RS9116W BLE AT Command Programming Reference Manual

Version 2.0

11/05/2020

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About this Document

This document describes the Bluetooth Low Energy (BLE) commands. Parameters used in commands, valid values for each command, and the expected responses from the modules are also described in this document. This document is used to write software for Host MCU in order to control and operate the module.

1 Architecture

The following figure depicts the overall architecture of the RS9116-WiSeConnect.

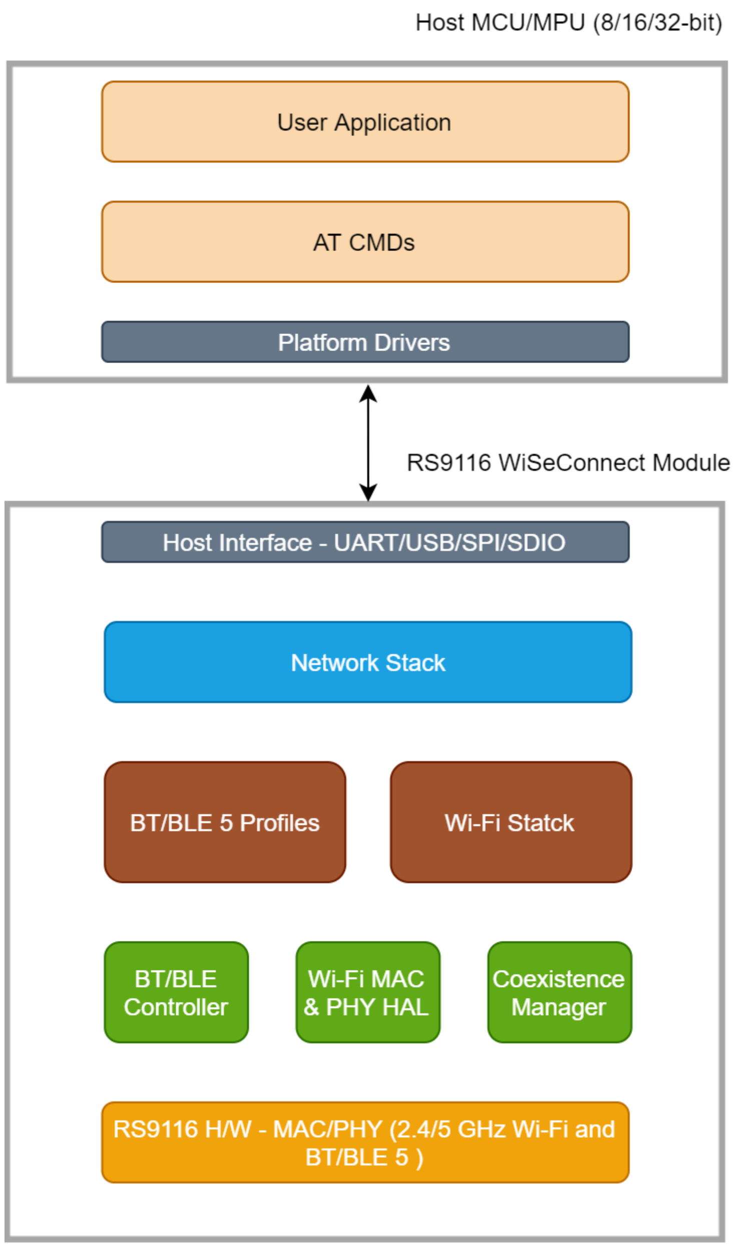

Host MCU/MPU (8/16/32-bit)
User Application
AT CMDs
Platform Drivers
RS9116 WiSeConnect Module
Host Interface - UART/USB/SPI/SDIO
Network Stack
BT/BLE 5 Profiles
Wi-Fi Statck
BT/BLE Controller
Wi-Fi MAC & PHY HAL
Coexistence Manager
RS9116 H/W - MAC/PHY (2.4/5 GHz Wi-Fi and BT/BLE 5)

Figure 1: Architecture Overview for RS9116W

Bluetooth Software Architecture

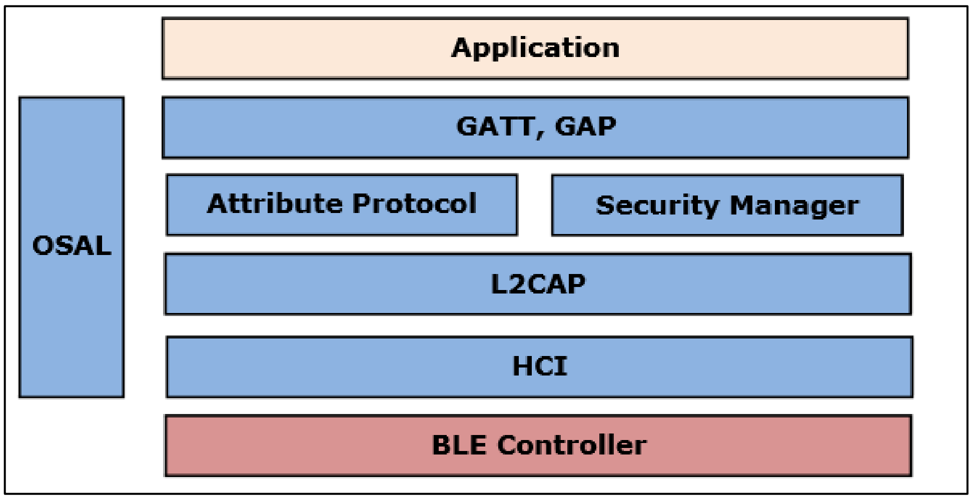


Figure 2: Bluetooth Software Architecture

Application

Application layer launches Bluetooth stack and uses commands to access various profiles on remote Bluetooth devices over the network.

Profiles

There are several Bluetooth profiles defined in the Bluetooth specification. Currently Generic Attribute Profile (GATT) and Generic Access Profile (GAP) profiles are supported. Framework to develop new profiles is provided and new profiles will be added.

Bluetooth Core

The Bluetooth core contains following higher layers of stack.

- SMP
- ATT
- L2CAP
- BLE Controller
- SMP is a security management protocol which provides services like pairing and key distribution.
- ATT (Attribute Protocol) provides a server to expose attribute values.
- L2CAP (Logical Link Control and Adaption Protocol) provides connection-oriented and connection less data services to upper layer protocols with data packet size upto 64KB in length.
- L2CAP performs the segmentation and reassembling of I/O packets from the baseband Controller.
- BLE Controller which includes link controller layers.

OS Abstraction Layer

This layer abstracts RTOS services (semaphores, mutexes and critical sections) that are used by the whole stack and the applications. The stack, which is designed in an RTOS-independent manner, can be used with any RTOS by porting this layer. It is also possible to use the Bluetooth stack standalone without RTOS.

Host-Module Interface

This document is primarily concerned with the host-module interface. Host can interface with RS9116-WiSeConnect using following list of interfaces to configure and send/receive data.

- SPI
- UART
- USB

2 Bootloader

This section briefs about features that are supported by the Network and Security Processor (NWP) bootloader.

Basic Features

- Load default firmware
- Load selected firmware
- Upgrade firmware from host
- Selecting default images
- Enable / Disable host interaction bypass
- Support for multiple host interfaces (SDIO / SPI / UART / USB / USB-CDC)
- Firmware integrity check
- Upgrading keys
- JTAG selection

The RS9116W supports two Boot loading modes:

1. **Host Interaction (Non-bypass) Mode:**
    a. In this mode host interacts with the bootloader and gives boot up options (commands) to configure different boot up operations.
    b. The host tells the module what operations it has to perform based on the selections made by the user.
2. **Bypass Mode:**
    a. In this mode boot-loader interactions are completely bypassed and uses the stored boot-up configurations (which are selected in host interaction mode) & loads default firmware image in the module.
    b. This mode is recommended for final production software to minimize the boot up time.

Host Interaction Mode

In this mode, host interaction varies based on host interface. Host interactions in SPI / USB and UART / USB-CDC are different. In UART & USB-CDC boot up options are menu based and in SPI / USB it uses command exchanges. The details are explained in the below section.

Host Interaction Mode in UART / USB-CDC

This section explains the host interaction mode in UART / USB CDC mode.

Startup Operation

After powering up, Host is required to carry out ABRD (Auto Baud Rate Detection) operation and after successful ABRD, the module displays menu of boot up options to host. Host needs to select the appropriate option.

Note:
On powerup, bootloader checks the integrity of the bootup options. If the integrity fails, it computes the integrity from backup. If integrity passes, it copies the backup to the actual location. If the integrity of the backup options also fails, the bootup options are reset/cleared. In either of the cases, bootloader bypass is disabled, or corresponding error messages are given to host. In case of integrity failure and when the backup integrity check passes, "LAST CONFIGURATION NOT SAVED" message is displayed. When backup integrity also fails, “BOOTUP OPTIONS CHECKSUM FAILED" is displayed before displaying the bootup options.

Hyper Terminal Configuration

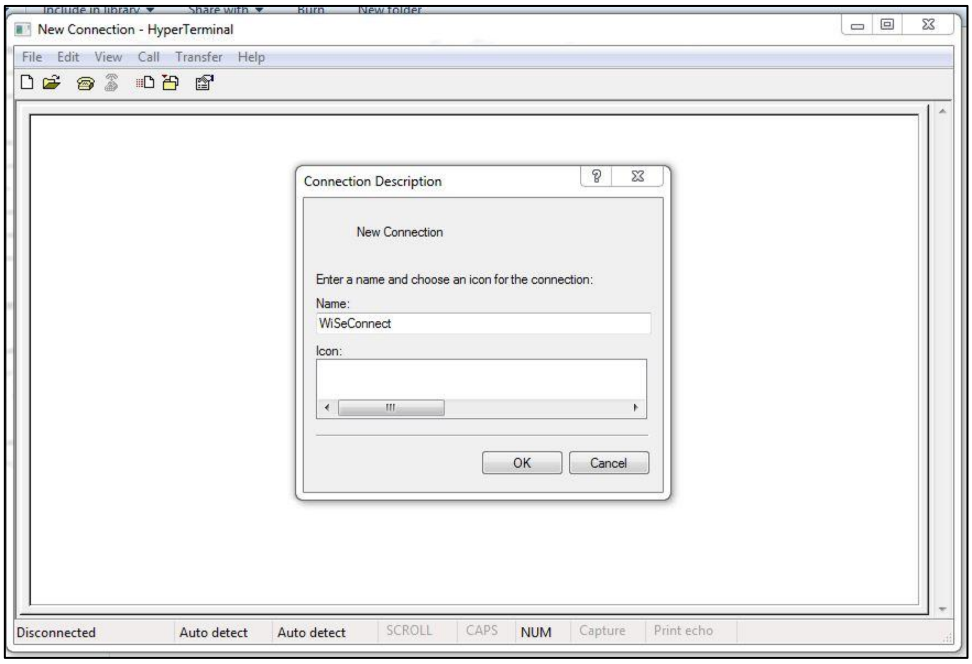
RS9116W uses the following UART interface configuration for communication:

Baud Rate: The following baud rates are supported by the module: 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps.
Data bits: 8
Parity: None
Stop bits: 1
Flow control: None

Before the module is powered up, follow sequence of steps as given below:

- Open HyperTerminal and enter any name in the **"Name"** field. After this, click **"OK"** button. Here, **"WiSeConnect"** is entered as shown below:

> **Note:**
> Default baud rate of the module is 115200.



New Connection - HyperTerminal

Connection Description

New Connection

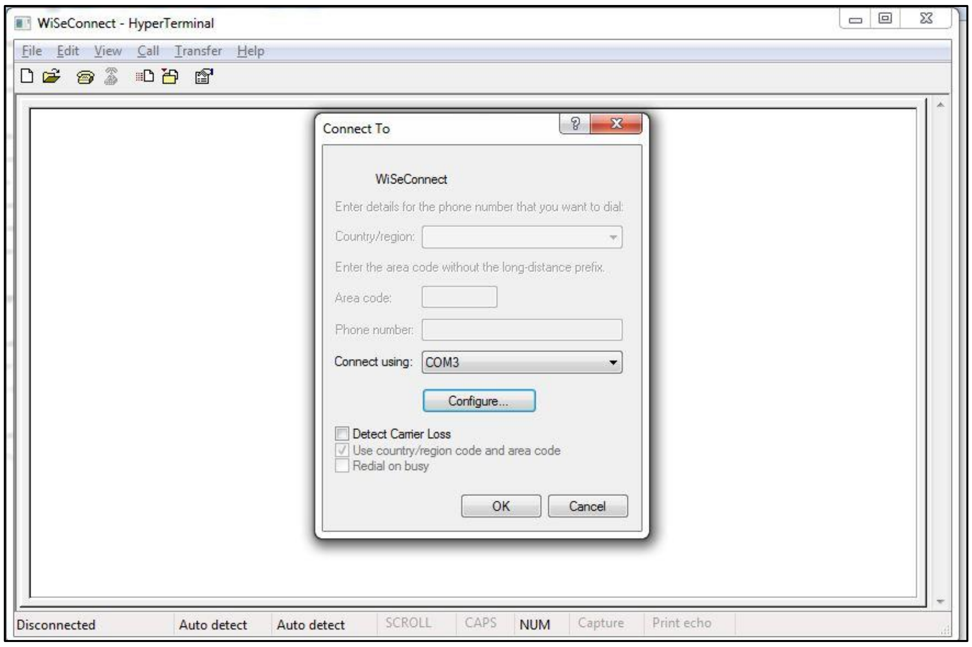
Enter a name and choose an icon for the connection:

Name: WiSeConnect

Icon:

Figure 3: HyperTerminal Name field Configuration

- After clicking **"OK"**, the following dialog box is displayed as shown in the figure below.



WiSeConnect - HyperTerminal

Connect To

WiSeConnect

Enter details for the phone number that you want to dial:

Country/region:

Enter the area code without the long-distance prefix.

Area code:

Phone number:

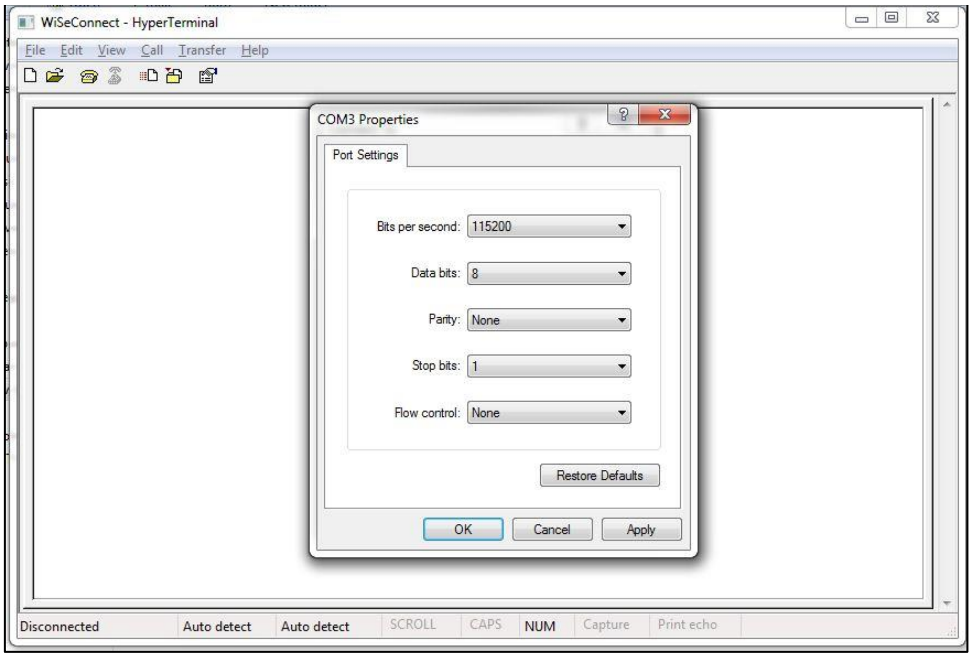
Connect using: COM3

Detect Carrier Loss
Use country/region code and area code
Redial on busy

Figure 4: HyperTerminal COM Port Field Configuration

In the **"Connect using"** field, select appropriate com port. In the figure above COM3 is selected. Click **"OK"** button.

- After clicking **"OK"** button the following dialog box is displayed as shown in the figure below.



Bits per second: 115200
Data bits: 8
Parity: None
Stop bits: 1
Flow control: None

Figure 5: HyperTerminal Baud Rate Field Configuration

Set the following values for different fields in figure 2-3 as given below.

- Set baud rate to 115200 in "Bits per second" field.
- Set Data bits to 8 in "Data bits" field.
- Set Parity to none in "Parity" field.
- Set stop bits to 1 in "Stop bits" field.
- Set flow control to none in "Flow control" field.
- Click "OK" button after entering the data in all the fields.

Auto Baud Rate Detection (ABRD)

The RS9116 automatically detects the baud rate of the Host's UART interface by exchanging some bytes. The Host should configure the UART interface for the following parameters for ABRD detection.
RS9116 uses the following UART interface configuration for communication:

Baud Rate: The following baud rates are supported: 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps.
Data bits: 8
Stop bits: 1
Parity: None
Flow control: None

To perform ABRD on the RS9116W, the host must follow the procedure outlined below.

1. Configure the UART interface of the Host at the desired baud rate.
2. Power on the board.
3. The Host, after releasing the module from reset, should wait for 20 ms for initial boot-up of the module to complete and then transmit 0x1C at the baud rate with which its UART interface is configured. After transmitting '0x1C' to the module, the Host should wait for the module to transmit 0x55 at the same baud rate.
4. If the '0x55' response is not received from the module, the host has to re-transmit 0x1C, after a delay of 200ms.
5. After finally receiving '0x55', the host should transmit '0x55' to the module. The module is now configured with the intended baud rate.

Note:
Performing ABRD in host interaction mode is must for USB CDC mode.

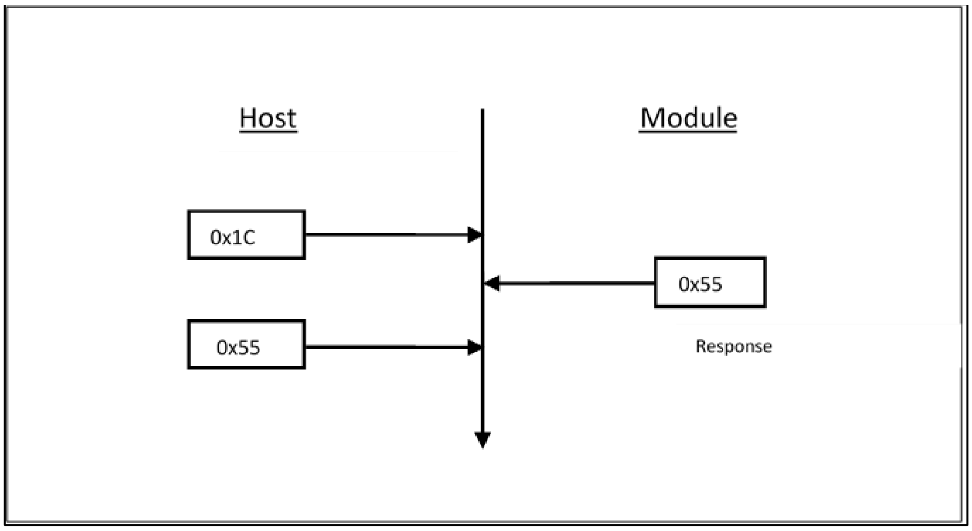


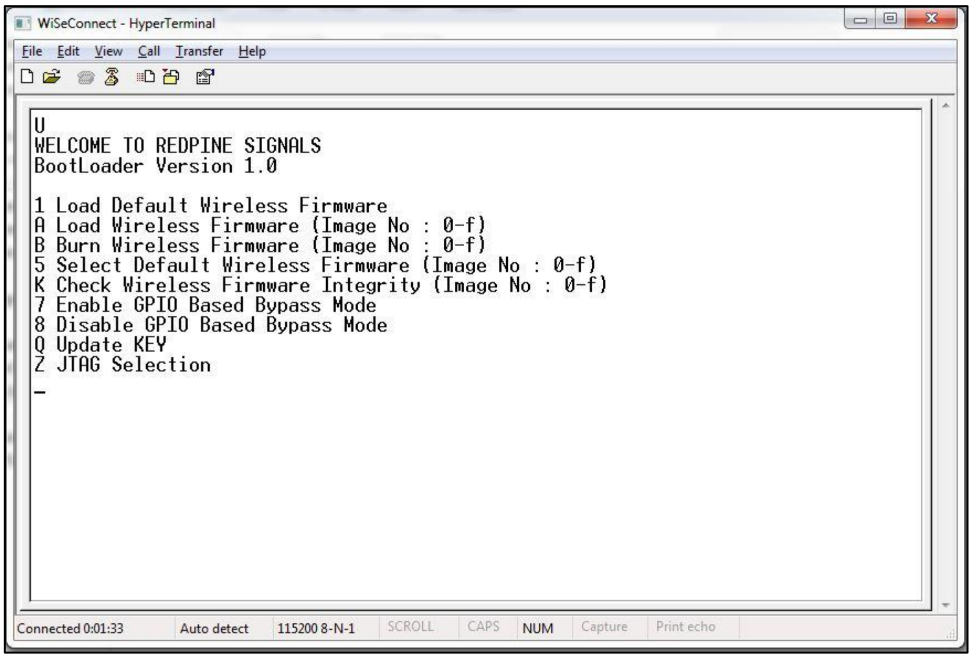
Figure 6: ABRD Exchange Between Host and Module

Below are the bootup options, firmware upgrade and firmware loading procedures for the product.

Start up messages on power-up

After powering up the module and performing ABRD you will see a welcome message on host, followed by boot up options:

> **Note:**
> Windows HyperTerminal is used to demonstrate boot up / upgrade procedure.


WiSeConnect - HyperTerminal
File Edit View Call Transfer Help

```
U
WELCOME TO REDPINE SIGNALS
BootLoader Version 1.0

1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
_
```

Connected 0:01:33 | Auto detect | 115200 8-N-1 | SCROLL | CAPS | NUM | Capture | Print echo

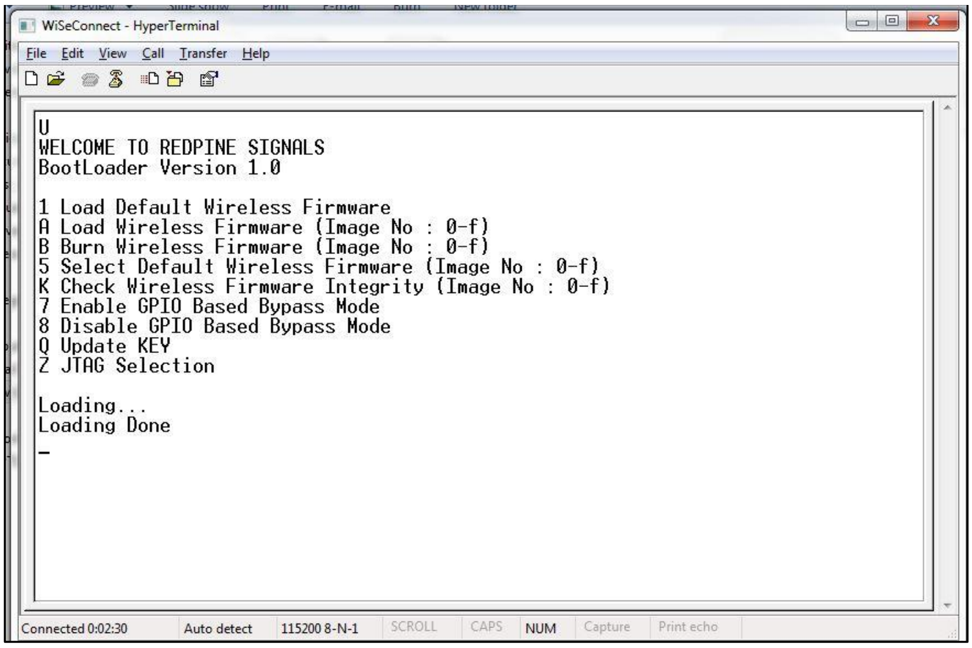
Figure 7: UART / USB-CDC Welcome Message

Loading the default wireless firmware in the module

To load the default firmware flashed onto the module, choose Option 1: "Load Default Wireless Firmware ".

Load Default Wireless Firmware

- After welcome message is displayed as shown in the above figure, select option 1 "Load Default Wireless Firmware " for loading image.



```
U
WELCOME TO REDPINE SIGNALS
BootLoader Version 1.0

1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection

Loading...
Loading Done
_
```

Figure 8: UART / USB-CDC Default Firmware Loaded

To load the selected firmware (from flash) onto the module, choose Option A: "Load Wireless Firmware (Image No: 0-f)".

Load Wireless Firmware

- After welcome message is displayed as shown in the above figure, select option A "Load Wireless Firmware (Image No: 0-f)" for loading Image.
- In response to the option A, Module asks to enter image number.
- Select the image number to be loaded from flash.
- After successfully loading the default firmware, "Loading Done" message is displayed.
- After firmware loading is completed, module is ready to accept commands.

