HUAWEI MU509 Series HSDPA LGA Module

Hardware Guide

Issue 09

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About This Document

Revision History

Document Version	Date	Chapter	Descriptions
01	2010-11-12		Creation
02	2011-04-18	1	Updated Overview
		2.2	Updated Table 2-1 Feature
		2.4	Updated 2.4 Application Block Diagram
		3.1	Updated 3.1 About This Chapter
		3.2	Updated Table 3-1 Definitions of pins on the LGA interface
		3.3.1	Updated 3.3.1 Overview
		3.3.2	Updated 3.3.2 VBAT Interface
		3.3.3	Updated 3.3.3 VCOIN Interface
		3.4	Updated 3.4 Signal Control Interface
		3.5	Updated 3.5 UART Interface
		3.6	Added 3.6 USB Interface
		3.7	Updated 3.7 SIM Card Interface
		3.8	Updated 3.8 Audio Interface
		3.9	Added 3.9 General Purpose I/O Interface
		3.10	Added 3.10 JTAG Interface
		3.11	Added 3.11 RF Antenna Interface
		3.12	Added 3.12 NC Pins
		4.2	Added 4.2 Antenna Installation Guidelines
		4.5.1	Updated 4.5.1 Conducted Receive Sensitivity
		4.5.2	Updated 4.5.2 Conducted Transmit Power

Document Version	Date	Chapter	Descriptions
		5.5.2	Updated 5.5.2 Power Consumption
		6.2	Updated 6.2 Dimensions and interfaces of MU509
		6.3	Added 6.3 Customer PCB Pad Design
		6.4	Updated 6.4 Label
		7	Added 7 Certifications
		8	Added 8 Safety Information
		9	Added 9 Appendix A Circuit of Typical Interface
		10	Updated 10 Appendix B Acronyms and Abbreviations
03	2011-07-08	2.3	Updated the Figure 2-1
		3.3.2	Replaced ‘2 mF’ with ‘2.2 mF’
		3.4.2	Updated the Figure 3-5 and the Figure 3-6
		3.6	Updated the Table 3-10
		3.7	Updated the Figure 3-16 and the Figure 3-18
		9	Updated the two figures
04	2012-04-23	3.7.2	Updated the value of the resistor which is used to connect the SIM_DATA pin to the VSIM pin.
		5.5.2	Updated the Table 5-7
		5.5.2	Added the Table 5-9 “DC power consumption for MU509-c(GSM/GPRS/EDGE)”
		7.2	Updated the Table 7-1
05	2012-08-27	All	Added the content of MU509-g
		2.2	Added A-tick in Table 2-1
		3.4.1	Updated the description of WAKEUP_IN in Table 3-5
		3.4.4	Updated the description of WAKEUP_IN Signal
		3.4.5	Updated the description of WAKEUP_OUT Signal

Document Version	Date	Chapter	Descriptions
		5.5.2	Update Table 5-6 DC power consumption (Power off mode and Standby mode) and Table 5-7 DC power consumption (Idle mode)
		6	Added the process design
		7	Updated the CE number
06	2012-12-19	All	Added the related content about HUAWEI MU509-1
		3.3.2	Updated the peak current to 2.75 V and the storage capacitors to 220 µF
		3.3.2	Updated Figure 3-2 Recommended power circuit of MU509 module
		3.4.2	Updated Table 3-7 Power off timing
		3.4.4	Updated Figure 3-13 WAKEUP_IN sequence
		3.5.2	Added the description of level conversion circuit and the wind blow in
07	2013-04-15	2.3	Updated Figure 2-1
		3.2	Updated Table 3-1
		3.3.1	Updated Table 3-2
		3.4.4	Updated Figure 3-13
		3.7.2	Updated Figure 3-18
		3.10	Updated Table 3-14
		4.6.1	Updated Chapter 4.6.1
		4.6.3	Updated Chapter 4.6.3
		5.2	Updated Table 5-1
		9	Updated Chapter 9
08	2013-10-26	2.2	Updated the extended working temperature in Table 2-1
		5.3	Updated the extended working temperature in Table 5-2
09	2014-03-06	5.5.2	Updated Power Consumption
		5.6	Updated Reliability Features
		5.7	Updated EMC and ESD Features

Document Version	Date	Chapter	Descriptions
		6.5	Updated the note of packaging
		6.6	Updated the note of label

Scope

MU509-b

MU509-c

MU509-g

HUAWEI MU509-1

Summary

This document provides information about the major functions, supported services, system architecture, and technical references of HUAWEI MU509 Series HSDPA LGA Module.

The following table lists the contents of this document.

Chapter	Details
1 Introduction	Describes the short introduction of the product.
2 Overall Description	Describes the Function overview, Circuit Block Diagram and Application Block Diagram of the product.
3 Description of the Application Interfaces	Describes the external application interfaces of the product.
4 RF Specifications	Describes the RF specifications of the product.
5 Electrical and Reliability Features	Describes the electrical and reliability features of the interfaces in the product.
6 Process Design	Describes the process design, the Dimension, Label and Packing System of the product.
7 Certifications	Describes the certifications of the product.
8 Safety Information	Lists the safety information when using the product.
8 9 Appendix A Circuit of Typical Interface	Lists the circuit of typical interface of the product.

Chapter	Details
10 Appendix B Acronyms and Abbreviations	Lists the acronyms and abbreviations mentioned in this document.

Contents

1 Introduction

This document describes the hardware application interfaces and air interfaces that are provided when the HUAWEI MU509 Series HSDPA LGA Module (hereinafter referred to as the MU509 module) is used.

This document helps you to understand the interface specifications, electrical features, and related product information of the MU509 module.

MU509 module is related to the following products:

Product name	Model name	Description
MU509	MU509-b	UMTS/HSDPA 2100/900 MHz GSM/GPRS/EDGE 850/900/1800/1900 MHz
	MU509-c	UMTS/HSDPA 1900/850 MHz GSM/GPRS/EDGE 850/900/1800/1900 MHz
	MU509-g	UMTS/HSDPA 2100/850 MHz GSM/GPRS/EDGE 850/900/1800/1900 MHz
	HUAWEI MU509-1	UMTS/HSDPA 2100 MHz GSM/GPRS/EDGE 850/900/1800/1900 MHz

Each product has two editions: Data only or Telematics. Data only does not support the voice function.

Function	Data only	Telematics
Analog voice input function	×	√
Analog voice output function	×	√
PCM voice function	×	√

2 Overall Description

2.1 About This Chapter

This chapter gives a general description of the MU509 module and provides:

- Function Overview
- Circuit Block Diagram
- Application Block Diagram

2.2 Function Overview

Table 2-1 Feature

Feature	Description
Physical Features	• Dimensions (L × W × H): 30 mm × 30 mm × 2.6 mm • Weight: about 5.5 g
Working Bands	• MU509-b: UMTS2100/900 MHz GSM850/900/1800/1900 MHz (Data only or Telematics) • MU509-c: UMTS1900/850 MHz GSM850/900/1800/1900 MHz (Data only or Telematics) • MU509-g: UMTS2100/850 MHz GSM850/900/1800/1900 MHz (Data only or Telematics) • HUAWEI MU509-1: UMTS 2100MHz GSM/GPRS/EDGE 850/900/1800/1900 MHz (Data only or Telematics) For the differences between Data only and Telematics, see "Chapter 1 ".
Operating Temperature	Normal working temperature: –20°C to +70°C
	Extended working temperature: –40°C to +85°C

Feature	Description
Ambient Temperature for Storage	–40°C to +85°C
Power Voltage	3.3 V to 4.2 V (3.8 V is recommended.)
AT Commands	For MU509-b, MU509-g and HUAWEI MU509-1, see the *HUAWEI MU509 HSDPA LGA Module AT Command Interface Specification*. For MU509-c, see the *HUAWEI MU509-c HSDPA LGA Module AT Command Interface Specification*.
Application Interface (145-pin LGA interface)	One 8-wire UART (Universal Asynchronous Receiver-Transmitter)
	One standard USIM (Universal Subscriber Identity Module) card (Class B and Class C)
	Audio (optional): (only Telematics version supports these functions) • 2×Micphone in • 1×Handset out • 1×Speaker out • 1×PCM
	USB 2.0 (full speed)
	Power on/off
	Hardware Reset
	Wakeup_In
	Wakeup_Out
	Light-emitting Diode (LED)
	Configurable General-purpose I/O (GPIO)
	RF pad
	Power
SMS	New message alert, text message receiving, and text message sending
	Management of text messages: read messages, delete messages, storage status, and message list
	Support for the Protocol Data Unit (PDU) mode
Data Services	GSM CS: UL 14.4 kbps/DL 14.4 kbps
	GPRS: UL 85.6 kbps/DL 85.6 kbps
	EDGE: UL 236.8 kbps/DL 236.8 kbps

Feature	Description
	WCDMA CS: UL 64 kbps/DL 64 kbps
	WCDMA PS: UL 384 kbps/DL 384 kbps
	HSDPA: DL 3.6 Mbps
Internet Protocols	TCP/IP, UDP/IP, PPP protocol
Applications	• SVD (Simultaneous Voice and Data), only for 3G • SIM PBM (Phone Book Management)
Certification Information	• Restriction of the use of certain Hazardous Substances (RoHS) • European Conformity (CE) • Federal Communications Commission (FCC) • Globe Certification Forum (GCF) • PCS Type Certification Review Board (PTCRB) • China Compulsory Certification (CCC) • A-tick

NOTE

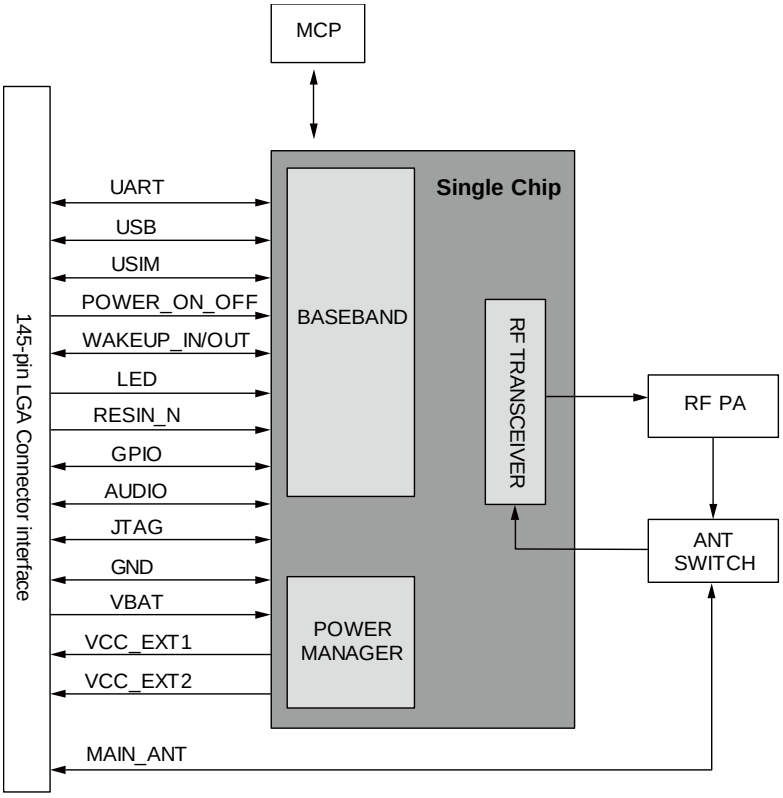
- The certifications of different type of MU509 module are different because of sale markets. To get the details, please refer to "Chapter 7 ".
- [1]:The temperatures outside of the range –20°C to +70°C; the module might slightly deviate from 3GPP TS 45.005 and 3GPP TS 34.121-1 specifications.

2.3 Circuit Block Diagram

Figure 2-1 shows the circuit block diagram of the MU509 module. The application block diagram and major functional units of the MU509 module contain the following parts:

- Baseband controller
- Power manager
- Multi-chip package (MCP) memory
- RF PA

Figure 2-1 Circuit block diagram of the MU509 module

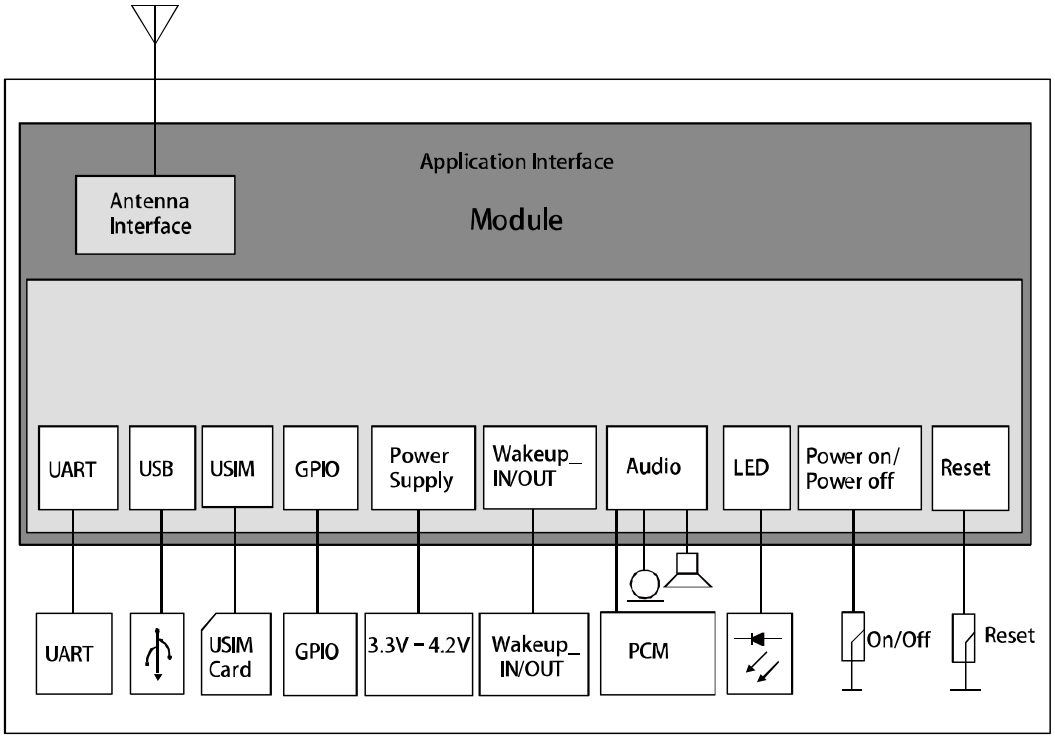


NOTE

Only Telematics version supports the audio function.

2.4 Application Block Diagram

Figure 2-2 Application block diagram of the MU509 module



UART Interface	The module supports 8-wire UART.
USB Interface	The USB interface supports USB 2.0 full speed standard.
USIM Interface	The USIM interface provides the interface for a USIM card. The USIM card can be inserted into the host side.
Power Supply	DC 3.8 V is recommended.
Audio Interface	The module supports one speaker output, two microphone input, one earpiece output and one PCM interface (only telematics version supports the audio function).
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 MU509 module, including:

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

3.2 LGA Interface

The MU509 module uses a 145-pin LGA as its external interface. For details about the module and dimensions of the LGA, see "6.4 Dimensions and interfaces".

If DTE supports other Huawei LGA modules, such as modules with system of CDMA, TD-SCDMA or HSPA, please refer to *HUAWEI 30 mm x 30 mm LGA Module Hardware Migration Guide*.

Table 3-1 shows the definitions of pins on the 145-pin signal interface of the MU509 module.

