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RA4W1 Bluetooth® LE Solution & Resource Quick Start Guide

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Introducing solutions and resources (including related information) for each development phase of your product.

Development Phase

Bluetooth Specification Survey		
	Bluetooth Specifications	
Device Specification Survey		
	Hardware Specifications	
PoC (Proof of Concept)		
	Evaluation Boards	*Evaluation Tools*
	Smartphone Sample Apps	*Windows Sample Apps*
Product Board Prototype/Development		
	Board Design Guides	
Software Development		
	Evaluation Boards	*Development Tools*
	Development Guidelines	*Software Library*
	Bluetooth LE Sample Programs	*Bluetooth Mesh Sample Programs*
	Smartphone Sample Apps	*Smartphone App Development Environment*
	Windows Sample Apps	*Windows App Development Environment*
	Evaluation Tools	
Product Registration		
	Bluetooth Qualification	*Radio Law Certification*

Bluetooth Specifications			
	All Specifications	WEB	Bluetooth SIG WEB Site - Active All Specifications
	Bluetooth Core Specification	WEB	Bluetooth SIG WEB Site - Active Core Specifications
	Bluetooth Mesh Specification	WEB	Bluetooth SIG WEB Site - Active Mesh Specifications
Hardware Specifications			
	RA4W1 IC(R7FA4W1xxxxxx)	WEB	The RA4W1 32-bit Bluetooth LE MCU incorporates Bluetooth 5.0 LE, a secure crypto engine, and low power functionality essential for any IoT application. The RA4W1 also features a rich set of peripheral features such as a capacitive touch sensing unit (CTSU) and a segment LCD controller (SLCDC), making it ideal for wireless applications that use a human machine interface (HMI). 
	RA4W1 Group Datasheet	PDF	This is a Microcomputer Datasheet.
	RA4W1 Group User's Manual: Hardware	PDF	Understand the hardware functions and electrical characteristics of microcomputer.

Evaluation Boards				
	Evaluation Kit for RA4W1 MCU Group EK-RA4W1 : RTK7EKA4W1S00000BJ	WEB	The EK-RA4W1 evaluation kit enables users to effortlessly evaluate the features of the RA4W1 MCU Group and develop embedded systems applications using Renesas' Flexible Software Package (FSP) and various IDE. 	
		Evaluation Kit for RA4W1 Microcontroller Group EK-RA4W1 User's Manual	PDF	Describes the hardware specifications. The EK-RA4W1 evaluation kit is no need to prepare an external emulator because it mounts an emulator (J-Link® OB). In addition, it has implemented through-holes for pin headers that allow access to all MCU signal pins.
		EK-RA4W1 – Quick Start Guide	ZIP	Guide to check the initial operation. By executing the quick start sample project, it is possible to connect to a smartphone and check the operation of Bluetooth LE wireless communication. Includes factory default software and function evaluation firmware.
		USB cable	—	Please prepare USB A-micro B. Two cables are required to use the emulator and USB serial communication at the same time.
Attached Document : Evaluation Board Design Data				
	EK-RA4W1v1 - Design Package		ZIP	The design data set (Schematic, BOM list, Gerber data) of the EK-RA4W1 evaluation kit is packaged.

Board Design Guides			
	RA4 Quick Design Guide	PDF	For the purpose of supplementing the hardware manual, it points out the MCU subtleties that may be overlooked and explains some important items that engineers need to start their own designs.
	RA Family Design Guide for Sub-Clock Circuit	PDF	Describes how to minimize malfunction due to noise when using a low load capacitance (Low CL) resonator in a sub clock oscillator circuit.
	RA4W1 Group Guidelines for 2.4 GHz Wireless Board Design	PDF	Describes the board design guidelines for the RA4W1 Bluetooth 5.0 RF transceiver part.
	Bluetooth Low Energy microcomputer Design Guidelines for a Pattern Antenna	PDF	Introducing an outline of antenna and procedures and examples for designing pattern antenna for the Bluetooth LE MCU.
	Tuning Procedure of Bluetooth Dedicated Clock Frequency	PDF	Describes a series of steps for optimally tuning the frequency of the RA4W1 group's Bluetooth dedicated clock (32MHz).

