RX Family

US159-DA14531EVZ BLE Control Module Using Firmware Integration Technology

Introduction

This application note describes the usage of the US159-DA14531EVZ BLE control module, which conforms to the Firmware Integration Technology (FIT) standard.

In the following pages, the US159-DA14531EVZ BLE control module software is referred to collectively as “the DA14531 BLE FIT module” or “the FIT module.”

The FIT module supports the following BLE module:

- DA14531MOD (US159-DA14531EVZ)
- DA14535MOD

In the following pages, the DA14531MOD and DA14535MOD are referred to as “the BLE module”.

Target Devices

- RX65N Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Target Compilers

- Renesas Electronics C/C++ Compiler Package for RX Family

Related Documents

[1] Firmware Integration Technology User’s Manual (R01AN1833)
[2] RX Family Board Support Package Module Using Firmware Integration Technology (R01AN1685)
[3] RX Smart Configurator User’s Guide: e² studio (R20AN0451)
[4] RX Family SCI Module Using Firmware Integration Technology (R01AN1815)
[5] RX Family BYTEQ Module Using Firmware Integration Technology (R01AN1683)
[6] CK-RX65N v1 – User's Manual (R20UT5100)

Contents

1. Overview

1.1. DA14531 FIT Module

The FIT module is designed to be added to user projects as an API. For instruction on adding the FIT module, refer to 2.11 Adding the FIT Module to Your Project.

1.2. Overview of the DA14531 BLE FIT Module

The DA14531 is an ultra-low power SoC integrating a 2.4 GHz transceiver and an Arm® Cortex-M0+ microcontroller with a RAM of 48 kB and a One-Time Programmable (OTP) memory of 32 kB. It can be used as a standalone application processor or as a data pump in hosted systems.

The Bluetooth® LE firmware includes the L2CAP service layer protocols, Security Manager (SM), Attribute Protocol (ATT), the Generic Attribute Profile (GATT), and the Generic Access Profile (GAP). All profiles published by the Bluetooth® SIG as well as custom profiles are supported.

1.2.1. Connection with DA14531 BLE

Examples of connection to the DA14531 BLE are shown below.

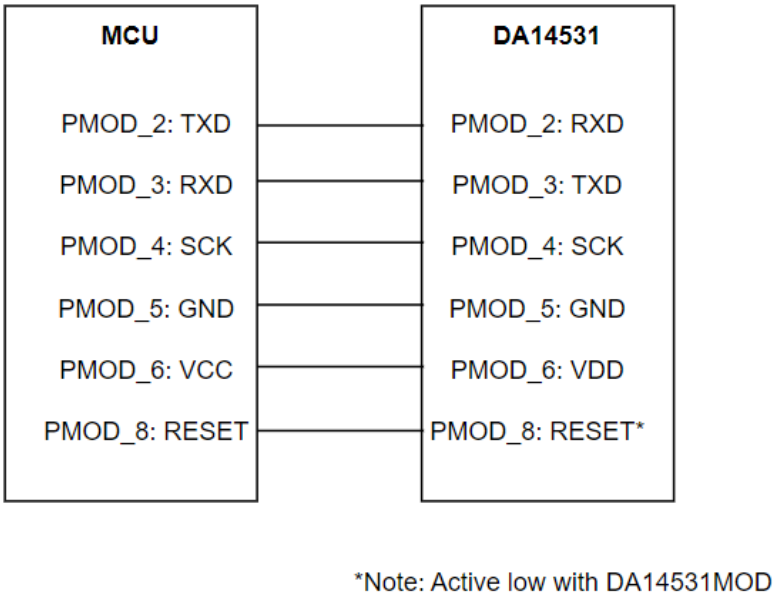

Figure 1.1 Example Connection to the DA14531 Module

1.2.2. Software configuration

Figure 1.2 shows the software configuration.

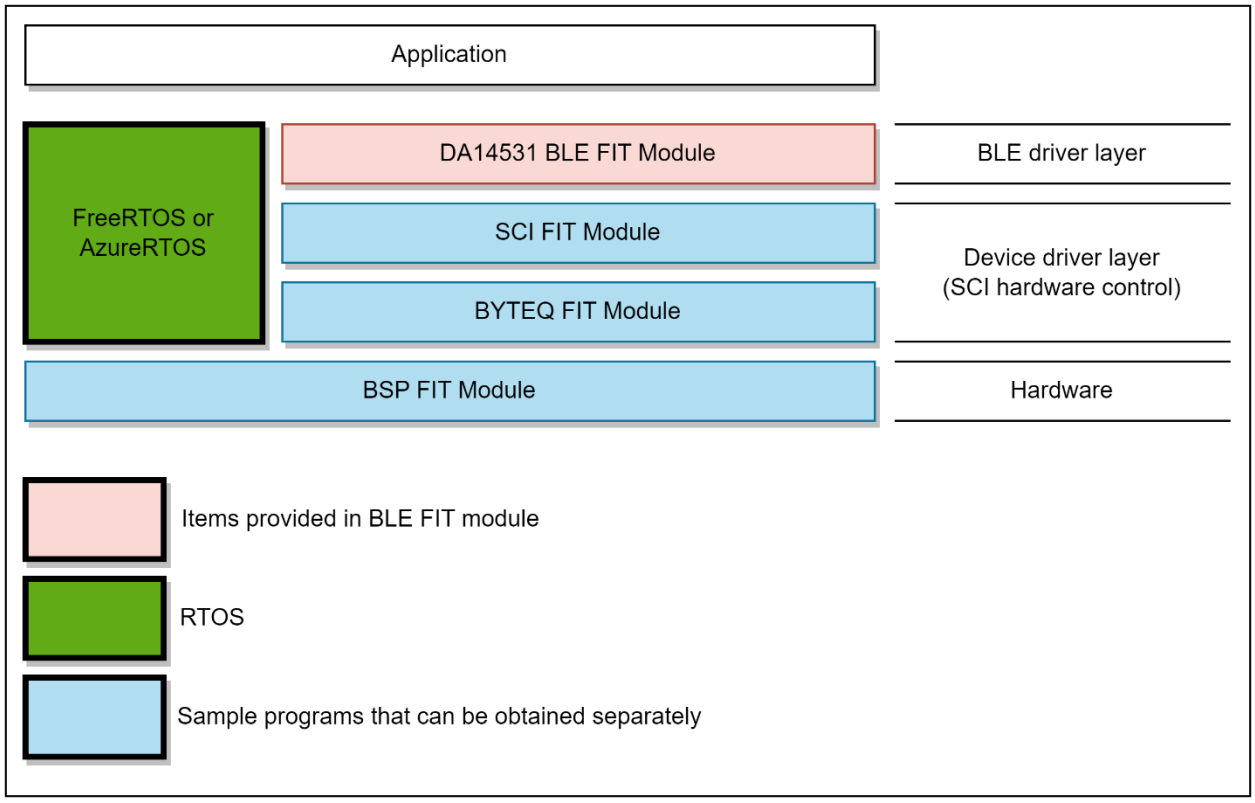

Figure 1.2 Software Configuration Diagram

1. DA14531 BLE FIT module
   The FIT module. This software is used to control the BLE module.
2. SCI FIT module
   Implements communication between the BLE module and the MCU. A sample program is available.
   Refer to “Related Documents” on page 1 and obtain the software.
3. BYTEQ FIT module
   Implements circular buffers used by the SCI FIT module. A sample programs is available.
   Refer to “Related Documents” on page 1 and obtain the software.
4. BSP FIT module
   The Board Support Package module. A sample programs is available.
   Refer to “Related Documents” on page 1 and obtain the software.
5. RTOS
   The RTOS manages the system overall. Operation of the FIT module has been verified using FreeRTOS or AzureRTOS or Bare metal by BSP_CFG_RTOS_USED.

1.3. Features

The Bluetooth Low Energy Abstraction module with GTL supports the following features:

- Common functionality
  - Boot from host for DA14531/DA14535 module
  - Use the 1-wire (default) or the 2-wire UART for booting
    - **Note:** The 2-wire UART booting only supports DA14535.
  - Open/Close the BLE protocol stack
- The following GAP Role support
  - Peripheral: The device that accepts a connection request from Central and establishes a connection
- GAP functionality
  - Initialize the Host stack
  - Setting address
  - Start/Stop Advertising
  - Connect/Disconnect a link
- GATT Common functionality
  - Get MTU Size
- GATT Server functionality
  - Initialization of GATT Server
  - Loading of Profile definition
  - Notification of characteristics modification
  - Read/Write of GATT Profile from host
- Security functionality (DA14531/DA14535 module acting as Peripheral)
  - Legacy Pairing supporting Just works functionality
  - Legacy Pairing supporting Passkey functionality
  - Initiate security request procedure from Peripheral as well

1.4. API Overview

Table 1.1 lists the API functions included in the FIT module. The required memory size are listed in 2.8 Code Size.

Table 1.1 API Functions

Function	Function Description
BLE Common Interface	
R_BLE_Open()	Open the BLE protocol stack.
R_BLE_Close()	Close the BLE protocol stack.
R_BLE_Execute()	Execute the BLE task.
R_BLE_IsTaskFree()	Check if the BLE task queue is free or not.
R_BLE_GetVersion()	Get the BLE FIT module version.
BLE GAP Interface	
R_BLE_GAP_Init()	Initialize the Host Stack.
R_BLE_GAP_Terminate()	Terminate the Host Stack.
R_BLE_GAP_UpdConn()	Update the connection parameters.
R_BLE_GAP_SetDataLen()	Update the packet size and the packet transmit time.
R_BLE_GAP_Disconnect()	Disconnect the link.
R_BLE_GAP_GetVerInfo()	Get the version number of the Controller and the host stack.
R_BLE_GAP_ReadRssi()	Get RSSI.
R_BLE_GAP_ReadChMap()	Get the Channel Map.
R_BLE_GAP_SetAdvParam()	Set advertising parameters.
R_BLE_GAP_SetAdvSresData()	Set advertising data/scan response data/periodic advertising data.
R_BLE_GAP_StartAdv()	Start advertising.
R_BLE_GAP_StopAdv()	Stop advertising.
R_BLE_GAP_GetRemainAdvBufSize()	Get buffer size for advertising data/scan response data/periodic advertising data in the Controller.
R_BLE_GAP_GetRemDevInfo()	Get the information about remote device.
R_BLE_GAP_SetPairingParams()	Set the parameters using pairing.
R_BLE_GAP_StartPairing()	Start pairing.
R_BLE_GAP_ReplyPairing()	Reply the pairing request from a remote device.
R_BLE_GAP_ReplyPasskeyEntry()	Reply the passkey entry request.
R_BLE_GAP_ReplyExKeyInfoReq()	Distribute the keys of local device.
R_BLE_GAP_ReplyLtkReq()	Reply the LTK request from a remote device.
BLE GATT Common Interface	
R_BLE_GATT_GetMtu()	Gets the current MTU used in GATT communication.
BLE GATT Server Interface	
R_BLE_GATTS_SetDbInst()	Sets GATT Database to host stack.
R_BLE_GATTS_RegisterCb()	Registers a callback for GATT Server event.

R_BLE_GATTS_DeregisterCb()	Deregisters the callback function for GATT Server event.
R_BLE_GATTS_Notification()	Sends a notification of an attribute's value.
R_BLE_GATTS_Indication()	Sends an indication of an attribute's value.
R_BLE_GATTS_GetAttr()	Gets an attribute value from the GATT Database.
R_BLE_GATTS_SetAttr()	Sets an attribute value to the GATT Database.
BLE GATT Client Interface	
R_BLE_GATTC_RegisterCb()	Registers a callback function for GATT Client event.
R_BLE_GATTC_DeregisterCb()	Deregisters the callback function for GATT Client event.
R_BLE_GATTC_ReqExMtu()	Sends a MTU Exchange Request PDU to a GATT Server in order to change the current MTU.
R_BLE_GATTC_DiscAllPrimServ()	Discovers all Primary Services in a GATT Server.
R_BLE_GATTC_DiscPrimServ()	Discovers Primary Service specified by p_uuid in a GATT Server.
R_BLE_GATTC_DiscIncServ()	Discovers Included Services within the specified attribute handle range in a GATT Server.
R_BLE_GATTC_DiscAllChar()	Discovers Characteristic within the specified attribute handle range in a GATT Server.
R_BLE_GATTC_DiscCharByUuid()	Discovers Characteristic specified by uuid within the specified attribute handle range in a GATT Server.
R_BLE_GATTC_DiscAllCharDesc()	Discovers Characteristic Descriptor within the specified attribute handle range in a GATT Server.
R_BLE_GATTC_ReadChar()	Reads a Characteristic/Characteristic Descriptor in a GATT Server.
R_BLE_GATTC_ReadCharUsingUuid()	Reads a Characteristic in a GATT Server using a specified UUID.
R_BLE_GATTC_ReadLongChar()	Reads a Long Characteristic in a GATT Server.
R_BLE_GATTC_ReadMultiChar()	Reads multiple Characteristics in a GATT Server.
R_BLE_GATTC_WriteCharWithoutRsp()	Writes a Characteristic in a GATT Server without response.
R_BLE_GATTC_SignedWriteChar()	Writes Signed Data to a Characteristic in a GATT Server without response.
R_BLE_GATTC_WriteChar()	Writes a Characteristic in a GATT Server.
R_BLE_GATTC_WriteLongChar()	Writes a Long Characteristic in a GATT Server.
R_BLE_GATTC_ReliableWrites()	Performs the Reliable Writes procedure described in GATT Specification.
R_BLE_GATTC_ExecWrite()	Executes a write to Characteristic.
BLE L2CAP Interface	
R_BLE_L2CAP_RegisterCfPsm()	Registers PSM that uses L2CAP CBFC Channel and a callback for L2CAP event.
R_BLE_L2CAP_DeregisterCfPsm()	Stops the use of the L2CAP CBFC Channel specified by the psm parameter and deregisters the callback function for L2CAP event.
R_BLE_L2CAP_ReqCfConn()	Sends a connection request for L2CAP CBFC Channel.
R_BLE_L2CAP_DisconnetCf()	Sends a disconnection request for L2CAP CBFC Channel.

R_BLE_L2CAP_SendCfCredit()	Sends credit to a remote device.
R_BLE_L2CAP_SendCfData()	Sends the data to a remote device via L2CAP CBFC Channel.
BLE Vendor Specific (VS) Interface	
R_BLE_VS_Init()	Initializes Vendor Specific API and registers a callback function for Vendor Specific Event.
R_BLE_VS_SetTxPower()	Configures transmit power.
R_BLE_VS_GetTxPower()	Gets transmit power.
R_BLE_VS_GetBdAddr()	Sets public/random address of local device to the area specified by the parameter.
R_BLE_VS_SetBdAddr()	Gets currently configured public/random address.
R_BLE_VS_GetRand()	Generates 4-16 bytes of random number used in creating keys.
Abstraction API for Renesas QE for BLE	
RM_BLE_ABS_Open()	Host stack is initialized with this function.
RM_BLE_ABS_Close()	Close the BLE channel.
RM_BLE_ABS_StartLegacyAdvertising()	Start Legacy Advertising after setting advertising parameters, advertising data and scan response data.

1.5. Status Transitions

Figure 1.1 shows the status transitions of the FIT module up to communication status.

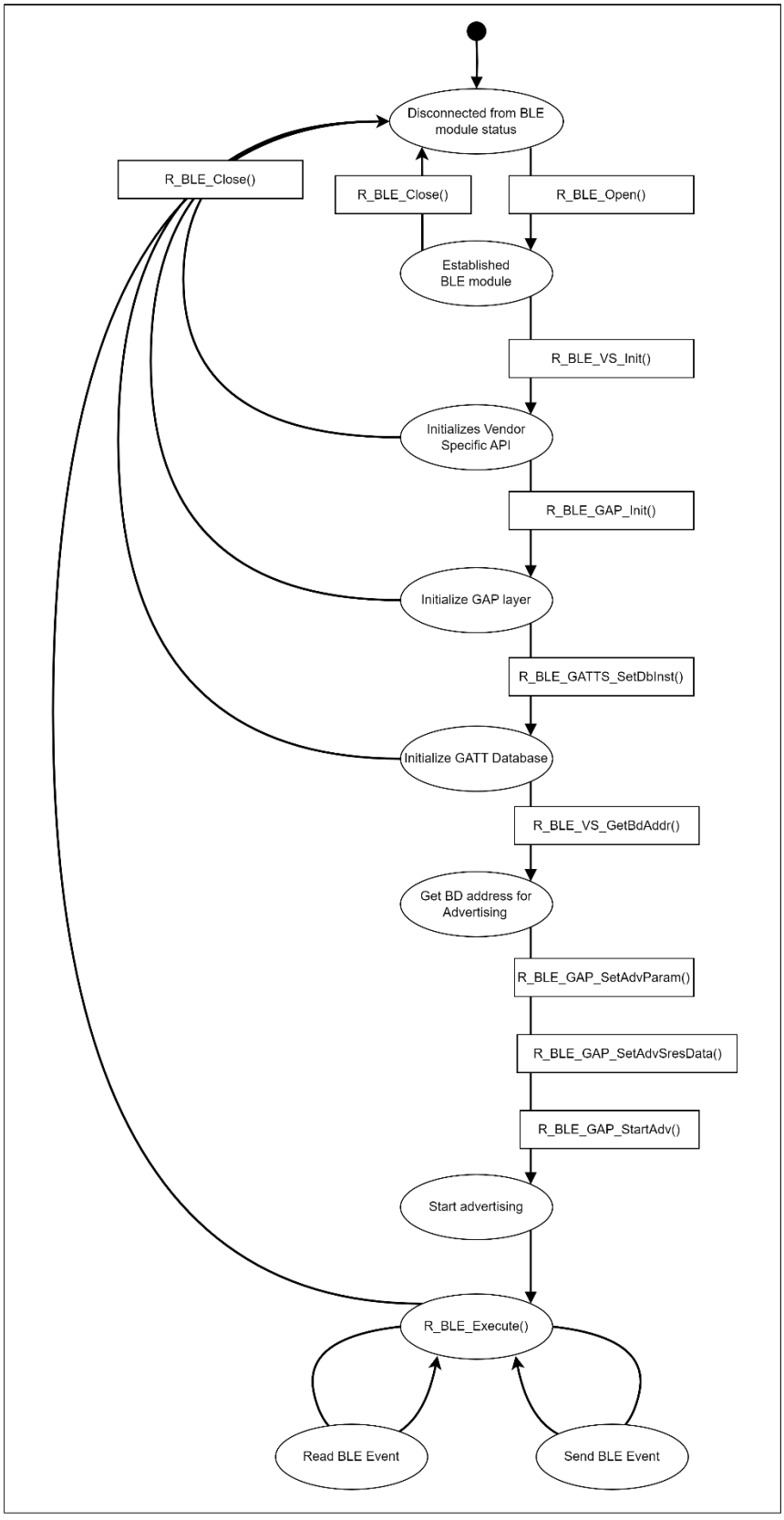

Figure 1.1 Status Transitions

2. API Information

The FIT module has been confirmed to operate under the following conditions.

