SIM8500E (Dual Band WIFI) Hardware Design

LTE Module

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Document Title:	SIM8500E (Dual Band WIFI) Hardware Design
Version:	V1.02
Date:	2022-11-25
Status:	Released

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Version History

Date	Version	Description of change	Author
2022-10-20	1.01	Original	Xiaobo Bai, Bing Li, Junfeng Zhang
2022-11-25	1.02	Modified the Power on sequence	Junfeng Zhang, Yujie Hou

Contents

Table Index

Figure Index

1 Introduction

SIM8500E (Dual Band WIFI) module is a smart module newly released by SIMCom Wireless Solutions Co., Ltd. This module has the Android operating system, and the customers could use it for the development of their hardware devices.

This document introduces the hardware interfaces of the SIM8500E (Dual Band WIFI) module. The users could quickly understand the definition of the interfaces, the electrical performance, and the die size of the module. Notice that SIM8500x series modules support different radio frequency (RF) range, different memory capacity, and different software version, etc. Please consult the local sales for more detailed information if needed.

1.1 Product Outline

SIM8500E (Dual Band WIFI) series module is a 4G Android smart module developing by the platform of Spreadtrum. It is a 4-Core customized ARM Cortex-A53. It's high performance basic frequency is up to 1.4GHz. SIM8500E (Dual Band WIFI) series module has abundant multi-media functions, including the 1080P@30 fps video codec, the 1440*720 single displaying screen, MIPI cameras, and the multi-channel analog- and digital-audio input and output. SIM8500E (Dual Band WIFI) series module supports multiple communication modes, including the GSM/GPRS/EDGE, the WCDMA, the LTE-FDD, and the LTE-TDD. It also supports the WiFi 802.11 b/g/n, and the BT4.2 short range communication. For the satellite positioning system, SIM8500E (Dual Band WIFI) series module supports the GPS, the GLONASS, and the BEIDOU. In conclusion, SIM8500E (Dual Band WIFI) series module is a highly integrated product, which is widely applying to intelligent terminal devices in the field of the Internet of Things(IOT).

Table 1 shows the frequency bands differences working on the SIM8500E (Dual Band WIFI) series module.

Table 1: SIM8500E (Dual Band WIFI) series module

General Frequency		SIM8500E	SIM8500E-W
CPU Frequency		1.4GHz	1.4GHz
Memory	RAM	1GB	1GB
	ROM	8GB	8GB
Standard & Frequency			
GSM	GSM850	✓	
	EGSM900	✓	

	DCS1800	✓	
	PCS1900	✓	
WCDMA	B1	✓	
	B2	✓	
	B5	✓	
	B8	✓	
FDD-LTE	B1	✓	
	B3	✓	
	B5	✓	
	B7	✓	
	B8	✓	
	B20	✓	
	B28A	✓	
	B28B	✓	
	B38	✓	
	B40	✓	
	B41	✓	
WLAN	2.4G：802.11b/g/n	✓	✓
	5G：802.11a/ac	✓	✓
BT	BT 4.2 + BR/EDR + BLE	✓	✓
GNSS	GPS	✓	
	GLONASS	✓	
	BEIDOU	✓	

1.2 Functional Overview

Table 2: General features

Feature	Description
Processor	Customized 4-Core ARM Cortex-A53 application processor High Performance frequency up to 1.4GHz 32KB L1 I-cache, 32 KB L1 D-cache, 256 KB L2 cache
Memory	LPDDR3 32-Bit BUS, Highest working frequency 667MHz Built-in eMMC 5.1 NAND Flash, Refer to the Table 1 for memory capacity, Default configuration: 8GB eMMC + 1GB LPDDR3, Selectable configuration: 16GB eMMC + 2GB LPDDR3
SD	SDC2 external interface supports SD3.0 TF card (Maximum 128G), hot-join

	support
GPU	Support Mali-T820 MP1 GPU, Performance frequency up to 680MHz
Operation System	Support Android 10.0
System Upgrade	Upgrade via USB interface, support forced download, support OTA upgrading
Power Supply	Voltage range: 3.4V~4.2V, support single-cell lithium battery power supply
Charge	Internal integrated the charging management chip, maximum current is 0.9A
Display	One 4-Lane MIPI_DSI interface, the highest rate is up to 1.5Gbps/lane, the highest resolution is 1440*720, 60fps.
Camera	2-Lane MIPI_CSI interface, the highest rate is up to 1.5Gbps/lane Rear camera: 4-Lane MIPI, the highest resolution is up to 13MP Front camera: 4-Lane MIPI, the highest resolution is up to 8MP Selectable configuration: 4/2/2 three cameras
Video Codec	Coding: 1080P@30fps (H.264, MPEG4, H.263) Decoding: 1080P@30fps (H.264, MPEG4, VP8) Wireless display(Coding & Decoding): 720P@30fps decode & 1080P@30fps encode
Audio	1-Channel Digital Audio Interface I2S 3-Channel Analog Audio Input (External Bias for interface application) Master Microphone Headphone Microphone Denoise Microphone 3-Channel Analog Audio Output Headphone: Class AB Amplifier Stereo Output Handset: Class AB Amplifier Differential Output Speaker: Class D Amplifier Differential Output
Audio Codec	MP3, AAC, AAC+, AMR-NB
Speech Codec	GSM-FR、GSM-EFR、GSM-HR; AMR-NB、AMR-WB; EVS-NB、EVS-WB、EVS-SWB
USB	Support 2-Lane USB 2.0 1-Lane USB support OTG (External 5V Power) 1-Lane USB Host for the extensive USB Hub
UART	Support up to 2 Serial Ports UART0: 4-Lane Serial Port, support RTS, CTS hardware flow control, the highest rate is up to 3.25Mbps UART1 (DEBUG): 2-Lane Serial Port, only for debug UART2: 2-Lane Serial Port (Do not support UART0 / UART2 at the same time)
I2C	Support up to four I2C for touch screen, camera, sensor and other peripherals
SPI	Support up to three SPI interfaces for peripherals

UIM Card	Support Dual Card Dual Standby: 1.8V/3V Dual Voltage Adaptive
Power Level	GSM900: Power Class 4 (33 dBm ±2 dB) DCS1800: Power Class 1 (30 dBm ±2 dB) WCDMA/HSPA+: Power Class 3 (23 dBm + 1/-3 dB) LTE: Power Class 3 (23 dBm ±2 dB)
LTE Features	Support 3GPP R10 CAT4 FDD and TDD Support 1.4 to 20 MHz RF Bandwidth Support Downstream 2x2 MIMO FDD: the maximum 150Mbps(DL) / the maximum 50Mbps(UL) TDD: the maximum 100Mbps(DL) / the maximum 30Mbps(UL)
UMTS Features	Support 3GPP R9 HSDPA/HSUPA/WCDMA Support 16-QAM, 64-QAM and QPSK modulation HSDPA: maximum 21Mbps(DL) HSUPA: maximum 11Mbps(UL) WCDMA: maximum 384Kbps(DL) / maximum 384bps(UL)
GSM Features	R99: CSD: 9.6Kbps, 14.4Kbps GPRS: Support GPRS Multi-Slot Level 33(Default 33) Coding format: CS-1, CS-2, CS-3, and CS-4 Maximum 85.6Kbps(UL) / Maximum 107Kbps(DL) EDGE: Support EDGE Multi-Slot Level 33(Default 33) Support GMSK and 8-PSK modulation and coding Methods Downlink Coding Format: MCS 1-9 Uplink Coding Format: MCS 1-9 The maximum 236.8Kbps(UL) / The maximum 296Kbps(DL)
WLAN Features	Support AP Mode & STA Mode Support 2.4G / 5G Frequency Range, Support 802.11 a/b/g/n/ac
BT Features	BT2.1 + EDR / 3.0 / 4.1 LE / 4.2 BLE
Satellite Positioning	GPS + GLONASS or GPS + BEIDOU Sensitivity: Tracking & Navigating: -158dBm, Recapturing: -156dBm, Cold Booting: -150dBm, TTFF@-130dBM: Hot Booting < 5s, Warm Booting < 15s, Cold Booting < 30s, CNo: 39.5dB/Hz @ -130dBm
Antenna Interface	MAIN antenna, DRX antenna, GNSS antenna, WIFI/BT antenna
Temperature	Operation Temperature: -35℃~ +75℃ Storage Temperature: -40℃~ +90℃
Physical Size	Size: 40.5 (±0.2) * 40.5 (±0.2) * 2.8 (±0.2) mm Package: LCC + LGA Weight: 10.6g

2 Package Information

2.1 Hardware Block Diagram

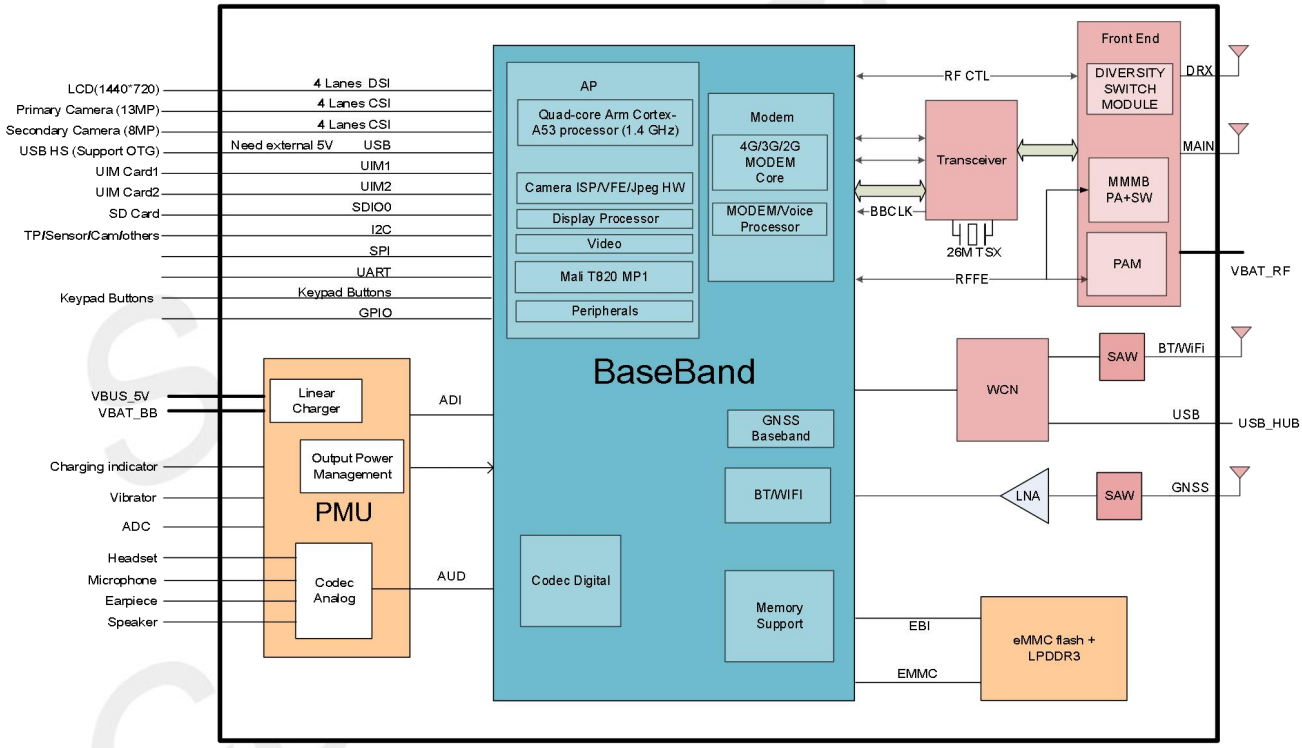


Figure 1: Module Block Diagram

2.2 Pin Assignment Overview

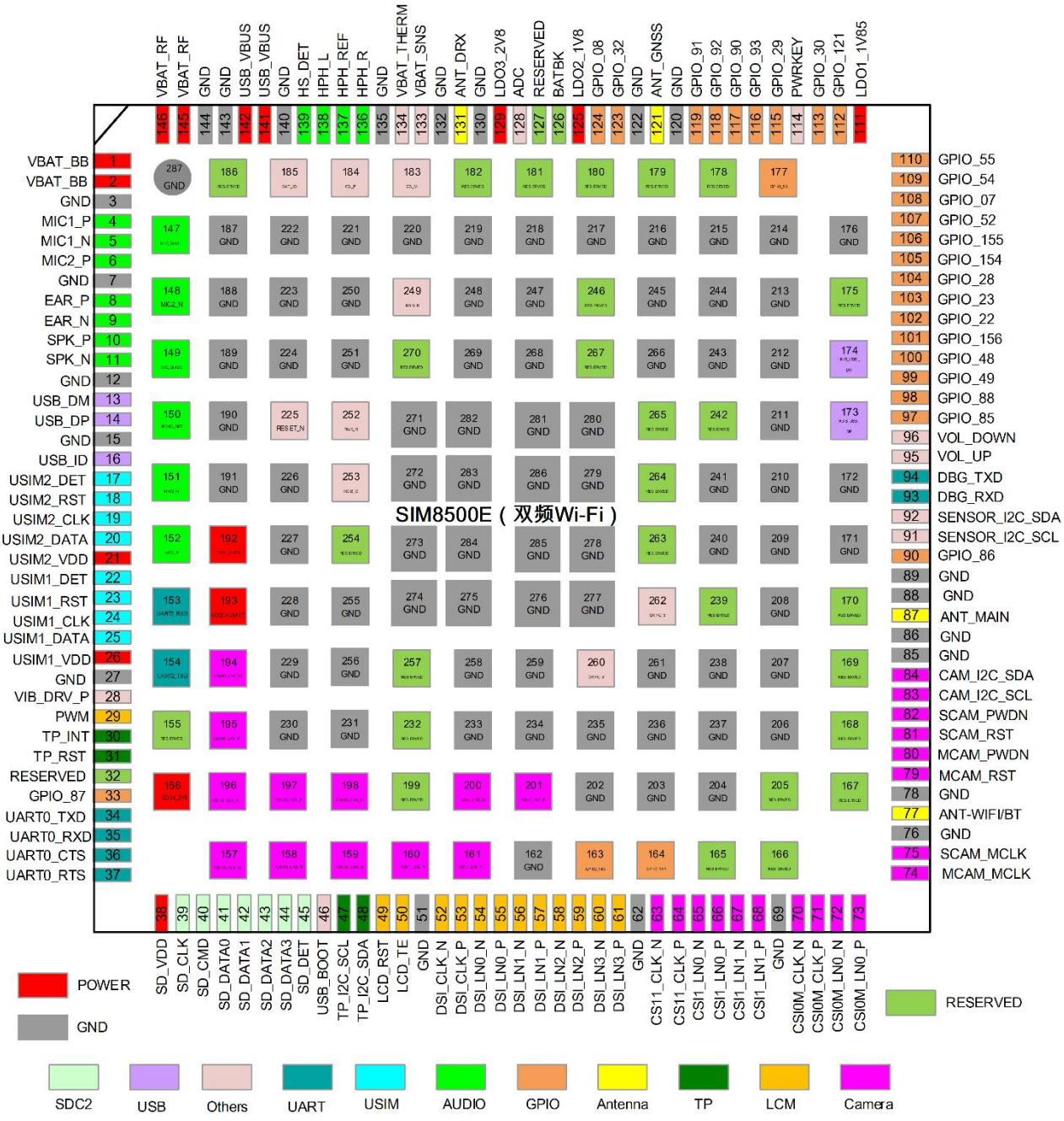


Figure 2: Pin Assignment Overview

2.3 PIN Description

Table 3: Defination of the I/O Parameters

Symble	Description
PIN Properties	
PI	Power Input
PO	Power Output
AI	Analog Input
AO	Analog Output
DI	Digital Input
DO	Digital Output
Digital Interface Pull Up and Pull Down	
NP	No Pull Up or No Pull Down
PU	Pull Up
PD	Pull Down

Table 4: Pin Properties

PIN Num	PIN Name	Voltage Range	QCM6125 PIN	Reset Status	Wakeup Interrupt	Notes
1	VBAT_BB	3.5~4.2V				
2	VBAT_BB	3.5~4.2V				
3	GND					
4	MIC1_P					
5	MIC1_N					
6	MIC2_P					
7	GND					
8	EAR_P					
9	EAR_N					
10	SPK_P					
11	SPK_N					
12	GND					
13	USB_DM					
14	USB_DP					
15	GND					
16	USB_ID	1.85 V	GPIO_126		EXTINT4	

17	USIM2_DET	1.85 V	GPIO_9			
18	USIM2_RST	1.8/3V	GPIO_162			
19	USIM2_CLK	1.8/3V	GPIO_160			
20	USIM2_DATA	1.8/3V	GPIO_161			
21	USIM2_VDD	1.8/3V				
22	USIM1_DET	1.85V	GPIO_31			
23	USIM1_RST	1.8/3V	GPIO_159			
24	USIM1_CLK	1.8/3V	GPIO_157			
25	USIM1_DATA	1.8/3V	GPIO_158			
26	USIM1_VDD	1.8/3V				
27	GND					
28	VIB_DRV_P	1.8-3.3V				
29	PWM		GPIO_123			
30	TP_INT	1.8V	GPIO_144		EXTINT0	
31	TP_RST	1.8V	GPIO_145		EXTINT1	
32	RESERVED					
33	GPIO_87	1.8V	GPIO_87			
34	UART0_TXD	1.8V	GPIO_60			
35	UART0_RXD	1.8V	GPIO_61			
36	UART0_CTS	1.8V	GPIO_62			
37	UART0_RTS	1.8V	GPIO_63			
38	SD_VDD	3V				
39	SD_CLK	1.8/3V	GPIO_153	DO		
40	SD_CMD	1.8/3V	GPIO_150	DO		
41	SD_DATA0	1.8/3V	GPIO_151	B		
42	SD_DATA1	1.8/3V	GPIO_152	B		
43	SD_DATA2	1.8/3V	GPIO_149	B		
44	SD_DATA3	1.8/3V	GPIO_148	B		
45	SD_DET	1.85V	GPIO_78	DI	EXTINT9	
46	USB_BOOT	1.85V		DI		
47	TP_I2C_SCL	1.85V	GPIO_146	DO		
48	TP_I2C_SDA	1.85V	GPIO_147	B		
49	LCD_RST	1.85V	GPIO_50			
50	LCD_TE	1.85V	GPIO_51			
51	GND					
52	DSI_CLK_N					
53	DSI_CLK_P					
54	DSI_LN0_N					
55	DSI_LN0_P					
56	DSI_LN1_N					
57	DSI_LN1_P					

58	DSI_LN2_N					
59	DSI_LN2_P					
60	DSI_LN3_N					
61	DSI_LN3_P					
62	GND					
63	CSI1_CLK_N					
64	CSI1_CLK_P					
65	CSI1_LN0_N					
66	CSI1_LN0_P					
67	CSI1_LN1_N					
68	CSI1_LN1_P					
69	GND					
70	CSI0M_CLK_N					
71	CSI0M_CLK_P					
72	CSI0M_LN0_N					
73	CSI0M_LN0_P					
74	MCAM_MCLK	1.85V		DO		
75	SCAM_MCLK	1.85V	GPIO_43	DO		
76	GND					
77	ANT_WIF/BT					
78	GND					
79	MCAM_RST	1.85V	GPIO_44			
80	MCAM_PWDN	1.85V	GPIO_46			
81	SCAM_RST	1.85V	GPIO_41			
82	SCAM_PWDN	1.85V	GPIO_40			
83	CAM_I2C_SCL	1.85V	GPIO_74			
84	CAM_I2C_SDA	1.85V	GPIO_75			
85	GND					
86	GND					
87	ANT_MAIN					
88	GND					
89	GND					
90	GPIO_86	1.85V	GPIO_86			
91	SENSOR_I2C_SCL	1.85V	GPIO_127			
92	SENSOR_I2C_SDA	1.85V	GPIO_128			
93	DBG_RXD	1.85V	GPIO_71			
94	DBG_TXD	1.85V				
95	VOL_UP	1.85V	GPIO_89			
96	VOL_DOWN	1.85V				
97	GPIO_85	1.85V	GPIO_85			
98	GPIO_88	1.85V	GPIO_88			

99	GPIO_49	1.85V	GPIO_49			
100	GPIO_48	1.85V	GPIO_48			
101	GPIO_156	1.85V	GPIO_156			
102	GPIO_22	1.85V	GPIO_22			
103	GPIO_23	1.85V	GPIO_23			
104	GPIO_28	1.85V	GPIO_28			
105	GPIO_154	1.85V	GPIO_154			
106	GPIO_155	1.85V	GPIO_155			
107	GPIO_52	1.85V	GPIO_52			
108	GPIO_07	1.85V	GPIO_07			
109	GPIO_54	1.85V	GPIO_54			
110	GPIO_55	1.85V	GPIO_55			
111	LDO1_1V85	1.85V				
112	GPIO_121	1.85V	GPIO_121		EXTINT11	
113	GPIO_30	1.85V	GPIO_30			
114	PWRKEY	3.5~4.2V		DI		
115	GPIO_29	1.85V	GPIO_29			
116	GPIO_93	1.85V	GPIO_93		EXTINT8	
117	GPIO_90	1.85V	GPIO_90		EXTINT5	
118	GPIO_92	1.85V	GPIO_92		EXTINT7	
119	GPIO_91	1.85V	GPIO_91		EXTINT6	
120	GND					
121	ANT_GNSS					
122	GND					
123	GPIO_33	1.85V	GPIO_33			
124	GPIO_08	1.85V	GPIO_08			
125	LDO2_1V8	1.8V				
126	BATBK					
127	RESERVED					
128	ADC	0-1.2V				
129	LDO3_2V8	2.8V				
130	GND					
131	ANT_DRX					
132	GND					
133	BAT_SNS	4.5V				
134	VBAT_THERM					
135	GND					
136	HPH_R					
137	HPH_REF					
138	HPH_L					
139	HS_DET					

140	GND					
141	USB_VBUS	5V				
142	USB_VBUS	5V				
143	GND					
144	GND					
145	VBAT_RF	3.5~4.2V				
146	VBAT_RF	3.5~4.2V				
147	MIC_BIAS1	2.2~3V				
148	MIC2_N					
149	MIC_BIAS2	2.2~3V				
150	HPMIC_DET					
151	MIC3_N					
152	MIC3_P					
153	UART2_RXD	1.85V	GPIO_73			
154	UART2_TXD	1.85V	GPIO_72			
155	RESERVED					
156	LDO4_2V8	2.8V				
157	CSI0S_CLK_N					
158	CSI0S_LN2_N					
159	CSI0S_LN3_N					
160	CSI1_LN2_N					
161	CSI1_LN2_P					
162	GND					
163	GPIO_143	1.85V	GPIO_143			
164	GPIO_141	1.85V	GPIO_141			
165	RESERVED					
166	RESERVED					
167	RESERVED					
168	RESERVED					
169	RESERVED					
170	RESERVED					
171	GND					
172	GND					
173	HUB_USB_DP					
174	HUB_USB_DM					
175	RESERVED					
176	GND					
177	GPIO_53	1.85V	GPIO_53			
178	RESERVED					
179	RESERVED					
180	RESERVED					

