (U2 pin 15)
CC1, CC2	USB ID, jack internal switch, cable inserted	Pull down
SH1, SH2, SH3, SH4	Shell	VSS
A1, B1, A12, B12	Ground	VSS

Signal/Bus names are shown on the board schematic (available in the FPB-RA2T1 v1 Design Package) and are compliant with that.

Yellow indicator LED3 shows the visual status of the debug interface. When the FPB-RA2T1 board is powered on and LED3 is blinking, it indicates that the RA4M2 (J-Link OB) is not connected to a programming host. When LED3 is on solid, it indicates that the RA4M2 (J-Link OB) is connected to a programming interface. When LED3 is flickering during the connection of the debugger, it indicates that data are being transferred between the RA4M2 (J-Link OB) and the programming host.

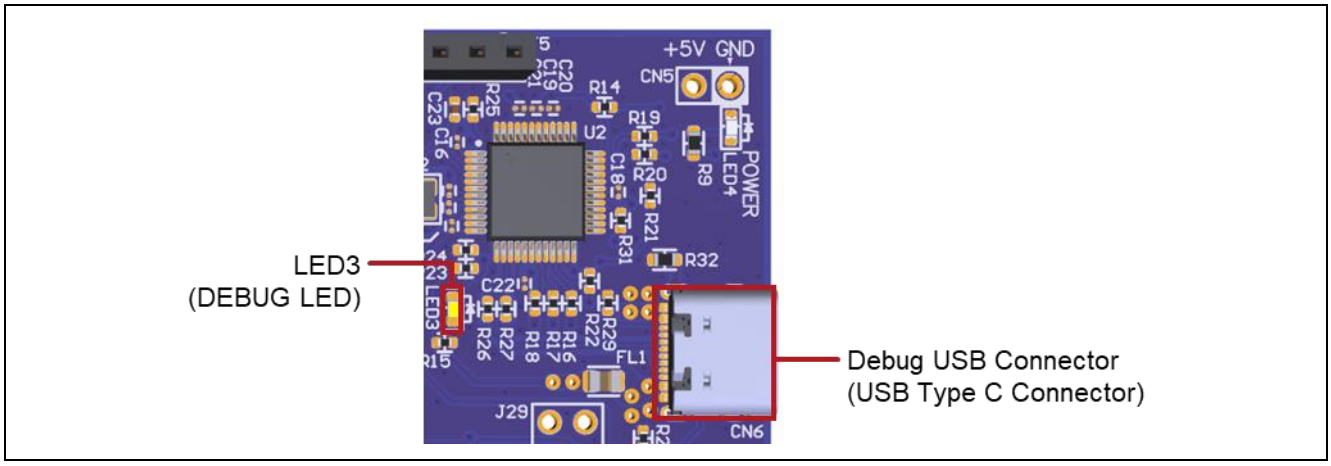

Figure 8. FPB-RA2T1 Debug Interface (FPB-RA2T1 Top View)

5.2.2 Debug In

The 10-pin Cortex® debug connector at CN4 supports the SWD (Serial Wire Debug) interface, allowing debugging of the target RA2T1 using an external debug tool.

To configure the FPB-RA2T1 board to use the Debug in mode, configure the jumpers as stated in Table 5.

Table 7. Debug In Port Assignments

Debug Connector CN4		FPB-RA2T1
Pin	**SWD Pin Name**	**Signal/Bus**
CN4-1	Vtref	3.3 V
CN4-2	SWDIO	P108/SWDIO
CN4-3	GND	VSS
CN4-4	SWCLK	P300/SWCLK
CN4-5	GND	VSS
CN4-6	TxD	P109/TXD9_B
CN4-7	Key (NC)	NC
CN4-8	RxD	P110/RXD9_B
CN4-9	UCON (GND Detect)	VSS
CN4-10	RES	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-RA2T1 board.

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

[Target Device]: Select [R7FA2T107].

