HUAWEI MU609 HSPA LGA Module

# Hardware Guide

Issue       03

Date      2014-12-03

# About This Document

## Revision History

| Document Version | Date | Chapter | Descriptions |
|---|---|---|---|
| 01 | 2013-04-10 | | Creation |
| 02 | 2014-01-02 | 2.2 | Updated Table 2-1 Feature |
| | | 2.3 | Updated Figure 2-1 Circuit block diagram of the MU609 module |
| | | 2.4 | Updated Figure 2-2 Application block diagram of the MU609 module |
| | | 3.2 | Updated Table 3-1 Definitions of pins on the LGA interface and Figure 3-1 Sequence of LGA interface (Top view) |
| | | 3.3.2 | Updated Figure 3-2 Recommended power circuit of MU609 module |
| | | 3.4 | Added description related to LED_MODE signal |
| | | 3.6 | Updated Figure 3-13 Recommended circuit of USB interface and its note |
| | | 3.7 | Updated Figure 3-14 Circuit of the USIM card interface |
| | | 3.11 | Updated 3.11 RF Antenna Interface |
| | | 4.4.1 | Updated Table 4-2 MU609 conducted Rx sensitivity (unit: dBm) |
| | | 5.6.2 | Updated 5.6.2 Power Consumption |
| | | 5.7 | Updated 5.7 Reliability Features |
| | | 5.8 | Updated 5.8 EMC and ESD Features |
| | | 9 | Updated Circuit of Typical Interface |
| 03 | 2014-12-03 | 1 | Added two editions description of MU609 module |

| Document Version | Date | Chapter | Descriptions |
|---|---|---|---|
| | | 3 | Updated definitions of pins and UART level description |
| | | 4.4.2 | Updated Table 4-4 MU609 conducted Tx power |
| | | 5.4 | Deleted electrical features of USIM of issue 02 |
| | | 5.5 | Deleted electrical features of application interfaces of issue 02 |
| | | 6.5 | Updated packaging of MU609 module |
| | | 6.7.2 | Deleted Figure 6-4 thermal pads design of issue 02 |
| | | 7 | Updated Table 7-1 product certifications |

# Contents

# 1 Introduction

This document describes the hardware application interfaces and air interfaces provided by MU609 module.

This document helps hardware engineer to understand the interface specifications, electrical features and related product information of the MU609 module.

MU609 module has two editions: GPS and No GPS.

# 2 Overall Description

## 2.1 About This Chapter

This chapter gives a general description of the MU609 module and provides:

- Function Overview
- Circuit Block Diagram
- Application Block Diagram

## 2.2 Function Overview

**Table 2-1** Features

| Feature | Description |
|---------|-------------|
| Physical Dimensions | • Dimensions (L × W × H): 30 mm × 30 mm × 2.27 mm <br> • Weight: about 5 g |
| Operating Bands | WCDMA/HSDPA/HSUPA/HSPA: Band 1, Band 2, Band 5, Band 8 <br> GSM/GPRS/EDGE: 850 MHz/900 MHz/1800 MHz/1900 MHz <br> GPS L1: 1575.42 MHz |
| Operating Temperature | Normal operating temperature: –20°C to +70°C <br> Extended operating temperature[1]: –40°C to +85°C |
| Storage Temperature | –40°C to +85°C |
| Power Voltage | DC 3.3 V–4.2 V (typical value is 3.8 V) |
| AT Commands | See the *HUAWEI MU609 HSPA LGA Module AT Command Interface Specification*. |
| Application Interface (145-pin LGA | One standard USIM card (Class B and Class C) |
| | Audio interface: PCM interface |

| Feature | Description |
|---|---|
| interface) | USB 2.0 (High Speed) |
| | 8-wire UART (Universal Asynchronous Receiver-Transmitter) x 1<br>2-wire UART x 1 (this is only used for debugging) |
| | GPIO (General-purpose I/O) x 5 |
| | LED (Light-Emitting Diode) x 1 |
| | Power on/off interface |
| | Hardware reset interface |
| | USIM interface |
| | JTAG (Joint Test Action Group) interface |
| | Sleep indicator interface (SLEEP_STATUS) |
| Antenna interface | WWAN MAIN antenna pad x1, WWAN AUX antenna pad x 1, GPS antenna pad x 1 |
| SMS | New message alert |
| | Management of SMS: read SMS, write SMS, send SMS, delete SMS and list SMS. |
| | Supports MO and MT: Point-to-point |
| Data Services | GPRS: UL 85.6 kbit/s; DL 85.6 kbit/s |
| | EDGE: UL 236.8 kbit/s; DL 236.8 kbit/s |
| | WCDMA PS: UL 384 kbit/s; DL 384 kbit/s |
| | HSPA: UL 5.76 Mbit/s; DL 14.4 Mbit/s |

📖 **NOTE**

[1]: When the MU609 module works in the range of –40°C to –20°C or +70°C to +85°C , **NOT** all its RF performances comply with 3GPP specifications.

# 2.3 Circuit Block Diagram

Figure 2-1 shows the circuit block diagram of the MU609 module. The major functional units of the MU609 module contain the following parts:

- Power management
- Baseband controller
- Multi-chip package (MCP) memory
- RF Circuit

**Figure 2-1** Circuit block diagram of the MU609 module
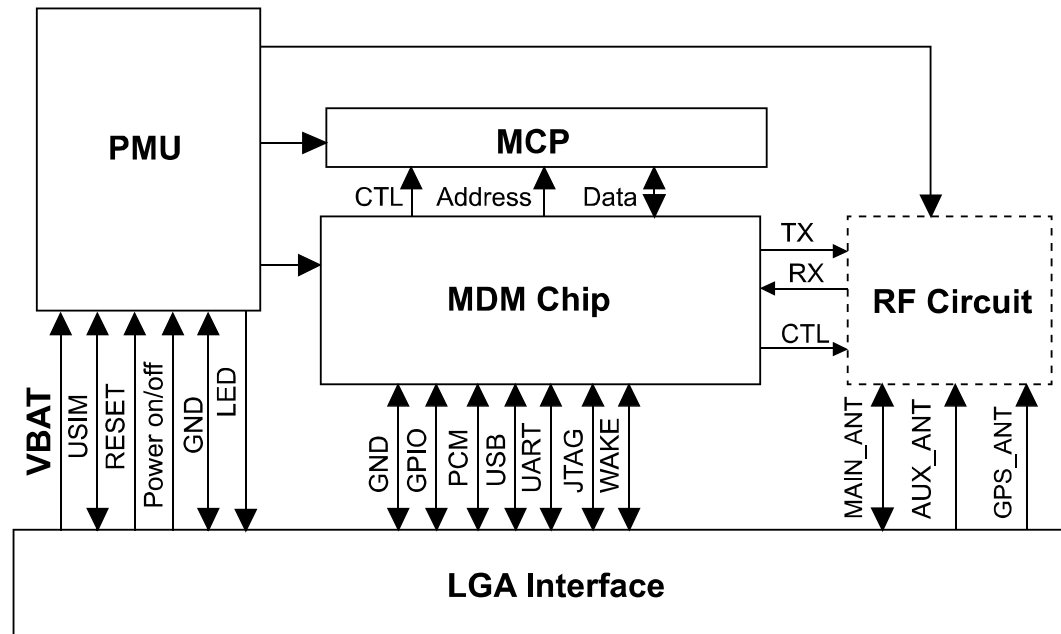


## 2.4 Application Block Diagram

**Figure 2-2** Application block diagram of the MU609 module
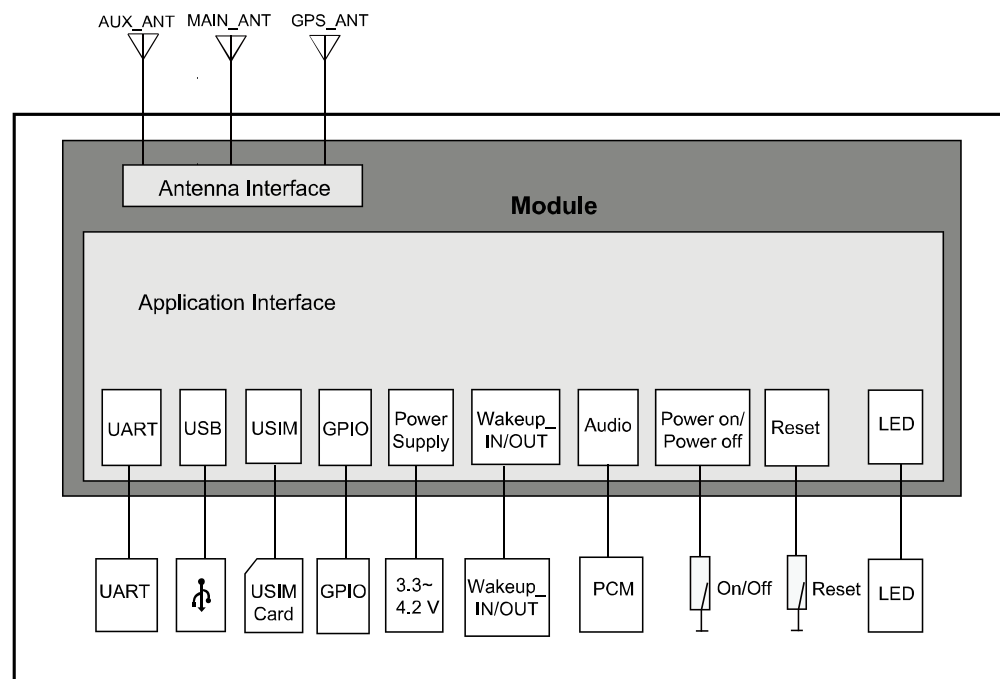
**UART Interface:**    The module supports 2 UART interfaces. One is 8-wire UART, and the other is 2-wire UART (only for debugging).

**USB Interface:**    The USB interface supports USB 2.0 high speed standard.

**USIM Interface:**    The USIM interface provides the interface for a USIM card.

**External Power Supply:**    DC 3.8 V is recommended.

**Audio Interface:**    The module supports one PCM interface.

**LED:**    Indicate the work status.

**RF Pad:**    RF antenna interface.

# 3 Description of the Application Interfaces

## 3.1 About This Chapter

This chapter mainly describes the external application interfaces of the MU609 module, including:

- LGA Interface
- Power Interface
- Signal Control Interface
- UART Interface
- USB Interface
- USIM Card Interface
- Audio Interface
- General Purpose I/O Interface
- JTAG Interface
- RF Antenna Interface
- Reserved Interface
- NC Interface

## 3.2 LGA Interface

The MU609 module uses a 145-pin LGA as its external interface. For details about the module and dimensions, see "Dimensions and ".

Figure 3-1 shows the sequence of pins on the 145-pin signal interface of the MU609 module.

**Figure 3-1** Sequence of LGA interface (**Top view**)

| Power pads | | GND pads | | Control pads | | RF ANT pads |
| UART pads | | SIM pads | | USB pads | | Audio pads |
| GPIO pads | | NC | | JTAG pads | | Reserved pads |

Table 3-1 shows the definitions of pins on the 145-pin signal interface of the MU609 module.

**Table 3-1** Definitions of pins on the LGA interface

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---------|----------|----------|-------------|-----------|----------|----------|----------|----------|
| 1 | UART1_TX | O | UART1 transmit output for debugging | $V_{OH}$ | 1.35 | - | 1.8 | - |
|   |          |   |            | $V_{OL}$ | 0 | - | 0.45 | - |
| 2 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 3 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 4 | UART1_RX | I | UART1 receive data input for debugging | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|   |          |   |            | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 5 | PCM_SYNC | O | PCM interface sync | $V_{OH}$ | 1.35 | - | 1.8 | - |
|   |          |   |            | $V_{OL}$ | 0 | - | 0.45 | - |
| 6 | PCM_DIN | I | PCM I/F data in | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|   |         |   |            | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 7 | PCM_DOUT | O | PCM I/F data out | $V_{OH}$ | 1.35 | - | 1.8 | - |
|   |          |   |            | $V_{OL}$ | 0 | - | 0.45 | - |
| 8 | PCM_CLK | O | PCM interface clock | $V_{OH}$ | 1.35 | - | 1.8 | - |
|   |         |   |            | $V_{OL}$ | 0 | - | 0.45 | - |
| 9 | Reserved | - | Reserved | - | - | - | - | - |
| 10 | Reserved | - | Reserved | - | - | - | - | - |
| 11 | WAKEUP_IN | I | Host to set the module into sleep or wake up the module from sleep. | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|    |           |   |            | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 12 | VBAT | PI | Power supply input | - | 3.3 | 3.8 | 4.2 | - |
| 13 | VBAT | PI | Power supply input | - | 3.3 | 3.8 | 4.2 | - |
| 14 | PS_HOLD | I | Power supply hold signal to the module | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|    |         |   |            | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 15 | SLEEP_STATUS | O | Sleep status of MU609 | $V_{OH}$ | 1.35 | - | 1.8 | - |
|    |              |   |            | $V_{OL}$ | 0 | - | 0.45 | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---|---|---|---|---|---|---|---|---|
| 16 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 17 | NC | - | Not connected, please keep open | - | - | - | - | - |
| 18 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 19 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 20 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 21 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 22 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 23 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 24 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 25 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 26 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 27 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 28 | Reserved | - | Reserved | - | - | - | - | - |
| 29 | Reserved | - | Reserved | - | - | - | - | - |
| 30 | JTAG_TMS | I | JTAG test mode select | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---------|----------|----------|-------------|-----------|----------|----------|----------|----------|
| 31 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 32 | VCC_EXT1 | PO | 1.8 V Power output | - | - | 1.8 | - | - |
| 33 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 34 | USIM_VCC | P | Power supply for USIM card | - | 1.75 | 1.8 | 1.98 | USIM_VCC=1.8 V |
| | | | | - | 2.75 | 2.85 | 3.3 | USIM_VCC=2.85 V |
| 35 | Reserved | - | Reserved | - | - | - | - | - |
| 36 | JTAG_TRST_N | I | JTAG reset | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 37 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 38 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 39 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 40 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 41 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 42 | JTAG_TCK | I | JTAG clock input | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 43 | Reserved | - | Reserved | - | - | - | - | - |
| 44 | Reserved | - | Reserved | - | - | - | - | - |
| 45 | Reserved | - | Reserved | - | - | - | - | - |
| 46 | Reserved | - | Reserved | - | - | - | - | - |
| 47 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---|---|---|---|---|---|---|---|---|
| 48 | GND | - | Ground | - | - | - | - | - |
| 49 | GND | - | Ground | - | - | - | - | - |
| 50 | GND | - | Ground | - | - | - | - | - |
| 51 | GPIO | I/O | General Purpose I/O pins. The function of these pins has not been defined. | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 | - |
| | | | | $V_{OH}$ | 1.35 | - | 1.8 | - |
| | | | | $V_{OL}$ | 0 | - | 0.45 | - |
| 52 | GND | - | Ground | - | - | - | - | - |
| 53 | GND | - | Ground | - | - | - | - | - |
| 54 | GND | - | Ground | - | - | - | - | - |
| 55 | GPIO | I/O | General Purpose I/O pins. The function of these pins has not been defined. | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 | - |
| | | | | $V_{OH}$ | 1.35 | - | 1.8 | - |
| | | | | $V_{OL}$ | 0 | - | 0.45 | - |
| 56 | GND | - | Ground | - | - | - | - | - |
| 57 | GND | - | Ground | - | - | - | - | - |
| 58 | GND | - | Ground | - | - | - | - | - |
| 59 | GND | - | Ground | - | - | - | - | - |
| 60 | Reserved | - | Reserved | - | - | - | - | - |
| 61 | Reserved | - | Reserved | - | - | - | - | - |
| 62 | Reserved | - | Reserved | - | - | - | - | - |
| 63 | Reserved | - | Reserved | - | - | - | - | - |
| 64 | Reserved | - | Reserved | - | - | - | - | - |
| 65 | Reserved | - | Reserved | - | - | - | - | - |
| 66 | Reserved | - | Reserved | - | - | - | - | - |
| 67 | Reserved | - | Reserved | - | - | - | - | - |
| 68 | Reserved | - | Reserved | - | - | - | - | - |
| 69 | Reserved | - | Reserved | - | - | - | - | - |
| 70 | Reserved | - | Reserved | - | - | - | - | - |
| 71 | WAKEUP_O | O | Module to wake up | $V_{OH}$ | 1.35 | - | 1.8 | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---------|----------|----------|-------------|-----------|----------|----------|----------|----------|
|         | UT       |          | the host    | $V_{OL}$  | 0        | -        | 0.45     |          |
| 72      | JTAG_TDO | O        | JTAG test data output | $V_{OH}$ | 1.35 | - | 1.8 | |
|         |          |          |             | $V_{OL}$  | 0        | -        | 0.45     | -        |
| 73      | UART0_DSR | O       | UART0 data set ready | $V_{OH}$ | 1.35 | - | 1.8 | - |
|         |          |          |             | $V_{OL}$  | 0        | -        | 0.45     | -        |
| 74      | UART0_RTS | O       | UART0 ready for receive | $V_{OH}$ | 1.35 | - | 1.8 | - |
|         |          |          |             | $V_{OL}$  | 0        | -        | 0.45     | -        |
| 75      | UART0_DCD | O       | UART0 data carrier detect | $V_{OH}$ | 1.35 | - | 1.8 | - |
|         |          |          |             | $V_{OL}$  | 0        | -        | 0.45     | -        |
| 76      | UART0_TX | O        | UART0 transmit output | $V_{OH}$ | 1.35 | - | 1.8 | - |
|         |          |          |             | $V_{OL}$  | 0        | -        | 0.45     | -        |
| 77      | UART0_RING | O      | UART0 ring indicator | $V_{OH}$ | 1.35 | - | 1.8 | - |
|         |          |          |             | $V_{OL}$  | 0        | -        | 0.45     | -        |
| 78      | UART0_RX | I        | UART0 receive data input | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|         |          |          |             | $V_{IL}$  | –0.3     | -        | 0.5      | -        |
| 79      | UART0_DTR | I       | Data terminal ready | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|         |          |          |             | $V_{IL}$  | –0.3     | -        | 0.5      |          |
| 80      | UART0_CTS | I       | UART0 clear to send | $V_{IH}$ | 1.2 | 1.8 | 2.1 | |
|         |          |          |             | $V_{IL}$  | –0.3     | -        | 0.5      |          |
| 81      | POWER_ON_OFF | I    | System power-on or power-off | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
|         |          |          |             | $V_{IL}$  | –0.3     | -        | 0.5      | -        |
| 82      | NC       | -        | Not connected, please keep this pin open | - | - | - | - | - |
| 83      | NC       | -        | Not connected, please keep this pin open | - | - | - | - | - |
| 84      | NC       | -        | Not connected, please keep this pin open | - | - | - | - | - |
| 85      | USB_DM   | I/O      | USB Data- defined in the USB 2.0 Specification | - | - | - | - | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---|---|---|---|---|---|---|---|---|
| 86 | USB_DP | I/O | USB Data+ defined in the USB 2.0 Specification | - | - | - | - | - |
| 87 | JTAG_TDI | I | JTAG test data input | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 | - |
| 88 | USIM_RESET | O | USIM card reset | $V_{OH}$ | 0.7 x USIM_VCC | - | 3.3 | USIM_VCC=1.8 V or 2.85 V |
| | | | | $V_{OL}$ | 0 | - | 0.2 x USIM_VCC | |
| 89 | USIM_DATA | I/O | USIM card data | $V_{IH}$ | 0.7 x USIM_VCC | - | 3.3 | USIM_VCC=1.8 V or 2.85 V |
| | | | | $V_{IL}$ | 0 | - | 0.2 x USIM_VCC | |
| | | | | $V_{OH}$ | 0.7 x USIM_VCC | - | 3.3 | |
| | | | | $V_{OL}$ | 0 | - | 0.2 x USIM_VCC | |
| 90 | USIM_CLK | O | USIM card clock | $V_{OH}$ | 0.7 x USIM_VCC | - | 3.3 | USIM_VCC=1.8 V or 2.85 V |
| | | | | $V_{OL}$ | 0 | - | 0.2 x USIM_VCC | |
| 91 | Reserved | - | Reserved | - | - | - | - | - |
| 92 | Reserved | - | Reserved | - | - | - | - | - |
| 93 | JTAG_RTCK | O | JTAG return clock | $V_{OH}$ | 1.35 | - | 1.8 | - |
| | | | | $V_{OL}$ | 0 | - | 0.45 | - |
| 94 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 95 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 96 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 97 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---|---|---|---|---|---|---|---|---|
| 98 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 99 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 100 | RESIN_N | I | Reset module. | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 | - |
| 101 | LED_MODE | I | Mode indicator Current sink Drive strength: 10 mA | - | - | - | - | - |
| 102 | Reserved | - | Reserved | - | - | - | - | - |
| 103 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 104 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 105 | GPIO | I/O | General Purpose I/O pins. The function of these pins has not been defined. | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 | - |
| | | | | $V_{OH}$ | 1.35 | - | 1.8 | - |
| | | | | $V_{OL}$ | 0 | - | 0.45 | - |
| 106 | GND | - | Ground | - | - | - | - | - |
| 107 | MAIN_ANT | - | RF main antenna pad | - | - | - | - | - |
| 108 | GND | - | Ground | - | - | - | - | - |
| 109 | GPIO | I/O | General Purpose I/O pins. The function of these pins has not been defined. | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 | - |
| | | | | $V_{OH}$ | 1.35 | - | 1.8 | - |
| | | | | $V_{OL}$ | 0 | - | 0.45 | - |
| 110 | GND | - | Ground | - | - | - | - | - |
| 111 | GPS_ANT | - | GPS antenna pad | - | - | - | - | - |
| 112 | GND | - | Ground | - | - | - | - | - |
| 113 | GPIO | I/O | General Purpose | $V_{IH}$ | 1.2 | 1.8 | 2.1 | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | I/O pins. The function of these pins has not been defined. | $V_{IL}$ | –0.3 | - | 0.5 | - |
| | | | | $V_{OH}$ | 1.35 | - | 1.8 | - |
| | | | | $V_{OL}$ | 0 | - | 0.45 | - |
| 114 | GND | - | Ground | - | - | - | - | - |
| 115 | AUX_ANT | - | RF AUX antenna pad | - | - | - | - | - |
| 116 | GND | - | Ground | - | - | - | - | - |
| 117 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 118 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 119 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 120 | NC | - | Not connected, please keep this pin open | - | - | - | - | - |
| 121 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 122 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 123 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 124 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 125 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 126 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 127 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 128 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 129 | GND | - | Thermal Ground Pad | - | - | - | - | - |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---|---|---|---|---|---|---|---|---|
| 130 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 131 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 132 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 133 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 134 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 135 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 136 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 137 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 138 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 139 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 140 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 141 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 142 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 143 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 144 | GND | - | Thermal Ground Pad | - | - | - | - | - |
| 145 | GND | - | Thermal Ground Pad | - | - | - | - | - |

