HUAWEI MC509 Series CDMA LGA Module

Hardware Guide

Issue 02

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About This Document

Revision History

Document Version	Date	Chapter	Descriptions
01	2011-07-04		Creation
02	2013-05-06	2.2	Updated Table 2-1 Feature
		2.3	Updated Figure 2-1 Circuit block diagram of the MC509 module
		2.4	Updated Figure 2-2 Application block diagram of the MC509 module
		3.2	Updated Table 3-1 Definitions of pins on the LGA interface
		3.2	Updated Figure 3-1 Bottom view of sequence of LGA interface pins
		3.3	Deleted the description related to VCOIN interface
		3.4.3	Updated Table 3-6 List of the LED_STATUS pin and LED_MODE pin
		3.5	Updated the description of UART Interface
		3.7.1	Updated Table 3-9 RUIM card interface signals
		3.7.2	Updated Figure 3-16 Circuit of the RUIM card interface
		3.7.3	Deleted ESD Protection for the RUIM Card Interface in issue 01
		4.6	Updated Antenna Design Requirements
		6	Updated Mechanical Specifications
		7.1	Updated Table 7-1 Product Certifications
		8	Updated Safety Information
		9	Updated Circuit of Typical Interfaces

Summary

This document provides information about the major functions, supported services, system architecture, and technical references of HUAWEI MC509 CDMA 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 Mechanical Specifications	Describes the Dimensions, Label and Packing System of the product.
7 Certifications	Describes the certifications of the product.
8 Safety Information	Lists the safety information of using the product.
9 Appendix A Circuit of Typical InterfacesI	Lists the circuit of typical interface of the product.
10 Appendix B Acronyms and Abbreviations	Lists the acronyms and abbreviations mentioned in this document.

Content

1 Introduction

This document describes the hardware application interfaces and air interfaces that are provided when the HUAWEI MC509 CDMA LGA Module (hereinafter referred to as the MC509 module) is used.

This document helps you to understand the interface specifications, electrical features, and related product information of the MC509 module.

Product name	Model name	Description
MC509	MC509	CDMA/EVDO 1900 MHz/800 MHz GPS
MC509	MC509-a	CDMA/EVDO 800 MHz GPS

CDMA/EVDO 1900 MHz/800 MHz (Data only or Telematics)

MC509 model has two editions: Data only or Telematics. Data only does not support the voice 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 MC509 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 × 2.65 mm Weight about 5.5 g
Working Bands	• MC509: CDMA2000 1x, CDMA2000 EV-DO Rev 0, CDMA2000 EV-DO Rev A Supports BC0 (800MHz band), BC1 (1900MHz band) GPS • MC509-a: CDMA2000 1x, CDMA2000 EV-DO Rev 0, CDMA2000 EV-DO Rev A Supports BC0 (800MHz band) GPS
Operating Temperature	Normal working temperature: –20°C to +70°C
	Extreme working temperatures[1]: –30°C to+75°C
Ambient Temperature for Storage	–40°C to +85°C
Power Voltage	3.3 V to 4.2 V (3.8 V is recommended.)

Feature	Description
AT Commands	See the *HUAWEI MC509 CDMA LGA Module AT Command Interface Specification*.
Application Interface (145-pin LGA interface)	Universal Asynchronous Receiver-Transmitter (UART) Supporting 8-wire UART
	One standard Removable User Identity Module (RUIM) card (3 V or 1.8 V)
	Audio (OPTION): (only telematics version supports this function) • 2×Micphone in • 1×Speaker out • 1×Earphone out • 1×PCM
	USB 2.0 (full speed)
	Power on/off
	Hardware Reset
	Wakeup_In
	Wakeup_out
	Light-emitting Diode
	Configurable General-purpose I/O (GPIO)
	WWAN MAIN antenna pad x1, WWAN AUX antenna pad x1, GPS antenna pad x1
	Power
SMS	New message alert, text message receiving, and text message sending
	Management of text messages: read messages, delete messages, storage status, and list message
	Support for the Protocol Data Unit (PDU) mode
Data Services	CDMA2000 1X: UL/DL 153.6 kbps
	CDMA2000 1X/EVDO Rev.0: UL 153.6 kbps DL 2.4 Mbps
	CDMA2000 1X/EVDO Rev A: UL 1.8 Mbps DL 3.1 Mbps
Applications	GPS Standalone
Certification Information	• Restriction of the use of certain Hazardous Substances (RoHS) • Federal Communications Commission (FCC) • China Compulsory Certification(CCC)

NOTE

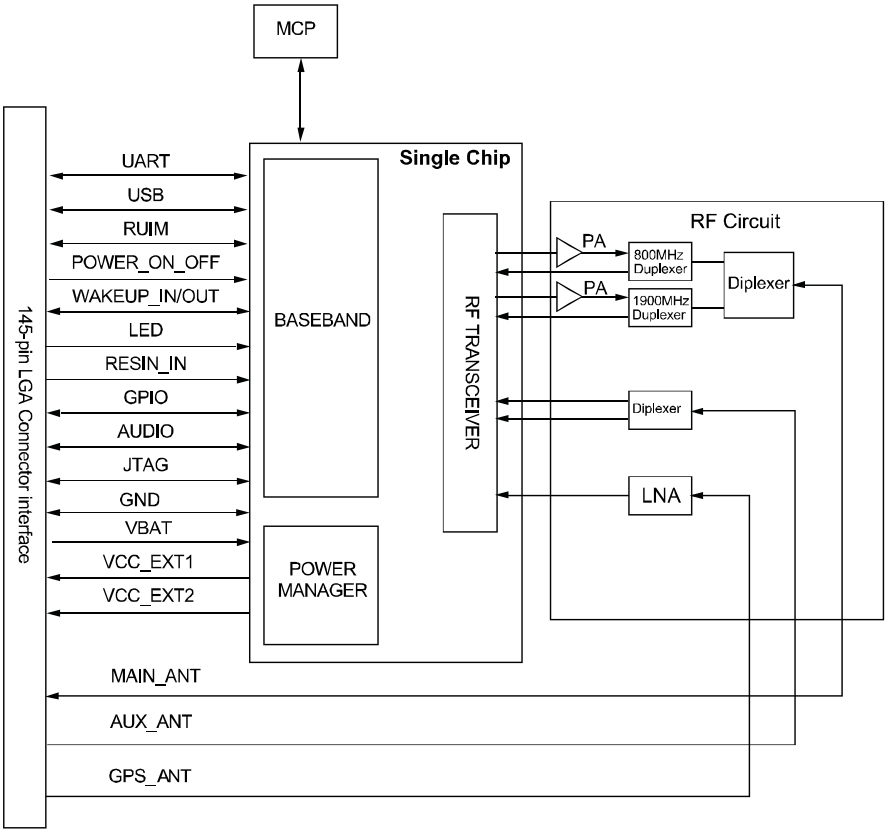
[1]:The temperatures outside of the range –20°C to +70°C; the module might slightly deviate from 3GPP2 C.S057D specifications.

2.3 Circuit Block Diagram

Figure 2-1 shows the circuit block diagram of the MC509 module. The application block diagram and major functional units of the MC509 module contain the following parts:

- Single chip
- Multi-chip package (MCP) memory
- RF Circuit

Figure 2-1 Circuit block diagram of the MC509 module

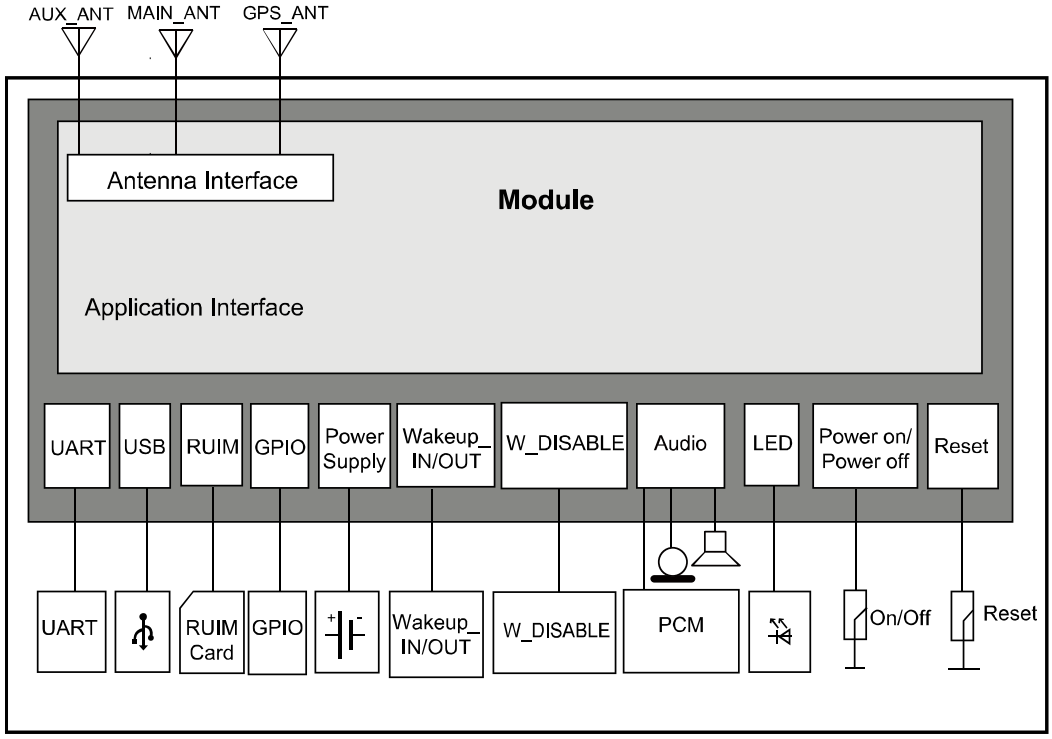


NOTE

- Only telematics version supports the audio function.
- MC509-a module supports CDMA/EVDO 800 MHz only.

2.4 Application Block Diagram

Figure 2-2 Application block diagram of the MC509 module



UART Interface: The module supports 8-wire UART.

USB Interface: The USB interface supports USB 2.0 full speed standard.

RUIM Interface: The RUIM interface provides the interface for a RUIM card. The RUIM card can be inserted into the host side.

Power Supply: DC 3.8 V is recommended.

Audio Interface: The module supports two microphone, one earphone, one speaker 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 MC509 module, including:

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

3.2 LGA Interface

The MC509 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 Huawei LGA module, such as module with system of CDMA, you can refer to *Huawei LGA Module Migration Guide* to get the details.

Table 3-1 shows the definitions of pins on the 145-pin signal interface of the MC509 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 wake up Module	–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	-	-	Used for JTAG interfaces 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	-	-	-
21	NC	-	-	Not connected, please keep this pin open	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
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	–0.3	2.6	2.9
31	VCC_EXT2	-	P	2.6V POWER output	-	2.6	-
32	VCC_EXT1	-	P	1.8V POWER output	-	1.8	-
33	NC	-	-	Not connected, please keep this pin open	-	-	-
34	RUIM_VCC	-	P	Power supply for RUIM card		1.8/2.85	
35	NC	-	-	NC	-	-	-
36	JTAG_TRST_N	-	I	JTAG reset	–0.3	2.6	2.9
37	NC	-	-	Not connected, please keep this pin open	-	-	-
38	MIC2_P	-	AI	(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	-	AI	(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	-	AI	(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	-	AI	(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	2.6	2.9
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	W_DISABLE	-	I	Close wireless communications	–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	-	-	-
57	GND	-	-	Ground	-	-	-
58	GND	-	-	Ground	-	-	-
59	GND	-	-	Ground	-	-	-
60	NC	-	-	Not connected, please keep this pin open	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
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	2.6	2.9
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
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	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
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	2.6	2.9
88	RUIM_RESET	-	O	RUIM reset		1.8/2.85	
89	RUIM_DATA	-	I/O	RUIM Data		1.8/2.85	
90	RUIM_CLK	-	O	RUIM Clock		1.8/2.85	
91	LED_STATUS	-	I	Status indicator SINK current source Driver strength: 10mA	-	-	-
92	NC	-	-	Not connected, please keep this pin open	-	-	-
93	JTAG_RTCK	-	I	JTAG return clock	–0.3	2.6	2.9
94	NC	-		Not connected, please keep this pin open	-	-	-
95	NC	-		Not connected, please keep this pin open	-	-	-
96	EAR_OUT_N	-	AO	(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	-	AO	(Only telematics version supports audio function , Data only version does not support this function) Positive pole of the output of Earphone interface	-	-	-
98	SPKR_OUT_P	-	AO	(Only telematics version supports audio function, Data only version does not support this function) Positive pole of the output of speaker interface	-	-	-

PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
99	SPKR_OUT_N	-	AO	(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 SINK current source Driver 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	GPS_ANT	-	-	RF GPS antenna pad	-	-	-
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	-	-	-
115	AUX_ANT	-	-	RF divert antenna pad	-	-	-
116	GND	-	-	Ground	-	-	-
117	NC	-	-	Not connected, please keep this pin open	-	-	-
118	NC	-	-	Not connected, please keep this pin open	-	-	-
119	NC	-	-	Not connected, please keep this pin open	-	-	-

