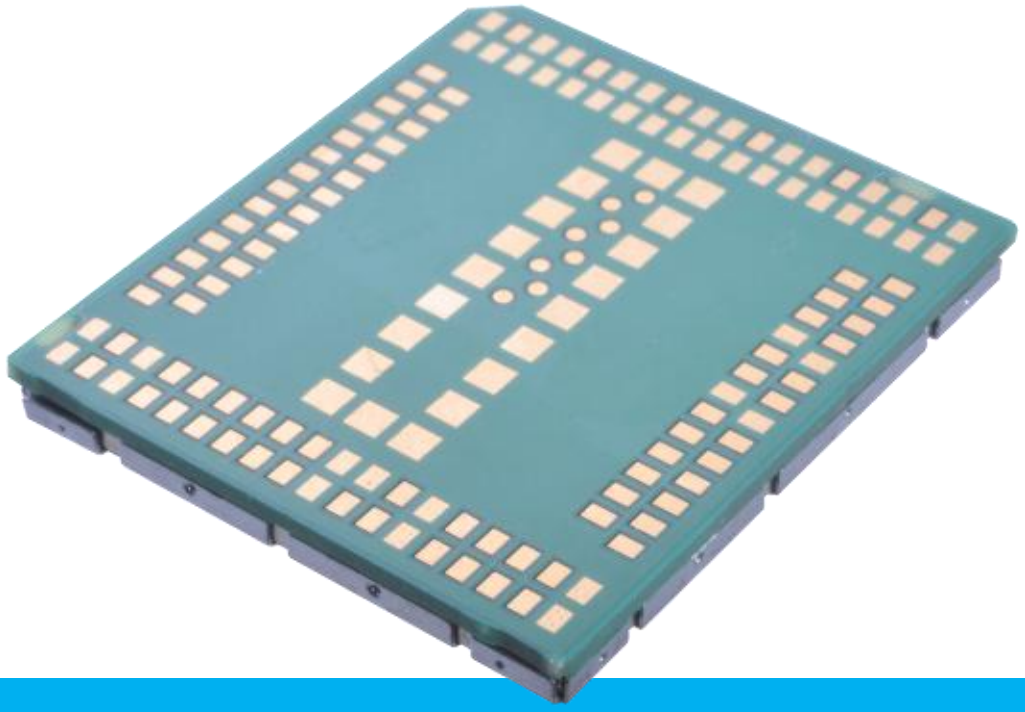

IMQ3 module user manual

Project Name: IMQ3 series Module

Author: Wistron NeWeb Corporation

Revision: 0.4

Revision Date: 2019/5/16

Contact Information

Technical Support website	https://SupportIoT.wnc.com.tw
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Revision History

Rev. #	Author	Summary of Changes	Date
0.1	WNC	Draft release	2018/12/25
0.2	WNC	Add FCC/IC Statement	2019/4/23
0.3	WNC	Remove the function diagram	2019/5/6
0.4	WNC	Update Antenna frequency range	2019/5/16

Contents

1. Introduction

The WNC IMQ3 series modules are includes the Qualcomm MDM9206 Cat. M1 baseband, a complete LTE RF front-end, memory, and required circuitry to fulfill 3GPP E-UTRA (Long Term Evolution - LTE, Rel-13 specifications). IMQ3 series modules provide a variety of interfaces including USB, SPI, UART, PCM, I2C, UIM.

1.1. Modules RF band support

This section lists main features and capability that IMQ3 series module support, for wireless technology and band support information among different modules, please refer to table1 for detail information.

Table 1. IMQ3 series module overview

Module	LTE CAT M1	GPRS/EGPRS	GPS
IMQ3-2	√	√	√
IMQ3-1	√	√	×
IMQ3-0	√	×	√
IMQ3-3	√	×	×

Note:
1. LTE global band definition is B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B28
2. EGPRS band definition is quad-band.
3. “ √ ” indicates supporting. “ × ” indicates not supporting.

1.2. Features

Feature list:

- LTE 3GPP release 13
- 3GPP category support: LTE Cat. M1 with 375 Kbps for UL, 300 Kbps for DL,
- Ultra-high-performance Cortex A7 microprocessor
- Modem subsystem (MSS)
- Resource and power management (RPM) subsystem
- Optimized for M2M and IoT markets
- Interfaces
  - HS USB 2.0 with integrated PHY
  - Dual UART interfaces (4 bit and 2 bit) for data transfer and diagnostic tools

- I2C/SPI interface
- USIM interface
- GPIOs
- ADC
- PCM/I2S

1.3. Module Connection Interface

The IMQ3 modules are LGA device. All electrical and mechanical connections are made through the 104 pads on the bottom side of the PCB.

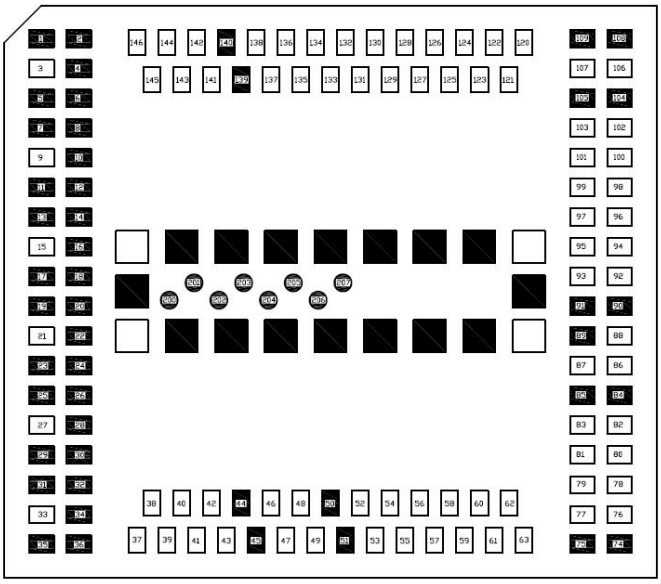


Figure 1. LGA pad

1.4. Environmental Specifications and Certifications

1.4.1. Environmental Specifications

The environmental specifications for both operating and storage conditions are defined in the table below.

Grade	Operating	3GPP compliant	Functional work	Storage
Industrial	–40 °C~+85 °C	–20 °C~+60 °C	–40 °C~+85 °C	–40 °C ~+85 °C

Note: The temperature above refers to ambient temperature.

1.4.2. Certifications

The IMQ3 module is compliant with the following regulations: PTCRB, GCF, FCC, IC, AT&T, Verizon and Sprint.

1.4.3. Green Product Compliance

RoHS (2011/65/EU)

2. Pin Definitions

2.1. LGA Module Pin Diagram

The IMQ3 LGA module pin layout is illustrated below.

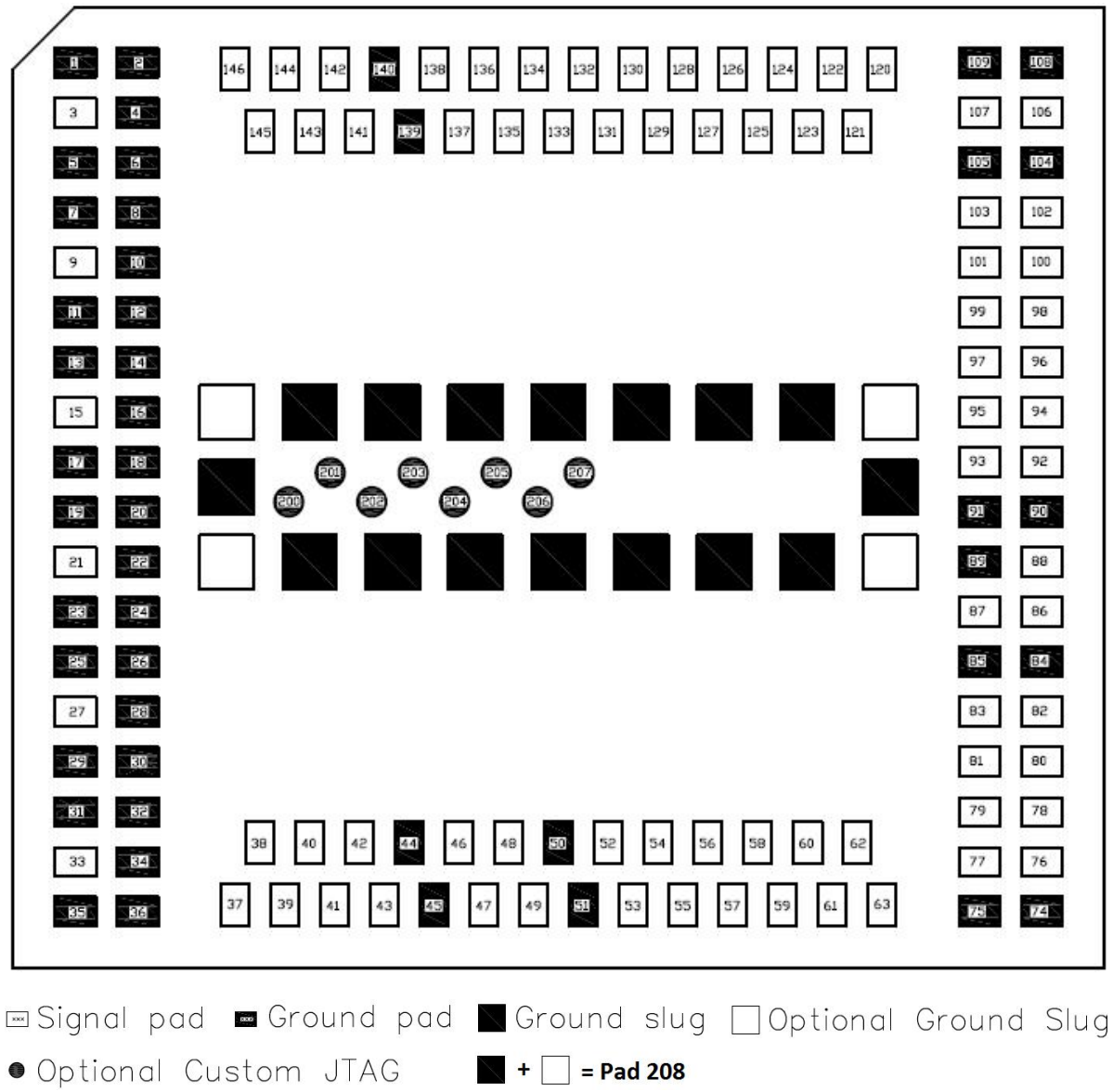


Figure 2. LGA pad diagram (top view)

2.2. LGA Module Pin Definitions

The signals and all the related details are listed in the below table.

