US159-DA14531EVZ

DA14531 Pmod™ Board

Description

The US159-DA14531EVZ Low Power Bluetooth® Pmod™ module enables the user to add low-power Bluetooth capability to any evaluation kit or microcontroller board equipped with a Pmod expansion capability. The board provides a standard Pmod™ Type 3A (Expanded UART) connection for the onboard Bluetooth 5.1 module.

The US159-DA14531EVZ features a Type 3A Pmod connector and incorporates the DA14531 SmartBond TINY™ Module, based on an extremely small and low-power Bluetooth 5.1 System-on-Chip. With its standard connector and software support, the US159-DA14531EVZ is ideal for Renesas' QuickConnect platform to rapidly create an IoT system.

Kit Contents

US159-DA14531EVZ Pmod board

Features

- DA14531 SmartBond TINY module
  - Cortex M0+ at 16MHz
  - Memory: 4kB RAM, 32kB OTP, and 1Mb Flash
  - Bluetooth 5.1 core-qualified
  - Integrated chip antenna
  - Worldwide certification
  - 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

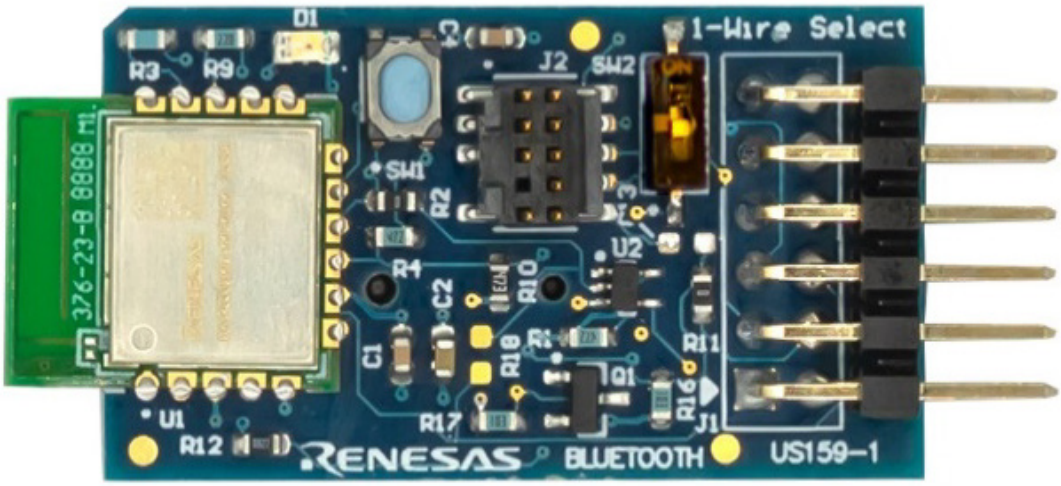


Figure 1. US159-DA14531EVZ Pmod Board (XE Evaluation Board)

Contents

Figures

1. Functional Description

The US159-DA14531EVZ 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. For more information, see the DA14531 SmartBond TINY module website.

1.1 Setup

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

- Any MCU board that supports Type 3A Pmod

1.2 Software Installation and Usage

Download the latest version of the e2 studio from the website. For the latest connectivity support and details on creating customized IoT system solutions, see the Quick-Connect website.

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, the 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-DA14531EVZ Pmod module with GTL image by using a 1-wire or 2-wire UART bootloader.

1.3 Kit Hardware Connections

Set up the kit as shown in Figure 2 and Figure 3 by completing the following steps:

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-DA14531EVZ board to the Pmod connector on the MCU evaluation kit by aligning pin 1 on the module to pin 1 on the MCU kit.
3. The US159-DA14531EVZ board is now ready to be used in the system. Follow the MCU kit instructions for connecting and powering up the evaluation kit.