181	RESERVED					
182	RESERVED					
183	CS_M					
184	CS_P					
185	BAT_ID	0-1.2V				
186	CHG_EN					
187	GND					
188	GND					
189	GND					
190	GND					
191	GND					
192	VDDCAMCORE	1-1.4V				
193	VDDCAMMOT					
194	CSI0M_LN1_N					
195	CSI0M_LN1_P					
196	CSI0S_CLK_P					
197	CSI0S_LN2_P					
198	CSI0S_LN3_P					
199	RESERVED					
200	CSI1_LN3_N					
201	CSI1_LN3_P					
202	GND					
203	GND					
204	GND					
205	RESERVED					
206	GND					
207	GND					
208	GND					
209	GND					
210	GND					
211	GND					
212	GND					
213	GND					
214	GND					
215	GND					
216	GND					
217	GND					
218	GND					
219	GND					
220	GND					
221	GND					

222	GND					
223	GND					
224	GND					
225	RESET_N					
226	GND					
227	GND					
228	GND					
229	GND					
230	GND					
231	GND					
232	RESERVED					
233	GND					
234	GND					
235	GND					
236	GND					
237	GND					
238	GND					
239	RESERVED					
240	GND					
241	GND					
242	RESERVED					
243	GND					
244	GND					
245	GND					
246	RESERVED					
247	GND					
248	GND					
249	RGB_B					
250	GND					
251	GND					
252	RGB_R					
253	RGB_G					
254	RESERVED					
255	GND					
256	GND					
257	RESERVED					
258	GND					
259	GND					
260	GRFC_8	1.85V	GPIO_27			
261	GND					
262	GRFC_5	1.85V	GPIO_24			

263	RESERVED					
264	RESERVED					
265	RESERVED					
266	GND					
267	RESERVED					
268	GND					
269	GND					
270	RESERVED					
271	GND					
272	GND					
273	GND					
274	GND					
275	GND					
276	GND					
277	GND					
278	GND					
279	GND					
280	GND					
281	GND					
282	GND					
283	GND					
284	GND					
285	GND					
286	GND					
287	GND					

Table 5: Pin Description

PIN Name	PIN Num	I/O	Description	Notes
Power Supply				
VBAT_BB	1,2	PI/PO	BB Power	Maximum Current 3A, Highly recommend increasing the power of the diode to prevent the surge and the static electricity.
VBAT_RF	145,146	PI	RF Power	
LDO1_1V85	111	PO	1.85V@100mA LDO	Only for the I/O pull up and the voltage switch, not for the external power supply.
LDO2_1V8	125	PO	1.8V@200mA LDO	External Power Supply, Highly recommend a capacitor of 2.2-4.7uF parallel connection,

				suspend if no connection.
LDO3_2V8	129	PO	2.8V@150mA LDO	External Power Supply, Highly recommend a capacitor of 2.2-4.7uF parallel connection, suspend if no connection.
LDO4_2V8	156	PO	2.8V@200mA LDO	External Power Supply, Highly recommend a capacitor of 2.2-4.7uF parallel connection, suspend if no connection.
CAM_DVDD	192	PO	1.2V@400mA LDO	External Power Supply, Highly recommend a capacitor of 2.2-4.7uF parallel connection, suspend if no connection.
VDDCAMMOT	193	PO	2.8V@100mA LDO	External Power Supply, Highly recommend a capacitor of 2.2-4.7uF parallel connection, suspend if no connection.
BATBK	126	PI/PO	RTC Power Supply Input	Suspend if no connection.
Ground				
GND	3、7、12、15、27、51、62、69、76、78、85、86、88、89、120、122、130、132、135、140、143、144、162、171、172、176、187、188、189、190、191、202、203、204、206、207、208、209、210、211、212、213、214、215、216、217、218、219、220、221、222、223、224、226、227、228、229、230、231、233、234、235、236、237、238、240、241、243、244、245、247、248、250、251、255、256、258、259、261、266、268、269、271、272、273、274、275、276、277、278、279、280、281、282、283、284、285、286、287		GND	
USB Interface				
USB_ VBUS	141,142	PI	VBUS Power Input	USB Power Input & USB Power Detection
USB_DM	13	I/O	USB_HS Differential Signal	Require 90+-10% impedance control
USB_DP	14	I/O		
USB _ID	16	DI	USB ID	Default High Voltage
USB_CCA	169	I/O	Type-C Interface Pin	Type-C CC1

USB_CCB	170	I/O		Type-C CC2
HUB_USB_DP	173	I/O	HUB_USB_HS Differential Signal	Require 90+-10% impedance control
HUB_USB_DM	174	I/O		
UIM Card Interface				
USIM2_DET	17	DI	SIM Card2 insert detecting signal, Active Low when inserting the SIM Card	1.8V Voltage Range, SIM Card detect pin is low active by default, Highly recommend connecting to the ground with a 1KR resistor if no connection.
USIM2_RST	18	DO	SIM Card2 Reset Signal	Do not use these signals as configurable GPIO
USIM2_CLK	19	DO	SIM Card2 Clock Signal	
USIM2_DATA	20	DI/DO	SIM Card2 Data Signal	
USIM2_VDD	21	PO	Output for SIM Card2 Power Supply, 1.8V/3V Dual Voltage	Voltage Adaption
USIM1_DET	22	DI	SIM Card1 insert detecting signal, Active Low when inserting the SIM Card	1.8V Voltage Range, SIM Card detect pin is low active by default, Highly recommend connecting to the ground with a 1KR resistor if no connection.
USIM1_RST	23	DO	SIM Card1 Reset Signal	Do not use these signals as configurable GPIO
USIM1_CLK	24	DO	SIM Card1 Clock Signal	
USIM1_DATA	25	DI/DO	SIM Card1 Data Signal	
USIM1_VDD	26	PO	Output for SIM Card2 Power Supply, 1.8V/3V Dual Voltage	Voltage Adaption
SDIO/SD Card Interface				
SD_VDD	38	PO	Power Output for SD VDD, Typical Voltage 3V, Maximum Output Current 400mA	Routing lines in PCB requires an 1A standard if supporting the SD, Highly recommend an external capacitor of 2.2uF parallel connection.
SD_CLK	39	DO	SDIO Clock	The SDIO signal line needs to go through the impedance lines with the value at 50 ohm ± 10%.
SD_CMD	40	DI/DO	SDIO Commend	
SD_DATA0	41	DI/DO	SDIO Data0	
SD_DATA1	42	DI/DO	SDIO Data1	
SD_DATA2	43	DI/DO	SDIO Data2	
SD_DATA3	44	DI/DO	SDIO Data3	
SD_DET	45	DI	SD Card insert detecting signal	Active Low when inserting the SD Card, Highly recommend connecting to the ground with a 1KR resistor if no connection.

Touching Panel Interface				
TP_I2C_SDA	48	DI/DO	TP I2C Data Signal	Internal Pull Up
TP_I2C_SCL	47	DO	TP I2C Clock Signal	
TP_INT	30	DI	TP Interruption Signal	1.85V Voltage Range, Configurable GPIO
TP_RST	31	DO	TP Reset Signal	1.85V Voltage Range, Active low when working, Configurable GPIO
Displaying Screen Interface				
PWM	29	DO	Output PWM Control for WLED Driver	1.85V Voltage Range, Configurable GPIO
LCD_RST	49	DO	LCD Reset Signal	1.85V Voltage Range, Configurable GPIO
LCD_TE	50	DI	LCD TE Signal	1.85V Voltage Range, Configurable GPIO
DSI_CLK_N	52	DO	LCD MIPI Signals	Require the value at 85 Ω ±15% for the differential impedance on the MIPI signal routings.
DSI_CLK_P	53	DO		
DSI_LN0_N	54	DO		
DSI_LN0_P	55	DO		
DSI_LN1_N	56	DO		
DSI_LN1_P	57	DO		
DSI_LN2_N	58	DO		
DSI_LN2_P	59	DO		
DSI_LN3_N	60	DO		
DSI_LN3_P	61	DO		
Camera Interface				
CS1I_CLK_N	63	DO	Rear Primary Camera MIPI Signals	Default Rear Camera, Require the value at 85 Ω ±15% for the differential impedance on the High-Speed MIPI signal routings.
CSI1_CLK_P	64	DO		
CSI1_LN0_N	65	DI		
CSI1_LN0_P	66	DI		
CSI1_LN1_N	67	DI		
CSI1_LN1_P	68	DI		
CSI1_LN2_N	160	DI		
CSI1_LN2_P	161	DI		
CSI1_LN3_N	200	DI		
CSI1_LN3_P	201	DI		
CSI0M_CLK_N	70	DO	Front Camera MIPI Signals	Default Front Camera, Require the value at 85 Ω ±15% for the differential impedance on the High-Speed MIPI signal routings.
CSI0M_CLK_P	71	DO		
CSI0M_LN0_N	72	DI		
CSI0M_LN0_P	73	DI		
CSI0M_LN1_N	194	DI		
CSI0M_LN1_P	195	DI		

CSI0S_CLK_N	157	DO	Rear Secondary Camera MIPI Signals	Default 2nd Rear Camera, Require the value at 85 Ω ±15% for the differential impedance on the High-Speed MIPI signal routings.
CSI0S_CLK_P	196	DO		
CSI0S_LN2_N	158	DI		
CSI0S_LN2_P	197	DI		
CSI0S_LN3_N	159	DI		
CSI0S_LN3_P	198	DI		
MCAM_MCLK	74	DO	Rear 1st Camera Clock	
SCAM_MCLK	75	DO	Front Camera Clock	1.85V Voltage Range, Configurable GPIO
MCAM_RST	79	DO	Rear 1st Camera Reset	
MCAM_PWDN	80	DO	Rear 1st Camera Power Down	
SCAM_RST	81	DO	Front Camera Reset	
SCAM_PWDN	82	DO	Front Camera Power Down	
CAM2_RST	164	DO	Rear 2nd Camera Reset	
CAM2_PWDN	163	DO	Rear 2nd Camera Power Down	
CAM_I2C_SCL	83	DO	Camera I2C Clock	
CAM_I2C_SDA	84	DI/DO	Camera I2C Data	
Key Interface				
VOL_UP	95	DI	Volume Up Key	Avoid an external pull up, suspend if no connection.
VOL_DOWN	96	DI	Volume Down Key	Avoid an external pull up, suspend if no connection.
PWRKEY	114	DI	Power Key	
RESET_N	225	DI	Reset Key	Suspend if no connection.
Sensor Interface				
SENSOR_I2C_SCL	91	OD	Sensor I2C Clock Signal	1.85V Voltage Range, Configurable GPIO
SENSOR_I2C_SDA	92	OD	Sensor I2C Data Signal	
General I2C Interface				
I2C4_SDA	167	OD	General I2C Data Signal	1.85V Voltage Range
I2C4_SCL	168	OD	General I2C Clock Signal	1.85V Voltage Range
ADC Interface				
ADC	128	AI	Analog to Digital Signal	Maximum 1.2V Voltage
Audio Interface				
EAR_P	8	AO	Headphone Output Positive	
EAR_N	9	AO	Headphone Output Negative	
HPH_R	136	AO	Headphone Right-Channel	
HPH_REF	137	PI	Headphone Main Reference Ground	
HPH_L	138	AO	Headphone Left-Channel	
HS_DET	139	DI	Headphone Push-in Detect	High Voltage represents inserting the headphone,

				Low Voltage represents pulling out the headphone, Connect to the ground with a 1KR resistor when without using headphone.
MIC1_P	4	AI	Primary Microphone Input Positive	
MIC1_N	5	AI	Primary Microphone Input Negative	
MIC2_P	6	AI	Headphone Microphone Input Positive	
MIC2_N	148	AI	Headphone Microphone Input Negative	
MIC3_P	152	AI	Denoise Microphone Input Positive	
MIC3_N	151	AI	Denoise Microphone Input Negative	
SPK_P	10	AO	Speaker Positive	
SPK_N	11	AO	Speaker Negative	
MIC_BIAS1	147	PO	Microphone Bias Voltage	Voltage Range: 2.2~3V
MIC_BIAS2	149	PO	Microphone Bias Voltage	
HPMIC_DET	150	AI	Headphone Microphone Detection	
Radio Frequency Antenna Interface				
ANT_MAIN	87	AI/AO	2G/3G/4G Main Antenna Interface	
ANT_DRX	131	AI	3G/ 4G DRX Antenna Interface	
ANT_GNSS	121	AI	GNSS Antenna Interface	
ANT-WIFI/BT	77	AI/AO	WIFI/BT Antenna Interface	
UART Interface				
DBG_RXD	93	DI	Debug UART1 Data Receiver	Mainly for the module's Debugging
DBG_TXD	94	DO	Debug UART1 Data Transmitter	
UART0_TXD	34	DO	Debug UART0 Data Transmitter	1.85V Voltage Range, suspend if no connection. Note that UART0 and UART2 could not use at the same time.
UART0_RXD	35	DI	Debug UART0 Data Receiver	
UART0_CTS	36	DI	Debug UART0 Delete Transmitter	
UART0_RTS	37	DO	Debug UART0 Request Transmitter	
UART2_RXD	153	DI	Debug UART2 Data Receiver	
UART2_TXD	154	DO	Debug UART2 Data Transmitter	
GPIO				

GPIO_87	33	DI/DO	GPIO	
GPIO_86	90	DI/DO	GPIO	
GPIO_85	97	DI/DO	GPIO	
GPIO_88	98	DI/DO	GPIO	
GPIO_49	99	DI/DO	GPIO	
GPIO_48	100	DI/DO	GPIO	
GPIO_156	101	DI/DO	GPIO	
GPIO_22	102	DI/DO	GPIO	
GPIO_23	103	DI/DO	GPIO	
GPIO_28	104	DI/DO	GPIO	
GPIO_154	105	DI/DO	GPIO	
GPIO_155	106	DI/DO	GPIO	EXTINT11
GPIO_52	107	DI/DO	GPIO	
GPIO_07	108	DI/DO	GPIO	
GPIO_54	109	DI/DO	GPIO	
GPIO_55	110	DI/DO	GPIO	
GPIO_121	112	DI/DO	GPIO	EXTINT12
GPIO_30	113	DI/DO	GPIO	
GPIO_29	115	DI/DO	GPIO	EXTINT13
GPIO_93	116	DI/DO	GPIO	EXTINT8
GPIO_90	117	DI/DO	GPIO	EXTINT5
GPIO_92	118	DI/DO	GPIO	EXTINT7
GPIO_91	119	DI/DO	GPIO	EXTINT6
GPIO_32	123	DI/DO	GPIO	
GPIO_08	124	DI/DO	GPIO	
GPIO_53	177	DI/DO	GPIO	
GRFC Interface				
GRFC_8	260	DO	RF Control Output	Only for GRFC RF Antenna Control
GRFC_5	262	DO	RF Control Output	
Charging Interface				
BAT_SNS	133	AI	Battery Voltage Detection Pin	Maximum Voltage 4.5V. Do not suspend this PIN. Connecting to the VBAT_BB when no battery.
VBAT_THERM	134	AI	Battery Thermal Detect Pin	Avoid suspend, An external 10KR resistor pulling down to the ground if no connection.
CS_M	183	AI	Voltameter Detection Negative	Connect to the ground without connection.
CS_P	184	AI	Voltameter Detection Positive	
BAT_ID	185	AI	Battery ID Pin	Voltage Range: 0~1.2V,

				suspend if no connection
RGB LED Interface				
RGB_R	252	AI	LED Cathode	Maximum Current 20 mA
RGB_G	253	AI	LED Cathode	Maximum Current 20 mA
RGB_B	249	AI	LED Cathode	Maximum Current 20 mA
Other Interface				
USB_BOOT	46	DI	USB Forced Download	Forced connect to the ground before booting up.
VIB_DRV_P	28	PO	Motor Drive Positive Voltage Range: 1.8V-3.3V, Maximum Current: 100mA	Connect to the Motor Positive
Reserved Pins (NC)				
RESERVED	32、127、155、165、166、167、168、175、178、179、180、181、182、199、205、232、239、242、246、254、257、263、264、265、267、270		RESERVED	Suspend if no connection.

NOTE

1、 Highly recommend all the GND pins are connecting to the ground.
2、 Highly recommend all the RESERVED and the unused pins disconnected.

3 Interface Applications

3.1 Power Supply

The VBAT Input power range of the SIM8500E (Dual Band WIFI) module is 3.5V to 4.2V, and the typical voltage is 3.8V. The instantaneous peak current of the SIM8500E (Dual Band WIFI) module could reach 3A. So, to enable the module is running smoothly, the power supply should be able to provide the peak current up to 3A. If the power supply is designed improperly, there would be a large voltage drop on the VBAT. The shutdown voltage of the SIM8500E (Dual Band WIFI) module is 3.1V. If the voltage drop on the VBAT is lower than 3.1V, the module would power off.

3.1.1 Pin Overview

SIM8500E (Dual Band WIFI) series module supports a single lithium battery power supply (4.2V / 4.35V battery cell). It also supports the other types of batteries. But the maximum voltage could not exceed the maximum allowance voltage of the module. Otherwise, the module would be burned. In terms of the non-battery power supply applications, the module would power by an LDO when the DC input is up to 5V. The reference design is showing in Figure 3.

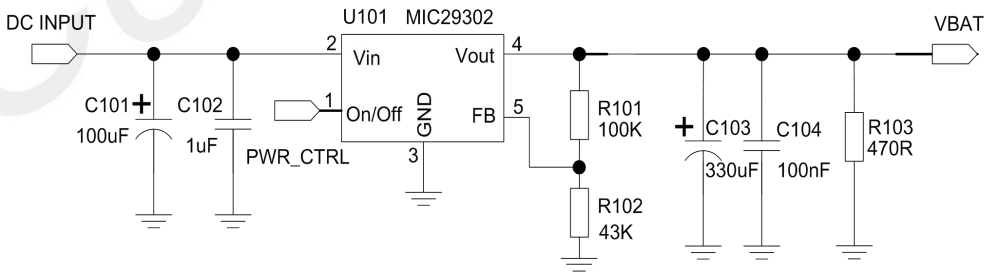


Figure 3: LDO Power Supply Reference Design

NOTE

Since the current consumption of the module is very small when powering off or sleeping. Highly recommend adding R103 as the minimum load to ensure the MIC29302 is working smoothly with the light load. Please refer to the MIC29302's specification for detailed information.

Highly recommend selecting a relative high efficiency switching power supply for hardware design when the difference between the input (DC Input) and the output (VBAT) is too large. The reference design is showing in Figure 4.

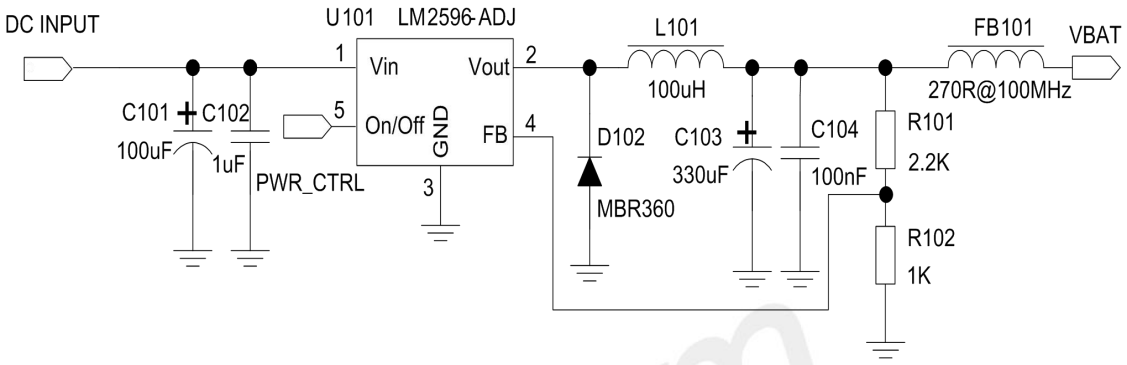


Figure 4: DC-DC Power Supply Reference Design

NOTE

1. Highly recommend disconnect the VBAT power supply to power off the module when the module is running abnormally. After that, restart the module by powering.
2. The module supports the charging function. There is a need to turn off the charging function in the software patch when the customers are using the power supply without the charging function. Or connect Schottky diodes in series on the VBAT channel to prevent the current anti-flowing into the chip.

3.1.2 Power Supply Stability Design

Highly recommend place bypass capacitors and voltage stabilizing components near the VBAT Pin to enhance the stability of the power supply. The reference design is showing in the Figure 5.

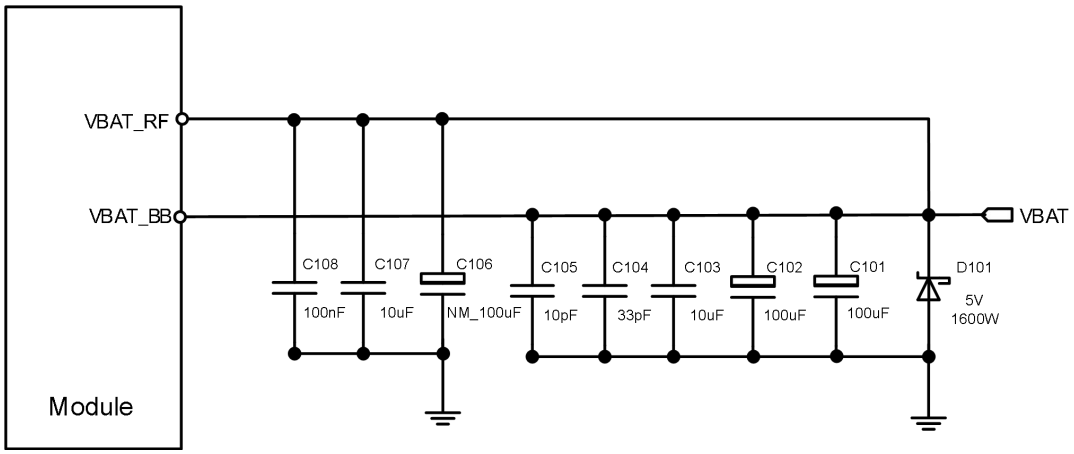


Figure 5: VBAT Input Reference Design

In Figure 5, C101 and C102 are two Low-ESR 100Uf tantalum capacitors. C103 is a 1uF to 10uF ceramic capacitor. The function of C104 and C105 is to decrease the high frequency interference. D101 is a 5V/1600W transient voltage suppression diode, preventing the chip from being damaged by surge. For PCB wiring, the capacitors and the diodes should be close to the VBAT Pin as far as possible, and the VBAT wiring should be as short as possible with the width at least 3mm.