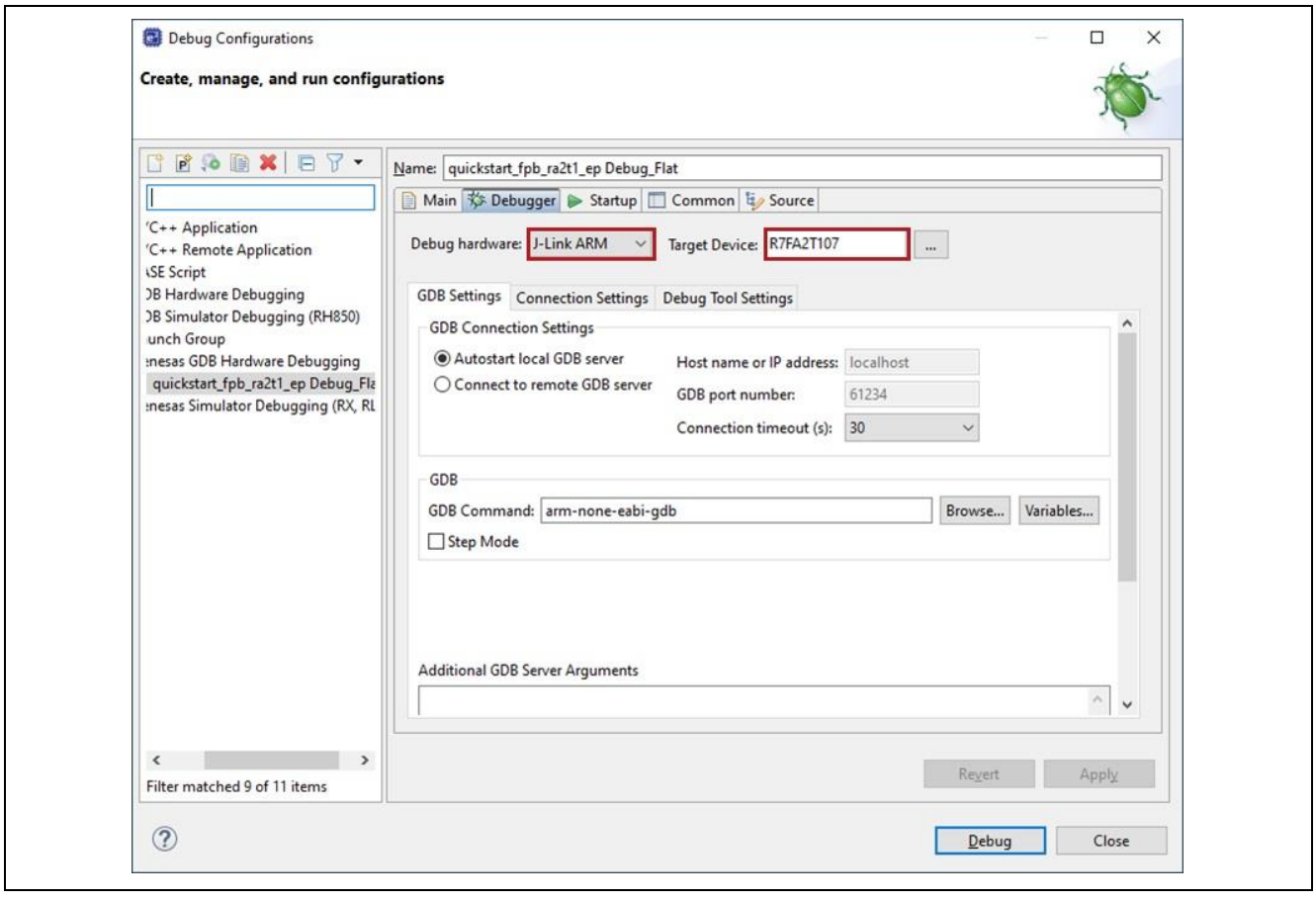

Figure 9. e² Studio Debugger Settings

5.2.4 VCOM Port

The FPB-RA2T1 board can perform USB-UART conversion by using the RA4M2 (J-Link OB). It is recognized by the host as a VCOM port (J-Link CDC UART port) and connected to the UART for RA2T1 by using the FPB-RA2T1 board (refer to Table 8).

Table 8. UART Assignments

RA2T1 Pin	RA2T1 Signal
U1-27	P110/RXD9_B
U1-26	P109/TXD9_B

5.3 Ecosystem

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

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

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-RA2T1 board also provides jumpers so the 12-pin connector may alternatively be used for Pmod Type 6A (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 SCI peripheral in “Simple SPI” mode, and so do not offer the full functionality of the SPI peripheral. Please see the hardware manual for full details of the SCI “Simple SPI” mode.

5.3.1.1 PMOD1

A 12-pin right angle connector is fitted at PMOD1. The connections support Pmod Type 2A (expanded SPI), Type 3A (expanded UART), and Type 6A (I²C). Type 2A and Type 3A are used for the connections by default. Type 6A can be used by changing copper jumper settings (E*x* designation). This interface may additionally be re-configured in firmware as several other Pmod types.

Table 9. PMOD1 Connector

PMOD1 Connector			**FPB-RA2T1**	**PMOD1 Configuration**	
Pin	**Option Type 2A/3A (Default)**	**Option Type 6A**	**Signal/Bus**	**Short**	**Open**
PMOD1-1	CS/CTS	INT	P103/SSLA0_A/CTS0_A/IRQ4_B	E48	
PMOD1-2	MOSI/TXD	RESET	P101/MOSIA_A/TXD0_A	E49	
PMOD1-3	MISO/RXD		P100/MISOA_A/RXD0_A	E41	E39
		SCL	P400/SCL0_A	E39	E41
PMOD1-4	SCK/RTS		P102/RSPCKA_A	E42	E35, E40
			P407/CTS0_RTS0_D	E35	E42, E40
		SDA	P401/SDA0_A	E40	E42, E35
PMOD1-5	GND		VSS		
PMOD1-6	VCC		3.3 V	E1, E6	E2, E5
			5.0 V	E2, E5	E1, E6
PMOD1-7	INT/GPIO	GPIO	P015/IRQ2_C	E50	
PMOD1-8	RESET/GPIO	GPIO	P915	E51	
PMOD1-9	CS2/GPIO	GPIO	P914	E52	
PMOD1-10	CS3/GPIO	GPIO	P913	E53	
PMOD1-11	GND		VSS		
PMOD1-12	VCC		3.3 V	E1, E6	E2, E5
			5.0 V	E2, E5	E1, E6

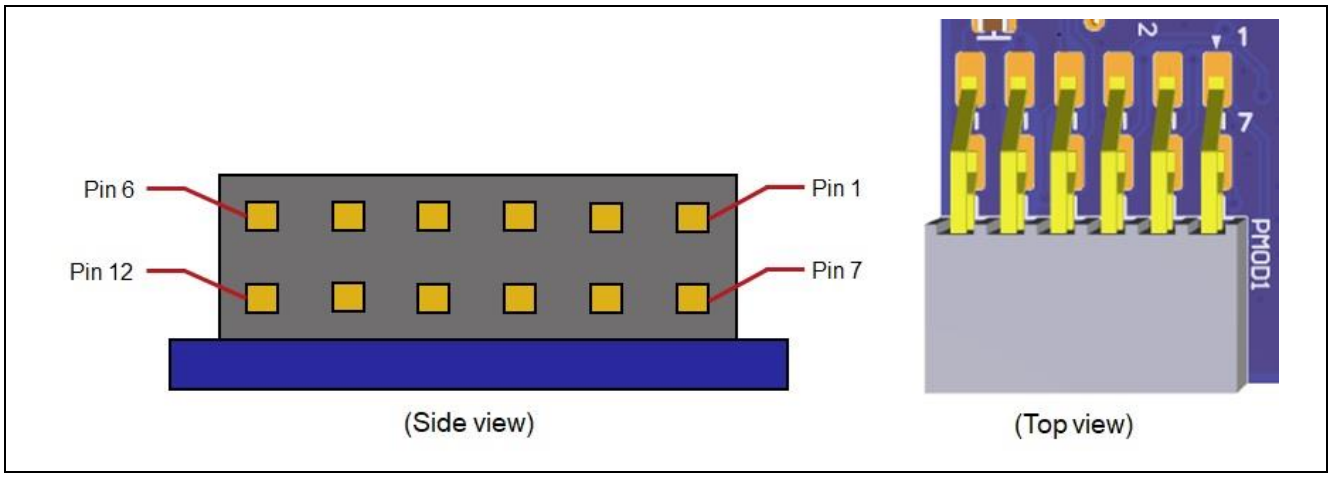

Figure 10. PMOD1 Connector

The PMOD1 interface supports 3.3-V devices by default. Ensure that any Pmod device installed is compatible with a 3.3-V supply.

