FC41D Getting Started Guide for FreeRTOS

Wi-Fi&Bluetooth Module Series

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About the Document

Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Author</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>2022-04-20</td>
<td>Brave LIU</td>
<td>Creation of the document</td>
</tr>
<tr>
<td>1.0.0</td>
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<td>Preliminary</td>
</tr>
</tbody>
</table>
Contents

About the Document .................................................................................................................. 3
Contents .................................................................................................................................. 4
Figure Index ............................................................................................................................. 5

1 Overview .............................................................................................................................. 6

2 Hardware Description .......................................................................................................... 7
  2.1. Datasheet ......................................................................................................................... 7
  2.2. Schematic ......................................................................................................................... 7
  2.3. Key Components .............................................................................................................. 8
  2.4. Hardware Requirement to Run FreeRTOS Demo .............................................................. 8
      2.4.1. Standard Kit Contents ........................................................................................... 8
      2.4.2. User Provided Items ........................................................................................... 8
      2.4.3. 3rd Party Purchasable Items ............................................................................... 9
  2.5. Additional Hardware References ................................................................................... 9

3 Set Up Development Environment ...................................................................................... 10
  3.1. Supported IDEs ............................................................................................................. 10
  3.2. Toolchains ................................................................................................................... 10
  3.3. SDKs ............................................................................................................................ 10
  3.4. Establishing a Serial Connection .................................................................................... 10
  3.5. Other Software Required to Develop and Debug Applications for the Device ............ 11
  3.6. Other Pre-requisites ..................................................................................................... 11
  3.7. Additional Software References .................................................................................... 11

4 Set Up Hardware .................................................................................................................. 12

5 Setup AWS account and Permissions ............................................................................... 13

6 Provision the device with AWS IoT .................................................................................... 14

7 Download FreeRTOS .......................................................................................................... 15

8 Configure FreeRTOS ........................................................................................................... 16

9 Build the FreeRTOS Demo .................................................................................................. 17

10 Run the FreeRTOS Demo Project ...................................................................................... 18

11 Debugging .......................................................................................................................... 20

12 Troubleshooting .................................................................................................................. 23

13 Appendix Terms and Abbreviations ................................................................................... 24
## Figure Index

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Key Component</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Establish a Serial Connection</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Flash Tool</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>Switch VCC to ON</td>
<td>20</td>
</tr>
</tbody>
</table>
1 Overview

FC41D is a highly integrated dual-mode Bluetooth 5.2 and Wi-Fi 802.11n combo solution with complete hardware and software resources needed for Wi-Fi and Bluetooth applications. It integrates Bluetooth Classic i.e. Basic Rate (BR) and Enhanced Data Rate (EDR) as well as Bluetooth Low Energy (BLE) features fully compliant with the Bluetooth 5.2 specification. It supports AP and Station mode concurrently.

A 32-bit MCU running up to 120 MHz and built-in 256 KB RAM enable the chip to support multi-cloud connectivity. The MCU's extended instructions specifically for signal processing allow for efficient audio encoding and decoding.

FC41D includes a rich set of peripherals, such as PWM, I2C, UART for program download and burning, SPI, SDIO and IrDA. FC41D can provide up to six 32-bit high-speed PWM channels for high-quality LED control. Each of the two PWM channels can be configured as a phase-controlled differential mode to support motor and strip drive.

FC41D integrates a Packet Traffic Arbitration (PTA) interface to facilitate coexistence of Bluetooth and 802.11 WLAN.

FC41D embeds eFUSE and supports OTP read/write in Flash, which can be used to provide unique ID, code encryption and secure the debug interface. A built-in True Random Number Generator (TRNG) and a security module are integrated to ensure secure communication and fast authentication and network connectivity.

FC41D supports low power sleep modes where the MCU can enter sleep modes with a micro amp level. In deep sleep mode, the chip can run a 32-bit clock with a few microamperes of current and can be woken up by this clock or by any GPIO.