Table 6: Recommended TVS Diode

	Vendor	Manufacture Number	Power(Watts)	Package
1	Prisemi	PTVSHC3N4V8U	3200W	DFN2×2-3L
2	Prisemi	PTVSHC2EN5VU	1600W	DFN1610-2L

3.2 Power On & Power Off

The on-off of the SIM8500E (Dual Band WIFI) series module has two status, including the normal on-off and the abnormal on-off. In terms of the high- and low-pressure, and the high- and low-temperature, it should be working within the maximum voltage range when running the module. Otherwise, exceeding the absolute maximum voltage range would cause permanent damage to the module.

3.2.1 Power On

PWRKEY Pin defines as the boot-up key when the VBAT is powering on, and triggering PWRKEY with at least 3s low-level pulse starts the module. PWRKEY Pin has internal pull-up, and the typical high-level voltage is 1.8V. The reference design is showing as below.

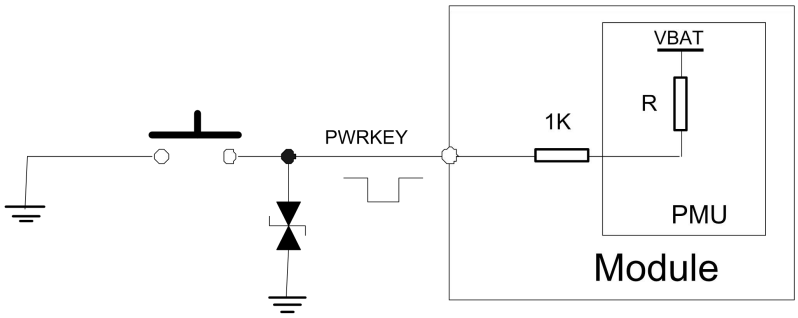


Figure 6: Power On/Off Design with a Key

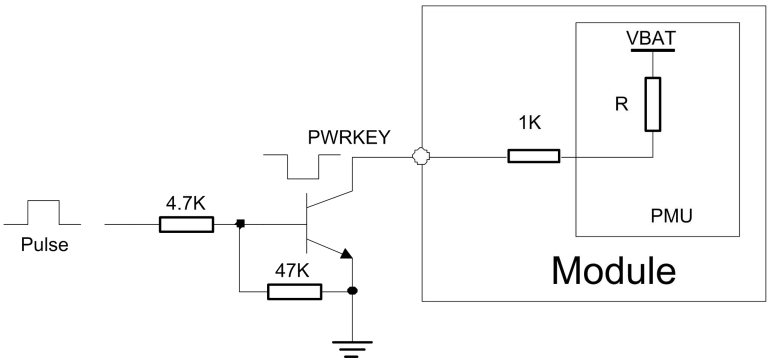


Figure 7: Power On/Off Design with an OC Gate

Highly recommend the customers consider the PWRKEY Pin's electrical characteristics when designing. The electrical characteristics are showing in Table 7.

Table 7: PWRKEY Features

Parameters	Description	Minimum	Typical	Maximum	Unit
V_{IH}	High-Level Input Voltage	1.4	-	-	V
V_{IL}	Low-Level Input Voltage	-	-	0.6	V

3.2.2 Power On Sequence

Figure 8 shows the power on sequence of the module.

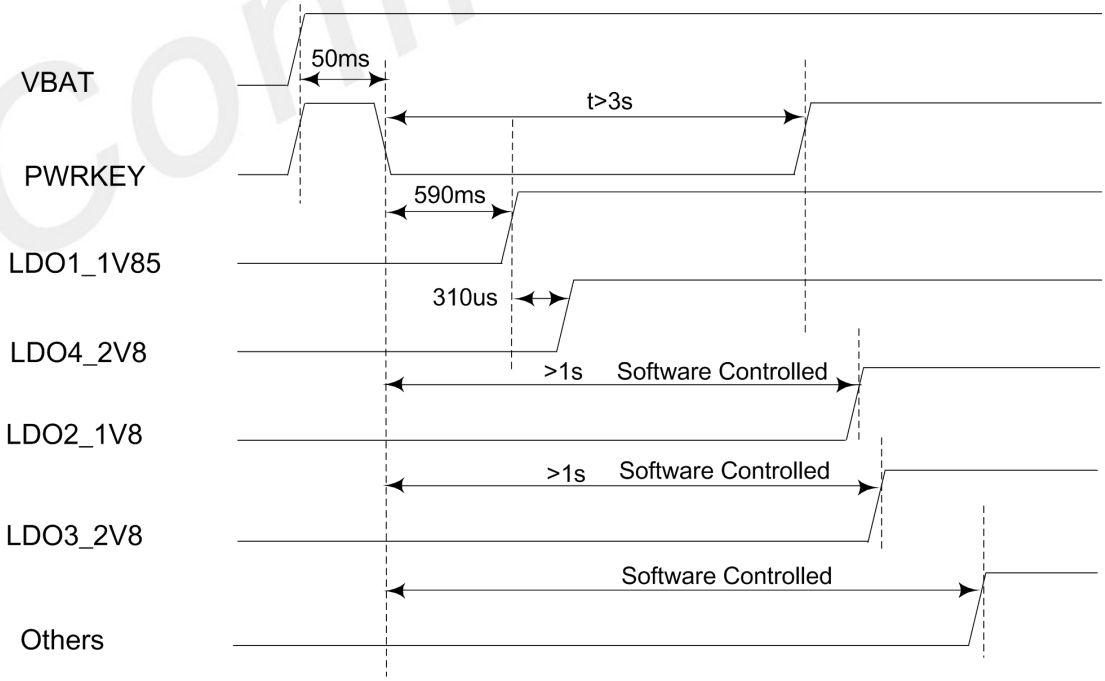


Figure 8: Power Sequence

NOTE

Highly recommend pulling down the PWRKEY Pin when booting up the VBAT voltage at 3.8V stabilizing for at least 50ms. Do not pull down the PWRKEY Pin all the time.

3.2.3 Power Off

Pull down the PWRKEY Pin with at least 1s to power off the module. There is a pop up prompt window confirming the action of shutting down the device when the module detects the control instructions. Apart from that, pulling down the PWRKEY Pin with over 8s would be forced restart the module.

Powering on and powering off are using the same pin, and they have the same reference design.

NOTE

1. The hardware design should cover the function of powering off the module. It is forbidden to run the module when powering off or restarting. Forced powering off the module adopts only when the module is running abnormally.
2. Highly recommend adding a low-cost microcontroller to control the PWRKEY. Not only for the normal powering on and powering off but also for the watchdog function to protect the operation system.
3. Do not cut off the VBAT power supply directly when the module is running smoothly. It is to protect the internal flash memory.
4. Highly recommend to power off the module by the PWRKEY Pin or the AT command before disconnecting the VBAT power supply.

3.3 Power Output

SIM8500E (Dual Band WIFI) series module has 12 power outputs in total, which are suitable for a wide range of external interfaces and peripherals. Highly recommend a capacitor of 33pF and a capacitor of 10pF parallel connection to the ground, which could prevent high-frequency interference effectively.

Table 8: Power Definition

Power Name	PIN Num	Output Voltage (V)	Rated Current (mA)	Default On	Description
LDO1_1V85	111	1.85	100	On	IOVDD(1.8V) Power and External GPIO pull up
LDO2_1V8	125	1.8	200	Off	Peripheral 1.8V Power
LDO3_2V8	129	2.8	150	Off	Camera AVDD and AFVDD LDO
LDO4_2V8	156	2.8	200	Off	TP AVDD and LCD AVDD2.8V Power
CAM_DVDD	192	1.2	400	Off	Camera DVDD LDO
SD_VDD	38	3	400	On	SD Card Power
USIM1_VDD	147	1.8/3	50	On	SIM Card1 Power
USIM2_VDD	149	1.8/3	50	On	SIM Card2 Power
CAM_DVDD	192	1.2	400	Off	Camera DVDD Power
VDDCAMMOT	193	2.8V	100	Off	Camera/Motor Power

3.4 USB Interface

SIM8500E (Dual Band WIFI) series module supports a USB interface, complying with USB 2.0 protocol and supporting USB OTG. It supports the function of the charging feature, of the data transmission, of the software debugging, and of the software upgrading.

Table 9: USB Interface Definition

PIN Name	PIN Num	Input/Output	Description	Note
USB_VBUS	141、142	PI	USB VBUS Power	Vmin=4.5V Vnorm=5.0V Vmax=9V
USB_DP	14	AI/AO	USB HS DP	With 90 Ω differential impedance
USB_DM	13	AI/AO	USB HS DN	
USB_CCA	169	I/O	Type-C Interface Pin	Type-C CC1
USB_CCB	170	I/O		Type-C CC2
HUB_USB_DP	173	AI/AO	USB HS DP	Only for USB Hub Host Mode
HUB_USB_DM	174	AI/AO	USB HS DN	
USB_ID	16	DI	USB ID Detect Signal	Default High Voltage, Floating when no connection

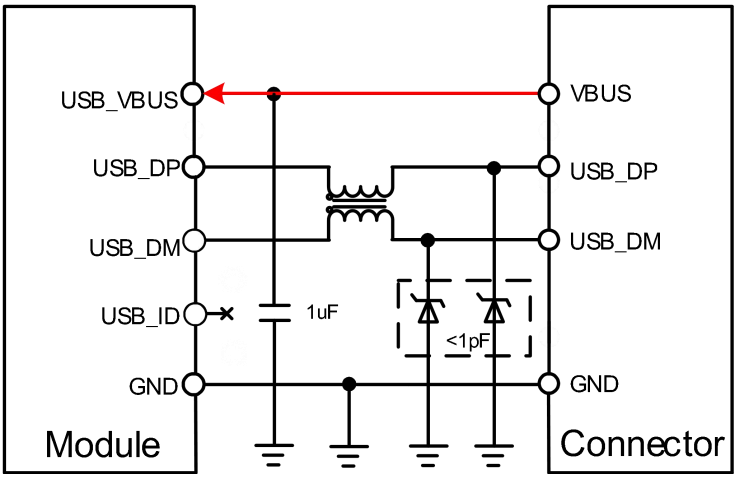


Figure 9: USB Connection Reference Design

SIM8500E (Dual Band WIFI) series module supports USB OTG function, there is a need of an external 5V power on the VBUS.

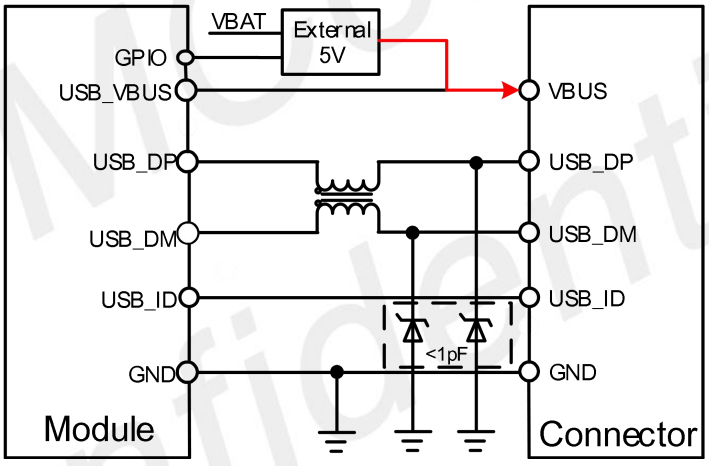


Figure 10: USB OTG Connection Reference Design

SIM8500E (Dual Band WIFI) series module supports USB HUB function, there is a need of an external 5V power on the VBUS.

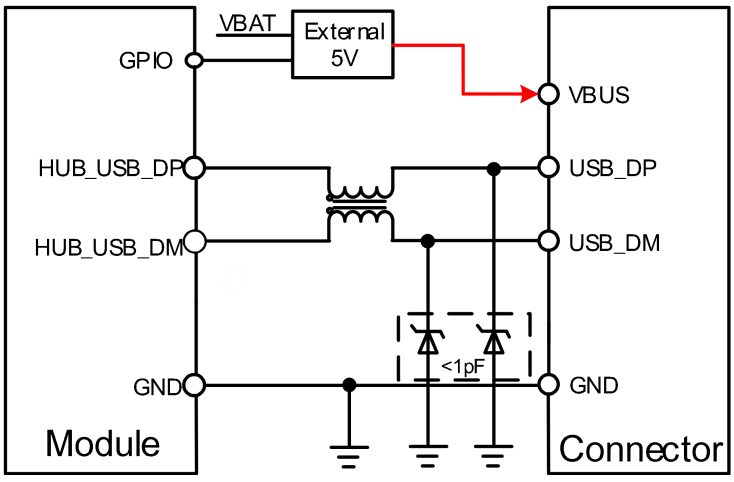


Figure 11: USB HUB Connection Reference Design

PCB wiring protocols and hardware design notices for USB signals are listing below.

- Differential pair routing, 90+-10% impedance control, and stereo ground plane are needed.
- Reserved ESD protection components close to the USB interface:
  Highly recommend the TVS junction capacitance value on the USB2.0 signal lines less than 2pF.
- Do not wiring the USB signals under the crystal oscillator, the oscillator, the magnetic devices, and the RF signals. Highly recommend routing in the inner layer and stereo ground plane.
- Highly recommend the USB2.0 signals are wiring as differential pairs separately.

Table 10: Comparison of the Charge Protocol

PIN Num	PIN Name	Length（mm）	Difference（mm）
14	USB_DP	20.51	1.37
13	USB_DM	19.14	
173	HUB_USB_DP	16.28	0.07
174	HUB_USB_DM	16.35	

3.5 Charging and Battery Management

SIM8500E (Dual Band WIFI) series module integrates the maximum current of the charging protocol up to 0.9A. It supports several charging modes, including the trickle charging mode, the pre-charging mode, the constant current charging mode, and the other charging modes.

Table 11: The Battery's Pin Definition

PIN Name	PIN Num	I/O	Description	Note
USB_VBUS	141、142	PI	USB VBUS Power	Vmin=4.5V Vnorm=5.0V Vmax=9V
VBAT_BB	1、2	PI/PO	VBAT Power Input Output	Vnorm=3.8V
BAT_ID	185	AI	Battery Detection	Input Range: 0~1.2 V. Floating when no connection.
CS_P	184	AI	Voltameter Detection +	Grounding when no connection.
CS_M	183	AI	Voltameter Detection -	Grounding when no connection.
BAT_THERM	134	AI	Battery Thermal Detection	Highly recommend an external 47KR resistor pulling up to the

				LDO1_1V85. Default 10k Ω NTC. Grounding with a 10 kΩ resistor when no connection.

3.5.1 Charging

- The Trickle Charging Mode:
  The system is running into the trickle charging mode when the voltage of the battery is between 1.1V and 2.05V. In this case, the charging current is about 70mA.
- The Pre-charging Mode:
  The system is running into the pre-charging mode when the voltage of the battery is between 2.05V and 3.05V. The charging current is about 450mA
- The Constant Current Charging Mode:
  The system is running into the constant current charging mode when the voltage of the battery is between 3.05V and 4.18V. The charging current is programmable up to 900mA (The Default USB charging current is setting at 450mA in the software configuration).
- The Constant Voltage Charging Mode:
  The system is running into the constant voltage charging mode when the voltage of the battery is reaching at 4.18V. In this case, the charging current is decreasing gradually. The charging status would stop when the charging voltage is full.

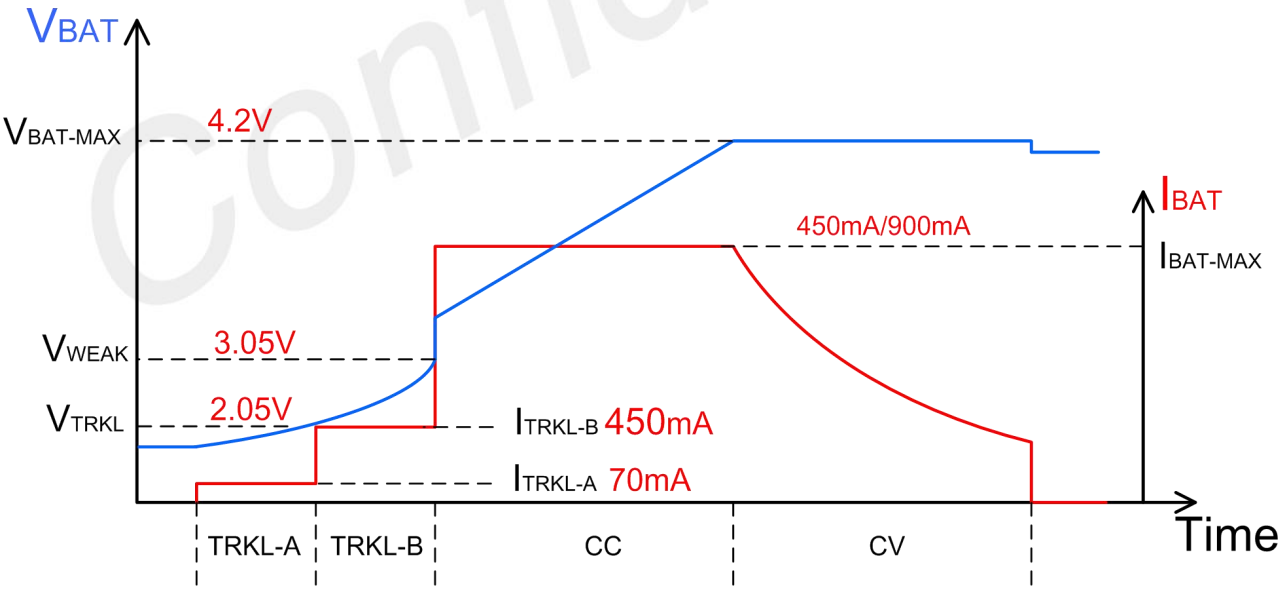


Figure 12: Charging Status Diagram

Table 12: Battery Charging Protocol Feature

Parameter	Status	Min	Typical	Max	Unit
ITRKL-A	Trickle-A Charging current	-	70	-	mA
ITRKL-B	Trickle-B Charging current	-	450	-	mA
VTRKL	Trickle-B threshold voltage range Programmable	-	2.05	-	V
VWEAK	Weak battery threshold range Programmable	-	3.05	-	V
VBAT_MAX	Maximum battery voltage Programmable	-	4.2	-	V
IBAT_MAX	Fast charging current range Programmable	-		900	mA

3.5.2 BAT_SNS Detection

The BAT_SNS is using for the battery voltage detection with the maximum voltage input at 4.5V. Avoiding to float BAT_SNS Pin. Connecting the BAT_SNS Pin to the battery positive node when charging with a lithium battery. Connecting to the module's VBAT_BB Pin when powering by an LDO or a DCDC component.

3.5.3 VBAT_THERM Detection

SIM8500E (Dual Band WIFI) series module has the function of battery temperature detection. This function requires an integrated thermistor in the battery (Recommend a 10KR ± 1% NTC Resistor). And the NTC resistor needs to connect to the VBAT_THERM Pin. The module would charge fail when suspending the BATT_THERM pin. Grounding the VBAT_THERM with a 10KR resistor when the battery does not have an internal NTC resistor.

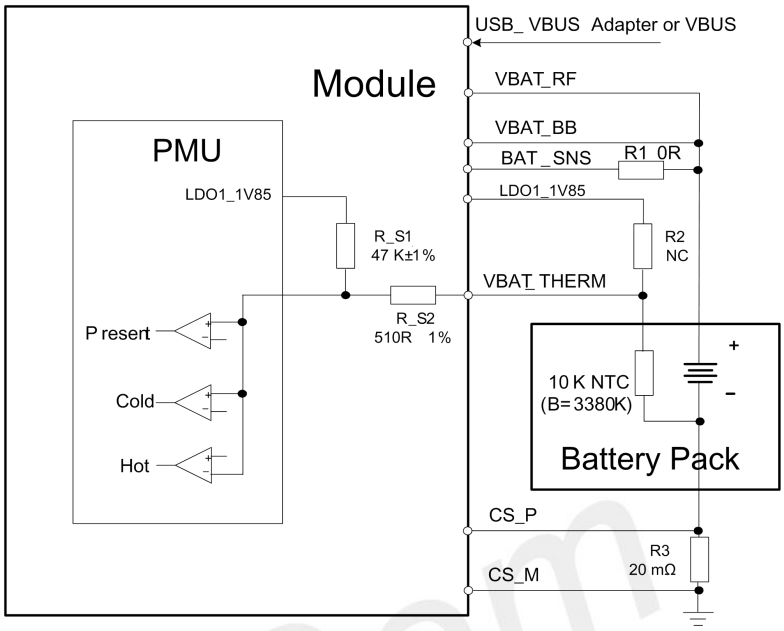


Figure 13: Battery Thermal Detection Diagram

SIM8500E (Dual Band WIFI) series module supports the current galvanometer by default. It is sampling by the resistor R3 with the value at 20mΩ. For different types of batteries, modifying the software settings enables the designated battery working properly.

Floating the VBAT_THERM Pin, grounding the CS_P/CS_M to the PCB main ground layer, and connecting the BAT_SNS Pin to the VBAT_BB Pin when without using the module's internal charging function. Referencing the following figure for detailed information.

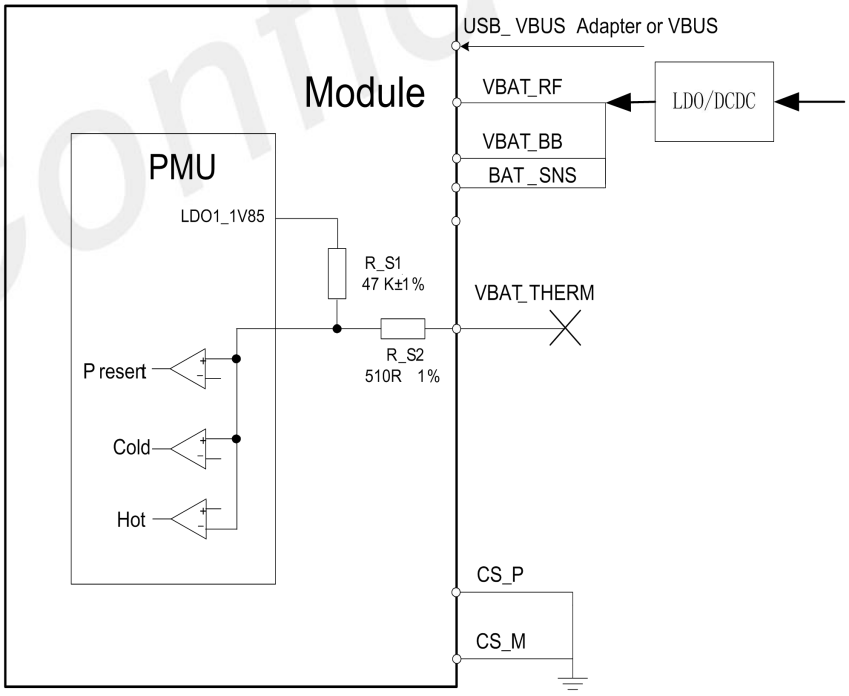


Figure 14: Without Using the Internal Charging Function Diagram

3.6 UART/SPI/I2C/I2S Interface

SIM8500E (Dual Band WIFI) series module supports multiple sets of the UART, the I2C, the SPI, and the I2S. The combination of multiple interfaces is flexible and achievable by the configuration of GPIOs. The interface voltage is 1.85V.

