

User Manual DA16200 16600 Mass Production UM-WI-011

Abstract

This User Manual explains how to setup production test in production.



Contents

Ab	Abstract1							
Co	Contents 2							
Figures								
Tal	Tables							
1	Term	s and De	finitions					
2	Refer	ences						
3	Overv	view			5			
4	Cons	ole Com	mand and A	T Command	6			
5	Prog	ramming	Firmware Ir	nages	6			
6	•	•		с 				
7								
•	7.1							
	7.2	Test Cha	annel					
	7.3	Test Cor	nmand					
	7.4	TX Test.						
		7.4.1	11B Mode .					
		7.4.2						
		7.4.3						
	7.5							
8		•						
	8.1							
_	8.2							
9								
10	-			nt				
11		•						
12		•						
	12.1 12.2			ommandommand				
40								
13					-			
	15.1	13.1.1		tSnippets Toolbox Windows				
		13.1.2		n EVB				
			13.1.2.1	Erase Flash Content				
			13.1.2.2	DA14531 Reset				
			13.1.2.3	DIP Switch Settings				
		13.1.3	Run Smart	Snippets Toolbox				
	13.2	Production	on Line Tool					
Ар	pendi	x A RF Te	est with Con	sole				
	A.1	•						
	A.2 Commands for TX Test							
Us	er Mar	nual		Revision 2.0	User Manual Revision 2.0 Sep. 27, 2023			



A.3	Commands for RX Test	31
Append	ix B Configure DA16600 EVB 4v0 to Use AT Command via UART2	33
B.1	Turn OFF Switch	33
B.2	Connect UART2 to FT2232H	33
Revision	ו History	35

Figures

Figure 1: Flow of Production Test for DA16200/DA16600	5
Figure 2: Offset in Frequency Domain	
Figure 3: Procedure of XTAL Calibration	
Figure 4: Certification Mode in AT GUI Tool	11
Figure 5: OTP Mode in AT GUI Tool	14
Figure 6: Network Mode in AT GUI Tool	16
Figure 7: Installation Wizard of Smartsnippets_Toolbox v5.0.10.2417	
Figure 8: DA16600 EVB Setup for Bluetooth® LE Test	21
Figure 9: DA14531 Reset	
Figure 10: SW5 and SW6 Setup	
Figure 11: SW10 Setup	
Figure 12: Initial Window of Smartsnippets_Toolbox	
Figure 13: Create New Project with DUT Name	
Figure 14: Find Connected COM Port with Refresh	
Figure 15: Open Project	
Figure 16: Verify Board Setup	
Figure 17: Select RF Master	24
Figure 18: RF Master Window with Log	
Figure 19: Select Binary File	
Figure 20: RF Master Log while Downloading Firmware and Reset	
Figure 21: Continuous Setting	
Figure 22: Continuous TX Command	
Figure 23: Select Mode for Rx	
Figure 24: Continuous Reception Using LE Rx Command	
Figure 25: Production Line Tool	
Figure 26: Setup for TX Test	29
Figure 27: Reference Table for TX Test	
Figure 28: Setup for RX Test	
Figure 29: RX PER (Good)	
Figure 30: RX PER (Not Good)	
Figure 31: SW3 and SW7 UART1 Connection	33
Figure 32: Connect UART2 to FT2232H	34
Figure 33: Setting for AT Command over UART2 on EVB 4v0	34

Tables

Table 1: AT Command to Check Version	6
Table 2: XTAL Offset OTP Address	
Table 3: RF Test Parameters	. 11
Table 4: RF AT Command	. 12
Table 5: 11B_1Mbps	. 12
Table 6: 11G_54Mbps	. 12
Table 7: 11N_MCS7	. 12
Table 8: AT Command for Writing/Reading MAC Address	. 14
Table 9: AT Command for Factory Reset	

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1 Terms and Definitions

EVB	Evaluation Board
GUI	Graphical User Interface
OTP	One Time Password
PLT	Production Line Tool
RF	Radio Frequency
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver/Transmitter

2 References

- [1] DA16200, Datasheet, Renesas Electronics
- [2] UM-WI-056, DA16200 DA16600 FreeRTOS Getting Started Guide, User Manual, Renesas Electronics
- [3] UM-WI-004, DA16200 AT GUI Tool User Manual, User Manual, Renesas Electronics
- [4] UM-WI-012, DA16200 SPI SFlash Downloader, User Manual, Renesas Electronics
- [5] UM-WI-039, DA16200 DA16600 Multi Downloader, User Manual, Renesas Electronics
- [6] UM-WI-046, DA16200 DA16600 FreeRTOS SDK Programmer Guide, User Manual, Renesas Electronics
- [7] UM-WI-003, DA16200 DA16600 Host Interface and AT Command, User Manual, Renesas Electronics
- [8] UM-B-041, SmartBond Production Line Tool, User Manual, Renesas Electronics





3 Overview

This document explains how to setup production tests for DA16200 and DA16600 in production, as well as the options and limitations that should be considered. Each procedure or the order introduced in this document can be omitted or changed according to production environment. Figure 1 shows recommended flow of the production test.

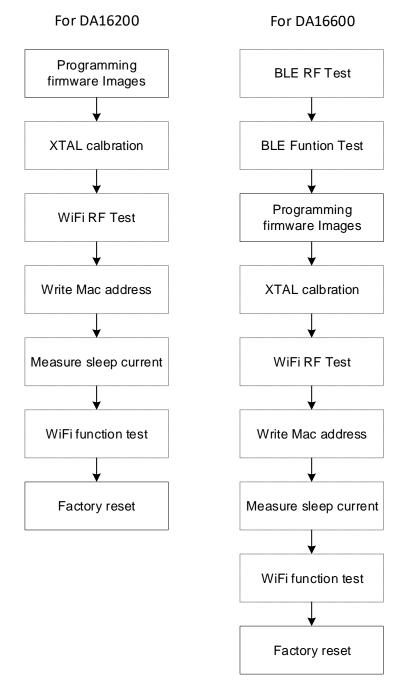


Figure 1: Flow of Production Test for DA16200/DA16600

NOTE

The flash should be empty when performing Bluetooth® LE test as Bluetooth® LE for DA16600 should be tested without firmware image.

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Revision 2.0

Sep. 27, 2023

4 Console Command and AT Command

Console commands on UART0 support programming firmware images, RF test, and writing value to OTP. AT commands are available for RF test, Wi-Fi function test and writing value to OTP over UART1 or 2. For DA16600, only UART2 is available, and UART1 is used for the GTL interface internally. The AT commands can be communicated using console terminal tools or AT GUI tool.

5 **Programming Firmware Images**

The first step is to program firmware images to serial flash memory over UART0 or SPI. For the address of each firmware images on the flash and how to program firmware images, see program firmware image section of the FreeRTOS Getting Started Guide, Ref. [2]. The programming firmware image can be done via SPI using GUI tool in Windows. For details, see the user manual Ref. [4].

After programming firmware images, NVRAM initialization can be done using the below console command.

[/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 complted

And the version of the programmed firmware image can be confirmed using the below console or AT command.

[/DA16200] # ver	

* * - CPU Type * - OS Type * - Serial Flash * - SDK Version * - F/W Version * - F/W Build Time * - Boot Index *	: Cortex-M4 (120 MHz) : FreeRTOS 10.4.3 : 4 MB : V3.2.8.0 GEN-ATCMD : FRTOS-GEN01-01-f017bfdf51-006558 : Aug 10 2023 13:44:35 : 0
iii iii iii iii iii iii iii iii iii ii	*********

Firmware for DA16200 FreeRTOS

NOTE

You can check the version information by using AT command as shown below.

