User Manual

DA16200 MESH Evaluation Kit

[Keywords]

Abstract

This user manual describes how to set-up and use the DA16200 Evaluation Kit.

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-B-110, DA16200, SDK Programmer Guide, User Manual, Dialog Semiconductor

3 DA16200 Module EVK

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

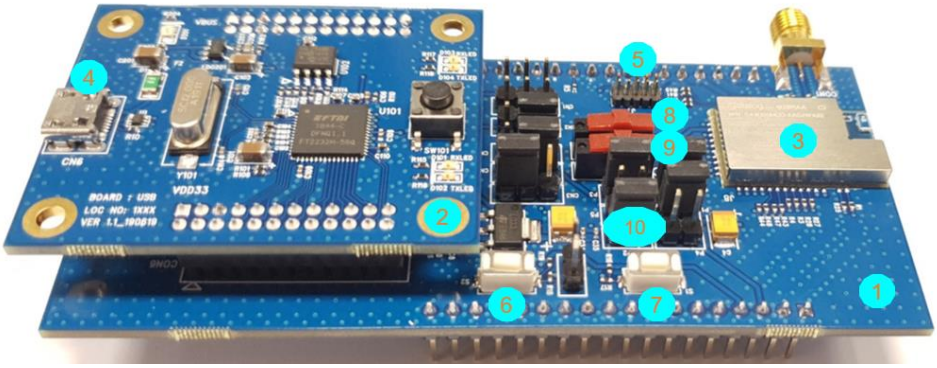


Figure 1: Hardware Configuration

DA16200 has the following components:

1. Main board: DA16200 module (DA16200MOD-AAC4WA32) is installed.
2. USB Interface board.
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.
   a. Pin 7 on each end is keyed with a white plug, so Pin 7 should be removed on EVK.

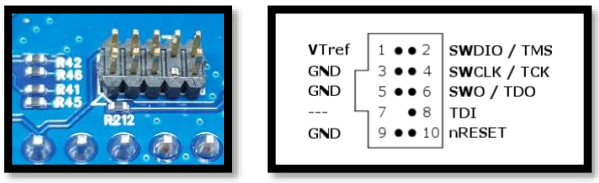


Figure 2: JTAG Pin Connection

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

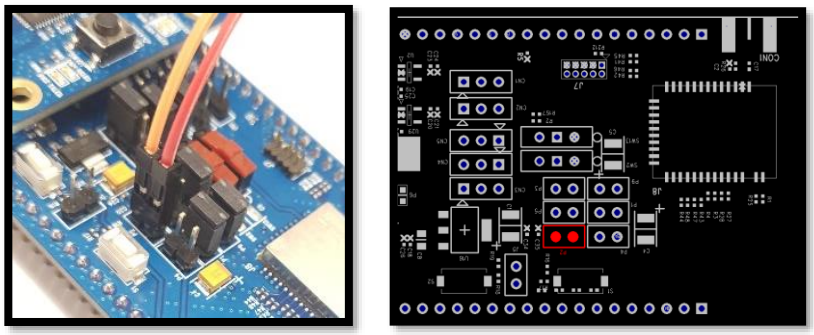


Figure 3: Test Point for Current Measurement

4 Test Sequence

This section describes test sequence for how we show the DA16200 benefits of 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 8)
  Section 5.1, 5.2, 5.3 > (Section 6) > Section 8
- SoftAP test (Section 5.4)
  Section 5.1, 5.2 > Section 5.4
- Firmware update
  Section 5.1, 5.2 > Section 10

5 Wi-Fi Mode Setup

This Section describes how to setup Station and Soft-AP mode 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. Know that the Soft-AP mode does not support full-fledged commercial level Access Point features. This mode is normally used for Provisioning.

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 running Microsoft Windows, the system will detect several devices and will automatically install 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.

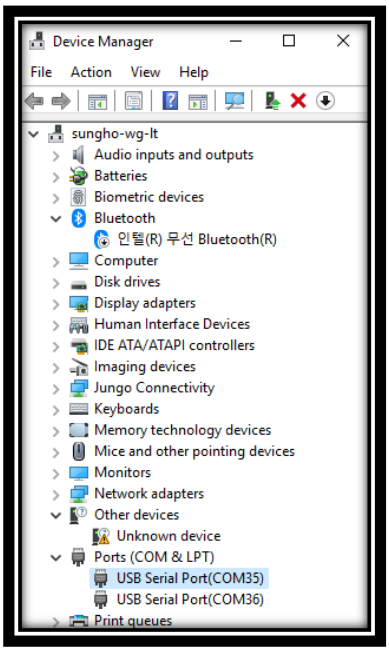


Figure 4: Check COM ports on Device Manager

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) which supports multiple communication including Serial port connections. Download **Tera Term** from https://ttssh2.osdn.jp. Run the teraterm-x.yy.exe and follow the installation wizard.

To make sure that the communication between the DA16200 EVK and host PC is properly established, it is necessary to verify the UART connection between the two nodes. To do so, do the following steps:

1. Connect the DA16200 EVK to the PC via USB cable to USB Port.
2. Verify that 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:
   a. Select **Serial**.
   b. Select the COM Port to use.
   c. Click **OK**.
5. Select `Setup` > `Serial Port` a as shown in and configure your UART port using the parameters as shown in Figure 5.
6. Open the Lowest COM port number assigned to the DA16200 EVK, refer to 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.

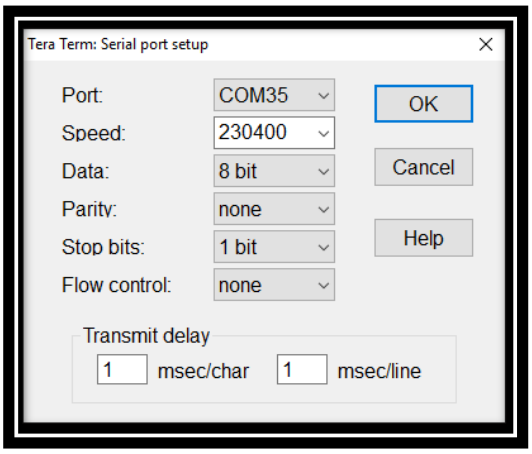


Figure 5: Serial Port Setup

5.3 Setup for Station Mode

Easy Setup is a Wi-Fi configuration wizard to easily configure the Wi-Fi functions of DA16200.

1. Run command `setup`.

NOTE
From here on, the setup query statements will continue. So please answer the questions as follows:

2. `Stop all services for the setting. Are you sure? [Yes/No]`: type **Yes**
   See Figure 6.

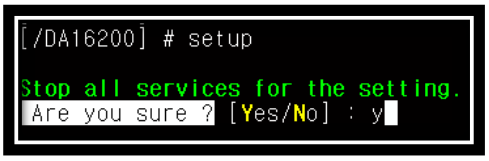


Figure 6 Easy setup start

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

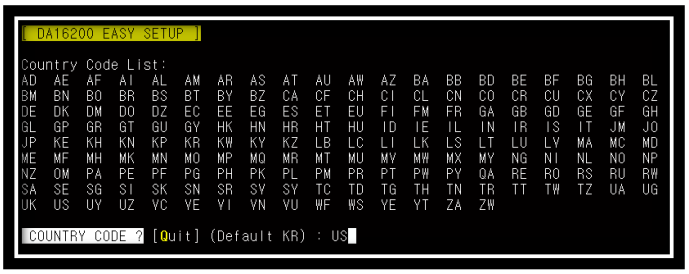


Figure 7 Country Selection

4. `MODE? [1/2/3/4/5/6/Quit] (Default Station)`: type **1**
   See Figure 8.

```
SYSMODE(WLAN MODE) ?
        1. Station
        2. Soft-AP
        3. WiFi Direct
        4. WiFi Direct P2P GO Fixed
        5. Station & SOFT-AP
        6. Station & WiFi Direct
 MODE ?  [1/2/3/4/5/6/Quit] (Default Station) : 1
```

Figure 8 Station mode Selection

5. `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 **Enter** to rescan.
      For example: SSID **ACST_AC_TEST2** is selected for testing.

```
[ STATION CONFIGURATION ]
==============================================================================
[NO] [SSID]                                          [SIGNAL] [CH] [SECURITY]
------------------------------------------------------------------------------
[ 1] ACST_AC_TEST2                                     -33   1 WPA2
[ 2] NETGEAR_RAX40                                     -46   5 WPA2
[ 3] [Hidden] BSSID-fe:ec:da:f4:62:aa                  -48   6 WPA2
[ 4] ZIO-2509N                                         -50  13 WPA2
[ 5] UBIQUITI_AC_LR                                    -51   6 WPA2
[ 6] DLINK_880L                                        -52   6 WPA / WPA2
[ 7] IPTIME_A3004_YOL                                  -57   1 WPA2
[ 8] IPTIME_A3004_NPG                                  -57   1 WPA2
[ 9] N_A1004_W2_AES                                    -57  11 WPA / WPA2
[10] SG_Linksys_EA7300                                 -57   6 WPA2
[11] N604R_MIKE                                        -57  10 WPA2
[12] TPLINK_ArcherC7_Ver5                              -59   1 WPA2
[13] DA16200_9FFD71                                    -59  13 WPA2
[14] TENDA_W311R                                       -60   6 WPA2
[15] DIRECT-B2-HP OfficeJet Pro 8710                   -60   6 WPA2
[16] in-test                                           -62   2 WPA2
[17] IPTIME_A3004                                      -64   1 WPA2
[18] Google_NLS1304A_NPG                               -65   1 WPA2
[19] DIRECT-D3-HP OfficeJet Pro 8710                   -66   6 WPA2
[20] PHICOMM_PSG1218                                   -66  11 WPA / WPA2
[21] IPTIME_N8004_Tk                                   -66  11 WPA
[22] N_N804V_W2_AES_ENT-allion                         -67  11 EAP
[23] [Hidden] BSSID-0a:18:e7:e8:ca:05                  -67  11 WPA2
[24] [Hidden] BSSID-0e:18:e7:e8:ca:05                  -67  11 WPA2
[25] JMC_DIR-615_Wx_AUTO                               -67  11 WPA / WPA2
[26] N_N804V_W2_AES_ENT-Linux                          -68  11 EAP
[27] LINKSYS_WRT54GL                                   -69   1 WPA / WPA2
[28] JMC_SWR-1100                                      -70   6 WPA2
[29] JMC_DIR-615_Wx_AUTO6                              -70  11 WPA2
[30] JMC_DIR-615_Wx_KeyUpdate_3600s                    -71  11 WPA2
------------------------------------------------------------------------------
[M] Manual Input
[Enter] Rescan
==============================================================================

Select SSID ? (1~30/Manual/Quit) : 1
```