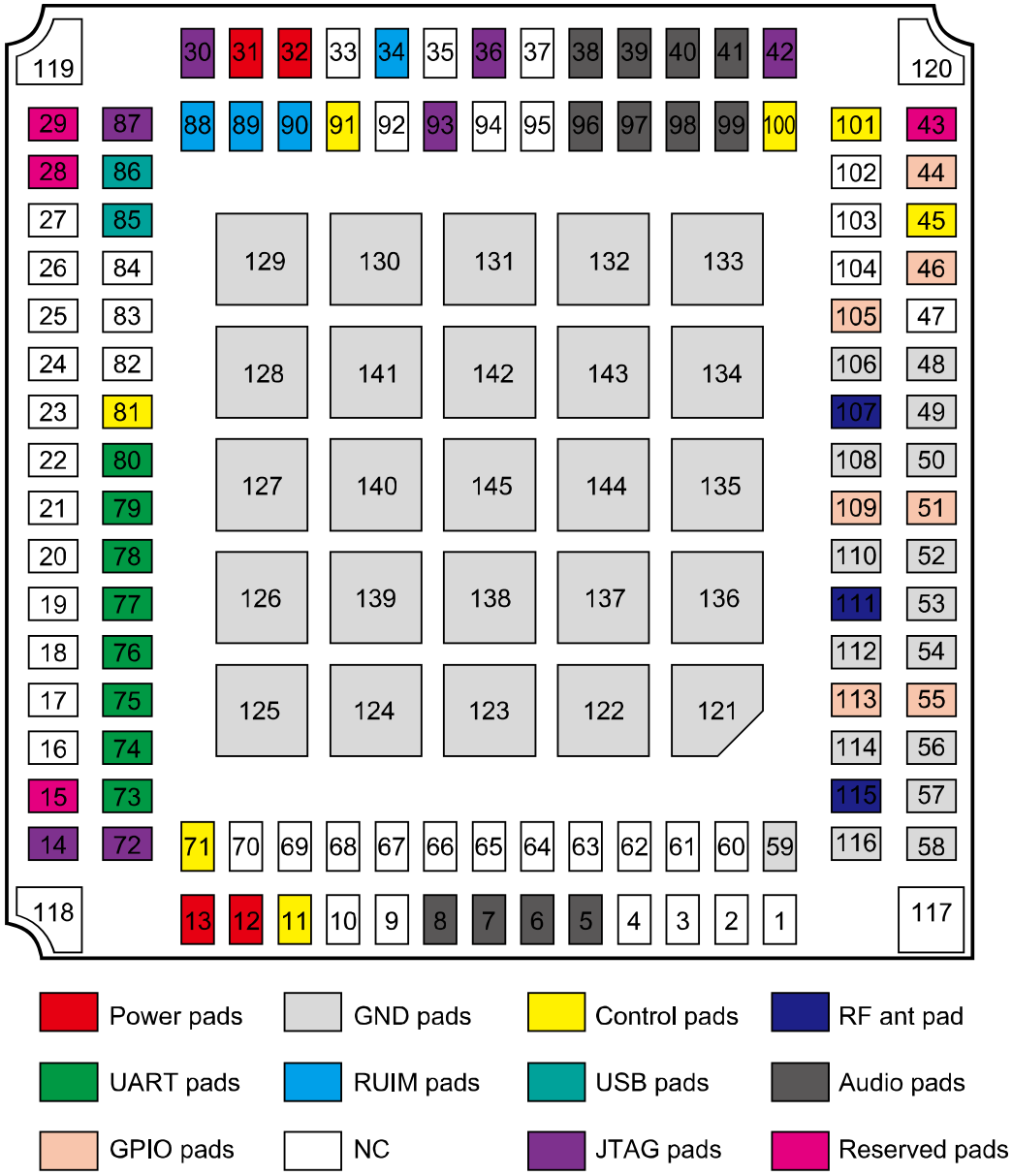
PIN No.	Pin Name		I/O	Description	DC Characteristics (V)		
	Normal	MUX			Min.	Typ.	Max.
120	NC	-	-	Not connected, please keep this pin open	-	-	-
121	GND	-	-	Thermal Ground Pad	-	-	-
122	GND	-	-	Thermal Ground Pad	-	-	-
123	GND	-	-	Thermal Ground Pad	-	-	-
124	GND	-	-	Thermal Ground Pad	-	-	-
125	GND	-	-	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	-	-	-
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. **AI** indicates pins for analog signal input; **AO** indicates pins for analog 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 MC509 module.

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



3.3 Power Interface

3.3.1 Overview

The power supply part of the MC509 module contains:

- VBAT pins for the power supply
- VCC_EXT1 pin for external power output
- VCC_EXT2 pinfor external power output
- RUIM_VCC PIN for RUIM 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	-	-	-
32	VCC_EXT1	P	Pin for external power output	-	1.8	-
31	VCC_EXT2	P	Pin for external power output	-	2.6	-
34	RUIM_VCC	P	Power supply for RUIM card	-	1.8/2.85	-
121–145	GND	-	Thermal Ground Pad	-	-	-

3.3.2 VBAT Interface

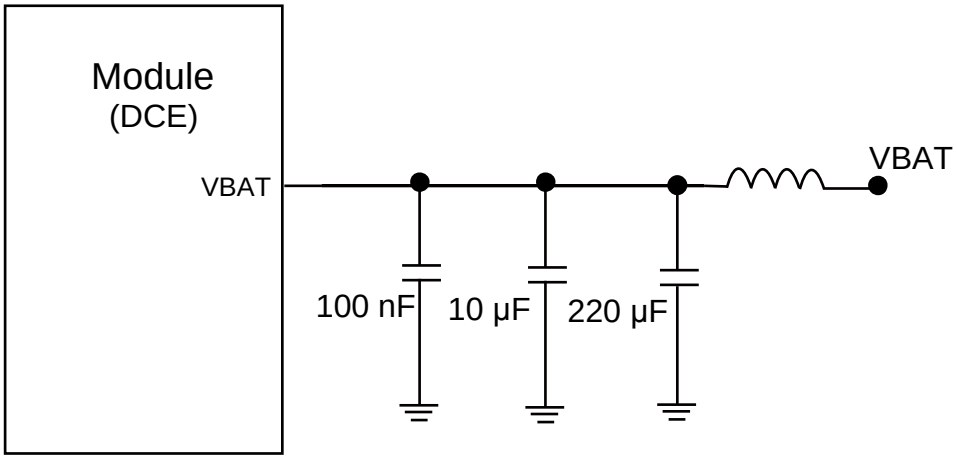
When the MC509 module works normally, power is supplied through the VBAT pins and the voltage ranges from 3.3 V to 4.2 V (typical value: 3.8 V). The 145-pin LGA provides two VBAT pins and GND pins for external power input. To ensure that the MC509 module works normally, all the pins must be used efficiently.

When the MC509 module is used for different external applications, pay special attention to the design for the power supply. When the MC509 module transmits signals at the maximum power, the transient current may reach the transient peak value of about 1.5 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 MC509 module may occur.

A low-dropout (LDO) regulator or switch power with current output of more than 1.5 A is recommended for external power supply. Furthermore, a 220 µF or above energy storage capacitor is connected in parallel at the power interface of the MC509 module.

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 MC509 module.

Figure 3-2 Recommended power circuit of MC509 module



3.3.3 Output Power Supply Interface

Output Power Supply Interface includes VCC_EXT1 pin and VCC_EXT2 pin.

Through the Output Power Supply interface, the MC509 module can supply 2.6 V and 1.8 V power externally with an output current of 10 mA (typical value) for external level conversion or other applications.

If the MC509 module is in Sleep mode, the Output Power Supply interface is in the low power consumption state. If the MC509 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 MC509 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
- W_DISABLE signal pin

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

Table 3-3 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	O	Pin for network status LED	-	-	-
101	LED_MODE	O	Pin for network mode LED	-	-	-
11	WAKEUP_IN	I	H: DTE wakeup MC509. L: DTE set MC509 to sleep mode.	–0.3	2.6	2.9
71	WAKEUP_OUT	O	L: default H: MC509 keeps 1 second high level to wakeup DTE (e.g. SMS&VOICE incoming)	–0.3	2.6	2.9
45	W_DISABLE	I	Close wireless communications	–0.3	2.6	2.9

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

3.4.2 Input Signal Control Pins

The MC509 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 MC509 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 3s again, the module is powered off.

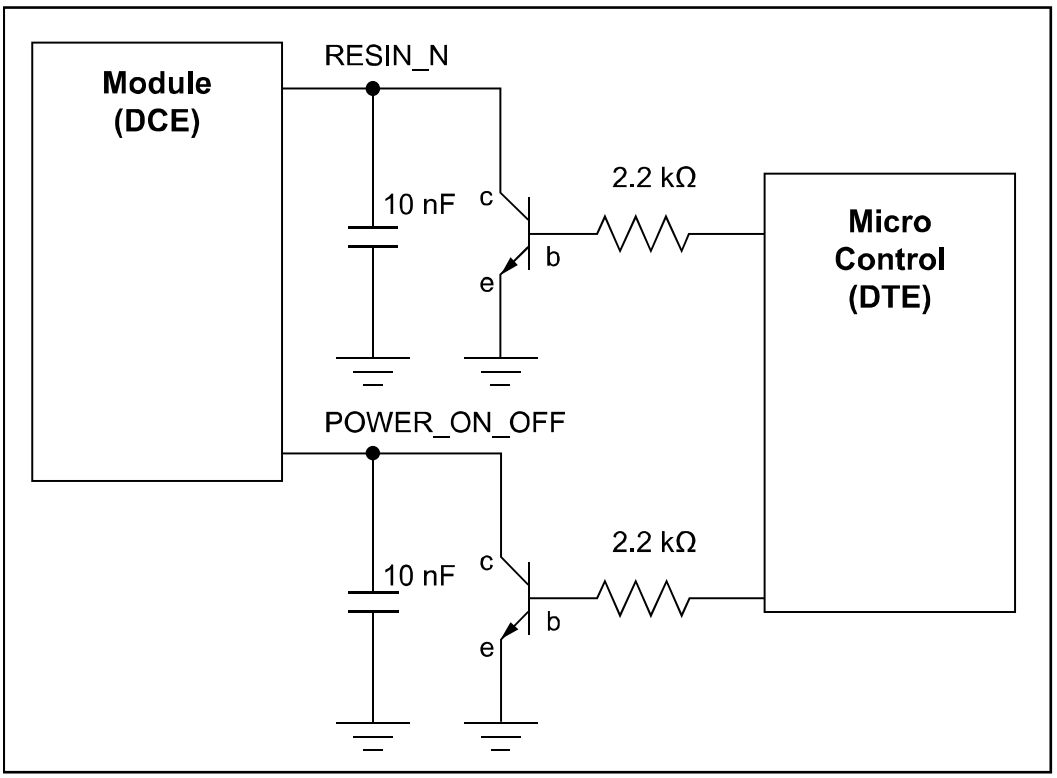
The RESIN_N pin is used to reset the hardware. When the software stops responding, the RESIN_N pin can be pulled down for 100 ms to reset the hardware.

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 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 3-3 shows the connections of the POWER_ON_OFF and RESIN_N pins.

Figure 3-3 Connections of the POWER_ON_OFF and RESIN_N pins



Power-On Time Sequence

After VBAT has been applied and is stable, the module will generate an on board power on reset signal and on the release of the reset, the module will boot up.

USB_DP will be pulled high when boot up completes, simultaneously the module starts to communicate with host via USB or UART. Figure 3-4 shows power on timing sequence.