Table 2. module pin definitions

Pin No.	PIN Definition	Voltage Level (V)		
		Min.	Typ.	Max.
1	GND	-	0	-
2	GND	-	0	-
3	NC	-	-	-
4	GND	-	0	-
5	GND	-	0	-
6	GND	-	0	-
7	GND	-	0	-
8	GND	-	0	-
9	RF_GNSS	-	-	-
10	GND	-	0	-
11	GND	-	0	-
12	GND	-	0	-
13	GND	-	0	-
14	GND	-	0	-
15	RF_1	-	-	-
16	GND	-	0	-
17	GND	-	0	-
18	GND	-	0	-
19	GND	-	0	-
20	GND	-	0	-
21	NC	-	-	-
22	GND	-	0	-
23	GND	-	0	-
24	GND	-	0	-
25	GND	-	0	-
26	GND	-	0	-
27	NC	-	-	-

28	GND	-	0	-
29	GND	-	0	-
30	GND	-	0	-
31	GND	-	0	-
32	GND	-	0	-
33	NC	-	-	-
34	GND	-	0	-
35	GND	-	0	-
36	GND	-	0	-
37	VCC1	3.3	3.8	4.2
38	VCC2	3.3	3.8	4.2
39	VCC3	3.3	3.8	4.2
40	VCC4	3.3	3.8	4.2
41	VCC5	3.3	3.8	4.2
42	VCC6	3.3	3.8	4.2
43	NC	-	-	-
44	GND	-	0	-
45	GND	-	0	-
46	PCM_SYNC/GPIO46 (RFU)	1.7	1.8	1.9
47	PCM_DIN/GPIO47 (RFU)	1.7	1.8	1.9
48	PCM_DOUT/GPIO48 (RFU)	1.7	1.8	1.9
49	PCM_CLK/GPIO49 (RFU)	1.7	1.8	1.9
50	GND	-	0	-
51	GND	-	0	-
52	Force USB BOOT Config	1.7	1.8	1.9
53	NC	-	-	-
54	GPIO03	1.7	1.8	1.9
55	NC	-	-	-
56	NC	-	-	-
57	NC	-	-	-
58	NC	-	-	-
59	NC	-	-	-
60	I2C_SDA/SPI_EN_1	1.7	1.8	1.9
61	I2C_SCL/SPI_CLK	1.7	1.8	1.9
62	SPI_MOSI	1.7	1.8	1.9

63	SPI_MISO	1.7	1.8	1.9
74	GND	-	0	-
75	GND	-	0	-
76	NC	-	-	-
77	NC	-	-	-
78	NC	-	-	-
79	NC	-	-	-
80	UART1_CTS (UART 1)	1.7	1.8	1.9
81	UART1_RTS (UART 1)	1.7	1.8	1.9
82	UART1_RX (UART 1)	1.7	1.8	1.9
83	UART1_TX (UART 1)	1.7	1.8	1.9
84	GND	-	0	-
85	GND	-	0	-
86	USB_Dp	-	Note6	-
87	USB Detect	1.7	1.8	1.9
88	USB_Dn	-	Note6	-
89	GND	-	0	-
90	GND	-	0	-
91	GND	-	0	-
92	GPIO92	1.7	1.8	1.9
93	GPIO93	1.7	1.8	1.9
94	GPIO94	1.7	1.8	1.9
95	GPIO95	1.7	1.8	1.9
96	GPIO96	1.7	1.8	1.9
97	GPIO97	1.7	1.8	1.9
98	GPIO98	1.7	1.8	1.9
99	NC	-	-	-
100	NC	-	-	-
101	GPIO101	1.7	1.8	1.9
102	GPIO102	1.7	1.8	1.9
103	NC	-	-	-
104	GND	-	0	-
105	GND	-	0	-
106	UART2_RX (UART 2)	1.7	1.8	1.9
107	UART2_TX (UART 2)	1.7	1.8	1.9

108	GND	-	0	-
109	GND	-	0	-
120	NC	-	-	-
121	NC	-	-	-
122	AD Converter	0.1	-	1.7
123	NC	-	-	-
124	NC	-	-	-
125	NC	-	-	-
126	NC	-	-	-
127	NC	-	-	-
128	NC	-	-	-
129	GPIO05	1.7	1.8	1.9
130	GPIO06	1.7	1.8	1.9
131	NC	-	-	-
132	NC	-	-	-
133	UIM_VCC	1.7/2.7	1.8/3.0	1.9/3.3
134	UIM_DATA	1.7/2.7	1.8/3.0	1.9/3.3
135	UIM_CLK	1.7/2.7	1.8/3.0	1.9/3.3
136	UIM_RESET	1.7/2.7	1.8/3.0	1.9/3.3
137	UIM_DETECT	1.7	1.8	1.9
138	NC	-	-	-
139	GND	-	0	-
140	GND	-	0	-
141	WWAN_STATE	1.7	1.8	1.9
142	POWER_ON/WAKEUP_IN	1.7	1.8	1.9
143	WAKEUP_OUT	1.7	1.8	1.9
144	NC	-	-	-
145	RESET	1.7	1.8	1.9
146	VREF	1.7	1.8	1.9
200	NC	-	-	-
201	NC	-	-	-
202	NC	-	-	-
203	NC	-	-	-
204	NC	-	-	-
205	NC	-	-	-

206	NC	-	-	-
207	NC	-	-	-

3. Electrical Specifications

3.1. Power supply

The IMQ3 modules are supplied through the power signal with the following characteristics.

Table 3. Power supply

	Direction	Vmin	Typical	Vmax
Power (37–42)	In	3.3 V	3.8 V	4.2 V
VREF	Out	1.71 V	1.8 V	1.89 V
UIM_VCC	Out	1.71 V	1.8 V	1.89 V
		2.85 V	3.0 V	3.15 V

3.2. Power consumption

This section describes typical power consumption of IMQ3 for reference. The current data is measured at 3.8V VCC.

Powering on	**Conditions**	**Result**
Peak power consumption		
	Max transient current consumption when the module runs at the maximum power.	620mA
Power off	**Conditions**	**Result**
Power off consumption		
	Only the module; no other devices; only RTC functions in deep sleep.	9.4uA
Working Mode	Conditions	Result

LTE Band 1 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	173mA
LTE Band 2 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	171mA
LTE Band 3 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	156mA
LTE Band 4 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	157mA
LTE Band 5 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	171mA
LTE Band 8 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	177mA
LTE Band 12 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	174mA
LTE Band 13 working mode		

	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	164mA
LTE Band 18 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	173mA
LTE Band 19 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	179mA
LTE Band 20 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	179mA
LTE Band 25 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	169mA
LTE Band 26 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	173mA
LTE Band 28 working mode		
	Max Tx power without throughput, Power voltage 3.8 V; average current, CMW500 eMTC mode.	174mA
GPRS working mode(1DL4UL)		
	Max Tx power without throughput, Power voltage 3.8 V; average current, GSM850	281.84mA

	Max Tx power without throughput, Power voltage 3.8 V; average current, GSM900	281mA
	Max Tx power without throughput, Power voltage 3.8 V; average current, DCS1800	236mA
	Max Tx power without throughput, Power voltage 3.8 V; average current, PCS1900	220.55mA
Low power Mode	Conditions	Result
Idle mode		
	LTE Standby, 1.28s	1.66mA
	LTE Standby, 2.56s	1.307mA
e-DRX mode		
	LTE standby 10MHz w/81.92s e-DRX PTW 20.48 and DRx 2.56Sec	0.902mA
PSM mode		
	T3412-Extended=24H,T3324=10s, One PSM cycle per day	20.57uA
Rock bottom current		
	Only the module; no other devices; only RTC functions in deep sleep.	9.4uA

Note: USB is disabled when testing airplane mode and standby mode.

