

US159-DA14535EVZ

DA14535 PMOD[™] Board

The US159-DA14535EVZ board 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-DA14535EVZ features a Type 3A PMOD connector and incorporates the <u>DA14535 SmartBond</u> <u>TINY™ Module</u>, which uses the efficient Bluetooth 5.3 SoC. With a standard connector and software support, the US159-DA14535EVZ is ideal for the Renesas Quick-Connect IoT to rapidly create an IoT system.

Kit Contents

US159-DA14535EVZ PMOD board

Features

- DA14535 SmartBond TINY module
 - Cortex M0+ at 16MHz
 - Memory: 64kB RAM, 12kB OTP, and 160kB ROM
 - Bluetooth 5.3 core-qualified
 - Integrated chip antenna
 - Worldwide certification
 - 3.3V supply voltage
 - 4dBm maximum output power
 - -94.5dBm sensitivity
 - Rx current 2.1mA at 3.3V
 - Tx current 3.5mA 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-DA14535EVZ PMOD Board (XE Evaluation Board)

Contents

1.	Functional Description							
	1.1	Setup	3					
	1.2	Software Installation and Usage	3					
	1.3 Kit Hardware Connections							
2.	Boa	rd Design	4					
3.	One-Wire Download using FSP BLE Framework							
	3.1	Introduction	5					
	3.2	Adding Bluetooth LE Communications	5					
4.	Board Design							
	4.1	Schematic Diagram	10					
	4.2	Bill of Materials	11					
	4.3 Board Layout							
5.	Orde	ering Information	15					
6.	Revi	ision History	15					

Figures

Figure 1. US159-DA14535EVZ PMOD Board (XE Evaluation Board)	1
Figure 2. Evaluation Kit Details – Image 1	3
Figure 3. Evaluation Kit Details – Image 2	4
Figure 4. DA14535 EVB (Top)	4
Figure 5. DA14535 EVB (Bottom)	4
Figure 6. FSP Configuration Option	5
Figure 7. Stacks Configuration Tab – New Thread	5
Figure 8. BLE Thread Configuration	6
Figure 9. RTOS Selection	6
Figure 10. New Stack – Networking Menu	7
Figure 11. HAL/Common Stacks Window	7
Figure 12. PMOD Pins Configuration for RA6M4-EK	8
Figure 13. Pins Tab – Peripherals > Connectivity: SPI Group	9
Figure 14. Pins Tab – Peripherals > Connectivity: SCI Group	9
Figure 15. US159-DA14535EVZ Application Schematic Diagram	10
Figure 16. Silkscreen Top	12
Figure 17. Copper Top	12
Figure 18. Copper L1 Layer	13
Figure 19. Copper L2 Layer	13
Figure 20. Copper Bottom	14
Figure 21. Silkscreen Bottom	14



1. Functional Description

The US159-DA14535EVZ 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 on the <u>DA14535 SmartBond TINY</u> module, visit the Renesas 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

For the latest version of the e2 studio, see the Renesas website, and for the latest connectivity support and details on creating customized IoT system solutions, visit the Quick-Connect IoT 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-DA14535 EVZ PMOD module with GTL image by using a 1-wire or 2-wire UART bootloader.

1.3 Kit Hardware Connections

To set up the kit as shown in Figure 2 and Figure 3, complete 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-DA14535EVZ board 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-DA14535EVZ 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

2. Board Design



Figure 4. DA14535 EVB (Top)



Figure 5. DA14535 EVB (Bottom)

3. One-Wire Download using FSP BLE Framework

3.1 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-DA14535 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, see <u>Prerequisites - Getting</u> <u>Started with DA14535 and FSP BLE Framework</u>. This document introduces the Flexible Software Package (FSP) drivers and middleware designed for the DA1453x Bluetooth Low Energy (LE) devices.

3.2 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 and then completing the following steps:

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



Figure 6. FSP Configuration Option

- 2. Select the **Stacks** configuration tab (this will be used for most of this document). The functions within this tab allow 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.

hreads	횐 New Thread	🕢 Remove 🛛 🖃
@ 11A		

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, 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
 - b. Total Heap Size: 0x800

Properti	es 🔀 👷 Problems 🏶 Smart Browser	
New Thr	ead	
Settings	Property > Common	Value
	✓ Thread	
	Symbol	ble_thread
	Name	BLE Thread
	Stack size (bytes)	2048
	Priority	2
	Thread Context	NULL
	Memory Allocation	Static
	Allocate Secure Context	Enable

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**.



Figure 9. RTOS Selection

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

ack >	A Fytend Stack >	Remov	e	
	Analog	>	H	
	Artificial Intelligence	>		
	Audio	>		
	Bootloader	>		
	CapTouch	>		
	Connectivity	>		
	DSP	>		
	Input	>		
	Monitoring	>		
	Motor	>		
	Networking	>		Bluetooth Low Energy Mesh Network modules >
	Power	>	•	AWS Cellular Interface on RYZ (rm_cellular_ryz_aws)
	RTOS	>	0	AWS Core HTTP
	Security	>	0	AWS Core MQTT
	Sensor	>	0	AWS Transport Interface on MbedTLS/PKCS11 (rm_aws_transport_interface_port)
	Storage	>	0	BLE SPP Transport on SPI (rm_ble_abs_spp_transport)
	System	>	•	BLE SPP Transport on UART (rm_ble_abs_spp_transport)
	Timers	>	0	Ethernet (r_ether)
	Transfer	>	•	Ethernet (r_ether_phy)
0	Search		0	FreeRTOS+ TCP
14	Jearchin		\$	GTL BLE Abstraction (rm_ble_abs_gtl)
			(SPP BLE Abstraction (rm_ble_abs_spp)