📖 NOTE

- **P** indicates power pins; **I** indicates pins for digital signal input; **O** indicates pins for digital signal output. **PO** indicates power output pins; **PI** indicates power input pins.

- $V_{IL}$ indicates Low-level Input voltage; $V_{IH}$ indicates High-level Input voltage; $V_{OL}$ indicates Low-level Output voltage; $V_{OH}$ indicates High-level Output voltage.

- The **NC** (Not Connected) pins are floating and there are no signal connected to these pins.

- The **Reserved** pins are internally connected to the module. Therefore, these pins should not be used, otherwise they may cause problems. Please contact with us for more details about this information.

# 3.3 Power Interface

## 3.3.1 Overview

The power supply part of the MU609 module contains:

- VBAT pins for the power supply
- VCC_EXT1 pin for external power output with 1.8 V
- USIM_VCC pin for USIM card power output

Table 3-2 lists the definitions of the pins on the power supply interface.

**Table 3-2** Definitions of the pins on the power supply interface

| Pin No. | Pin Name | Pad Type | Description | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---------|----------|----------|-------------|----------|----------|----------|----------|
| 12 and 13 | VBAT | PI | 3.3 V DC supply input. | 3.3 | 3.8 | 4.2 | - |
| 48–50, 52–54, 56–59, 106, 108, 110, 112, 114 and 116 | GND | - | Ground | - | - | - | - |
| 32 | VCC_EXT1 | PO | 1.8 V power output | - | 1.8 | - | - |
| 34 | USIM_VCC | P | Power supply for USIM card | 1.75 | 1.8 | 1.98 | USIM_VCC =1.8 V |
| | | | | 2.75 | 2.85 | 3.3 | USIM_VCC =2.85 V |
| 121–145 | GND | - | Thermal Ground Pad | - | - | - | - |

## 3.3.2 Power Supply VBAT Interface

When the MU609 module works normally, power is supplied through the VBAT pins and the voltage ranges from 3.3 V to 4.2 V (typical value: 3.8 V). The 145-pin LGA provides two VBAT pins and GND pins for external power input. To ensure that the MU609 module works normally, all the pins must be used efficiently.

When the MU609 module is used for different external applications, pay special attention to the design for the power supply. When the MU609 module works at 2G mode and transmits signals at the maximum power, the transient current may reach the transient peak value of about 2.75 A due to the differences in actual network environments. In this case, the VBAT voltage drops. If you want wireless good performance, please make sure that the voltage does not decrease below 3.3 V in any case. Otherwise, exceptions such as restart of the MU609 module may occur.

A low-dropout (LDO) regulator or switch power with current output of more than 3 A is recommended for external power supply. Furthermore, five 220 µF or above energy storage capacitors are connected in parallel at the power interface of the MU609 module. In addition, to reduce the impact of channel impedance on voltage drop, you are recommended to try to shorten the power supply circuit of the VBAT interface.

It is recommended that add the EMI ferrite bead (NR3015T4R7M manufactured by TAIYO YUDEN or VLS3015T-4R7MR99 manufactured by TDK is recommended) to directly isolate DTE from DCE in the power circuit. Figure 3-2 shows the recommended power circuit of MU609 module.

**Figure 3-2** Recommended power circuit of MU609 module
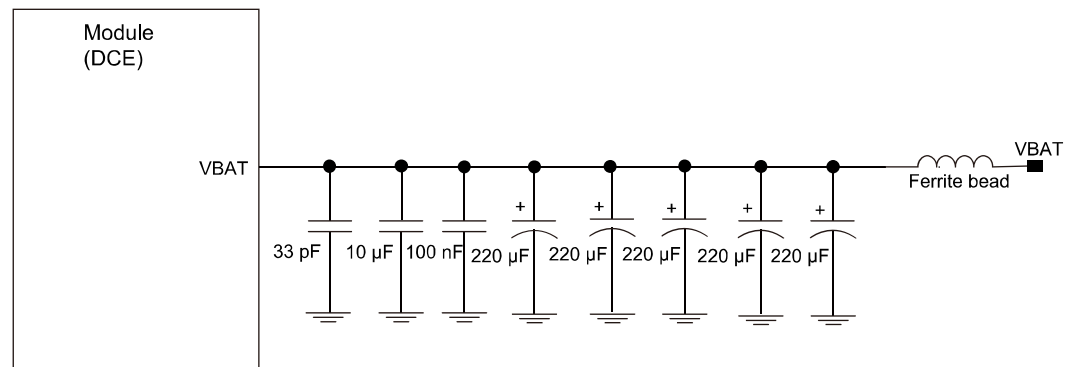


When the system power restarts, a discharge circuit is recommended to make sure the power voltage drops below 1.9 V for 1s at least.

### 3.3.3 Output Power Supply Interface

Output power supply interface is VCC_EXT1.

Through the output power supply interface, the MU609 module can supply 1.8 V power externally with an output current of 10 mA (typical value) for external level conversion or other applications.

If the MU609 module is in sleep mode, the output power supply interface is in the low power consumption state (< 500 µA). If the MU609 module is in power down mode, the output power supply is in the disabled state.

# 3.4 Signal Control Interface

## 3.4.1 Overview

The signal control part of the interface in the MU609 module consists of the following:

- Power-on/off (POWER_ON_OFF) pin
- System reset (RESIN_N) pin
- WAKEUP_IN Signal (WAKEUP_IN) pin
- WAKEUP_OUT Signal (WAKEUP_OUT) pin
- SLEEP_STATUS Signal (SLEEP_STATUS) pin
- LED signal (LED_MODE) pin

Table 3-3 lists the pins on the signal control interface.

**Table 3-3** Definitions of the pins on the signal control interface

| Pin No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---|---|---|---|---|---|---|---|
| 81 | POWER_ON_OFF | I | Pin for controlling power-on and power-off | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
|  |  |  |  | $V_{IL}$ | −0.3 | - | 0.5 |
| 100 | RESIN_N | I | Pin for resetting the system | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
|  |  |  |  | $V_{IL}$ | −0.3 | - | 0.5 |
| 11 | WAKEUP_IN | I | H: Sleep mode is disabled | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
|  |  |  | L: Sleep mode is enabled (default value) | $V_{IL}$ | −0.3 | - | 0.5 |
| 71 | WAKEUP_OUT | O | Module to wake up the host. H: Wake up the host, the module hold 1s high-level-voltage pulse and then output low-level-voltage. | $V_{OH}$ | 1.35 | - | 1.8 |
|  |  |  | L: Do not wake up the host (default value). | $V_{OL}$ | 0 | - | 0.45 |
| 15 | SLEEP_STATUS | O | Indicates sleep status of MU609 H: MU609 is in wakeup state. | $V_{OH}$ | 1.35 | - | 1.8 |
|  |  |  | L: MU609 is in sleep state. | $V_{OL}$ | 0 | - | 0.45 |
| 101 | LED_MODE | I | Mode indicator Current sink Drive strength: 10 mA | - | - | - | - |

## 3.4.2 Power-on/off (POWER_ON_OFF) Pin

The MU609 module can be controlled to power on/off by the POWER_ON_OFF pin.

**Table 3-4** Two states of POWER_ON_OFF

| Item. | Pin state | Description |
|-------|-----------|-------------|
| 1 | Low (when MU609 is in power off state.) | MU609 is powered on. **POWER_ON_OFF pin should be pulled down for 0.5s to 1.0s.** |
| 2 | Low (when MU609 is in power on state.) | MU609 is powered off. **POWER_ON_OFF pin should be pulled down for 3.0s to 5.0s.** |

**Figure 3-3** Connections of the POWER_ON_OFF pin
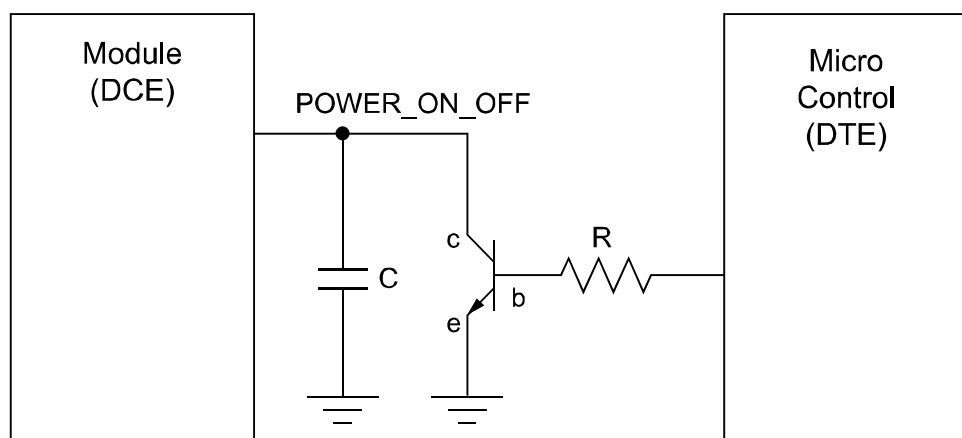


## Power-On Time Sequence

After VBAT has been applied and is stable, the POWER_ON_OFF signal is pulled down, and then the module will boot up.

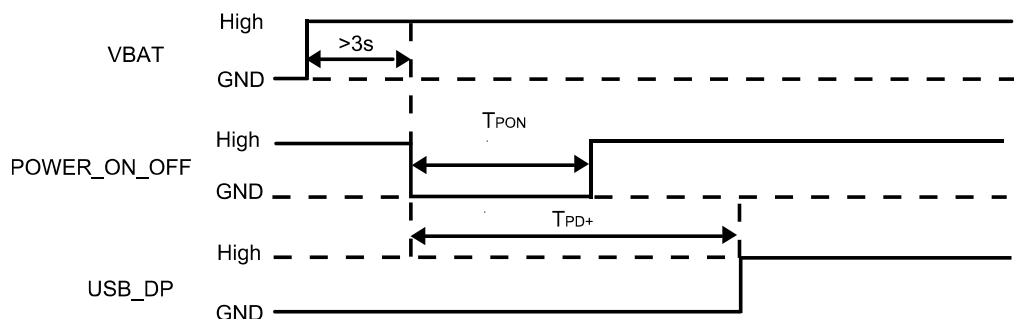During power on timing, please make sure the VBAT is stable.

**Figure 3-4** Power on timing sequence

**Table 3-5** Power on timing

| Parameter | Comments | Time (Nominal values) | Unit |
|---|---|---|---|
| $T_{PON}$ | POWER_ON_OFF turn on time. | 0.5–1.0 | s |
| $T_{PD+}$ | POWER_ON_OFF Valid to USB D+ high | 3.0–5.0 | s |

If the DTE needs to detect the PID/VID of module during the BIOS phase, the detection time should exceed the $T_{PD+}$ time.

