User Manual

DA16200 Evaluation Kit

UM-WI-023

Abstract

This user manual describes how to set up and use the DA16200 Evaluation Kit, version 6.0 and higher. If you use EVK version 5.0 or lower, please see the previous version of this manual.

Contents

Figures

Tables

1 Terms and Definitions

DPM	Dynamic Power Management
AP	Access Point
USB	Universal Serial Bus
UART	Universal Asynchronous Receiver-Transmitter
RTC	Real Time Clock
WPS	Wi-Fi Protected Setup
SSID	Service Set Identifier
SDK	Software Development Kit
ARP	Address Resolution Protocol

2 References

[1] DA16200, Datasheet, Dialog Semiconductor

[2] UM-WI-002, DA16200, SDK Programmer Guide, User Manual, Dialog Semiconductor

[3] UM-B-114, DA14531, Devkit Pro Hardware, User Manual, Dialog Semiconductor

[4] UM-WI-012, DA16200 SPI SFlash Downloader, User Manual Rev 1v5, Dialog Semiconductor

3 DA16200 Module EVK

Figure 1 shows the hardware configuration of the DA16200 Module Evaluation Kit (EVK).

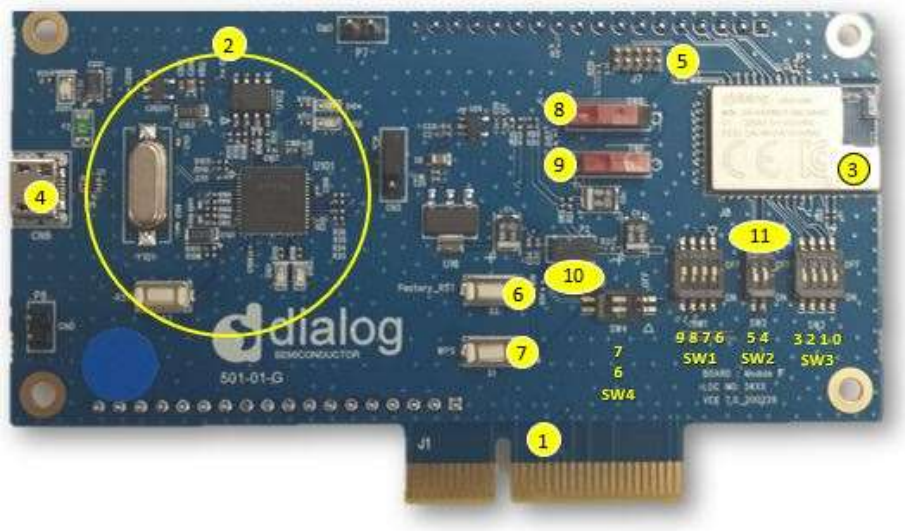

Figure 1: Hardware Configuration

DA16200 has the following components:

1. Main board: DA16200 module (DA16200MOD-AAC4WA32) is installed on the PCI-type main board.
2. USB Interface part.
3. DA16200MOD-AAC4WA32 Wi-Fi Module.
4. USB Port: UART0 (for debug) and UART1 (for AT command).
5. JTAG PIN: to be able to connect I-jet (a JTAG debugger from IAR). See Figure 2.
   - Pin 7 on each end is keyed with a white plug, so Pin 7 should be removed on EVK

Figure 2: JTAG Pin Connection

6. Factory Reset Button: press for more than 5 seconds to initialize `nvram` data.
7. WPS Button: press to start WPS mode.
8. RTC Wake-up key: switch to wake up the board from Sleep mode.
9. RTC Power key: switch to turn the board on/off.
10. Pin (P2): selected part in red color is for current measurement. For normal operation, this pin should be shorted. See Figure 3.
    - Pull out the Short Pin cap and use the jumper wire to connect to measuring equipment

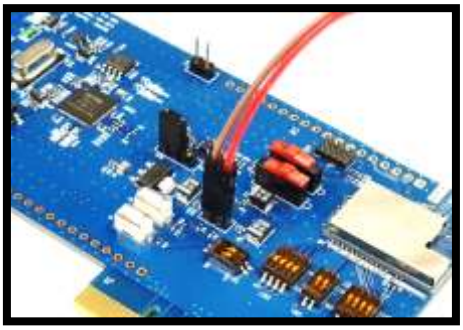

Figure 3: Test Point for Current Measurement

11. GPIO, SPI selective switch: SW2, SW3, SW4 (Default: on), SW1 (Default: off). See Table 1.
    - For more details on how to use the pins, see the schematic of the 6.0 EVK in the manual [4]

Table 1: GPIO, SPI Selective Switch

Selective Switch	On	Off
SW3: GPIO 0, 1, 2, 3	Image download using SPI 1	Not defined
SW2: GPIO 4, 5	UART 1(TXD, RXD) to FT232H	UART 1 to external MCU for Test
SW1: GPIO 6, 7	Image download using SPI 2	WPS, Factory Reset
SW1: GPIO 8, 9	Image download using SPI 2	Not defined
SW4: GPIO 6, 7	WPS, Factory Reset	Not defined

4 Test Sequence

This section describes the test sequence for how we show the DA16200 benefits of the following test items:

- Current measure (Section 7)
  - Section 7.1 > Section 5.1, 5.2 > Section 7.2 (Sleep1), Section 7.3 (Sleep 2)
  - Section 7.1 > Section 5.1, 5.2 > Section 6 > Section 7.4
- Ping test (Section 7)
- Section 5.1, 5.2, 5.3 > (Section 6) > Section 7
- Throughput test (Section 9)
- Section 5.1, 5.2, 5.3 > Section 9
- SoftAP test (Section 5.4)
- Section 5.1, 5.2 > Section 5.4
- Firmware update
- Section 5.1, 5.2 > Section 10.3

5 Wi-Fi Mode Setup

This section describes how to set up the Station and Soft-AP modes that are supported by DA16200.

- Station: a mode that runs the 802.11 STA interface
- Soft-AP: a mode that runs the Software Access Point. The Soft-AP mode does not support full-fledged commercial level Access Point features. This mode is normally used for Provisioning

NOTE
If the customer/developer starts with a new SFLASH or a full initialized SFLASH, then the "factory" command should be run on the console after the first boot to initialize the NVRAM drive.

5.1 DA16200 Connecting the Board

This section describes the installation procedure for the drivers, the configuration of the serial port, and all necessary steps to verify the connection with the PC as well as solutions to any problems that may occur.

On first connection to a host PC with Microsoft Windows as an operating system, the system detects several devices and automatically installs all necessary drivers. If not automatically installed, then get the driver from the following URL: http://www.ftdichip.com/Drivers/CDM/CDM21224_Setup.zip.

There are two virtual COM ports created by the Windows driver. The first COM port (lower number, COM35 in this example) provides a UART interface for debugging or firmware download between the PC and the DA161200. The second (higher number, COM36 in this example) is used for ATCOMMAND. See Figure 4.

Figure 4: Check COM Ports on Device Manager

5.2 Configure the Serial Port for UART

On a Windows Host, the utility **Tera Term** is used to fully validate the connection to the DA16200 EVK. **Tera Term** is a free software terminal emulator (communication program) that supports multiple communication including serial port connections. Download **Tera Term** from https://ttssh2.osdn.jp. Run the **teraterm-x.yy.exe** executable and follow the installation wizard.

To make sure that the communication between the DA16200 EVK and the host PC is properly established, the UART connection between the two nodes needs to be verified. For that purpose, do the following steps:

1. Connect the DA16200 EVK to the PC via USB cable to USB Port.
2. Check if the host discovered two serial ports as shown in Figure 4. The second is connected to UART (see Section 5.1).
3. Open **Tera Term** from the Windows Start menu.
4. In the **Tera Term: New connection** dialog box:
   a. Select **Serial**.
   b. Select the COM Port to use.
   c. Click **OK**.
5. Select **Setup** > **Serial Port** and configure your UART port with the parameters as shown in Figure 5.
6. Open the Lowest COM port number assigned to the DA16200 EVK (see Figure 4), to figure out which port number is used by Windows by running the Device Manager. Make sure that the UART is configured as shown in Figure 5.

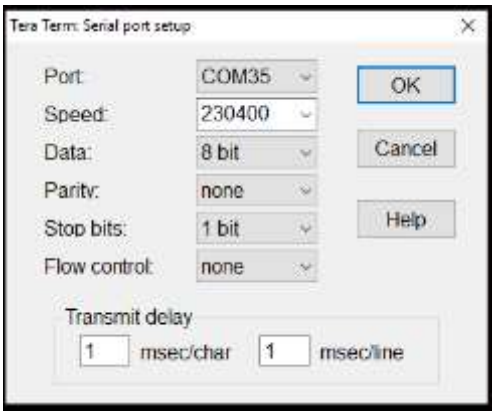

Figure 5: Serial Port Setup

5.3 Setup for Station Mode

Use Easy Setup to configure the Wi-Fi functions of DA16200 via a Wi-Fi configuration wizard:

1. Run command `setup`.
2. From here on, the setup query statements continue. So please answer the questions as described in the following steps.
3. `Stop all services for the setting. Are you sure? [Yes/No]:` type **Yes**
   See Figure 6.

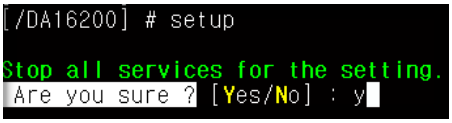

Figure 6: Easy Setup Start

4. `COUNTRY CODE? [Quit] (Default KR)`: type **US** for testing
   See Figure 7.

Figure 7: Country Selection

5. `MODE? [1/2/Quit] (Default Station)`: type **1**
   See Figure 8.

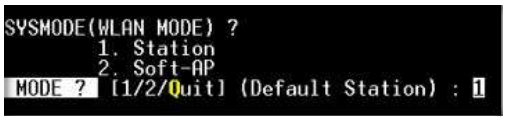

Figure 8: Station Mode Selection

6. `SELECT SSID? (1~30/Manual/Quit)`: type **1**
   See Figure 9.
   a. Select the SSID of the AP to which you want to connect. If there is no AP that you want to connect to, please press **Enter** to rescan.
      For example: SSID **ACST_AC_TEST2** is selected for testing.

Figure 9: AP Selection

7. `PSK-KEY (ASCII characters 8~63 or hexadecimal characters 64)? [Quit] : ********` type the password that matches the encryption method of the selected AP.
8. `WIFI CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**. See Figure 10.
9. `IP Connection Type? [Automatic IP/Static IP/Quit]: type` **A**
   IP is automatically assigned by DHCP.
10. `IP CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**
11. `SNTP Client enable`: type **N**
    If time synchronization is not needed, then there is no need to run the SNTP Client.
12. `Dynamic Power Management? [Yes/No/Quit]`: type **N**
    See section 6.1 for more information about DPM.

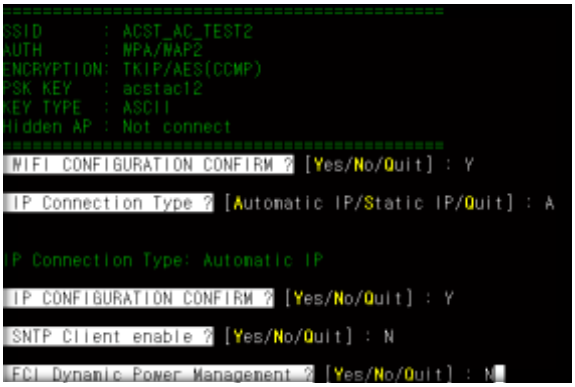

Figure 10: Check Wi-Fi Configuration

13. Once all settings are made as shown in Figure 10, the configuration is saved and the system will reboot as shown in Figure 11.

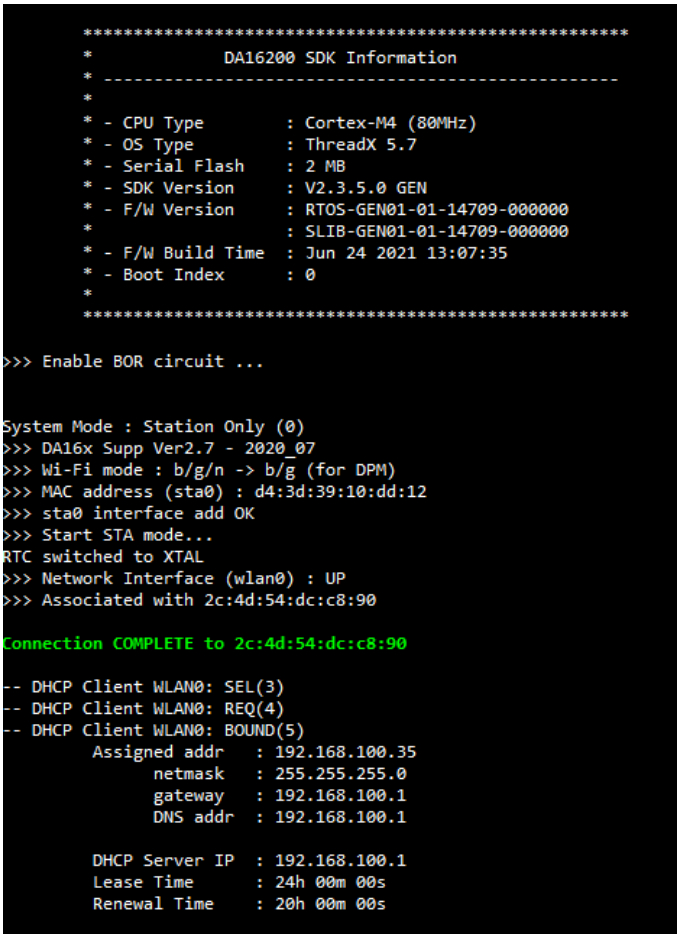

Figure 11: Wi-Fi Configuration Completed

5.4 Setup for Soft-AP Mode

The setup for the Soft-AP mode is almost the same as for the STA mode. You can also use Easy Setup to set up the Soft-AP mode. Do the following:

1. At the prompt, run the command `setup`.
2. From here on, the setup query statements continue. So please answer the questions as described in the following steps.