Figure 10. New Stack – Networking Menu

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

hreads	શ New Thread શ Remove 📃	BLE Thread Stacks	🐑 New Stack > 🚢 Extend Stack > 🕷 Remove
 ✓ Section 49 g_iop 49 g_iop 49 FreeR ✓ Ø BLE Three 49 FreeR 	nmon ort I/O Port (r_ioport) TOS Port (rm_freertos_port) ad TOS Heap 4	op 4 🗘 🕀 GTL BLE Abstract	on (rm_ble_abs_gtl)
🕀 GTL BI	LE Abstraction (rm_ble_abs_gtl)	 DA14531 GTL Dr Layer Image: Control of the second sec	ver
biects	New Object > Remove		
			Add DTC Driver for Transmission [Recommended but optional] [Recommended]

Figure 11. 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: 0.7
- c. Reset Pin: 08
- d. RTS Port: 04
- e. RTS Pin: 12

gs Property ✓ Common	Value
DA1453x Device	DA14535
Reset Polarity	Active Low
Reset Port	07
Reset Pin	08
RTS Port	04
RTS Pin	12
Boot from Host	1-wire UART
 Module DA14531 GTL Driver Layer 	
Role	Peripheral

Figure 12. PMOD Pins Configuration for RA6M4-EK

Note: The DA14535 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 DA14535 from host MCU through 1-Wire UART (disabled by default).
- 12. Select *DA14535* under **Common > DA1453x Device** as shown in the above image.

Note: The DA14535 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 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 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**.

Pin Configuration					Generate Project Conten
Select Pin Configuration		Export to CSV	/ file 🚺 C	onfigure Pin Driver Warning	Is
RA6M4 EK	Manage configurations	Generate	Generate data: g_bsp_pin_cfg		
Pin Selection	Pin Configuration				Cycle Pin Group
Type filter text ✓ Peripherals	Name Pin Group Selection	Value _B only Disabled	Lock	Link	
 Analog:ADC Analog:ANALOG Analog:DAC Connectivity:CAN Connectivity:ETHERC Connectivity:IIC Connectivity:SCI Connectivity:SPI SPI0 	✓ Input/Output MISOB MOSIB RSPCKB SSLB0 SSLB1 SSLB2 SSLB3	None None None None None None None None		000000000000000000000000000000000000000	
 Connectivity:SSI Connectivity:USB Input:CTSU Input:ICU Monitoring:CAC Storage:OSPI Storage:QSPI Storage:SDHI System:BUS System:CGC 	< Module name: SPI1 Usage: For SPI, same	Pin Group recommended			>

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.

[DA14531_RA_Boot] FSP Configurati	on ×					- [
Pin Configuration						Generate Project Content
Select Pin Configuration			Export to CS	V file 🚺 🤇	Configure Pin Driver Wa	arnings
RA6M4 EK		Manage configurations	Generat	e data: g	_bsp_pin_cfg	
Pin Selection 📔 🕀	⊟ ↓ª₂ I	Pin Configuration				Cycle Pin Group
Type filter text	~	Name Pin Group Selection	Value Mixed	Lock	Link	
 Connectivity::IC Connectivity:SCI SCI0 SCI1 SCI2 SCI3 SCI4 SCI5 SCI6 SCI7 SCI8 SCI9 Connectivity:SPI Connectivity:SSI Connectivity:SI Connectivity:USB Input:CTSU 		Operation Mode ✓ Input/Output TXD0 RXD0 SCK0 CTS0 SDA0 SCL0 CTSRTS0	Asynchronous UART			
> Monitoring:CAC > Storage:OSPI > Storage:QSPI > Storage:SDHI > System:BUS	~	Control Contro	imple I2C mode, ensure port p ng between I2C and other mod	ins output es, first dis	type is n-ch open drain able.	▶

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

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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.

4. Board Design

4.1 Schematic Diagram



Figure 15. US159-DA14535EVZ Application Schematic Diagram

4.2 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 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, 10Ohm, 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	R9, R12 Resistor, 22Ω, 1/8W, 1%, 100ppm, SM,75WV, 100OV, Thick Film, 0603, RoHS		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	DA14535MOD, Bluetooth Low Energy 5.3 Module, SM	Renesas Electronics	DA14535MOD-00F01002
1	U2	IC, Digital, Buffer, Inverting, Open Drain, SM, SC-70-5, RoHS	Texas Instruments	SN74LVC1G06DCKT

4.3 Board Layout



Figure 16. Silkscreen Top



Figure 17. Copper Top



Figure 18. Copper L1 Layer



Figure 19. Copper L2 Layer



Figure 20. Copper Bottom



Figure 21. Silkscreen Bottom

5. Ordering Information

Part Number	Description
US159-DA14535EVZ	DA14535 Evaluation Board

6. Revision History

Revision	Date	Description		
1.01	1.01Sep 24, 2024Updated note below Figure 12.			
1.00	Sep 4, 2024	Initial release.		

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Corporate Headquarters

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

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