泰凌 BT/BLE Controller SDK 开发手册

功能描述

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关键词

蓝牙，蓝牙低功耗，Controller，SDK

摘要

本文为泰凌 BT/BLE 双模 Controller SDK 的功能描述。

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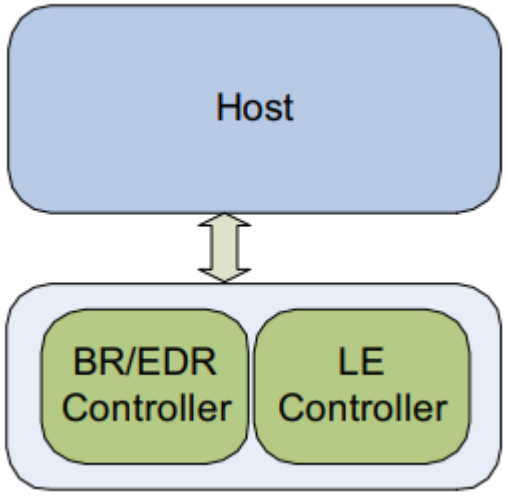
目录

1. 前言

1.1 文档描述

本文主要是对泰凌 BT/BLE 双模 controller SDK 功能的描述，通过 HCI 接口来适配不同的 host,支持标准的 HCI 协议和 HCI 流控，硬件上支持 UART 和 USB 模块作为传输接口。

图 1-1 Host 和 Controller 间的传输



	仅 LE	仅 BT	BT/BLE
模式	√	√	√

1.2 SDK 架构总览

图 1-2 SDK 架构总览

main.c

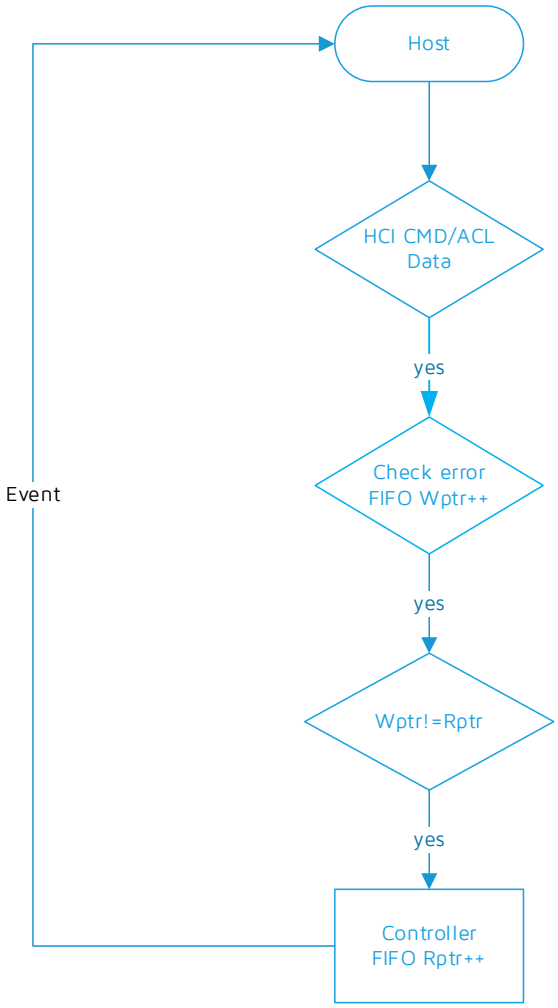
```
{
    sys_init(DCDC_1P4_LDO_1P8,VBAT_MAX_VALUE_GREATER_THAN_3V6);

    clock_init(PLL_CLK_192M, PAD_PLL_DIV, PLL_DIV4_TO_CCLK, CCLK_DIV2_TO_HCLK, HCLK_DIV1_TO_PCLK, CCLK_TO_MSPI_CLK);
    /* random number generator must be initiated here( in the beginning of user_init_nromal).
     * When deepSleep retention wakeUp, no need initialize again */
    random_generator_init();  //this is must

    intcntl_init();

    io_debug_init();

#if (ENABLE_PRINT||ENABLE_VCD)
    debug_init();
#endif

#if(ENABLE_BT_CLASSIC||ENABLE_LE)
    hci_transport_init(HCI_TRANSPORT_MODE);
#endif

#if(ENABLE_BT_CLASSIC||ENABLE_LE)
    btble_schedule_init();
#endif

#if ENABLE_LE
    ble_init();
#endif

#if ENABLE_BT_CLASSIC
    bt_init();
#endif

    user_init();

    core_enable_interrupt();

    while (1) {
        main_loop();
```