Table 1: AT Command to Check Version

Command	Parameters	Description
AT+VER	(none)	Get version information.
		Response: +VER: <threadx rtos="" version="">,< ThreadX SLIB version></threadx>
		Response: +VER: <freertos rtos="" version=""></freertos>

ate	In order to see the AT comman	nd
Echo on		
OK		
AT+VER		
User Manual	Revision 2.0	Sep. 27, 2023



+VER:FRIOS-GEN01-01-56c232799-004158	FreeRIOS	verison
OK		

An efficient way for production test using AT commands and programming firmware image for final product at the same time is to program both images to different regions in one step. DA16200 provides two regions of RTOS image. The running image can be changed using boot index which is stored in flash memory and can be changed by console command or AT command. The default value of the boot index is 0 for the first region. The following steps are how to program both images and proceed production test.

- 1. Program BOOT firmware image (bootloader).
- 2. Program RTOS firmware image for AT command to first region and firmware image for final product to the second region.
- 3. Initialize the NVRAM.
- 4. Production test.
- 5. After the step 4 is complete, change boot index to 1 for RTOS firmware image for final product.

How to create firmware images for AT command is described in Ref [7].

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6 XTAL Calibration

The calibration TX power and temperature frequency for DA16200 are done during the ATE test. This section covers XTAL frequency calibration using AT GUI tool. The purpose of XTAL calibration is to match the desired tone for proper RF transmission and reception as shown below and Figure 2.

Register range is 0x00 ~ 0x7F, and there is about 2 kHz deviation per register code.

- Example: if Measured Tone is #1,
 Offset = Measured Desired (2411994000-2412000000) = -6000, Offset value is < 0 It needs to decrease Register value lower to move towards Desired Tone.
- Example: if Measured Tone is #2,
 Offset = Measured Desired (2412006000-2412000000) = +6000, Offset value is > 0 It needs to increase Register value higher to move towards Desired Tone.

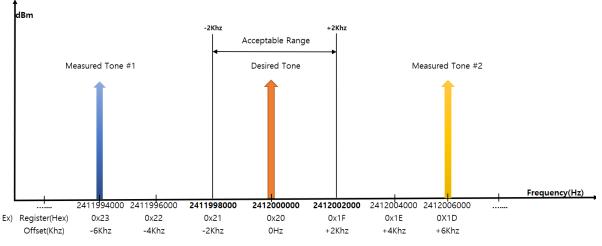


Figure 2: Offset in Frequency Domain

The procedure for XTAL calibration is:

- 1. Program firmware image for the AT command.
- 2. Run the TX test mode and Write default XTAL register with the below AT commands.
 - a. AT+TMRFNOINIT=1 // Configure RF Test mode
 - b. AT+RESTART // Restart DA16200 to enter RF Test mode
 - c. AT+RFTESTSTART // RF Test start
 - d. AT+RFCWTEST=2412,0,0 // CW Setting on Channel 1
 - e. AT+XTALWR=3F // 0x3F is Center Register from 0x00 to 0x7F
- 3. Measure and calculate frequency offset.
 - a. Offset = Measured Frequency (by Spectrum Analyzer) Desire Tone Frequency (2412000000 Hz)
 - i. Example:
 - if Measured Frequency is 2412040000 Hz
 - Offset = 2412040000 Hz 2412000000 Hz= +40000 Hz
 - ii. Example:
 - if Measured Frequency is 2411960000 Hz
 - Offset = 2411960000 Hz 2412000000 Hz = -40000 Hz

b. Depending on the SDK version, Desire Tone might be 2413000000 Hz

- 4. Calculate the starting XTAL register value.
 - a. To reduce the calibration time in MP, it might be required to control the starting value.
 - b. Starting XTAL register = Default XTAL register (0x3F) + offset/4000

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User	Manual

Sep. 27, 2023



(Frequency offset is expressed as a Decimal value, 40000/4000 = 10 (Dec) = 0x0A (Hex))

Example: if Offset is +40000 Hz > 0,
 Starting XTAL Register = 0x3F + 0x0A = 0x49

Write 0x49 value should be written to the register. See the example below.

AT+XTALWR=49

c. Starting XTAL register = Default XTAL register - offset/4000

- Example, if Offset is -40000 Hz < 0, Starting XTAL Register = 0x3F - 0x0A = 0x35 Write 0x35 value should be written to the register. See the example below. AT+XTALWR=35
- 5. If the offset is less than +2 kHz and greater than -2 kHz, the value is within the margin. If not, do the step 5 to change the XTAL register value. See the note below.

NOTE

Main Clock: 40 MHz, Recommend XTAL: +/- 20 ppm

To make 2.4 GHz band, PLL uses 40 MHz main clock * 60.

Additionally, **need to trim below 1 ppm to take temperature change into account** since XTAL has a deviation of +/- 20 ppm depending on temperature change.

Therefore, Variation : 40000000 * 1/1000000 = 40

From an RF perspective, the value increases to 40 * 60 = 2400, which is 2400 Hz. As a result, it becomes -2.4 kHz ~ Center frequency ~ +2.4 kHz (400 Hz as a margin).

6. Check the offset sign.

When calculated, the offset value will have a plus (+) or minus (-) sign value.

If offset is plus (offset > 0), increase XTAL register. It can be increased < Max 0x7F (Dec : 127).

- a. Example:
 - i. AT+XTALWR=50 (First time)
 - ii. AT+XTALWR=51 (Second time)
 - iii. AT+XTALWR=52 (Third time)

If offset is minus (offset < 0), decrease XTAL register. It can be decreased < Min 0x00 (Dec: 0).

- b. Example:
 - i. AT+XTALWR=35 (First time)
 - ii. AT+XTALWR=34 (Second time)
 - iii. AT+XTALWR=33 (Third time)
- 7. Write the final value of XTAL register with AT command to OTP memory.
 - AT+UOTPWRASC=0428,1, <XTAL Register value>
 - Example: AT+UOTPWRASC=0428,1,33

DA16200 has two slots to store the XTAL offset in the OTP memory, see Table 2. To use AT command to write value at OTP address, address x 4 should be taken because address is 4-byte aligned address. For more details, see the **OTP Commands** section in the user manual, Ref. [7].

Table 2: XTAL Offset OTP Address

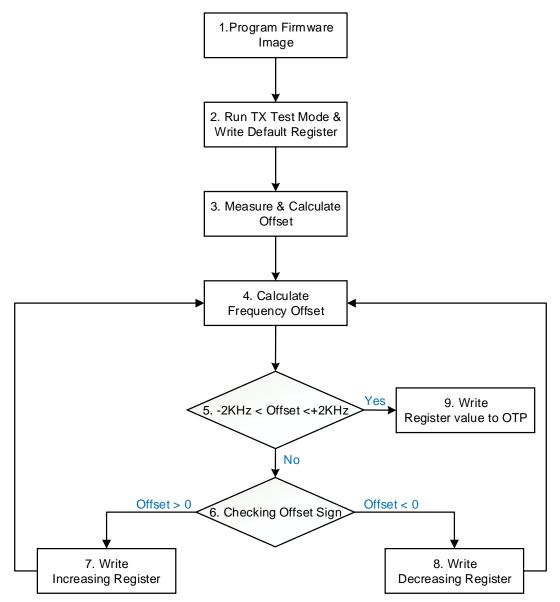
Slot	OTP Address	Address for AT Command	Size (Byte)
XTAL Offset #0	0x10A	428	2

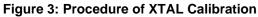
User Manual



Slot	OTP Address	Address for AT Command	Size (Byte)
XTAL Offset #1	0x10B	42c	2

Figure 3 shows the procedure of XTAL calibration.