3. MODE? [1/2/Quit] (Default Station) : type **2**
   See Figure 12.

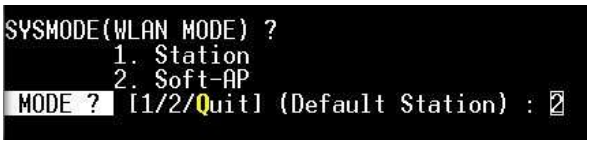

Figure 12: Soft-AP Mode Selection

4. SSID? (Default 16200_9FFFFF) : **TEST AP**. See Figure 13.
   a. Choose the SSID you want to use.
5. CHANNEL? [1~11, Auto:0/QUIT] : press **[ENTER]**
6. AUTHENTICATION? [1/3/4/5/QUIT] : type **4**
   - WPA2-PSK is recommended
7. ENCRYPTION? [1/2/3/Quit] : type **2**
8. PSK-KEY (ASCII characters 8~63 or hexadecimal characters 64)? [Quit]
   : ******** Enter the password you want to use.

Figure 13: Setup AP

9. Do you want to set advanced Wi-Fi configuration? [No/Yes/Quit] (Default No) : type **N**
   See Figure 14.
10. WIFI CONFIGURATION CONFIRM? [Yes/No/Quit] : type **Y**
11. IP ADDRESS? [Quit] (Default 10.0.0.1) : press **[ENTER]**
12. SUBNET? [Quit] (Default 255.255.255.0) : press **[ENTER]**
13. GATEWAY? [Quit] (Default 10.0.0.1) : press **[ENTER]**
14. DNS? [Quit] (Default 8.8.8.8) : press **[ENTER]**
15. IP CONFIGURATION CONFIRM? [Yes/No/Quit] : type **Y**
16. DHCP SERVER CONFIGURATION? [Yes/No/Quit] : type **Y**
17. DHCP SERVER LEASE IP Count (MAX 10)? [Quit] (Default 10) : press **[ENTER]**
18. DHCP SERVER LEASE TIME (60 ~ 86400 SEC)? [Quit] (Default 1800) : press **[ENTER]**
19. DHCP SERVER CONFIGURATION CONFIRM? [Yes/No/Quit] : type **Y**

Figure 14: AP Mode Selection

Figure 15: AP Setup Completed

Once all settings are made, the configuration is saved and the system reboots.

A message is printed that Soft-AP mode started successfully. See Figure 15.

6 DPM Setup

6.1 What is DPM

DPM (Dynamic Power Management) is a synthesis of breakthrough ultra-low-power technologies that enable extremely low power operation in the DA16200. DPM shuts down every microelement of the chip that is not in use, which allows a near-zero level of power consumption when not actively transmitting or receiving data. Such low-power consumption can provide a battery life of one year or more, depending on the application. DPM also enables ultra-low-power transmission and receive modes when the SoC needs to be awake to exchange information with other devices. Advanced algorithms enable to stay asleep until the exact required moment to wake up to transmit or receive.

6.2 Enable DPM Mode

To enable the DPM mode:

1. Do the steps in section 5.1 until step 12: **Dynamic Power Management? [Yes/No/Quit]**.
2. At prompt `Dynamic Power Management? [Yes/No/Quit]`: type **Y**. See Figure 16.
   a. To use the default DPM factor, `DPM factors: Defaults? [Yes/No/Quit]`, type **Y**
   b. `DPM CONFIGURATION CONFIRM [Yes/No/Quit]`: type **Y**

NOTE
TIM wakeup count in 10 dtim is the default value. This means: 10dtim*102.4 = 1,024 ms = 1sec @ DTIM = 1 (in case that AP DTIM = 3, 10dtim is 921.6 ms) Wake-up from sleep state takes place every second to check for a receive packet.

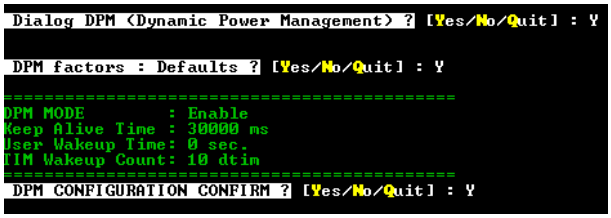

Figure 16: Setting DPM Factor with Default

   c. To use the user-defined DPM factor, `DPM factors: Defaults? [Yes/No/Quit]`, type **N.** See Figure 17.
      i. `DPM Keep Alive Time (0~600000 ms)? [Quit] (Default 30000 ms)`: press **[ENTER]** or type value within the range
      ii. `DPM User Wakeup Time (0~86400 Sec.)? [Quit] (Default 0 Sec.)`: press **[ENTER]** or type value within the range
      iii. `DPM TIM Wakeup Count (1~65535 dtim)? [Quit] (Default 10)`: press **[ENTER]** or type value within the range
      iv. `DPM CONFIGURATION CONFIRM [Yes/No/Quit]`: type **Y**

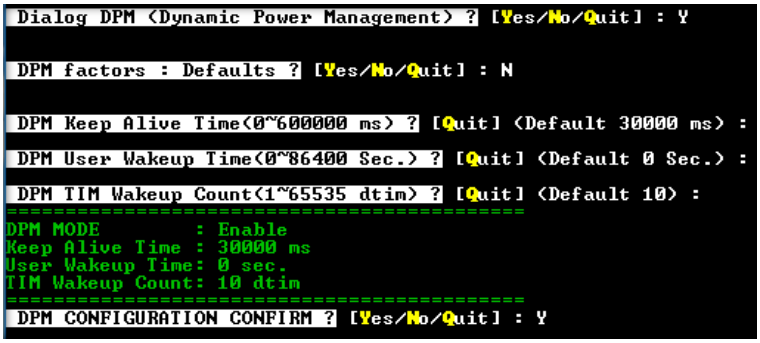

Figure 17: Setting DPM Factor with User Defined

3. After reboot, DA16200 will enter DPM sleep. `The print message >>> Start DPM Power-Down!!!` means that DA16200 has entered DPM Sleep. See Figure 18.

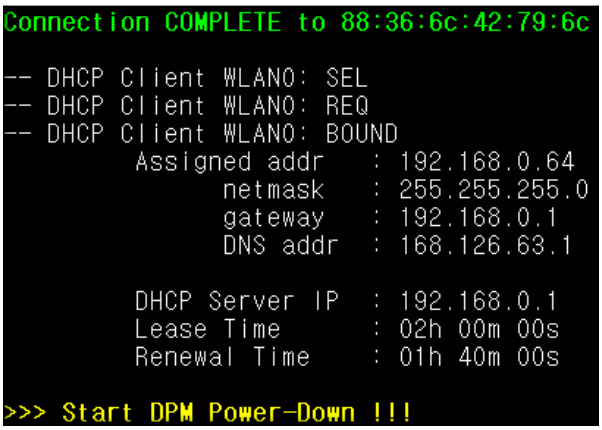

Figure 18: DPM Mode Running after Reboot

NOTE
As soon as the system has entered DPM Sleep (After ">>> Start DPM Power-Down !!!" is printed on Console), any user input via UART console will not work, because UART interface gets down when DPM Sleep is entered.

6.3 Hold DPM Mode

As described in the Note above, user input is not possible after DPM Sleep is entered, which is normal. To exit this state and start over with `setup`, do the following:

1. Copy the string `dpm hold` to the clipboard.
   a. For example: open Notepad, type `dpm hold`, and then copy (Ctrl + C) the command string.
2. Use RTC_PWR_KEY to power off (move to OFF position).
3. Use RTC_PWR_KEY to power on (move to ON position).
4. Before the message `>>> Start DPM Power-Down !!!` is printed on the console, do the following:
   a. With the `dpm hold` string copied, right-click in the terminal window to paste the string.
   b. Immediately press the **ENTER** key.
   c. Once this procedure is done quickly and successfully, the message `DPM Sleep Manager HOLD...` is printed. See Figure 19.
   d. If the DPM mode does not stop successfully, you may need to retry several times.
5. Run `setup` again to configure DA16200 in a different mode.

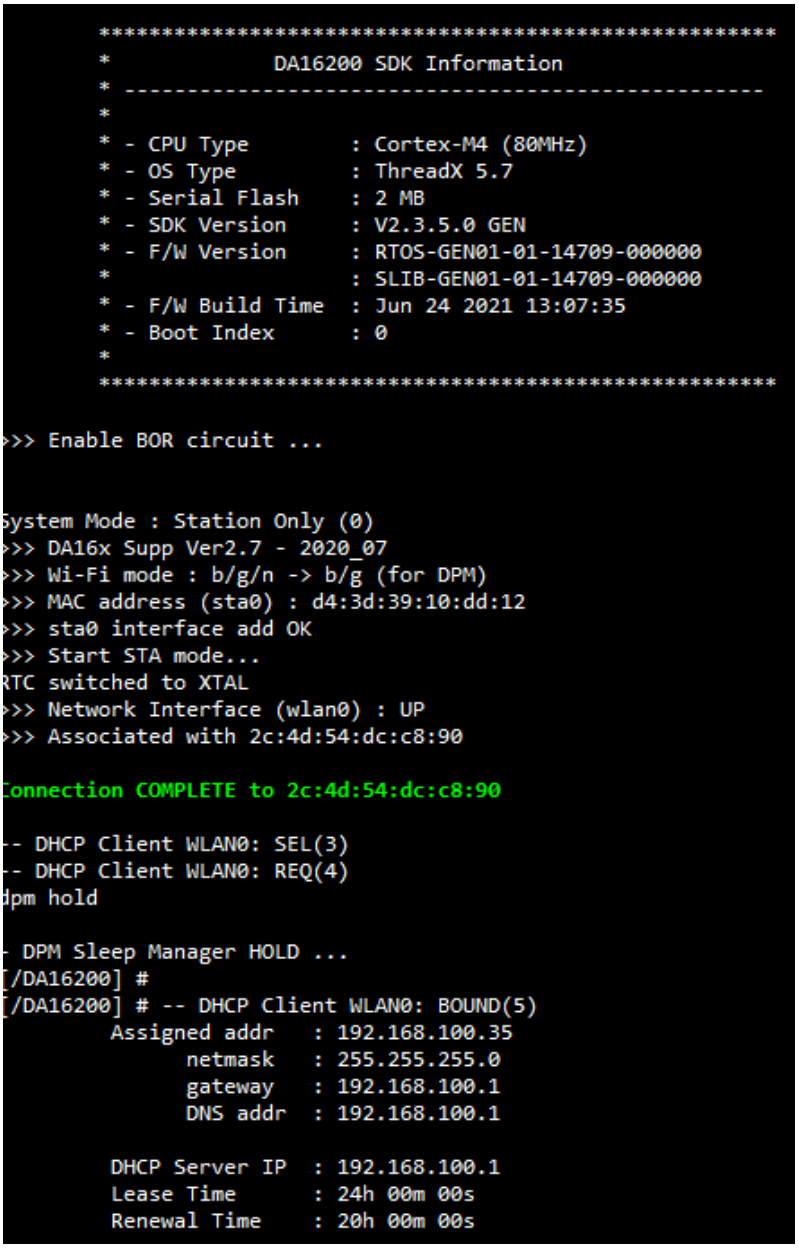

Figure 19: DPM Mode Hold

6.4 Disable DPM Mode

Though we make DPM enabled during `setup`, we can disable DPM mode with command `dpm off` at the prompt. DA16200 will reboot and connect to AP as shown in Figure 20.

Figure 20: DPM Mode Off

7 Current Measurement

For more detailed information on Sleep mode, see section “Low Power Operation Mode” in DA16200 Datasheet [1]. To measure the current waveform, connect EVK's current measurement point (P2) with the measurement instrument (KEYSIGHT 14585A).

7.1 Test Setup

Figure 21 shows a typical test setup environment.

Figure 21: Current Test Environment

7.2 Sleep 1

To measure the Sleep 1 current, use RTC_PWR_KEY to power off (move to OFF position). See Section 3, number 9. See Figure 22.