3.6.1 UART/SPI/I2C/I2S Interface Multiplexing

Table 13: UART/SPI/I2C/I2S Interface Multiplexing Feature

PIN Name	PIN Num	I/O	Description	Note
UART Interface				
UART0_TXD	34	DO	UART0 TX	Multiplex GPIO, Do not support UART0 and UART2 at the same time
UART0_RXD	35	DI	UART0 RX	
UART0_CTS	36	DI	UART0 CTS	
UART0_RTS	37	DO	UART0 RTS	
DBG_RXD	93	DI	UART1 RX Only for Debug	Only for Debug
DBG_TXD	94	DO	UART1 TX Only for Debug	
UART2_RXD	153	DI	UART2 RX	Multiplex GPIO
UART2_TXD	154	DO	UART2 TX	Multiplex GPIO
I2C Interface				
TP_I2C_SCL	47	DO	TP I2C Clock	Multiplex GPIO
TP_I2C_SDA	48	DI/DO	TP I2C Data	
CAM_I2C_SCL	83	DO	Front Camera I2C Clock	
CAM_I2C_SDA	84	DI/DO	Front Camera I2C Data	
SENSOR_I2C_SCL	91	OD	Sensor I2C Clock	
SENSOR_I2C_SDA	92	OD	Sensor I2C Data	
GPIO_48	100	OD	Rear Camera I2C Clock	Multiplex I2C0_SCL
GPIO_49	99	OD	Rear Camera I2C Data	Multiplex I2C0_SDA
GPIO_154	105	OD	I2C4 Clock	Multiplex I2C4_SCL
GPIO_155	106	OD	I2C4 Data	Multiplex I2C4_SCL
SPI Interface				
GPIO_52	107	DO	SPI2 Chip Select	Multiplex SPI2_CS
GPIO_53	177	DO	SPI2 Data Output	Multiplex SPI2_DO

GPIO_54	109	DI	SPI2 Data Input	Multiplex SPI2_DI
GPIO_55	110	DO	SPI2 Clock	Multiplex SPI2_CLK
GPIO_93	116	DO	SPI0 Clock	Multiplex SPI0_CLK
GPIO_90	117	DO	SPI0 Chip Select	Multiplex SPI0_CS
GPIO_92	118	DI	SPI0 Data Input	Multiplex SPI0_DI
GPIO_91	119	DO	SPI0 Data Output	Multiplex SPI0_DO

- Please consult SIMCom staff to review the reference design and functions for these pins.
- SIM8500E (Dual Band WIFI) series module supports 2 sets of SPI, 2 sets of UART, 5 sets of I2C.
- SPI only supports the master mode, and highly recommend complying with SPI0 for fingerprint identification function.
- UART interface could support the working frequency up to 3.25Mbps.

3.6.2 UART Voltage Level Switch Circuit

SIM8500E (Dual Band WIFI) series module supports up to 2 sets of the UART interfaces, including the 2 sets of the 2-Lane interface, and the Debug UART for debugging. UART0 is the 4-Lane interface support the hardware flow control with the highest speed up to 3.25Mbps. The interface voltage for UART on the SIM8500E (Dual Band WIFI) series module is 1.85V. Taking a voltage level switch chip for voltage switching if needed. Highly recommend pick TI's TXS0104EPWR, and the reference design is showing in the following Figures.

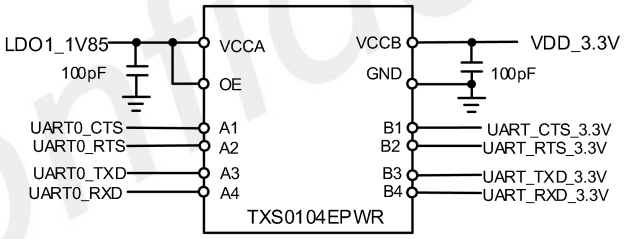


Figure 15: UART Voltage Level Switch Reference Design

The compatible reference design is showing below.

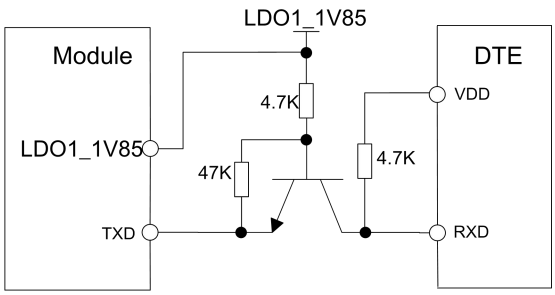


Figure 16: TX Voltage Level Switch Reference Design

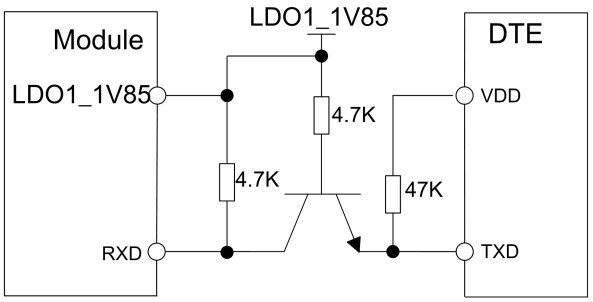


Figure 17: RX Voltage Level Switch Reference Design

3.7 SD Card Interface

SIM8500E (Dual Band WIFI) series module supports SD 3.0 cards with 4-Bit data interface. The SD cards comply with 1.8V or 3V protocols.

Table 14: SD Card Interface Definition

PIN Name	PIN Num	I/O	Description	Note
SD_VDD	38	PO	SD Card Power	Vnormal = 3V I max = 400mA Routing lines in PCB requires an 1A standard if supporting the high capacity SD Card.
SD_CLK	39	DO	SD Clock	The SD signal line needs to go through the impedance lines with the value at 50 ohm ± 10%.
SD_CMD	40	DI/DO	SD Commend	
SD_DATA0	41	DI/DO	SD Data0	
SD_DATA1	42	DI/DO	SD Data1	
SD_DATA2	43	DI/DO	SD Data2	
SD_DATA3	44	DI/DO	SD Data3	
SD_DET	45	DI	SD Detection	Active Low when inserting the SD Card, Highly recommend connecting to the ground with a 1KR resistor if no connection.

Table 15: SD Card Interface Electrical Feature (1.8V Voltage Level)

Parameter	Description	Minimum	Typical	Maximum	Unit
VIH	High Level Input Voltage	1.3	-	-	V
VIL	Low Level Input Voltage	-0.3	-	0.53	V
VOH	High Level Output Voltage	1.58	-	-	V
VOL	Low Level Output Voltage	0	-	0.19	V

Table 16: SD Card Interface Electrical Feature (3V Voltage Level)

Parameter	Description	Minimum	Typical	Maximum	Unit
VIH	High Level Input Voltage	2.17	-	-	V
VIL	Low Level Input Voltage	-0.3	-	0.87	V
VOH	High Level Output Voltage	2.61	-	-	V
VOL	Low Level Output Voltage	0	-	0.31	V

The reference design for SD card is showing below.

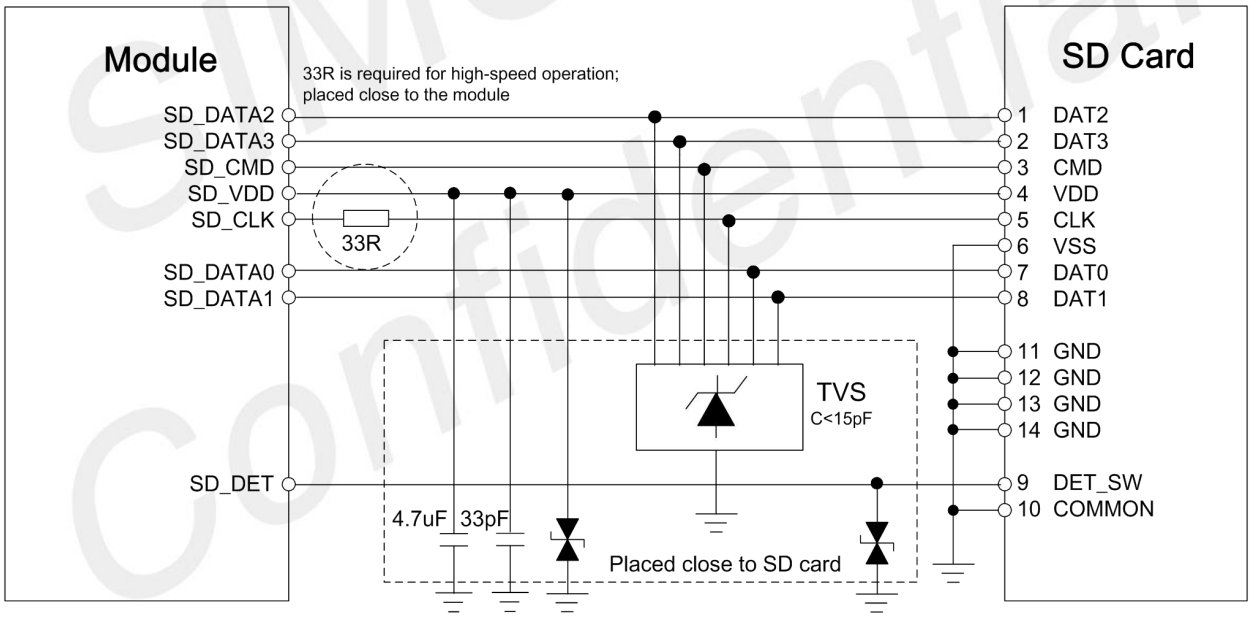


Figure 18: SD Card Reference Design

The requirements for the SD card signal are showing as follows.

- Highly recommend a complete stereo ground plane and the full reference ground.
- Differential pair routings with 50Ω differential impedance and the error at ±10%.
- Highly recommend the length difference between the CLK and the DATA/CMD is less than 1mm.
- Highly recommend the line spacing at least 2 times the linewidth.
- Highly recommend the total capacitance on the signal line shall be less than 15pF.

Table 17: SD Card Interface PCB Wiring Length

PIN Num	PIN Name	Length（mm）
39	SD_CLK	44.28
40	SD_CMD	43.67
41	SD_DATA0	43.94
42	SD_DATA1	44.02
43	SD_DATA2	43.81
44	SD_DATA3	43.11

3.8 LCD Interface

SIM8500E (Dual Band WIFI) series module's video output interface meets the requirements of MIPI_DSI standard. It has a 4-Lane MIPI DSI interface with the speed up to 1.5Gbps. It also supports dual screen display with the maximum resolution of 1440*720 (HD+).

The PWM pin of the module could control the backlight brightness by software configuration.

The MIPI signal lines are high-speed signal lines. Highly recommend place a common mode inductor close to the LCM to avoiding EMI interference. The reference design is showing below.

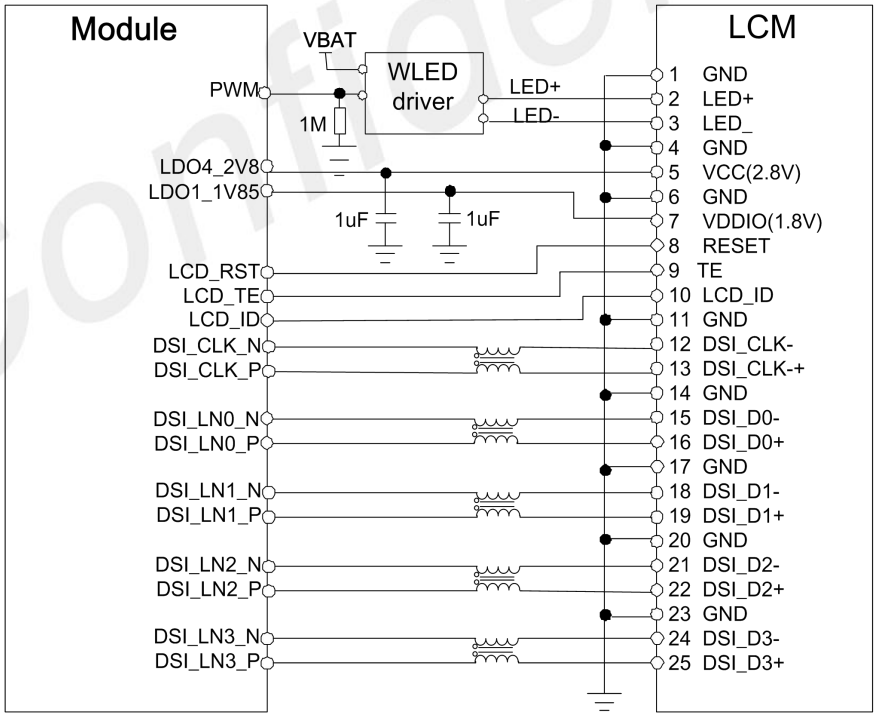


Figure 19: LCD Interface & the Backlight Reference Design

Table 18: LCD Interface Definition

PIN Name	PIN Num	I/O	Description	Note
LDO1_1V85	111	PO	Output 1.85V LCD VDDIO Power Enable Signal	Vnorm = 1.85 V IO max = 100 mA
LDO4_2V8	156	PO	Output 2.80V LCD VCC Power	Vnorm = 2.80 V IO max = 200 mA
PWM	29	DO	PWM Output, LCD Backlight	1.85 V Voltage Range Multiplex GPIO
LCD_RST	49	DO	LCD Reset Signal	1.85 V Voltage Range Multiplex GPIO
LCD_TE	50	DI	LCD TE Signal	1.85 V Voltage Range Multiplex GPIO
DSI_CLK_N	52	DO	LCD MIPI Signal	Require the value at 85 Ω ±15% for the differential impedance on the MIPI signal routings.
DSI_CLK_P	53	DO		
DSI_LN0_N	54	DO		
DSI_LN0_P	55	DO		
DSI_LN1_N	56	DO		
DSI_LN1_P	57	DO		
DSI_LN2_N	58	DO		
DSI_LN2_P	59	DO		
DSI_LN3_N	60	DO		
DSI_LN3_P	61	DO		

3.9 TP Interface

SIM8500E (Dual Band WIFI) series module provides an I2C interface, an interruption function pin, and a reset pin, connecting the touching panel to operate.

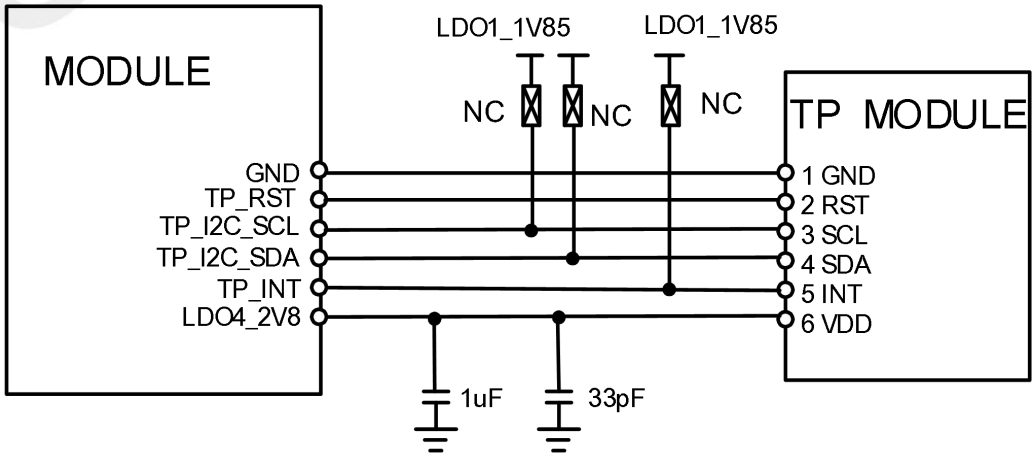


Figure 20: TP Interface Reference Design

NOTE

Highly recommend an external 2.2KR resister pulling up to the 1.8V power supply for TP I2C.

Table 19: TP Interface Definition

PIN Name	PIN Num	I/O	Description
LDO1_1V85	111	PO	Output 1.85V External TP I/O Power Enable Signal
LDO4_2V8	156	PO	Output 2.80V TP VCC Power
TP_I2C_SDA	48	OD	TP I2C Data
TP_I2C_SCL	47	OD	TP I2C Clock
TP_INT	30	DI	1.85 V Voltage Range Multiplex GPIO
TP_RST	31	DO	1.85 V Voltage Range Multiplex GPIO

3.10 Camera Interface

SIM8500E (Dual Band WIFI) series module's video input interface meets the requirements of MIPI_CSI standard. It supports 2 cameras or 3 cameras in application. The rear camera is a 4-Lane CSI1 MIPI Data Interface, supporting the highest resolution at 13MP. The front camera is a 4-Lane or a 2-Lane CSI0 MIPI Data Interface, supporting the highest resolution at 8MP.

CSI1 supports 4-Lane PHY, and the sensor could working in a 4-Lane, a 2-Lane or a 1-Lane mode. 2-Lane sensor could work at Lane0 or Lane1, but 1-Lane sensor could only work at Lane0. Remember, the MIPI Clk is only using CSI1_CLK_P/CSI1_CLK_N.

Table 20: Camera Interface Definition

PIN Name	PIN Num	I/O	Description	Note
CSI1_CLK_N	63	DI	Rear 1st Camera MIPI Signal	Require the value at 100 Ω ±10% for the differential impedance on the High-Speed MIPI signal routings.
CSI1_CLK_P	64	DI		
CSI1_LN0_N	65	DI		
CSI1_LN0_P	66	DI		
CSI1_LN1_N	67	DI		

CSI1_LN1_P	68	DI		
CSI1_LN2_N	160	DI		
CSI1_LN2_P	161	DI		
CSI1_LN3_N	200	DI		
CSI1_LN3_P	201	DI		
CSI0M_CLK_N	70	DI	Front Camera MIPI Signal	Require the value at 100 Ω ±10% for the differential impedance on the High-Speed MIPI signal routings.
CSI0M_CLK_P	71	DI		
CSI0M_LN0_N	72	DI		
CSI0M_LN0_P	73	DI		
CSI0M_LN1_N	194	DI		
CSI0M_LN1_P	195	DI		
CSI0S_CLK_N	157	DI	Rear 2nd Camera MIPI Signal	Require the value at 100 Ω ±10% for the differential impedance on the High-Speed MIPI signal routings.
CSI0S_CLK_P	196	DI		
CSI0S_LN2_N	158	DI		
CSI0S_LN2_P	197	DI		
CSI0S_LN3_N	198	DI		
CSI0S_LN3_P	195	DI		
MCAM_MCLK	74	DO	Rear 1st Camera Clock	1.85 V Voltage Range
SCAM_MCLK	75	DO	Front Camera Clock	1.85 V Voltage Range Multiplex GPIO
MCAM_RST	79	DO	Rear 1st Camera Reset	
MCAM_PWDN	80	DO	Rear 1st Camera Power Down	
SCAM_RST	81	DO	Front Camera Reset	
SCAM_PWDN	82	DO	Front Camera Power Down	
CAM2_RST	164	DO	Rear 2nd Camera Reset	
CAM2_PWDN	163	DO	Rear 2nd Camera Power Down	
CAM_I2C_SCL	83	DO	Camera I2C Clock	
CAM_I2C_SDA	84	DI/DO	Camera I2C Data	
I2C1_SCL	166	DO	Camera I2C Clock	
I2C1_SDA	205	DI/DO	Camera I2C Data	
LDO2_1V8	125	PO	Camera IOVDD Power	Vnorm = 1.80 V I O max = 200 mA
LDO3_2V8	129	PO	Camera AVDD/AFVDD 2.8V Power	Vnorm = 2.80 V I O max = 150 mA
CAM_DVDD	192	PO	Camera DVDD Power	Vnorm = 1.20 V I O max = 400 mA

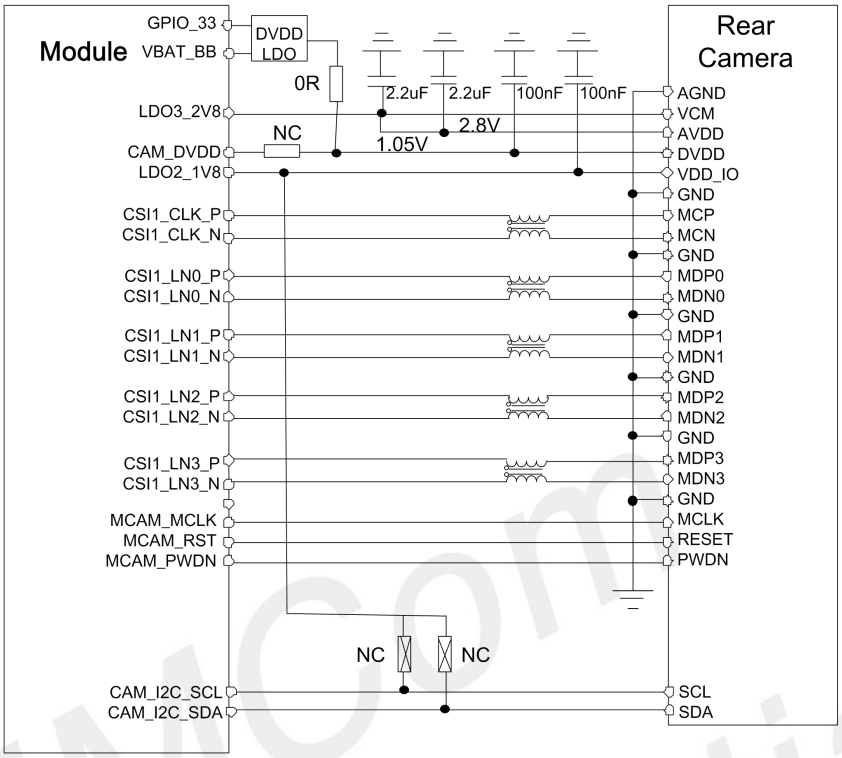


Figure 21: Rear Camera Interface Reference Design

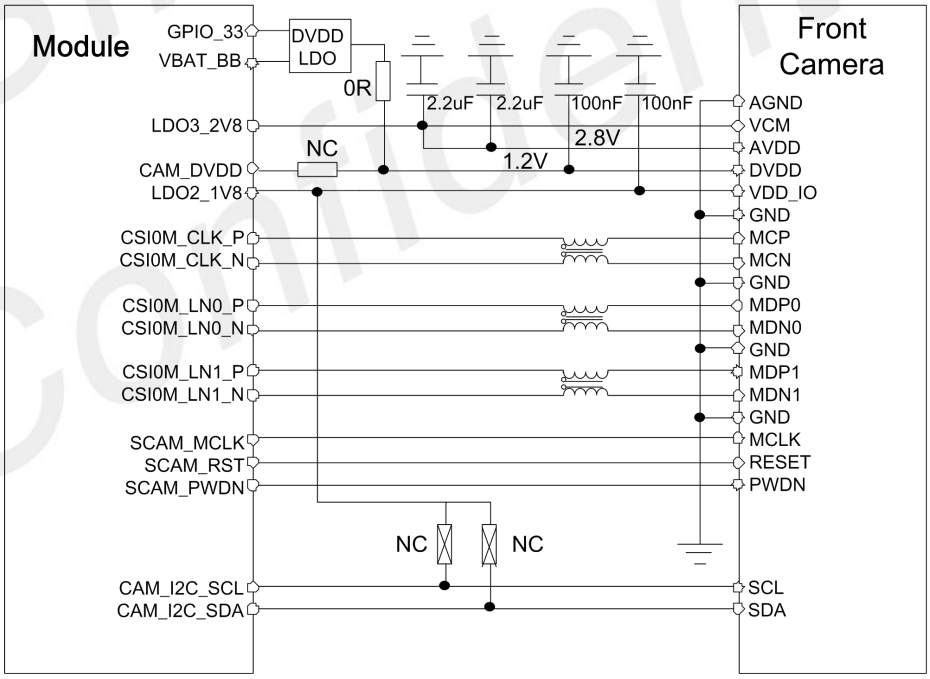


Figure 22: Front Camera Interface Reference Design

3.11 Audio Interface

SIM8500E (Dual Band WIFI) series module supports three analog audio inputs, including the MIC1 differential pair interface for the master microphone, the MIC3 differential pair interface for the denoising microphone, and the MIC2 single ended interface for the audio jack.