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

Figure 3-4 Power on timing sequence

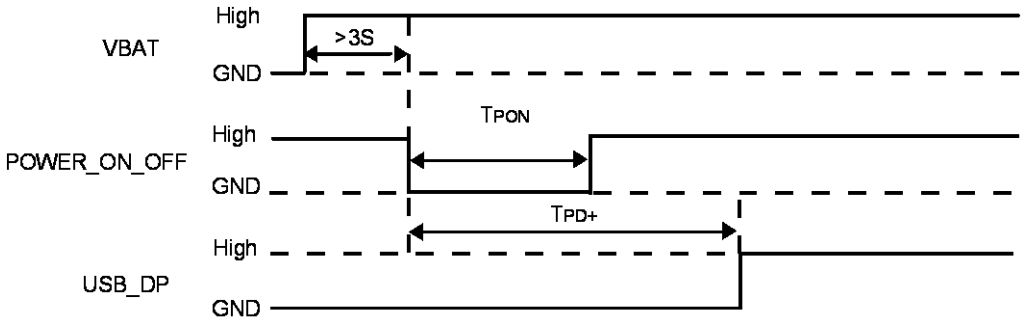


Table 3-4 Power on timing

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 3-5 Power off timing

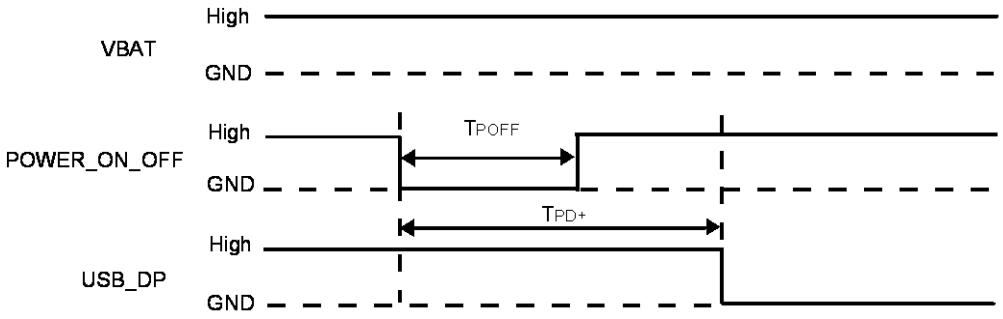


Table 3-5 Power off timing

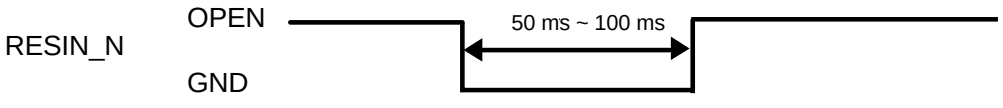
Parameter	Comments	Time(Nominal values)	Units
T_{POFF}	POWER_ON_OFF turn off time.	3< T_{POFF} <4	s
T_{PD+}	POWER_ON_OFF Valid to USB D+ high	about 4	s

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

RESIN_N

The MC509 module supports hardware reset function. If the software of the MC509 module stops responding, the MC509 module can be reset through the RESIN_N signal. After the hardware is reset, the software starts powering on the module and reports relevant information according to the actual settings.

Figure 3-6 Reset pulse timing

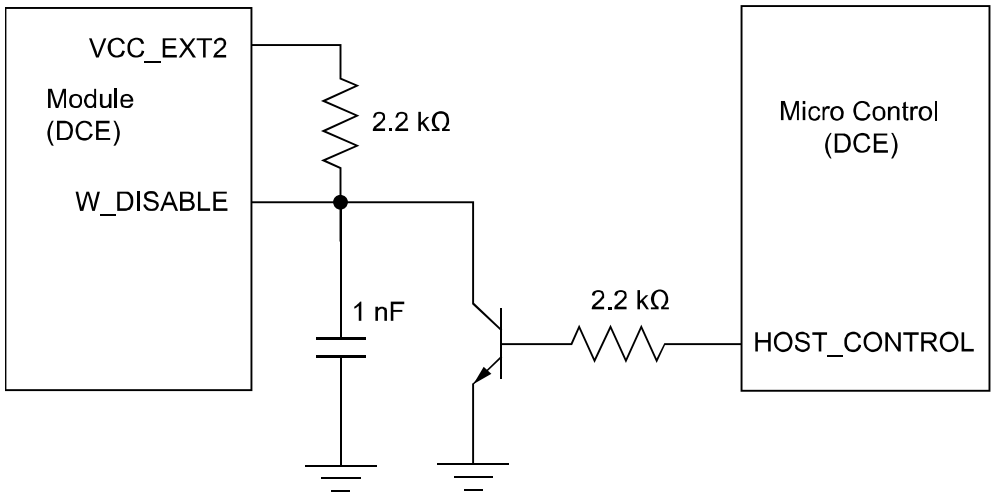


NOTE
The low-level pulse through the RESIN_N pin cannot last for more than 2s. Otherwise, the MC509 module will be powered off.

W_DISABLE

The W_DISABLE signal is provided to allow users to disable wireless communications add-in cards. When the W_DISABLE signal is asserted, all radios should be disabled. When the W_DISABLE signal is not asserted, the radio may transmit signals if it is not disabled by other means such as software.

Figure 3-7 Connection of W_DISABLE control pin



3.4.3 Output Signal Control Pin

The MC509 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).

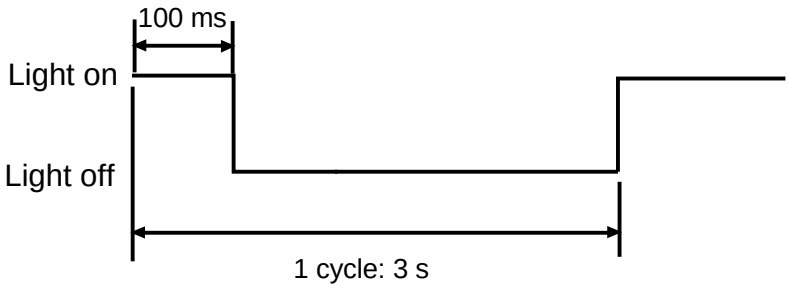
Different blinking modes of the status LED indicate different network status. Table 3-6 describes the status of the LED_STATUS pin and LED_MODE pin.

Table 3-6 List of the LED_STATUS pin and LED_MODE pin

No.	Operating Status	LED_STATUS	LED_MODE
1	The 3G network is searched and registered.	The indicator blinks once each time.	GND **- OFF**
2	3G PS Service. Connected in a packet data connection (Dormant).	OPEN **- Always ON**	GND **- OFF**
3	3G PS Service. Connected in a packet data connection but actively transferring data.	The indicator blinks fast	GND **- OFF**
4	The software is being downloaded or upgraded.	GND **- OFF**	The indicator blinks fast
5	Module is not registered but searching for a operator (CREG:0,2 or CREG:0,0).	the indictor blinks twice each time	GND **- OFF**
6	Low power mode	GND **- OFF**	GND **- OFF**

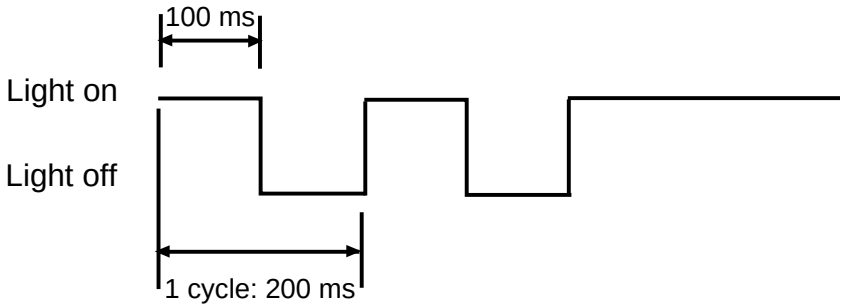
Blinking Once Each Time

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



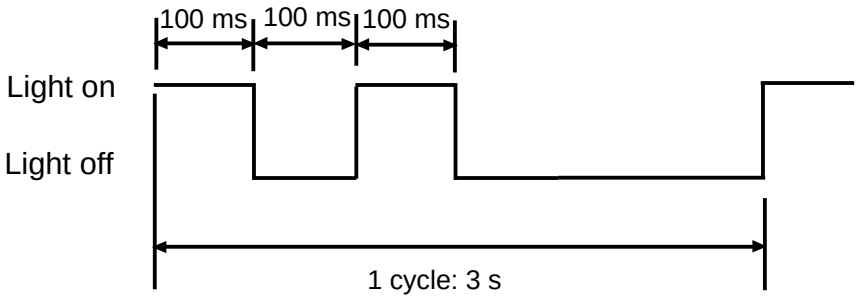
Blinking Fast

Figure 3-9 Status when the indictor blinks fast



Blinking Twice Each Time

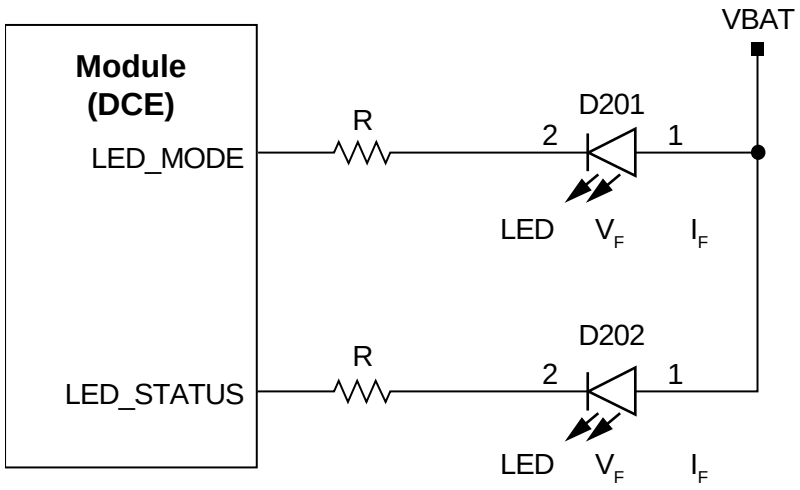
Figure 3-10 Status when the indictor blinks twice each time



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

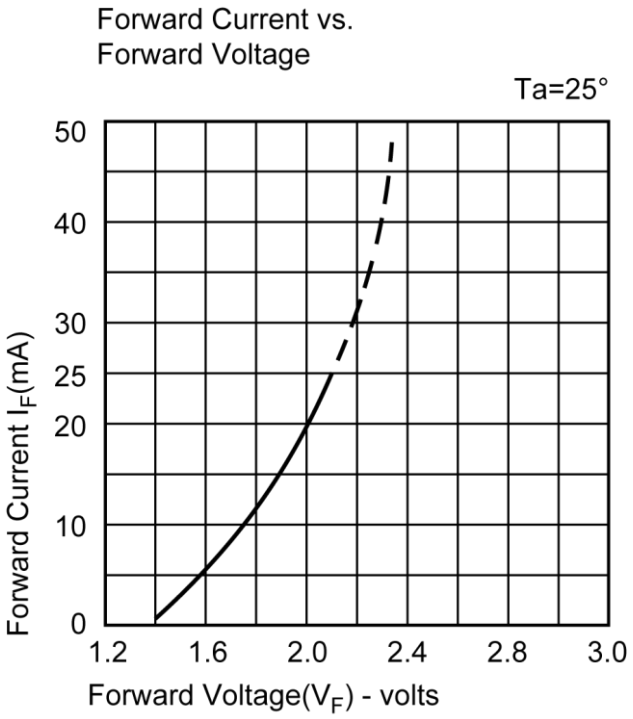
V_F: Forward Voltage

I_F: Forward current

Take the LED 19-213/GVC-AMNB/3T as an example (its manufacturer is Everlight Electronics., Ltd. And the website is http://www.everlight.com). 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 MC509 module through the WAKEUP_IN signal.

If there is no external WAKEUP_IN signal, the wireless module keeps in the wakeup status by default. After receiving the WAKEUP_IN signal, the wireless module determines whether to enter the sleep mode according to the level status of the WAKEUP_IN signal.

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

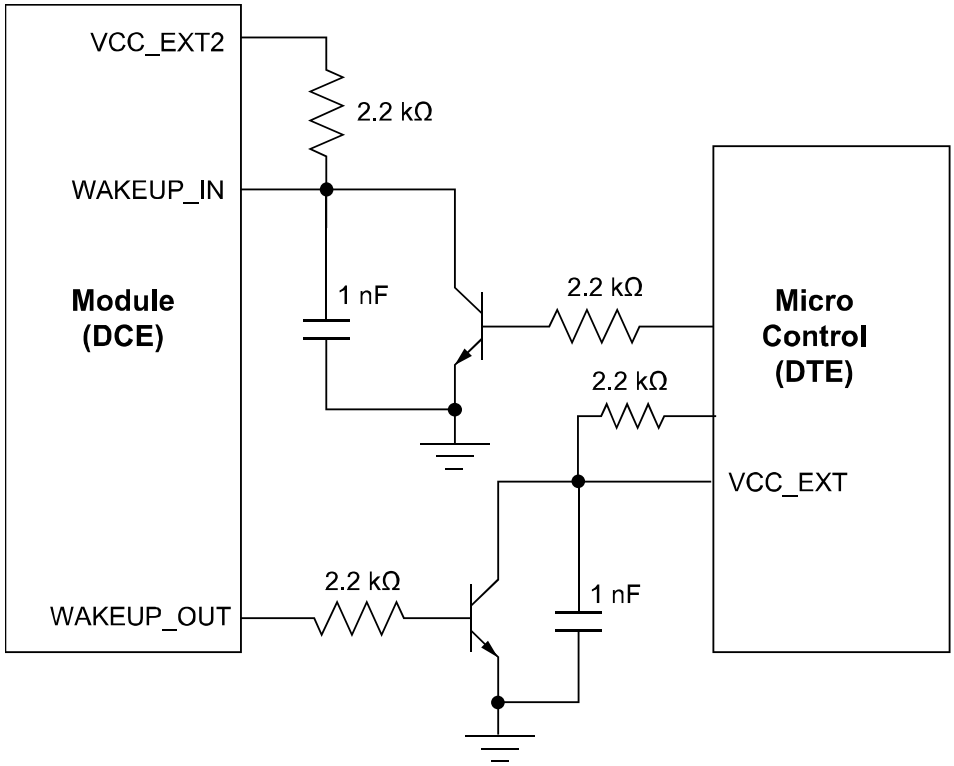
3.4.5 WAKEUP_OUT Signal

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

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

Figure 3-13 shows the recommended schematic.