Evaluation Tools

GATTBrowser (Smartphone Application)			A generic data communication application for checking the operation of Bluetooth LE. You can experience data communication with Bluetooth LE by scanning Bluetooth LE devices operating in the vicinity and connecting to those devices. 
	GATTBrowser for iOS Smartphone Application Instruction manual	PDF	Describes how to use the iOS smartphone application "GATTBrowser" for confirm the operation of Bluetooth LE.
	GATTBrowser for Android Smartphone Application Instruction manual	PDF	Describes how to use the Android smartphone application "GATTBrowser" for confirm the operation of Bluetooth LE.
	GATTBrowser (for iOS) (App Store)	WEB	GATT Browser download link for iOS.
	GATTBrowser (for Android) (Google Play)	WEB	GATT Browser download link for Android.
GATTBrowser (Windows Application)			This is a general-purpose data communication application for confirm the operation of Bluetooth LE. You can use the Windows PC to scan nearby Bluetooth LE devices and connect to them to experience Bluetooth LE data communication. 
	GATTBrowser for Windows Windows Application Instruction manual	ZIP	GATTBrowser download link for Windows. Describes how to use the Windows application "GATTBrowser" to confirm the operation of Bluetooth LE.
Bluetooth Test Tool Suite (BTTS) (Windows Application)			BTTS is a tool suite for controlling an MCU evaluation board connected to a Windows PC via USB Serial and evaluating the three functions of RF, beacon communication, and data communication in Bluetooth 5.0 LE. 
	Bluetooth LE MCU Bluetooth Test Tool Suite operating instructions	ZIP	BTTS for Windows and download link for operation manual. HCI firmware for EK-RA4W1 evaluation kit is included.
	Host Controller Interface (HCI) Firmware	ZIP	This is a project exasmple of HCI firmware for the EK-RA4W1 evaluation kit. When operating HCI on a customer's prototype / product board equipped with RA4W1, change the UART terminal settings according to the board specifications.

Development Tools

Integrated Development Environment (IDE)				
	e^2 studio	WEB	An integrated development environment for Renesas microcontrollers based on the open source Eclipse IDE and CDT (C/C++ development Tooling).	
	e^2 studio User's Manual : Quick Start Guide	PDF	Understand the features of e^2 studio when starting hardware and software system development using target devices.	
	e^2 studio platform Installer (GitHub)	WEB	The e^2 studio platform Installer can install not only the **e^2 studio tool** but also the following items. ・**Flexible Software Package（FSP）** ・**GCC (Arm GNU) toolchain** ・**Segger J-Link driver** ・**QE for BLE[RA,RE,RX]**	
e^2 studio Extension Plug-in				
	QE for BLE[RA,RE,RX]	WEB	A support tool for developing embedded software for systems that support the Bluetooth Low Energy protocol stack. QE for BLE can be installed using the e^2 studio platform Installer. QE for BLE includes a template file "**QE Utility**" for application profile development.	
C/C++ Compiler				
	GCC Compiler	—	The GNU Compiler (GCC) is Included in the Arm GNU toolchain. It is targeted for the 32-bits Arm Cortex-M processor family. The toolchain can be installed using the e^2 studio platform Installer.	
Terminal Emulator Tera Term		WEB	Used as a serial terminal tool.	Used in Windows 10 Bluetooth LE Application and Mesh sample application.

Development Guidelines

Bluetooth LE wireless communication			
	RA4W1 Group - Bluetooth Low Energy Application Developer's Guide	PDF	Describes how to develop applications for broadcast, point-to-point, and point-to-multipoint data communication using the Bluetooth Low Energy protocol stack on the integrated development environment e2 studio. This guideline includes the Beacon, Peripheral, Central, and Multi-role sample programs that operates on the EK-RA4W1 evaluation kit.
Bluetooth Mesh			
	RA4W1 Group Bluetooth Mesh Introduction	PDF	Describes an overview of application development using the FSP's Bluetooth Mesh module and published application notes.
	RA4W1 Group Bluetooth Mesh Development Guide	PDF	Describes the software configuration of the FSP's Bluetooth Mesh module and an overview of each layer, how to develop a Mesh application.
	RA4W1 Group Bluetooth Mesh Startup Guide	ZIP	Describes how to operats the Mesh demo using the Bluetooth Mesh sample application. This guide includes a set of build environment of the smartphone (iOS / Android) application "Mesh Mobile" used in the Mesh demo. (Please refer to the included documentation for how to build and install of the Mesh Mobile.)
Profile			
	Bluetooth LE microprocessor / module Profile Developer's Guide	PDF	Describes how to develop an application that supports the Bluetooth SIG standard profile or proprietary custom profile on the e^2 studio extension "QE for BLE [RA, RE, RX]" using the Bluetooth Low Energy protocol stack.

