RF SubG

User Guide

V1.2

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1. Introduction

This document describes the process to perform transmitting and receiving using Rafael RF with or without MAC layer. Users can use provided APIs to set RF parameters and perform transmitting or receiving through a series of primitives as defined in following sections.

In SubG_TRX project, we provide two modes: 15p4 mode (pure 802.15.4 RF) and MAC mode (802.15.4 MAC layer + RF).

2. APIs

This section provides and overview the APIs.

2.1 Sample Initialization

Sample Initialization function.

```
void rfb_sample_init(uint8_t RfbPciTestCase);
```

- **Parameter**

Name	Type	Description
RfbPciTestCase	Integer	1: TX case (RFB_PCI _BURST_TX_TEST) 2: Sleeping TX case (RFB_PCI_SLEEP_TX_TEST) 3: RX case (RFB_PCI _RX_TEST)

2.2 RF Control APIs

For SubG devices, the RF control APIs are as followed. Just for simple demo, some of these APIs will be described in detail below. To see more, you can also find all the description of these APIs in the definition of rfb_subg_ctrl_t in the header file rfb.h.

```
rfb_subg_ctrl_t const rfb_ctrl =
{
    rfb_port_subg_init,
    rfb_port_modem_set,
    rfb_port_frequency_set,
    rfb_port_subg_is_channel_free,
    rfb_port_subg_rx_config_set,
    rfb_port_subg_tx_config_set,
    rfb_port_data_send,
    rfb_port_sleep_set,
    rfb_port_idle_set,
    rfb_port_rx_start,
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    rfb_port_rssi_read,
    rfb_port_version_get,
    rfb_port_15p4_address_filter_set,
    rfb_port_15p4_mac_pib_set,
    rfb_port_15p4_phy_pib_set,
    rfb_port_15p4_auto_ack_set,
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    rfb_port_auto_state_set,
    rfb_port_15p4_src_addr_match_ctrl,
    rfb_port_15p4_short_addr_ctrl,
    rfb_port_15p4_extend_addr_ctrl,
    rfb_port_key_set,
    rfb_port_csl_receiver_ctrl,
    rfb_port_csl_accuracy_get,
    rfb_port_csl_uncertainty_get,
    rfb_port_csl_sample_time_update,
    rfb_port_rtc_time_read,
    rfb_port_ack_packet_read,
    rfb_port_rx_rtc_time_get,
    rfb_port_current_channel_get,
    rfb_port_frame_counter_get,
};
```

Note that for 15p4 mode, section 2.2.2 to 2.2.7 can be skipped.

2.2.1 Register Interrupt Event Initialization

The following API initiates the register interrupt event.

```
RFB_EVENT_STATUS rfb_port_subg_init
                    (rfb_interrupt_event_t *_rfb_interrupt_event,
                     rfb_keying_type_t keying_mode,
                     uint8_t band_type);
```

The definition of `rfb_interrupt_event_t`.

```
typedef struct rfb_interrupt_event_s
{
    void  (*rx_done)(uint16_t  packet_length,  uint8_t  *rx_data_address,
            uint8_t crc_status, uint8_t rssi, uint8_t snr);
    void (*tx_done)(uint8_t tx_status);
    void (*rx_timeout)(void);
} rfb_interrupt_event_t;
```

- **Parameter**

Name	Description
rx_done	Interrupt event when RX completes
tx_done	Interrupt event when TX completes
rx_timeout	Interrupt event when the device doesn’t receive packet in expected time

The definition of `rfb_keying_type_t`.

```
typedef enum
{
    RFB_KEYING_FSK      = 1,  //For SubG data rate = 50~300 kbps
    RFB_KEYING_OQPSK    = 2,  //For SubG data rate = 6.25, 12.5, 25 kbps
} rfb_keying_type_t;
```

The definition of band type for `keying_mode` = `RFB_KEYING_FSK.`

```
typedef enum
{
    BAND_SUBG_915M   = 0,
    BAND_2P4G        = 1,
    BAND_SUBG_868M   = 2,
    BAND_SUBG_433M   = 3,
    BAND_SUBG_315M   = 4
} band_type_t;
```

The definition of band type for `keying_mode` = `RFB_KEYING_OQPSK.`

```
typedef enum
{
    BAND_OQPSK_SUBG_915M   = 0,
    BAND_OQPSK_SUBG_868M   = 1,
    BAND_OQPSK_SUBG_433M   = 2,
    BAND_OQPSK_SUBG_315M   = 3
} oqpsk_band_type_t;
```

2.2.2 MAC PIB Attributes Initialization

The following API is for MAC PIB Attributes setting.

```
RFB_EVENT_STATUS rfb_port_15p4_mac_pib_set
                (uint32_t a_unit_backoff_period,
                 uint32_t mac_ack_wait_duration,
                 uint8_t mac_max_BE,
                 uint8_t mac_max_CSMA_backoffs,
                 uint32_t mac_max_frame_total_wait_time,
                 uint8_t mac_max_frame_retries,
                 uint8_t mac_min_BE);
```