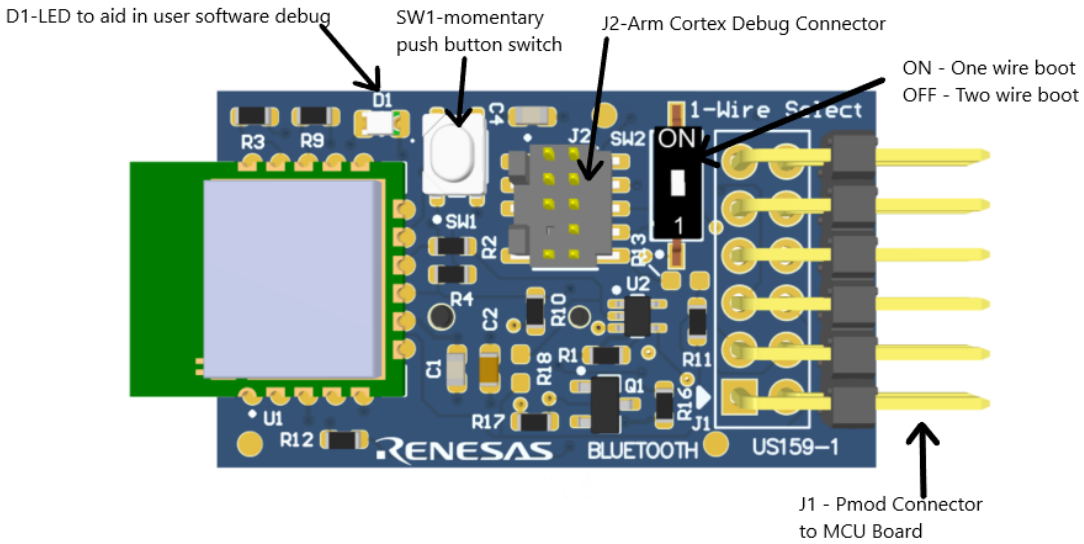


Figure 2. Evaluation Kit Details – Image 1

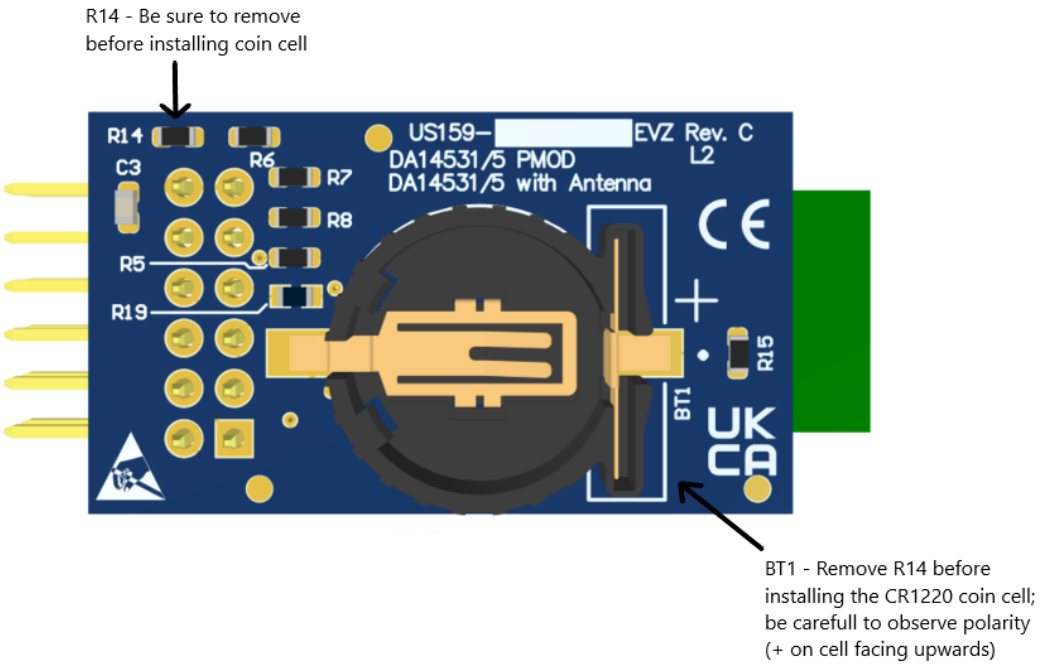


Figure 3. Evaluation Kit Details – Image 2

1.4 Board Images

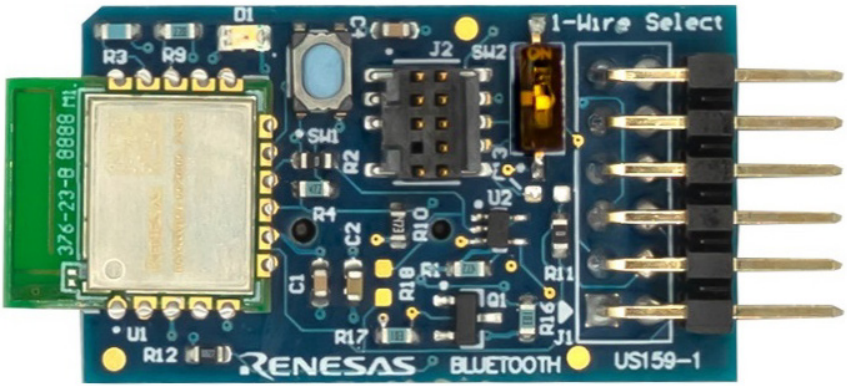


Figure 4. DA14531 Evaluation Board (Top)

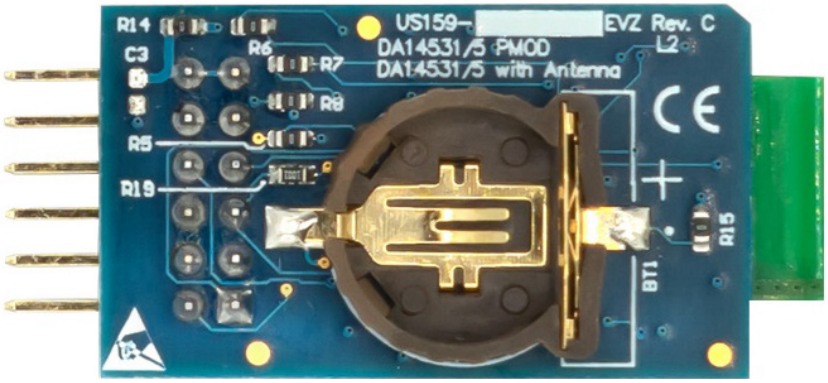


Figure 5. DA14531 Evaluation Board (Bottom)

2. One-Wire Download using FSP BLE Framework

2.1 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-DA14531EVZ Pmod module with GTL image by using a 1-wire or 2-wire UART bootloader.

For more information about hardware setup and creating the FSP application, see Prerequisites – Getting Started with DA1453x and FSP BLE Framework. This document introduces the Flexible Software Package (FSP) drivers and middleware designed for the DA1453x Bluetooth Low Energy (LE) devices.

2.2 Adding Bluetooth LE Communications

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

1. Click on the *FSP Configuration* option in the top-right corner.

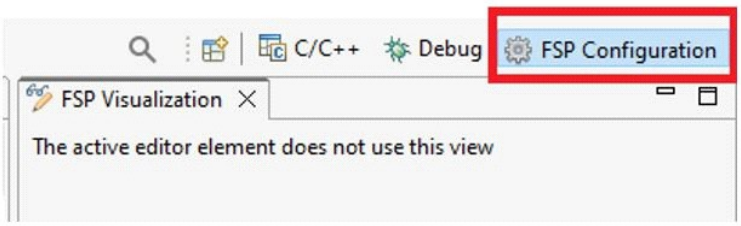


Figure 6. FSP Configuration Option

2. Select the **Stacks Configuration** tab (this is used for most of this document). The functions within this tab allow for 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 appears. This thread is used by the DA1453x GTL middleware.

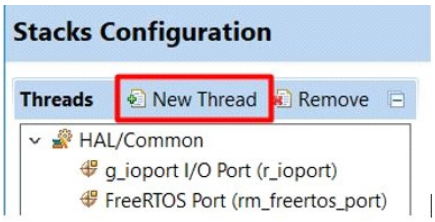


Figure 7. Stacks Configuration Tab – New Thread

4. Select the **Properties** tab. It can be found in the lower-left pane, directly under the Project Explorer. In the **Thread** section (see Figure 8), edit the new thread properties to match the configuration as follows:
   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 must be enabled.

