US159-DA14531/5EVZ

DA14531 Pmod™ Board

The US159-DA14531/5EVZ is a low power Bluetooth Pmod module that enables you to add a low power Bluetooth™ capability to any evaluation kit or MCU board equipped with a Pmod expansion capability. The board provides a standard Pmod Type 3A (expanded UART) connection for the on-board Bluetooth 5.1 module.

The US159-DA14531/5EVZ features a Type 3A Pmod connector and incorporates the DA14531 SmartBond TINY™ Module, which uses the efficient Bluetooth 5.1 SoC. With a standard connector and software support, the US159-DA14531/5EVZ is ideal for the Renesas Quick-Connect IoT to rapidly create an IoT system.

Kit Contents

- US159-DA14531/5EVZ Pmod Board

Features

- DA14531 SmartBond TINY Module
  - Cortex M0+ at 16 MHz
  - Memory: 4kB RAM, 32kB OTP and 1Mb Flash
  - Bluetooth 5.1 core qualified
  - Integrated chip antenna
  - Worldwide certification
  - IoTMark™, BLE score of 18300
  - 3.3V supply voltage
  - +2.2dBm maximum output power
  - -93dBm sensitivity
  - Rx current 2mA at 3.3V
  - Tx current 4mA at 3.3V at 0dBm
- Standardized Type 3A Pmod connector supports an expanded UART interface
- Optional battery operation with on-board CR1220 coin cell
- Momentary pushbutton switch (SW1) to aid in user software debug
- LED (D1) to aid in user software debug
- 10-pin 1.27mm pitch Arm Cortex-Debug connector (J2) for software development and debug support

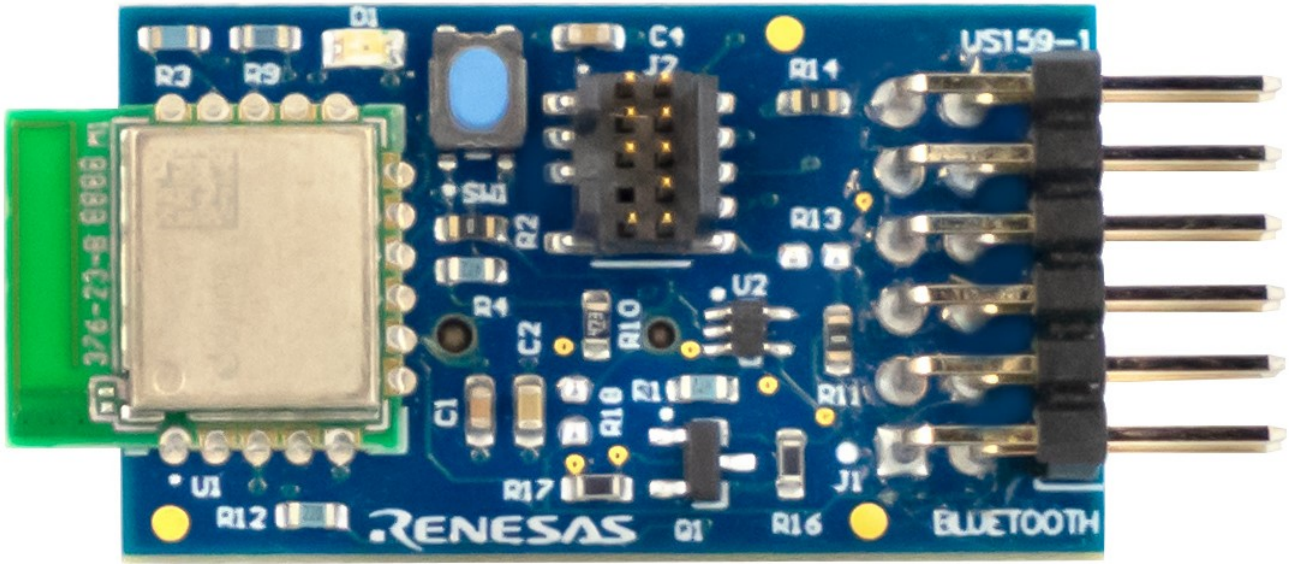

Figure 1. US159-DA14531EVZ Pmod Board (XE Evaluation Board)

Contents

1. Functional Description

The US159-DA14531/5EVZ module functions as a Bluetooth wireless building block to create a custom IoT system solution. This module adds Bluetooth connectivity capability to any IoT system that supports Pmod expansion modules. Visit the Renesas website for more details on the DA14531/5 SmartBond TINY Module.

2. Setup

2.1 Required or Recommended User Equipment

The following additional lab equipment is recommended using the module (and is sold separately):

- Any MCU board that supports Type 3A Pmod.

2.2 Software Installation and Usage

For the latest version of the e2 studio, use the Renesas website, and for the latest connectivity support and details on creating customized IoT system solutions, visit the Quick-Connect IoT site.

The Renesas Flexible Software Package (FSP) is an enhanced software package that provides easy-to-use, scalable, high-quality software for embedded system designs using the Renesas RA family of Arm Microcontrollers. With the support of a new Arm TrustZone and other advanced security features, FSP provides a quick and versatile way to build secure, connected IoT devices using production-ready drivers, Azure RTOS, FreeRTOS, and other middleware stacks.

The firmware for evaluating the functioning of the module comes with a Renesas EK-RA6M4 evaluation kit and an HS3001 PMOD board (for temperature and humidity) is preloaded on the US159-DA14531/5 EVZ Pmod module with GTL image by using a 1-wire or 2-wire UART bootloader.

2.3 Kit Hardware Connections

Follow these procedures to set up the kit as shown on Figure 2.

1. Ensure the MCU evaluation kit being used has a Pmod connector set to Type 3A. (For help, refer to the kit hardware manual.)
2. Plug in the US159-DA14531/5EVZ to the Pmod connector on the MCU evaluation kit, and be careful to align Pin 1 on the module to Pin 1 on the MCU kit.
3. The US159-DA14531/5EVZ is now ready to be used in the system. Follow the MCU kit instructions for connecting and powering up the evaluation kit.