- sys_init：系统初始化，配置系统供电模式，电压等级
- clock_init：时钟初始化
- random_generator_init：随机数生成模块初始化
- intcntl_init：中断表初始化
- io_debug_init：gpio 调试初始化，通用 gpio 功能，用户可以自己配置
- debug_init：系统调试初始化，开发者可以用来打印 log

- hci_transport_init：HCI 模块初始化，用来配置传输的方式
- btble_schedule_init：系统调度初始化，系统用来调度各种任务的运行
- ble_init：ble 模块初始化
- bt_init：bt 模块初始化
- user_init：预留给开发者使用的模块
- core_enable_interrupt：经过前面全部的初始化后，使能全局中断，系统便可以进入运行状态
- main_loop：系统循环，在这里处理各类的任务。

1.3 HCI 流程总览

图 1-3 HCI 流程



2. Controller 配置

2.1 LE Link 配置

这部分是关于 LE 部分的配置，是否使能 LE，以及 LE 作为 master 和 slave 时连接个数。

```
/* LE */
#define ENABLE_LE                       1
#define MASTER_MAX_NUM                  2
#define SLAVE_MAX_NUM                   1
#define BLE_MAX_CONN_NUM                (MASTER_MAX_NUM + SLAVE_MAX_NUM)
```

若完全禁用 LE 的功能，将 ENABLE_LE 置为 0 即可。

2.2 BT Link 配置

这部分是关于 BT 部分的配置，注意如果只需一路 BT 连接，BT_ACL_LINK_NUM 设置为 1 即可。

```
/* CLASSIC BLUETOOTH*/
#define ENABLE_BT_CLASSIC               1


#define BT_ACL_LINK_NUM                 1
```

BT 模块包含的功能模块采用注册模式，客户可根据自己的需求，是否选择注册该功能。

图 2-1 BT Link 配置

*app_bt.c stack_config.h

```
102
103 void btc_module_init(void)
104 {
105     // AFH
106     btc_afh_register_module(&env_afh[0]);
107     // AFH CLS
108     btc_afh_cls_register_module();
109     // ROLE SWITCH
110     btc_rsw_register_module(&env_rsw[0]);
111
112     // LEGACY PAIR
113     btc_legacy_pair_register_module();
114     // SECURE SIMPLE PAIR
115     btc_ssp_register_module(&env_ssp[0]);
116     // LEGACY AUTHEN
117     btc_legacy_authen_register_module();
118     // SECURE AUTHEN
119
120     // ENCRYPTION
121     btc_enc_register_module(&env_enc[0]);
122     // ESCO
123 //    btc_sco_register_module(&env_sco[0]);
124     // SNIFF
125 //    btc_sniff_register_module(&env_sniff[0]);
126     // LOW POWER
127
128     //TEST MODE
129 //    btc_test_mode_register_module(&env_test_mode[0]);
130 }
131
132
```

2.3 HCI 传输配置

这部分是关于 HCI 部分的配置，用户选择使用哪种方式作为传输。

```
/* HCI TRANSPORT*/

#define ENABLE_HCI_TRANSPORT            1

#define HCI_TRANSPORT_MODE              2//1-usb bulk,2-uart
```

2.3.1 UART 传输配置

关于 UART 作为 HCI 传输的配置，要求 host 端的对接设备必须支持 UART 的流控。

包含波特率配置，端口配置，pin 脚配置。

图 2-2 UART 传输配置

hci_transport.h

```
21
22 ////////////////////  FLOW CONTROL //////////////////////////////////
23 #define UART_FLOW_CTR                0
24 #define CTS_STOP_VOLT                1 //0 :Low level stops TX.  1 :High level stops TX.
25 #define UART_MANUAL_FLOW_CTR_RTS_STOP               gpio_set_high_level(UART_RTS_PIN)
26 #define UART_MANUAL_FLOW_CTR_RTS_START              gpio_set_low_level(UART_RTS_PIN)
27
28 //baudrate of UART
29 #define UART_BAUDRATE   115200
30 /*! HCI Transport configuration  */
31 #if 0//UART0
32 #define UART_ID          UART0
33 #define UART_TX_PIN      UART0_TX_PD2
34 #define UART_RX_PIN      UART0_RX_PD3
35 #define UART_CTS_PIN     UART0_CTS_PA1
36 #define UART_RTS_PIN     UART0_RTS_PA2
37 #define UART_IRQ         IRQ19_UART0
38 #define UART_IRQHandler uart0_irq_handler
39
40 #else
41 #define UART_ID          UART1
42 #define UART_TX_PIN      UART1_TX_PE0
43 #define UART_RX_PIN      UART1_RX_PE2
44 #define UART_CTS_PIN     UART1_CTS_PE1
45 #define UART_RTS_PIN     UART1_RTS_PE3
46 #define UART_IRQ         IRQ18_UART1
47 #define UART_IRQHandler uart1_irq_handler
48
```