- Three-Channel analog audio output interface.
  Handset.
  Speaker.
  Stereo Headphone and LINEOUT.

Table 21: Audio Interface Definition

PIN Name	PIN Num	I/O	Description	Note
EAR_P	8	AO	Headphone Output Positive	
EAR_N	9	AO	Headphone Output Negative	
HPH_R	136	AO	Headphone Right-Channel	
HPH_REF	137	PI	Headphone Main Reference Ground	
HPH_L	138	AO	Headphone Left-Channel	
HS_DET	139	DI	Headphone Push-in Detect	High Voltage represents inserting the headphone, Low Voltage represents pulling out the headphone, Connect to the ground with a 1KR resistor when without using headphone.
MIC1_P	4	AI	Primary Microphone Input Positive	
MIC1_N	5	AI	Primary Microphone Input Negative	
MIC2_P	6	AI	Headphone Microphone Input Positive	
MIC2_N	148	AI	Headphone Microphone Input Negative	
MIC3_P	152	AI	Denoise Microphone Input Positive	
MIC3_N	151	AI	Denoise Microphone Input Negative	
SPK_P	10	AO	Speaker Positive	
SPK_N	11	AO	Speaker Negative	
MIC_BIAS1	147	PO	Microphone Bias Voltage	Output Voltage Range: 2.2~3V
MIC_BIAS2	149	PO	Microphone Bias Voltage	
HPMIC_DET	150	AI	Headphone Microphone Detect	

3.11.1 Microphone Interface

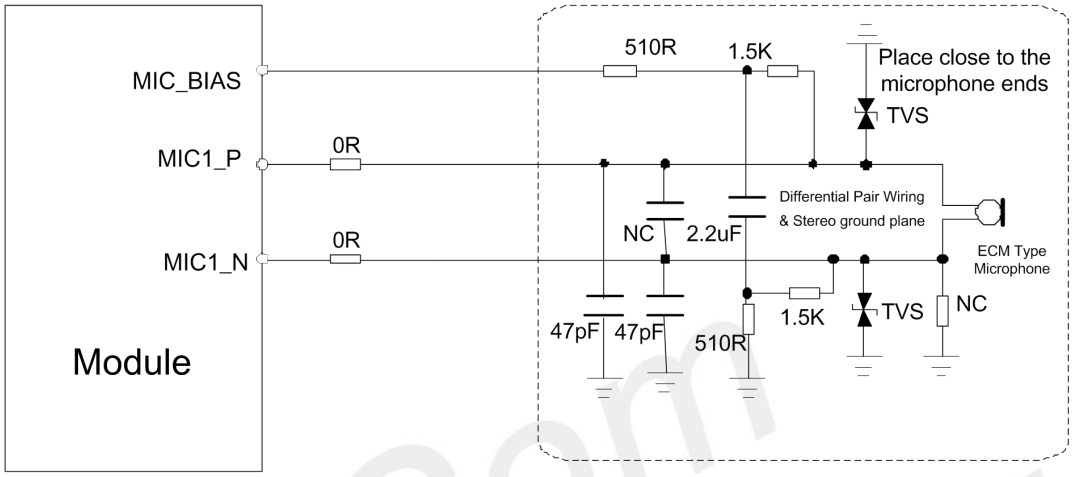


Figure 23: ECM Type Microphone Reference Design (Single MIC)

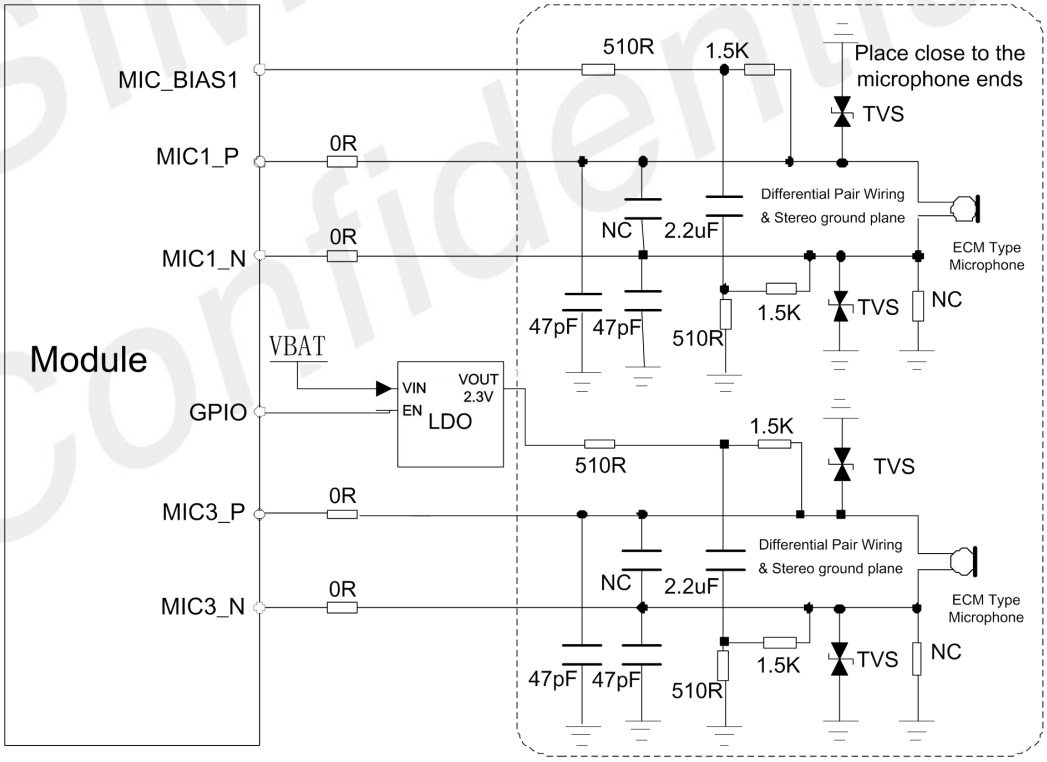


Figure 24: ECM Type Microphone Reference Design (Dual MIC)

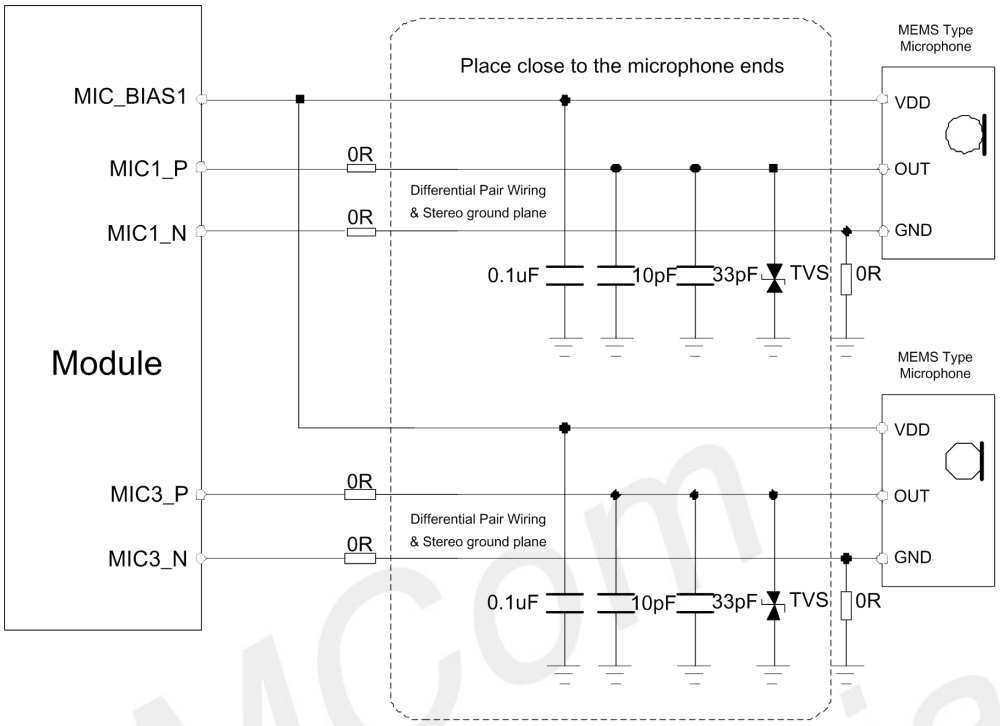


Figure 25: MEMS Type Microphone Reference Design

Notice that figure 23 is the ECM type microphone reference design for the single MIC. But figure 24 is the ECM type microphone reference design for the dual MIC. As MIC1 and MIC3 inside the module are taking the same MIC_BIAS for the bias voltage. To prevent the crosstalk, customers need to add an external bias when using the MIC1 and the MIC3 at the same time. The voltage bias is setting at 2.3V by default.

3.11.2 Headphone Interface

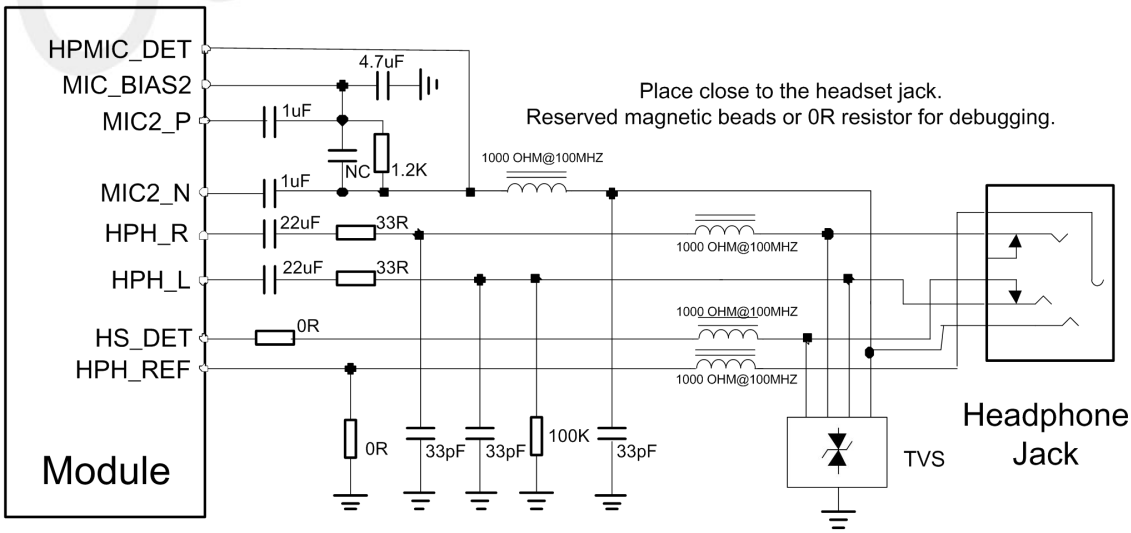


Figure 26: Headphone Reference Design

NOTE

1. Highly recommend to wire as the differential pair for the microphone configuration.
2. Highly recommend the HPH_L connects a 100KR resistor pulling down to the ground for the headphone detection.
3. Picking a bidirectional TVS on the network due to the negative voltage on the HPH signal.

3.11.3 Handset Interface

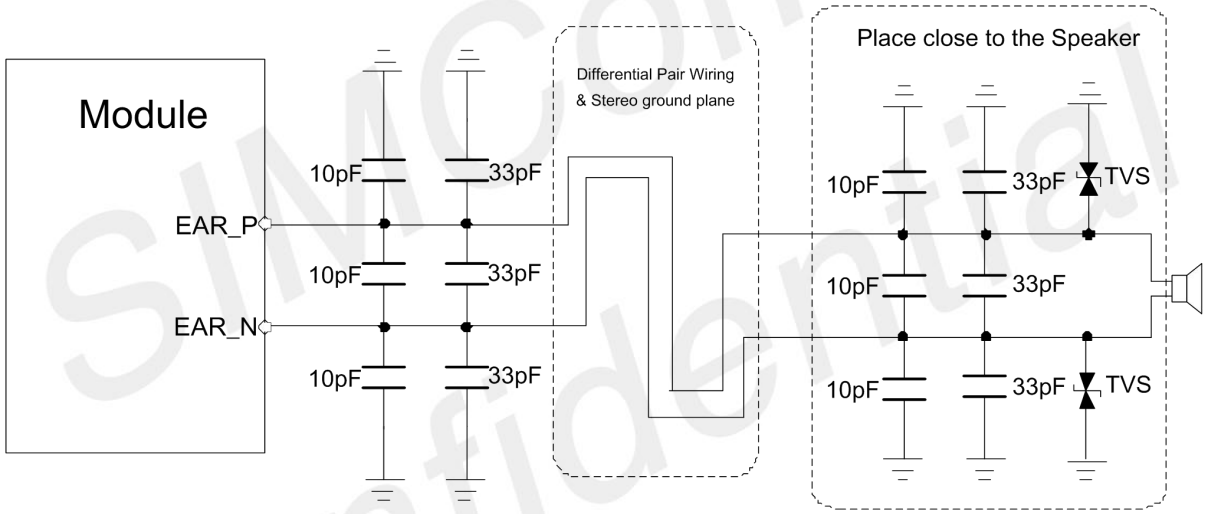


Figure 27: Speaker Reference Design

3.11.4 Speaker Interface

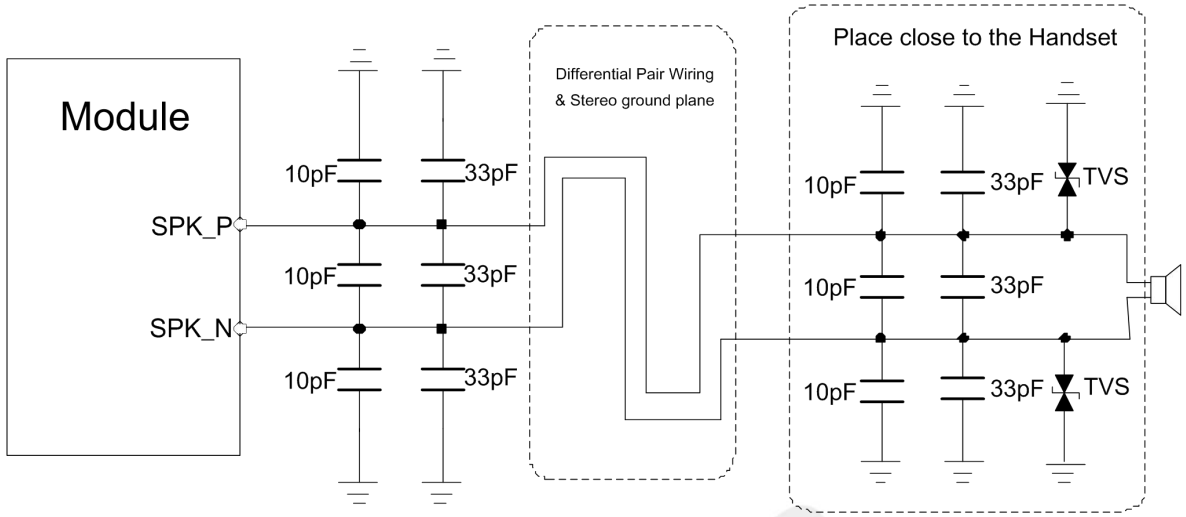


Figure 28: Handset Reference Design

3.11.5 Audio PCB Wiring Requirements

The requirements for the audio signal are showing as follows.

- Highly recommend wiring the audio signal lines away from the antennas, the RF signal lines, and other high-speed signal lines.
- Highly recommend all the audio signal lines are wiring with a complete stereo ground plane and the full reference ground, and away from the return VBAT.
- Highly recommend wiring the MIC1_P/N, the EAR_P/ N, and the SPK_P/N as differential pairs.
- Highly recommend isolating the HPH_L and the HPH_R with the HPH_REF in the middle to decrease the crosstalk interference.
- Highly recommend wiring the 25mil line width for the SPK signal when picking an 8Ω load.
- Highly recommend wiring the 30mil line width for the SPK signal when picking a 4Ω load.

3.12 UIM Card Interface

SIM8500E (Dual Band WIFI) series module offers two UIM Cards interface, supporting dual card dual standby. The UIM Cards interface also supports the 1.8V/3.0V dual voltage and the hot-join detect function.

NOTE

The standard software version supports dual cards, and the single card function needs to be supported by the special software version.

Table 22: UIM Card Interface Definition

PIN Name	PIN Num	I/O	Description
USIM2_DET	17	DI	UIM Card2 Detect, Inserting with low level on detection pin, Multiplex GPIO
USIM2_RST	18	DO	UIM Card2 Reset
USIM2_CLK	19	DO	UIM Card2 Clock
USIM2_DATA	20	DI/DO	UIM Card2 Data
USIM2_VDD	21	PO	UIM Card2 Power, 1.8V/3V Dual Voltage 1.8V UIM: Vmax = 1.85 V Vmin = 1.75 V 3V UIM: Vmax = 3.1 V Vmin = 2.9 V
USIM1_DET	22	DI	UIM Card1 Detect, Inserting with low level on detection pin, Multiplex GPIO
USIM1_RST	23	DO	UIM Card1 Reset
USIM1_CLK	24	DO	UIM Card1 Clock
USIM1_DATA	25	DI/DO	UIM Card1 Data
USIM1_VDD	26	PO	UIM Card1 Power, 1.8V/3V Dual Voltage 1.8V UIM: Vmax = 1.85 V Vmin = 1.75 V 3V UIM: Vmax = 3.1 V Vmin = 2.9 V

Table 23: UIM Card Interface Electrical Feature (USIM_VDD = 1.8V or 3V)

Parameter	Description	Minimum	Typical	Maximum	Unit
VIH	High Level Input Voltage	0.7* USIM_VDD	-	USIM_VDD +0.3	V
VIL	Low Level Input Voltage	-0.3	-	0.2* USIM_VDD	V
VOH	High Level Output Voltage	0.9* USIM_VDD	-	USIM_VDD	V
VOL	Low Level Output Voltage	0	-	0.1* USIM_VDD	V

The reference design for the UIM Card is showing below.

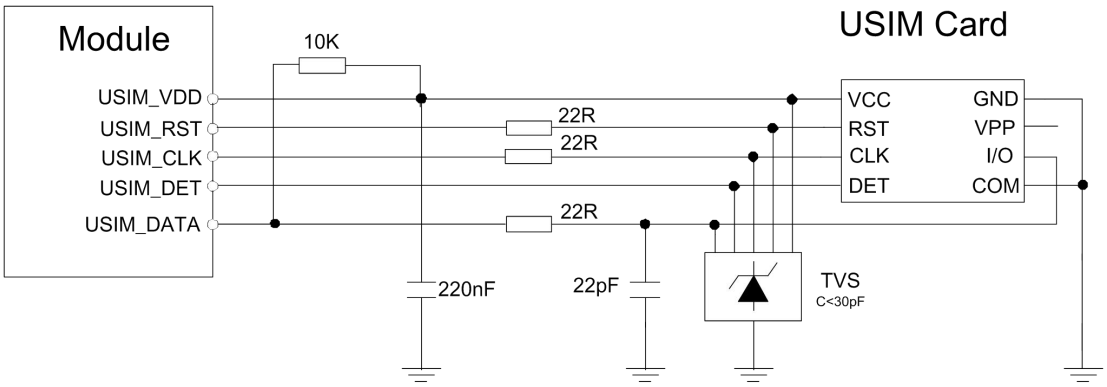


Figure 29: 8-PIN UIM Card Interface Reference Design

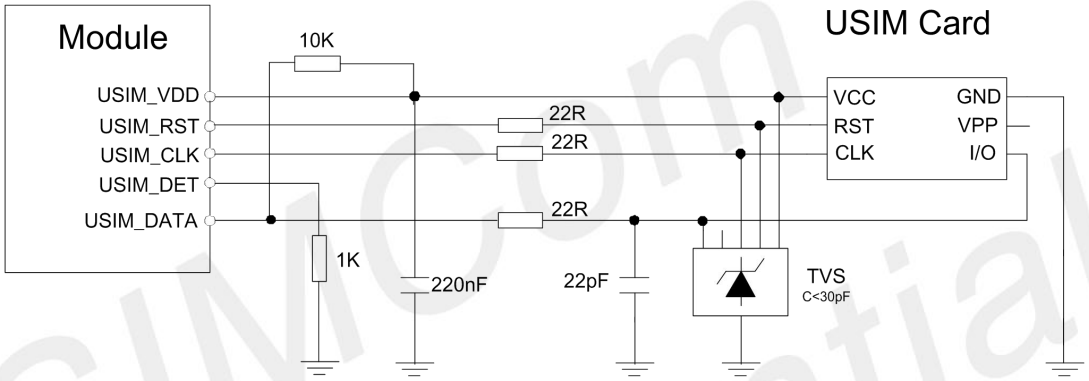


Figure 30: 6-PIN UIM Card Interface Reference Design

NOTE

1. The UIM_DATA Pin of the module pulls up to the USIM_VDD internally. Avoid external pull up.
2. Place the TVS close to the UIM Card receptacle interface.
3. Highly recommend the parasitic capacitance of the TVS on the UIM_CLK should be less than 30pF.
4. Highly recommend the 22R resistor in series on the signal lines to enhance the ESD protection.
5. Highly recommend reserved 22pF capacitor pulling down to the ground on the UIM_DATA line preventing the radio frequency interference.

3.13 ADC

SIM8500E (Dual Band WIFI) series module offers a 12-Bit resolution ADC providing by the power management IC. The feature is showing below.

Table 24: ADC Interface Feature

Parameter	PIN Num	I/O	Description	Note
ADC	128	AI	Common ADC Interface	Maximum Input Voltage at 1.2 V

NOTE

Highly recommend connecting the ADC with a resistance voltage division circuit preventing the module from burning due to the high power supply voltage ADC detection.