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7 Wi-Fi RF Test

The TX/RX performance of DA16200 can be tested in the Certification Mode menu of the AT GUI tool. See Figure 4. For more information about AT commands, see the **RF Test Function Commands** section in the user manual Ref. [3].

🚥 DA16200 DA16600 AT GUI Tool v1.13	-	· □ ×
Settings Certification OTP Network Data Transfe	er MQTT Client TLS	
Mode Select O NET Mode Image: TEST Mode (Wi-Ri Test) (TX, RX Test)	RX Setting Channel : CH1 (2412MHz) Test Time : 0 (0 for infinite) Time : / s	Start RX
TX Setting O Packet O cont Image: CWI of the content of the conten	Vaid FCS Error PHY Error Overflow Error Total Packet	Packets Packets Packets Packets Packets
Preamble Packet Amount 11B_LONG 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.	Success Rate Wi-R Configuration Wi-R List Password :	% Search Connect Index : 0
Override CCA Stop TX	SSID : Security : MAC :	

Figure 4: Certification Mode in AT GUI Tool

7.1 Test Parameter

Basic RF test parameters are listed in Table 3.

7.2 Test Channel

DA16200 supports up to channel 13, but Renesas highly recommends checking the performance at CH1 (2412 MHz), CH7 (2442 MHz) and CH13 (2472 MHz). To confirm the best performance of the product, it is recommended to check the test parameter of the Receiver and Transmitter mentioned in Table 3.

Table 3: RF Test Parameters

Test Parameter	802.11 B	802.11 G	802.11 N (HT20)
	EVM	EVM	EVM
	Frequency Tolerance	Frequency Tolerance	Frequency Tolerance
	Output Power	Output Power	Output Power
Тх	Data rate	Data rate	Data rate
	Symbol Clock Tolerance	Symbol Clock Tolerance	Symbol Clock Tolerance
	Tx Carrier Leakage	Tx Carrier Leakage	Tx Carrier Leakage
	Spectrum Emission Mask	Spectrum Emission Mask	Spectrum Emission Mask
Rx	Sensitivity	Sensitivity	Sensitivity

7.3 Test Command

Before RX/TX test, it is required to run AT commands as shown below first to initialize RF. See Table 4.

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Sep. 27, 2023

Table 4: RF AT Command

Command	Parameters	Description
AT+TMRFNOINIT=1	<0,1>	Set boot mode. 0: normal boot 1: RF test mode boot
AT+RESTART	(none)	If set the boot mode as RF test mode (AT+TMRFNOINIT=1), restart the DA16200 (AT+RESTART)
AT+RFTESTSTART	(none)	Start RF test mode.

7.4 TX Test

7.4.1 11B Mode

Table 5: 11B_1Mbps

Command	Description
AT+RFTX=2412,0,0,200,b1,0	11B 1 Mbps/Channel 1
AT+RFTXSTOP	Stop Tx
AT+RFTX=2442,0,0,200,b1,0	11B 1 Mbps/Channel 7
AT+RFTXSTOP	Stop Tx
AT+RFTX=2472,0,0,200,b1,0	11B 1 Mbps/Channel 13
AT+RFTXSTOP	Stop Tx

7.4.2 11G Mode

Table 6: 11G_54Mbps

Command	Description
AT+RFTX=2412,0,0,1000,g54,0	11G 54 Mbps/Channel 1
AT+RFTXSTOP	Stop Tx
AT+RFTX=2442,0,0,1000,g54,0	11G 54 Mbps/Channel 7
AT+RFTXSTOP	Stop Tx
AT+RFTX=2472,0,0,1000,g54,0	11G 54 Mbps/Channel 13
AT+RFTXSTOP	Stop Tx

7.4.3 11N Mode

Table 7: 11N_MCS7

Command	Description
AT+RFTX=2412,0,0,1000,n65,0	11N MCS7/Channel 1
AT+RFTXSTOP	Stop Tx
AT+RFTX=2442,0,0,1000,n65,0	11N MCS7/Channel 7
AT+RFTXSTOP	Stop Tx
AT+RFTX=2472,0,0,1000,n65,0	11N MCS7/Channel 13
AT+RFTXSTOP	Stop Tx

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Revision 2.0

Sep. 27, 2023

7.5 RX Test

For accurate RX measurement, measure lossless (Shield room or Anechoic chamber) conditions without external signal influence.

- Channel: Support CH1 ~ CH13
- Test Time: Maximum 3600s (Duration is 1 second fixed)
- RX Packet Rate: FCS + PHY + Overflow packet / Total packet = Error rate The error rate should not exceed 10 %.



8 Writing MAC Address

The MAC addresses written in the OTP memory is used for the WLAN0 interface (Station) MAC address and the next number is automatically designated as the WLAN1 (Soft AP) MAC address. For example, if AA:BB:11:22:33:44 is written in the OTP memory, then WLAN0 has AA:BB:11:22:33:44 and WLAN1 has AA:BB:11:22:33:45.

As each DA16200 chip consumes two MAC addresses, when writing a mac address to a DA16200 chip, the last byte of the mac address should be bigger **by 2** than the previous DA16200 chip in the production line.

For example, AA:BB:11:22:33:44, AA:BB:11:22:33:46, AA:BB:11:22:33:48. The last digit of the WLAN0 MAC address should be an even number.

The Mac address is already pre-programmed at the DA16200 chipset production stage. There are two ways to write the MAC address if required, AT GUI and Console.

8.1 AT GUI Tool

In AT GUI tool, write MAC addresses in OTP Mode. DA16200 provides 4 slots to store MAC addresses in the OTP memory. When a new MAC address is written, the previous slot should be invalidated. See Ref. [3].

Chip Setting Certification Mode	OTP Mode Network Mode	
OTP Enbale		Test
Power cal (0.2 Step)	Temp cal	Freq Offset cal
1st	1st	1st
2nd Test	2nd	2nd Test
Write	Write	Write
MAC Address setup		
1st	3rd	
2nd	4th	Write
EX) AA:BB:CC:DD:EE:FF		

Figure 5: OTP Mode in AT GUI Tool

Command	Parameters	Description
		Write MAC address in the OTP memory. An old MAC address in the OTP will be invalidated if one exists. There are four mac address slots available in OTP. Thus, only a maximum of four MAC addresses are written in total at production.
AT+WFOTP	<mac></mac>	Response: OK or ERROR
		The last hex of <mac> should be an even number.</mac>
		The MAC address written in the OTP is used as WLAN0 MAC address and then WLAN's MAC+1 will be used as WLAN1 MAC address.

User Manual	Revision 2.0	Sep. 27, 2023



Command	Parameters	Description	
		Get the current MAC address of the activated WLAN interface.	
AT+WFMAC	(none)	DA16200 provides three types of MAC addresses (OTP MAC address, user MAC address and spoofing MAC address). The priority is OTP < User < Spoofing.	
		Response: +WFMAC: <mac></mac>	

8.2 Console Command

Use command setotpmac as shown in the example code, to write the new MAC address to an empty slot. This command invalidates the previous slot and validates the new slot.

[/DA16200] # setotpmac AA:BB:11:22:33:44

Use command getwlanmac to check what the new MAC address is.

User	Manual



9 Wi-Fi Function Test

To test the basic Wi-Fi function (station and Soft AP), use the Network Mode menu in the AT GUI tool. For more information, see DA16200 AT GUI Tool User Manual, Ref. [3]. For related commands, see the **Network Function Commands** section in the user manual, Ref. [7].