Note:

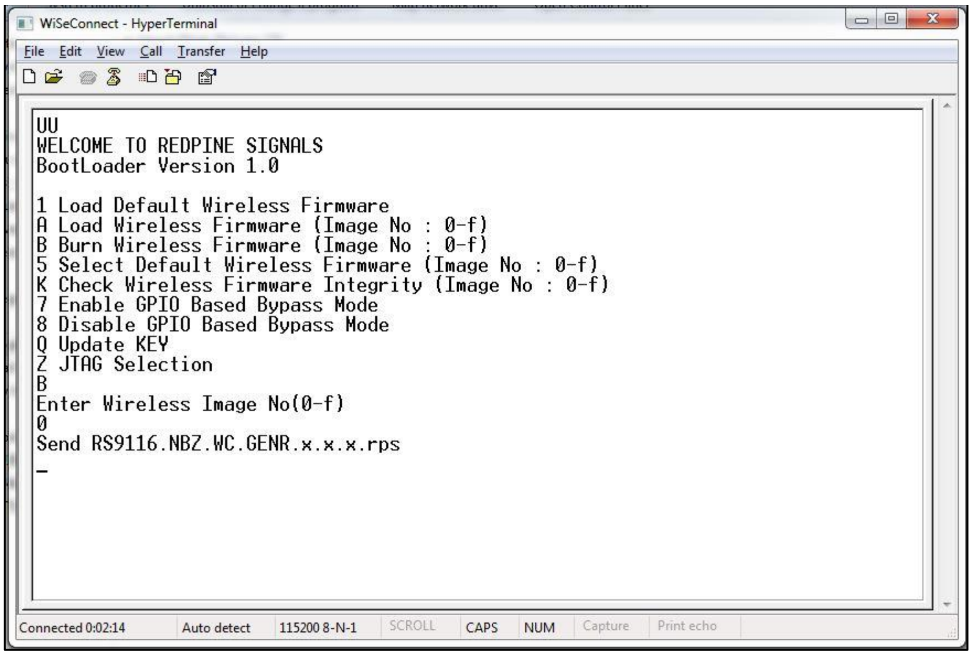
1. In order to use host bypass mode user has to select one of the images as default image by selecting options 5 (Select Default Wireless Firmware).
2. In Host interaction mode if there is no option selected after bootup menu for 20 seconds then bootloader will load selected Wireless default image.
3. If valid firmware is not present, then a message prompting "Valid firmware not present" will be displayed.

Firmware Upgradation

After powering up the module, a welcome message is displayed.

Upgrade NWP firmware Image

- After the welcome message is displayed, select option B “Burn Wireless Firmware (Image No: 0-f)" to upgrade Wireless Image.
- The message "Enter Wireless Image No (0-f)"
- Then select the Image no to be upgraded.
- The message "Send RSXXXXX.NBZ.WC.GENR.x.x.x.rps" should appear as shown in the figure below.

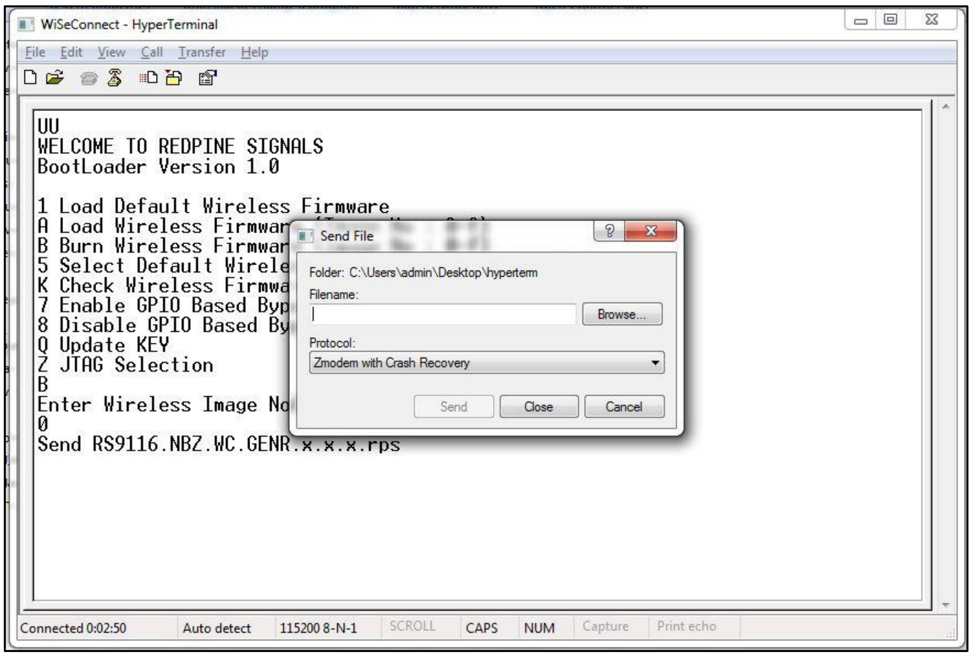

WiSeConnect - HyperTerminal
File Edit View Call Transfer Help

```
UU
WELCOME TO REDPINE SIGNALS
BootLoader Version 1.0

1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
B
Enter Wireless Image No(0-f)
0
Send RS9116.NBZ.WC.GENR.x.x.x.rps
_
```

Connected 0:02:14 | Auto detect | 115200 8-N-1 | SCROLL | CAPS | NUM | Capture | Print echo

Figure 9: Firmware Upgrade File Prompt Message

- In the "File" menu of HyperTerminal, select the "send file" option. A dialog box will appear as shown in the figure below. Browse to the path where "RS9116.NBZ.WC.GENR.X.X.X.rps" is located and select Kermit as the protocol option. After this, click the "Send" button to transfer the file.


WiSeConnect - HyperTerminal
File Edit View Call Transfer Help
Send File
Browse...
Send
Close
Cancel

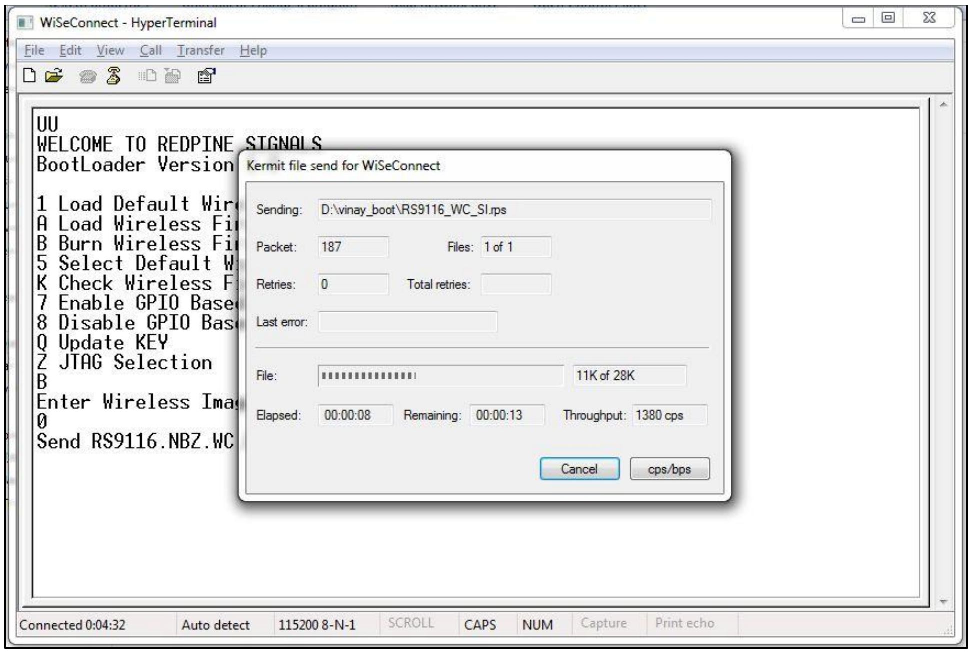
```
UU
WELCOME TO REDPINE SIGNALS
BootLoader Version 1.0

1 Load Default Wireless Firmware
A Load Wireless Firmwar
B Burn Wireless Firmwar
5 Select Default Wirele
K Check Wireless Firmwa
7 Enable GPIO Based Byp
8 Disable GPIO Based By
Q Update KEY
Z JTAG Selection
B
Enter Wireless Image No
0
Send RS9116.NBZ.WC.GENR.x.x.x.rps
```

Folder: C:\Users\admin\Desktop\hyperterm
Filename:
Protocol: Zmodem with Crash Recovery

Connected 0:02:50 | Auto detect | 115200 8-N-1 | SCROLL | CAPS | NUM | Capture | Print echo

Figure 10: Firmware Upgrade File Selection Message

- The dialog box message is displayed while file transfer is in progress as shown in the figure below:



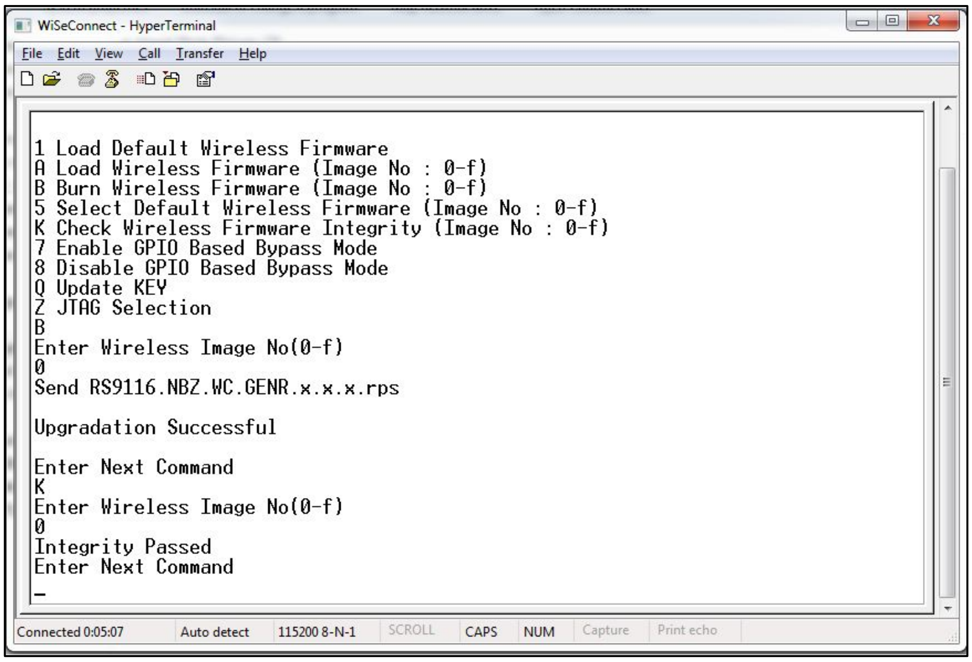
```
UU
WELCOME TO REDPINE SIGNALS
BootLoader Version

1 Load Default Wir
A Load Wireless Fi
B Burn Wireless Fi
5 Select Default W
K Check Wireless F
7 Enable GPIO Base
8 Disable GPIO Bas
Q Update KEY
Z JTAG Selection
B
Enter Wireless Ima
0
Send RS9116.NBZ.WC
```

Kermit file send for WiSeConnect

Sending: D:\vinay_boot\RS9116_WC_SI.rps
Packet: 187 Files: 1 of 1
Retries: 0 Total retries:
Last error:
File: 11K of 28K
Elapsed: 00:00:08 Remaining: 00:00:13 Throughput: 1380 cps

Figure 11: Firmware Upgrade File Transfer Message

- After successfully completing the file transfer, module computes the integrity of the image and displays "Upgradation Failed, re-burn the image" in the case of failure. Module displays "Upgradation Failed and default image invalid, Bypass disabled" in the case of both failure and corruption of the default image.
- In the case of success, module checks if bootloader bypass is enabled and computes the integrity of the default image selected. If the integrity fails, it sends "Upgradation successful, Default image invalid, gpio bypass disabled". If integrity passes or gpio bypass is not enabled, it sends "Upgradation Successful" message on terminal as shown in the figure below.



```
1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
B
Enter Wireless Image No(0-f)
0
Send RS9116.NBZ.WC.GENR.x.x.x.rps

Upgradation Successful

Enter Next Command
K
Enter Wireless Image No(0-f)
0
Integrity Passed
Enter Next Command
_
```

Figure 12: Firmware Upgrade Completion Message

- At this point, the upgraded firmware image is successfully flashed to the module.
- User can again cross check the integrity of the Image by selecting the Option K " Check Wireless Firmware Integrity (Image No: 0-f)" for Wireless Image.
- Follow the steps mentioned in the section **Loading the Default Wireless Firmware in the Module** to load the firmware from flash, select Option 1 from the above shown figure.

- The module is ready to accept commands from the Host.

Host Interaction Mode in SPI / USB

This section explains the exchange between host and module in host interaction mode (while bootloading) to select different boot options through SPI / USB interfaces.

SPI Startup Operations

If the selected host interface is SPI or USB, the Bootloader uses two of the module hardware registers to interact with the host. In case of SPI host, these registers can be read or written using SPI memory read/write operations. In case of USB host vendor specific reads and writes on control end point are used to access these registers. Bootloader indicates its current state through HOST_INTF_REG_OUT and host can give the corresponding commands by writing onto HOST_INTF_REG_IN.
The significance of 4 bytes of the value written into HOST_INTF_REG_IN register is as follows:

Table 1: HOST_INTF_REG_IN Register values

Nibble[1:0]	Message code.
Nibble[2]	Represents the Image number based on command type.
Nibble[3]	Represents the validity of the value in HOST_INTF_REG_IN register. Bootloader expects this value to be 0xA (HOST_INTERACT_REG_VALID). Bootloader validates the value written into this register if and only if this value is 0xA
Nibble[7:4]	Represents Mode for JTAG selection

Table 2: Bootloader message exchange registers

HOST_INTF_REG_OUT	0x4105003C
HOST_INTF_REG_IN	0x41050034
PING Buffer	0x18000
PONG Buffer	0x19000

Table 3: Bootloader Message Codes

HOST_INTERACT_REG_IN_VALID		0xA000
HOST_INTERACT_REG_OUT_VALID		0xAB00
LOAD_DEFAULT_NWP_FW	'1'	0x31
LOAD_NWP_FW	'A'	0x41
BURN_NWP_FW	'B'	0x42
SELECT_DEFAULT_NWP_FW	'5'	0x35
ENABLE_GPIO_BASED_BYPASS	'7'	0x37
DISABLE_GPIO_BASED_BYPASS	'8'	0x38
CHECK_NWP_INTEGRITY	'K'	0x4B
KEY_UPDATE	'Q'	0x51
JTAG_SELECTION	'Z'	0x5A
LOAD_DEFAULT_NWP_FW_ACTIVE_LOW		0x71
LOAD_NWP_FW_ACTIVE_LOW		0x72
SELECT_DEFAULT_NWP_FW_ACTIVE_LOW		0x75
EOF_REACHED	'E'	0x45

PING_BUFFER_VALID	'I'	0x49
JUMP_TO_ZERO_PC	'J'	0x4A
INVALID_ADDRESS	'L'	0x4C
PONG_BUFFER_VALID	'O'	0x4F
POLLING_MODE	'P'	0x50
CONFIGURE_AUTO_READ_MODE	'R'	0x52
DISABLE_FWUPGRADE	'T'	0x54
ENABLE_FWUPGRADE	'N'	0x4E
DEBUG_LOG	'G'	0x47

Table 4: Bootloader Response Codes

LOADING_INITIATED	'1'	0x31
VALID_FIRMWARE_NOT_PRESENT	'#'	0x23
SEND_RPS_FILE	'2'	0x32
UPGRADATION_SUCCESFULL	'S'	0x53
PONG_AVAIL	'O'	0x4F
PING_AVAIL	'I'	0x49
CMD_PASS		0xAA
CMD_FAIL		0xCC
FLASH_MEM_CTRL_CRC_FAIL		0xF1
FLASH_MEM_CTRL_BKP_CRC_FAIL		0xF2
INVALID_CMD		0xF3
UPGRADATION_SUCCESFULL_INVALID_DEFAULT_IMAGE		0xF4
INVALID_DEFAULT_IMAGE		0xF5
UPGRADATION_FAILED_INVALID_DEFAULT_IMAGE		0xF6
IMAGE_STORED_IN_DUMP		0xF7
FLASH_NOT_PRESENT		0xFA
IMAGE_INTEGRITY_FAILED		0xFB
BOOT_FAIL		0xFC
BOARD_READY	(BL_VER_HIGH << 4 | BL_VER_LOW)	0x10
LAST_CONFIG_NOT_SAVED		0xF1
BOOTUP_OPTIONS_INTEGRITY_FAILED		0xF2
FWUP_BUFFER_VALID		0x5AA5

SPI Startup Messages on Powerup

Upon power-up the HOST_INTF_REG_OUT register will hold value 0xABxx. Here 0xAB (HOST_INTERACT_REG_OUT_VALID) signifies that the content of OUT register is valid. Bootloader checks for the integrity of the boot up options by computing CRC. If the integrity fails, it checks the integrity from backup. If integrity

passes, it copies the backup to the actual location and writes (HOST_INTERACT_REG_OUT_VALID | LAST_CONFIG_NOT_SAVED) in HOST_INTF_REG_OUT register. If integrity of backup options also fails, the boot up options are reset and (HOST_INTERACT_REG_OUT_VALID | BOOTUP_OPTIONS_INTEGRITY_FAILED) is written in HOST_INTF_REG_OUT register. In either of the cases, bootloader bypass is disabled. If the boot up options integrity passes, HOST_INTF_REG_OUT register contains 0xABxx where xx represents the two nibble bootloader version. This message is referred as BOARD_READY indication throughout the document.
For instance, for bootloader version 1.0, value of register will be 0xAB10. Host is expected to poll for one of the three values and should give any succeeding command (based on error codes if present) only after reading the correct value in HOST_INTF_REG_OUT reg.

Loading Default Wireless Firmware in the Module

Host can give options to bootloader to select the firmware load image type that will load the firmware from the flash of the module.

Load Default Wireless Firmware

Upon receiving Boardready, if host wants to load default wireless firmware, it is expected to write value (HOST_INTERACT_REG_IN_VALID | LOAD_DEFAULT_NWP_FW) or (HOST_INTERACT_REG_IN_VALID | LOAD_DEFAULT_NWP_FW_ACTIVE_LOW) in HOST_INTF_REG_IN register. If host command is (HOST_INTERACT_REG_IN_VALID | LOAD_DEFAULT_NWP_FW) it is assumed that host platform is expecting active high interrupts. If command is (HOST_INTERACT_REG_IN_VALID | LOAD_DEFAULT_TA_FW_ACTIVE_LOW) it is assumed that host is expecting active low interrupts and SPI hardware will be configured accordingly. After sending this command host should wait for interrupt for card ready message from loaded firmware.

Note:
For USB host interface mode interrupt configuration is not required, host should send (HOST_INTERACT_REG_IN_VALID | LOAD_DEFAULT_TA_FW) to load default wireless Image.

Loading Selected Wireless Firmware in the Module

Host can give options to bootloader to select the firmware load image type that will load the firmware from the flash of the module.

Load Selected Wireless Firmware

Upon receiving Boardready, if host wants to load a selected wireless firmware, it is expected to write value (HOST_INTERACT_REG_IN_VALID | LOAD_NWP_FW | (IMAGE_NO << 8)) or (HOST_INTERACT_REG_IN_VALID | LOAD_NWP_FW_ACTIVE_LOW | (IMAGE_NO << 8)) in HOST_INTF_REG_IN register. If host command is (HOST_INTERACT_REG_IN_VALID | LOAD_NWP_FW | (IMAGE_NO << 8)) it is assumed that host platform is expecting active high interrupts. If command is (HOST_INTERACT_REG_IN_VALID | LOAD_DEFAULT_NWP_FW_ACTIVE_LOW) it is assumed that host is expecting active low interrupts and SPI hardware will be configured accordingly. After sending this command host should wait for interrupt for card ready message from loaded firmware.

Note:
For USB host interface mode interrupt configuration is not required, host should send (HOST_INTERACT_REG_IN_VALID | LOAD_NWP_FW | (IMAGE_NO << 8)) to load selected wireless Image.

Upgrading Wireless Firmware in the Module

With this option host can select to upgrade firmware in the flash of the module.

Upgrading Wireless Firmware

Steps for firmware upgradation sequence after receiving board ready are outlined below:

1. After reading the valid BOARD_READY (i.e. HOST_INTERACT_REG_OUT_VALID | BOOTLOADER VERSION) value in HOST_INTF_REG_OUT, host writes (HOST_INTERACT_REG_IN_VALID | BURN_NWP_FW | (IMAGE_NO << 8)) in HOST_INTF_REG_IN and host starts polling for HOST_INTF_REG_OUT.
2. Module polls for HOST_INTF_REG_IN register. When module reads a valid value (i.e. HOST_INTERACT_REG_IN_VALID | BURN_NWP_FW | (IMAGE_NO << 8)) in HOST_INTF_REG_IN, module writes (HOST_INTERACT_REG_OUT_VALID | SEND_RPS_FILE) in HOST_INTF_REG_OUT.

3. When host reads valid value (i.e. HOST_INTERACT_REG_OUT_VALID | SEND_RPS_FILE) in HOST_INTF_REG_OUT, host will write first 4Kbytes of firmware image in PING Buffer and writes (HOST_INTERACT_REG_IN_VALID | PING_VALID) in HOST_INTF_REG_IN register. Upon receiving PING_VALID command module starts burning this 4k bytes chunk onto the flash. When module is ready to receive data in PONG Buffer it sets value PONG_AVAIL (HOST_INTERACT_REG_OUT_VALID | PONG_AVAIL) in HOST_INTF_REG_OUT. Host is required to wait for this value to be set before writing next 4Kbytes chunk onto the module.
4. On reading valid value (i.e. HOST_INTERACT_REG_OUT_VALID | PONG_AVAIL) in HOST_INTF_REG_OUT, host starts memory write on PONG location and start polling for HOST_INTF_REG_OUT to read valid value (i.e. HOST_INTERACT_REG_OUT_VALID | PING_AVAIL). Module reads (HOST_INTERACT_REG_OUT_VALID | PONG_VALID) 0xAB4F value in HOST_INTF_REG_OUT and begin to write the data from PONG location into the flash.
5. This write process continues until host has written all the data into the PING-PONG buffers and there is no more data left to write.
6. Host writes a (HOST_INTERACT_REG_IN_VALID | EOF_REACHED) into HOST_INTF_REG_IN register and start polling for HOST_INTF_REG_OUT.
7. On the other side module polls for HOST_INTF_REG_IN register. When module reads (HOST_INTERACT_REG_IN_VALID | EOF_REACHED) in HOST_INTF_REG_IN, it computes integrity for entire received firmware image. Then it checks if bypass is enabled. If enabled, it checks for the validity of the default image. If integrity is correct and default image is valid/GPIO bypass not enabled, module writes (HOST_INTERACT_REG_OUT_VALID | FWUP_SUCCESSFUL) in HOST_INTF_REG_OUT register. If integrity is correct and default image is invalid (bypass enabled), module writes (HOST_INTERACT_REG_OUT_VALID | UPGRADATION_SUCCESSFUL_INVALID_DEFAULT_IMAGE) in HOST_INTF_REG_OUT register and bypass is disabled. If the integrity is failed and default image is valid / GPIO bypass is not enabled, then the module writes (HOST_INTERACT_REG_OUT_VALID | CMD_FAIL) in HOST_INTF_REG_OUT register. If the integrity is failed and default image is invalid (bypass enabled), then the module writes (HOST_INTERACT_REG_OUT_VALID | UPGRADATION_FAILED_INVALID_DEFAULT_IMAGE) in HOST_INTF_REG_OUT register and bypass is disabled.

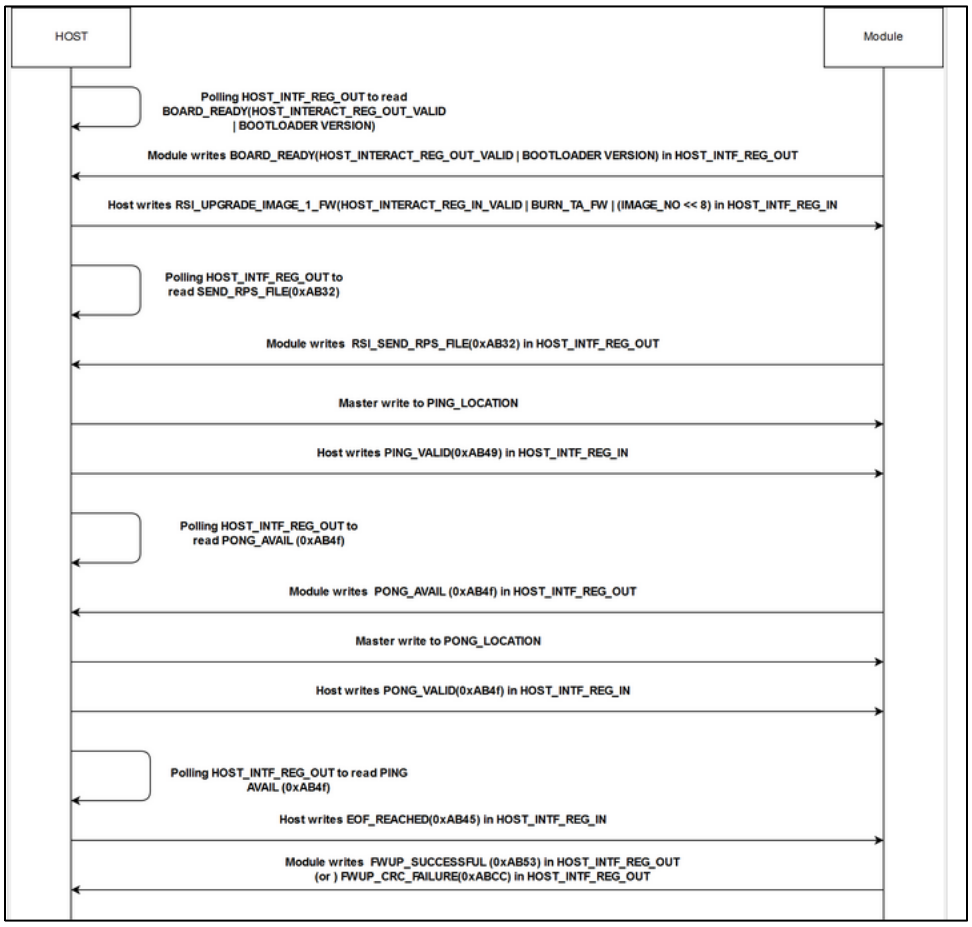

HOST
Module
Polling HOST_INTF_REG_OUT to read BOARD_READY(HOST_INTERACT_REG_OUT_VALID | BOOTLOADER VERSION)
Module writes BOARD_READY(HOST_INTERACT_REG_OUT_VALID | BOOTLOADER VERSION) in HOST_INTF_REG_OUT
Host writes RSI_UPGRADE_IMAGE_1_FW(HOST_INTERACT_REG_IN_VALID | BURN_TA_FW | (IMAGE_NO << 8) in HOST_INTF_REG_IN
Polling HOST_INTF_REG_OUT to read SEND_RPS_FILE(0xAB32)
Module writes RSI_SEND_RPS_FILE(0xAB32) in HOST_INTF_REG_OUT
Master write to PING_LOCATION
Host writes PING_VALID(0xAB49) in HOST_INTF_REG_IN
Polling HOST_INTF_REG_OUT to read PONG_AVAIL (0xAB4f)
Module writes PONG_AVAIL (0xAB4f) in HOST_INTF_REG_OUT
Master write to PONG_LOCATION
Host writes PONG_VALID(0xAB4f) in HOST_INTF_REG_IN
Polling HOST_INTF_REG_OUT to read PING AVAIL (0xAB4f)
Host writes EOF_REACHED(0xAB45) in HOST_INTF_REG_IN
Module writes FWUP_SUCCESSFUL (0xAB53) in HOST_INTF_REG_OUT (or) FWUP_CRC_FAILURE(0xABCC) in HOST_INTF_REG_OUT

Figure 13: Wireless Firmware Upgradation through SPI/USB

GPIO Based Bootloader Bypass Mode

In GPIO based bootloader bypass mode host interactions with bootloader can be bypassed. There are two steps to enable GPIO based Bootloader bypass mode:

1. Host need to select default wireless image to load in bypass mode and "Enable" Bootloader bypass mode.
2. Assert LP_WAKEUP to Bypass Bootloader on powerup.