- **Parameter**

Name	Type	Description
a_unit_backoff_period	Integer	The time forming the basic time period used by the CSMA-CA algorithm, specified in us.
mac_ack_wait_duration	Integer	The maximum time to wait for an acknowledgment frame to arrive following a transmitted data frame, specified in us.
mac_max_BE	Integer	The maximum value of the back off exponent, BE, in the CSMA-CA algorithm.
mac_max_CSMA_backoffs	Integer	The maximum number of back off the CSMA-CA algorithm will attempt before declaring a channel access failure.
mac_max_frame_total_wait_time	Integer	The maximum time to wait either for a frame intended as a response to a data request frame, specified in us.
mac_max_frame_retries	Integer	The maximum number of retries allowed after a transmission failure.
mac_min_BE	Integer	The minimum value of the back off exponent (BE) in the CSMA-CA algorithm

2.2.3 PHY PIB Attributes Initialization

The following API is for PHY PIB Attributes setting.

```
RFB_EVENT_STATUS rfb_port_15p4_phy_pib_set
                (uint16_t a_turnaround_time,
                 uint8_t phy_cca_mode,
                 uint8_t phy_cca_threshold,
                 uint16_t phy_cca_duration);
```

- **Parameter**

Name	Type	Description
a_turnaround_time	Integer	RX-to-TX or TX-to-RX turnaround time, specified in us.
phy_cca_mode	Integer	0: Energy above threshold, 1: Carrier sense only, 2: Carrier sense with energy above threshold, where the logical operator is AND. 3: Carrier sense with energy above threshold, where the logical operator is OR.
phy_cca_threshold	Integer	The received power threshold for CCA
phy_cca_duration	Integer	The duration for CCA, specified in us.

2.2.4 Automatic Transmitting of Acknowledgment Initialization

The following API enables/disables automatic transmitting of acknowledgment frame.

```
RFB_EVENT_STATUS rfb_port_15p4_auto_ack_set(uint8_t auto_ack_enable);
```

- **Parameter**

Name	Type	Description
auto_ack_enable	Integer	True: enable automatic transmitting of ack frame, False: disable automatic transmitting of ack frame.

2.2.5 Address Filter Initialization

The following API is for address filter setting.

```
RFB_EVENT_STATUS rfb_port_15p4_address_filter_set
                (uint8_t mac_promiscuous_mode,
                 uint16_t short_source_address,
                 uint32_t long_source_address_0,
                 uint32_t long_source_address_1,
                 uint16_t pan_id,
                 uint8_t is_coordinator);
```

- **Parameter**

Name	Type	Description
`mac_promiscuous_mode`	Integer	True: activate promiscuous mode, False: deactivate promiscuous mode.
`short_source_address`	Integer	16-bit short address
`long_source_address_0`	Integer	First 32 bits of 64-bit extended address
`long_source_address_1`	Integer	Last 32 bits of 64-bit extended address
`pan_id`	Integer	16-bit PAN ID
`is_coordinator`	Integer	Whether the device is coordinator or not [0:false, 1:true]

2.2.6 Frame Pending Flag Initialization

The following API is for frame pending bit setting.

```
RFB_EVENT_STATUS rfb_port_15p4_pending_bit_set
                (uint8_t pending_bit_enable);
```

- **Parameter**

Name	Type	Description
`pending_bit_enable`	Integer	Frame pending bit flag [0:false, 1:true]

2.2.7 Automatic Transferring of State Initialization

The following API enables/disables automatically transferring of state when RFB is idle.

```
RFB_EVENT_STATUS rfb_port_auto_state_set(bool rxOnWhenIdle);
```

- **Parameter**

Name	Type	Description
rxOnWhenIdle	bool	Whether to transfer to RX state automatically when RFB is idle [0:false, 1:true]

2.2.8 Frequency Initialization

The following API is for frequency setting.

```
RFB_EVENT_STATUS rfb_port_frequency_set(uint32_t rf_frequency);
```

- **Parameter**

Name	Type	Description
rf_frequency	Integer	Radio frequency, specified in kHz.

2.2.9 RX configuration Initialization

The following API is for RX configuration setting.

```
RFB_EVENT_STATUS rfb_port_subg_rx_config_set
                (uint8_t data_rate,
                 uint16_t preamble_len,
                 fsk_mod_t mod_idx,
                 crc_type_t crc_type,
                 whiten_enable_t whiten_enable,
                 uint32_t rx_timeout,
                 bool rx_continuous,
                 uint8_t filter_type);
```