Table 3-1 Definitions of pins on the LGA interface

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
1	NC	-	-	Not connected, please keep this pin open.	-	-	-
2	NC	-	-	Not connected, please keep this pin open.	-	-	-
3	NC	-	-	Not connected, please keep this pin open.	-	-	-
4	NC	-	-	Not connected, please keep this pin open.	-	-	-
5	PCM_SYNC	-	O	PCM interface sync	–0.3	2.6	2.9
6	PCM_DIN	-	I	PCM I/F data in	–0.3	2.6	2.9
7	PCM_DOUT	-	O	PCM I/F data out	–0.3	2.6	2.9
8	PCM_CLK	-	O	PCM interface clock	–0.3	2.6	2.9
9	NC	-	-	Not connected, please keep this pin open.	-	-	-
10	NC	-	-	Not connected, please keep this pin open.	-	-	-
11	WAKEUP_IN	-	I	Host to set the module into sleep or wake up the module from sleep.	–0.3	2.6	2.9
12	VBAT	-	P	Power supply input	3.3	3.8	4.2
13	VBAT	-	P	Power supply input	3.3	3.8	4.2
14	PS_HOLD	-	I	Used for JTAG interface assigning a test point for it.	-	1.8	-
15	Reserved	-	-	Reserved	-	-	-
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.	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
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	-	-	-
31	VCC_EXT2	-	P	2.6 V POWER output	2.5	2.6	2.7
32	VCC_EXT1	-	P	1.8 V POWER output	1.65	1.8	1.95
33	NC	-	-	Not connected, please keep this pin open.	-	-	-
34	SIM_VCC	-	P	Power supply for SIM card	-	1.8/2.85	-
35	VCOIN	-	P	Coin cell input	1.5	3.0	3.25
36	JTAG_TRST_N	-	I	JTAG reset	-	-	-
37	NC	-	-	Not connected, please keep this pin open.	-	-	-
38	MIC2_P	-	I	(Only Telematics version supports audio function, Data only version does not support this function) Positive pole of the input of audio interface 2	-	-	-
39	MIC2_N	-	I	(Only Telematics version supports audio function, Data only version does not support this function) Negative pole of the input of audio interface 2	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
40	MIC1_P	-	I	(Only Telematics version supports audio function, Data only version does not support this function) Positive pole of the input of audio interface 1	-	-	-
41	MIC1_N	-	I	(Only Telematics version supports audio function, Data only version does not support this function) Negative pole of the input of audio interface 1	-	-	-
42	JTAG_TCK	-	I	JTAG clock input	–0.3	1.8	2.1
43	Reserved	-	-	Reserved	-	-	-
44	GPIO	-	I/O	General I/O pin. The function of these pins has not been defined.	–0.3	2.6	2.9
45	GPIO	-	I/O	General I/O pin. The function of these pins has not been defined.	–0.3	2.6	2.9
46	GPIO	-	I/O	General I/O pins. The function of these pins has not been defined.	–0.3	2.6	2.9
47	NC	-	-	Not connected, please keep this pin open.	-	-	-
48	GND	-	-	Ground	-	-	-
49	GND	-	-	Ground	-	-	-
50	GND	-	-	Ground	-	-	-
51	GPIO	-	I/O	General I/O pins. The function of these pins has not been defined.	–0.3	2.6	2.9
52	GND	-	-	Ground	-	-	-
53	GND	-	-	Ground	-	-	-
54	GND	-	-	Ground	-	-	-
55	GPIO	-	I/O	General I/O pins. The function of these pins has not been defined.	–0.3	2.6	2.9
56	GND	-	-	Ground	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
57	GND	-	-	Ground	-	-	-
58	GND	-	-	Ground	-	-	-
59	GND	-	-	Ground	-	-	-
60	NC	-	-	Not connected, please keep this pin open.	-	-	-
61	NC	-	-	Not connected, please keep this pin open.	-	-	-
62	NC	-	-	Not connected, please keep this pin open.	-	-	-
63	NC	-	-	Not connected, please keep this pin open.	-	-	-
64	NC	-	-	Not connected, please keep this pin open.	-	-	-
65	NC	-	-	Not connected, please keep this pin open.	-	-	-
66	NC	-	-	Not connected, please keep this pin open.	-	-	-
67	NC	-	-	Not connected, please keep this pin open.	-	-	-
68	NC	-	-	Not connected, please keep this pin open.	-	-	-
69	NC	-	-	Not connected, please keep this pin open.	-	-	-
70	NC	-	-	Not connected, please keep this pin open.	-	-	-
71	WAKEUP_OUT	-	O	Module to wake up the host	–0.3	2.6	2.9
72	JTAG_TDO	-	O	JTAG test data output	–0.3	1.8	2.1
73	UART_DSR	-	O	UART Data Set Ready	–0.3	2.6	2.9
74	UART_RTS	-	O	UART Ready for receive	–0.3	2.6	2.9
75	UART_DCD	-	O	UART Data Carrier Detect	–0.3	2.6	2.9
76	UART_TX	-	O	UART transmit output	–0.3	2.6	2.9
77	UART_RING	-	O	UART Ring Indicator	–0.3	2.6	2.9
78	UART_RX	-	I	UART receive data input	–0.3	2.6	2.9
79	UART_DTR	-	I	Data Terminal Ready	–0.3	2.6	2.9

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
80	UART_CTS	-	I	UART Clear to Send	–0.3	2.6	2.9
81	POWER_ON_OFF	-	I	System power-on or power-off	-	Pulled up on chip	-
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	Full-speed USB D-	-	-	-
86	USB_DP	-	I/O	Full-speed USB D+	-	-	-
87	JTAG_TDI	-	I	JTAG test data input	–0.3	1.8	2.1
88	SIM_RESET	-	O	SIM reset	-	1.8/2.85	-
89	SIM_DATA	-	I/O	SIM data	-	1.8/2.85	-
90	SIM_CLK	-	O	SIM clock	-	1.8/2.85	-
91	LED_STATUS	-	I	Status indicator Current sink Drive strength: 10 mA	-	-	-
92	NC	-	-	Not connected, please keep this pin open.	-	-	-
93	JTAG_RTCK	-	I	JTAG return clock	–0.3	1.8	2.1
94	NC	-	-	Not connected, please keep this pin open.	-	-	-
95	NC	-	-	Not connected, please keep this pin open.	-	-	-
96	EAR_OUT_N	-	O	(Only Telematics version supports audio function, Data only version does not support this function) Negative pole of the output of Earphone interface	-	-	-
97	EAR_OUT_P	-	O	(Only Telematics version supports audio function, Data only version does not support this function) Positive pole of the output of Earphone interface	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
98	SPKR_OUT_P	-	O	(Only Telematics version supports audio function, Data only version does not support this function) Positive pole of the output of speaker interface	-	-	-
99	SPKR_OUT_N	-	O	(Only Telematics version supports audio function, Data only version does not support this function) Negative pole of the output of speaker interface	-	-	-
100	RESIN_N	-	I	Reset module.	–0.3	1.8	2.1
101	LED_MODE	-	I	Mode indicator Current sink Drive strength: 10 mA	-	-	-
102	NC	-	-	Not connected, please keep this pin open.	-	-	-
103	NC	-	-	Not connected, please keep this pin open.	-	-	-
104	NC	-	-	Not connected, please keep this pin open.	-	-	-
105	GPIO	-	I/O	General I/O pins. The function of these pins has not been defined.	–0.3	2.6	2.9
106	GND	-	-	Ground	-	-	-
107	MAIN_ANT	-	-	RF main antenna pad	-	-	-
108	GND	-	-	Ground	-	-	-
109	GPIO	-	I/O	General I/O pins. The function of these pins has not been defined.	–0.3	2.6	2.9
110	GND	-	-	Ground	-	-	-
111	NC	-	-	Not connected, please keep this pin open.	-	-	-
112	GND	-	-	Ground	-	-	-
113	GPIO	-	I/O	General I/O pins. The function of these pins has not been defined.	–0.3	2.6	2.9
114	GND	-	-	Ground	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
115	NC	-	-	Not connected, please keep this pin open.	-	-	-
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	-	-	-
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	-	-	-

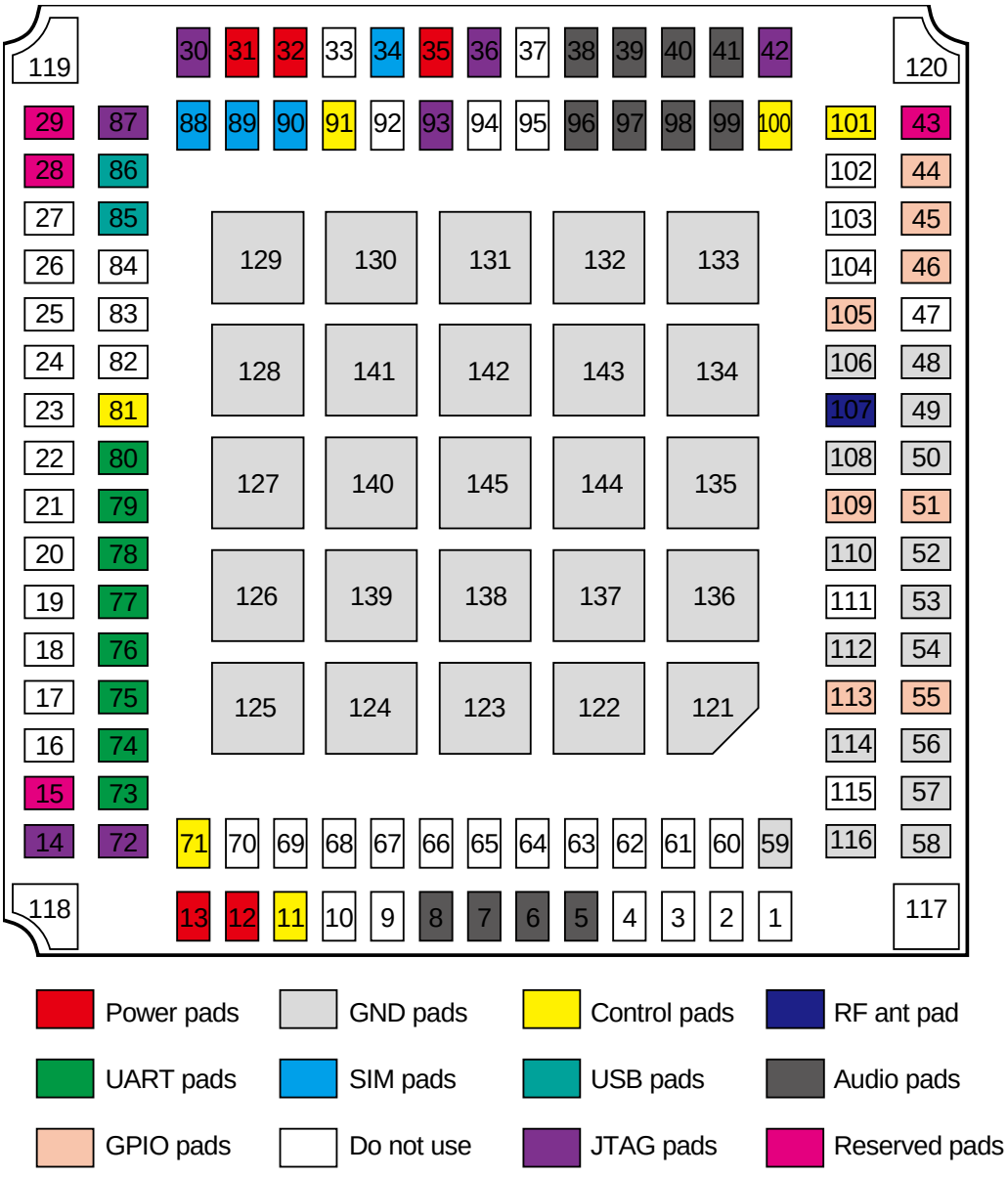
PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
142	GND	-	-	Thermal Ground Pad	-	-	-
143	GND	-	-	Thermal Ground Pad	-	-	-
144	GND	-	-	Thermal Ground Pad	-	-	-
145	GND	-	-	Thermal Ground Pad	-	-	-

NOTE

- P indicates power pins; I indicates pins for digital signal input; O indicates pins for digital signal output.
- The NC (Not Connected) pins are internally connected to the module. Therefore, these pins should not be used, otherwise they may cause problems. Please contact us for more details about this information.
- 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.

Figure 3-1 shows the sequence of pins on the 145-pin signal interface of the MU509 module.

Figure 3-1 Bottom view of sequence of LGA interface pins



3.3 Power Interface

3.3.2 Overview

The power supply part of the MU509 module contains:

- VBAT pins for the power supply
- VCOIN pin for the standby power supply of the real-time clock (RTC)

- VCC_EXT1 pin for external power output
- VCC_EXT2 pin for external power output
- SIM_VCC pin for SIM 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.	Signal Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
12, 13	VBAT	P	Pins for power voltage input	3.3	3.8	4.2
48, 49, 50, 52, 53, 54, 56, 57, 58, 59, 106, 108, 110, 112, 114, 116	GND	-	GND	-	-	-
35	VCOIN	P	Pin for standby power input of the RTC	1.5	3.0	3.25
32	VCC_EXT1	P	Pin for external power output	1.65	1.8	1.95
31	VCC_EXT2	P	Pin for external power output	2.5	2.6	2.7
34	SIM_VCC	P	Power supply for SIM card	-	1.8/2.85	-
121–145	GND	-	Thermal Ground Pad	-	-	-

3.3.3 VBAT Interface

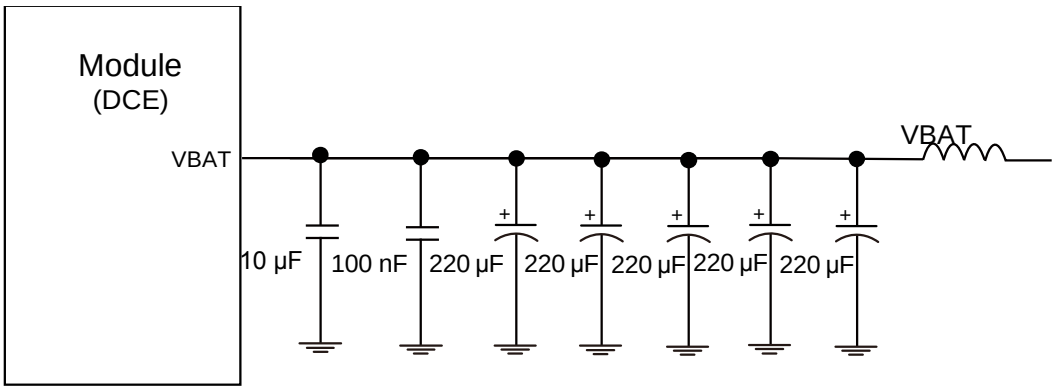
When the MU509 module works normally, power is supplied through the VBAT pins and the voltage ranges from 3.3 V to 4.2 V (typical value: 3.8 V). The 145-pin LGA provides VBAT pins and GND pins for external power input. To ensure that the MU509 module works normally, all the pins must be used efficiently.

When the MU509 module is used for different external applications, pay special attention to the design for the power supply. When the MU509 module 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. Make sure that the voltage does not decrease below 3.3 V in any case. Otherwise, exceptions such as restart of the MU509 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, at least five 220 µF storage capacitors are connected in parallel at the power interface of the MU509 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 MU509 module.

Figure 3-2 Recommended power circuit of MU509 module



3.3.4 VCOIN Interface

VCOIN pin of MU509 module is used as an analog input from the 3 V coin cell for Sudden Momentary Power Loss (SMPL), Real-time Clock (RTC) and External Crystal Oscillator (XTAL) keep-alive power. A capacitor (rather than a coin cell) can be used if only SMPL is supported (not RTC or XTAL). VCOIN pin is also used as an analog output for a coin cell or a capacitor charging.

Sudden momentary power loss

If the monitored VBAT drops out-of-range (< 2.55 V nominal), the SMPL feature initiates a power-on sequence without software intervention, and then VBAT returns in-range within a programmable interval of between 0.5 and 2.0 seconds. SMPL achieves immediate and automatic recovery from momentary power loss. A valid voltage on VCOIN is required to run the SMPL timer. If a capacitor is used instead of a coin, it must be connected between VCOIN and the ground. The capacitor must be charged to operate properly as the SMPL power source. The capacitor value depends on the SMPL timer setting.

Table 3-3 Keep-alive capacitor values vs. SMPL timer settings

SMPL timer setting	Capacitor value	Capacitor package (X5R)
0.5s	1.5 µF	0805
1.0s	3.3 µF	0805
1.5s	4.7 µF	0805
2.0s	6.8 µF	1206

If the SMPL counter expires without VBAT returning to its valid range, the MU509 must undergo the normal power-on sequence whenever the VBAT is detected.

Real-time clock

If RTC is used, a manganese-lithium rechargeable battery is recommended, for example, the SII Micro Parts HB-414 and the Panasonic ML-series. Two sets of coin cell specifications are compared in Table 3-4 . When the MU509 is off, RTC and its oscillator source are still active, provided by a coin cell battery which is installed. This allows continued monitoring of RTC alarms programmed via software.

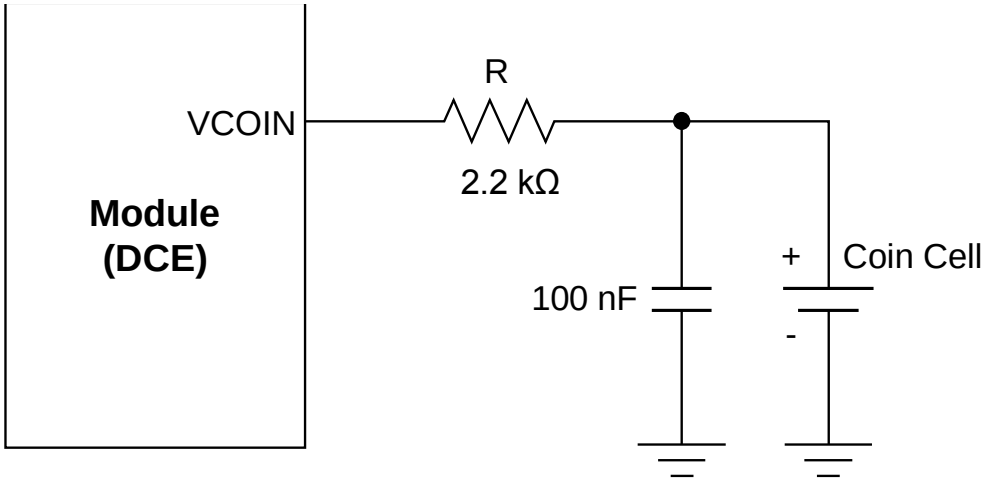
Table 3-4 Coin cell characteristics

Parameter	Specifications	
	HB-414	ML-series
Nominal voltage	3 V	3 V
Nominal capacity	0.3 mAh	3.4 mAh
Continuous standard load	5 mA	10 mA
Operating temperature	–20°C to +60°C	–20°C to +60°C
Diameter	4.8 mm	6.8 mm
Height	1.4 mm	1.45 mm
Weight	0.07 g	0.17 g

An interrupt is generated if the coin cell voltage drops too low (and the main battery is not present). If this interrupt occurs, the RTC might be corrupted. A different interrupt is generated if the crystal oscillator stops; this signifies that handset timing is no longer accurate. Again, the RTC is corrupted.