To enable Bootloader Bypass mode host first has to give default image that has to be loaded in bypass mode and select the bypass mode(enable). After rebooting the module, it goes to bypass mode and directly loads the default firmware image.

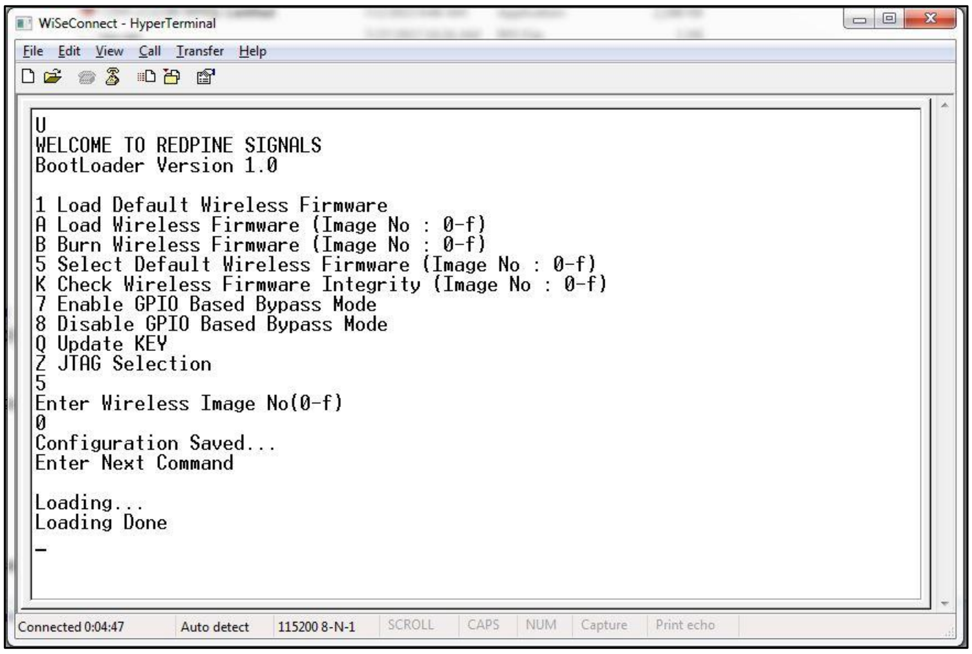
Bypass Mode in UART / USB-CDC

Making Default Wireless Firmware Selection

With this option host can select the default firmware image to be loaded.

Selecting a valid image as the default image

- After the welcome message is displayed, host can select option 5, “Select Default Wireless Firmware (Image No: 0-f)".
- The message "Enter Wireless Image No (0-f)"
- Then select the image no.
- It is better to check the integrity of image before selecting it as default image.
- When default image is selected, module checks for the validity of the image selected and displays "Configuration saved".



```
U
WELCOME TO REDPINE SIGNALS
BootLoader Version 1.0

1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
5
Enter Wireless Image No(0-f)
0
Configuration Saved...
Enter Next Command

Loading...
Loading Done
_
```

Figure 14: Making Image no - 0 as Default Image

Enable/Disable GPIO Based Bypass Option

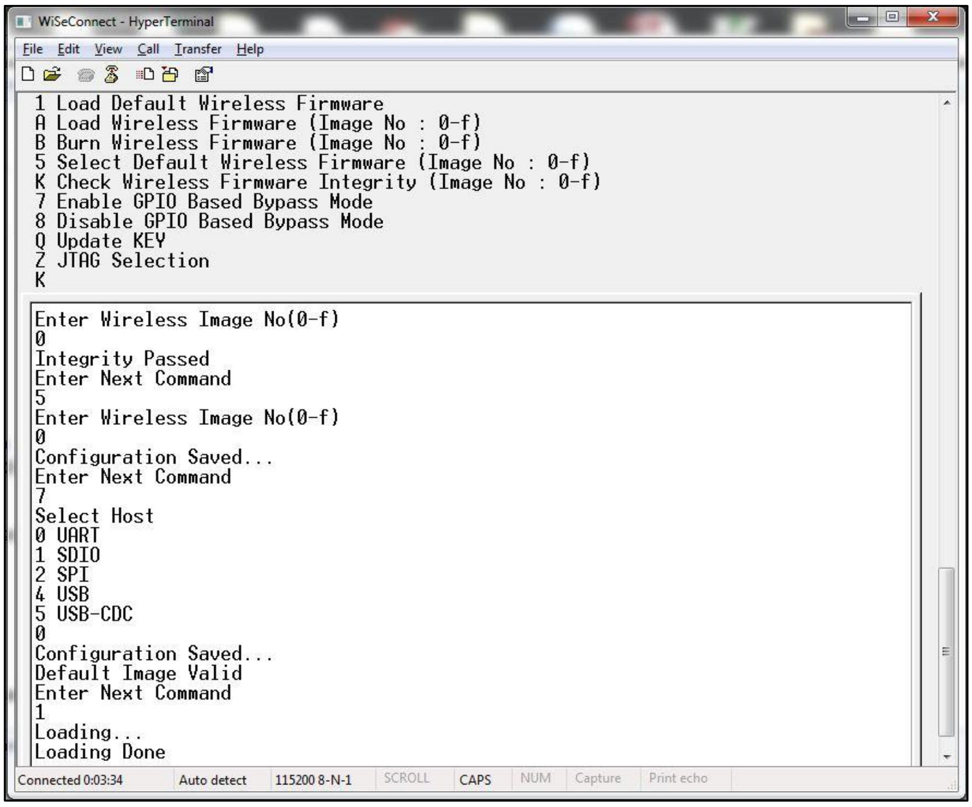
This option is for enabling or disabling the GPIO bootloader bypass mode.

Enabling the GPIO Based Bypass Mode

- If you select option 7, GPIO based Bootloader bypass gets enabled.
- When this option is selected, module checks for the validity of the image selected and displays "Configuration saved" if valid.
- If valid default image is not present, then a message saying "Default image invalid" will be displayed.
- Once enabled, from next bootup, Bootloader will latch the value of LP_WAKEUP. If asserted, it will bypass the whole boot loading process and will load the default firmware image selected.

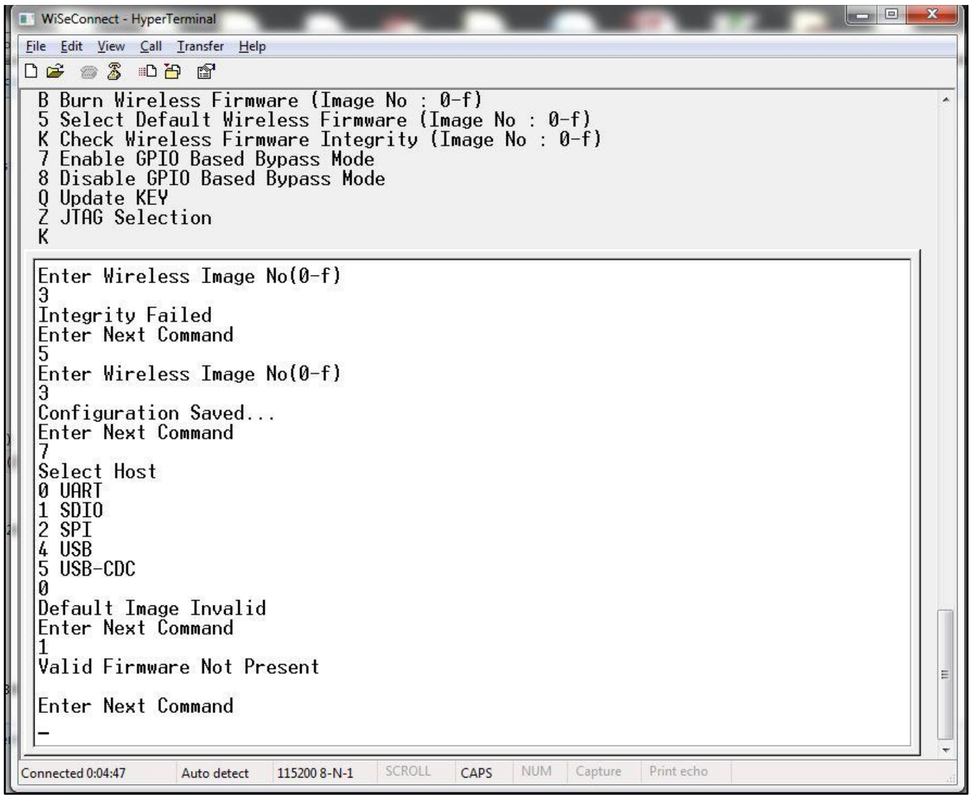
- After the welcome message is displayed, select option 5, “Select Default Wireless Firmware (Image No : 0-f)".
- The window will display "Enter Wireless Image No. (0-f)".
- Select the required image no.
- It is better to check the integrity of image before selecting it as default Image.
- When default image is selected, the module checks for the validity of the image selected and displays "Configuration saved".
- After this, select option 7 "Enable GPIO Based Bypass Mode".
- The module responds to select the host interface in Bypass mode (0 - UART , 1 - SDIO , 2 - SPI , 4 - USB , 5 - USB-CDC).
- Select the required interface.

If the default image is valid, then it enables GPIO Bypass mode, otherwise it will not enable the GPIO Bypass mode.



```
1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
K

Enter Wireless Image No(0-f)
0
Integrity Passed
Enter Next Command
5
Enter Wireless Image No(0-f)
0
Configuration Saved...
Enter Next Command
7
Select Host
0 UART
1 SDIO
2 SPI
4 USB
5 USB-CDC
0
Configuration Saved...
Default Image Valid
Enter Next Command
1
Loading...
Loading Done
```

Figure 15: Enabling the GPIO-based Bypass Mode; Valid Default Firmware


WiSeConnect - HyperTerminal
File Edit View Call Transfer Help
Connected 0:04:47 Auto detect 115200 8-N-1 SCROLL CAPS NUM Capture Print echo

```
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
K
Enter Wireless Image No(0-f)
3
Integrity Failed
Enter Next Command
5
Enter Wireless Image No(0-f)
3
Configuration Saved...
Enter Next Command
7
Select Host
0 UART
1 SDIO
2 SPI
4 USB
5 USB-CDC
0
Default Image Invalid
Enter Next Command
1
Valid Firmware Not Present

Enter Next Command
_
```

Figure 16: Enabling the GPIO-based Bypass Mode; Invalid Firmware

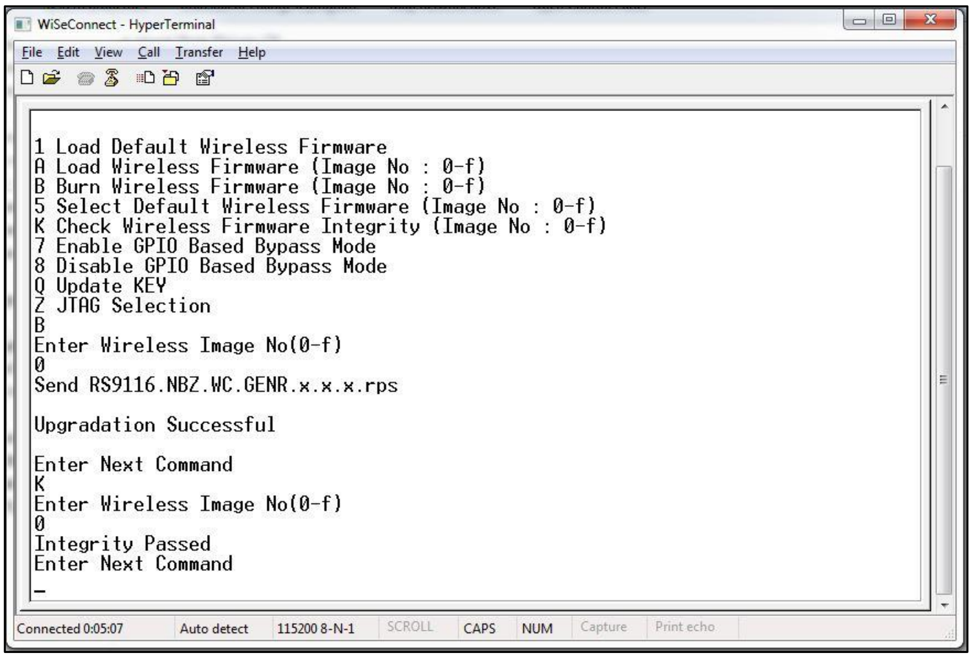
Disabling the GPIO Based Bypass Mode

- If host selects option 8, GPIO based bypass gets disabled.

Note:
GPIO-15 needs to be de-asserted on power up to move to host interaction mode, to select bootup options like disable Bypass mode or to change default image.

Check Integrity of the Selected Image

This option enables user to check whether the given image is valid or not. When this command is given, bootloader asks for the image for which integrity has to be verified as shown in figure below.


WiSeConnect - HyperTerminal
File Edit View Call Transfer Help
Connected 0:05:07 Auto detect 115200 8-N-1 SCROLL CAPS NUM Capture Print echo

```
1 Load Default Wireless Firmware
A Load Wireless Firmware (Image No : 0-f)
B Burn Wireless Firmware (Image No : 0-f)
5 Select Default Wireless Firmware (Image No : 0-f)
K Check Wireless Firmware Integrity (Image No : 0-f)
7 Enable GPIO Based Bypass Mode
8 Disable GPIO Based Bypass Mode
Q Update KEY
Z JTAG Selection
B
Enter Wireless Image No(0-f)
0
Send RS9116.NBZ.WC.GENR.x.x.x.rps

Upgradation Successful

Enter Next Command
K
Enter Wireless Image No(0-f)
0
Integrity Passed
Enter Next Command
_
```

Figure 17: Integrity Check Passed

Bypass Mode in SPI / USB

Selecting the Default Image

Upon receiving Board ready, if host wants to select default functional image, it is expected to write value (HOST_INTERACT_REG_IN_VALID | SELECT_DEFAULT_NWP_FW | (IMAGE_NO << 8)) in HOST_INTF_REG_IN register. Host is expected to receive confirmation (HOST_INTERACT_REG_OUT_VALID | CMD_PASS) in HOST_INTF_REG_OUT register if default image is valid. If default image is invalid, (HOST_INTERACT_REG_OUT_VALID | CMD_FAIL) is written in HOST_INTF_REG_OUT register.

Enable/Disable GPIO Based Bootloader Bypass Mode

1. Upon receiving Board ready, if host wants to enable or disable GPIO based bypass mode, it is expected to write value (HOST_INTERACT_REG_IN_VALID | ENABLE_GPIO_BASED_BYPASS) or (HOST_INTERACT_REG_IN_VALID | DISABLE_GPIO_BASED_BYPASS) in HOST_INTF_REG_IN register.
2. The Host expected to receive (HOST_INTERACT_REG_IN_VALID | ENABLE_GPIO_BASED_BYPASS) or (HOST_INTERACT_REG_IN_VALID | DISABLE_GPIO_BASED_BYPASS) in HOST_INTF_REG_OUT register if command is successful. If default image is invalid, (HOST_INTERACT_REG_OUT_VALID | INVALID_DEFAULT_IMAGE) is written in HOST_INTF_REG_OUT register. The host is expected to reboot the board after receiving confirmation (HOST_INTERACT_REG_IN_VALID | ENABLE_GPIO_BASED_BYPASS) or (HOST_INTERACT_REG_IN_VALID | DISABLE_GPIO_BASED_BYPASS) or (HOST_INTERACT_REG_OUT_VALID | INVALID_DEFAULT_IMAGE) in HOST_INTF_REG_OUT register.
3. If GPIO based bypass is enabled, from next bootup onwards, bootloader will latch the state of LP_WAKEUP. If LP_WAKEUP is asserted, bootloader will not give board ready and it will directly load the default functional image selected.

Note:
LP_WAKEUP needs to be de-asserted on power up to move to host interaction mode, to select bootup options like disable Bypass mode or to change default image.

Other Operations

This section contains additional, less frequently used bootloader options.

Update KEY

Note:
This feature is not enabled in current release.

JTAG Selection

Note:
This feature is not enabled in current release.

3 Host Interfaces

RS9116 WiSeConnect Module supports SPI, USB, UART and SDIO for interfacing to host. This section describes UART interface in detail including the supported features, protocols and commands.

Only UART and USB-CDC interfaces are supported in AT mode.

Note:

USB and SDIO interfaces are currently not supported.

3.1 UART Interface

This section describes RS9116-WiSeConnect UART interface, including the commands and processes to operate the module via UART.

UART on the RS9116-WiSeConnect is used as a host interface to configure the module to send and receive data.

Features

- Supports hardware (RTS/CTS) flow control.
- Supports following list of baud rates,
    - 9600 bps
    - 19200 bps
    - 38400 bps
    - 57600 bps
    - 115200 bps
    - 230400 bps
    - 460800 bps
    - 921600 bps

Note:

For baud rates greater than 115200, it is mandatory to enable UART hardware flow control.

Hardware Interface

RS9916W uses TTL serial UART at an operating voltage of 3.3V.
Host UART device must be configured with the following settings:

- Data bits - 8
- Stop bits - 1
- Parity - None
- Flow control - None

Software Protocol

AT+ command mode

This section explains the procedure that the host needs to follow in order to send Wi-Fi commands frames to the module and to receive responses from the module in AT+ command mode.

TX Operation

The Host uses TX operations:

1. To send management commands to the module from the Host.

2. To send actual data to the module which is to be transmitted onto the air.
3. If the host receives error code indicating packet dropped, the host has to wait for a while and send the next command /data.
4. The host should send next data packet only if it receives "OK<number of bytes sent>" response for the previous one.

Rx Operation

The RS9116W responds with either an 'OK' or 'ERROR' string, for Management or Data frames along with a result or error code.

The module sends the response/received data to Host in a format as shown below:

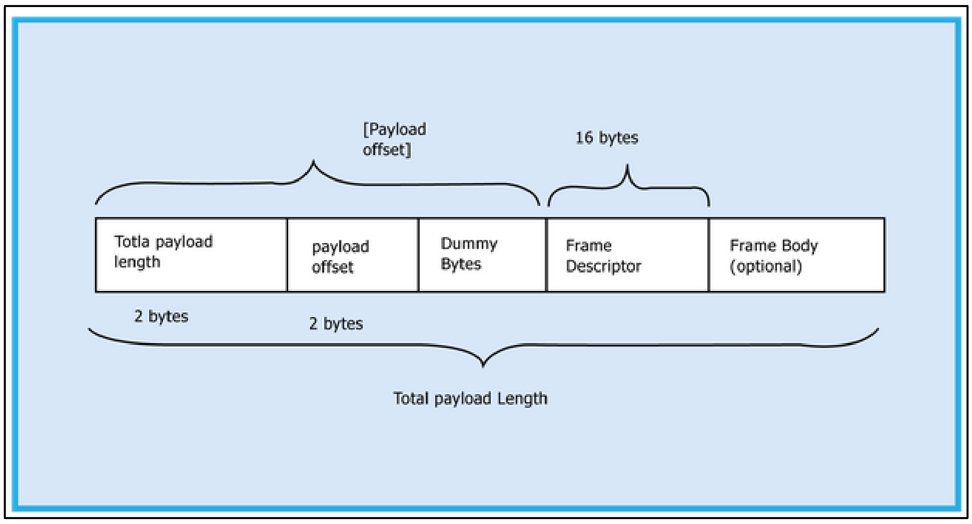


Figure 18: RX Frame Format

Note:
If Payload offset is 'x', 'x-4' dummy bytes will be added before Frame Descriptor.

The host should follow the steps below to read the frame from the Module:

Read 4 bytes using Frame read.

1. Decode Total payload length and payload offset.
2. Read remaining payload by sending Frame to read with (total payload length – 4 bytes), discard Dummy bytes and then decode Frame descriptor and Frame Body.

4 Command Mode Selection

This section describes AT command mode or Binary mode selection in UART and USB-CDC.

After bootloader interaction, the module issues "Loading Done" string in ASCII format to host. After receiving "Loading Done", based on first command received from the host, the module selects command mode.

The module reads first 4 bytes, if it matches with "AT+R", it configures AT command mode otherwise Binary mode is configured. Once mode is configured, it will remain in same mode until next reset or power cycle.

There is an option in bootloader to select AT mode or binary mode.

Note:
"AT+R" is not case sensitive.

5 Command Format

- This section explains the general command format, commands should be sent to the module in the specified format.
- Format is same for both Classic and LE modes.
- Commands are sent to the module and responses are read from the module using frame write/frame read (as mentioned in the preceding sections), these commands are called as command frames.
- The format of the command frames is divided into two parts:
    a. Frame descriptor
    b. Frame Body (Frame body is often called as Payload)

Frame Descriptor (16 bytes)	**Frame Body (multiples of 4 bytes)**

Command frame format is shown below. This description is for a Little-Endian System.

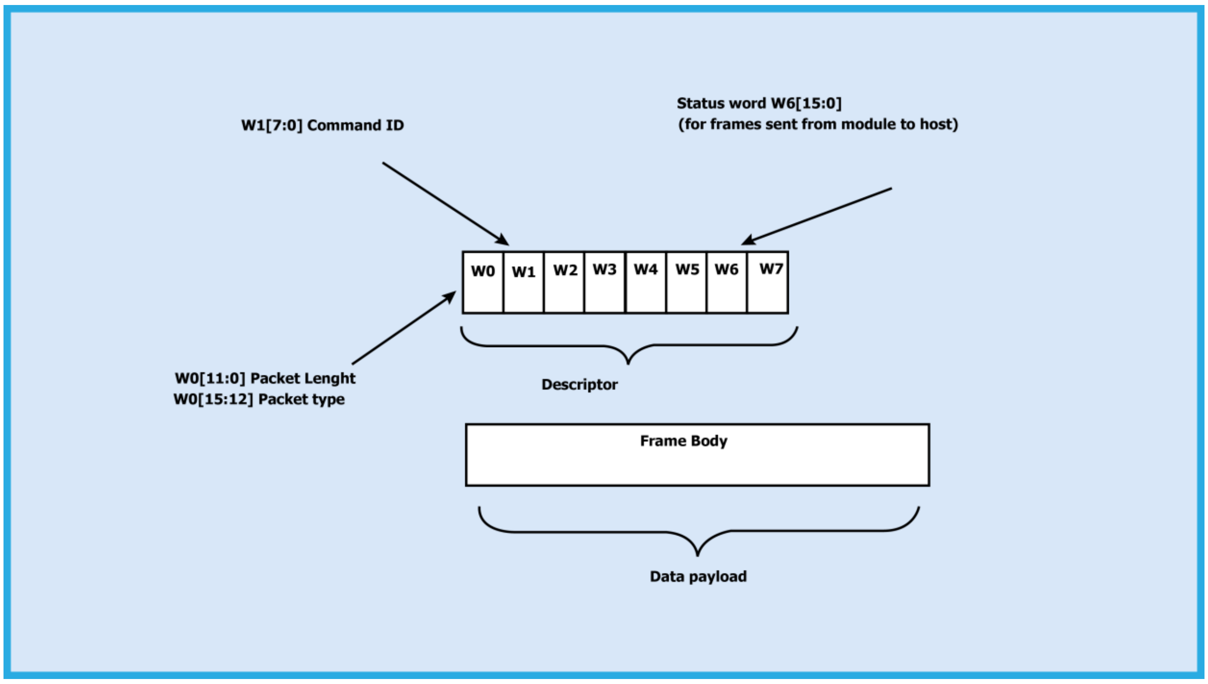


Figure 19: Command Frame Format

The following table provides the general description of the frame descriptor.

Table 5: Frame Descriptor

Word	Frame Descriptor
Word0 W0[15:0]	Bits [11:0] – Length of the frame Bits [15:12] – 2(indicates Bluetooth packet).
Word1 W1[15:0]	Bits [15:0] – Packet type
Word2 W2[15:0]	Reserved
Word3 W3[15:0]	Reserved
Word4 W4[15:0]	Reserved

Word	Frame Descriptor
Word5 W5 [15:0]	Reserved
Word6 W6 [15:0]	1. (0x0000) when sent from host to module. 2. When sent from module to host (as response frame), it contains the status.
Word7 W7 [15:0]	Reserved

Three types of frames will get exchanged between the module and the host.