Software Library

Flexible Software Package (FSP)	WEB	FSP is a software package for developing embedded systems using the Renesas RA family. FSP can be installed using the e² studio platform Installer. 
Renesas Flexible Software Package (FSP) User's Manual	WEB	This manual describes how to use the Renesas Flexible Software Package (FSP) to create applications for the RA microcontroller series (how to use e² studio, FSP architecture, API reference). The user's manual PDF file can be downloaded from the "Flexible Software Package (FSP)" page.
Bluetooth Low Energy (Protocol Stack) Library Module		This module is a protocol stack library that conform to the Bluetooth Core Spec Ver 5.0. It is possible to develop applications that use the Bluetooth Low Energy communication function. This module is configured via QE for BLE. In addition, you can select the optimum configuration from three types of libraries (Extended, Balance, Compact) according to the functions required by the target system.
Bluetooth Mesh (Network) Module		By using this module, you can develop products that conform to the Bluetooth Mesh Networking specifications. In the relevant section, API specifications are described for each mesh network function.
EK-RA4W1 Example Project (GitHub)	WEB	Various project examples for using the peripheral functions of RA4W1 with the EK-RA4W1 evaluation kit are registered on this site. Please refer to the "EK-RA4W1 Example Project Bundle" application note for how to use these project examples.

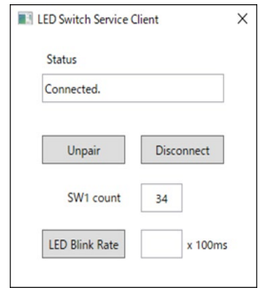
Bluetooth LE Sample Programs			
	RA Family BLE Sample Application Devel of Basic Bluetooth LE Comm Program	ZIP	These sample programs use a custom profile to change the blink rate of the LED mounted on the board from a remote device such as a smartphone and send notification by pushing switch mounted on the board to remote device via Bluetooth LE wireless communication. They operate on the EK-RA4W1 evaluation kit or user's custom board.
	RA4W1 Group Apple Notification Center Service (ANCS) Sample Program App Development for Connecting to Smartphone	ZIP	The ANCS sample application operates on the EK-RA4W1 evaluation kit and connects to iOS devices via Bluetooth LE wireless communication.
	RA4W1 Group - Apple Media Service and Apple Notification Center Service Sample Application App Development for Connecting to Smartphone	ZIP	This sample application connects to an iOS device via Bluetooth LE wireless communication and realize to uses Apple Media Service (AMS) to control media playback on the iOS device and get information about the media being played (song title, artist name, etc.). This sample application also includes the Apple Notification Center Service (ANCS) feature.
	RA4W1 High Data throughput sample application Make Wired System Wireless	ZIP	This sample application uses LE 2MPHY to realize high data throughput Bluetooth LE wireless communication between one pair of EK-RA4W1 evaluation kit. Both server and client side demo projects are provided.
	RA4W1 group Environmental sensor network solution control sample software for building / HVAC Connection with Multiple Devices App Devel	ZIP	This software is an environmental sensor network solution control sample software for building / HVAC using RA4W1, ZMOD4410 (IAQ), HS3001 (Humidity & Temp. Sensor). By using this software, it is possible to collect IAQ (air quality) and humidity & temperature information of multiple devices via Bluetooth LE wireless communication.
	Beacon Sample Program Beacon Application Development	ZIP	These are sample programs for the EK-RA4W1 evaluation kit included in the RA4W1 Group - Bluetooth Low Energy Application Developer's Guide.
	Peripheral Sample Program Implementation of Peripheral Function		
	Central Sample Program Implementation of Central Function		
	Multi-role Sample Program Implementation of Both Central and Peripheral Functions		
Bluetooth Mesh Sample Programs			
	RA4W1 Group Bluetooth Mesh sample application Bluetooth Mesh Application Development	ZIP	The demo program included in this sample application can execute the four phases of Bluetooth Mesh (Provisioning, Configuration, Model Communication, and Node Removal). Please refer to "RA4W1 Group Bluetooth Mesh Startup Guide" for the smartphone application used in the demo.