	- 🗆 X
Settings Certification OTP Network Data Transfer	MQTT Client TLS
Mode : Station Mode ~	Factory Reset Reboot
Scan AP Mode	-Wi-Fi Connect SSID :
	Security :
	Password : Index : 0
	Connect
	IP Address IP Addr :
	Netmask :
Scan	Gateway :
_ SNTP	DNS #1 :
Server :	DNS #2 :
R Enable Disable Confirm	DHCP : O Enable O Disable Confirm
PING Test	
Ping! Count : 4	Recv / Send : /
Destination IP: 172601	Min/Max/Avr : / / ms

Figure 6: Network Mode in AT GUI Tool

10 Sleep Current Measurement

To detect any current leakage in the DA16200, measure the sleep current consumption. The following example code makes DA16200 go to sleep mode.

```
[/DA16200] # sys.hal
[/DA16200/SYS] # sleep [mode] [time]
Mode: sleep mode
2: Sleep mode 2.
3: Sleep mode 3.
Time: DA16200 wakes up after this time passes (second)
```

See the Current Measurement section in Ref. [2] about measuring current consumption.

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11 Factory Reset

DA16200 should be initialized to the factory settings as multiple profiles may be written in the NVRAM during the production process. To erase all user NVRAM items, use the command code example below or AT commands in Table 9.

11.1 Console Command

[/DA16200] # factory FACTORY RESET [N/y/?]y Start Factory-Reset ...

Rebooting

11.2 AT Command

Table 9: AT Command for Factory Reset

Command	Parameters	Description
ATF	(none)	DA16200 factory reset.

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12 Change Boot Index

The boot index can be changed by using console command boot_idx. Also, the SDK version and boot index can be confirmed during boot as shown below.

12.1 DA16200 Console Command

[/DA16200] # boot_idx 1 [/DA16200] # reboot	*****	Moving the boot index from 0 to 1
* DA162	00 SDK Information	
*		
*		
* – CPU Type	: Cortex-M4 (120 MHz)	
* – OS Type	: FreeRTOS 10.4.3	
* - Serial Flash	: 4 MB	
* - SDK Version	: V3.2.8.0 GEN	
* - F/W Version	: FRTOS-GEN01-01-f017bfdf51-006558	
* - F/W Build Time	: Aug 10 2023 13:44:35	
* – Boot Index	: 1	Need to check the boot index
*		
************	******	

12.2 DA16600 Console Command

For DA16600, BLE firmware image is programmed from DA16200 to DA14531 during boot. Check whether the programming was successful through the logs below from DA16200.

```
****
                  DA16600 SDK Information
            _____
       * – CPU Type
                      : Cortex-M4 (120 MHz)
       * - OS Type
                      : FreeRTOS 10.4.3
       * - Serial Flash : 4 MB
       * - SDK Version : V3.2.8.0 GEN-ATCMD
       * - F/W Version : FRTOS-GEN01-01-f017bfdf51-006558
       * - F/W Build Time : Aug 10 2023 14:09:33
       * - Boot Index : 1
                                                Need to check the boot index
       *
       gpio wakeup enable 00000402
 [combo][iot sensor]
   is provisioned = 0
   is_sensor_started = 0
 [combo] dpm boot type = 0
 >>> UART1 : Clock=80000000, BaudRate=115200
 >>> UART1 : DMA Enabled ...
 [combo] BLE BOOT MODE 0
 [combo] BLE FW VER to transfer ....
User Manual
                                     Revision 2.0
                                                                            Sep. 27, 2023
```



>>> v_6.0.14.1114.3 (id=1) at bank_1	
RTC switched to XTAL	
combo] BLE FW transfer done	Make sure to check this message "BLE FW Transfer done"
System Mode : Station Only (0)	
>>> Start DA16X Supplicant	
>>> DA16x Supp Ver2.7 - 2022_03	
>>> MAC address (sta0) : d4:3d:39:11:5e:c6	
>>> sta0 interface add OK	
>>> Start STA mode	
by default, rf_meas_btcoex(1, 0, 0)	
>>> UART2 : Clock=80000000, BaudRate=115200	
>>> UART2 : DMA Enabled	
< GAPM_DEVICE_READY_IND	
IoT dev_name="DA16600-5EC6", len=12	
[combo] Advertising	Make sure to check this message "Advertising"

User Manual



13 Bluetooth® LE Test

This section describes how to perform production test for Bluetooth[®] LE device on EVB for helping users to understand the test procedure in the final product.

13.1 SmartSnippets Tool

SmartSnippets[™] Toolbox is provided with the Development Kit of Renesas's Bluetooth[®] LE chipset. The toolbox is a tool that helps Bluetooth[®] LE smart application developers test without expensive and bulky equipment. We recommend using this tool for Bluetooth[®] LE RF test.

To get the tool and user manuals, download it from Renesas website (https://www.renesas.com/us/en/products/wireless-connectivity/wi-fi/low-power-wi-fi).

- UM-B-083 SmartSnippets[™] Toolbox
- For DA14531, the latest version is SmartSnippets Toolbox V5.0.16 for Windows OS

13.1.1 Install SmartSnippets Toolbox Windows

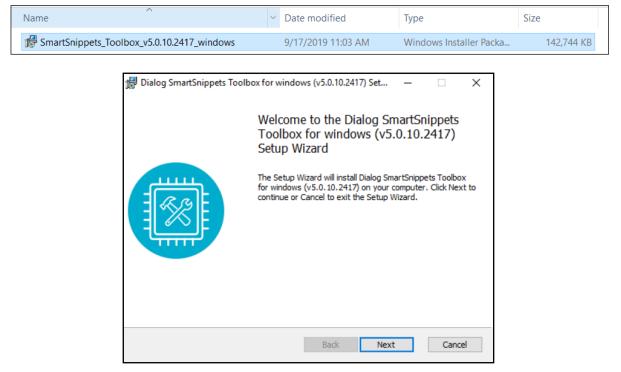


Figure 7: Installation Wizard of Smartsnippets_Toolbox v5.0.10.2417

13.1.2 Setup HW on EVB

We provide a SmartSnippets tool to check the RF performance of Bluetooth[®] LE DA14531 and it is required to check the board before the test. The board should be configured to connect UART in DA16600 EVB and change the RF path of DA14531. Figure 8 shows how to configure the DA16600 EVB.

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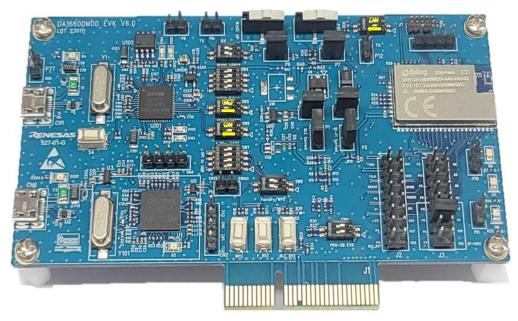


Figure 8: DA16600 EVB Setup for Bluetooth[®] LE Test

13.1.2.1 Erase Flash Content

Before Bluetooth[®] LE test, if the flash is not empty, run the following command to erase the flash content of the DA16600 module and go to [MROM] prompt by typing reset on the prompt:

• [MROM] sflash erase 0 400000

The flash should be empty and DA16200 does not download Bluetooth[®] LE image binary to DA14531 or it does not boot as no images in the flash.

13.1.2.2 DA14531 Reset

In DA16600, P0_0 for DA14531 reset is the Test Point. To use the SmartSnippets tool on the customer board, pin 43 (GPIOA1) of DA16600 must be pinned out.

Figure 9 shows a circuit configured for DA14531 reset in DA16600 EVB. Switch (S3) on the DA16600 board or the #10 in Figure 8 is the reset button during the test. When the reset is required, make sure to release the Switch (S3) quickly after pressing the button.