- **Parameter**

Name	Type	Description
data_rate	Integer	Data rate (unit: K = kbps) For FSK: 3: FSK_200K, 4: FSK_100K, 5: FSK_50K, 6: FSK_300K, 7: FSK_150K For OQPSK: 3: OQPSK_25K, 4: OQPSK_12P5K, 5: OQPSK_6P25K
preamble_len	Integer	Preamble length, specified in bytes.
mod_idx	Integer	Modulation index [0: modulation index = 0.5, 1: modulation index = 1]
crc_type	Integer	CRC type [0: 16-bit CRC, 1: 32-bit CRC]
whiten_enable	Integer	Whitening flag [0: disable whitening, 1: enable whitening]
rx_timeout	Integer	Time for RX timeout, specified in microseconds.
rx_continuous	Integer	1: continuous mode, 0: RX off after one time RX or timeout
filter_type	Integer	FSK filter type [0: FSK, 1: GFSK]

2.2.10 TX configuration Initialization

The following API is for TX configuration setting.

```
RFB_EVENT_STATUS rfb_port_subg_tx_config_set
                (tx_power_level_t tx_power,
                 uint8_t data_rate,
                 uint16_t preamble_len,
                 fsk_mod_t mod_idx,
                 crc_type_t crc_type,
                 whiten_enable_t whiten_enable,
                 uint8_t filter_type);
```

- **Parameter**

Name	Type	Description
tx_power	Integer	TX power mode [0: 20 dBm , 1: 14 dBm, 2: 0 dBm]
data_rate	Integer	Data rate (unit: K = kbps) For FSK: 3: FSK_200K, 4: FSK_100K, 5: FSK_50K, 6: FSK_300K, 7: FSK_150K For OQPSK: 3: OQPSK_25K, 4: OQPSK_12P5K, 5: OQPSK_6P25K
preamble_len	Integer	Preamble length, specified in bytes.
mod_idx	Integer	Modulation index [0: modulation index = 0.5, 1: modulation index = 1]
crc_type	Integer	CRC type [0: 16-bit CRC, 1: 32-bit CRC]
whiten_enable	Integer	Whitening flag [0: disable whitening, 1: enable whitening]
filter_type	Integer	FSK filter type [0: FSK, 1: GFSK]

2.2.11 Send Frame Function

The following API is for data frame transmitting.

```
RFB_WRITE_TXQ_STATUS rfb_port_data_send
                     (uint8_t *tx_data_address,
                      uint16_t packet_length,
                      uint8_t InitialCwAckRequest,
                      uint8_t Dsn);
```

- **Parameter**

Name	Type	Description
tx_data_address	Pointer	Data address
packet_length	Integer	Packet length
InitialCwAckRequest	Integer	TX control parameter (set to 0 for 15p4 mode; generated in mac_data_gen for MAC mode)
Dsn	Integer	Data sequence number (set to 0 for 15p4 mode)

2.3 Data Generation for 15p4 Mode

The following is an example data generation function.

```
void data_gen(uint8_t *pbuf, uint16_t len)
```

- **Parameter**

Name	Type	Description
pbuf	Pointer	Address for data storing
len	Integer	Data length

2.4 Frame Generation for MAC Mode

The following is an example frame generation function.

```
void Rfb_MacFrameGen
     (MacBuffer_t *pbuf,
      uint8_t *InitialCwAckRequest,
      uint8_t Dsn,
      uint16_t MacDataLength);
```

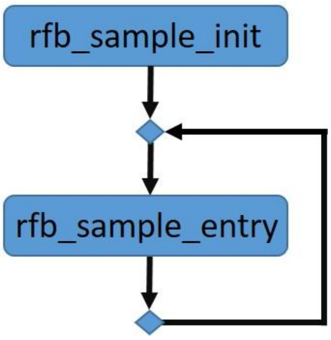
- **Parameter**

Name	Type	Description
pbuf	Pointer	Address for data storing
InitialCwAckRequest	Pointer	TX control parameter address
Dsn	Integer	Data sequence number
MacDataLength	Integer	MAC layer payload length