7.3 Sleep 2

To measure the Sleep 2 current, the following command is required:

1. Use RTC_PWR_KEY to power on (move to on position). See section 3, number 9.
2. Type command `factory` to make DA16200 use the default setting.
3. The board will reboot.
4. At prompt, run command `sleep 2 time(sec) [/DA16200/SYS.HAL] # sleep 2 time(sec)`
   - `For instance, [/DA16200/SYS.HAL] # sleep 2 10`
   - `It will sleep for a set amount of time (10 seconds), and then reboot and wake up.`

7.4 Sleep 3

1. Do the steps in Section 6.2 until step 3.
   - When you run the DA16200 with DPM settings, DA16200 will run `DPM Sleep`, `wake up for Beacon check` and `Keep Alive` according to the configured DTIM

For example: the current waveform in Figure 22 shows settings DTIM 10 (about 1sec @ AP DTIM=1) and Keep Alive 30s.

Sleep 3 current means current between RX or between RX and TX.

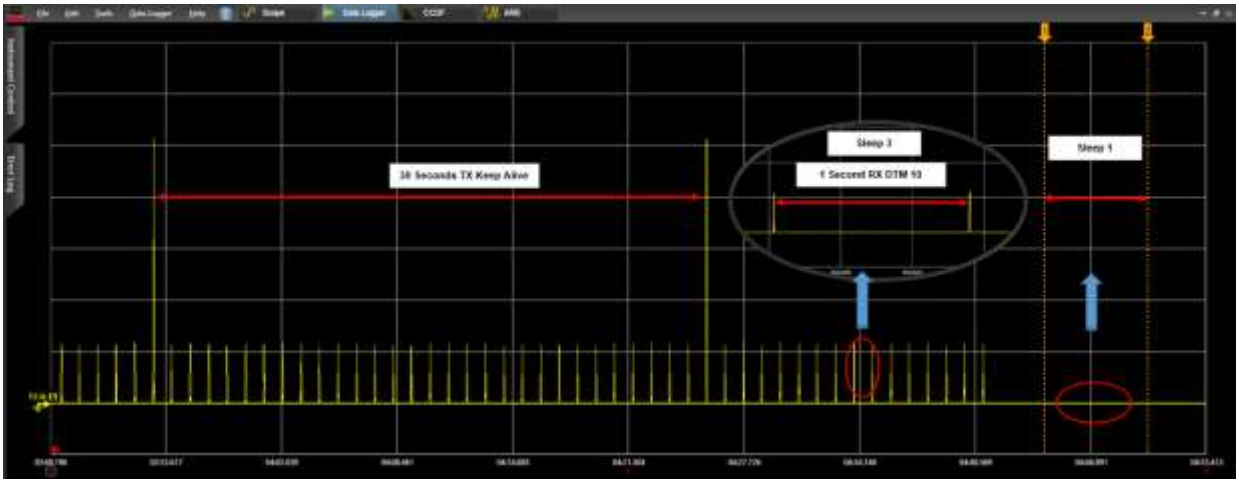

Figure 22: Current Measurement with DPM

8 Ping Test

DA16200 has command `ping` to verify communication test (Ping Test) during DPM mode.

8.1 Test Setup

For a communication test (Ping Test) there are two stations–DA16200 and Laptop–and an Access Point (AP) required. Both must be connected to the same subnetwork AP. See Figure 23.

DA16200 must be connected to the AP via WI-FI, and the laptop must be connected to the AP with an Ethernet cable. After configuration, DA16200 will be in DPM Sleep mode (Sleep 3). Then DA16200 can wake up from sleep mode when unicast packets are sent while remaining in sleep mode most of the time.

In this test, a Ping application that runs on the laptop acts as a network peer that sends a unicast packet to DA16200. This is to check if DA16200 in DPM Sleep mode can successfully wake up and receive the unicast packets in real-time.

Figure 23: Ping Test Environment

1. Run the command window (CMD) as administrator.
2. Type command `ipconfig` to see what the IP address is of the laptop. See Figure 24.
   For example: the laptop's IP is 192.168.0.65, and the Default Gateway IP is 192.168.0.1

```
Connection-specific DNS Suffix  . :
Link-local IPv6 Address . . . . . : fe80::9809:ccc1:b552:e47f%19
IPv4 Address. . . . . . . . . . . : 192.168.0.65
Subnet Mask . . . . . . . . . . . : 255.255.255.0
Default Gateway . . . . . . . . . : 192.168.0.1
```

Figure 24: Ethernet IP Address Assign

3. Run the DA16200 terminal window and set DA16200 in Station mode (see Section 5.3).
   - For example: the assigned IP of DA16200 is 192.168.0.66. See Figure 25

```
Connection COMPLETE to 88:36:6c:42:79:6c

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
        Assigned addr    : 192.168.0.66
                netmask  : 255.255.255.0
                gateway  : 192.168.0.1
                DNS addr : 168.126.63.1

        DHCP Server IP   : 192.168.0.1
        Lease Time       : 02h 00m 00s
        Renewal Time     : 01h 40m 00s
```

Figure 25: DA16200 IP Address Assign

8.2 Add ARP Record

This section describes how to add a DHCP-assigned IP address to the ARP table and to change that IP address from a dynamic to a static IP address.

Since retransmission logic is not included in the higher protocol (TCP/UDP), an additional ARP record is required for ping tests between the laptop and the DA16200 operating in DPM sleep mode.

1. Use command `arp -s 192.168.0.66 ec-9f-f9-32` to add an ARP record manually.

NOTE
When you set the ARP cache to static with command `arp -s` on higher versions of Windows, you may get an error like `Failed to add ARP entry, Access is denied`. It is recommended to use command `netsh` to change the network settings.

2. Do the following steps to change the ARP record to a static IP address.
3. Use command `arp -a` to view the ARP table of the network interface. See Figure 26.
   - `For example: C:\WINDOWS\system32>arp -a`

```
Interface: 192.168.0.65 --- 0x13
  Internet Address      Physical Address      Type
  192.168.0.1           88-36-6c-42-79-6c     dynamic
  192.168.0.66          ec-9f-0d-9f-f9-32     dynamic
  192.168.0.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.2             01-00-5e-00-00-02     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static
```

Figure 26: Check ARP Record

4. Use command `netsh interface show interface` to find the interface name. See Figure 27.
   - `For example: C:\WINDOWS\system32>netsh interface show interface`

```
C:¥WINDOWS¥system32>netsh interface show interface

Admin State    State          Type             Interface Name
-------------------------------------------------------------------------
Enabled        Connected      Dedicated        Ethernet
Enabled        Disconnected   Dedicated        Wi-Fi
```

Figure 27: Interface Name for ARP Record

5. Use the interface name found for DA16200 to set the ARP cache to static with command `C:\WINDOWS\system32> netsh interface ipv4 add neighbors "<Interface Name>" "<IP>" "<MAC>"`. See Figure 28.
   - For example: `C:\WINDOWS\system32> netsh interface ip add neighbors "Ethernet" "192.168.0.66" "ec-9f-0d-9f-f9-32"`
6. Use command `arp -a` on the laptop to check if the ARP cache is configured correctly. See Figure 28.
   - For example: `C:\WINDOWS\system32>arp -a`
   - DA16200's IP address 192.168.0.66 is added to ARP table as a static type

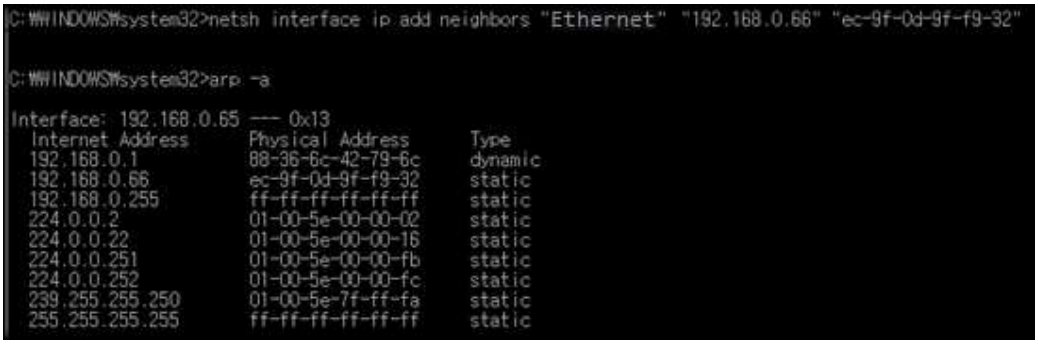

Figure 28: Success ARP Record for DA16200

7. Use command `arp -d` or `netsh interface ip delete arpcache` to initialize the ARP cache.

8.3 Perform Ping Test

Ping application is a simple generic application provided by Network Stack for network management purposes. Its main purpose is to check if a node is alive in the same subnetwork. Ping just sends out a request once and then waits for a reply. Ping prints the result only if a Reply packet arrives from the peer.

1. Make DPM enable. See Section 6.2.
2. Run a ping on the Laptop. See Figure 29.
   For example: `C:\WINDOWS\system32>ping 192.168.0.66 -t`
   Next, DA16200 wakes up and receives the ping message, sends a reply, and goes to DPM sleep again.

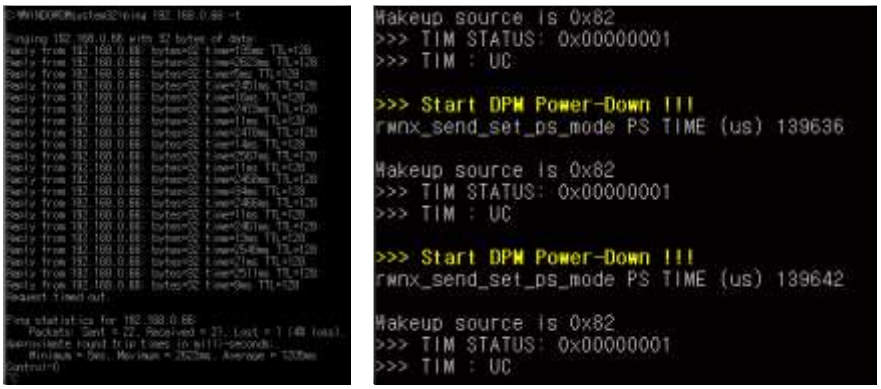

Figure 29: Ping Test with DPM

NOTE
If you have multiple network interfaces enabled, then put the `arp` entry under the specific interface. For example: `arp -s 192.168.20.52 aa-ff-00-88-66-80 -S 192.168.100.100` 192.168.100.100 is the interface from which the ping command should be sent. In this case, specifying the network interface is required in the ping command. For example: `ping 192.168.20.52 -S 192.168.100.100`

9 Throughput Test

DA16200 has command `iperf` to measure the packet transfer performance. This is known as the throughput test. To do the throughput test, prepare the DA16200 to operate in Station mode (see Section 5.1) without using DPM (see Section 6.4). This section shows the throughput test with the use of a TCP client/server protocol.

9.1 Test Setup

Figure 30: Iperf Test Environment

The Iperf tool should be ready on your laptop. **Iperf Version 2.0.9** is recommended.

To set up the Iperf tool, do the following:

1. Download Iperf from https://iperf.fr/iperf-download.php.
2. Create a folder called **Iperf** in path **C:**
3. Unzip the downloaded file and move the contents to the Iperf folder.
4. Prepare the DA16200 to operate in Station mode. See Sections 5.1 to 5.3.
5. Use command `iperf` or `iperf -h` to see the available options in Iperf. See Figure 31.
   - For example: `[/DA16200/NET] # iperf`

```
[/DA16200] # net
    Command-List is changed, 'NET'
[/DA16200/NET] # iperf
Usage: iperf -i [WLAN0|WLAN1] [-s|-c host][options]
       iperf [-h] [-v]

Client/Server:
       -i      interface [WLAN0|WLAN1]
       -u      use UDP rather than TCP
       -p, #   server port to listen on/connect to
       -w, #   TCP window size (4 ~ 64K)
       -f, [kmKM]   format to report: Kbits, Mbits, KBytes, MBytes
       -d      finsh service
               ex) iperf -d -c -u : udp clinet
                   iperf -d -c    : tcp clinet
                   iperf -d -u    : udp server
                   iperf -d       : tcp server

Server specific:
       -s      run in server mode
       -T  #   Rx Time Out Min:1 sec, 'F' Forever

Client specific:
       -c      <host>   run in client mode, connecting to <host>
       -t  #   time in seconds to transmit for (default 10 secs)
       -l  #   PacketSize option (UDP default 1470, IPv6 1440 TCP 1000
)
       -n  #   UDP Tx packet number
       -S  #   RWM TOS option
               |224|192|
               |184|160|152|144|136|
               |112|96|0|
               |88|72|56|40|32|
       -P, #   Pair index (0,1,2)
               (default Max, Step 1-100 Mbps)
       -0      use Main Packet Pool

Miscellaneous:
       -m #    Print MIB info(debug only)
               1 counter reset
               2 counter retention
       -h      print this message
       -v      print version
[/DA16200/NET] #
```

Figure 31: Iperf Test Command

9.2 Iperf Test with Client Mode

To set up the Iperf test with Client mode, do the following:

1. Connect the laptop you want to use as a server to the AP.
2. In the CMD window, use the command `ipconfig/all` to find the IP address. See Figure 32.

Figure 32: Check IP Address

NOTE
The IP address can be different depending on the home AP setting.

3. For stable Iperf testing, run the Windows Security APP to turn off the network firewall.
   It is recommended to disable the laptop from all network firewalls before attempting a test. See Figure 33.