3.3. I/O Interface

I/O type description:

- AO : Analog Output
- AI : Analog Input
- DO : Digital Output
- DI : Digital Input

Table 4. Pin interface family

Interface Family	Signal	Description	I/O
RF Interfaces			
	RF_GNSS	Reserved for GNSS receiver	AI
	RF_1	Main Antenna	AI/AO
User Identity Module			
	UIM_VCC	Power source for UIM	AO
	UIM_DATA	Data in/out	DI/DO
	UIM_CLK	Clock signal	DO
	UIM_RESET	Reset signal	DO
	UIM_DETECT	UIM Detect signal	DI/DO
Data Interfaces- USB 2.0			
	USB_HS_DP	USB Data Positive	DI/DO
	USB Detect	USB Detect	DI
	USB_HS_DM	USB Data Negative	DI/DO
Data Interfaces- UART1			
	UART1_CTS_N	Clear To Send for UART 1	DI
	UART1_RFR_N	Ready for receive for UART1	DO
	UART1_RX	Receive for UART 1	DI
	UART1_TX	Transmit for UART 1	DO
Data Interfaces- UART2			
	UART2_RX	Receive for UART 2	DI
	UART2_TX	Transmit for UART 2	DO
Data Interfaces- I2C/ SPI			
	I2C_SDA	Data in/out	DI/DO

	SPI_EN_1	SPI chip select	DO
	I2C_SCL	Clock signal	DO
	SPI_CLK	SPI serial clock	DO
	SPI_MOSI	SPI master out slave in	DO
	NC	NC	-
	SPI_MISO	SPI master in slave out	DI
Module Control and State Interfaces			
	WWAN_STATE	Wireless WAN Radio State	DO
	POWER_ON	Power On the module	DI
	WAKEUP_OUT	Module wakes up host	DO
	WAKEUP_IN	Host wakes up module	DI
	RESET	Reset the module	DI
Power and Ground			
	VREF	Voltage Reference Output	AO
	VCC	Main Power	AI
	GND	GND	AI
General Purpose			
	GPIO	Digital I/O	DI/DO
	ADC_CONVENTOR	ADC_CONVENTOR	AI
AUDIO- PCM/I2S（RFU）			
	PCM_DIN	PCM_DIN	DI
	I2S_DATA0	I2S_DATA0	DI/DO
	PCM_DOUT	PCM_DOUT	DO
	I2S_DATA1	I2S_DATA1	DI/DO
	PCM_CLK	PCM_CLK	DO
	I2S_SCK	I2S_SCK	DO
	PCM_SYNC	PCM_SYNC	DO
	I2S_WS	I2S_WS	DO
RFU- RFU			
	RFU	Reserved For Future Use	-
Debug- Force_USB_BOOT			
	Force_USB_BOOT_CONFIG	Force USB BOOT CONFIG	DI

Notes: *2. Do not pull pin143 WAKEUP_OUT to high; otherwise boot will fail.

*3. Pull Pin144 WAKEUP_IN to VREF with a 100k resistor and keep it high before system boot process is complete.

*4. Pull pin142 POWER_ON to VREF with a 100k resistor for stability considerations.

*6. Refer to section 2.3, for more information please check USB2.0 standard

*8. Pull pin87 USB detect to VREF with a 100k resistor to enable module USB, pull pin87 low to disable module USB, CPU USB PHY consumes some current when USB is enabled.

*9. Do not pull pin52 to high before the system boot process is complete.

*10. Leave unused pins floating

*11. Reserve test points on pin52/86/88/106/107 for debug purpose if possible.

*12. If voltage level of digital I/O from the other side is not compatible with module, level shifter is recommended to transfer the voltage level to 1.8V.

⚠ Note2,3,4,8,9,10 must be followed otherwise module may fail or malfunction.

Table 5. Digital I/O characteristics

Parameter		Comments	Min	Max	Unit
V_{IH}	High-level input voltage	CMOS/Schmitt	0.65 * V_{DD_Px}	–	V
V_{IL}	Low-level input voltage	CMOS/Schmitt	–	0.35 * V_{DD_Px}	V
V_{OH}	High-level output voltage	CMOS, at rated drive strength	V_{DD_Px} - 0.45		V
V_{OL}	Low-level output voltage	CMOS, at rated drive strength	–	0.45	V
R_P	Pull resistance	Pullup and pulldown	55	390	kΩ
R_K	Keeper resistance		30	150	kΩ
I_{IH}	Input high leakage current	No pulldown	–	1	µA
I_{IL}	Input low leakage current [4]	No pullup	-1	–	µA
V_{SHYS}	Schmitt hysteresis voltage		100	–	mV
$C_{I/O}$	I/O capacitance		–	5	pF

Below is the I/O default setting table to describe the level. It's recommended to follow the pulling High or Low to choose a suitable GPIO for application.

PU: Pull Up.

PD: Pull Down

NP: Non-Pull

Table 6. I/O default setting table

Pin No.	Signal Name	Type	Default setting in Normal mode
46	PCM_SYNC/GPIO46(RFU)	DI /DO	PD
47	PCM_IN/GPIO47(RFU)	DI /DO	PD
48	PCM_OUT/GPIO48(RFU)	DI /DO	PD
49	PCM_CLK/GPIO49(RFU)	DI /DO	PD
52	Force USB BOOT Config	DI/DO	PD
54	GPIO03	DI/DO	PD
60	I2C_SCL/SPI_CLK	DI/DO	PD
61	I2C_SDA/SPI_EN_1	DI/DO	PD
62	SPI_MOSI	DI/DO	PD
63	SPI_MISO	DI/DO	PD
80	UART1_CTS (UART1)	DI/DO	PD
81	UART1_RTS (UART1)	DI/DO	PD
82	UART1_RX (UART1)	DI/DO	PD
83	UART1_TX (UART1)	DI/DO	PD
92	GPIO92	DI/DO	PD
93	GPIO93	DO	NP
94	GPIO94	DI/DO	PD
95	GPIO95	DI/DO	PD
96	GPIO96	DI/DO	PD
97	GPIO97	DI/DO	PD
98	GPIO98	DI/DO	PU
101	GPIO101	DI/DO	PD
102	GPIO102	DI/DO	PD
106	UART2_RX (UART2)	DI/DO	PD
107	UART2_TX (UART2)	DI/DO	PD
120	GPIO120	DI/DO	PD
129	GPIO05	DI/DO	PD
130	GPIO06	DI/DO	PD
141	WWAN_STATE	DI/DO	PD
143	WAKEUP_OUT	DI/DO	PD
144	WAKEUP_IN	DI	PD

3.4. USB interface

The IMQ3 series modules comply with USB 2.0 high-speed protocol. The USB input/output lines follow USB 2.0 specifications.

Table 7. Signals of the USB interface

Name	Description	Input/Output (Direction to module)	Voltage Level (V)		
			Min.	Typ.	Max.
D+					
	USB data positive (low-/full-speed)				
		Input High	2	3.3	3.6
		Input Low	0		0.8
		Output High	2.8	3.3	3.6
		Output Low			0.3
	USB data positive (high-speed)				
		Input High	0.3		0.44
		Input Low	0		0.01
		Output High	0.36	0.38	0.44
		Output Low	0		0.01
D–					
	USB data negative (low-/full-speed)				
		Input High	2	3.3	3.6
		Input Low	0		0.8
		Output High	2.8	3.3	3.6
		Output Low			0.3
	USB data negative (high-speed)				
		Input High	0.3		0.44
		Input Low	0		0.01
		Output High	0.36	0.38	0.44
		Output Low	0		0.01

3.5. UIM interface

IMQ3 series modules provide an UIM_DETECT input pin for UIM connector to detect UIM card. When UIM card is present, UIM_DETECT should be high(1.8V). If UIM card is absent, UIM_DETECT should be low. It's required to pull UIM_DETECT to VREF with a 470k resistor. A 0.1µF and a 33pF capacitor are recommended to place between UIM_VCC and Ground in parallel. A 33pF capacitor is recommended to place between UIM_RESET, UIM_CLK and UIM_DATA and Ground in parallel see Figure5 for reference.
Electrostatic discharge (ESD) protection circuit is also recommended to place near the UIM socket as close as possible, and the Ground pin of the ESD protection component must be well connected to the Ground plane.

The following figure shows an example of UIM card circuit.

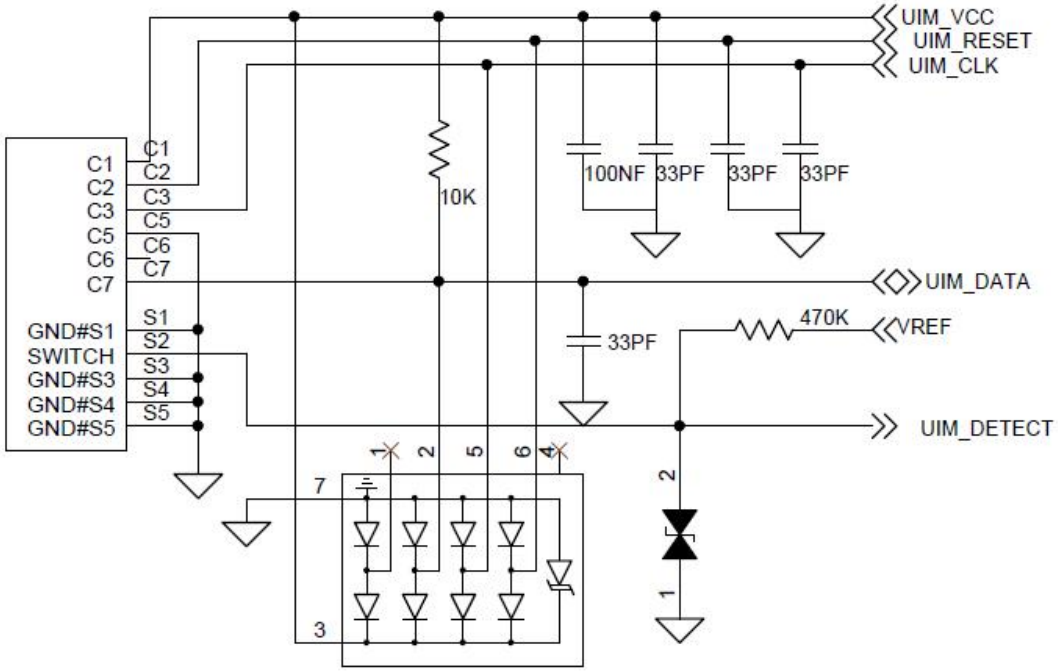


Figure 3. UIM card circuit example

It's highly suggested to make sure that SIM electrical characteristics can meet ETSI TS 102 221 requirement before going to certification like PTCRB. Refer to the following capture from ETSI TS 102 221 section 5 for critical requirement:

5.2 Class B operating conditions

5.2.1 Supply voltage Vcc (contact C1)

The terminal shall operate the UICC within the following limits.

Table 5.5: Electrical characteristics of Vcc under normal operating conditions

Symbol	Minimum	Maximum	Unit
Vcc	2,7	3,3	V

5.2.2 Reset (RST) (contact C2)

The terminal shall operate the UICC within the following limits.

