HUAWEI M.2 Module

# Tunable Antenna Application Notes

Issue 01

Date 2013-08-05

Huawei Technologies Co., Ltd. provides customers with comprehensive technical support and service. For any assistance, please contact our local office or company headquarters.


# Huawei Technologies Co., Ltd.

Huawei Industrial Base, Bantian, Longgang, Shenzhen 518129, People's Republic of China
Tel: +86-755-28780808 Global Hotline: +86-755-28560808 Website: www.huawei.com
E-mail: mobile@huawei.com


Please refer color and shape to product. Huawei reserves the right to make changes or improvements to any of the products without prior notice.



**Notice**

Some features of the product and its accessories described herein rely on the software installed, capacities and settings of local network, and may not be activated or may be limited by local network operators or network service providers, thus the descriptions herein may not exactly match the product or its accessories you purchase.
Huawei Technologies Co., Ltd reserves the right to change or modify any information or specifications contained in this manual without prior notice or obligation.

**NO WARRANTY**

THE CONTENTS OF THIS MANUAL ARE PROVIDED "AS IS". EXCEPT AS REQUIRED BY APPLICABLE LAWS, NO WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE MADE IN RELATION TO THE ACCURACY, RELIABILITY OR CONTENTS OF THIS MANUAL.
TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO CASE SHALL HUAWEI TECHNOLOGIES CO., LTD BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, OR LOST PROFITS, BUSINESS, REVENUE, DATA, GOODWILL OR ANTICIPATED SAVINGS.

**Import and Export Regulations**

Customers shall comply with all applicable export or import laws and regulations and will obtain all necessary governmental permits and licenses in order to export, re-export or import the product mentioned in this manual including the software and technical data therein.

# About This Document

## Revision History

| Document Version | Date | Chapter | Descriptions |
|---|---|---|---|
| 01 | 2013-08-05 | | Creation |

# Contents

**1 Overview ..... 5**
1.1 Purpose ..... 5
1.2 Organization ..... 5
1.3 Application Scope ..... 5
**2 Tunable Antenna Function ..... 6**
2.1 About This Chapter ..... 6
2.2 Huawei Tunable Antenna Solution ..... 6
2.3 Tunable Antenna Mechanism ..... 6
**3 Hardware Interface ..... 8**
3.1 About This Chapter ..... 8
3.2 Tunable Antenna Pin ..... 9
**4 Software Interface ..... 11**
4.1 About This Chapter ..... 11
4.2 AT^ANTENCFG–Set Tunable Antenna ..... 11
4.2.1 Command Syntax ..... 11
4.2.2 Interface Description ..... 12
4.2.3 Parameter Description ..... 12
4.2.4 Property Description ..... 15
4.2.5 Example ..... 15
**5 Acronyms and Abbreviations ..... 17**

# 1 Overview

## 1.1 Purpose

The antenna is an important part of the radio communication system, and the efficiency is a very important parameter to evaluate the quality of antenna. In the realistic environment, many factors will reduce the efficiency of antenna, such as antenna feed impedance, location of antenna, and various error sources.

To improve the efficiency of antenna, Huawei M.2 module supports tunable antenna function, which can implement the impedance matching of the antenna and the transmitter. Huawei M.2 module provides four GPIO interfaces for the host (PC or tablet), so that the host can use these interfaces to match the impedance of antenna.

The tunable antenna function is customized. Host sets the GPIO configurations, and then the configurations are embedded in the software of Huawei M.2 module.

## 1.2 Organization

- Huawei Tunable Antenna Solution
- Hardware Interface
- Software Interface

## 1.3 Application Scope

Customers can refer to this document when using the tunable antenna of Huawei M.2 module.

# 2 Tunable Antenna Function

## 2.1 About This Chapter

Huawei M.2 module provides the tunable antenna function, which uses relevant GPIO interfaces to match the impedance of antenna and transmitter.