7. Expand **Common** and then **Memory Allocation**. Change following properties to:
   a. **Support Dynamic Allocation**: Enabled

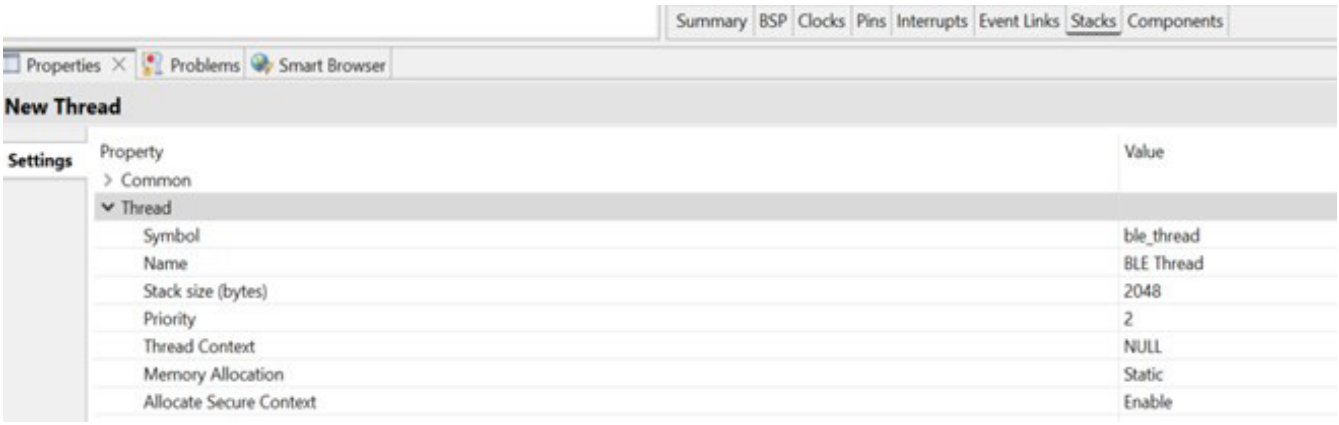


Figure 8. BLE Thread Configuration

8. Select **HAL/Common** on the Threads list and click on *New Stack*. From the menu, select **RTOS > FreeRTOS Heap 4** (see Figure 9).

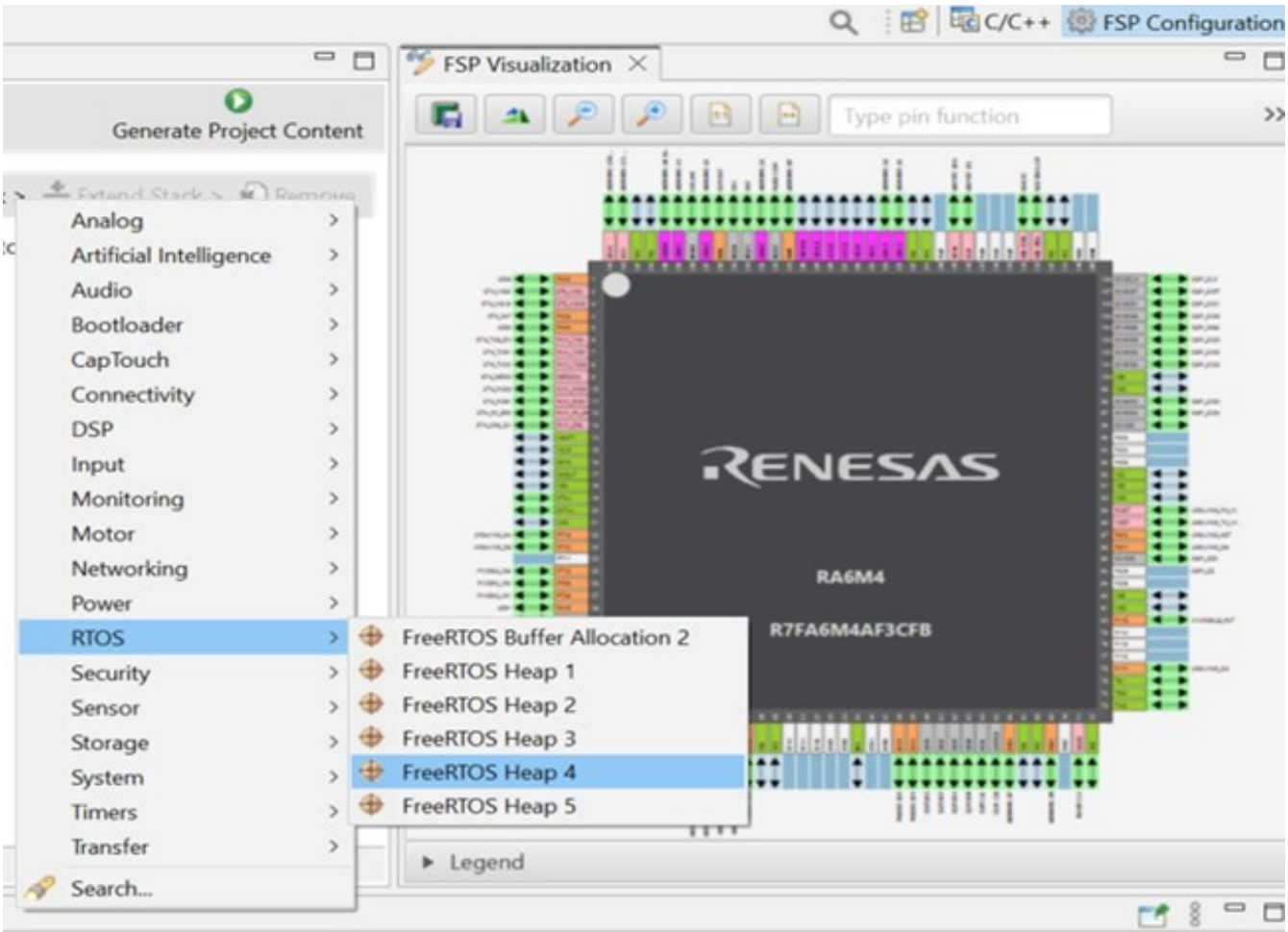


Figure 9. RTOS Selection

9. Select the BLE Thread and open the **New Stack** menu. Select **Networking > GTL BLE Abstraction (rm_ble_abs_gtl)** (see Figure 10).