2.3.2 USB 传输配置

USB 的配置如下。注意该模式下的打印方式只能使用 UART debug 方式。

```
#define ENABLE_HCI_TRANSPORT          1

#define HCI_TRANSPORT_MODE            1//1-usb bulk,2-uart
```

3. 调试和打印

3.1 USB 打印 log

该模式需要配合 Telink 专有软件使用，在 USB HCI 模式下有冲突，不可以使用该模式，只能在 UART HCI 模式下使用，演示如下：

```
#define PRINT_MODE                  0 //usb 打印模式
```

图 3-1 USB 打印 log

```
17:54:27.807  <53> HCI-> Event:         04 0e 09 01 27 0c 00 11  00 00 00 00
17:54:28.241  <54> <<<_CMD_CMPT>        04 070e         01 05 14 00 11 00 00
17:54:28.242  <55> dma_offset&readmasize:       04 00 00 00 ff 03 00 00  02 00 00 00 00 00 00 00
17:54:28.242  <56> fifo_hci_data :
        06 00 00 00 01 05 14 02  11 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
17:54:28.242  <57> packet_len :         06 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
17:54:28.243  <58> fifo_hci_data_p :
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
17:54:28.243  <59> complete_hci_data from_host:
17:54:28.243  <60> <<<_CMD_CMPT>        04 090e         01 27 0c 00 11 00 00 00  00
17:54:28.243  <61> @ bt-->hci_exec data(8)_id(4)_fucntion:      01 05 14 02 11 00 00 00  f5 00 00 00 68
17:54:28.244  <62> @ HCI_RD_RSSI_CMD_OPCODE_1405_f5:    01 05 14 02 11 00
17:54:28.244  <63> HCI-> Event:         04 0e 07 01 05 14 00 11  00 00
17:54:28.244  <64> dma_offset&readmasize:       04 00 00 00 ff 03 00 00  02 00 00 00 00 00 00 00
17:54:28.244  <65> fifo_hci_data :
        06 00 00 00 01 27 0c 02  11 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
17:54:28.244  <66> packet_len :         06 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
17:54:28.245  <67> fifo_hci_data_p :
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
17:54:28.245  <68> complete_hci_data from_host:
17:54:28.245  <69> @ bt-->hci_exec data(8)_id(4)_fucntion:      01 27 0c 02 11 00 00 00  83 00 00 00 64
17:54:28.245  <70> @ HCI_RD_AUTO_FLUSH_TO_CMD_OPCODE_0c27_83:   01 27 0c 02 11 00
17:54:28.245  <71> HCI-> Event:         04 0e 09 01 27 0c 00 11  00 00 00 00
```

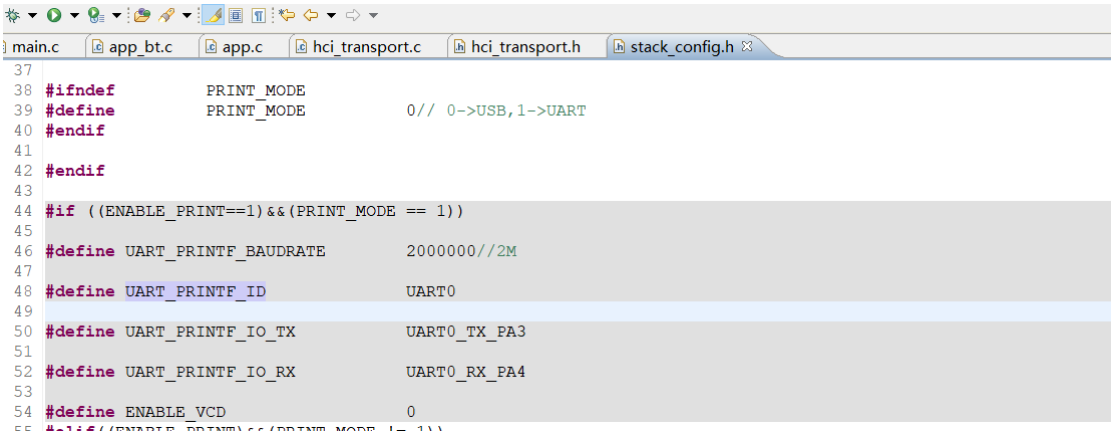
3.2 UART 打印 log

该打印 log 模式，可以在 UART/USB 的 HCI 下均可以使用

```
#define PRINT_MODE                  1//uart 打印模式
```