Figure 3-13 Connections of the WAKEUP_IN and WAKEUP_OUT pins



3.5 UART Interface

3.5.1 Overview

The MC509 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)
- Not support Self-adapted baud rate ranging from 1200 bit/s to 115200 bit/s

Table 3-7 lists the UART interface signals.

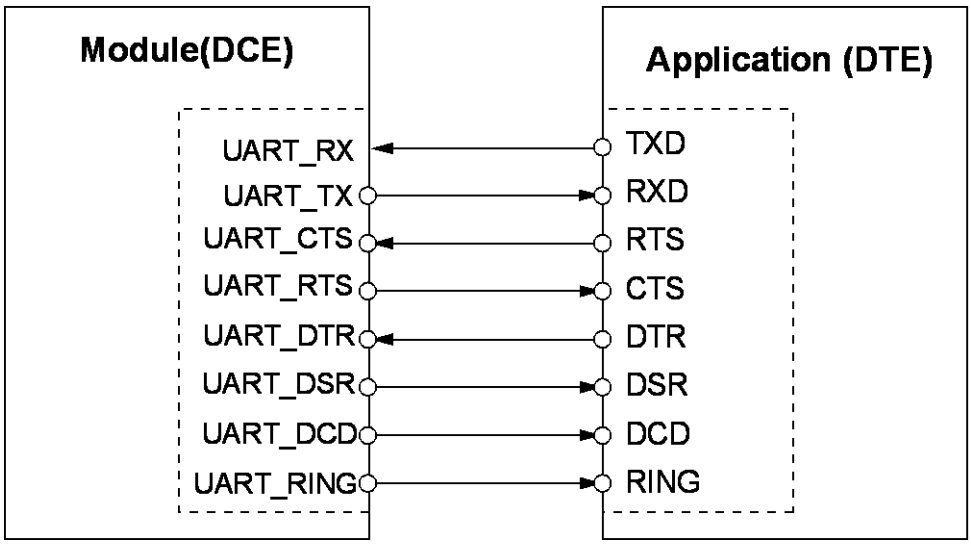
Table 3-7 UART interface signals

Pin No.	Pin Name	I/O	Description	Feature	DC Characteristics (V)		
					Min.	Typ.	Max.
76	UART_TX	O	Data sending on the wireless module	The DTE receives serial data.	–0.3	2.6	2.9
78	UART_RX	I	Data receive end of the module	The DTE transmits serial data.	–0.3	2.6	2.9
77	UART_RING	O	Ringing indication on the wireless module	The DTE is notified of a remote call.	–0.3	2.6	2.9
74	UART_RTS	O	Data sending request on the wireless module	The DTE notifies the DCE of sending requests.	–0.3	2.6	2.9
79	UART_DTR	I	Data terminal ready on the wireless module	The DTE is ready.	–0.3	2.6	2.9
80	UART_CTS	I	Clearing to send on the wireless module	The DCE switches to the receiving mode.	–0.3	2.6	2.9
75	UART_DCD	O	Data carrier detection on the wireless module	Data links are connected.	–0.3	2.6	2.9
73	UART_DSR	O	Data ready on the wireless module	The DCE is ready.	–0.3	2.6	2.9

3.5.2 Circuit Recommended for the UART Interface

Figure 3-14 shows the connection of the UART interface in the MC509 module (DCE) with the host (DTE).

Figure 3-14 Connection of the UART interface in the MC509 module (DCE) with the host (DTE)



NOTE

- For detailed application of the MC509 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 for debug.
- 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 MC509 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 MC509 module.

3.6 USB Interface

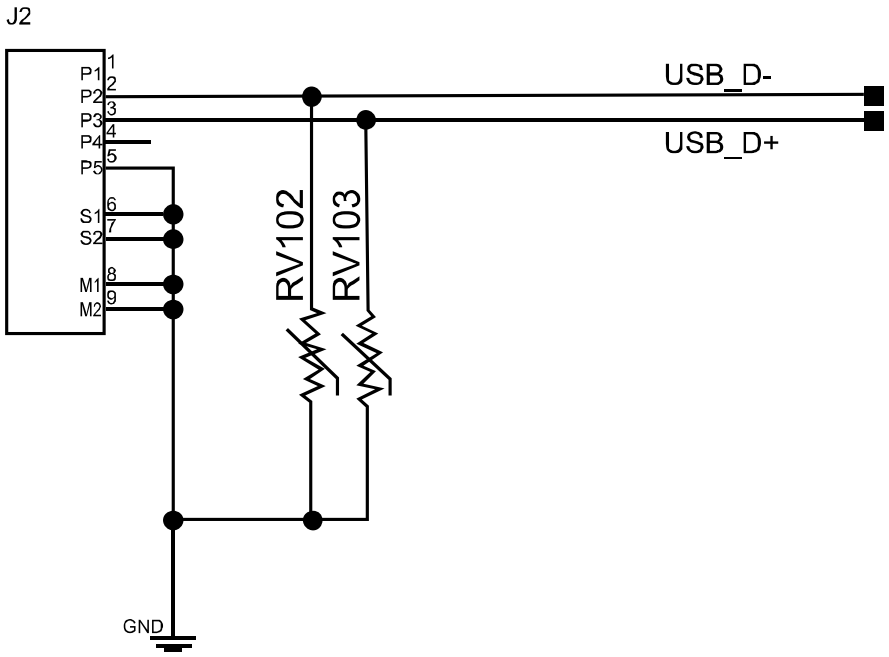
The MC509 is compliant with USB 2.0 full speed protocol. The USB interface is powered directly from the 3.3 V supply. The USB input/output lines are compatible with the USB 2.0 3.3 V signal specifications. Figure 3-15 shows the circuit of the USB interface.

Table 3-8 USB interface signals

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 MC509 USB signal, please refer to the chapter 7.3.2 of Universal Serial Bus Specification 2.0.

Figure 3-15 Recommended circuit of USB interface



NOTE

- Since the USB interface of MC509 module supports USB 2.0 full speed, the resistance “RV102 and RV103” 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 ohm
- It is recommended that set USB D+ and USB D- pins as test points and then place these test points on the DTE for debug.

3.7 RUIM Card Interface

3.7.1 Overview

The MC509 module provides a RUIM card interface complying with the C.S0023 standard and supports automatic detection of a 3.0 V RUIM card or a 1.8 V RUIM card. Table 3-9 lists the RUIM card interface signals.

Table 3-9 RUIM card interface signals

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
34	RUIM_VCC	O	Power source for the external RUIM.		1.8/2.85	
89	RUIM_DATA	I/O	External RUIM data signal.		1.8/2.85	
90	RUIM_CLK	O	External RUIM clock signal.		1.8/2.85	
88	RUIM_RESET	O	External RUIM reset signal.		1.8/2.85	

3.7.2 Circuit Recommended for the RUIM Card Interface

As the MC509 module is not equipped with a RUIM card socket, a RUIM card socket need to be placed on the user interface board. The RUIM card signals are transmitted outwards through the 145-pin LGA interface. Figure 3-16 shows the circuit of the RUIM card interface.

Figure 3-16 Circuit of the RUIM card interface

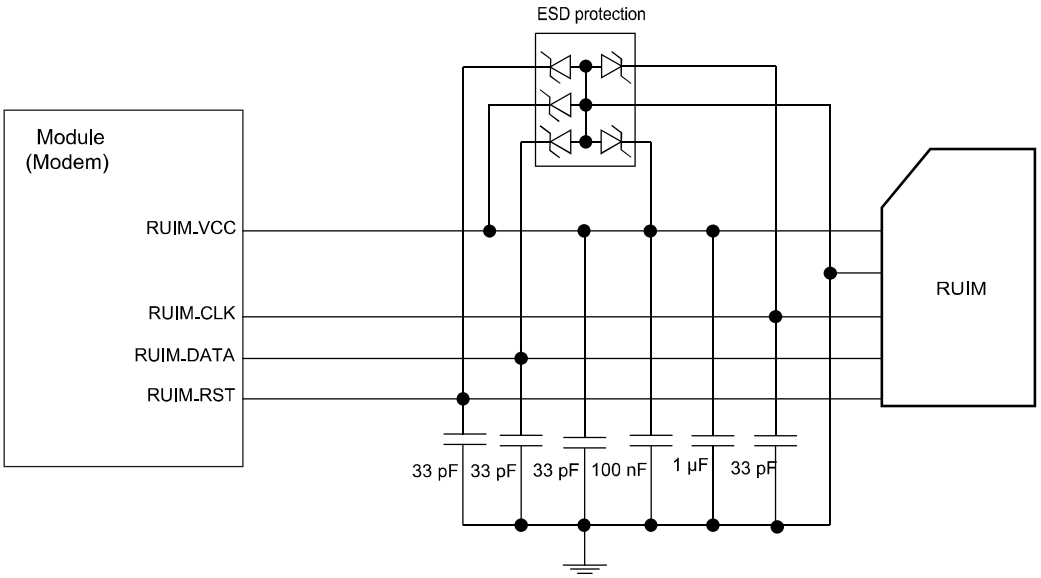
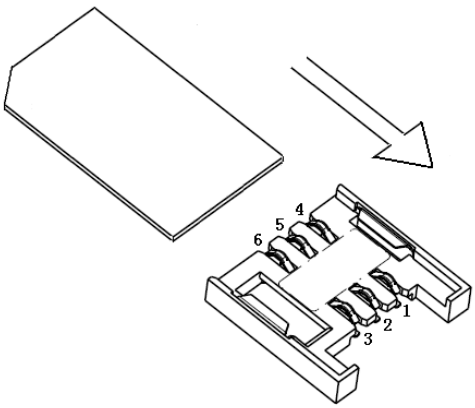


Figure 3-17 Pin definition of RUIM Socket



pin1:	RUIM_VCC
pin2:	RUIM_RESET
pin3:	RUIM_CLK
pin4:	GND
pin5:	NULL
pin6:	RUIM_DATA

CAUTION

- To meet the requirements of 3GPP TS 11.11protocols and electromagnetic compatibility (EMC) authentication, the RUIM card socket should be placed near the LGA interface (it is recommended that the PCB circuit connecting the LGA interface and the RUIM card socket not exceed 100mm), because a long circuit may lead to wave distortion, thus affecting signal quality.
- It is recommended that the user should wrap the area adjacent to the RUIM_CLK and RUIM_DATA signal wires with a ground wire. The GND pin of the RUIM card socket and the GND pin of the RUIM card must be well connected to the power GND pin supplying power to the MC509 module.
- A 0.1 μF capacitor and1 μF capacitor are placed between the RUIM_VCC and GND pins in a parallel manner (If RUIM_VCC circuit is too long, that the larger capacitance such as 4.7 μF can be employed if necessary). Three 33 pF capacitors are placed between the RUIM_DATA and Ground pins, the RUIM_RST and Ground pins, and the RUIM_CLK and Ground pins in parallel to filter interference from RF signals.
- It is not recommended that pull the RUIM_DATA pin up during design as a 15000-ohm resistor is used to connect the RUIM_DATA pin to the RUIM_VCC.
- It is recommended to take electrostatic discharge (ESD) protection measures near the RUIM 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 MC509 module.

3.8 Audio Interface

3.8.1 Analogue Audio

The MC509 provides two audio channels (Data only doesn’t support the voice function).