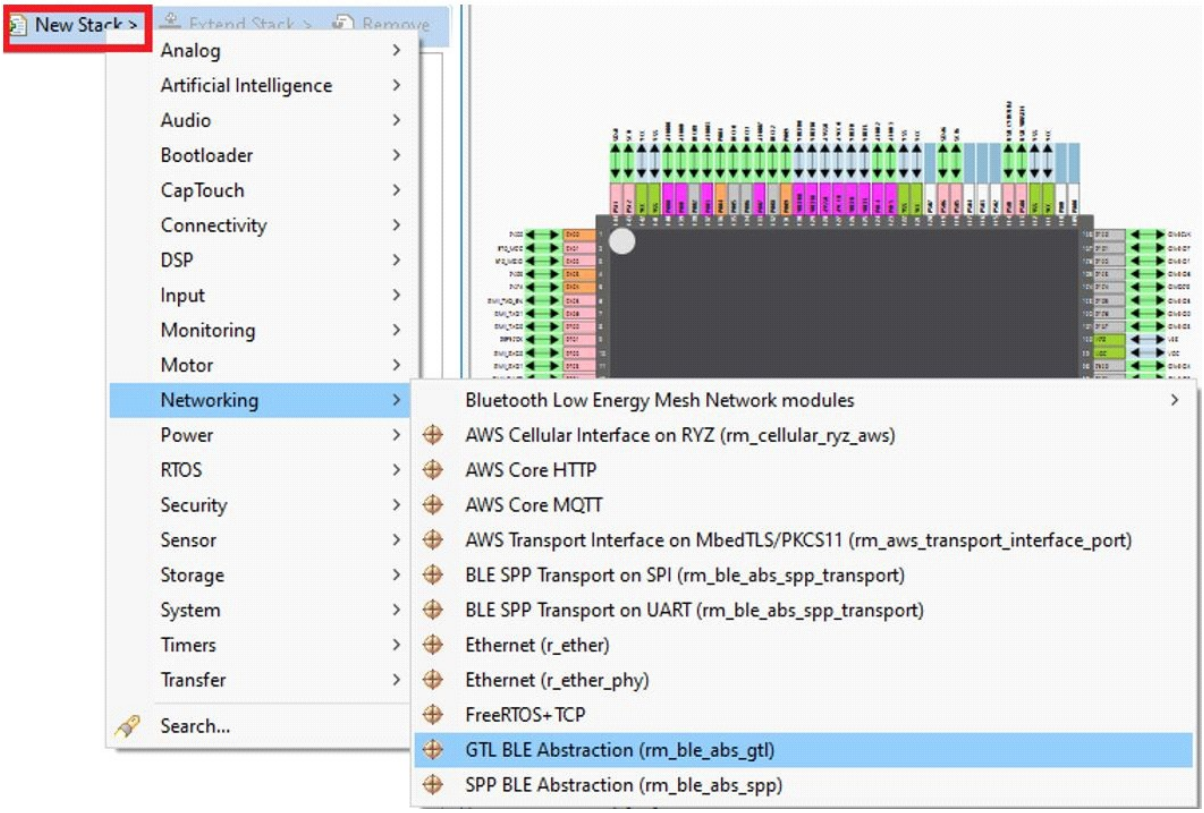


Figure 10. New Stack – Networking Menu

A new module stack will be added to the HAL/Common Stacks context (see Figure 11).

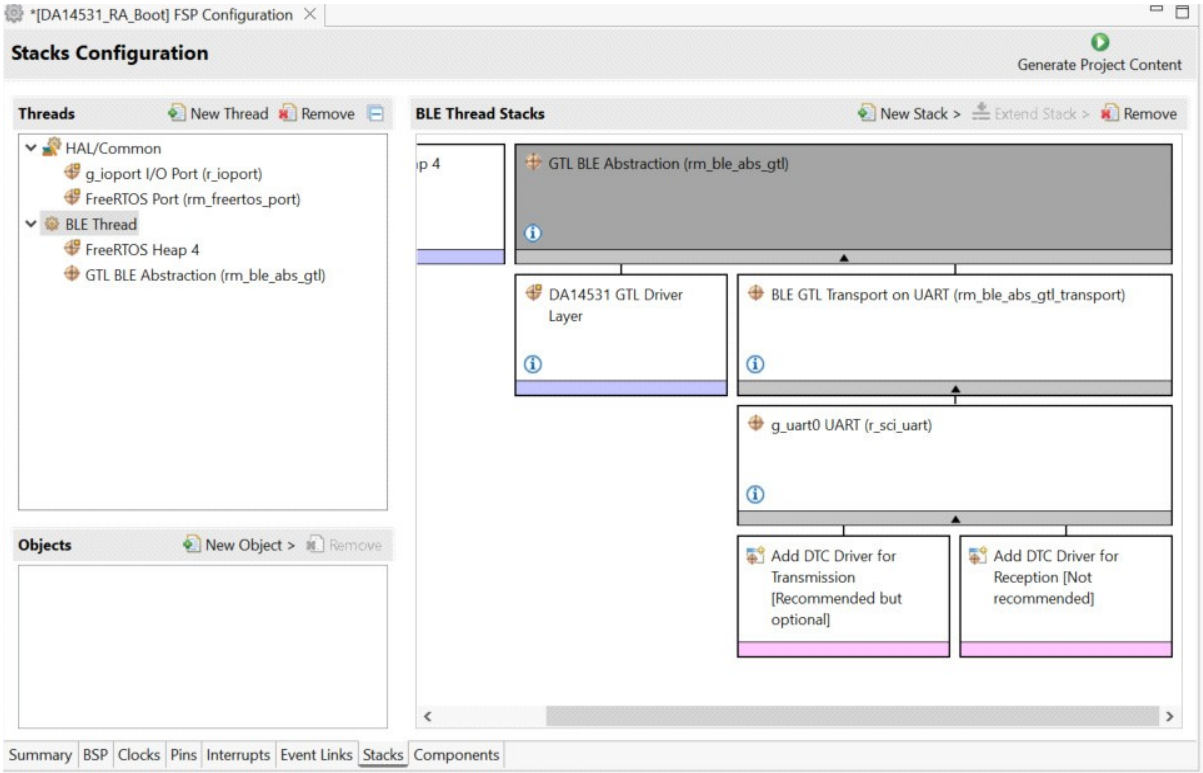


Figure 11. HAL/Common Stacks Window

10. Select the **DA14531 GTL Driver Layer**.
    Note: Option to select the device under **Common > DA1453x Device** is available in the latest FSP v5.4.0.
    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

