

M031BT/M032BT AT Command User Guide

Application Note for 32-bit NuMicro® Family

Document Information

Abstract	This document introduces how to use the AT command set to control a BLE transparent transmission module.
Apply to	NuMicro® M031BT/M032BT BLE MCU series.

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1 Introduction

This document shows how to use NuMaker-M03xBT board and AT command firmware as a BLE transparent transmission module. With the AT command set, you can control the module settings and do data transmission via remote BLE central side.

2 BLE Module

For the BLE transparent transmission module, an external MCU can control it and do BLE transmission via an UART interface.

The BLE module supports two operating modes: AT command mode and data transmission mode. In AT command mode, use AT command to control BLE module or get related information from BLE module. In data transmission mode, user can do bidirectional data transfer with another BLE central device.

2.1 Creating a BLE Module

Follow the steps below to create a BLE module:

1. Open the project *BLE\Demo\Peripheral\ATCMD_Peripheral* to build the AT command firmware.
2. Program the AT command firmware to the NuMaker-M03xBT board.

2.2 BLE Module State

The BLE module has following states:

- Standby – The BLE module is initialized and waits for operation.
- Advertising – The BLE module enables advertising and can be scanned by other BLE central devices.
- Connected – A BLE central device is connected to the BLE module.

2.3 Data Flash Partition

The BLE module uses the Data Flash partition to store the settings, and the range of Data Flash partition is the last 3 pages of APROM. This definition is defined in the *porting_flash.h* and *porting_flash.c* file located in the folder *BLE\Source\Porting*. User can modify it to change the size.

```
#define SIZE_OF_DATA_FLASH FLASH_PAGE_SIZE * 3
```

```
/* The Data Flash partition must be the most top partition */
flash_data_partition_addr = total_flash_size - SIZE_OF_DATA_FLASH;
```

In Data Flash partition, only two pages are used currently. The first page stores the Bluetooth device address. This page should not be modified in BLE operating or factory reset settings. The second page stores the AT command settings. This page may be updated or erased in BLE operating or factory reset settings.

The BLE module occupies an area in Flash page to store the AT command settings. The settings are listed as follows:

- BLE device name – 23 bytes, including 3-byte advertising information and 20-bytes device name strings.
- Baud rate – 4 bytes, the UART baud rate.

- RF TX power – 3 bytes, the TX power level of 3 different BLE modes.

For all items, the start address must be the 4-bytes alignment. The total size of the area is $24+4+4 = 32$ bytes.

2.4 Limitation of Updating Settings

After the BLE RF starts the advertising/scan/connect action, the Flash page erase action is not allowed. This prevents to affect the BLE RF interrupt and cause BLE behavior abnormal.

When running the BLE module for the first time, the default value of settings will be written to the first area. After any setting in the area is changed via an AT command, it uses the next area in the same page to store the latest settings. When the module is booting or reset, it may erase the Flash page and then only keep the latest settings in the first area.

The size of M031BT/M032BT Flash page is 512/2048 bytes, and the size of one area to store settings is 32 bytes, so there are 16/64 areas in one Flash page. During the period that BLE module keeps running without reset, the Flash page is allowed to update new area for 15/63 times. After updating the area 15/63 times and the AT command trying to change a setting, the system will report an error to indicate the Flash page is full.

2.5 Data Flash Partition Reset

To reset the Data Flash partition, use either Keil IDE or Nuvoton NuMicro ICP Programming Tool to delete the Data Flash partition. After the Data Flash partition is deleted, the AT command firmware will create the partition again and then fill the default value of settings to the first area.

2.6 Power Saving

To reduce the power consumption, use AT command to enable/disable the BLE module to enter Power-down mode when idle. After entering Power-down mode, either a BLE event or UART data can wake up the BLE module.

2.7 Deep Sleep

To reduce more power consumption, use AT command to enter Deep Sleep mode. During this mode, the BLE RF cannot do anything until wakeup.

3 AT Command

3.1 AT Command Set

The BLE module supports the following AT command set. Please note that some AT commands are only available in specified BLE states. If the AT command runs in invalid BLE state, it will return an error directly.

1. Test command

Command	Response	Description
AT	OK	-

2. Query supported AT commands

Command	Response	Description
AT+HELP?	+HELP:<Param> OK	Param: Supported AT commands

3. Get firmware version

Command	Response	Description
AT+VERSION?	+VERSION:<Param> OK	Param: Firmware version and date information

[Example]

AT+VERSION?\r\n

+VERSION:1.0.0-20200827

OK

4. Restart module

Command	Response	Description
AT+RESET	OK	-

5. Query BLE state

Command	Response	Description
AT+STATE?	+STATE:<Param> OK	Param: BLE module state, could be 0: Standby

		1: Advertising 2: Connected
--	--	--------------------------------

[Example]

AT+STATE?