FC41D supports Bluetooth Classic i.e. Basic Rate (BR) and Enhanced Data Rate (EDR) as well as all Bluetooth LE 5.2 rates and features, including Long Range, High Data Rate, and angle-of-arrival (AoA) and angle-of-departure (AoD) positioning with up to four antennas.
2 Hardware Description

2.1. Datasheet


2.2. Schematic

2.3. Key Components

![Key Component Image]

Figure 1: Key Component

2.4. Hardware Requirement to Run FreeRTOS Demo

2.4.1. Standard Kit Contents

a. FC41D demo board
b. USER-Serial cable (CH430)

2.4.2. User Provided Items

None
2.4.3. 3rd Party Purchasable Items

None

2.5. Additional Hardware References

3 Set Up Development Environment

3.1. Supported IDEs

CLI based (CMake)
Under bk7231_freertos_aws-sdk directory, follow below steps to generate demo target:

a. Execute CMD: generate_make.bat, the script contains below command.

(cmake -DVENDOR=beken -DBOARD=FC41D -DCOMPILER=arm-gcc -DAFR_ENABLE_TESTS=0
-DAFR_METADATA_MODE=1 -S -Bbuild -G"Unix Makefiles")
b. Go to the build directory and execute make command. Thus can build out the image.

3.2. Toolchains

a. cmake: https://github.com/Kitware/CMake/releases/download/v3.22.0-rc2/cmake-3.22.0-rc2-windows-x86_64.msi
c. GNU make: https://sourceforge.net/projects/gnuwin32/

3.3. SDKs

None

3.4. Establishing a Serial Connection

a. Get the CH340 USB-Serial driver (CH341USB-Serial-driver.exe, which is a very common driver) from projects/beken/tools directory and double-click it to install the driver for the serial tool.
b. Connect the serial cable with the UART1 on the demo board as below (baud rate: 115200)
Figure 2: Establish a Serial Connection

3.5. Other Software Required to Develop and Debug Applications for the Device

None

3.6. Other Pre-requisites

None

3.7. Additional Software References

None
4 Set Up Hardware

UART1 can supply power and download image to board, so just connect the serial cable to UART1.
5 Setup AWS account and Permissions

To create an AWS account, see *Create and Activate an AWS Account*.

To add an IAM user to your AWS account, see *IAM User Guide*. To grant your IAM user account access to AWS IoT and FreeRTOS, attach the following IAM policies to your IAM user account:

- AmazonFreeRTOSFullAccess
- AWSIoTFullAccess

To attach the AmazonFreeRTOSFullAccess policy to your IAM user:

1. Browse to the *IAM console*, and from the navigation pane, choose *Users*.
2. Enter your user name in the search text box, and then choose it from the list.
3. Choose *Add permissions*.
4. Choose *Attach existing policies directly*.
5. In the search box, enter AmazonFreeRTOSFullAccess, choose it from the list, and then choose **Next: Review**.
6. Choose *Add permissions*.

To attach the AWSIoTFullAccess policy to your IAM user:

1. Browse to the *IAM console*, and from the navigation pane, choose *Users*.
2. Enter your user name in the search text box, and then choose it from the list.
3. Choose *Add permissions*.
4. Choose *Attach existing policies directly*.
5. In the search box, enter AWSIoTFullAccess, choose it from the list, and then choose **Next: Review**.
6. Choose *Add permissions*.

The examples in this document are intended only for dev environments. All devices in your fleet must have credentials with privileges that authorize only intended actions on specific resources. The specific permission policies can vary for your use case. Identify the permission policies that best meet your business and security requirements. For more information, refer to *Example policies* and *Security Best practices*.

For more information about IAM and user accounts, see *IAM User Guide*. For more information about policies, see *IAM Permissions and Policies*. 
6 Provision the device with AWS IoT

Refer to *Register your board manually.*

Follow *steps 1–6* under the heading *To create an AWS IoT policy.* In step 1, note that the AWS region for your account can also be found in the drop-down between the account name and Support drop-downs in the top menu bar.

