RA4W1 Group

Host Controller Interface Firmware

Introduction

This application note describes Host Controller Interface for RA4W1 Bluetooth® 5.0 (Core Specification v5.0) RF transceiver.

Target Device

RA4W1 group

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1. Introduction

This application note describes Host Controller Interface (Hereafter referred to as **HCI FW**) for RA4W1 Bluetooth 5.0 (Core Specification v5.0) RF transceiver. HCI FW is a firmware for RF characteristics evaluation or BTTS (Bluetooth Trial Tool Suite: R01AN4554) or Bluetooth dedicated clock frequency tuning (R01AN4887). BLE communication can be performed by sending HCI commands from the host device connected to the serial interface such as a PC to the RA4W1 microcontroller. HCI event corresponding to BLE communication is sent from RA4W1 to the host device.

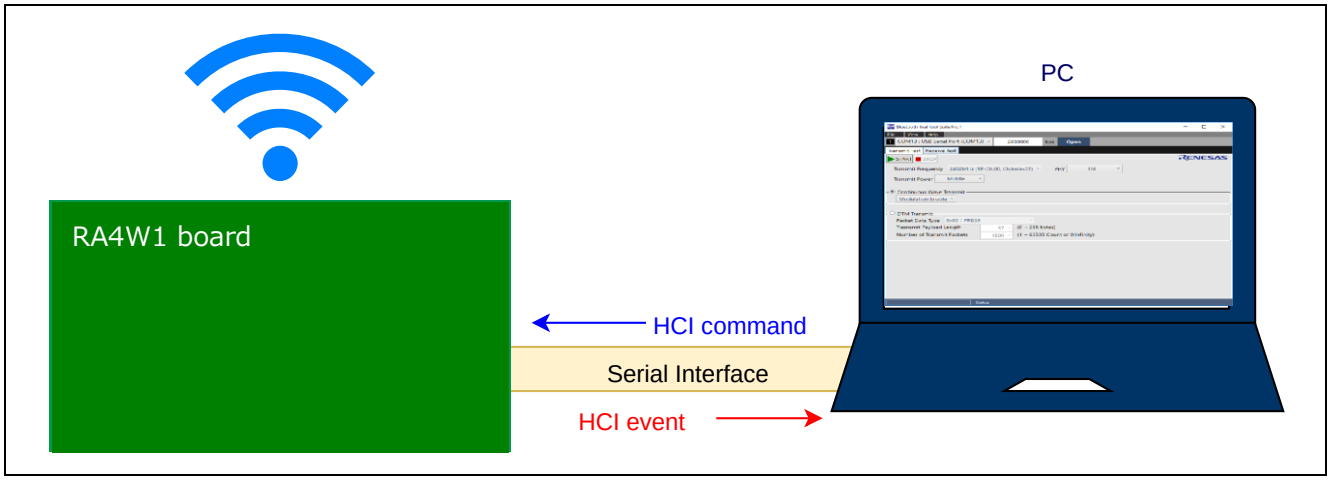


Figure 1 HCI FW evaluation board and PC connection

2. Software structure

Figure 2 shows the HCI FW software structure. User applications cannot be implemented in HCI FW.