The two audio 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 circuits, 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 for a full-scale +3 dBm sine wave into a 32-ohm 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 3-18 Circuit diagram of the interface of the first audio channel

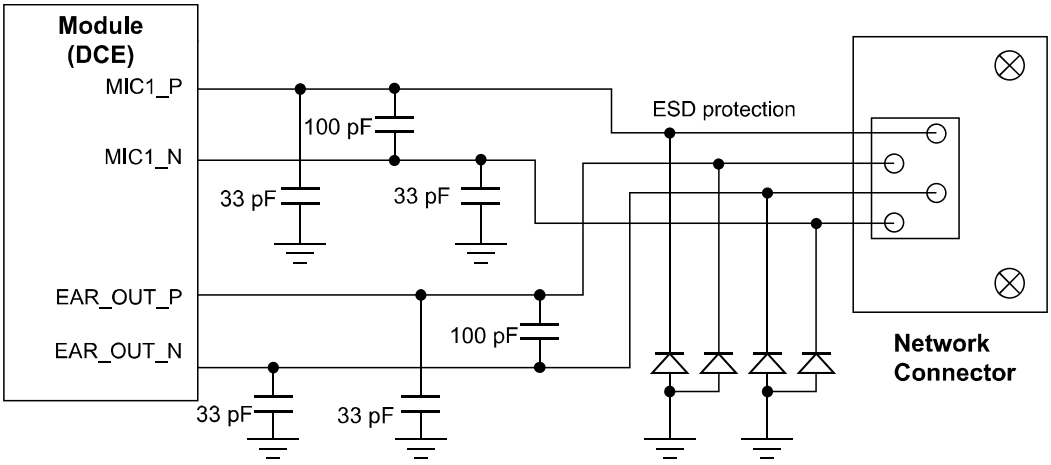
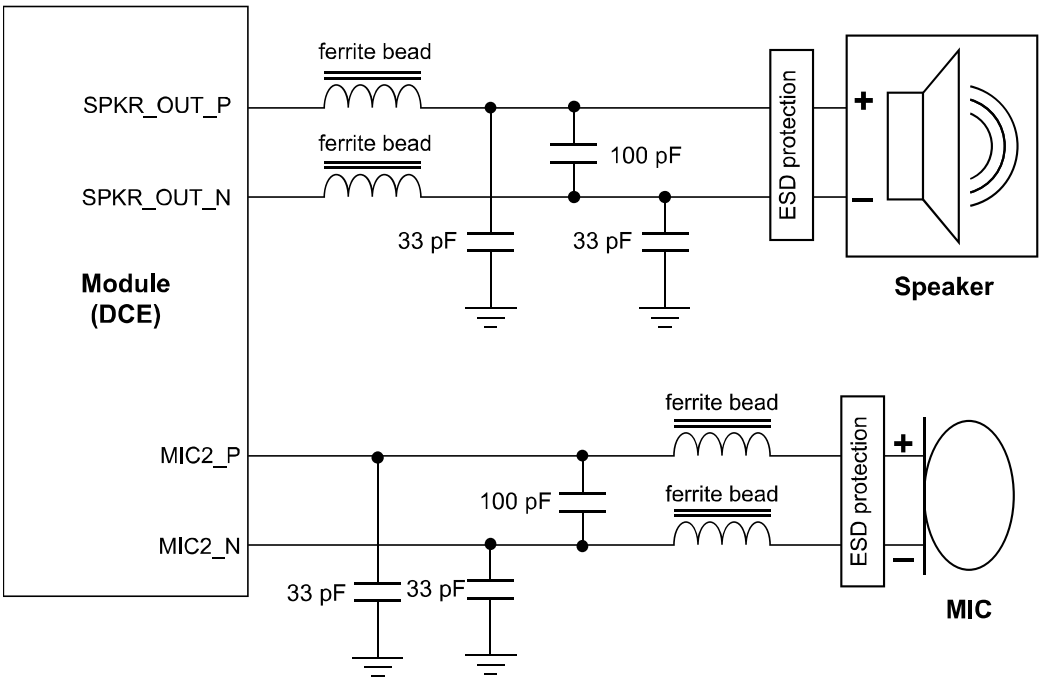


Figure 3-19 Circuit diagram of the interface of the second audio channel



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

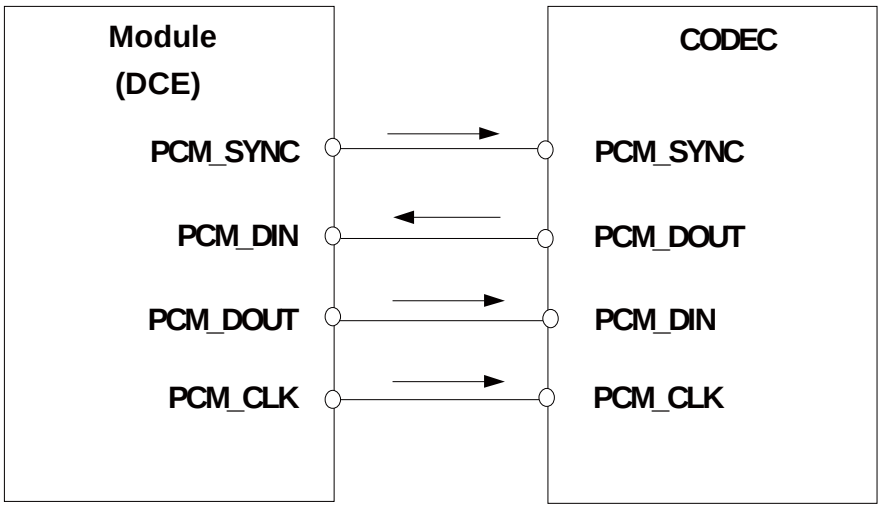
The MC509 provides one digital audio channels (Data only doesn't support the voice function). Table 3-10 lists the signals on the digital audio interface.

Table 3-10 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 MC509 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 3-20 Circuit diagram of the interface of the PCM (MC509 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.
- When the MC509 module works on master mode, PCM_CLK and PCM_SYNC pins are in the output status.

Primary Mode

On Primary mode MC509 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 seven channels GPIO pins for customers to applications of controlling signal. Customers can use AT command to control the state of logic levels of eight channels GPIO output signal. See the *HUAWEI MC509 CDMA LGA Module AT Command Interface Specification*.

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

3.10 JTAG Interface

LGA MC509 module provides one JTAG interface (Joint Test Action Group). Set the pins in the following table as the test pins. And place the test points in the DTE for debugging.

Pin No.	Pin Name	I/O	Description	DC Characteristics (V)		
				Min.	Typ.	Max.
30	JTAG_TMS	I	JTAG Test mode select	–0.3	2.6	2.9
36	JTAG_TRST_N	I	JTAG reset.	–0.3	2.6	2.9
42	JTAG_TCK	I	JTAG clock input	–0.3	2.6	2.9
72	JTAG_TDO	O	JTAG test data output	–0.3	2.6	2.9
87	JTAG_TDI	I	JTAG test data input	–0.3	2.6	2.9
93	JTAG_RTCK	O	JTAG return clock	–0.3	2.6	2.9
14	PS_HOLD	I	Used for JTAG interfaces assigning a test point for it.	-	1.8	-
31	VCC_EXT2	O	2.6V POWER output	-	2.6	-
100	RESIN_N	I	Reset module	–0.3	1.8	2.1

NOTE

It is recommended that set the 9 pins related to JTAG interface as test points on the DTE for tracing and debugging.

3.11 RF Antenna Interface

MC509 module provides an RF ANT PAD for connecting an external antenna. Through the MAIN_ANT pad, the antenna interface is routed to the coaxial connector on the DTE (impedance 50 Ω).The external antenna is connected to the module through the coaxial connector.

A match for the antenna must be reserved at the antenna port.

Table 3-11 Signals on RF Antenna interface

Pin No.	Pin Name	I/O	Description
107	MAIN_ANT	-	RF main antenna pad
111	GPS_ANT	-	RF GPS antenna pad
115	AUX_ANT		RF divert antenna pad

3.12 Reserved Interface

The module provides 4 reserved pins. All of reserved pins cannot be used by the customer.

Table 3-12 List of reserved pins

Pin No.	Pin Name	I/O	Description
15, 28, 29, 43	Reserved	-	Reserved

3.13 NC Interface

The LGA module has 46 NC pins. All the NC interfaces should not be connected. Please keep this pin open.

Table 3-13 List of not connected pins

Pin No.	Pin Name	I/O	Description
1–4, 9, 10, 16–27, 33, 35, 37, 47, 60–70, 82–84, 92, 94, 95, 102–104, 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 MC509 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 MC509.

Table 4-1 RF bands

Operating Band	Tx	Rx
CDMA 800 (BC0)	824 MHz–849MHz	869 MHz–894 MHz
CDMA 1900 (BC1)	1850 MHz–1910MHz	1930 MHz–1990 MHz
GPS	NA	1574.42 MHz–1576.42 MHz

4.4 Conducted RF Measurement

4.4.1 Test Environment

Test instrument	Agilent 8960
Power supply	KEITHLEY 2306
RF cable for testing	L08-C014-350 of DRAKA COMTEQ or Rosenberger Cable length: 29cm

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 3GPP2 test standards relating to 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 MC509.

The **3GPP Protocol Claim** column in Table 4-2 lists the required minimum values, and the **Test Value** column lists the tested values of MC509.

Table 4-2 MC509 conducted Rx sensitivity (Unit: dBm)

Item		3GPP2 Protocol Claim (dBm)	MC509 Test Value (dBm)		
			Min.	Typ.	Max.
CDMA 800 Primary	1x(FER<0.5%)	< –104	-	–107	–104
	EVDO(PER<0.5%)	< –105.5	-	–109	–105.5
CDMA1900 Primary	1x(FER<0.5%)	< –104	-	–107	–104
	EVDO(PER<0.5%)	< –105.5	-	–109	–105.5
CDMA 800 Diversity	1x(FER<0.5%)	-	-	–106	-
	EVDO(PER<0.5%)	-	-	–107	-
CDMA1900	1x(FER<0.5%)	-	-	–106.5	-

Item		3GPP2 Protocol Claim (dBm)	MC509 Test Value (dBm)		
			Min.	Typ.	Max.
Diversity	EVDO(PER<0.5%)	-	-	–107.5	-

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 MC509. The conducted transmit power refers to the maximum power that the module tested at the antenna port can transmit. According to the 3GPP2 protocol, the required transmit power varies with the power class.

Table 4-3 lists the required ranges of the conducted transmit power of MC509. The tested values listed in the Test Value column must range from the minimum power to the maximum power.

Table 4-3 MC509 conducted Tx power (Unit: dBm)

Item	MC509 Test Value (dBm)		
	Min.	Typ.	Max.
BC0(CDMA 800 MHz)	23	24	25
BC1(CDMA 1900 MHz)	23	24	25

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 MC509 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 MC509 to ensure high radio performance of the module:

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

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

S11 or VSWR

S11 indicates the degree to which the input impedance of an antenna matches the reference impedance (50-ohm). 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 MC509:

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

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

Isolation

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

Antenna isolation depends on the following factors:

- Distance between antennas
- Antenna type
- Antenna direction

The primary antenna must be placed as near as possible to the MC509 to minimize the cable length. The diversity antenna needs to be installed perpendicularly to the primary antenna. The diversity antenna can be placed farther away from the MC509 Antenna isolation can be measured with a two-port vector network analyzer.

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

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

Polarization

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

The linear polarization is recommended for the antenna of MC509.

Envelope Correlation Coefficient

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

- Distance between antennas
- Antenna type
- Antenna direction

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

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

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 can be used for wireless terminals. 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 MC509:
Primary/diversity/GPS antenna: omnidirectional

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

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 MC509: **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 CDMA Antenna Requirements

The antenna for MC509 must fulfill the following requirements:

CDMA 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 CDMA800 (25 MHz for diversity antenna) 140 MHz in CDMA1900 (60 MHz for diversity antenna)
Gain	Gain ≤ 2.5 dBi
Impedance	50-ohm
VSWR absolute max	≤ 3:1 (≤ 2:1 for GPS antenna)
VSWR recommended	≤ 2:1 (≤ 1.5:1 for GPS antenna)

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 6 GHz. The test items are described as follows:

Passive Tests

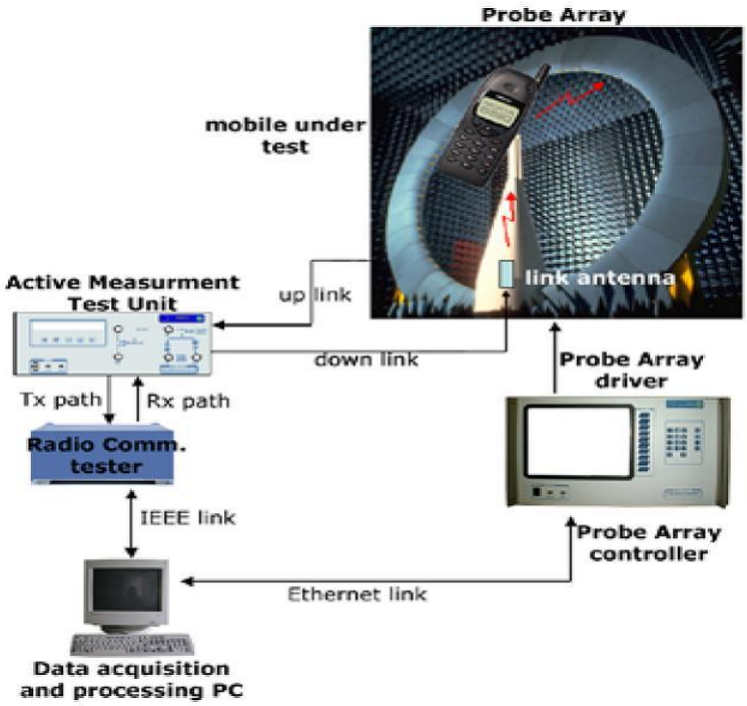
- Antenna efficiency
- Gain
- Pattern shape
- Envelope correlation coefficient

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 MC509 module, including:

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

5.2 Extreme Working Conditions

WARNING

Table 5-1 lists the extreme working conditions for the MC509 module. Using the MC509 module beyond these conditions may result in permanent damage to the module.

Table 5-1 Extreme working conditions for the MC509 module

Symbol	Specification	Minimum Value	Maximum Value	Unit
VBAT	External power voltage	–0.5	4.5	V
V_I	Data pin voltage	–0.4	3.3	V

5.3 Operating and Storage Temperatures and Humidity

Table 5-2 lists the operating and storage temperatures and humidity for the MC509 module.