Table 5.6: Electrical characteristics of RESET (RST) under normal operating conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{OH}	I_{OHmax} = +20 µA	0,8 x Vcc	Vcc (see note)	V
V_{OL}	I_{OLmax} = -200 µA	0 (see note)	0,2 x Vcc	V
t_R t_F	C_{in} = C_{out} = 30 pF		400	µs
NOTE: To allow for overshoot the voltage on RST should remain between -0,3 V and Vcc + 0,3 V during dynamic operations.				

5.2.3 Clock CLK (contact C3)

The terminal shall support 1 MHz to 5 MHz. The terminal shall supply the clock. When only the interface specified in the present document is activated, no "internal clock" shall be used in the UICC.

The duty cycle shall be between 40 % and 60 % of the period during stable operation.

The terminal shall operate the UICC within the following limits.

Table 5.7: Electrical characteristics of Clock (CLK) under normal operating conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{OH}	I_{OHmax} = +20 µA	0,7 x Vcc	Vcc (see note)	V
V_{OL}	I_{OLmax} = -20 µA	0 (see note)	0,2 x Vcc	V
t_R t_F	C_{in} = C_{out} = 30 pF		50	ns
NOTE: To allow for overshoot the voltage on CLK should remain between -0,3 V and Vcc + 0,3 V during dynamic operations.				

5.2.4 I/O (contact C7)

Table 5.8 defines the electrical characteristics of the I/O (contact C7). The values given in the table allow the derivation of the values of the pull-up resistor in the terminal and the impedance of the drivers and receivers in the terminal and UICC.

Table 5.8: Electrical characteristics of I/O under normal operating conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{IH}	I_{IHmax} = ±20 µA (see note 2)	0,7 x Vcc	Vcc + 0,3	V
V_{IL}	I_{ILmax} = +1 mA	-0,3	0,2 x Vcc	V
V_{OH} (see note 1)	I_{OHmax} = +20 µA	0,7 x Vcc	Vcc (see note 3)	V
V_{OL}	I_{OLmax} = -1mA	0 (see note 3)	0,4	V
t_R t_F	C_{in} = C_{out} = 30 pF		1 100 (see note 4)	µs ns

NOTE 1: It is assumed that a pull-up resistor is used on the interface device (recommended value: 20 kΩ).
NOTE 2: During static conditions (idle state) only the positive value can apply. Under dynamic operating conditions (transmissions) short-term voltage spikes on the I/O line may cause a current reversal.
NOTE 3: To allow for overshoot the voltage on I/O shall remain between -0,3 V and Vcc + 0,3 V during dynamic operation.
NOTE 4: This value applies when the low impedance buffer is selected.

5.3 Class C operating conditions

5.3.1 Supply voltage Vcc (contact C1)

The terminal shall operate the UICC within the following limits.

Table 5.9: Electrical characteristics of Vcc under normal operating conditions

Symbol	Minimum	Maximum	Unit
Vcc	1,62	1,98	V

5.3.2 Reset (RST) (contact C2)

The terminal shall operate the UICC within the following limits.

Table 5.10: Electrical characteristics of RESET (RST) under normal operating conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{OH}	I_{OHmax} = +20 µA	0,8 x Vcc	Vcc (see note)	V
V_{OL}	I_{OLmax} = -200 µA	0 (see note)	0,2 x Vcc	V
t_R t_F	C_{in} = C_{out} = 30 pF		400	µs

NOTE: To allow for overshoot the voltage on RST should remain between -0,3 V and Vcc + 0,3 V during dynamic operations.

5.3.3 Clock CLK (contact C3)

Table 5.11: Electrical characteristics of Clock (CLK) under normal operating conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{OH}	I_{OHmax} = +20 µA	0,7 x Vcc	Vcc (see note)	V
V_{OL}	I_{OLmax} = -20 µA	0 (see note)	0,2 x Vcc	V
t_R t_F	C_{in} = C_{out} = 30 pF		50	ns

NOTE: To allow for overshoot the voltage on CLK should remain between -0,3 V and Vcc + 0,3 V during dynamic operations.

5.3.4 I/O (contact C7)

Table 5.12 defines the electrical characteristics of the I/O (contact C7). The values given in the table allow the derivation of the values of the pull-up resistor in the terminal and the impedance of the drivers and receivers in the terminal and UICC.

Table 5.12: Electrical characteristics of I/O under normal operating conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{IH}	I_{IHmax} = ±20 µA (see note 2)	0,7 x Vcc	Vcc + 0,3	V
V_{IL}	I_{ILmax} = +1 mA	-0,3	0,2 x Vcc	V
V_{OH} (see note 1)	I_{OHmax} = +20 µA	0,7 x Vcc	Vcc (see note 3)	V
V_{OL}	I_{OLmax} = -1mA	0 (see note 3)	0,3	V
t_R t_F	C_{in} = C_{out} = 30 pF		1 100 (see note 4)	µs ns

NOTE 1: It is assumed that a pull-up resistor is used on the interface device (recommended value: 20 kΩ).
NOTE 2: During static conditions (idle state) only the positive value can apply. Under dynamic operating conditions (transmissions) short-term voltage spikes on the I/O line may cause a current reversal.
NOTE 3: To allow for overshoot the voltage on I/O shall remain between -0,3 V and Vcc + 0,3 V during dynamic operation.
NOTE 4: This value applies when the low impedance buffer is selected.

3.6. Control interface

This section describes the power-on/off, wake-up and reset interface on how to control the module.

3.6.1. Power-on/ WAKEUP_IN Signal

The POWER_ON is an active Low input signal used to enable or disable the module. Do not toggle the PERST# pin during power-on. This signal has the highest priority over the wakeup, the alarms signals, and the digital control pins.

There are three possible states of the module:

- Module Off - VCC is not present.
- Module Enabled - VCC is supplied, and the module is enabled.
- Module Disabled - VCC is supplied, and the module is disabled.

The state transitions are defined as follows:

- When voltage is applied to VCC, the module shall enter the Module Disabled state.
- An input to the POWER_ON pin shall trigger the transition from the Module Disabled to the Module Enabled state. See figure6, a low pulse(tlow > 0s) on

POWER_ON pad will enable the module after VCC is applied.

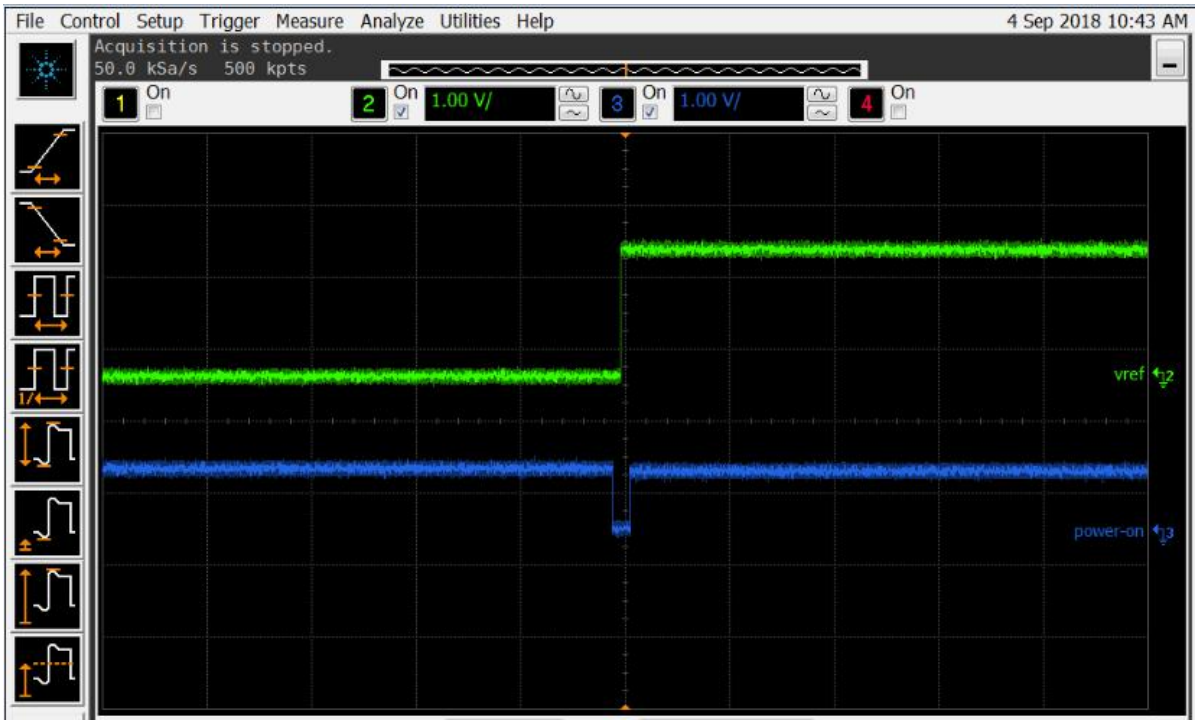


Figure 4. Power ON/OFF timing

After module power on, it also can wakeup the module in PSM deep sleep mode if host want to transmit data.

WAKEUP_IN description: (Host: Output, Modem: Input)

– HIGH:

Host does not require the modem (allowing it to enter PSM deep-sleep mode).

– LOW:

If the modem is in PSM deep-sleep mode, set this pin to low level will wakeup the modem.

3.6.2. WAKEUP_OUT interface

"WAKEUP_OUT" (Host: Input, Modem: Output):

- LOW: The modem is power off or in PSM deep-sleep mode.
- HIGH: The modem is normal/eDRX /DRX mode and other status.

3.6.3. Reset Signal

T he Reset Signal is a hardware reset signal to control the system reset directly. You can connect it to a key or a control signal. A low pulse(3s<tlow<4s) after power on will reset the

module, see figure7.