When the VBAT power supply of the MU509 is normal, the coin cell is charged from VBAT. The MU509 reads the coin cell voltage and monitors the charging. During normal operation, the VCOIN pin voltage will stay above 2.2 V, even when the coin cell charger is turned off. Figure 3-3 shows the reference RTC circuit.

Figure 3-3 VCOIN interface circuit



3.3.5 Output Power Supply Interface

Output power supply interface includes VCC_EXT1, VCC_EXT2 and SIM_VCC.

Through the output power supply interface, the MU509 module can supply 2.6 V and 1.8 V power externally with an output current of 20 mA (typical value) for external level conversion or other applications.

If the MU509 module is in sleep mode, the output power supply interface is in the low power consumption state (< 500 μA). If the MU509 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 MU509 module consists of the following:

- Power-on/off (POWER_ON_OFF) pin
- Hardware reset (RESIN_N) pin
- Network status LED (LED_STATUS/LED_MODE) pin
- WAKEUP_IN Signal (WAKEUP_IN) pin
- WAKEUP_OUT Signal (WAKEUP_OUT) pin

Table 3-5 lists the pins on the signal control interface.

Table 3-5 Pins on the signal control interface

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
81	POWER_ON_OFF	I	Pin for controlling power-on and power-off	-	Pulled up on chip	-
100	RESIN_N	I	Pin for resetting the hardware	–0.3	1.8	2.1
91	LED_STATUS	I	Pin for network status LED	-	-	-
101	LED_MODE	I	Pin for network mode LED	-	-	-
11	WAKEUP_IN	I	Host to set the module into forced sleep or wake up the module from forced sleep	–0.3	2.6	2.9
71	WAKEUP_OUT	O	Module to wake up the host.	–0.3	2.6	2.9

NOTE
It is recommended to use resistance of 0 Ω in the DTE to isolate signals transmitted from above pins in Table 3-5 .

3.4.2 Input Signal Control Pins

The MU509 module implements power-on and power-off and resets the hardware through the input signal control pins.

The power-on, power-off, and reset control parts of the interface of the MU509 module include power-on/power-off interface signal (POWER_ON_OFF) and the hardware reset interface signal (RESIN_N).

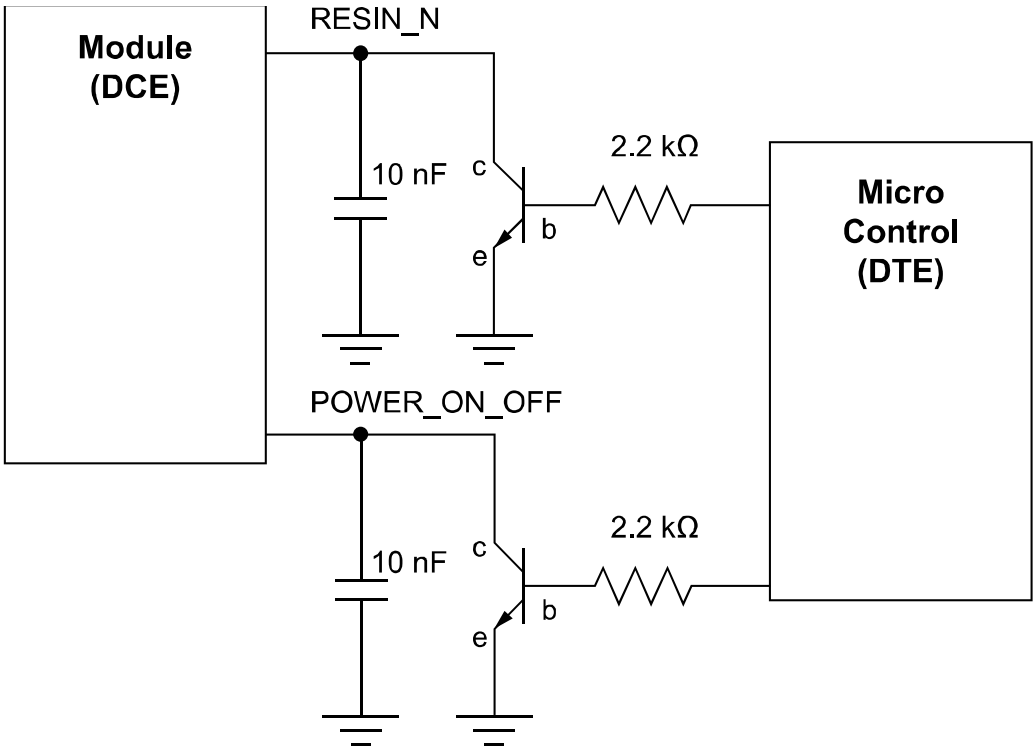
The POWER_ON_OFF pin is used to implement power-on and power-off. If the POWER_ON_OFF pin is pulled down for at least 0.5s, the module is powered on; if the POWER_ON_OFF pin is pulled down for at least 0.5s again, the module is powered off.

The RESIN_N pin is used to reset the hardware. When the software stops responding, the RESIN_N pin can be pulled down for at least 10 ms to reset the hardware.

CAUTION

As the RESIN_N and POWER_ON_OFF signals are relatively sensitive, it is recommended that you install a 10 nF 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.

Figure 3-4 Connections of the POWER_ON_OFF and RESIN_N pins



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 3-5 Power on timing sequence

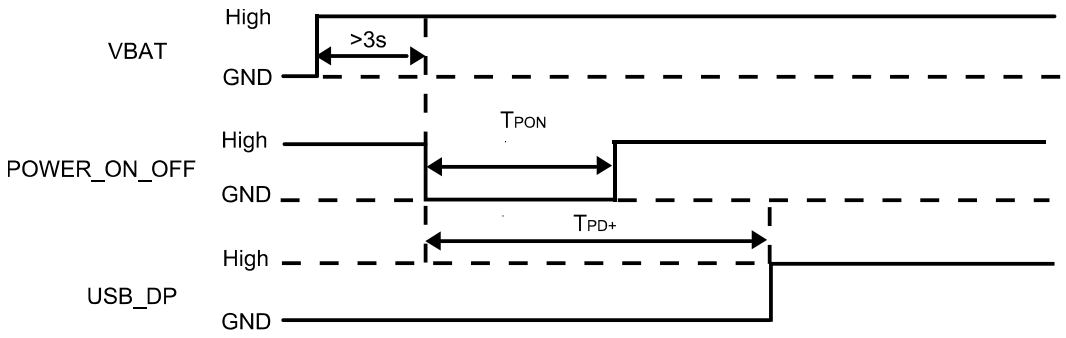


Table 3-6 Power on timing

Parameter	Comments	Time(Nominal values)	Units
T_{PON}	POWER_ON_OFF turn on time.	0.5 < T_{PON} < 1	s
T_{PD+}	POWER_ON_OFF Valid to USB D+ high	4	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.

Figure 3-6 Power off timing

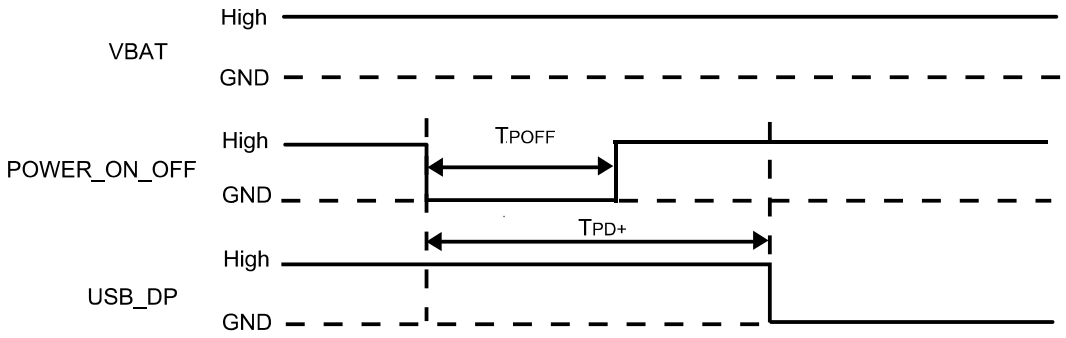


Table 3-7 Power off timing

Parameter	Comments	Time(Nominal values)	Units
T_{POFF}	POWER_ON_OFF turn off time.	0.5 < T_{POFF} < 4	s
T_{PD+}	POWER_ON_OFF Valid to USB D+ high	4.6	s

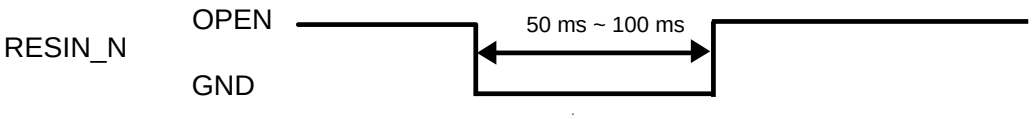
NOTE

For detailed information about power supply design and printed circuit board (PCB) design, see the *HUAWEI Module Power Supply Design Guide* and the *HUAWEI LGA Module PCB Routing Design Guide*.

RESIN_N

The MU509 module supports hardware reset function. If the software of the MU509 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 for more than 50 ms, 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



NOTE

The low-level pulse through the RESET pin cannot last for more than 2s. Otherwise, the MU509 module will be powered off.

3.4.3 Output Signal Control Pin

The MU509 module provides a network status LED pin LED_STATUS and LED_MODE. The pulse signal output through this pin controls the status LED on the user interface board to display the network status. The LEDs are controlled by a current sink. The high voltage is the voltage of VBAT (with the typical value of 3.8 V).

Different blinking modes of the status LED indicate different network status. Table 3-8 describes the status of the LED_STATUS pin and LED_MODE pin.

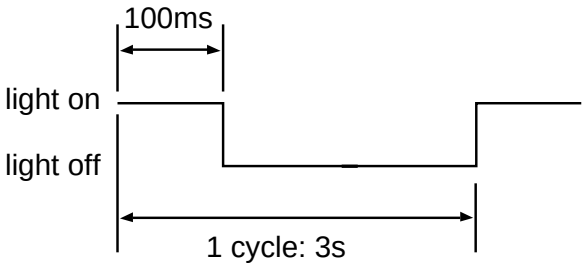
Table 3-8 The status of the LED_STATUS pin and LED_MODE pin

No.	Operating Status	LED_STATUS	LED_MODE
1	The 3G network is successfully registered.	The indicator blinks once each time.	Light off
2	The dial-up connection is set up for accessing 3G data services.	Light on	Light off
3	The software is being downloaded or upgraded.	Light off	The indicator blinks fast.
4	The network is being searched for or no network is detected.	Light off	The indicator blinks twice each time.

No.	Operating Status	LED_STATUS	LED_MODE
5	The 2G network is successfully registered.	Light off	The indicator blinks once each time.
6	The dial-up connection is set up for accessing 2G data services.	Light off	Light on

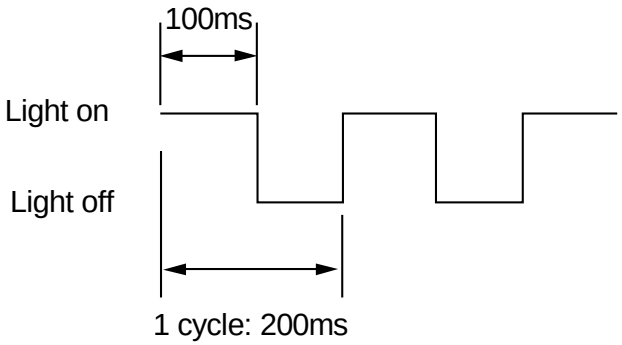
Blinking Once Each Time

Figure 3-8 Status when the indictor blinks once each time



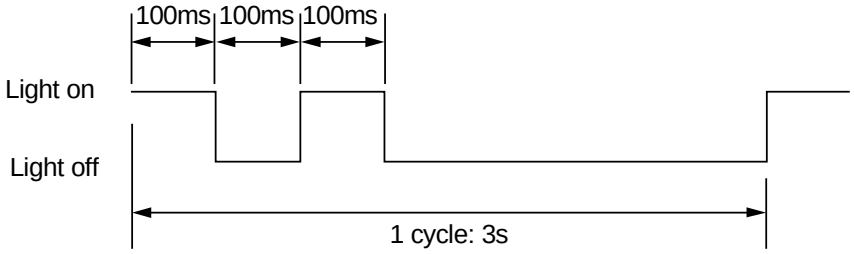
Blinking Fast

Figure 3-9 Status when the indictor blinks fast



Blinking Twice Each Time

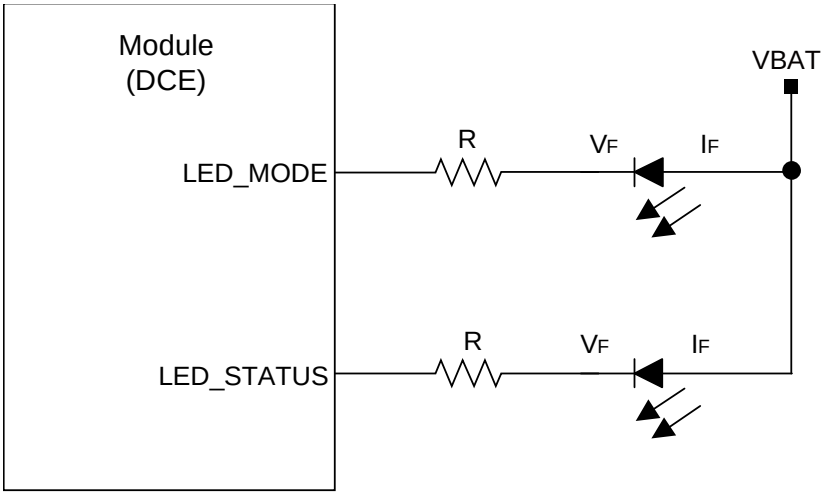
Figure 3-10 Status when the indictor blinks twice each time



External Circuits

Figure 3-11 shows the recommended circuits of the LED_MODE and LED_STATUS pins. According to LED feature, you can adjust the LED brightness by adjusting the impedance of resistor R.

Figure 3-11 Driving circuit



For resistance of R placed on user board, choose the value such that it satisfies the following equation:

I_F *R+V_F = VBAT

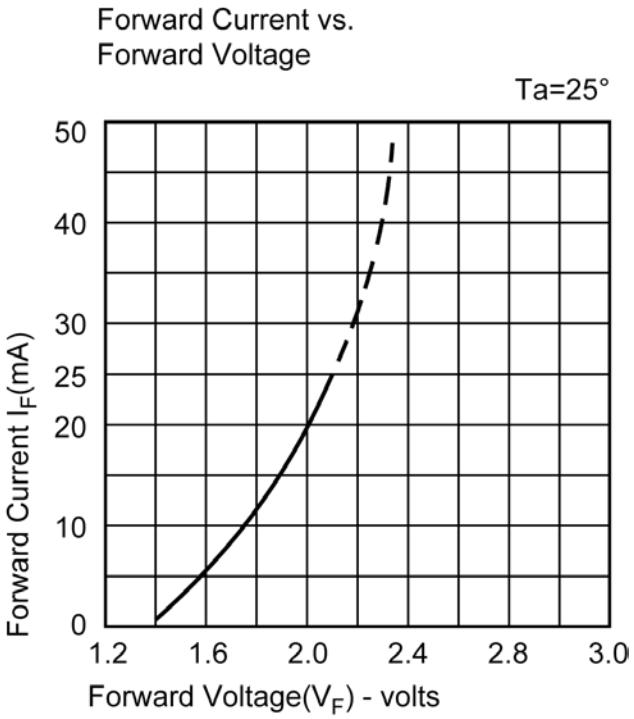
V_F: Forward voltage

I_F: Forward current

Take a LED as an example, Figure 3-12 shows its I_F - V_F curves. If VBAT is 3.8 V and the desired current through the LED I_F is 3 mA, then the voltage of the LED V_F is 1.5 V according to I_F - V_F curves, and the corresponding value for resistance of R is (3.8-1.5)/0.003 = 767 Ω.