+STATE:2 → In connected state

OK

6. Factory default settings

Command	Response	Description
AT+ORGL	OK / ERROR	Available only in standby state. After doing factory default settings, the system will be reset.

[Default settings]

Device name: NVT-M031BT

Baud rate: 115200 bps

TX power: +8 dBm

7. Set/Query UART baud rate

Command	Response	Description
AT+UART=<Param>	OK / ERROR	Param: Baud rate, could be 9600 / 19200 / 38400 / 57600 / 115200.
AT+UART?	+UART:<Param> OK	

[Example]

AT+UART=56000\r\n → Non-supported baud rate

ERROR

AT+UART=57600\r\n

OK

AT+UART?\r\n

+UART:57600

OK

8. Set/Query command echo mode

Command	Response	Description
AT+ECHO=<Param>	OK / ERROR	Available only in standby state.

AT+ECHO?	+ECHO:<Param> OK	Param: Echo mode, could be 0: Echo off 1: Echo on
----------	------------------	---

9. Set/Query Device Name

Command	Response	Description
AT+NAME=<Param>	OK	Available in standby or advertising state. Param: Scan response device name, max length is 20 bytes.
AT+NAME?	+NAME:<Param> OK	

[Example]

AT+NAME=NVT_TRSP\r\n

OK

AT+NAME?\r\n

+NAME:NVT_TRSP

OK

10. Query module device address

Command	Response	Description
AT+ADDR?	+ADDR:<Param> OK	Param: Bluetooth device address

[Example]

AT+ADDR?\r\n

+ADDR:16-15-14-13-12-11

OK

11. Enable/Disable advertising

Command	Response	Description
AT+ADVEN	OK / ERROR	-
AT+ADVDIS	OK / ERROR	

[Example]

AT+ADVEN\r\n → Start BLE advertising.

OK

12. Set/Query advertising interval

Command	Response	Description
AT+ADVINT=<Param>	OK / ERROR	Available only in standby state. Param: Advertising interval time, unit is 0.625ms, range is 20ms ~ 10.24s.
AT+ADVINT?	+ADVINT:<Param> OK	

[Example]

AT+ADVINT=160\r\n → Set advertising interval to 100ms.

OK

13. Set/Query connection interval

Command	Response	Description
AT+CONINT=<Param>	OK / ERROR	Available only in connected state. Param: Connection interval time, unit is 1.25ms, range is 7.5ms~4s.
AT+CONINT?	+CONINT:<Param> OK	

[Example]

AT+CONINT=20\r\n → Try to set connection interval to 25ms.

OK

AT+CONINT?\r\n

+CONINT:24 → After communicated with central device, the final is set to 30ms.

OK

14. Set/Query Tx power

Command	Response	Description
AT+TXPWR=<Param1>,<Param2>	OK / ERROR	Available only in standby state. Param1: BLE mode, could be 1: ADVERTISING (for peripheral) 2: SCANNING (for central, not support yet) 3: INITIATING (for central, not support yet) Param2: TX power level, could be 9 / 8 / 6 / 4 / 2 / 0 / -3 / -6 / -10 / -15 / -20 (dBm)
AT+TXPWR?<Param1>	+TXPWR: <Param1>,<Param2> OK	

[Example]

AT+TXPWR=0,4\r\n → Invalid BLE mode
ERROR

AT+TXPWR=1,5\r\n → Invalid TX power level
ERROR

AT+TXPWR=1,4\r\n → Set all states of peripheral mode with +4 dBm TX power level
OK

15. Set/Query Phy mode

Command	Response	Description
AT+PHY=<Param>	OK / ERROR	Available only in connected state. Param: Phy mode, could be 1 / 2 (Mbps)
AT+PHY?	+PHY:<Param> OK	

[Example]

AT+PHY=2\r\n → Set Phy mode to 2 Mbps
OK

AT+PHY?\r\n
+PHY:2
OK

16. Disconnect the current connection

Command	Response	Description
AT+DISCON	OK / ERROR	Available only in connected state.

17. Enable/Disable to enter Power-down mode when idle

Command	Response	Description
AT+SLEEP	OK	-
AT+NOSLEEP	OK	-

18. Enter Deep Sleep mode immediately

Command	Response	Description
AT+DSLEEP	OK / ERROR	Available only in standby state. The BLE RF will also enter Deep Sleep.