1. Request/Command frames - These are sent from Host to Module. Each Request/ Command has an associated response with it.
2. Response frames – These are sent from Module to Host. These are given in response to the previous Request/Command from the Host. Each command has a single response.
3. Event frames – These are sent from Module to Host. These are given when there are multiple responses for a Request/ Command frame. There is Asynchronous message to be sent to host.

The following are the types of frame requests and responses and the corresponding codes. The commands are different for both Classic and LE modes. The below Table lists the Command, Response and Event frames in LE mode.
In both the modes, the corresponding code is to be filled in W1 [15:0] mentioned in the Table above.

Table 6: Types of Frame Requests and Responses and the Corresponding Codes

Command	Command ID
Set Local Name	0x0001
Get Local Name	0x0002
Get RSSI	0x0005
Get Local BD Address	0x0007
Advertise	0x0075
Scan	0x0076
Connect	0x0077
Disconnect	0x0078
Query Device State	0x0079
Connection parameter update	0x007A
Start Encryption	0x007B
SMP Pair Request	0x007C
SMP Response	0x007D
SMP Passkey	0x007E
Query Profiles list	0x007F
Query Profile	0x0080
Query Characteristic Services	0x0081
Query Include Services	0x0082
Read Characteristic Value by UUID	0x0083

Command	Command ID
Query Attribute Descriptor	0x0084
Query Attribute Value	0x0085
Query Multiple Attribute Values	0x0086
Query Long Attribute Values	0x0087
Set Attribute Value	0x0088
Set Attribute Value No Ack	0x0089
Set Long Attribute Value	0x008A
Set Prepare Long Attribute Value	0x008B
Execute Long Attribute Value Write	0x008C
Initialize BLE module	0x008D
De-initialize BLE module	0x008E
Antenna Select	0x008F
Add New Service	0x0092
Add New Attribute	0x0093
Set local attribute value	0x0094
Get local attribute value	0x0095
Notify request	0x0096
Set advertise data	0x009C
Get LE ping timeout	0x00A1
Set LE ping timeout	0x00A2
Set Random Address	0x00A3
Data Encrypt	0x00A4
GATT Read	0x00A5
Scan Response	0X00A8
White List	0X00AA
Remove Service	0X00AB
Remove Attribute	0X00AC
Resolvlist	0X00AD
Get Resolvlist Size	0X00AE
Set Resolution Enable	0X00AF
Read Phy	0X00B0
Set Phy	0X00B1
Set Data Length	0x00B2
Read Data Length	0x00B3
Set Privacy Mode	0x00B4

Command	Command ID
CBFC Connection Request	0x00B5
CBFC Connection Response	0x00B6
CBFC Tx Data	0x00B7
CBFC Disconnect	0x00B8
LE LTK Request Reply	0x00BA
Rx Test Mode	0x00BB
Tx Test Mode	0x00BC
End Test Mode	0x00BD
Vendor Specific	0x00BE
PER Tx Mode	0x00BF
PER Rx Mode	0x00C0
Profiles Async Request	0x00F2
Profile Async Request	0x00F3
Get char services Async	0x00F4
Get Include services Aync	0x00F5
Read char value by UUID Async	0x00F6
Get attribute Async	0x00F7
Get Descriptor value async	0x00F8
Get multiple values Async	0x00F9
Get Long desc values Async	0x00FA
Set desc value Async	0x00FB
Set prepare write Async	0x00FC
Execute Long desc write Async	0x00FD

Table 7: Response IDs in BLE Mode

Response	Response ID
Card Ready	0x0505
Set Local Name	0x0001
Get Local Name	0x0002
Get RSSI	0x0005
Get Local BD Address	0x0007
Advertise	0x0075
Scan	0x0076
Connect	0x0077
Disconnect	0x0078

Response	Response ID
Query Device State	0x0079
Connection parameter update	0x007A
Start Encryption	0x007B
SMP Pair Request	0x007C
SMP Response	0x007D
SMP Passkey	0x007E
Query Profiles list	0x007F
Query Profile	0x0080
Query Characteristic Services	0x0081
Query Include Services	0x0082
Read Characteristic Value by UUID	0x0083
Query Attribute Descriptor	0x0084
Query Attribute Value	0x0085
Query Multiple Attribute Values	0x0086
Query Long Attribute Values	0x0087
Set Attribute Value	0x0088
Set Attribute Value No Ack	0x0089
Set Long Attribute Value	0x008A
Set Prepare Long Attribute Value	0x008B
Execute Long Attribute Value Write	0x008C
Initialize BLE module	0x008D
Deinitialize BLE module	0x008E
Antenna Select	0x008F
Add New Service	0x0092
Add New Attribute	0x0093
Set local attribute value	0x0094
Get local attribute value	0x0095
Notify Response	0x0096
Indicate value	0x0097
Set advertise data	0x009C
Get le ping timeout	0x00A1
Set le ping timeout	0x00A2
Set Random Address	0x00A3
Data Encrypt	0x00A4
GATT Read	0x00A5

Response	Response ID
Scan Response	0X00A8
White List	0X00AA
Remove Service	0X00AB
Remove Attribute	0X00AC
Resolvlist	0X00AD
Get Resolvlist Size	0X00AE
Set Resolution Enable	0X00AF
Read Phy	0X00B0
Set Phy	0X00B1
Set Data Length	0x00B2
Read Data Length	0x00B3
Set Privacy Mode	0x00B4
CBFC Connect Request	0x00B5
CBFC Connect Response	0x00B6
CBFC Tx Data	0x00B7
CBFC Disconnect	0x00B8
LE LTK Request Reply	0x00BA
Rx Test Mode	0x00BB
Tx Test Mode	0x00BC
End Test Mode	0x00BD
Vendor Specific	0x00BE
PER Tx Mode	0x00BF
PER Rx Mode	0x00C0
Profiles Async Request	0x00F2
Profile Async Request	0x00F3
Get char services Async	0x00F4
Get Include services Aync	0x00F5
Read char value by UUID Async	0x00F6
Get attribute Async	0x00F7
Get Descriptor value async	0x00F8
Get multiple values Async	0x00F9
Get Long desc values Async	0x00FA
Set desc value Async	0x00FB
Set prepare write Async	0x00FC
Execute Long desc write Async	0x00FD

Table 8 Event IDs in BLE mode

Event	Event ID
Disconnected	0x1006
GATT Error Response	0x1500
GATT Desc Val Response	0x1501
GATT Primary Service by UUID	0x1502
GATT Read Char Services	0x1503
GATT Read Include Services	0x1504
GATT Read Val by UUID	0x1505
GATT Read Response	0x1506
GATT Read Blob Response	0x1507
GATT Read Multiple Response	0x1508
GATT Primary Service list	0x1509
GATT Write Response	0x150A
GATT Prepare Write Response	0x150B
GATT Execute Write Response	0x150C
Scan Response	0x150E
Connection Status	0x150F
SMP Request	0x1510
SMP Response	0x1511
SMP Passkey	0x1512
SMP Failed	0x1513
GATT Notification	0x1514
GATT Indication	0x1515
Encrypt Status	0x1516
GATT Write	0x1517
LE ping timeout expired	0x1518
Prepare Write	0x1519
Execute Write	0x151A
GATT Read	0x151B
MTU size	0x151C
SMP passkey display	0x151D
Phy Update Complete	0x151E
Data length change event	0x151F
SMP SC Passkey	0x1520
Enhanced Connection Event	0x1521

Event	Event ID
Directed Advertising Report	0x1522
Security Keys	0x1523
PSM Connection Request	0x1524
PSM Connection Complete	0x1525
PSM Rx Data	0x1526
PSM Disconnect	0x1527
LE LTK Request	0x152A
Connection Update Complete	0x152B
Remote Features	0x152C
BLE More Data Request	0x152D

6 BLE Commands

This section explains various BLE commands, the parameters they take and their responses. For API prototypes of these commands, please refer to the API Library Section.

Note:
A command should not be issued by the Host before receiving the response of a previously issued command from the module.

6.1 Generic Commands

6.1.1 Set Operating Mode

Description:
This is the first command that needs to be sent from the Host after receiving card ready frame from module. This command configures the module in different functional modes.
Command Format:
AT Mode:

```
at+rsi_opermode=
<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bit_map>,<ext_custom_feature_bit_map>,<bt_custom_feature_bit_map>,<ext_tcp_ip_feature_bit_map>,<ble_custom_feature_bit_map>,<ble_custom_ext_feature_bit_map>,<config_feature_bit_map>\r\n
```

Note:

If BIT(31) is set to ‘1’ in custom_feature_bitmap
at+rsi_opermode=<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bitmap><ext_custom_feature_bit_map>\r\n

if BIT(31) is set to ‘1’ in tcp_ip_feature_bit_map
at+rsi_opermode=<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bitmap><ext_tcp_ip_feature_bit_map>\r\n

if BIT(31) is set to ‘1’ in both custom_feature and ext_custom_feature bit maps
at+rsi_opermode=<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bitmap><ext_custom_feature_bit_map> <bt_custom_feature_bit_map>\r\n

if BIT(31) is set to 1 in bt_custom_feature_bit_map

at+rsi_opermode=<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bitmap><ext_custom_feature_bit_map><bt_custom_feature_bit_map><ext_tcp_ip_feature_bit_map><ble_custom_feature_bit_map>\r\n

if BIT(31) is set to 1 in ble_custom_feature_bit_map

at+rsi_opermode=<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bitmap><ext_custom_feature_bit_map><bt_custom_feature_bit_map><ext_tcp_ip_feature_bit_map><ble_custom_feature_bit_map>,<ble_custom_ext_feature_bit_map>\r\n

if BIT(31) is set to '1' in both tcp_ip_feature_bit_map and ext_tcp_ip_feature_bit_map

at+rsi_opermode=<oper_mode>,<feature_bit_map>,<tcp_ip_feature_bit_map>,<custom_feature_bitmap><ext_custom_feature_bit_map><bt_custom_feature_bit_map><ext_tcp_ip_feature_bit_map><ble_custom_feature_bit_map>,<ble_custom_ext_feature_bit_map>,<config_feature_bit_map>\r\n

Command Parameters:

Oper_mode(4 bytes):
Sets the mode of operation. oper_mode contains two parts <wifi_oper_mode, coex_mode>. Lower two bytes represent wifi_oper_mode and higher two bytes represent coex_mode.

oper_mode = ((wifi_oper_mode) | (coex_mode << 16))

Note:
please refer to **RS9116W Wi-Fi AT Command Programming Reference Manual.pdf** at https://docs.silabs.com/rs9116 for more details on WLAN and co-existence of other protocols with WLAN. In BTLE mode, BT mode needs to be enabled as well.

Following table represents possible BLE coex modes supported (WLAN is supported only in RS9116 WiSeConnect):

8	Dual Mode (Bluetooth and BLE)
12	BLE mode

* Will be supported in future releases.

Table 5-1: BLE Coex Modes Supported

Note:

1. If coex mode is enabled in opermode command, then BT / BLE protocol will start and give corresponding card ready in parallel with opermode command response (which will be handled by corresponding application).
2. BT card ready frame is described in **RS9116W BT Classic AT Command Programming Reference Manual.pdf** at https://docs.silabs.com/rs9116, BLE card ready frame is described in **RS9116W BLE AT Command Programming Reference Manual.pdf** at https://docs.silabs.com/rs9116**.**
3. Feature selection utility is provided in the package. WiSeConnect device supports the selected features combination only if it is feasible as per the **RSXXXXX_TCPIP_Feature_Selection_vX.xlsx**

custom_feature_bit_map(4 bytes):

This bitmap is used to enable following BT/BLE custom features:

BIT[11]: To Enable Packet Pending Indication(**wake on wireless**) in UART mode

1 - Enable
0 – Disable

BIT[29]: To Enable IAP support in BT mode

1 - Enable
0 – Disable

BIT[31]: This bit is used to validate extended custom feature bitmap.

1 – Extended feature bitmap valid

0 – Extended feature bitmap is invalid

BIT[0:1], BIT[3:4], BIT[7], BIT[21], BIT[30]: Reserved, should be set to all '0'.

If opermode is 8 (PER mode is selected) - feature_bit_map, tcp_ip_feature_bit_map and custom_feature_bit_map can be ignored or not valid. Set to zero.

ext_custom_feature_bit_map(4 bytes):

This feature bitmap is an extension of custom feature bitmap and is valid only if BIT[31] of custom feature bitmap is set. This enables the following feature.
BIT[0]: To enable antenna diversity feature.

1 – Enable antenna diversity feature
0 – Disable antenna diversity feature

BIT[1]:This bit is used to enable 4096 bit RSA key support

1 – Enable 4096-bit RSA key support
0 – Disable 4096-bit RSA key support

This bit is required to set for 4096-bit RSA key support. If key size is 4096-bit, module will use a software routine for exponentiation, so connection time will increase.

BIT[3]: This bit is used to enable SSL certificate with 4096-bit key support

1 – Enable 4096-bit key support for SSL sockets
0 – Disable 4096-bit key support for SSL sockets

If this bit is enabled, then connected client who is in power save may miss the packet.

BIT[5]: This bit is used to enable Pre-authentication Support.

1 – Enable Pre-authentication Support
0 – Disable Pre-authentication Support

BIT[6]: This bit is used to enable 40MHZ Support

1 – Enable 40MHZ Support
0 – Disable 40MHZ Support

(BIT[20] | BIT[21]) -This bit is used to configure the 384k mode.

Note:
It is mandatory to use 384k mode for all use-cases.

1- Enable
0-Disable

BIT[31]: This bit is used to validate bt and ble feature bitmap.

1 – BT & BLE feature bitmap valid
0 – BT & BLE feature bitmap is invalid

bt_custom_feature_bit_map(4 bytes):

This bitmap is valid only if BIT[31] of the extended custom feature bit map is set.

BIT[0:1] – HP/LP Chain selection in bt classic

0 - BDR/EDR HP chain
1- BDR HP chain
2- BDR LP chain

BIT[2:14] – reserved

BIT[15] – HFP profile bit enable

1- Enable the HFP profile
0- Disable the HFP profile

BIT[16:19] – reserved for future use

BIT[20:22] – Number of slaves supported by BT

Maximum no of BT slaves: 2

BIT [23] – A2DP profile bit enable

1- Enable the A2DP profile
0- Disable the A2DP profile

BIT [24] – A2DP profile role selection

1- A2DP source
0- A2DP sink

BIT [25] – A2DP accelerated mode selection

1- Enable accelerated mode
0- Disable accelerated mode

BIT [26] – A2DP i2s mode selection

1- Enable i2s mode
0- Disable i2s mode

BIT [27:29] – reserved

BIT[30] – RF Type selection

1 - Internal Rf Type selection
0 - External Rf Type selection

BIT[31] - Validate ble feature bit map.

1 - valid ble feature bit map
0 - Ignore ble feature bit map

ble_custom_feature_bit_map(4 bytes):

This bitmap is valid only if BIT[31] of bt custom feature bit map is set.

BIT [0:7] – BLE nbr of attributes,

Maximum No of Ble attributes = 80, Please refer **NOTE** given below for more info

BIT[8:11] – BLE Nbr of GATT services

Maximum no services - 10, Please refer **NOTE** given below for more info

BIT [12:15] – BLE Nbr of slaves

Maximum No of Ble slaves = 8, Please refer **NOTE** given below for more info

BIT[16:23] – BLE tx power save index

Give 31 as ble tx power index (eg: 31<<16)

This variable is used to select the ble tx power index value. The following are the possible values.

Default Value for BLE Tx Power Index is 31
The range for the BLE Tx Power Index is 1 to 75 (0, 32 index is invalid)

1 - 31   BLE -0DBM Mode

33 - 63 BLE- 10DBM Mode

64- 75 BLE - HP Mode.

BIT[24:26] – BLE power save options

BLE_DUTY_CYCLING	BIT(24)
BLR_DUTY_CYCLING	BIT(25)
BLE_4X_PWR_SAVE_MODE	BIT(26)

BIT [27:28] - BLE Nbr of masters

Maximum No od BLE Masters = 2, Please refer **NOTE** given below for more info

BIT[29] - GATT SYNC BIT

0 - Gatt Async

1 - Gatt Sync

BIT[30] - To ensure the RS9113 - RS9116 compatible features

1 - Enable the 9116 compatible features

0 - Enable the 9113 compatible features

BIT[31] -Validate ble custom ext feature bit map.

1 - valid ble custom ext feature bit map
0 - Ignore ble custom ext feature bit map

ble_custom_ext_feature_bit_map(4 bytes):

This bitmap is valid only if BIT[31] of ble custom feature bit map is set.

BIT [0:4] – BLE nbr of Connection Events

BIT[5:12] - BLE nbr of record size in bytes (n)

Note:

Eg: n*16:(n=60, Default 1024 bytes(1K)).

BIT[13] - GATT INIT

0 - Gatt Init in Firmware

1 - Gatt Init in Host

Note:

If bit bt_custom_feature_bit_map[31] is set:

1. User can enter maximum of 8 BLE slaves.
2. User can enter maximum of 2 BLE masters.
3. Maximum of 10 services in total can exist out of which two services namely GAP and GATT are added by default. So, if this bitmap has value 10 user can add up to 8 services.
4. Maximum of 80 attributes in total can exist out of which ten attributes of GAP and GATT are added by default. So, if this bitmap has value 80 user can add up to 70 attributes.

If bit bt_custom_feature_bit_map is not set:

1. Default number of BLE slaves supported is 3.
2. Default number of BLE masters supported is 1.
3. Maximum of 5 services in total can exist out of which two services namely GAP and GATT are added by default. So, user can add up to 3 services.
4. Maximum of 20 attributes in total can exist out of which ten attributes of GAP and GATT are added by default. So, user can add up to 10 attributes.

config_feature_bit_map(4 bytes):

This bitmap is valid only if BIT[31] of ext_tcp_ip_feature_bit_map is set.

Config Feature bitmap	Functionality	Bit set to 0	Bit set to 1	Note and Info
config_feature_bit_map[0]	To select wakeup indication to host. If it is disabled UULP_GPIO_3 is used as a wakeup indication to host. If it is enabled UULP_GPIO_0 is used as a wakeup indication to host.	Disable	Enable	
config_feature_bi_map[1:15]	Reserved			
config_feature_bi_map[16]	Active high or low interrupt mode selection for wake on wireless operation If it is disabled active low interrupt is used in wake on wireless operation. If it is enabled active high interrupt is used in wake on wireless operation.	Disable	Enable	
config_feature_bi_map[17:31]	Reserved			

Note:

32KHz external clock connection and power save pins

As per Silicon Labs datasheet update in May 2019, the 32KHz external clock and the power save pins connections have changed. To keep SW compatibility between initial design (i.e. first EVKs developed by Silicon Labs) as well as new designs, there are currently 2 options for connecting the 32KHz external clock and the power save pins:

Option 1:

External 32KHz clock connection pins: XTAL_32KHZ_P & XTAL_32KHZ_N

Power Save connection pins : HOST_BYP_ULP_WAKEUP & UULP_VBAT_GPIO_3

Option 2:

External 32KHz clock connection pin: UULP_VBAT_GPIO_3

Power Save connection pins : HOST_BYP_ULP_WAKEUP & UULP_VBAT_GPIO_0

As per Silicon Labs datasheet updated in May'2019, Option 2 must be used for External 32KHz external clock and Power save connections in new designs

Response:

AT Mode:

Result Code	Description
OK	Successful execution of the command
ERROR<Error code>	Failure

Example 1:
To enable wlan and ble operating mode with ble power save index as 31 and 9116 compatible feature enabled.

AT Mode:

```
at+rsi_opermode=851968,0,1,2147483648,2150629376,3221225472,0,3760128000,2048\r\n
```

Response:

```
OK\r\n
bt_loaded\r\n
```

Example 2:

To enable 7 ble slaves, 5 services and 25 attributes, 30 ble power save index

Command in AT Mode:

```
at+rsi_opermode=851968,0,1,2147483648,2150629376,3221225472,0,1996057\r\n
```

Response:

```
OK\r\n
bt_loaded\r\n
```

6.1.2 Query RSSI

Description:
This is used to query RSSI of the connected remote BD device

AT command format:

```
at+rsibt_getrssi=<BDAddress>?\r\n
```

Parameter: BDAddress(6 bytes) - BT Address of the connected remote device.

Result Code	Description
OK <rssi value>	Command Success.
ERROR <Error_code>	Command Fail.

Response parameters:
RSSI – RSSI value of the connected remote device.

AT command Ex:

```
at+rsibt_getrssi=AA-BB-CC-DD-EE-FF?\r\n
```

Response:

OK 130\r\n

6.1.3 Query Local BD Address

Description:
This is used to query the BD address of the local device

AT command format:

at+rsibt_getlocalbdaddr?\r\n

Result Code	Description
OK <bd_addr>	Command Success with valid response.
ERROR <Error_code>	Command Fail.

Response Parameters:
BDAddress(6 bytes) - BT Address of the local device

AT command Ex:

at+rsibt_getlocalbdaddr?\r\n

Response:

OK AA-BB-CC-DD-EE-FF\r\n

6.1.4 Query BT Stack Version

Description:

This is used to query the Current BT Stack Version.

AT command format:

at+rsibt_getbtstackversion?\r\n

Result Code	Description
OK <stack version>	Command Success with valid response.
ERROR <Error_code>	Command Fail.

Response Parameters:
stackVersion(10 bytes) - Current Stack Version

AT command Ex:

at+rsibt_getbtstackversion?\r\n

Response:

OK 2.0

6.1.5 BLE PER Transmit

Description:

This command can be given to start the ble transmission.

AT Command format:

at+rsibt_bletransmit=<enable/disable>,<access_addr>,<ble_rate>,<rx_channel_num>,<tx_channel_num>,<scrambler_seed>,<le_channel_type>,<hopping_type>,<antenna_sel>,<pll_mode>,<rf_type>,<rf_chain>,<pkt_len>,<payload_type>,<tx_power_index>,<tx_mode>,<inter_packet_gap>,<num_of_packets>\r\n

Parameters:

Access Address: It is a 32-bit address in hexadecimal format, e.g.,00112233

ble_rate: 1Mbps - 1, 2Mbps - 2, 125Kbps - 4, 500Kbps - 8

rx_channel_index: Receive channel index, as per the Bluetooth standard. i.e., 0 to 39

tx_channel_index: Transmit channel index, as per the Bluetooth standard. i.e., 0 to 39 scrambler_seed: Initial seed to be used for whitening. It should be set to ‘0’ in order to disable whitening.

le_channel_type: advertising channel - 0, data channel - 1

hopping_type: no hopping -0, fixed hopping - 1, random hopping - 2

antenna_sel: onchip antenna - 2, u.f.l - 3

pll_mode: PLL_MODE0 – 0, PLL_MODE1 – 1, PLL_MODE2 –   2

rf_type: External RF – 0, Internal RF – 1

rf_chain: WLAN_HP_CHAIN 0, WLAN_LP_CHAIN 1, BT_HP_CHAIN 2, BT_LP_CHAIN 3

pkt_len: Length of the packet, in bytes, to be transmitted. Max pkt_len to be transmitted is 240

payload_type: Type of payload to be transmitted

‘0’ – Payload consists of PRBS9 sequence

‘1’ – Payload consists of all 0x0F’s

‘2’ – Payload consists of all 0x55’s

‘3’ – Payload consists of all PBRS15 sequence

‘4’ – Payload consists of all 0xFF's

‘5’ – Payload consists of all 0x00's

‘6’ – Payload consists of all 0xF0's

‘7’ – Payload consists of all 0xA0's

tx_power_index : Transmit power value should be transmitted.

For the BLE-LP Chain, 1 - 31 - 0DBM Mode, 33-63 - 10DBM Mode.

For BLE-LP Chain tx_power value 0 and 32 are invalid.

tx_mode: Burst mode - 0, Continuous mode - 1

inter_pkt_gap: Number of slots to be skipped between two packets - Each slot will be 1250usec

no_of_packets: Number of packets to be transmitted. It is valid only when the <tx_mode> is set to Burst mode.

AT command Ex:

at+rsibt_bletransmit=1,71764129,1,10,10,0,1,0,3,0,1,3,240,1,31,0,0,0\r\n(enable/start)

Response:

OK\r\n

6.1.6 BLE PER Receive

Description:

This command can be given to start the ble reception.

AT Command format:

at+rsibt_blereceive=<enable/disable>,<access_addr>,<ble_rate>,<rx_channel_num>,<tx_channel_num>,<scrambler_seed>,<le_channel_type>,<hopping_type>,<antenna_sel>,<pll_mode>,<rf_type>,<rf_chain>,<ext_data_len_ind>,<loop_back_mode>,<duty_cycling>\r\n

Parameters:

Access Address: It is a 32-bit address in hexadecimal format, e.g.,00112233

ble_rate: 1Mbps - 1 ,2Mbps - 2, Long Range (LR) - 4

rx_channel_num: Receive channel index, as per the Bluetooth standard. i.e., 0 to 39

tx_channel_num: Transmit channel index, as per the Bluetooth standard. i.e., 0 to 39

scrambler_seed: Initial seed to be used for whitening. It should be set to ‘0’ in order to disable whitening.

le_channel_type: advertising channel – 0, data channel – 1

hopping_type: no hopping -0, fixed hopping - 1, random hopping - 2

antenna_sel: onchip antenna - 2, u.fl – 3 pll_mode: PLL_MODE0 – 0, PLL_MODE1 – 1, PLL_MODE2 – 2

rf_type: External RF – 0, Internal RF – 1

rf_chain: WLAN_HP_CHAIN 0, WLAN_LP_CHAIN 1, BT_HP_CHAIN 2, BT_LP_CHAIN 3

ext_data_len_ind: 0 – Disable (37 Bytes)

1 – Enable (240 Bytes)

loop_back_mode: Disable – 0, Enable – 1

duty_cycling: powersave_options BIT(7) - BLE-4X Mode, BIT(0) - Duty Cycling Mode

AT command Ex:

at+rsibt_blereceive=1,71764129,1,10,10,0,1,0,3,0,1,3,240,1,0\r\n(enable/start)

Response:

OK\r\n

Appendix

Frequencies and channel Numbers used for Bluetooth LE Mode:

Band (GHz)	Bandwidth (MHz)	Channel	Center Freq (MHz)
2.4	2	0	2402
2.4	2	1	2404
2.4	2	2	2406
2.4	2	3	2408
2.4	2	4	2410
2.4	2	5	2412
2.4	2	6	2414
2.4	2	7	2416
2.4	2	8	2418
2.4	2	9	2420
2.4	2	10	2422
2.4	2	11	2424
2.4	2	12	2426
2.4	2	13	2428
2.4	2	14	2430
2.4	2	15	2432
2.4	2	16	2434
2.4	2	17	2436
2.4	2	18	2438
2.4	2	19	2440
2.4	2	20	2442
2.4	2	21	2444
2.4	2	22	2446
2.4	2	23	2448

Band (GHz)	Bandwidth (MHz)	Channel	Center Freq (MHz)
2.4	2	24	2450
2.4	2	25	2452
2.4	2	26	2454
2.4	2	27	2456
2.4	2	28	2458
2.4	2	29	2460
2.4	2	30	2462
2.4	2	31	2464
2.4	2	32	2466
2.4	2	33	2468
2.4	2	34	2470
2.4	2	35	2472
2.4	2	36	2474
2.4	2	37	2476
2.4	2	38	2478
2.4	2	39	2480

6.1.7 PER CW Mode

Description:

This command can be given to enable the Continuous Wave mode transmission.