The brightness of the LED depends on the current value, and for most of the indicator lights the current from 2 mA to 5 mA is already enough.

Figure 3-12 LED Typical Electro-Optical Characteristics Curves



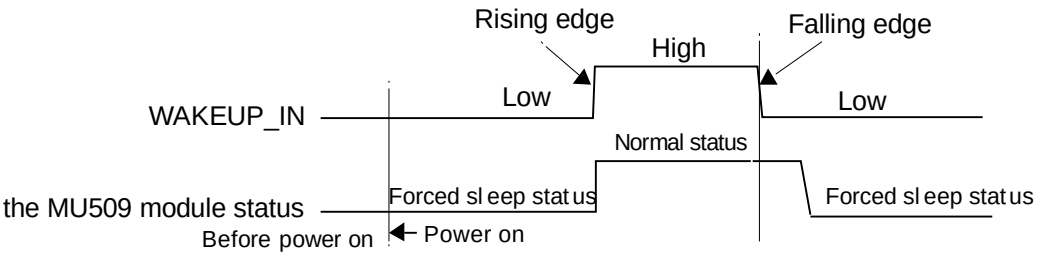
3.4.4 WAKEUP_IN Signal

The DTE controls the sleep and wakeup status of the MU509 module through the WAKEUP_IN signal. The DTE can control the MU509 module to enter forced sleep status in following two cases:

1. Before MU509 module is powered on, if the WAKEUP_IN pin carries a low-level voltage, MU509 module is allowed to enter forced sleep status after MU509 module is powered on.
2. After MU509 module is powered on, if WAKEUP_IN pin's level status changes from high to low (that is, the pin level is in falling edge), MU509 module is allowed to enter forced sleep status.

If the level status of the WAKEUP_IN signal changes from low to high when the MU509 module is in forced sleep status, the MU509 module will exit from forced sleep status.

Figure 3-13 WAKEUP_IN sequence



The level status of WAKEUP_IN signal is high by default.

3.4.5 WAKEUP_OUT Signal

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

WAKEUP_OUT signal is low by default. When a phone call or an SMS is coming, the MU509 module will output a high pulse which lasts for 1s.

Within the duration of the high pulse, if a new phone call or an SMS is coming, the MU509 module will output the high pulse over again.

Figure 3-14 WAKEUP_OUT sequence

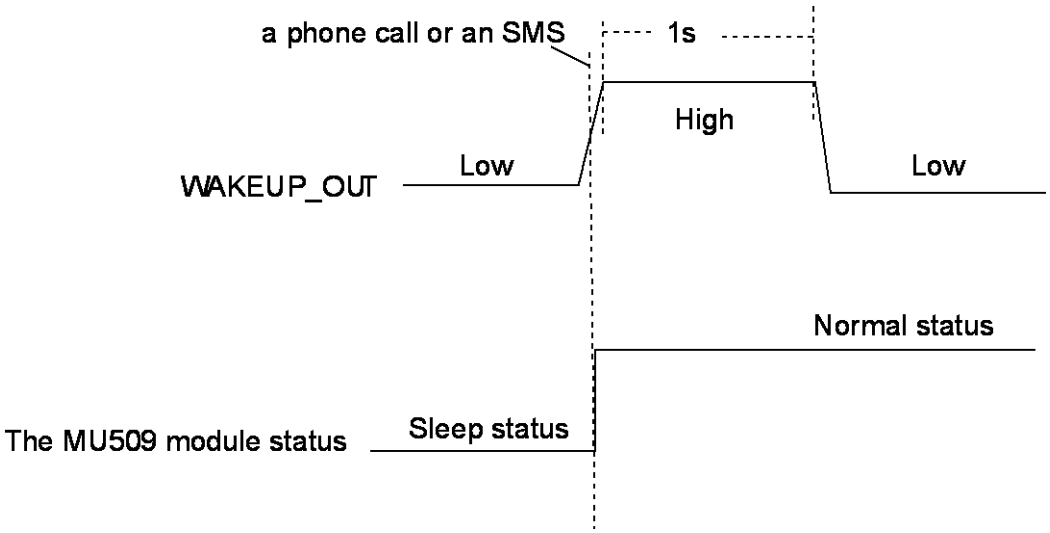
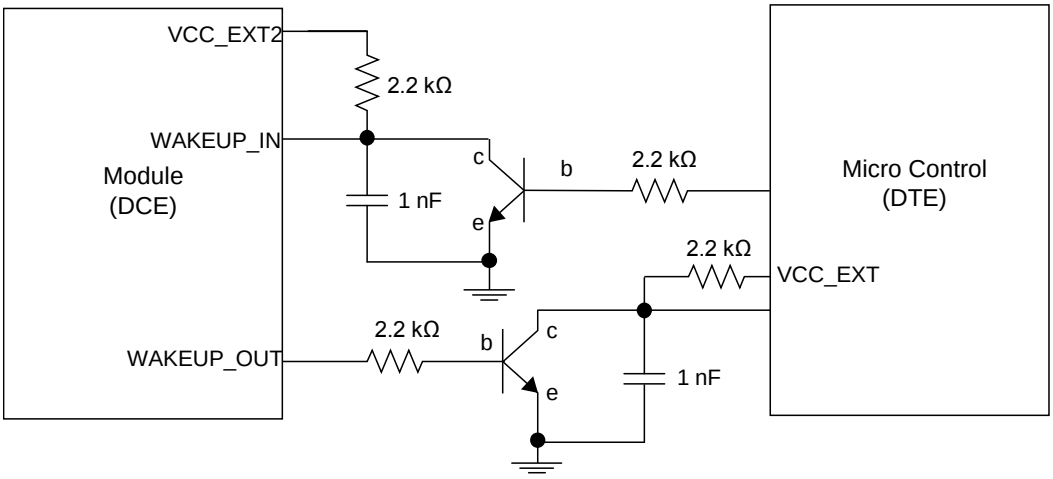


Figure 3-15 Connections of the WAKEUP_IN and WAKEUP_OUT pins



3.5 UART Interface

3.5.1 Overview

The MU509 module provides the UART (8-wire UART) interface for one asynchronous communication channel. As the UART interface supports signal control through standard modem handshake, AT commands are entered and serial communication is performed through the UART interface. 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)

Table 3-9 lists the UART interface signals.

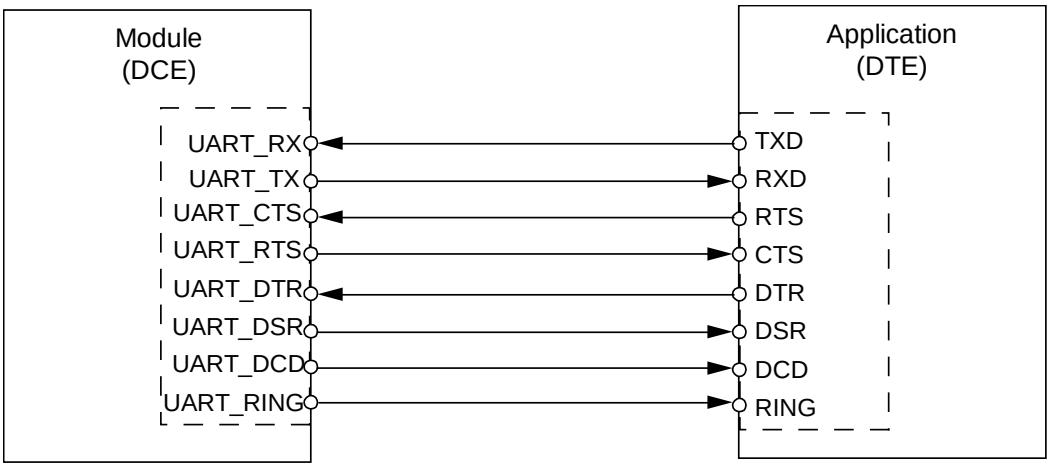
Table 3-9 UART interface signals

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
76	UART_TX	O	Data sending on the wireless module	–0.3	2.6	2.9
78	UART_RX	I	Data receive end of the module	–0.3	2.6	2.9
77	UART_RING	O	Ringing indication on the wireless module	–0.3	2.6	2.9
74	UART_RTS	O	Data sending request on the wireless module	–0.3	2.6	2.9
79	UART_DTR	I	Data terminal ready on the wireless module	–0.3	2.6	2.9
80	UART_CTS	I	Clearing to send on the wireless module	–0.3	2.6	2.9
75	UART_DCD	O	Data carrier detection on the wireless module	–0.3	2.6	2.9
73	UART_DSR	O	Data ready on the wireless module	–0.3	2.6	2.9

3.5.2 Circuit Recommended for the UART Interface

Figure 3-16 shows the connection of the UART interface in the MU509 module (DCE) with the host (DTE).

Figure 3-16 Connection of the UART interface in the MU509 module (DCE) with the host (DTE)



NOTE

- For detailed application of the MU509 UART interface, see the *HUAWEI Module UART Serial Port Design Guide*.
- It is recommended that set the pins related to UART interface as test points on the DTE board for debugging.
- The maximum level of UART interface signals is 2.9 V. If these signals are connected to a host with 3.3 V level, a level conversion circuit is required.
- Make sure that the level of the UART signals are 0 V before MU509 module is powered on to avoid the wind blow in which may cause the module cannot work properly.
- The level of RS-232 Transceivers must match that of the MU509 module.

3.6 USB Interface

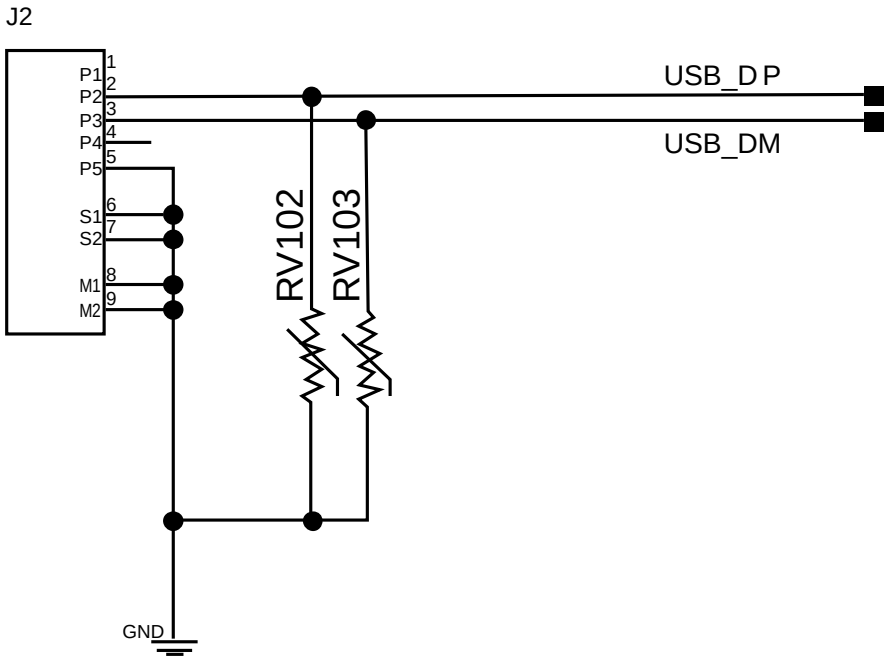
The MU509 is compliant with USB 2.0 full speed protocol. Figure 3-17 shows the circuit of the USB interface.

Table 3-10 Definition of the USB interface

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
86	USB_DP	I/O	USB data signal D+	-	-	-
85	USB_DM	I/O	USB data signal D-	-	-	-

According to USB protocol, for bus timing or electrical characteristics of MU509 USB signal, please refer to the chapter 7.3.2 of *Universal Serial Bus Specification 2.0.*

Figure 3-17 Recommended circuit of USB interface



NOTE

- Since the USB interface of MU509 module supports USB 2.0 full speed, the resistance "RV102 and RV103" in the Figure 3-17 must be Voltage Sensitive Resistor with small capacitance (ALVC18S02003 manufactured by AMOTECH or B72590T7900V60 manufactured by EPCOS is recommended.). In addition, the layout design of this circuit on the DTE board should comply with the USB 2.0 full speed protocol, with differential lining and impedance control to 90 Ω.
- It is recommended that set USB_DM and USB_DP pins as test points and then place these test points on the DTE for debugging.

3.7 SIM Card Interface

3.7.1 Overview

The MU509 module provides a SIM card interface complying with the ISO 7816-3 standard and supports automatic detection of a Class B SIM card or a Class C SIM card. Table 3-11 lists the SIM card interface signals.

Table 3-11 SIM card interface signals

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
34	SIM_VCC	P	Power source for the external USIM.	-	1.8/2.85	-
89	SIM_DATA	I/O	External USIM data signal.	-	1.8/2.85	-
90	SIM_CLK	O	External USIM clock signal.	-	1.8/2.85	-
88	SIM_RESET	O	External USIM reset signal.	-	1.8/2.85	-

3.7.2 Circuit Recommended for the SIM Card Interface

As the MU509 module is not equipped with a SIM card socket, you need to place a SIM card socket on the user interface board. The SIM card signals are transmitted outwards through the 145-pin LGA interface. Figure 3-18 shows the circuit of the SIM card interface.

Figure 3-18 Circuit of the SIM card interface

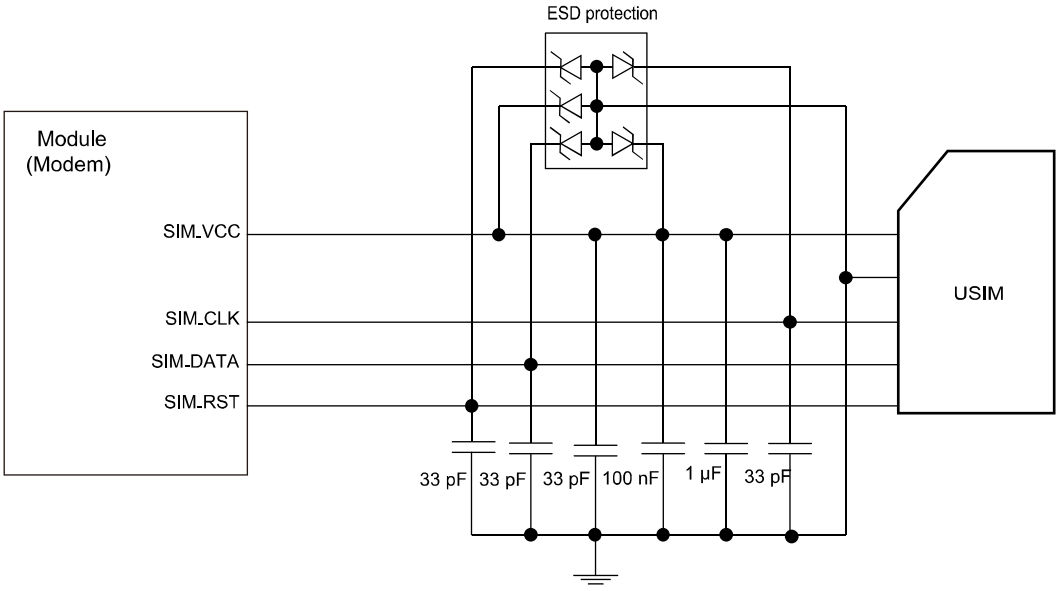
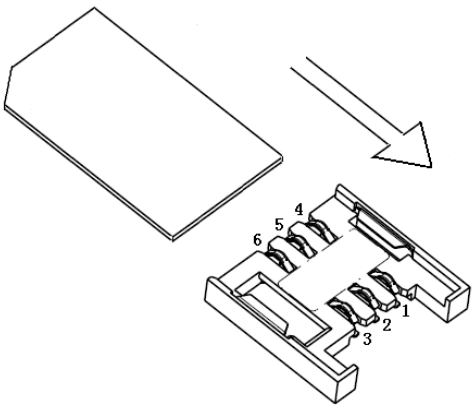


Figure 3-19 Pin definition of SIM Socket



pin1: SIM_VCC

pin2: SIM_RESET

pin3: SIM_CLK

pin4: GND

pin5: NULL

pin6: SIM_DATA

CAUTION

- To meet the requirements of 3GPP TS 51.010-1 protocols and electromagnetic compatibility (EMC) authentication, the SIM card socket should be placed near the LGA interface (it is recommended that the PCB circuit connecting the LGA interface and the SIM card socket 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 SIM_CLK and SIM_DATA signal wires with a ground wire. The GND pin of the SIM card socket and the GND pin of the SIM card must be well connected to the power GND pin supplying power to the MU509 module.
- A 0.1 μF or a 0.22 μF capacitor and a 1 μF capacitor are placed between the SIM_VCC and GND pins in a parallel manner. Three 10 pF capacitors are placed between the SIM_DATA and GND pins, the SIM_RST and GND pins, and the SIM_CLK and GND pins in parallel to filter interference from RF signals.
- You do not need to pull the SIM_DATA pin up during design as a 20000-Ω resistor is used to connect the SIM_DATA pin to the VSIM pin.
- 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 MU509 module.