Figure 9 AP Selection

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


```
=============================================
SSID       : ACST_AC_TEST2
AUTH       : WPA/WAP2
ENCRYPTION: TKIP/AES(CCMP)
PSK KEY    : acstac12
KEY TYPE   : ASCII
Hidden AP  : Not connect
=============================================
 WIFI CONFIGURATION CONFIRM ? [Yes/No/Quit] : Y

 IP Connection Type ? [Automatic IP/Static IP/Quit] : A


IP Connection Type: Automatic IP

 IP CONFIGURATION CONFIRM ? [Yes/No/Quit] : Y

 SNTP Client enable ? [Yes/No/Quit] : N

 FCI Dynamic Power Management ? [Yes/No/Quit] : N
```

Figure 10 Check Wi-Fi Configuration

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

```
Configuration OK

Reboot...


P.TIM is relocated to RETMEM (20f835c0, 3)
dpm_init_retmemory::350 DPM INIT CONFIGURATION(1)

Wakeup source is 0x1


        ************************************************
        *             DA16200 SDK Information
        * ----------------------------------------------
        *
        * - CPU Type        : Cortex-M4 (80MHz)
        * - OS Type         : ThreadX 5.7
        * - Serial Flash    : 16 Mbits (2 MBytes)
        * - SDK Type        : Generic v1.1.0
        * - F/W Version     : RTOS-GEN01-01-8254-000000
        *                   : SLIB-GEN01-01-8209-000000
        * - F/W Build Time  : Sep  9 2019 19:55:35
        * - Boot Index      : 0
        *
        ************************************************


[1213] ADC CAL loop 1, time 135 us

System Mode : Station Only (0)
>>> FC9K supplicant Ver1.00-20170213-01
>>> MAC address (sta0) : ec:9f:0d:9f:f9:3a
>>> sta0 interface add OK
>>> Start STA mode...

>>> UART1 : Clock=80000000, BaudRate=115200
>>> UART1 : DMA Enabled ...
>>> Selected BSS 88:36:6c:42:79:6c ssid='ACST_AC_TEST2' (-18)
>>> Network Interface (wlan0) : UP
>>> Associated with 88:36:6c:42:79:6c

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

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
         Assigned addr   : 192.168.0.67
               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 00m 00s
```

Figure 11 Wi-Fi Configuration completed

5.4 Setup for Soft-AP Mode

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

1. At the prompt, run command `setup`.

Note 1 From here on, the setup query statements will continue. So please answer the questions as follows:

2. `MODE? [1/2/3/4/5/6/Quit] (Default Station)`: type **2**
   See Figure 12.

```
SYSMODE(WLAN MODE) ?
        1. Station
        2. Soft-AP
        3. WiFi Direct
        4. WiFi Direct P2P GO Fixed
        5. Station & SOFT-AP
        6. Station & WiFi Direct
 MODE ?  [1/2/3/4/5/6/Quit] (Default Station) : 2
```

Figure 12 Soft-AP mode Selection

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

```
[ SOFT-AP CONFIGURATION ]

 SSID ? (Default DA16200_9FFFFF) : TEST AP

 CHANNEL ? [1~13, Auto:0/Quit] (Default Auto) :


AUTHENTICATION ?
        1. OPEN
        2. WEP(Unsupported)
        3. WPA-PSK
        4. WPA2-PSK (Recommend)
        5. WPA/WPA2-PSK
 AUTHENTICATION ? [1/3/4/5/Quit] : 4


ENCRYPTION ?
        1. TKIP (CAUTION: Unsupported 802.11N Mode)
        2. AES(CCMP)
        3. TKIP/AES(CCMP)
 ENCRYPTION ? [1/2/3/Quit] : 2

 PSK-KEY(ASCII characters 8~63 or Hexadecimal characters 64) ? [Quit]
[123456789|123456789|123456789|123456789|123456789|123456789|1234]
:12345678
```

Figure 13 Setup AP

7. `Do you want to set advanced Wi-Fi configuration? [No/Yes/Quit] (Default No)`: type **N**
   See Figure 14.
8. `WIFI CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**
9. `IP ADDRESS? [Quit] (Default 10.0.0.1)`: press **[ENTER]**
10. `SUBNET? [Quit] (Default 255.255.255.0)`: press **[ENTER]**
11. `GATEWAY? [Quit] (Default 10.0.0.1)`: press **[ENTER]**

12. DNS? [Quit] (Default 8.8.8.8): press **[ENTER]**
13. IP CONFIGURATION CONFIRM? [Yes/No/Quit]: type **Y**
14. DHCP SERVER CONFIGURATION? [Yes/No/Quit]: type **Y**
15. DHCP SERVER LEASE IP Count (MAX 10)? [Quit] (Default 10): press **[ENTER]**
16. DHCP SERVER LEASE TIME (60 ~ 86400 SEC)? [Quit] (Default 1800): press **[ENTER]**
17. DHCP SERVER CONFIGURATION CONFIRM? [Yes/No/Quit]: type **Y**

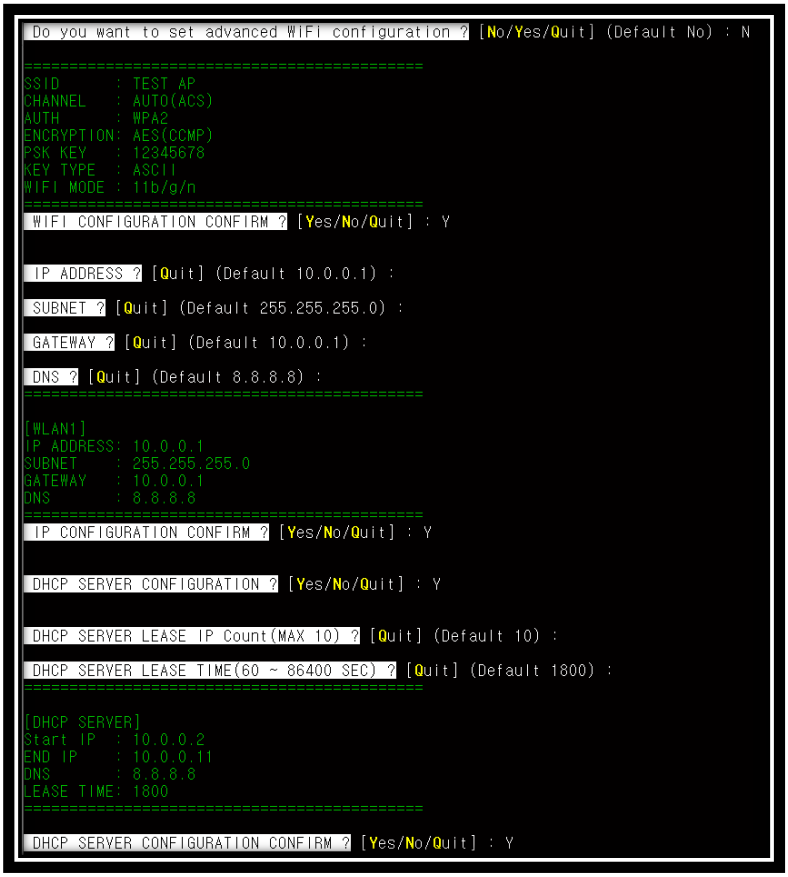


Figure 14 AP mode Selection

```
Configuration OK

Reboot...


P.TIM is relocated to RETMEM (20f835c0, 3)
dpm_init_retmemory::350 DPM INIT CONFIGURATION(1)

Wakeup source is 0x0


        ************************************************
        *             DA16200 SDK Information
        * ---------------------------------------------
        *
        * - CPU Type         : Cortex-M4 (80MHz)
        * - OS Type          : ThreadX 5.7
        * - Serial Flash     : 16 Mbits (2 MBytes)
        * - SDK Type         : Generic v1.1.0
        * - F/W Version      : RTOS-GEN01-01-8254-000000
        *                    : SLIB-GEN01-01-8209-000000
        * - F/W Build Time   : Sep  9 2019 19:55:35
        * - Boot Index       : 0
        *
        ************************************************


[11806] ADC CAL loop 14, time 10729 us

System Mode : Soft-AP (1)
Starting DHCP Server(WLAN1)
>>> FC9K supplicant Ver1.00-20170213-01
>>> Add SoftAP Inteface (softap1) ...
>>> MAC address (softap1) : ec:9f:0d:9f:f9:3b
>>> softap1 interface add OK
>>> AP Operating Channel: AUTO

>>> UART1 : Clock=80000000, BaudRate=115200
>>> UART1 : DMA Enabled ...
ACS: Ideal channel is 12
>>> Network Interface (wlan1) : UP
BSS Isolate Enabled

Soft-AP is Ready (ec:9f:0d:9f:f9:3b)
```

Figure 15 **AP setup completed**

Once all settings are made as given above, the configuration is saved, and the system will reboot. A message is printed that Soft-AP mode started successfully. See Figure 15.