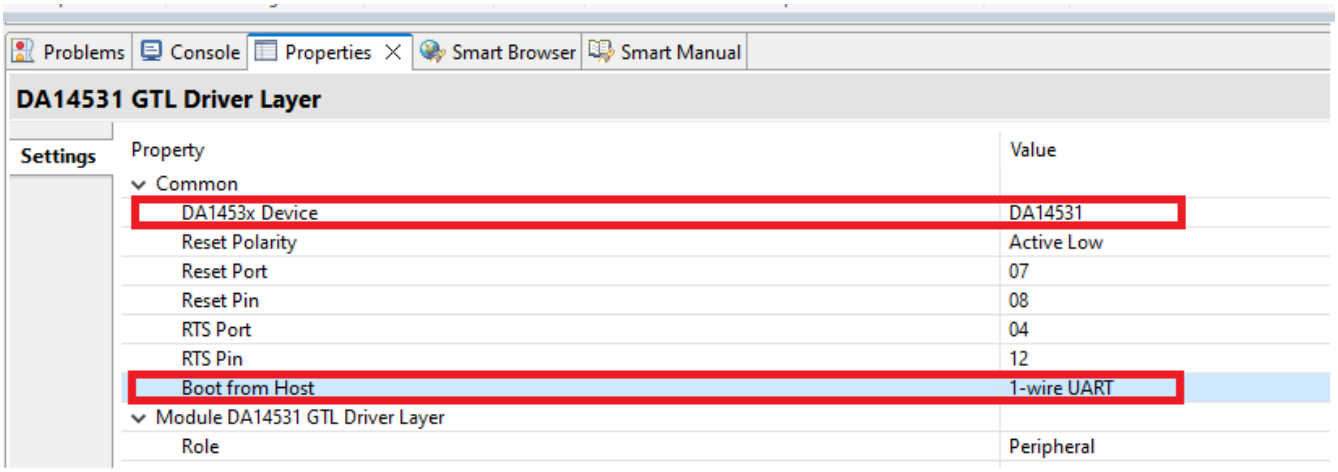


Figure 12. Pmod Pins Configuration for RA6M4-EK

Note: The DA14531 Pmod board is pre-loaded with the SUotA bootloader binary for 2-wire boot support. Turning on the switch on the Pmod selects one-wire boot and turning off the switch selects 2-wire boot, regardless of what the user selects in the **Boot from Host** option in the FSP.

11. Enable the option to boot DA14531 from host MCU through 1-Wire UART (disabled by default).
12. Select **DA14531** under **Common > DA1453x Device** as shown in Figure 12.

Note: The DA14531 Pmod module will be connected on the Pmod 2 of the RA6M4 development kit. When considering the use of another MCU, all the steps previously mentioned 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 13).

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**.

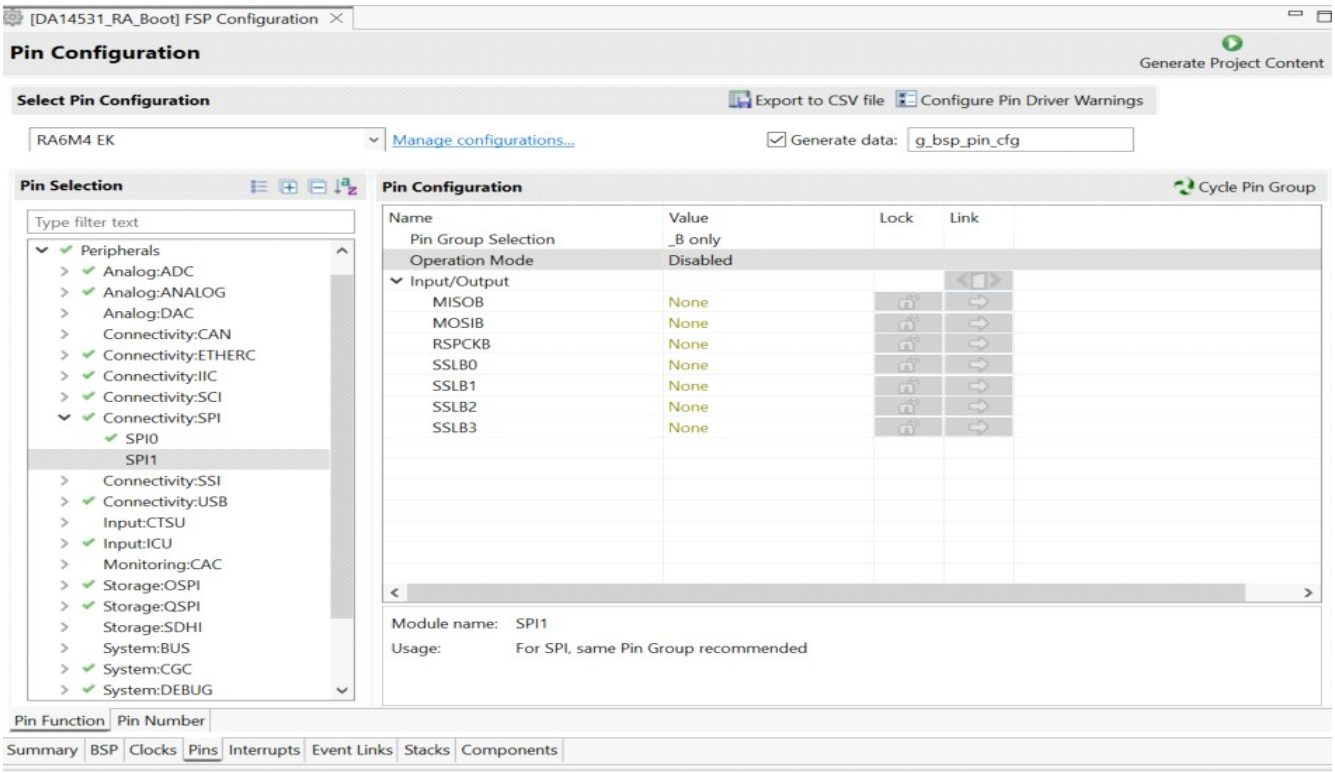


Figure 13. Pins Tab – Peripherals > Connectivity: SPI Group

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*, respectively (see Figure 14).