AT Command format:

at+rsibt_percwmode=<Enable/Disable>\r\n

Parameters:

Disable - 0

Enable - 1

Note:
Need to issue this command after giving the ble transmit command.

6.2 BLE Core Commands

6.2.1 Advertise Local Device

Description:
This is used to expose or advertise about the local device to the remote BT devices.

AT Command format:

at+rsibt_advertise=< Status >,< AdvertiseType >,< FilterType >,<DirectAddrType>,<DirectAddr>,< adv_int_min >,< adv_int_max >,< own_add_type >,< adv_channel_map >\r\n

Note:

All parameters should be in decimal except DirectAddr, it should be in hexadecimal.

Parameters:
Status (1 byte) – To enable/disable Advertising.

1 – Enable Advertising
0 – Disable Advertising

AdvertiseType (1 byte) –

State	Description
0x80	Connectable undirected
0x81	Connectable directed with high duty cycle
0x82	Scannable undirected
0x83	Non connectable undirected
0x84	Connectable directed with low duty cycle

FilterType (1 byte) –

Filter type	Description
0	Allow Scan Request from Any, Allow Connect Request from Any.
1	Allow Scan Request from White List Only, Allow Connect Request from Any.
2	Allow Scan Request from Any, Allow Connect Request from White List Only.
3	Allow Scan Request from White List Only, Allow Connect Request from White List Only.

DirectAddrType(1 byte) -

0 – Public address
1 – Random address

DirectAddr(1 byte)- Remote device BD Address
adv_int_min(2 bytes) -

Value	Parameter Description
N = 0xXXXX	Minimum advertising interval for non-directed advertising. Range: 0x0020 to 0x4000 Default: N = 0x0800 (1.28 second) Time = N * 0.625 msec Time Range: 20 ms to 10.24 sec.

adv_int_max(2 bytes) -

Value	Parameter Description
N = 0xXXXX	Minimum advertising interval for non-directed advertising. Range: 0x0020 to 0x4000 Default: N = 0x0800 (1.28 second) Time = N * 0.625 msec Time Range: 20 ms to 10.24 sec.

own_add_type(1 byte) -

Value	Parameter Description
0x00	Public Device Address (default)
0x01	Random Device Address

Value	Parameter Description
0x02 – 0xFF	Reserved for future use

adv_channel_map(1 byte)-

Value	Parameter Description
00000000b	Reserved for future use
xxxxxxx1b	Enable channel 37 use
xxxxxx1xb	Enable channel 38 use
xxxxx1xxb	Enable channel 39 use
00000111b	Default (all channels enabled)

AT command Ex:

at+rsibt_advertise=1,128,0,0,0,32,32,0,7\r\n(enable)

Response:

OK\r\n

Note:
For scannable undirected and non-connectable undirected advertising modes, minimum advertising interval should be 41ms and maximum advertising interval should be 1.28s

6.2.2 Scan

Description: This is used to scan for remote LE advertise devices.

AT Command format:

at+rsibt_scan=< Status >, < Scantype >, < FilterType >,< own_add_type >,< scan_int >,< scan_win >\r\n

Note:
All Parameters should be in Decimal.

Parameters:
Status (1 byte) – To enable/disable Scanning

1 – Enable Scanning
0 – Disable Scanning

Scantype(1 byte) –

Scan type	Description
0	Passive Scanning
1	Active Scanning

FilterType(1 byte) –

Value	Parameter Description
0	Accept all advertisement packets.
1	Accept only white listed device advertisement packets.

Scan_int(2 bytes) -

Value	Description
N = 0xXXXX	This is defined as the time interval from when the Controller started its last LE scan until it begins the subsequent LE scan. Range: 0x0004 to 0x4000 Default: 0x0010 (10 ms) Time = N * 0.625 msec Time Range: 2.5 msec to 10 . 24 seconds

scan_win(2 bytes) -

Value	Description
N = 0xXXXX	The duration of the LE scan. LE_Scan_Window shall be less than or equal to LE_Scan_Interval Range: 0x0004 to 0x4000 Default: 0x0010 (10 ms) Time = N * 0.625 msec Time Range: 2.5 msec to 10240 msec

own_add_type(1 byte) -

Value	Parameter Description
0x00	Public Device Address (default)
0x01	Random Device Address
0x02 – 0xFF	Reserved for future use

AT command Ex:

at+rsibt_scan=1,0,0,0,100,10\r\n (enable scan)

Response:

OK\r\n

AT command Ex:

at+rsibt_scan=0,0,0,0,100,10\r\n (disable scan)

Response:

OK\r\n

Note:

In parameters Scan Interval must be greater than scan window.

6.2.3 Connect

Description: This is used to create connection with remote LE device.
AT Command format:

at+rsibt_connect=< AddressType >, < BDAddress >< LeScanInterval >,< LeScanWindow >,< ConnIntervalMin >,< ConnIntervalMax >,< ConnLatency >,< SupervisionTimeout >\r\n

Parameters:
AddressType(1 byte) – Specifies the type of the address mentioned in BDAdress

0 – Public Address
1 – Random Address

BDAdress(6 bytes) – BD Address of the remote device

le_scan_interval and le_scan_window parameters are recommendations from the Host on how long (LE_Scan_Window) and how frequently (LE_Scan_Interval) the Controller should scan.

LE_Scan_Interval(2 bytes):

Value	Description
N = 0xXXXX	This is defined as the time interval from when the Controller started its last LE scan until it begins the subsequent LE scan. Range: 0x0004 to 0x4000 Time = N * 0.625 msec Time Range: 2.5 msec to 10.24 seconds

LE_Scan_Window(2 bytes):

Value	Description
N = 0xXXXX	Amount of time for the duration of the LE scan. LE_Scan_Window shall be less than or equal to LE_Scan_Interval Range: 0x0004 to 0x4000 Time = N * 0.625 msec Time Range: 2.5 msec to 10.24 seconds

The conn_interval_min and conn_interval_max parameters define the minimum and maximum allowed connection interval.

Conn_Interval_Min(1byte):

Value	Description
N = 0xXXXX	Minimum value for the connection event interval. This shall be less than or equal to Conn_Interval_Max. Range: 0x0006 to 0x0C80 Time = N * 1.25 msec Time Range: 7.5 msec to 4 seconds.
0x0000 – 0x0005 and 0x0C81 – 0xFFFF	Reserved for future use

Conn_Interval_Max(2 byte):

Value	Description
N = 0xXXXX	Minimum value for the connection event interval. This shall be greater than or equal to Conn_Interval_Min. Range: 0x0006 to 0x0C80 Time = N * 1.25 msec Time Range: 7.5 msec to 4 seconds.
0x0000 – 0x0005 and 0x0C81 – 0xFFFF	Reserved for future use

Conn_Latency(2 bytes):

The conn_latency parameter defines the maximum allowed connection Latency.

Value	Description
N = 0xXXXX	Slave latency for the connection in number of connection events. Range: 0x0000 to 0x01F4

Supervision_Timeout(2 bytes):

The supervision_tout parameter defines the link supervision timeout for the connection.

Value	Description
N = 0xXXXX	Supervision timeout for the LE Link. Range: 0x000A to 0x0C80 Time = N * 10 msec Time Range: 100 msec to 32 seconds
0x0000 – 0x0009 and 0x0C81 – 0xFFFF	Reserved for future use

AT command Ex:

at+rsibt_connect=0,B4-99-4C-64-BE-F5,96,32,160,160,0,100\r\n

Response:

OK\r\n

Note:

Reception of the response doesn't mean that Connection with the remote device is completed.
Connection is said to complete after it receives **Connection Complete Event**. The user is recommended not to give further commands before receiving the above Event. But the user can give **Disconnect** even before **Connection Complete Event** is received.

6.2.4 Disconnect

Description: This is used to cancel create Connection or disconnect HCI Connection, if already connected.
AT Command format*:*

at+rsibt_disconnect=<BDAddress>\r\n

Parameters:
BDAdress(6 bytes) – BD Address of the remote device
AT command Ex:

at+rsibt_disconnect=53-41-CC-FF-91-2A\r\n

Response:

OK\r\n

6.2.5 Query Device State

Description: This is used to query state of the local device.
AT Command format:

at+rsibt_getdevstate?\r\n

Result Code	Description
OK,< state>	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:
DeviceState(1 byte) –

Bit	Description
0	Advertise (0-disable/1-enable)
1	scan state (0-disable/ 1-enable)
2	connection initiated (0-not initiated/1-initiated)
3	connected state (0-not connected/1-connected)

AT command Ex:

at+rsibt_getdevstate?\r\n

Response:

OK 8\r\n

6.2.6 Start Encryption

Description: This is used to initiate the Encryption procedure.

AT command Format: at+rsibt_startencrypt=<BDAddress>,<RemoteEDIV>,<RemoteRand>,<RemoteLTK>\r\n

Parameters:

BDAddress(6 bytes) - Remote BD Address.

RemoteEDIV(2 bytes) - Remote device Encryption Diversifier

RemoteRand(8 bytes) - Remote device Random number

RemoteLTK(16 bytes) - Remote device Long Term Key

AT command Ex:

```
at+rsibt_startencrypt=B4-99-4C-64-BE-
F5,253C,45,B6,53,7A,37,42,85,9D,65,BA,84,DA,CC,56,85,9D,3A,74,3C,45,23,78,4D,3A\r\n
```

Response:

```
OK\r\n
```

6.2.7 SMP Pair Request

Description: This is used to send SMP Pair Request command to the connected remote device.

AT Command format:

```
at+rsibt_smpreq=<BDAddress>,<IO Capability>\r\n
```

Parameters:

BDAddress(6 bytes) - Remote BD Address.

IOCapability(1 byte) –

IO Capability type	Description
0	Display Only
1	Display Yes No
2	Keyboard only
3	No input no output

AT command Ex:

```
at+rsibt_smpreq=B4-99-4C-64-BE-F5,1\r\n
```

Response:

```
OK\r\n
```

6.2.8 SMP Response

Description: This is used to send SMP response to the SMP request made by the remote device.

AT Command format:

```
at+rsibt_smpresp=<BDAddress>,<IOCapability>\r\n
```

Parameters:

BDAddress(6 bytes) - Remote BD Address.

IOCapability (1 byte) –

IO Capability type	Description
0	Display Only
1	Display Yes No
2	Keyboard only
3	No input no output

AT command Ex:

```
at+rsibt_smpresp=74-04-2B-7A-93-EF,1\r\n
```

Response:

OK\r\n

6.2.9 SMP Passkey

Description: This is used to send SMP Passkey required to connect with the remote device.
AT Command format:

at+rsibt_smppasskey=<BDAddress>,<Passkey>\r\n

Parameters:

BDAddress(6 bytes) - Remote BD Address.
Passkey(4 bytes) – Passkey to authenticate with the Remote device.

AT command Ex:

at+rsibt_smppasskey=B4-99-4C-64-BE-F5,12345\r\n

Response:

OK\r\n

6.2.10 Initialize BLE Module

Description: This is used to initialize the BLE module
AT Command format:

at+rsibt_btinit\r\n

AT command Ex:

at+rsibt_btinit\r\n

Response:

OK\r\n

6.2.11 Deinitialize BLE Module

Description: This is used to de-initialize the BLE module.
AT Command format:

at+rsibt_btdeinit\r\n

AT command Ex:

at+rsibt_btdeinit\r\n

Response:

OK\r\n

6.2.12 BT Antenna Select

Description: This is used to select the internal or external antenna of the BT module.
AT Command format:

at+rsibt_btantennaselect=<AntennaVal>\r\n

Parameters:
AntennaVal(1 byte) – To select the internal or external antenna

0 – Internal Antenna.
1 – External Antenna.

AT command Ex:

at+rsibt_btantennaselect=1\r\n

Response:

OK\r\n

6.2.13 BLE Set Advertise Data

Description: This command is used to set the advertise data to expose remote devices.
AT Command format:

at+rsibt_setadvertisedata=<DataLen>,<Data>\r\n

Parameters:
Length (1 byte) – data length. Max advertise data length is 31.
Data (31 bytes) – Actual data
AT command Ex:

at+rsibt_setadvertisedata=8,2,1,6,4,9,72,72,72\r\n

Response: OK\r\n

Note:
Name set in this command will be shown on remote device when remote device scan for advertising device (except for iOS versions).

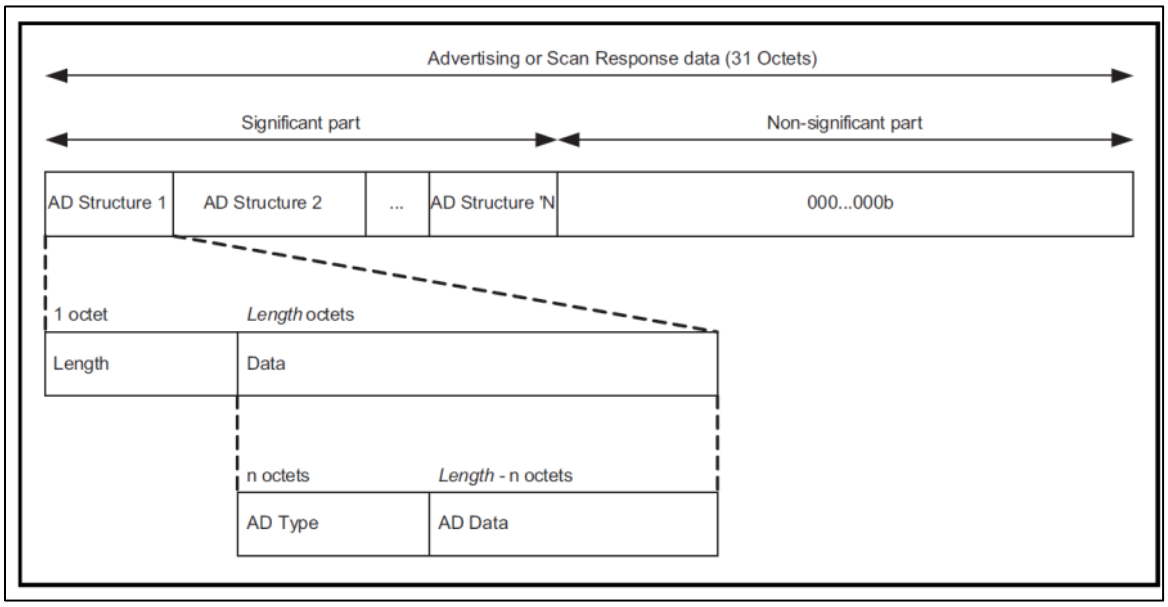


Figure 20: Advertising or Scan Response Data

For more information on this advertising data with types, information is available at following link:
https://www.bluetooth.com/specifications/assigned-numbers/generic-access-profile

6.2.14 BLE Set Scan Response Data

Description:

This command is used to set the scan response data.

AT Command format:

at+rsibt_setscanrspdata=<DataLen>,<Data>\r\n

Parameters:

Length(1 byte) – data length. Max Scan Response data length is 31.

Data(31 bytes) – Actual data

AT command Ex:

at+rsibt_setscanrspdata=8,2,1,6,4,9,72,72,72\r\n

Response:

OK\r\n

Note:
Name set in this command will be shown on remote device when remote device scan for advertising device (except for iOS versions).

Note:

Controller has default scan response data which enable the flags 2,1,6.

6.2.15 BLE Set LE Ping Timeout

Description: This command is used to set the LE ping timeout.

AT command Format:

```
at+rsibt_setlepingtimeout=<BDAddress>, <Timeout>\r\n
```

Parameters:
BDAddress(6 bytes): Remote BD Address.
Timeout(2 bytes)

Value	Parameter Description
N = 0xXXXX	Maximum amount of time specified between packets authenticated by a MIC. Default = 0x0BB8 (30 seconds) Range: 0x0001 to 0xFFFF Time = N * 10 msec Time Range: 10 msec to 655,350 msec

AT command Ex:

```
at+rsibt_setlepingtimeout=B4-99-4C-64-BE-F5,30000\r\n
```

Response:

```
OK\r\n
```

6.2.16 BLE Get LE Ping Timeout

Description: This command is used to get the LE ping timeout (In milliseconds).

Note:

Currently Get LE ping is not supported.

AT command Format:

```
at+rsibt_getlepingtimeout=<Connected Remote BD_ADDR>\r\n
```

AT command Ex:

```
at+rsibt_setlepingtimeout?\r\n
```

Response:

```
OK 30000\r\n
```

6.2.17 BLE Set Random Device Address

Description:

This command is used by the Host to set the LE Random Device Address in the Controller.

AT command Format:

at+rsibt_setrandadd=<BDAddress>\r\n

Parameters:
BDAddress(6 bytes):

Value	Parameter Description
0xXXXXXXXXXXXX	Random Device Address as defined by Device Address

Return Parameters:
Status:

Value	Parameter Description
0x00	LE_Set_Random_Address command succeeded.
0x01 – 0xFF	LE_Set_Random_Address command failed.

AT command Ex:

at+rsibt_setrandadd= B4-99-4C-64-BE-F5\r\n

Response:

OK 0\r\n

6.2.18 BLE Data Encrypt

Description: This command is used to encrypt the data.

AT command Format:
at+rsibt_leencrypt=<key>,<data>\r\n
Parameters:
key – key length is 16 Bytes.
Data – Actual data , length is 16 Bytes.

Result Code	Description
OK <EncData>	Command Success.
ERROR <Error_code>	Command Fail.

AT command Ex:

at+rsibt_leencrypt=1,2,3,4,5,6,7,8,9,0,B,C,D,E,F,10, 1,2,3,4,5,6,7,8,9,0,B,C,D,E,F,10\r\n

Response:

OK 10 93 c1 5a e4 a5 db fd 5e c2 4c 61 8a a3 11 28 \r\n

6.2.19 BLE Whitelist

Description: This is used to add a particular BD-Address to the white list.

AT command format: at+rsibt_lewhitelist=<Add/deletebit>,<BDAddress>,<BDAddressType>\r\n

Parameters:
Add/Delete bit(1 byte) – This bit specifies the operation to be done

0 – Clear all entries
1 – Add entry to white list
2 – Delete entry from the white list

BDAddress(6 bytes) – BDAddress of the remote device that needed to be added to white list

BDAddressType(1 byte) – Type of the BDAddress

0- Public Device Address
1 – Random Device Address

ATcommandEx:

at+rsibt_lewhitelist=1,00-23-A7-80-6F-CD,1\r\n

Response:

OK\r\n

6.2.20 BLE Set MTU Size Command

Description: This is used to set the MTU size for the BLE stack.

AT command format: at+rsibt_blesetmtu=<BDAddress>,<MTU Size>\r\n

Parameters:
BDAddress (6 bytes)– BDAddress of the remote device

MTU Size - MTU size for BLE.

ATcommandEx:

at+rsibt_blesetmtu=69-76-4A-4C-13-8C,80\r\n

Response:

OK\r\n

Note:

By default, MTU size is 240bytes. Until issue this command, MTU size won't be changed from 240bytes.

6.2.21 BLE Set Phy Command

Description: The LE_Set_PHY command is used to set the PHY preferences for the connection identified by the Connection_Handle.

AT command format:

at+rsibt_setphy=<remotebdaddress>,<all_phy>,<tx_phy>,<rx_phy>,<phy_ options>

Parameters:

BDAddress(6 bytes) – BDAddress of the remote device.

<All_phy>(1 byte)– The Host has no preference among the transmitter PHYs supported by the Controller.

< tx_phy >(1 byte)-

BIT(0) - The Host prefers to use the LE 1M transmitter PHY (possibly among others)

BIT(1) - The Host prefers to use the LE 2M transmitter PHY (possibly among others)

BIT(2) - The Host prefers to use the LE Coded transmitter PHY (possibly among others)

BIT(3) – BIT(7) Reserved for future use

<rx_phy>(1 byte) -

BIT(0) - The Host prefers to use the LE 1M receiver PHY (possibly among others)

BIT(1) - The Host prefers to use the LE 2M receiver PHY (possibly among others)

BIT(2) - The Host prefers to use the LE Coded receiver PHY (possibly among others)

BIT(3) – BIT(7) Reserved for future use

<phy_ options>(2 bytes)

0 = the Host has no preferred coding when transmitting on the LE Coded

PHY

1 = the Host prefers that S=2 coding be used when transmitting on the LE

Coded PHY

2 = the Host prefers that S=8 coding be used when transmitting on the LE

Coded PHY

3 = Reserved for future use

ATcommandEx:

at+rsibt_setphy=00-23-A7-00-00-0D,0,1,2,0

Response:

OK\r\n

6.2.22 BLE Read Phy Command

Description: The LE_Read_PHY command is used to read the current transmitter PHY and receiver PHY on the connection identified by the Connection_Handle.

AT command format: at+rsibt_readphy=<remotebdaddr>

Parameters:
remotebdaddr(6 bytes) – BDAddress of the remote device.

ATcommandEx:

at+rsibt_readphy=00-23-A7-00-00-0D

Response:

OK\r\n

6.2.23 BLE Set Data Length Command

Description: The LE_Set_Data_Length command allows the Host to suggest maximum transmission packet size and maximum packet transmission time.

AT command format:

At+rsibt_setdatalength=<BDAddress>,<TXOctets><TXTime>\r\n

Parameters:

BDAddress(6 bytes) – BDAddress of the remote device.
TXOctets(2 bytes)– Preferred maximum number of payload octets that the local I Controller should include in a single Link Layer packet on this connection.
TXTime(2 bytes)-Preferred maximum number of microseconds that the local Controller should use to transmit a single Link Layer packet on this connection.

ATcommandEx:

at+rsibt_setdatalength =00-23-A7-80-6F-CD,40,330,\r\n

Response:

OK\r\n

6.2.24 BLE Read Maximum Data Length Command

Description: The LE_Read_Maximum_Data_Length command allows the Host to read the Controller's maximum supported payload octets and packet duration times for transmission and reception.

AT command format:

At+rsibt_readdatalength?

ATcommandEx:

at+rsibt_readdatalength?\r\n

Response:

OK\r\n

6.2.25 BLE_Resolvlist

Description: The Resolving_List command is used to add/remove/clear one device to the list of address translations used to resolve Resolvable Private Addresses in the Controller.

AT command format:

at+rsibt_resolvlist=<Process_type>,<address_type>,<peer_address>,<peer_irk>,<local_irk>

Parameters:

<Process_type>

1 = Add
2=Remove
3=Clear Resolvlist.

<AddressType > =

0x00 Public Identity Address
0x01 Random (static) Identity Address
0x02 – 0xFF Reserved for Future Use

<peer_address> = Public or Random (static) Identity address of the peer device

< peer_irk> = IRK of the peer device.

<local_irk> = IRK of the local device.

ATcommandEx:

Example 1:
-- > Add device to resolvlist
at+rsibt_resolvlist=1,0,00-23-A7-00-00-0D,01,01,01,01,01,01,01,01,01,01,01,01,01,01,01,01,02,02,02,02,02,02,02,02,02,02,02,02,02,02,02,02
Example 2:
-->remove device from resolvlist
at+rsibt_resolvlist=2,<address_type>,<peer_address>
eg:at+rsibt_resolvlist=2,0,00-23-A7-00-00-0D
Example 3:
-->clear resolvlist
at+rsibt_resolvlist=3

Response:

OK\r\n

6.2.26 BLE GetResolvlist Size

Description: The BLE_Read_Resolving_List_Size command is used to read the total number of address translation entries in the resolving list that can be stored in the Controller.

AT command format:

At+rsibt_ getresolvlistsize?\r\n

ATcommandEx:

at+rsibt_ getresolvlistsize?\r\n

Response:

OK\r\n

6.2.27 BLE SetResolution Enable

Description: The BLE_Set_Address_Resolution_Enable command is used to enable resolution of Resolvable Private Addresses in the Controller,The LE _Timeout command set the length of time the Controller uses a Resolvable Private Address before a new resolvable private address is generated and starts being used. This timeout applies to all addresses generated by the Controller.

AT command format:

at+rsibt_setresolutionenable=<enable>,<timeout>

Parameters:

<enable> =

0-disable
1-Enable

<timeout>-RPA_Timeout measured in s

Range for N: 0x0001 – 0xA1B8 (1 s – approximately 11.5 hours)

Default: N= 0x0384 (900 s or 15 minutes)

ATcommandEx:

at+rsibt_setresolutionenable=1,60

Response:

OK\r\n

6.2.28 BLE SetPrivacy Mode

Description:

The HCI_LE_Set_Privacy_Mode command is used to allow the Host to specify the privacy mode to be used for a given entry on the resolving list.