3.14 Motor Interface

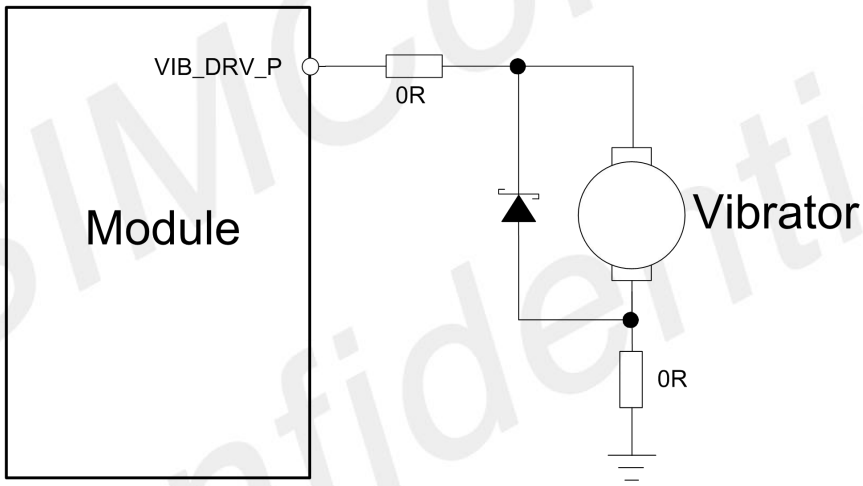


Figure 31: Motor Interface Reference Design

Table 25: Motor Interface Feature

PIN Name	PIN Num	I/O	Description	Note
VIB_DRV_P	28	PO	Motor Driver Output	Output Voltage Range: 1.8V-3.3V Maximum Output Current at 100mA

3.15 Sensor Interface

SIM8500E (Dual Band WIFI) series module communicates with sensors via I2C. It supports various sensors, including the hall sensor, the acceleration sensor, the geomagnetism sensor, the gyroscope sensor, the temperature sensor, the light sensor, and the pressure sensor.

The sensors interface's pins in the module are showing below.

Table 26: Sensor Interface Feature

PIN Name	PIN Num	I/O	Description	Notes
SENSOR_I2C_SCL	91	OD	External Sensor I2C Clock	1.85 V Voltage Range Multiplex GPIO
SENSOR_I2C_SDA	92	OD	External Sensor I2C Data	
GPIO_52	107	DI	Light Sensor Interruption	
GPIO_53	177	DI	Geomagnetism Interruption	
GPIO_54	109	DI	Gyroscope Interruption	
GPIO_55	110	DI	Acceleration Interruption	

3.16 RGB LED Interface

SIM8500E (Dual Band WIFI) series module supports RGB tri-color indicator. Selecting a LED chip with the common athode is needed. The maximum current on each channel is 20mA, and it supports PWM debugging.

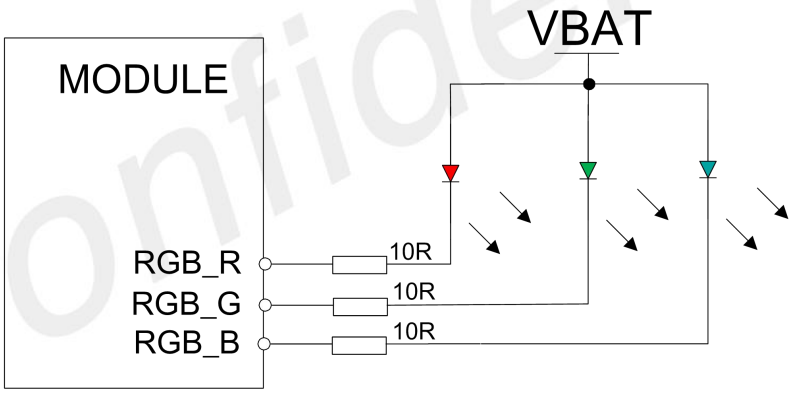


Figure 32: RGB Interface Reference Design

Table 27: LED Interface Feature

PIN Name	PIN Num	I/O	Description	Notes
RGB_R	252	AI	LED Control Negative	Maximum Current 20 mA
RGB_G	253	AI	LED Control Negative	Maximum Current 20 mA
RGB_B	249	AI	LED Control Negative	Maximum Current 20 mA

3.17 Forced Emergency Download Interface

SIM8500E (Dual Band WIFI) series module offers a USB_BOOT Pin, which is an emergency download interface. Pulling down the USB_BOOT to the Ground before powering on enables the module to run into the emergency download mode, which is also applying for the treatment when the product starts abnormally. Highly recommend reserved the testing points for software upgrading and debugging.

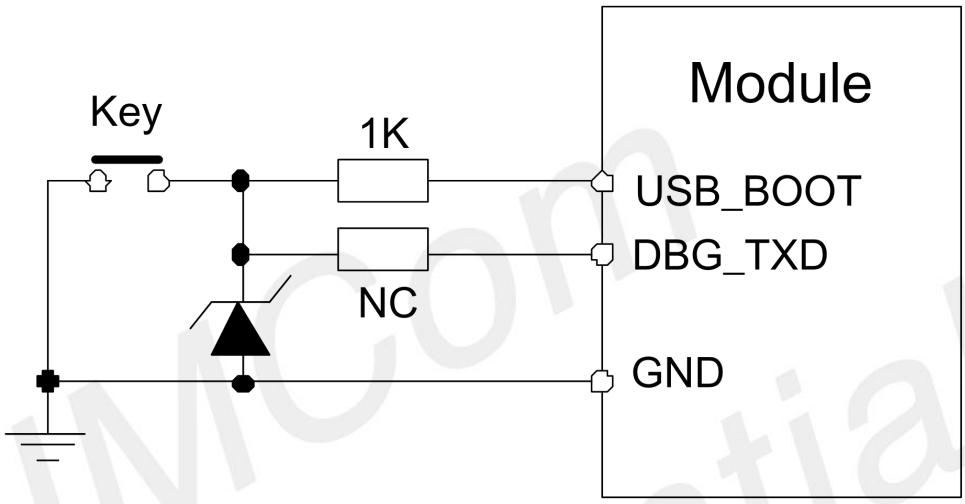


Figure 33: Emergency Download Interface Reference Design

Table 28: USB Boot Interface Feature

PIN Name	PIN Num	I/O	Description	Notes
USB_BOOT	46	DI	USB BOOT Download PIN, Pulling down the USB_BOOT to the Ground before powering on.	Reserved Test Points

4 WIFI / BT & GNSS

SIM8500E (Dual Band WIFI) series module offers a common antenna interface combining the WIFI and the BT function. The customers could connect the external WIFI and BT two in one antenna via this interface. In the TDD mode, the WIFI and the BT coexist.

SIM8500E (Dual Band WIFI) series module supports multiple positioning systems, including the GPS, the GLONSS, and the BeiDou. LNA is a built-in component in the module to effectively enhance the receiving sensitivity of GNSS.

4.1 WIFI Outline

Table 29: 2.4G WIFI Emitter Feature

Emission Feature			
Mode	802.11B（11M）	802.11G（54M）	802.11N(MCS7)
Emission Power	17dBm±2dB	14dBm±2dB	12dBm±2dB
EVM	<35%	<-25 dB	<-27 dB
Receiving Feature			
Mode	802.11B（11M）	802.11G（54M）	802.11N(MCS7)
Receiving Sensitivity	-87dBm	-74dBm	-72dBm

Table 30: 5G WIFI Emitter Feature

Emission Feature			
Mode	802.11a（54M）	802.11n（MCS7）	802.11ac(MCS9)
Emission Power	TBD	TBD	TBD
EVM	<35%	<-25 dB	<-27 dB
Receiving Feature			
Mode	802.11a（54M）	802.11n（MCS7）	802.11ac(MCS9)
Receiving Sensitivity	TBD	TBD	TBD

4.2 BT Outline

Table 31: BT RF Feature

Emission Feature			
Mode	DH5	2DH5	3DH5
Emission Power	9dBm±2dB	7dBm±2dB	7dBm±2dB
Receiving Feature			
Mode	DH5	2DH5	3DH5
Receiving Sensitivity	-90dBm	-80dBm	-80dBm

4.3 GNSS Outline

Table 32: GNSS Feature

Type	GPS,GLANOSS,BEIDOU	
CNo	39.5dB/Hz@-130dBm	
Sensitivity	Tracking	-158dBm
	Recapturing	-156dBm
	Cold Booting	-150dBm
TTFF	Cold Booting	<30s
	Warm Booting	<15s
	Hot Booting	<5s

5 Antenna Interface

5.1 Antenna Interface

SIM8500E (Dual Band WIFI) series module has four antenna interfaces, including the MAIN antenna, the DRX antenna, the GNSS antenna, and the WIFI/BT antenna. To ensure the well RF performance of the products, the RF lines wiring through the antenna pin to the antenna interfaces must meet the following requirements.

- Ensure the RF lines are wiring with the 50Ω impedance.
- The RF lines must have a complete stereo ground plane.
- The RF lines must away from the other interference sources, including the high-speed signals, the clock signals, the sound sensing devices, and the motor, etc.
- The RF lines shall be as short as possible to avoid loss and interference.

5.1.1 TRX Antenna

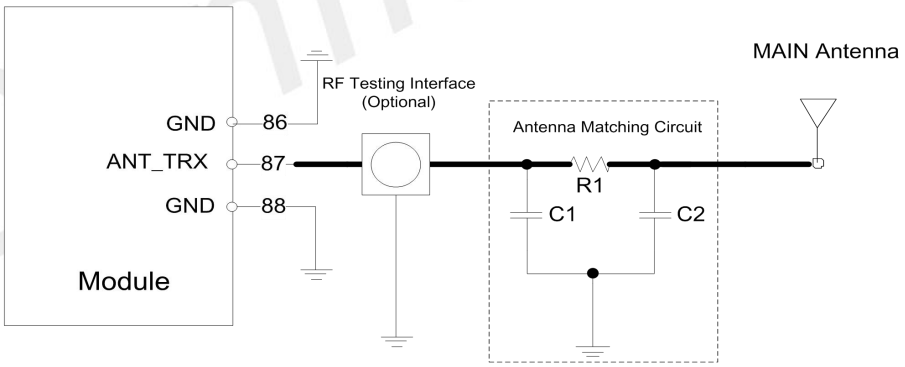


Figure 34: TRX Antenna Reference Design

In this Figure, R1, C1, and C2 are the antenna matching components. All these three components are adjustable to match the efficient and effective communication quality based on the interface debugging result. Selecting R1 with 0R resistor by default, and reserved C1 and C2 with disconnection by default. Highly recommend reserved an RF testing interface to modify accurately and conveniently. Considering the low cost, recommend ensure 50Ω impedance for the RF lines and cancel the RF testing interface.

5.1.2 DRX Antenna

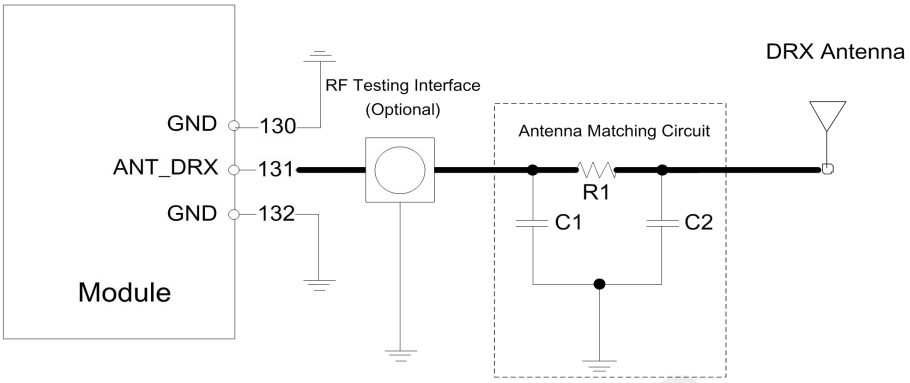


Figure 35: DRX Antenna Reference Design

In this Figure, R1, C1, and C2 are the antenna matching components. All these three components are adjustable to match the efficient and effective communication quality based on the interface debugging result. Selecting R1 with 0R resistor by default, and reserved C1 and C2 with disconnection by default. Highly recommend reserved an RF testing interface to modify accurately and conveniently. Considering the low cost, recommend ensure 50Ω impedance for the RF lines and cancel the RF testing interface.

5.1.3 GNSS Passive Antenna

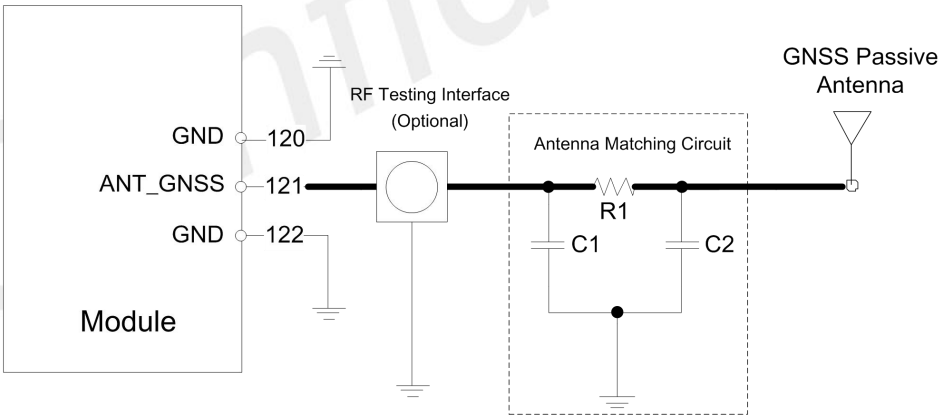


Figure 36: GNSS Passive Antenna Reference Design

In this Figure, R1, C1 and C2 are the antenna matching components. All these three components are adjustable to match the efficient and effective communication quality based on the interface debugging result. Selecting R1 with 0R resistor by default, and reserved C1 and C2 with disconnection by default. Highly recommend reserved an RF testing interface to modify accurately and conveniently. Considering the low cost, recommend ensure 50Ω impedance for the RF lines and cancel the RF testing interface.

5.1.4 GNSS Active Antenna

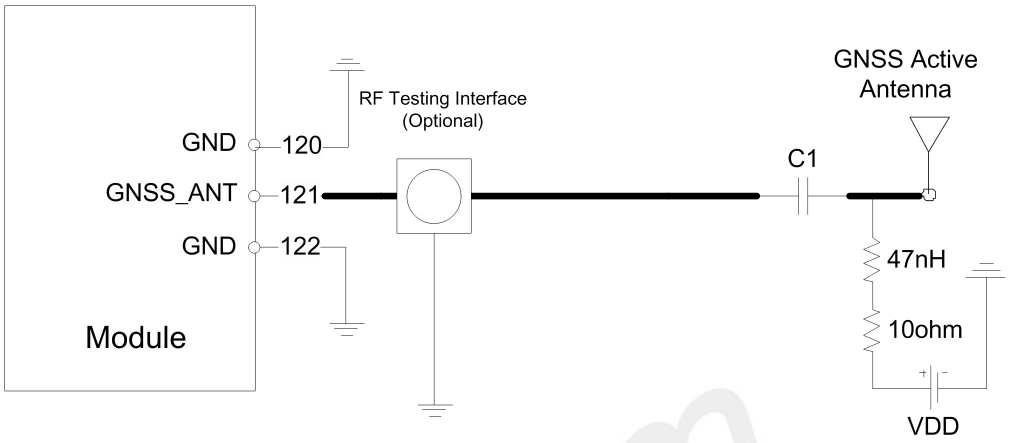


Figure 37: GNSS Active Antenna Reference Design

In this Figure, VDD is using to for the active antenna's power supply. The voltage value is determined by the antenna's feature. C1 is using to isolate straight, and the default value is 33pF. Highly recommend reserved an RF testing interface to modify accurately and conveniently. Considering the low cost, recommend ensure 50Ω impedance for the RF lines and cancel the RF testing interface.

5.1.5 WIFI/BT Antenna

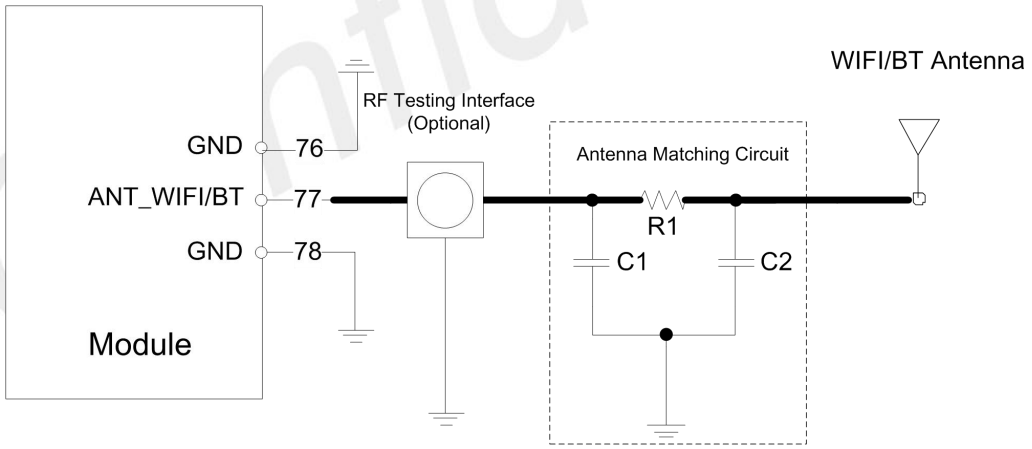


Figure 38: WIFI/BT Antenna Reference Design

In this Figure, R1, C1 and C2 are the antenna matching components. All these three components are adjustable to match the efficient and effective communication quality based on the interface debugging result. Selecting R1 with 0R resistor by default, and reserved C1 and C2 with disconnection by default. Highly recommend reserved an RF testing interface to modify accurately and conveniently. Considering the low cost, recommend ensure 50Ω impedance for the RF lines and cancel the RF testing interface.

5.2 RF Signals PCB Wiring Guideline

Highly recommend the characteristic impedance of all RF signal lines shall be controlled at 50Ω when the customers route their PCB. Generally, the impedance of RF signal lines is determined by the dielectric constant (ER), the wiring width (W), the ground clearance (S), the height of the reference ground plane (H), and other factors.

RF routing characteristic impedance control usually adopts the microstrip-slot line and the coplanar waveguide-slot line. The reference designs of 50Ω impedance are showing as follows.

- **Microstrip-slot Line Structure**

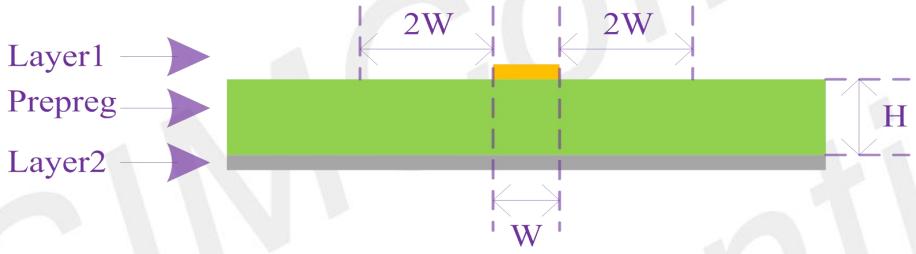


Figure 39: Two Layers PCB Microstrip-slot Line Structure

Table 33: Two Layers PCB Microstrip-slot Line Structure Impedance Control Feature

Thickness	Er	Signal Thickness	Signal Layer	Reference Layer	Impedance	Width
1mm	4.2	0.035mm	Layer1	Layer2	50 ohm	1.7mm (67 mil)
1.6mm	4.2	0.035mm	Layer1	Layer2	50 ohm	3mm (118 mil)

- **Coplanar Waveguide-slot Line**

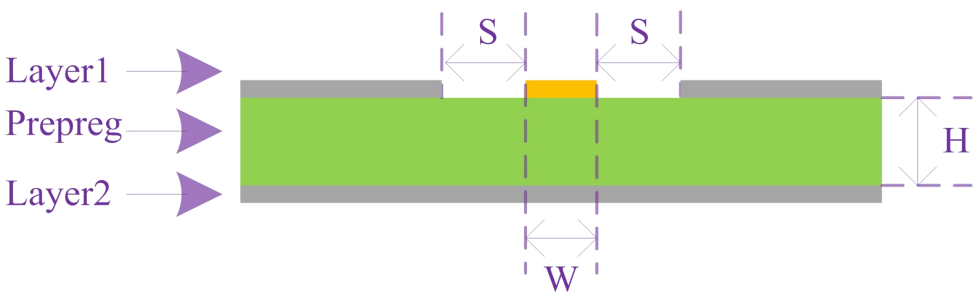


Figure 40: Two Layers PCB Coplanar Waveguide-slot Line Structure

Table 34: Two Layers PCB Coplanar Waveguide-slot Line Structure Impedance Control Feature

Thickness	Er	Signal Thickness	Signal	Reference	Impedance	S	W
1mm	4.2	0.035mm	Layer1	Layer2	50 ohm	0.65mm(25.6 mil)	0.2mm (7.8 mil)
1.6mm	4.2	0.035mm	Layer1	Layer2	50 ohm	0.65mm(25.6 mil)	0.15mm (5.9 mil)

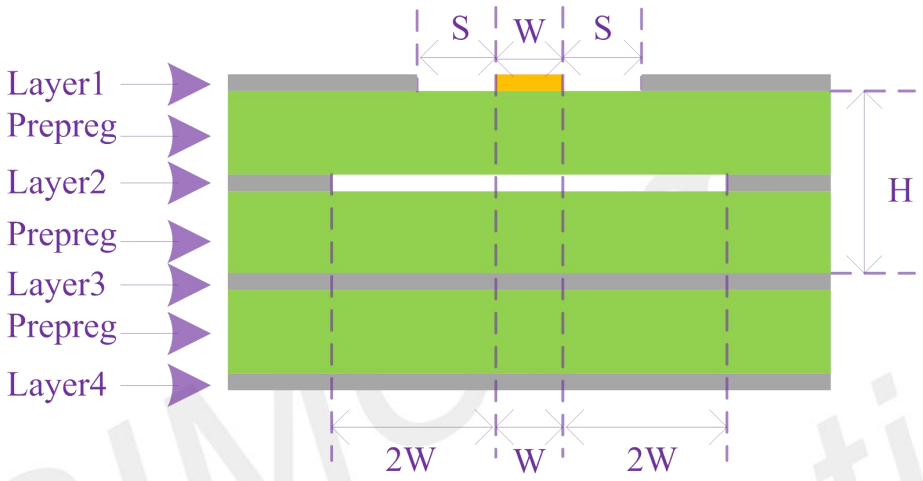


Figure 41: Four Layers PCB Coplanar Waveguide-slot Line Structure (Reference Layer Three)

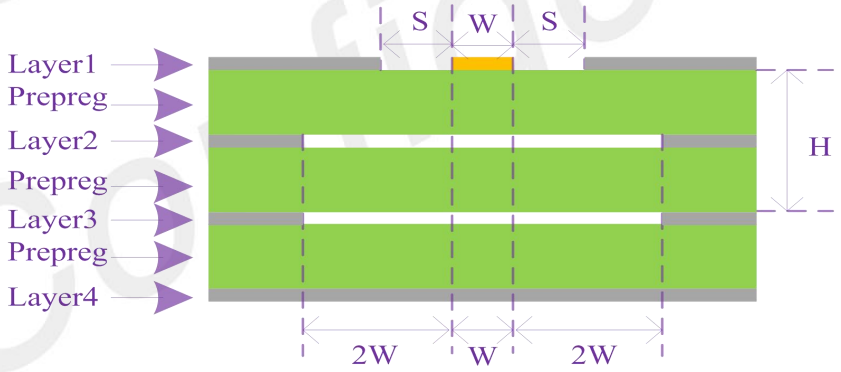


Figure 42: Four Layers PCB Coplanar Waveguide-slot Line Structure (Reference Layer Four)

To ensure the well RF performance of the products, the RF lines wiring through the antenna pin to the antenna interfaces must meet the following requirements.