Operation of Pmod Type 6A
PMOD1 can be configured with the specifications of the Pmod Type-6A connector, which supports I^2C connections. There is also an alternative 5-V power source option. To configure PMOD1 for operation as Type 6A, modify the copper jumpers as listed in Table 9. Figure 11 shows the copper jumpers (Jumper Trace Cut (closed) and Jumper Solder Bridge (open)). P400/SCL0_A and P401/SDA0_A are 5.0-V tolerant ports, but other ports must be disconnected when support for 5.0-V power is in use.

Note: Take care while modifying power-source trace jumpers E1, E2, E5, and E6. Careless work may lead to permanent damage to the FPB-RA2T1 board and/or connected modules.

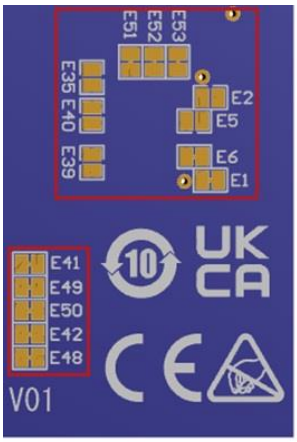

Figure 11. PMOD1 Copper Jumpers (FPB-RA2T1 Bottom View)

5.3.1.2 PMOD2

A 12-pin right angle connector is fitted at PMOD2. Type 6A is used for the connections by default.

Table 10. PMOD2 Connector

PMOD2 Connector		FPB-RA2T1		PMOD2 Configuration	
Pin	**Option Type 6A (Default)**	**Signal/Bus**		**Short**	**Open**
PMOD2-1	INT	P408/IRQ7_B		E54	
PMOD2-2	RESET	P212		E55	
PMOD2-3	SCL	P400/SCL0_A		E56	
PMOD2-4	SDA	P401/SDA0_A		E57	
PMOD2-5	GND	VSS			
PMOD2-6	VCC	VCC	3.3 V	E33, E6	E34, E5
			5.0 V	E34, E5	E33, E6
PMOD2-7	GPIO	P208		E58	
PMOD2-8	GPIO	P207		E59	
PMOD2-9	GPIO	P206		E60	
PMOD2-10	GPIO	P301		E61	
PMOD2-11	GND	VSS			
PMOD2-12	VCC	VCC	3.3 V	E33, E6	E34, E5
			5.0 V	E34, E5	E33, E6

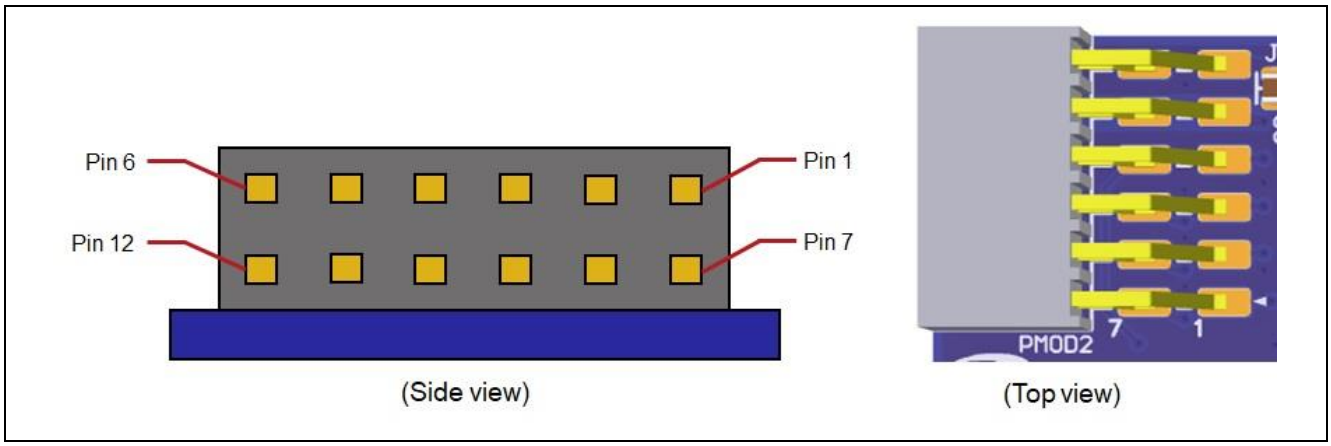

Figure 12. PMOD2 Connector

The PMOD2 interface supports 3.3-V devices by default. Ensure that any Pmod device installed is compatible with a 3.3-V supply. There is also an alternative 5-V power source option. Modify the copper jumpers as listed in Table 10. Figure 13 shows the copper jumpers (Jumper Trace Cut (closed) and Jumper Solder Bridge (open)). P400/SCL0_A and P401/SDA0_A are 5.0-V tolerant ports, but other ports must be disconnected when support for 5.0-V power is in use.

Note: Take care while modifying power-source trace jumpers E5, E6, E33, and E34. Careless work may lead to permanent damage to the FPB-RA2T1 board and/or connected modules.