AT command format:

at+rsibt_setprivacymode=<peer_addr_type>,<peer_addr>,<privacy_mode>

Parameters:

<peer_addr_type>-

Value	Parameter Description
0x00	Public Identity Address
0x01	Random (static) Identity Address

All other values Reserved for future use

<peer_addr> - Public Identity Address or Random (static) Identity Address of the advertiser.

<privacy_mode> -

0x00	Use Network Privacy Mode for this peer device (default)
0x01	Use Device Privacy Mode for this peer device

All other values Reserved for future use

ATcommandEx:

at+rsibt_setprivacymode=0,00-23-A7-00-00-0D,1

Response:

OK\r\n

6.2.29 BLE Connection Update Command

Description: The LE_UPDATE_PARAMS command is used to change the Link Layer connection parameters of a connection.

AT command format:

at+rsibt_updateparams=<bd_addr>,<Conn_Interval_Min>,<Conn_Interval_Max>,<Conn_Latency>,<Supervision_Timeout>

Parameters:

bd_addr – BDAddress of the remote device.

Conn_Interval_Min (in dec) – Minimum value for the connection interval. This shall be less than or equal to Conn_Interval_Max.

Conn_Interval_Max (in dec) – Maximum value for the connection interval. This shall be greater than or equal to Conn_Interval_Min.

Min and max interval Range: 6 to 3200 (Time = N * 1.25 ms, Time Range: 7.5 ms to 4 s.)

Conn_Latency (in dec) – Slave latency for the connection in number of connection events.

Range: 0 to 499

Supervision_Timeout (in dec) – Supervision timeout for the LE Link.

Range: 10 to 3200 (Time = N * 10 ms, Time Range: 100 ms to 32 s)

No need to pass Min_CE_Len and Max_CE_Len value.

All other values Reserved for future use

ATcommandEx:

at+rsibt_updateparams=00-1A-7D-DA-71-13,12,12,0,500

Response:

OK\r\n

6.3 BLE GATT Profile Commands

6.3.1 Query Profiles List

Description: This is used to query all the supported profiles list from the connected remote device.

AT Command format: at+rsibt_getallprofiles=<BDAddress>,<StartHandle>,<EndHandle>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

StartHandle(2 bytes) – Start of the handle from which Include services are to be known.

EndHandle(2 bytes) – End of the handle till which Include services are to be known.

Result Code	Description
OK ,<nbr_profiles>,<profile descriptors list>	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

Parameter	Size/type	Description
nbr_profiles	8 bit	No of profiles supported by the remote device
profile descriptors list	PROFILE_DESCRIPTOR (10 bytes)	Profiles descriptors of the profiles

AT command Ex:

at+rsibt_getallprofiles=B4-99-4C-64-BE-F5,1,10\r\n

Response:

OK 3\n
1,B,2,1800\n
C,F,2,1801\n
10,FFFF,2,180A\r\n

6.3.2 Query Profile

Description: This is used to query particular profile details from the connected remote device.

AT command format:

at+rsibt_getprofile=<BDAddress>,<size_uuid>,<ProfileUUID>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.
ProfileUUID – UUID of the profile.

Result Code	Description
OK ,<profile descriptor>\r\n	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

ProfileDescriptor(28 bytes) – PROFILE_DESCRIPTOR is explained above.

AT command Ex:

at+rsibt_getprofile=77-A8-E3-CC-41-CB,2,1800\r\n

Response:

OK 1,5,2,1800\r\n

6.3.3 Query Characteristic Services

Description:

This is used to query characteristic services, with in the range, from the connected remote device.

AT command format:

at+rsibt_getcharservices=<BDAddress>,<StartHandle>,<EndHandle>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address

StartHandle(2 bytes) – Start of the handle from which Characteristics services are to be known.

EndHandle(2 bytes) – End of the handle till which Characteristics services are to be known.

Result Code	**Description**
OK,<NumberOfCharServices>,< CharacteristicService >	Command Success.
ERROR <Error_code>	Command Fail.

Response parameters:

Parameter	**Size/type**	**Description**
NumberOfCharServices	8 bit	No of Characteristic services.
CharacteristicService[5]	CHARACTERISTIC_SERVICE(5 bytes)	Each Characteristic Service details.

AT COMMAND Ex:

at+rsibt_getcharservices=B4-99-4C-64-BE-F5,1,10\r\n

Response:

```
OK 5, 2,2,3,2,2A00\n
4,2,5,2,2A01\n
6,2,7,2,2A02\n
8,8,9,2,2A03\n
A,2,B,2,2A04\r\n
```

6.3.4 Query Include Services

Description: This is used to query include services, with in the particular range, from the connected remote device.

AT Command format*:*

at+rsibt_getincservices=<BDAddress>,<StartHandle>,<EndHandle>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

StartHandle(2 bytes) – Start of the handle from which Include services are to be known.

EndHandle(2 bytes) – End of the handle till which Include services are to be known.

AT command Ex:

at+rsibt_getincservices=68-2F-10-0B-62-63,1,10\r\n

Response:

OK 0,\r\n

6.3.5 Read Characteristic Value By UUID

Description: This is used to get the characteristic attribute value of specified UUID.

AT Command format:

at+rsibt_readbytype=<BDAddress>,<StartHandle>,<Endhandle>,<size>, <UUID>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

StartHandle(2 bytes) – Start of the handle from which Attribute values are to be known.

EndHandle(2 bytes) - End of the handle till which Attribute values are to be known.

Reserved(2 bytes) - Padding

CharacterUUID – UUID whose Attribute values are to be known.

Result Code	**Description**
OK, <NumberOfValues>,< CharacterValue >\r\n	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

NumberOfValues(1 byte) – Number of valid bytes in the CharacterValue.

CharacterValue(30 bytes) – Attribute value of the given CharacterUUID.

AT command Ex:

at+rsibt_readbytype=65-65-11-B4-8C-08,1,10,2,2A00\r\n

Response:

OK 6,3,0,69,50,61,64\r\n

6.3.6 Query Attribute

Description:

This is used to query the Attribute Descriptors from the connected remote device. The Descriptor includes both the Handle and UUID.

AT Command Format:

at+rsibt_getdescriptors=<BDAddress>,<StartHandle>,<EndHandle>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

StartHandle(2 bytes) – The handle from which Attribute Descriptors are to be known**.**

EndHandle(2 bytes) – The handle till which Attribute Descriptors are to be known**.**

Result Code	**Description**
OK <NumberOfAttributes >,< AttributeDescriptor >\r\n	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

NumberOfAttributes(1 byte) – No of attributes

AttributeDescriptor(5 bytes) – Descriptor of each Attribute

AT command Ex:

at+rsibt_getdescriptors=B4-99-4C-64-BE-F5,1,ffff\r\n

Response:

OK 5

1,2,2800

2,2,2803
3,2,2A00
4,2,2803
5,2,2A01\r\n

6.3.7 Query Attribute Value

Description: This is used to query Attribute value from the connected remote device.

AT Command format:

at+rsibt_readvalue=<BDAddress>,<Handle>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle of the Attribute whose value is to be known.

Result Code	Description
OK ,<NumberOfValues>,< AttributeValues >\r\n	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

NumberOfValues(1 bytes) – No of valid bytes in the AttributeValues

AttributeValues(30 bytes) – Attribute value of the specified Handle

AT command Ex:

at+rsibt_readvalue=65-65-11-B4-8C-08,1\r\n

Response:

OK 2,0,18\r\n

6.3.8 LE L2CAP Credit Based Flow Control Connection Request

Description:

This command is used to initiate new PSM connection with remote device.

AT Command format:

at+rsibt_psmconnreq=<remote_addr>, <psm>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

PSM(2 bytes) - Protocol/Service Multiplexer (PSM) This field helps to indicate the protocol.

AT CommandEx:

at+rsibt_psmconnreq=00-23-A7-00-00-0A,23

Response:

OK\r\n

6.3.9 LE L2CAP Credit Based Flow Control Data Transfer

Description: This command is used to send data to remote device through specific PSM connection.

AT command format:

at+rsibt_sendpsmdata=<remote_addr>, <lcid>,<data_len>,<data>\r\n

Parameters:

Remote-BDAddress(6 bytes) – BDAddress of the remote device

Lcid(2 bytes) – local channel identifiervalue

Data_len(2 bytes) – length of the data to be sent to remote device.

Data –Actual data that must be sent.

ATcommandEx:

at+rsibt_sendpsmdata=00-232-A7-00-00-09, 80,5,1,1,2,3,4 r\n

Response:

OK\r\n

6.3.10 LE L2CAP Credit Based Flow Control Connection Response

Description:

This command is used to accept or reject the remote device PSM connection request.

AT command format:

at+rsibt_psmconnresp=<remote_addr>,<lcid>,<resp>\r\n

Parameters:

Remote-BDAddress(6 bytes) – BDAddress of the remote device.

Lcid(2 bytes) – local channel identifier value

resp(1 byte):

0 - Reject the PSM connection request

1 - Accept the PSM connection request

ATcommandEx:

at+rsibt_psmconnresp=00-232-A7-00-00-09,1 r\n

Response:

OK\r\n

6.3.11 LE L2CAP Credit Based Flow Control Disconnection

Description:

This command is used to disconnect the logical connection between the devices.

AT command format:

at+rsibt_psmdisconn=<remote_addr>, <lcid>\r\n

Parameters:

Remote-BDAddress(6 bytes) – BDAddress of the remote device.

Lcid(2 bytes) – local channel identifier value

ATcommandEx:

at+rsibt_psmdisconn =00-232-A7-00-00-09,80r\n

Response:

OK\r\n

6.3.12 LE Enhanced Receiver Test Mode

Description:

This command is used to start a test where the DUT receives test reference packets at a fixed interval.

AT command format:

at+rsibt_enhancedrxtest=<RX_channel>, <phy>,<Modulation>\r\n

Parameters:

<RX_channel>(1 byte) - Channel in which packet have to be received.

<phy>(1 byte)– 0x00 Reserved for future use

0x01 Receiver set to use the LE 1M PHY

0x02 Receiver set to use the LE 2M PHY

0x03 Receiver set to use the LE Coded PHY

0x04 – 0xFF Reserved for future use.

<Modulation>(1 byte) – 0x00 Assume transmitter will have a standard modulation index

0x01 Assume transmitter will have a stable modulation index

0x02 – 0xFF Reserved for future use

ATcommandEx:

at+rsibt_enhancedrxtest=30,1,1\ r\n

Response:

OK\r\n

6.3.13 LE Enhanced Transmitter Test Mode

Description: This command is used to start a test where the DUT generates test reference packets at a fixed interval.

AT command format:

at+rsibt_enhancedtxtest=<RX_channel>, <phy>,< TxLen>,< TxDataMode>\r\n

Parameters:

<TX_channel>(1 byte) - Channel in which packet have to be sent.

<phy>(1 byte)– 0x00 Reserved for future use

0x01 Receiver set to use the LE 1M PHY

0x02 Receiver set to use the LE 2M PHY

0x03 Receiver set to use the LE Coded PHY

0x04 – 0xFF Reserved for future use.

< TxLen>(1 byte) - Length in bytes of payload data in each packet.

< TxDataMode>(1 byte) - 0x00 PRBS9 sequence ‘11111111100000111101...

0x01 Repeated ‘11110000’

0x02 Repeated ‘10101010’

0x03 PRBS15

0x04 Repeated ‘11111111’

0x05 Repeated ‘00000000’

ATcommandEx:

at+rsibt_enhancedtxtest=30,1,2,0\ r\n

Response:

OK\r\n

6.3.14 LE Enhanced End Test Mode

Description:

This command is used to stop any test which is in progress.

AT command format:

at+rsibt_endtest\r\n

Return Parameters:

< NumOfPkts >(2 bytes) - Number of RX packets received are displayed

ATcommandEx:

at+rsibt_entest\ r\n

Response:

10

6.3.15 LE LTK Request Reply

Description: This is used to intimate controller about the long term key in host.

AT command format:

at+rsibt_leltkreqreply=<BD Address>,<reply type>, <Local Long term key> \r\n

Parameters:

BDAddress(6 bytes) – BDAddress of the remote device that needed to be added to white list

Reply Type(1 byte) –

0- Negative reply

1 – Positive reply

Local Long term key(16 bytes) – Either NULL or 16 bytes value.

ATcommandEx:

at+rsibt_leltkreqreply=6E-35-7C-35-50-2F,0,0 \r\n
at+rsibt_leltkreqreply=6E-35-7C-35-50-2F,1,<LocalLTK of 16 bytes> \r\n

Response:

OK\r\n

6.3.16 LE Read Multiple

Description:

This is used to query Multiple Attribute values from the connected remote device.

AT Command format:

at+rsibt_readmultiple=<BDAddress>,<NumberofHandles>,<Handles>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

NumberOfHandles(1 byte) – No of handles whose Attribute values are to be known.

Handles(10 bytes) – The handle whose Attribute value is to be known.

Result Code	Description
OK,<NumberOfValues>,< AttributeValues >	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

NumberOfValues(2 bytes) – No of valid bytes in the AttributeValues

AttributeValues(30 bytes) – Attribute value of the specified Handles

AT command Ex:

at+rsibt_readmultiple=65-65-11-B4-8C-08,3,1,2,5\r\n

Response:

OK 9,0,18,2,3,0,0,2A,80,2\r\n

6.3.17 Query Long Attribute Value

Description:

This is used to query long Attribute value from the connected remote device. This is useful when the Attribute value is more than 30 bytes.

AT Command format:

at+rsibt_longread=<BDAddress>,<Handle>,<Offset>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle of the Attribute whose value is to be known.

Offset(2 bytes) – Offset from which Attribute values are to be known.

Result Code	Description
OK ,<NumberOfValues>,< LongAttrValue >	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

NumberOfValues – No of valid bytes in the LongAttValue.

LongAttValue – Attribute value of the specified Handle.

AT command Ex:

at+rsibt_longread=65-65-11-B4-8C-08,10,1\r\n

Response:

OK 12,0,D9,D9,AA,FD,BD,9B,21,98,A8,49,E1,45,F3,D8,D1,69\r\n

6.3.18 Set Attribute Value

Description:

This is used to Set attribute value of the connected remote device.

AT Command format:

at+rsibt_writevalue=<BDAddress>,<Handle>,<Length>,<value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle of the Attribute whose value has to be set.

Length(1 byte) – No of bytes to be set in the specified Handle

Value(25 bytes) – Value to be set in the specified Handle

AT command Ex:

at+rsibt_writevalue=65-65-11-B4-8C-08,34,2,1,0\r\n

Response:

OK \r\n

6.3.19 Set Attribute Value No Ack

Description:

This is used to Set attribute value of the connected remote device. If Attribute value is set using this command, Ack will not be received from the remote device.

AT Command format:

at+rsibt_writecmd=<BDAddress>,<Handle>,<Length>,<value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle of the Attribute whose value has to be set.

Length(1 byte) – No of bytes to be set in the specified Handle

Value(25 bytes) – Value to be set in the specified Handle

AT command Ex:

at+rsibt_writecmd=65-65-11-B4-8C-08,1,1,2\r\n

Response:

OK\r\n

6.3.20 Set Long Attribute Value

Description:

This is used to Set long attribute value of the connected remote device. This is useful when the no of bytes to be set are more than 25 and when from a offset byte are to be written.

AT Command format:

at+rsibt_longwrite=<BDAddress>,<Handle>,<Offset>,<Length>,<value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle of the Attribute whose value has to be set.

Offset(2 bytes) – Offset from which Value has to set in the specified Handle

Length(1 byte) – No of bytes to be set in the specified Handle

Value(40 bytes) – Value to be set in the specified Handle

AT command Ex:

at+rsibt_longwrite =C0-FF-EE-C0-FF-EE,1,1,1,2\r\n

Response:

OK\r\n

6.3.21 Set Prepare Long Attribute Value

Description:

This is used to Set Long Attribute value in the connected remote device. When Value is set using this API, the remote device will wait for "Execute Long Attribute Value " to come before updating its handle with the value received.

AT Command format:

at+rsibt_preparewrite=<BDAddress>,<Handle>,<Offset>,<Length>,<Value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle of the Attribute whose value has to be set.

Offset(2 bytes) – Offset from which Value has to set in the specified Handle

Length(1 byte) – No of bytes to be set in the specified Handle

Value(40 bytes) – Value to be set in the specified Handle

AT command Ex:

at+rsibt_preparewrite=B4-99-4C-64-BC-AF,1,1,1,2\r\n

Response:

OK \r\n (or)
ERROR, err_no\r\n

6.3.22 Execute Long Attribute Value

Description:

This is used to send Execute Long Attribute Value to the connected remote device. Depending on the "flag" of this command, the remote device will either set/not set the previously sent Prepare Long Attribute values.

AT Command format:

at+rsibt_executewrite=<BDAddress>,<Flag>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Flag(1 byte) – This parameter decides whether to set/not set the previously sent Prepare Long Attribute values.

0 – Don't set the values
1 – Set the values

AT command Ex:

at+rsibt_executewrite=C0-FF-EE-C0-FF-EE,1\r\n

Response:

OK\r\n

6.4 BLE Create New Service Commands

6.4.1 Add GATT Service Record

Description:

This is used to add the new service Record in BLE GATT record list. If service is created successfully service record handle is returned, else error value is returned.

AT Command format:

at+rsibt_addservice=<uuid_size>,<ServiceUUID>,<NbrAttributes>,<MaxAttDataSize>\r\n

Parameters:

ServiceUUID – BLE supporting service UUID value.

NbrAttributes(2 bytes) – number of attributes need to add for this service.

MaxAttDataSize(2 bytes) – maximum number of data length that can be used in attribute list.

Result Code	Description
OK, < ServiceHndlerPtr >,< StartHndl >	Command Success.
ERROR <Error_code>	Command Fail.

Response Parameters:

ServiceHndlerPtr – created GATT service record handle.

StartHndl(2 bytes) - service record starting attribute handle value.

AT command Ex:

at+rsibt_addservice=2,18ff,3,30\r\n

Response:

OK 157A8,A\r\n

6.4.2 Add Attribute Record

Description:

This is used to add the attribute record to the specific service using service record handle.

AT Command format:

at+rsibt_addattribute=<ServiceHndlerPtr>,<Hndl>,<AttUUIDsize>,<AttUUID>,<prop>,<DataLen>,<ConfigBitmap>,<Data>\r\n

Parameters:

ServiceHndlerPtr – service record handle.

Hndl(2 bytes) – handle of the attribute record.

AttUUID – attribute record UUID.

Prop(1 byte) – property of the attribute.

DataLen(2 bytes) – attribute record data length.

Data (max 20 bytes) – attribute record data value.

ConfigBitmap – attribute configuration bitmap. *Refer below Notes

Note:

If DataLen is less than 20 bytes and ConfigBitmap=0 then the attribute record will be maintained inside the RSI_DEVICE.

Either of the case fails, Application must maintain the record data.

ConfigBitmap

```
#define ATT_REC_MAINTAIN_IN_HOST     BIT(0)       /* Att record maintained by the Host */
#define SEC_MODE_1_LEVEL_1           BIT(1)       /* NO Auth & No Enc                 */
#define SEC_MODE_1_LEVEL_2           BIT(2)       /* UnAUTH with Enc                  */
#define SEC_MODE_1_LEVEL_3           BIT(3)       /* AUTH with Enc                   */
#define SEC_MODE_1_LEVEL_4           BIT(4)       /* AUTH LE_SC Pairing with Enc      */
```

All other bits are reserved.

AT command Ex:

at+rsibt_addattribute=157A8,A,2,2A02,1,9,0,1,2,3,4,5,6,7,8,0\r\n

Response:

OK\r\n

6.4.3 Set Local Attribute Value

Description: This is used to set/change the local attribute record value to the specific service using service record handle.

AT Command format:

at+rsibt_setlocalattvalue=<Hndl>,<DataLen>,<Data>\r\n

Parameters:

Hndl(2 bytes) – handle of the attribute record.

DataLen(2 bytes) – attribute record data length.

Data(31 bytes) – attribute record data value.

AT command Ex:

at+rsibt_setlocalattvalue=A,1,EE\r\n

Response:

OK\r\n

6.4.4 Get Local Attribute Value

Description:

This is used to read the local attribute record value to the specific service using service record handle.

AT Command format:

at+rsibt_getlocalattvalue=<Hndl>\r\n

Parameters:

Hndl(2 bytes) – handle of the attribute record.

Result Code	Description
OK, <Handle >,<data_len>,<data>	Command Success
ERROR <Error_code>	Command Fail

Parameters:

Hndl(2 bytes) – handle of the attribute record.

DataLen(2 bytes) – attribute record data length.

Data(31 bytes) – attribute record data value.

AT command Ex:

at+rsibt_getlocalattvalue=A\r\n

Response:

OK A,1,EE\r\n

6.4.5 Remove Service

Description:

This command is used to remove service from the profile.

AT command format:

at+rsibt_removeservice=<Servicehandlerptr>

Parameters:

ServiceHndlerPtr – service record handle.

ATcommandEx:

at+rsibt_removeservice=157A8

Response:

OK\r\n

6.4.6 Remove Attribute

Description:

This command is used to remove an attribute.

AT command format:

at+rsibt_removeattribute=<Servicehandlerptr>,<AttHandle>

Parameters:

ServiceHndlerPtr – service record handle.

AttHandle(2 bytes)-Handle of the attribute which has to be removed.

ATcommandEx:

at+rsibt_removeservice=157A8,10

Response:

OK\r\n

6.5 BLE Core Events

6.5.1 Advertise Report Event

Description:

This event indicates the remote device's Advertisement. It comes when **Scan** is enabled in the local device.

AT Event format:

AT+RSIBT_ADVRTISE, <<addr_type >, <bd_addr >,<RSSI>,<Type>,<adv_data_len>,< adv_data >>\r\n

Parameters:

addr_type(1 byte): Type of address of advertiser.
0-Public address
1-Random address
2-Public Identity Address
3-Random(static) Identity Address

bd_add(6 bytes)r: Advertiser address
RSSI(1 byte): Signal strength indication between devices
adv_data_len(1 byte): total raw advertisement data length
adv_data(31 bytes): advertisement data

type(1 byte) : 0→ Connectable undirected advertising (ADV_IND).

1→ Connectable directed advertising (ADV_DIRECT_IND)

2 → Scannable undirected advertising (ADV_SCAN_IND)

3 → Non connectable undirected advertising (ADV_NONCONN_IND)

4 → Scan Response (SCAN_RSP)

0x05-0xFF Reserved for future use

AT event Ex:

AT+RSIBT_ADVRTISE,addr_type:0,addr:B4-99-4C-64-BC-AF,RSSI:-31,Type:3,adv_data_len:3,adv_data:2,1,6
In the above example
addr_type = 0
addr = B4-99-4C-64-BC-AF
RSSI = -31
adv_data_len = 3
adv_data = 2,1,6
type:3

Note:

1. RSSI in decimal format
2. addr_type, addr, adv_data_len are in ascii format

6.5.2 LE Connected Event

Description:

This event indicates either the Connection is Success or not, when 9113 compatible features BIT[30] is set from ble_custom_feature_bit_map in opermode.

AT Event format:

AT+RSIBT_ LE_DEVICE_CONNECTED= <addr_type>,<bd_addr>,<status>\r\n

Parameters:

BDAddresstype(1 byte) – Address type of the connected device

0 – Public address
1 – Random address

BDAddress(6 bytes) – BD Address of the connected device
Status(1 byte): 0 – Success,

Non-zero – Failure

AT event Ex:

AT+RSIBT_LE_DEVICE_CONNECTED=0,B4-99-4C-64-BE-F5,0\r\n

6.5.3 Disconnected

Description:
This event is raised when disconnection happens between the local BT device and the remote device.

AT Event Format:

AT+RSIBT_LE_DISCONNECTED < bd_addr>,<dev_type>\r\n

Parameters:

BDAddress(6 bytes) – BD address of the remote BT device.

dev_type(1 byte) - Device type

AT event Ex:

AT+RSIBT_LE_DISCONNECTED 62-CB-12-9D-CA-F2,4E13\r\n

6.5.4 SMP Request Event

Description:
This event is raised when the SMP Request comes from the connected remote device.

Action:
Upon reception of this event **SMP Response** command has to be given.

AT Event format:

AT+RSIBT_SMP_REQUEST <bd_addr>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

AT event Ex:

AT+RSIBT_SMP_REQUEST AA-BB-CC-DD-EE-FF\r\n

6.5.5 SMP Response Event

Description:
This event is raised when the SMP Response comes from the connected remote device.

Action:
Upon reception of this event **SMP Passkey** command has to be given.

AT event format:

AT+RSIBT_SMP_RESPONSE <bd_addr>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

AT Event Ex:

AT+RSIBT_SMP_RESPONSE AA-BB-CC-DD-EE-FF \r\n

6.5.6 SMP Passkey Event

Description:
This event is raised when the SMP Passkey comes from the connected remote device.

Action:
Upon reception of this event **SMP Passkey** command has to be given.

Event format*:*

AT+RSIBT_SMPPASSKEY <bd_addr>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

AT event Ex:

AT+RSIBT_SMP_PASSKEY AA-BB-CC-DD-EE-FF\r\n

6.5.7 SMP Failed Event

Description:

This event is raised when the SMP exchange fails. The reason for failure would be present in the Descriptor frame.

Event format*:*

AT+RSIBT_SMP_FAILED, <bd_addr>,<error>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Error – reason for SMP failing.

Event Ex:

AT+RSIBT_SMP_FAILED, AA-BB-CC-DD-EE-FF,4B01\r\n

6.5.8 SMP Encrypt Enabled Event

Description:

This event is raised when the encryption gets started. If some problem occurs in starting the encryption, an error code will be sent in this event.

Event format:

AT+RSIBT_ENCRYPTION_ENABLED 88-DA-1A-9E-81-87, Local EDIV: 1FFF Local
RAND: 71,80,0,BF,0,0,C0,1 Local LTK: 63,63,6D,45,62,55,81,9D,A4,22,8E,69,CA,77,7F,B0\r\n or
AT+RSIBT_ENCRYPTION_DISABLED\r\n

6.5.9 LE Ping Payload Timeout

Note:
Currently LE ping is not supported.