Smartphone Sample Apps

TryBT		TryBT provides projects, source code, and icon image data that can be used with iOS and Android development environments, and is a sample application that can be used as a development base for Bluetooth LE communication apps for smartphones. TryBT is equipped with the functions required for communication with Bluetooth LE products, and you can confirm the linked operation (LED blinking, virtual temperature / humidity display) with the firmware preinstalled in the EK-RA4W1 evaluation kit. 
When using TryBT as a development base for Bluetooth LE communication apps for smartphone		
Bluetooth Low Energy Smartphone Application Example TryBT for iOS Smartphone Application Development	ZIP	The project, source code, and icon image data included in the package to operate with Xcode and can be used as a development base for Bluetooth LE communication app.
Bluetooth Low Energy Smartphone Application Example TryBT for Android Smartphone Application Development	ZIP	The project, source code, and icon image data included in the package can be used as a development base for Bluetooth LE communication apps by importing them into Android Studio.
When using TryBT as an evaluation app		
Bluetooth Low Energy Smartphone Application Example TryBT for iOS	PDF	Describing the basic operation of TryBT for iOS.
Bluetooth Low Energy Smartphone Application Example TryBT for Android	PDF	Describing the basic operation of TryBT for Android.
TryBT for iOS (App Store)	WEB	Download link for TryBT for iOS.
TryBT for Android (Google Play)	WEB	Download link for TryBT for Android.
MeshMobile (Mesh Mobile)		MeshMobile is a mobile application that works as a Provisioner and a Configuration of Bluetooth Mesh wireless communication. You can easily evaluate Bluetooth Mesh communication operation with the RA4W1.
When using MeshMobile as a development base for Bluetooth Mesh communication apps for smartphone		
Mesh Mobile Application Mesh Smartphone Application Development	ZIP	A suite of build environment for the smartphone (iOS, Android) application "Mesh Mobile" used in the Mesh demo is included in the "RA4W1 Group Bluetooth Mesh Startup Guide".
When using MeshMobile as an evaluation app		
MeshMobile for iOS (App Store)	WEB	Download link for MeshMobile for iOS.
MeshMobile for Android (Google Play)	WEB	Download link for MeshMobile for Android.

Smartphone App Development Environment				
Smartphone (iOS / Android common) App Development Environment				
	Node.js	WEB	Node.js is an asynchronous event-driven JavaScript environment designed to build scalable network applications over the V8 JavaScript engine. Includes the development tools **npm** (Node Package Manager) needed to build Mesh Mobile.	Used in Mesh Mobile Application.
	Python	WEB	Python is a language that can be used in a variety of fields, from embedded application development and website construction to deep learning.	Used in Mesh Mobile Application.
	Capacitor	WEB	Capacitor is a cross-platform native library that makes it easy to build applications that execute natively on iOS and Android.	Used in Mesh Mobile Application.
	Ionic Framework	WEB	Ionic Framework is a framework for creating mobile apps with web technology.	Used in Mesh Mobile Application.
Smartphone (iOS) App Development Environment				
	Apple Developer Program	WEB	A paid license is required to develop iOS applications. The Apple Developer Program is a license for applications distributed via the App Store.	
	Apple Developer Enterprise Program	WEB	A paid license is required to develop iOS applications. The Apple Developer Enterprise Program is a license for in-house applications.	
	Xcode	WEB	Xcode is an integrated development environment for iOS. Works only on Mac PCs. You will need **Apple ID** to download.	Used in Try BT and Mesh Mobile Application.
	Homebrew	WEB	Homebrew is a package manager for installing and managing various libraries in the Mac OS environment.	Used in Try BT.
	CocoaPods	WEB	CocoaPods is a tool for managing third-party libraries for iOS apps.	Used in Try BT.
Smartphone (Android) App Development Environment				
	Android Studio	WEB	Tools for building apps on all types of Android devices.	Used in Try BT and Mesh Mobile Application.
	USB driver for Android devices	WEB	The Google USB driver for Windows required for adb debugging on Google devices.	Used in Try BT and Mesh Mobile Application.