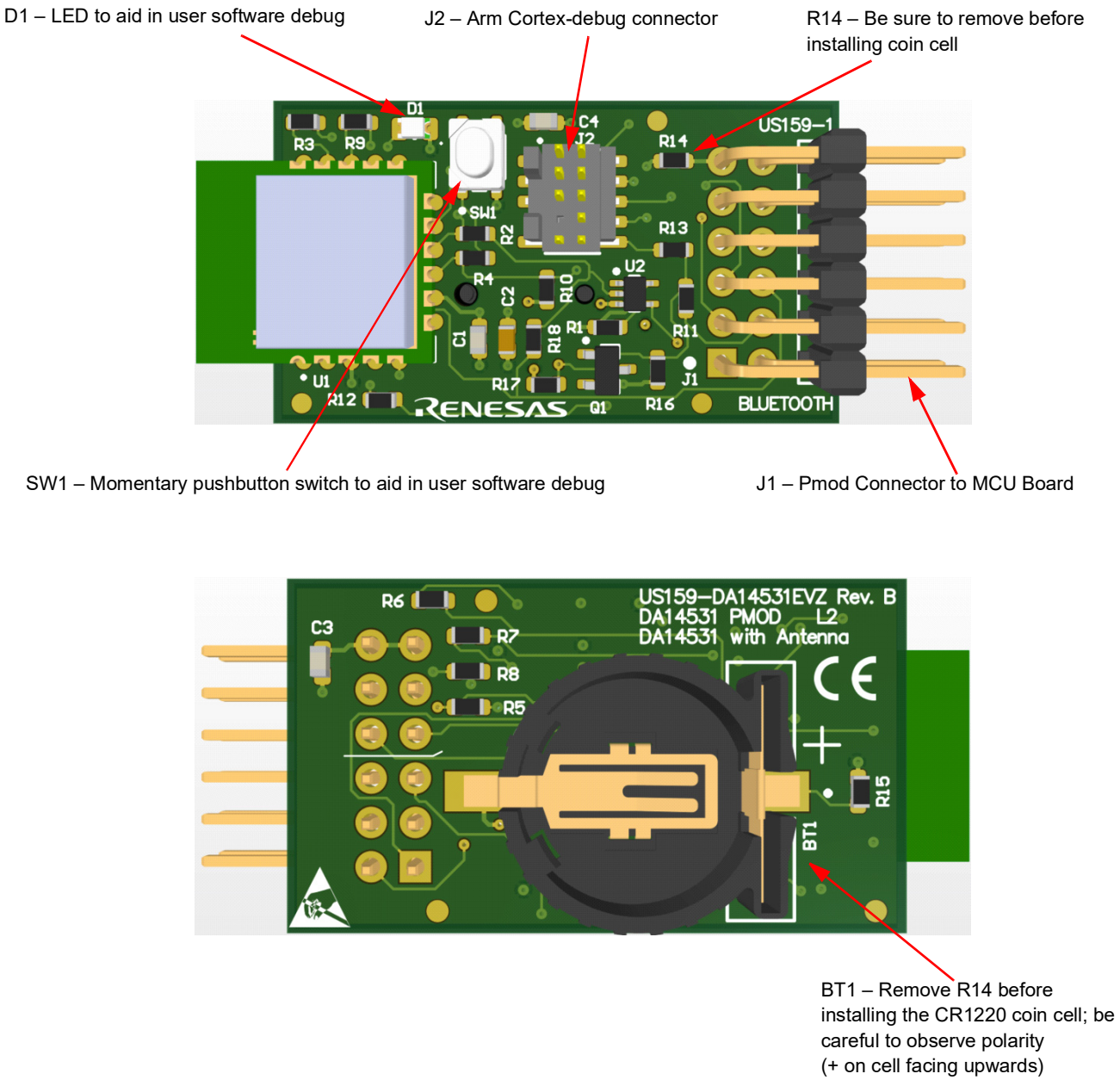

Figure 2. Evaluation Kit Details

3. Board Design – DA14531/5 PMOD

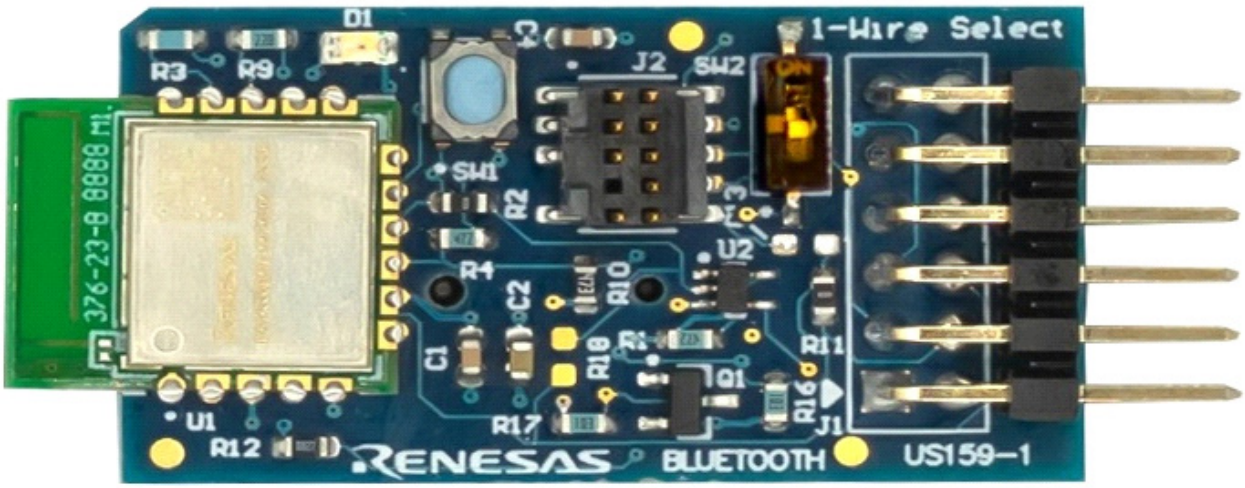

Figure 3. DA14531/5 Image (Top)

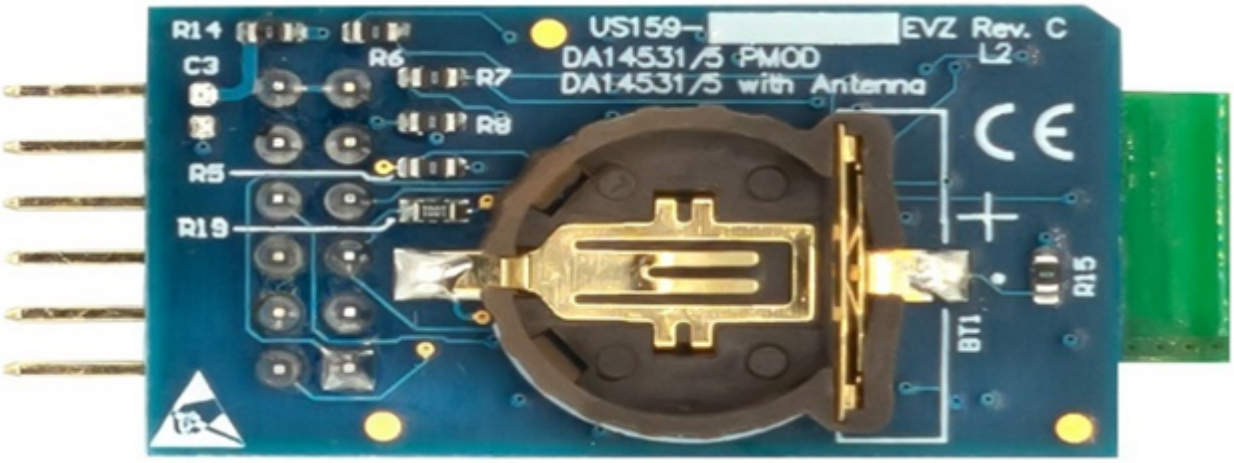

Figure 4. DA14531/5 Image (Bottom)

4. One-Wire Download using FSP BLE Framework

4.1 Introduction

The firmware for evaluating the functioning of the module comes with a Renesas EK-RA6M4 evaluation kit and an HS3001 Pmod board (for temperature and humidity) is preloaded on the US159-DA14531/5 EVZ Pmod module with GTL image by using a 1-wire or 2-wire bootloader.