Description:

This event is raised when the LE ping timeout exceeds.

Event format*:*

AT+RSIBT_LE_PING_TIMEOUT <bd_addr>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Event Ex:

AT+RSIBT_LE_PING_TIMEOUT 88-DA-1A-16-E6-1C\r\n

6.5.10 LE MTU Size

Description:

This event is raised after LE connection.

Event format*:*

AT+RSIBT_LE_REMOTE_MTU_SIZE ,<bd_addr>,<mtu_size>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

MTU_size(2 bytes) - Size of MTU

Event Ex:

AT+RSIBT_LE_REMOTE_MTU_SIZE 00-1A-7D-34-54-66,64

6.5.11 SMP Passkey Display Event

Description:
This event is raised when the SMP Passkey comes from the connected remote device.

> **Note:**
> If IO_Capability request in SMP Passkey Request is DISPLAY_ONLY then only this event occurs.

Action:

Upon reception of this event **SMP Passkey** command is not required.

Event format*:*

AT+RSIBT_SMPPASSKEY_DISPLAY <bd_addr>,<Passkey>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Passkey(4 bytes) - Passkey

AT event Ex: AT+RSIBT_SMP_PASSKEY_DISPLAY AA-BB-CC-DD-EE-FF,123456\r\n

> **Note:**
> If IO_Capability request as DISPLAY_ONLY in both sides then SMP will won't work.

6.5.12 Phy Update Event

Description:

The LE PHY Update Complete Event is used to indicate that the Controller has changed the transmitter PHY or receiver PHY in use.

Event format:

Event format:
AT+RSIBT_LE_PHY_UPDATE_COMPLETE = <bd_addr>, <status><Tx_phy> Rx_phy>\r\n

Parameters:

BDAddress(6 bytes) – BD Address of the connected device

< tx_phy >(1 byte)-

  0 - The Host prefers to use the LE 1M transmitter PHY (possibly among others)

  1 - The Host prefers to use the LE 2M transmitter PHY (possibly among others)

  2 - The Host prefers to use the LE Coded transmitter PHY (possibly among others)

  3 – 7 Reserved for future use

<rx_phy>(1 byte) -

  0 - The Host prefers to use the LE 1M receiver PHY (possibly among others)

  1 - The Host prefers to use the LE 2M receiver PHY (possibly among others)

  2 - The Host prefers to use the LE Coded receiver PHY (possibly among others)

  3 – 7 Reserved for future use

Status(1 byte): 0 – Success,

  Non-zero – Failure

AT event Ex:

AT+RSIBT_ LE_PHY_UPDATE_COMPLETE =B4-99-4C-64-BE-F5,0,2,1\r\n

6.5.13 BLE Data Length Change Event

Description:
The LE Data Length Change event notifies the Host of a change to either the maximum Payload length or the maximum transmission time of packets in either direction.

Event format*:*

AT+RSIBT_LE_DATA_LENGTH_CHANGE_EVENT <BDAddress><MaxTxOctets>,<MaxTxTime>,<MaxRxOctets><MaxRxTime>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

MaxTXOctets(2 bytes)– The maximum number of payload octets in a Link Layer packet that the local Controller will send on this connection.

MaxTXTime(2 bytes)- The maximum time that the local Controller will take to send a Link Layer packet on this connection.

MaxRXOctets(2 bytes)– The maximum number of payload octets in a Link Layer packet that the local Controller expects to receive on this connection

MaxRXTime(2 bytes)- The maximum time that the local Controller expects to take to receive a Link Layer packet on this connection

Event Ex:

AT+RSIBT_LE_DATA_LENGTH_UPDATE 00-23-A7-12-23-24,40,330,50,320 \r\n

6.5.14 SMP Secure Connection Passkey Event

Description:
This event is raised when the SMP Secure Connection Passkey comes from the connected remote device.
Action:
Upon reception of this event **SMP Passkey** command has to be given.

Event format*:*

AT+RSIBT_LE_SC_PASSKEY_ENTRY = <bd_addr>,<passkey>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Passkey(4 bytes)- Passkey to authenticate with the Remote device.

AT event Ex:

AT+RSIBT_LE_SC_PASSKEY_ENTRY <remote_addr>,<passkey>\r\n

6.5.15 LE Directed Advertising Report Event

Description:

The LE Directed Advertising Report event indicates that directed advertisements have been received.

Event format*:*

AT+RSIBT_LE_DIRECTED_ADV_REPORT<AddressType><Address>,<DirectedAddressType>,<DirectedAddress><Rssi>\r\n

Parameters:

<AddressType>(1 byte)- Specifies the type of the address mentioned in BDAdress

0 – Public Address
1 – Random Address
2- Public Identity Address.

<BDAddress>(18 bytes) – Remote BD Address.

<DirectedAddressType>(1 byte) - Random Device Address.

<DirectedAddress>(18 bytes) - Random Device Address.

<Rssi>(1 byte)-Received signal strength value.

Event Ex:

AT+RSIBT_LE_DATA_LENGTH_CHANGE_EVENT 1,00-23-A7-12-23-24,1, 00-23-A7-12-23-24,21\r\n

6.5.16 Enhanced Connection Complete Event

Description: Enhanced Connection Complete Event indicates both of the hosts forming a connection that a new connection has been established.

Event format*:*

AT+RSIBT_ LE_DEVICE_ENHANCE_CONNECTED= <addr_type>,<bd_addr>, <status>,<LocalResolvableAddr >,< PeerResolvableAddr >\r\n

Parameters:

BDAddresstype(1 byte) – Address type of the connected device

0 – Public address
1 – Random address

BDAddress(6 bytes) – BD Address of the connected device

Status(1 byte): 0 – Success,

Non-zero – Failure

LocalResolvableAddr(6 bytes)-Resolvable address of the local device.

PeerResolvableAddr(bytes)-Resolvable address of the remote device.

AT event Ex:

AT+RSIBT_ LE_DEVICE_ENHANCE_CONNECTED=0,B4-99-4C-64-BE-F5, 74-99-4C-64-BB-F5, 48-99-4C-64-BE-F5,0\r\n

6.5.17 L2cap Credit Based Flow Control Connection Request Event

Description:

This event is used to notify the PSM connection request to host

Event format:

AT+RSIBT_LEPSMCONNREQ<remote_addr>,<status>,<psm>,<MTU>, <MPS>,<lcid>\r\n

Parameters:

Remote-BDAddress(6 bytes) – BD Address of the remote device

Status(1 byte): 0 – Success,

Non-zero – Failure

Psm(2 bytes) – Protocol/Service Multiplexer (PSM) This field helps to indicate the protocol.

MTU(2 bytes) – Maximum transmission unit that device can transmit.

MPS(2 bytes) – Maximum payload size , this is the maximum size of l2cap packet that can be transmitted.

Lcid(2 bytes) – local device channel identifier

AT event Ex:

AT+RSIBT_LEPSMCONNREQ B4-99-4C-64-BE-F5,0,23,17,17,80 \r\n

6.5.18 L2cap Credit Based Flow Control Connection Complete Event

Description:

This event is used to notify the PSM connection request to host

Event format:

AT+RSIBT_LEPSMCONNCOMPLETE <remote_addr>,<status>,<psm>,<MTU>, <MPS>,<lcid>\r\n

Parameters:

Remote-BDAddress(6 bytes) – BD Address of the remote device

Status(1 byte): 0 – Success, Non-zero – Failure

Psm(2 bytes) – Protocol/Service Multiplexer (PSM) This field helps to indicate the protocol.

MTU(2 bytes) – Maximum transmission unit that device can transmit.

MPS(2 bytes) – Maximum payload size , this is the maximum size of l2cap packet that can be transmitted.

Lcid(2 bytes) – local device channel identifier

AT event Ex:

AT+RSIBT_LEPSMCONNCOMPLETE B4-99-4C-64-BE-F5,0,23,17, 17,80\r\n

6.5.19 L2cap Credit Based Flow Control RX Data Event

Description:

This event is used to notify the remote device specific PSM data has been transferd to Host

Event format:

AT+RSIBT_PSMDATARX <remote_bdaddr>,<lcid>, <data_length>,<data>\r\n

Parameters:

Remote-BDAddress(6 bytes) – BD Address of the remote device

Lcid (2 bytes)– local device channel identifier

Data length (2 bytes)– length of data transferred

Data ()– Actual data that got transfered

AT event Ex:

AT+RSIBT_PSMDATARX B4-99-4C-64-BE-F5,80, 5,1,2,3,4,5\r\n

6.5.20 L2cap Credit Based Flow Control Disconnection Event

Description:

This function is used to notify the disconnect event to host.

Event format:

AT+RSIBT_PSMDISCONNECTED <remote_bdaddr>,<lcid>\r\n

Parameters:

Remote-BDAddress (6 bytes)– BD Address of the remote device

Lcid (2 bytes)– local device channel identifier

AT event Ex:

AT+RSIBT_PSMDISCONNECTED B4-99-4C-64-BE-F5,80\r\n

6.5.21 PSM Conn Failed Event

Description:

This event is raised when the PSM connection fails. The reason for failure would be present in the Descriptor frame.

Event format*:*

AT+RSIBT_LE_PSMCONNFAILED ,<error>\r\n

Parameters:

Error – reason for PSM conn failing.

Event Ex:

AT+RSIBT_LE_PSMCONNFAILED ,4C02 \r\n

6.5.22 LE LTK Request Event

Description:

This event is raised when the LE long-term key of local device is requested by it's LE controller.

Event format:

AT+RSIBT_LTK_REQUEST <bd_addr>, < LocalEDIV >, < LocalRand >\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

LocalEDIV (2 bytes) is a 16-bit stored value used to identify the LTK distributed during LE legacy pairing. A new EDIV is generated each time a unique LTK is distributed.

LocalRand(8 bytes) is a 64-bit stored valued used to identify the LTK distributed during LE legacy pairing. A new Rand is generated each time a unique LTK is distributed.

6.5.23 LE Security Keys Event

Description:

This event is raised after encryption enabled with remote device.

Event format:

AT+RSIBT_SECURITY_KEYS <BDAddress>, <LocalIRK>, <RemoteIRK>, <RemoteEDIV>, <RemoteRand>, <RemoteLTK>, <Remote Identity Address Type>,<Remote Identity Address>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

LocalIRK(16 bytes) - IRK of local device

RemoteIRK(16 bytes) - IRK of remote device

RemoteEDIV(2 bytes) is a 16-bit stored value used to identify the LTK distributed during LE legacy pairing. A new EDIV is generated each time a unique LTK is distributed.

RemoteRand(16 bytes) is a 64-bit stored valued used to identify the LTK distributed during LE legacy pairing. A new Rand is generated each time a unique LTK is distributed.

RemoteLTK (16 bytes) - Remote device Long Term Key

IdentityAddressType(1 byte) - Address type of the remote device Identity Address

IdentityAddress(6 bytes) - Identity Address of the remote device

6.5.24 Conn Update Event

Description:

The LE CONN Update Complete Event is used to indicate that the Controller has changed the connection parameter.

Event format:

AT+RSIBT_LE_CONN_UPDATE_COMPLETE <BDAddress>, <status>, <Conn_Interval>, <Conn_Latency>, <Supervision_Timeout>\r\n

Parameters:

bd_addr(6 bytes) - BD Address of the connected device

status(1 byte) (in hex)

0x00 Connection_Update command successfully completed.

0x01 – 0xFF Connection_Update command failed to complete.

Conn_Interval(2 bytes) (in hex) - Connection interval used on this connection.

Range: 0x0006 to 0x0C80 (Time = N * 1.25 ms, Time Range: 7.5 ms to 4000 ms.)

Conn_Latency(2 bytes) (in hex) – Slave latency for the connection in number of connection events.

Range: 0x0000 to 0x01F3

Supervision_Timeout(2 bytes) (in hex)– Supervision timeout for the LE Link.

Range: 0x000A to 0x0C80 (Time = N * 10 ms, Time Range: 100 ms to 32000 ms)

AT event Ex:

AT+RSIBT_LE_CONN_UPDATE_COMPLETE 00-1A-7D-DA-71-13,0,6,0,C80\r\n

6.6 BLE GATT Events

6.6.1 GATT Notification

Description:

This event is raised when GATT Notification packet is received from the connected remote device.

Event format:

AT+RSIBT_NOTIFY, <bd_addr>,<handle+pkt_type>,<length>,<value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle related to the Value

pkt_type - packet type

RSI_BLE_WRITE_CMD_EVENT	0x01
RSI_BLE_WRITE_REQUEST_EVENT	0x02
RSI_BLE_NOTIFICATION_EVENT	0x03
RSI_BLE_INDICATION_EVENT	0x04

Length(1 byte) – Number of valid bytes in the Value

Value(50 bytes) – The contents of the received Notification packet

NOTE:

handle+pkt_type are clubbed (Ex: 3303, MSB: 33 is the handle and **03** is the packet type)

actual length is (length-1)

Ignore the first value after length parameter

Event Ex:

AT+RSIBT_NOTIFY,C0-FF-EE-C0-FF-EE,3303,2,0,2\r\n

In above examples 3303 → 33 is handle and 03 is packet type

length =1

value = 2

6.6.2 GATT Indication

Description:

This event is raised when GATT Indication packet is received from the connected remote device.

Event format:

AT+RSIBT_INDICATION,<bd_addr>,<handle + pkt_type>,<length>,<value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle related to the Value

pkt_type - packet type

RSI_BLE_WRITE_CMD_EVENT	0x01
RSI_BLE_WRITE_REQUEST_EVENT	0x02

RSI_BLE_NOTIFICATION_EVENT 0x03
RSI_BLE_INDICATION_EVENT 0x04

Length(1 byte) – Number of valid bytes in the Value

Value(50 bytes) – The contents of the received Notification packet

NOTE:

handle+pkt_type are clubbed (Ex: 3304, MSB: 33 is the handle and **04** is the packet type)

actual length is (length-1)

Ignore the first value after length parameter

Event Ex:

AT+RSIBT_INDICATION,C0-FF-EE-C0-FF-EE,3304,2,0,2\r\n

In above examples 3304 → 33 is handle and 04 is packet type

length =1

value = 2

6.6.3 GATT Write

Description:

This event is raised when GATT write packet is received from the connected remote device.

Event format:

AT+RSIBT_WRITE,<bd_addr>,<handle + pkt_type>,<length>,<value>\r\n

Parameters:

BDAddress(6 bytes) – Remote BD Address.

Handle(2 bytes) – Handle related to the Value

pkt_type - packet type

RSI_BLE_WRITE_CMD_EVENT 0x01
RSI_BLE_WRITE_REQUEST_EVENT 0x02
RSI_BLE_NOTIFICATION_EVENT 0x03
RSI_BLE_INDICATION_EVENT 0x04

Length(1 byte) – Number of valid bytes in the Value

Value(50 bytes) – The contents of the received Notification packet

Event Ex:

AT+RSIBT_WRITE,C0-FF-EE-C0-FF-EE,C01,3,0,1,2\r\n

In above examples C01 → C is handle and 01 is packet type

length =2

value = 1,2

6.6.4 GATT Read

Description:

This event is raised when read request is received from the connected remote device.

Event format:

AT+RSIBT_READ,<bd_addr>,<handle>,<type>,<value>,<offset>\r\n

Parameters:

BDAddress (6 bytes)– Remote BD Address.

Handle(2 bytes) – Handle related to the Value

Type(1 byte) - To indicate read type

0 – read request
1 – read blob request

Reserved(1 byte) – Reserved for future use

Offset(2 bytes) – The offset of the first octet to be read.

Note:
In BTLE mode, need to enable BT mode.

1. A command **should not** be issued by the Host before receiving the response of a previously issued command from the module
2. AT mode is supported in RS9116 WiSeConnect.
3. WLAN / Wi-Fi / TCP-IP is supported in RS9116 WiSeConnect.

7 BLE Error Codes

7.1 Generic Error Codes

Following Table represents possible coex modes supported:

Table 9: Bluetooth Generic Error Codes

Error Code	Description
0x0103	Timeout
0x4E01	Unknown HCI command
0x4E02	Unknown Connection Identifier
0x4E03	Hardware failure
0x4E04	Page timeout
0x4E05	Authentication failure
0x4E06	Pin missing
0x4E07	Memory capacity exceeded
0x4E08	Connection timeout
0x4E09	Connection limit exceeded
0x4E0A	SCO limit exceeded
0x4E0B	ACL Connection already exists
0x4E0C	Command disallowed
0x4E0D	Connection rejected due to limited resources
0x4E0E	Connection rejected due to security reasons
0x4E0F	Connection rejected for BD address
0x4E10	Connection accept timeout
0x4E11	Unsupported feature or parameter
0x4E12	Invalid HCI command parameter
0x4E13	Remote user terminated connection
0x4E14	Remote device terminated connection due to low resources
0x4E15	Remote device terminated connection due to power off
0x4E16	Local device terminated connection
0x4E17	Repeated attempts
0x4E18	Pairing not allowed
0x4E19	Unknown LMP PDU
0x4E1A	Unsupported remote feature
0x4E1B	SCO offset rejected
0x4E1C	SCO interval rejected
0x4E1D	SCO Air mode rejected

Error Code	Description
0x4E1E	Invalid LMP parameters
0x4E1F	Unspecified
0x4E20	Unsupported LMP Parameter
0x4E21	Role change not allowed
0x4E22	LMP response timeout
0x4E23	LMP transaction collision
0x4E24	LMP PDU not allowed
0x4E25	Encryption mode not acceptable
0x4E26	Link key cannot change
0x4E27	Requested QOS not supported
0x4E28	Instant passed
0x4E29	Pairing with unit key not supported
0x4E2A	Different transaction collision
0x4E2B	Reserved 1
0x4E2C	QOS parameter not acceptable
0x4E2D	QOS rejected
0x4E2E	Channel classification not supported
0x4E2F	Insufficient security
0x4E30	Parameter out of mandatory range
0x4E31	Reserved 2
0x4E32	Role switch pending
0x4E33	Reserved 3
0x4E34	Reserved slot violation
0x4E35	Role switch failed
0x4E36	Extended Inquiry Response too large
0x4E37	Extended SSP not supported
0X4E38	Host busy pairing
0X4E3C	Directed Advertising Timeout
0X4E3D	Connection terminated due to MIC failure
0x4E3E	Connection Failed to be Established
0X4E60	Invalid Handle Range
0x4E62	Invalid Parameters
0x4E63	BLE Buffer Count Exceeded
0x4E64	BLE Buffer already in use
0x4E65	Invalid Attribute Length When Small Buffer Mode is Configured

7.2 Mode Error Codes

Table 10: BLE Error Codes

Error Code	Description
0x4A01	Invalid Handle
0x4A02	Read not permitted
0x4A03	Write not permitted
0x4A04	Invalid PDU
0x4A05	Insufficient authentication
0x4A06	Request not supported
0x4A07	Invalid offset
0x4A08	Insufficient authorization
0x4A09	Prepare queue full
0x4A0A	Attribute not found
0x4A0B	Attribute not Long
0x4A0C	Insufficient encryption key size
0x4A0D	Invalid attribute value length
0x4A0E	Unlikely error
0x4A0F	Insufficient encryption
0x4A10	Unsupported group type
0x4A11	Insufficient resources
0x4B01	SMP Passkey entry failed
0x4B02	SMP OOB not available
0x4B03	SMP Authentication Requirements
0x4B04	SMP confirm value failed
0x4B05	SMP Pairing not supported
0x4B06	SMP Encryption key size insufficient
0x4B07	SMP command not supported
0x4B08	SMP pairing failed
0x4B09	SMP repeated attempts
0x4B0C	SMP Failed
0x4C02	PSM Conn Failed
0x4D00	BLE Remote device found
0x4D01	BLE Remote device not found
0x4D02	BLE Remote device structure full
0x4D03	Unable to change state
0x4D04	BLE not Connected

Error Code	Description
0x4D05	BLE socket not available.
0x4D06	Attribute record not found
0x4D07	Attribute entry not found
0x4D08	Profile record full
0x4D09	Attribute record full
0x4D0A	BLE profile not found (profile handler invalid)
0x4057	HW Buffer Overflow

8 BLE Power Save Operation

Description:
This feature explains the configuration of **Power Save** modes of the module. These can be issued at any time after Opermode command. By default, Power Save is in disable state.
There are five different modes of Power Save. They are outlined below.

1. Power Save mode 0
2. Power Save mode 2
3. Power Save mode 3
4. Power Save mode 8
5. Power Save mode 9

Note:
If user wants to enable power save in coex mode (WLAN + BT LE) mode - It is mandatory to enable WLAN power save along with BT LE power save.

Device will enter into power save if and only if both protocol (WLAN, BLE) power save modes are enabled.

Power Save Operations

The behavior of the module differs according to the power save mode it is configured.
The following terminology can be used in the below section in order to describe the functionality.

Protocol	Non-Connected State	Connected State
BLE	This mode is significant when module is in Idle (standby) state.	This mode is significant when module is in Advertising state, Scan state or Connected state.

In BLE, Power Save mode 2 and 3 can be used during Advertise /Scan /Connected states. Operational behavior is as below depending on the state.

- **Advertise State:** In this state, the module is awake during advertising event duration and sleeps till Advertising interval.
- **Scan State:** In this state, the module is awake during scanning window duration and sleeps till scanning interval.
- **Connected state:** In this state, the module wakes up for every connection interval. The default connection interval is 200 msec which is configurable.

8.1 Power Save Mode 0

In this mode the module is in active state and power save is been disabled.
It can be configured at any time while power save is enable with Power Save mode 2 and 3 or Power Save mode 8 and 9.

8.2 Power Save Mode 2 (GPIO Based Mode)

Once the module is configured to power save mode 2, it can be woken up either by the Host or periodically during its sleep-wake up cycle based upon the connected state intervals.

Power mode 2 is GPIO based. In ULP mode, feature_bit_map[4]has to be set in opermode command. In this mode, Whenever host want to send data to the module, gives wakeup indication to module by setting ULP_GPIO_5 high in case of LP or UULP_GPIO_2 in case of ULP(which make module to wake up from power save). After wakeup, if the module is ready for data transfer, it sends wakeup indication to host (by setting UULP_GPIO_3 high). Host required to wait until module give wakeup indication before sending any data to module.

After completion of data transfer host can give sleep permission to module by resetting ULP_GPIO_5 in case of LP or UULP_GPIO_2 in case of ULP. After recognizing sleep permission from host, module give confirmation to host by resetting UULP_GPIO_3 and again gets back to its sleep-wake up cycle.
Module can send received packets or responses to host at any instant of time. No handshake is required on Rx path.

8.3 Power Save Mode 3 (Message Based Mode)

Power Mode 3 is message-based power save. In Power Mode 3 like Power mode 2 both radio and SOC of RS9116-WiSeConnect are in power save mode. This mode is significant when module is in connected state which is any state mentioned the above table. Module wakes up periodically upon every connected state based on the intervals and gives wakeup message ("WKP") to host. For example, in advertising state, he module is awake during advertising event duration and sleeps till Advertising interval.

Module cannot be woken up asynchronously. Every time module intends to go to sleep it sends a sleep request message ("SLP") to the host and expects host to send the ack message. Host either send ack ("ACK") or any other pending message. But once ack is sent, Host should not send any other message unless next wakeup message from module is received.

Module shall not go into complete power-save state if ack is not received from host for given sleep message. Module can send received packets or responses to host at any instant of time. No handshake is required on Rx path.

(a)

AT mode
"WKP"
"SLP"

(b)

AT mode
"ACK"

Note:
Power save disable command has to be given before changing the state from standby to the remaining states and wise-versa. Suppose if Power Save is enabled in standby state, so, in order to move to Scanning state, first Power Save disable command need to be issued before giving Scan command.

When the module is configured in a co-ex mode and WLAN is in INIT_DONE state, power save mode 2 & 3 are valid after association in the WLAN. Whereas in BT & BLE alone modes, it will enter power save mode (2 & 3) in all states except in standby state.

8.4 Power Save Mode 8

This command has to be issued after the opermode command. Module should be in non-connected state before giving this command. Please refer the above table for the state description.
In Power Mode 8 both RF and SoC are in complete power save mode. This mode is significant when module is not connected with any AP. Power mode 8 is GPIO based. In ULP mode , feature_bit_map[4]has to be set in opermode command.
In case of LP (when ulp_mode_enable is '0') host can wakeup the module from power save by making ULP_GPIO_5 high.
In case of ULP (when ulp_mode_enable is '1' or '2') host can wakeup the module from power save by making UULP_GPIO_2 high.
When ulp_mode_enable is set to '0' or '1',once the module gets wakeup it continues to be in wakeup state until it gets power mode 8 commands from host.
When ulp_mode_enable is set to '2', after waking up from sleep module sends following message to host when RAM retention is not enabled. After receiving this message host needs to start giving commands from beginning (opemode) as module's state is not retained.

AT mode
"WKP FRM SLEEP"

8.5 Power Save Mode 9

In Power Mode 9 both Radio and SoC in complete power save mode. This command must be issued after the opermode command. Module should be in non-connected state before giving this command. Please refer the above table for the state description. Once power mode 9 command is given, the module goes to sleep immediately and wakes up after sleep duration configurable by host by set sleep timer command. If host does not set any default time, then the module wakes up in 1 sec by default. Upon wakeup module sends a wakeup message to the host and expects host to give ack before it goes into next sleep cycle. Host either send ack or any other messages but once ACK is sent no other packet should be sent before receiving next wakeup message.
When ulp_mode_enable is set to '2', after waking up from sleep, the module sends following message to host when RAM retention is not enabled. After receiving this message, host needs to start giving commands from beginning (opermode) as module's state is not retained.