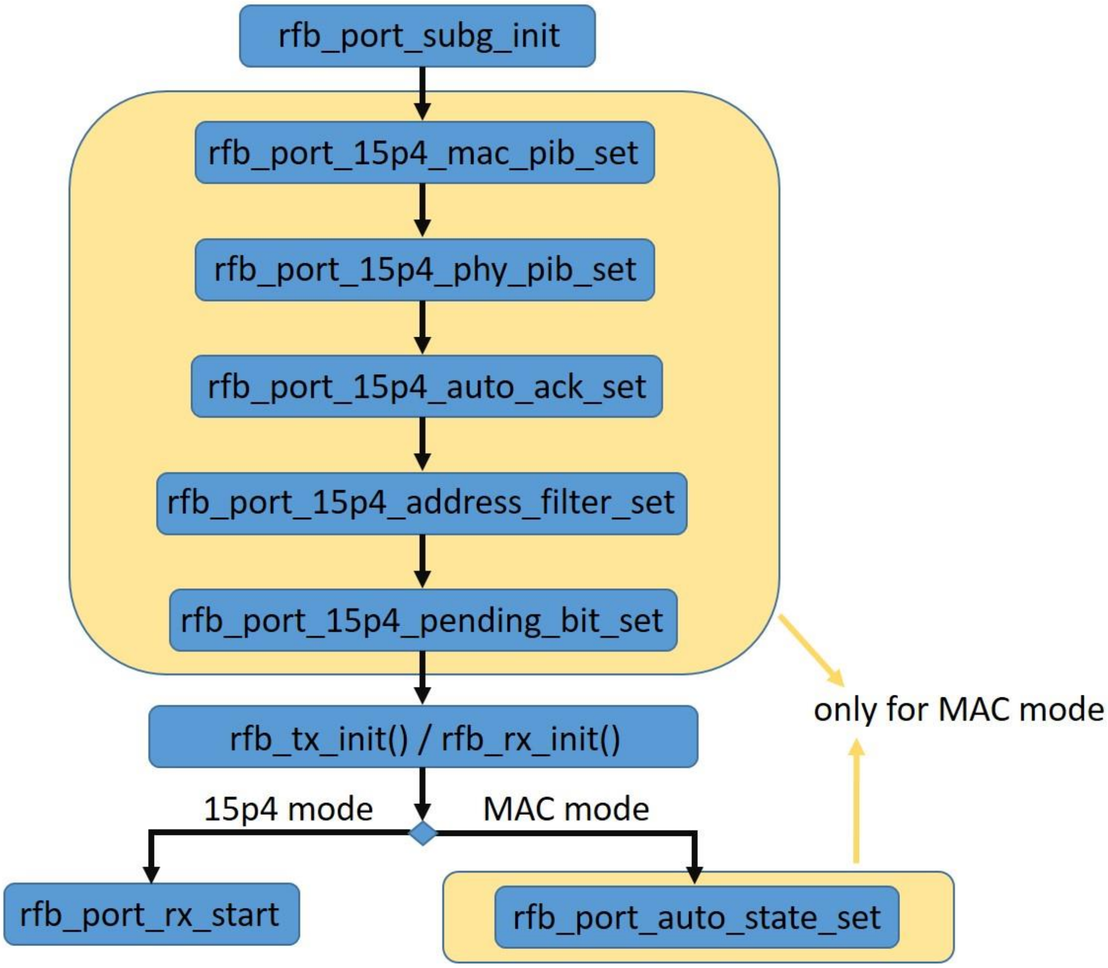
Note that in this function, user needs to set the parameters in frame control field of MAC header. An example code can be found in section 4.

3. Setup Procedure

3.1 Main flow



3.2 Initialization Flow in rfb_sample_init


rfb_port_subg_init
rfb_port_15p4_mac_pib_set
rfb_port_15p4_phy_pib_set
rfb_port_15p4_auto_ack_set
rfb_port_15p4_address_filter_set
rfb_port_15p4_pending_bit_set
only for MAC mode
rfb_tx_init() / rfb_rx_init()
15p4 mode
MAC mode
rfb_port_rx_start
rfb_port_auto_state_set

The steps in yellow rectangles are executed only in MAC mode.

4. Example Code

The example code in this section can be found in the project at the following path: Project\Application\SubG_Demo\SubG_TRX.

4.1 Common Setting

The following is some of setting code that users usually need to modify. These parts of example code are also highlighted in blue in section 4.2 to section 4.5.

4.1.1 Case Setting

```
/* Set RFB test case
1. RFB_PCI_BURST_TX_TEST: Tester sends a certain number of packets
2. RFB_PCI_SLEEP_TX_TEST: Tester sends a certain number of packets and
                           sleeps between each tx
3. RFB_PCI_RX_TEST: Tester receives and verify packets
*/
rfb_pci_test_case = RFB_PCI_RX_TEST;
```

4.1.2 Mode Setting

The user should set SUBG_MAC as true for MAC mode, and set it as false for 15p4 mode.

```
#define SUBG_MAC (false)
```

4.1.3 Address Filter Setting

The setting in this section should be the same as the destination part of section 4.1.4.

```
/* Address Filter Set */
uint16_t short_addr = 0x1234;
uint32_t long_addr_0 = 0x11223333;
uint32_t long_addr_1 = 0x55667788;
uint16_t pan_id = 0x1AAA;
```

4.1.4 Addressing Field Setting

This section is only effective for RFB_PCI_BURST_TX_TEST case.

```
MacHdr.destPanid                  = 0x1AAA;
MacHdr.destAddr.mode              = SHORT_ADDR; //LONG_ADDR;
MacHdr.destAddr.shortAddr         = 0x1234;
MacHdr.destAddr.longAddr[0]       = 0x11223333;
MacHdr.destAddr.longAddr[1]       = 0x55667788;
.
.
.
MacHdr.srcPanid                   = 0x1aaa;
MacHdr.srcAddr.mode               = SHORT_ADDR; //LONG_ADDR;
MacHdr.srcAddr.shortAddr          = 0x1111;
MacHdr.srcAddr.longAddr[0]        = 0x00000001;
MacHdr.srcAddr.longAddr[1]        = 0xacde4800;
```