For more information about hardware setup and creating the FSP application, refer to Prerequisites - Getting started with DA14531 and FSP BLE Framework. This guide introduces the Flexible Software Package (FSP) drivers and middleware designed for the DA1453x Bluetooth Low Energy (LE) devices.

4.2 Adding Bluetooth LE Communications

This section describes how to add Bluetooth LE Communications to the project. In the event the RA configuration screen was closed previously, launch the RA Configuration screen by double-clicking **configuration.xml** in the Project Explorer pane and following the steps below.

1. Select the FSP Configuration option in the top right corner.

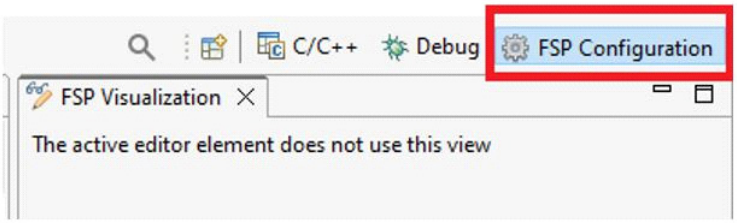

Figure 5. FSP Configuration Option

2. Select the Stacks configuration tab (this will be used for most of this document). The functions within this tab allows the quick creation and configuration of threads, RTOS objects and driver/middleware instances.
3. Add a thread for the application. Click on *New Thread* and a new thread will appear. This thread will be used by the DA1453x GTL Middleware.

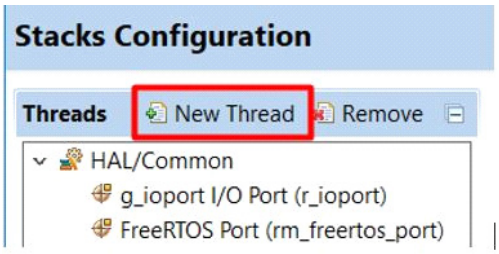

Figure 6. Stacks Configuration Tab – New Thread

4. Select the *Properties* tab. It can be found in the lower-left pane, directly under the Project Explorer. In the **Thread** section, edit the new thread properties to match the configuration, as shown below:
   a. **Symbol**: ble_thread
   b. **Name**: BLE Thread
   c. **Stack size (bytes)**: 2048
   d. **Priority**: 2
5. Navigate to *Common* > *General* and set the following properties:
   a. **Use Mutexes**: Enabled
   b. **Use Recursive Mutexes**: Enabled
6. Expand *Optional Functions* and set the following properties:
   a. **oxTimerPendFunctionCall()**: Function Enabled

The DA1453x middleware uses heap memory to create tasks and queues, so dynamic memory allocation needs to be enabled.

7. Expand Common and then Memory Allocation. Change following properties to:
   a. **Support Dynamic Allocation**: Enabled
   b. **Total Heap Size**: 0x800

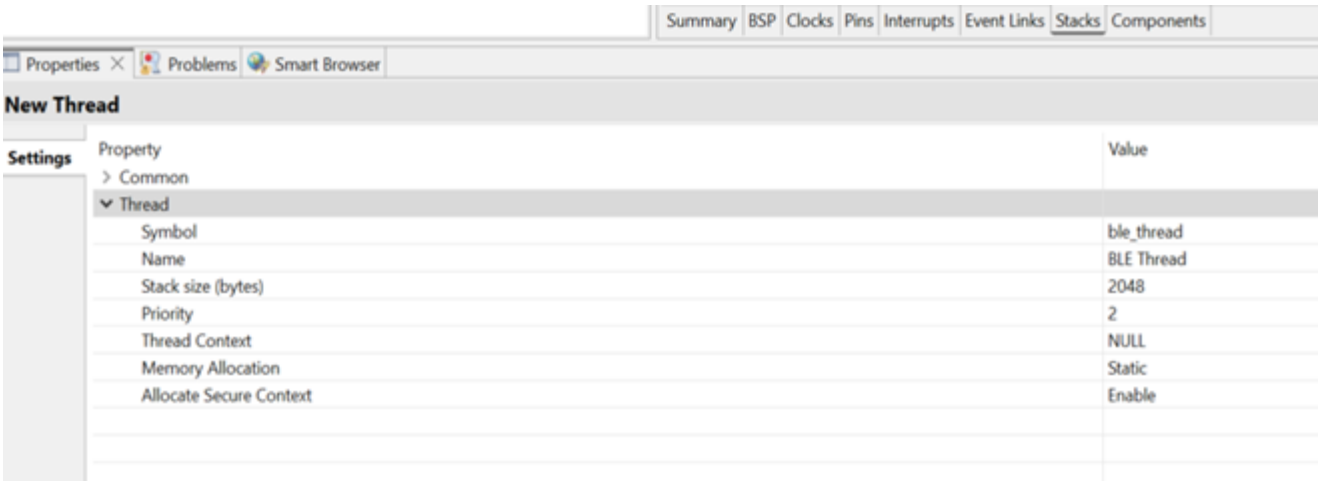

Figure 7. BLE Thread Configuration

8. Select *HAL/Common* on the **Threads** list and click on *New Stack*. From the menu, select *RTOS -> FreeRTOS Heap 4*.