2.1. Hardware Requirements

The MCU used must support the following functions:

- Serial communication
- I/O ports

2.2. Software Requirements

The driver is dependent upon the following FIT module:

r_bsp
r_sci_rx
r_byteq_rx
FreeRTOS
AzureRTOS

2.3. Support Toolchain

The FIT module has been confirmed to work with the toolchain listed in 6.1 Confirmed Operation Environment.

2.4. Interrupt Vector

None

2.5. Header Files

All API calls and their supporting interface definitions are in r_ble_da14531_if.h.

2.6. Integer Types

This project uses ANSI C99. These types are defined in stdint.h.

2.7. Compile Settings

The configuration option settings of the FIT module are contained in r_ble_da14531_config.h.
The names of the options and their setting values are listed in the table below.

Table 2.1 Configuration Options (r_ble_da14531_config.h)

Configuration Options in r_ble_da14531_config.h	
BLE_CFG_PARAM_CHECKING_ENABLE Note: The default is System Default	Parameter checking.
BLE_CFG_SCI_CHANNEL Note: The default is 6	SCI channel for DA1453x GTL command communication.
BLE_CFG_SCI_INTERRUPT_LEVEL Note: The default is 3	Interrupt Level for BLE_CFG_SCI_CHANNEL.
BLE_CFG_RESET_PORT Note: The default is 5	General-purpose port PDR register connected to the DA1453x reset port.
BLE_CFG_RESET_PIN Note: The default is 5	General-purpose port PODR register connected to the DA1453x reset pin.
BLE_CFG_SCK_PORT Note: The default is 0	General-purpose port PDR register connected to the DA1453x SCK port.
BLE_CFG_SCK_PIN Note: The default is 2	General-purpose port PODR register connected to the DA1453x SCK pin.
BLE_CFG_RESET_POLARITY Note: The default is 0	Reset Polarity.
BLE_CFG_HOST_BOOT_MODE Note: The default is 0.	Boot SDK download from host MCU. When using this feature via 1-Wire UART or 2-Wire UART, please refer to 2.13.5 Limitations
BLE_CFG_DA1453x_DEVICE Note: The default is DA14531_DEVICE	Select PMOD device: Either DA14531PMOD or DA14535PMOD.

Table 2.2 Configuration Options (r_sci_rx_config.h)

Configuration Options in r_ sci_rx_config.h	
#define SCI_CFG_CHx_INCLUDED Notes: 1. CHx = CH0 to CH12 2. The default values are as follows: CH0 CH2 to CH12: 0, CH1: 1	Each channel has resources such as transmit and receive buffers, counters, interrupts, other programs, and RAM. Setting this option to 1 assigns related resources to the specified channel.
#define SCI_CFG_CHx_TX_BUFSIZ Notes: 1. CHx = CH0 to CH12 2. The default value is 80 for all channels.	Specifies the transmit buffer size of an individual channel. The buffer size of the channel specified by BLE_CFG_SCI_CHANNEL should be set to 4096.
#define SCI_CFG_CHx_RX_BUFSIZ Notes: 1. CHx = CH0 to CH12 2. The default value is 80 for all channels.	Specifies the receive buffer size of an individual channel. The buffer size of the channel specified by BLE_CFG_SCI_CHANNEL should be set to 4096.
#define SCI_CFG_TEI_INCLUDED Note: The default is 0.	Enables the transmit end interrupt for serial transmissions. This option should be set to 1.

Table 2.3 Configuration Options (r_bsp_config.h)

Configuration Options in r_ bsp_config.h	
#define BSP_CFG_RTOS_USED Note: The default is 0.	Specifies the type of real-time OS. When using this FIT module, set the following. Bare metal: 0, FreeRTOS:1, AzureRTOS: 5

2.8. Code Size

Typical code sizes associated with this module are listed below.
The ROM (code and constants) and RAM (global data) sizes are determined by the build-time configuration options described in 2.7 Compile Settings. The table lists reference values when the C compiler's compile options are set to their default values, as described in 2.3 Support Toolchain. The compile option default values are optimization level: 2, optimization type: for size, and data endianness: little-endian. The code size varies depending on the C compiler version and compile options.

The values in the table below are confirmed under the following conditions.
Module Revision: r_ble_da14531_rx rev1.40.
Compiler Version: Renesas Electronics C/C++ Compiler Package for RX Family V3.06.00
(The option of "-lang=c99" is added to the default settings of the integrated development environment.)
Configuration Options: Default settings.

Table 2.4 Memory Sizes

Device	RTOS	Category	Memory usage
			Renesas Compiler
RX65N	FreeRTOS (*1) (*2)	ROM	49106 bytes
		RAM	6382 bytes
	AzureRTOS(*2)	ROM	23815 bytes
		RAM	23660 bytes
	Bare metal (*1) (*2)	ROM	41028 bytes
		RAM	6131 bytes

Notes:

(*1) ROM usage included 13KB (13517 bytes) of DA14531 Boot image.
(*2) ROM usage included the QE module, which is generated based on the sample app.

2.9. Return values

The error codes returned by API functions are listed below. The enumerated types of return values and API function declarations are contained in r_ble_api.h.

```
typedef uint16_t ble_status_t;

enum RBLE_STATUS_enum
{
    BLE_SUCCESS = 0x0000,

    /* common error code */
    BLE_ERR_INVALID_PTR         = 0x0001,
    BLE_ERR_INVALID_DATA        = 0x0002,
    BLE_ERR_INVALID_ARG         = 0x0003,
    BLE_ERR_INVALID_FUNC        = 0x0004,
    BLE_ERR_INVALID_CHAN        = 0x0005,
    BLE_ERR_INVALID_MODE        = 0x0006,
    BLE_ERR_UNSUPPORTED         = 0x0007,
    BLE_ERR_INVALID_STATE       = 0x0008,
    BLE_ERR_INVALID_OPERATION   = 0x0009,
    BLE_ERR_ALREADY_IN_PROGRESS = 0x000A,
    BLE_ERR_CONTEXT_FULL        = 0x000B,
    BLE_ERR_MEM_ALLOC_FAILED    = 0x000C,
    BLE_ERR_NOT_FOUND           = 0x000D,
    BLE_ERR_INVALID_HDL         = 0x000E,
    BLE_ERR_DISCONNECTED        = 0x000F,
    BLE_ERR_LIMIT_EXCEEDED      = 0x0010,
    BLE_ERR_RSP_TIMEOUT         = 0x0011,
    BLE_ERR_NOT_YET_READY       = 0x0012,
    BLE_ERR_UNSPECIFIED         = 0x0013,
    BLE_ERR_ALREADY_INITIALIZED = 0x0014,

    /* HCI Spec Error */
    BLE_ERR_HC_UNKNOWN_HCI_CMD              = 0x1001,
    BLE_ERR_HC_NO_CONN                      = 0x1002,
    BLE_ERR_HC_HW_FAIL                      = 0x1003,
    BLE_ERR_HC_PAGE_TO                      = 0x1004,
    BLE_ERR_HC_AUTH_FAIL                    = 0x1005,
    BLE_ERR_HC_KEY_MISSING                  = 0x1006,
    BLE_ERR_HC_MEM_FULL                     = 0x1007,
    BLE_ERR_HC_CONN_TO                      = 0x1008,
    BLE_ERR_HC_MAX_NUM_OF_CONN              = 0x1009,
    BLE_ERR_HC_MAX_NUM_OF_SCO_CONN          = 0x100A,
    BLE_ERR_HC_ACL_CONN_ALREADY_EXISTS      = 0x100B,
    BLE_ERR_HC_CMD_DISALLOWED               = 0x100C,
    BLE_ERR_HC_HOST_REJ_LIMITED_RESRC       = 0x100D,
    BLE_ERR_HC_HOST_REJ_SEC_REASONS         = 0x100E,
    BLE_ERR_HC_HOST_REJ_PERSONAL_DEV        = 0x100F,
    BLE_ERR_HC_HOST_TO                      = 0x1010,
    BLE_ERR_HC_UNSPRT_FEAT_OR_PARAM         = 0x1011,
    BLE_ERR_HC_INVALID_HCI_CMD_PARAM        = 0x1012,
    BLE_ERR_HC_OTHER_END_TERM_USER          = 0x1013,
    BLE_ERR_HC_OTHER_END_TERM_LOW_RESRC     = 0x1014,
    BLE_ERR_HC_OTHER_END_TERM_PW_OFF        = 0x1015,
    BLE_ERR_HC_CONN_TERM_BY_LOCAL_HOST      = 0x1016,
    BLE_ERR_HC_REPEATED_ATTEMPTS            = 0x1017,
    BLE_ERR_HC_PAIRING_NOT_ALLOWED          = 0x1018,
    BLE_ERR_HC_UNKNOWN_LMP_PDU              = 0x1019,
    BLE_ERR_HC_UNSPRT_REM_FEAT              = 0x101A,
    BLE_ERR_HC_SCO_OFFSET_REJ               = 0x101B,
    BLE_ERR_HC_SCO_INTERVAL_REJ             = 0x101C,
```

```
    BLE_ERR_HC_SCO_AIR_MODE_REJ             = 0x101D,
    BLE_ERR_HC_INVALID_LMP_PARAM            = 0x101E,
    BLE_ERR_HC_UNSPECIFIED_ERR              = 0x101F,
    BLE_ERR_HC_UNSPRT_LMP_PARAM_VAL         = 0x1020,
    BLE_ERR_HC_ROLE_CHANGE_NOT_ALLOWED      = 0x1021,
    BLE_ERR_HC_LMP_RSP_TO                   = 0x1022,
    BLE_ERR_HC_LMP_ERR_TX_COLLISION         = 0x1023,
    BLE_ERR_HC_LMP_PDU_NOT_ALLOWED          = 0x1024,
    BLE_ERR_HC_ENC_MODE_NOT_ACCEPTABLE      = 0x1025,
    BLE_ERR_HC_UNIT_KEY_USED                = 0x1026,
    BLE_ERR_HC_QOS_IS_NOT_SPRT              = 0x1027,
    BLE_ERR_HC_INSTANT_PASSED               = 0x1028,
    BLE_ERR_HC_PAIRING_UNIT_KEY_NOT_SPRT    = 0x1029,
    BLE_ERR_HC_DIFF_TRANSACTION_COLLISION   = 0x102A,
    BLE_ERR_HC_QOS_UNACCEPTABLE_PARAM       = 0x102C,
    BLE_ERR_HC_QOS_REJ                      = 0x102D,
    BLE_ERR_HC_CH_CLASSIFICATION_NOT_SPRT   = 0x102E,
    BLE_ERR_HC_INSUFFICIENT_SEC             = 0x102F,
    BLE_ERR_HC_PARAM_OUT_OF_MANDATORY_RANGE = 0x1030,
    BLE_ERR_HC_ROLE_SWITCH_PENDING          = 0x1032,
    BLE_ERR_HC_RESERVED_SLOT_VIOLATION      = 0x1034,
    BLE_ERR_HC_ROLE_SWITCH_FAIL             = 0x1035,
    BLE_ERR_HC_EXT_INQUIRY_RSP_TOO_LARGE    = 0x1036,
    BLE_ERR_HC_SSP_NOT_SPRT_BY_HOST         = 0x1037,
    BLE_ERR_HC_HOST_BUSY_PAIRING            = 0x1038,
    BLE_ERR_HC_CONN_REJ_NO_SUIT_CH_FOUND    = 0x1039,
    BLE_ERR_HC_CTRL_BUSY                    = 0x103A,
    BLE_ERR_HC_UNACCEPTEBALE_CONN_INTERVAL  = 0x103B,
    BLE_ERR_HC_ADV_TO                       = 0x103C,
    BLE_ERR_HC_CONN_TREM_DUE_TO_MIC_FAIL    = 0x103D,
    BLE_ERR_HC_CONN_FAIL_TO_BE_EST          = 0x103E,
    BLE_ERR_HC_MAC_CONN_FAIL                = 0x103F,
    BLE_ERR_HC_COARSE_CLK_ADJUST_REJ        = 0x1040,
    BLE_ERR_HC_TYPE0_SUBMAP_NOT_DEFINED     = 0x1041,
    BLE_ERR_HC_UNKNOWN_ADV_ID               = 0x1042,
    BLE_ERR_HC_LIMIT_REACHED                = 0x1043,
    BLE_ERR_HC_OP_CANCELLED_BY_HOST         = 0x1044,

    /* SMP Spec Error */
    BLE_ERR_SMP_LE_PASSKEY_ENTRY_FAIL        = 0x2001,
    BLE_ERR_SMP_LE_OOB_DATA_NOT_AVAILABLE    = 0x2002,
    BLE_ERR_SMP_LE_AUTH_REQ_NOT_MET          = 0x2003,
    BLE_ERR_SMP_LE_CONFIRM_VAL_NOT_MATCH     = 0x2004,
    BLE_ERR_SMP_LE_PAIRING_NOT_SPRT          = 0x2005,
    BLE_ERR_SMP_LE_INSUFFICIENT_ENC_KEY_SIZE = 0x2006,
    BLE_ERR_SMP_LE_CMD_NOT_SPRT              = 0x2007,
    BLE_ERR_SMP_LE_UNSPECIFIED_REASON        = 0x2008,
    BLE_ERR_SMP_LE_REPEATED_ATTEMPTS         = 0x2009,
    BLE_ERR_SMP_LE_INVALID_PARAM             = 0x200A,
    BLE_ERR_SMP_LE_DHKEY_CHECK_FAIL          = 0x200B,
    BLE_ERR_SMP_LE_NUM_COMP_FAIL             = 0x200C,
    BLE_ERR_SMP_LE_BREDR_PAIRING_IN_PROGRESS = 0x200D,
    BLE_ERR_SMP_LE_CT_KEY_GEN_NOT_ALLOWED    = 0x200E,
    BLE_ERR_SMP_LE_DISCONNECTED              = 0x200F,
    BLE_ERR_SMP_LE_TO                        = 0x2011,
    BLE_ERR_SMP_LE_LOC_KEY_MISSING           = 0x2014,

    /* GATT Spec Error */
    BLE_ERR_GATT_INVALID_HANDLE              = 0x3001,
    BLE_ERR_GATT_READ_NOT_PERMITTED          = 0x3002,
    BLE_ERR_GATT_WRITE_NOT_PERMITTED         = 0x3003,
```

```
    BLE_ERR_GATT_INVALID_PDU                 = 0x3004,
    BLE_ERR_GATT_INSUFFICIENT_AUTHENTICATION = 0x3005,
    BLE_ERR_GATT_REQUEST_NOT_SUPPORTED       = 0x3006,
    BLE_ERR_GATT_INVALID_OFFSET              = 0x3007,
    BLE_ERR_GATT_INSUFFICIENT_AUTHORIZATION  = 0x3008,
    BLE_ERR_GATT_PREPARE_WRITE_QUEUE_FULL    = 0x3009,
    BLE_ERR_GATT_ATTRIBUTE_NOT_FOUND         = 0x300A,
    BLE_ERR_GATT_ATTRIBUTE_NOT_LONG          = 0x300B,
    BLE_ERR_GATT_INSUFFICIENT_ENC_KEY_SIZE   = 0x300C,
    BLE_ERR_GATT_INVALID_ATTRIBUTE_LEN       = 0x300D,
    BLE_ERR_GATT_UNLIKELY_ERROR              = 0x300E,
    BLE_ERR_GATT_INSUFFICIENT_ENCRYPTION     = 0x300F,
    BLE_ERR_GATT_UNSUPPORTED_GROUP_TYPE      = 0x3010,
    BLE_ERR_GATT_INSUFFICIENT_RESOURCES      = 0x3011,

    /* defined in CSS */
    BLE_ERR_GATT_WRITE_REQ_REJECTED       = 0x30FC,
    BLE_ERR_GATT_CCCD_IMPROPERLY_CFG      = 0x30FD,
    BLE_ERR_GATT_PROC_ALREADY_IN_PROGRESS = 0x30FE,
    BLE_ERR_GATT_OUT_OF_RANGE             = 0x30FF,

    /* L2CAP Spec Error */
    BLE_ERR_L2CAP_PSM_NOT_SUPPORTED         = 0x4002,
    BLE_ERR_L2CAP_NO_RESOURCE               = 0x4004,
    BLE_ERR_L2CAP_INSUF_AUTHEN              = 0x4005,
    BLE_ERR_L2CAP_INSUF_AUTHOR              = 0x4006,
    BLE_ERR_L2CAP_INSUF_ENC_KEY_SIZE        = 0x4007,
    BLE_ERR_L2CAP_REFUSE_INSUF_ENC          = 0x4008,
    BLE_ERR_L2CAP_REFUSE_INVALID_SCID       = 0x4009,
    BLE_ERR_L2CAP_REFUSE_SCID_ALREADY_ALLOC = 0x400A,
    BLE_ERR_L2CAP_REFUSE_UNACCEPTABLE_PARAM = 0x400B,
};
```