4.1.5 Transmitting Configuration

```
g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_100K, 8, MOD_1,
                           CRC_16, WHITEN_DISABLE, GFSK);
.
.
.
g_rfb_ctrl->frequency_set(g_100k_freq_support[0]);
```

4.1.6 Receiving Configuration

```
g_rfb_ctrl->rx_config_set(FSK_100K, 8, MOD_1, CRC_16,
                          WHITEN_DISABLE, 0, rx_continuous, GFSK);
.
.
.
g_rfb_ctrl->frequency_set(g_100k_freq_support[0]);
```

4.2 Main Function

```
int32_t main(void)
{
    RFB_PCI_TEST_CASE rfb_pci_test_case;

    /* RF system priority set */
    set_priotity();

    /* Init debug pin*/
    init_default_pin_mux();

    dma_init();

    /*init debug uart port for printf*/
#if (PRINTF_ENABLE == 1)
    util_uart_0_init();
#endif

#if (MODULE_ENABLE(SUPPORT_DEBUG_CONSOLE_CLI))
    extern int cli_console_init(void);
    extern int cli_console_proc(void);
    cli_console_init();
#if (SUBG_TEST_PLAN_BER)
    while (!g_start_flag)
    {
        cli_console_proc();
    }
#endif
#endif

    /* Set RFB test case
    1. RFB_PCI_BURST_TX_TEST: Tester sends a certain number of packets
    2. RFB_PCI_SLEEP_TX_TEST: Tester sends a certain number of packets and
                               sleeps between each tx
    3. RFB_PCI_RX_TEST: Tester receives and verify packets
    */
    rfb_pci_test_case = RFB_PCI_RX_TEST;
    printf("Test Case:%X\n", rfb_pci_test_case);

    /* Init RFB */
    rfb_sample_init(rfb_pci_test_case);

    while (1)
    {
        rfb_sample_entry(rfb_pci_test_case);
#if (MODULE_ENABLE(SUPPORT_DEBUG_CONSOLE_CLI))
        cli_console_proc();
#endif
    }

}
```

4.3 rfb_sample_init

```
void rfb_sample_init(uint8_t RfbPciTestCase)
{
    uint32_t FwVer;
#if (SUBG_MAC)
    /* MAC PIB Parameters */
    uint32_t a_unit_backoff_period = A_UNIT_BACKOFF_PERIOD;
    uint32_t mac_ack_wait_duration = MAC_ACK_WAIT_DURATION;
    uint8_t mac_max_BE = MAC_MAX_BE;
    uint8_t mac_max_CSMA_backoffs = MAC_MAX_CSMACA_BACKOFFS;
    uint32_t mac_max_frame_total_wait_time = MAC_MAX_FRAME_TOTAL_WAIT_TIME;
    uint8_t mac_max_frame_retries = MAC_MAX_FRAME_RETRIES;
    uint8_t mac_min_BE = MAC_MIN_BE;

    /* PHY PIB Parameters */
    uint16_t a_turnaround_time = A_TURNAROUND_TIMR;
    uint8_t phy_cca_mode = ENERGY_DETECTION_OR_CHARRIER_SENSING;
    uint8_t phy_cca_threshold = 80;
    uint16_t phy_cca_duration = A_TURNAROUND_TIMR;

    /* AUTO ACK Enable Flag */
    uint8_t auto_ack_enable = true;

    /* Frame Pending Bit */
    uint8_t frame_pending_bit = true;

    /* Address Filter Set */
    uint16_t short_addr = 0x1234;
    uint32_t long_addr_0 = 0x11223333;
    uint32_t long_addr_1 = 0x55667788;
    uint16_t pan_id = 0x1AAA;
    uint8_t is_coordinator = true;
    uint8_t mac_promiscuous_mode = false;
#endif
    /* Register rfb interrupt event */
    struct_rfb_interrupt_event.tx_done = rfb_tx_done;
    struct_rfb_interrupt_event.rx_done = rfb_rx_done;
    struct_rfb_interrupt_event.rx_timeout = rfb_rx_timeout;

    /* Init rfb */
    g_rfb_ctrl = rfb_subg_init();
#if (SUBG_TEST_PLAN_BER)
    if (g_data_rate >= 50000)
    {
        g_rfb_ctrl->init(&struct_rfb_interrupt_event, RFB_KEYING_FSK,
                         g_band_type);
    }
    else
    {
        g_rfb_ctrl->init(&struct_rfb_interrupt_event, RFB_KEYING_OQPSK,
                         g_band_type);
    }
#else
    g_rfb_ctrl->init(&struct_rfb_interrupt_event, RFB_KEYING_FSK,
                      BAND_SUBG_915M);
#endif

#if (SUBG_MAC)
    g_rfb_ctrl->mac_pib_set(a_unit_backoff_period, mac_ack_wait_duration,
                           mac_max_BE, mac_max_CSMA_backoffs,
                           mac_max_frame_total_wait_time,
                           mac_max_frame_retries, mac_min_BE);

    g_rfb_ctrl->phy_pib_set(a_turnaround_time, phy_cca_mode,
                           phy_cca_threshold, phy_cca_duration);

    g_rfb_ctrl->auto_ack_set(auto_ack_enable);

    g_rfb_ctrl->address_filter_set(mac_promiscuous_mode, short_addr,
                                   long_addr_0, long_addr_1, pan_id,
                                   is_coordinator);

    g_rfb_ctrl->frame_pending_set(frame_pending_bit);
```

```
#endif
    /* Init test counters*/
    g_crc_success_count = 0;
    g_crc_fail_count = 0;
    g_rx_total_count = 0;
    g_tx_total_count = 0;
#if (SUBG_TEST_PLAN_BER)
    g_tx_count_target = (g_pkt_number * 1000) + 1;
#else
    g_tx_count_target = 1000;
#endif

    data_gen(&g_prbs9_buf[0], FSK_RX_LENGTH);

    /* Set test parameters*/
    switch (RfbPciTestCase)
    {
    case RFB_PCI_BURST_TX_TEST:
    case RFB_PCI_SLEEP_TX_TEST:
        rfb_tx_init();
        break;
    case RFB_PCI_RX_TEST:
        rfb_rx_init(0, true);
        /* Enable RF Rx*/
#if (SUBG_MAC)
        g_rfb_ctrl->auto_state_set(true);
#else
        g_rfb_ctrl->rx_start();
#endif
        break;
    }
    FwVer = g_rfb_ctrl->fw_version_get();
    printf("RFB Firmware version: %d\n", FwVer);
}
```