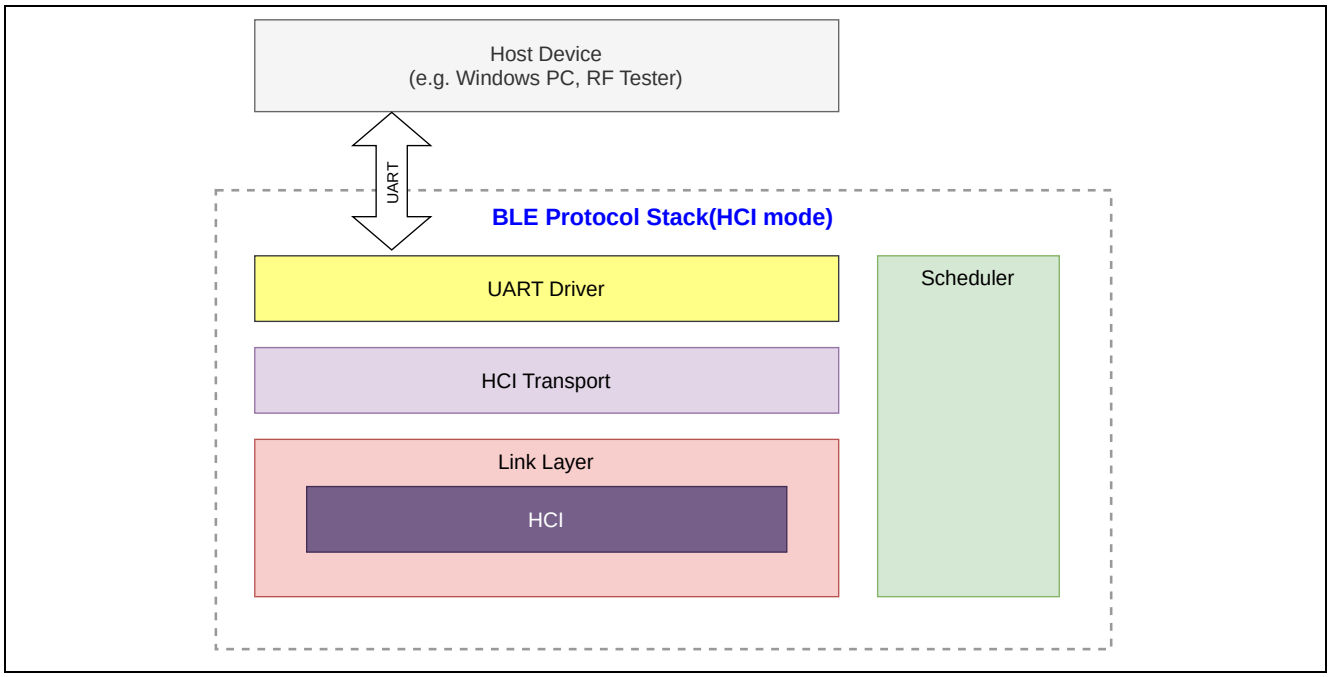


Figure 2 HCI FW software structure

3. Sample Project

The sample project for HCI FW is included in this document. Table 1 shows sample project for HCI FW.

Table 1 Sample Project

File Name	Description
ble_demo_ra4w1_uart_hci.zip	HCI FW e² studio project for EK-RA4W1. And supported compiler is gcc. This sample project can work on FSP4.1.0 or later and e2studio 2022-10 or later.