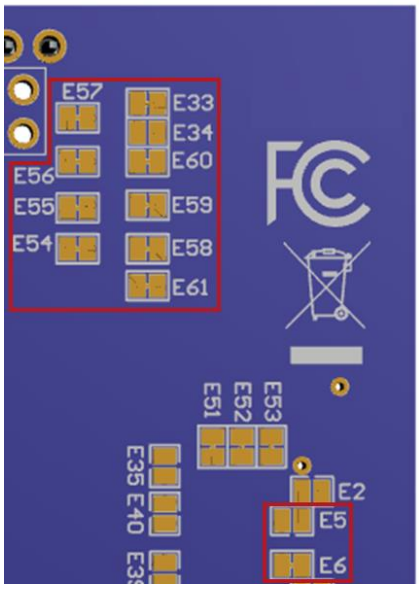

Figure 13. PMOD2 Copper Jumpers (FPB-RA2T1 Bottom View)

5.3.2 Arduino® Connector

An Arduino® Uno R3 compatible connector interface is provided.

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

Table 11. Arduino® Connector

Arduino® Connector		**FPB-RA2T1**
Pin	**Description**	**Signal/Bus**
J2-1	NC	NC
J2-2	IOREF	3.3 V
J2-3	RESET	RES
J2-4	3V3	3.3 V
J2-5	5V	5.0 V
J2-6	GND	VSS
J2-7	GND	VSS
J2-8	VIN	NC

J6-1	A0	P000/AN008
J6-2	A1	P001/AN009
J6-3	A2	P002/AN010
J6-4	A3	P013/AN000
J6-5	A4	P014/AN001
J6-6	A5	P015/AN002

J5-1	RX/D0	P301/RXD2_A
J5-2	TX/D1	P302/TXD2_A
J5-3	2	P409/IRQ6_B
J5-4	~3	P111/IRQ4_A/GTIOC1A_C
J5-5	4	P012
J5-6	~5	P913/GTIOC1B_A
J5-7	~6	P500/GTIOC2A_C
J5-8	7	P206

J1-1	8	P104
J1-2	~9	P112/GTIOC1B_C
J1-3	~10	P103/SSLA0_A/GTIOC2A_A
J1-4	~11	P101/MOSIA_A/GTIOC1A_B
J1-5	12	P100/MISOA_A
J1-6	13	P102/SCK0_A
J1-7	GND	VSS
J1-8	AREF	P010/VREFH0 (J1-8 is open by default; short-circuited by E18.)
J1-9	SDA	P401/SDA0_A
J1-10	SCL	P400/SCL0_A

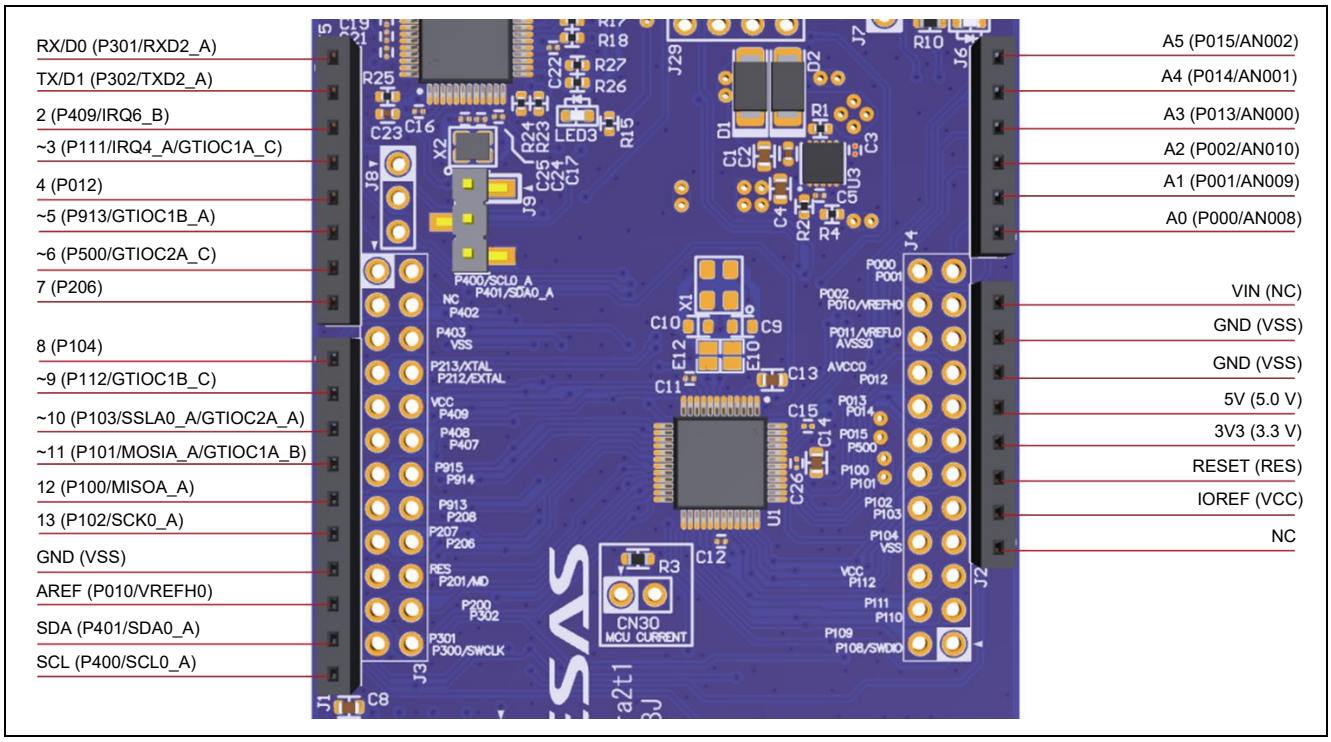

Figure 14. Arduino® Connectors (FPB-RA2T1 Top View)

5.4 Miscellaneous

5.4.1 User and Power LEDs

Four LEDs are provided on the FPB-RA2T1 board.