5.5 Setup for Mesh Network

5.5.1 Mesh Network Overview

1. Configuration for the MESH network See Figure 12Figure 16 Mesh .

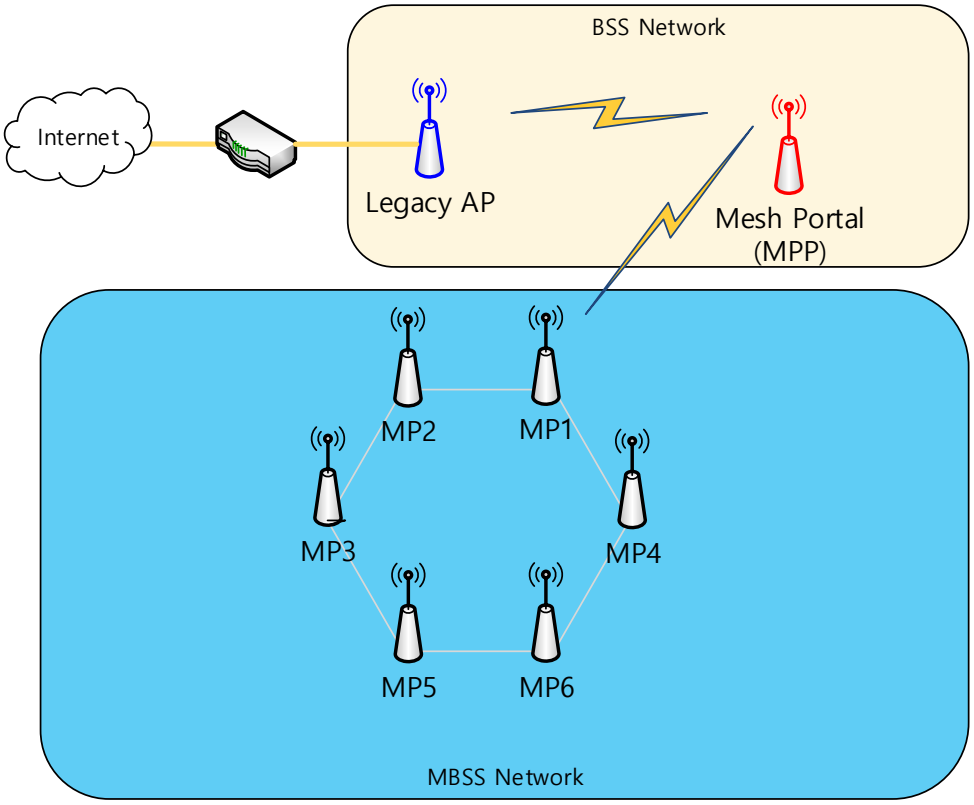


Figure 16 Mesh Network

2. Specification of DA16200 MESH Network
- Up to 4 nodes can be connected to a Mesh Point.
- Only one Mesh Point node can be connected to the Mesh Portal.
- The whole mesh network is able to include up to 32 nodes
.- The basic channel of the mesh network should be set identically.
- It is recommended to set CPU clock of DA16200 to 120Mhz or higher.
- In the Mesh Portal, the MP channel operates in the channel defaultly set, and when the Station of the Mesh Portal connects to the AP, it switches to the channel of the AP that is connected to the Station of Mesh Portal.

5.5.2 Setup for Mesh Portal Mode

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

2. At the prompt, run command `setup`.

Note 2 Please answer the questions as follows to properly set up Mesh Portal Mode

3. `MODE? [1/2/3/4/Quit] (Default Station): type` **4**
   See Figure 17 Mesh Portal mode Selection.

```
SYSMODE(WLAN MODE) ?
        1. Station
        2. Soft-AP
        3. Mesh Point
        4. Mesh Portal(Station & Mesh Point)
        <Quit>
 MODE ? (Default Station) : 4
```

Figure 17 Mesh Portal mode Selection

4. `SELECT SSID? (1~30/Manual/Quit):`
   Figure 18 Mesh Portal AP Selection
   a. Select the SSID of the AP to which you want to connect. If there is no AP that you want to connect to, press **Enter** to re-scan.
      For example: SSID **UBIQUITI_AC_LR** is selected for testing.

```
==========================================================================
[NO] [SSID]                                          [SIGNAL] [CH] [SECURITY]
--------------------------------------------------------------------------
[ 1] DA16200_MESH_JMC                                   -5  11 MESH SAE
[ 2] DA16200_MESH_JMC                                   -7  11 MESH SAE
[ 3] DA16200_SOFTAP_JMC                                -18  11 SAE
[ 4] DLINK_616                                         -27   1 WPA2
[ 5] N_A1004_WPA2_AES                                  -29  11 WPA2
[ 6] JMC_DIR-615_Wx_AUTO6                              -35  11 WPA2
[ 7] Google_NLS1304A_NPG                               -35   1 WPA2
[ 8] ACST_AC_TEST2                                     -35   3 WPA2
[ 9] TPLINK_ArcherC7_Ver5                              -35  11 WPA2
[10] ZIO_FREEZION                                      -37   6 WPA2
[11] UBIQUITI_AC_LR                                    -37   1 WPA2
[12] IPTIME_A3004_VOL                                  -37   1 WPA2
[13] DA16200_223303                                    -38  11 WPA2
[14] [Hidden] BSSID-fe:ec:da:f4:62:aa                  -38   1 WPA2
[15] netis_M3200N                                      -39   6 WPA2
[16] JMC_DIR-615_Wx_KeyUpdate_30s                      -40  11 WPA2
[17] JMC_DIR-615_Wx_AUTO                               -40  11 WPA / WPA2
[18] 360_F5S                                           -40   6 WPA2
[19] JMC_DIR-615_Wx_KeyUpdate_3600s                    -41  11 WPA2
[20] JMC_SWR-1100                                      -42   6 WPA2
[21] IPTIME_A3004_NPG                                  -42   1 WPA2
[22] N604R_MIKE                                        -42  10 WPA2
[23] Synology_MR2200AC_WPA3_SAE                        -43  11 SAE
[24] BELKIN_F7D6301                                    -45   6 WPA / WPA2
[25] DA16200_MESH                                      -45   1 MESH SAE
[26] N_N300-JWNR2000v2_Wx_AUTO                         -46   1 WPA / WPA2
[27] [Hidden] BSSID-16:11:32:a5:95:8b                  -46  11 WPA2
[28] netis_2G                                          -46   1 WPA / WPA2
[29] Synology_MR2200AC_WPA3_OWE                        -47  11 OWE
[30] AS_ZXCV                                           -48   2 WPA2
--------------------------------------------------------------------------
[M] Manual Input
[Enter] Rescan
==========================================================================

 Select SSID ? (1~30/Manual/Quit) : 11
```

Figure 18 Mesh Portal AP Selection

5. `PSK-KEY (ASCII characters 8~63 or hexadecimal characters 64)? [Quit] : ********` type in the password that matches the encryption method of the selected AP.
6. `WIFI CONFIGURATION CONFIRM? [Yes/No/Quit]:` type **Y**. See Figure 20 Mesh Portal Mesh Point Interface.
7. `IP Connection Type? [Automatic IP/Static IP/Quit]: type` **A**
   IP is automatically assigned by DHCP.
8. `IP CONFIGURATION CONFIRM? [Yes/No/Quit]:` type **Y**

9. `SNTP Client enable`: type **N**
   If time synchronization is not needed, then there is no need to run the SNTP Client.

```
PSK-KEY(ASCII characters 8~63 or Hexadecimal characters 64) ? [Quit]
[123456789|123456789|123456789|123456789|123456789|123456789|1234]
:N12345678
==========================================
SSID      : UBIQUITI_AC_LR
AUTH      : WPA/WAP2
ENCRYPTION: TKIP/AES(CCMP)
PSK KEY   : N12345678
KEY TYPE  : ASCII
Hidden AP : Not connect
==========================================
WIFI CONFIGURATION CONFIRM ? [Yes/No/Quit] : y

IP Connection Type ? [Automatic IP/Static IP/Quit] : a


IP Connection Type: Automatic IP

IP CONFIGURATION CONFIRM ? [Yes/No/Quit] : y

SNTP Client enable ? [Yes/No/Quit] : n
```

Figure 19 Mesh Portal Station Interface

10. `SSID? (Default 16200_9FFFFF)`: **MESH_NETWORK**. See Figure 20 Mesh Portal Mesh Point Interface.
    - Choose the SSID you want to use.
11. `SAE-KEY (ASCII characters and Recommendation: 64 characters or less)? [Quit] : ********` Enter the password you want to use.
12. `Do you want to set advanced Wi-Fi configuration? [No/Yes/Quit] (Default No)`: type **N**
    See Figure 20 Mesh Portal Mesh Point Interface.
13. `WIFI CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**

```
[ MESH POINT CONFIGURATION ]

SSID ? (Default DA16200_9FFD19) : MESH_NETWORK

CHANNEL ? [1~13, /Quit] (Default 11) :

SAE-PASSWORD(ASCII) ? [Quit]
[123456789|123456789|123456789|123456789|123456789|123456789|1234]
:12345678

Do you want to set advanced WiFi configuration ? [No/Yes/Quit] (Default No) : n

==========================================
SSID      : MESH_NETWORK
AUTH      : SAE
ENCRYPTION: AES(CCMP)
SAE KEY   : 12345678
==========================================
WIFI CONFIGURATION CONFIRM ? [Yes/No/Quit] : y
```

Figure 20 Mesh Portal Mesh Point Interface

14. `IP ADDRESS? [Quit] (Default 10.0.0.1)`: press **[ENTER]**
15. `SUBNET? [Quit] (Default 255.255.255.0)`: press **[ENTER]**
16. `GATEWAY? [Quit] (Default 10.0.0.1)`: press **[ENTER]**

17. DNS? [Quit] (Default 8.8.8.8): press **[ENTER]**
18. IP CONFIGURATION CONFIRM? [Yes/No/Quit]: type **Y**

See Figure 21 Mesh Portal Network Interface

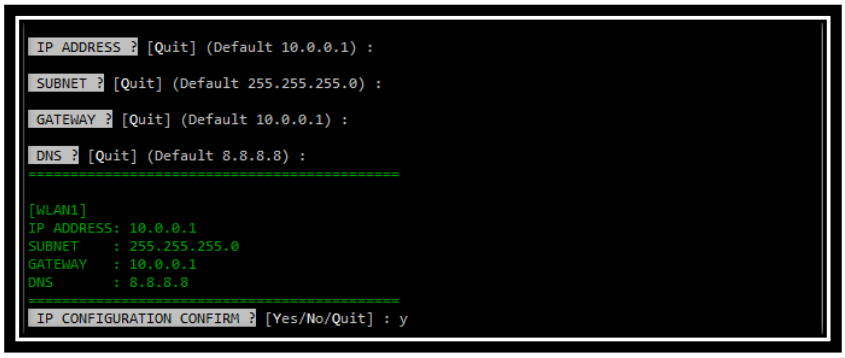


Figure 21 Mesh Portal Network Interface

19. DHCP SERVER CONFIGURATION? [Yes/No/Quit]: type **Y**
20. DHCP SERVER LEASE IP Count (MAX 35)? [Quit] (Default 35): press **[ENTER]**
21. DHCP SERVER LEASE TIME (60 ~ 86400 SEC)? [Quit] (Default 86400): press **[ENTER]**
22. DHCP SERVER CONFIGURATION CONFIRM? [Yes/No/Quit]: type **Y**