- Ensure the RF lines are wiring with the 50Ω impedance.
- The RF lines must have a complete stereo ground plane.
- Add more ground holes around the RF signal lines and the reference ground to enhance the RF performance.
- The RF lines must away from the other interference sources, including the high-speed signals, the clock signals, the sound sensing devices, and the motor, etc.
- The RF lines shall be as short as possible to avoid loss and interference.

- The GND pin adjacent to the RF interface pin of the module is not subject to thermal pad treatment and is in full contact with the ground.
- Avoid wiring crossing the whole PCB. Avoid the right-angle routing. Highly recommend wiring with a circular arc or a 135-degree routing.
- Be aware of the distance between the components and the lower PCB ground, especially for the RF connecting device package.
- Digging out the GND copper foil on the surface of the PCB below the connector if necessary.
- The distance between the ground hole and the signal line shall be at least 2 times the line width(2*W).

5.3 Antenna Installation

SIM8500E (Dual Band WIFI) series module's antenna interface installation requirements are showing as follows.

Table 35: Antenna Installation Requirements

Antenna	Parameters' Requirements
GSM/WCDMA/LTE	Standing wave ratio: ≤ 2 Gain (dBi): >1 Maximum Input Power (W): 50 Input Impedance (Ω): 50 Polarization Type: Vertical Insertion Loss: < 1dB (GSM850/EGSM900, WCDMA B5/B8, LTEB5/B8/B20/B28) Insertion Loss: < 1.5dB (DCS1800/PCS1900, WCDMA B1/B3, LTE B1/B3) Insertion Loss: < 2dB (B7/B38/B40/B41)
Wi-Fi/BT	Standing wave ratio: ≤ 2 Gain (dBi): > 1 Maximum Input Power (W): 50 Input Impedance (Ω): 50 Polarization Type: Vertical Insertion Loss: < 1dB
GNSS	Frequency Range: 1559 - 1607MHz Polarization Type: Right-Handed Circular or Linear Polarization Standing wave ratio: < 2 (Typical) Passive Antenna Gain: > 0dBi Active Antenna Noise Coefficient: < 1.5dB (Typical) Active Antenna Gain: > -2dBi

	Active Antenna Integrated LNA Gain: <17dB (Typical) Active Antenna Total Gain: <17dBi (Typical)

5.4 RF Connector

Highly recommend pick the Hirose U.FL-R-SMT's RF connector.

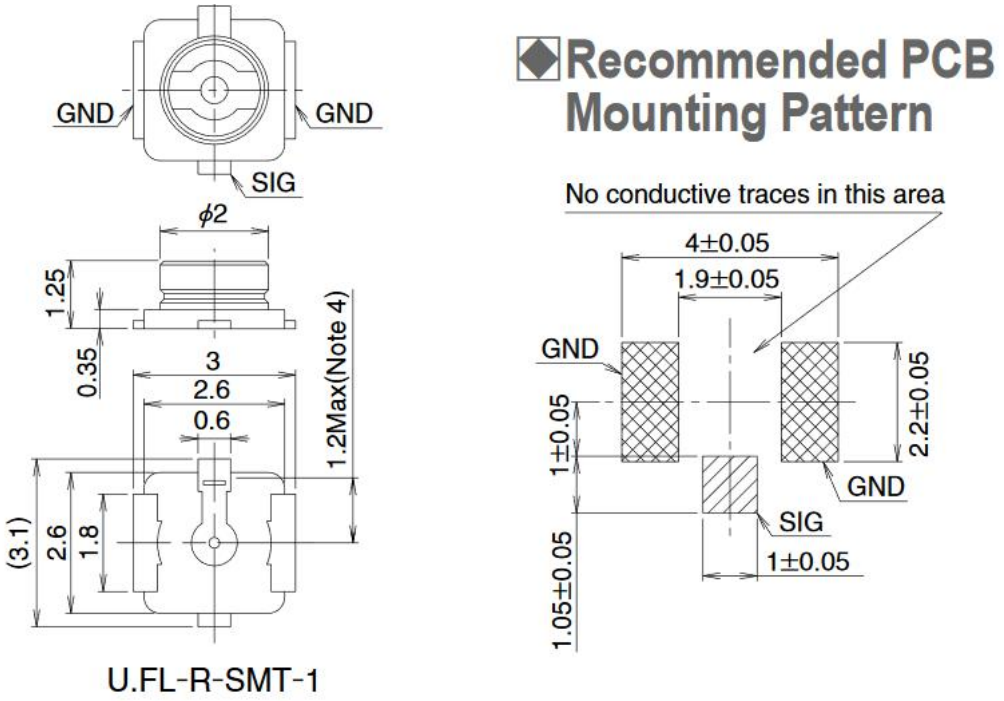


Figure 43: Hirose U.FL-R-SMT Connector's Size and Package

6 PCB Wiring

This chapter mainly introduces the requirements in PCB layout wiring. The purpose is to minimize the interference issue, to optimize the product performance, and to shorten the Research and Development (R&D) cycle.

6.1 Stack Selection

Highly recommend at least a four-layer through holes PCB layout design to facilitate impedance control and signal line shielding.

6.2 PCB Routing Guidelines

Highly recommend considering the following aspects in PCB layout design.

6.2.1 Antenna

SIM8500E (Dual Band WIFI) series modules has four antenna interfaces in total, including the ANT_TRX, the ANT_DRX, the ANT_GNSS, and the ANT_WIFI/BT. The requirements for the RF components are showing as follows.

- Ensure the RF lines are wiring with the 50Ω impedance.
- The RF lines must have a complete stereo ground plane.
- Add more ground holes around the RF signal lines and the reference ground to enhance the RF performance.
- The RF lines must away from the other interference sources, including the high-speed signals, the clock signals, the sound sensing devices, and the motor, etc.
- The RF lines shall be as short as possible to avoid loss and interference.
- Avoid wiring crossing the whole PCB. Avoid the right-angle routing. Highly recommend wiring with a circular arc or a 135-degree routing.
- Be aware of the distance between the components and the lower PCB ground, especially for the RF

connecting device package.

6.2.2 Power Supply & Ground

Highly recommend wiring the VBAT positive electrode as short and thick as possible. Highly recommend wiring through large capacitors and zener diodes before connecting to the power supply pin of the module. Considering the backflow ground of the power supply is necessary when routing. Wiring the VBAT to the ground path as shore as possible to ensure the lower impedance.

6.2.3 UIM Card

The requirements for the UIM card are showing as follows.

- Highly recommend the UIM card receptacle interface is away from the RF antennas.
- Highly recommend wiring the UIM card signals away from the RF signal lines, the VBAT, and the high-speed signal lines as far as possible.
- Highly recommend the ground of the UIM card is well connecting to the main ground of the module.
- Notice that well protect the UIM_CLK signal to prevent the interference from other signals.
- Highly recommend wiring the UIM card signals away from the return path of the VBAT because there is a large current passing through the return path on VBAT.

6.2.4 MIPI

The requirements for the MIPI signal are showing as follows.

- Two-phase differential pair routings with 85Ω differential impedance and the error at ±15Ω.
- Three-phase differential pair routings with 44Ω single ended and the error at ±15Ω.
- Highly recommend a complete stereo ground plane and the full reference ground.
- Highly recommend minimizing the number of vias.
- Highly recommend the total length of wiring is less than 305mm.
- Highly recommend the length difference in the group is less than 0.7mm.
- Highly recommend the length difference between groups is less than 1.4mm.

Table 36: MIPI Lane Wiring Difference

Pin Num	Net Name	Length(mm)
52	DSI_CLK_N	27.39
53	DSI_CLK_P	27.80

54	DSI_LN0_N	27.63
55	DSI_LN0_P	27.41
56	DSI_LN1_N	26.76
57	DSI_LN1_P	27.78
58	DSI_LN2_N	27.44
59	DSI_LN2_P	28.38
60	DSI_LN3_N	27.87
61	DSI_LN3_P	27.29
63	CSI1_CLK_N	11.29
64	CSI1_CLK_P	11.87
65	CSI1_LN0_N	13.34
66	CSI1_LN0_P	13.60
67	CSI1_LN1_N	15.47
68	CSI1_LN1_P	16.60
160	CSI1_LN2_N	5.25
161	CSI1_LN2_P	4.53
200	CSI1_LN3_N	2.76
201	CSI1_LN3_P	3.20
70	CSI0M_CLK_N	15.77
71	CSI0M_CLK_P	16.03
72	CSI0M_LN0_N	16.52
73	CSI0M_LN0_P	17.76
194	CSI0M_LN1_N	26.56
195	CSI0M_LN1_P	26.89
157	CSI0S_CLK_N	19.89
196	CSI0S_CLK_P	19.64
158	CSI0S_LN2_N	19.61
197	CSI0S_LN2_P	20.01
159	CSI0S_LN3_N	11.60
198	CSI0S_LN3_P	11.28

6.2.5 USB

The requirements for the USB signal are showing as follows.

- Highly recommend place the common mode inductance close to the USB connector.
- Differential pair routings with 90Ω differential impedance and the error at ±10%.
- Highly recommend the length difference of HS differential pair is less than 2.0mm.
- Highly recommend wiring the VBUS as wide as possible if the USB integrates the charging function.
- Highly recommend placing the testing points on the routing path to minimize the branch length.

- Place the data line of the USB signal away from sensitive circuits or signals because they are high-frequency signals. The sensitive signals include the RF signals, the audio signals, and the 38.4MHZ XO signals.
- Highly recommend reserved the RX and the TX at least 3 times the linewidth, and other signals 4 times the linewidth.

6.2.6 SD Card

The requirements for the SD card signal are showing as follows.

- Highly recommend a complete stereo ground plane and the full reference ground.
- Differential pair routings with 50Ω differential impedance and the error at ±10%.
- Highly recommend the length difference between the CLK and the DATA/CMD is less than 1mm.
- Highly recommend the line spacing at least 2 times the linewidth.
- Highly recommend the total capacitance on the signal line shall be less than 15pF.

6.2.7 Audio

The requirements for the audio signal are showing as follows.

- Highly recommend wiring the audio signal lines away from the antennas, the RF signal lines, and other high-speed signal lines.
- Highly recommend all the audio signal lines are wiring with a complete stereo ground plane and the full reference ground, and away from the return VBAT.
- Highly recommend wiring the MIC1_P/N, the EAR_P/ N, and the SPK_P/N as differential pairs.
- Highly recommend isolating the HPH_L and the HPH_R with the HPH_REF in the middle to decrease the crosstalk interference.
- Highly recommend wiring the 25mil line width for the SPK signal when picking an 8Ω load.
- Highly recommend wiring the 30mil line width for the SPK signal when picking a 4Ω load.

7 Electrical & Reliability

7.1 Absolute Maximum Value

Table 37: Absolute Maximum Value

Parameter	Description	Minimum	Maximum	Unit
VBAT	DC Supply Voltage	-0.3	5	V
USB_VBUS	USB 5V Supply Voltage	-0.3	12	V
I/O	Digital PIN Voltage	-0.3	1.98	V

7.2 Temperature Range

Table 38: Temperature Range

Parameter	Minimum	Typical	Maximum	Unit
Operating Temperature	-35	25	+75	℃
Storage Temperature	-40		+90	℃

7.3 Operating Voltage

Table 39: Operating Voltage

Parameter	Minimum	Typical	Maximum	Unit
VBAT	3.5	3.9	4.2	V
VBUS	4.5	5	9	V

7.4 Digital Interface Feature

Table 40: GPIO Electrical Feature

Parameter	Description	Minimum	Typical	Maximum	Unit
V_{IH}	High Level Input Voltage	1.39	-	2	V
V_{IL}	Low Level Input Voltage	-0.3	-	0.48	V
V_{OH}	High Level Output Voltage	1.46	-	1.85	V
V_{OL}	Low Level Output Voltage	-	-	0.2	V

7.5 Current Consumption (VBAT = 3.9V)

Table 41: Current Consumption (TBD)

Parameter	Condition	Minimum	Typical	Maximum	Unit
Shutdown Leakage Current	Shutdown Leakage Current		TBD		uA
Flight Mode	Flight Mode		TBD		mA
Standby Current	GSM/GPRS BS-PA-MFRMS=9 BS-PA-MFRMS=5 BS-PA-MFRMS=2		 TBD TBD TBD		mA
	WCDMA, 2.56sec,DRX=8		TBD		mA
	LTE-FDD, standby 2.56s, DRX=8		TBD		mA
	LTE-FDD, standby 1.28s, DRX=7		TBD		mA
	LTETDD, standby 2.56s, DRX=8		TBD		mA
Data Transmission Maximum Current	**WCDMA Max power** WCDMA B1 Max power@ 23dBm WCDMA B5 Max power@ 23dBm WCDMA B8 Max power@ 23dBm **LTE FDD Max power** B1 power@ 23dBm BW=10MHZ Channel= 18300 B3 power@ 23dBm BW=10MHZ Channel= 19575 B5 power@ 23dBm BW=10MHZ	 - - - - - - -	 TBD TBD TBD 630 670 550 660 544	 - - - -	mA

	Channel= 20525 B7 power@ 23dBm BW=10MHZ Channel= 21100 B8 power@ 23dBm BW=10MHZ Channel= 21625 B20 power@ 23dBm BW=10MHZ Channel= 24300 B28 power@ 23dBm BW=10MHZ Channel= 27435 **LTE TDD Max power** B38 power@ 23dBm BW=10MHZ Channel= 38000 B40 power@ 23dBm BW=10MHZ Channel= 39150 B41 power@ 23dBm BW=10MHZ Channel= 40620	- - - - -	568 528 310 330 306	-	
Peak Current	Control the power at the maximum level (Radio Frequency Burst)			3.0	A

7.6 Electrostatic Protection

Notice that the electrostatic protection is very important when producing, assembling and operating modules. The performance parameters of the module test results are as follows:

Table 42: ESD Feature (Temperature: 25℃, Humidity: 45%)

PIN Name	Contact Discharge	Air Discharge
VBAT	±5KV	±10KV
GND	±6KV	±12KV
Antenna Interface	±5KV	±10KV
Other Interface	±0.5KV	±1KV

7.7 Module Working Band

Table 43: Module Working Band

Frequency Band	Receiver	Emitter	Channel

GSM850	869-894MHz	824-849MHz	128-251
EGSM900	925-960MHz	880-915MHz	0-124, 975-1023
DCS1800	1805-1880MHz	1710-1785MHz	512-885
PCS1900	1930-1990MHz	1850-1910MHz	512-810
WCDMA B1	2110-2170 MHz	1920-1980 MHz	TX: 9612-9888 RX: 10562-10838
WCDMA B5	869-894MHz	824-849MHz	TX: 4132-4233 RX: 4357-4458
WCDMA B8	925-960MHz	880-915 MHz	TX: 2712-2863 RX: 2937-3088
LTE B1	2110-2170 MHz	1920-1980 MHz	TX: 18000-18599 RX: 0-599
LTE B3	1805-1880 MHz	1710-1785 MHz	TX: 19200-19949 RX: 1200-1949
LTE B5	869-894 MHz	824-849MHz	TX: 20400-20649 RX: 2400-2649
LTE B7	2620-2690MHz	2500-2570MHz	TX: 20750-21449 RX: 2750-3449
LTE B8	925-960 MHz	880-915 MHz	TX: 21450-21799 RX: 3450-3799
LTE B20	791-821MHz	832-862MHz	TX: 24150-24449 RX: 6150-6449
LTE B28	703-748MHz	758-803MHz	TX: 27210-27659 RX: 9210-9659
LTE B38	2570-2620 MHz	2570-2620 MHz	37750-38249
LTE B40	2300-2400 MHz	2300-2400 MHz	38650-39649
LTE B41	2555-2655 MHz	2555-2655MHz	40240-41240

7.8 RF Transmission Power

Table 44: Conducted Output Power

Frequency Band	Maximum	Minimum
GSM850	33dBm±2dB	5dBm±5dB
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
PCS1900	30dBm±2dB	0dBm±5dB
GSM850(8-PSK)	27dBm±3dB	5dBm±5dB
E-GSM900 (8-PSK)	27dBm±3dB	5dBm±5dB
DCS1800 (8-PSK)	26dBm±3dB	0dBm±5dB

PCS1900(8-PSK)	26dBm±3dB	0dBm±5dB
WCDMA B1	23dBm+1/-3dB	<-50dBm
WCDMA B5	23dBm+1/-3dB	<-50dBm
WCDMA B8	23dBm+1/-3dB	<-50dBm
LTE-FDD B1	23dBm±2dB	<-44dBm
LTE-FDD B3	23dBm±2dB	<-44dBm
LTE-FDD B5	23dBm±2dB	<-44dBm
LTE-FDD B7	23dBm±2dB	<-44dBm
LTE-FDD B8	23dBm±2dB	<-44dBm
LTE-FDD B20	23dBm±2dB	<-44dBm
LTE-FDD B28	23dBm±2dB	<-44dBm
LTE-TDD B38	23dBm±2dB	<-44dBm
LTE-TDD B40	23dBm±2dB	<-44dBm
LTE-TDD B41	23dBm±2dB	<-44dBm

7.9 Conducted Receiving Sensitivity

Table 45: Conducted Receiving Sensitivity

Frequency Band	Receiving Sensitivity (Typical)	Receiving Sensitivity (Maximum)
GSM850	<-108	3GPP standard
EGSM900	<-108	3GPP standard
DCS1800	<-108	3GPP standard
PCS1900	<-108	3GPP standard
WCDMA B1	<-109	3GPP standard
WCDMA B2	<-109	3GPP standard
WCDMA B4	<-109	3GPP standard
WCDMA B5	<-109	3GPP standard
WCDMA B8	<-109	3GPP standard
LTE FDD/TDD	Table 45	3GPP standard

Table 46: LTE Reference Sensitivity 3GPP Standard (QPSK)

E-UTRA Frequency Band Code	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Duplex Mode
1	-	-	-100	-97	-95.2	-94	FDD
2	-102.7	-99.7	-98	-95	-93.2	-92	FDD

3	-101.7	-98.7	-97	-94	-92.2	-91	FDD
4	-104.7	-101.7	-100	-97	-95.2	-94	FDD
5	-103.2	-100.2	-98	-95			FDD
6	-	-	-100	-97			FDD
7	-	-	-98	-95	-93.2	-92	FDD
8	-102.2	-99.2	-97	-94			FDD
9	-	-	-99	-96	-94.2	-93	FDD
10	-	-	-100	-97	-95.2	-94	FDD
11	-	-	-100	-97			FDD
12	-101.7	-98.7	-97	-94			FDD
13			-97	-94			FDD
14		-	-97	-94			FDD
17	-	-	-97	-94			FDD
18	-	-	-100	-97	-95.2	-	FDD
19	-	-	-100	-97	-95.2	-	FDD
20			-97	-94	-91.2	-90	FDD
21			-100	-97	-95.2		FDD
22			-97	-94	-92.2	-91	FDD
23	-104.7	-101.7	-100	-97			FDD
24			-100	-97			FDD
25	-101.2	-98.2	-96.5	-93.5	-91.7	-90.5	FDD
26	-103.2	-100.2	-98	-95	-92.2		FDD
28		-100.2	-98	-95	-93.2	-92	FDD
33	-	-	-100	-97	-95.2	-94	TDD
34	-	-	-100	-97	-95.2	-	TDD
35	-106.2	-102.2	-100	-97	-95.2	-94	TDD
36	-106.2	-102.2	-100	-97	-95.2	-94	TDD
37	-	-	-100	-97	-95.2	-94	TDD
38	-	-	-100	-97	-95.2	-94	TDD
39	-	-	-100	-97	-95.2	-94	TDD
40	-	-	-100	-97	-95.2	-94	TDD
41	-	-	-99	-96	-94.2	-93	TDD
42	-	-	-99	-96	-94.2	-93	TDD
43	-	-	-99	-96	-94.2	-93	TDD

8 Manufacture & Production

8.1 Top- and Bottom-View of the Module

Figure 44: Top- and Bottom-View of the Module

NOTE

This picture is the effect drawing of the module design.