Behavior of the LEDs on the FPB-RA2T1 board is described in the following table.

Table 12. FPB-RA2T1 Board LED Functions

Designator	Color	Function	RA MCU Control Port
LED1	Green	User LED	P213
LED2	Green	User LED	P914
LED3	Yellow	Debug LED	Port for the RA4M2 (J-Link OB)
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 P213, Jumper Trace Cut (closed) E8 must be open. To disconnect LED2 from P914, Jumper Trace Cut (closed) E7 must be open.

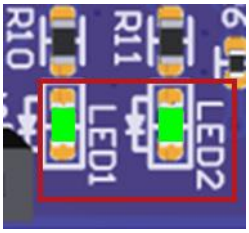

Figure 15. User LEDs (FPB-RA2T1 Top View)

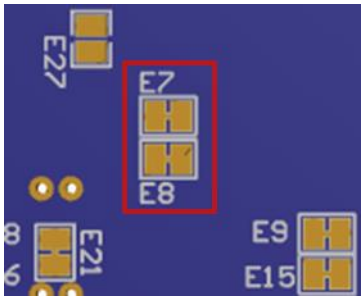

Figure 16. Jumpers for User LEDs (FPB-RA2T1 Bottom View)

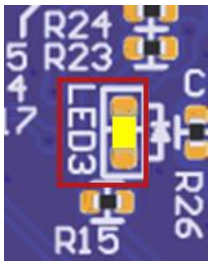

Figure 17. Debug LED (FPB-RA2T1 Top View)

Figure 18. Power LED (FPB-RA2T1 Top View)

5.4.2 User and Reset Switches

Two miniature, momentary, mechanical push-button type SMD switches are mounted on the FPB-RA2T1 board.

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

Table 13. FPB-RA2T1 Board Switches

Designator	Function	RA MCU Control Port
S1	User Switch	P200/NMI
S2	RA 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, Jumper Trace Cut (closed) E24 must be open.

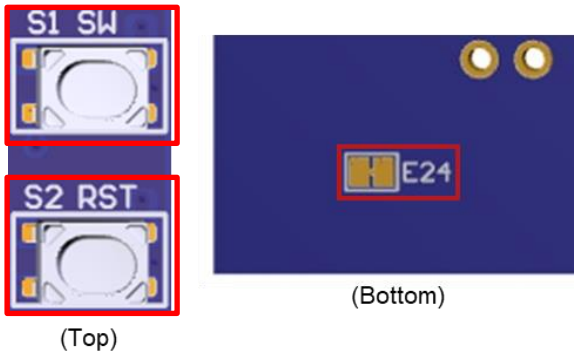

Figure 19. User Switch (S1), Reset Switch (S2), and Jumper Trace Cut (Closed) (E24)

5.4.3 MCU Boot Mode

The target RA MCU (P201) can select the MCU boot mode. For normal operation (single-chip mode), leave J7 open. For enable SCI boot mode, place a jumper on J7 to close it.

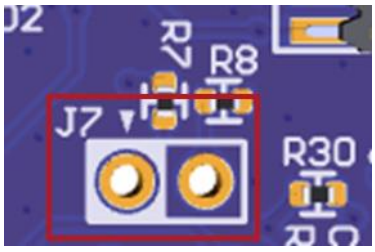

Figure 20. MCU Boot Mode Jumper (J7) (FPB-RA2T1 Top View)

5.4.4 MCU Clocks

Components of the main-clock oscillation circuit for the RA2T1 are not fitted on the board. It is possible to provide a precision 20.000-MHz reference clock by fitting components of the main-clock oscillation circuit and short-circuiting (closing) E10 and E12 of the Jumper Solder Bridge (open). A recommended component for X1 on the board is ABM8-20.000MHZ-10-B1U-T from Abracon.

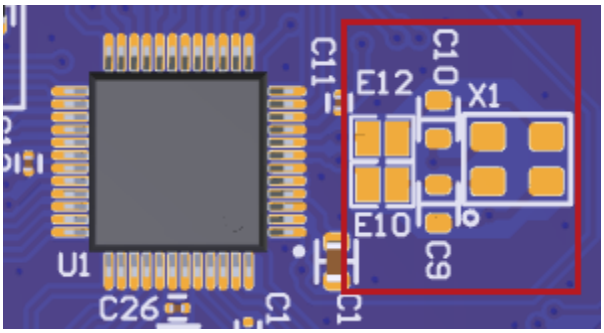

Figure 21. Main-clock Oscillation Circuit (FPB-RA2T1 Top View)

6. MCU Native Pin Access

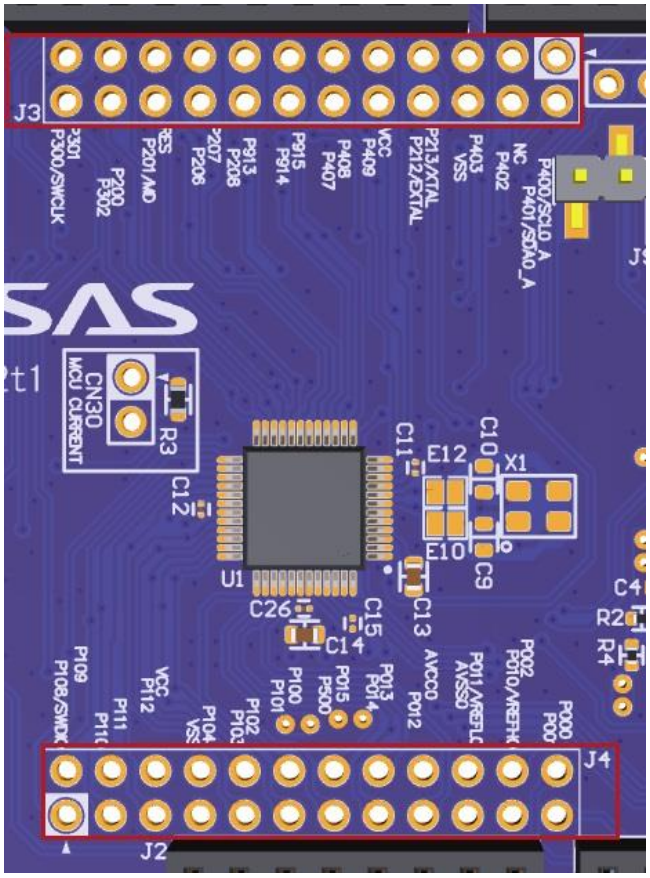

Figure 22. Native Pin Access (Breakout Pin Headers J3 and J4) (FPB-RA2T1 Top View)

6.1 Breakout Pin Headers

The FPB-RA2T1 board pin headers, J3 (not fitted) and J4 (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 RA2T1 MCU Group User's Manual for details of each port function, and the FPB-RA2T1 board schematic for pin header port assignments.