2.10. Parameter

```
/* Application callback event types */
#define R_BLE_GTL_CB_EVT_TYPE_MASK              0xF000U
#define R_BLE_GTL_CB_EVT_TYPE_GAP               0x1000U
#define R_BLE_GTL_CB_EVT_TYPE_GATTS             0x3000U
#define R_BLE_GTL_CB_EVT_TYPE_GATTC             0x4000U
#define R_BLE_GTL_CB_EVT_TYPE_L2CAP             0x5000U
#define R_BLE_GTL_CB_EVT_TYPE_VS                0x8000U

/* GTL Task ID's */
#define R_BLE_GTL_TASK_ID_GATTM                 0x000B
#define R_BLE_GTL_TASK_ID_GATTC                 0x000C
#define R_BLE_GTL_TASK_ID_GAPM                  0x000D
#define R_BLE_GTL_TASK_ID_GAPC                  0x000E
#define R_BLE_GTL_TASK_ID_GTL                   0x0010

/* GTL GATTM Command ID's */
#define R_BLE_GTL_GATTM_ADD_SVC_REQ             0x0B00
#define R_BLE_GTL_GATTM_ADD_SVC_RSP             0x0B01
#define R_BLE_GTL_GATTM_ATT_GET_VALUE_REQ       0x0B0A
#define R_BLE_GTL_GATTM_ATT_GET_VALUE_RSP       0x0B0B
#define R_BLE_GTL_GATTM_ATT_SET_VALUE_REQ       0x0B0C
#define R_BLE_GTL_GATTM_ATT_SET_VALUE_RSP       0x0B0D

/* GTL GATTC Command ID's */
#define R_BLE_GTL_GATTC_CMP_EVT                 0x0C00
#define R_BLE_GTL_GATTC_EXC_MTU_CMD             0x0C01
#define R_BLE_GTL_GATTC_MTU_CHANGED_IND         0x0C02
#define R_BLE_GTL_GATTC_DISC_CMD                0x0C03
#define R_BLE_GTL_GATTC_DISC_SVC_IND            0x0C04
#define R_BLE_GTL_GATTC_DISC_CHAR_IND           0x0C06
#define R_BLE_GTL_GATTC_DISC_CHAR_DESC_IND      0x0C07
#define R_BLE_GTL_GATTC_READ_CMD                0x0C08
#define R_BLE_GTL_GATTC_READ_IND                0x0C09
#define R_BLE_GTL_GATTC_SEND_EVT_CMD            0x0C10
#define R_BLE_GTL_GATTC_WRITE_CMD               0x0C0A
#define R_BLE_GTL_GATTC_WRITE_EXECUTE_CMD       0x0C0B
#define R_BLE_GTL_GATTC_READ_REQ_IND            0x0C13
#define R_BLE_GTL_GATTC_READ_CFM                0x0C14
#define R_BLE_GTL_GATTC_WRITE_REQ_IND           0x0C15
#define R_BLE_GTL_GATTC_WRITE_CFM               0x0C16

/* GTL GAPM Command ID's */
#define R_BLE_GTL_GAPM_CMP_EVT                  0x0D00
#define R_BLE_GTL_GAPM_DEVICE_READY_IND         0x0D01
#define R_BLE_GTL_GAPM_RESET_CMD                0x0D02
#define R_BLE_GTL_GAPM_CANCEL_CMD               0x0D03
#define R_BLE_GTL_GAPM_SET_DEV_CONFIG_CMD       0x0D04
#define R_BLE_GTL_GAPM_GET_DEV_INFO_CMD         0x0D06
#define R_BLE_GTL_GAPM_DEV_VERSION_IND          0x0D07
#define R_BLE_GTL_GAPM_DEV_BDADDR_IND           0x0D08
#define R_BLE_GTL_GAPM_GEN_RAND_ADDR_CMD        0x0D16
#define R_BLE_GTL_GAPM_GEN_RAND_NB_CMD          0x0D19
#define R_BLE_GTL_GAPM_GEN_RAND_NB_IND          0x0D1A
#define R_BLE_GTL_GAPM_UNKNOWN_TASK_IND         0x0D1D
#define R_BLE_GTL_GAPM_START_ADVERTISE_CMD      0x0D0D

/* GTL GAPC Command ID's */
#define R_BLE_GTL_GAPC_CMP_EVT                  0x0E00
#define R_BLE_GTL_GAPC_CONNECTION_REQ_IND       0x0E01
```

```
#define R_BLE_GTL_GAPC_CONNECTION_CFM           0x0E02
#define R_BLE_GTL_GAPC_DISCONNECT_IND           0x0E03
#define R_BLE_GTL_GAPC_DISCONNECT_CMD           0x0E04
#define R_BLE_GTL_GAPC_GET_INFO_CMD             0x0E05
#define R_BLE_GTL_GAPC_PEER_VERSION_IND         0x0E07
#define R_BLE_GTL_GAPC_PEER_FEATURES_IND        0x0E08
#define R_BLE_GTL_GAPC_CON_RSSI_IND             0x0E09
#define R_BLE_GTL_GAPC_GET_DEV_INFO_REQ_IND     0x0E0A
#define R_BLE_GTL_GAPC_GET_DEV_INFO_CFM         0x0E0B
#define R_BLE_GTL_GAPC_PARAM_UPDATE_CMD         0x0E0E
#define R_BLE_GTL_GAPC_PARAM_UPDATE_REQ_IND     0x0E0F
#define R_BLE_GTL_GAPC_PARAM_UPDATE_CFM         0x0E10
#define R_BLE_GTL_GAPC_PARAM_UPDATED_IND        0x0E11
#define R_BLE_GTL_GAPC_CON_CHANNEL_MAP_IND      0x0E1D
#define R_BLE_GTL_GAPC_LECB_CONNECT_CMD         0x0E20
#define R_BLE_GTL_GAPC_LECB_ADD_CMD             0x0E24
#define R_BLE_GTL_GAPC_LECB_SEND_CMD            0x0E25
#define R_BLE_GTL_GAPC_LECB_DISCONNECT_CMD      0x0E26
#define R_BLE_GTL_GAPC_SET_LE_PKT_SIZE_CMD      0x0E2B
#define R_BLE_GTL_GAPC_LE_PKT_SIZE_IND          0x0E2C

/* GTL Auxiliary Command ID's */
#define R_BLE_GTL_AUX_SET_TX_POWER_CMD          0xA005
#define R_BLE_GTL_AUX_SET_TX_POWER_CMP_EVT      0xA006
#define R_BLE_GTL_AUX_GET_TX_POWER_CMD          0xA007
#define R_BLE_GTL_AUX_GET_TX_POWER_RSP          0xA008

#define R_BLE_GTL_PERIPHERAL_ROLE               0x0A
#define R_BLE_GTL_ADV_FLAG_FIELD_LEN            3
#define R_BLE_GTL_ADV_DATA_LEN_MAX              31
#define R_BLE_GTL_ADV_DATA_TYPE_FLAGS           0x01
#define R_BLE_GTL_SCAN_RSP_DATA_LEN_MAX         31
#define R_BLE_GTL_KEY_LEN                       0x10
#define R_BLE_GTL_GET_RAND_SIZE_MAX             8
#define R_BLE_GTL_DATA_LEN_TX_OCTETS_MAX        251
#define R_BLE_GTL_DATA_LEN_TX_TIME_MAX          2120
#define R_BLE_GTL_GAP_NON_DISCOVERABLE          0x00
#define R_BLE_GTL_GAP_GEN_DISCOVERABLE          0x01
#define R_BLE_GTL_GAP_LIM_DISCOVERABLE          0x02
#define R_BLE_GTL_GAP_BROADCASTER_MODE          0x03

/* Attribute permissions defined in QE profile */
#define R_BLE_GTL_QE_ATT_PERM_READ              0x01
#define R_BLE_GTL_QE_ATT_PERM_WRITE             0x02
#define R_BLE_GTL_QE_ATT_PERM_NOTIFY            0x10
#define R_BLE_GTL_QE_ATT_PERM_INDICATE          0x20

/* Attribute permissions defined in GTL message(s) */
#define R_BLE_GTL_ATT_PERM_READ_ENABLE          0x00000001UL
#define R_BLE_GTL_ATT_PERM_WRITE_ENABLE         0x00000008UL
#define R_BLE_GTL_ATT_PERM_INDICATE_ENABLE      0x00000040UL
#define R_BLE_GTL_ATT_PERM_NOIFY_ENABLE         0x00000200UL
#define R_BLE_GTL_ATT_PERM_WRITE_REQ_ACCEPTED   0x00020000UL
#define R_BLE_GTL_ATT_PERM_UUID_LEN_128         0x00080000UL

#define R_BLE_GTL_SVC_GAP_UUID                  0x1800
#define R_BLE_GTL_SVC_GATT_UUID                 0x1801
#define R_BLE_GTL_ATT_PRIMARY_SVC_DECL          0x2800
#define R_BLE_GTL_ATT_SECONDARY_SVC_DECL        0x2801
#define R_BLE_GTL_CHAR_DECLARATION              0x2803
#define R_BLE_GTL_CHAR_USER_DESC                0x2901
```

```
#define R_BLE_GTL_CHAR_DEVICE_NAME              0x2A00
#define R_BLE_GTL_CHAR_APPEARANCE               0x2A01

/* The first two bits of a non-public (random) address must be binary ones */
#define R_BLE_GTL_PUBLIC_BD_ADDR_MASK           0xC0

#define R_BLE_GTL_MS_PER_SECOND                 1000UL
#define R_BLE_GTL_ADV_TIMER_TICKS_PER_SECOND    100UL

/* Service permissions defined in GTL messages(s), can be or'd together */
#define R_BLE_GTL_SVC_PERM_ENABLE               0x04
#define R_BLE_GTL_SVC_PERM_UUID_LEN_128         0x40
#define R_BLE_GTL_SVC_PERM_PRIMARY              0x80

/* "RBLE" in ASCII. Used to determine if the control block is open. */
#define R_BLE_GTL_OPEN                          0x52424C45U

/* Mutex give/take defines */
#define R_BLE_GTL_MUTEX_TX                      (1UL << 0)
#define R_BLE_GTL_MUTEX_RX                      (1UL << 1)
#define R_BLE_GTL_MUTEX_TEI                     (1UL << 2)

/* UART boot protocol message types */
#define R_BLE_GTL_BOOT_STX                      0x02
#define R_BLE_GTL_BOOT_SOH                      0x01
#define R_BLE_GTL_BOOT_ACK                      0x06
#define R_BLE_GTL_BOOT_NACK                     0x15

/* Defines for host DB */
#define DB_INVALID_INDEX                        0xFFFF
#define DB_VALID_INDEX                          0x0000
#define BLE_SERV_CCC_UUID                       0x2902

typedef enum e_r_ble_gtl_rx_msg_parser_state
{
    R_BLE_GTL_RX_MSG_PARSER_STATE_IDLE = 0,
    R_BLE_GTL_RX_MSG_PARSER_STATE_RX_HEADER,
    R_BLE_GTL_RX_MSG_PARSER_STATE_RX_PARAM
} r_ble_gtl_rx_msg_parser_state_t;

typedef enum e_r_ble_gtl_gapm_operation
{
    R_BLE_GTL_GAPM_OP_NONE = 0x00,
    R_BLE_GTL_GAPM_OP_RESET,
    R_BLE_GTL_GAPM_OP_CANCEL,
    R_BLE_GTL_GAPM_OP_SET_DEV_CONFIG,
    R_BLE_GTL_GAPM_OP_SET_CHANNEL_MAP,
    R_BLE_GTL_GAPM_OP_GET_DEV_VERSION,
    R_BLE_GTL_GAPM_OP_GET_DEV_BDADDR,
    R_BLE_GTL_GAPM_OP_GET_DEV_ADV_TX_POWER,
    R_BLE_GTL_GAPM_OP_GET_WLIST_SIZE,
    R_BLE_GTL_GAPM_OP_ADD_DEV_IN_WLIST,
    R_BLE_GTL_GAPM_OP_RMV_DEV_FRM_WLIST,
    R_BLE_GTL_GAPM_OP_CLEAR_WLIST,
    R_BLE_GTL_GAPM_OP_ADV_NON_CONN,
    R_BLE_GTL_GAPM_OP_ADV_UNDIRECT,
    R_BLE_GTL_GAPM_OP_ADV_DIRECT,
    R_BLE_GTL_GAPM_OP_ADV_DIRECT_LDC,
    R_BLE_GTL_GAPM_OP_UPDATE_ADVERTISE_DATA,
    R_BLE_GTL_GAPM_OP_SCAN_ACTIVE,
    R_BLE_GTL_GAPM_OP_SCAN_PASSIVE,
```

```
    R_BLE_GTL_GAPM_OP_CONNECTION_DIRECT,
    R_BLE_GTL_GAPM_OP_CONNECTION_AUTO,
    R_BLE_GTL_GAPM_OP_CONNECTION_SELECTIVE,
    R_BLE_GTL_GAPM_OP_CONNECTION_NAME_REQUEST,
    R_BLE_GTL_GAPM_OP_RESOLV_ADDR,
    R_BLE_GTL_GAPM_OP_GEN_RAND_ADDR,
    R_BLE_GTL_GAPM_OP_USE_ENC_BLOCK,
    R_BLE_GTL_GAPM_OP_GEN_RAND_NB,
    R_BLE_GTL_GAPM_OP_PROFILE_TASK_ADD,
    R_BLE_GTL_GAPM_OP_DBG_GET_MEM_INFO,
    R_BLE_GTL_GAPM_OP_PLF_RESET,
    R_BLE_GTL_GAPM_OP_SET_SUGGESTED_DFLT_LE_DATA_LEN,
    R_BLE_GTL_GAPM_OP_GET_SUGGESTED_DFLT_LE_DATA_LEN,
    R_BLE_GTL_GAPM_OP_GET_MAX_LE_DATA_LEN,
    R_BLE_GTL_GAPM_OP_GET_RAL_SIZE,
    R_BLE_GTL_GAPM_OP_GET_RAL_LOC_ADDR,
    R_BLE_GTL_GAPM_OP_GET_RAL_PEER_ADDR,
    R_BLE_GTL_GAPM_OP_ADD_DEV_IN_RAL,
    R_BLE_GTL_GAPM_OP_RMV_DEV_FRM_RAL,
    R_BLE_GTL_GAPM_OP_CLEAR_RAL,
    R_BLE_GTL_GAPM_OP_USE_P256_BLOCK,
    R_BLE_GTL_GAPM_OP_NETWORK_MODE_RAL,
    R_BLE_GTL_GAPM_OP_DEVICE_MODE_RAL,
    R_BLE_GTL_GAPM_OP_KEY_RENEW,
    R_BLE_GTL_GAPM_OP_GEN_P256_KEY = R_BLE_GTL_GAPM_OP_KEY_RENEW,
    R_BLE_GTL_GAPM_OP_LAST
} r_ble_gtl_gapm_operation_t;

typedef enum e_r_ble_gtl_gapc_operation
{
    R_BLE_GTL_GAPC_OP_NONE = 0x00,
    R_BLE_GTL_GAPC_OP_DISCONNECT,
    R_BLE_GTL_GAPC_OP_GET_PEER_NAME,
    R_BLE_GTL_GAPC_OP_GET_PEER_VERSION,
    R_BLE_GTL_GAPC_OP_GET_PEER_FEATURES,
    R_BLE_GTL_GAPC_OP_GET_PEER_APPEARANCE,
    R_BLE_GTL_GAPC_OP_GET_PEER_SLV_PREF_PARAMS,
    R_BLE_GTL_GAPC_OP_GET_CON_RSSI,
    R_BLE_GTL_GAPC_OP_GET_CON_CHANNEL_MAP,
    R_BLE_GTL_GAPC_OP_UPDATE_PARAMS,
    R_BLE_GTL_GAPC_OP_BOND,
    R_BLE_GTL_GAPC_OP_ENCRYPT,
    R_BLE_GTL_GAPC_OP_SECURITY_REQ,
    R_BLE_GTL_GAPC_OP_LE_CB_CREATE,
    R_BLE_GTL_GAPC_OP_LE_CB_DESTROY,
    R_BLE_GTL_GAPC_OP_LE_CB_CONNECTION,
    R_BLE_GTL_GAPC_OP_LE_CB_DISCONNECTION,
    R_BLE_GTL_GAPC_OP_LE_CB_ADDITION,
    R_BLE_GTL_GAPC_OP_GET_LE_PING_TO,
    R_BLE_GTL_GAPC_OP_SET_LE_PING_TO,
    R_BLE_GTL_GAPC_OP_SET_LE_PKT_SIZE,
    R_BLE_GTL_GAPC_OP_GET_PEER_CENTRAL_RPA,
    R_BLE_GTL_GAPC_OP_GET_PEER_RPA_ONLY,
    R_BLE_GTL_GAPC_OP_LE_CB_SEND,
} r_ble_gtl_gapc_operation_t;
```

```
typedef enum e_r_ble_gtl_gattc_operation
{
    R_BLE_GTL_GATTC_OP_NONE = 0x00,
    R_BLE_GTL_GATTC_OP_MTU_EXCH,
    R_BLE_GTL_GATTC_OP_DISC_ALL_SVC,
    R_BLE_GTL_GATTC_OP_DISC_BY_UUID_SVC,
    R_BLE_GTL_GATTC_OP_DISC_INCLUDED_SVC,
    R_BLE_GTL_GATTC_OP_DISC_ALL_CHAR,
    R_BLE_GTL_GATTC_OP_DISC_BY_UUID_CHAR,
    R_BLE_GTL_GATTC_OP_DISC_DESC_CHAR,
    R_BLE_GTL_GATTC_OP_READ,
    R_BLE_GTL_GATTC_OP_READ_LONG,
    R_BLE_GTL_GATTC_OP_READ_BY_UUID,
    R_BLE_GTL_GATTC_OP_READ_MULTIPLE,
    R_BLE_GTL_GATTC_OP_WRITE,
    R_BLE_GTL_GATTC_OP_WRITE_NO_RESPONSE,
    R_BLE_GTL_GATTC_OP_WRITE_SIGNED,
    R_BLE_GTL_GATTC_OP_EXEC_WRITE,
    R_BLE_GTL_GATTC_OP_REGISTER,
    R_BLE_GTL_GATTC_OP_UNREGISTER,
    R_BLE_GTL_GATTC_OP_NOTIFY,
    R_BLE_GTL_GATTC_OP_INDICATE,
} r_ble_gtl_gattc_operation_t;

typedef enum e_r_ble_gtl_aux_operation
{
    R_BLE_GTL_AUX_OP_NONE = 0x00,
    R_BLE_GTL_AUX_SET_TX_POWER = 0x06,
} r_ble_gtl_aux_operation_t;

typedef enum e_r_ble_gtl_host_error_code
{
    R_BLE_GTL_GAP_ERR_NO_ERROR = 0x00,
    R_BLE_GTL_ATT_ERR_INVALID_HANDLE,
    R_BLE_GTL_ATT_ERR_READ_NOT_PERMITTED,
    R_BLE_GTL_ATT_ERR_REQUEST_NOT_SUPPORTED = 0x06,
    R_BLE_GTL_GAP_ERR_CANCELED = 0x44
} r_ble_gtl_host_error_code_t;

typedef enum e_r_ble_gtl_gapc_device_info
{
    R_BLE_GTL_GAPC_DEV_NAME = 0x00,
    R_BLE_GTL_GAPC_DEV_APPEARANCE,
    R_BLE_GTL_GAPC_DEV_SLV_PREF_PARAMS,
    R_BLE_GTL_GAPC_DEV_CENTRAL_RPA,
    R_BLE_GTL_GAPC_DEV_RPA_ONLY,
} r_ble_gtl_gapc_device_info_t;

typedef enum e_r_ble_gtl_device_state
{
    R_BLE_GTL_DEV_STATE_IDLE = 0x00,
    R_BLE_GTL_DEV_STATE_ADVERTISING,
    R_BLE_GTL_DEV_STATE_CONNECTED,
} r_ble_gtl_device_state_t;
```

2.11. Adding the FIT Module to Your Project

The FIT module must be added to each project in which it is used. Renesas recommends the method using the Smart Configurator described in (1) below. However, the Smart Configurator only supports some RX devices. Please use the methods of (2) for RX devices that are not supported by the Smart Configurator.