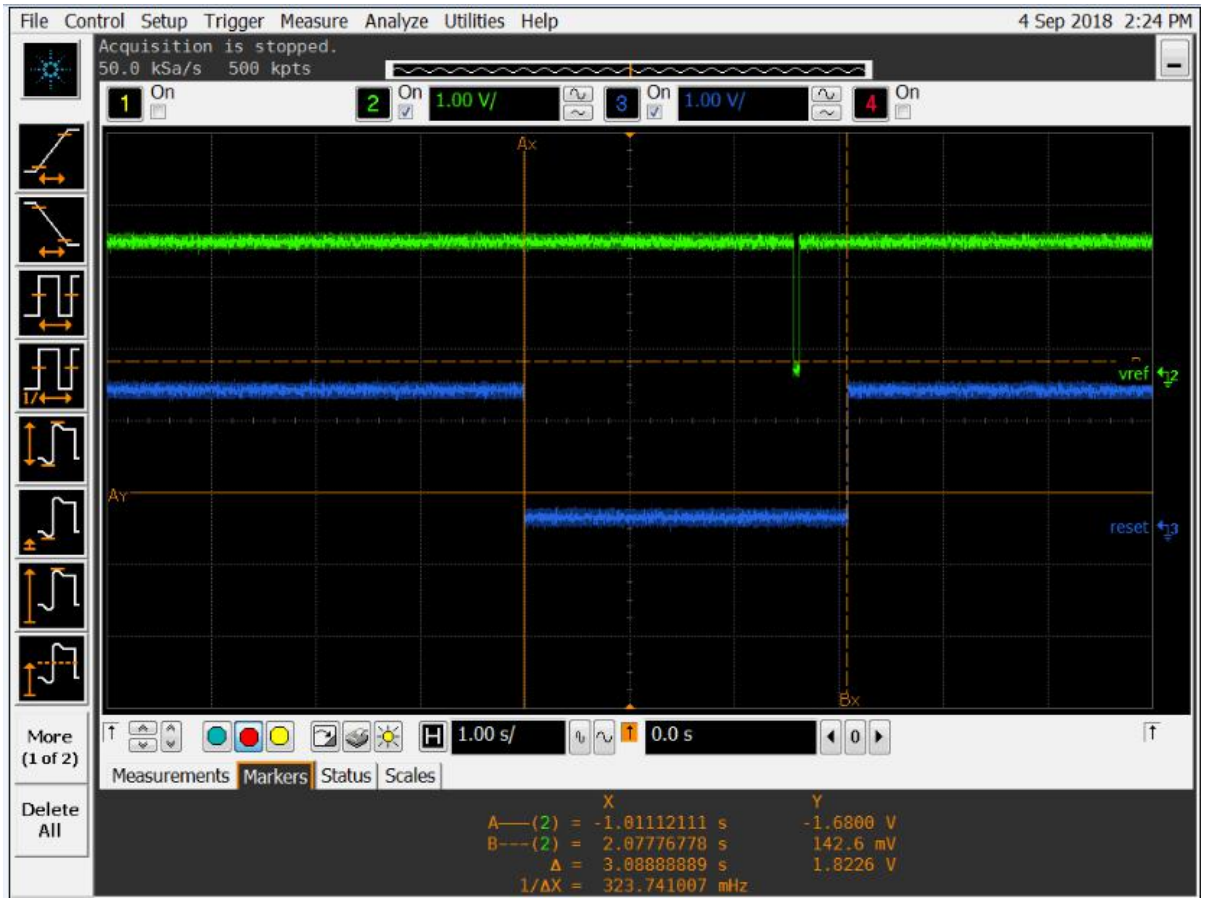


Figure 5. Reset Signals circuit

3.6.4. SPI Master Interface

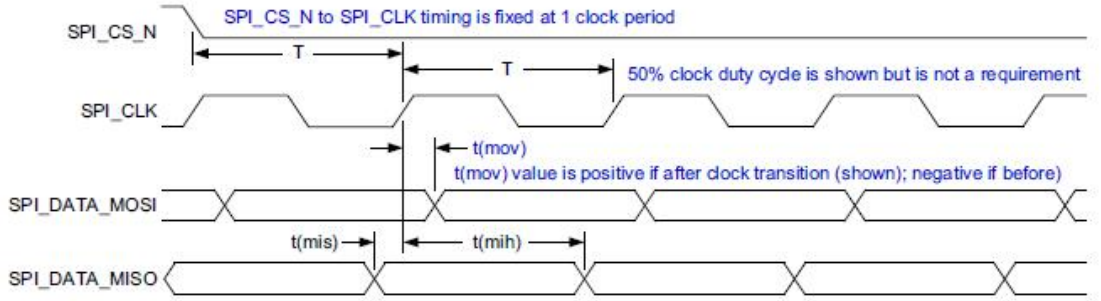
SPIM_CLK – Output clock

SPIM_CS – Output, chip-select

SPIM_MOSI – Output, data to slave

SPIM_MISO – Input, data from slave

Timing



Parameter	Comments	Min	Typ	Max	Unit
T [1]	SPI clock period: 50 MHz max	20.0	–	–	ns
t(ch)	Clock high	9.0	–	–	ns
t(cl)	Clock low	9.0	–	–	ns
t(mov)	Master output valid	-5.0	–	5.0	ns
t(mis)	Master input setup	5.0	–	–	ns
t(mih)	Master input hold	1.0	–	–	ns

1. The minimum clock period includes 1% jitter of the maximum frequency.

Figure 6. SPI timing parameters

3.6.5. PCM Interface

IMQ3 series modules provide one PCM master digital audio interface. Keep PCM signal traces far away from noise and radiating signal on PCB

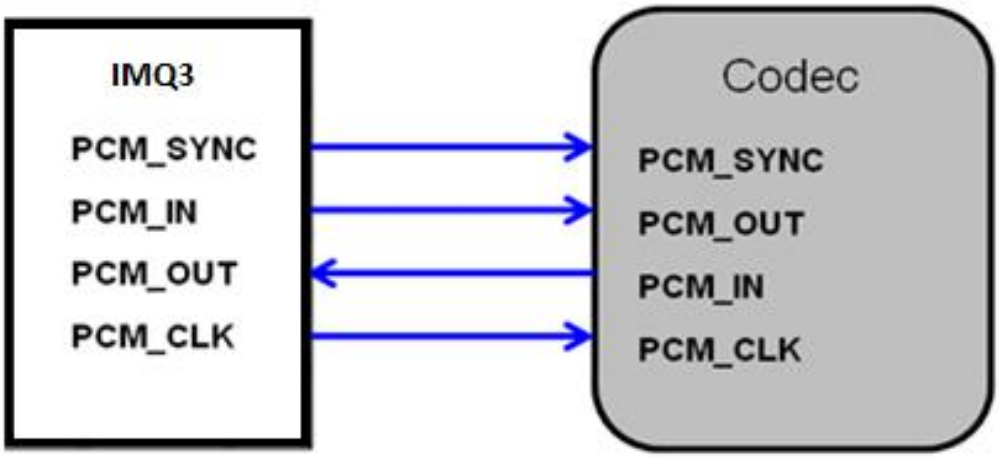


Figure 7. PCM connection (example)

Timing

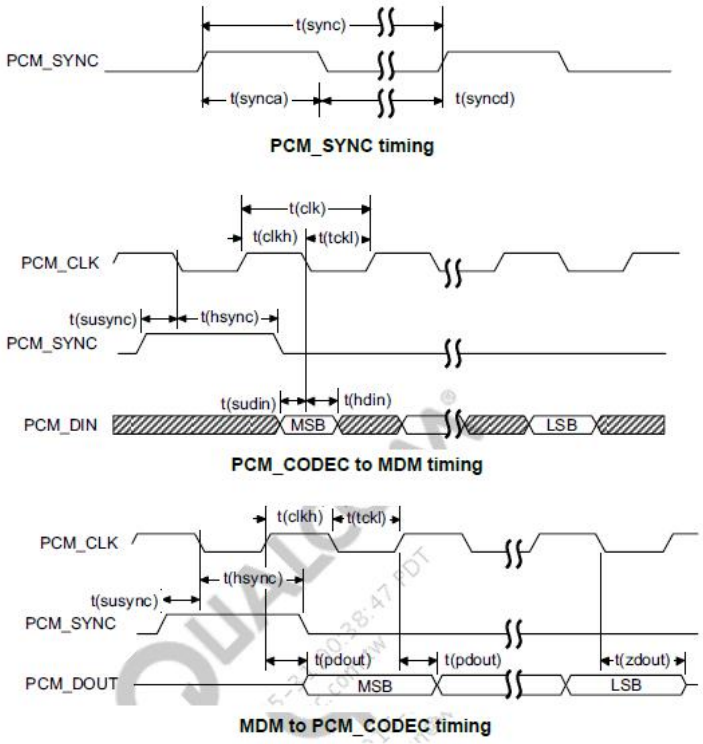


Figure 8. PCM timing diagram

Parameter		Comments	Min	Typ	Max	Unit
t(sync)	PCM_SYNC cycle time		–	125	–	µs
t(synca)	PCM_SYNC asserted time		–	488	–	ns
t(syncd)	PCM_SYNC de-asserted time		–	124.5	–	µs
t(clk)	PCM_CLK cycle time		–	488	–	ns
t(clkh)	PCM_CLK high time		–	244	–	ns
t(clkl)	PCM_CLK low time		–	244	–	ns
t(susync)	PCM_SYNC offset time to PCM_CLK falling		–	122	–	ns
t(sudin)	PCM_DIN setup time to PCM_CLK falling		60	–	–	ns
t(hdin)	PCM_DIN hold time after PCM_CLK falling		10	–	–	ns
t(pdout)	Delay from PCM_CLK rising to PCM_DOUT valid		–	–	60	ns
t(zdout)	Delay from PCM_CLK falling to PCM_DOUT HIGH-Z		–	160	–	ns