3.1 How to load sample project

1. Put “ble_demo_ek_ra4w1_uart_hci.zip” into any folder.
2. Launch e²studio.

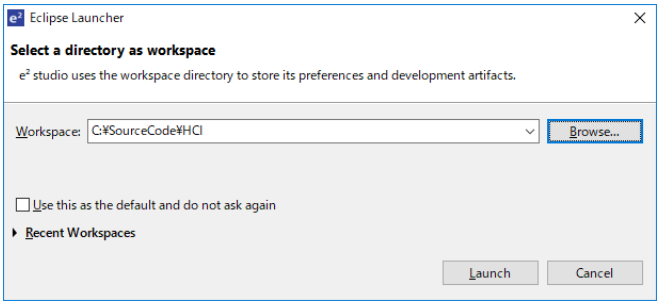


Figure 3 Launch e²studio

3. Click [file] → [Import] and then following dialog will appear.

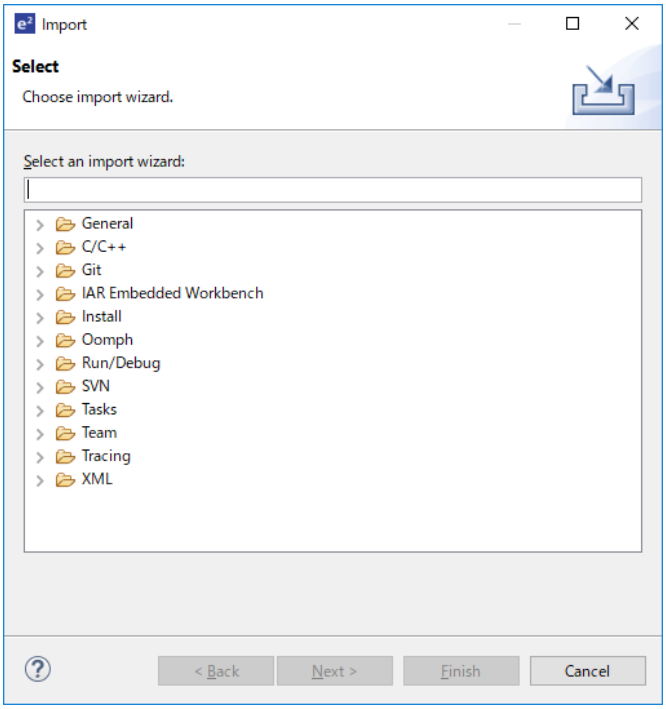


Figure 4 Import dialog

4. Select [General] → [Existing Project into workspace] and then following dialog will appear.

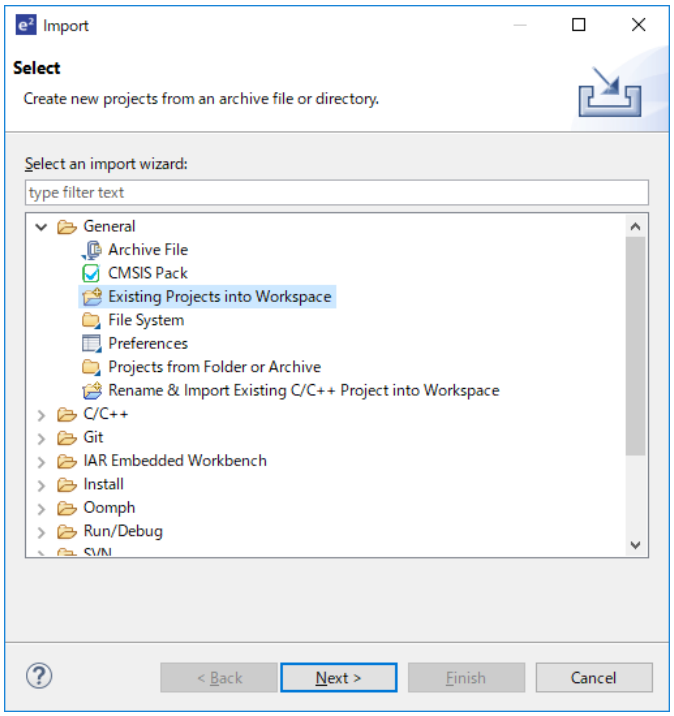


Figure 5 Select import wizard

5. Click [Next] and then following dialog will appear.

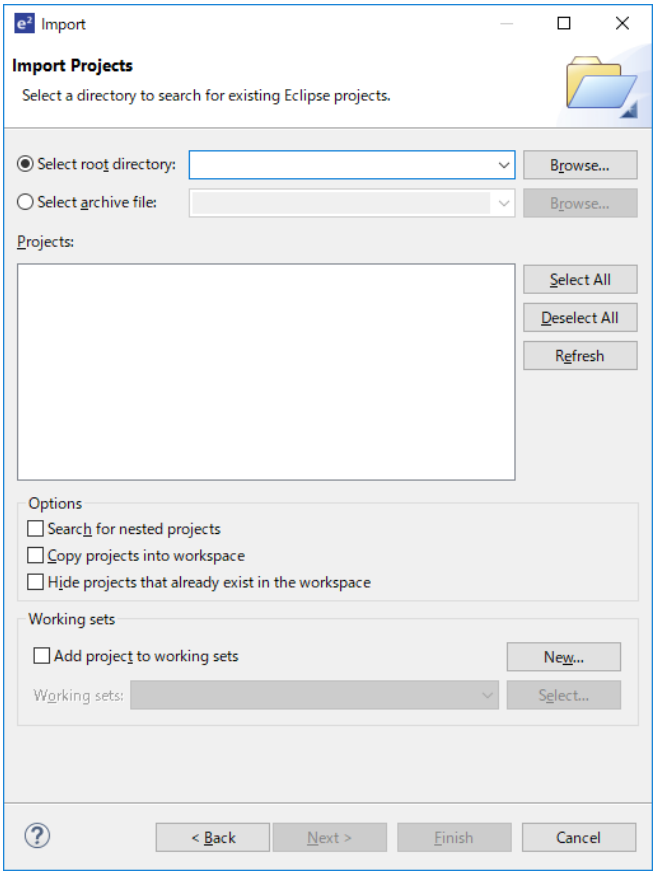