    See Figure 21 Mesh Portal Network Interface

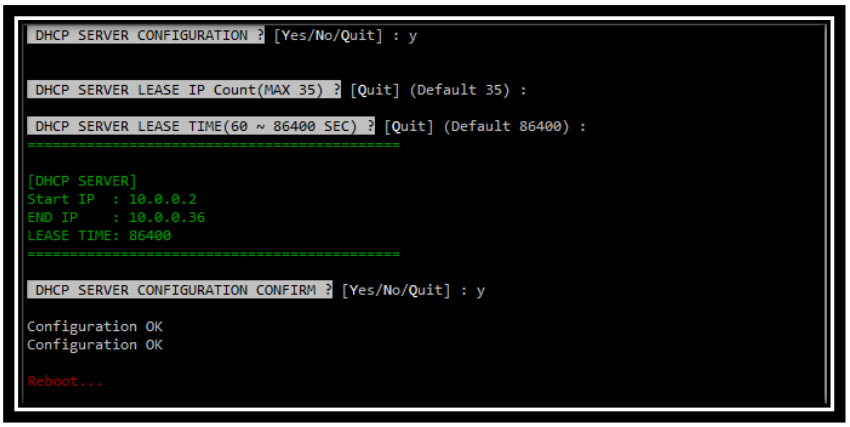


Figure 22 Mesh Portal DHCP Server

```
System Mode : MESH Portal (7)
NAT Enabled
Starting DHCP Server(WLAN1)
>>> DA16K Supplicant Ver2.00-201908
>>> MAC address (sta0) : ec:9f:0d:9f:fd:18
>>> sta0 interface add OK
>>> MAC address (mesh1) : ec:9f:0d:9f:fd:19
>>> mesh1 interface add OK

>>> Start MESH Point Mode...
mesh1: interface state UNINITIALIZED->ENABLED
AP-ENABLED
joining mesh MESH_NETWORK
RTC switched to XTAL
>>> Network Interface (wlan1) : UP

Mesh Point is Ready
MESH-GROUP-STARTED ssid="MESH_NETWORK" id=3
!!! No selected network !!!
SME: Trying to authenticate with fc:ec:da:f4:62:aa (SSID='UBIQUITI_AC_LR' freq=2412 MHz)
Trying to associate with fc:ec:da:f4:62:aa (SSID='UBIQUITI_AC_LR' freq=2412 MHz)
>>> Network Interface (wlan0) : UP
Associated with fc:ec:da:f4:62:aa
CTRL-EVENT-SUBNET-STATUS-UPDATE status=0
WPA: Key negotiation completed with fc:ec:da:f4:62:aa [PTK=CCMP GTK=CCMP]

Connection COMPLETE to fc:ec:da:f4:62:aa
[wpa_supplicant_set_state] Channel Change --> assoc : 2412 , cur_bss : 2412
[wpa_supplicant_event] freq=2412 ht_enabled=1 ch_offset=0 cf1=2412 cf2=0

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
         Assigned addr   : 172.16.30.153
               netmask   : 255.255.224.0
               gateway   : 172.16.0.1
               DNS addr  : 168.126.63.1

         DHCP Server IP  : 172.16.0.1
         Lease Time      : 02h 00m 00s
```

Figure 23 Mesh Portal setup completed

Once all settings are done as above, the configuration is saved, and the system will reboot.

A message is printed like "*Mesh Portal mode started* **successfully".** See Figure 23 Mesh Portal setup completed.

5.5.3 Setup for Mesh Point Mode

The setup for Mesh Point mode is almost same as for Mesh Portal mode: you can also use Easy Setup to set up the Mesh Point mode. Please follow the instructions:

1. At the prompt, run command `setup`.

Note 3 Please answer the questions as follows to properly set up Mesh Portal Mode:

2. `MODE? [1/2/3/Quit] (Default Station):` type **3**
   See Figure 24 Mesh Point mode SelectionFigure 12.

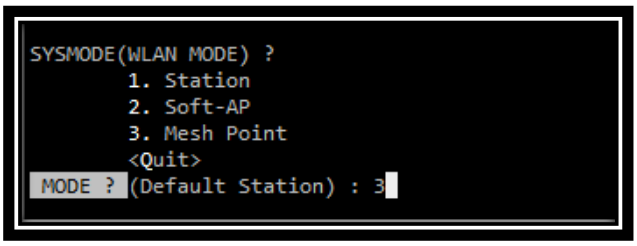


Figure 24 Mesh Point mode Selection

3. `SSID? (Default 16200_9FFFFF)`: **MESH_NETWORK**. See Figure 25 Mesh Point.
   - Choose the SSID you want to use. (You should use the same SSID as Mesh Portal)
4. `SAE-KEY (ASCII characters and Recommendation: 64 characters or less)? [Quit] : ********` Enter the password you want to use.(Requires the same password as Mesh Portal)
5. `WIFI CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**

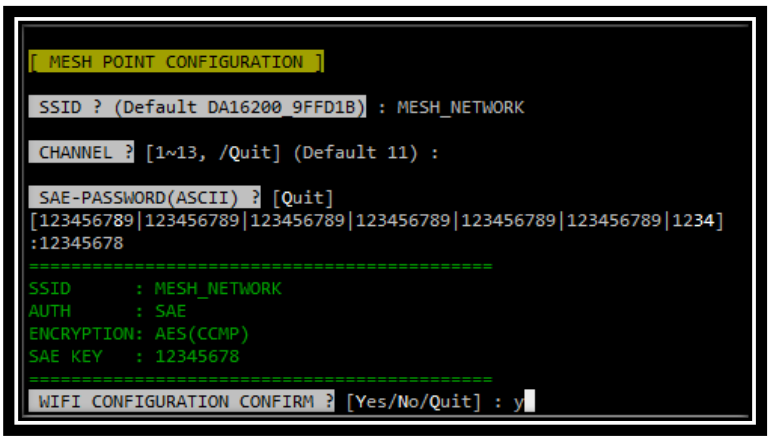


Figure 25 Mesh Point

6. `IP Connection Type? [Automatic IP/Static IP/Quit]: type` **A**
   IP is automatically assigned by DHCP.
7. `IP CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**
8. `SNTP Client enable`: type **N**
   If time synchronization is not needed, then there is no need to run the SNTP Client.
9. `IP CONFIGURATION CONFIRM? [Yes/No/Quit]`: type **Y**

See Figure 26 Mesh Point Network InterfaceFigure 12.

```
IP Connection Type ? [Automatic IP/Static IP/Quit] : a

IP Connection Type: Automatic IP

IP CONFIGURATION CONFIRM ? [Yes/No/Quit] : y

SNTP Client enable ? [Yes/No/Quit] : n

Configuration OK

Reboot...
```

Figure 26 Mesh Point Network Interface

```
System Mode : MESH Point (6)
>>> DA16K Supplicant Ver2.00-201908
>>> MAC address (sta0) : ec:9f:0d:9f:fd:1a
>>> MAC address (mesh1) : ec:9f:0d:9f:fd:1b
>>> mesh1 interface add OK

>>> Start MESH Point Mode...
mesh1: interface state UNINITIALIZED->ENABLED
AP-ENABLED
joining mesh MESH_NETWORK
>>> Network Interface (wlan1) : UP

Mesh Point is Ready
MESH-GROUP-STARTED ssid="MESH_NETWORK" id=3

-- DHCP Client WLAN0: SEL
new peer notification for ec:9f:0d:9f:fd:19
[wpa_supplicant_event] freq=2412 ht_enabled=1 ch_offset=0 cf1=2412 cf2=0
new peer notification for ec:9f:0d:9f:fd:19
new peer notification for ec:9f:0d:9f:fd:19
mesh plink with ec:9f:0d:9f:fd:19 established
MESH-PEER-CONNECTED ec:9f:0d:9f:fd:19
-- DHCP Client WLAN0: INIT

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
        Assigned addr   : 10.0.0.2
              netmask   : 255.255.255.0
              gateway   : 10.0.0.1
              DNS addr  : 8.8.8.8

        DHCP Server IP  : 10.0.0.1
        Lease Time      : 24h 00m 00s
        Renewal Time    : 12h 00m 00s
```

Figure 27 Mesh Point setup completed

Once all settings are made as above, the configuration is saved, and the system will reboot.

A message is printed like "*Mesh Point mode started* **successfully".** See Figure 27 Mesh Point setup completed.

* Set up other Mesh Point devices in the same way.

5.5.4 Setup for Mesh Portal Mode via CLI CMD

1. Setup for Station Interface

- Run the commands sequentially at the prompts.


```
net
cli add_network 0
cli set_network 0 ssid  'xxxxx' ← Legacy AP SSID
cli set_network 0 mode 0        ← Operation Mode: Station
cli set_network 0 proto RSN
cli set_network 0 key_mgmt SAE WPA-PSK
cli set_network 0 pairwise CCMP
cli set_network 0 psk '12345678'

cli save_config
```

2. Setup for Mesh Point Interface

- Run the commands sequentially at the prompts.

```
net
cli add_network 3
cli set_network 3 mode 5        ← Operation Mode: Mesh Point
cli set_network 3 ssid 'xxxxx' ← Mesh ID(SSID)
cli set_network 3 key_mgmt SAE
cli set_network 3 sae_password '12345678'
cli set_network 3 channel 11 or cli set_network 3 frequency 2437
cli sae_group 19

cli save_config
```

3. Setup for Mesh Network Interface

- Run the commands sequentially at the prompts.

```
nvram
setenv SYSMODE 7
setenv NAT 1
net
ifconfig wlan0 dhcp      ← Station Interface
ifconfig wlan1 10.0.0.1 255.255.255.0 0.0.0.0 ← Mesh Interface
dhcpd range 10.0.0.2 10.0.0.35
dhcpd lease_time 86400
dhcpd dns 8.8.8.8
dhcpd wlan1 boot on
```

4. Setup Complete and Reboot

- Run the commands sequentially at the prompts.

```
reboot
```

5.5.5 Setup for Mesh Point Mode via CLI CMD

1. Setup for Mesh Point Interface

- Run the commands sequentially at the prompts.


```
net
cli add_network 3
cli set_network 3 mode 5        ← Operation Mode: Mesh Point
cli set_network 3 ssid 'xxxxx' ← Mesh ID(SSID)
cli set_network 3 key_mgmt SAE
cli set_network 3 sae_password '12345678'
cli set_network 3 channel 11 or cli set_network 3 frequency 2437
cli sae_group 19

cli save_config
```

2. Setup for Mesh Network Interface

- Run the commands sequentially at the prompts.

```
nvram
setenv SYSMODE 6
net
ifconfig wlan1 dhcp ← Mesh Interface
```