3.8 Audio Interface

3.8.1 Analogue Audio

The MU509 provides two audio I/O channels (Data only does not support the voice function).

The two audio I/O channels are completely different and thus have good performance of resisting RF interferences. The routes on the printed circuit board (PCB) should be placed in parallel with each other and should be short. The filter circuit on the two sides should be symmetric. The differential signals should be close to each other. The audio output signals in differential pairs and the audio input signals in differential pairs should be separated effectively through ground. In addition, the audio signals should be located away from the circuits of the power supply, RF, and antenna.

The first audio channel can be used for the handset without requiring any audio amplifier. The output power for the differential ear output is typically 50 mW into a 32 Ω speaker.

The second audio channel can be used for the hands-free without requiring any audio amplifier. The output pins are configured differently, with a rated output of 500 mW into an 8 Ω speaker. Considerable current flows between the audio output pins and the speaker, and thus wide PCB traces are recommended (20 mils).

Figure 3-20 Circuit diagram of the interface of the first audio channel

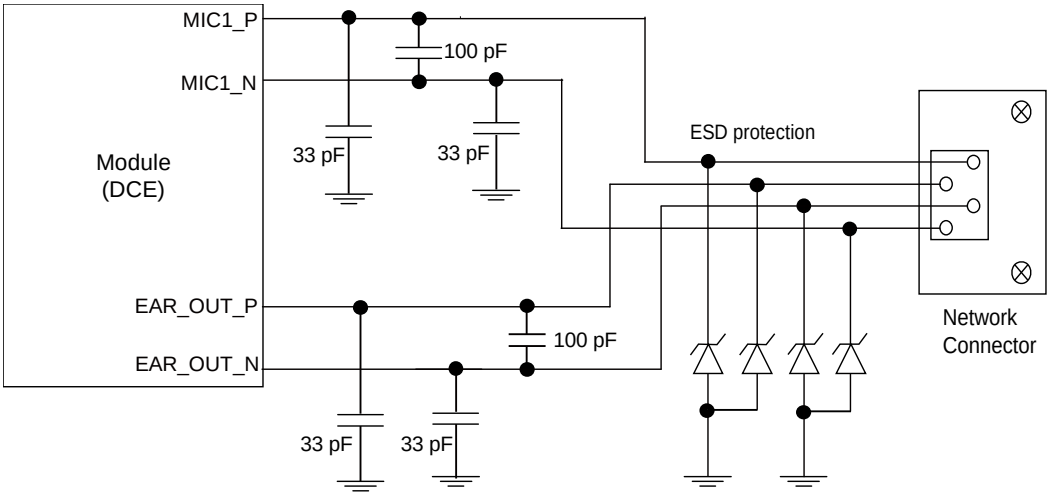
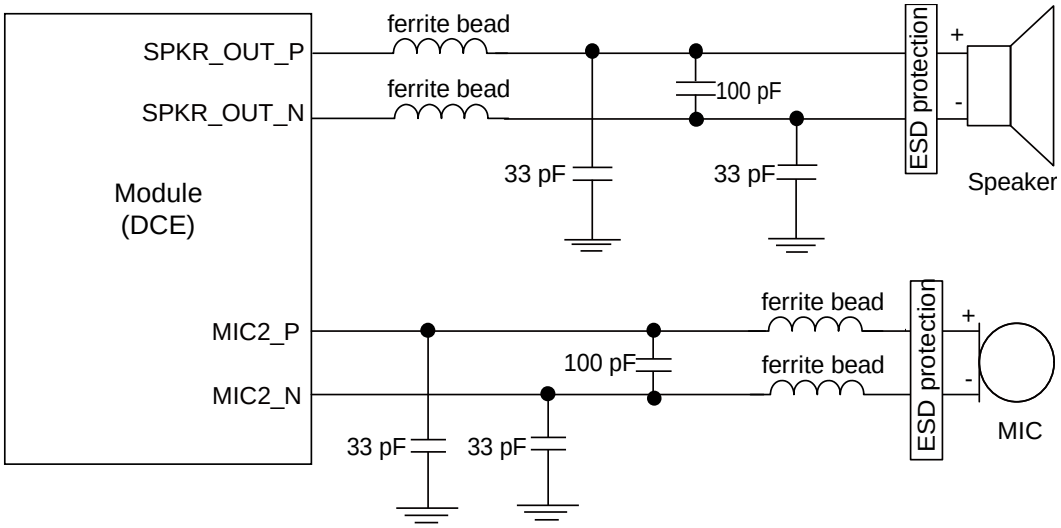


Figure 3-21 Circuit diagram of the interface of the second audio channel



NOTE

- It is recommended that a TVS be used on the related interface, to prevent electrostatic discharge and protect integrated circuit (IC) components.
- Data only does not support the voice function.

3.8.2 Digital Audio

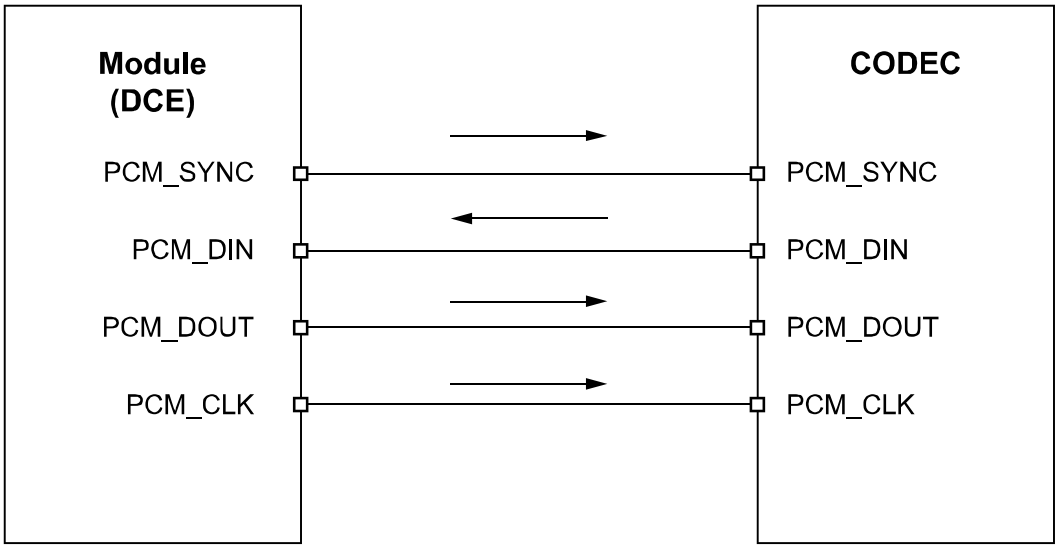
The MU509 provides one digital audio channels (Data only does not support the voice function). Table 3-12 lists the signals on the digital audio interface.

Table 3-12 Signals on the digital audio interface

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
5	PCM_SYNC	O	PCM interface sync	–0.3	2.6	2.9
6	PCM_DIN	I	PCM I/F data in	–0.3	2.6	2.9
7	PCM_DOUT	O	PCM I/F data out	–0.3	2.6	2.9
8	PCM_CLK	O	PCM interface clock	–0.3	2.6	2.9

The MU509 PCM interface enables communication with an external codec to support linear and μ-law format. The PCM_SYNC runs at 8 kHz with a 50% duty cycle.

Figure 3-22 Circuit diagram of the interface of the PCM (MU509 is used as PCM master)



NOTE

- PCM_SYNC: Output when PCM master.
- PCM_CLK: Output when PCM master.
- It is recommended that a TVS be used on the related interface, to prevent electrostatic discharge and protect integrated circuit (IC) components.
- Data only edition does not support the voice function.
- The MU509 module only works on primary master mode, PCM_CLK and PCM_SYNC pins are in the output status.

3.8.3 Primary Mode

On Primary mode MU509 provides a 16-bit linear or μ-law, with short-sync and 2.048 MHz clock (on the PCM_CLOCK pin).

3.9 General Purpose I/O Interface

The LGA module provides 8 channels GPIO pins for customers to use controlling signals which are worked at 2.6 V CMOS logic levels. Customers can use AT command to control the state of logic levels of eight channels GPIO output signal. For MU509-b, MU509-g and HUAWEI MU509-1, see the *HUAWEI MU509 HSDPA LGA Module AT Command Interface Specification*. For MU509-c, see the *HUAWEI MU509-c HSDPA LGA Module AT Command Interface Specification*.

Table 3-13 Signals on the GPIO interface

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
44, 45, 46, 51, 55, 105, 109, 113	GPIO	I/O	General I/O pins	–0.3	2.6	2.9

3.10 JTAG Interface

The MU509 module provides one JTAG interface (Joint Test Action Group). It is suggested that place the follow test points in the DTE board for debug. It is recommended that set the 9 pins related to JTAG interface as test points on the DTE for tracing and debugging.

Table 3-14 Signals on the JTAG interface

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
30	JTAG_TMS	I	JTAG Test mode select	–0.3	1.8	2.1
36	JTAG_TRST_N	I	JTAG reset.	–0.3	1.8	2.1
42	JTAG_TCK	I	JTAG clock input	–0.3	1.8	2.1
72	JTAG_TDO	O	JTAG test data output	–0.3	1.8	2.1
87	JTAG_TDI	I	JTAG test data input	–0.3	1.8	2.1
93	JTAG_RTCK	O	JTAG return clock	–0.3	1.8	2.1
14	PS_HOLD	I	This input high to keep power on, low to shut down.	-	1.8	-
32	VCC_EXT1	P	1.8 V POWER output	-	1.8	-

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
100	RESIN_N	I	Reset module.	–0.3	1.8	2.1

3.11 RF Antenna Interface

The MU509 module provides an RF antenna pad for connecting an external antenna. Through the MAIN_ANT pad, the antenna interface is routed to the coaxial connector on the DTE (for impedance 50 Ω).The external antenna is connected to the module through the coaxial connector.

A matching location for the antenna must be reserved at the antenna port.

Table 3-15 Signals on RF Antenna pad

Pin No.	Pin Name	I/O	Description
107	MAIN_ANT	-	RF main antenna pad

3.12 NC Pins

The LGA module have 47 NC pins, All of NC interface should not be connected. Please keep these pins open.

Table 3-16 Signals on NC interface

Pin No.	Pin Name	I/O	Description
1–4, 9, 10, 16–27, 33, 37, 47, 60–70, 82–84, 92, 94, 95, 102–104, 111, 115, 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 MU509 module, including:

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

4.2 Antenna Installation Guidelines

- Install the antenna in a place covered by the signal.
- The Antenna must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.
- Antenna must not be installed inside metal cases.
- Antenna must be installed also according Antenna manufacturer instructions.

4.3 Operating Frequencies

Table 4-1 shows the RF bands supported by MU509.

Table 4-1 RF bands

Operating Band	Tx	Rx
UMTS 2100 (Band I)	1920 MHz–1980 MHz	2110 MHz–2170 MHz
UMTS 1900 (Band II)	1850 MHz–1910 MHz	1930 MHz–1990 MHz
UMTS 900 (Band VIII)	880 MHz–915 MHz	925 MHz–960 MHz
UMTS 850 (Band V)	824 MHz–849 MHz	869 MHz–894 MHz

Operating Band	Tx	Rx
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

4.4 Conducted RF Measurement

4.4.1 Test Environment

Test instrument	R&S CMU200
Power supply	KEITHLEY 2306
RF cable for testing	L08-C014-350 of DRAKA COMTEQ or Rosenberger Cable length: 29 cm Compensation for 850 MHz or 900 MHz: 0.6 dB Compensation for 2100 MHz, 1900MHz or 1800 MHz: 0.8 dB

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.

4.4.2 Test Standards

Huawei modules meet all 3GPP test standards relating to both 2G and 3G. Each module passes strict tests at the factory and thus the quality of the modules is guaranteed.

4.5 Conducted Rx Sensitivity and Tx Power

4.5.1 Conducted Receive Sensitivity

The conducted receive sensitivity is a key parameter that indicates the receiver performance of MU509.

The **3GPP Protocol Claim** column in Table 4-2 lists the required minimum values, and the **Test Value** column lists the tested values of MU509.

Table 4-2 MU509 conducted Rx sensitivity

Item		3GPP Protocol Claim (dBm)	MU509 Test Value (dBm)		
			Min.	Typ.	Max
GSM850	GMSK (BER < 2.43%)	< –102	-	–109	–106
	8PSK (MCS5, BLER < 10%)	< –98	-	–103	–100
GSM900	GMSK (BER < 2.43%)	< –102	-	–109	–106
	8PSK (MCS5, BLER < 10%)	< –98	-	–103	–100
GSM1800	GMSK (BER < 2.43%)	< –102	-	–109	–106
	8PSK (MCS5, BLER < 10%)	< –98	-	–103	–100
GSM1900	GMSK (BER < 2.43%)	< –102	-	–109	–106
	8PSK (MCS5, BLER < 10%)	< –98	-	–103	–100
BandI (BER < 0.1%)		< –106.7	-	–110	–107
BandII (BER < 0.1%)		< –104.7	-	–108.5	–106.5
Band VIII (BER < 0.1%)		< –103.7	-	–110	–107
Band V (BER < 0.1%)		< –104.7	-	–110	–107

NOTE
The test values are the average of some test samples.

4.5.2 Conducted Transmit Power

The conducted transmit power is another indicator that measures the performance of MU509. The conducted transmit power refers to the maximum power that the module tested at the antenna port can transmit. According to the 3GPP protocol, the required transmit power varies with the power class.

Table 4-3 lists the required ranges of the conducted transmit power of MU509. The tested values listed in the Test Value column must range from the minimum power to the maximum power.

Table 4-3 MU509 conducted Tx power

Item		3GPP Protocol Claim (dBm)	MU509 Test Value (dBm)		
			Min.	Typ.	Max.
GSM850	GMSK(1Tx Slot)	31–35	31	32.5	34

Item		3GPP Protocol Claim (dBm)	MU509 Test Value (dBm)		
			Min.	Typ.	Max.
	8PSK(1Tx Slot)	24–30	25.5	27	28.5
GSM900	GMSK(1Tx Slot)	31–35	31	32.5	34
	8PSK(1Tx Slot)	24–30	25.5	27	28.5
GSM1800	GMSK(1Tx Slot)	28–32	28	29.5	31
	8PSK(1Tx Slot)	23–29	24.5	26	27.5
GSM1900	GMSK(1Tx Slot)	28–32	28	29.5	31
	8PSK(1Tx Slot)	23–29	24.5	26	27.5
Band I(W2100)		21–25	21.5	23	24.5
Band II(W1900)		21–25	21.5	23	24.5
Band VIII(W900)		21–25	21.5	23	24.5
Band V(W850)		21–25	21.5	23	24 .5

4.6 Antenna Design Requirements

4.6.1 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 MU509 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 be as low as possible, for example, U.FL-LP-088 made by HRS.

The following antenna efficiency (free space) is recommended for MU509 to ensure high radio performance of the module: **Efficiency of the master antenna: ≥ 40% (below 960 MHz); ≥ 50% (over 1710 MHz)**. 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 values are recommended for the antenna of MU509: **S11 of the master antenna ≤ –6 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 MU509.

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 (θ and φ), 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 MU509. **Master antenna: omnidirectional**.

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 MU509. **Gain of the master 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.

4.6.2 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.

4.6.3 GSM/WCDMA Antenna Requirements

The antenna for MU509 must fulfill the following requirements:

GSM/WCDMA 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)
Bandwidth	70 MHz in GSM850 80 MHz in GSM900 170 MHz in DCS 140 MHz in PCS 70 MHZ in WCDMA850 80 MHz in WCDMA900 140 MHz in WCDMA1900 250 MHz in WCDMA2100
Gain	≤ 2.5 dBi
Impedance	50 Ω
VSWR absolute max	≤ 3:1
VSWR recommended	≤ 2:1

4.6.4 Radio Test Environment

The antenna efficiency, antenna gain, radiation pattern, total radiated power (TRP), and TIS can be tested in a microwave testing chamber.