Figure 9. PCM timing parameters

3.6.6. I2S Interface

PCM and I2S share the same pins on the modules, I2C only support master mode, keep I2S signal trace far away from noise and radiating signal on PCB

Config1	Config2
PCM_SYNC	I2S_WS
PCM_DIN	I2S_DATA0
PCM_DOUT	I2S_DATA1
PCM_CLK	I2S_SCK

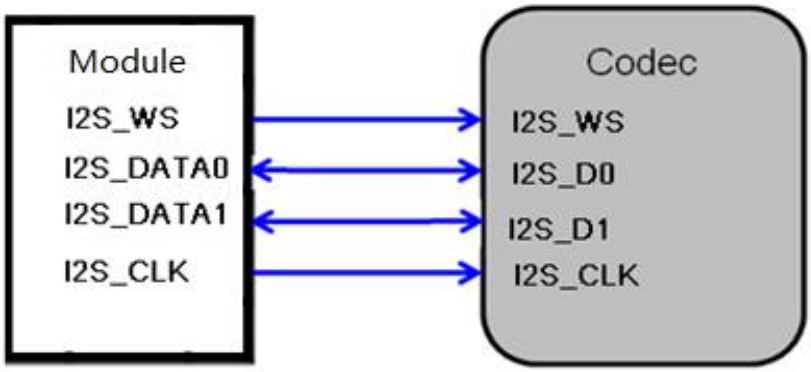
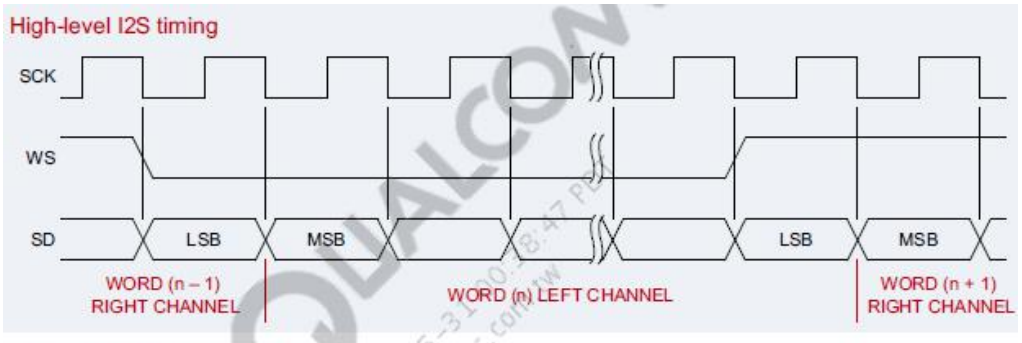


Figure 10. I2S connection (example)

Timing



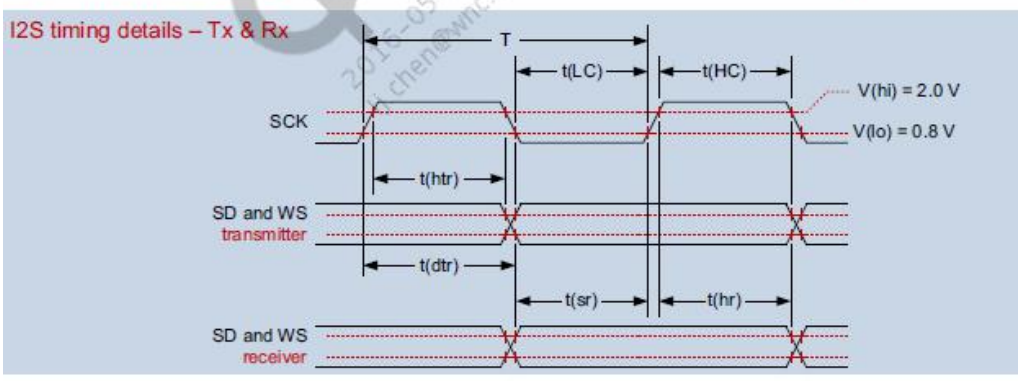


Figure 11. I2S timing diagram

Parameter		Comments [1]	Min	Typ	Max	Unit
Using internal SCK						
	Frequency		–	–	12.288	MHz
T	Clock period		81.380	–	–	ns
t(HC)	Clock high		0.45 · T	–	0.55 · T	ns
Parameter		**Comments [1]**	**Min**	**Typ**	**Max**	**Unit**
t(LC)	Clock low		0.45 · T	–	0.55 · T	ns
t(sr)	SD and WS input setup time		16.276	–	–	ns
t(hr)	SD and WS input hold time		0	–	–	ns
t(dtr)	SD and WS output delay		–	–	65.100	ns
t(htr)	SD and WS output hold time		0	–	–	ns
Using external SCK						
	Frequency		–	–	12.288	MHz
T	Clock period		81.380	–	–	ns
t(HC)	Clock high		0.45 · T	–	0.55 · T	ns
t(LC)	Clock low		0.45 · T	–	0.55 · T	ns
t(sr)	SD and WS input setup time		16.276	–	–	ns
t(hr)	SD and WS input hold time		0	–	–	ns
t(dtr)	SD and WS output delay		–	–	65.100	ns
t(htr)	SD and WS output hold time		0	–	–	ns

1. Load capacitance is between 10 and 40 pF.

Figure 12. I2S timing parameters

3.6.7. I2C Interface

IMQ3 series modules provide one I2C interface, I2C only support master mode.

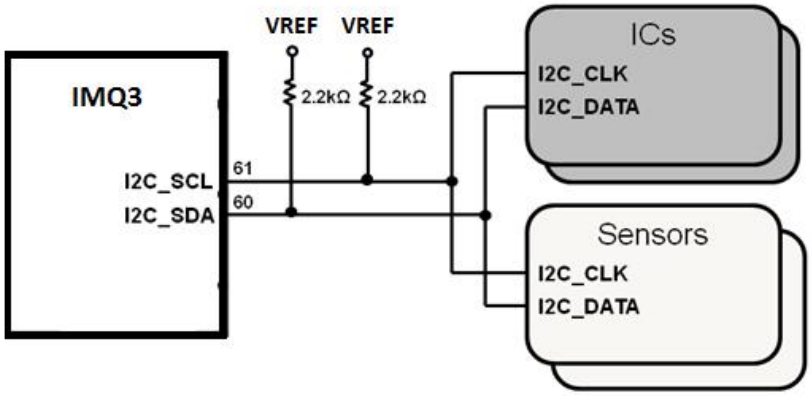


Figure 13. I2C connection (example)

3.6.8. UART Interface

There are dual UART interfaces. One is 4 bit for high-speed data transfer, and the other is 2 bit for diagnostic tools and debugging. Recommended to reserve a pull down 1k Ω resistor on UART1_RTS signal near IMQ3 module

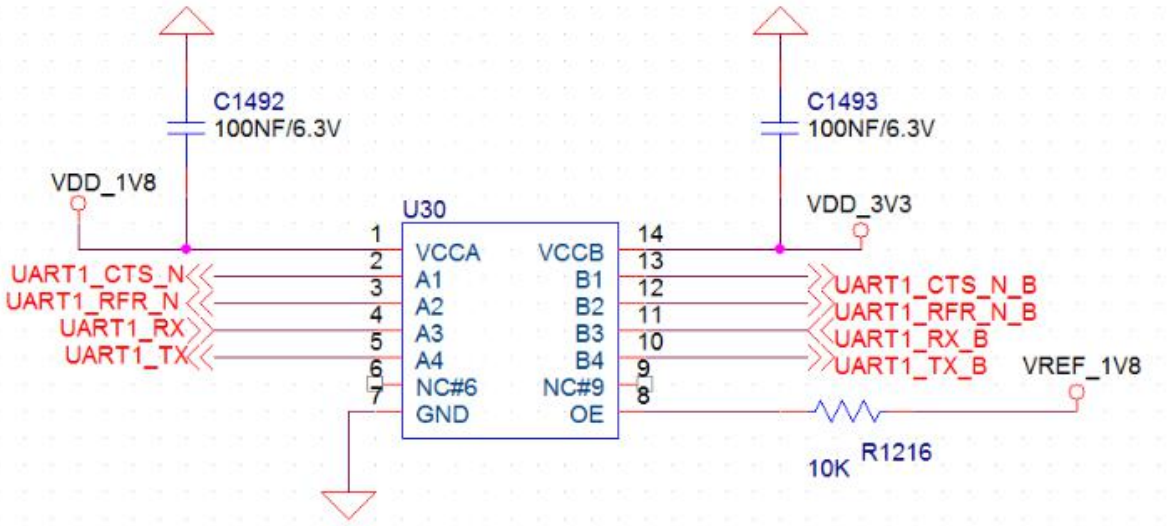


Figure 14. Recommended circuit for UART interface (4 bit) with Level Shifter

3.6.9. ADC Interface

An Analog to Digital Converter (ADC) input is provided by the IMQ3 series. The converter is 16 bit resolution, ranging from 0.1 V to 1.7 V, with a sampling rate of 2.4 MHz.