4. Setup Complete and Reboot

- Run the commands sequentially at the prompts.

```
reboot
```

5.5.6 Check for Mesh Network

1. Mesh Portal Configuration Status

   At the prompt, run command `net.cli status`

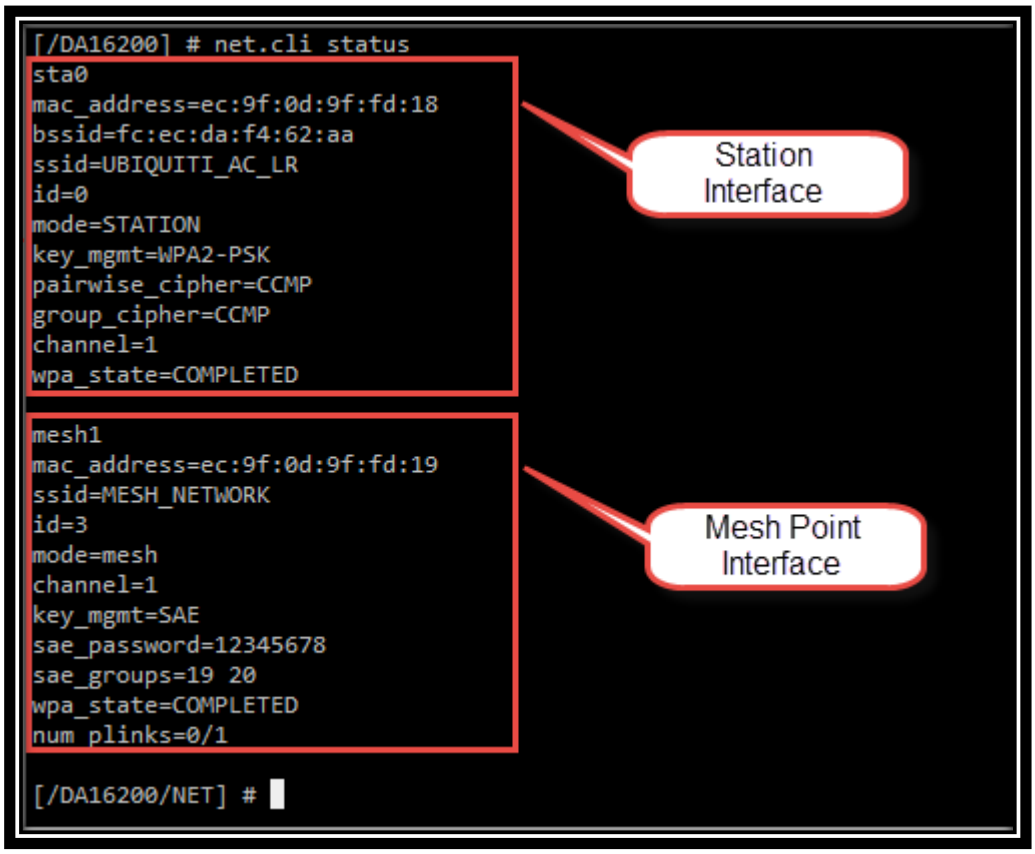


Figure 28 Mesh Point setup completed

2. Mesh Point Configuration Status

   At the prompt, run command `net.cli status`

Figure 29 Mesh Point setup completed

3. MESH Point / Mesh Portal connection State

   At the prompt, run command `net.cli all_sta`


```
[/DA16200/NET] # net.cli all_sta
ec:9f:0d:9f:fd:19
flags=[AUTH][ASSOC][WMM][MFP][HT]
aid=1
capability=0x0
listen_interval=0
wifi_mode=802.11n
timeout_next=NULLFUNC POLL
rx_packets=220
tx_packets=0
rx_bytes=19994
tx_bytes=1444
inact_cnt=0
sae_group=19
plink_state=5
```

Figure 30 Mesh Point connection State

4. MESH Point Not connect

   (Neighbor MESH Point)

   At the prompt, run command `net.cli status`

```
[/DA16200/NET] # net.cli all_sta
ec:9f:0d:9f:fd:19
flags=[WMM][MFP][HT]
aid=2
capability=0x0
listen_interval=0
wifi_mode=802.11n
timeout_next=NULLFUNC POLL
rx_packets=4
tx_packets=0
rx_bytes=354
tx_bytes=384
inact_cnt=0
plink_state=1
```

Figure 31 Mesh Point Not Connect

5. Check mesh network data communication.

 - Check the gateway IP address of the Station interface in the mesh portal.(CMD:ifconfig)


```
[/DA16200/NET] # ifconfig

WLAN0
        NetMode: DHCP Client
        MAC Address EC:9F:0D:9F:FD:18
        IP Address:172.16.30.108  Mask:255.255.224.0  Gateway:172.16.0.1  MTU:1500
        DNS: 168.126.63.1
        IP Lease Time      : 02h 00m 00s
        IP Renewal Time    : 01h 00m 00s
           Timeout         : 00h 51m 00s


WLAN1 (WLAN0:1)
        NetMode: Static IP
        MAC Address EC:9F:0D:9F:FD:19
        IP Address:10.0.0.1  Mask:255.255.255.0  MTU:1500

[/DA16200/NET] #
```

Figure 32 Mesh Portal Gateway IP

- Ping the Legacy AP's IP address(Mesh portal gateway IP) with a ping command on each mesh point device.

-

```
[/DA16200/NET] # ping 172.16.0.1
PING 172.16.0.1 32 bytes of data.
32 bytes from 172.16.0.1: icmp_req=1 time=20ms
32 bytes from 172.16.0.1: icmp_req=2 time<10ms
32 bytes from 172.16.0.1: icmp_req=3 time=10ms
32 bytes from 172.16.0.1: icmp_req=4 time<10ms

--- 172.16.0.1 ping statistics ---
4 packets transmitted,  4 received, 0%(0) packet loss, time 30ms
rtt min/avg/max = 0/7/20 ms

[/DA16200/NET] #
```

Figure 33 Mesh Point Ping TEST

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 micro element 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 transmit 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

This section shows how to enable the DPM mode:

1. Do the steps in section 5.1 until step 11: Dynamic Power Management? [Yes/No/Quit].
2. At prompt `Dynamic Power Management? [Yes/No/Quit]`: type **Y**. See Figure 34.
   a. To use default DPM factor, `DPM factors: Defaults? [Yes/No/Quit]`, type **Y**
   b. `DPM CONFIGURATION CONFIRM [Yes/No/Quit]`: type **Y**

NOTE
TIM wakeup count 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 1 seconds to check for a receive packet

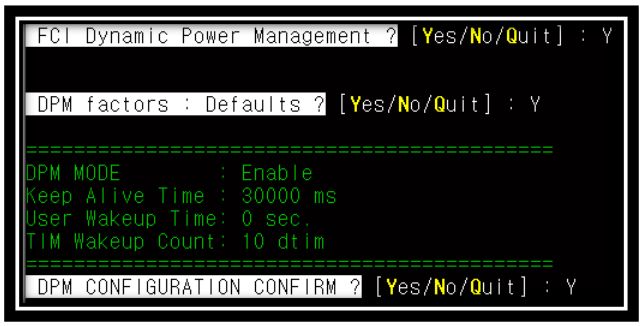


Figure 34 Setting DPM factor with default

   c. To use user defined DPM factor, `DPM factors: Defaults? [Yes/No/Quit]`, type **N**. See Figure 35.
      i. `DPM Keep Alive Time (0~600000 ms)? [Quit] (Default 30000 ms)`: press **[ENTER]** or type value within range
      ii. `DPM User Wakeup Time (0~86400 Sec.)? [Quit] (Default 0 Sec.)`: press **[ENTER]** or type value within range
      iii. `DPM TIM Wakeup Count (1~65535 dtim)? [Quit] (Default 10)`: press **[ENTER]** or type value within range
      iv. `DPM CONFIGURATION CONFIRM [Yes/No/Quit]`: type **Y**

```
FCI Dynamic Power Management ? [Yes/No/Quit] : y

DPM factors : Defaults ? [Yes/No/Quit] : n

DPM Keep Alive Time(0~600000 ms) ? [Quit] (Default 30000 ms) :

DPM User Wakeup Time(0~86400 Sec.) ? [Quit] (Default 0 Sec.) :

DPM TIM Wakeup Count(1~65535 dtim) ? [Quit] (Default 10) :
=========================================
DPM MODE         : Enable
Keep Alive Time : 30000 ms
User Wakeup Time: 0 sec.
TIM Wakeup Count: 10 dtim
=========================================
DPM CONFIGURATION CONFIRM ? [Yes/No/Quit] : y
```

Figure 35 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 36.

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

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
         Assigned addr    : 192.168.0.64
               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

>>> Start DPM Power-Down !!!
```

Figure 36 DPM Mode Running after reboot

NOTE
After the system starts running with DPM, user input via the UART will not work from that moment.

6.3 Hold DPM Mode

Once the system starts running with DPM, user input via the UART does not work anymore from that moment. This is because the UART interface is down during DPM Sleep, which is normal. To exit this state and start over with `setup`, do the following instructions:

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, quickly 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 37.
   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.

```
        ***************************************************
        *              DA16200 SDK Information
        * ------------------------------------------------
        *
        * - CPU Type          : Cortex-M4 (80MHz)
        * - OS Type           : ThreadX 5.7
        * - Serial Flash      : 16 Mbits (2 MBytes)
        * - SDK Type          : Generic v1.1.0
        * - F/W Version       : RTOS-GEN01-01-8254-000000
        *                     : SLIB-GEN01-01-8209-000000
        * - F/W Build Time    : Sep  9 2019 19:45:04
        * - Boot Index        : 0
        *
        ***************************************************


[1230] ADC CAL loop 1, time 138 us

System Mode : Station Only (0)
>>> FC9K supplicant Ver1.00-20170213-01
>>> Wi-Fi mode : b/g/n -> b/g (for DPM)
>>> MAC address (sta0) : ec:9f:0d:9f:f9:34
>>> sta0 interface add OK
>>> Start STA mode...

[/DA16200] #
[/DA16200] # >>> Selected BSS 88:36:6c:42:79:6c ssid='ACST_AC_TEST2' (-25
)
>>> Network Interface (wlan0) : UP
>>> Associated with 88:36:6c:42:79:6c

[/DA16200] #
Connection COMPLETE to 88:36:6c:42:79:6c

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
dpm hold

- DPM Sleep Manager HOLD ...
[/DA16200] #
[/DA16200] #
[/DA16200] # -- DHCP Client WLAN0: BOUND
         Assigned addr    : 192.168.0.69
               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
dpm hold

- DPM Sleep Manager HOLD ...
[/DA16200] #
[/DA16200] #
[/DA16200] # dpm hold

- DPM Sleep Manager HOLD ...
[/DA16200] #
```

Figure 37 DPM Mode hold

6.4 Disable DPM Mode

Though we make DPM enable during `setup`, we can disable DPM mode by using command `dpm off` at prompt. DA16200 will be reboot and connect to AP as shown in Figure 38.