Huawei has a complete set of OTA test environments (SATIMO microwave testing chambers and ETS microwave testing chambers). The testing chambers are certified by professional organizations and are applicable to testing at frequencies ranging from 380 MHz to 6GHz. The test items are described as follows:

Passive Tests

- Antenna efficiency
- Gain

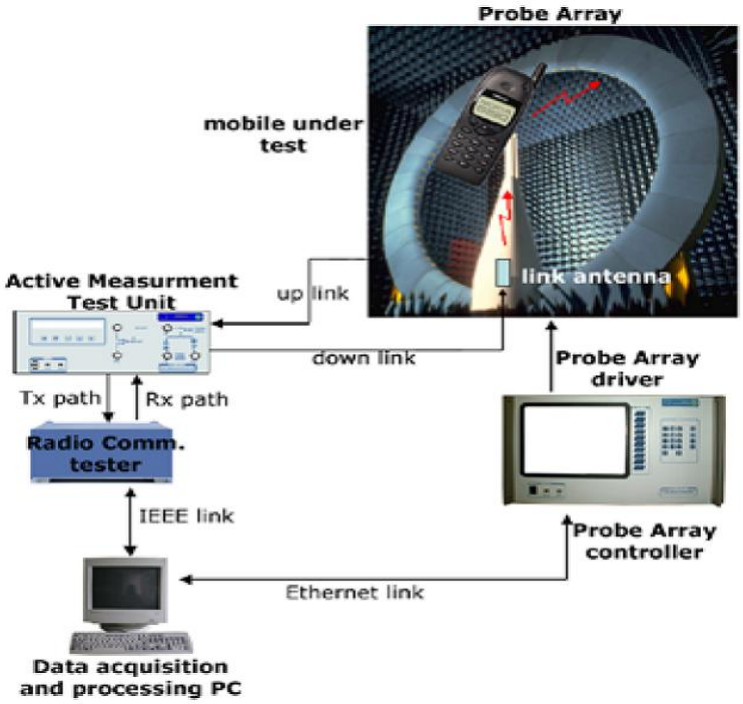
- Pattern shape
- Envelope correlation coefficient

Active Tests

- **TRP:** GSM, WCDMA, CDMA, TD-SCDMA, and LTE systems
- **TIS:** GSM, WCDMA, CDMA, TD-SCDMA, and LTE systems

Figure 4-1 shows the SATIMO microwave testing chamber.

Figure 4-1 SATIMO microwave testing chamber



5 Electrical and Reliability Features

5.1 About This Chapter

This chapter describes the electrical and reliability features of the interfaces in the MU509 module, including:

- Extreme Operating Conditions
- Operating and Storage Temperatures and Humidity
- Electrical Features of Application Interfaces
- Power Supply Features
- Reliability Features
- EMC and ESD Features

5.2 Extreme Operating Conditions

WARNING

Table 5-1 lists the extreme operating conditions for the MU509 module. Using the MU509 module beyond these conditions may result in permanent damage to the module.

Table 5-1 Extreme working conditions for the MU509 module

Symbol	Specification	Minimum Value	Maximum Value	Unit
VBAT	External power voltage	–0.4	5.0	V
VCOIN	Input voltage of standby power for the RTC	1.5	3.25	V
V_I	Data pin voltage	–0.3	V_I+0.3	V

NOTE

V_I is 2.6 V or 1.8 V. To get the details about the voltage of V_I, please refer to Table 3-1 .

5.3 Operating and Storage Temperatures and Humidity

Table 5-2 lists the operating and storage temperatures and humidity for the MU509 module.

Table 5-2 operating and storage temperatures and humidity for the MU509 module

Specification	Minimum Value	Maximum Value	Unit
Normal working temperatures[1]	–20	+70	°C
Extended working temperatures	–40	–20	°C
Extended working temperatures	+70	+85	°C
Ambient temperature for storage	–40	+85	°C
Moisture	5	95	%

NOTE

[1]: The temperatures outside of the range –20°C to +70°C; the module might slightly deviate from 3GPP TS 45.005 and 3GPP TS 34.121-1 specifications.

5.4 Electrical Features of Application Interfaces

Table 5-3 lists electrical features (typical values).

Table 5-3 Electrical features of application interfaces

Parameter	Description	Minimum Value	Maximum Value	Unit
V_{IH}	High-level input voltage	0.65 x V_{DD_PX}	V_{DD_PX} + 0.3	V
V_{IL}	Low-level input voltage	–0.3	0.35 x V_{DD_PX}	V
I_{leak}	Input leakage current	–0.2	0.2	μA
V_{OH}	High-level output voltage	V_{DD_PX} – 0.45	V_{DD_PX}	V

Parameter	Description	Minimum Value	Maximum Value	Unit
V_{OL}	Low-level output voltage	0	0.45	V
I_{OH}	High-level output current	1.5	-	mA
I_{OL}	Low-level output current	-	–1.5	mA

NOTE

V_{DD_PX} is 2.6 V or 1.8 V. To get the details about the voltage of V_{DD_PX}, please refer to Table 3-1 .

5.5 Power Supply Features

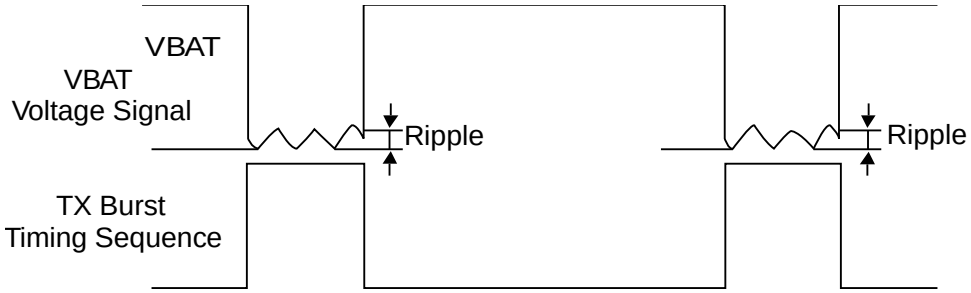
5.5.1 Input Power Supply

Table 5-4 lists the requirements for input power of the MU509 module.

Table 5-4 Requirements for input power of the MU509 module

Parameter	Minimum Value	Typical Value	Maximum Value	Ripple	Unit
VBAT	3.3	3.8	4.2	< 50 mVpp (0 Hz to 2.5 GHz)	V
VCOIN	1.5	3.0	3.25	< 30 mVpp	V

Figure 5-1 Power Supply During Burst Emission



NOTE

The VBAT Minimum Value must be guaranteed during the burst (with 2.75 A Peak in GSM, GPRS or EGPRS mode).

Table 5-5 Requirements for input current of the MU509 module

Power	Peak (Maximum)	Normal (Maximum)
3.8 V	2750 mA	1100 mA

5.5.2 Power Consumption

The power consumptions of MU509 in different scenarios are respectively listed in Table 5-6 to Table 5-12 .

The power consumption listed in this section are tested when the power supply of MU509 module is normal voltage 3.8V and all of test values are measured at room temperature.

Table 5-6 Averaged power off DC power consumption of MU509 module

Description	Test Value (uA)	Notes/Configuration
	Typical	
Power off	8	Normal voltage (3.8 V) is ON and POWER_ON_OFF pin is pulled low

Table 5-7 Averaged standby DC power consumption of MU509 module (HSDPA/WCDMA /GSM/GPRS/EDGE)

Description		Bands	Test Value (mA)	Notes/Configuration
			Typical	
Sleep	HSDPA/WCDMA	UMTS bands	2	Module is powered up. DRX cycle=8 (2.56s) Module is registered on the network. USB is in suspend.
	GPRS/EDGE	GSM bands	3	Module is powered up. MFRMS=5 (1.175s) Module is registered on the network. USB is in suspend.
Idle	HSDPA/WCDMA	LTE bands	66	Module is powered up. DRX cycle=8 (2.56s) Module is registered on the network, and no data is transmitted. USB is in active.

Description		Bands	Test Value (mA)	Notes/Configuration
			Typical	
	GSM/GPRS/EDGE	GSM bands	64	Module is powered up. MFRMS=5 (1.175s) Module is registered on the network, and no data is transmitted. USB is in active.

Table 5-8 Averaged Data Transmission DC power consumption of MU509 module (HSDPA/WCDMA)

Description	Band	Test Value (mA)	Notes/Configuration
		Typical	
WCDMA MU509-b	Band I (IMT2100)	295	0 dBm Tx Power
		320	10 dBm Tx Power
		535	23.5 dBm Tx Power
	Band VIII (900 M)	195	0 dBm Tx Power
		230	10 dBm Tx Power
		510	23.5 dBm Tx Power
WCDMA MU509-c	Band V (850 M)	270	0 dBm Tx Power
		290	10 dBm Tx Power
		570	23.5 dBm Tx Power
	Band II (PCS 1900)	185	0 dBm Tx Power
		330	10 dBm Tx Power
		545	23.5 dBm Tx Power
WCDMA MU509-g	Band I (IMT2100)	293	0 dBm Tx Power
		321	10 dBm Tx Power
		535	23.5 dBm Tx Power
	Band V (850 M)	267	0 dBm Tx Power
		289	10 dBm Tx Power
		524	23.5 dBm Tx Power
WCDMA HUAWEI	Band I (IMT2100)	245	0 dBm Tx Power
		290	10 dBm Tx Power

Description	Band	Test Value (mA)	Notes/Configuration
		Typical	
MU509-1		585	23.5 dBm Tx Power
HSDPA MU509-b	Band I (IMT2100)	310	0 dBm Tx Power
		340	10 dBm Tx Power
		550	23.5 dBm Tx Power
	Band VIII (900 M)	215	0 dBm Tx Power
		305	10 dBm Tx Power
		510	23.5 dBm Tx Power
HSDPA MU509-c	Band V (850 M)	285	0 dBm Tx Power
		315	10 dBm Tx Power
		540	23.5 dBm Tx Power
	Band II (PCS 1900)	195	0 dBm Tx Power
		340	10 dBm Tx Power
		520	23.5 dBm Tx Power
HSDPA MU509-g	Band I (IMT2100)	311	0 dBm Tx Power
		338	10 dBm Tx Power
		549	23.5 dBm Tx Power
	Band V (850 M)	301	0 dBm Tx Power
		328	10 dBm Tx Power
		598	23.5 dBm Tx Power
HSDPA HUAWEI MU509-1	Band I (IMT2100)	260	0 dBm Tx Power
		320	10 dBm Tx Power
		585	23.5 dBm Tx Power

Table 5-9 Averaged DC power consumption of MU509-b (GPRS/EDGE)

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
GPRS850	310	5	1 Up/1 Down
	470		2 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	690		4 Up/1 Down
	165	10	1 Up/1 Down
	250		2 Up/1 Down
	410		4 Up/1 Down
GPRS900	290	5	1 Up/1 Down
	440		2 Up/1 Down
	625		4 Up/1 Down
	155	10	1 Up/1 Down
	235		2 Up/1 Down
	380		4 Up/1 Down
GPRS1800	212	0	1 Up/1 Down
	310		2 Up/1 Down
	440		4 Up/1 Down
	110	10	1 Up/1 Down
	145		2 Up/1 Down
	185		4 Up/1 Down
GPRS1900	215	0	1 Up/1 Down
	315		2 Up/1 Down
	450		4 Up/1 Down
	120	10	1 Up/1 Down
	155		2 Up/1 Down
	185		4 Up/1 Down
EDGE850	210	8	1 Up/1 Down
	320		2 Up/1 Down
	410		4 Up/1 Down
	126	15	1 Up/1 Down
	166		2 Up/1 Down
	223		4 Up/1 Down
EDGE900	185	8	1 Up/1 Down
	285		2 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	375		4 Up/1 Down
	115	15	1 Up/1 Down
	155		2 Up/1 Down
	205		4 Up/1 Down
EDGE1800	175	2	1 Up/1 Down
	265		2 Up/1 Down
	345		4 Up/1 Down
	110	10	1 Up/1 Down
	145		2 Up/1 Down
	185		4 Up/1 Down
EDGE1900	176	2	1 Up/1 Down
	255		2 Up/1 Down
	322		4 Up/1 Down
	117	10	1 Up/1 Down
	148		2 Up/1 Down
	186		4 Up/1 Down

Table 5-10 Averaged DC power consumption of MU509-c (GPRS/EDGE)

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
GPRS850	300	5	1 Up/1 Down
	515		2 Up/1 Down
	160		4 Up/1 Down
	240	10	1 Up/1 Down
	285		2 Up/1 Down
	490		4 Up/1 Down
GPRS900	155	5	1 Up/1 Down
	235		2 Up/1 Down
	240		4 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	395	10	1 Up/1 Down
	115		2 Up/1 Down
	150		4 Up/1 Down
GPRS1800	230	0	1 Up/1 Down
	365		2 Up/1 Down
	125		4 Up/1 Down
	160	10	1 Up/1 Down
	195		2 Up/1 Down
	310		4 Up/1 Down
GPRS1900	515	0	1 Up/1 Down
	115		2 Up/1 Down
	155		4 Up/1 Down
	210	10	1 Up/1 Down
	190		2 Up/1 Down
	300		4 Up/1 Down
EDGE850	495	8	1 Up/1 Down
	155		2 Up/1 Down
	230		4 Up/1 Down
	355	15	1 Up/1 Down
	185		2 Up/1 Down
	290		4 Up/1 Down
EDGE900	475	8	1 Up/1 Down
	115		2 Up/1 Down
	150		4 Up/1 Down
	195	15	1 Up/1 Down
	175		2 Up/1 Down
	270		4 Up/1 Down
EDGE1800	430	2	1 Up/1 Down
	110		2 Up/1 Down
	145		4 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	190	10	1 Up/1 Down
	145		2 Up/1 Down
	185		4 Up/1 Down
EDGE1900	176	2	1 Up/1 Down
	255		2 Up/1 Down
	322		4 Up/1 Down
	117	10	1 Up/1 Down
	148		2 Up/1 Down
	186		4 Up/1 Down

Table 5-11 Averaged DC power consumption of MU509-g (GPRS/EDGE)

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
GPRS850	310	5	1 Up/1 Down
	470		2 Up/1 Down
	690		4 Up/1 Down
	165	10	1 Up/1 Down
	250		2 Up/1 Down
	410		4 Up/1 Down
GPRS900	290	5	1 Up/1 Down
	440		2 Up/1 Down
	625		4 Up/1 Down
	155	10	1 Up/1 Down
	235		2 Up/1 Down
	380		4 Up/1 Down
GPRS1800	245	0	1 Up/1 Down
	345		2 Up/1 Down
	480		4 Up/1 Down
	110	10	1 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	145		2 Up/1 Down
	185		4 Up/1 Down
GPRS1900	215	0	1 Up/1 Down
	315		2 Up/1 Down
	450		4 Up/1 Down
	120	10	1 Up/1 Down
	155		2 Up/1 Down
	200		4 Up/1 Down
EDGE850	210	8	1 Up/1 Down
	320		2 Up/1 Down
	410		4 Up/1 Down
	126	15	1 Up/1 Down
	166		2 Up/1 Down
	223		4 Up/1 Down
EDGE900	185	8	1 Up/1 Down
	285		2 Up/1 Down
	375		4 Up/1 Down
	115	15	1 Up/1 Down
	155		2 Up/1 Down
	205		4 Up/1 Down
EDGE1800	175	2	1 Up/1 Down
	265		2 Up/1 Down
	345		4 Up/1 Down
	110	10	1 Up/1 Down
	145		2 Up/1 Down
	185		4 Up/1 Down
EDGE1900	176	2	1 Up/1 Down
	255		2 Up/1 Down
	322		4 Up/1 Down
	117	10	1 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	148		2 Up/1 Down
	186		4 Up/1 Down

Table 5-12 Averaged DC power consumption of HUAWEI MU509-1 (GPRS/EDGE)

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
GPRS850	300	5	1 Up/1 Down
	450		2 Up/1 Down
	640		4 Up/1 Down
	162	10	1 Up/1 Down
	245		2 Up/1 Down
	385		4 Up/1 Down
GPRS900	325	5	1 Up/1 Down
	500		2 Up/1 Down
	700		4 Up/1 Down
	165	10	1 Up/1 Down
	255		2 Up/1 Down
	410		4 Up/1 Down
GPRS1800	215	0	1 Up/1 Down
	310		2 Up/1 Down
	460		4 Up/1 Down
	113	10	1 Up/1 Down
	145		2 Up/1 Down
	190		4 Up/1 Down
GPRS1900	230	0	1 Up/1 Down
	350		2 Up/1 Down
	500		4 Up/1 Down
	115	10	1 Up/1 Down
	150		2 Up/1 Down

Description	Test Value (mA)	PCL	Notes/Configuration
	Typical		
	195		4 Up/1 Down
EDGE850	190	8	1 Up/1 Down
	290		2 Up/1 Down
	375		4 Up/1 Down
	120	15	1 Up/1 Down
	160		2 Up/1 Down
	210		4 Up/1 Down
EDGE900	205	8	1 Up/1 Down
	310		2 Up/1 Down
	400		4 Up/1 Down
	120	15	1 Up/1 Down
	160		2 Up/1 Down
	220		4 Up/1 Down
EDGE1800	185	2	1 Up/1 Down
	265		2 Up/1 Down
	345		4 Up/1 Down
	110	10	1 Up/1 Down
	145		2 Up/1 Down
	190		4 Up/1 Down
EDGE1900	190	2	1 Up/1 Down
	280		2 Up/1 Down
	355		4 Up/1 Down
	115	10	1 Up/1 Down
	150		2 Up/1 Down
	195		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 4.5.2 Conducted Transmit Power, which are listed in Table 4-3 ; for max. data throughput, see 2.2 Function Overview, which are listed in Table 2-1 .