1) Adding the FIT module to your project using the Smart Configurator in e2 studio. By using the Smart Configurator in e2 studio, the FIT module is automatically added to your project. Refer to “RX Smart Configurator User’s Guide: e2 studio (R20AN0451)” for details.
2) Adding the FIT module to your project using the FIT Configurator in e2 studio. By using the FIT Configurator in e2 studio, the FIT module is automatically added to your project. Refer to “RX Family Adding Firmware Integration Technology Modules to Projects (R01AN1723)” for details.

2.12. “for”, “while” and “do while” Statements

In FIT module, “for”, “while” and “do while” statements (loop processing) are used in processing to wait for register to be reflected and so on. For these loop processing, comments with “WAIT_LOOP” as a keyword are described. Therefore, if user incorporates fail-safe processing into loop processing, user can search the corresponding processing with “WAIT_LOOP”.

This FIT module does not have any WAIT_LOOP. But others might have. Please take care for this WAIT_LOOP.

2.13. Usage Notes

2.13.1 Getting Started Guide

The below guide walks users through building a fully working solution in order to run a BLE application from the RX MCU using the GTL interface.

UM-B-177: Getting started with DA1453x and RX BLE Framework on Renesas Microcontrollers — Getting started with DA14531 and FSP BLE Framework

2.13.2 Addresses

When using a public BD address the address pre-programmed into the DA14531 will be used and can't be overridden. A random address can be set by calling the R_BLE_VS_SetBdAddr function before the R_BLE_GAP_Init function is called.

2.13.3 Heap Requirements

Ensure the BSP heap size is set to at least 2K bytes.
When using FreeRTOS ensure the heap 4 size is set to a minimum of 2K bytes.

2.13.4 Module Firmware Compatibility

This middleware module is compatible with GTL binary version 6.0.22 and later. You must ensure that the DA14531/DA14535 Module (or PMOD) you are using contains this version (or later) firmware or that you use the boot from host feature and have the host MCU load the binary into the DA14531/DA14535. Note that DA14531 and DA14535 are not firmware compatible even though the GTL API is the same.

Instructions detailing how to upgrade the firmware in a DA14531 Module can be found here:

https://lpccs-docs.renesas.com/US159-DA14531EVZ_Firmware_Upgrade/index.html

The GTL binary file can be downloaded using the tool described in the above instructions, or by using the following link:

https://www.renesas.com/us/en/document/swo/fsp-gtl-binary-us159-da14531evz-pmod-programming?r=1564826

2.13.5 Limitations

Developers should be aware of the following limitations when using the BLE_ABS:

- Following a power on reset, the R_BLE_VS_GetRand function always returns the same number. Subsequent calls to this function produce random numbers.

- Service and characteristic write callback functions, created when using the QE Tool are not supported.

- The boot from host feature currently support 1-wire UART & 2-wire UART:

  - When using a 1-wire boot from host with DA14531/DA14535, the UART RX and TX pins on the host RX MCU must be connected together using a 1K ohm resistor to boot which resistor can remain in place after the boot operation is completed.
  - When using a 2-wire boot from host with DA14535MOD, the 1K ohm resistor is not required to initiate the process, as it has already been written with a second bootloader supported in its memory.
  - Boot from host using 2-wire UART is not supported when using a DA14531MOD module because not all the required pins are exposed.

- Some code-generated setting with the custom profile generation feature do not work in combination with FIT for the DA14531 module. Also, be sure to perform sufficient test on the generated code.

  - Workaround: Please refer to FIT documents about details of functional restriction.

- Notes on arguments for R_BLE_GATTS_GetAttr functions **(1)**: In the case of DA14531 modules, add code to allocate memory for the members of the structure to be passed to the third argument at the call of the R_BLE_GATTS_GettAttr function in the code generated by QE for BLEAPI Functions.

- Please note that if you use QE for BLE to generate code again, the changes will be removed.

- Notes on Notification and Client Characteristic Configuration Descriptor **(2)**: In the case of DA14531 modules, the value of the Client Characteristic Configuration Descriptor cannot be obtained from the R_BLE_SERVS_GetDesc function. As a result, calling R_BLE_<Service>_Notify<Characteristic> function generated by QE for BLE does not issue a Notify.

- To issue a Notify, comment out the part where getting the value of the Client Characteristic Configuration Descriptor and set the value of cccd appropriately.
- Also, please note that if you use QE for BLE to generate code again, the changes will be removed.

Example Notes **(1)**, **(2)** above can be found here: QE for BLE[RA,RE,RX] V1.7.0 Release Note (renesas.com)

3. API Function

3.1. R_BLE_Open()

Open the BLE protocol stack.

Format

```
ble_status_t R_BLE_Open (
      void
)
```

Parameters

None

Return values

BLE_SUCCESS	Success

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function should be called once before using the BLE protocol stack.

Reentrant

No

Example

```
R_BLE_Open();
```

Special Notes:

None.

3.2. R_BLE_Close()

Close the BLE protocol stack.

Format

```
ble_status_t R_BLE_Close (
      void
)
```

Parameters

None

Return values

BLE_SUCCESS	Success

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function should be called once to close the BLE protocol stack.

Reentrant

No

Example

```
R_BLE_Close();
```

Special Notes:

None

3.3. R_BLE_Execute()

Execute the BLE task.

Format

```
ble_status_t R_BLE_Execute (
      void
)
```

Parameters

None

Return values

BLE_SUCCESS	Success

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This handles all the task queued in the BLE protocol stack internal task queue and return. This function should be called repeatedly in the main loop.

Reentrant

No

Example

```
R_BLE_Open();
while (1)
{
    R_BLE_Execute();
}
```

Special Notes:

None

3.4. R_BLE_IsTaskFree()

Check if the BLE task queue is free or not.

Format

```
uint32_t R_BLE_IsTaskFree(
      void
)
```

Parameters

None

Return values

0x0	BLE task queue is not free.
0x1	BLE task queue is free.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function returns the BLE task queue free status.

When this function returns 0x0, call R_BLE_Execute() to execute the BLE task.

Example

```
R_BLE_Open();
while (1)
{
    R_BLE_Execute();
    if(0 != R_BLE_IsTaskFree())
    {
        xEventGroupWaitBits();
    }
}
```

Special Notes:

None

3.5. R_BLE_GetVersion()

Get the BLE FIT module version.

Format

```
uint32_t R_BLE_GetVersion(
      void
)
```

Parameters

None

Return values

Version number

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function returns the BLE FIT module version.

The major version(BLE_VERSION_MAJOR) is contained in the two most significant bytes, and the minor version(BLE_VERSION_MINOR) occupies the remaining two bytes.

Example

```
uint32_t version;

version = R_BLE_GetVersion();
```

Special Notes:

None

3.6. R_BLE_GAP_Init()

Initialize the Host Stack.

Format

```
ble_status_t R_BLE_GAP_Init (
      ble_gap_app_cb_t gap_cb
)
```

Parameters

gap_cb	A callback function registered with this function.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	gap_cb is specified as NULL.
BLE_ERR_INVALID_STATE(0x0008)	The reason for this error is as follows: - Host Stack was already initialized. - The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

Host stack is initialized with this function. Before using All the R_BLE APIs, it's necessary to call this function. A callback function is registered with this function. In order to receive the GAP event, it's necessary to register a callback function.

The result of this API call is notified in BLE_GAP_EVENT_STACK_ON event.

Reentrant

No

Example

None

Special Notes:

None

3.7. R_BLE_GAP_Terminate()

Terminate the Host Stack.

Format

```
ble_status_t R_BLE_GAP_Terminate(
      void
)
```

Parameters

None

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	Host stack hasn't been initialized.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The host stack is terminated with this function.

In order to reset all the Bluetooth functions, it's necessary to call this function.

The result of this API call is notified in BLE_GAP_EVENT_STACK_OFF event.

Reentrant

No

Example

None

Special Notes:

None

3.8. R_BLE_GAP_UpdConn()

Update the connection parameters.

Format

```
ble_status_t R_BLE_GAP_UpdConn(
      uint16_t                      conn_hdl,
      uint8_t                       mode,
      uint16_t                      accept,
      st_ble_gap_conn_param_t *     p_conn_updt_param
)
```

Parameters

conn_hdl — Connection handle identifying the link to be updated.

mode — Connection parameter update request or response.

macro	description
BLE_GAP_CONN_UPD_MODE_REQ (0x01)	Request for updating the connection parameters.
BLE_GAP_CONN_UPD_MODE_RSP (0x02)	Reply a connection parameter update request.

accept — When mode is BLE_GAP_CONN_UPD_MODE_RSP, accept or reject the connection parameters update request. If mode is BLE_GAP_CONN_UPD_MODE_REQ, accept is ignored.

macro	description
BLE_GAP_CONN_UPD_ACCEPT (0x0000)	Accept the update request.
BLE_GAP_CONN_UPD_REJECT (0x0001)	Reject the update request.

p_conn_updt_param — Connection parameters to be updated. When mode is BLE_GAP_CONN_UPD_MODE_RSP and accept is BLE_GAP_CONN_UPD_REJECT, p_conn_updt_param is ignored.

Return values

BLE_SUCCESS(0x0000) — Success

BLE_ERR_INVALID_PTR(0x0001) — When accept is BLE_GAP_CONN_UPD_ACCEPT, p_conn_updt_param is specified as NULL.

BLE_ERR_INVALID_ARG(0x0003) — The following is out of range.

- mode
- accept
- conn_intv_min field in p_conn_updt_param
- conn_intv_max field in p_conn_updt_param
- conn_latency in p_conn_updt_param
- sup_to in p_conn_updt_param
- conn_hdl

BLE_ERR_INVALID_STATE(0x0008) — Not connected with the remote device.

BLE_ERR_CONTEXT_FULL(0x000B) — Sending a L2CAP command, an error occurred.

BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function updates the connection parameters or replies to a request for updating connection parameters notified by BLE_GAP_EVENT_CONN_PARAM_UPD_REQ event. When the connection parameters have been updated, BLE_GAP_EVENT_CONN_PARAM_UPD_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.9. R_BLE_GAP_SetDataLen()

Update the packet size and the packet transmit time.

Format

```
ble_status_t R_BLE_GAP_SetDataLen(
      uint16_t    conn_hdl,
      uint16_t    tx_octets,
      uint16_t    tx_time
)
```

Parameters

conn_hdl	Connection handle identifying the link whose the transmission packet size or the transmission time to be changed.
tx_octets	Maximum transmission packet size. Valid range is 0x001B - 0x00FB.
tx_time	Maximum transmission time(us). Valid range is 0x0148 - 0x4290.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function requests for changing the maximum transmission packet size and the maximum packet transmission time. When Controller has received the request from host stack, BLE_GAP_EVENT_SET_DATA_LEN_COMP event is notified to the application layer. When the transmission packet size or the transmission time has been changed, BLE_GAP_EVENT_DATA_LEN_CHG event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.10. R_BLE_GAP_Disconnect()

Disconnect the link.

Format

```
ble_status_t R_BLE_GAP_Disconnect   (
      uint16_t          conn_hdl,
      uint8_t           reason
)
```

Parameters

conn_hdl	Connection handle identifying the link to be disconnected.
reason	The reason for disconnection. Usually, set 0x13 which indicates that a user disconnects the link. If setting other than 0x13, refer the error code described in Core Specification Vol.2 Part D ,"2 Error Code Descriptions".

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	conn_hdl is out of range.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function disconnects a link. When the link has disconnected, BLE_GAP_EVENT_DISCONN_IND event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.11. R_BLE_GAP_GetVerInfo()

Get the version number of the Controller and the host stack.

Format

```
ble_status_t R_BLE_GAP_GetVerInfo   (
      void
)
```

Parameters

None

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function retrieves the version information of local device. The result of this API call is notified in BLE_GAP_EVENT_LOC_VER_INFO event.

Reentrant

No

Example

None

Special Notes:

None

3.12. R_BLE_GAP_ReadRssi()

Get RSSI.

Format

```
ble_status_t R_BLE_GAP_ReadRssi     (
      uint16_t    conn_hdl
)
```

Parameters

conn_hdl	Connection handle identifying the link whose RSSI to be retrieved.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	conn_hdl is out of range.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function retrieves RSSI. The result of this API call is notified in BLE_GAP_EVENT_RSSI_RD_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.13. R_BLE_GAP_ReadChMap()

Get the Channel Map.

Format

```
ble_status_t R_BLE_GAP_ReadChMap    (
      uint16_t    conn_hdl
)
```

Parameters

conn_hdl Connection handle identifying the link whose channel map to be retrieved.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	conn_hdl is out of range.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function retrieves the channel map. The result of this API call is notified in BLE_GAP_EVENT_CH_MAP_RD_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.14. R_BLE_GAP_SetAdvParam()

Set advertising parameters.

Format

```
ble_status_t R_BLE_GAP_SetAdvParam (
      st_ble_gap_adv_param_t * p_adv_param
)
```

Parameters

p_adv_param Advertising parameters.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	p_adv_param is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The below p_adv_param field value is out of range. • adv_handle • adv_intv_min/adv_intv_max • adv_ch_map • o_addr_type • p_addr_type • adv_phy • sec_adv_phy • scan_req_ntf_flag
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function sets advertising parameters. It's possible to do advertising where the advertising parameters are different every each advertising set. The number of advertising set in the Controller is defined as BLE_MAX_NO_OF_ADV_SETS_SUPPORTED. Each advertising set is identified with advertising handle (0x00-0x03). Create an advertising set with this function before start advertising, setting periodic advertising parameters, start periodic advertising, setting advertising data/scan response data/periodic advertising data. The result of this API call is notified in BLE_GAP_EVENT_ADV_PARAM_SET_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.15. R_BLE_GAP_SetAdvSresData()

Set advertising data/scan response data/periodic advertising data.

Format

```
ble_status_t R_BLE_GAP_SetAdvSresData     (
      st_ble_gap_adv_data_t *       p_adv_srsp_data
)
```

Parameters

p_adv_srsp_data Advertising data/scan response data/periodic advertising data.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The reason for this error is as follows: • p_adv_srsp_data is specified as NULL. • data_length field in p_adv_srsp_data parameter is not 0 and p_data field is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The following field in p_adv_srsp_data parameter is out of range. • adv_hdl • data_type • data_length • zero_length_flag
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function sets advertising data/scan response data/periodic advertising data to the advertising set. It is necessary to create an advertising set by R_BLE_GAP_SetAdvParam(), before calling this function. Set advertising data/scan response data/periodic advertising data, after allocating the memory for the data. The following shall be applied regarding the adv_prop_type field and the data_type field in st_ble_gap_adv_param_t parameter specified in R_BLE_GAP_SetAdvParam().

Reentrant

No

Example

None

Special Notes:

None

3.16. R_BLE_GAP_StartAdv()

Start advertising.

Format

```
ble_status_t R_BLE_GAP_StartAdv     (
      uint8_t           adv_hdl,
      uint16_t          duration,
      uint8_t           max_extd_adv_evts
)
```

Parameters

adv_hdl	The advertising handle pointing to the advertising set which starts advertising. The valid range is 0x00 - 0x03.
duration	The duration for which the advertising set identified by adv_hdl is enabled. Time = duration * 10ms. When the duration expires, BLE_GAP_EVENT_ADV_OFF event notifies that advertising is stopped. The valid range is 0x0000 - 0xFFFF. The duration parameter is ignored when the value is set to 0x0000.
max_extd_adv_evts	The maximum number of advertising events that be sent during advertising. When all the advertising events(max_extd_adv_evts) have been sent, BLE_GAP_EVENT_ADV_OFF event notifies that advertising is stopped. The max_extd_adv_evts parameter is ignored when the value is set to 0x00.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	adv_hdl is out of range.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function starts advertising. Create the advertising set specified with adv_hdl by R_BLE_GAP_SetAdvParam(), before calling this function. The result of this API call is notified in BLE_GAP_EVENT_ADV_ON event.

Reentrant

No

Example

None

Special Notes:

None

3.17. R_BLE_GAP_StopAdv()

Stop advertising.