Follow *steps 1-10* under the heading *To create an IoT thing, private key, and certificate for your device.*
7 Download FreeRTOS

You can download the code from https://github.com/bekencorp/bk7231n_freertos_aws.git.
Configure FreeRTOS

Follow the instructions under the heading **Configuring the FreeRTOS Demo**.

Actually we only need to configure following things:

1. Need to acquire the key and certificate from AWS IoT (refer to above instructions)
2. generate the `demos\include\aws_clientcredential_keys.h`
3. Need to define the device thing name and endpoint, and Wi-Fi client credentials in the `demos\include\aws_clientcredential.h`. 
9 Build the FreeRTOS Demo

1. Execute the script: `generate_make.bat`, which will generate one build folder automatically.

2. `cd build folder`, and execute command: `make`, it will make all objects.

3. The final target image is: `all.bin`.

```
D:\bk7231_freetos_aws\sdk\build
D:\bk7231_freetos_aws\sdk\build>make
[ 1%] Building C object CMakeFiles/afr_kernel.dir/freertos_kernel/event_groups.c.obj
[ 1%] Building C object CMakeFiles/afr_kernel.dir/freertos_kernel/list.c.obj
[ 2%] Building C object CMakeFiles/afr_kernel.dir/freertos_kernel/queue.c.obj
[ 2%] Building C object CMakeFiles/afr_kernel.dir/freertos_kernel/stream_buffer.c.obj
[ 2%] Building C object CMakeFiles/afr_kernel.dir/freertos_kernel/tasks.c.obj
[ 3%] Building C object CMakeFiles/afr_kernel.dir/freertos_kernel/timers.c.obj
[ 7%] Linking C static library afr_kernel.a

Running Post-build step

---

.......

```

Export app partition image: bk7231_uart_0_0_0.bin

time: 1.29s

```

Success!

```
10 Run the FreeRTOS Demo Project

After building FreeRTOS demo and get the image successfully, open the flash tool `projects\beken\tools\bk_writer_v6.13.exe`.

You can follow the below steps to flash image to board:

1. Choose the chip type: BK7231N
2. Choose the serial port, e.g., COM3
3. Click "浏览(F5)…" to select the image file to download, e.g., `all.bin`
4. Click "烧录" to download image to board. Note that after click the "烧录" button, switch VCC "ON-OFF-ON" quickly. Do not need to click "读取 flash" and "擦除 flash", both are for debug.
5. After more than ten seconds, you can see the "操作成功".

To verify MQTT messages are being received by AWS IoT Core:

From the AWS IoT Core console at `console.aws.amazon.com/iot`, select Test from the navigation pane, and choose MQTT test client. Choose Subscribe to a topic and Enter the topic (or use the # wildcard to see all topics), then choose Subscribe. You should see messages being received. Below is the MQTT demo example message exported from AWS IoT core:

Also you can close this tool, and open one serial tool, then you can see the demo project logs, below is an example:
11 Debugging

When connecting the demo board with computer via serial tool, switch VCC to ON.

You should see following initial logs on the serial console:

prvHeapInit-start addr:0x409950, size:157360
[Flash]id:0xeb6015
--write status reg:4004,2--
[Flash]init over
sctrl_sta_ps_init
SDK Rev: 3.0.36
cset:0 0 0 0
No TLV header found in flash
bandgap_calm_in_efuse=0x6b
[load]bandgap_calm=0x20->0x2b,vddig=4->5
[FUNC]rmxl_init

Figure 4: Switch VCC to ON
IP Rev: W4-3.0.36-P0

[bk]tx_txdesc_flush

[FUNC]intc_init

[FUNC]calibration_main

get rfcali_mode=1
device_id=0x20521010
calibration_main over

NO TXPWR_TAB found in flash
Load default txpwr for b:0xd6b74
Load default txpwr for g:0xd6b82

fit n20 table with dist:4
Load default txpwr for n40:0xd6b90
Load default txpwr for ble:0xd6bd6

NO TXID found in flash, use def temp:330
temp in flash is:330
NO TXID found in flash, use lpf i&q:116, 116
NO TXID found in flash, use def xtal:38
xtal in flash is:38
xtal_cali:38
--init_xtal = 38