AT mode
"WKP FRM SLEEP"

9 BLE AT CMD Configuration Changes/Enhancements

S.No	Configuration/Parameter	Existing Configuration	New/Modified Configuration	Comments
1	384k mode is mandatory from 2.X.X release for any BT use-case.	256K mode was supported.	256K mode is no longer supported. Only 384K mode is supported from 2.X.X.	Set BIT[20] and BIT[21] in '**ext_custom_feature_bit_map**' parameter in '**at+rsi_opermode**' command.
2	Maximum packet length PER TRANSMIT is changed to 240.	Maximum packet length was 255	Maximum packet length supported in 240 from 2.X.X release	Set '**pkt_len**' parameter to 240 in '**at+rsibt_bletransmit**'
3	1) Gatt Write Event handle+packet_type are cluubed 2) actual length is length-1, and ignore first value which is '0' **NOTE**: The above behavior is only for current release 2.0. From next release onwards issue will be addressed for length to reflect the actual length and the first redundant parameter with value '0' will be removed. Documentation will be updated accordingly.	packet type was not there and there was no reserved value/parameter.	AT+RSIBT_WRITE,<bd_addr>,<handle + Pkt_type>,<length-1>,<value>	handle+pkt_type are clubbed (Ex: C01, MSB: **C** is the handle and **01** is the packet type) actual length is (length-1) Ignore the first value after length parameter
4	Gatt Notify Event handle+packet_type are cluubed 2) actual length is length-1, and ignore first value which is '0' **NOTE**: The above behavior is only for current release 2.0. From next release onwards issue will be addressed for length to reflect the actual length and the first redundant parameter with value '0' will be	packet type was not there and there was no reserved value/parameter.	AT+RSIBT_NOTIFY,<bd_addr>,<handle + Pkt_type>,<length-1>,<value>	handle+pkt_type are clubbed (Ex: 3303, MSB: 33 is the handle and **03** is the packet type) actual length is (length-1) Ignore the first value after length parameter

S.No	Configuration/Parameter	Existing Configuration	New/Modified Configuration	Comments
	removed. Documentation will be updated accordingly.			
5	Gatt Indicate Event handle+packet_type are cluubed 2) actual length is length-1, and ignore first value which is '0' **NOTE**: The above behavior is only for current release 2.0. From next release onwards issue will be addressed for length to reflect the actual length and the first redundant parameter with value '0' will be removed. Documentation will be updated accordingly.	packet type was not there and there was no reserved value/parameter.	AT+RSIBT_INDICATION,<bd_addr>,<handle + pkt_type>,<length-1>,<value>	handle+pkt_type are clubbed (Ex: 3304, MSB: 33 is the handle and **04** is the packet type) actual length is (length-1) Ignore the first value after length parameter
6	In at+rsibt_addattribute config_bitmap position is changed	at+rsibt_addattribute=<ServiceHndlerPtr>,<Hndl>,<AttUUIDsize>,<AttUUID>,<prop>,<DataLen>,<Data>,<ConfigBitmap>	at+rsibt_addattribute=<ServiceHndlerPtr>,<Hndl>,<AttUUIDsize>,<AttUUID>,<prop>,<DataLen>,<ConfigBitmap>,<Data>	Position of configbitmap got changed

10 Revision History

Revision #	Version #	Date	Changes
1	1.0	November 2017	Advance version
2	1.1	Feb 2018	Formatting changes
3	1.2	April 2018	Generalized for WiSeConnect
4	1.3	June 2018	Replaced the old commands with updated ones.
5	1.4	July 2018	1. BLE few commands modified 2. BLE Appendix changes
6	1.5	August 2018	1. Added ext_custom_feat_bitmap field description and modified feature 2. bitmap description in opermode command 3. Updated PASSKEY event 4. Segregation of features for different products
7	1.6	April 2019	1.Deleted the Zigbee section 2.Added BLE More data request event id 0x152D in Table Event IDs 3.Added HW Buffer overflow 0x4057 Error code in BLE Error Codes
8	1.7	May 2019	1. Pulled changes to Master PRM 2. Added multiexcerpts for linking documents
9	1.8	Oct 2019	1. Modified the at+rsibt_addattribute command format 2. Modified the at+rsibt_addattribute command format
11	1.9	Nov 2019	Added the BLE Error codes
12	1.10	Feb 2020	Added BLE PER CW mode command Added set MTU size for BLE Added a Note in EXT_TCP_IP_FEATURE_BITMAP info in opermode Added config_feature_bit_map in set operating mode
13	1.11	April 2020	BLE documentation changes
14	2.0	Sep 2020	1. Modified rsi_bt_addattribute command format. 2. Removed 'Related Resources' section. 3. Moved 'SPI Interface', 'UART Interface', 'USB Interface' sections to 'Host Interfaces'. 4. Renamed document name from 'Embedded BLE Software Programming Reference Manual (PRM)' to 'RS9116W BLE AT Command Programming Reference Manual'. 5. **Removed all Binary Commands.** 6. Updated 384k mode. 7. Updated advertise report as per specification. 8. Removed SDIO, USB, SPI interfaces from Host Interfaces section. 9. Added 'Changes/Enhancements in BLE AT Commands, Configurations and Mechanisms' section. 10. Added length for each AT CMD (parameters and responses).

11 Appendix A: Sample Flows

11.1 Sample flow of APIs for BLE

1. Configure BLE device in Central Mode

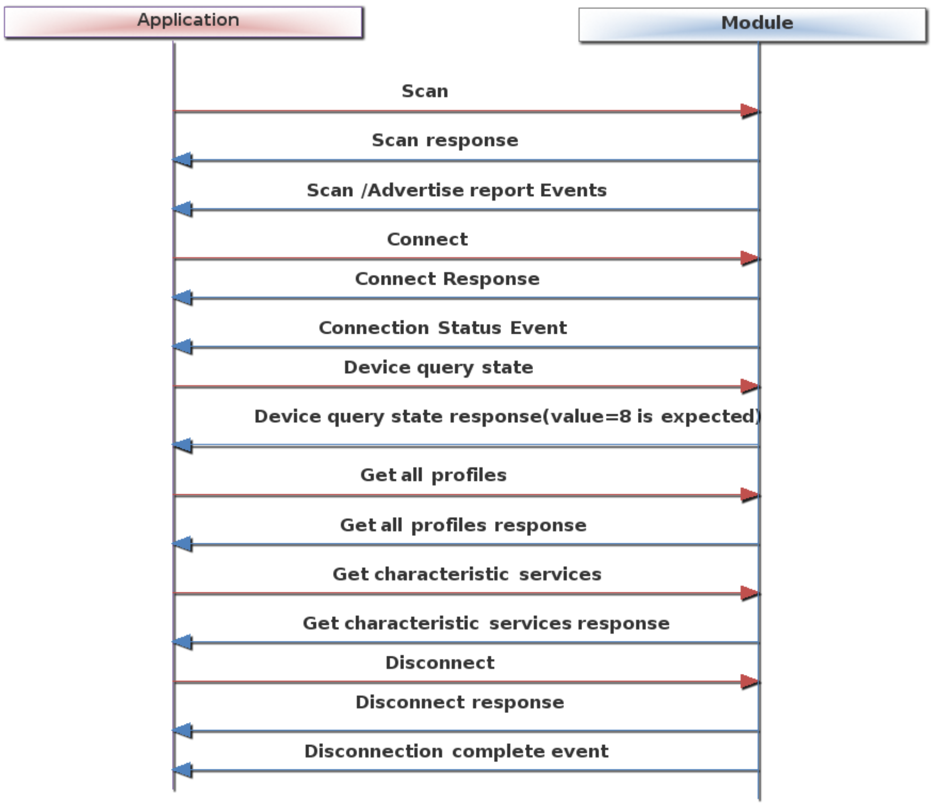

Application
Module
Scan
Scan response
Scan /Advertise report Events
Connect
Connect Response
Connection Status Event
Device query state
Device query state response(value=8 is expected)
Get all profiles
Get all profiles response
Get characteristic services
Get characteristic services response
Disconnect
Disconnect response
Disconnection complete event

Figure 21: Sample Command Sequence of BLE Central Mode

2. Configure BLE device in Peripheral Mode

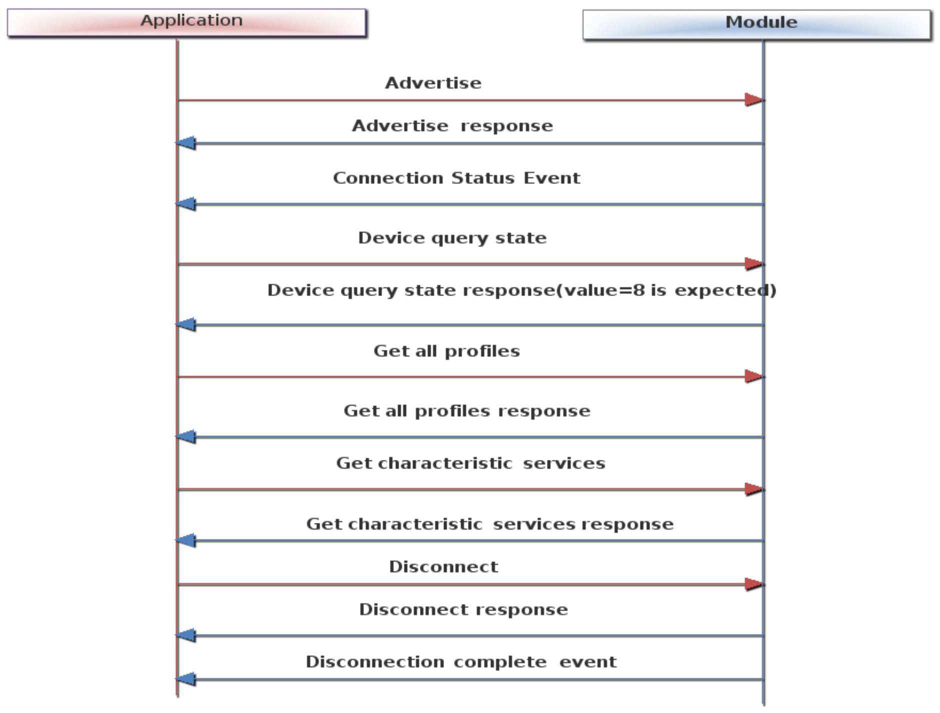

Application
Module
Advertise
Advertise response
Connection Status Event
Device query state
Device query state response(value=8 is expected)
Get all profiles
Get all profiles response
Get characteristic services
Get characteristic services response
Disconnect
Disconnect response
Disconnection complete event

Figure 22: Sample Command Sequence of BLE Peripheral Mode

3. Configure BLE device in Central Mode to connect to multiple slaves

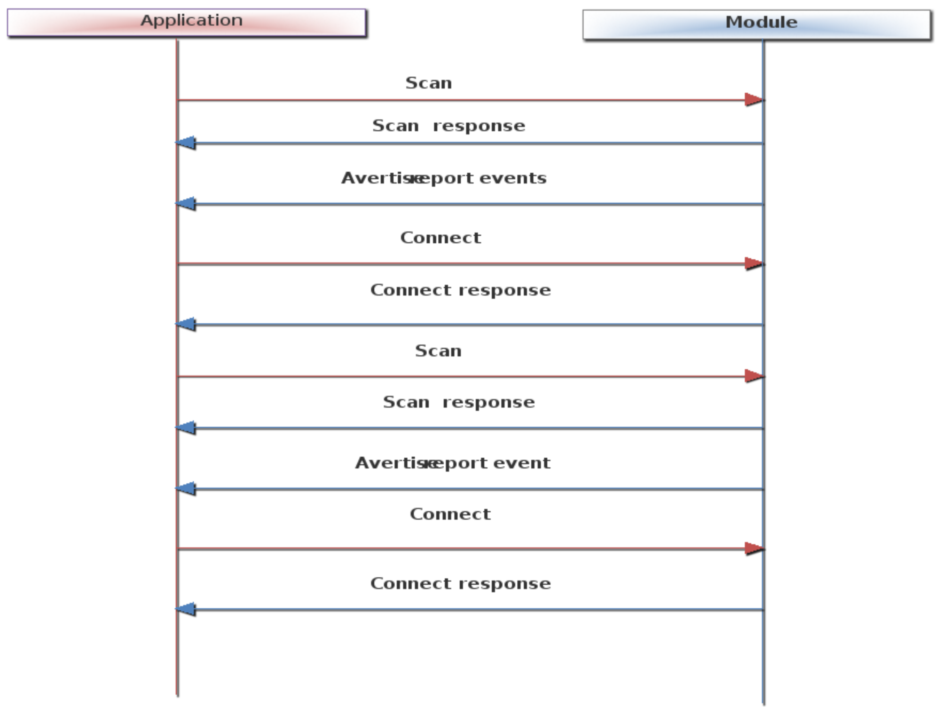


Figure 23: Sample Command Sequence of BLE Multiple Slaves

4. Configure BLE device to act as both Central and Peripheral simultaneously (Dual Role)

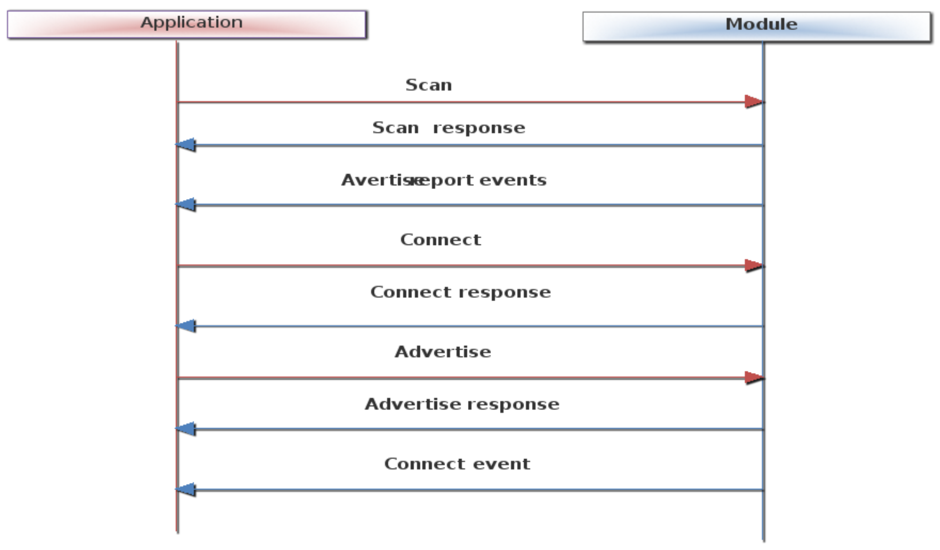


Figure 24: Sample Command Sequence of BLE Dual Role

5. Security Management Protocol (SMP) in Slave mode

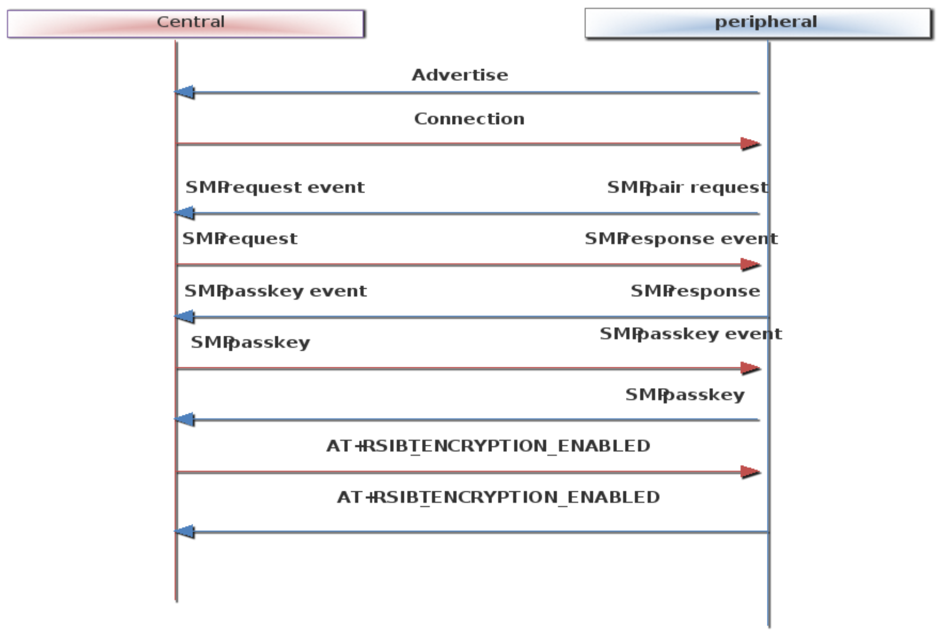


Figure 25: SMP Command Sequence of BLE Slave (Peripheral) Mode

6. Security Management Protocol (SMP) in Master mode

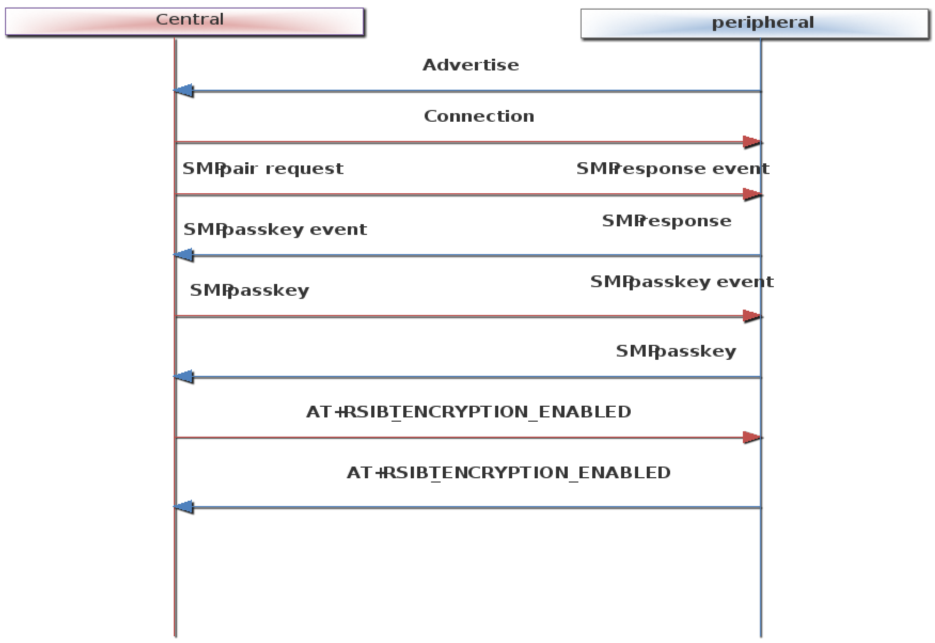


Figure 26: SMP Command Sequence of BLE Master (Central) Mode

11.2 Sample flow of APIs for WiFi+BT LE Co-ex mode

In order to run the Wi-Fi client and BT-LE coexistence mode, user must issue the operating mode as first command with coex parameters.
After operating mode command module will operate in both Wi-Fi STA mode and BT LE mode. So, user can issue Wi-Fi commands as well as BT LE commands in parallel on host interface.

Common Command:

- Set the operating mode command with below parameters to run in Wi-Fi + BT-LE Coex Mode.

  Oper_mode = ((wifi_oper_mode) | (coex_mode << 16))

  Wifi_oper_mode = 0 (to operate wifi in STA mode)

  Coex_mode= 13 (to operate in WiFi+BT LE coex mode)

  Feature_bit_map = 1 (to operate WiFi in open security mode)

  Tcp_ip_feature_bit_map = 1 (TCP/IP Bypass mode)

  Custom_feature_bit_map = (1<<31)

  ext_custom_feature_bit_map = (1<<31)

  bt_custom_feature_bit_map

  To configure the number of GATT Records the following parameter is required;

  bt_custom_feature_bit_map i.e, 6th parameter.

  Bt_custom_feature_bit_map is valid when the 31st bit of ext_custom_feature_bit_map is set.

Wi-Fi Command Sequence to Associate with Access Point:

- Band: This command sets the operating mode of the module
- Init: This command initializes the module
- Scan: This command scans for Aps and reports the Aps found
- Join: This command associates the module to the AP

Please refer to **RS9116W Wi-Fi AT Command Programming Reference Manual** at https://docs.silabs.com/rs9116 for Wi-Fi commands description.

BT LE Command Sequence:

- Scan: This command scans for BT LE devices and reports the devices found
- Connect: This command associates the module to the remote device

After successful Wi-Fi and BT LE connection user can send Wi-Fi raw data packets into air and also can issue GATT commands.

Wi-Fi+BT LE coex Rx flow:

Upon reception of response from module to host, host has to check whether it is Wi-Fi or BT-Le response based on word0[15:12] in frame descriptor.

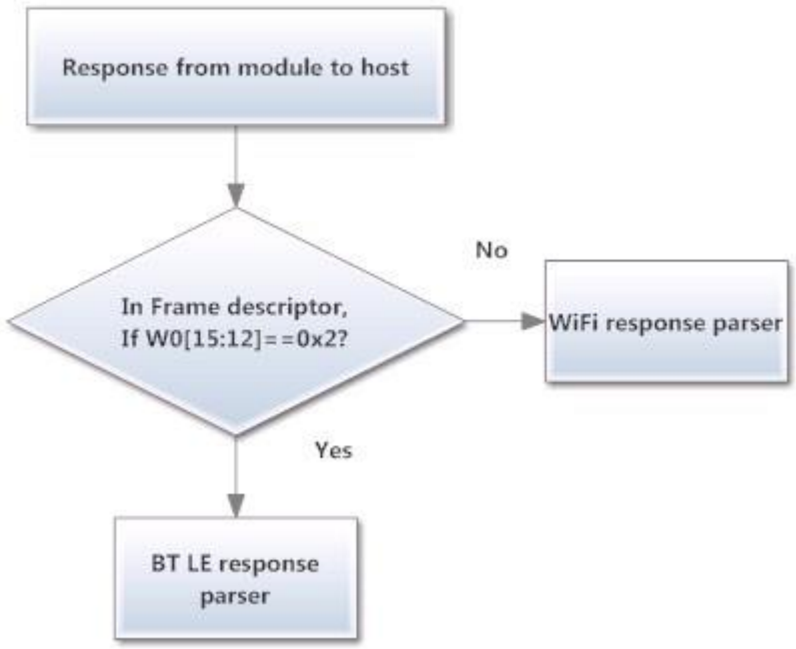
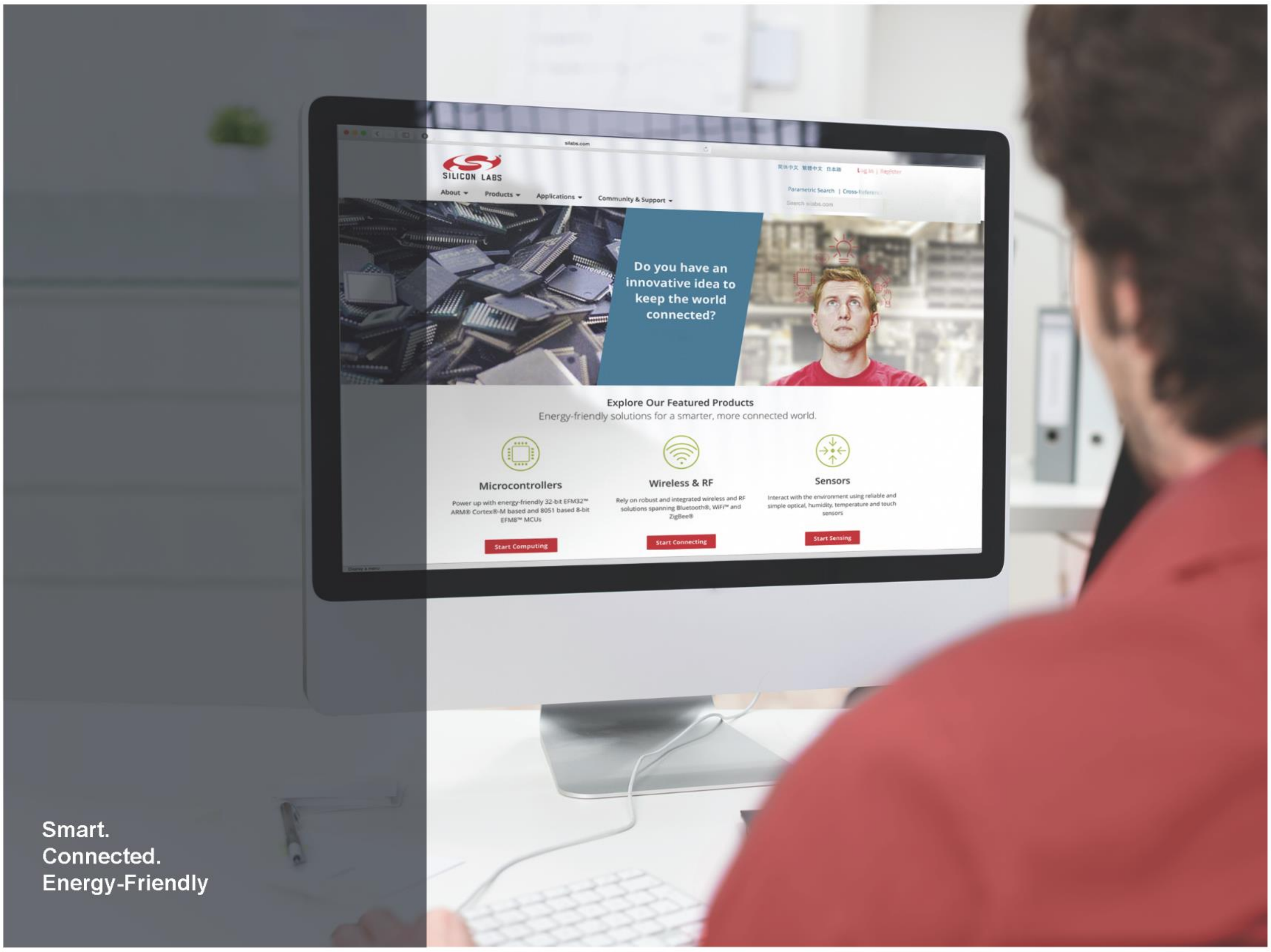


Figure 27: Sample Flow for WiFi + BT LE Response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