```
[/DA16200] #
[/DA16200] # dpm off

>>> Network Interface (wlan0) : DOWN
[wpa_supplicant_event_disassoc] CTRL-EVENT-DISCONNECTED bssid=88:36:6c:9a:f5:4e
ally_generated=1
[wpa_supp_ev_disassoc_fin] Disconnect event - remove keys
P.TIM is relocated to RETMEM (20f835c0, 3)
dpm_init_retmemory::350 DPM INIT CONFIGURATION(1)

Wakeup source is 0x0


        ************************************************
        *             DA16200 SDK Information
        * ---------------------------------------------
        *
        * - CPU Type        : Cortex-M4 (80MHz)
        * - OS Type         : ThreadX 5.7
        * - Serial Flash    : 16 Mbits (2 MBytes)
        * - SDK Type        : Generic v1.1.0
        * - F/W Version     : RTOS-GEN01-01-8254-000000
        *                   : SLIB-GEN01-01-8209-000000
        * - F/W Build Time  : Sep  9 2019 19:55:35
        * - Boot Index      : 0
        *
        ************************************************


[1208] ADC CAL loop 1, time 135 us

System Mode : Station Only (0)
>>> FC9K supplicant Ver1.00-20170213-01
>>> MAC address (sta0) : ec:9f:0d:9f:f9:34
>>> sta0 interface add OK
>>> Start STA mode...

>>> UART1 : Clock=80000000, BaudRate=115200
>>> UART1 : DMA Enabled ...
>>> Selected BSS 88:36:6c:9a:f5:4e ssid='Dialog_CS_Jinwoo' (-21)
>>> Network Interface (wlan0) : UP
>>> Associated with 88:36:6c:9a:f5:4e

Connection COMPLETE to 88:36:6c:9a:f5:4e

-- DHCP Client WLAN0: SEL
-- DHCP Client WLAN0: REQ
-- DHCP Client WLAN0: BOUND
         Assigned addr   : 192.168.0.5
               netmask   : 255.255.255.0
               gateway   : 192.168.0.1
               DNS addr  : 164.124.101.2

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

Figure 38 DPM Mode off

7 Current measurement

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

7.1 Test Setup

Figure 39 shows a typical test setup environment.

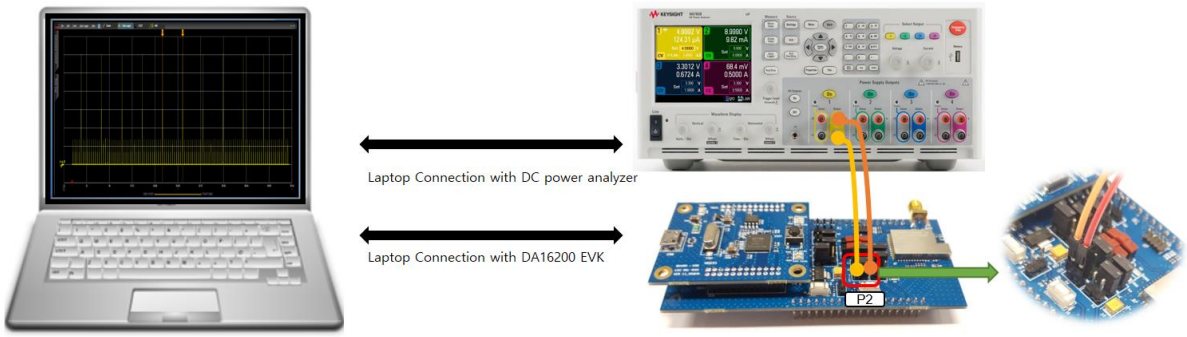


Figure 39 Current Test Environment

7.2 Sleep 1

To measure sleep 1 current, use RTC_PWR_KEY to power off (move to OFF position). See section 3, number 9. See Figure 40.

7.3 Sleep 2

To measure 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. Command `factory` to make DA16200 use default setting.
3. Board will be 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 40 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.

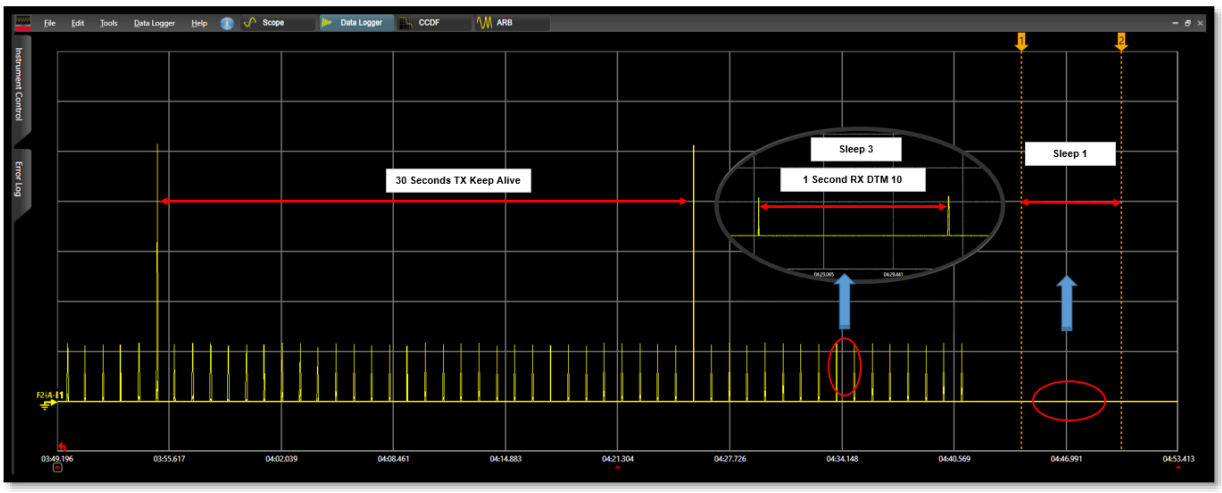


Figure 40 Current Measurement with DPM

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), two stations (DA16200 and Laptop) and Access Point (AP) are required. Both must be connected to the same sub-network AP. See Figure 41. DA16200 must be connected to the AP via WIFI, 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.

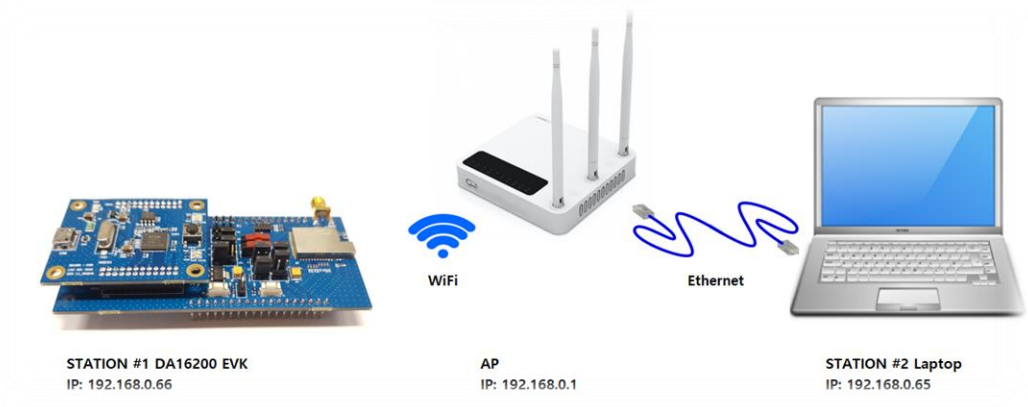


Figure 41: Ping Test Environment

1. Run the command window (`CMD`) as administrator.
2. Type command `ipconfig` to see what the IP address is of the laptop. See Figure 42.
   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 42: 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 43.

```
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 43: 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

Do the following steps to change the ARP record to a static IP address:

2. Use command `arp -a` to view ARP table of the network interface. See Figure 44.
   - 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 44: Check ARP Record

3. Use command `netsh interface show interface` to find the interface name. See Figure 45.
   - 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        이더넷
Enabled        Disconnected   Dedicated        Wi-Fi
```