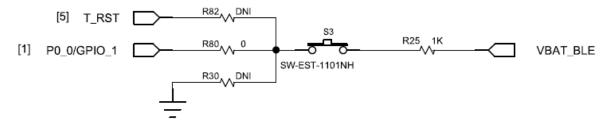


Figure 9: DA14531 Reset

13.1.2.3 DIP Switch Settings

For 1-wire (P0_5) UART to test RF performance of DA14531, turn on pin1 and 2 of SW6 to use UART and turn off pin 1 and 2 of SW5 as shown in Figure 10 and Figure 8.

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U	Sei	Manual	

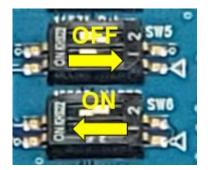


Figure 10: SW5 and SW6 Setup

SW10 can control RF switch. Turn on pin1 of SW10 to control RF switch to Bluetooth® LE RF path.



Figure 11: SW10 Setup

13.1.3 Run SmartSnippets Toolbox

The following is the procedure of the basic setup and test method using SmartSnippets.

SmartSnippets Toolbox v5.0.10.2434 - Settings ar	ad Virtual COM part / ITAG		×
Sinarcomppets rootbox vo.o. ro.2454 - Settings a			^
Please select settings:	Please select the COM Port or JTAG Serial #:	Please select the chip version: Bold entry marks the chip lastly detected on the selected JTAG	
		 ✓ DA14531 DA14580-01 DA14581-00 DA14583-01 DA14585-00 DA14586-00 DA14586-01 DA14680-01 DA14681-01 	
Open Edit Delete New	Refresh Detect Cannot see my board	2 Help	5
Support Pack Using all bundled support pack	ks. Chips from all families are listed.		

Figure 12: Initial Window of Smartsnippets_Toolbox

1. To create a new project with the DUT name, click **New** and specify the name. For example, for DA16600EVK, write DA16600.

Heer	Menuel
User	Manual





New Settings		×
Settings Name:	DA16600	
* Up to 30 characters long (no s	pecial chars), must be unique	
Settings Description:		1
	Save	

Figure 13: Create New Project with DUT Name

2. Click the **DA16600** name, choose the **DA14531-00** checkbox and select the **UART only** mode. Then, click **Refresh** to find the COM port of the DUT.

SmartSnippets Toolbox v5.0.10.2434 - Settings and	d Virtual COM port / JTAG		Х
Please select settings:	Please select the COM Port or TTAG Serial #:	Please select the chip version: Bold entry marks the chip lastly detected on the selected JTAG	
DA16600	COM30 COM31	 ✓ DA14531 ▲ DA14580-01 ⇒ DA14581-00 ⇒ DA14583-01 ⇒ DA14585-00 ⇒ DA14586-00 ⇒ DA14580-01 ⇒ DA14681-01 	
Open Edit Delete New Support Pack Using all bundled support pack	Refresh Detect <u>Cannot see my board</u>	2 Help)

Figure 14: Find Connected COM Port with Refresh

3. Select the higher COM port out of the two that were created when the board is connected (non-Console COM port) and then click **Open**.

SmartSnippets Toolbox v5.0.10.2434 - Settings an	d Virtual COM port / JTAG		×
Please select settings:	Please select the COM Port or JTAG Serial #: O UARTISPI UART only JTAG Hybrid	Please select the chip version: Bold entry marks the chip lastly detected on the selected JTAG	
DA16600	COM30	☑ DA14531	1
	COM31	DA14580-01	
		DA14581-00	
		DA14583-01	
		DA14585-00	
		DA14586-00	1
		DA14680-01	
		DA14681-01	
Open Edit Delete New	Refresh Detect Cannot see my board	2 Help	J
Support Pack Using all bundled support pack	s. Chips from all families are listed.		

Figure 15: Open Project Revision 2.0



CFR0012



4. Go to Layout > Booter & Board Setup and verify that the board setup is similar to Figure 16.

	reale Load Delete ayout Layout ~ Layout ~	Power Moniter SPI Flash/EEPROM / RF Master yout	DTP Terminal Scripting Booter & Board Setup	
connecting FTI This determine P0_0, P0 P0_3, P0	UART port (Tx-Rx pair) DI with the board. as the baud rate (Bd): _1, 115200 Bd _3, 115200 Bd _5, 115200 Bd	,		

Figure 16: Verify Board Setup

5. Go to Layout > RF master. As shown in Figure 18, click Browse to download.

	Layout	Tools				
Load latest	Load default	Create Layout	Load Layout V	Delete Layout ~	Power Monitor SPI Flash/EEPROM	OTP Terminal Scripting Booter & Board Setup
	Layout					

Figure 17: Select RF Master

	Layout) Toois	RF Master				
Load latest	Load default	Create Layout	Load Layout ~	Delete Layout ~	Power Monitor SPI Flash/EEPROM RF Master	OTP Terminal Scripting Booter & Board Setup	
🐟 RF	Master 🗙						8. D
	rmware Dow test Firmwa					Browse Download	*
🚸 L	E Tx/Rx						¥
🐠 U	nmodulated	Tx/Rx					*
🚸 c	ontinuous Tr						¥
X	FAL						¥
🐠 s	еер						×

Figure 18: RF Master Window with Log

6. Select the binary file prod_test_531_1wire_P05.bin as shown in Figure 19. The pre-built prod_test_531_1wire_P05.bin located in DA14531 SDK of DA16600 SDK: .\DA16200_DA16600_SDK_FreeRTOS_Manufacture_*\utility\combo\da14531_sdk_v_6.0.14.11114\binaries\da14531\prod_test\

lleor	Manual
USCI	manuar

Open				×
Lookin	C:\0.MyPC	\00.DA14531\6.0.12.1020.2_coex\6.0.12.1020.2_coex\bin ~	🧊 📂 🛄 •	
최근 문서 비당 회면	prod_test_	531.hex 531_1wire_P03.bin 531_1wire_P05.bin 531_2wire_P00P01.bin		
문서				
- 🗳	File <u>n</u> ame:	prod_test_531_1wire_P05.bin		Open
네트워크	Files of type:	Hex/ihex/bin files	~	Cancel

Figure 19: Select Binary File

 Click Download and then Reset HW as shown in Figure 20, when the green text appears, click Hardware Reset button - S3 in Figure 9 or #15 in Figure 8. If "reset detected" does not displayed in the log box, make sure to release the S3 button guickly after clicking it.