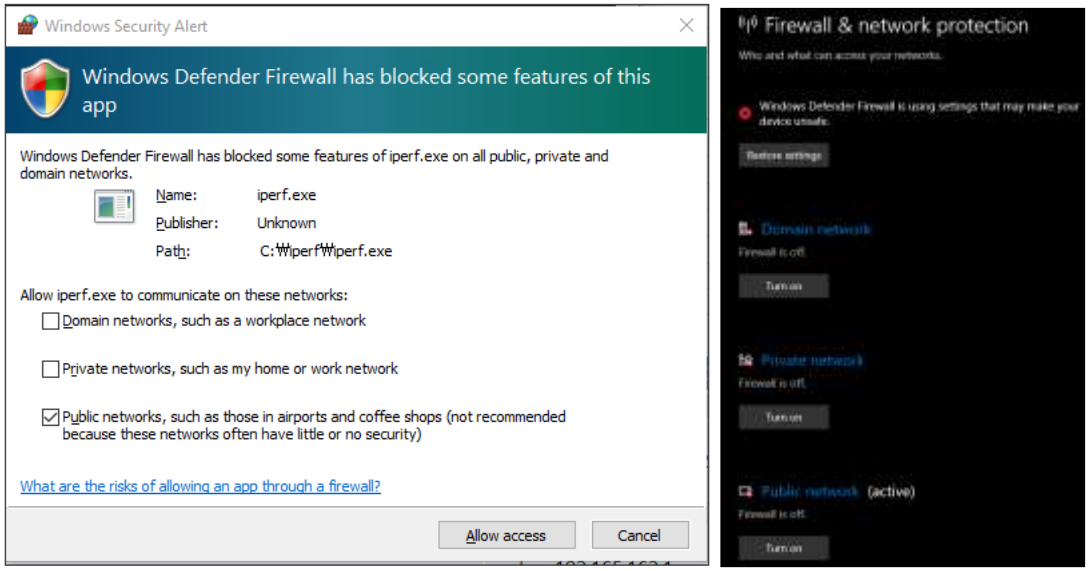

Figure 33: Disable Firewall for Iperf Test

4. In the CMD window, move to the directory where Iperf is installed, and type `iperf -s` to configure the TCP server.

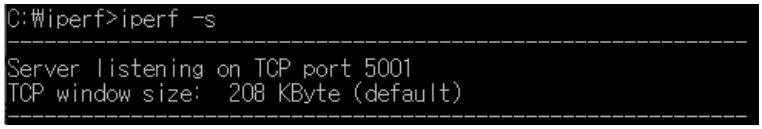

Figure 34: Run Iperf Server on PC

NOTE
When you see the message as shown in Figure 34, the Iperf test is ready to start.

5. In the DA16200 console window, run the Iperf test with Client mode. See Figure 35.
   - For example: `[/DA16200/NET] #iperf -I wlan0 -c 192.168.123.5 -t 5 -i 1`
     - The format of the command type is:
     - `iperf -I [INTERFACE] [-s/-c] [DESTINATION IP] (-u) -i [INTERVAL TIME] -t [TEST TIME]`

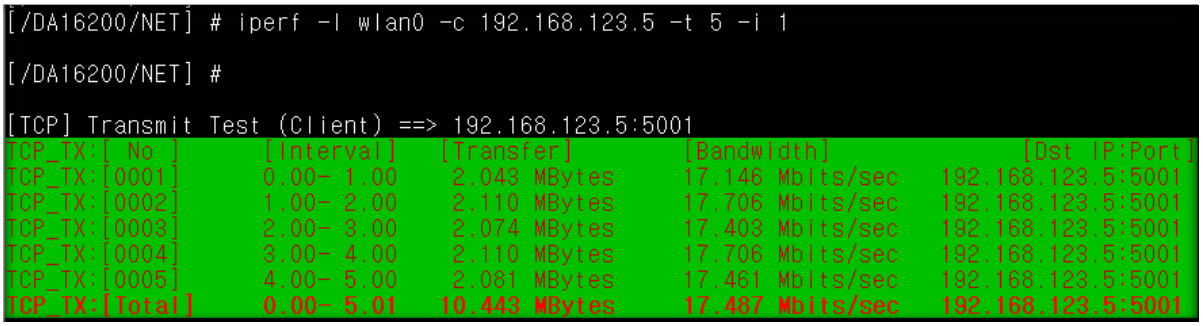

Figure 35: Run Iperf Client on the DA16200

9.3 Iperf Test with Server Mode

A server mode test should be run with a configuration that is opposite to that of client mode. In this case, the DA16200 is prepared as a server. The laptop becomes a client and sends data to the DA16200.

1. In the DA16200 console window, check the assigned IP address for DA16200 as shown in Figure 36.

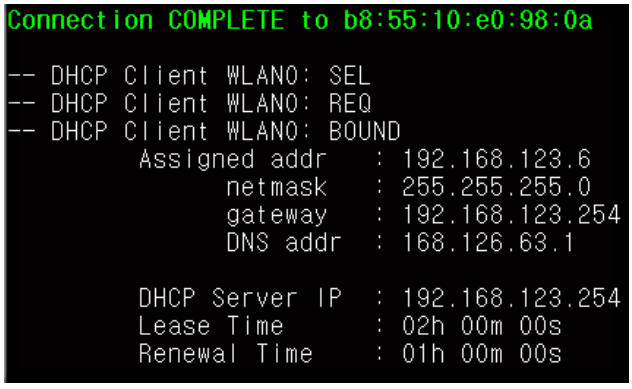

Figure 36: Check the IP Address of DA16200

2. Run the Iperf test with Server mode on the DA16200 console window. See Figure 37.
   - For example: `[/DA16200/NET] # iperf -I wlan0 -s`

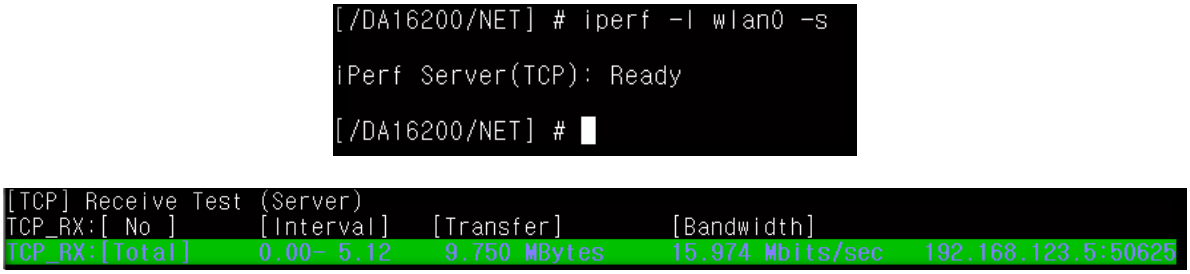

Figure 37: Run Iperf Server on Terminal

3. In the CMD window, run the Iperf test with Client mode. See Figure 38.
   - For example: `C:\iperf>iperf -c 192.168.123.6 -t 5 -i 1`

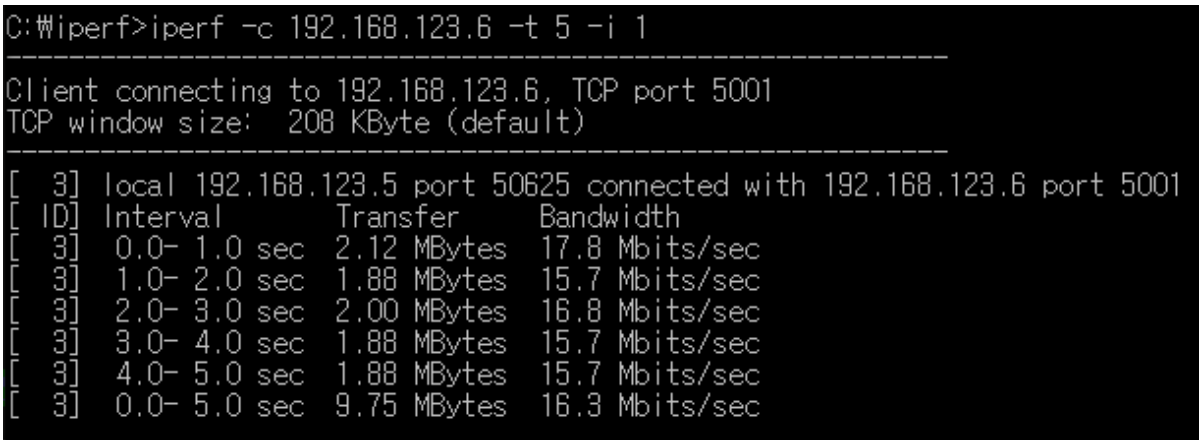

Figure 38: Run Iperf Client on the Laptop

10 DA16200 Commands

The DA16200 has various console commands to operate its functions. The UART0 interface connects the console with a serial terminal tool. Some commands in the following sections may be disabled according to the SDK's features configuration.

10.1 Console Commands

The DA16200 console commands are categorized as follows:

- root
  - `[/DA16200] #`
- mem
  - `[/DA16200/MEM] #`
- sys
  - `[/DA16200/SYS] #`
- nvram
  - `[/DA16200/NVRAM] #`
- net
  - `[/DA16200/NET] #`
- user
  - `[/DA16200/USER] #`

Use command `help or ? (Question mark)` to list the available commands and options.

There is a function to display the console command history, and up to five commands can be saved. Use the following keys and characters to access the history function:

- `↑ or ↓ (arrow key)` on your keyboard: show the command history one by one
- `! (Exclamation mark)`: view the list of the command history
- `! (Exclamation mark) + Number`: select and execute one previous command in the list

It is possible to move between categories. Use these options:

- `top`: move to the highest rank, Root
- `up`: move to one step upper rank category
- Category command (for example `sys`, `nvram`, `net`): move to the category. To run each command of each category, go to the category first, or prefix the category name to the command as shown in the example:
  - `net`
  - `net.ifconfig`

10.1.1 Root Commands

Table 2: Root Commands

Command	Parameters	Description
help /?	(none)	Display help information for the corresponding category
up	(none)	Move up one rank category
top	(none)	Move to the Root category
factory	(none)	Factory reset for all settings
ps	(none)	Display thread information
setup	(none)	DA16200 general function setting wizard (Easy Setup) Make step-by-step configuration settings for elements such as SYSMODE, WI-FI, and NETWORK
reboot	(none) [mode]	Reboot • por: POR rebooting
reset	(none)	Reset to the Bootloader prompt
ver	(none)	Display SDK version and system information
time	[option]	Display or set the current time • time set [YYYY-MM-DD] [hh:mm:ss]: set date and time • time zone [-hh:mm]: set time zone • time boot: display booting time • time uptime: display booting duration • time help: display help
getwlanmac	(none)	Display the MAC address for network interfaces
setwlanmac	[xx:xx:xx:xx:xx:xx | xx-xx-xx-xx-xx-xx |xxxxxxxxxxxx]	Set up the MAC address for network interfaces For example: setwlanmac aa:bb:cc:00:00:02 | aa-bb-cc-00-00-02 | aabbcc000002
dpm	[options]	Set DPM condition • on | off: DPM feature enable or disable • status: DPM Status print • rtm: view DPM backup data • rtc: view DPM RTC timer • debug [level]: turn DPM debug on/off ○ level = 1(MSG_ERROR), 2(MSG_INFO), 3(MSG_DEBUG), 4(MSG_EXCESSIVE)

10.1.2 Network Commands

To move to the network command category, type the command net.

Table 3: Network Commands

Command	Parameter	Description
ifconfig	(none) [interface wlan0|wlan1] [options]	Display or set the basic network setting and status ● ifconfig: display basic network settings information ● ifconfig –a: display details of all network interfaces ● ifconfig [wlan0|wlan1]: display details of a network interface ● ifconfig [wlan0|wlan1] [ipaddress] [subnet] [gateway]: set static IP addresses to a network interface ● ifconfig [wlan0|wlan1] dhcp: enable/disable DCHP to a network interface ● ifconfig [wlan0|wlan1] [up|down]: go up/down a network interface ● ifconfig [wlan0|wlan1] [start|stop|renew|release]: DHCP client command ● ifconfig [wlan0|wlan1] [dns] [DNS ServerIP]: set DNS server address (static IP) to a network interface ● ifconfig help: display help
ping	–I [interface wlan0|wlan1] [domain|ip] –n [count] –l [size] –w [timeout] –i [interval]	Ping test to the target address with a certain option ● [interface wlan0|wlan1]: ○ Network interface. With no designated interface, an interface for a subnet band of the same destination IP address is designated ● [count]: the count of ping tests ● [size]: the size of data to be transmitted (max: 10000) ● [timeout]: waiting time for a response to the transmitted message (min: 10 ms) ● [interval]: waiting time for message transmission (min: 10 ms) ● [–6]: ping test with an IPv6 address For example: ping 172.16.0.1 –l 1024 –n 10 –w 1000 –i 1000 ping –6 fe80::1:2 –I wlan0
arp	[interface] [options]	Display the ARP table of a network interface ● a: display the ARP table of every interface ● d: delete all ARP tables ● Help: Help display
arpsend	[interface] [dst ipaddress]	Transmit the ARP request message of the target IP For example: arpsend wlan0 10.0.0.1
garpsend	[interface] [option]	Transmit a GARP message with the option: ● 0: normal garp ● 1: check IP conflict For example: arpsend wlan0

Command	Parameter	Description
dhcpd	[interface] [options]	DHCP server setting ● boot [on|off]: automatic start setting with a certain interface ● range <Start IP ADDRESS> <END IP Address>: IP lease band setting (max 10) ● lease_time <Integer>: lease time setting (min 60 sec) ● dns <IP Address>: lease IP DNS server address setting ● response_delay <Integer>: time of response delay ● status: display DHCP Server status ● lease [0|1]: display IP lease table ○ Display tables including un-allotted tables when flag = 1
iperf	-I [interface] [-s|-c host] [options]	Setup Iperf client/server
cli	[options]	Refer to the CLI section
debug	[options]	Execute various types of debug commands ● arp [on|off]: arp debug message output on/off ● dhcpd [level]: DHCP Server debug level setting (level = 0~2 default 0) ● dhcpc [level]: DHCP Client debug level setting (level = 0~5 default 1) ● umac [on|off] mask: debug umac 1 0x4
act	[on | off]	Start or stop DPM Auto Configuration

10.2 CLI Command

10.2.1 Overview

The DA16200 supplicant plays a key role in providing users with Wi-Fi functionality. Major functions include IEEE 802.11 management frame, various security functions (WPA and RSN by IEEE 802.11i), and CLI (Command Line Interface) to control DA16200 Wi-Fi performance.
The CLI in DA16200 can execute commands in the network command state.
For example, in the Station mode, the network information of the DA16200 is obtained with CLI command: `[/DA16200/NET] cli status`. See Figure 39.