## Power-Off Time Sequence

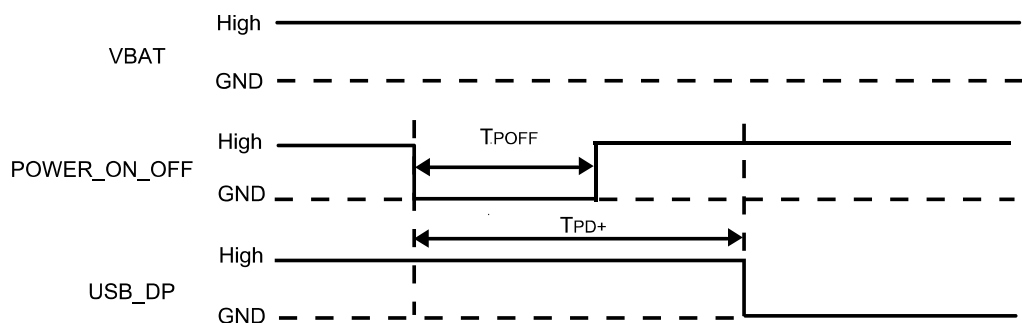**Figure 3-5** Power off timing sequence



**Table 3-6** Power off timing

| Parameter | Comments | Time (Nominal values) | Unit |
|---|---|---|---|
| $T_{POFF}$ | POWER_ON_OFF turn off time. | 3.0 | s |
| $T_{PD+}$ | POWER_ON_OFF Valid to USB D+ low | 3.0–5.0 | s |

## 3.4.3 RESIN_N Pin

The RESIN_N pin is used to reset the module's system. When the software stops responding, the RESIN_N pin can be pulled down to reset the hardware.

**Figure 3-6** Connections of the RESIN_N pin



---
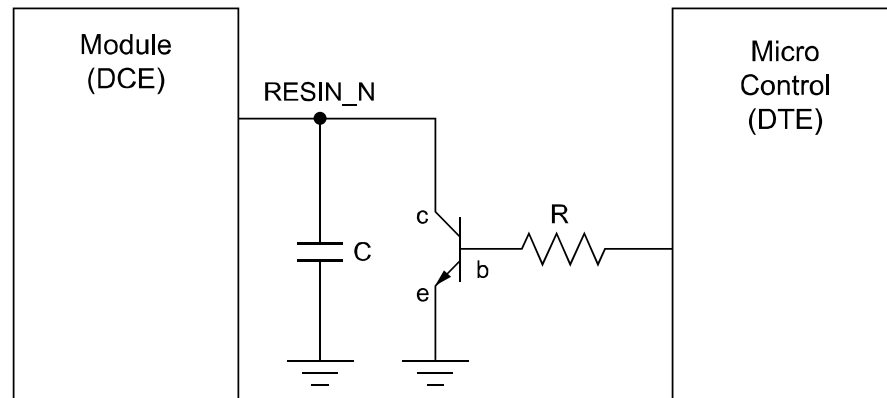
⚠️ **CAUTION**

As the RESIN_N and POWER_ON_OFF signals are relatively sensitive, it is recommended that you install a 10 nF–0.1 μF capacitor near the RESIN_N and POWER_ON_OFF pins of the interface for filtering. In addition, when you design a circuit on the PCB of the interface board, it is recommended that the circuit length not exceed 20 mm and that the circuit be kept at a distance of 2.54 mm (100 mil) at least from the PCB edge. Furthermore, you need to wrap the area adjacent to the signal wire with a ground wire. Otherwise, the module may be reset due to interference.

---

The MU609 module supports hardware reset function. If the software of the MU609 module stops responding, you can reset the hardware through the RESIN_N signal as shown in Figure 3-7 .When a low-level pulse is supplied through the RESIN_N pin, the hardware will be reset. After the hardware is reset, the software starts powering on the module and reports relevant information according to the actual settings. For example, the AT command automatically reports ^SYSSTART.
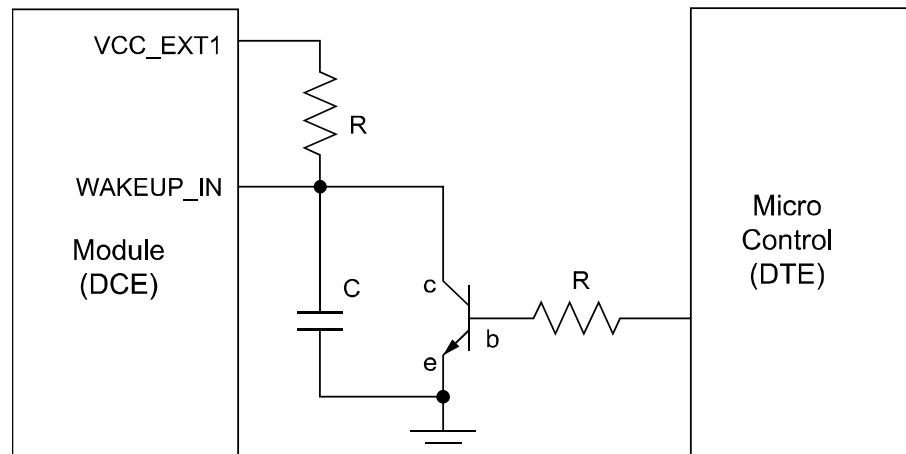
**Figure 3-7** Reset pulse timing
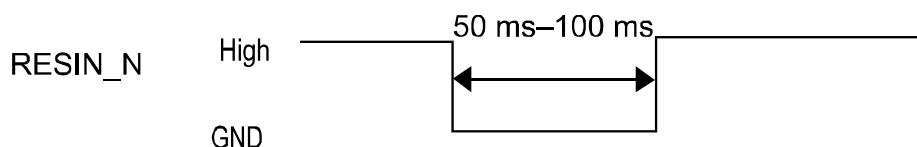


## 3.4.4 WAKEUP_IN Signal

WAKEUP_IN pin is the authorization signal of MU609 entering sleep mode. If this pin is floating, it will keep in low level by default. Table 3-1 shows the definition of the WAKEUP_IN signal.

This pin is pulled up to high level (1.8 V), the module cannot enter sleep mode.

**Figure 3-8** Connections of the WAKEUP_IN pin



## 3.4.5 WAKEUP_OUT Signal

The WAKEUP_OUT signal is used to wake up the external devices.

Table 3-3 shows the definition of the WAKEUP_OUT signal.

Figure 3-9 shows recommended circuit of the WAKEUP_OUT pin.

**Figure 3-9** Connections of the WAKEUP_OUT pin
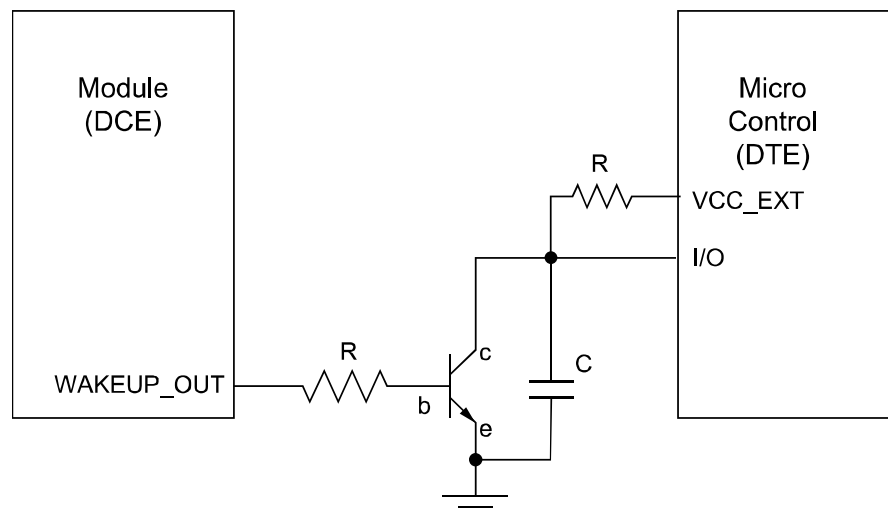


## 3.4.6 SLEEP_STATUS Signal

SLEEP_STATUS signal is used to indicate the sleep status of MU609. The external devices can get to know whether the module is in sleep mode by reading SLEEP_STATUS pin.

When SLEEP_STATUS pin is in high level, MU609 is in wakeup state.

When SLEEP_STATUS pin is in low level, MU609 is in sleep state.

Figure 3-10 shows recommended circuit of the SLEEP_STATUS pin.

**Figure 3-10** Connections of the SLEEP_STATUS pin



## 3.4.7 LED_MODE Signal

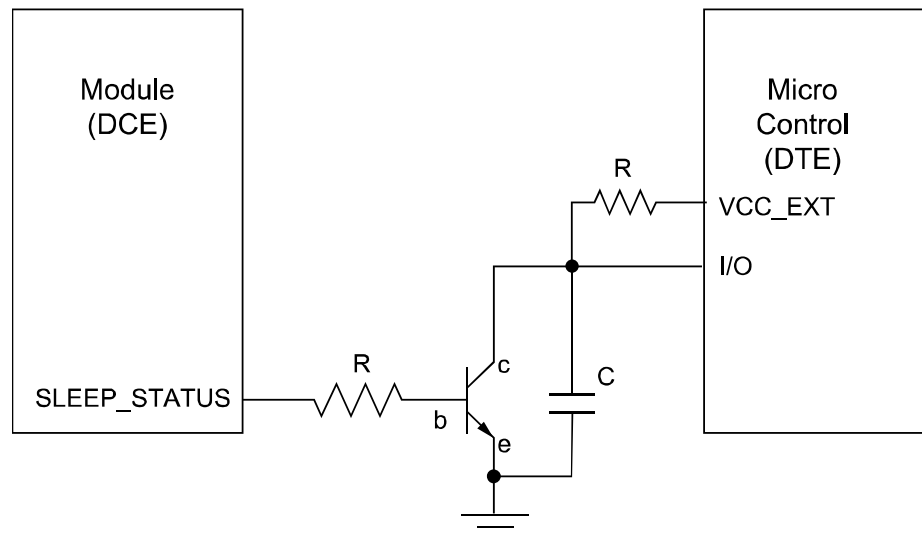MU609 provides a LED_MODE signal to indicate the work status.

**Table 3-7** State of the LED_MODE pin

| No. | Operating Status | LED_MODE |
|-----|------------------|----------|
| 1 | No service/Restricted service | Outputs: low (0.1s)-high (0.1s)-low (0.1s)-high (1.7s)<br>2s cycle |
| 2 | Register to the network | Outputs: low (0.1s)-high (1.9s)<br>2s cycle |
| 3 | Dial-up successfully | Outputs: low |

## External Circuits

Figure 3-11 shows the recommended circuits of the LED_MODE pin. According to LED feature, you can adjust the LED brightness by adjusting the resistance of resistor R. The mode indicator (LED_MODE) is current sink. Drive strength: 10mA.

**Figure 3-11** Driving circuit
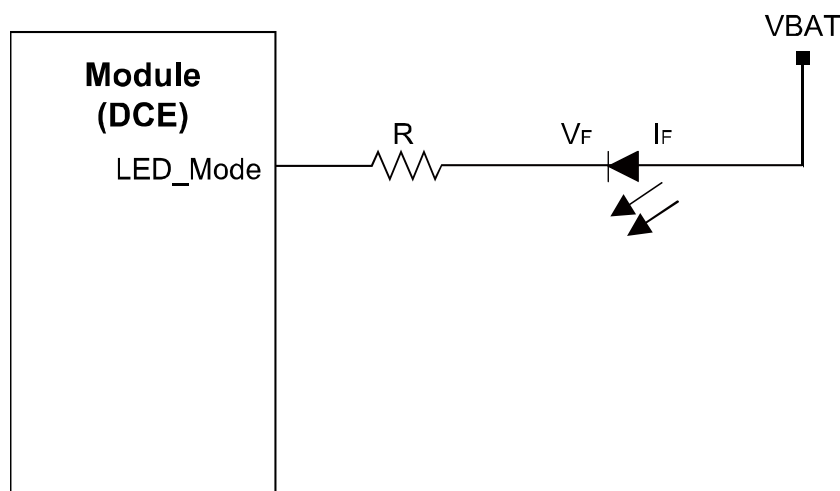


# 3.5 UART Interface

## 3.5.1 Overview

The MU609 module provides the UART0 (8-wire UART) interface for one asynchronous communication channel. As the UART0 interface supports signal control through standard modem handshake, AT commands are entered and serial communication is performed through the UART0 interface. The UART1 (2-wire UART) interface is provided by MU609 module. AT commands are entered through the UART1 interface for debugging. The UART has the following features:

- Full-duplex
- 7-bit or 8-bit data
- 1-bit or 2-bit stop bit
- Odd parity check, even parity check, or non-check
- Baud rate clock generated by the system clock
- Direct memory access (DMA) transmission
- Baud rate ranging from 600 bit/s to 230400 bit/s (115200 bit/s by default)

  Baud rate adaptive changes are not supported.

Table 3-8 lists the UART interface signals.

**Table 3-8** UART interface signals

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---|---|---|---|---|---|---|---|
| 1 | UART1_TX | O | UART1 transmit output only for debugging. | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 4 | UART1_RX | I | UART1 receive | $V_{IH}$ | 1.2 | 1.8 | 2.1 |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---------|----------|----------|-------------|-----------|----------|----------|----------|
| | | | data input for debugging. | $V_{IL}$ | −0.3 | - | 0.5 |
| 76 | UART0_TX | O | UART0 transmit output | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 78 | UART0_RX | I | UART0 receive data input | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 77 | UART0_RING | O | UART0 Ring Indicator | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 74 | UART0_RTS | O | UART0 Ready for receive | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 79 | UART0_DTR | I | Data Terminal Ready | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 80 | UART0_CTS | I | UART0 Clear to Send | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 75 | UART0_DCD | O | UART0 Data Carrier Detect | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 73 | UART0_DSR | O | UART0 Data Set Ready | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |

## 3.5.2 Circuit Recommended for the UART Interface

Figure 3-12 Connection of the UART interface in the MU609 module (DCE) with the host (DTE)
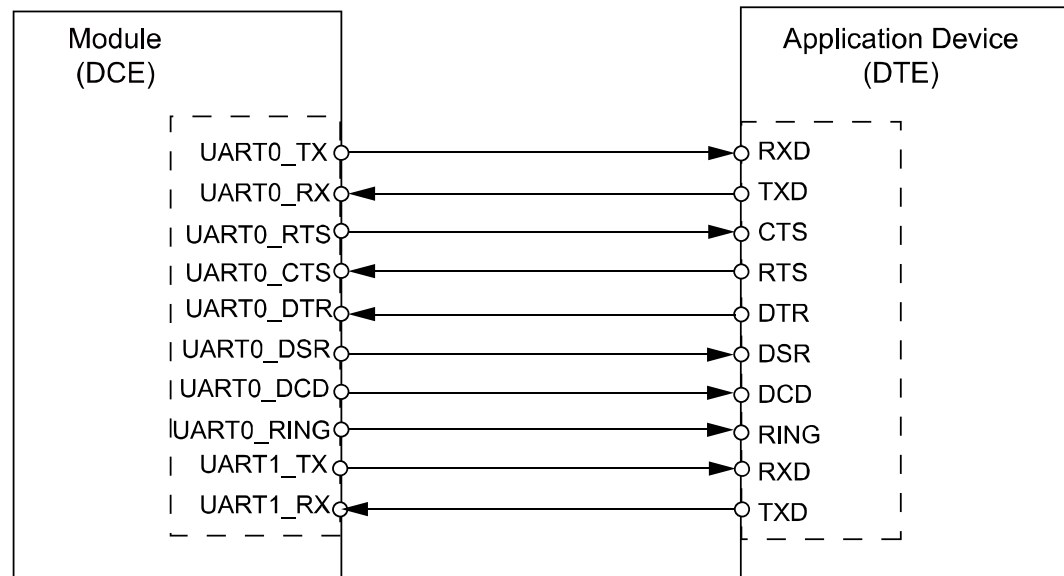


The RS-232 chip can be used to connect the MU609 module with UART. In this connection, the Complementary Metal Oxide Semiconductor (CMOS) logic level and the Electronic Industries Association (EIA) level are converted mutually. For example, it is recommended that you use the MAX218 chip (The MAX218's max baud is 120000 bit/s) with a 2-wire serial port.

◻ NOTE

- It is recommended that set the pins related to UART interface as test points on the DTE board for debugging.

- When you want the module to be in sleep status, UART0_RX and UART1_RX must be pulled down.

- The level of RS-232 transceivers must match that of the MU609 module.

## 3.6 USB Interface

The MU609 is compliant with USB 2.0 High speed protocol. The USB interface is powered directly from the VBAT supply. The USB signal lines are compatible with the USB 2.0 signal specifications. Figure 3-13 shows the circuit of the USB interface.