5.6 Reliability Features

Table 5-13 lists the test conditions and results of the reliability of the MU509 module.

Table 5-13 Test conditions and results of the reliability of the MU509 module

Item		Test Condition	Standard	Sample size	Results
Stress	Low-temperature storage	• Temperature: –40ºC • Operation mode: no power, no package • Test duration: 24 h	JESD22-A119-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	High-temperature storage	• Temperature: 85ºC • Operation mode: no power, no package • Test duration: 24 h	JESD22-A103-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Low-temperature operating	• Temperature: –40ºC • Operation mode: working with service connected • Test duration: 24 h	IEC60068-2-1	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	High-temperature operating	• Temperature: 85ºC • Operation mode: working with service connected • Test duration: 24 h	JESD22-A108-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Temperature cycle operating	• High temperature: 85ºC • Low temperature: -40ºC • Operation mode: working with service connected • Test duration: 30 cycles;1 h+1h /cycle	JESD22-A105-B	3pcs/group	Visual inspection: ok Function test: ok RF specification: ok

Item		Test Condition	Standard	Sample size	Results
Stress	Damp heat cycling	• High temperature: 55ºC • Low temperature: 25ºC • Humidity: 95%±3% • Operation mode: working with service connected • Test duration: 6 cycles; 12 h+12 h/cycle	JESD22-A101-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Thermal shock	• Low temperature: –40º • High temperature: 85ºC • Temperature change interval: < 20s • Operation mode: no power • Test duration: 100 cycles; 15 min+15 min/cycle	JESD22-A106-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Salty fog test	• Temperature: 35°C • Density of the NaCl solution: 5%±1% • Operation mode: no power, no package • Test duration: Spraying interval: 8 h Exposing period after removing the salty fog environment: 16 h	JESD22-A107-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Sine vibration	• Frequency range: 5 Hz to 200 Hz • Acceleration: 1 Grms • Frequency scan rate: 0.5 oct/min • Operation mode: working with service connected • Test duration: 3 axial directions. 2 h for each axial direction. • Operation mode: working with service connected	JESD22-B103-B	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok

Item		Test Condition	Standard	Sample size	Results
Stress	Shock test	• Half-sine wave shock • Peak acceleration: 30 Grms • Shock duration: 11 ms • Operation mode: working with service connected • Test duration: 6 axial directions. 3 shocks for each axial direction. • Operation mode: working with service connected	JESD-B104-C	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
	Drop test	• 0.8 m in height. Drop the module on the marble terrace with one surface facing downwards, six surfaces should be tested. • Operation mode: no power, no package	IEC60068-2-32	3 pcs/group	Visual inspection: ok Function test: ok RF specification: ok
ESD	ESD with DVK (or embedded in the host)	• Contact Voltage: ±2 kV, ±4 kV • Air Voltage : ±2 kV, ±4 kV, ±8 kV • Operation mode: working with service connected	IEC61000-4-2	2 pcs	Visual inspection: ok Function test: ok RF specification: ok
NOTE Groups ≥ 2					

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

- Resistors in parallel and a 10 nF 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 1×10^4 Ω while less than 1×10^9 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 1×10^9 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
  - 1×10^5 Ω ≤ Soft ground resistance < 1×10^9 Ω
  - 1×10^5 Ω ≤ ICT fixture soft ground resistance < 1×10^{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

The HUAWEI MU509 module does not include any protection against overvoltage.

6 Process Design

6.1 About This Chapter

This chapter describes the process design and mechanical specifications:

- Storage Requirement
- Moisture Sensitivity
- Dimensions and interfaces
- 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

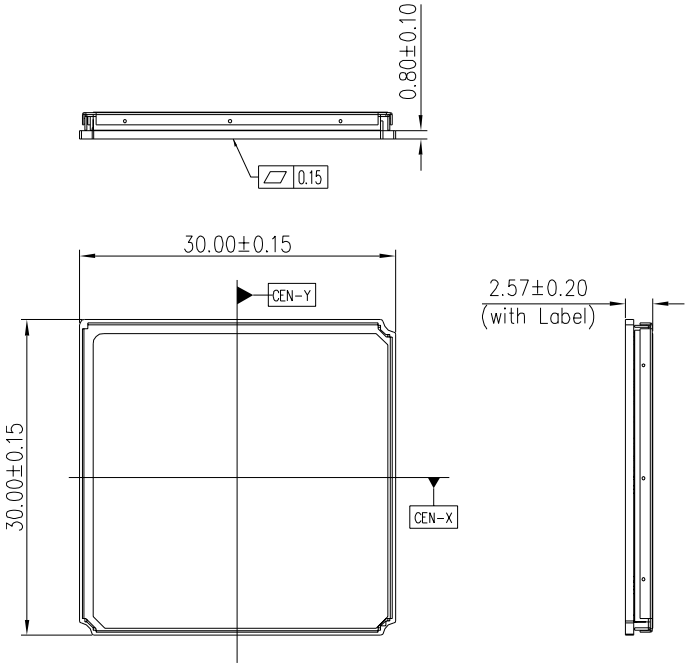
Baking Temperature	Baking Condition	Baking Duration	Remarks
125°C±5°C	Relative humidity ≤ 60%	8 hours	-

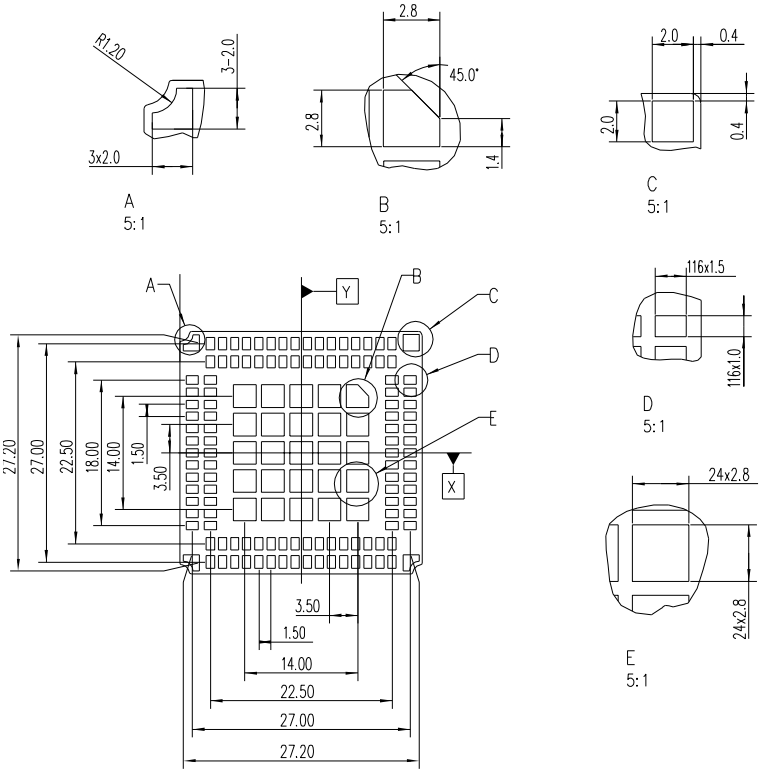
NOTE
Moving, storing, and processing the product must comply with IPC/JEDEC J-STD-033.

6.4 Dimensions and interfaces

Figure 6-1 shows the dimensions in details.

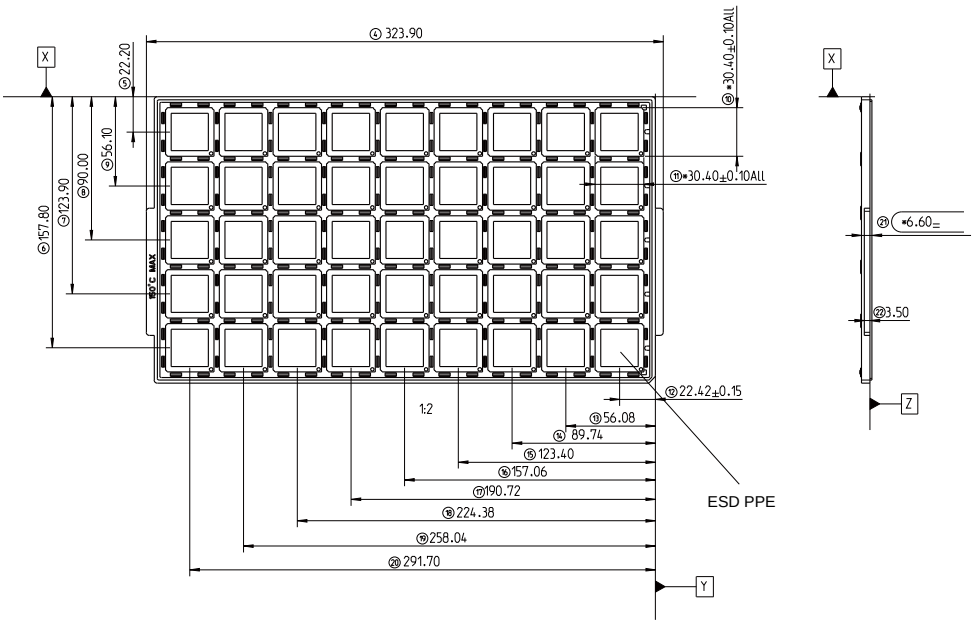
Figure 6-1 Dimensions (unit: mm)





6.5 Packaging

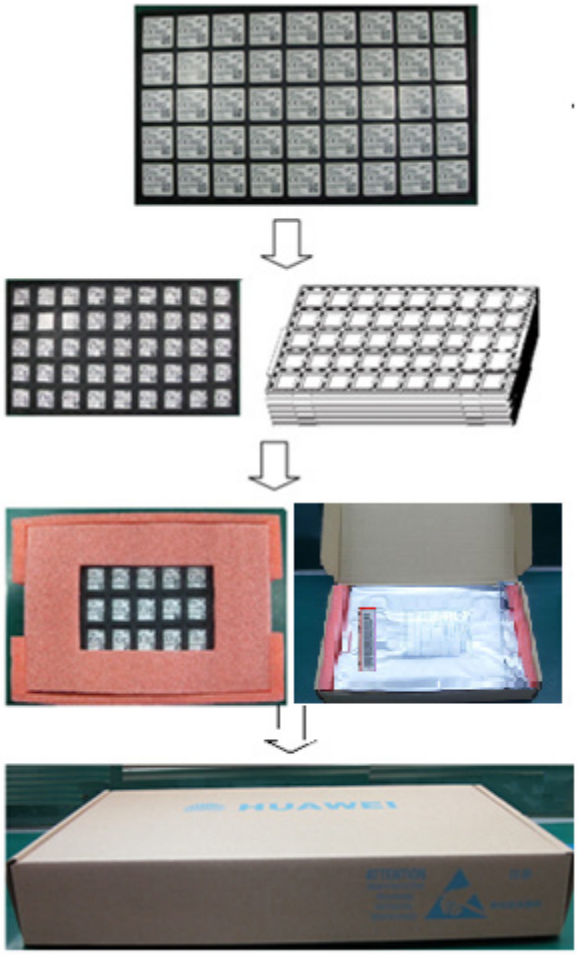
HUAWEI LGA module uses five layers ESD pallet, anti-vibration foam and vacuum packing into cartons.



NOTE

- All materials used must meet eco-friendly requirements.
- According to the requirements and test methods specified in EIA 541, the surface resistance must be not greater than 1 x 10^{10} Ω and triboelectricity must be lower than 100 V.
- Packaging materials must be resistant to temperature higher than or equal to 150°C.

The following figure shows the packaging.



Orient LGA modules in the specified direction.

Module quantity per tray: 5 x 9 = 45 pcs/tray

6 trays in each vacuum package. Do not place any modules on the tray at the top of each package.

Total quantity per package: 5 x 45 = 225 pcs/vacuum package.

Use vacuum packages; one package per carton; module quantity per carton: 5 x 45 = 225 pcs/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 Label for MU509-b, MU509-c and MU509-g

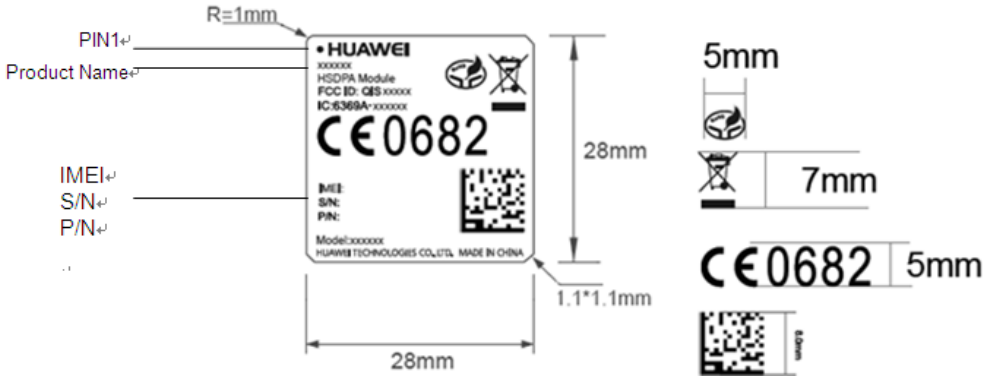
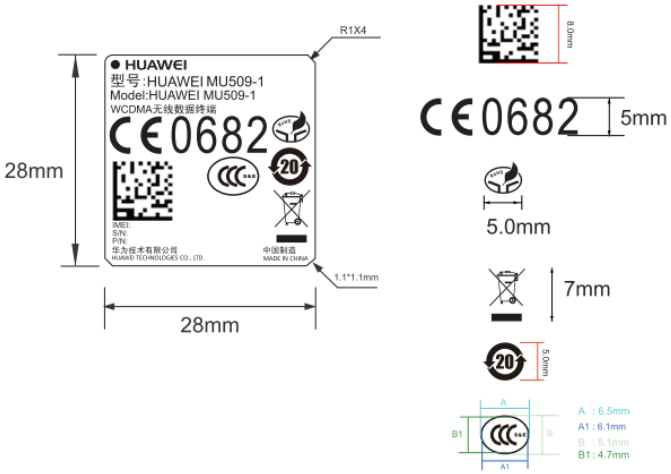


Figure 6-3 Label for HUAWEI MU509-1



NOTE

- The picture mentioned above is only for reference.
- The material and surface finishing and coatings which used have to make satisfied with the RoHS directives.
- The label must be heated up for 20s–40s and able to endure the high temperature of 260 °C.
- For MU509-c module, the label in Figure 6-2 is the common label (there is the other label specified for MU509-c).