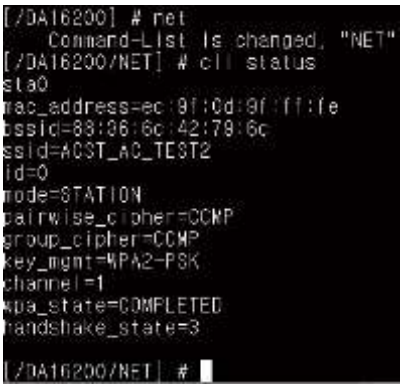

Figure 39: CLI Check

10.2.2 CLI Format

There are four CLI formats (Type A~D):

- Read/Write Parameter (Type A)
  - Read: `[/DA16200/NET] # cli [CLI]`
  - Write: `[/DA16200/NET] # cli [CLI] <VALUE>`
- Write Only Parameter (Type B)
  - `[/DA16200/NET] # cli [CLI] <VALUE>` or `cli [CLI] <OPTION> <VALUE>`
- Read Only Parameter (Type C)
  - `[/DA16200/NET] # cli [CLI]` or `cli [CLI] <OPTION>`
- Execution Parameter (Type D)
  - `[/DA16200/NET] # cli [CLI]` or `cli [CLI] < OPTION>`

10.2.3 Common Commands

Table 4: CLI Commands in Common Mode

CLI	Parameter	Description
status	(none)	Get the main information on the interface being operated at DA16200 For example: `[/DA16200/NET] # cli status`

save_config	(none)	Save all parameters modified through CLI and so forth in NVRAM
		(Saved values become applicable after a reboot) (D)
		For example: `[/DA16200/NET] # cli save_config`
		* Information saved in NVRAM may be inquired with the following command:
		For example:
		`[/DA16200/NVRAM] # printenv`
		`Total length (95)`
		`country_code (STR,03) ..... KR`
		`SYSMODE (STR,02) ..... 0`
		`0: NETMODE (STR,02) ..... 1`
		`N0_Profile (STR,02) ..... 1`
		`N0_ssid (STR,16) ..... "ACST_AC_TEST1"`

select_network	<mode>	Execute a motion in a certain mode (STA access, AP operation, and so on) (D) ● <mode> STA: 0 | AP: 1 For example: `[/DA16200/NET] # cli select_network 0` ● Implement STA access * For a certain mode through the `select_network` CLI, execute the following tasks first: ● `add_network` (profile generation) ● SSID generation through `set_network` ● For AP operation, set up the frequency and country code values with command `set_network` ● For Security, generate WPA or WEP key values with command `set_network` (option)
add_network	<mode>	Generate a specific mode (STA, AP) Profile (access information table) (D) <mode>: 0(STA) | 1(AP) For example: `[/DA16200/NET] # cli add_network 1` ● Generate a profile for AP Mode

CLI	Parameter	Description
remove_network	<mode>	Delete a certain mode (STA, AP) profile (D) <mode>: 0(STA) | 1(AP) For example: [/DA16200/NET] # cli remove_network 1 ● Delete a profile for AP Mode
set_network	<mode> <variable> <value>	Set parameter values for a specific mode (STA, AP) (B) <mode>: 0(STA) | 1(AP) <variable>: a specific parameter ● ssid: [STA] Operation SSID for AP SSID / [AP] AP interface to be connected ● psk: passphrase or PSK values ● proto: for WPA use, set up the version (<WPA(=WPA1)> | <RSN(=WPA2)> | <WPA RSN>) ● key_mgmt: key management mode (<NONE> | <WPA_PSK> | <WPA-EAP>) ● pairwise: unicast data message encryption mode (<TKIP> | <CCMP> | <TKIP CCMP>) ● group: broadcast data message encryption mode (<TKIP> | <CCMP> | <TKIP CCMP>) ● wep_key#: WEP key (#:0~3) values ● wep_tx_keyidx: WEP key index to be used ● frequency: [AP] Operation Frequency (MHz) ● mode: Operation Mode <0(STA)> | <2(AP)> ● Wi-Fi_mode: <0(BGN)> | <1(GN)> | <2(BG)> | <3(N)> | <4(G)> | <5(B)> ● beacon_int: [AP] Beacon transport interval ● dtim_period: [AP] DTIM interval ● ap_power: [AP] Output Power (dBm) ● isolate: 'Isolate' Use (<0(off)> | <1(on)>) ● -disabled: automatic profiling prevented upon rebooting (<0(off)> | <1(on)>) <value>: settings for a certain variable For example: [/DA16200/NET] # cli set_network 1 ssid 'DA16200_AP' ○ For DA16200 AP operation, SSID= DA16200_AP setting For example: [/DA16200/NET] # cli set_network 1 beacon_int 200 ○ For DA16200 AP operation, Beacon interval 20 ms setting For example: [/DA16200/NET] # cli set_network 0 key_mgmt WPA_PSK ○ For DA16200 STA operation, access in the WPA PSK security mode * A profile needs to be generated with command add_network so that a profile can be set with command set_network (with no profile, 'FAIL')
get_network	<mode> <variable>	Get specific parameter values for a specific mode (STA, AP) (C) <mode>: 0(STA) | 1(AP) <variable>: a specific parameter For example: [/DA16200/NET] # cli set_network 0 ssid ● Inquiry of an object subject to DA16200 STA access (“TEST_BED_AP”) For example: [/DA16200/NET] # cli set_network 1 psk ● For DA16200 AP operation, inquiry of the PSK password setting

CLI	Parameter	Description
country	<value>	Set a country related to channel operation (A) <value>: Country Code that meets ISO 3166-1 alpha-2 standards Default: KR For example: [/DA16200/NET] # cli country US ● Set the Country Code to US For example: [/DA16200/NET] # cli country ● KR
flush	(none)	For every interface (STA, AP), DA16200 deletes the Profile and closes DA16200 service operation (D)

10.2.4 STA Commands

Table 5: CLI Commands on STA Mode

Command	Parameters	Description
scan	(none) or <freq>	Active scanning (Probe Request Broadcast) (D) For <freq> inputs, it is possible to scan APs of a certain frequency range (MHz) only (option) For example: [/DA16200/NET] # cli scan ● Scans all channels that correspond to the current country setting
disconnect	(none)	Disconnect the accessed AP (D) For example: [/DA16200/NET] # cli disconnect ● OK (With no AP being accessed, 'FAIL')
roam	(none) or <oper>	Roaming On/Off and Roaming status inquiry (A) <oper> run: On | stop: Off Default: Roaming Off For example: [/DA16200/NET] # cli roam ● Roaming = STOP, Threshold = -65 ● Usage: cli roam [run/stop] For example: [/DA16200/NET] # cli roam stop ● Roaming function-off
roam_threshold	<value>	Roaming triggering RSSI value (dBm) setting (B) <value>: Roaming threshold RSSI (dBm) Default: -65 (dBm) For example: [/DA16200/NET] # cli roam_threshold -85 ● Set the roaming threshold to -85 dBm

10.2.5 Soft-AP Commands

Table 6: CLI Commands on Soft-AP Mode

Command	Parameter	Description
ap	<option>	AP interface beginning/closing/restarting (Applicable with no reboot after main info modification of AP interface SSID, PSK, and so forth) (D) <option>: start | stop | restart For example: [/DA16200/NET] # cli ap start ● AP interface initiating (If it is being operated, 'FAIL') For example: [/DA16200/NET] # cli ap stop ● AP interface closing (If not being operated, 'FAIL') For example: [/DA16200/NET] # cli set_network 1 ssid 'DA16200_AP2' For example: [/DA16200/NET] # cli ap restart ● Modify SSID of the interface of AP being operated For example: [/DA16200/NET] # cli set_network 1 pairwise TKIP For example: [/DA16200/NET] # cli ap restart ● Modify the AP interface encryption mode to TKIP
ap_chan_switch	<Ch.>	Modify the AP interface operation channel (B) <Ch.>: AP operation channel (1~14) or frequency (MHz) For example: [/DA16200/NET] # cli ap_chan_switch 3 ● Modify the AP interface channel to 3 (242 MHz) For example: [/DA16200/NET] # cli ap_chan_switch 11 2462 ● Modify the AP interface channel to 11 (2462 MHz)

ap_status	(none)	Get main information about the interface at DA16200 (C)
		For example:
		[/DA16200/NET] # cli ap_status
		state=ENABLED
		phy=fc9k_phy0
		freq=2472
		num_sta_non_erp=0
		num_sta_no_short_slot_time=0
		num_sta_no_short_preamble=0
		olbc=0
		num_sta_ht_no_gf=0
		num_sta_no_ht=0
		num_sta_ht_20_mhz=0
		num_sta_ht40_intolerant=0
		olbc_ht=0
		ht_op_mode=0x0
		cac_time_seconds=0
		cac_time_l

Command	Parameter	Description
all_sta	(none)	Output the list information of STA being accessed to the AP interface (C) For example: [/DA16200/NET] # cli all_sta 50:77:05:DB:C4:3E flags=[AUTH][ASSOC][AUTHORIZED][SHORT_PREAMBLE][WMM aid=1 capability=0x431 listen_interval=10 mode = 802.11n timeout_next=0 rx_packets=632 tx_packets=9 rx_bytes=67451 tx_bytes=4767 connected_time=77 sta_count=1
deauthenticate	<addr>	The deauthenticate message is transmitted to the access STA with a certain MAC address to cancel the access (D) <addr>: MAC address of the access STA For example: [/DA16200/NET] # cli deauthenticate aa:ff:01:00:00:00 ● Transmit the de-authentication message to STA whose MAC address is AA:FF:01:00:00:00
disassociate	<addr>	The disassociation message is transmitted to the access STA with a certain MAC address to cancel the access (D) <addr>: MAC address of the access STA For example: [/DA16200/NET] # cli disassociate aa:ff:01:00:00:00 ● Transmit the disassociation message to STA whose MAC address is AA:FF:01:00:00:00
wmm_enabled	<value>	WMM function availability setting and inquiry (A) <value>: On: 1 | Off: 0 Default: Off For example: [/DA16200/NET] # cli wmm_enabled 1 ● Use the WMM function
wmm_ps_enabled	<value>	WMM-PS function availability setting and inquiry (A) <value>: On: 1 | Off: 0 Default: Off For example: [/DA16200/NET] # cli wmm_ps_enabled 1 ● Use the WMM-PS function
wmm_params	<target> <category> <AIFS> <CWmin> <CWmax> <Burst(AP) or TxOP Limit(STA)>	Set up details of DA16200 AP or STA's certain category WMM parameters (B) <target>: ap | sta <category>: be(best-effort) | bk(background) | vi(video) | vo(voice) For example: [/DA16200/NET] # cli wmm_params ap be 3 15 63 10 ● For WMM AP's best-effort category, AIFS = 3, CWmin = 15, CWmax = 63, and Burst = 10 For example: [/DA16200/NET] # cli wmm_params sta vo 4 7 15 60 ● For WMM STA's voice category, AIFS = 4, CWmin = 7, CWmax = 15, TXOP_Limit = 60