该 debug 方式使用了 UART 的 DMA 方式，用户可配置该模块引脚以及波特率

图 3-2 UART 打印配置



需要注意的是当使用 UART HCI 时，切勿将 UART debug 的引脚配置成和 UART HCI 一样。

图 3-3 UART 打印 log

```
@ bt—>hci_exec data(8)_id(4)_fucntion:01 03 0c 00 00 00 00 00 5f 00 00 00 e0 7e 02 20
HCI_RESET_CMD_OPCODE_0c03_5f:01 03 0c 00|
pscan_win:40 00
pscan_intv:ac 00
HCI-> Eent:04 0e 04 01 03 0c 00
dma_offset&readmasize:04 00 00 00 ff 03 00 00 00 00 00 00 00 00 00 00
fifo_hci_data :04 00 00 00 01 05 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 
00 00 00 00 00 00 00 00 00 00 00
packet_len :04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
fifo_hci_data_p :00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0
00 00 00 00 00 00 00 00 00 00 00 00
complete_hci_data from_host:
@ bt—>hci_exec data(8)_id(4)_fucntion:01 05 10 00 00 00 00 00 e5 00 00 00 ec 69 02 20
@ HCI_RD_BUFF_SIZE_CMD_OPCODE_1005_e5:01 05 10 00
HCI-> Event:04 0e 0b 01 05 10 00 bc 02 40 04 00 08 00
dma_offset&readmasize:08 00 00 00 fe 03 00 00 03 00 00 00 00 00 00 00
fifo_hci_data :0b 00 00 00 01 33 0c 07 9b 06 ff 14 00 0a 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 
00 00 00 00 00 00 00 00 00 00 00
packet_len :0b 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
fifo_hci_data_p :00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0
00 00 00 00 00 00 00 00 00 00 00 00
complete_hci_data from_host:
@ bt—>hci_exec data(8)_id(4)_fucntion:01 33 0c 07 9b 06 ff 14 8f 00 00 00 30 76 02 20
@ HCI_HOST_BUF_SIZE_CMD_OPCODE_0c33_8f:01 33 0c 07 9b 06 ff 14 00 0a 00
HCI-> Event:04 0e 04 01 33 0c 00
dma_offset&readmasize:04 00 00 00 ff 03 00 00 00 00 00 00 00 00 00 00
fifo_hci_data :04 00 00 00 01 01 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 
00 00 00 00 00 00 00 00 00 00 00
packet_len :04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
fifo_hci_data_p :00 00 00 00 00 0a 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0
00 00 00 00 00 00 00 00 00 00 00 00
complete_hci_data from_host:
@ bt—>hci_exec data(8)_id(4)_fucntion:01 01 10 00 00 00 00 00 e1 00 00 00 78 6b 02 20
@ HCI_RD_LOCAL_VER_INFO_CMD_OPCODE_1001_e1:01 01 10 00
HCI-> Event:04 0e 0c 01 01 10 00 0b 0c 00 0b 11 02 0b 00
dma_offset&readmasize:04 00 00 00 ff 03 00 00 00 00 00 00 00 00 00 00
fifo_hci_data :04 00 00 00 01 09 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 
00 00 00 00 00 00 00 00 00 00 00
packet_len :04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
fifo_hci_data_p :00 00 00 00 00 0a 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0
00 00 00 00 00 00 00 00 00 00 00 00
complete_hci_data from_host:
@ bt—>hci_exec data(8)_id(4)_fucntion:01 09 10 00 00 00 00 00 e9 00 00 00 90 69 02 20
@ HCI_RD_BD_ADDR_CMD_OPCODE_1009_e9:01 09 10 00
HCI-> Event:04 0e 0a 01 09 10 00 2e c5 c9 60 b8 03
dma_offset&readmasize:04 00 00 00 ff 03 00 00 00 00 00 00 00 00 00 00
```

4. 用户自定义 HCI CMD 功能

该 SDK 预留了 callback 接口，来供实现用户自己的 HCI 自定义功能，需要按照 0CF 值注册对应自定义功能。如下表：

表格 4-1 0CF 对应表

0GF	0CF
0x3F	0x08
	0x09
	0x0a
	0x0b

演示：

当返回值为 0，注册正确，否则注册失败。

```
int hci_vendor_spec_register_cb_port(hci_cmd_vendor_spec_callback_t cb,u8 vs_opcode_num);
```

图 4-1 注册演示

app.c

```
47 }
48 void my_vs_test_func(u8 *para)
49 {
50     gpio_toggle(GPIO_D);
51 }
52
53
54 void user_init(void)
55 {
56     hci_vendor_spec_register_cb_port(my_vs_test_func,0x08);
57 }
```