Table 3-9 Definition of the USB interface

| PIN No. | Pin Name | Pad Type | Description |
|---------|----------|----------|-------------|
| 85 | USB_DM | I/O | USB data signal D- |
| 86 | USB_DP | I/O | USB data signal D+ |

According to USB protocol, for bus timing or electrical characteristics of MU609 USB signal, please refer to the chapter 7.3.2 of *Universal Serial Bus Specification 2.0.*

**Figure 3-13** Recommended circuit of USB interface
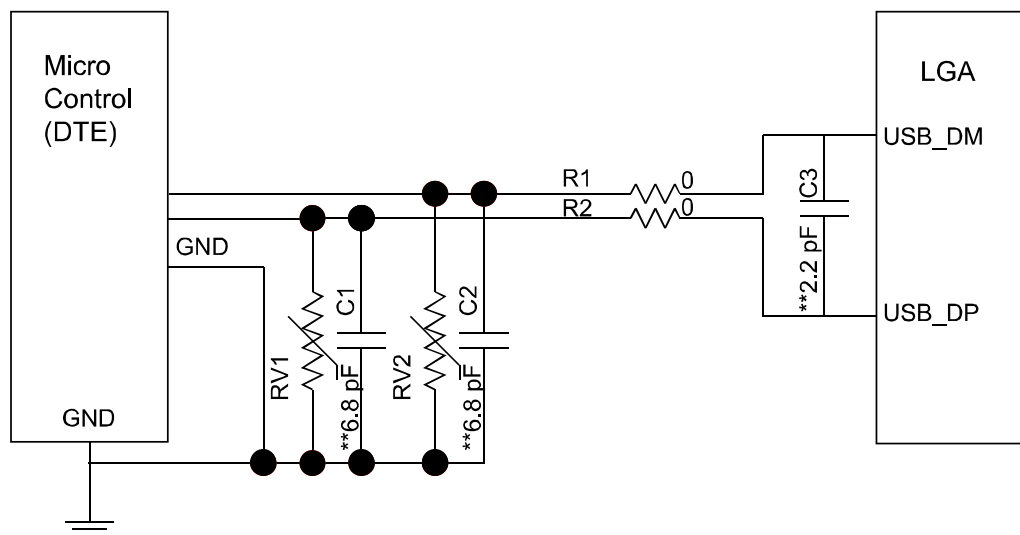


## NOTE

- USB_DM and USB_DP are required to control the differential impedance –90 ohm (±10%).
- The length of the gap between USB_DM and USB_DP should not exceed 5 mil.
- The USB differential signal trace must be as short as possible, and laid out away from high-speed clock signals and other periodic signals as far as possible.
- Minimize through-holes and turning angles on the USB signal trace to reduce signal reflection and impedance change.
- Do not route the USB signal trace under the following components: crystal, oscillator, clock circuit, electromagnetic component, and IC that uses or generates clocks.
- Avoid stubs on the USB signal trace because stubs generate reflection and affect the signal quality.
- Route the USB signal trace on a complete reference plane (GND) and avoid crossing inter-board gaps because inter-board gaps cause a large reflow channel area and increase inductance and radiation. In addition, avoid signal traces on different layers.
- The USB signal trace must be far away from core logical components because the high current pulse generated during the state transitions process of core components may impose interference on signals.
- The USB signal trace must be far away from board edges with a minimum distance of 20 × h (h indicates the vertical distance between the trace and the reference layer) to avoid signal radiation.
- C1 and C2 are ready for dealing with filter differential mode interference and C3 is ready for dealing with filter common mode interference. You can choose the value of the C1, C2 and C3 according to the actual PCB which is integrated 30 mm × 30 mm LGA Module

# 3.7 USIM Card Interface

## 3.7.1 Overview

The MU609 module provides a USIM card interface complying with the ISO 7816-3 standard and supports both Class B and Class C USIM cards.

**Table 3-10** USIM card interface signals

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) | Comments |
|---------|----------|----------|-------------|-----------|----------|----------|----------|----------|
| 88 | USIM_RESET | O | USIM card reset | $V_{OH}$ | 0.7 x USIM_VCC | - | 3.3 | USIM_VCC =1.8 V or 2.85 V |
| | | | | $V_{OL}$ | 0 | - | 0.2 x USIM_VCC | |
| 90 | USIM_CLK | O | USIM card clock | $V_{OH}$ | 0.7 x USIM_VCC | - | 3.3 | USIM_VCC =1.8 V or 2.85 V |
| | | | | $V_{OL}$ | 0 | - | 0.2 x USIM_VCC | |
| 89 | USIM_DATA | I/O | USIM card data | $V_{IH}$ | 0.7 x USIM_VCC | - | 3.3 | USIM_VCC =1.8 V or 2.85 V |
| | | | | $V_{IL}$ | 0 | - | 0.2 x USIM_VCC | |
| | | | | $V_{OH}$ | 0.7 x USIM_VCC | - | 3.3 | |
| | | | | $V_{OL}$ | 0 | - | 0.2 x USIM_VCC | |
| 34 | USIM_VCC | PO | Power supply for USIM card | - | 1.75 | 1.8 | 1.98 | USIM_VCC =1.8 V |
| | | | | - | 2.75 | 2.85 | 3.3 | USIM_VCC =2.85 V |

## 3.7.2 Circuit Recommended for the USIM Card Interface

As the MU609 module is not equipped with a USIM socket, you need to place a USIM socket on the user interface board.

Figure 3-14 shows the circuit of the USIM card interface.

**Figure 3-14** Circuit of the USIM card interface
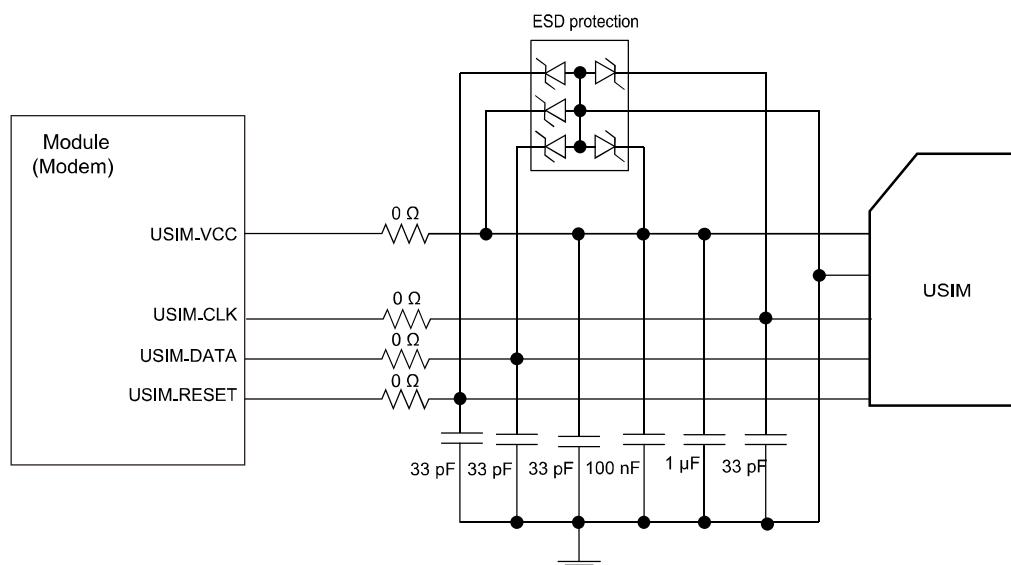


⚠️ **CAUTION**

- To meet the requirements of 3GPP TS 51.010-1 protocols and electromagnetic compatibility (EMC) authentication, the USIM socket should be placed near the LGA interface (it is recommended that the PCB circuit connects the LGA interface and the USIM socket does not exceed 100 mm), because a long circuit may lead to wave distortion, thus affecting signal quality.

- It is recommended that you wrap the area adjacent to the USIM_CLK and USIM_DATA signal wires with ground. The Ground pin of the USIM socket and the Ground pin of the USIM card must be well connected to the power Ground pin supplying power to the MU609 module.

- A 100 nF capacitor and1 μF capacitor are placed between the USIM_VCC and GND pins in a parallel manner (If USIM_VCC circuit is too long, that the larger capacitance such as 4.7 μF can be employed if necessary). Three 33 pF capacitors are placed between the USIM_DATA and Ground pins, the USIM_RESET and Ground pins, and the USIM_CLK and Ground pins in parallel to filter interference from RF signals.

- It is recommended to take electrostatic discharge (ESD) protection measures near the USIM card socket. The TVS diode with Vrwm of 5 V and junction capacitance less than 10 pF must be placed as close as possible to the USIM socket, and the Ground pin of the ESD protection component is well connected to the power Ground pin that supplies power to the MU609 module.

# 3.8 Audio Interface

MU609 provided one PCM digital audio interface. Table 3-11 lists the signals on the digital audio interface.

**Table 3-11** Signals on the digital audio interface

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---------|----------|----------|-------------|-----------|----------|----------|----------|
| 8 | PCM_CLK | O | PCM clock | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 6 | PCM_DIN | I | PCM data input | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 5 | PCM_SYNC | O | PCM interface sync | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 7 | PCM_DOUT | O | PCM data output | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |

The MU609 PCM interface enables communication with an external codec to support linear format.

**Figure 3-15** Circuit diagram of the interface of the PCM (MU609 is used as PCM master)
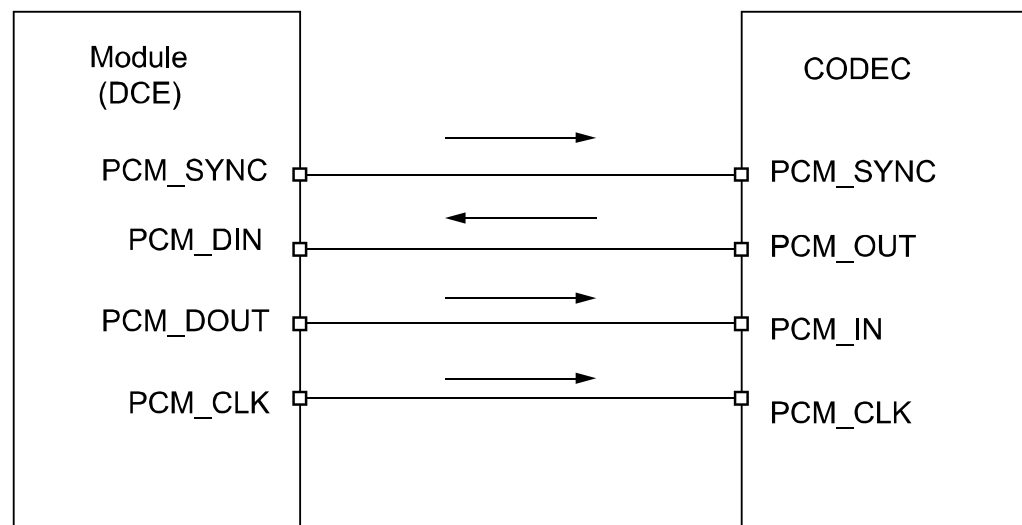


**NOTE**

- PCM_SYNC: Output when PCM is in master mode.
- PCM_CLK: Output when PCM is in master mode.
- The PCM function of MU609 is only supported in master mode.
- It is recommended that a TVS be used on the related interface, to prevent electrostatic discharge and protect integrated circuit (IC) components.

# 3.9 General Purpose I/O Interface

The MU609 module provides 5 GPIO pins for customers to use controlling signals which are worked at 1.8 V CMOS logic levels. Customers can use AT command to control the state of logic levels of 5 GPIO output signal. See the *HUAWEI MU609 HSPA LGA Module AT Command Interface Specification*.

**Table 3-12** Signals on the GPIO interface

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---|---|---|---|---|---|---|---|
| 51, 55, 105, 109 and 113 | GPIO | I/O | General Purpose I/O pins. The function of these pins has not been defined. | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| | | | | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |

# 3.10 JTAG Interface

The MU609 module provides Joint Test Action Group (JTAG) interface. Table 3-13 shows the signals on the JTAG interface. It is recommended that route out the 9 pins as test points on the DTE for tracing and debugging.

**Table 3-13** Signals on the JTAG interface

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---|---|---|---|---|---|---|---|
| 30 | JTAG_TMS | I | JTAG test mode selection | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 36 | JTAG_TRST_N | I | JTAG test reset | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 42 | JTAG_TCK | I | JTAG test clock | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 72 | JTAG_TDO | O | JTAG test data output | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |
| 87 | JTAG_TDI | I | JTAG test serial data input | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | −0.3 | - | 0.5 |
| 93 | JTAG_RTCK | O | JTAG test clock return signal | $V_{OH}$ | 1.35 | - | 1.8 |
| | | | | $V_{OL}$ | 0 | - | 0.45 |

| PIN No. | Pin Name | Pad Type | Description | Parameter | Min. (V) | Typ. (V) | Max. (V) |
|---------|----------|----------|-------------|-----------|----------|----------|----------|
| 14 | PS_HOLD | I | Power supply hold signal to PMU | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 |
| 100 | RESIN_N | I | Reset module. | $V_{IH}$ | 1.2 | 1.8 | 2.1 |
| | | | | $V_{IL}$ | –0.3 | - | 0.5 |
| 32 | VCC_EXT1 | PO | 1.8 V power output | - | - | 1.8 | - |

☐ NOTE

It is recommended that route out the JTAG pins on the DTE board as the test point for debugging.

# 3.11 RF Antenna Interface

The MU609 module provided three antenna pads (MAIN_ANT, GPS_ANT and AUX_ANT) for connecting the external antennas.

Table 3-14  Definition of the antenna pads

| PIN No. | Pin Name | Pad Type | Description |
|---------|----------|----------|-------------|
| 107 | MAIN_ANT | - | RF MAIN pad |
| 111 | GPS_ANT | - | RF GPS pad |
| 115 | AUX_ANT | - | RF AUX pad |

Route the antenna pad as close as possible to antenna connector. In addition, the impedance of RF signal traces must be 50 Ω.

**Figure 3-16** RF signal trace design about MAIN_ANT for reference (the same for AUX & GPS)
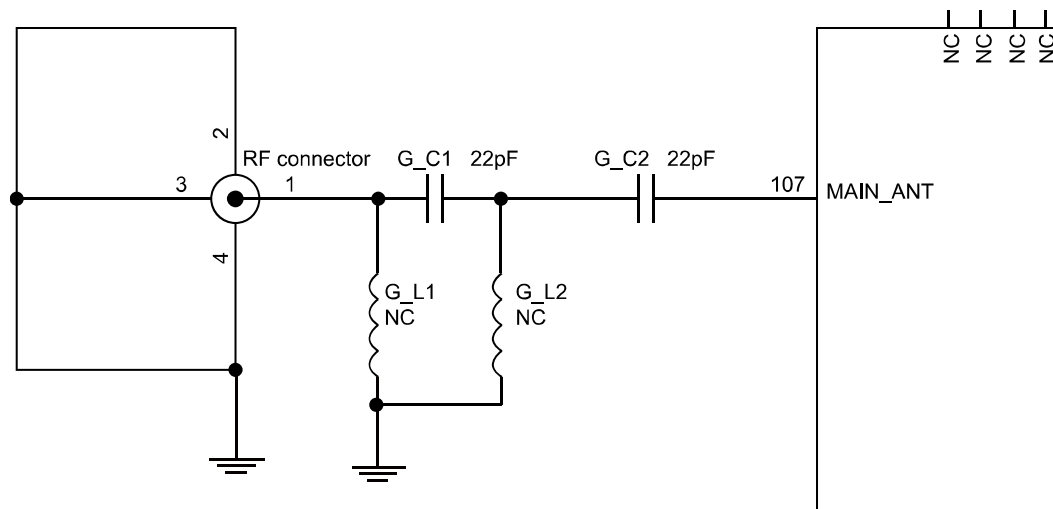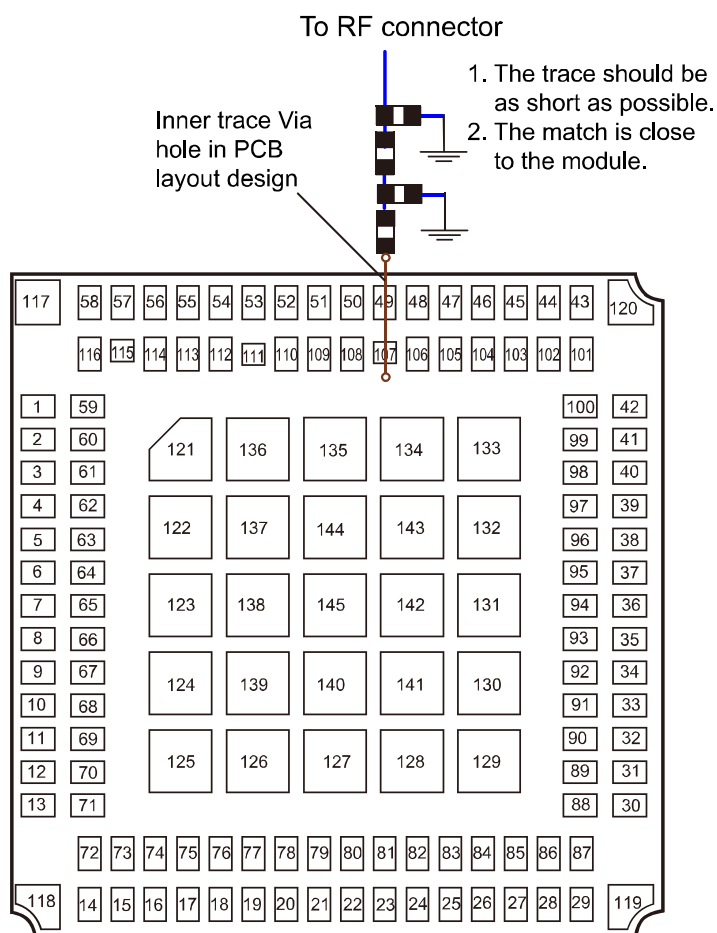


**Figure 3-17** RF signal layout design about MAIN_ANT for reference (the same for AUX & GPS)

For the PCB designed by the user, the impedance of all the RF signal tracks must be 50 ohm. Generally, the impedance depends on the medium factor, track width, and distance from the floor.