This document describes the interfaces of hardware and software related to the tunable antenna function and the common usages and processes of these interfaces.

## 2.2 Huawei Tunable Antenna Solution

According to customer's requirement, Huawei M.2 module provides the tunable antenna solution. The solution contains two parts: hardware section and software section .

### Hardware section

Huawei M.2 module provides four GPIO interfaces, which can be set to output high or low level in accordance with the customer's requirement. Through different output levels of four GPIO interfaces, the host can implement tuning the antenna efficiency.

### Software section

Huawei M.2 module provides an AT command interface. Customers can use the AT command interface to tune the antenna efficiency and get the configuration of different bands. These configurations can be written into the firmware of the module. The module will control the output level of GPIO interfaces according to these configurations.

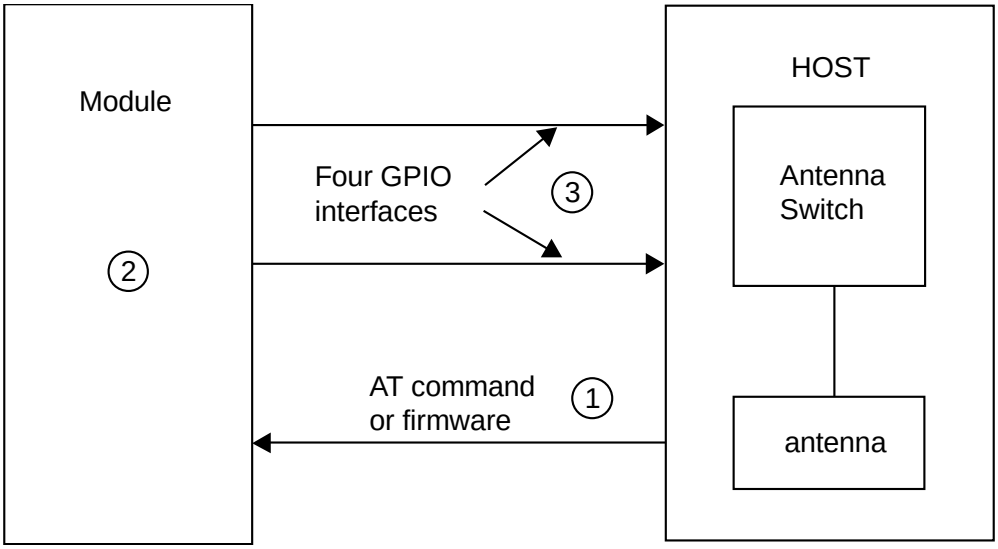
Take care that we should use the software section and hardware section together. Software section is used to debug the function and create the GPIO configuration. Hardware section is used to control the antenna.

## 2.3 Tunable Antenna Mechanism

The tunable antenna function mechanism is as follows:

1. The GPIO configuration is written into the module by the firmware on Huawei product line or AT command by customers.
2. The module searches the frequencies based on targeted carrier area.
3. The module controls the GPIO to switch antenna according to the measured band in ② and configuration in ①.
4. The tunable antenna in the host side works according to the set by antenna switch in ③.

**Figure 2-1** Tunable antenna feature diagram




**Main Features**

- Supporting to set the antenna control configuration for any band and any mode such as GSM, WCDMA, CDMA, and LTE, etc.
- Supporting to customize the configuration on the firmware of the module.
- Supporting to restore or modify the configuration after upgrade.