	StratSrippets Tooloox v2.0.10.2454 - D410500 @ COMIS [Device DA14331]	- = - ×
Image: Constant file Image: Constant file Image: Constant file Ima	0000	
International Solution	Layout Teels Af Haster	
Process Consists Constants	Lass Lass Crass Lass Deers Schwart Schwart Stratter	
Control Control <t< th=""><th></th><th></th></t<>		
Lister formane in conservation (add) train (explored, fail, 53), from (robot (add)) train (explored, fail) train		(DEG &f Marter #21-05-24 15:23:33) Started doulcating firmare
	* Filman Damage	C.Vo.EyST:00.Eki4531Vd.0.22.1201.2 com/6.0.12.1202.1 com/binaries/dai4531/grod_rest/prod_rest_531_buirt_555/akia to the board-
Image:	Latest himmane xomanesids (453 hprod_lestprod_lest_531_hure_P00 pm	Crich.MyGCrich.TA1433146.0.13.1030.2_comet6.0.13.1030.2_commissionaries(da145311prod_test/srod_test_533_ivire_P05.bis has been asisected for downlowing.
Image: State in the state i	(Auton	[INTO &F Marker 021-05-24 [SciPid] Connection to COMD pour has seconsofially speed. [INTO DF Marker 021-05-25 [SciPid] formation from the seconsofial.
Sections Present Present <th></th> <th>[ACTION AF Marter #23-08-26 (5:20:12) Fields press the harmonic reset motion on the board to start the download process.</th>		[ACTION AF Marter #23-08-26 (5:20:12) Fields press the harmonic reset motion on the board to start the download process.
Sections In the section of the secti		[INTO Booker E25-08-24 18-19-37] Savatasfally disconstoled from port CBM15.
Prediction Prediction <th>Select Mode: Transmitte:</th> <th>12870 Rf Martar \$23-08-24 15-22:37] Successfully downloaded fizmears file to the brand.</th>	Select Mode: Transmitte:	12870 Rf Martar \$23-08-24 15-22:37] Successfully downloaded fizmears file to the brand.
Predet Length 27 None 27 None 27 Tester 1	Frequence: 2.402.GHz (Ch.97)	
Predet Length 27 None 27 None 27 Tester 1		
Note: Contracts To		
But Pre International Laborational Laboratione Laborational Laborational Laborational Laboratione Labor	Packet Lengh: 27	
Vermedatus Taffar Vermedatus Ta	Node: Contexces Tr .	
Vermedatus Taffar Vermedatus Ta		
Image: Second		
Immediate fulls 1	Stat Ity	
Contrarson Tx C C C C C C C C C C C C C C C C C C		
© Cuttous Tx 0 © Cuttous Tx 0 © True 0 The Union 0 T		
* 77% * * 67mg # * 57mg # * 6 # * 70mg #	👹 Ormodulube Telfa 🛛 🖇	
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A Constraint of the constraint	as 174, x	
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Seeo lubre tona a transmissione tona a transmissione transmi		
bintes 0		
Seconda: 0 (a)	Windex 0	
	Seconds 0	
Court	Greate	

Figure 20: RF Master Log while Downloading Firmware and Reset

8. For continuous transmission, select **Continuous TX** (duty cycle close to 100 %). Set the correct frequency and click **Start**. The DUT will appear responding successfully to the command in the **Log** tab (response in green text). Click **Stop** to end the command.





RF Master	x
C 14. C	
RF Master	Tests pad
📣 LE TARK	
ST LE DARG	
📣 Unmodulai	tad Ty/Ry
w onnodula	
📣 Continuou	s Tx
	• 17
0	
Frequency:	2.402 GHz (Ch.37)
riequency.	
Payload:	Pseudo Rand 9
	Start Stop
44 MILLI	
XTAL	
A Oliver	
Sleep	

Figure 21: Continuous Setting

🔨 RF Master 💥 📃 🗄	tog X
V Firmware Download	[INFO RF Master \$19-09-29 22:06:13] Started continuous transmission with frequency 2.402 GHz (Ch.37) and payload Pseudo Rand 9. [2x RF Master \$19-09-29 22:06:13]
Lalest Firmware: Browse Download	
	frequency : 0x00
🔬 LE TVRx 🛛 👻	payload type : 0x00
140 mm 1414	Pagload : OF FE 02 00 00
Unmodulated TxRx ¥	[Rx RF Master 019-09-22:06:13]
Continuous Tx R	> (19-09-29 22:06:13.955) Rx < event : 0x0E
0	length : Dx03 parameters: Dx06 Ox0F OxFE
	parameters ukoo uko varu Paylaad : Uko Jok of FZ
Frequency: 2.402 GHz (Ch.37) T	region : up us up up the
Payload: Pseudo Rand 9	
Stop	

Figure 22: Continuous TX Command

 For continuous reception, go to LE TxRx and select Mode Receiver. Set the correct frequency and click Start. The DUT will appear responding successfully to the command in the Log tab (response in green text). Click Stop to end the command.

RF Master 🗙		з 🗆
RF Master Tes	ts ad	
Latest Firmware:		Browse
LE Tx/Rx		
Ø		
Select Mode:	Receiver	
Frequency:	2.402 GHz (Ch.37)	
With RF stats:	No	
	Start Stop	

Figure 23: Select Mode for Rx

User	Man	ual	





🔨 RF Master 🗙 📃 🛨 🗖	Log X
Firmware Download	[INFO RF Master 01-09-19 22:22:06] Started receiving packets with RF stats and frequency 2.402 GEz (Ch.37). [Tx RF Master 01-09-19 22:22:06) ===>> [19-09-22:22:06:02] Interpret of the state
ILE TURK * Salect Mode: Receiver Frequency: 2.402 GH2 (Ch.37)	Payload : 0C FE 01 00 (Rx RF Master 019-09-29 22:22:06) ::::::::::::::::::::::::::::::::::::
With RF stats: Yes P Bart Stop	

Figure 24: Continuous Reception Using LE Rx Command

13.2 Production Line Tool

By using the PLT, it is possible to test, calibrate, and load firmware for 16 different devices under test (DUTs) in parallel.

There is a Production tool that can perform a production test setup for the DA14531. This tool can be used to test all functions of Bluetooth[®] LE including XTAL Trim and to write the BD address into OTP.

For more information about using PLT, see Ref. [8].

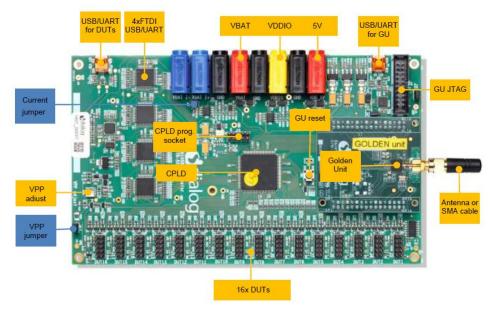


Figure 25: Production Line Tool

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User	wa	nuai



Appendix A RF Test with Console

The following describes how to check the Wi-Fi TX and RX RF performance using a UART debug port. There are two UARTs available on the DA16200 which can be used to check RF performance.

UART0 is used for debugging and checking Wi-Fi function by programming firmware images and using CLI commands.

A.1 Setup for RF Test

Console commands are normally undefined due to memory limitations and must be enabled to use console commands for performing RF tests through the debug port. See the SDK application note for enabling the console command interface for debugging.

To test using the DA16200 EVB, firmware image for AT command must be programmed. Prebuilt firmware images for AT command can be downloaded from the Renesas website (https://www.renesas.com/us/en/products/wireless-connectivity/wi-fi/low-power-wi-fi).

*****	*******	
* DA162	00 SDK Information	
*		
*		
* – CPU Type	: Cortex-M4 (120 MHz)	
* - OS Type	: FreeRTOS 10.4.3	
* - Serial Flash	: 4 MB	
* - SDK Version	: V3.2.8.0 GEN-ATCMD	Need to check the image version
* - F/W Version	: FRTOS-GEN01-01-f017bfdf51-006558	
* - F/W Build Time	: Aug 10 2023 13:44:35	
* – Boot Index	: 0	
*		
*******	*******	

For more detail on using CLI commands, see the getting started guide, Ref. [2]. List the available NVRAM commands by using the ? or Help command.

Enter test mode using the setenv NOINITWLAN 1 command and verify that the message "!!! TEST MODE !!!" is displayed.

NOTE

setenv NOINITWLAN 0 can be used to change to normal mode.