In order to reflect the rules of design, the following figures indicate the complete structure of the microstrip and stripline with an impedance of 50 ohm as well as the reference design for stack.

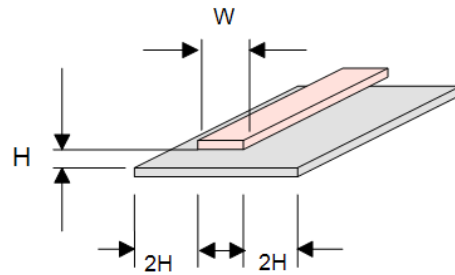**Figure 3-18** Complete structure of the microstrip

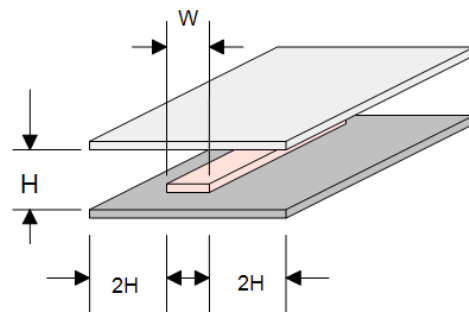**Figure 3-19** Complete structure of the stripline
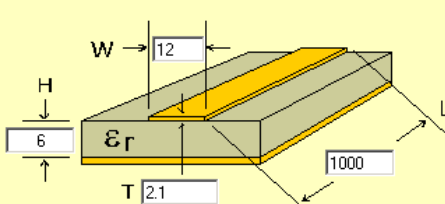
**Figure 3-20** Routing for the RF interface
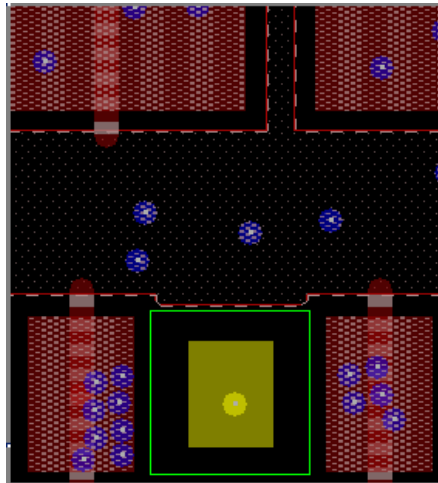


Please use tools such as Microstrip to calculate RF MAIN pad impedance. the RF MAIN pad dimension of MU609 is 1.1 mm (L) x 0.9 mm (W). You can get the impedance with lower the 50 Ω calculated by Microstrip as shown in the following figure. Yet the target impedance is 50 Ω. The solution is that to increase the thickness of dielectric material. You need carve out the copper area of the second layer that projected by the RF MAIN pad at top layer. How many layers should be carved out depend on the permittivity, track width, and distance from the floor of your own PCB.

**Figure 3-21** Reference layout
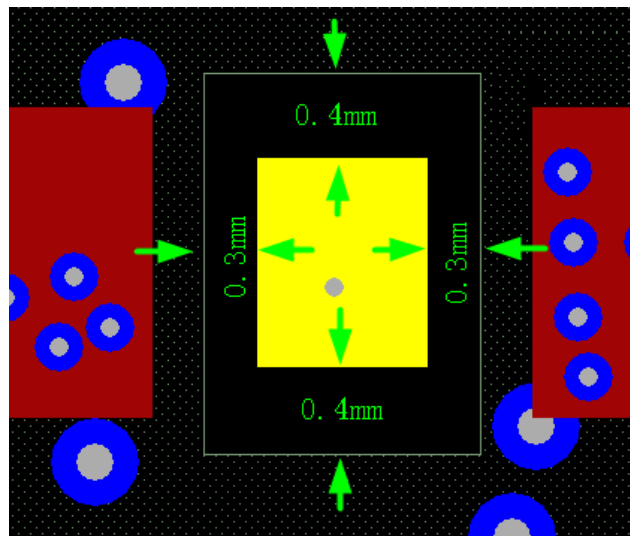


## 3.12 Reserved Interface

The MU609 module provides some reserved pins. All reserved pins cannot be used by the customer.

**Table 3-15** Reserved pin

| PIN No. | Pin Name | Pad Type | Description |
|---|---|---|---|
| 9, 10, 28, 29, 35, 43–46, 60–70, 91, 92 and 102 | Reserved | - | Reserved, please keep open |

## 3.13 NC Interface

The MU609 module has some NC pins. All NC pins should not be connected. Please keep these pins open.

| PIN No. | Pin Name | Pad Type | Description |
|---|---|---|---|
| 2, 3, 16–27, 31, 33, 37–41, 47, 82–84, 94–99, 103, 104 and 117–120 | NC | - | Not connected, please keep this pin open. |

# 4 RF Specifications

## 4.1 About This Chapter

This chapter describes the RF specifications of the MU609 module, including:

- Operating Frequencies
- Conducted RF Measurement
- Conducted Rx Sensitivity and Tx Power
- Antenna Design Requirements

## 4.2 Operating Frequencies

Table 4-1 shows the RF bands supported by MU609.

**Table 4-1** RF bands

| Operating Band | Tx | Rx |
|---|---|---|
| UMTS Band 1 | 1920 MHz–1980 MHz | 2110 MHz–2170 MHz |
| UMTS Band 2 | 1850 MHz–1910 MHz | 1930 MHz–1990 MHz |
| UMTS Band 5 | 824 MHz–849 MHz | 869 MHz–894 MHz |
| UMTS Band 8 | 880 MHz–915 MHz | 925 MHz–960 MHz |
| GSM 850 | 824 MHz–849 MHz | 869 MHz–894 MHz |
| GSM 900 | 880 MHz–915 MHz | 925 MHz–960 MHz |
| GSM 1800 (DCS) | 1710 MHz–1785 MHz | 1805 MHz–1880 MHz |
| GSM 1900 (PCS) | 1850 MHz–1910 MHz | 1930 MHz–1990 MHz |
| GPS | - | 1574.42 MHz–1576.42 MHz |

## 4.3 Conducted RF Measurement

### 4.3.1 Test Environment

| | |
|---|---|
| **Test instrument** | R&S CMU200 |
| **Power supply** | KEITHLEY 2306 |
| **RF cable for testing** | L08-C014-350 of DRAKA COMTEQ or Rosenberger<br>Cable length: 29 cm |

📖 NOTE
- The compensation for different frequency bands relates to the cable and the test environment.
- The instrument compensation needs to be set according to the actual cable conditions.

### 4.3.2 Test Standards

Huawei modules meet 3GPP test standards. Each module passes strict tests at the factory and thus the quality of the modules is guaranteed.

## 4.4 Conducted Rx Sensitivity and Tx Power

### 4.4.1 Conducted Receive Sensitivity

The conducted receive sensitivity is a key parameter that indicates the receiver performance of MU609.

**Table 4-2** MU609 conducted Rx sensitivity (unit: dBm)

| Band | Typical Value | Note |
|---|---|---|
| GSM 850 | –110 dBm | BER Class II < 2.44% |
| GSM 900 | –110 dBm | BER Class II < 2.44% |
| DCS 1800 | –109.5 dBm | BER Class II < 2.44% |
| PCS 1900 | –109 dBm | BER Class II < 2.44% |
| WCDMA Band 1 Main RX | –111 dBm | BER < 0.1% |
| WCDMA Band 2 Main RX | –110 dBm | BER < 0.1% |
| WCDMA Band 5 Main RX | –111 dBm | BER < 0.1% |
| WCDMA Band 8 Main RX | –112 dBm | BER < 0.1% |

**Table 4-3** MU609 GPS main characteristics

| Item | Typical Value |
|------|---------------|
| Receive Sensitivity (Cold start) | –144 dBm |
| Receive Sensitivity (Hot start) | –155 dBm |
| Receive Sensitivity (Tracking mode) | –155 dBm |
| TTFF @-130 dBm (Cold start) | 35s |
| TTFF @-130 dBm (Hot start) | 1s |

☐ NOTE

The test values are the average of some test samples.

## 4.4.2 Conducted Transmit Power

The conducted transmit power is another indicator that measures the performance of MU609. The conducted transmit power refers to the maximum power that the module tested at the antenna pad can transmit. According to the 3GPP protocol, the required transmit power varies with the power class.

Table 4-4 lists the required ranges of the conducted transmit power of MU609.

**Table 4-4** MU609 conducted Tx power

| Band | | Typical Value (Unit: dBm) | Note (Unit: dB) |
|------|------|---------------------------|-----------------|
| GSM850 | GMSK(1Tx Slot) | 32.5 | ±1.5 |
| | 8PSK(1Tx Slot) | 27 | ±2 |
| GSM900 | GMSK(1Tx Slot) | 32.5 | ±1.5 |
| | 8PSK(1Tx Slot) | 27 | ±2 |
| GSM1800 | GMSK(1Tx Slot) | 29.5 | ±1.5 |
| | 8PSK(1Tx Slot) | 26 | ±2 |
| GSM1900 | GMSK(1Tx Slot) | 29.5 | ±1.5 |
| | 8PSK(1Tx Slot) | 26 | ±2 |
| WCDMA Band 1 | | 23.5 | –1.5/+1 |
| WCDMA Band 2 | | 23.5 | –1.5/+1 |
| WCDMA Band 5 | | 23.5 | –1.5/+1 |
| WCDMA Band 8 | | 23.5 | –1.5/+1 |

# 4.5 Antenna Design Requirements

## 4.5.1 Antenna Design Indicators

### Antenna Efficiency

Antenna efficiency is the ratio of the input power to the radiated or received power of an antenna. The radiated power of an antenna is always lower than the input power due to the following antenna losses: return loss, material loss, and coupling loss. The efficiency of an antenna relates to its electrical dimensions. To be specific, the antenna efficiency increases with the electrical dimensions. In addition, the transmission cable from the antenna port of MU609 to the antenna is also part of the antenna. The cable loss increases with the cable length and the frequency. It is recommended that the cable loss is as low as possible.

The following antenna efficiency (free space) is recommended for MU609 to ensure high radio performance of the module:

- **Efficiency of the primary antenna: ≥ 40% (below 960 MHz); ≥ 50% (over 1710 MHz)**
- **Efficiency of the diversity antenna: ≥ half of the efficiency of the primary antenna in receiving band**
- **Efficiency of the GPS antenna: ≥ 50%**

In addition, the efficiency should be tested with the transmission cable.

### S11 or VSWR

S11 indicates the degree to which the input impedance of an antenna matches the reference impedance (50 Ω). S11 shows the resonance feature and impedance bandwidth of an antenna. Voltage standing wave ratio (VSWR) is another expression of S11. S11 relates to the antenna efficiency. S11 can be measured with a vector analyzer.

The following S11 value is recommended for the antenna of MU609:

- **S11 of the primary antenna: ≤ –6 dB**
- **S11 of the diversity antenna: ≤ –6 dB**
- **S11 of the GPS antenna: ≤ –10 dB**

In addition, S11 is less important than the efficiency, and S11 has weak correlation to wireless performance.

### Isolation

For a wireless device with multiple antennas, the power of different antennas is coupled with each other. Antenna isolation is used to measure the power coupling. The power radiated by an antenna might be received by an adjacent antenna, which decreases the antenna radiation efficiency and affects the running of other devices. To avoid this problem, evaluate the antenna isolation as sufficiently as possible at the early stage of antenna design.

Antenna isolation depends on the following factors:

- Distance between antennas

- Antenna type
- Antenna direction

The primary antenna must be placed as near as possible to the MU609 to minimize the cable length. The diversity antenna needs to be installed perpendicularly to the primary antenna. The diversity antenna can be placed farther away from the MU609. Antenna isolation can be measured with a two-port vector network analyzer.

The following antenna isolation is recommended for the antennas on laptops:

- **Isolation between the primary and diversity antennas: ≤ –12 dB**
- **Isolation between the primary (diversity) antenna and the GPS antenna: ≤ –15 dB**
- **Isolation between the primary (diversity) antenna and the Wi-Fi antenna: ≤ –15 dB**

## Polarization

The polarization of an antenna is the orientation of the electric field vector that rotates with time in the direction of maximum radiation.

The linear polarization is recommended for the antenna of MU609.

## Radiation Pattern

The radiation pattern of an antenna reflects the radiation features of the antenna in the remote field region. The radiation pattern of an antenna commonly describes the power or field strength of the radiated electromagnetic waves in various directions from the antenna. The power or field strength varies with the angular coordinates ($\theta$ and $\varphi$), but is independent of the radial coordinates.

The radiation pattern of half wave dipole antennas is omnidirectional in the horizontal plane, and the incident waves of base stations are often in the horizontal plane. For this reason, the receiving performance is optimal.

The following radiation patterns are recommended for the antenna of MU609.
**Primary/diversity/GPS antenna: omnidirectional**

In addition, the diversity antenna's pattern should be complementary with the primary antenna's pattern.

## Envelope Correlation Coefficient

The envelope correlation coefficient indicates the correlation between different antennas in a multi-antenna system (primary antenna, diversity antenna, and MIMO antenna). The correlation coefficient shows the similarity of radiation patterns, that is, amplitude and phase, of the antennas. The ideal correlation coefficient of a diversity antenna system or a MIMO antenna system is 0. A small value of the envelope correlation coefficient between the primary antenna and the diversity antenna indicates a high diversity gain. The envelope correlation coefficient depends on the following factors:

- Distance between antennas
- Antenna type
- Antenna direction

The antenna correlation coefficient differs from the antenna isolation. Sufficient antenna isolation does not represent a satisfactory correlation coefficient. For this reason, the two indicators need to be evaluated separately.

For the antennas on laptops, the recommended envelope correlation coefficient between the primary antenna and the diversity antenna is smaller than 0.5.

## Gain and Directivity

The radiation pattern of an antenna represents the field strength of the radiated electromagnetic waves in all directions, but not the power density that the antenna radiates in the specific direction. The directivity of an antenna, however, measures the power density that the antenna radiates.

Gain, as another important parameter of antennas, correlates closely to the directivity. The gain of an antenna takes both the directivity and the efficiency of the antenna into account. The appropriate antenna gain prolongs the service life of relevant batteries.

The following antenna gain is recommended for MU609. **Gain of the primary/diversity antenna ≤ 2.5 dBi**

⬜ NOTE

- The antenna consists of the antenna body and the relevant RF transmission cable. Take the RF transmission cable into account when measuring any of the preceding antenna indicators.
- Huawei cooperates with various famous antenna suppliers who are able to make suggestions on antenna design, for example, Amphenol, Skycross, etc.

## 4.5.2 Interference

Besides the antenna performance, the interference on the user board also affects the radio performance (especially the TIS) of the module. To guarantee high performance of the module, the interference sources on the user board must be properly controlled.

On the user board, there are various interference sources, such as the LCD, CPU, audio circuits, and power supply. All the interference sources emit interference signals that affect the normal operation of the module. For example, the module sensitivity can be decreased due to interference signals. Therefore, during the design, you need to consider how to reduce the effects of interference sources on the module. You can take the following measures: Use an LCD with optimized performance; shield the LCD interference signals; shield the signal cable of the board; or design filter circuits.

Huawei is able to make technical suggestions on radio performance improvement of the module.

## 4.5.3 GSM/WCDMA/GPS Antenna Requirements

The antenna for MU609 must fulfill the following requirements:

| GSM/WCDMA/GPS Antenna Requirements | |
|---|---|
| Frequency range | Depending on frequency band(s) provided by the network operator, the customer must use the most suitable antenna for that/those band(s) |

| GSM/WCDMA/GPS Antenna Requirements | |
|---|---|
| Bandwidth | 70 MHz in GSM850 |
| | 80 MHz in GSM900 |
| | 170 MHz in DCS |
| | 140 MHz in PCS |
| | 70 MHZ in WCDMA Band 5 (25 MHz for diversity antenna) |
| | 80 MHz in WCDMA Band 8 (35 MHz for diversity antenna) |
| | 140 MHz in WCDMA Band 2 (60 MHz for diversity antenna) |
| | 250 MHz in WCDMA Band 1 (60 MHz for diversity antenna) |
| | 2 MHz in GPS |
| Gain | ≤ 2.5 dBi |
| Impedance | 50 Ω |
| VSWR absolute max | ≤ 3:1 (≤ 2:1 for GPS antenna) |
| VSWR recommended | ≤ 2:1 (≤ 1.5:1 for GPS antenna) |

# 5 Electrical and Reliability Features

## 5.1 About This Chapter

This chapter describes the electrical and reliability features in the MU609 module, including:

- Absolute Ratings
- Operating and Storage Temperatures and Humidity
- Deleted electrical features of USIM
- Power Supply Features
- Reliability Features
- EMC and ESD Features

## 5.2 Absolute Ratings

⚠️ **WARNING**

Table 5-1 lists the absolute ratings for the MU609 module. Using the MU609 module beyond these conditions may result in permanent damage to the module.