# 3 Hardware Interface

## 3.1 About This Chapter

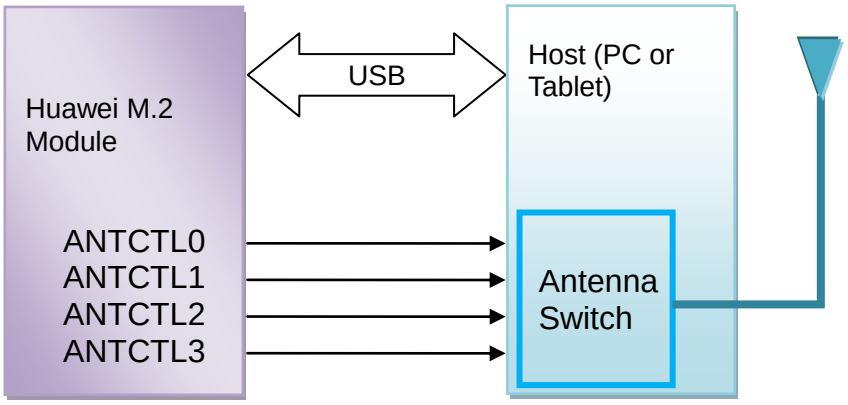
The tunable antenna design of Huawei M.2 module contains hardware and software design. This chapter describes the hardware design.

Huawei M.2 module supports four GPIO pins to implement the tunable antenna function. The tunable antenna signal is output.

**Table 3-1** Hardware interface signals

| Pin No. | Pin Name | I/O | Description | DC Characteristics(V) | | |
|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. |
| 59 | ANTCTL0 | O | Tunable antenna control signal bit 0 | –0.3 | 1.8 | 2.1 |
| 61 | ANTCTL1 | O | Tunable antenna control signal bit 1 | –0.3 | 1.8 | 2.1 |
| 63 | ANTCTL2 | O | Tunable antenna control signal bit 2 | –0.3 | 1.8 | 2.1 |
| 65 | ANTCTL3 | O | Tunable antenna control signal bit 3 | –0.3 | 1.8 | 2.1 |

**Figure 3-1** The diagram of hardware interface



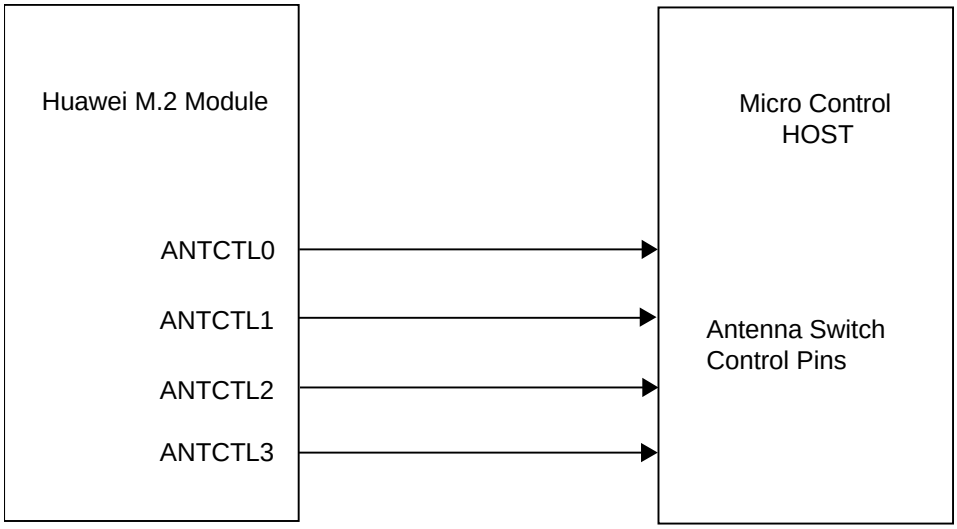

# 3.2 Tunable Antenna Pin

The tunable antenna signals output high or low level. Four GPIO interfaces (ANTCTL0-ANTCTL3) will be differently combined, and each frequency band has a corresponding combination. Host uses these different combinations to control the antennas for the corresponding frequency bands to meet the efficiency requirement of antenna.