6.7 Customer PCB Design

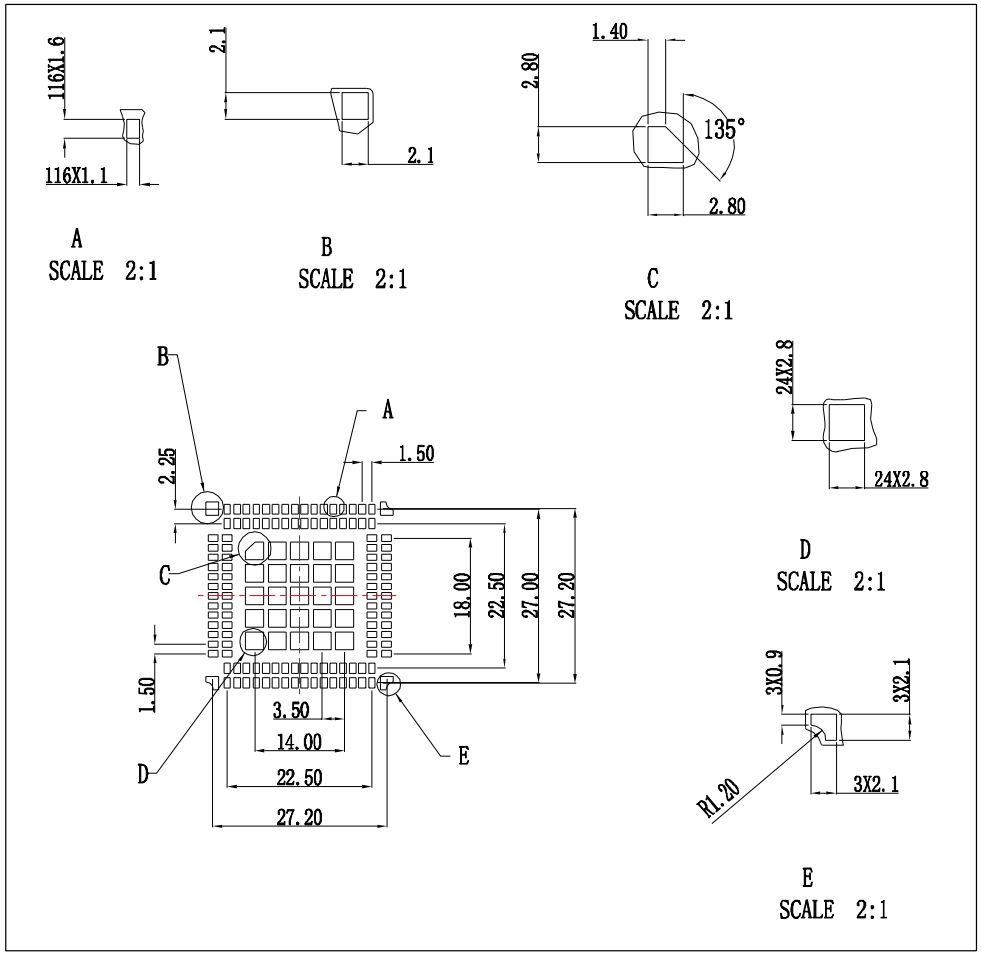
6.7.1 PCB Surface Finish

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 6-4 Design of the solder pads on customers' PCBs (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 1.5 mm.
- When the PCB layout is double sided, it is recommended that the LGA module 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

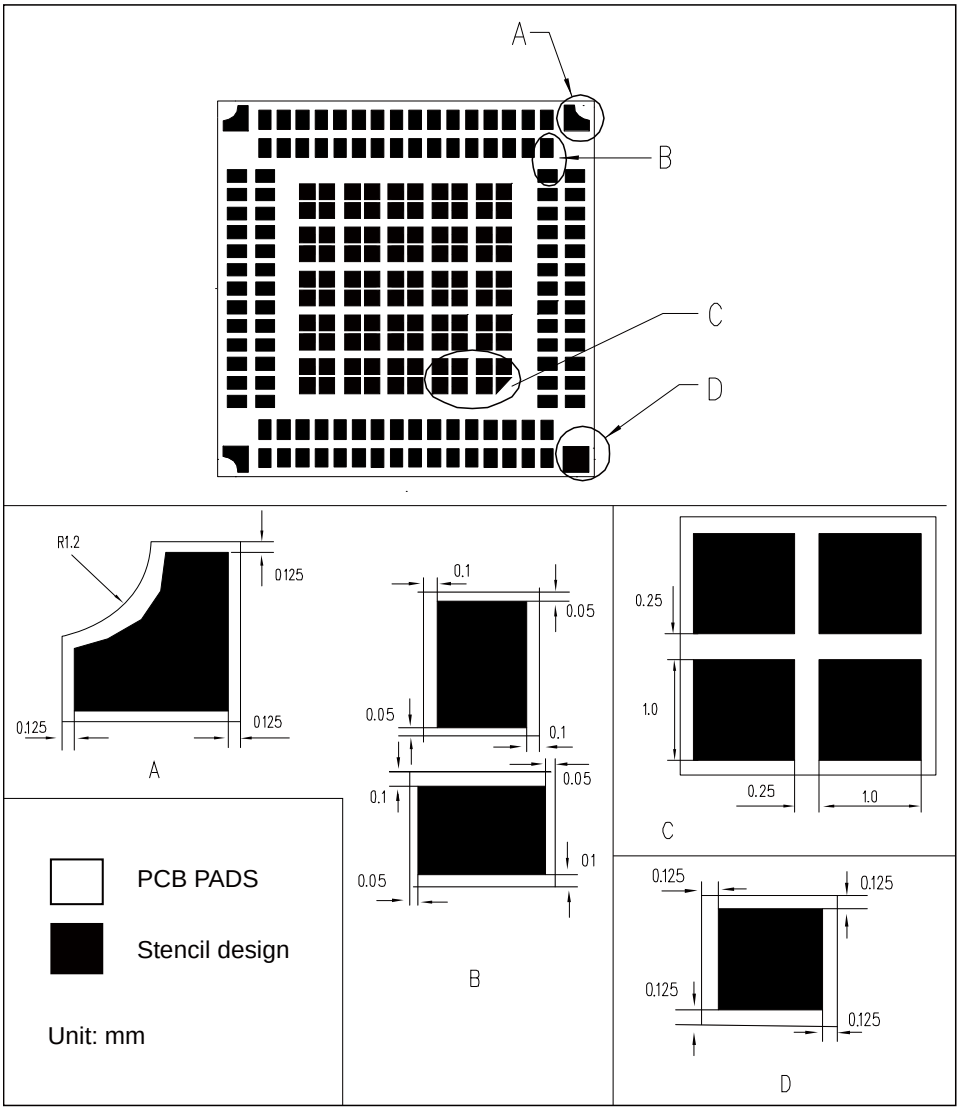
6.8.1 General Description of Assembly Processes

- 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 6-5 Recommended stencil design of LGA module



NOTE

The stencil design has been qualified for HUAWEI mainboard 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 6-6 Reflow profile

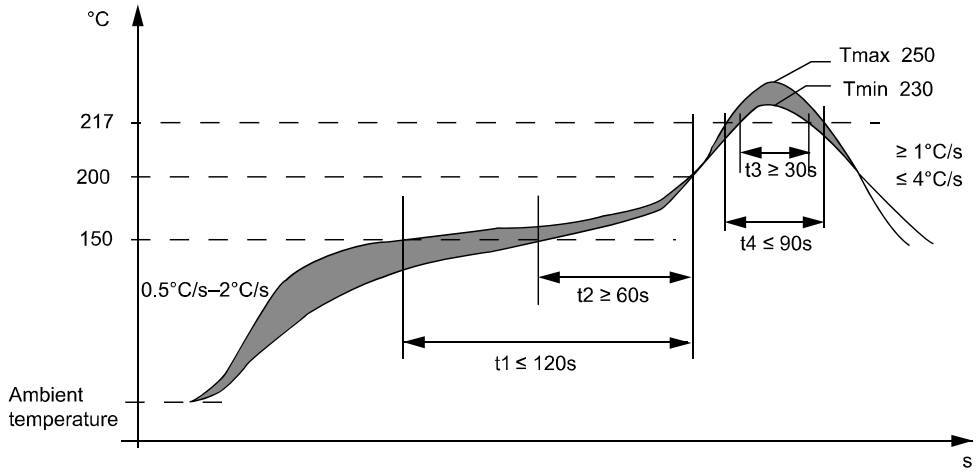
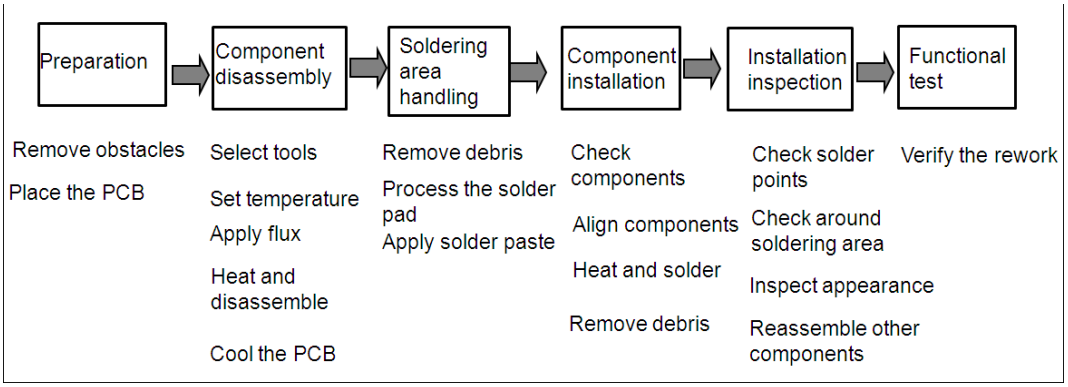


Table 6-2 Reflow parameters

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 cannot stand high temperature before rework.
- If the device to be reworked is beyond the storage period, bake the device according to Table 6-1 .

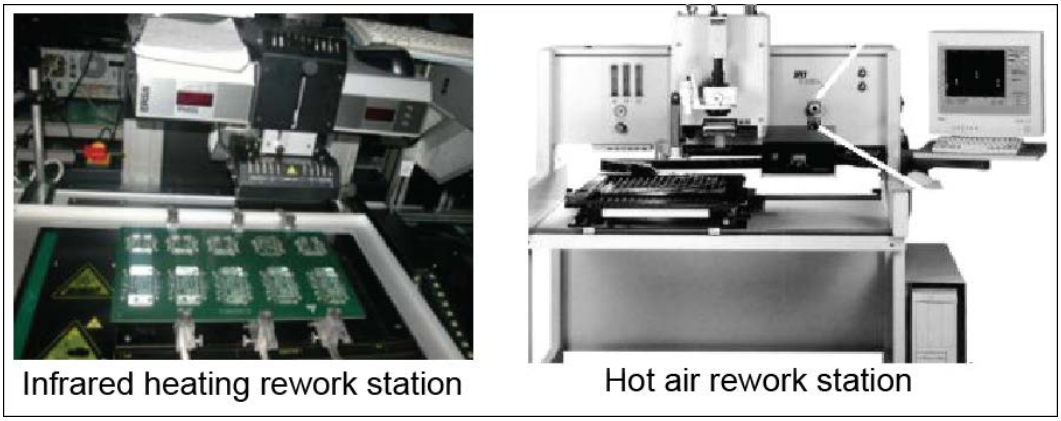
6.9.3 Removing of the Module

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

Figure 6-7 Equipment used for rework



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).

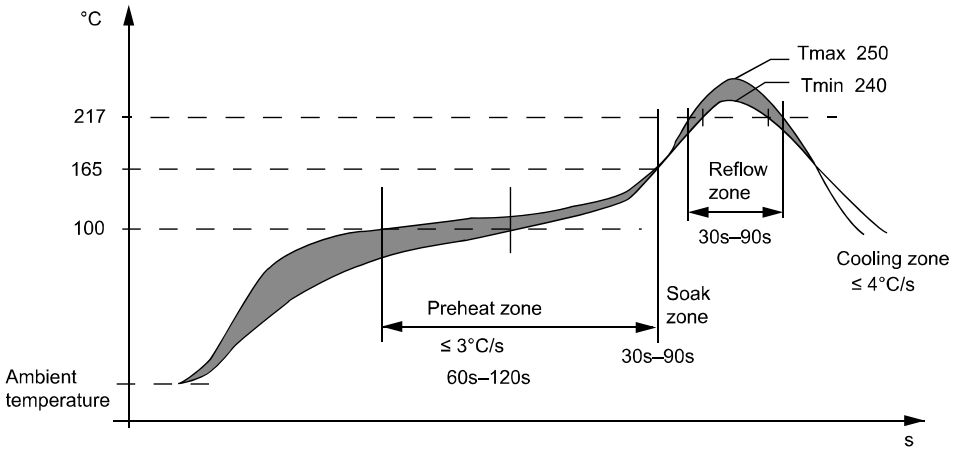
NOTE

- 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 6-8 Temperature graph of rework



7 Certifications

7.1 About This Chapter

This chapter gives a general description of certifications for MU509.

7.2 Certifications

NOTE
Table 7-1 shows certifications the MU509 module has been implemented. For more demands, please contact us for more details about this information.

Table 7-1 Product Certifications

Certification	Model name			
	MU509-b	MU509-c	MU509-g	HUAWEI MU509-1
CE number	CE0682	CE0682	CE0682	CE0682
FCC number	QISMU509B	QISMU509C	QISMU509G	-
CCC	√	-	-	√
NCC	-	√	-	-
A-TICK	-	-	√	-
Jate&Telec	-	-	-	-
IC number	6369A-MU509B	6369A-MU509C	-	-
EU RoHS	√	√	√	√
JGPSSI	-	-	-	-

Certification	Model name			
	MU509-b	MU509-c	MU509-g	HUAWEI MU509-1
SGS RoHS	-	-	-	-
PVC-Free	-	-	-	-
GCF	√	-	-	-
PTCRB	√	√	-	-

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).

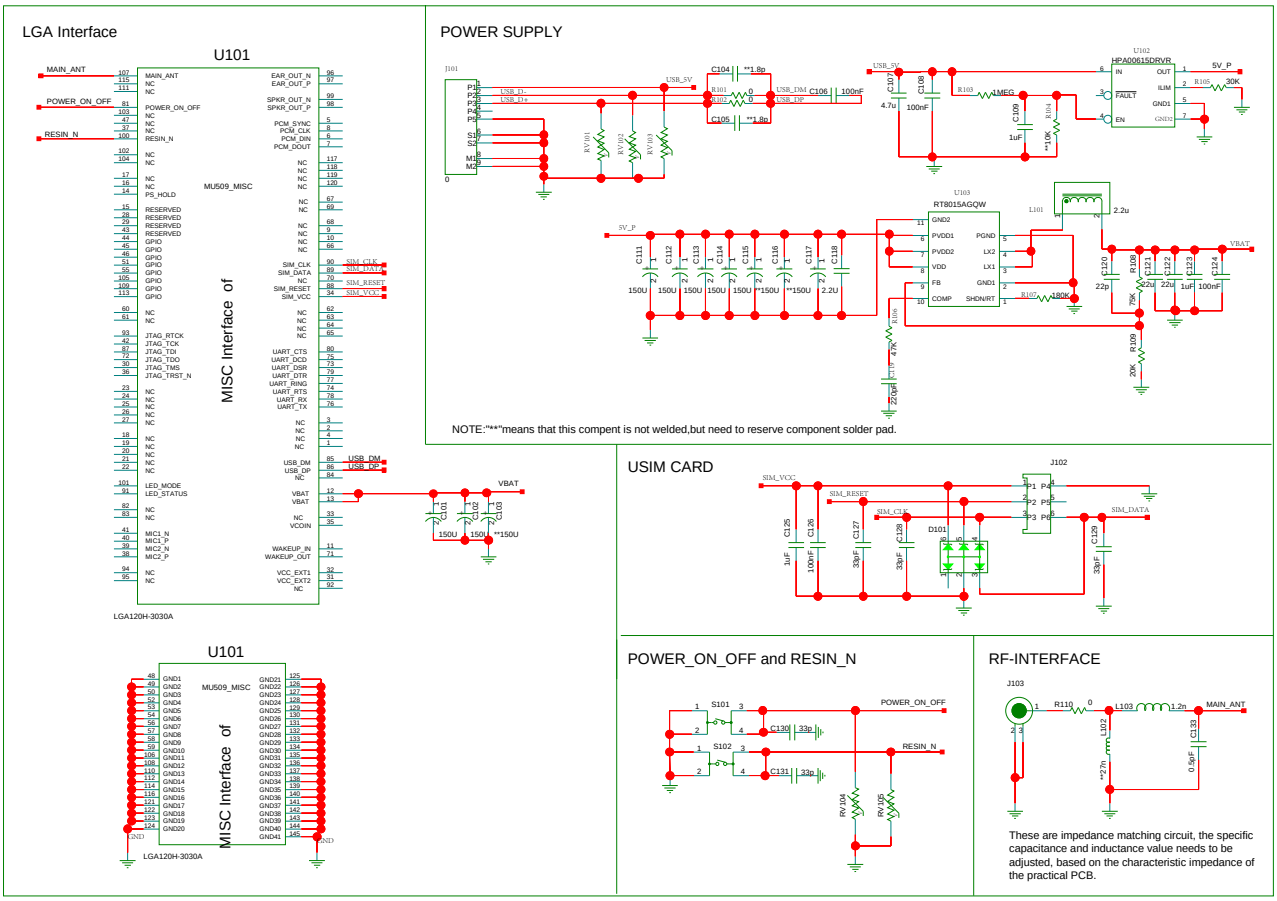
Federal Communications Commission Notice (United States): Before a wireless device model is available for sale to the public, it must be tested and certified to the FCC that it does not exceed the limit established by the government-adopted requirement for safe exposure.

8.13.2 FCC Statement

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
AP	Application Process
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
CS	Coding Scheme
DC	Direct Current
DCE	Data Circuit-terminating Equipment
DMA	Direct Memory Access
DTE	Data Terminal Equipment
EDGE	Enhanced Data Rate for GSM Evolation
EIA	Electronic Industries Association
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EU	European Union
FCC	Federal Communications Commission

Acronym or Abbreviation	Expansion
GMSK	Gaussian MinimumSshift Keying
GPIO	General-purpose I/O
GPRS	General Packet Radio Service
ISO	International Standards Organization
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
NSMD	Non-solder Mask Defined
PA	Power Amplifier
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PID	Product IDentity
RF	Radio Frequency
RoHS	Restriction of the Use of Certain Hazardous Substances
RTC	Real-time Clock
RFU	For future use
SIM	Subscriber Identity Module
SMS	Short Message Service
TIS	Total Isotropic Sensitivity
TRP	Total Radiated Power
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver-Transmitter
UL	Up Link
UMTS	Universal Mobile Telecommunications System

Acronym or Abbreviation	Expansion
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module
VSWR	Voltage Standing Wave Ratio
WEEE	Waste Electrical and Electronic Equipment
WCDMA	Wideband CODE Division Multiple Access