4.3.1 rfb_tx_init

```
void rfb_tx_init(void)
{
    /*Set RF State to Idle*/
    g_rfb_ctrl->idle_set();

    /*Set TX config*/
#if (SUBG_TEST_PLAN_BER)
    switch (g_data_rate)
    {
    case 6250:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, OQPSK_6P25K, 8, MOD_UNDEF,
                                   CRC_16, WHITEN_DISABLE, OQPSK);
        break;
    case 12500:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, OQPSK_12P5K, 8, MOD_UNDEF,
                                   CRC_16, WHITEN_DISABLE, OQPSK);
        break;
    case 25000:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, OQPSK_25K, 8, MOD_UNDEF,
                                   CRC_16, WHITEN_DISABLE, OQPSK);
        break;
    case 50000:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_50K, 8, MOD_1, CRC_16,
                                   WHITEN_DISABLE, GFSK);
        break;
    case 100000:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_100K, 8, MOD_1, CRC_16,
                                   WHITEN_DISABLE, GFSK);
        break;
    case 150000:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_150K, 8, MOD_1, CRC_16,
                                   WHITEN_DISABLE, GFSK);
        break;
    case 200000:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_200K, 8, MOD_1, CRC_16,
                                   WHITEN_DISABLE, GFSK);
        break;
    case 300000:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_300K, 8, MOD_1, CRC_16,
                                   WHITEN_DISABLE, GFSK);
        break;

    default:
        g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_100K, 8, MOD_1, CRC_16,
                                   WHITEN_DISABLE, GFSK);
        break;
    }
#else
    g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_100K, 8, MOD_1, CRC_16,
                               WHITEN_DISABLE, GFSK);
#endif
    /*
    * Set channel frequency :
    * For band is subg, units is kHz
    * For band is 2.4g, units is mHz
    */

#if (SUBG_TEST_PLAN_BER)
    g_rfb_ctrl->frequency_set(g_frequency);
#else
    g_rfb_ctrl->frequency_set(g_100k_freq_support[0]);
#endif

    g_tx_len = PHY_MIN_LENGTH;
}
```