Format

```
ble_status_t R_BLE_GAP_StopAdv      (
      uint8_t     adv_hdl
)
```

Parameters

adv_hdl The advertising handle pointing to the advertising set which stops advertising. The valid range is 0x00 - 0x03.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	adv_hdl is out of range.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function stops advertising. The result of this API call is notified in BLE_GAP_EVENT_ADV_OFF event.

Reentrant

No

Example

None

Special Notes:

None

3.18. R_BLE_GAP_GetRemainAdvBufSize()

Get buffer size for advertising data/scan response data/periodic advertising data in the Controller.

Format

```
ble_status_t R_BLE_GAP_GetRemainAdvBufSize      (
      uint16_t *  p_remain_adv_data_size,
      uint16_t *  p_remain_perd_adv_data_size
)
```

Parameters

p_remain_adv_data_size	The free buffer size of Controller to which advertising data/scan response data can be currently set.
p_remain_perd_adv_data_size	The free buffer size of Controller to which periodic advertising data can be currently set.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	p_remain_adv_data_size or p_remain_perd_adv_data_size is specified as NULL.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function gets the total size of advertising data/scan response data/periodic advertising data which can be currently set to Controller(all of the advertising sets). The application layer gets the data sizes via the parameters. By this API function call, no events occur.

Reentrant

No

Example

None

Special Notes:

None

3.19. R_BLE_GAP_GetRemDevInfo()

Get the information about remote device.

Format

```
ble_status_t R_BLE_GAP_GetRemDevInfo      (
      uint16_t    conn_hdl
)
```

Parameters

conn_hdl Connection handle identifying the remote device whose information to be retrieved.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function retrieves information about the remote device. The information includes BD_ADDR, the version number and LE features. The result of this API call is notified in BLE_GAP_EVENT_GET_REM_DEV_INFO event.

Reentrant

No

Example

None

Special Notes:

None

3.20. R_BLE_GAP_SetPairingParams()

Set the parameters using pairing.

Format

```
ble_status_t R_BLE_GAP_SetPairingParams(
      st_ble_gap_pairing_param_t * p_pair_param
)
```

Parameters

p_pair_param Pairing parameters.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	The following field in p_pair_param is out of range. • iocap • max_key_size • mitm • boding • key_notf • sec_conn_only

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function sets the parameters used in pairing.

Reentrant

No

Example

None

Special Notes:

None

3.21. R_BLE_GAP_StartPairing()

Start pairing.

Format

```
ble_status_t R_BLE_GAP_StartPairing(
      uint16_t conn_hdl
)
```

Parameters

conn_hdl Connection handle identifying the remote device which local device starts pairing with.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	While generating OOB data, this function was called.
BLE_ERR_CONTEXT_FULL(0x000B)	While pairing, this function was called.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function starts pairing with a remote device. The result of this API call is returned by a return value. The result of pairing is notified in BLE_GAP_EVENT_PAIRING_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.22. R_BLE_GAP_ReplyPairing()

Reply the pairing request from a remote device.

Format

```
ble_status_t R_BLE_GAP_ReplyPairing(
      uint16_t conn_hdl,
      uint8_t response
)
```

Parameters

conn_hdl Connection handle identifying the remote device which local device starts pairing with.

response Accept or reject the pairing request from the remote device.

macro	description
BLE_GAP_PAIRING_ACCEPT(0x00)	Accept the pairing request
BLE_GAP_PAIRING_REJECT(0x01)	Reject the pairing request

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	Response is out of range.
BLE_ERR_INVALID_STATE(0x0008)	While generating OOB data, this function was called.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.
BLE_ERR_NOT_YET_READY(0x0012)	When this function was called, host stack has not yet received BLE_GAP_EVENT_PAIRING_REQ event.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function replies to the pairing request from the remote device. The pairing request from the remote device is notified in BLE_GAP_EVENT_PAIRING_REQ event. The result of this API call is returned by a return value. The result of pairing is notified in BLE_GAP_EVENT_PAIRING_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.23. R_BLE_GAP_ReplyPasskeyEntry()

Reply the passkey entry request.

Format

```
ble_status_t R_BLE_GAP_ReplyPasskeyEntry(
      uint16_t conn_hdl,
      uint32_t passkey,
      uint8_t response
)
```

Parameters

conn_hdl Connection handle identifying the remote device which the reply to passkey entry is sent.

passkey Passkey. The valid range is 000000 - 999999 in decimal.

response Active or negative reply to passkey entry.

macro	description
BLE_GAP_PAIRING_ACCEPT(0x00)	Accept the passkey entry pairing
BLE_GAP_PAIRING_REJECT(0x01)	Reject the passkey entry pairing

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	Passkey or response is out of range.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.
BLE_ERR_NOT_YET_READY(0x0012)	When this function was called, pairing has not yet started.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When BLE_GAP_EVENT_PASSKEY_ENTRY_REQ event is notified, the response to passkey entry is sent by this function. The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.24. R_BLE_GAP_ReplyExKeyInfoReq()

Distribute the keys of local device.

Format

```
ble_status_t R_BLE_GAP_SetPairingParams(
      st_ble_gap_pairing_param_t * p_pair_param
)
```

Parameters

conn_hdl Connection handle identifying the remote device to which the key is distributed.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.
BLE_ERR_NOT_YET_READY(0x0012)	When this function was called, pairing has not yet started.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When key exchange request is notified by BLE_GAP_EVENT_EX_KEY_REQ event at pairing, keys of the local device are distributed. The result is returned from this API.

Reentrant

No

Example

None

Special Notes:

None

3.25. R_BLE_GAP_ReplyLtkReq()

Reply the LTK request from a remote device.

Format

```
ble_status_t R_BLE_GAP_ReplyLtkReq(
      uint16_t conn_hdl,
      uint16_t ediv,
      uint8_t *p_peer_rand,
      uint8_t response
)
```

Parameters

conn_hdl Connection handle identifying the remote device which sent the LTK request.

ediv Ediv notified in BLE_GAP_EVENT_LTK_REQ event.

p_peer_rand Rand notified in BLE_GAP_EVENT_LTK_REQ event.

response Response to the LTK request. If "BLE_GAP_LTK_REQ_ACCEPT" is specified, when no LTK has been exchanged in pairing, reject the LTK request.

macro	description
BLE_GAP_LTK_REQ_ACCEPT(0x00)	Reply for the LTK request
BLE_GAP_LTK_REQ_DENY(0x01)	Reject the LTK request

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	p_peer_rand is specified as NULL in case of legacy pairing.
BLE_ERR_INVALID_ARG(0x0003)	response is out of range.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function replies to the LTK request in BLE_GAP_EVENT_LTK_REQ event from a remote device. The result of the LTK reply is returned in BLE_GAP_EVENT_LTK_RSP_COMP event. When the link encryption has completed, BLE_GAP_EVENT_ENC_CHG event is notified.

Reentrant

No

Example

None

Special Notes:

None

3.26. R_BLE_GATT_GetMtu()

This function gets the current MTU used in GATT communication.

Format

```
ble_status_t R_BLE_GATT_GetMtu      (
      uint16_t    conn_hdl,
      uint16_t *  p_mtu
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server or the GATT Client.
p_mtu	The Current MTU. Before MTU exchange, this parameter is 23 bytes. After MTU exchange, this parameter is the negotiated MTU.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The mtu parameter is NULL.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server or the GATT Client specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

Both GATT server and GATT Client can use this function.

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.27. R_BLE_GATTS_SetDbInst()

This function sets GATT Database to host stack.

Format

```
ble_status_t R_BLE_GATTS_SetDbInst  (
      st_ble_gatts_db_cfg_t *       p_db_inst
)
```

Parameters

p_db_inst GATT Database to be set.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The reason for this error is as follows. • The db_inst parameter is specified as NULL. • The array in the db_inst is specified as NULL.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.28. R_BLE_GATTS_RegisterCb()

This function registers a callback for GATT Server event.

Format

```
ble_status_t R_BLE_GATTS_RegisterCb (
      ble_gatts_app_cb_t      cb,
      uint8_t                 priority
)
```

Parameters

cb	Callback function for GATT Server event.
priority	The priority of the callback function. Valid range is 1 <= priority <= BLE_GATTS_MAX_CB. A lower priority number means a higher priority level.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The cb parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The priority parameter is out of range.
BLE_ERR_CONTEXT_FULL(0x000B)	Host stack has already registered the maximum number of callbacks.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The number of the callback that may be registered by this function is the value specified by R_BLE_GATTS_Init().

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.29. R_BLE_GATTS_DeregisterCb()

This function deregisters the callback function for GATT Server event.

Format

```
ble_status_t R_BLE_GATTS_DeregisterCb     (
      ble_gatts_app_cb_t      cb
)
```

Parameters

cb Callback function for GATT Server event.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The cb parameter is specified as NULL.
BLE_ERR_NOT_FOUND(0x000D)	The callback has not been registered.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.30. R_BLE_GATTS_Notification()

This function sends a notification of an attribute's value.

Format

```
ble_status_t R_BLE_GATTS_Notification     (
      uint16_t                            conn_hdl,
      st_ble_gatt_hdl_value_pair_t *      p_ntf_data
)
```

Parameters

conn_hdl	Connection handle identifying the remote device to be sent the notification.
p_ntf_data	The attribute value to send.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_ntf_data parameter or the value field in the value field in the p_ntf_data parameter is NULL.
BLE_ERR_INVALID_ARG(0x0003)	The value_len field in the value field in the p_ntf_data parameter is 0 or the attr_hdl field in the p_ntf_data parameters is 0.
BLE_ERR_INVALID_OPERATION(0x0009)	This function was called while processing other request.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The maximum length of the attribute value that can be sent with notification is MTU-3.

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.31. R_BLE_GATTS_Indication()

This function sends an indication of an attribute's value.

Format

```
ble_status_t R_BLE_GATTS_Indication (
      uint16_t                          conn_hdl,
      st_ble_gatt_hdl_value_pair_t *    p_ind_data
)
```

Parameters

conn_hdl	Connection handle identifying the remote device to be sent the indication.
p_ind_data	The attribute value to send.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_ind_data parameter or the value field in the value field in the p_ind_data parameter is NULL.
BLE_ERR_INVALID_ARG(0x0003)	The value_len field in the value field in the p_ind_data parameter is 0 or the attr_hdl field in the p_ind_data parameters is 0.
BLE_ERR_INVALID_OPERATION(0x0009)	This function was called while processing other request.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The maximum length of the attribute value that can be sent with indication is MTU-3.

The result of this API call is returned by a return value.

The remote device that receives a indication sends a confirmation.

BLE_GATTS_EVENT_HDL_VAL_CNF event notifies the application layer that the confirmation has been received.

Reentrant

No

Example

None

3.32. R_BLE_GATTS_GetAttr()

This function gets an attribute value from the GATT Database.

Format

```
ble_status_t R_BLE_GATTS_GetAttr    (
      uint16_t                conn_hdl,
      uint16_t                attr_hdl,
      st_ble_gatt_value_t *   p_value
)
```

Parameters

conn_hdl If the attribute value that has information about the remote device is retrieved, specify the remote device with the conn_hdl parameter. When information about the remote device is not required, set the conn_hdl parameter to BLE_GAP_INVALID_CONN_HDL.

attr_hdl The attribute handle of the attribute value to be retrieved.

p_value The attribute value to be retrieved.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_value parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The attr_hdl parameter is 0 or larger than the last attribute handle of GATT Database.
BLE_ERR_INVALID_STATE(0x0008)	The attribute is not in a state to be read.
BLE_ERR_INVALID_OPERATION(0x0009)	The attribute cannot be read.
BLE_ERR_NOT_FOUND(0x000D)	The attribute specified by the attr_hdl parameter is not belonging to any services or characteristics.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by the conn_hdl parameter was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.33. R_BLE_GATTS_SetAttr()

This function sets an attribute value to the GATT Database event.

Format

```
ble_status_t R_BLE_GATTS_SetAttr    (
      uint16_t                conn_hdl,
      uint16_t                attr_hdl,
      st_ble_gatt_value_t *   p_value
)
```

Parameters

conn_hdl	If the attribute value that has information about the remote device is retrieved, specify the remote device with the conn_hdl parameter. When information about the remote device is not required, set the conn_hdl parameter to BLE_GAP_INVALID_CONN_HDL.
attr_hdl	The attribute handle of the attribute value to be set.
p_value	The attribute value to be set.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_value parameter is specified as NULL.
BLE_ERR_INVALID_DATA(0x0002)	The write size is larger than the length of the attribute value.
BLE_ERR_INVALID_ARG(0x0003)	The attr_hdl parameter is 0 or larger than the last attribute handle of GATT Database.
BLE_ERR_INVALID_STATE(0x0008)	The attribute is not in a state to be written.
BLE_ERR_INVALID_OPERATION(0x0009)	The attribute cannot be written.
BLE_ERR_NOT_FOUND(0x000D)	The attribute specified by the attr_hdl parameter is not belonging to any services or characteristics.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by the conn_hdl parameter was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.34. R_BLE_GATTC_RegisterCb()

This function registers a callback function for GATT Client event.

Format

```
ble_status_t R_BLE_GATTC_RegisterCb (
      ble_gattc_app_cb_t      cb,
      uint8_t                 priority
)
```

Parameters

cb	Callback function for GATT Client event.
priority	The priority of the callback function. Valid range is 1 <= priority <= BLE_GATTC_MAX_CB. A lower priority number means a higher priority level.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The cb parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The priority parameter is out of range.
BLE_ERR_CONTEXT_FULL(0x000B)	Host stack has already registered the maximum number of callbacks.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.35. R_BLE_GATTC_DeregisterCb()

This function deregisters the callback function for GATT Client event.

Format

```
ble_status_t R_BLE_GATTC_DeregisterCb     (
      ble_gattc_app_cb_t      cb
)
```

Parameters

cb	The callback function to be deregistered.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The cb parameter is specified as NULL.
BLE_ERR_NOT_FOUND(0x000D)	The callback has not been registered.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.36. R_BLE_GATTC_ReqExMtu()

This function sends a MTU Exchange Request PDU to a GATT Server in order to change the current MTU.

Format

```
ble_status_t R_BLE_GATTC_ReqExMtu   (
      uint16_t    conn_hdl,
      uint16_t    mtu
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be sent.
mtu	The maximum size(in bytes) of the GATT PDU that GATT Client can receive. Valid range is 23 <= mtu <= 247.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	The mtu parameter is out of range.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

MTU Exchange Response is notified by BLE_GATTC_EVENT_EX_MTU_RSP event.

The new MTU is the minimum value of the mtu parameter specified by this function and the mtu field in BLE_GATTC_EVENT_EX_MTU_RSP event. Default MTU size is 23 bytes.

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.37. R_BLE_GATTC_DiscAllPrimServ()

This function discovers all Primary Services in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_DiscAllPrimServ  (
      uint16_t    conn_hdl
)
```

Parameters

conn_hdl Connection handle identifying the GATT Server to be discovered.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_OPERATION(0x0009)	This function was called while processing other requests.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When 16-bit UUID Primary Service has been discovered,
BLE_GATTC_EVENT_PRIM_SERV_16_DISC_IND event is notified to the application layer.

When 128-bit UUID Primary Service has been discovered,
BLE_GATTC_EVENT_PRIM_SERV_128_DISC_IND event is notified to the application layer.

When the Primary Service discovery has been completed,
BLE_GATTC_EVENT_ALL_PRIM_SERV_DISC_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.38. R_BLE_GATTC_DiscPrimServ()

This function discovers Primary Service specified by p_uuid in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_DiscPrimServ     (
      uint16_t    conn_hdl,
      uint8_t *   p_uuid,
      uint8_t     uuid_type
)
```

Parameters

conn_hdl Connection handle identifying the GATT Server to be discovered.

p_uuid UUID of Primary Service to be discovered.

uuid_type UUID type(16-bit or 128-bit).

macro	description
BLE_GATT_16_BIT_UUID_FORMAT(0x01)	16-bit UUID
BLE_GATT_128_BIT_UUID_FORMAT(0x02)	128-bit UUID

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_uuid parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The uuid_type parameter is out of range.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When Primary Service whose uuid is the same as the specified uuid has been discovered,
BLE_GATTC_EVENT_PRIM_SERV_16_DISC_IND event or
BLE_GATTC_EVENT_PRIM_SERV_128_DISC_IND event is notified to the application layer.

When the Primary Service discovery has been completed,
BLE_GATTC_EVENT_PRIM_SERV_DISC_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.39. R_BLE_GATTC_DiscIncServ()

This function discovers Included Services within the specified attribute handle range in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_DiscIncServ      (
      uint16_t    conn_hdl,
      st_ble_gatt_hdl_range_t *     p_range
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be discovered.
p_range	Retrieval range of Included Service.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_range parameter is specified as NULL.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When Included Service that includes 16-bit UUID Service has been discovered, BLE_GATTC_EVENT_INC_SERV_16_DISC_IND event is notified to the application layer.

When Included Service that includes 128-bit UUID Service has been discovered, BLE_GATTC_EVENT_INC_SERV_128_DISC_IND event is notified to the application layer.

When the Included Service discovery has been completed, BLE_GATTC_EVENT_INC_SERV_DISC_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.40. R_BLE_GATTC_DiscAllChar()

This function discovers Characteristic within the specified attribute handle range in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_DiscAllChar      (
      uint16_t                      conn_hdl,
      st_ble_gatt_hdl_range_t *     p_range
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be discovered.
p_range	Retrieval range of Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_range parameter is specified as NULL.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When 16-bit UUID Characteristic has been discovered, BLE_GATTC_EVENT_CHAR_16_DISC_IND event is notified to the application layer.

When 128-bit UUID Characteristic has been discovered, BLE_GATTC_EVENT_CHAR_128_DISC_IND event is notified to the application layer.