8.2 Mechanical Dimensional Size

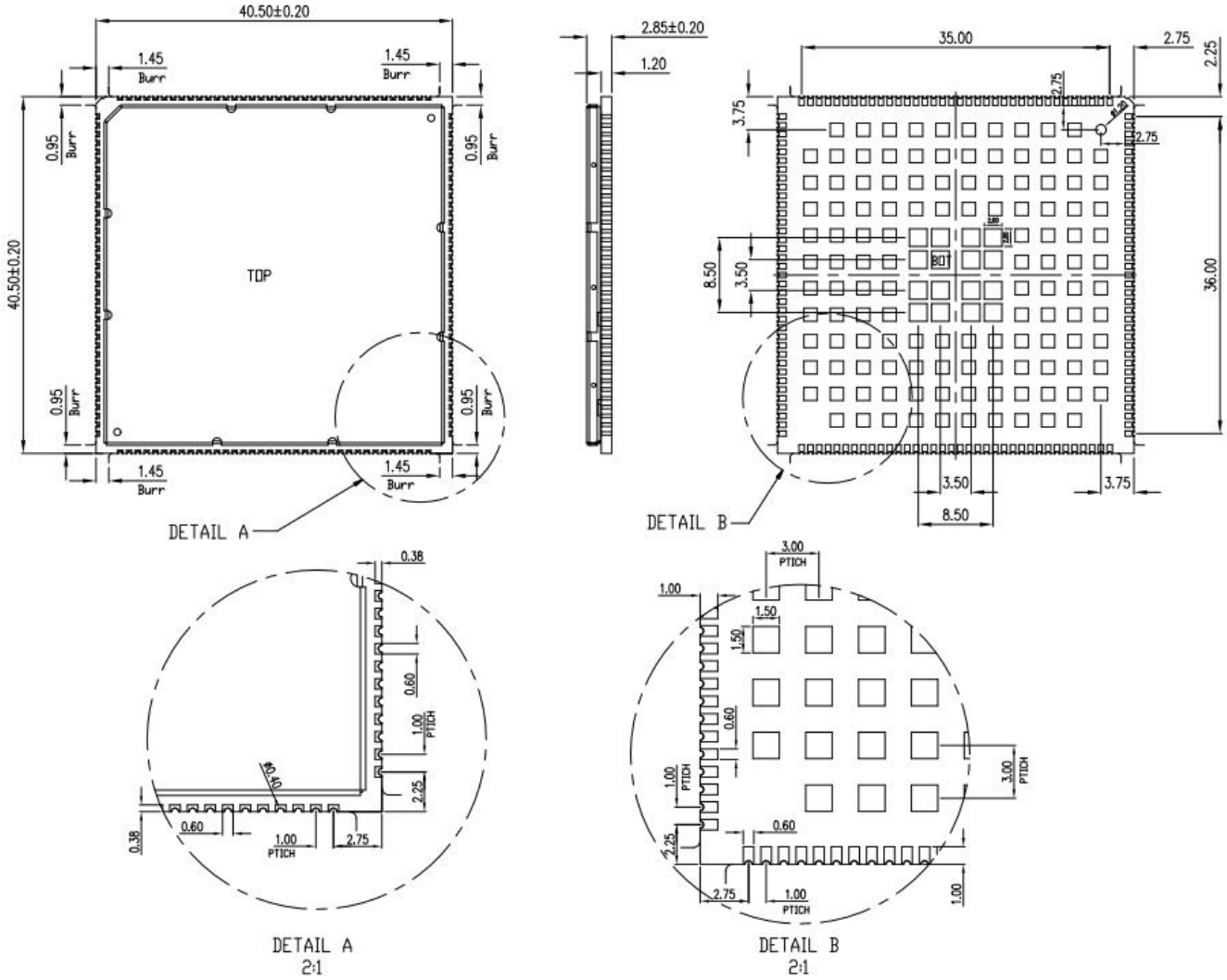


Figure 45: Three-Dimensional Size (Unit: mm)

8.3 Recommend Physical Outline Drawing

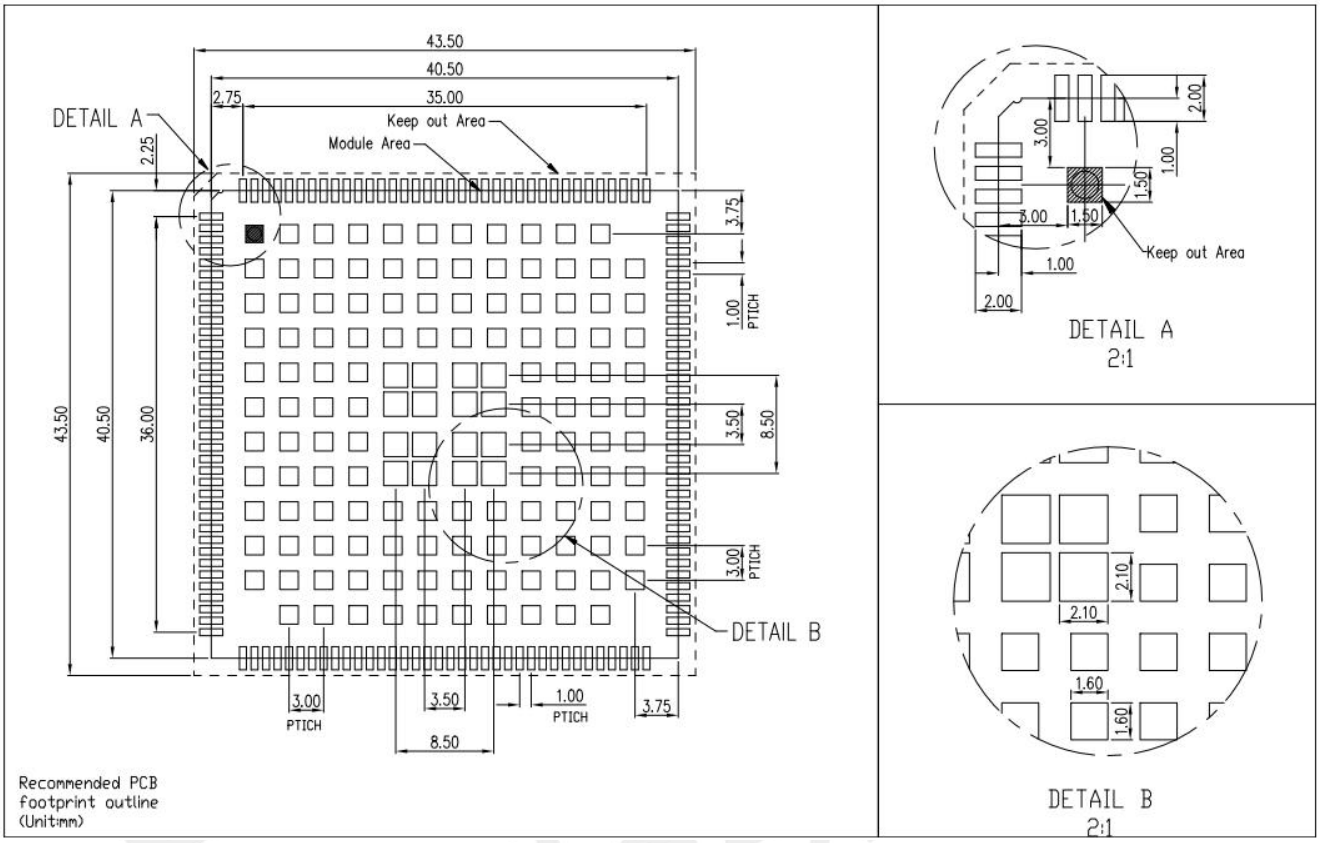


Figure 46: Recommend Physical Outline Drawing (Unit: mm)

8.4 Recommend Physical SMT Stencil Drawing

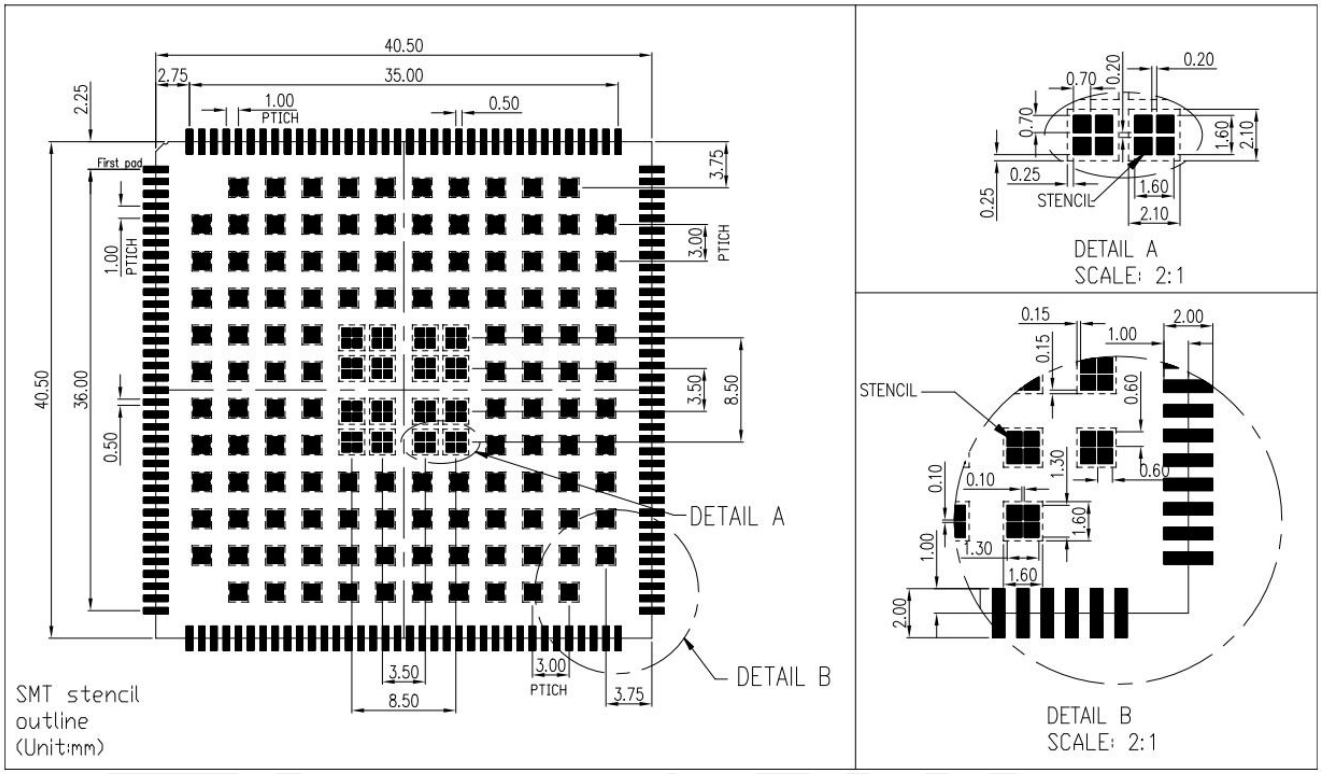
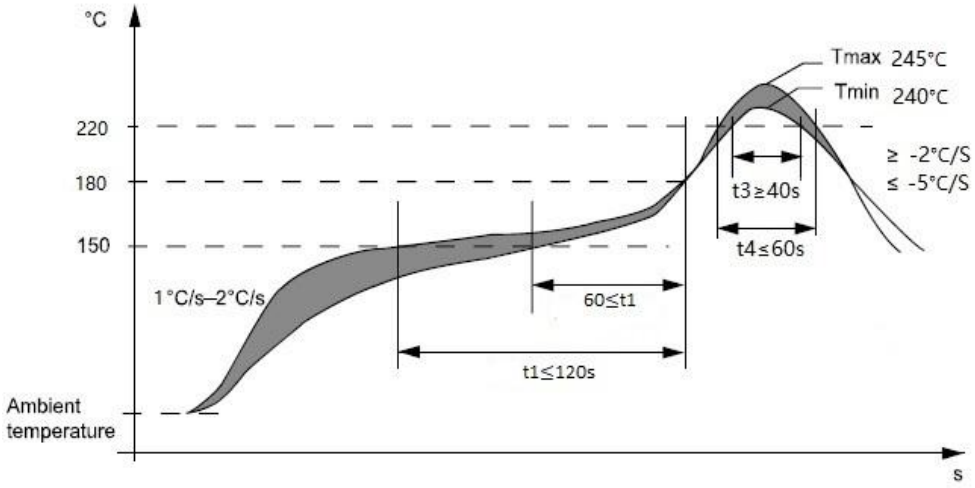


Figure 47: Recommend Physical SMT Stencil Drawing (Unit: mm)

8.5 Recommend Temperature Curve of Reflow Furnace



二、主板回流温度曲线要求说明

温区	时间	关键参数
预热区(室温～150℃)	NA	升温斜率：1～2℃/s
保温区(150～180℃)	60-120s	/
二次升温区（180-220℃）	15-20s	/
回流区(≥220℃)	50-70s	峰值温度：240～245℃
冷却区	冷却斜率：-2～-5℃/s	

备注：测试位置包含模块MCU焊点、底部LGA焊点及外部LCC管脚焊点

Figure 48: Recommend Temperature Curve of Reflow Furnace

NOTE

Please review the “Module Secondary-SMT-UGD” for detailed information on the module transmission, manufacture, and production.

8.6 Moisture Sensitivity Level (MSL)

The SIM8500E (Dual Band WIFI) module complies with the MSL Class 3.The dry packaging shall comply with J-STD-020C specification according to IPC/JEDEC standard when the environmental temperature is

under 30 degree and the relative humidity is less than 60%. The shelf life of the unpacking products shall be at least 6 months in the area where the environmental temperature is under 40 degree and the relative humidity is less than 90%.

Table 47: Moisture Sensitivity Level Classification

Classification	Factory Environment ≦ +30℃/60%RH
1	Indefinite Shelf Life Environment ≦+30℃/85% RH
2	1 Year
2a	4 Weeks
3	168 Hours
4	72 Hours
5	48 Hours
5a	24 Hours
6	Attaching after forced baking After baking, the module must be pasted within the time limit specified on the label

8.7 Baking Requirements

SIM8500E (Dual Band WIFI) series module should be full baked before reflow welding due to the moisture sensitivity level. Otherwise, the module may be permanently damaged during reflow welding. SIM8970x series module shall be baked for 192 hours in a low-temperature container with the temperature at 40°C +5°C /-0°C and a relative humidity of less than 5%. Or the module shall be baked for 8 hours in a high-temperature container with a temperature of 120°C±5°C. Note that the tray could not resistant to high temperature. The user should take the module out of the tray for baking, otherwise the tray may be damaged by high temperature.

Table 48: Baking Requirements

Optional Baking Condition	Baking Period
40°C±5°C，<5% RH	192 Hours
120°C±5°C，<5% RH	8 Hours

8.8 Packaging

The SIM8500E (Dual Band WIFI) module offers the following packaging size.

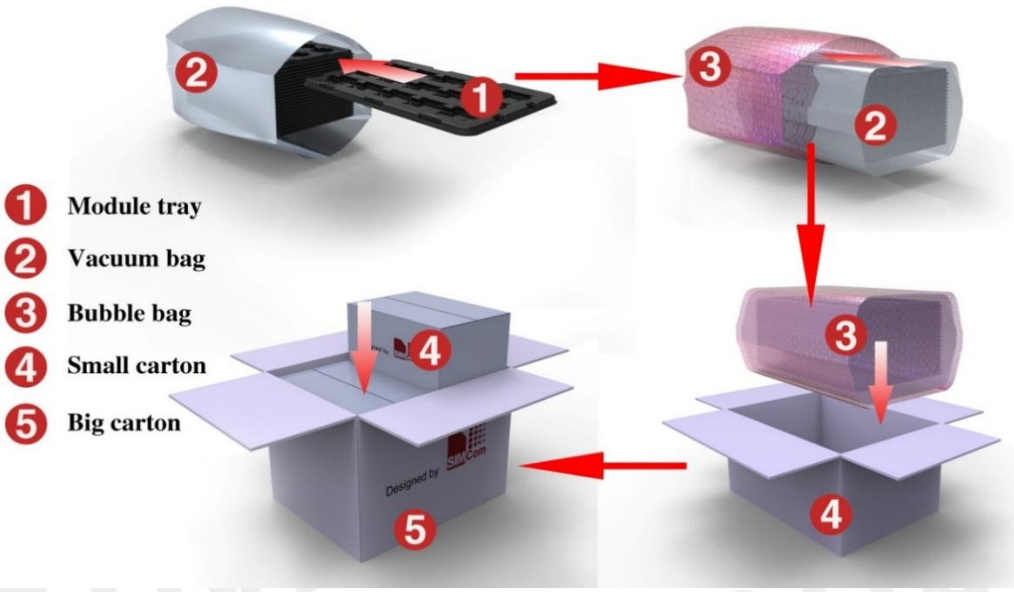


Figure 49: Packaging Diagram

The module tray of the SIM8500E (Dual Band WIFI) series module is showing as follows.

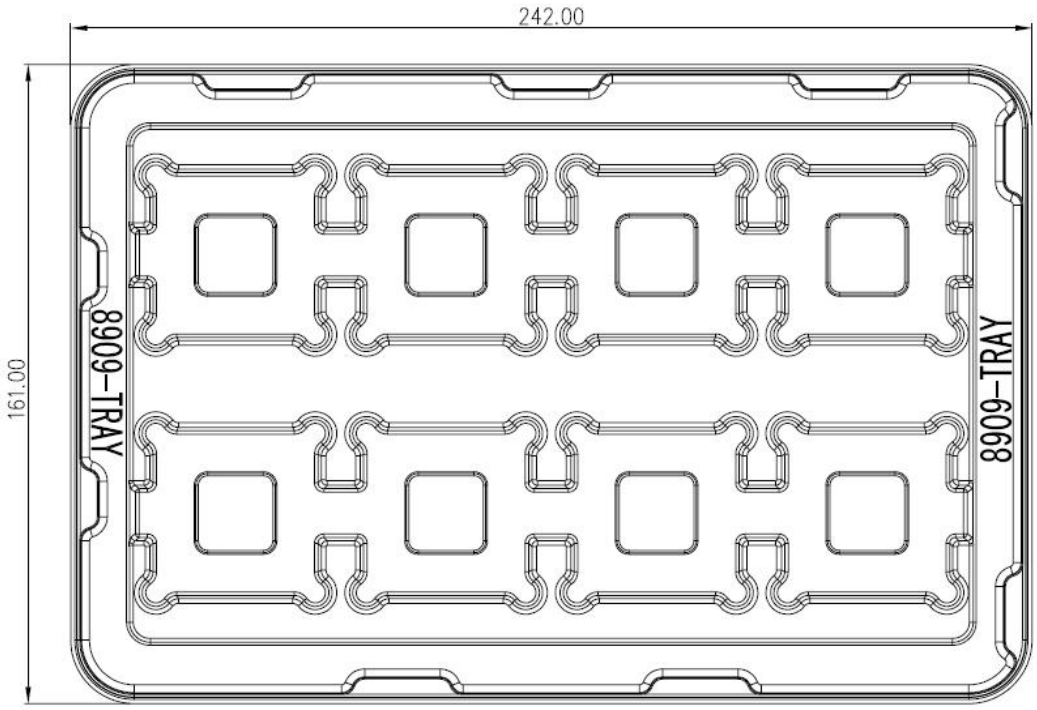


Figure 50: Module Tray Size

Table 49: Module Tray Size

Length（±3mm）	Width（±3mm）	Standard Packaging Num
242.0	161.0	8

The small carton size of the SIM8500E (Dual Band WIFI) series module is showing as follows.

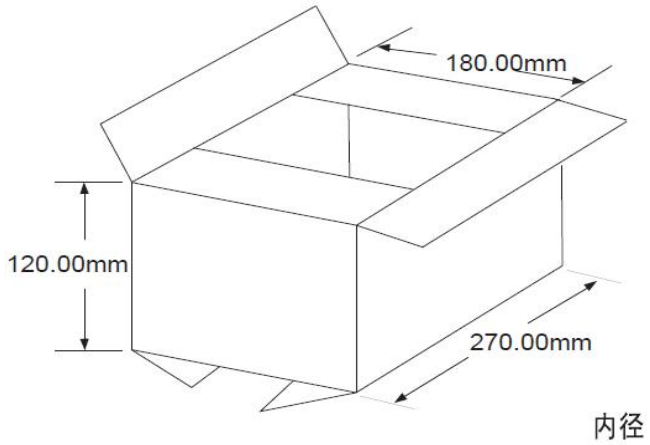


Figure 51: Small Carton Size

Table 50: Small Carton Size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Standard Packaging
270	180	120	8*19-2=150

The big carton size of the SIM8500E (Dual Band WIFI) series module is showing as follows.

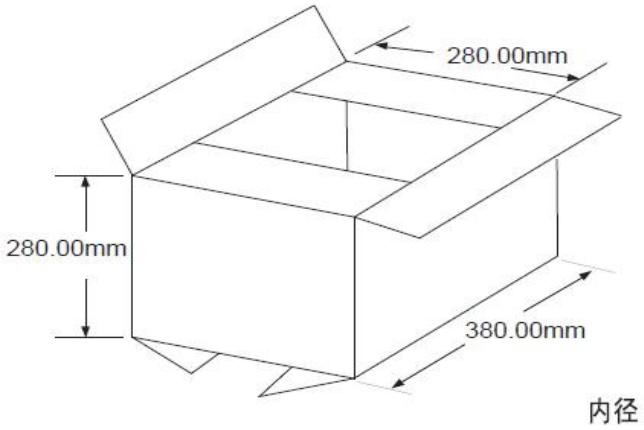


Figure 52: Big Carton Size

Table 51: Big Carton Size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Standard Packaging
380	280	280	150*4=600

9 Appendix

9.1 Relative Documents

Table 52: Relative Documents

No.	Document Name	Description
[1]	GSM 07.07 :	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[2]	GSM 07.10 :	Support GSM 07.10 multiplexing protocol
[3]	GSM 07.05 :	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[4]	GSM 11.14 :	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[5]	GSM 11.11 :	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[6]	GSM 03.38 :	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[7]	GSM 11.10	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification; Part 1: Conformance specification
[8]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[9]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[10]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[11]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[12]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3:

		Abstract Test Suites.
[13]	EN 301 908-02 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000. Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive
[14]	EN 301 489-24 V1.2.1	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
[15]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[16]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[17]	2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

9.2 Terms & Abbreviations

Table 53: Terms & Abbreviations

Terms	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
BOM	Bill of materials
bps	Bits per second
BT	Bluetooth
CDMA	Code division multiple access
CS	Coding Scheme
CSD	Circuit Switched Data
CSI	Camera serial interface
CTS	Clear to Send
DAC	Digital-to-analog converter
DDR	Double data rate
DSDA	Dual SIM dual active
DSDS	Dual SIM dual standby
DSP	Digital signal processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)

DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ESR	Effective series resistance
ETS	European Telecommunication Standard
EVDO	Evolution data optimized
FDD	Frequency division duplex
FR	Full Rate
GNSS	Global navigation satellite system
GPIO	General-purpose input/output
GPRS	General Packet Radio Service
GPU	Graphics processing unit
GSM	Global Standard for Mobile Communications
HR	Half Rate
HSPA	High-speed packet access
I2C	Inter-integrated circuit
IMEI	International Mobile Equipment Identity
ISP	Image signal processing
Kbps	kilobits per second
LCD	Liquid crystal display
LDO	Low dropout (linear regulator)
LPDDR	Low-power DDR
MIC	Microphone
MIPI	Mobile industry processor interface
PA	Power amplifier
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
RF	Radio Frequency
PM	Power management
RoHS	Restriction of hazardous substances
PPP	Point-to-point protocol
PWM1	Pulse-width modulator
RMS	Root Mean Square (value)
RTC	Real-time clock
RX	Receive Direction
SD	Secure digital

SDC	Secure digital controller
SIM	Subscriber Identification Module
SMS	Short Message Service
SMT	Surface mount technology
SPI	Serial peripheral interface
TDD	Time Division Distortion
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
UIM	User identity module
URC	Unsolicited Result Code
USB	Universal serial bus
USSD	Unstructured Supplementary Service Data
WCDMA	Wideband code division multiple access
WCN	Wireless connectivity network
WLAN	Wireless local area network

9.3 Safety Caution

Table 54: Safety Caution

Marks	Requirements
	When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive and not operate normally due to RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forgetting to think much of these instructions may impact the flight safety, or offend local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.

Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.

GSM cellular terminals or mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, especially with a mobile fee or an invalid SIM card. While you are in this condition and need emergent help, please remember to use emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.

Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call.

Also, some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.