**Table 5-1** Absolute ratings for the MU609 module

| Symbol | Specification | Min. | Max. | Unit |
|--------|---------------|------|------|------|
| VBAT | External power voltage | –0.3 | 4.5 | V |
| VI | Digital input voltage | –0.3 | 2.3 | V |

# 5.3 Operating and Storage Temperatures and Humidity

Table 5-2 lists the operating and storage temperatures and humidity for the MU609 module.

**Table 5-2** operating and storage temperatures and humidity for the MU609 module

| Specification | Min. | Max. | Unit |
|---|---|---|---|
| Normal working temperatures | –20 | +70 | °C |
| Extended temperatures[1] | –40 | +85 | °C |
| Ambient temperature for storage | –40 | +85 | °C |

 NOTE

[1]: When the MU609 module works in the range of –40°C to –20°C or +70°C to +85°C, **NOT** all its RF performances comply with 3GPP specifications.

# 5.4 Power Supply Features

## 5.4.1 Input Power Supply

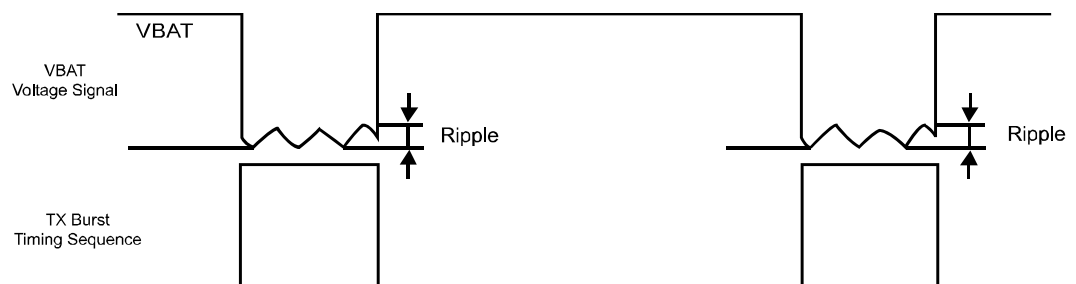Table 5-3 lists the requirements for input power of the MU609 module.

**Table 5-3** Requirements for input power for the MU609 module

| Parameter | Min. | Typ. | Max. | Ripple | Unit |
|---|---|---|---|---|---|
| VBAT | 3.3 | 3.8 | 4.2 | 0.1 | V |

**Figure 5-1** Power Supply During Burst Emission



 NOTE

The VBAT minimum value must be guaranteed during the burst (with 2. 5 A Peak in GPRS or GSM mode).

**Table 5-4** Requirements for input current of the MU609 module

| Power | Peak (Maximum) | Normal (Maximum) |
|-------|----------------|------------------|
| VBAT | 2500 mA | 1100 mA |

## 5.4.2 Power Consumption

The power consumption of MU609 in different scenarios are respectively listed in Table 5-5 to Table 5-9 .

The power consumption listed in this section are tested when the power supply of MU609 module is normal voltage (3.8 V) and all of Test values are measured at room temperature.

**Table 5-5** Averaged power off DC power consumption of MU609

| Description | Test Value (μA) | Notes/Configuration |
|-------------|-----------------|---------------------|
| | Typical | |
| Power off | 115 | Normal voltage (3.8 V) is on and POWER_ON_OFF pin is pulled low. |

**Table 5-6** Averaged standby DC power consumption of MU609

| Description | | Bands | Test Value (mA) | Notes/Configuration |
|-------------|---|-------|-----------------|---------------------|
| | | | Typical | |
| Sleep | HSPA+/WCDMA | UMTS bands | 2.1 | Module is powered up. DRX cycle=8 (2.56s) Module is registered on the network. USB is in suspend. |
| | GPRS/EDGE | GSM bands | 2.5 | Module is powered up. MFRMS=5 (1.175s) Module is registered on the network. USB is in suspend |
| | Radio Off | All bands | 1.5 | Module is powered up. RF is disabled. USB is in suspend |

| Description | | Bands | Test Value (mA) | Notes/Configuration |
|---|---|---|---|---|
| | | | Typical | |
| Idle | HSPA+/WCDMA | UMTS bands | 20 | Module is powered up. DRX cycle=8 (2.56s) Module is registered on the network, no data is transmitted. USB is in active. |
| | GPRS/EDGE | GSM bands | 20 | Module is powered up. MFRMS=5 (1.175s) Module is registered on the network, no data is transmitted. USB is in active |
| | Radio Off | All bands | 17 | Module is powered up. RF is disabled. USB is in active. |

**Table 5-7** Averaged Data Transmission DC power consumption of MU609 (HSPA/WCDMA)

| Description | Band | Test Value (mA) | Power (dBm) |
|---|---|---|---|
| | | Typical | |
| WCDMA | Band 1 (IMT2100) | 290 | 1 dBm Tx Power |
| | | 350 | 10 dBm Tx Power |
| | | 680 | 23.5 dBm Tx Power |
| | Band 2 (PCS 1900) | 300 | 1 dBm Tx Power |
| | | 360 | 10 dBm Tx Power |
| | | 705 | 23.5 dBm Tx Power |
| | Band 5 (850 MHz) | 260 | 1 dBm Tx Power |
| | | 300 | 10 dBm Tx Power |
| | | 600 | 23.5 dBm Tx Power |
| | Band 8 (900 MHz) | 300 | 1 dBm Tx Power |
| | | 320 | 10 dBm Tx Power |
| | | 640 | 23.5 dBm Tx Power |
| HSDPA | Band 1 (IMT2100) | 380 | 1 dBm Tx Power |
| | | 430 | 10 dBm Tx Power |

| Description | Band | Test Value (mA) | Power (dBm) |
| --- | --- | --- | --- |
| | | Typical | |
| | | 720 | 23.5 dBm Tx Power |
| | Band 2 (PCS 1900) | 375 | 1 dBm Tx Power |
| | | 430 | 10 dBm Tx Power |
| | | 745 | 23.5 dBm Tx Power |
| | Band 5 (850 MHz) | 330 | 1 dBm Tx Power |
| | | 380 | 10 dBm Tx Power |
| | | 620 | 23.5 dBm Tx Power |
| | Band 8 (900 MHz) | 350 | 1 dBm Tx Power |
| | | 390 | 10 dBm Tx Power |
| | | 660 | 23.5 dBm Tx Power |
| HSUPA | Band 1 (IMT2100) | 390 | 1 dBm Tx Power |
| | | 450 | 10 dBm Tx Power |
| | | 730 | 23.5 dBm Tx Power |
| | Band 2 (PCS 1900) | 380 | 1 dBm Tx Power |
| | | 440 | 10 dBm Tx Power |
| | | 755 | 23.5 dBm Tx Power |
| | Band 5 (850 MHz) | 350 | 1 dBm Tx Power |
| | | 390 | 10 dBm Tx Power |
| | | 630 | 23.5 dBm Tx Power |
| | Band 8 (900 MHz) | 360 | 1 dBm Tx Power |
| | | 410 | 10 dBm Tx Power |
| | | 680 | 23.5 dBm Tx Power |

**Table 5-8** Averaged DC power consumption of MU609 (GPRS/EDGE)

| Description | Test Value (mA) | PCL | Configuration |
| --- | --- | --- | --- |
| | Typical | | |
| GPRS850 | 300 | 5 | 1 Up/1 Down |
| | 460 | | 2 Up/1 Down |
| | 630 | | 4 Up/1 Down |

| Description | Test Value (mA) | PCL | Configuration |
| --- | --- | --- | --- |
| | **Typical** | | |
| | 180 | 10 | 1 Up/1 Down |
| | 280 | | 2 Up/1 Down |
| | 460 | | 4 Up/1 Down |
| GPRS900 | 280 | 5 | 1 Up/1 Down |
| | 430 | | 2 Up/1 Down |
| | 590 | | 4 Up/1 Down |
| | 170 | 10 | 1 Up/1 Down |
| | 270 | | 2 Up/1 Down |
| | 440 | | 4 Up/1 Down |
| GPRS1800 | 230 | 0 | 1 Up/1 Down |
| | 350 | | 2 Up/1 Down |
| | 490 | | 4 Up/1 Down |
| | 120 | 10 | 1 Up/1 Down |
| | 170 | | 2 Up/1 Down |
| | 230 | | 4 Up/1 Down |
| GPRS1900 | 240 | 0 | 1 Up/1 Down |
| | 360 | | 2 Up/1 Down |
| | 520 | | 4 Up/1 Down |
| | 110 | 10 | 1 Up/1 Down |
| | 160 | | 2 Up/1 Down |
| | 220 | | 4 Up/1 Down |
| EDGE850 | 290 | 8 | 1 Up/1 Down |
| | 430 | | 2 Up/1 Down |
| | 610 | | 4 Up/1 Down |
| | 170 | 15 | 1 Up/1 Down |
| | 270 | | 2 Up/1 Down |
| | 450 | | 4 Up/1 Down |
| EDGE900 | 270 | 8 | 1 Up/1 Down |
| | 430 | | 2 Up/1 Down |
| | 580 | | 4 Up/1 Down |

| Description | Test Value (mA) | PCL | Configuration |
|---|---|---|---|
| | Typical | | |
| | 160 | 15 | 1 Up/1 Down |
| | 260 | | 2 Up/1 Down |
| | 440 | | 4 Up/1 Down |
| EDGE1800 | 220 | 2 | 1 Up/1 Down |
| | 340 | | 2 Up/1 Down |
| | 480 | | 4 Up/1 Down |
| | 120 | 10 | 1 Up/1 Down |
| | 160 | | 2 Up/1 Down |
| | 230 | | 4 Up/1 Down |
| EDGE1900 | 230 | 2 | 1 Up/1 Down |
| | 350 | | 2 Up/1 Down |
| | 510 | | 4 Up/1 Down |
| | 110 | 10 | 1 Up/1 Down |
| | 150 | | 2 Up/1 Down |
| | 210 | | 4 Up/1 Down |

 NOTE

- All power consumption test configuration can be referenced by GSM Association Official Document TS.09: Battery Life Measurement and Current Consumption Technique.

- Test condition: For Max. Tx. power, see 4.4.2 Conducted Transmit Power, which are listed in Table 4-4 ; for Max. data throughput, see 2.2 Function Overview, which are listed in Table 2-1 .

**Table 5-9** Averaged GPS operation DC power consumption

| Description | Test Value (mA) | Notes/Configuration |
|---|---|---|
| | Typical | |
| GPS fixing | 100 | RF is disabled; |
| GPS tracking | 100 | USB is in active; The Rx power of GPS is –130 dBm. |

# 5.5 Reliability Features

Table 5-10 lists the test conditions and results of the reliability of the MU609 module.

**Table 5-10** Test conditions and results of the reliability of the MU609 module

| Item | | Test Condition | Standard | Sample size | Results |
|------|--|----------------|----------|-------------|---------|
| Stress | Low-temperature storage | • Temperature: –40ºC<br>• Operation mode: no power, no package<br>• Test duration: 24 h | JESD22-A119-C | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | High-temperature storage | • Temperature: 85ºC<br>• Operation mode: no power, no package<br>• Test duration: 24 h | JESD22-A103-C | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | Low-temperature operating | • Temperature: –30ºC<br>• Operation mode: working with service connected<br>• Test duration: 24 h | IEC60068-2-1 | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | High-temperature operating | • Temperature: 75ºC<br>• Operation mode: working with service connected<br>• Test duration: 24 h | JESD22-A108-C | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | Temperature cycle operating | • High temperature: 75ºC<br>• Low temperature: –30ºC<br>• Operation mode: working with service connected<br>• Test duration: 30 cycles;1 h+1 h/cycle | JESD22-A105-B | 3pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | Damp heat cycling | • High temperature: 55ºC<br>• Low temperature: 25ºC<br>• Humidity: 95%±3%<br>• Operation mode: working with service connected<br>• Test duration: 6 cycles; 12 h+12 h/cycle | JESD22-A101-B | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |

| Item | | Test Condition | Standard | Sample size | Results |
|---|---|---|---|---|---|
| | Thermal shock | • Low temperature: –40ºC<br>• High temperature: 85ºC<br>• Temperature change interval: < 20s<br>• Operation mode: no power<br>• Test duration: 100 cycles; 15 min+15 min/cycle | JESD22-A106-B | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | Salty fog test | • Temperature: 35°C<br>• Density of the NaCl solution: 5%±1%<br>• Operation mode: no power, no package<br>• Test duration:<br>Spraying interval: 8 h<br>Exposing period after removing the salty fog environment: 16 h | JESD22-A107-B | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | Sine vibration | • Frequency range: 5 Hz to 200 Hz<br>• Acceleration: 1 Grms<br>• Frequency scan rate: 0.5 oct/min<br>• Operation mode: working with service connected<br>• Test duration: 3 axial directions. 2 h for each axial direction.<br>• Operation mode: working with service connected | JESD22-B103-B | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | Shock test | • Half-sine wave shock<br>• Peak acceleration: 30 Grms<br>• Shock duration: 11 ms<br>• Operation mode: working with service connected<br>• Test duration: 6 axial directions. 3 shocks for each axial direction.<br>• Operation mode: working with service connected | JESD-B104-C | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |

| Item | | Test Condition | Standard | Sample size | Results |
|---|---|---|---|---|---|
| | Drop test | • 0.8 m in height. Drop the module on the marble terrace with one surface facing downwards, six surfaces should be tested.<br>• Operation mode: no power, no package | IEC60068-2-32 | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| Life | High temperature operating life | • Temperature: 70ºC<br>• Operation mode: working with service connected<br>• Test duration: 168 h, 336 h, 500 h, 1000 h for inspection point | JESD22-A108-B | 50 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | High temperature & high humidity | • High temperature: 85ºC<br>• Humidity: 85%<br>• Operation mode: powered on and no working<br>• Test duration: 168 h, 336 h, 500 h, 1000 h for inspection point | JESD22-A110-B | 50 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok<br>Cross section: ok |
| | Temperature cycle-Non operating | • High temperature: 85ºC<br>• Low temperature: –40ºC<br>• Temperature change slope: 6ºC/min<br>• Operation mode: no power<br>• Test duration: 168 h, 336 h, 500 h, 1000 h for inspection point | JESD22-A104-C | 50 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok<br>Cross section: ok |
| ESD | HBM (Human Body Model) | • 1 kV (Class 1 B)<br>• Operation mode: no power | JESD22-A114-D | 3 pcs/group | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |
| | ESD with DVK (or embedded in the host) | • Contact Voltage: ±2 kV, ±4 kV<br>• Air Voltage : ±2 kV, ±4 kV, ±8 kV<br>• Operation mode: working with service connected | IEC61000-4-2 | 2 pcs | Visual inspection: ok<br>Function test: ok<br>RF specification: ok |

📖 **NOTE**

Groups ≥ 2

# 5.6 EMC and ESD Features

The following are the EMC design comments:

- Attention should be paid to static control in the manufacture, assembly, packaging, handling and storage process to reduce electrostatic damage to HUAWEI module.

- RSE (Radiated Spurious Emission) may exceed the limit defined by EN301489 if the antenna port is protected by TVS (Transient Voltage Suppressor), which is resolved by making some adjustment on RF match circuit.

- TVS should be added on the USB port for ESD protection, and the parasitic capacitance of TVS on D+/D- signal should be less than 2 pF. Common-mode inductor should be added in parallel on D+/D- signal.

- TVS should be added on the USIM interface for ESD protection. The parasitic capacitance of TVS on USIM signal should be less than 10 pF;

- Resistors in parallel and a 10nF capacitance should be added on RESIN_N and POWER_ON_OFF signal to avoid shaking, and the distance between the capacitor and the related pins should be less than 100 mil.

- PCB routing should be V-type rather than T-type for TVS.

- An integrated ground plane is necessary for EMC design.

The following are the requirements of ESD environment control:

- The electrostatic discharge protected area (EPA) must have an ESD floor whose surface resistance and system resistance are greater than $1 \times 10^4$ Ω while less than $1 \times 10^9$ Ω.

- The EPA must have a sound ground system without loose ground wires, and the ground resistance must be less than 4 Ω.

- The workbench for handling ESD sensitive components must be equipped with common ground points, the wrist strap jack, and ESD pad. The resistance between the jack and common ground point must be less than 4 Ω. The surface resistance and system resistance of the ESD pad must be less than $1 \times 10^9$ Ω.

- The EPA must use the ESD two-circuit wrist strap, and the wrist strap must be connected to the dedicated jack. The crocodile clip must not be connected to the ground.

- The ESD sensitive components, the processing equipment, test equipment, tools, and devices must be connected to the ground properly. The indexes are as follows:

  - Hard ground resistance < 4 Ω

  - $1 \times 10^5$ Ω ≤ Soft ground resistance < $1 \times 10^9$ Ω

  - $1 \times 10^5$ Ω ≤ ICT fixture soft ground resistance < $1 \times 10^{11}$ Ω

  - The electronic screwdriver and electronic soldering iron can be easily oxidized. Their ground resistance must be less than 20 Ω.

- The parts of the equipment, devices, and tools that touch the ESD sensitive components and moving parts that are close to the ESD sensitive components must be made of ESD materials and have sound ground connection. The parts that are not made of ESD materials must be handled with ESD treatment, such as painting the ESD coating or ionization treatment (check that the friction voltage is less than 100 V).