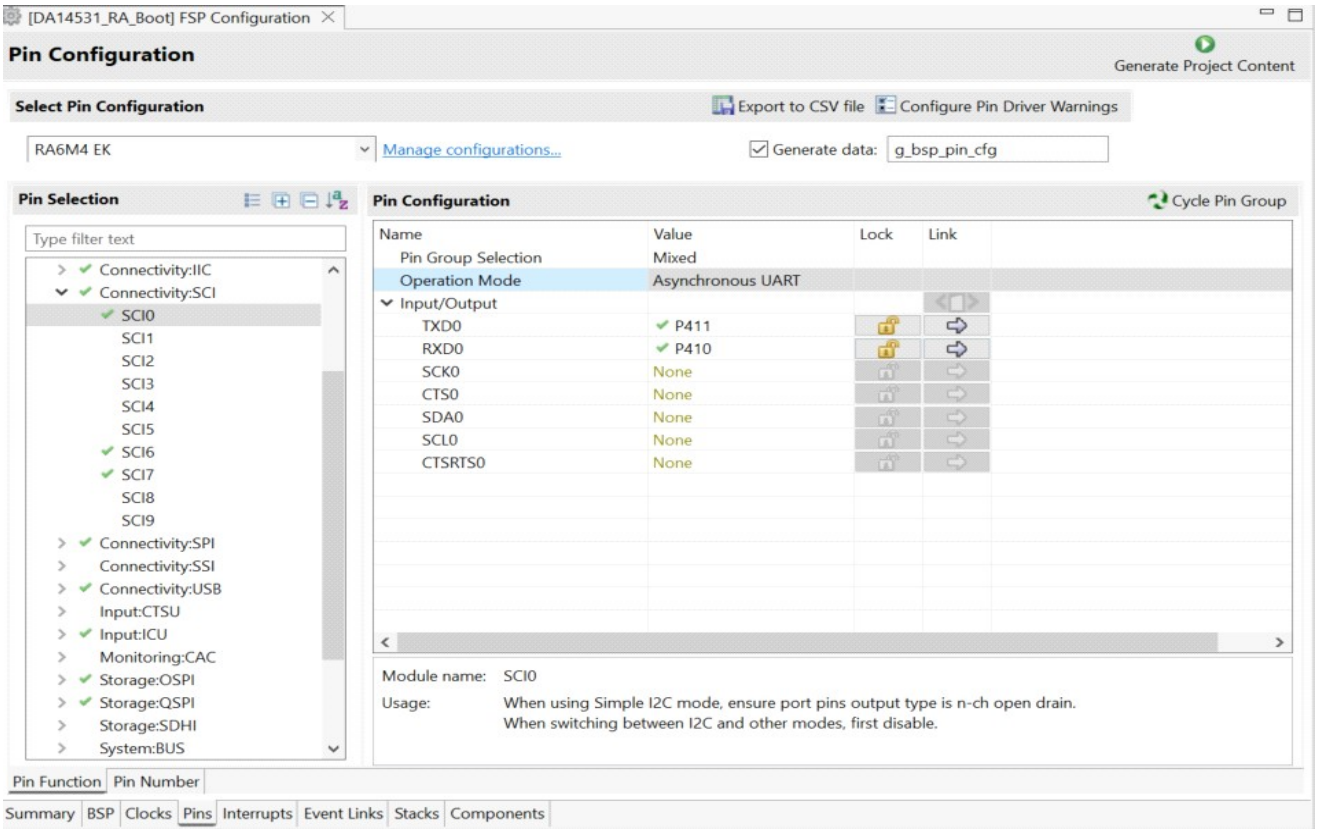


Figure 14. Pins Tab – Peripherals > Connectivity: SCI Group

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

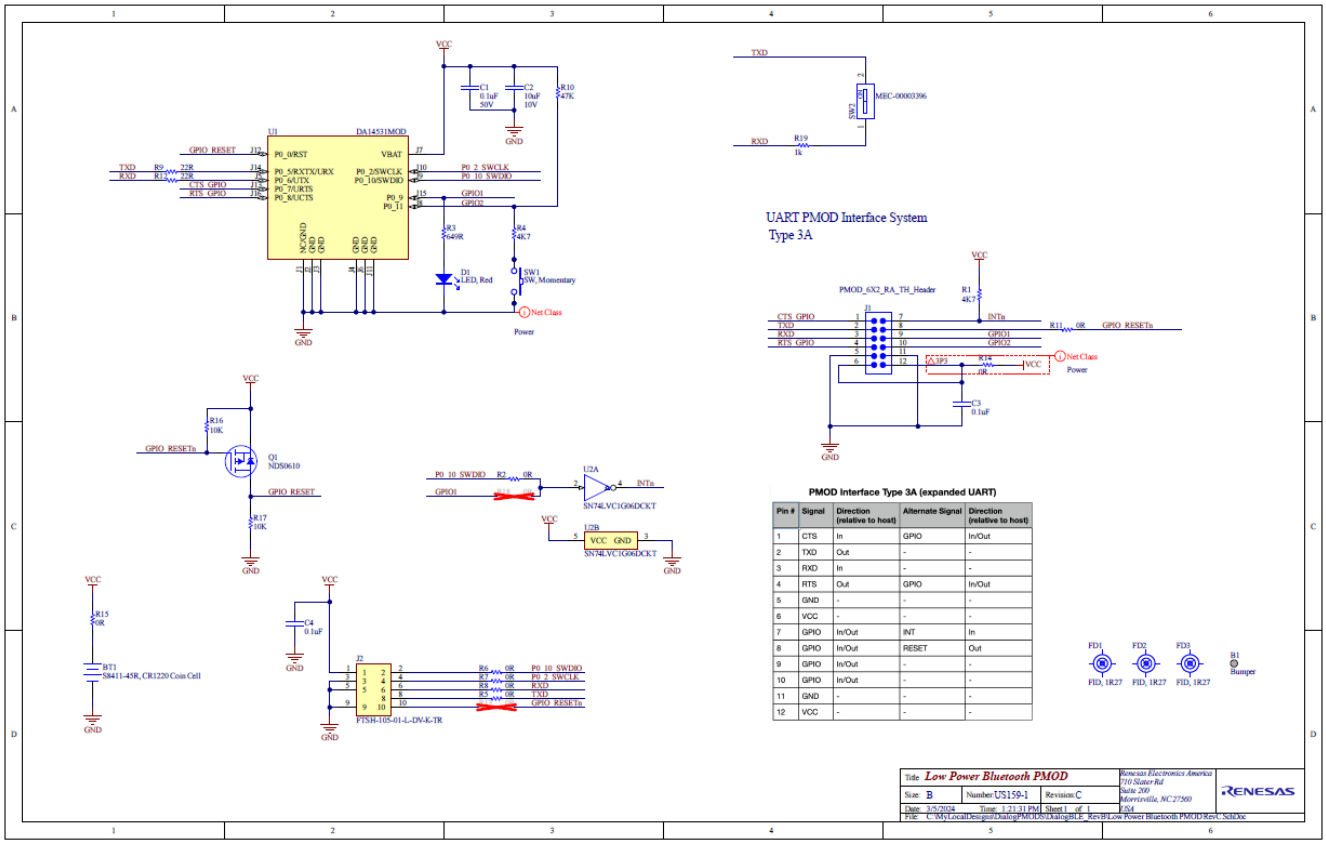
The RA Configuration for this section is now complete. Apply changes to the project source by clicking the *Generate Project Content* button in the top-right corner of the **Pin Configuration** window.

The RA Configurator extracts 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.