Command	Parameter	Description
all_wmm	(none)	Inquiry of all parameters that can be set up by means of wmm_params CLI (C) (See example) For example: [/DA16200/NET] # cli all_wmm
acl_mac	<addr>	Add the MAC address to the Access Control Management List (B) <addr>: AP MAC Address For example: [/DA16200/NET] # cli acl_mac AA:FF:01:00:00:06 ● Add MAC address AA:FF:01:00:00:06 to ACL
Acl	<oper> <addr>	Set up, delete, or inquire the use of ACL (A) <oper>: allow | deny | clear | delete (If none, inquire of it) <addr>: AP MAC Address (only when oper = ”delete”) [/DA16200/NET] # cli acl [allow/deny/clear/delete mac_address] For example: [/DA16200/NET] # cli acl For example: [/DA16200/NET] # cli acl allow ● Access allowed only for AP Lists in ACL For example: [/DA16200/NET] # cli acl deny ● Access denied only for AP Lists in ACL For example: [/DA16200/NET] # cli acl clear ● Entire ACL clear For example: [/DA16200/NET] # cli delete aa:ff:01:00:00:08 ● Delete AA:FF:01:00:00:08 from ACL
ap_max_inactivity	<value>	If there is no data frame exchange of accessed STA during the time setting, disconnect the STA (A) <value>: inactivity timeout (sec) Default: 300 (sec.) For example: [/DA16200/NET] # cli ap_max_inactivity 600 ● Disconnect the access STA with no data frame exchange for 600 seconds For example: [/DA16200/NET] # cli ap_max_inactivity 0 ● Uncheck data frame exchange of the accessed STA For example: [/DA16200/NET] # cli ap_max_inactivity ● Read ap_max_inactivity value
ap_send_ka	<value>	A function to send 'keep-alive' NULL packets to the accessed STA at intervals of 30 seconds and check ACK receipts (A) <value>: On: 1 | Off: 0 ● On: if the STA accessed to DA16200 AP interface goes out of coverage or is closed abnormally, the disconnect will occur after the ‘ap_max_inactivity timeout’ passes ● Off: if there is no constant data frame exchange with the STA accessed to DA16200 AP interface for ap_max_inactivity timeout, then disconnect. Default: 0 (not used) For example: [/DA16200/NET] # cli ap_send_ka 1 ○ ap_send_ka=1

Command	Parameter	Description
ap_rts	<value>	For AP mode operation, set up the RTS Threshold value to be used (A) <value>: The standard for the size of packets that use the RTS Control Frame (bytes) Default: 2437 (bytes) For example: [/DA16200/NET] # cli ap_rts 1000 ● Use RTS for transmission of 1000 bytes or larger frames ● ap_rts=1000 For example: [/DA16200/NET] # cli ap_rts ● ap_rts=2437
greenfield	<value>	Enable/Disable use of Greenfield <value>: On: 1 | Off: 0 If Greenfield is on, DA16200 uses 11n HT mode only. In that case, 11b, 11g info and STA access are not allowed Default: 0 (not used) For example: [/DA16200/NET] # cli greenfield 1 ● Use the Greenfield function ● greenfield=1 For example: [/DA16200/NET] # cli greenfield ● greenfield=0

10.2.6 Advanced Commands

Table 7: Advanced CLI Commands

Command	Parameters	Description
wps_pbc	(none)	Run WPS PBC (Push Button Configuration)
wps_pin	<pin>	Run WPS PIN method <pin> pin code (any: generate a random code) For example: [/DA16200/NET] # cli wps_pin 27833513 For example: [/DA16200/NET] # cli wps_pin any

10.3 MROM Commands

10.3.1 Common Commands

Table 8: Common Commands in MROM

Command	Parameters	Description
!	(none)	None
reboot	(none) [mode]	Reboot por: POR rebooting
reset	(none)	Reset to the Bootloader prompt
ver	(none)	Display version of MaskRom
help /?	(none)	Display help information for the corresponding category
boot	[address]	booting address: booting address

10.3.2 Memory Access Commands

Table 8: Memory Access Commands in MROM

Command	Parameters	Description
brd	[addr] [length]	byte read memory
bwr	[addr] [data] [length]	byte write memory
wrd	[addr] [length]	word read memory
wwr	[addr] [data] [length]	word write memory
lrd	[addr] [length]	long read memory
lwr	[addr] [data] [length]	long write memory

10.3.3 Download Commands

Table 8: Download Commands in MROM

Command	Parameters	Description
loady	[addr][sector_size][format] boot	Download image to SFLASH boot: '0' address
ymodem	[addr] [size] sfdp	Download image to RAM sfdp: download sfdp to 0xf80040 (retention memory)

10.3.4 SFLASH Commands

Table 8: SFLASH Commands in MROM

Command	Parameters	Description
sflash	[op][start][length]	Sflash access op: read, write, erase start: start address length: length

10.3.5 Secure Commands

Table 8: Secure Commands in MROM

Command	Parameters	Description
sbrom	[target][bootaddress][debug]	Secure boot command target: sflash boot address: 0 (boot) or a000(rtos) debug: anything
socid	(none)	Display socid(secure soc id)

10.3.6 Additional Commands

Table 8: Additional Commands in MROM

Command	Parameters	Description
bmcfg	[op][bootmode]	Boot mode config Not used

Command	Parameters	Description
oops	[op] [value]…	Oops configuration Not used
dbgt	[op] [op] [value0]…	Debug mode configuration Not used
floady	[addr] [sector_size] [format] [boot]	Fast download image to sflash Not used
rs485	[offset] [id]	Download image with rs485 Not used
clock	[new clock]	System clock setting
setsfl	[mode]	Select sflash Mode: 0 (stacked sflash), 1 (external sflash) Used ‘1’only

11 Firmware Update

The security features of DA16200 support Secure Boot, to avoid booting with fake or untrusted images and to protect against being hacked. The DA16200 SoC includes a security hardware block called CryptoCell-312 (CC312). With proper security keys and certificates installed (in OTP and images), the DA16200 can boot in a secure mode.

DA16200 requires three images. With a serial terminal tool, each image can be loaded individually into DA16200.

- <Bootloader image>: also known as Second Bootloader
  - `DA16200_[image_type]-[vendor]-[major]-[minior]-[customer_ver]_[sflash_model].img`
    - [Image_type]: Bootloader (BOOT), Main, or System library (SLIB)
    - [vendor]: Internal use by vendor
    - [major]: Major version
    - [minor]: Minor version or SDK patch version
    - [customer_ver]: User-configurable customer version
    - [sflash_model]: sflash model or type used
  - For example: `DA16200_BOOT_GEN01-01-XXXXX_IS25WP016D.img`
- <System Library image>: includes RF drivers and libraries for DPM
  - For example: `DA16200_SLIB_GEN01-01-XXXX-000000.img`
- <Main image>: includes RTOS and applications
  - For example: `DA16200_RTOS_GEN01-01-XXXX-000000.img`

11.1 Flash MAP

DA16200 provides two images: #0 and #1. It is possible to use these regions for each image set and change the index of the booting image set. The default value of the Boot Index points to #0.

Table 8: 2 MB Serial Flash Memory Map

Address	Item	Size
0x0000_0000	2nd Bootloader	36 kB
0x0000_9000	Boot Index	4 kB
0x0000_A000	RTOS #0	924 kB
0x000F_1000	SLIB #0 (RamLib + TIM)	52 kB
0x000F_E000	RTOS #1	924 kB
0x001E_5000	SLIB #1 (RamLib + TIM)	52 kB

Table 9: 4 MB Serial Flash Memory Map

Address	Item	Size
0x0000_0000	2nd Bootloader	36 kB
0x0000_9000	Boot Index	4 kB
0x0000_A000	RTOS #0	1536 kB
0x0018_A000	SLIB #0 (RamLib + TIM)	64 kB
0x0020_0000	RTOS #1	1536 kB
0x0038_0000	SLIB #1 (RamLib + TIM)	64 kB

11.2 OTP Lock Protection

To protect OTP and download firmware safely, lock the OTP before firmware download:

1. In MROM, select **macro**.
2. Select **mrom_otp_lock_check.ttl**

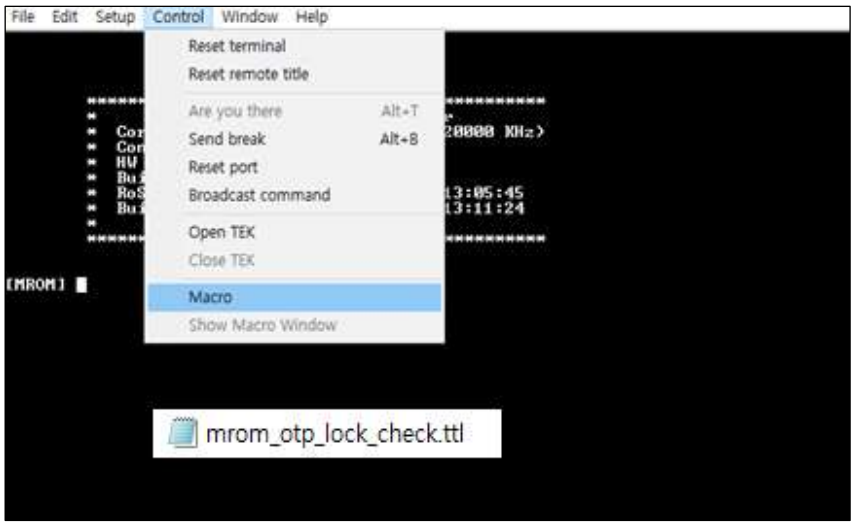

Figure 40: Run Macro

3. See a message box that notifying the OTP lock is done.

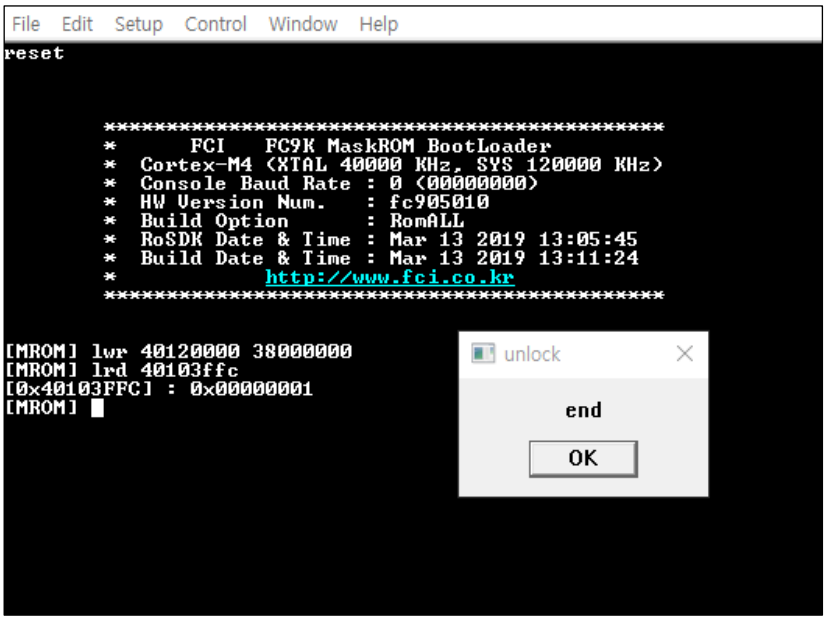

Figure 41: OTP Locked

4. Download firmware safely.

11.3 Bootloader Image

<Bootloader image> is also known as the second bootloader, which is the first thing loaded into memory for a factory-created DUT (for example with an empty flash).

Know that this image has SFDP information, which is important sflash type information, so always load this image before other images are loaded.

If you get a new SDK, then always load the <Bootloader image> first.

1. Power on the DA16200 board.
2. At the `[/DA16200]` prompt, type `reset` to go to the Mask ROM prompt `[MROM]`. See Figure 42.

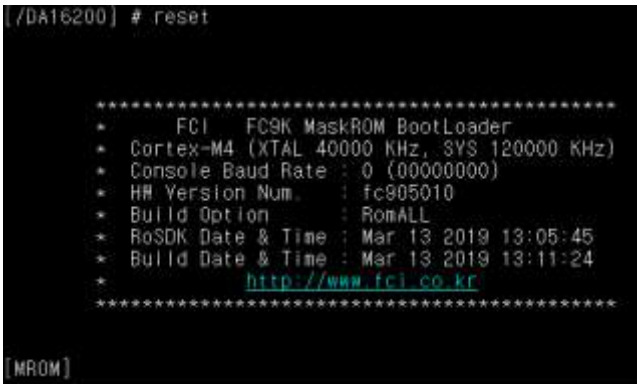

Figure 42: Mask ROM

3. At the `[MROM]` prompt, type `loady boot`. See Figure 43.

```
[MROM] loady boot
Load Addr: 000f6684
To cancel a session, press Ctrl+X
Load Y-Modem (Load Offset:f6684)
CC
xyzModem - CRC mode, 7(SOH)/29(STX)/0(CAN) PKTs, 9 retries, err:Timed o
ut
## Total Size      = 0x00007070 = 28784 Bytes
[MROM]
```

Figure 43: Bootloader Prompt on Command Window

4. Choose menu **File** > **Transfer** > **YMODEM** > **Send** to select the image file for the **Bootloader**. See Figure 44.
   - For example: `DA16200_BOOT_GEN01-01-XXXX-_IS25WP016D.img`
   - The result is printed at the end of the transfer
     Please ignore any messages like "`err:..`"

Figure 44: Load Image File

11.4 System Library Image

The <System Library image> includes system libraries, RF drivers, and libraries to operate the DPM.