Parameter	Comments	Minimum	Typ	Maximum	Units
Supply voltage	Connected internally to VREG_L3	–	1.8	–	V
Resolution	Decimated data	–	–	15	bits
Analog-input bandwidth		–	100	–	kHz
Sample rate	XO/8	–	2.4	–	MHz
Offset error	Relative to full-scale	–1	–	+1	%
Gain error	Relative to full-scale	–1	–	+1	%
INL	15-bit output	–8	–	+8	LSB
DNL	15-bit output	–4	–	+4	LSB

AMUX Ch #	Function	Typical input range		Automatic scaling	Typical output range	
		Min (V)	Max (V)		Min	Max
16–21	MPP_01 to MPP_06 pin	0.1	1.7	1	0.1	1.7
32–37	MPP_01 to MPP_06 pin	0.3	VPH_ PWR	1/3	0.1	1.7

Layout suggestion:

- ADC signal trace should be well protected by GND plane
- ADC signal trace should be protected from noise and other radiating signals

3.7. RF Specifications

3.7.1. Band support

Table 8. Band support

LTE Band	Uplink (MHz)	Downlink (MHz)
LTE Band 1	1,920-1,980	2,110-2,170
LTE Band 2	1,850–1,910	1,930–1,990
LTE Band 3	1,710-1,785	1,805-1,880
LTE Band 4	1,710–1,755	2,110–2,155
LTE Band 5	824–849	869–894
LTE Band 8	880-915	925-960
LTE Band 12	699–716	729–746
LTE Band 13	777-787	746-756
LTE Band 18	815-830	860-875
LTE Band 19	830-845	875-890
LTE Band 20	832-862	791-821
LTE Band 25	1,850–1,915	1,930–1,995
LTE Band 26	814-849	859-894
LTE Band 28	703-748	758-803
EGPRS Band	Uplink (MHz)	Downlink (MHz)
GSM850	824–849	869–894

GSM900	880-915	925-960
DCS1800	1,710-1,785	1,805-1,880
PCS1900	1,850–1,910	1,930–1,990

3.7.2. Bandwidth support

Table 9. Bandwidth support

Band	Bandwidth					
	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
LTE Band 1	-	-	✓	✓	✓	✓
LTE Band 2	✓	✓	✓	✓	✓	✓
LTE Band 3	✓	✓	✓	✓	✓	✓
LTE Band 4	✓	✓	✓	✓	✓	✓
LTE Band 5	✓	✓	✓	✓	-	-
LTE Band 8	✓	✓	✓	✓	-	-
LTE Band 12	✓	✓	✓	✓	-	-
LTE Band 13	-	-	✓	✓	-	-
LTE Band 18	-	-	✓	✓	✓	-
LTE Band 19	-	-	✓	✓	✓	-
LTE Band 20	-	-	✓	✓	✓	✓
LTE Band 25	✓	✓	✓	✓	✓	✓
LTE Band 26	✓	✓	✓	✓	✓	-
LTE Band 28	-	✓	✓	✓	✓	✓

3.7.3. RF Transmit Specification

Table 10. Conductive Tx output power

Band	Items	Parameter	Unit	Min.	Typ.	Max.
LTE Band 1	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 2	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 3	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 4	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 5	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 8	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 12	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7

LTE Band 13	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 18	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 19	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 20	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 25	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 26	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 28	Max. TX Power	10 MHz 4 RBs/QPSK	dBm	19.8	23	25.7
Band	Items	Parameter	Unit	Min.	Typ.	Max.
EGPRS 850	Max. TX power	-	dBm	21	23	25
EGPRS900	Max. TX power	-	dBm	21	23	25
EGPRS1800	Max. TX power	-	dBm	20	22	24
EGPRS1900	Max. TX power	-	dBm	20	22	24

Note: 1.The RF Transmit Specification is defined at the LGA pad.

2. IMQ3 series meet 3GPP TS 36.521-1/TS 51.010-1 test standard.

3.7.4. RF Receiver Specification

Table 11. Conductive Rx sensitivity-3GPP

LTE Band	Items	Parameter	Unit	Typ.	3GPP limit
LTE Band 1	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107	-102.3
LTE Band 2	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107	–100.3
LTE Band 3	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107.5	–99.3
LTE Band 4	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107.5	–102.3
LTE Band 5	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107	–100.8
LTE Band 8	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107	–99.8
LTE Band 12	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-108	–99.3
LTE Band 13	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-108	–99.3
LTE Band 18	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107.5	–102.3
LTE Band 19	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107	–102.3
LTE Band 20	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-108	–99.8
LTE Band 25	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107.5	–98.8
LTE Band 26	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-107	–100.3
LTE Band 28	RX Sensitivity	5 MHz with 4 RBs	dBm/720KHz	-108	–100.8

GSM Band	Items	Parameter	Unit	Typ.	3GPP limit
EGPRS850(MCS9)	RX Sensitivity	-	dBm	-91	–86
EGPRS900(MCS9)	RX Sensitivity	-	dBm	-91	–86
EGPRS1800(MCS9)	RX Sensitivity	-	dBm	-91	–86
EGPRS1900(MCS9)	RX Sensitivity	-	dBm	-91	–86

Note: 1. The RF Receiver Specification is defined at the LGA pad.

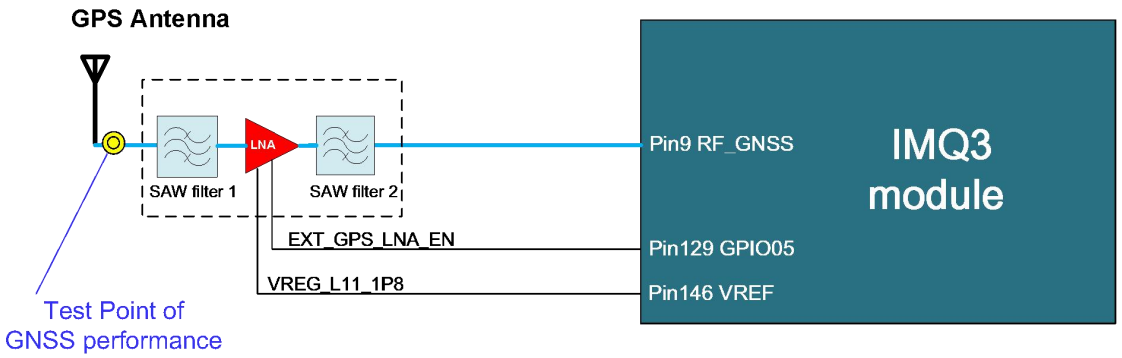
2. IMQ3 series meet 3GPP TS 36.521-1/TS 34.121-1 test standard.

3.7.5. GNSS Receiver Specification

Table 12. GNSS receiver performance

Test items	Parameter	Min.	Typ.	Max.
Cold start TTFF	(@-130dBm)	-	38S	-
Hot start TTFF	(@-130dBm)	-	2S	-
CEP-50 Accuracy	Open sky with -130 dBm input	-	<3m	-
Cold start sensitivity	Acquire First with Signal level	-	-146dBm	-
Tracking sensitivity(GPS)	Detect an in-view satellite 50% of the time.	-	-162dBm	-
Tracking sensitivity (Glonass)	Detect an in-view satellite 50% of the time.	-	-162dBm	-

Note1. The test point shows as below.



4. Software Interface

4.1. Support tools

The IMQ3 series modules are compatible with the following support tools:

- WNC IMQ3 Connection Manager (WNCCM) (TBD)

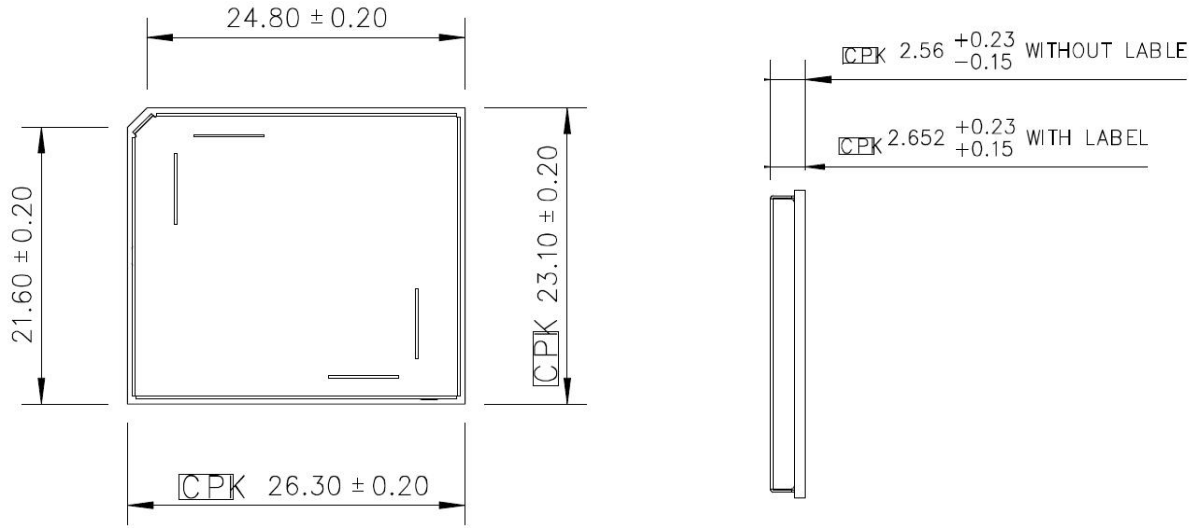
4.2. USB interface

The IMQ3 series modules support 3GPP standard AT commands and proprietary AT commands.

5. Mechanical

5.1. PCBA Form Factor

IMQ3 series modules have the same dimensions:
26.3 mm (typ.) × 23.1 mm (typ.) × 2.56 mm (typ.)