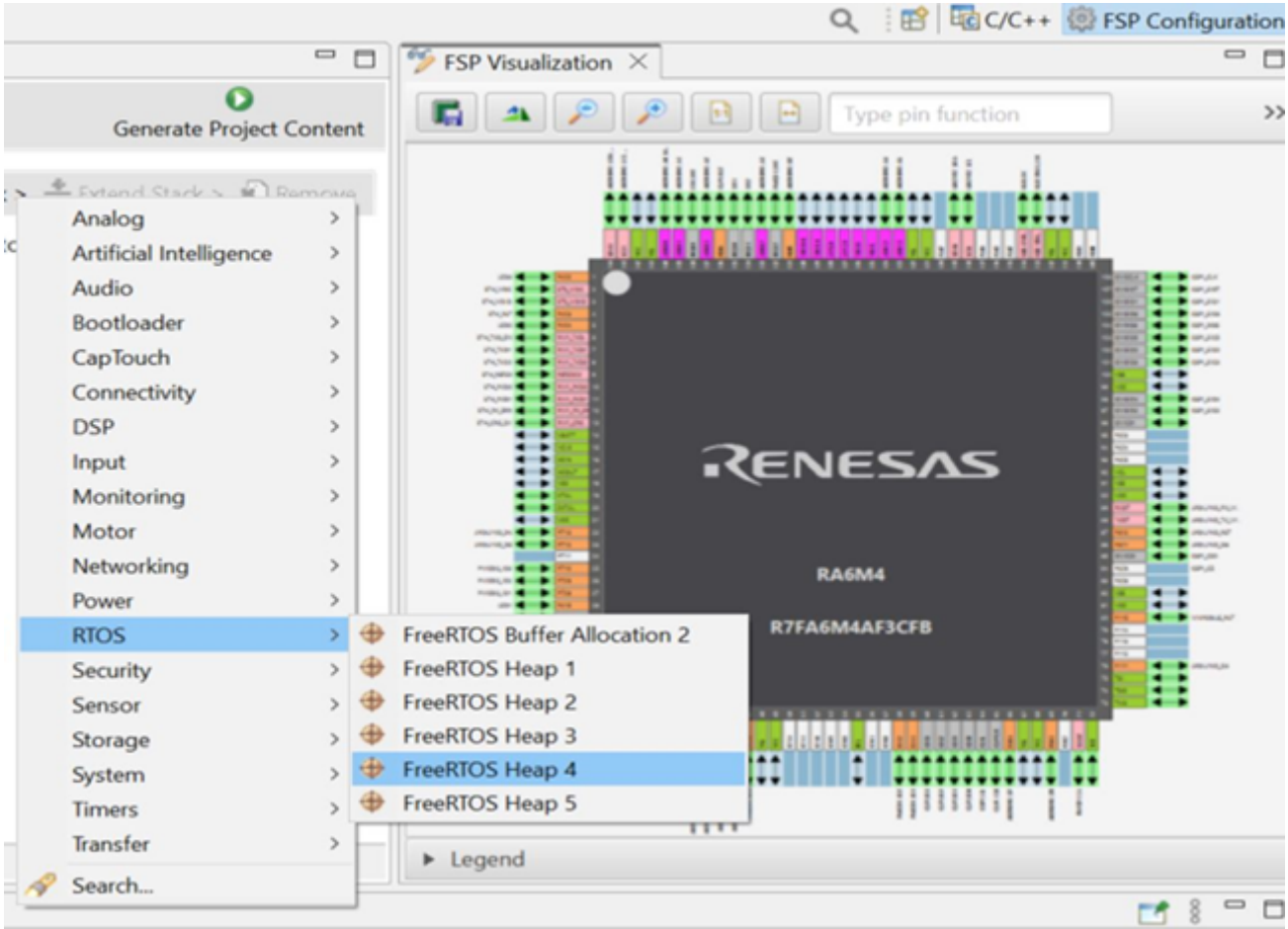

Figure 8. RTOS Selection

9. Select the BLE Thread and open the **New Stack** menu. Select *Networking -> GTL BLE Abstraction (rm_ble_abs_gtl).*

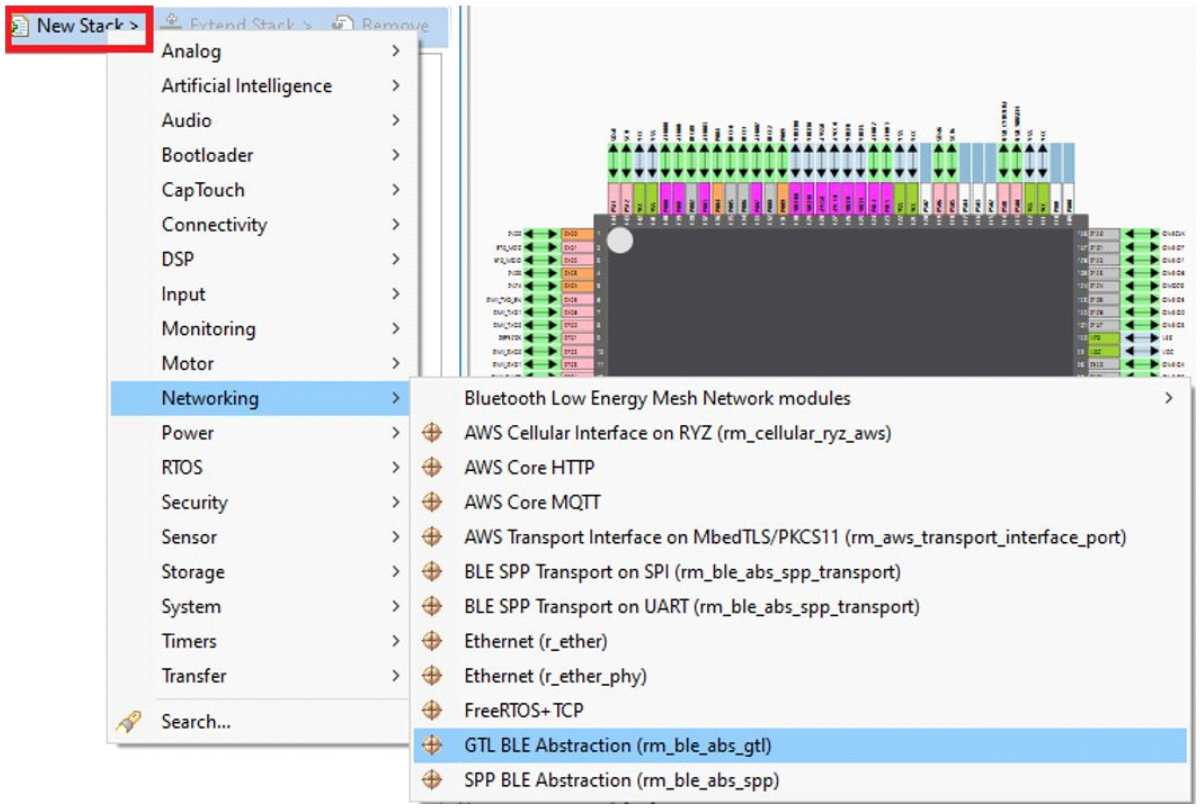

Figure 9. New Stack – Networking Menu

A new module stack will be added to the HAL/Common Stacks context.