Table 5-2 Operating and storage temperatures and humidity for the MC509 module

Specification	Minimum Value	Maximum Value	Unit
Normal working temperatures	–20	+70	°C
Extreme working temperatures [1]	–30 to –20	+70 to +75	°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 3GPP2 C.S057D 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	–1	1	μA
V_{OH}	High-level output voltage	V_{DD_PX} – 0.45	V_{DD_PX}	V
V_{OL}	Low-level output voltage	0	0.45	V
I_{OH}	High-level output current	3.0	-	mA
I_{OL}	Low-level output current	-	–3.0	mA

NOTE

V_{DD_PX} is 2.6 V or 1.8 V, about the voltage, 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 MC509 module.

Table 5-4 Requirements for input power of the MC509 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

Table 5-5 Requirements for input current of the MC509 module

Power	Peak (Maximum)	Normal (Maximum)
3.8 V	< 1500 mA	< 1000 mA

5.5.2 Power Consumption

The power consumptions of MC509 in different scenarios are respectively listed in Table 5-6 .

The power consumption listed in this section is tested when the power supply of MC509 module is 3.8 V. Typical values are measured at room temperature, and minimum and maximum values are measured over the entire operating temperature range.

Table 5-6 Averaged standby DC power consumption

Working mode		Max.	Unit
Power off mode		50	μA
Standby mode	800 MHz	3	mA
	1900 MHz	3	mA
Data mode	800 MHz	650	mA
	1900 MHz	700	mA

NOTE

- Standby current consumption with Sleep mode deactivated-Idle (assumes USB bus is fully suspended during measurements).
- The above values are the average of some test samples.

5.6 Reliability Features

Table 5-7 lists the test conditions and results of the reliability of the MC509 module.

Table 5-7 Test conditions and results of the reliability of the MC509 module

Item	Test Condition	Standard
Low-temperature storage	Temperature: –40ºC±2ºC Test duration: 24 h	IEC60068
High-temperature storage	Temperature: 85ºC±2ºC Test duration: 24 h	IEC60068
Low-temperature working	Temperature: –30ºC±2ºC Test duration: 24 h	IEC60068
High-temperature working	Temperature: 75ºC±2ºC Test duration: 24 h	IEC60068
Damp heat cycling	High temperature: 55ºC±2ºC Low temperature: 25ºC±2ºC Humidity: 95% Repetition times: 4 Test duration: 12 h+12 h	IEC60068
Temperature shock	Low temperature: –40ºC±2ºC High temperature: 85ºC±2ºC Temperature change interval: < 30s Test duration: 15 min Repetition times: 100	IEC60068
Salty fog test	Temperature: 35ºC Density of the NaCl solution: 5%±1% Spraying interval: 8 h Duration of exposing the module to the temperature of 35ºC: 16 h	IEC60068

Item	Test Condition	Standard
Sine vibration	Frequency range: 5 Hz to 200 Hz Acceleration: 10 m/s^2 Frequency scan rate: 1oct/min Test period: 3 axial directions. Five circles for each axial direction.	IEC60068
Shock test	Half-sine wave shock Peak acceleration: 300 m/s^2 Shock duration: 11 ms Test period: 6 axial directions. One shock for each axial direction.	IEC60068
Clash test	Half-sine wave Peak acceleration: 180 m/s^2 Pulse duration: 6 ms Repetition time: 6 directions. 1000 times for each direction.	IEC60068
Drop test	First case: 0.3 m in height. Drop the MC509 module on the marble terrace with one surface facing downwards twice. Six surfaces should be tested. Second case: 0.8 m in height. Drop the MC509 module on the marble terrace with one surface facing downwards twice. Six surfaces should be tested.	IEC60068

5.7 EMC and ESD Features

EMC tests have to be performed on the application as soon as possible to detect any potential problems.MC509 module meet the requirements of IEC61000-4-2 protocols, contact discharge 4 kV, air discharge 8 kV.

When designing, special attention should be paid to the following:

- Possible harmful emissions radiated by the application to the RF receiver in the receiver band.
- ESD protection is mandatory on all signals which are externally accessible
- Typically, ESD protection is mandatory for the following:
  - RUIM
  - UART
  - USB
  - Audio

- Length of the RUIM interface lines (preferably <10 cm).
- EMC protection on audio input/output (filters against 900MHz emissions).
- Biasing of the microphone inputs.
- Ground plane: HUAWEI Wireless recommends a common ground plane for analog/digital/RF grounds.
- A metallic case or plastic casing with conductive paint is recommended, except for the area around the antenna.

NOTE

The HUAWEI MC509 Module does not include any protection against over voltage.

6 Mechanical Specifications

6.1 About This Chapter

This chapter describes the following aspects of the MC509 module:

- Storage Requirement
- Moisture Sensitivity
- Dimensions and interfaces
- PCB Pad Design
- 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 40ºC 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 30ºC 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
125ºC±5ºC	Relative humidity ≤ 60%	8 hours	

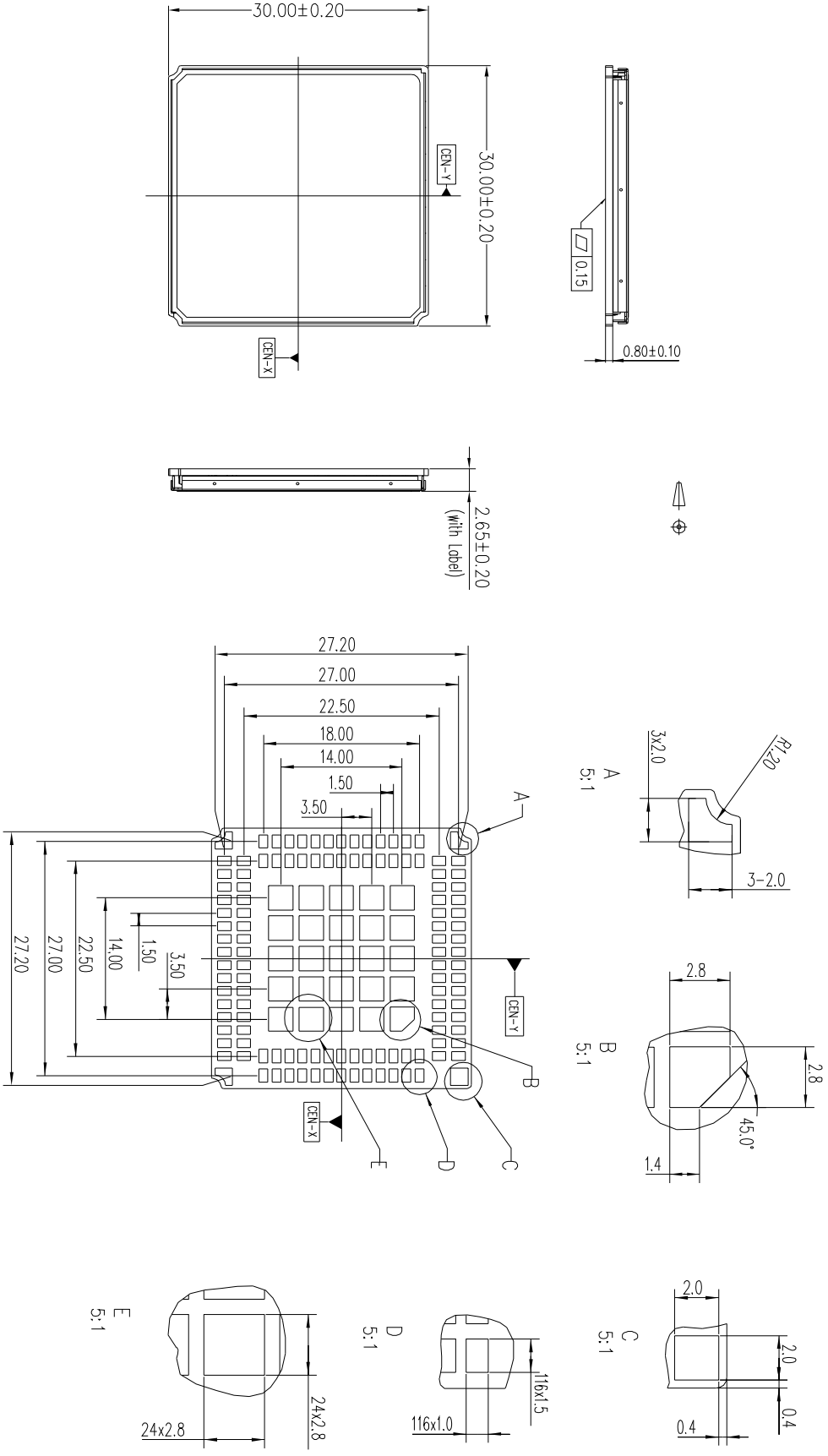
NOTE
Moving, storing, and processing the product must comply with IPC/JEDEC J-STD-033.

6.4 Dimensions and interfaces

The dimension of MC509 is 30 mm (length) × 30 mm (width) × 2.65 mm (height).

Figure 6-1 shows the dimensions of MC509 in details.

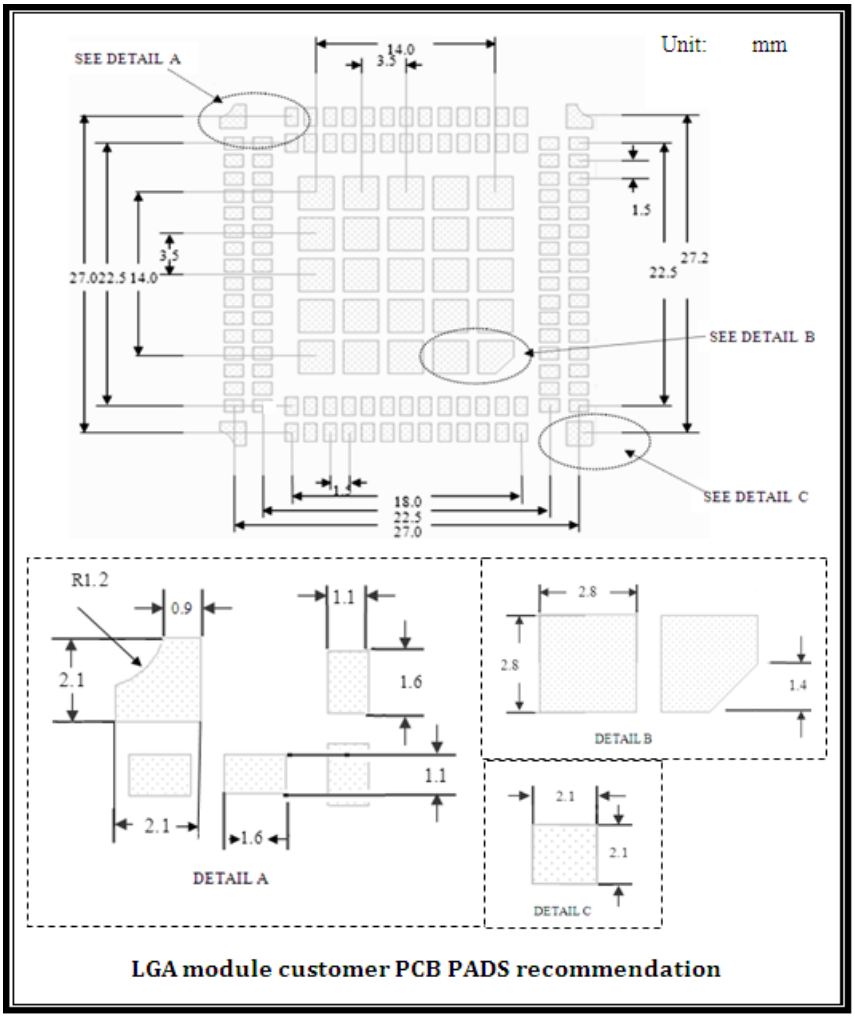
Figure 6-1 Dimensions of MC509



6.5 PCB Pad Design

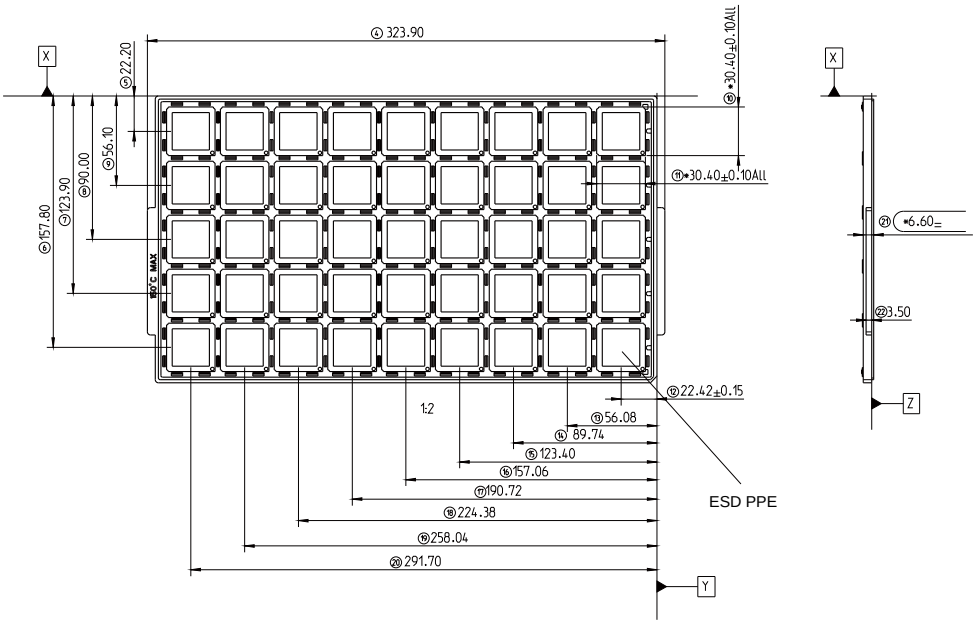
To achieve assembly yields and solder joints of high reliability, it is recommended that the PCB pad size be designed as follows: the size of the pad in the middle region is the same as the pad size of the product package; other pads are 0.05 mm larger than the unilateral pad of the product package. For details, see Figure 6-2 .