When the Characteristic discovery has been completed, BLE_GATTC_EVENT_ALL_CHAR_DISC_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.41. R_BLE_GATTC_DiscCharByUuid()

This function discovers Characteristic specified by uuid within the specified attribute handle range in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_DiscCharByUuid   (
        uint16_t                          conn_hdl,
        uint8_t *                         p_uuid,
        uint8_t                           uuid_type,
        st_ble_gatt_hdl_range_t *         p_range
)
```

Parameters

conn_hdl Connection handle identifying the GATT Server to be discovered.

p_uuid UUID of Characteristic to be discovered.

uuid_type UUID type of Characteristic to be discovered.

macro	description
BLE_GATT_16_BIT_UUID_FORMAT(0x01)	The p_uuid parameter is 16-bit UUID.
BLE_GATT_128_BIT_UUID_FORMAT(0x02)	The p_uuid parameter is 128-bit UUID.

p_range Retrieval range of Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_uuid parameter or the p_range parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The uuid_type parameter is out of range.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When 16-bit UUID Characteristic has been discovered, BLE_GATTC_EVENT_CHAR_16_DISC_IND event is notified to the application layer.

When 128-bit UUID Characteristic has been discovered, BLE_GATTC_EVENT_CHAR_128_DISC_IND event is notified to the application layer.

When the Characteristic discovery has been completed, BLE_GATTC_EVENT_CHAR_DISC_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.42. R_BLE_GATTC_DiscAllCharDesc()

This function discovers Characteristic Descriptor within the specified attribute handle range in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_DiscAllChar      (
      uint16_t                      conn_hdl,
      st_ble_gatt_hdl_range_t *     p_range
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be discovered.
p_range	Retrieval range of Characteristic Descriptor.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_range parameter is specified as NULL.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When 16-bit UUID Characteristic Descriptor has been discovered,
BLE_GATTC_EVENT_CHAR_DESC_16_DISC_IND event is notified to the application layer.

When 128-bit UUID Characteristic Descriptor has been discovered,
BLE_GATTC_EVENT_CHAR_DESC_128_DISC_IND event is notified to the application layer.

When the Characteristic Descriptor discovery has been completed,
BLE_GATTC_EVENT_ALL_CHAR_DESC_DISC_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.43. R_BLE_GATTC_ReadChar()

This function reads a Characteristic/Characteristic Descriptor in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_ReadChar   (
      uint16_t    conn_hdl,
      uint16_t    value_hdl
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be read.
value_hdl	Value handle of the Characteristic/Characteristic Descriptor to be read.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	0 is specified in the value_hdl parameter.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of the read is notified in BLE_GATTC_EVENT_CHAR_READ_RSP event.

Reentrant

No

Example

None

Special Notes:

None

3.44. R_BLE_GATTC_ReadCharUsingUuid()

This function reads a Characteristic in a GATT Server using a specified UUID.

Format

```
ble_status_t R_BLE_GATTC_ReadCharUsingUuid      (
      uint16_t                      conn_hdl,
      uint8_t *                     p_uuid,
      uint8_t                       uuid_type,
      st_ble_gatt_hdl_range_t *     p_range
)
```

Parameters

conn_hdl Connection handle that identifies Characteristic to be read to GATT Server.

p_uuid UUID of the Characteristic to be read.

uuid_type UUID type of the Characteristic to be read.

macro	description
BLE_GATT_16_BIT_UUID_FORMAT(0x01)	The p_uuid parameter is 16-bit UUID.
BLE_GATT_128_BIT_UUID_FORMAT(0x02)	The p_uuid parameter is 128-bit UUID.

p_range Retrieval range of Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_uuid parameter or the p_range parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The uuid_type parameter is out of range.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of the read is notified in BLE_GATTC_EVENT_CHAR_READ_BY_UUID_RSP event.

Reentrant

No

Example

None

Special Notes:

None

3.45. R_BLE_GATTC_ReadLongChar()

This function reads a Long Characteristic in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_ReadLongChar     (
      uint16_t    conn_hdl,
      uint16_t    value_hdl,
      uint16_t    offset
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be read.
value_hdl	Value handle of the Long Characteristic to be read.
offset	Offset that indicates the location to be read. Normally, set 0 to this parameter.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	0 is specified in the value_hdl parameter.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The contents of the Long Characteristic that has been read is notified every MTU-1 bytes to the application layer by BLE_GATTC_EVENT_CHAR_READ_RSP event.

When all of the contents has been received in GATT Client,
BLE_GATTC_EVENT_LONG_CHAR_READ_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.46. R_BLE_GATTC_ReadMultiChar()

This function reads multiple Characteristics in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_ReadMultiChar    (
      uint16_t                                conn_hdl,
      st_ble_gattc_rd_multi_req_param_t *     p_list
)
```

Parameters

conn_hdl Connection handle that identifies Characteristic to be read to GATT Server.

p_list List of Value Handles that point the Characteristics to be read.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_list parameter or the p_hdl_list field in the p_list parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	0 is specified in the value_hdl parameter.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The contents of the multiple Characteristics that has been read is notified to the application layer by BLE_GATTC_EVENT_MULTI_CHAR_READ_RSP event.

Reentrant

No

Example

None

Special Notes:

None

3.47. R_BLE_GATTC_WriteCharWithoutRsp()

This function writes a Characteristic in a GATT Server without response.

Format

```
ble_status_t R_BLE_GATTC_WriteCharWithoutRsp    (
      uint16_t                          conn_hdl,
      st_ble_gatt_hdl_value_pair_t *    p_write_data
)
```

Parameters

conn_hdl	Connection handle that identifies Characteristic to be read to GATT Server.
p_write_data	Value to be written to the Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_write_data parameter or the p_value field in the value field in the p_write_data parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The reason for this error is as follows: • 0 is specified in the value_len field in the p_value field in the p_write_data parameter. • 0 is specified in the attr_hdl field in the p_write_data parameter.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result is returned from the API.

Reentrant

No

Example

None

Special Notes:

None

3.48. R_BLE_GATTC_SignedWriteChar()

This function writes Signed Data to a Characteristic in a GATT Server without response.

Format

```
ble_status_t R_BLE_GATTC_SignedWriteChar  (
      uint16_t                            conn_hdl,
      st_ble_gatt_hdl_value_pair_t *      p_write_data
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be written.
p_write_data	Signed Data to be written to the Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_write_data parameter or the p_value field in the value field in the p_write_data parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The reason for this error is as follows: • 0 is specified in the value_len field in the value field in the p_write_data parameter. • 0 is specified in the attr_hdl field in the p_write_data parameter.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.49. R_BLE_GATTC_WriteChar()

This function writes a Characteristic in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_WriteChar  (
      uint16_t                              conn_hdl,
      st_ble_gatt_hdl_value_pair_t *        p_write_data
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be written.
p_write_data	Signed Data to be written to the Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_write_data parameter or the p_value field in the value field in the p_write_data parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The reason for this error is as follows: • 0 is specified in the value_len field in the value field in the p_write_data parameter. • 0 is specified in the attr_hdl field in the p_write_data parameter.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of the write is notified in BLE_GATTC_EVENT_CHAR_WRITE_RSP event.

Reentrant

No

Example

None

Special Notes:

None

3.50. R_BLE_GATTC_WriteLongChar()

This function writes a Long Characteristic in a GATT Server.

Format

```
ble_status_t R_BLE_GATTC_WriteLongChar    (
      uint16_t                            conn_hdl,
      st_ble_gatt_hdl_value_pair_t *      p_write_data,
      uint16_t                            offset
)
```

Parameters

conn_hdl	Connection handle identifying the GATT Server to be written.
p_write_data	Value to be written to the Long Characteristic.
offset	Offset that indicates the location to be written. Normally, set 0 to this parameter. If this parameter sets to a value other than 0, adjust the offset parameter and the length of the value to be written not to exceed the length of the Long Characteristic.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_write_data parameter or the p_value field in the value field in the p_write_data parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The reason for this error is as follows: • The value_len field in the value field in the p_write_data parameter is 0. • The sum of the value_len field in the value field in the p_write_data parameter and the offset parameter larger than 512. • The attr_hdl field in the p_write_data parameter is 0.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of a write that has been done every segmentation is notified to the application layer in BLE_GATTC_EVENT_CHAR_PART_WRITE_RSP event.

The maximum writable size to a Long Characteristic with this function is 512 bytes.

When all of the contents has been written to the Long Characteristic, BLE_GATTC_EVENT_LONG_CHAR_WRITE_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.51. R_BLE_GATTC_ReliableWrites()

This function performs the Reliable Writes procedure described in GATT Specification.

Format

```
ble_status_t R_BLE_GATTC_ReliableWrites   (
      uint16_t                                          conn_hdl,
      st_ble_gattc_reliable_writes_char_pair_t *        p_char_pair,
      uint8_t                                           pair_num,
      uint8_t                                           auto_flag
)
```

Parameters

conn_hdl Connection handle identifying the GATT Server to be written.

p_char_pair Pair of Characteristic Value and Characteristic Value Handle identifying the Characteristic to be written by Reliable Writes.

pair_num The number of the pairs specified by the p_char_pair parameter.

Valid range is 0 < pair_num <= BLE_GATTC_RELIABLE_WRITES_MAX_CHAR_PAIR.

auto_flag The flag that indicates whether auto execution or not.

macro	description
BLE_GATTC_EXEC_AUTO(0x01)	Auto execution.
BLE_GATTC_EXEC_NOT_AUTO (0x02)	Not auto execution.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The reason for this error is as follows: • The p_char_pair parameter is specified as NULL. • The p_value field in the value field in the write_data field in the p_char_pair parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The reason for this error is as follows: • The pair_num parameter or the auto_flag parameter is out of range. • The value_len field in the value field in the write_data field in the p_char_pair parameter is 0.
BLE_ERR_INVALID_OPERATION(0x0009)	While processing other request, this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function or to store the temporary write data.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When the data written to the Characteristic has been transmitted, BLE_GATTC_EVENT_CHAR_PART_WRITE_RSP event is notified to the application layer.

If the data included in the event is different from the data that GATT Client has sent, host stack automatically cancels the Reliable Writes.

After all of the contents has been sent to the GATT Server, if the auto_flag parameter has been set to BLE_GATTC_EXEC_AUTO, the GATT Server automatically writes the data to the Characteristic.

If the auto_flag parameter has been set to BLE_GATTC_EXEC_NOT_AUTO, BLE_GATTC_EVENT_RELIABLE_WRITES_TX_COMP event notifies the application layer in GATT Client that all of the contents has been sent to the GATT Server. Then GATT Client requests for writing the data to the Characteristic to the GATT Server with R_BLE_GATTC_ExecWrite().

When the write has been done, BLE_GATTC_EVENT_RELIABLE_WRITES_COMP event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.52. R_BLE_GATTC_ExecWrite()

This function is used to execute a write to Characteristic.

Format

```
ble_status_t R_BLE_GATTC_ExecWrite  (
      uint16_t    conn_hdl,
      uint8_t     exe_flag
)
```

Parameters

conn_hdl Connection handle identifying the target GATT Server.

exe_flag The flag that indicates whether execution or cancellation.

macro	description
BLE_GATTC_EXECUTE_WRITE_CANCEL_FLAG(0x00)	Execute the write.
BLE_GATTC_EXECUTE_WRITE_EXEC_FLAG(0x01)	Cancel the write.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	The exe_flag parameter is out of range.
BLE_ERR_INVALID_OPERATION(0x0009)	The reason for this error is as follows: • GATT Client has not requested for Reliable Writes by R_BLE_GATTC_ReliableWrites(). • Although auto execution has been specified by R_BLE_GATTC_ReliableWrites(), this function was called.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The GATT Server specified by conn_hdl was not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When all of the contents has been sent to the GATT Server, BLE_GATTC_EVENT_RELIABLE_WRITES_TX_COMP event notifies the application layer.

After this event has been received, execute the write by this function.

The result of the write is notified by BLE_GATTC_EVENT_RELIABLE_WRITES_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.53. R_BLE_L2CAP_RegisterCfPsm()

This function registers PSM that uses L2CAP CBFC Channel and a callback for L2CAP event.

Format

```
ble_status_t R_BLE_L2CAP_RegisterCfPsm    (
      ble_l2cap_cf_app_cb_t   cb,
      uint16_t                psm,
      uint16_t                lwm
)
```

Parameters

cb Callback function for L2CAP event.

psm Identifier indicating the protocol/profile that uses L2CAP CBFC Channel.

type	range	description
Fixed, SIG assigned	0x0001 - 0x007F	PSM defined by SIG. For more information on PSM, refer Bluetooth SIG Assigned Number. (https://www.bluetooth.com/specifications/assigned-numbers).
Dynamic	0x0080 - 0x00FF	Statically allocated PSM by custom protocol or dynamically allocated PSM by GATT Service.

lwm Low Water Mark that indicates the LE-Frame numbers that the local device can receive.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The cb parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The psm parameter is out of range.
BLE_ERR_CONTEXT_FULL(0x000B)	More than BLE_L2CAP_MAX_CBFC_PSM+1 PSMs, callbacks has been registered.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

Only one callback is available per PSM. Configure in each PSM the Low Water Mark of the LE-Frames that the local device can receive.

When the number of the credit reaches the Low Water Mark, BLE_L2CAP_EVENT_CF_LOW_RX_CRD_IND event is notified to the application layer.

The number of PSM is defined as BLE_L2CAP_MAX_CBFC_PSM.

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.54. R_BLE_L2CAP_DeregisterCfPsm()

This function stops the use of the L2CAP CBFC Channel specified by the psm parameter and deregisters the callback function for L2CAP event.

Format

```
ble_status_t R_BLE_L2CAP_DeregisterCfPsm  (
      uint16_t    psm
)
```

Parameters

psm PSM that is to be stopped to use the L2CAP CBFC Channel.
Set the PSM registered by R_BLE_VS_Init().

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_NOT_FOUND(0x000D)	The callback function allocated by the psm parameter is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.55. R_BLE_L2CAP_ReqCfConn()

This function sends a connection request for L2CAP CBFC Channel.

Format

```
ble_status_t R_BLE_L2CAP_ReqCfConn  (
      uint16_t                          conn_hdl,
      st_ble_l2cap_conn_req_param_t *   p_conn_req_param
)
```

Parameters

conn_hdl	Connection handle identifying the remote device that the connection request is sent to.
p_conn_req_param	Connection request parameters.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_conn_req_param parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The mtu parameter or the mps parameter is out of range.
BLE_ERR_INVALID_STATE(0x0008)	CF Channel connection has not been established.
BLE_ERR_CONTEXT_FULL(0x000B)	New CF Channel can not be registered or other L2CAP Command is processing.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	Insufficient memory is needed to generate this function.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by conn_hdl is not found.
BLE_ERR_NOT_YET_READY(0x0012)	The psm parameter is not registered.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The connection response is notified by BLE_L2CAP_EVENT_CF_CONN_CNF event.

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.56. R_BLE_L2CAP_DisconnetCf()

This function sends a disconnection request for L2CAP CBFC Channel.

Format

```
ble_status_t R_BLE_L2CAP_DisconnectCf     (
      uint16_t    lcid
)
```

Parameters

lcid	CID identifying the L2CAP CBFC Channel that has been disconnected. The valid range is 0x40 - (0x40 + BLE_L2CAP_MAX_CBFC_PSM - 1).

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_OPERATION(0x0009)	CF Channel connection has not been established.
BLE_ERR_CONTEXT_FULL(0x000B)	This function was called while processing other L2CAP command.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for L2CAP Command.
BLE_ERR_NOT_FOUND(0x000D)	CID specified the lcid parameter is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When L2CAP CBFC Channel has been disconnected, BLE_L2CAP_EVENT_CF_DISCONN_CNF event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.57. R_BLE_L2CAP_SendCfCredit()

This function sends credit to a remote device.

Format

```
ble_status_t R_BLE_L2CAP_SendCfCredit     (
      uint16_t    lcid,
      uint16_t    credit
)
```

Parameters

lcid	CID identifying the L2CAP CBFC Channel on local device that sends credit.
credit	Credit to be sent to the remote device.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_ARG(0x0003)	The credit parameter is set to 0.
BLE_ERR_CONTEXT_FULL(0x000B)	This function was called while processing other L2CAP command.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for L2CAP Command.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

In L2CAP CBFC communication, if credit is 0, the remote device stops data transmission.

Therefore when processing the received data has been completed and local device affords to receive data, the remote device is notified of the number of LE-Frame that local device can receive by this function and local device can continue to receive data from the remote device.

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.58. R_BLE_L2CAP_SendCfData()

This function sends the data to a remote device via L2CAP CBFC Channel.

Format

```
ble_status_t R_BLE_L2CAP_SendCfData (
      uint16_t    conn_hdl,
      uint16_t    lcid,
      uint16_t    data_len,
      uint8_t *   p_sdu
)
```

Parameters

conn_hdl	Connection handle identifying the remote device to be sent the data.
lcid	CID identifying the L2CAP CBFC Channel on local device used in the data transmission.
data_len	Length of the data.
p_sdu	Service Data Unit. Input the data length specified by the data_len parameter to the first 2 bytes (Little Endian).

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_data parameter is specified as NULL.
BLE_ERR_INVALID_ARG(0x0003)	The length parameter is out of range.
BLE_ERR_INVALID_STATE(0x0008)	CF Channel connection has not been established or the data whose length exceeds the MTU has been sent.
BLE_ERR_ALREADY_IN_PROGRESS(0x000A)	Data transmission has been already started.
BLE_ERR_CONTEXT_FULL(0x000B)	L2CAP task queue is full.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for L2CAP Command.
BLE_ERR_NOT_FOUND(0x000D)	CID specified the lcid parameter is not found.
BLE_ERR_INVALID_HDL(0x000E)	The remote device specified by the conn_hdl parameter is not found.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

When the data transmission to Controller has been completed, BLE_L2CAP_EVENT_CF_TX_DATA_CNF event is notified to the application layer.

Reentrant

No

Example

None

Special Notes:

None

3.59. R_BLE_VS_Init()

This function initializes Vendor Specific API and registers a callback function for Vendor Specific Event.

Format

```
ble_status_t R_BLE_VS_Init    (
      ble_vs_app_cb_t   vs_cb
)
```

Parameters

vs_cb Callback function to be registered.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The vs_cb parameter is specified as NULL.
BLE_ERR_CONTEXT_FULL(0x000B)	Callback function has already been registered.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is returned by a return value.

Reentrant

No

Example

None

Special Notes:

None

3.60. R_BLE_VS_SetTxPower()

This function configures transmit power.

Format