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

Table 14. Breakout Pin Header J3

J3 Pin No.	Circuit Net Name	RA2T1 MCU	J3 Pin No.	Circuit Net Name	RA2T1 MCU
1	P400/SCL0_A	U1-1	2	P401/SDA0_A	U1-2
3	—	—	4	P402	U1-4
5	P403	U1-5	6	VSS	—
7	P213/XTAL	U1-7	8	P212/EXTAL	U1-8
9	3.3 V	—	10	P409/IRQ6_B	U1-10
11	P408	U1-11	12	P407	U1-12
13	P915	U1-13	14	P914	U1-14
15	P913/GTIOC1B_A	U1-15	16	P208	U1-16
17	P207	U1-17	18	P206	U1-18
19	RES	U1-19	20	P201/MD	U1-20
21	P200/NMI	U1-21	22	P302/TXD2_A	U1-22
23	P301/RXD2_A	U1-23	24	P300/SWCLK	U1-24

Table 15. Breakout Pin Header J4

J4 Pin No.	Circuit Net Name	RA2T1 MCU	J4 Pin No.	Circuit Net Name	RA2T1 MCU
1	P108/SWDIO	U1-25	2	P109/TXD9_B	U1-26
3	P110/RXD9_B	U1-27	4	P111/IRQ4_A/ GTIOC1A_C	U1-28
5	P112/GTIOC1B_C	U1-29	6	3.3 V	—
7	VSS	—	8	P104	U1-32
9	P103/SSLA0_A/ GTIOC2A_A	U1-33	10	P102/SCK0_A	U1-34
11	P101/MOSIA_A/ GTIOC1A_B	U1-35	12	P100/MISOA_A	U1-36
13	P500/GTIOC2A_C	U1-37	14	P015/AN002	U1-38
15	P014/AN001	U1-39	16	P013/AN000	U1-40
17	P012	U1-41	18	AVCC0	U1-42
19	AVSS0	U1-43	20	P011/VREFL0	U1-44
21	P010/VREFH0	U1-45	22	P002/AN010	U1-46
23	P001/AN009	U1-47	24	P000/AN008	U1-48

6.2 MCU Current Measurement

Included near the RA2T1 is resistor R3 and test connector CN30 (not fitted) to measure the VCC current of the RA2T1.

Resistor R3 is 0 Ω (SMD 0603). 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 RA2T1 can then be calculated using Ohm's Law.

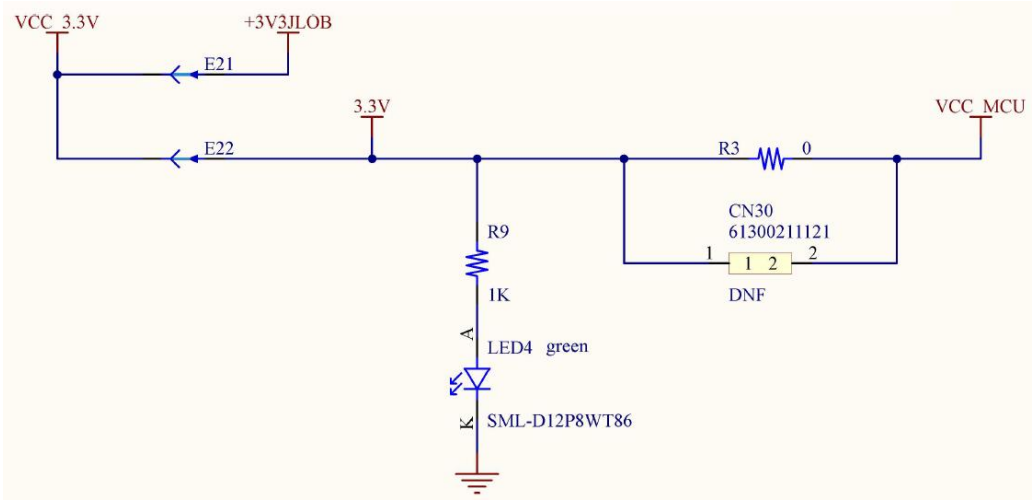

Figure 23. RA2T1 VCC Current Measurement Circuit

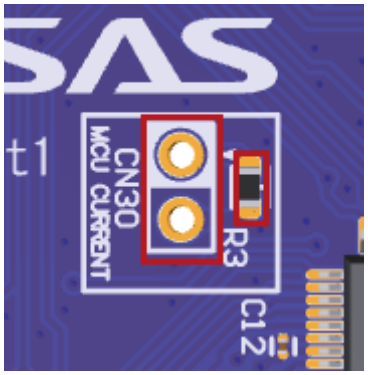

Figure 24. RA2T1 VCC Current Measurement Point (CN30) and R3 (FPB-RA2T1 Top View)

7. Recommended Parts

The following table list 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
J3, J4	24-pin dual pin header	12 x 2 pins, 2.54 mm pitch, parts to fit 1.15 mm dia. holes on board	
J7, 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-RA2T1 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-RA2T1 v1 kit is available in the “FPB-RA2T1 v1 Design Package” available on renesas.com/fpb-ra2t1.