- Key parts in the production equipment (parts that touch the ESD sensitive components or parts that are within 30 cm away from the ESD sensitive components), including the conveyor belt, conveyor chain, guide wheel, and SMT nozzle, must all be made of ESD materials and be connected to the ground properly (check that the friction voltage is less than 100 V).

- Engineers that touch IC chips, boards, modules, and other ESD sensitive components and assemblies must wear ESD wrist straps, ESD gloves, or ESD finger cots properly. Engineers that sit when handling the components must all wear ESD wrist straps.

- Noticeable ESD warning signs must be attached to the packages and placement areas of ESD sensitive components and assemblies.

- Boards and IC chips must not be stacked randomly or be placed with other ESD components.

- Effective shielding measures must be taken on the ESD sensitive materials that are transported or stored outside the EPA.

📖 NOTE

HUAWEI MU609 module does not include any protection against overvoltage.

# 6 Mechanical Specifications

## 6.1 About This Chapter

This chapter describes the process design and mechanical specifications:

- Storage Requirement
- Moisture Sensitivity
- Dimensions and
- Packaging
- Label
- Customer PCB Design
- Assembly Processes
- Specification of Rework

## 6.2 Storage Requirement

The module must be stored and sealed properly in vacuum package under a temperature below 40°C and the relative humidity less than 90% in order to ensure the weldability within 12 months.

## 6.3 Moisture Sensitivity

- The moisture sensitivity is level 3.
- After unpacking, the module must be assembled within 168 hours under the environmental conditions that the temperature is lower than 30°C and the relative humidity is less than 60%. If the preceding conditions cannot be met, the module needs to be baked according to the parameters specified in Table 6-1 .

**Table 6-1** Baking parameters

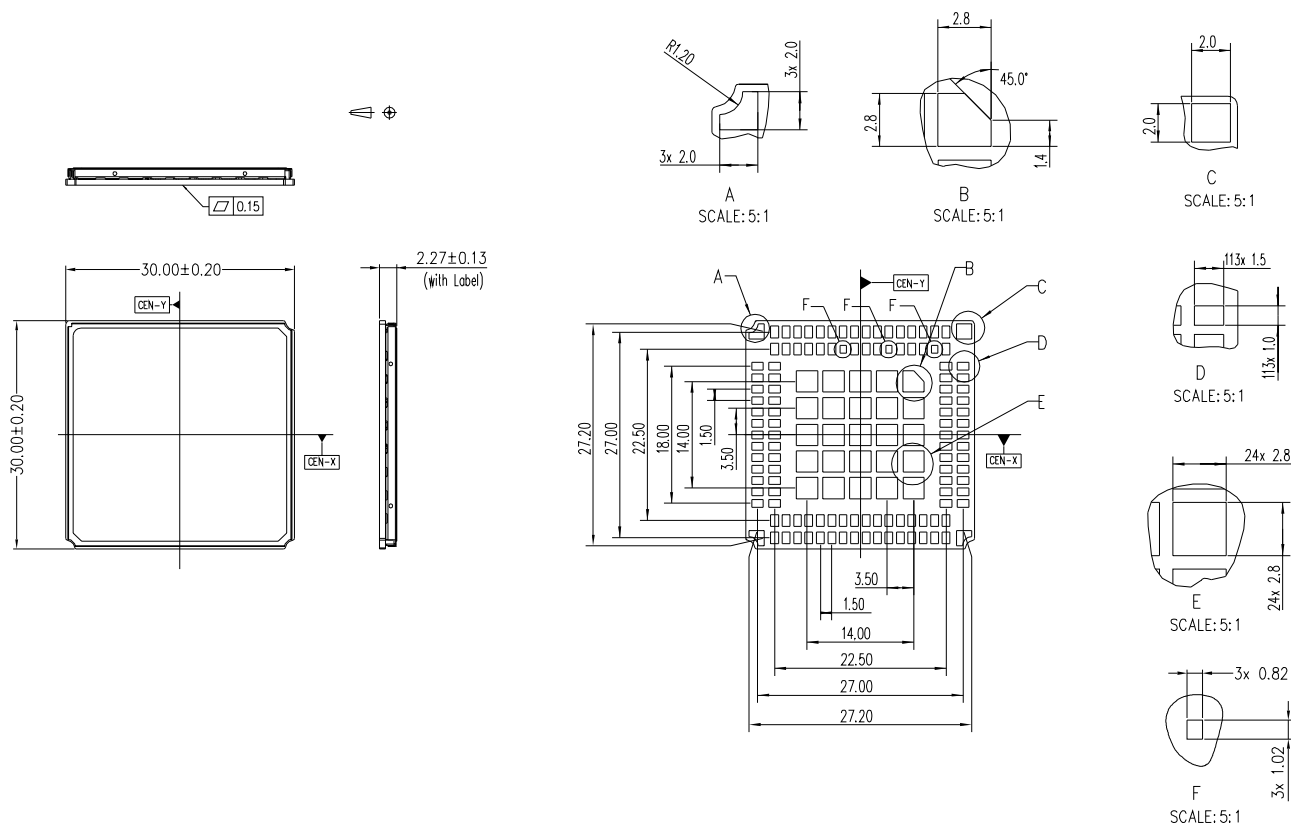| Baking Temperature | Baking Condition | Baking Duration | Remarks |
|---|---|---|---|
| 125°C±5°C | Relative humidity ≤ 60% | 8 hours | |

 NOTE

Moving, storing, and processing the product must comply with IPC/JEDEC J-STD-033.
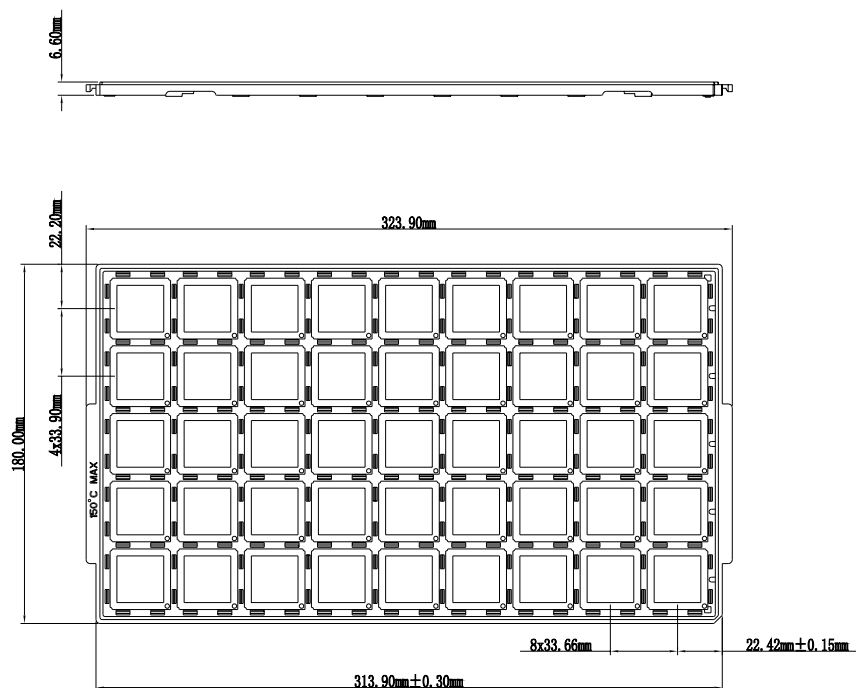
# 6.4 Dimensions and Interfaces

Figure 6-1 shows the dimensions in details.

**Figure 6-1** Dimensions (unit: mm)



# 6.5 Packaging

HUAWEI LGA module uses five layers ESD pallet, anti-vibration foam and vacuum packing into cartons.

The following figure shows the packaging.
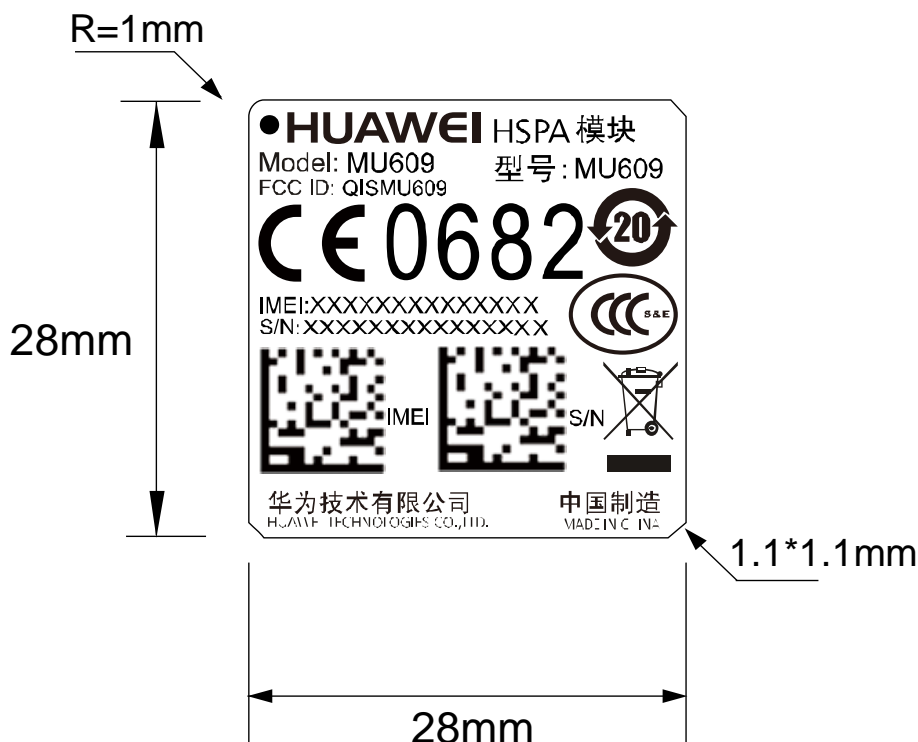
Module quantity per tray:
5 x 9 = 45 pcs/tray

Use vacuum packages;
five trays per carton;
module quantity per carton:
5 x 45 = 225pcs/carton.

# 6.6 Label

The label is made from deformation-resistant, fade-resistant, and high-temperature-resistant material and is able to endure the high temperature of 260°C.

**Figure 6-2** MU609 label



> **NOTE**
>
> The picture mentioned above is only for reference.

# 6.7 Customer PCB Design

## 6.7.1 PCB Surface Finish

The PCB surface finish recommended is Electroless Nickel, immersion Gold (ENIG). Organic Solderability Preservative (OSP) may also be used, ENIG preferred.

## 6.7.2 PCB Pad Design

To achieve assembly yields and solder joints of high reliability, it is recommended that the PCB pad size be designed as follows:

**Figure 6-3** MU609 Footprint design (unit: mm)
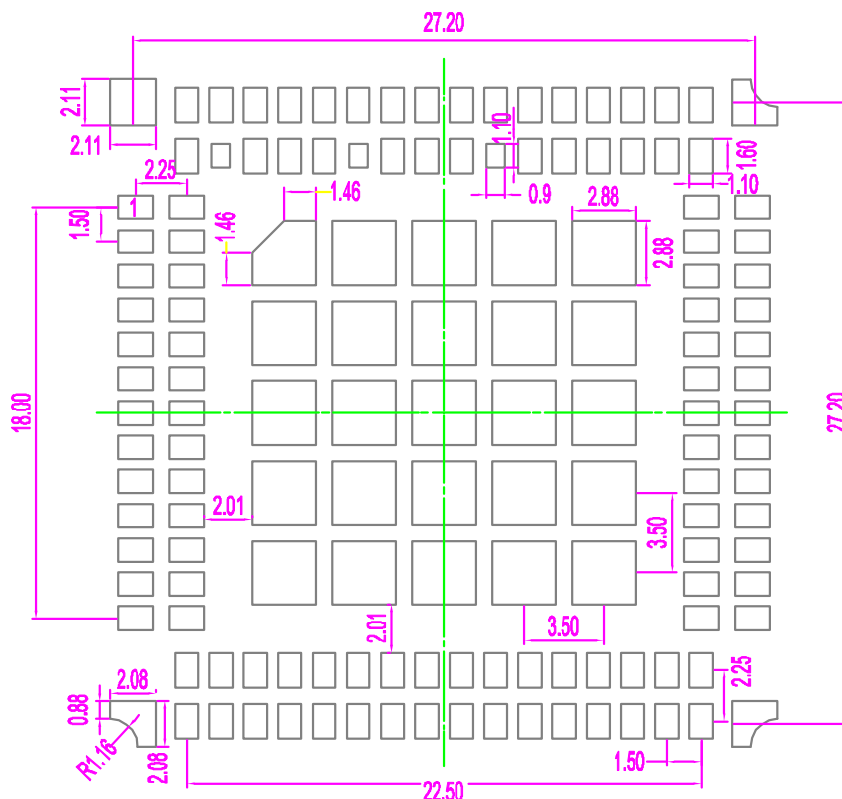


## 6.7.3 Solder Mask

NSMD is recommended. In addition, the solder mask of the NSMD pad design is larger than the pad so the reliability of the solder joint can be improved.

The solder mask must be 100 μm–150 μm larger than the pad, that is, the single side of the solder mask must be 50 μm–75 μm larger than the pad. The specific size depends on the processing capability of the PCB manufacturer.

## 6.7.4 Requirements on PCB Layout

- To reduce deformation, a thickness of at least 1.0 mm is recommended.
- Other devices must be located more than 3 mm (5 mm recommended) away from the LGA module. The minimum distance between the LGA module and the PCB edge is 0.5 mm.
- When the PCB layout is double sided, the LGA module must be placed on the second side for assembly; so as to avoid module dropped from PCB or component (located in module) re-melding defects caused by uneven weight.

# 6.8 Assembly Processes

## 6.8.1 General Description of Assembly Processes

- Tray modules are required at SMT lines, because LGA modules are placed on ESD pallets.
- Reflow ovens with at least seven temperature zones are recommended.
- Use reflow ovens or rework stations for soldering, because LGA modules have large solder pads and cannot be soldered manually.

## 6.8.2 Stencil Design

It is recommended that the stencil for the LGA module be 0.15 mm in thickness. For the stencil design. see the following figure:

**Figure 6-4** Recommended stencil design of LGA module (unit: mm)
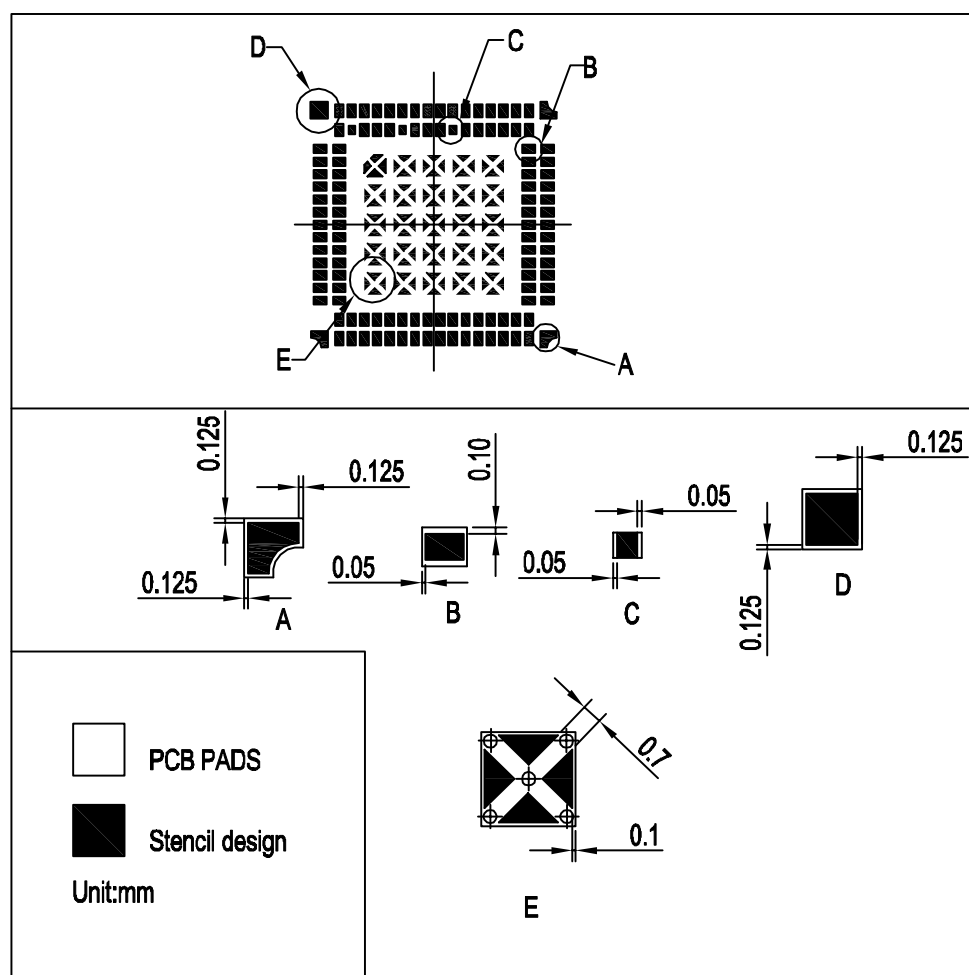


> **NOTE**
>
> The stencil design has been qualified for HUAWEI motherboard assembly, customers can adjust the parameters by their motherboard design and process situation to assure LGA soldering quality and no defect.