4.3.2 rfb_rx_init

```
void rfb_rx_init(uint32_t rx_timeout_timer, bool rx_continuous)
{
    /*Set RF State to Idle*/
    g_rfb_ctrl->idle_set();

    /*Set RX config*/
    if (rx_continuous == true)
    {
#if (SUBG_TEST_PLAN_BER)
        switch (g_data_rate)
        {
        case 6250:
            g_rfb_ctrl->rx_config_set(OQPSK_6P25K, 8, MOD_UNDEF, CRC_16,
                                      WHITEN_DISABLE, 0, rx_continuous,
                                      OQPSK);
            break;
        case 12500:
            g_rfb_ctrl->rx_config_set(OQPSK_12P5K, 8, MOD_UNDEF, CRC_16,
                                      WHITEN_DISABLE, 0, rx_continuous,
                                      OQPSK);
            break;
        case 25000:
            g_rfb_ctrl->rx_config_set(OQPSK_25K, 8, MOD_UNDEF, CRC_16,
                                      WHITEN_DISABLE, 0, rx_continuous,
                                      OQPSK);
            break;
        case 50000:
            g_rfb_ctrl->rx_config_set(FSK_50K, 8, MOD_1, CRC_16,
                                      WHITEN_DISABLE, 0, rx_continuous,
                                      GFSK);
            break;
        case 100000:
            g_rfb_ctrl->rx_config_set(FSK_100K, 8, MOD_1, CRC_16,
                                      WHITEN_DISABLE, 0, rx_continuous,
                                      GFSK);
            break;
        case 150000:
            g_rfb_ctrl->rx_config_set(FSK_150K, 8, MOD_1, CRC_16,
                                          WHITEN_DISABLE, 0, rx_continuous,
                                          GFSK);
            break;
        case 200000:
            g_rfb_ctrl->rx_config_set(FSK_200K, 8, MOD_1, CRC_16,
                                          WHITEN_DISABLE, 0, rx_continuous,
                                          GFSK);
            break;
        case 300000:
            g_rfb_ctrl->rx_config_set(FSK_300K, 8, MOD_1, CRC_16,
                                          WHITEN_DISABLE, 0, rx_continuous,
                                          GFSK);
            break;

        default:
            g_rfb_ctrl->tx_config_set(TX_POWER_20dBm, FSK_100K, 8, MOD_1,
                                          CRC_16, WHITEN_DISABLE, GFSK);
            break;
        }
#else
        g_rfb_ctrl->rx_config_set(FSK_100K, 8, MOD_1, CRC_16, WHITEN_DISABLE,
                                      0, rx_continuous, GFSK);
#endif
    }
    else
    {
        g_rfb_ctrl->rx_config_set(FSK_100K, 8, MOD_1, CRC_16, WHITEN_DISABLE,
                                      rx_timeout_timer, rx_continuous, GFSK);
    }
    /* Set channel frequency */
#if (SUBG_TEST_PLAN_BER)
    g_rfb_ctrl->frequency_set(g_frequency);
#else
    g_rfb_ctrl->frequency_set(g_100k_freq_support[0]);
```

```
#endif
}
```

4.4 rfb_sample_entry

```
void rfb_sample_entry(uint8_t rfb_pci_test_case)
{
#if (SUBG_MAC)
    uint8_t tx_control = 0;
    uint8_t Dsn = 0;
    static MacBuffer_t MacBuf;
#else
    uint16_t max_length = ((g_rfb.modem_type == RFB_MODEM_FSK) ?
                           2047 : 127);
#endif
    switch (rfb_pci_test_case)
    {
    case RFB_PCI_BURST_TX_TEST:

        /* Abort test if TX count is reached in burst tx test */
        if (burst_tx_abort())
        {
            break;
        }

        g_tx_done = false;

#if (SUBG_MAC)
        /* Generate IEEE802.15.4 MAC Header and append data */
        mac_data_gen(&MacBuf, &tx_control, &Dsn);
        g_rfb_ctrl->data_send(MacBuf.dptr, MacBuf.len, tx_control, Dsn);
        g_tx_len = MacBuf.len;
#else
        /* Determine TX packet length*/
#if (SUBG_TEST_PLAN_BER)
        g_tx_len = 0x40;
        if (g_tx_total_count == 0)
        {
            timer_config_mode_t cfg0;

            cfg0.int_en = ENABLE;
            cfg0.mode = TIMER_PERIODIC_MODE;
            cfg0.prescale = TIMER_PRESCALE_1;

            Timer_Open(3, cfg0, _timer_isr_handler_tx);

            uint32_t delay_tick = 39000000;
            delay_tick = ((g_data_rate >= 100000) ?
                           400 : (delay_tick / g_data_rate));
            Timer_Start(3, delay_tick);
        }
        while (tx_trigger == 0);
        tx_trigger = 0;
#else
        g_tx_len ++;
        if (g_tx_len > (max_length - CRC16_LENGTH))
        {
            g_tx_len = PHY_MIN_LENGTH;
        }
#endif
        /* Send data */
        g_rfb_ctrl->data_send(&g_prbs9_buf[0], g_tx_len, 0, 0);
#endif
        /* Wait TX finish */
        while (tx_done_check() == false);

        /* Add delay to increase TX interval*/
#if (!SUBG_TEST_PLAN_BER)
        Delay_us(30000);
#endif
        break;

    case RFB_PCI_SLEEP_TX_TEST:
        /* Abort test if TX count is reached in burst tx test */
        if (burst_tx_abort())
        {
            break;
        }

        g_tx_done = false;

#if (SUBG_MAC)
        g_rfb_ctrl->auto_state_set(true);

        /* Generate IEEE802.15.4 MAC Header and append data */
        mac_data_gen(&MacBuf, &tx_control, &Dsn);
        g_rfb_ctrl->data_send(MacBuf.dptr, MacBuf.len, tx_control, Dsn);
        g_tx_len = MacBuf.len;
#else
        g_rfb_ctrl->idle_set();

        /* Determine TX packet length*/
        g_tx_len ++;
        if (g_tx_len > (max_length - CRC16_LENGTH))
        {
            g_tx_len = PHY_MIN_LENGTH;
        }

        /* Send data */
        g_rfb_ctrl->data_send(&g_prbs9_buf[0], g_tx_len, 0, 0);
#endif
        /* Wait TX finish */
        while (tx_done_check() == false);

        /*Set RF State to SLEEP*/
#if (SUBG_MAC)
        g_rfb_ctrl->auto_state_set(false);
#else
        g_rfb_ctrl->sleep_set();
#endif
```

```
        /*Start timer to wake me up later and sleep*/
        timer_config_mode_t cfg;

        cfg.int_en = ENABLE;
        cfg.mode = TIMER_PERIODIC_MODE;
        cfg.prescale = TIMER_PRESCALE_1;

        Timer_Open(3, cfg, _timer_isr_handler);
        Timer_Start(3, 800000); //for 40kHz timer, 40k = 1s;

        Lpm_Set_Low_Power_Level(LOW_POWER_LEVEL_SLEEP0);
        Lpm_Enable_Low_Power_Wakeup(LOW_POWER_WAKEUP_32K_TIMER);
        Lpm_Enter_Low_Power_Mode();

        break;

    case RFB_PCI_RX_TEST:
#if (!SUBG_TEST_PLAN_BER)
        g_rx_total_count_last = g_rx_total_count;

        /* Check whether RX data is comming during certain interval */
        Delay_us(1000000);
        if (g_rx_total_count_last == g_rx_total_count)
        {
            printf("[E] No RX data in this period\n");
        }
#endif
        break;
    }

}
```