Figure 6-2 PCB pad design



6.6 Packaging

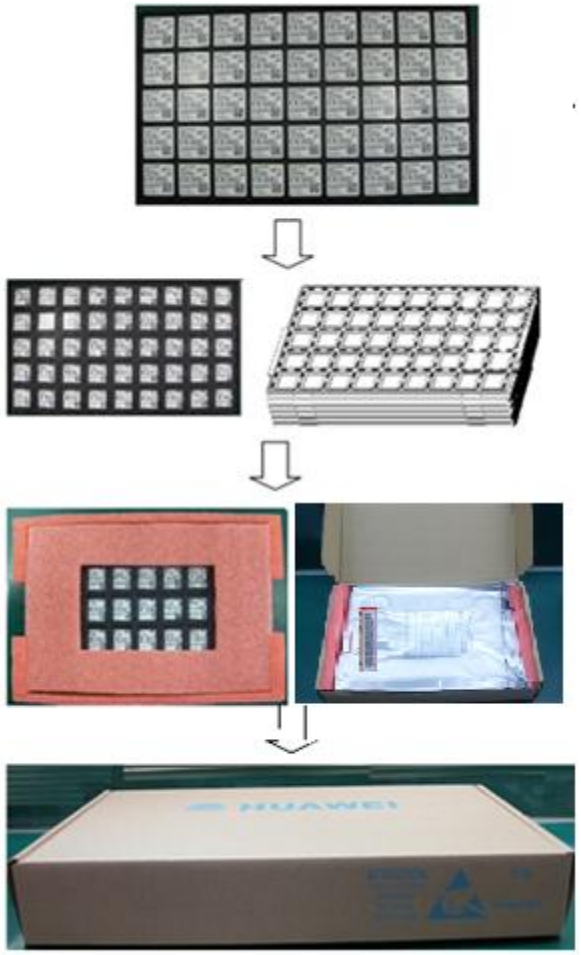
HUAWEI LGA module uses five layers ESD pallet, anti-vibration foam and vacuum packing into cartons.



NOTE

- All materials used must meet eco-friendly requirements.
- According to the requirements and test methods specified in EIA 541, the surface resistance must range from 10,000 Ω to 1000,000 Ω.
- Packaging materials must be resistant to temperature higher than or equal to 150ºC.
- Triboelectricity must be lower than 100 V.

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 = 225pcs/vacuum package.

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

NOTE

- A secondary SMT assembly will be conducted on the LGA modules. To keep LGA modules dry and ensure a quality secondary SMT assembly, use vacuum packing for the LGA modules in accordance with the packing standards for Moisture Sensitivity Level (MSL) 3 components.
- Include desiccant and humidity indicators in the packages. Attach the packages with labels indicating that the LGA modules contained in the packages are MSL 3 components.
- Packages must be made of ESD materials. Packages or containers must be attached with ESD labels.

6.7 Label

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

Figure 6-3 Label for MC509

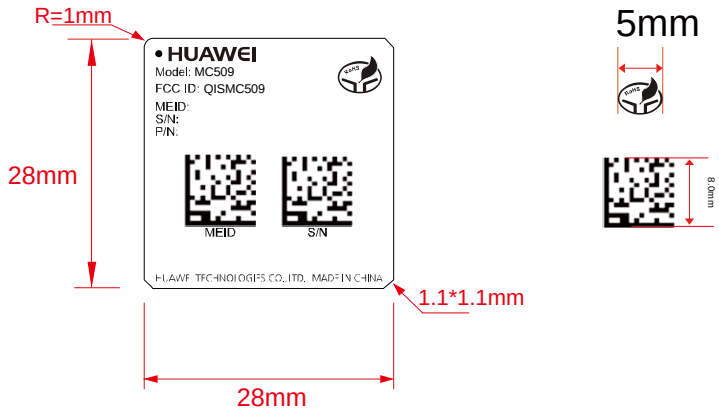
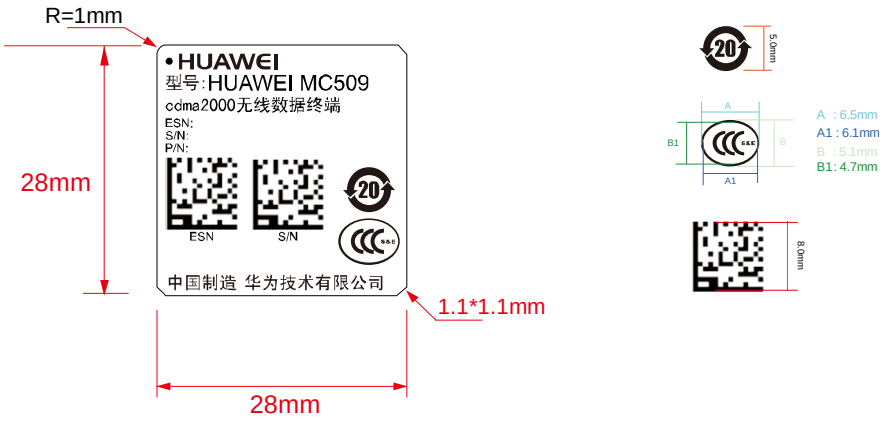


Figure 6-4 Label for MC509-a



NOTE

- The picture mentioned above is only for reference.
- Make the film according to the drawing.
- The silk-screen should be clear, without burrs, and dimension should be accurate.
- This nameplate should not be covered by the film.
- 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 260ºC. And the color of the material of the nameplate can't change.

6.8 Customer PCB Design

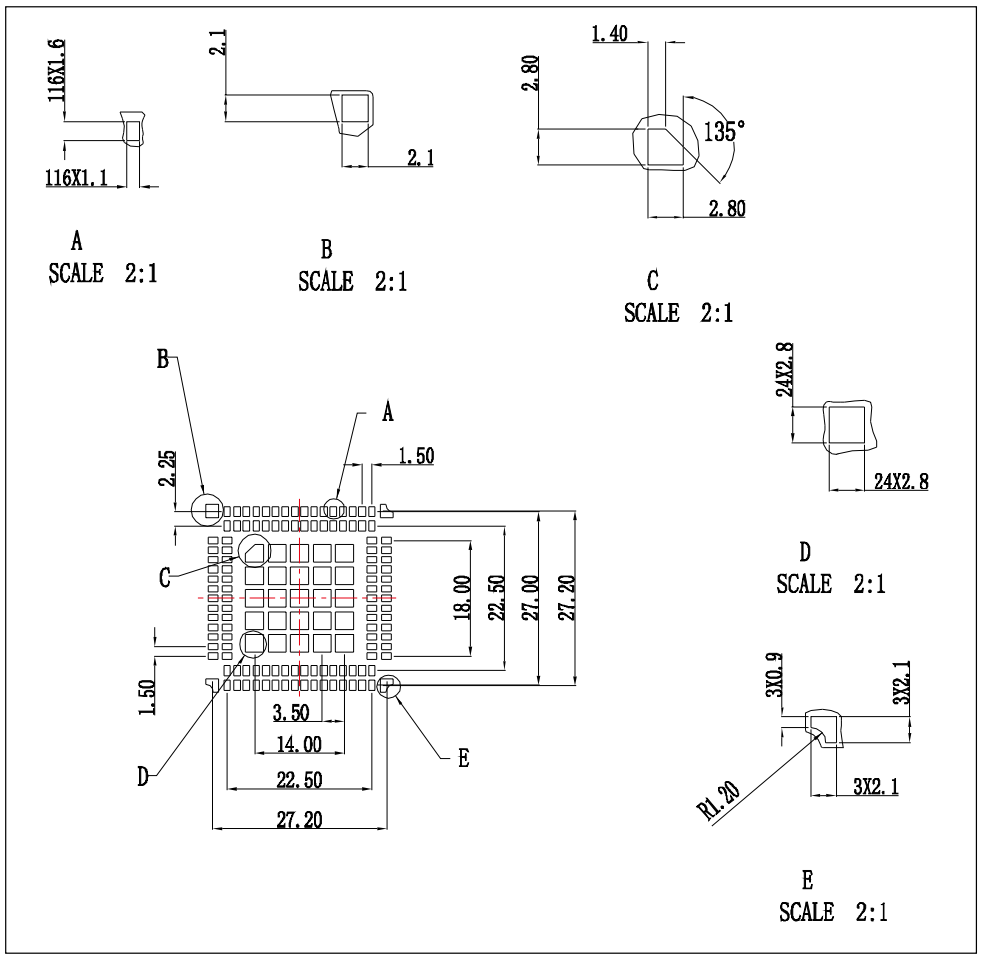
6.8.1 PCB Surface Finish

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

6.8.2 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 6-5 Design of the solder pads on customers' PCBs (Unit: mm)



6.8.3 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.

6.8.4 Requirements on PCB Layout

- To reduce deformation, a thickness of at least 1.0 mm is recommended.
- Other devices must be located more than 3 mm (5 mm recommended) away from the LGA module. The minimum distance between the LGA module and the PCB edge is 0.5 mm.

- When the PCB layout is double sided, 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.

6.9 Assembly Processes

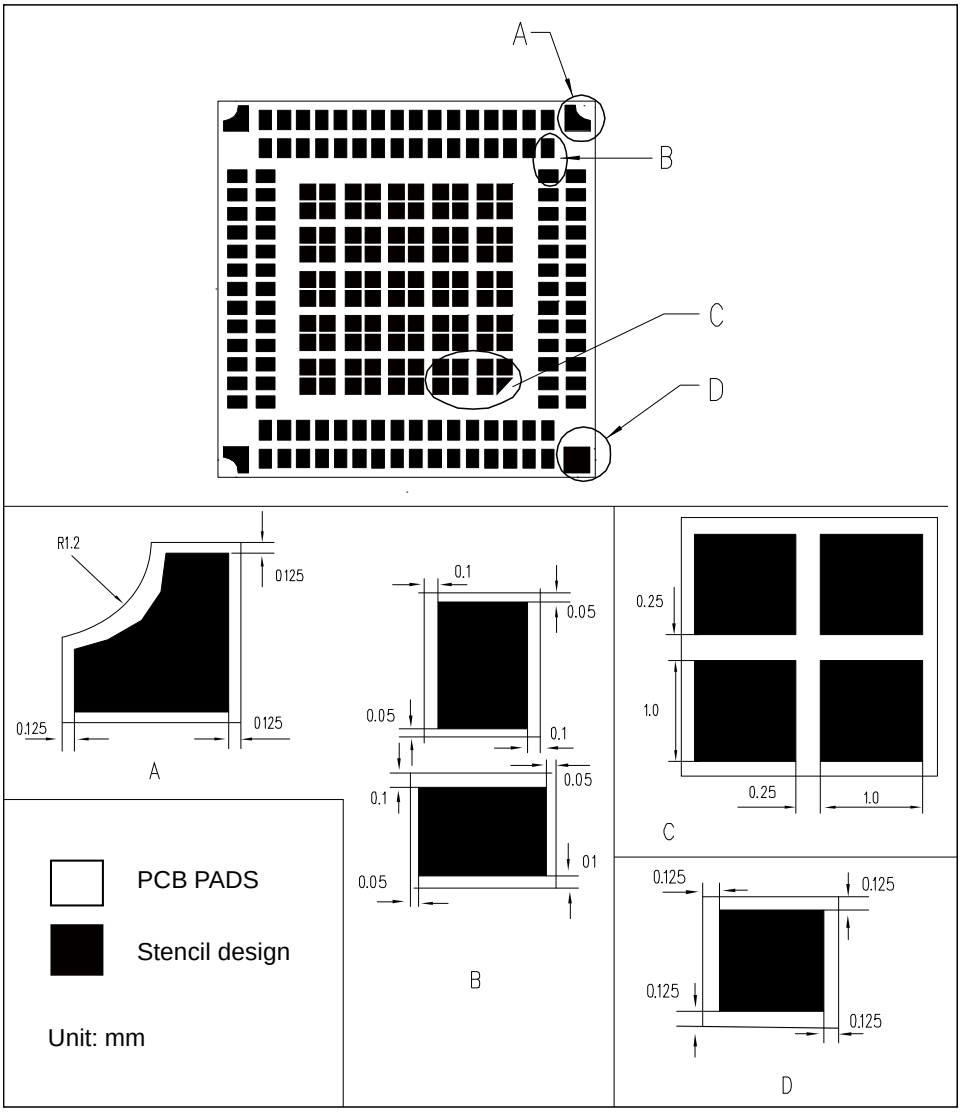
6.9.1 General Description of Assembly Processes

- 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.