Windows Sample Apps

Windows 10 Bluetooth LE Application			The Windows 10 Bluetooth LE application provides a set of projects that can be used in Visual Studio 2017, and is a application example that can be used as a development base for Bluetooth LE communication apps for Windows. This sample application communicates with the firmware pre-installed on the evaluation board equipped with RA4W1, controls the LED blinking interval on the evaluation board, and counts the number of times the switch is pressed. 
	Bluetooth LE microcomputer / module Windows 10 Bluetooth LE Application **Windows Application Development**	ZIP	When using a Windows 10 Bluetooth LE application as a development base for a Bluetooth LE communication app that executes on Windows 10.
			Download a suite of project available in Visual Studio 2017 and use it as a development base for Bluetooth LE communication apps that execute on Windows 10.
			When using the Windows 10 Bluetooth LE application as an evaluation app
			Download the Windows 10 Bluetooth LE application for Windows and operating instructions manual.

Windows App Development Environment					
	Windows App Development Environment				
		Visual Studio 2017	EXE	Visual Studio 2017 supports building to management applications and native desktop applications.	Used in Windows 10 Bluetooth LE Application.
		Windows 10 SDK Version 2004 (10.0.19041.0)	EXE	The Windows SDK provides headers, libraries, metadata, and tools for building Windows apps. You can use this SDK to build Universal Windows Platform (UWP) and Win32 applications.	Used in Windows 10 Bluetooth LE Application.

Bluetooth Qualification				
	Bluetooth LE microcomputer / module Bluetooth qualification acquisition Application Note	PDF	When selling a device equipped with a Renesas Bluetooth LE microcomputer or module as a Bluetooth product, product registration (declaration) using the Qualified Design Identification number (QDID) of our certified and registered design is required. This document describes how to do it.	
	Launch Studio	WEB	Interface to guide the Bluetooth qualification process (login required).	
	Listing Search	WEB	Search for qualified designs and declared products.	
	Bluetooth Qualification Test Facility (BQTF)	WEB	Bluetooth Qualification Test Facility (BQTF) is recognized by the Bluetooth SIG as competent to execute qualification test cases identified within the Test Case Reference List (TCRL) as “Category A at or below the Host Controller Interface (HCI) layer.” A list of BQTFs is published on this site.	
	Test Case Reference List (TCRL)	WEB	The Test Case Reference List (TCRL) is a qualification reference for all Bluetooth Special Interest Group (SIG) members. It is a document that introduces new test cases, removes test cases, and categorizes test cases.	Thies informations are required when implementing profiles / services of versions or specifications that are unsupported by Renesas.
	Profile Tuning Suite (PTS)	WEB	Test software that automates compliance testing of the Bluetooth Host part.	
Radio Law Certification				
	RA4W1 Group Testing for Certification of Compliance with the Radio Law (Japan) Application Note	PDF	Describes how to prepare an application for obtaining certification of compliance with the Radio Law in Japan and the operations involved in testing.	
	RF Test Tool	—	The Bluetooth Test Tool Suite (BTTS) is available as an RF test tool.	

Revision History

Rev.	Date	Description
1.00	May.30.22	First edition issued
1.01	Jun.30.22	Added the description about the included sample program to the explanation column of RA4W1 Group - Bluetooth Low Energy Application Developer's Guide.
		Added Beacon / Central / Peripheral / Multi-role sample programs to Bluetooth LE Sample Programs.
		Changed name and link due to commonalization of the Profile Developer's Guide.
1.02	Jul.05.22	Moved Node.js from Smartphone (iOS) App Development Environment to Smartphone (iOS / Android common) App Development Environment.
1.03	Sep.02.22	Changed the framework library of the smartphone application development environment from "Apache Cordova" to "Capacitor".
		Added application store download link to MeshMobile.
1.04	Dec.23.22	Updated Renesas Flexible Software Package (FSP) User's Manual contents.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on
   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
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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