3. Board Design

3.1 Schematic Diagrams



Pin #	Signal	Direction (relative to host)	Alternate Signal	Direction (relative to host)
1	CTS	In	GPIO	In/Out
2	TXD	Out	-	-
3	RXD	In	-	-
4	RTS	Out	GPIO	In/Out
5	GND	-	-	-
6	VCC	-	-	-
7	GPIO	In/Out	INT	In
8	GPIO	In/Out	RESET	Out
9	GPIO	In/Out	-	-
10	GPIO	In/Out	-	-
11	GND	-	-	-
12	VCC	-	-	-

Figure 15. US159-DA14531EVZ Application Schematic Diagram

3.2 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 Electronics	150080RS75000
1	J1	Male Header 0.1" pitch PMOD 2 × 6 Right Angle, through hole	Wurth Electronics	61301221021
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	ON Semiconductor	NDS0610
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	R19	Chip Resistor Thick Film 0603, 1K0 ohm 1% 1/10W	Vishay	CRCW06031K00FKEAC
1	SW1	Switch, Pushbutton, Top Actuated, SM, RoHS	C&K Components	PTS810 SJG 250 SMTR LFS
1	SW2	WS-DISV Small Compact SMT Flat Actuator with Top Tape, 1.27 mm	Wurth Electronics	416131160801
1	U1	DA14531MOD, Bluetooth Low Energy 5.3 Module, SM	Renesas Electronics	DA14531MOD-00F01002
1	U2	IC, Digital, Buffer, Inverting, Open Drain, SM, SC-70-5, RoHS	Texas Instruments	SN74LVC1G06DCKT

3.3 Board Layout

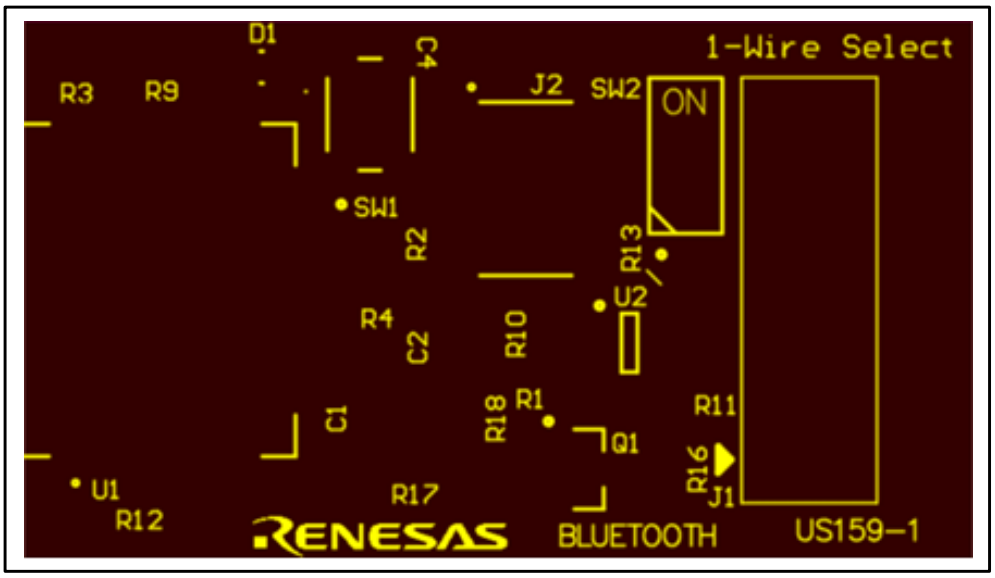


Figure 16. Silkscreen Top

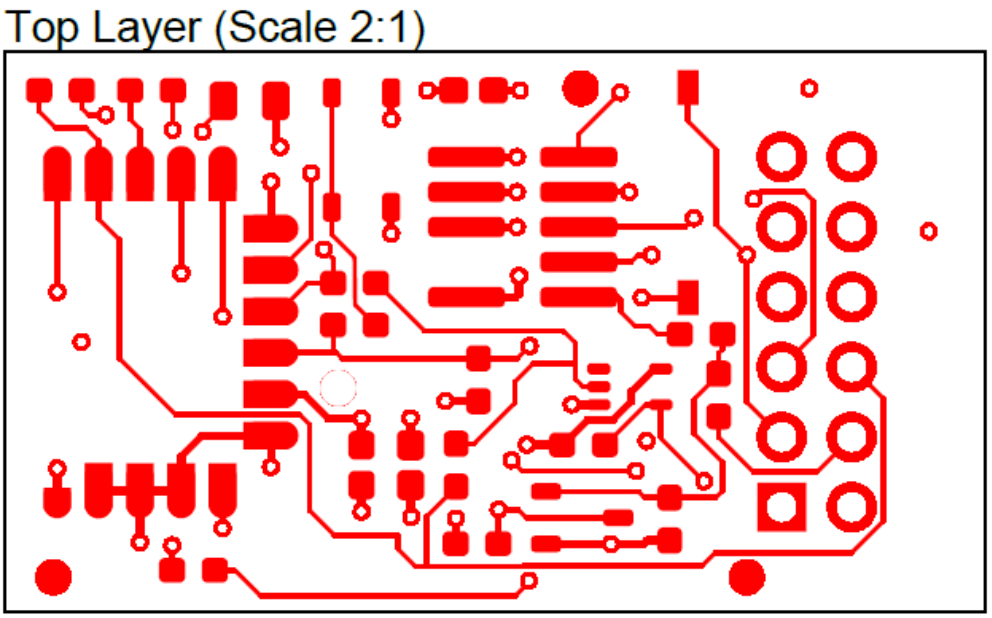


Figure 17. Copper Top

Int1 (GND) (Scale 2:1)

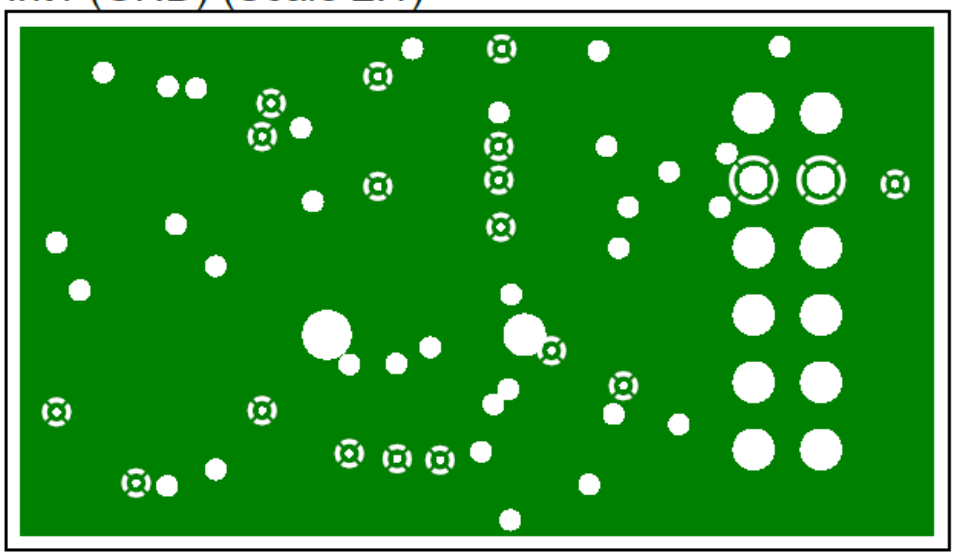


Figure 18. Copper L1 Layer

Int2 (PWR) (Scale 2:1)