[/DA16200] # nvram Command-List is changed	, "NVRAM"	Enter the NVRAM	
[/DA16200/NVRAM] # setenv N [/DA16200/NVRAM] # reboot	OINITWLAN 1	setenv NOINITWLAN 1 : Test mode Needed reboot command	
Wakeup source is 0x0 [dpm_init_retmemory] DPM IN	IT CONFIGURATION(1)		
	*****	+++	
* DA162	00 SDK Information		
*			
	: Cortex-M4 (120 MHz)		
* - OS Type * - Serial Flash			
	: V3.2.8.0 GEN-ATCMD		
,	: FRTOS-GEN01-01-f017bfdf51-006	558	
* - Boot. Index	: Aug 10 2023 13:44:35 : 0		
*			
*************	**********************************	***	
Fail to initialize WLAN. (s	tep 1)		
Isor Manual	Povision 2	n	Son 27 2023



!!! TEST MODE !!!	
>>> UART1 : Clock=80000000, BaudRate=1	15200
>>> UART1 : DMA Enabled	

setenv NOINITWLAN 1 : Test mode

Before performing an RX test or TX test, the device must be initialized using the following commands:

[/DA16200] # lmac.tx.init MAC init. OK [/DA16200/IMAC.IMAC TX] # start START [/DA16200/IMAC.IMAC TX] # Initializing to enable LMAC command

start command

NOTE

Once all tests are complete, the DA16200 must be returned to Wi-Fi operational mode by using the "Factory" command.

A.2 Commands for TX Test

A typical TX test environment is shown in Figure 26. TX power of the EVB can be measured using a signal analyzer. Accurate measurements are only possible using Conducted RF testing. Measuring RF with an antenna may show a significant difference in performance depending on the surrounding environment and the distance from the device, therefore it is recommended to perform the measurements using an RF cable connected to the U.FL connector on the module.

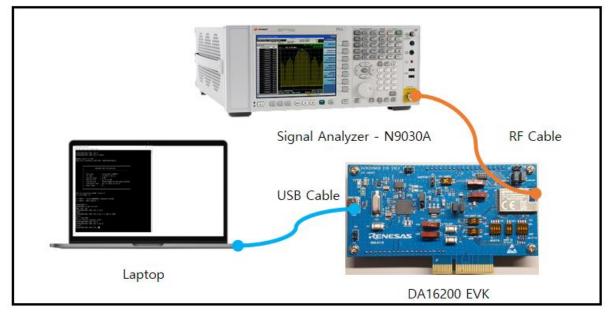


Figure 26: Setup for TX Test

[/DA16200] # lmac.tx.init	
IMAC init. OK	
[/DA16200/IMAC.IMAC TX] # start	
START	
[/DA16200/IMAC.LMAC TX] #	
[/DA16200/IMAC.IMAC TX] # txp 1 1 1007 0 1194	TX ON command
TX on.	
desc = 0xc5d80	
Set RF Channel Frequency 2412	
[/DA16200/IMAC.LMAC TX] # txp 0	TX OFF command
TX off.	
[/DA16200/IMAC.LMAC TX] #	

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The following sequence is for TX signal generation:

- 1. Type lmac and tx to enter LMAC > TX command mode.
- 2. Type init and start.
- 3. Type txp 1 [channel] [modulation type] [power level] [data length] to generate the TX signal.
 - Example 1) txp 1 1 400 0 32
 - CH 1, 11B 1Mbps, Power level=0 (max power)
 - Example 2) txp 1 11 1007 4 1194
 - CH 11, 11N MCS7, Power grade=4

Depending on the Tx power, it has a gain about 0.8dB

At the end of the test, type txp = 0 which sets the TX signal to the off state. Otherwise, txp = 1 sets the TX signal to the on state. It is required to turn off the signal generation using txp = 0 before performing another test.

Here is an example of TX command for each Wi-Fi standards:

		Setting	Duty cycle : 95%		For example	
Modu	Modulation		Data length	[3	
			Byte[Hex]	Channel 1	Channel 7	Channel 13
	1Mbps	400	32	txp 1 1 400 3 32	txp 1 7 400 3 32	txp 1 13 400 3 32
11b	2M	401	64	txp 1 1 401 3 64	txp 1 7 401 3 64	txp 1 13 401 3 64
110	5.5M	402	12C	txp 1 1 402 3 12C	txp 1 7 402 3 12C	txp 1 13 402 3 12C
	11M	403	258	txp 1 1 403 3 258	txp 1 7 403 3 258	txp 1 13 403 3 258
	6M	404	1F4	txp 1 1 404 3 1F4	txp 1 7 404 3 1F4	txp 1 13 404 3 1F4
	9M	405	2BC	txp 1 1 405 3 2BC	txp 1 7 405 3 2BC	txp 1 13 405 3 2BC
	12M	406	3E8	txp 1 1 406 3 3E8	txp 1 7 406 3 3E8	txp 1 13 406 3 3E8
11-	18M	407	578	txp 1 1 407 3 578	txp 1 7 407 3 578	txp 1 13 407 3 578
11g	24M	408	708	txp 1 1 408 3 708	txp 1 7 408 3 708	txp 1 13 408 3 708
	36M	409	BB8	txp 1 1 409 3 BB8	txp 1 7 409 3 BB8	txp 1 13 409 3 BB8
	48M	40a	FA0	txp 1 1 40a 3 FA0	txp 1 7 40a 3 FA0	txp 1 13 40a 3 FA0
	54M	40b	FA0	txp 1 1 40b 3 FA0	txp 1 7 40b 3 FA0	txp 1 13 40b 3 FA0
	MCS0	1000	1F4	txp 1 1 1000 3 1F4	txp 1 7 1000 3 1F4	txp 1 13 1000 3 1F4
	MCS1	1001	3E8	txp 1 1 1001 3 3E8	txp 1 7 1001 3 3E8	txp 1 13 1001 3 3E8
	MCS2	1002	5DC	txp 1 1 1002 3 5DC	txp 1 7 1002 3 5DC	txp 1 13 1002 3 5DC
11-	MCS3	1003	7D0	txp 1 1 1003 3 7D0	txp 1 7 1003 3 7D0	txp 1 13 1003 3 7D0
11n	MCS4	1004	BB8	txp 1 1 1004 3 BB8	txp 1 7 1004 3 BB8	txp 1 13 1004 3 BB8
	MCS5	1005	FA0	txp 1 1 1005 3 FA0	txp 1 7 1005 3 FA0	txp 1 13 1005 3 FA0
	MCS6	1006	1194	txp 1 1 1006 3 1194	txp 1 7 1006 3 1194	txp 1 13 1006 3 1194
	MCS7	1007	1194	txp 1 1 1007 3 1194	txp 1 7 1007 3 1194	txp 1 13 1007 3 1194

Figure 27: Reference Table for TX Test

User	Man	
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A.3 Commands for RX Test

For RX and conducted RF test, measurements should be performed without external signal interference. When checking the weak electric field signal such as 11b 1 Mbps mode, accurate measurement results may not be obtained if the measurement is not performed under shield room conditions.

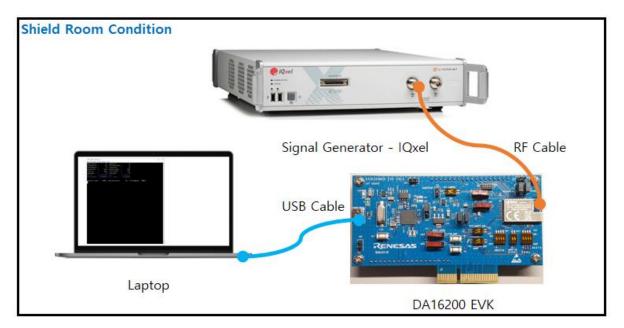


Figure 28: Setup for RX Test

The sequence of commands to initialize with mac layer is the same as for the TX test.