```
ble_status_t R_BLE_VS_SetTxPower    (
      uint16_t conn_hdl,
      uint8_t tx_power
)
```

Parameters

conn_hdl Connection handle identifying the link whose transmit power to be configured.

tx_power Transmission power. Select one of the following.

macro	description
BLE_VS_TX_POWER_HIGH	High power level with address 0x00
BLE_VS_TX_POWER_MID	Middle power level with address 0x01
BLE_VS_TX_POWER_LOW	Low power level with address 0x02

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for Vendor Specific Command.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function configures the following transmit power.

- The transmit power used in sending advertising PDU, scan request PDU, connection request PDU (in not connected state)
- The transmit power used in sending PDU in connected state. When configuring the transmit power used in not connected state, set the conn_hdl parameter to BLE_GAP_INIT_CONN_HDL(0xFFFF).

  When the transmit power used in connected state is configured, set the conn_hdl parameter to the connection handle of the link.

Select one of the following transmit power levels.

- High
- Middle
- Low

Max transmit power of "High" is dependent on the configuration of the firmware.

The result of this API call is notified in BLE_VS_EVENT_SET_TX_POWER event.

Reentrant

No

Example

None

Special Notes:

None

3.61. R_BLE_VS_GetTxPower()

This function gets transmit power.

Format

```
ble_status_t R_BLE_VS_GetTxPower    (
      uint16_t conn_hdl
)
```

Parameters

conn_hdl Connection handle identifying the link whose transmit power to be retrieved.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for Vendor Specific Command.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

This function gets the following transmit power.

- The transmit power used in sending advertising PDU, scan request PDU, connection request PDU (in not connected state)
- The transmit power used in sending PDU in connected state. When getting the transmit power used in not connected state, set the conn_hdl parameter to BLE_GAP_INIT_CONN_HDL(0xFFFF).

  When the transmit power used in connected state is retrieved, set the conn_hdl parameter to the connection handle of the link.

The result of this API call is notified in BLE_VS_EVENT_GET_TX_POWER event.

Reentrant

No

Example

None

Special Notes:

None

3.62. R_BLE_VS_GetBdAddr()

This function gets currently configured public/random address.

Format

```
ble_status_t R_BLE_VS_GetBdAddr     (
      uint8_t     area,
      uint8_t     addr_type
)
```

Parameters

area The area that the address is to be retrieved.

Select one of the following.

macro	description
BLE_VS_ADDR_AREA_REG(0x00)	Retrieve the address in register.
BLE_VS_ADDR_AREA_DATA_FLASH(0x01)	Retrieve the address in DataFlash area.

addr_type The address type that is type of the address to be retrieved.

macro	description
BLE_GAP_ADDR_PUBLIC(0x00)	Public address.
BLE_GAP_ADDR_RAND(0x01)	Random address.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for Vendor Specific Command.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The area parameter specifies the place where this function retrieves public/random address.

The result of this API call is notified in BLE_VS_EVENT_GET_ADDR_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.63. R_BLE_VS_SetBdAddr()

This function sets public/random address of local device to the area specified by the parameter.

Format

```
ble_status_t R_BLE_VS_SetBdAddr     (
      uint8_t                 area,
      st_ble_dev_addr_t *     p_addr
)
```

Parameters

area The area that the address is to be written in.

Select one of the following.

macro	description
BLE_VS_ADDR_AREA_REG(0x00)	Address writing to non-volatile area is not performed. Only the address in register is written.
BLE_VS_ADDR_AREA_DATA_FLASH(0x01)	Address wiring to DataFlash area is performed.

p_addr The address to be set to the area. Set BLE_GAP_ADDR_PUBLIC(0x00) or BLE_GAP_ADDR_RAND(0x01) to the type field in the p_addr parameter.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_PTR(0x0001)	The p_addr parameter is specified as NULL.
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for Vendor Specific Command.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

If the address is written in non-volatile area, the address is used as default address on the next MCU reset.

For more information on the random address, refer to Core Specification Vol 6, PartB, "1.3.2 Random Device Address".

The result of this API call is notified in BLE_VS_EVENT_SET_ADDR_COMP event.

Reentrant

No

Example

None

Special Notes:

None

3.64. R_BLE_VS_GetRand()

This function generates 4-16 bytes of random number used in creating keys.

Format

```
ble_status_t R_BLE_VS_GetRand (
      uint8_t     rand_size
)
```

Parameters

rand_size Length of the random number (byte).
The valid range is 4<=rand_size<=16.

Return values

BLE_SUCCESS(0x0000)	Success
BLE_ERR_INVALID_STATE(0x0008)	The task for host stack is not running.
BLE_ERR_MEM_ALLOC_FAILED(0x000C)	There are no memories for Vendor Specific Command.

Properties

Prototype declarations are contained in r_ble_api.h.

Description

The result of this API call is notified in BLE_VS_EVENT_GET_RAND event.

Reentrant

No

Example

None

Special Notes:

None

4. Abstraction API for Renesas QE for BLE

4.1 RM_BLE_ABS_Open()

Host stack is initialized with this function.

Format

```
fsp_err_t RM_BLE_ABS_Open     (
      ble_abs_ctrl_t * const p_ctrl,
      ble_abs_cfg_t * p_cfg
)
```

Parameters

p_ctrl	Pointer to control structure.
p_cfg	Pointer to the configuration structure for this instance.

Return values

FSP_SUCCESS	Channel opened successfully.
FSP_ERR_ASSERTION	Null pointer presented.
FSP_ERR_ALREADY_OPEN	Requested channel is already open in a different configuration.
FSP_ERR_INVALID_ARGUMENT	Invalid input parameter.
FSP_ERR_INVALID_MODE	Invalid mode during open call.

Properties

Prototype declarations are contained in rm_ble_abs.h.

Description

Before using All the R_BLE APIs, it's necessary to call this function. A callback functions are registered with this function. In order to receive the GAP, GATT, Vendor specific event, it's necessary to register a callback function. The result of this API call is notified in BLE_GAP_EVENT_STACK_ON event. Implements ble_abs_api_t::open.

Reentrant

No

Example

```
/* Open the module. */
err = RM_BLE_ABS_Open(&g_ble_abs0_ctrl, &g_ble_abs0_cfg);
```

Special Notes:

None

4.2 RM_BLE_ABS_Close()

Close the BLE channel.

Format

```
fsp_err_t RM_BLE_ABS_Close    (
      ble_abs_ctrl_t * const p_ctrl
)
```

Parameters

p_ctrl Pointer to control structure.

Return values

FSP_SUCCESS	Channel closed successfully.
FSP_ERR_ASSERTION	Null pointer presented.
FSP_ERR_NOT_OPEN	Control block not open.

Properties

Prototype declarations are contained in rm_ble_abs.h.

Description

Implements ble_abs_api_t::close.

Reentrant

No

Example

```
/* Close BLE driver */
err = RM_BLE_ABS_Close(&g_ble_abs0_ctrl);
```

Special Notes:

None

4.3 RM_BLE_ABS_StartLegacyAdvertising()

Start Legacy Advertising after setting advertising parameters, advertising data and scan response data.

Format

```
fsp_err_t RM_BLE_ABS_StartLegacyAdvertising     (
ble_abs_ctrl_t * const                                  p_ctrl,
ble_abs_legacy_advertising_parameter_t const * const  p_advertising_parameter
)
```

Parameters

p_ctrl	Pointer to control structure.
p_advertising_parameter	Pointer to Advertising parameters for Legacy Advertising.

Return values

FSP_SUCCESS	Operation succeeded.
FSP_ERR_ASSERTION	p_instance_ctrl is specified as NULL.
FSP_ERR_NOT_OPEN	Control block not open.
FSP_ERR_INVALID_STATE	Host stack hasn't been initialized.
FSP_ERR_INVALID_POINTER	p_advertising_parameter is specified as NULL.
FSP_ERR_INVALID_ARGUMENT	The advertising parameter is out of range.

Properties

Prototype declarations are contained in rm_ble_abs.h.

Description

Legacy advertising uses the advertising set whose advertising handle is 0. The advertising type is connectable and scannable (ADV_IND). The address type of local device is Public Identity Address or RPA (If the resolving list contains no matching entry, use the public address.). Scan request event (BLE_GAP_EVENT_SCAN_REQ_RECV) is not notified. Implements ble_abs_api_t::startLegacyAdvertising.

Reentrant

No

Example