6.9.2 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 6-6 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.

6.9.3 Reflow Profile

For the soldering temperature of the LGA module, see the following figure.

Figure 6-7 Reflow profile

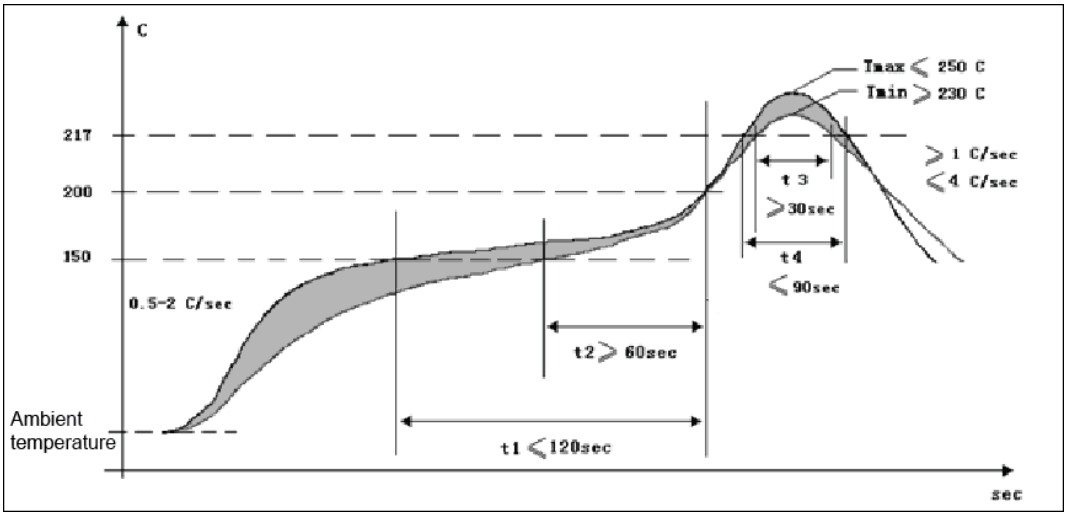
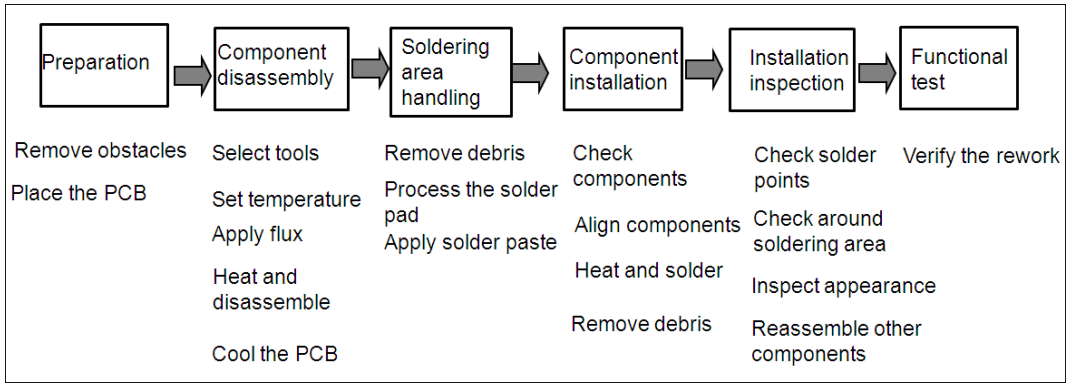


Table 6-2 Reflow parameters

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

6.10 Specification of Rework

6.10.1 Process of Rework



6.10.2 Preparations of Rework

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

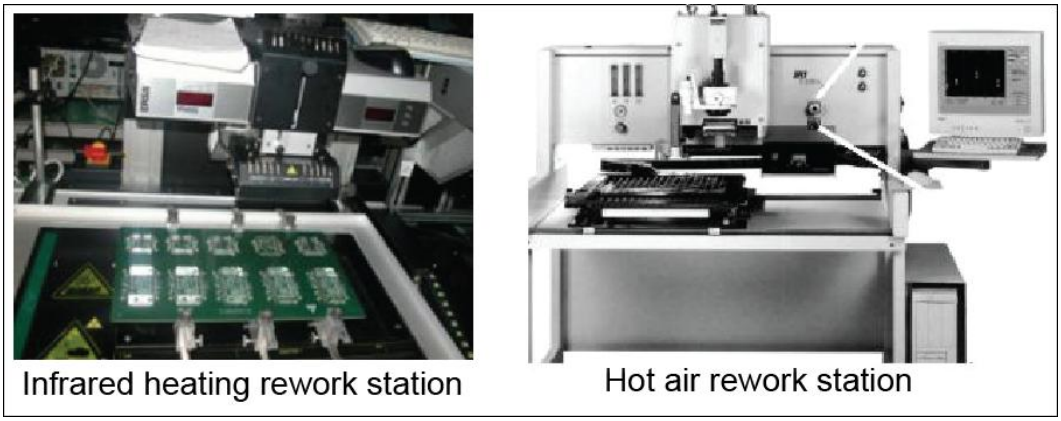
6.10.3 Removing of the Module

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 6-8 Equipment used for rework



6.10.4 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.

6.10.5 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).

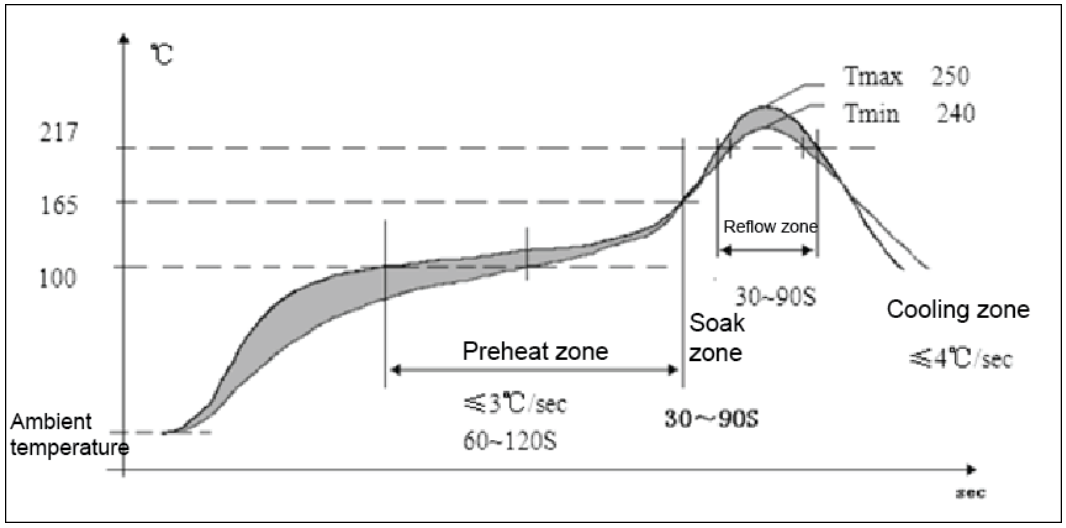
NOTE

- 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.

6.10.6 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 240ºC–250ºC. The following parameters are recommended during the rework.

Figure 6-9 Temperature graph of rework



7 Certifications

7.1 About This Chapter

This chapter gives a general description of certifications for MC509:

Table 7-1 Product Certifications

Certification	Model name	
	MC509	MC509-a
FCC	√	-
RoHS	√	-
CCC	√	√

NOTE
The model of MC509-a module for CCC certification is HUAWEI MC509.

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 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).

8.9 Laws and Regulations Observance

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

8.10 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.

8.11 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.

8.12 Regulatory Information

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

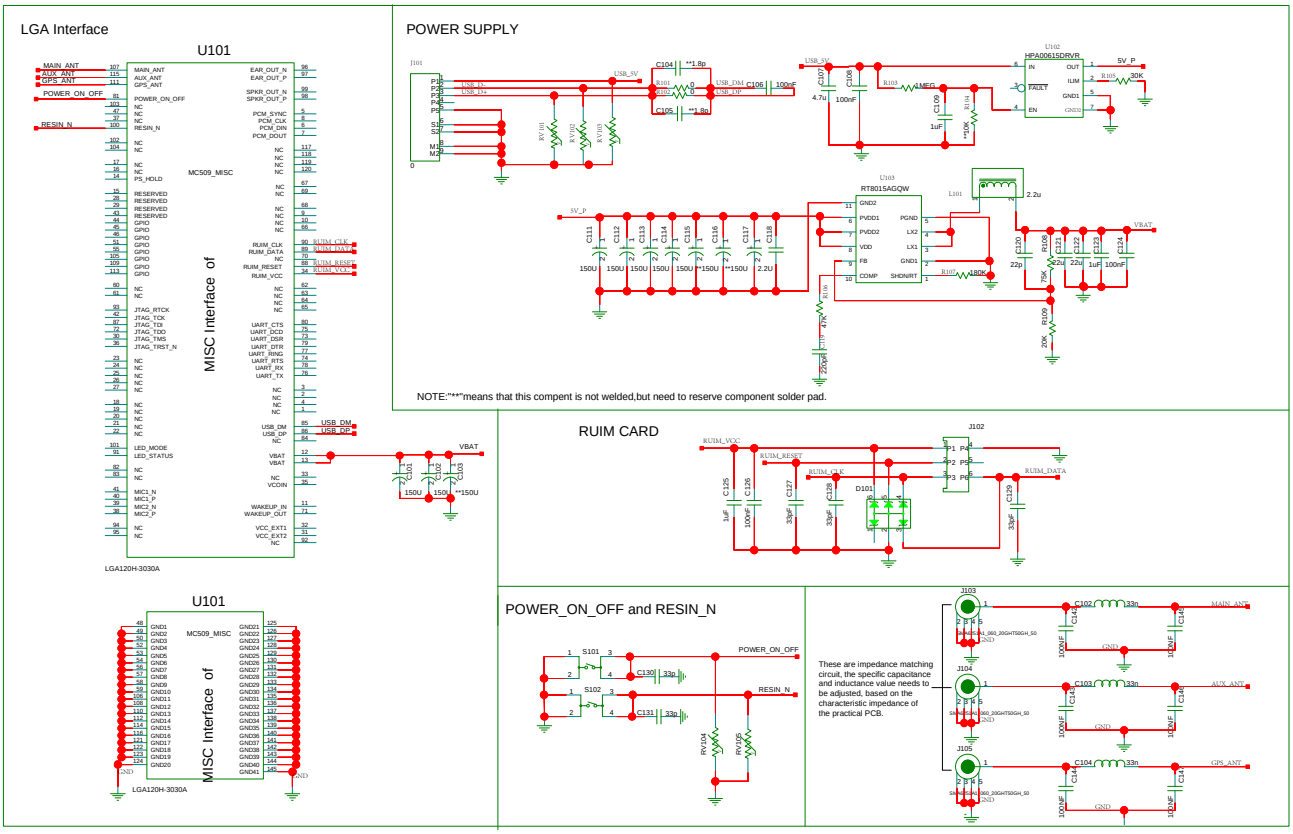
8.12.1 FCC Statement

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

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

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

9 Appendix A Circuit of Typical Interfaces



10 Appendix B Acronyms and Abbreviations

Acronym or Abbreviation	Expansion
ACLR	Adjacent Channel Leakage Power Radio
AMPS	Advanced Mobile Phone System
BB	Baseband
CDMA	Code-division Multiple Access
CE	European Conformity
CS	Coding Scheme
CSD	Circuit Switched Data
DC	Direct Current
DCCH	Dedicated Control Channel
DCE	Data Circuit-terminating Equipment
DMA	Direct Memory Access
DTE	Data Terminal Equipment
EACH	Enhanced Access Channel
EIA	Electronic Industries Association
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EVDO	Evolution Data Only
EVRC	Enhanced Variable Rate Coder
FCC	Federal Communications Commission
ISO	International Standards Organization

Acronym or Abbreviation	Expansion
LCP	Liquid Crystal Polyester
LDO	Low-dropout
LED	Light-emitting Diode
LNA	Low Noise Amplifier
LPF	Low Pass Filter
MCP	Multi-chip Package
NF	Noise Figure
NTC	Negative Temperature Coefficient
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PCM	Pulse Coded Modulation
PCS	Personal Communication System
PDU	Protocol Data Unit
PLL	Phase Lock Loop
RF	Radio Frequency
RoHS	Restriction of the use of certain Hazardous Substances
RTC	Real-time Clock
RUIM	Removable User Identity Module
Rx	Receive
SCH	Supplemental Channel
SYNCH	Sync Channel
TTL	Transistor-transistor Logic
TVS	Transient Voltage Suppressor
UDP	User Datagram Protocol
VSWR	Voltage Standing Wave Ratio