- FPB-RA2T1 v1 Board Design Package file name: fpb-ra2t1-v1-designpackage.zip
- FPB-RA2T1 v1 Board Design Package contents

Table 17. FPB-RA2T1 Board Design Package Contents

File Type	Content	File/Folder Name
File (PDF)	Schematics	fpb-ra2t1-v1-schematics
File (PDF)	Mechanical Drawing	fpb-ra2t1-v1-mechdwg
File (PDF)	BoM	fpb-ra2t1-v1-bom
File (PDF)	3D Drawing	fpb-ra2t1-v1-3d
Folder	Manufacturing Files	Manufacturing Files
Folder	Design Files	Design Files - Altium

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-RA2T1 Resources	renesas.com/fpb-ra2t1
RA Kit Information	renesas.com/ra/kits
RA Product Information	renesas.com/ra
RA Product Support Forum	renesas.com/ra/forum
RA Videos	renesas.com/ra/videos
Renesas Support	renesas.com/support

11. Notes on Usage

This chapter gives notes on using the FPB-RA2T1 v1 board.

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

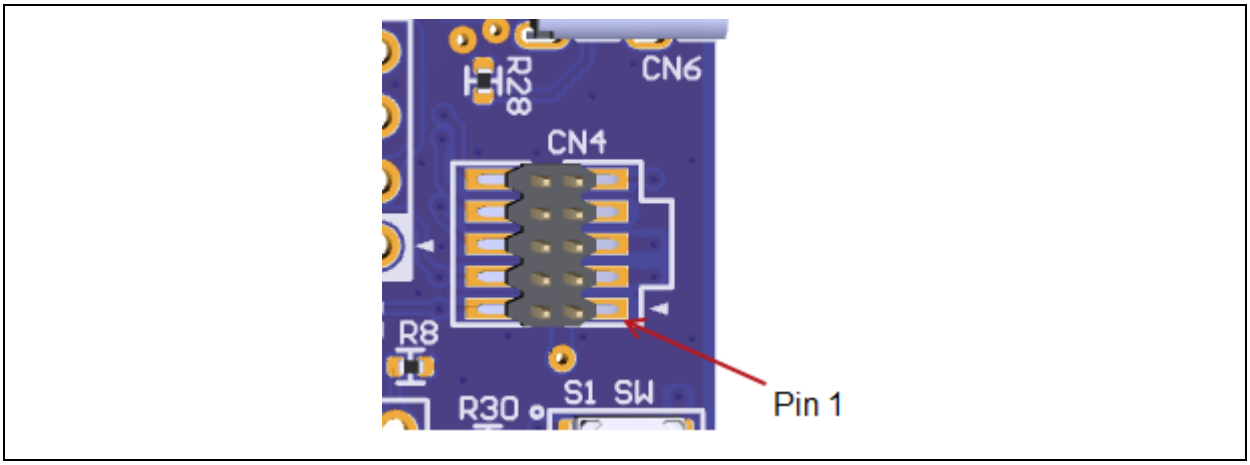

Figure 25. Position of CN4-1 (FPB-RA2T1 Top View)

2. P109/TXD9_B and P110/RXD9_B are connected to RA4M2 (J-Link OB). cut Jumper Trace Cut (closed) E25 and E28 if not used as J-Link virtual COM port (VCOM).

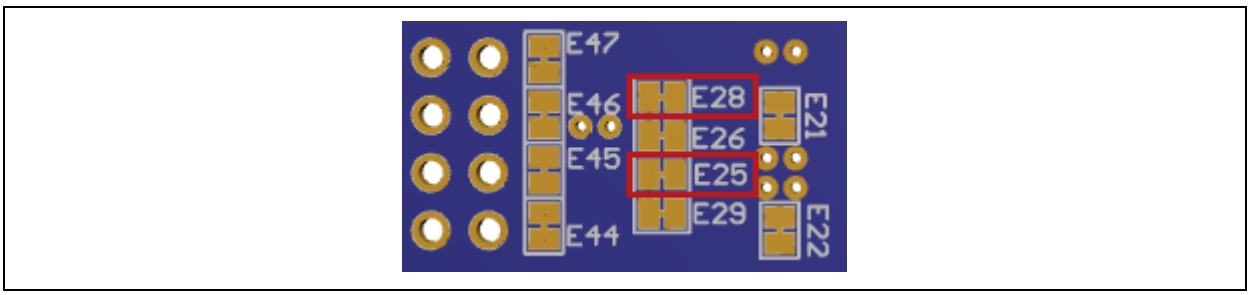

Figure 26. Jumper Trace Cut (Closed) for the VCOM Port (FPB-RA2T1 Bottom View)