[FUNC]ps_init

int watchdog enabled, period=10000
task watchdog enabled, period=60000

[FUNC]func_init_extended OVER!!!

start_type:0
 Initializing TCP/IP stack
bk_wlan_app_init finished
rf_thread_init ok
WIFI_On:166 conn_state=0

[sa_sta]MM_RESET_REQ
[bk]tx_txdesc_flush
[sa_sta]ME_CONFIG_REQ
[sa_sta]ME_CHAN_CONFIG_REQ
[sa_sta]MM_START_REQ

PSKC: ssid test, passphrase 12345678
sizeof(wpa_supplicant)=760
mm_add_if_req_handler:0
hapd_intf_add_vif,type:2, s:0, id:0

wpa_dInit
enter low level!
mac c8:47:8c:42:88:48
leave low level!
[net]addvif_idx:0
wpa_supplicant_req_scan
Setting scan request: 0.000000 sec
wpa_supplicant_scan
wpa_drv_scan
wpa_send_scan_req
no ht in scan
scan_start_req_handler
wpa_driver_scan_start_cb
0 504 [app] WiFi module initialized. Connecting to AP test

wpa_driver_scan_cb
Scan completed in 1.332000 seconds
get_scan_rst_null
WIFI_ConnectAP: conn_state=0 returnCode=1 ssid:test key:1234567  connect the WIFI AP
12 Troubleshooting

When IDT call the script to flash image to board to test, the script will start another CMD console automatically to flash image to board, sometimes it will hang on the "Getting the bus".

Please switch the VCC quickly "ON->OFF->ON"
## 13 Appendix Terms and Abbreviations

Table 1: Terms and Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AoA</td>
<td>Angle-of-arrival</td>
</tr>
<tr>
<td>AoD</td>
<td>Angle-of-departure</td>
</tr>
<tr>
<td>AP</td>
<td>Access Point</td>
</tr>
<tr>
<td>AWS</td>
<td>Amazon Web Service</td>
</tr>
<tr>
<td>BLE</td>
<td>Bluetooth Low Energy</td>
</tr>
<tr>
<td>BR</td>
<td>Basic Rate</td>
</tr>
<tr>
<td>CLI</td>
<td>Common Layer Interface</td>
</tr>
<tr>
<td>CMD</td>
<td>Command</td>
</tr>
<tr>
<td>EDR</td>
<td>Enhanced Data Rate</td>
</tr>
<tr>
<td>GPIO</td>
<td>General-Purpose Input /Output Ports</td>
</tr>
<tr>
<td>I2C</td>
<td>Inter—Integrated Circuit</td>
</tr>
<tr>
<td>ID</td>
<td>Identification</td>
</tr>
<tr>
<td>IDE</td>
<td>Integrated Development Environment</td>
</tr>
<tr>
<td>IDT</td>
<td>Intelligent Data Terminal</td>
</tr>
<tr>
<td>IoT</td>
<td>Item of Thing</td>
</tr>
<tr>
<td>IrDA</td>
<td>Infra-red Data Association</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>MCU</td>
<td>Micro Control Unit</td>
</tr>
<tr>
<td>MQTT</td>
<td>Message Queuing Telemetry Transport Protocol</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>OTP</td>
<td>One Time Programable</td>
</tr>
<tr>
<td>PTA</td>
<td>Packet Traffic Arbitration</td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse Width Modulation</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
</tr>
<tr>
<td>RTOS</td>
<td>Real-time Operating System</td>
</tr>
<tr>
<td>SDIO</td>
<td>Secure Digital Input and Output</td>
</tr>
<tr>
<td>SDK</td>
<td>Software Development Kit</td>
</tr>
<tr>
<td>SPI</td>
<td>Software Process Improvement</td>
</tr>
<tr>
<td>TRNG</td>
<td>True Random Number Generator</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver/Transmitter</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>VCC</td>
<td>Virtual Circuit Connection</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Networks</td>
</tr>
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