## 6.8.3 Reflow Profile

For the soldering temperature of the LGA module, see the following figure.
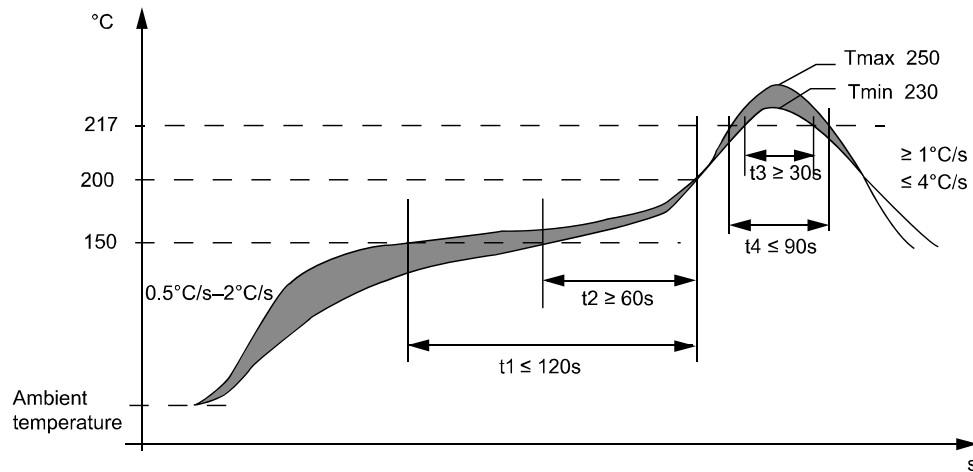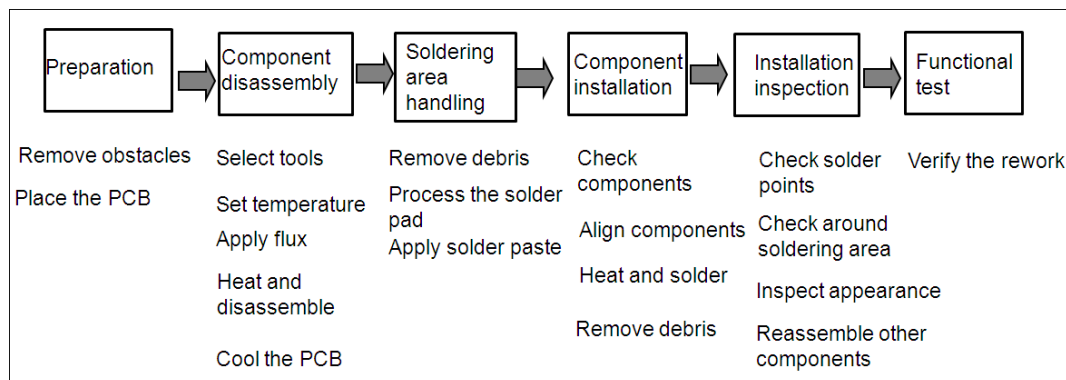
**Figure 6-5** Reflow profile



**Table 6-2** Reflow parameters

| Temperature Zone | Time | Key Parameter |
|---|---|---|
| Preheat zone (40°C–150°C) | 60s–120s | Heating rate: 0.5°C/s–2°C/s |
| Soak zone (150°C–200°C) | (t1–t2): 60s–120s | Heating rate: < 1.0°C/s |
| Reflow zone (> 217°C) | (t3–t4): 30s–90s | Peak reflow temperature: 230°C–250°C |
| Cooling zone | Cooling rate: 1°C/s ≤ Slope ≤ 4°C/s | |

# 6.9 Specification of Rework

## 6.9.1 Process of Rework



## 6.9.2 Preparations of Rework

- Remove barrier or devices that can't stand high temperature before rework.
- If the device to be reworked is beyond the storage period, bake the device according to Table 6-1 .

## 6.9.3 Removing of the Module

The solder is molten and reflowed through heating during the module removing process. The heating rate must be quick but controllable in order to melt all the solder joints simultaneously. Pay attention to protect the module, PCB, neighboring devices, and their solder joints against heating or mechanical damages.

📖 NOTE

- The LGA module has many solder pads and the pads are large. Therefore, common soldering irons and heat guns cannot be used in the rework. Rework must be done using either infrared heating rework stations or hot air rework stations. Infrared heating rework stations are preferred, because they can heat components without touching them. In addition, infrared heating rework stations produce less solder debris and less impact on modules, while hot air rework stations may cause shift of other components not to be reworked.

- You must not reuse the module after disassembly from PCB during rework.

- It is proposed that a special clamp is used to remove the module.

**Figure 6-6** Equipment used for rework



Infrared heating rework station    Hot air rework station
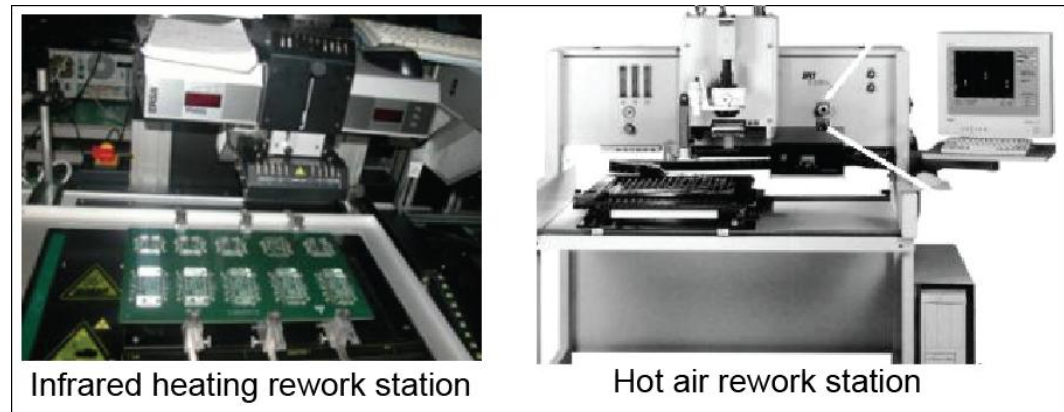
## 6.9.4 Welding Area Treatment

Step 1    Remove the old solder by using a soldering iron and solder braid that can wet the solder.

Step 2    Clean the pad and remove the flux residuals.

Step 3    Solder pre-filling: Before the module is installed on a board, apply some solder paste to the pad of the module by using the rework fixture and stencil or apply some solder paste to the pad on the PCB by using a rework stencil.

⬛ NOTE

It is recommended that a fixture and a mini-stencil be made to apply the solder paste in the rework.

## 6.9.5 Module Installation

Install the module precisely on the module and ensure the right installation direction of the module and the reliability of the electrical connection with the PCB. It is recommended that the module be preheated in order to ensure that the temperature of all parts to be soldered is uniform during the reflow process. The solder quickly reflows upon heating so the parts are soldered reliably. The solder joints undergo proper reflow duration at a preset temperature to form a favorable Intermetallic Compound (IMC).
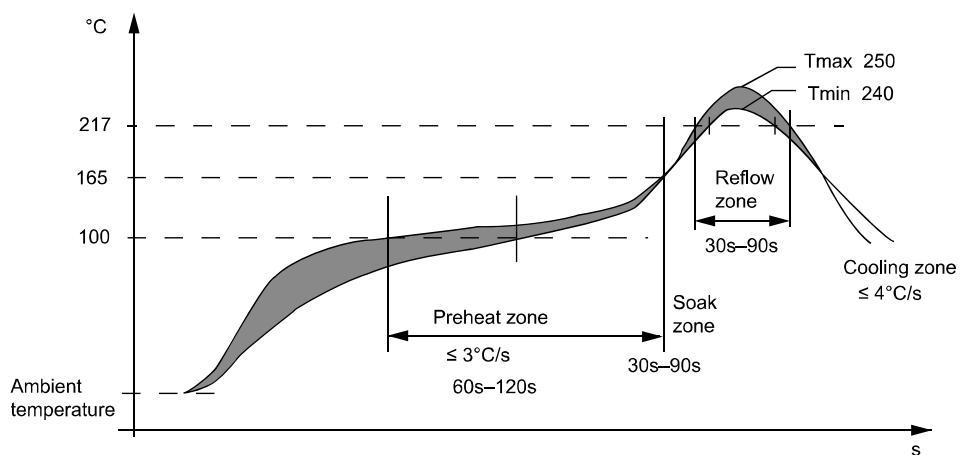
⬛ NOTE

● It is recommended that a special clamp be used to pick the module when the module is installed on the pad after applied with some solder.

● A special rework device must be used for the rework.

## 6.9.6 Specifications of Rework

Temperature parameter of rework: for either the removing or welding of the module, the heating rate during the rework must be equal to or smaller than 3°C/s, and the peak temperature between 240°C–250°C. The following parameters are recommended during the rework.

**Figure 6-7** Temperature graph of rework

# 7 Certifications

## 7.1 About This Chapter

This chapter gives a general description of certifications of MU609.

## 7.2 Certifications

📖 NOTE

Table 7-1 shows certifications the MU609 has been implemented. For more demands, please contact us for more details about this information.

**Table 7-1** Product Certifications

| Certification | Model name |
| --- | --- |
| | **MU609** |
| CE | √ |
| FCC | √ |
| CCC | √ |
| RoHS | √ |
| GCF | √ |
| PTCRB | √ |
| WEEE | √ |
| A-Tick | √ |

# 8 Safety Information

Read the safety information carefully to ensure the correct and safe use of your wireless device. Applicable safety information must be observed.

## 8.1 Interference

Power off your wireless device if using the device is prohibited. Do not use the wireless device when it causes danger or interference with electric devices.

## 8.2 Medical Device

- Power off your wireless device and follow the rules and regulations set forth by the hospitals and health care facilities.
- Some wireless devices may affect the performance of the hearing aids. For any such problems, consult your service provider.
- Pacemaker manufacturers recommend that a minimum distance of 15 cm be maintained between the wireless device and a pacemaker to prevent potential interference with the pacemaker. If you are using an electronic medical device, consult the doctor or device manufacturer to confirm whether the radio wave affects the operation of this device.

## 8.3 Area with Inflammables and Explosives

To prevent explosions and fires in areas that are stored with inflammable and explosive devices, power off your wireless device and observe the rules. Areas stored with inflammables and explosives include but are not limited to the following:

- Gas station
- Fuel depot (such as the bunk below the deck of a ship)
- Container/Vehicle for storing or transporting fuels or chemical products
- Area where the air contains chemical substances and particles (such as granule, dust, or metal powder)
- Area indicated with the "Explosives" sign

- Area indicated with the "Power off bi-direction wireless equipment" sign
- Area where you are generally suggested to stop the engine of a vehicle

# 8.4 Traffic Security

- Observe local laws and regulations while using the wireless device. To prevent accidents, do not use your wireless device while driving.
- RF signals may affect electronic systems of motor vehicles. For more information, consult the vehicle manufacturer.
- In a motor vehicle, do not place the wireless device over the air bag or in the air bag deployment area. Otherwise, the wireless device may hurt you owing to the strong force when the air bag inflates.

# 8.5 Airline Security

Observe the rules and regulations of airline companies. When boarding or approaching a plane, power off your wireless device. Otherwise, the radio signal of the wireless device may interfere with the plane control signals.

# 8.6 Safety of Children

Do not allow children to use the wireless device without guidance. Small and sharp components of the wireless device may cause danger to children or cause suffocation if children swallow the components.

# 8.7 Environment Protection

Observe the local regulations regarding the disposal of your packaging materials, used wireless device and accessories, and promote their recycling.

# 8.8 WEEE Approval

The wireless device is in compliance with the essential requirements and other relevant provisions of the Waste Electrical and Electronic Equipment Directive 2012/19/EU (WEEE Directive).

# 8.9 RoHS Approval

The wireless device is in compliance with the restriction of the use of certain hazardous substances in electrical and electronic equipment Directive 2011/65/EU (RoHS Directive).

# 8.10 Laws and Regulations Observance

Observe laws and regulations when using your wireless device. Respect the privacy and legal rights of the others.

# 8.11 Care and Maintenance

It is normal that your wireless device gets hot when you use or charge it. Before you clean or maintain the wireless device, stop all applications and power off the wireless device.

- Use your wireless device and accessories with care and in clean environment. Keep the wireless device from a fire or a lit cigarette.

- Protect your wireless device and accessories from water and vapour and keep them dry.

- Do not drop, throw or bend your wireless device.

- Clean your wireless device with a piece of damp and soft antistatic cloth. Do not use any chemical agents (such as alcohol and benzene), chemical detergent, or powder to clean it.

- Do not leave your wireless device and accessories in a place with a considerably low or high temperature.

- Use only accessories of the wireless device approved by the manufacture. Contact the authorized service center for any abnormity of the wireless device or accessories.

- Do not dismantle the wireless device or accessories. Otherwise, the wireless device and accessories are not covered by the warranty.

- The device should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

# 8.12 Emergency Call

This wireless device functions through receiving and transmitting radio signals. Therefore, the connection cannot be guaranteed in all conditions. In an emergency, you should not rely solely on the wireless device for essential communications.

# 8.13 Regulatory Information

The following approvals and notices apply in specific regions as noted.

## 8.13.1 CE Approval (European Union)

The wireless device is approved to be used in the member states of the EU. The wireless device is in compliance with the essential requirements and other relevant provisions of the Radio and Telecommunications Terminal Equipment Directive 1999/5/EC (R&TTE Directive).

## 8.13.2 FCC Statement

Federal Communications Commission Notice (United States): Before a wireless device model is available for sale to the public, it must be tested and certified to the FCC that it does not exceed the limit established by the government-adopted requirement for safe exposure.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**Warning:** Changes or modifications made to this equipment not expressly approved by HUAWEI may void the FCC authorization to operate this equipment.

# 9 Appendix A Circuit of Typical Interface
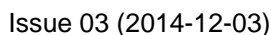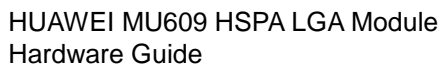
# 10 Appendix B Acronyms and Abbreviations

| Acronym or Abbreviation | Expansion |
|---|---|
| 3GPP | Third Generation Partnership Project |
| 8PSK | 8 Phase Shift Keying |
| AUX | Auxiliary |
| BER | Bit Error Rate |
| BLER | Block Error Rate |
| BIOS | Basic Input Output System |
| CCC | China Compulsory Certification |
| CE | European Conformity |
| CMOS | Complementary Metal Oxide Semiconductor |
| CTL | Control |
| CS | Coding Scheme |
| CSD | Circuit Switched Data |
| DC | Direct Current |
| DCE | Data Communication Equipment |
| DL | Down Link |
| DMA | Direct Memory Access |
| DTE | Data Terminal Equipment |
| EBU | External Bus Unit |
| EDGE | Enhanced Data Rate for GSM Evolation |
| EIA | Electronic Industries Association |

| Acronym or Abbreviation | Expansion |
|---|---|
| EMC | Electromagnetic Compatibility |
| ESD | Electrostatic Discharge |
| EU | European Union |
| FCC | Federal Communications Commission |
| GMSK | Gaussian Minimum Shift Keying |
| GPIO | General-purpose I/O |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning System |
| GSM | Global System for Mobile Communication |
| HBM | Human Body Model |
| HSDPA | High-Speed Downlink Packet Access |
| HSPA | Enhanced High Speed Packet Access |
| HSUPA | High Speed Up-link Packet Access |
| ISO | International Standards Organization |
| JTAG | Joint Test Action Group |
| LCP | Liquid Crystal Polyester |
| LDO | Low-Dropout |
| LED | Light-Emitting Diode |
| LGA | Land Grid Array |
| MCP | Multi-chip Package |
| MDM | Mobile Data Modem |
| MO | Mobile Originated |
| MT | Mobile Terminated |
| NC | Not Connected |
| NTC | Negative Temperature Coefficient |
| NSMD | Non-solder Mask Defined |
| PA | Power Amplifier |
| PBCCH | Packet Broadcast Control Channel |
| PCB | Printed Circuit Board |
| PCM | Pulse Code Modulation |

| Acronym or Abbreviation | Expansion |
|---|---|
| PDU | Protocol Data Unit |
| PID | Product IDentity |
| PMU | Power Management Unit |
| RF | Radio Frequency |
| RoHS | Restriction of the Use of Certain Hazardous Substances |
| SMS | Short Message Service |
| TIS | Total Isotropic Senstivity |
| TRP | Total Radiated Power |
| TTFF | Time to First Fix |
| TVS | Transient Voltage Suppressor |
| UART | Universal Asynchronous Receiver-Transmitter |
| UL | Up Link |
| UMTS | Universal Mobile Telecommunications System |
| USB | Universal Serial Bus |
| USIM | Universal Subscriber Identity Module |
| VIP | Vendor IDentity |
| VSWR | Voltage Standing Wave Ratio |
| WEEE | Waste Electrical and Electronic Equipment |
| WCDMA | Wideband Code Division Multiple Access |
| WWAN | Wireless Wide Area Network |