Its work scheme is simple:

- If tunable antenna is set ANTCTLx (x=0, 1, 2, 3)=1 by software, the Huawei M.2 module will drive the ANTCTLx pin output 1.8 V high level.
- If tunable antenna is set ANTCTLx (x=0, 1, 2, 3)=0 by software, the Huawei M.2 module will drive the ANTCTLx pin output 0 V low level.
- If tunable antenna function is not used, these pins will output 0 V by default.
- The four GPIO interfaces should be connected to the antenna switch control pins of host, as shown in Figure 3-2 .

**Figure 3-2** Connections of the tunable antenna pins




ANTCTLx (x=0, 1, 2, 3) supports output 1.8 V

**NOTE**

Since the output of GPIO interface is 1.8 V, customers should add a level conversion circuit in the host if needing other output level.

# 4 Software Interface

## 4.1 About This Chapter

This chapter describes the software interfaces of the tunable antenna function.

## 4.2 AT^ANTENCFG–Set Tunable Antenna

### 4.2.1 Command Syntax

| |
|---|
| AT^ANTENCFG=<mode>,<pattern>[,<band>[,<pattern>,<band>[…]]] |
| Possible Response(s) |
| <CR><LF>OK<CR><LF><br>In case of an MT-related error:<br><CR><LF>ERROR<CR><LF> |
| AT^ANTENCFG? |
| Possible Response(s) |
| <CR><LF>^ANTENCFG: <CR><LF><mode>:<br><pattern>,<band>[,<pattern>,<band>[...]][[<CR><LF><mode>:<br><pattern>,<band>[,<pattern>,<band>[...]]][…]]<CR><LF><CR><LF>OK<CR><LF><br>In case of an MT-related error:<br><CR><LF>ERROR<CR><LF> |
| AT^ANTENCFG=? |
| Possible Response(s) |
| <CR><LF>^ANTENCFG: (list of supported <mode>s),(list of supported <pattern>s),(list of supported <band>s)<CR><LF><CR><LF>OK<CR><LF> |

## 4.2.2 Interface Description

The set command sets the antenna tuner configuration for each band of every mode.

The read command queries the antenna tuner configuration of each band of all modes.

The test command queries the parameter values supported by the command.

## 4.2.3 Parameter Description

<mode>: the mode of network.

| | |
|---|---|
| 0 | GSM |
| 1 | WCDMA |
| 2 | CDMA |
| 3 | LTE |

<pattern>: the configuration of antenna tuner. Pattern bit field, 8-bit digit with hexadecimal. A binary bit indicates an ANTCTL pin.

| Bit[4-7] | Bit[3] | Bit[2] | Bit[1] | Bit[0] |
|---|---|---|---|---|
| reserved | ANTCTL3 | ANTCTL2 | ANTCTL1 | ANTCTL0 |

| | |
|---|---|
| 0 | Low Level |
| 1 | High Level |

<band>: band bit field, 64-bit digit with hexadecimal. A binary bit indicates a frequency band. The value of binary bit is shown in the following table.

**Table 4-1** The value of <band> when <mode>=0

| Parameters | Band |
|---|---|
| 0000000000000001 | GSM850 |
| 0000000000000002 | GSM900 |
| 0000000000000004 | GSM1800 |
| 0000000000000008 | GSM1900 |
| … | … |
| FFFFFFFFFFFFFFFF | All bands |

**Table 4-2** The value of <band> when <mode>=1

| Parameters | Band |
|---|---|
| 0000000000000001 | WCDMA_I_IMT_2000 |
| 0000000000000002 | WCDMA_II_PCS_1900 |
| 0000000000000004 | WCDMA_III_1700 |
| 0000000000000008 | WCDMA_IV_1700 |
| 0000000000000010 | WCDMA_V_850 |
| 0000000000000020 | WCDMA_VI_800 |
| 0000000000000040 | WCDMA_VII_2600 |
| 0000000000000080 | WCDMA_VIII_900 |
| 0000000000000100 | WCDMA_IX_1700 |
| 0000000000000200 | WCDMA_X |
| 0000000000000400 | WCDMA_XI |
| 0000000000000800 | WCDMA_XII |
| 0000000000001000 | WCDMA_XIII |
| 0000000000002000 | WCDMA_XIV |
| 0000000000004000 | WCDMA_XV |
| 0000000000008000 | WCDMA_XVI |
| 0000000000010000 | WCDMA_XVII |
| 0000000000020000 | WCDMA_XVIII |
| 0000000000040000 | WCDMA_XIX |
| … | … |
| FFFFFFFFFFFFFFFF | All bands |