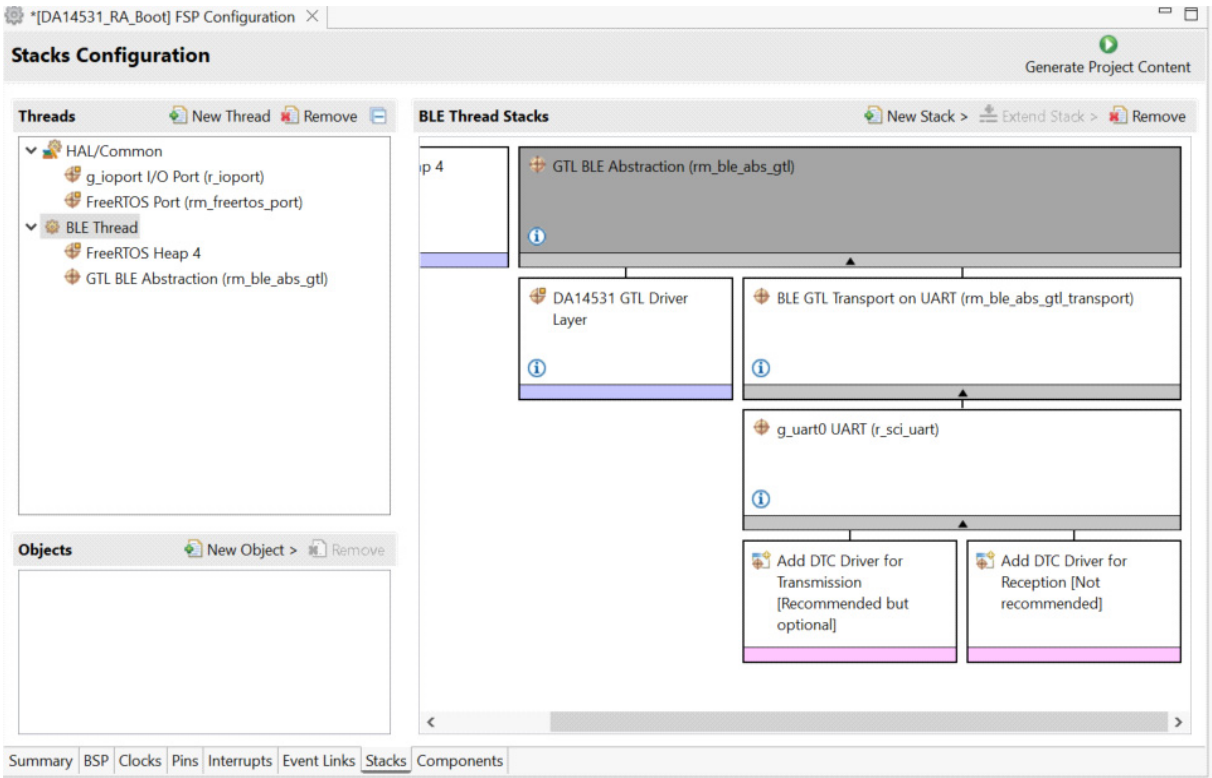

Figure 10. HAL/Common Stacks Window

10. Select the *DA14531 GTL Driver Layer*.

    Note: Option to select the device under common, DA1453x Device, available in the latest FSP 5.4.0.

    From the **Properties** tab, set the following properties:

    a. **Reset Polarity**: Active Low

    b. **Reset Port**: 07

    c. **Reset Pin**: 08

    d. **RTS Port**: 04

    e. **RTS Pin**: 12

Figure 11. Pmod™ Pins Configuration for RA6M4-EK

Note: Select the 2-wire UART to boot the DA14535 from the host MCU through 2-wire UART. The DA14535 Pmod board is preloaded with the SUotA bootloader binary and the switch should be OFF on the DA14535 Pmod board.

11. Enable the option to boot DA14535 from host MCU through 1-Wire UART (disabled by default).

12. Select *DA14531 / DA14535* under *Common* > *DA1453x Device* as shown in the image above.

Note: The DA14531/5 Pmod™ module will be connected on the Pmod™ 2 of the RA6M4 development kit. When considering to use another MCU, all the steps previously mentioned earlier are the same and correctly configuring the Reset PIN for the Pmod™ on that Dev kit is all that is required

13. Navigate to the **Pins** tab within the **Pins Configuration** window (see Figure 12).

    On the left side, expand **Peripherals > Connectivity: SPI** groups and select *SPI1*. Choose the value *Disabled* from the **Operation Mode** drop-down menu. Since the pins are multiplexed, SPI1 is disabled so these pins can be reused for UART communication.

14. On the PMOD board, turn the switch to **ON**.

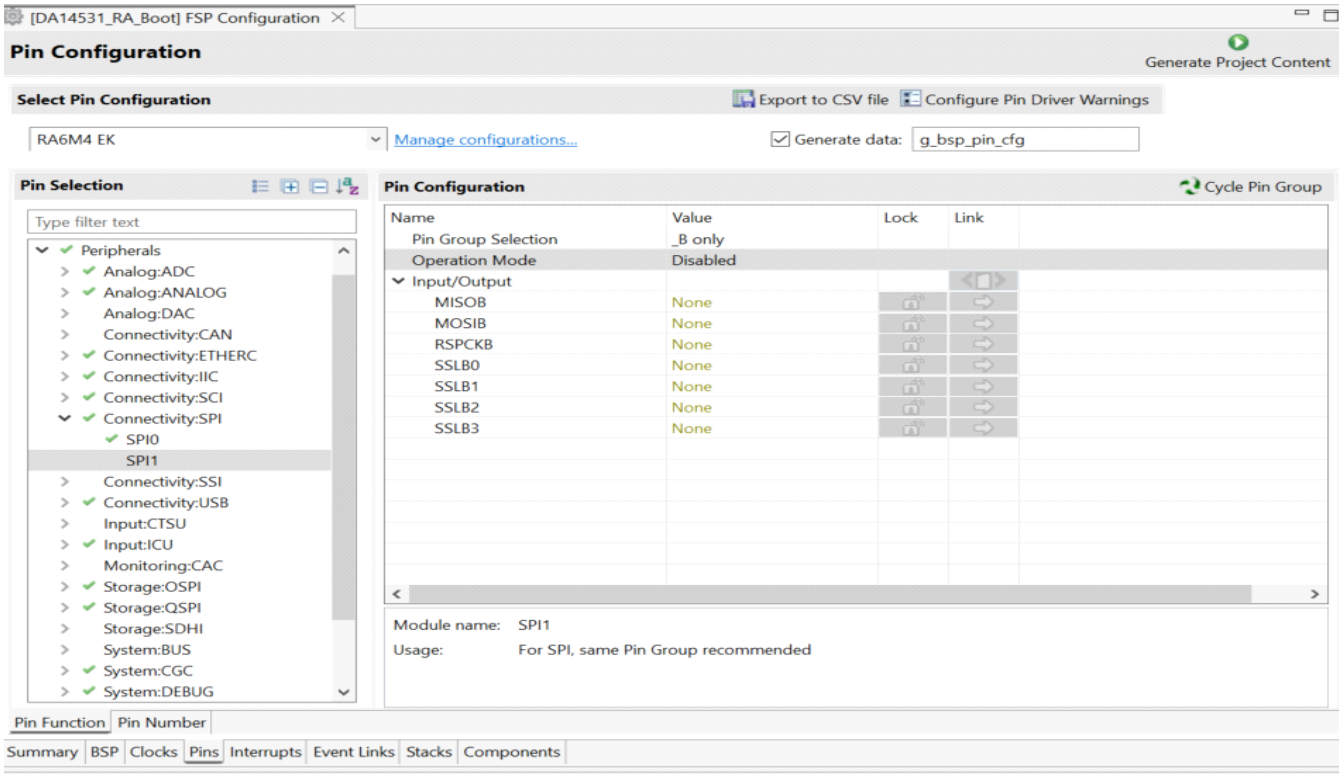

Figure 12. Pins Tab – Peripherals > Connectivity: SPI Group

15. Under the **Peripherals > Connectivity: SCI** group, select *SCI0*. Set the **Operation Mode** to *Asynchronous UART*. The **TXD0** and **RXD0** pins are automatically set to P411 and P410.