Figure 45: Interface name for ARP Record

4. 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 46.
   - For example: `C:\WINDOWS\system32> netsh interface ip add neighbors "이더넷" "192.168.0.66" "ec-9f-0d-9f-f9-32"`
5. Use command `arp -a` on the laptop to check if the ARP cache is configured correctly. See Figure 46.
   - For example: `C:\WINDOWS\system32>arp -a`
   - DA16200's IP address 192.168.0.66 is added to ARP table as a static type

```
C:₩WINDOWS₩system32>netsh interface ip add neighbors "이더넷" "192.168.0.66" "ec-9f-0d-9f-f9-32"


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     static
  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 46: Success ARP Record for DA16200

6. 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 sub network. 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 47.
   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.

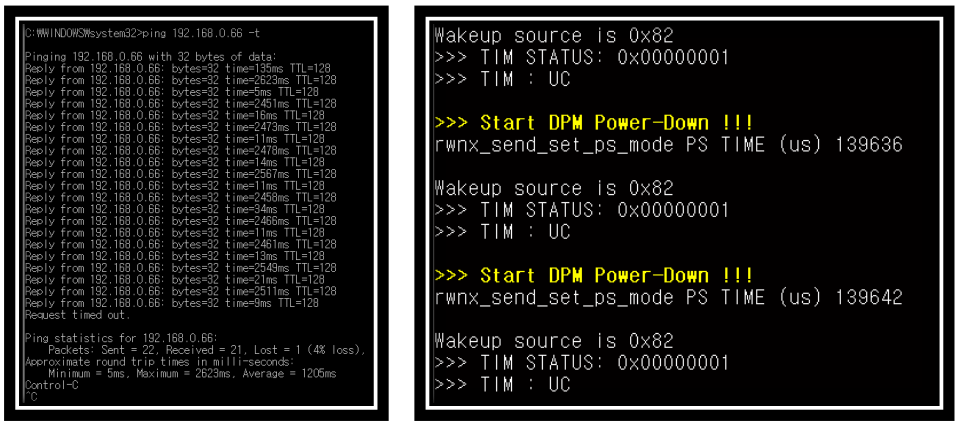


Figure 47: PING TEST with DPM

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 network interface is required in the ping command. For example: `ping 192.168.20.52 -S 192.168.100.100`

9 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.

9.1 Console Commands

The DA16200 console commands are categorized as follow:

- 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 5 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 commands of each category, go to the category first, or prefix the category name to the command as shown in the example:
  - `net`
  - `net.ifconfig`

9.1.1 Root Commands

Table 1: 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
`.`	`(none)`	Re-execute the previous command
`!`	`(none)` `[index]`	Display the history of executed commands Command index in the history For example: `!` ○ 1: echo test ○ 2: echo ○ 3: repeat ○ 4: trace ○ 5: help For example: `!3` means re-execute command number 3 in the history
`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 & 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`

Command	Parameters	Description
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)

9.1.2 Network Commands

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

Table 2: 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	[domain|ip] -n [count] -l [size] -w [timeout] -i [interval]	Ping test to the target address with a certain option ● [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 a 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
arp	[options]	Display the ARP table of a network interface ● a: display the ARP table of every interface ● d: delete all of ARP table ● Help: Help display

Command	Parameter	Description
arpsend	[dst ipaddress]	Transmit the ARP request message of the target IP For example: arpsend 10.0.0.1
garpsend	[interface] [option]	Transmit a GARP message with option: ● 0: normal garp ● 1: check IP conflict For example: arpsend wlan
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	[-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

9.2 CLI command

9.2.1 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 & 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 DA16200 is obtained with CLI command: [/DA16200/NET] cli status. See Figure 48.

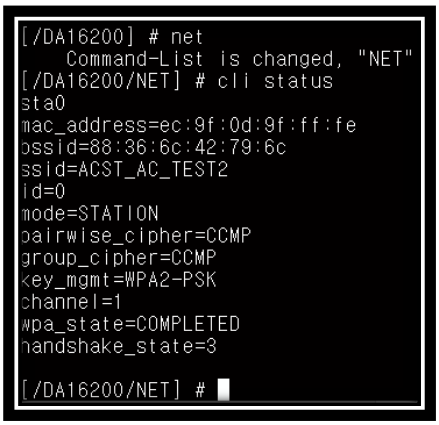


Figure 48 CLI Check

9.2.2 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>`

9.2.3 Common Commands

Table 3: 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, etc. 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"`

CLI	Parameter	Description
select_network	<mode>	Execute a motion in a certain mode (STA access, AP operation, etc.) (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, the following tasks need to be carried out 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
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

CLI	Parameter	Description
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)

9.2.4 STA Commands

Table 4: 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 -85dBm

9.2.5 Soft-AP Commands

Table 5: 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, etc.) (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

Command	Parameter	Description
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 (2422 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)
		(See example)
		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

all_sta	(none)	Output the list information of STA being accessed to the AP interface (C) (See example) 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

Command	Parameter	Description
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
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

Command	Parameter	Description
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

Command	Parameter	Description
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

Command	Parameter	Description
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, 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
ap_rts	<value>	For AP mode operation, set up the RTS Threshold value to be used (A) <value>: The standard for a 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

9.2.6 Advanced Commands

Table 6: 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 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 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-XXXX-000000_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`

10.1 Flash MAP

DA16200 provides two image, #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 7: 2MB Serial Flash Memory Map

address	Item	size
0x0000_0000	2nd Bootloader	36KB
0x0000_9000	Boot Index	4KB
0x0000_A000	RTOS #0	924KB

address	Item	size
0x000F_1000	SLIB #0 (RamLib + TIM)	52KB
0x000F_E000	RTOS #1	924KB
0x001E_5000	SLIB #1 (RamLib + TIM)	52KB

Table 8: 4MB Serial Flash Memory Map

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

10.2 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 <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 49.

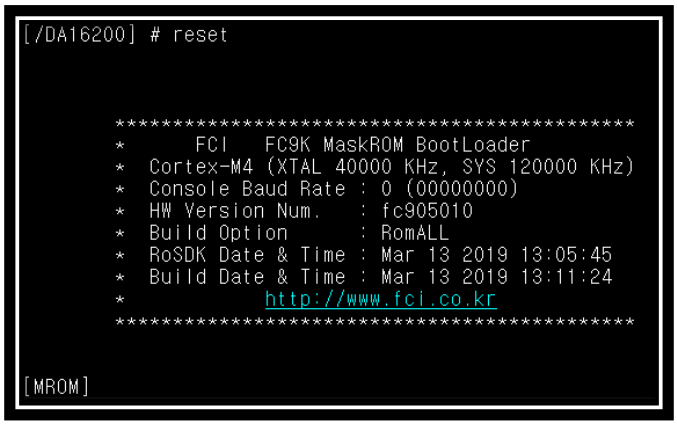


Figure 49: Mask ROM

3. At the `[MROM]` prompt, type `loady boot`. See Figure 50.


```
[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 50: Bootloader Prompt on Command Window

4. Choose menu `File > Transfer > YMODEM > Send` to select the image file for the **Bootloader**. See Figure 51.
   - For example: `DA16200_BOOT_GEN01-01-XXXX-000000_IS25WP016D.img`
   - The result is printed at the end of the transfer
     Please ignore any messages like "`err:..`"

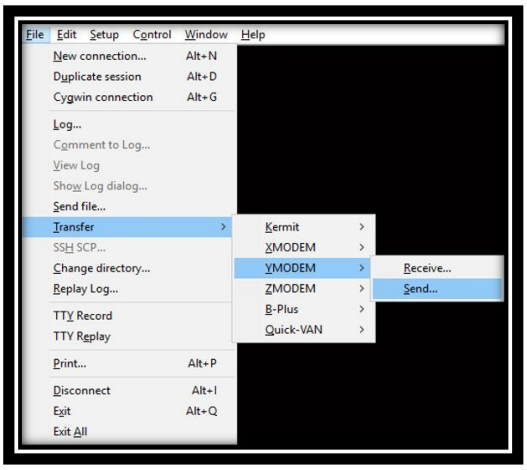


Figure 51: Load Image File

10.3 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 52.

NOTE
DA16200 has different address based on Flash size, 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 customer uses 4MB 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 52 System Library Prompt on Command Window

2. Choose menu `File > Transfer > YMODEM > Send` to select the <System Library image> file. See Figure 53.
   - For example: `DA16200_SLIB_GEN01-XX-YYYY-ZZZZZZ.img`

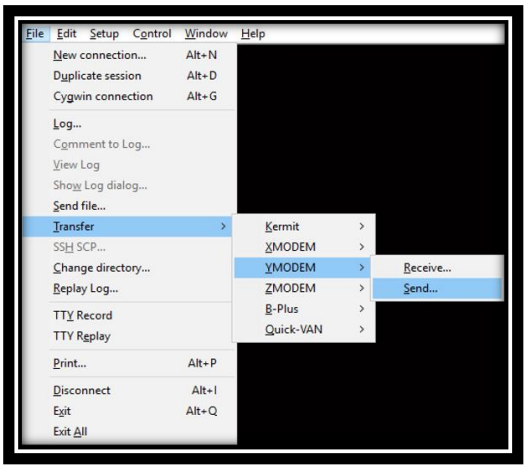


Figure 53: Load Image File

10.4 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 54.

NOTE
DA16200 has different address based on Flash size, 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 customer uses 4MB 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 54 Main Image Prompt on Command Window

2. Choose menu `File` > `Transfer` > `YMODEM` > `Send` to select the <Main image> file. See Figure 55.
   - For example: `DA16200_RTOS_GEN01-XX-YYYY-ZZZZZZ.img`

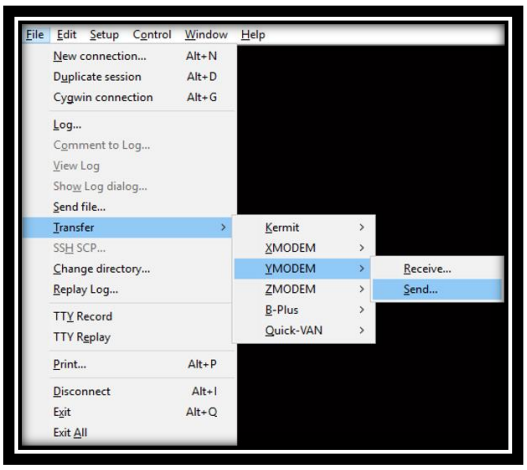


Figure 55: Load Image file

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 56.


```
[/DA16200] # factory
FACTORY RESET [N/y/?] y


Start Factory-Reset ...

Rebooting....


RaLIB is relocated to RETMEM (20f815c0, 567, 18758114, 18758114)
P.TIM is relocated to RETMEM (20f835c0, 2)
dpm_init_retmemory::326 DPM INIT CONFIGURATION(1)

Wakeup source is 0x0


        ************************************************
        *             DA16200 SDK Information
        * ----------------------------------------------
        *
        * - CPU Type         : Cortex-M4 (80MHz)
        * - OS Type          : ThreadX 5.7
        * - Serial Flash     : 16 Mbits (2 MBytes)
        * - SDK Type         : Manufacture v1.0.0
        * - F/W Version      : RTOS-GEN01-01-7149-000000
        *                    : Combined-Image
        * - F/W Build Time   : Aug  8 2019 10:26:18
        * - Boot Index       : 0
        *
        ************************************************


System Mode : Station Only (0)
>>> FC9K supplicant Ver1.00-20170213-01
>>> MAC address (sta0) : ec:9f:0d:9f:ff:fe
>>> sta0 interface add OK
>>> Start STA mode...

>>> UART1 : Clock=80000000, BaudRate=115200
>>> UART1 : DMA Enabled ...

[/DA16200] #
```

Figure 56 Factory Mode Prompt on Command Window

NOTE
Now everything is done.

10.5 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 normal, then use command `[/DA16200] # brd f80000 100` to check if the SFPD information is copied to the Retention Memory. See Figure 57.