4.5 Rfb_MACFrameGen

```
void Rfb_MacFrameGen(MacBuffer_t *pbuf, uint8_t *tx_control, uint8_t Dsn,
                      uint16_t MacDataLength)
{
    uint16_t idx;
    uint16_t payloadLength = MacDataLength;
    uint8_t initialCW;
    uint8_t ackRequest;
    uint16_t max_data_size = ((g_rfb.modem_type == RFB_MODEM_FSK) ?
                             FSK_MAX_DATA_SIZE : OQPSK_MAX_DATA_SIZE);

    MacHdr_t MacHdr;
    memset(&pbuf->buf[0], 0x0, max_data_size);
    pbuf->dptr = &pbuf->buf[0];
    pbuf->len = 0;

    MacHdr.macFrmCtrl.secEnab          = false;
    MacHdr.macSecCtrl.secLevel         = SEC_LEVEL_NONE;
    MacHdr.macSecCtrl.keyIdMode        = KEY_ID_MODE_IMPLICITY;

    MacHdr.destPanid                   = 0x1AAA;
    MacHdr.destAddr.mode                = SHORT_ADDR; //LONG_ADDR;
    MacHdr.destAddr.shortAddr            = 0x1234;
    MacHdr.destAddr.longAddr[0]          = 0x11223333;
    MacHdr.destAddr.longAddr[1]          = 0x55667788;

    MacHdr.macFrmCtrl.panidCompr         = true;

    MacHdr.srcPanid                    = 0x1aaa;
    MacHdr.srcAddr.mode                 = SHORT_ADDR; //LONG_ADDR;
    MacHdr.srcAddr.shortAddr             = 0x1111;
    MacHdr.srcAddr.longAddr[0]          = 0x00000001;
    MacHdr.srcAddr.longAddr[1]          = 0xacde4800;

    MacHdr.macFrmCtrl.framePending       = true;
    MacHdr.macFrmCtrl.frameType          = MAC_COMMAND;
    MacHdr.macFrmCtrl.ackReq          = true;

    MacHdr.dsn = Dsn;
    initialCW = DIRECT_TRANSMISSION;
    ackRequest = MacHdr.macFrmCtrl.ackReq;
    *tx_control = (((initialCW << 1) & 0x02) | ((ackRequest) & 0x01));

    switch (MacHdr.macFrmCtrl.frameType)
    {
    case MAC_COMMAND:
    case MAC_BEACON:
    case MAC_DATA:
        mac_genHeader(pbuf, &MacHdr);
        break;
    case MAC_ACK:
        mac_genAck(pbuf, MacHdr.macFrmCtrl.framePending, MacHdr.dsn);
        break;
    default:
        break;
    }

    // add payload
    for (idx = pbuf->len; idx < (payloadLength + pbuf->len); idx++)
    {
        pbuf->buf[idx] = idx;
    }
    if ((pbuf->len + payloadLength) > max_data_size)
    {
        pbuf->len = max_data_size;
    }
    else
    {
        pbuf->len += payloadLength;
    }
}
```

Revision History

Revision	Description	Owner	Date
1.0	Initial version	Jiawei	2022/09/16
1.1	Update with SDK_v1.3.0	Jiawei	2023/01/05
1.2	Update with SDK_v1.6.0	Jiawei	2023/07/21

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