Figure 6 Import project dialog

6. Click [Select archive file] and select “ble_demo_ra4w1_uart_hci.zip” which put in step 1.

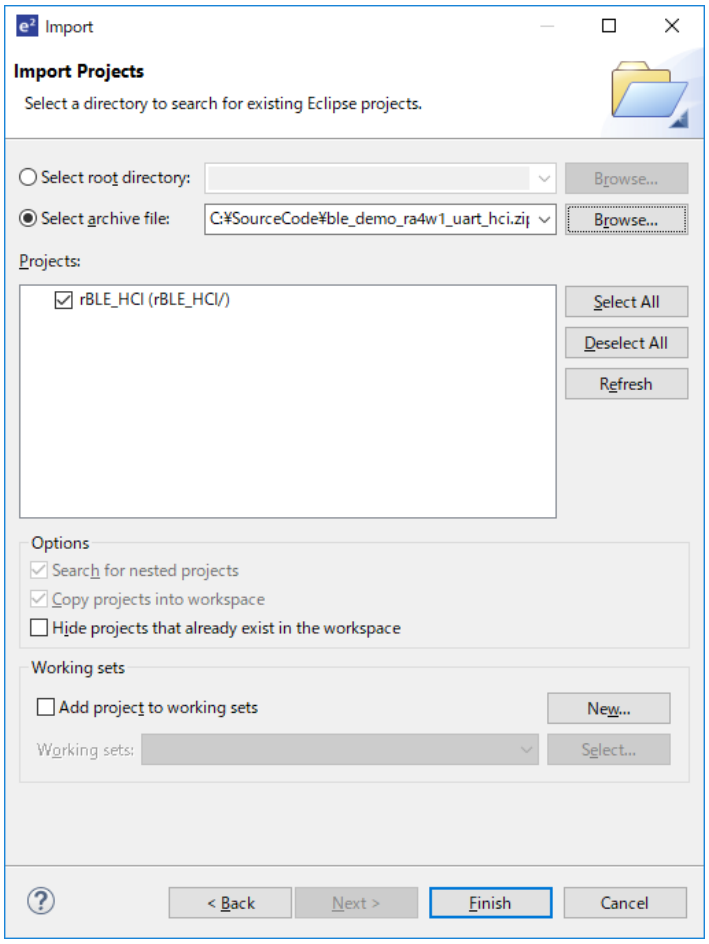


Figure 7 Import project from archive file

7. Click [Finish] and then project of HCI FW will load into e2studio.

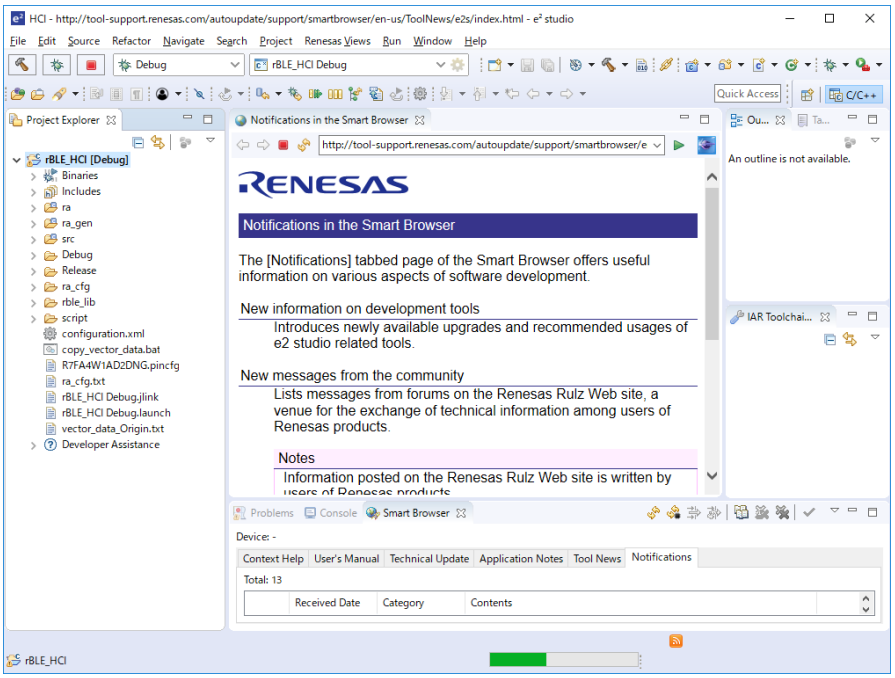


Figure 8 e2studio after import project

3.2 UART Driver

In HCI FW, UART (Universal Asynchronous Receiver/Transmitter) communication is performed using RA4W1 Serial Communication Interface (SCI) and Data Transfer Controller (DTC) peripheral functions.