19. Set/Query MCU memory

Command	Response	Description
AT+MEMORY=<Param 1>, <Param2>	OK / ERROR	Param1: Memory address Param2: Value in hexadecimal
AT+MEMORY?<Param 1>	+MEMORY: <Param1>,<Param2> OK	

[Example]

AT+MEMORY=0x40004040,0x00000040\r\n → Set GPB3 as output mode

OK

AT+MEMORY?0x40004040\r\n

+MEMORY: 0x40004040,0x00000040

OK

3.2 Return Value of AT Command

After executing an AT command, the return value is listed as follows:

Return value	Description
OK	AT command runs success
ERROR	AT command runs fail or is unsupported
BUSY	Previous AT command is still running, so skip this AT command

3.3 Module Default Value

The default setting of BLE module is listed as follows:

Description	Default Setting
Baud rate	115200 bps, n, 8, 1
Device name	Nuvoton_ATCMD
Device address	Create by UID
Service UUID	00112233-4455-6677-8899-AABBCCDDEEFF
Advertising interval	100 ms
TX power	+9 dBm
Phy mode	1 Mbps
MCU Sleep	Disable

4 Testing the BLE Module

Following sections introduce how to test the BLE module.

4.1 BLE Mobile App

Since the BLE transparent transmission is not a standard BLE profile, the easiest way to test the data transmission is using the Nuvoton NuBLE App. Please refer to the *M031 BLE Quick Start Guide* for details.

4.2 Controlling the BLE Module

To control the BLE module, use either an external MCU or a Windows terminal tool.

4.2.1 Using an External MCU

To use an external MCU to control the BLE module, you need to connect following pins between BLE module and external MCU:

- UART RXD (PA0) – The UART0 RXD pin
- UART TXD (PA1) – The UART0 TXD pin
- Mode Control (PB1) – The BLE module operating mode control pin

The external MCU uses the UART interface to communicate with the BLE module, and uses the mode control pin to control the operating mode of BLE module. When the mode control pin is set to low and the BLE module is in connected state, the BLE module works in data transmission mode. Otherwise, the BLE module works in AT command mode.

4.2.2 Using a Windows Terminal Tool

To use a Windows terminal tool, use an USB cable to connect to NuMaker-M03xBT board directly. For the serial port setting, user can get the information of Nu-Link2 Virtual Com from Windows Device Manager, as shown in Figure 4-1.

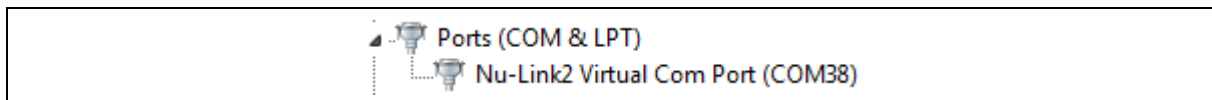


Figure 4-1 Virtual Com of the NuMaker Board

4.3 BLE Data Transmission

Follow the steps below to do BLE data transmission:

1. Use either an external MCU or a Windows terminal tool to control BLE module.
2. Send AT command “AT+ADVEN” to enable BLE advertising and confirm the response is “OK”.
3. Use NuBLE or another BLE App to scan and connect to BLE module.
4. After the BLE central device (mobile) is connected, set mode control pin (PB2) to low to change the operating mode to data transmission mode.
5. Through UART interface, the external MCU or Windows terminal tool can do bidirectional

data transfer with BLE central device.

4.4 Controlling the Peripheral of BLE Module

To control the peripheral of BLE module, use AT+MEMORY command. The following example is to light the LED on board.

AT+MEMORY?0x40004140\r\n	→ Check the register PF_MODE
+MEMORY:0x40004140,0x40000000	→ LED pin (PF15) is already output mode
OK	
AT+MEMORY?0x40004148\r\n	→ Check the register PF_DOUT
+MEMORY:0x40004148,0x0000C07F	→ PF15 is high
OK	
AT+MEMORY=0x40004148,0x0000407F\r\n	→ Set PF15 to be low to light LED
OK	

Revision History

Date	Revision	Description
2020.08.28	1.00	1. Initially issued.
2021.07.15	1.10	1. Added some AT commands.
2021.08.31	2.00	1. Supported SDK v2.
2021.12.23	2.01	1. Made editorial changes.
2022.04.01	2.02	1. Added some AT commands.

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