1. At the `[MROM]` prompt, type `loady f1000` to load a <System Library image> in boot index #0. See Figure 45.

NOTE
DA16200 has a different address based on Flash size and boot index. The System Library address map register depends on the flash memory size. Currently, DA16200 EVK uses 2 MB SFLASH MAP even though there is SFLASH 4 MB memory on the module. Therefore, the address must be `0xf1000 for boot index 0 or 0x1E5000 for boot index 1`. In this case, at the `[MROM]` prompt, type `loady f1000 or loady 1e5000` So, if a customer uses 4 MB SFLASH MAP for the application, the address must be `0x18a000 for boot index 0 or 0x380000 for boot index 1`. In this case, at the `[MROM]` prompt, type `loady 18a000 for boot index #0 or loady 380000 for boot index #1` For more details, please refer to DA16200 SDK Programmer Guide [2].

```
[MROM] loady f1000
Load Addr: 000f6684
To cancel a session, press Ctrl+X
Load Y-Modem (Load Offset:f6684)
CC
xyzModem - CRC mode, 3(SOH)/29(STX)/0(CAN) PKTs, 5 retries, err:Timed o
ut
## Total Size      = 0x000072a0 = 29344 Bytes
```

Figure 45: System Library Prompt on Command Window

2. Choose menu **File** > **Transfer** > **YMODEM** > **Send** to select the <System Library image> file. See Figure 46.
   - For example: `DA16200_SLIB_GEN01-XX-YYYY-ZZZZZZ.img`

Figure 46: Load Image File

11.5 Main RTOS Image

This <Main image> contains RTOS, Wi-Fi libraries, and system/user applications.

1. At the `[MROM]` prompt, type `loady a000`. See Figure 47.

NOTE
DA16200 has a different address based on flash size and boot index. The System Library address map register depends on the flash memory size. Currently, DA16200 EVK uses 2 MB SFLASH MAP even though there is SFLASH 4 MB memory on the module. Therefore, the address must be `0xa000 for boot index 0 or 0xfe000 for boot index 1`. In this case, at the `[MROM]` prompt, type `loady a000 or loady fe000`. So, if the customer uses a 4 MB SFLASH MAP for the application, the address must be 0xa000 `for boot index 0 or 0x200000 for boot index 1`. In this case, at the `[MROM]` prompt, type `loady a000 for boot index #0 or loady 200000 for boot index #1`. For more details, please refer to DA16200 SDK Programmer Guide [2].

```
[MROM] loady a000
Load Addr: 000f6684
To cancel a session, press Ctrl+X
Load Y-Modem (Load Offset:f6684)
CC
xyzModem - CRC mode, 1(SOH)/828(STX)/0(CAN) PKTs, 7 retries, err:Timed out
## Total Size      = 0x000cee80 = 847488 Bytes
[MROM]
```

Figure 47: Main Image Prompt on Command Window

2. Choose menu **File** > **Transfer** > **YMODEM** > **Send** to select the <Main image> file. See Figure 48.
   - For example: `DA16200_RTOS_GEN01-XX-YYYY-ZZZZZZ.img`

Figure 48: Load Image File

3. If the three images are loaded, then at the `[MROM]` prompt, type `boot` to boot your images.
4. Run `factory` reset as shown in Figure 49.

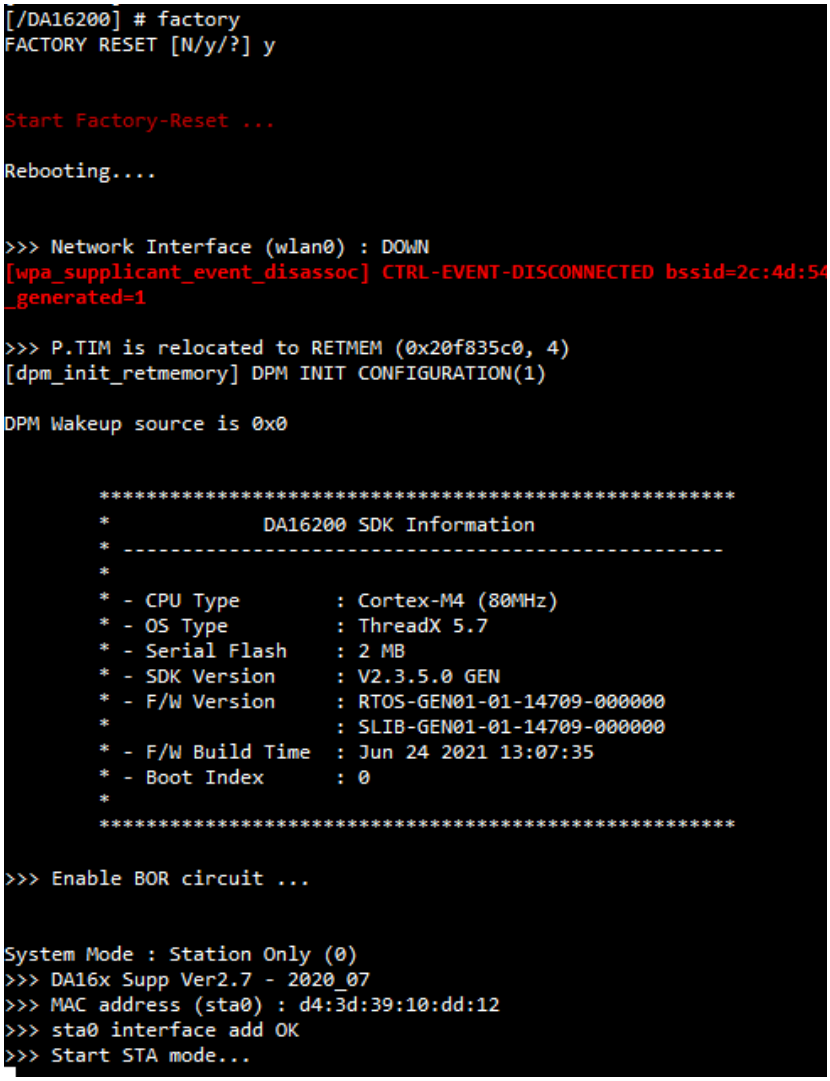

Figure 49: Factory Mode Prompt on Command Window

Now everything is done.

11.6 Download Image with Script (Macro)

You can download all images automatically with the use of a script.

1. In the **Control** menu, select **Macro.**
2. In the **MACRO: Open macro** dialog window, choose a **.ttl** file. See Figure 50.

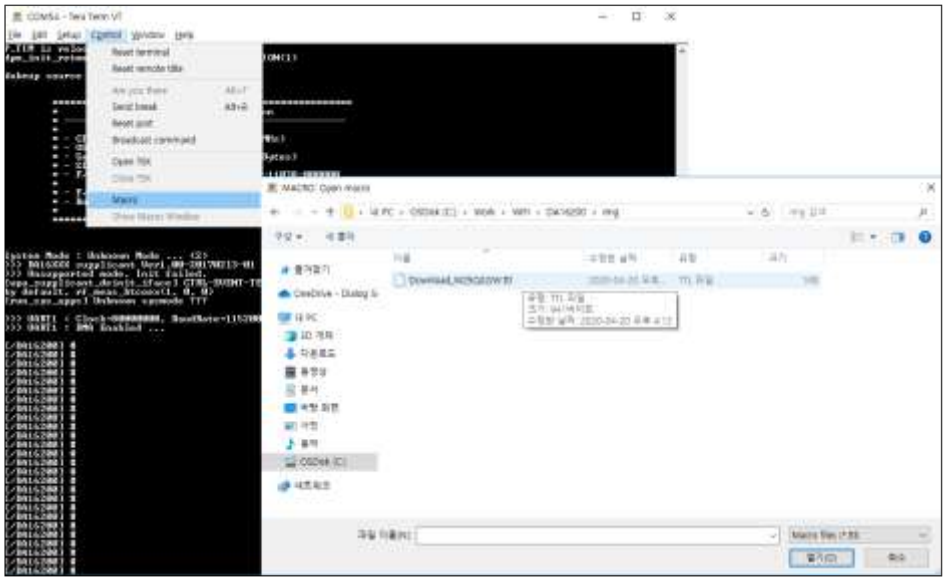

Figure 50: Load Macro

3. The download starts with the bootloader image. See Figure 51.

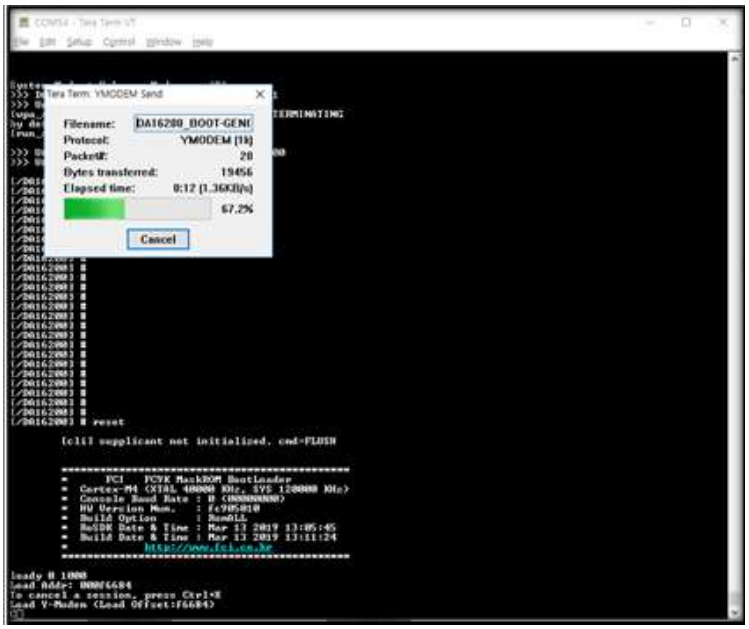

Figure 51: Download Bootloader

4. Download RTOS image. See Figure 52.

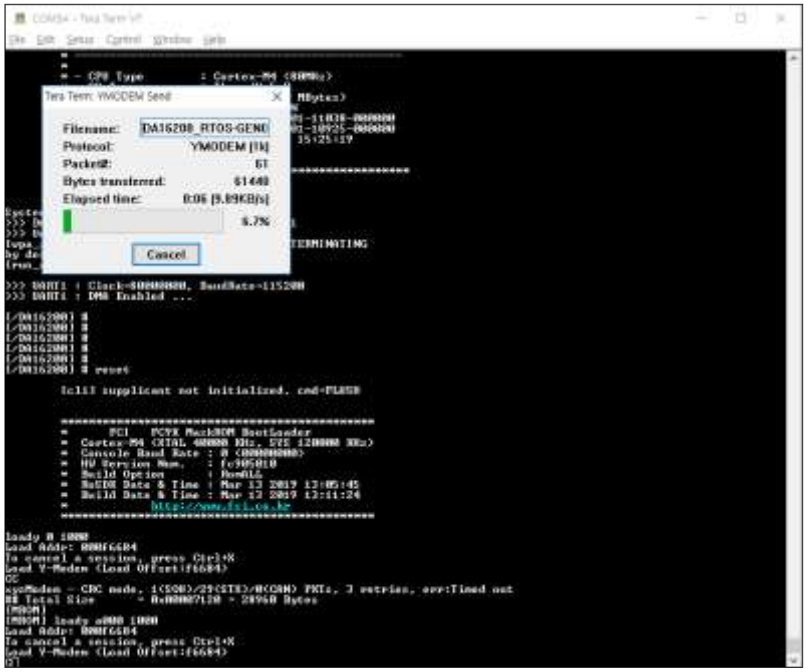

Figure 52: Download RTOS Image

5. Download the SLIB Image. See Figure 53.

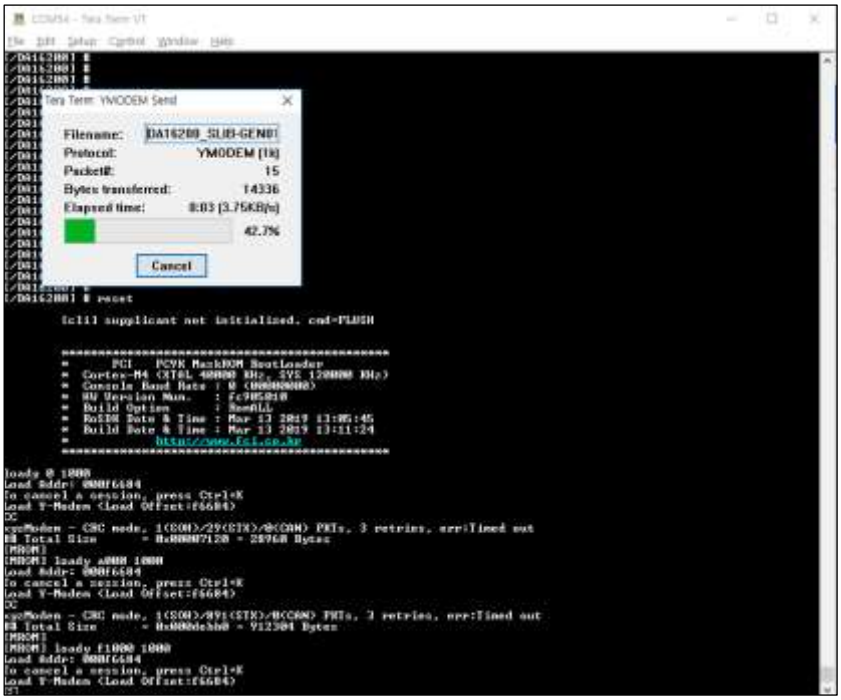

Figure 53: Download Slib Image

6. DA16200 will boot automatically after all images are downloaded.

NOTE
TTL command references send : Sends data. Format : send <data1> <data2>.... sendln : Sends data with new-line. Format : sendln <data1> <data2>.... waitln : Waits a line that contains string. Format : waitln <string1> [<string2> ...] mpause : Pauses. Format : mpause <time>, milliseconds getdir : Gets the current working directory for MACRO. Format : getdir <strvar> strconcat : Appends a string. Format : strconcat <strvar> <string> ymodemsend : Sends a file from the host with the YMODEM protocol. Format : ymodemsend <filename>

11.7 SFDP Checking

SFDP information of SFLASH is added to the boot loader image. When the boot loader image loads into the DA16200, SFDP information is copied to the Retention Memory.