```
  /* Start advertising. */
  err = RM_BLE_ABS_StartLegacyAdvertising(&g_ble_abs0_ctrl,
&legacy_advertising_parameter);
```

Special Notes:

None

5. Demo Project

5.1 BLE DA1453x Demo Projects

5.1.1 Prerequisites

- Hardware requirements:
  - CK-RX65N: Renesas CK-RX65N Cloud Kit v1 (Product no.: RTK5CK65N0S04000BE).
  - PC running Windows® 10.
  - Micro-USB cables for Power supply and for on-board debugging (included as part of the kit. See CK-RX65N v1 – User's Manual at “Related Documents” on page 1).
  - US159-DA14531EVZ BLE Pmod

- Software requirements for Windows 10 PC:
  - IDE: e2 studio 2024-04 (24.4.0) or later.
  - Compiler: Renesas Electronics C/C++ Compiler for RX Family V3.06.00.
  - QE for BLE Tool version 1.7.0 or later.

Figure 5.1 iOS Renesas GATT Browser

Figure 5.2 Android Renesas GATT Browser

5.1.2 Import the Demo Project

Users can import the demo project by adding the demo to their e2 studio workspace (see section 5.3 Adding a Demo to a Workspace) or by downloading the demo project (see section 5.4 Downloading Demo Projects).

- Import “ck_rx65n_da14531_ble_baremetal” for Bare metal application.
- Import “ck_rx65n_da14531_ble_freertos” for FreeRTOS application.
- Import “ck_rx65n_da14531_ble_azurertos” for AzureRTOS application.

5.1.3 Hardware Setup

- Connect the DA14531 Pmod module to the CK-RX65N PMOD1 connector.
- Connect the micro-USB cable from PC to CK-RX65N micro-USB connector (J14) for Power supply.
- Connect the micro-USB cable from PC to CK-RX65N micro-USB connector (J20) for logging output.
- Set the jumper of J16 to “Debug”.

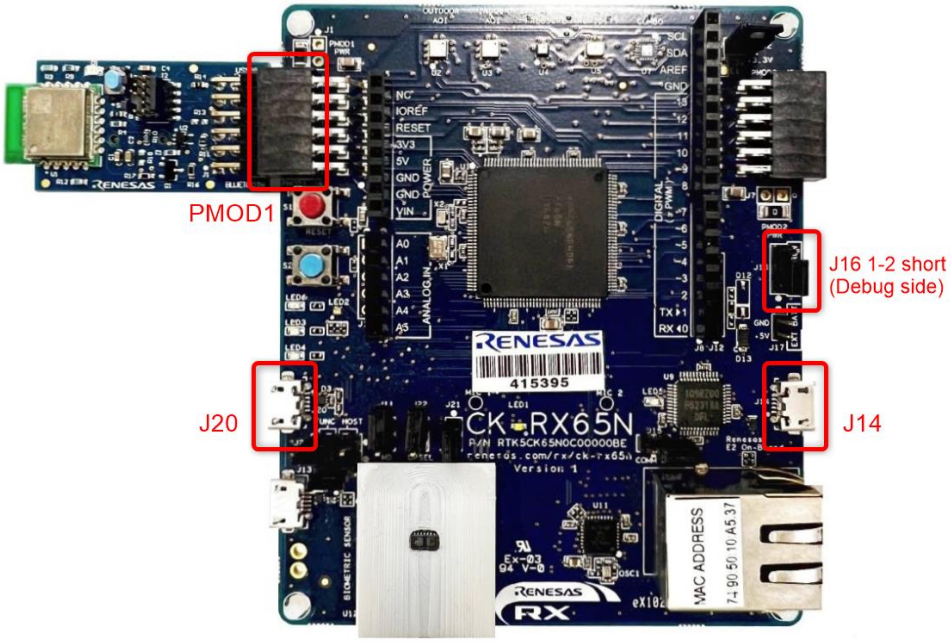

Figure 5.3 Operating Enviroment

5.1.4 Software Setup

a) Folder Structure

The following table lists the file structure of the Bare metal sample program.

Table 5.1 File Structure of the Bare Metal Sample Program

Folder name, file name	Explanation
ck_rx65n_da14531_ble_baremetal	Project folder
├qe_gen	Generated by QE tool
└src	Program storage folder
├smc_gen	Smart Configurator generator folder
│ ├general	
│ ├r_ble_da14531_rx	
│ ├r_bsp	
│ ├r_byteq	
│ ├r_config	
│ ├r_gpio_rx	
│ ├r_pincfg	
│ └r_sci_rx	
└ ck_rx65n_da14531_ble_baremetal.c	Main processing source file

The following table lists the file structure of the FreeRTOS sample program.

Table 5.2 File Structure of the FreeRTOS Sample Program

Folder name, file name	Explanation
ck_rx65n_da14531_ble_freertos	Project folder
├qe_gen	Generated by QE tool
└src	Program storage folder
├FreeRTOS	FreeRTOS kernel source code
├frtos_config	FreeRTOS configuration files
├frtos_skeleton	Template files for FreeRTOS tasks
├frtos_startup	FreeRTOS startup files
├smc_gen	Smart Configurator generator folder
│ ├general	
│ ├r_ble_da14531_rx	
│ ├r_bsp	
│ ├r_byteq	
│ ├r_config	
│ ├r_gpio_rx	
│ ├r_pincfg	
│ └r_sci_rx	
└ ck_rx65n_da14531_ble_freertos.c	Main processing source file

The following table lists the file structure of the AzureRTOS sample program.

Table 5.3 File Structure of the AzureRTOS Sample Program

Folder name, file name	Explanation
ck_rx65n_da14531_ble_azurertos	Project folder
├libs	Contain source AzureRTOS ThreadX
├qe_gen	Generated by QE tool
└src	Program storage folder
├rtos_config	Contain Azurertos init file
├rtos_skeleton	Main processing source file
│ └ble_thread_entry.c	
├smc_gen	Smart Configurator generator folder
│ ├general	
│ ├r_ble_da14531_rx	
│ ├r_bsp	
│ ├r_byteq	
│ ├r_config	
│ ├r_gpio_rx	
│ ├r_pincfg	
│ └r_sci_rx	
├demo_threadx.c	Example ThreadX kernel
├hardware_setup.c	Hardware setup file
└hardware_setup.h	

b) Project Settings

Open the Project Settings, go to Tool Settings -> Compiler -> Source, and make sure that all folders and directories have been added before build project.

5.1.5 How to Run the Demo

a) Select Device and PMOD Setting
Use the Smart Configurator to configure
Open the Smart Configurator as shown in the image below, select the appropriate device and PMOD.

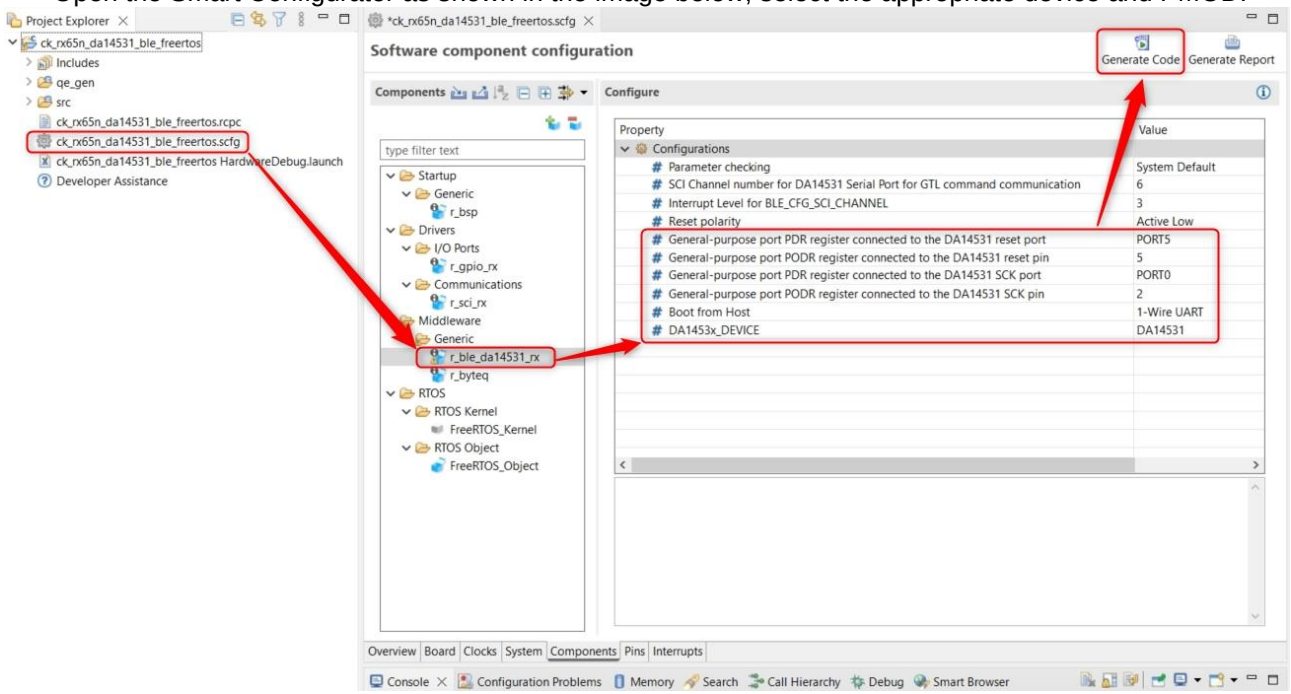

Figure 5.4 Device and PMOD Setting

- "DA143x_DEVICE": Allows to choose between two devices, DA14531 and DA14535.
- "BLE_CFG_HOST_BOOT_MODE": The default for this macro is currently disabled. Please select "***1-wire UART***" if you want to run the demo with the DA14531/DA14535 device. In case you use "***2-wire UART***", make sure that "***DA143x_DEVICE***" is selected with the DA14535 device. Other cases are not supported at the moment.
- The PMOD pins are configured as shown in the table below:

Table 5.4 Configuration PMOD

	PMOD1	PMOD2
Reset port	5	A
Reset pin	5	1
SCK port	0	3
SCK pin	2	4

b) QE Custom profile Setting
The configurations for this section are thoroughly detailed. It will show how to configure it in section 2.13.1 Getting Started Guide. However, if the ***Notification*** feature is to be used, it is necessary to follow the instructions as shown in the image below.

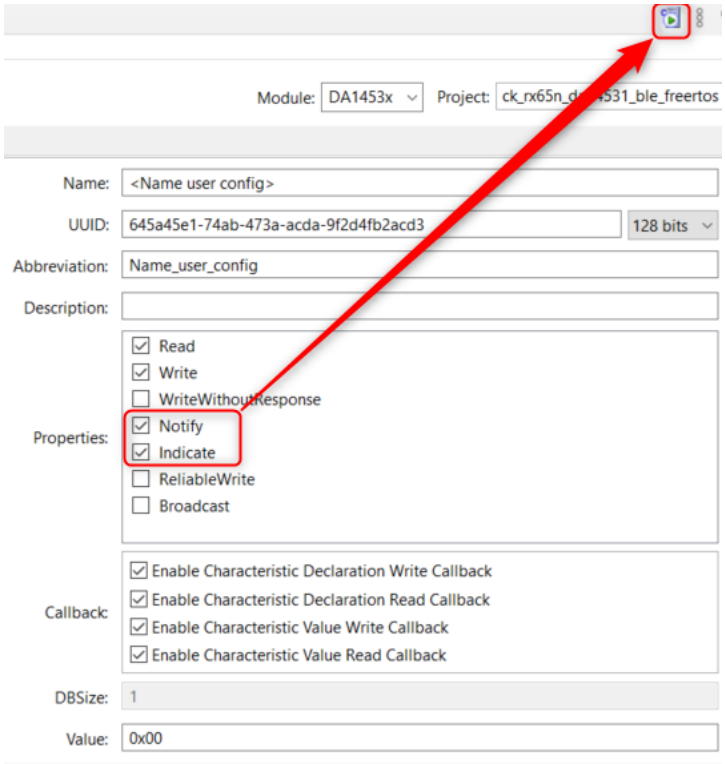

Figure 5.5 Notification Setting

- In the Characteristic section, it is necessary to tick the ***Notify*** and ***Indicate*** checkboxes which Notification feature is to be supported.
- Ensure that after pressing the generate button, the ***qe_gen*** folder, as mentioned in section 5.1.4 Software Setup, will appearance.

c) Legacy Paring Settings
With the Legacy Pairing feature, it supports two connection methods as below:
- Just works functionality
- Passkey functionality

Click on qe_gen > ble > app_main.c at the location of the GAP API callback function (gap_cb), and select iocap as *BLE_GAP_IOCAP_NOINPUT_NOOUTPUT* to enable legacy pairing feature to operate in ***Just works*** mode. Alternatively, select iocap as *BLE_GAP_IOCAP_DISPLAY_YESNO* to enable it in ***Passkey*** mode.

d) Building & Debugging the Demo Project
Refer to the 2.13.1 Getting Started Guide or following section "***4.5. Building and running the application"*** at UM-B-177: Getting started with DA1453x and RX BLE Framework on Renesas Microcontrollers — Getting started with DA14531 and FSP BLE Framework

e) Connect to the application from Renesas GATT Browser
The GATT Server demo works as below.
- After starting, it starts advertising and waits for a command.
- By scanning from a remote device, it is detected by the device name configured in "Peripheral > Local Name" through the QE tool introduced in guide 2.13.1 Getting Started Guide.

Figure 5.6 Determine the Device Name

- When connected, it stops advertising.

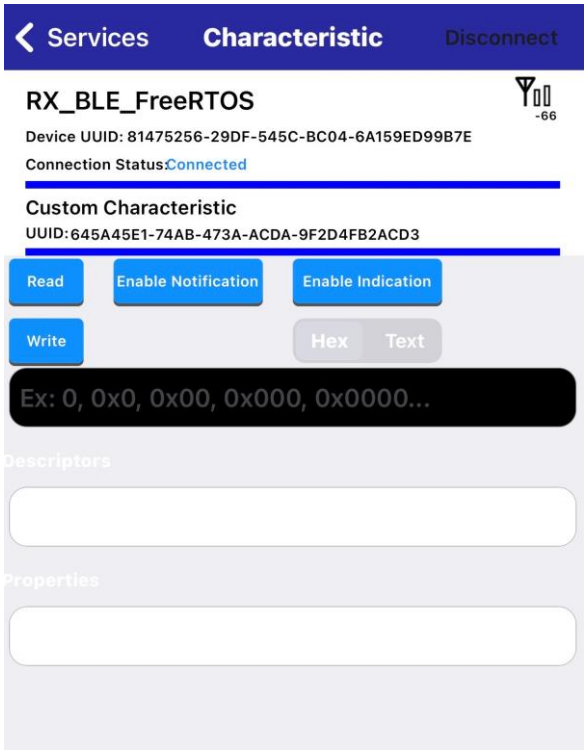

Figure 5.7 Connect Device

- By writing a number to the LED Control characteristic, the LED turns on by writing the number (0x01~0xFF) to the characteristic. The LED turns off by writing zero to the characteristic.
- When the notification button is enabled, the status value number after writing will be displayed on the app interface. Furthermore, the Read button allows users to easily check the current value status.
- When disconnected, it restarts advertising.

The GAP Service for Legacy Pairing works as below.

- After the remote device successfully connects to GATT, click on the three dots in the top-left corner of the GATT browser app and select "***Create bond"*** to proceed with pairing.

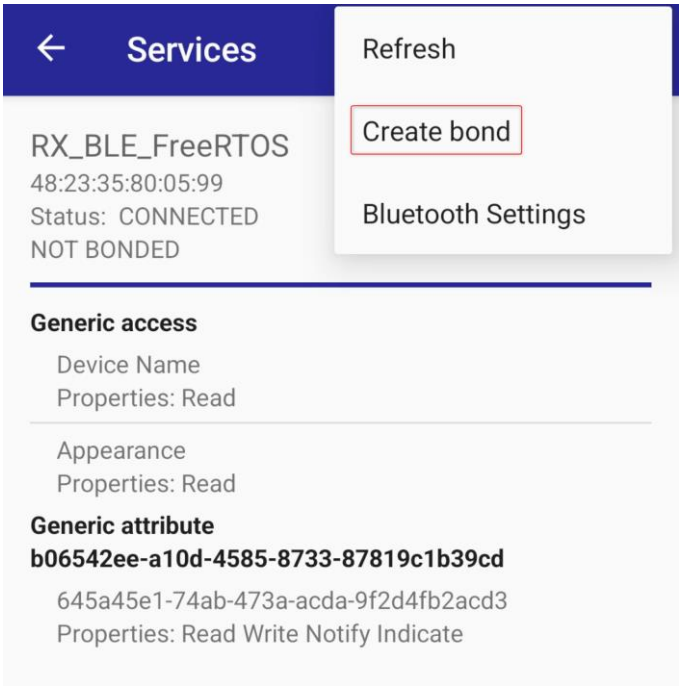

Figure 5.8 Start Pairing

- When clicking on ***"Create Bond"***, a notification appears to pair with the device.

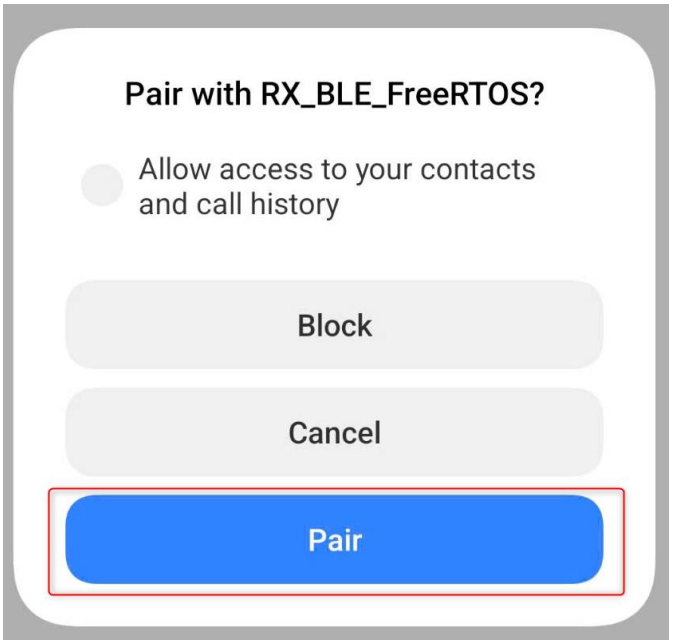

Figure 5.9 Legacy Pairing with Just Works mode

- In Passkey mode, the default password is ***"123456"***.

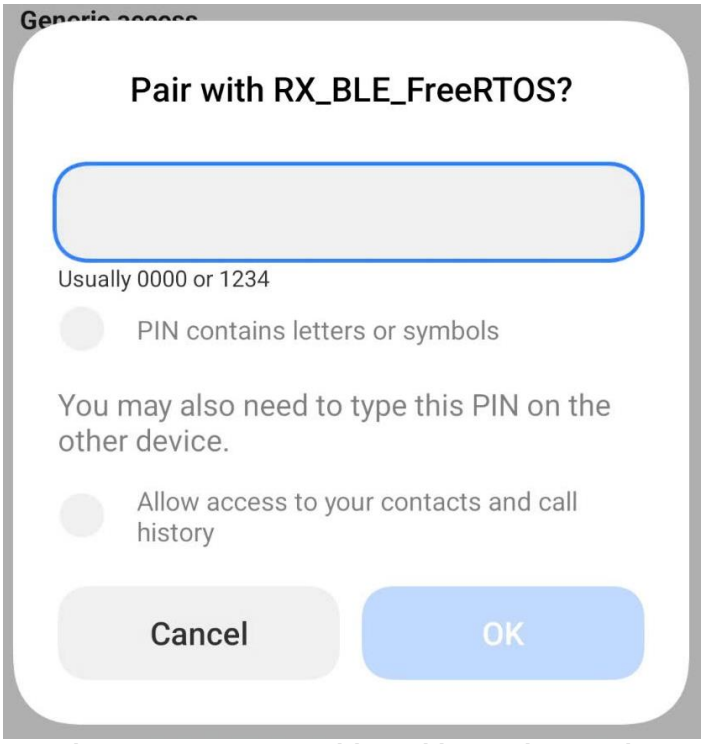

Figure 5.10 Legacy Pairing with Passkey mode

- After bonding is successfully completed, Security Establishment will be automatically triggered when the remote device disconnects from GATT and reconnects.
- The main role of Security Establishment is to ensure that the encrypted link between previously paired devices is securely re-established without the need for pairing again.
- The LED will turn on to indicate that security is activated and will turn off upon disconnection.

5.2 Creating a New BLE DA1453x project

Refer to “*Getting Started Guide*” from section 2.13.1 Getting Started Guide

5.3 Adding a Demo to a Workspace

Demo projects are found in the FITDemos subdirectory of the distribution file for this application note. To add a demo project to a workspace, select File >> Import >> General >> Existing Projects into Workspace, then click “Next”. From the Import Projects dialog, choose the “Select archive file” radio button. “Browse” to the FITDemos subdirectory, select the desired demo zip file, then click “Finish”.

5.4 Downloading Demo Projects

Demo projects are not included in the RX Driver Package. When using the demo project, the FIT module needs to be downloaded. To download the FIT module, right click on this application note and select “Sample Code (download)” from the context menu in the Smart Brower >> Application Notes tab.

6. Appendix

6.1. Confirmed Operation Environment

This section describes confirmed operation environment for the FIT module.

Table 6.1 Confirmed Operation Environment (Ver. 1.00)

Item	Contents
Integrated development environment	Renesas Electronics e2 studio 2023.01
C compiler	Renesas Electronics C/C++ Compiler for RX Family V3.05.00
	Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian order	Big endian / little endian
Revision of the module	Rev.1.00
Board used	Renesas CK-RX65N Cloud Kit (Product no.: RTK5CK65N0S04000BE)

Table 6.2 Confirmed Operation Environment (Ver. 1.20)

Item	Contents
Integrated development environment	Renesas Electronics e2 studio 2023.07
C compiler	Renesas Electronics C/C++ Compiler for RX Family V3.05.00
	Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian order	Big endian / little endian
Revision of the module	Rev.1.20
Board used	Renesas CK-RX65N Cloud Kit (Product no.: RTK5CK65N0S04000BE)

Table 6.3 Confirmed Operation Environment (Ver. 1.30)

Item	Contents
Integrated development environment	Renesas Electronics e2 studio 2024.04
C compiler	Renesas Electronics C/C++ Compiler for RX Family V3.06.00 Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian order	Big endian / little endian
Revision of the module	Rev.1.30
Board used	Renesas CK-RX65N Cloud Kit (Product no.: RTK5CK65N0S04000BE)

Table 6.4 Confirmed Operation Environment (Ver. 1.40)

Item	Contents
Integrated development environment	Renesas Electronics e2 studio 2024.10
C compiler	Renesas Electronics C/C++ Compiler for RX Family V3.06.00 Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian order	Big endian / little endian
Revision of the module	Rev.1.40
Board used	Renesas CK-RX65N Cloud Kit (Product no.: RTK5CK65N0S04000BE)

6.2. Troubleshooting

(1) Q: I have added the FIT module to the project and built it. Then I got an error: Could not open-source file "platform.h".

A: The FIT module may not be added to the project properly. Check if the method for adding FIT modules is correct with the following document:

For e2 studio, Application note "Adding Firmware Integration Technology Modules to Projects (R01AN1723)".

When using this FIT module, the board support package FIT module (BSP module) must also be added to the project. Refer to the application note "Board Support Package Module Using Firmware Integration Technology (R01AN1685)".

(2) Q: I have added the FIT module to the project and built it. Then I got an error of wrong setting configuration.

A: The setting in the file “r_ble_da14531_config.h” may be wrong. Check the file "r_ble_da14531_config.h". If there is a wrong setting, set the correct value for that. Refer to 2.7 Compile Settings for details.

(3) Q: The pin setting is supposed to be done, but it doesn’t look like that.

A: The pin setting may not be performed correctly. When using this FIT module, the pin setting must be performed. Refer to 2.7 Compile Settings for details.

7. Reference Documents

User's Manual: Hardware
(The latest versions can be downloaded from the Renesas Electronics website.)

Technical Update/Technical News
(The latest information can be downloaded from the Renesas Electronics website.)

User's Manual: Development Tools
RX Family CC-RX Compiler User's Manual (R20UT3248)
(The latest versions can be downloaded from the Renesas Electronics website.)

Revision History

Rev.	Date	Revision History	
		Page	Summary
1.00	Jun. 30, 2023	-	First edition issued
1.10	Sep. 18, 2023	6	Add support AzureRTOS
		7-9	Update Table 1.1 API functions
		11	Update Table 2.1 and Table 2.3
		16	Update data of some parameters
		19-93	Update description of API functions
		94-105	Add Sample Code Generation using QE for BLE
		106	Update Revision of Table 5.1
1.20	Feb. 23, 2024	-	Update document format
		5	Update Figure 1.1 to update the connection with BLE DA14531 module
		6	Update description of RTOS in Software Configuration Section
		7	Add 1.3 Features
		8, 27	Add R_BLE_GetVersion()
		11	Add 1.5 Status Transitions
		12	Add 1.6 Usage Notes
		14	Update Table 2.1
		16	Update Table Memory Usage in 2.8 Code Size
		20-21	Add new parameters about UART boot protocol message types
		96-108	Update 5. Sample Code Generation Using QE BLE
		109	Update 6.1 Limitations
		109	Add Table 6.2
1.30	Sep. 30, 2024	-	Update document format
		1	Top page Update related documents with RX board manual.
		5	Section 1.2.1 Update diagram
		6	Section 1.2.2 Add description.
		7	Section 1.3 Update new feature for DA14535.
		9	Section 1.4 Add new function & description for R_BLE_VS_SetTxPower() & R_BLE_VS_SetTxPower()
		15	Section 2.8 Update new description & note
		20	Section 2.10 Add new macro of GTL Auxiliary Command ID's
		23	Add section 2.12 “for”, “while” and “do while”
		24	Update section 2.13 Usage Notes
		24 - 25	Section 2 add new section 2.13.1, 2.13.2, 2.13.3, 2.13.4, 2.13.5
		92 - 93	Section 3.54 Add new function & description for R_BLE_VS_SetTxPower()
		94	Section 3.55 Add new function & description for R_BLE_VS_SetTxPower()
		102 - 109	Update section 5 Demo Project
		110	Section 6.1 Add new table for latest version (v1.30)
1.40	Nov. 21, 2024	-	Update document format
		7	Section 1.3 Update new features for Legacy Pairing
		8	Section 1.4 Update new function support Legacy Pairing
		13	Section 2.7 Update Table 2.1 Configuration Options (r_ble_da14531_config.h)
		14	Section 2.8 Update Module revision & memory usage
		20, 22	Section 2.10 Update new macro Mutex give/take defines, Defines for host DB
		48 - 54	Section 3. API function: Add new function 3.20. R_BLE_GAP_SetPairingParams() 3.21. R_BLE_GAP_StartPairing() 3.22. R_BLE_GAP_ReplyPairing()

			3.23.R_BLE_GAP_ReplyPasskeyEntry() 3.24. R_BLE_GAP_ReplyExKeyInfoReq() 3.25. R_BLE_GAP_ReplyLtkReq()
		111 - 112	Section 5.1.4 Modified file structure in software setup
		114, 116 - 117	Section 5.1.5 Update Legacy Pairing Settings
		120	Section 6.1 Add table 6.4 Confirmed Operation Environment (Ver. 1.40)

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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