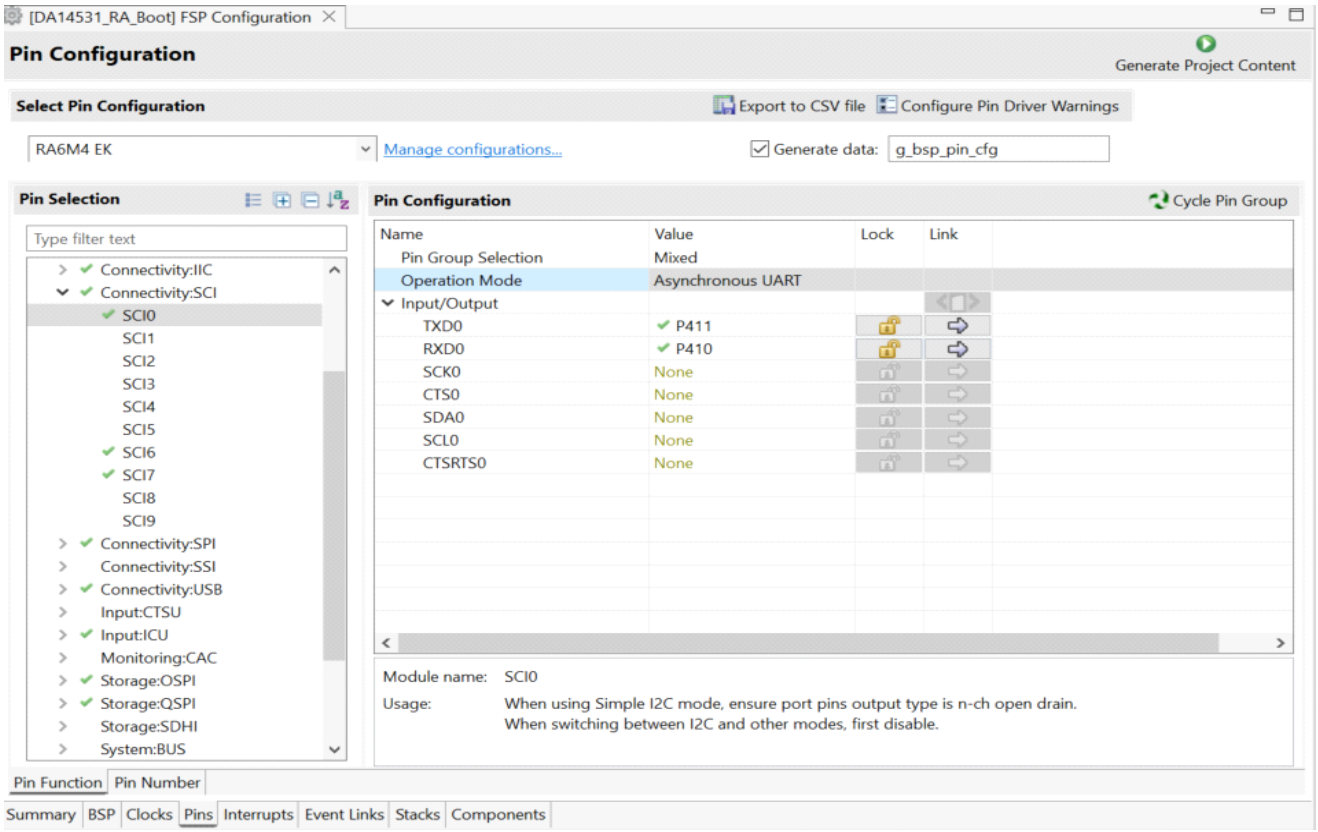

Figure 13. Pins Tab – Peripherals > Connectivity: SCI Group

16. Under **Ports > P4**, select *P412*. Set the Operation Mode to **Output mode** (Initial Low).

The RA Configuration for this section is now complete. Apply changes to the project source by clicking the **Generate Project Content** button in the top-right corner of the Configurator window.

The RA Configurator will extract all the necessary drivers and generate the code based on the configurations provided in the **Properties** tab.

For more information about Profile development with QE for BLE, QE GATT profile, and Application Testing, see Profile Development for with QE for BLE.