With lmac.per command, check the packet error rate of the signals received by DA16200.

Type PER on the console to stop receiving packets and end the test. This is known as RX test OFF.

Lmac.per : RX test On

per : RX test Off (Must be typed during RX test packet reception)

[/DA16200] #
[/DA16200] # lmac.tx.init
IMAC already initiated
[/DA16200/IMAC.IMAC_TX] # start
START
[/DA16200/IMAC.IMAC_TX] # lmac.per RX Test CN command

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User	Manual



The PER for the signal received from the signal generator is displayed in the output generated by the lmac.per command as marked with the green box in the picture below. The error rate will be displayed based on how many packets have been received compared to the transmitted packets.

💻 COM16 - Tera T	erm V	т							_	×
<u>F</u> ile <u>E</u> dit <u>S</u> etup	C <u>o</u> ntr	ol <u>W</u> indow	<u>H</u> el	p						
phyerroracc	=	0	,	phyerror	=	0				^
errored acc	=	41	,	errored pkts	=	6				
rxovflowacc	=	0	,	rxovflow	=	0				
passed acc	=	564	,	passed pkts	=	106				
rcvd acc	=	605	,	rcvd total	=	112				
vga_gain	=	0	,	lna_gain	=	0				
per acc	= (0.067768	,	per		0.053571				
perfixedacc	= (0.000000	,	per fixed		0.000000				
measure time	5=	1000	,	okt/duration=		10 , t	throughput=	0Mbps		

Figure 29: RX PER (Good)

The number of receivable packets per standard may vary. An error rate of less than 10% compared to send packets can be considered as a performance indicator.

Below is an error and it is displayed in red, but it is not a problem because the error rate is about 0.1%.

💻 COM16 - Tera Te	rm VT								_	×
<u>File E</u> dit <u>S</u> etup C	C <u>o</u> ntrol	<u>W</u> indow <u>I</u>	<u>H</u> elp)						
phyerroracc	=	0	,	phyerror	=	0				^
errored acc	=	138	,	errored pkts	=	15				
rxovflowacc	=	0	,	rxovflow	=	0				
passed acc	=	2826) ر	passed pkts	=	124				
rcvd acc	=	2964	,	rcvd total	=	139				
vga_gain	=	0	,	lna_gain	=	0				
per acc	= 0.0	046558	,	per		0.107913				
perfixedacc	= 0.0	000000	,	per fixed		0.000000				
measure time	=	1000,	р	kt/duration=		10,	throughput=	0Mbps		

Figure 30: RX PER (Not Good)

User	Manual	



Appendix B Configure DA16600 EVB 4v0 to Use AT Command via UART2

DA16600 supports AT command via the DA16200's UART. DA16200 supports 3 UARTs, and UART2 should be used for AT command UART0 is used for debug, and UART1 is used for communication between DA16200 and DA14531 on DA16600.

UART2 is not connected to FT2232H on EVB 4v0, thus additional manual modifications are required to use AT command via UART2. See the steps below.

The GPIO of UART1 or UART2 for AT command interface set in the DA16200, DA16600 Firmware image for AT command provided by default is assigned as follows:

- DA16200 Firmware image for AT command : UART1 GPIOA_4, GPIOA_5
- DA16600 Firmware image for AT command: UART2 GPIOC_6, GPIOC_7

B.1 Turn OFF Switch

UART1 is connected to FT2232H on the board, so the switch needs to be turned off first. To disconnect UART1 from FT2232H, SW3 and 5~8 of SW should be turned off. See Figure 31.

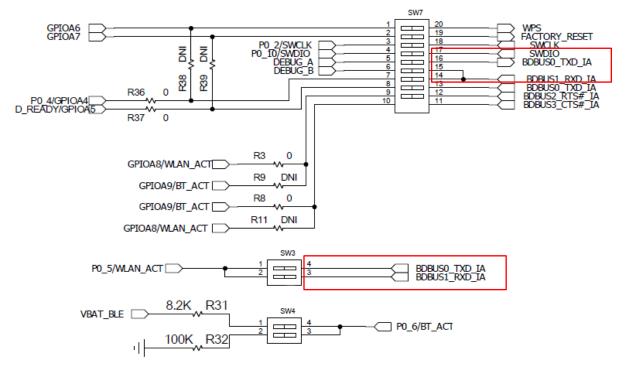


Figure 31: SW3 and SW7 UART1 Connection

B.2 Connect UART2 to FT2232H

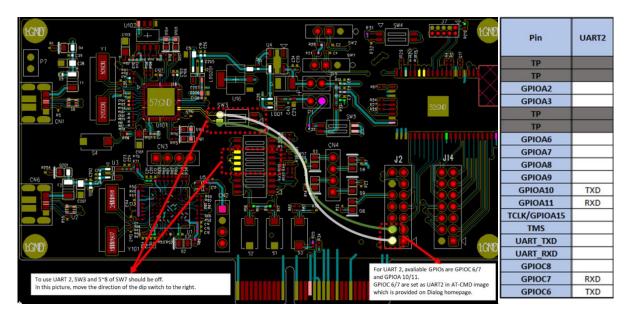
UART2 is available with GPIOA10/11 or GPIOC6/7. See pin mux in Figure 32. GPIOC6/7 are set as UART2 in the DA16600 Manufacture image, so UART2 can be connected to FT2232H to use AT command. The image is available in Renesas website (https://www.renesas.com/us/en/products/wireless-connectivity/wi-fi/low-power-wi-fi).

GPIOC6/7 are 2/4 pins of J2 connector, connect the wires from SW3 to J2. See Figure 32.

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Sep. 27, 2023





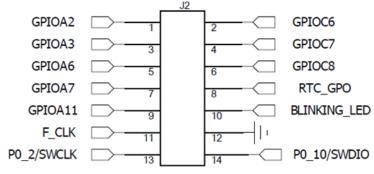


Figure 32: Connect UART2 to FT2232H

See Figure 33 for the picture of AT command connection via UART on EVB 4v0.

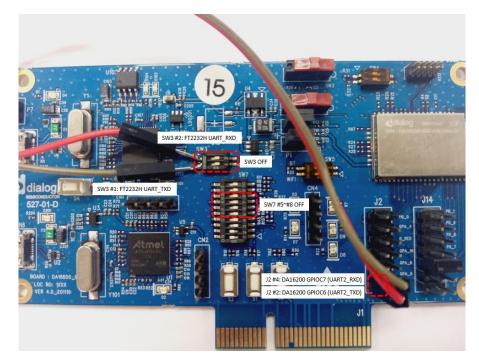


Figure 33: Setting for AT Command over UART2 on EVB 4v0

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Revision History

Revision	Date	Description
2.0	Sep. 27, 2023	 Reorganized document according to sequence of production test Updated XTAL Calibration section
1.9	June 30, 2023	Updated the reference section
1.8	Jan. 12, 2023	Updated descriptions in Writing MAC Address sectionRemoved supporting channel 14
1.7	Aug. 16, 2022	 DA16600MOD Mass Production guide (UM-WI-054) merged into this document Removed Manufacture Image parts
1.6	Apr. 13, 2022	Updated RF Test with Console sectionUpdated reference section
1.5	Mar. 28, 2022	Updated logo, disclaimer, and copyright
1.4	Mar. 17, 2021	Added Note 1
1.3	Nov. 21, 2019	Finalized for publication
1.2	Nov. 18, 2019	Editorial reviewAdded description for OTP write command
1.1	Nov 12, 2019	 Added Download the AT command and General Images Added Change Boot Index section Error correction on Table 4
1.0	July 31, 2019	First Release





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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User Manual

Revision 2.0

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