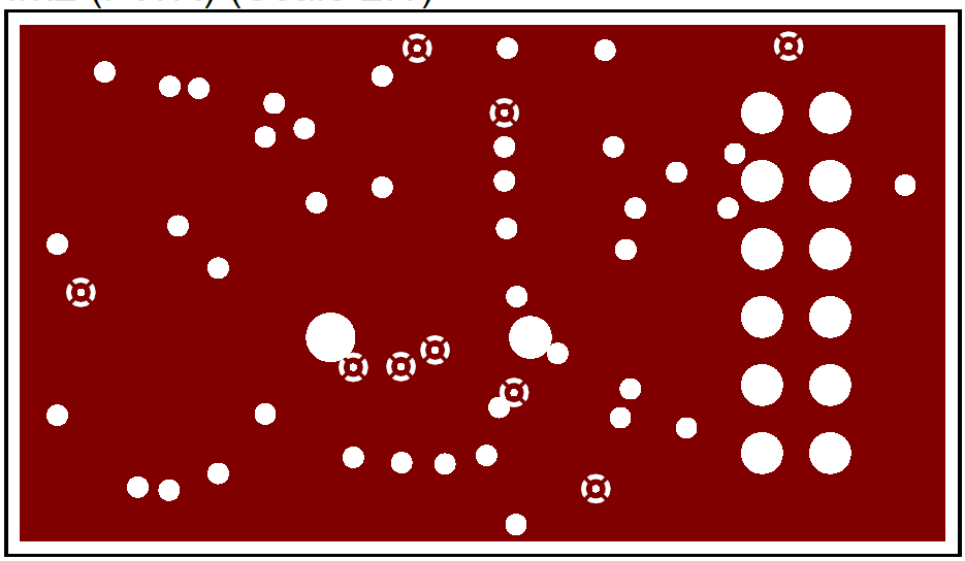


Figure 19. Copper L2 Layer

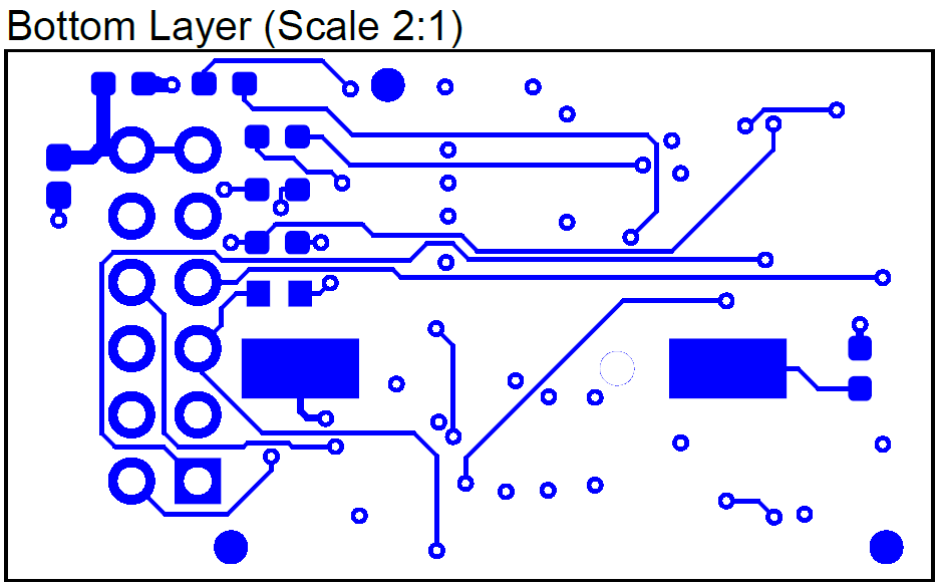


Figure 20. Copper Bottom

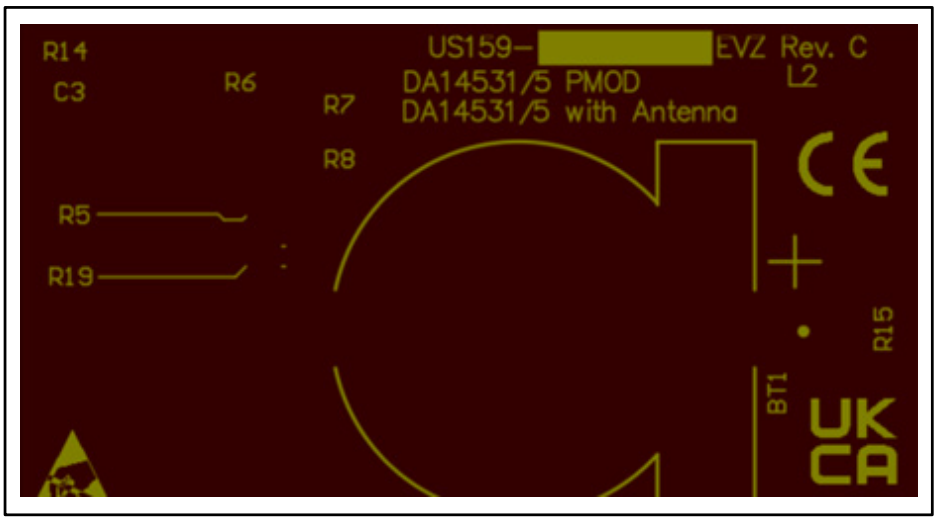


Figure 21. Silkscreen Bottom

4. Ordering Information

Part Number	Description
US159-DA14531EVZ	DA14531 Evaluation Board

5. Revision History

Revision	Date	Description
1.03	Jan 28, 2025	▪ Separated previous US159-DA14531/5 manual into a specific user manual for US159-DA14531 ▪ Updated Schematic Diagrams ▪ Updated Bill of Materials ▪ Updated FSP Firmware
1.02	Jul 29, 2024	Added Board Design – DA14531/5 Pmod and One-Wire Download using FSP BLE Framework sections.
1.01	Sep 8, 2023	▪ Replaced Figure 1 with updated image ▪ Updated note below Figure 12
1.00	Jun 27, 2022	Initial release.

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