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

- `[/DA16200] # brd f80000 100`

```
[/DA16200] # brd f80000 100
[00F80000] : 00 00 00 02 FF FF FF FF FF FF FF FF 00 00 00 40        ................@
[00F80010] : A1 00 91 FC C0 15 F8 20 00 30 08 00 C0 1D 00 00        ....... .0......
[00F80020] : 0B 00 00 00 C0 D4 01 80 00 00 00 00 54 C1 A8 5E        ............T..^
[00F80030] : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01 64        ................d
[00F80040] : 53 46 44 50 15 16 60 EF 00 00 40 00 F5 20 F1 FF        SFDP..`...@.. ..
[00F80050] : FF FF FF 01 44 EB 08 6B 08 3B 04 BB EE FF FF FF        ....D..k.;......
[00F80060] : FF FF 00 FF FF FF 44 EB 0C 20 0F 52 10 D8 00 FF        ......D.. .R....
[00F80070] : 11 34 1E F3 83 3A 00 CC CC 43 1C 62 7A 75 7A 75        .4...:...C.bzuzu
[00F80080] : 07 CD D5 5C 42 00 EF 40 FF 7F 00 01 07 02 36 39        ...\B..@......69
[00F80090] : 3C FF E1 E0 FF 00 00 00 32 68 68 68 32 64 00 04        <.......2hhh2d..
[00F800A0] : 00 04 00 00 00 00 00 00 90 9F AB 5A 05 01 04 06        ...........Z....
[00F800B0] : 50 66 99 00 00 B9 AB 38 FF B7 E9 00 00 02 32 00        Pf.....8......2.
[00F800C0] : 02 32 00 20 00 0B 60 35 00 00 00 00 00 00 00 00        .2. ..`5........
[00F800D0] : 00 00 00 00 28 50 78 A0 40 40 40 80 00 00 00 00        ....(Px.@@@.....
[00F800E0] : 00 00 00 00 FF FF FF FF FF FF FF FF FF FF FF FF        ................
[00F800F0] : 5B 8A D5 7C 00 00 00 00 00 00 00 00 00 00 00 00        [..|............
```

Figure 57 SFDP

10.6 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 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`

   In the `build\SBOOT\SFDP` folder, find Flash SFDP file which is corresponding to Flash ID as `W25Q32JW.bin`.
5. Run command `[MROM] sflash erase 0 200000` to erase the entire flash for recovery.
   - Know that this command can take a long time to complete. Please wait until the `[MROM]` prompt appears again.
6. Re-load all images in the specified order for serial flash recovery.
   - `[MROM] loady boot`

- [MROM] loady f1000
- [MROM] loady a000

7. Run command `boot` to boot DA16200. The image version is printed.
8. Initialize `NVRAM` for Serial Flash Recovery with 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] #
```

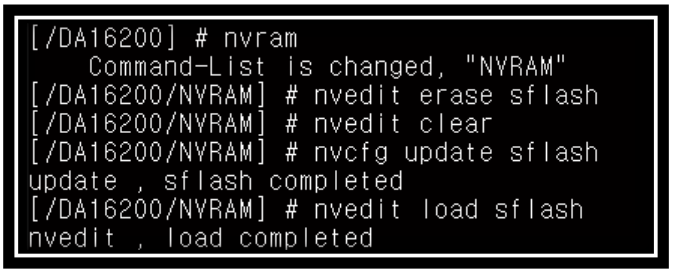


Figure 58 Initialize NVRAM

10.7 Serial Flash Recovery from Boot

If there are any memory conflicts during updating the image or errors while building the SDK, there may be a case that it cannot run DA16200. In this case, you cannot do anything in the command window. DA16200 must be forced to enter boot mode. Follow the procedure below.

1. Use RTC_PWR_KEY to power off (move to OFF position).
   - 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 59
   - F_CLK is connected to Pin 21 of the module connector

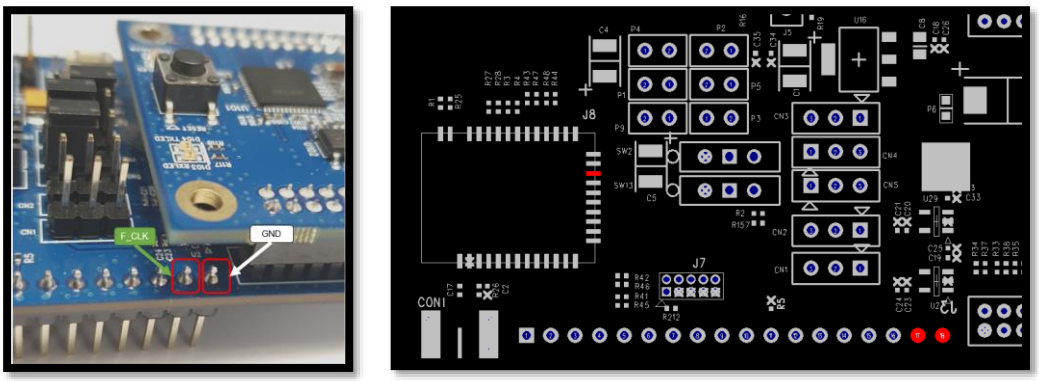
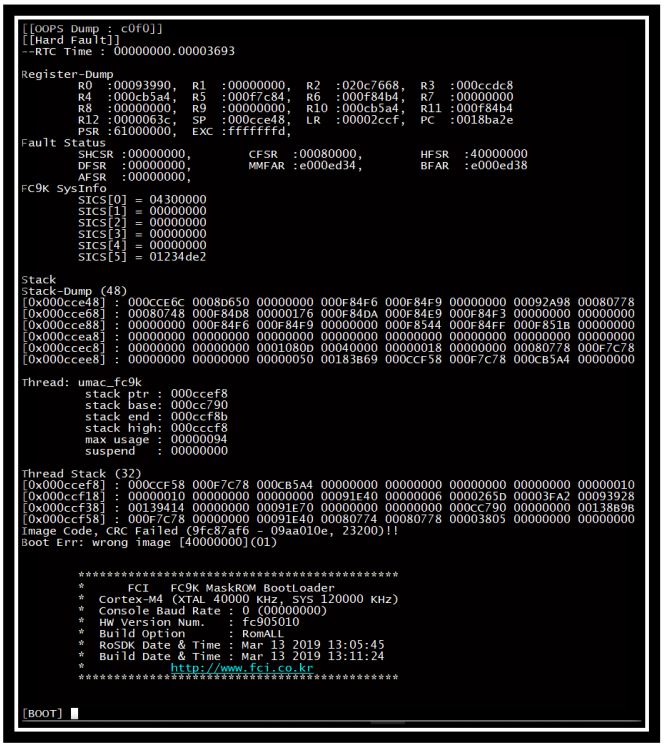


Figure 59 Recovery Point in the EVK

2. Use **RTC_PWR_KEY** to power on (move to ON position).
   - Boot DA16200.Turn the power on when the two pins are connected
   - Disconnect the two pins. Pin 17 (F_CLK) and pin 18 (GND)
3. See the DA16200 go into the **BOOT** mode. See Figure 60.
4. At the `[BOOT] #` prompt, run command `reset`.
5. Do the steps in section 10.6 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] : 000ccr6c 0008b650 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 0001080b 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 00138B9B
[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 60 Run with BOOT mode

10.8 Boot index change

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

Console Command to change 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 (80MHz)
        * - 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
        *
        ***************************************************
```

10.9 MAC Address checking

By default, a MAC address is programmed in the OTP. However, if for some reason no MAC address is and 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.

11 Country Codes

Table 9: 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
AF	Afghanistan	EG	Egypt	LK	Sri Lanka	RS	Serbia
AI	Anguilla	ES	Spain	LS	Lesotho	RU	Russia
AL	Albania	ET	Ethiopia	LT	Lithuania	RW	Rwanda
AM	Armenia	EU	Europe	LU	Luxembourg	SA	Saudi
AR	Argentina	FI	Finland	LV	Latvia	SE	Sweden
AS	Samoa	FM	Micronesia	MA	Morocco	SG	Singapore
AT	Austria	FR	France	MC	Monaco	SI	Slovenia
AU	Australia	GA	Gabon	MD	Moldova	SK	Slovakia
AW	Aruba	GB	United Kingdom	ME	Montenegro	SN	Senegal
AZ	Azerbaijan	GD	Grenada	MF	Saint Martin	SR	Suriname
BA	Bosnia	GE	Georgia	MH	Marshall Islands	SV	El Salvador
BB	Barbados	GF	French Guiana	MK	Macedonia	SY	Syria
BD	Bangladesh	GH	Ghana	MN	Mongolia	TC	Turks Caicos
BE	Belgium	GL	Greenland	MO	Macao	TD	Chad
BF	Burkina Faso	GP	Guadeloupe	MP	Northern Mariana Islands	TG	Togo
BG	Bulgaria	GR	Greece	MQ	Martinique	TH	Thailand
BH	Bahrain	GT	Guatemala	MR	Mauritania	TN	Tunisia
BL	Barthelemy	GU	Guam	MT	Malta	TR	Turkey
BM	Bermuda	GY	Guyana	MU	Mauritius	TT	Trinidad and Tobago
BN	Brunei	HK	Hong Kong	MV	Maldives	TW	Taiwan
BO	Bolivia	HN	Honduras	MW	Malawi	TZ	Tanzania
BR	Brazil	HR	Croatia	MX	Mexico	UA	Ukraine
BS	Bahamas	HT	Haiti	MY	Malaysia	UG	Uganda
BT	Bhutan	HU	Hungary	NG	Nigeria	UK	United Kingdom
BY	Belarus	ID	Indonesia	NI	Nicaragua	US	USA
BZ	Belize	IE	Ireland	NL	Netherlands	UY	Uruguay
CA	Canada	IL	Israel	NO	Norway	UZ	Uzbekistan

Code	Country	Code	Country	Code	Country	Code	Country
CF	Central Africa	IN	India	NP	Nepal	VA	Vatican City
CH	Switzerland	IR	Iran	NZ	New Zealand	VC	St. Vincent and Grenadines
CI	Ivory Coast	IS	Iceland	OM	Oman	VE	Venezuela
CL	Chile	IT	Italy	PA	Panama	VI	Virgin Islands, US
CN	China	JM	Jamaica	PE	Peru	VN	Vietnam
CO	Colombia	JO	Jordan	PF	Polynesia	VU	Vanuatu
CR	Costa Rica	JP	Japan	PG	Papua New Guinea	WF	Wallis and Futuna Islands
CU	Cuba	KE	Kenya	PH	Philippines	WS	Samoa
CX	Christmas Island	KH	Cambodia	PK	Pakistan	YE	Yemen
CY	Cyprus	KN	St. Kitts and Nevis	PL	Poland	YT	Mayotte
CZ	Czech	KP	N.Korea	PM	St. Pierre and Miquelon	ZA	S.Africa
DE	Germany	KR	S.Korea	PR	Puerto Rico	ZW	Zimbabwe
DK	Denmark	KW	Kuwait	PT	Portugal	ALL	ALL
DM	Dominica	KY	Cayman Islands	PW	Palau		
DO	Dominican Rep	KZ	Kazakhstan	PY	Paraguay		
DZ	Algeria	LB	Lebanon	QA	Qatar		

Revision History

Revision	Date	Description
1.0	7-Aug-2020	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.
APPROVED or unmarked	The content of this document has been approved for publication.

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