5. Schematic Diagram

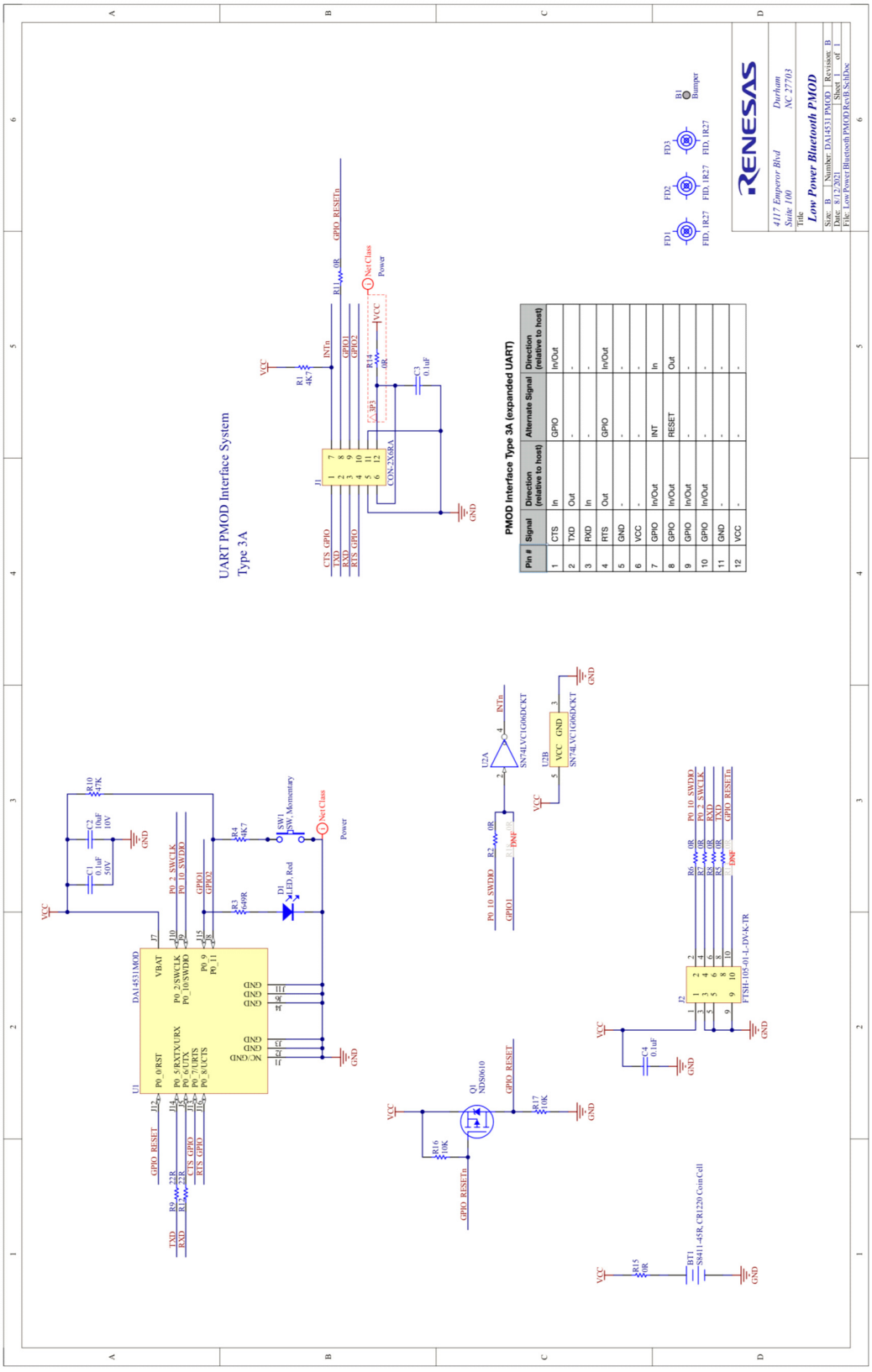

Figure 14. US159-DA14531EVZ Application Schematic Diagram

6. Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	B1	Bumper, Cylindrical, 0.375" D, 0.19" HSM	Bumper Specialties	BS35CL01X02RP
1	BT1	Battery Holder, 12mm Coin Cell, CR1220, SM, RoHS	Harwin	S8411-45R
3	C1, C3, C4	Capacitor, 0.1µF, 50V, SM 0603, Multilayer Ceramic, X7R, RoHS	Yageo	CC0603KRX7R9BB104
1	C2	Capacitor, 10µF, 10V, SM 0603, Multilayer Ceramic, X5R, RoHS	Murata	GRM188R61A106KE69D
1	D1	LED, Red, Clear, 0805, SM, RoHS	Wurth Elektronik	150080RS75000
1	J1	Connector, 2×6, 0.1", Pmod, Right Angle, Unshrouded, RoHS	Harwin	M20-9950645
1	J2	Connector, 2×5 Header, Vertical, 1.27mm Pitch, Pin 7, SM, RoHS	Samtec	FTSH-105-01-L-DV-007-K
1	Q1	Transistor, P-Ch Mosfet, 60V, 120mA, 10Ω, SM, SOT23-3, RoHS	Diodes Inc.	DMP10H4D2S-7
2	R1, R4	Resistor, 4.7kΩ, 1/8W, 1%, 100ppm, SM, 75WV, 100OV, Thick Film, 0603, RoHS	KOA Speer	RK73H1JTTD4701F
8	R2, R5, R6, R7, R8, R11, R14, R15	Resistor, 0Ω, 1/8W, 1%, 100ppm, SM, 75WV, 100OV, Thick Film, 0603, RoHS	KOA Speer	RK73Z1JTTD
1	R3	Resistor, 649Ω, 1/8W, 1%, 100ppm, SM, 75WV, 100OV, Thick Film, 0603, RoHS	KOA Speer	RK73H1JTTD6490F
2	R9, R12	Resistor, 22Ω, 1/8W, 1%, 100ppm, SM, 75WV, 100OV, Thick Film, 0603, RoHS	KOA Speer	RK73H1JTTD22R0F
1	R10	Resistor, 47kΩ, 1/8W, 1%, 100ppm, SM, 75WV, 100OV, Thick Film, 0603, RoHS	KOA Speer	RK73H1JTTD6802F
2	R16, R17	Resistor, 10kΩ, 1/8W, 1%, 100ppm, SM, 75WV, 100OV, Thick Film, 0603, RoHS	KOA Speer	RK73H1JTTD1002F
1	SW1	Switch, Pushbutton, Top Actuated, SM, RoHS	C&K Components	PTS810 SJG 250 SMTR LFS
1	U1	DA14531MOD, Bluetooth Low Energy 5.1 Module, 128kB Flash, 144kB ROM, 48kB RAM, 16-SMD Module, SM, RoHS	Dialog Semiconductor	DA14531MOD-00F01002
1	U2	IC, Digital, Buffer, Inverting, Open Drain, SM, SC-70-5, RoHS	Diodes Inc.	74LVC1G06SE-7