However, under certain conditions, the ROM of the DA16200 has the task to clear the contents of Retention Memory. If the SFDP information in the Retention Memory is deleted due to certain conditions, the bootloader image should be loaded again. In this case, we recommend that the **boot loader image** and the **other two image files** (RTOS and SLIB) are loaded again.

If the images load normally, then use command `[/DA16200] # brd f80000 100` to check if the SFPD information is copied to the Retention Memory. See Figure 54.

Example code to read the Retention Memory and check if SFDP is alive:

- `[/DA16200] # brd f80000 100`

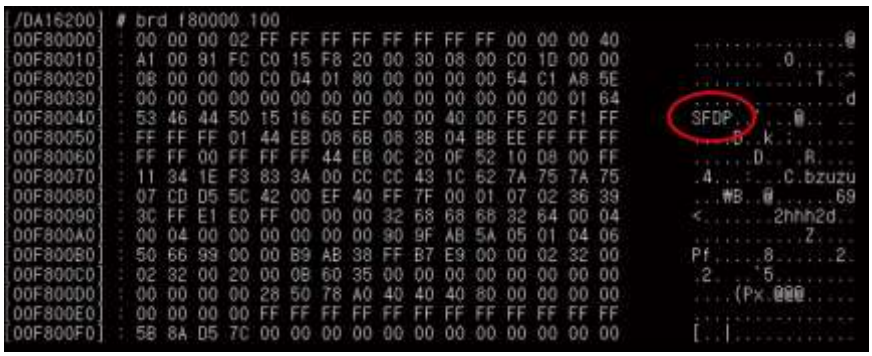

Figure 54: SFDP

11.8 Serial Flash Recovery

When the serial flash is replaced, the flash memory map is changed, or if you think that the flash memory is corrupted, then follow the steps below to re-initialize or recover sflash and check the process:

1. Boot DA16200.
2. At the `[/DA16200] #` prompt, run the command `reset`

3. At [MROM] prompt, run command sflash info to read serial flash information.
   For example, SFLASH: ef601615
   This is the flash product ID of W25Q32JW. See also the IDs below.

   W25Q32JWSNIQ: ef601615
   IS25WP016D: 9d701514
   IS25LQ032B: 9d401615s

4. Run command ymodem sfdp.
5. In the build\SBOOT\SFDP folder, find the Flash SFDP file which is corresponding to Flash ID as W25Q32JW.bin.
6. Run command [MROM] sflash erase 0 200000 to erase the entire flash for recovery.

NOTE
This command can take a long time to complete. Please wait until the [MROM] prompt appears again.

7. Reload all images in the specified order for serial flash recovery.
   - [MROM] loady boot
   - [MROM] loady f1000
   - [MROM] loady a000
8. Run command boot to boot DA16200. The image version is printed.
9. Initialize NVRAM for Serial Flash Recovery with the following commands:

```
[/DA16200] #
[/DA16200] # nvram
[/DA16200/NVRAM] # nvedit erase sflash
[/DA16200/NVRAM] # nvedit clear
[/DA16200/NVRAM] # nvcfg update sflash
update , sflash completed
[/DA16200/NVRAM] # nvedit load sflash
nvedit , load completed
[/DA16200/NVRAM] #
```

Figure 55: Initialize NVRAM

11.9 Serial Flash Recovery from Boot

If there are any memory conflicts during updating the image or errors while building the SDK, then it cannot run DA16200. In this case, you cannot do anything in the command window. You must force the DA16200 to enter boot mode:

1. Use RTC_PWR_KEY to power off (move to OFF position):
   a. Connect the two pins. Pin 17(F_CLK) and pin 18(GND) in the header Pin (J3) of the external connector of EVK. See Figure 56.

b. F_CLK is connected to Pin 21 of the module connector.

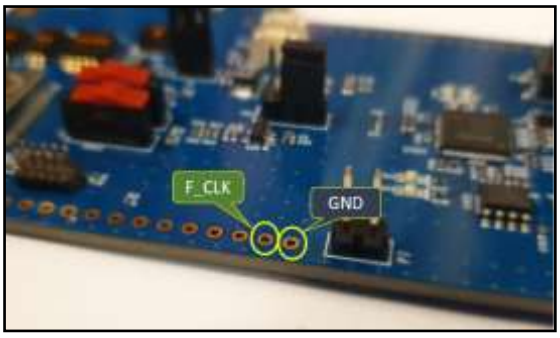

Figure 56: Recovery Point in the EVK

2. Use RTC_PWR_KEY to power on (move to ON position):
   a. Boot DA16200.Turn the power on when the two pins are connected.
   b. Disconnect the two pins. Pin 17 (F_CLK) and pin 18 (GND).
3. See the DA16200 go into the **BOOT** mode. See Figure 57.
4. At the `[BOOT] #` prompt, run command `reset`.
5. Do the steps in Section 11.8 from step 3.

```
[[OOPS Dump : c0f0]]
[[Hard Fault]]
--RTC Time : 00000000.00003693

Register-Dump
        R0  :00093990,  R1  :00000000,  R2  :020c7668,  R3  :000ccdc8
        R4  :000cb5a4,  R5  :000f7c84,  R6  :000f84b4,  R7  :00000000
        R8  :00000000,  R9  :00000000,  R10 :000cb5a4,  R11 :000f84b4
        R12 :0000063c,  SP  :000cce48,  LR  :00002ccf,  PC  :0018ba2e
        PSR :61000000,  EXC :fffffffd,
Fault Status
        SHCSR :00000000,        CFSR  :00080000,        HFSR  :40000000
        DFSR  :00000000,        MMFAR :e000ed34,        BFAR  :e000ed38
        AFSR  :00000000,
FC9K SysInfo
        SICS[0] = 04300000
        SICS[1] = 00000000
        SICS[2] = 00000000
        SICS[3] = 00000000
        SICS[4] = 00000000
        SICS[5] = 01234de2

Stack
Stack-Dump (48)
[0x000cce48] : 000cce6c 0008d650 00000000 000f84f6 000f84f9 00000000 00092a98 00080778
[0x000cce68] : 00080748 000f84d8 00000176 000f84da 000f84e9 000f84f3 00000000 00000000
[0x000cce88] : 00000000 000f84f6 000f84f9 00000000 000f8544 000f84ff 000f851b 00000000
[0x000ccea8] : 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
[0x000ccec8] : 00000000 00000000 0001080d 00040000 00000018 00000000 00080778 000f7c78
[0x000ccee8] : 00000000 00000000 00000050 00183b69 000ccf58 000f7c78 000cb5a4 00000000

Thread: umac_fc9k
        stack ptr : 000ccef8
        stack base: 000cc790
        stack end : 000ccf8b
        stack high: 000cccf8
        max usage : 00000094
        suspend   : 00000000

Thread Stack (32)
[0x000ccef8] : 000ccf58 000f7c78 000cb5a4 00000000 00000000 00000000 00000000 00000010
[0x000ccf18] : 00000010 00000000 00000000 00091e40 00000006 0000265d 00003fa2 00093928
[0x000ccf38] : 00139414 00000000 00091e70 00000000 00000000 000cc790 00000000 00138898
[0x000ccf58] : 000f7c78 00000000 00091e40 00080774 00080778 00003805 00000000 00000000
Image Code, CRC Failed (9fc87af6 - 09aa010e, 23200)!!
Boot Err: wrong image [40000000](01)


        ********************************************
        *      FCI   FC9K MaskROM BootLoader
        *  Cortex-M4 (XTAL 40000 KHz, SYS 120000 KHz)
        *  Console Baud Rate : 0 (00000000)
        *  HW Version Num.   : fc905010
        *  Build Option      : RomALL
        *  RoSDK Date & Time : Mar 13 2019 13:05:45
        *  Build Date & Time : Mar 13 2019 13:11:24
        *           http://www.fci.co.kr
        ********************************************


[BOOT] #
```

Figure 57: Run with BOOT Mode

11.10 Boot Index Change

To change the boot index, you must change the boot index number and then reboot. After the reboot is complete, verify that the version printed at boot and the **boot_idx** values have changed.

The following console commands can change the boot index:

- `boot_idx 0` // to boot with boot index 0
- `boot_idx 1` // to boot with boot index 1

```
[/DA16200] # boot_idx 1     // or boot_idx_0
[/DA16200] # reboot

>>> Network Interface (wlan0) : DOWN
[wpa_supplicant_event_disassoc] CTRL-EVENT-DISCONNECTED bssid=aa:ab:ac:ad:ae:af
reason=3 locally_generated=1
[wpa_supp_ev_disassoc_fin] Disconnect event - remove keys
RaLIB is relocated to RETMEM (20f815c0, 564, 12904718, 12904718)
P.TIM is relocated to RETMEM (20f835c0, 3)
dpm_init_retmemory::316 DPM INIT CONFIGURATION(1)

Wakeup source is 0x0
        ************************************************
        *             DA16200 SDK Information
        * ---------------------------------------------
        *
        * - CPU Type         : Cortex-M4 (80 MHz)
        * - OS Type          : ThreadX 5.7
        * - Serial Flash     : 16 Mbits (2 MBytes)
        * - SDK Type         : Generic v1.0.0
        * - F/W Version      : RTOS-GEN01-01-7140-000000
        *                    : SLIB-GEN01-01-7089-000000
        * - F/W Build Time   : Jul  5 2019 17:35:59
        * - Boot Index       : 1
        *
        ************************************************
```

11.11 MAC Address Checking

By default, a MAC address is programmed in the OTP. However, if for some reason there is no MAC address or it is cleared.
For example: `[/DA16200] # setwlanmac aa:ff:00:00:00:00`

At prompt `[/DA16200] # type` command `getwlanmac` to check where the MAC address was written. One of the following lines is displayed: `MAC TYPE: OTP MAC or NVRAM MAC`. See example:

```
[/DA16200] # getwlanmac
MAC TYPE: OTP MAC
WLAN0 - EC:9F:0D:9F:F9:34
WLAN1 - EC:9F:0D:9F:F9:35
```

NOTE
Each EVK should have a unique address, and the last number of address must be even.

12 Country Codes

Table 10: Country Codes

Code	Country	Code	Country	Code	Country	Code	Country
AD	Andorra	EC	Ecuador	LC	Saint Lucia	RE	Reunion
AE	United Arab Emirates	EE	Estonia	LI	Liechtenstein	RO	Romania
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Revision History

Revision	Date	Description
2.1	24-Jun-2021	Added a description of MROM commands. Added description to use new SFLASH in Section 5
2.0	09-Feb-2021	Removed Section 7.5 Current Measurement with PRO-SB Power Meter and SmartSnippets
1.9	07-Jan-2021	Added OPT lock protection in Section 11.2
1.8	24-Jul-2020	Small textual changes and updated figures based on SDK v2.1.1.0
1.7	04-May-2020	Updated figures based on EVK 7.0 revision
1.6	14-Nov-2019	Small textual changes in updates done in version 1.5
1.5	04-Nov-2019	Added boot index configuration in Section 11.1, 11.3, 11.4, and 11.8
1.4	15-Oct-2019	Updated Layout Removed Draft status
1.3	14-Oct-2019	Error correction at page 9, 10, 48 and 50 Added explanation to use 2MB SFLASH MAP and 4MB SFLASH MAP at page 45 Added reference at page 6
1.2	20-Sep-2019	Error correction Add detailed description for test Section 4 added to show test sequence Section 10, Section 11 moved to the end
1.1	23-Aug-2019	Error correction
1.0	17-Jul-2019	Initial Version

Status Definitions

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
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Contacting Dialog Semiconductor

United Kingdom (Headquarters)
Dialog Semiconductor (UK) LTD
Phone: +44 1793 757700

Germany
Dialog Semiconductor GmbH
Phone: +49 7021 805-0

The Netherlands
Dialog Semiconductor B.V.
Phone: +31 73 640 8822

Email:
enquiry@diasemi.com

North America
Dialog Semiconductor Inc.
Phone: +1 408 845 8500

Japan
Dialog Semiconductor K. K.
Phone: +81 3 5769 5100

Taiwan
Dialog Semiconductor Taiwan
Phone: +886 281 786 222

Web site:
www.dialog-semiconductor.com

Hong Kong
Dialog Semiconductor Hong Kong
Phone: +852 2607 4271

Korea
Dialog Semiconductor Korea
Phone: +82 2 3469 8200

China (Shenzhen)
Dialog Semiconductor China
Phone: +86 755 2981 3669

China (Shanghai)
Dialog Semiconductor China
Phone: +86 21 5424 9058