**Table 4-3** The value of <band> when <mode>=2

| Parameters | Band |
|---|---|
| 0000000000000001 | BC0 A |
| 0000000000000002 | BC0 B |
| 0000000000000004 | BC1 |
| 0000000000000008 | BC2 |
| 0000000000000010 | BC3 |
| 0000000000000020 | BC4 |

| Parameters | Band |
|---|---|
| 0000000000000040 | BC5 |
| 0000000000000080 | BC6 |
| … | … |
| FFFFFFFFFFFFFFFF | All bands |

**Table 4-4** The value of <band> when <mode>=3

| Parameters | Band |
|---|---|
| 0000000000000001 | band 1 |
| 0000000000000002 | band 2 |
| 0000000000000004 | band 3 |
| 0000000000000008 | band 4 |
| 0000000000000010 | band 5 |
| 0000000000000020 | band 6 |
| 0000000000000040 | band 7 |
| 0000000000000080 | band 8 |
| 0000000000000100 | band 9 |
| 0000000000000200 | band 10 |
| 0000000000000400 | band 11 |
| 0000000000000800 | band 12 |
| 0000000000001000 | band 13 |
| 0000000000002000 | band 14 |
| 0000000000004000 | band 15 |
| 0000000000008000 | band 16 |
| 0000000000010000 | band 17 |
| 0000000000020000 | band 18 |
| 0000000000040000 | band 19 |
| 0000000000080000 | band 20 |
| … | … |
| FFFFFFFFFFFFFFFF | All bands |

[,<band>[,<pattern>,<band>]…]: indicates that select all supported bands when all parameters are default. One <pattern> is set according to the <band> in the same group.

**NOTE**

- The parameter can be set to be several groups (less or equal to nine groups) of pattern at one time.
- Now the module does not distinguish between CDMA BC0 A and B, so only BC0 A can be set.

## 4.2.4 Property Description

| Saving upon Power-off | PIN |
|---|---|
| Y | N |

## 4.2.5 Example

| | | |
|---|---|---|
| Run: | AT^ANTENCFG=? | |
| Response: | ^ANTENCFG: (0-1),(0-15),(0000000000000000F,0000000000000001)<br><br>OK | Indicate that the module supports GSM and WCDMA. The pattern is from 0 to 15. The module supports GSM 4 bands and WCDMA B1. |
| Run: | AT^ANTENCFG=0,1,2 | Set the antenna tuner configuration of GSM900 to be 1. |
| Response: | OK | |
| Run: | AT^ANTENCFG=1,2,1 | Set the antenna tuner configuration of WCDMA_I_IMT_2000 to be 2. |
| Response: | OK | |
| Run: | AT^ANTENCFG? | |

| | | |
|---|---|---|
| Response: | ^ANTENCFG:<br>0:0,000000000000000D,1,0000000000000002<br>1:2,0000000000000001<br><br>OK | Indicate that the current configuration of GSM900 is 1, other bands of GSM are 0. The current configuration of WCDMA_I_IMT_2000 is 2. |

# 5 Acronyms and Abbreviations

| Acronym or Abbreviation | Expansion |
|---|---|
| CDMA | Code Division Multiple Access |
| GPIO | General-purpose I/O |
| GSM | Global System for Mobile Communications |
| M.2 | New Name for NGFF |
| NGFF | Next Generation Form Factor |
| LTE | Long Term Evolution |
| WCDMA | Wideband Code Division Multiple Access |