6.1 Board Layout

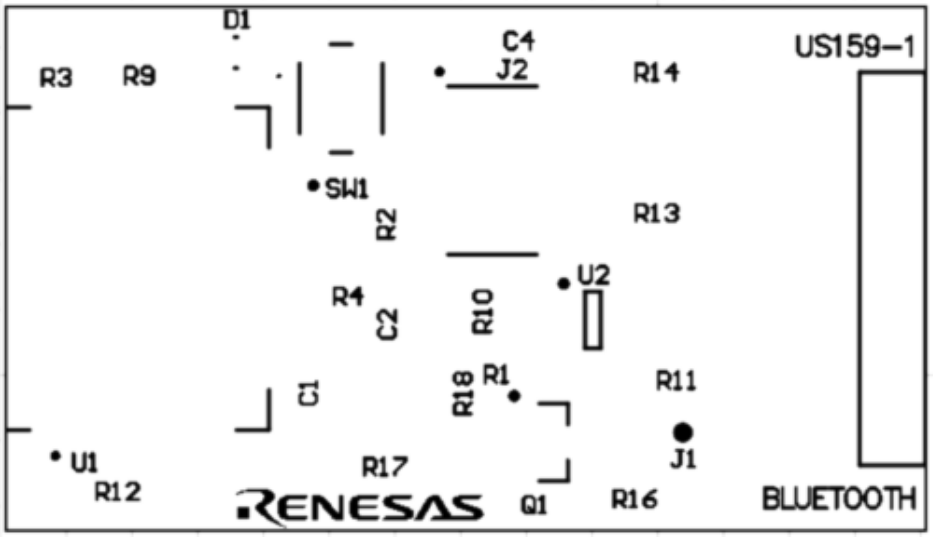

Figure 15. Silkscreen Top

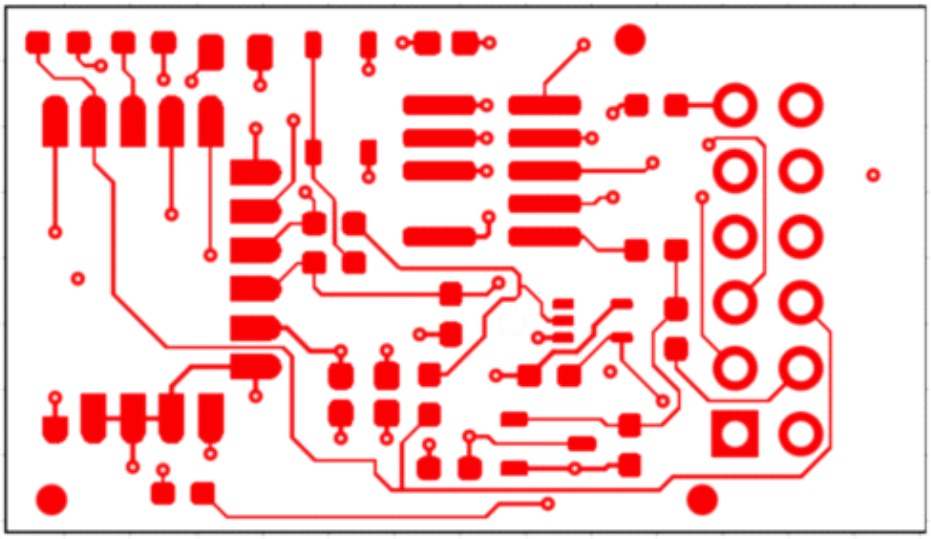

Figure 16. Copper Top

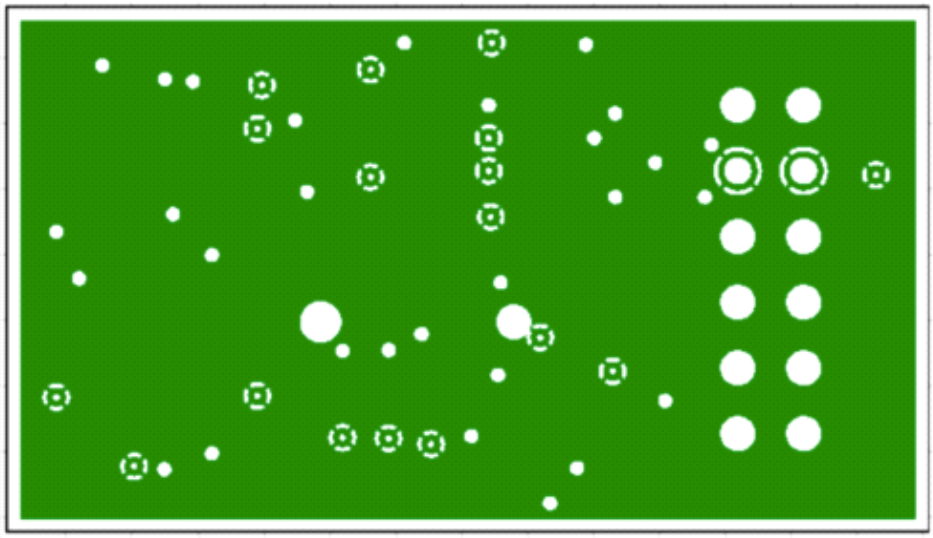

Figure 17. Copper L1 Layer

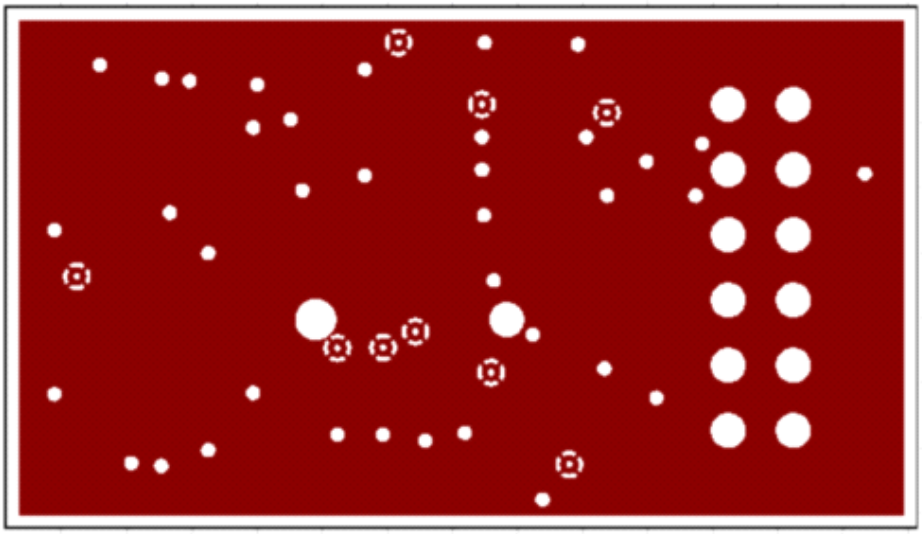

Figure 18. Copper L2 Layer

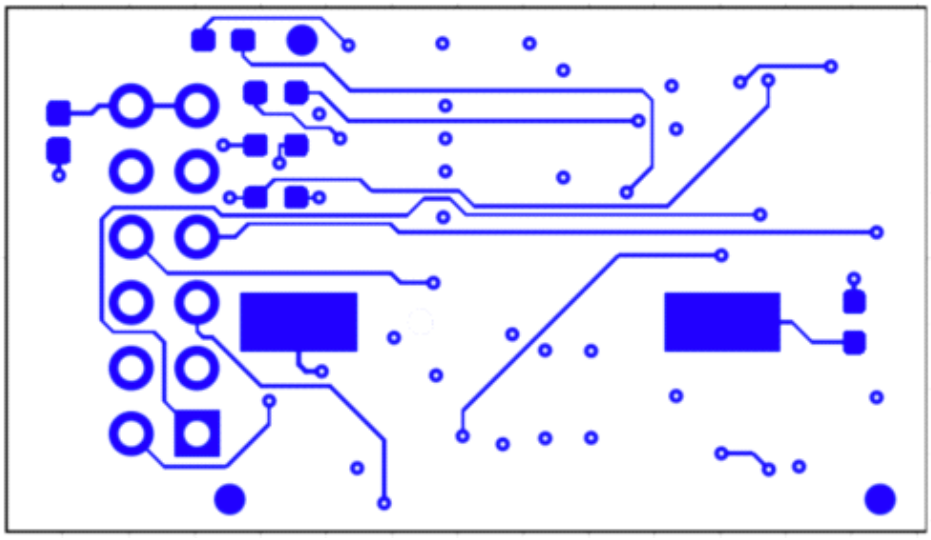

Figure 19. Copper Bottom

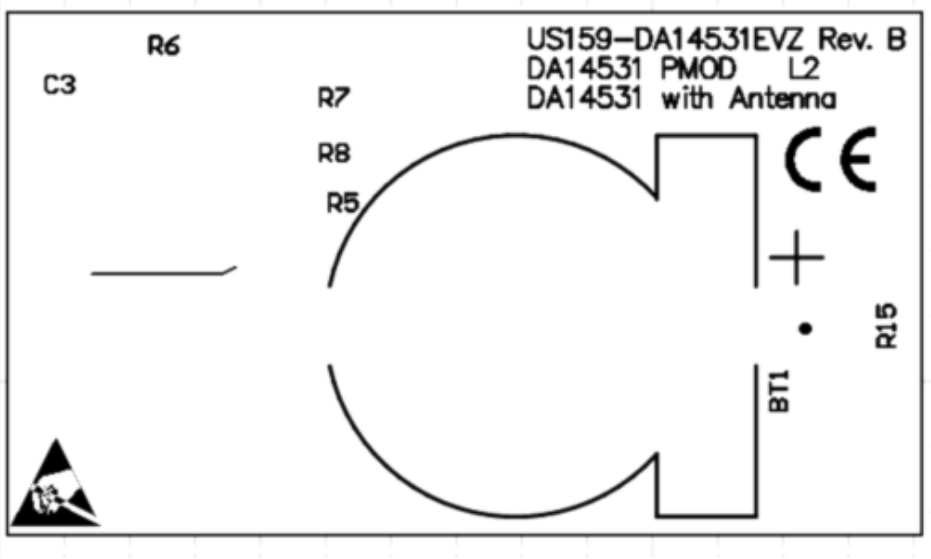

Figure 20. Silkscreen Bottom

7. Ordering Information

Part Number	Description
US159-DA14531EVZ	DA14531 Pmod Board

8. Revision History

Revision	Date	Description
1.02	Jul 29, 2024	▪ Added Board Design – DA14531/5 PMOD and One-Wire Download using FSP BLE Framework sections. ▪ Renamed document to US159-DA14531/**5**EVZ from US159-DA14531EVZ.
1.01	Sep 8, 2023	Replaced Figure 1 with updated image.
1.00	Jun 27, 2022	Initial release

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01 Jan 2024)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.