12. Appendix

12.1 Layout Diagram of Components on the FPB-RA2T1 Board

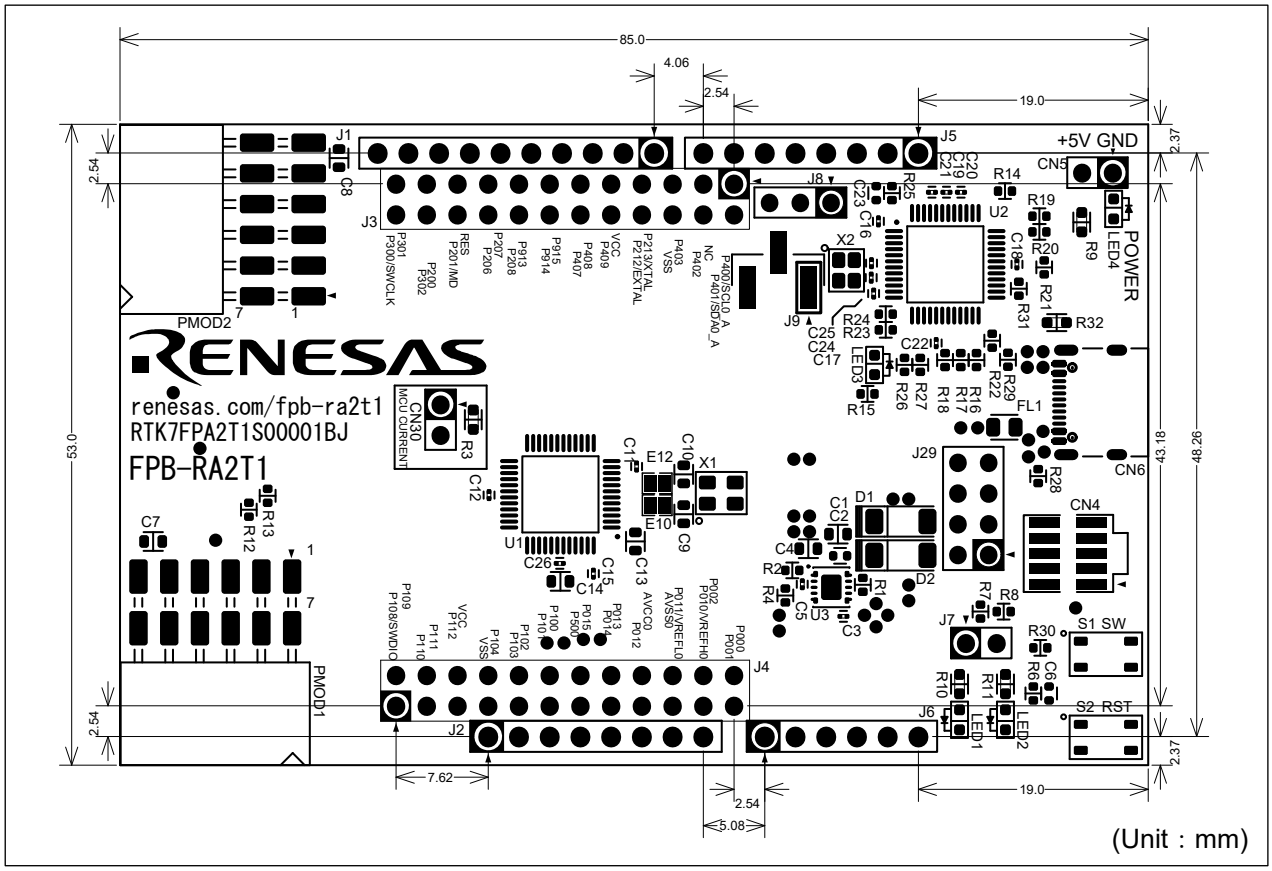

Figure 27. Layout Diagram of Components on the FPB-RA2T1 Board (Top View)

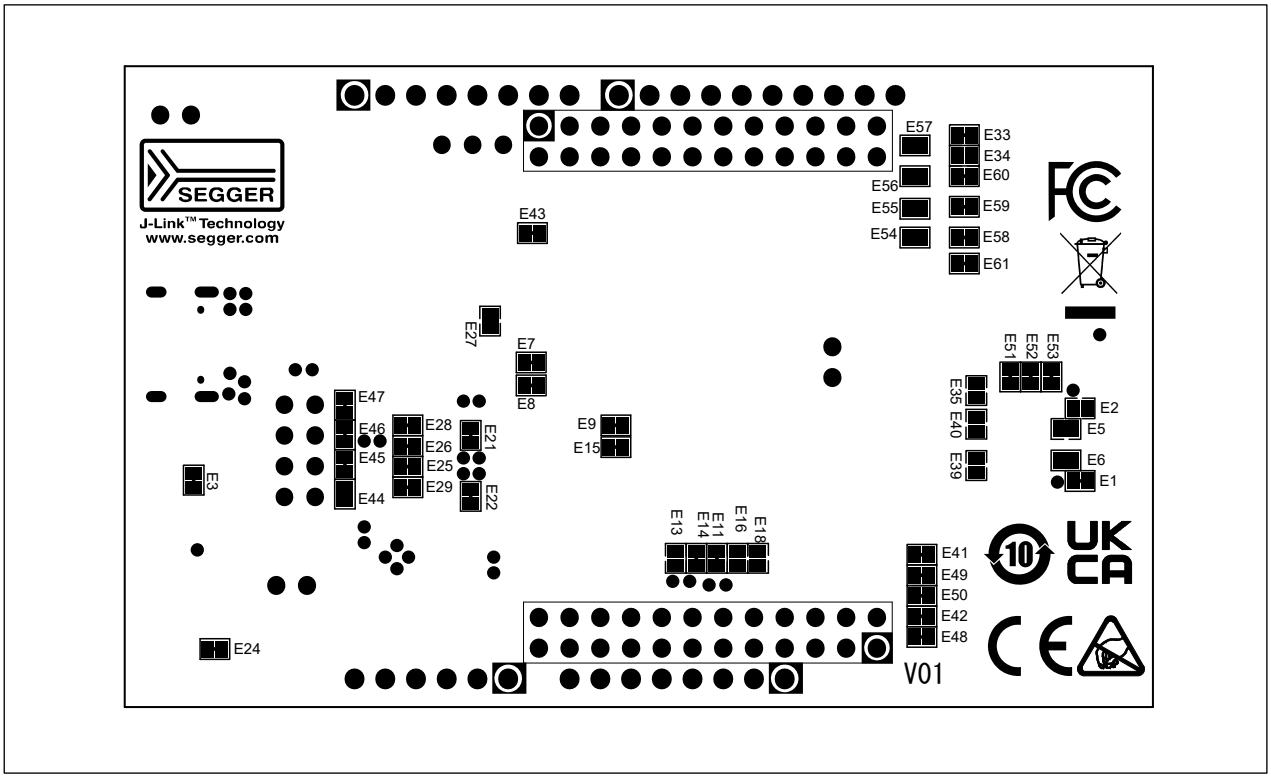

Figure 28. Layout Diagram of Components on the FPB-RA2T1 Board (Bottom View)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Apr.15.25	—	First Edition issued

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