In this FW, dedicated UART driver is prepared and UART driver APIs are used from BLE Protocol Stack.

Table 2 shows the UART driver file contents in HCI FW.

Table 2 UART driver contents

File Name	Description
r_ble_dtc.c	DTC control driver source file
r_ble_dtc.h	DTC control driver header file
r_ble_uart_hci.c	SCI control driver source file
r_ble_uart_hci.h	SCI control driver header file *1

*1: When changing the SCI channel, this file need to edit.

3.2.1 Configuration Option of UART Driver

UART driver can change SCI channel, UART baud rate, etc. by each configuration options in the “r_ble_uart_hci.h” file. Edit the file directly to change configuration options.

For each configuration options, setting location branches depending on the value of BLE_CFG_BOARD_TYPE macro in “r_ble_ra4w1_config.h” file.

When setting in customer board environment, set “0” to BLE_CFG_BOARD_TYPE macro in “r_ble_ra4w1_config.h” file.

Table 3 shows UART driver configuration in “r_ble_uart_hci.h”.

Table 3 UART driver configurations

No.	Macro Name	Default	Description
1	SCI_CHANNEL	4	Set SCI channel number. 0: SCI0 1: SCI1 4: SCI4 9: SCI9
2	SCI_INTR_PRIORITY	1	Sets SCI interrupt priority level. Range: 1 (High priority) to 15 (Low priority)
3	SCI_CTS_RTS_EN	0	Sets SCI CTS/RTS function. 0: CTS/RTS disable 1: RTS enable 2: CTS enable
4	SCI_RXD_PORT SCI_RXD_PIN	2 6	Set port and pin number used at SCI RXD. Example P206 : SCI_RXD_POTR = 2, SCI_RXD_PIN=6
5	SCI_TXD_PIN_X SCI_TXD_PIN_Y	2 5	Set port and pin number used at SCI TXD. Example: P205 : SCI_RXD_POTR = 2, SCI_RXD_PIN=5
[6]	SCI_CTS_RTS_PORT SCI_CTS_RTS_PIN	- -	When SCI_CTS_RTS_EN is 1, set port number used at SCI CTS/RTS. Example P407 : SCI_CTS_RTS_PORT = 4, SCI_CTS_RTS_PIN = 7
7	DBG_CALC_BAUDRATE	Enable	When this macro is enabled, the register setting value corresponding to UART baudrate is automatically calculated. When this macro is disabled, SCI Bit Rate Register (BRR) and Modulation Duty Register (MDDR) must be set manually.
8	DBG_BAUDRATE_SWITCH	Disable	When this macro is enabled, the input status of the port specified by SCI_BR_SW_PORT and SCI_BR_SW_PIN is checked when UART driver is initialized, and the baudrate is switched according to the input level. Input level low: Select D_UART_BR_SWITCH Input level high: Select D_UART_BR
9	D_UART_BR	115200	Sets the initial baudrate when DBG_CALC_BAUDRATE macro is enabled.
10	D_UART_BR_SWITCH	2000000	Sets the baudrate for switching when DBG_CALC_BAUDRATE and DBG_BAUDRATE_SWITCH macros are enabled.
11	SCI_BR_SW_PORT SCI_BR_SW_PIN	- -	Sets the port number to check the input level when the DBG_CALC_BAUDRATE and DBG_BAUDRATE_SWITCH macros are enabled. Example: P105 : SCI_BR_SW_PORT=1, SCI_BR_SW_PORT=5

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	07. May. 2020	—	Initial release
1.01	27. Apr. 2022	4	Support FSP3.7.0
1.02	20. May. 2022	--	Refactoring attached sample project.
1.03	30. Jun. 2022	4	Support FSP3.8.0
1.04	25. Oct. 2022	4	Support FSP4.1.0

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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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Corporate Headquarters

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

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