Top view Right view

Figure 15. PCBA dimension

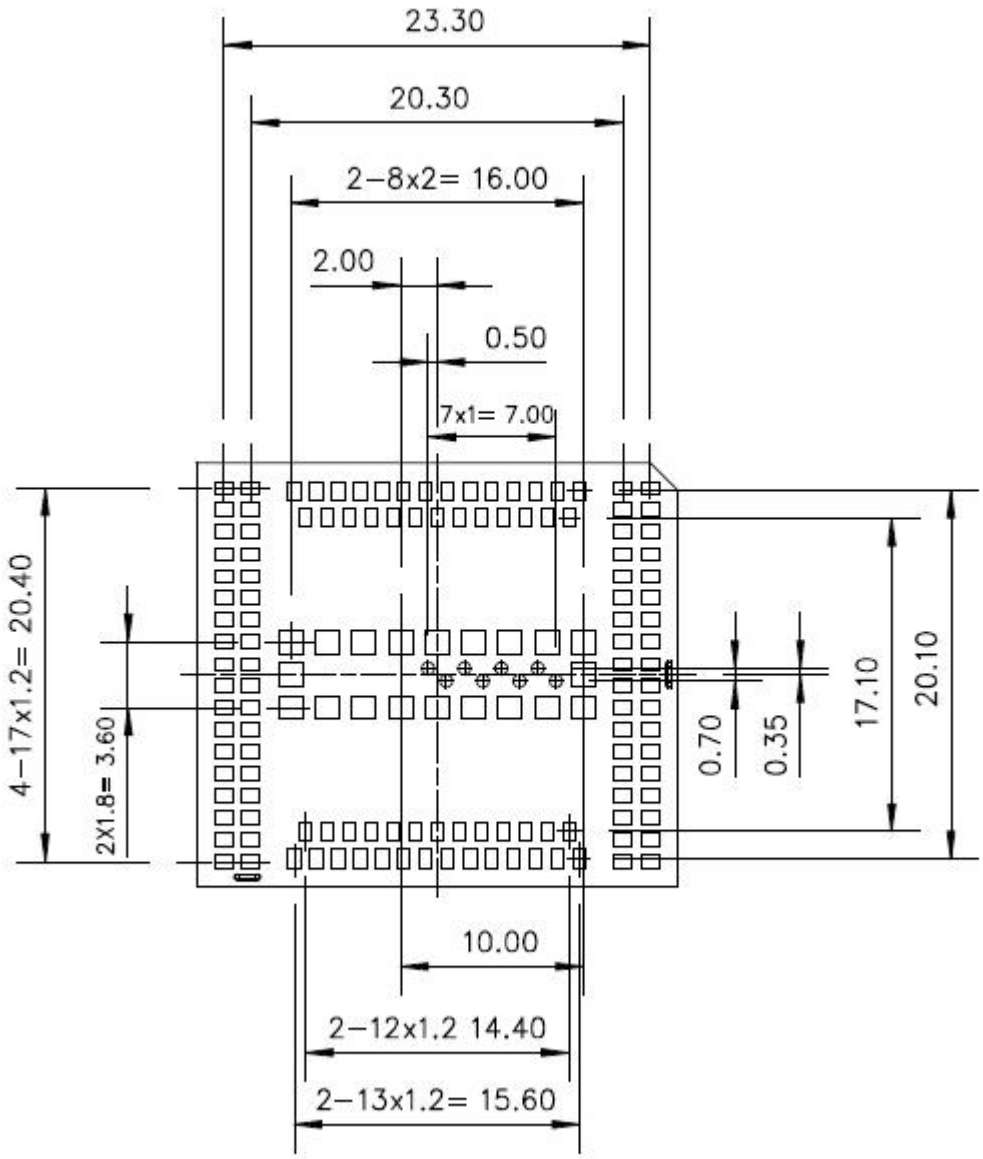


Figure 16. Pad dimension(Bottom view)

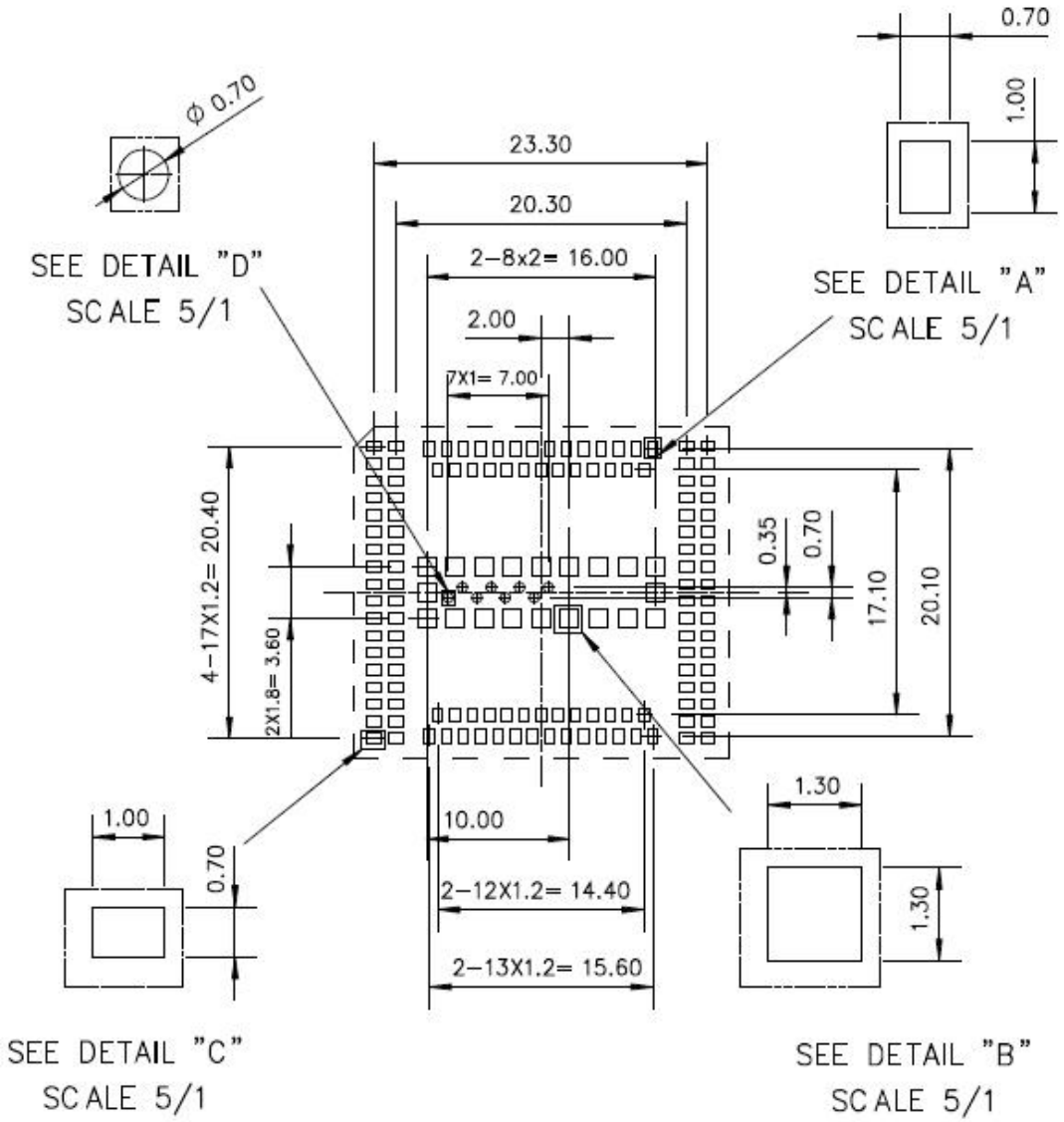


Figure 17. Recommend PCB footprint

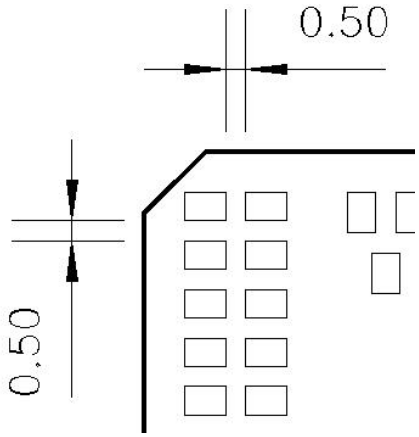


Figure 18. Pin1 location

6. Design Guide

6.1. Power supply

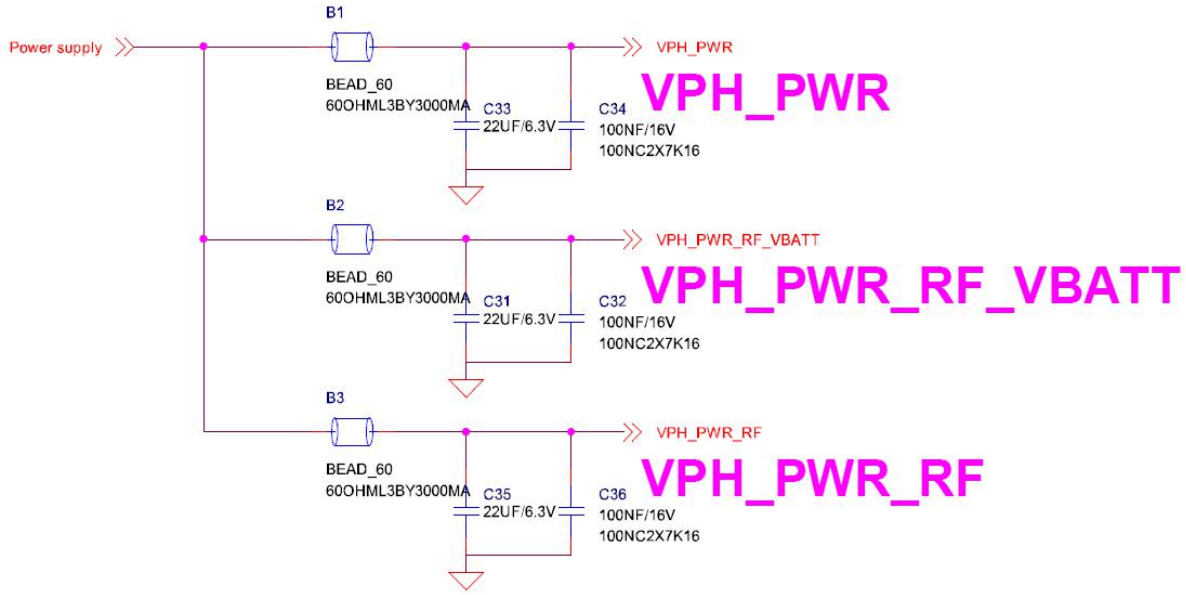
LTE module power input is VCC. The internal power chipset will transfer VCC to other power level.

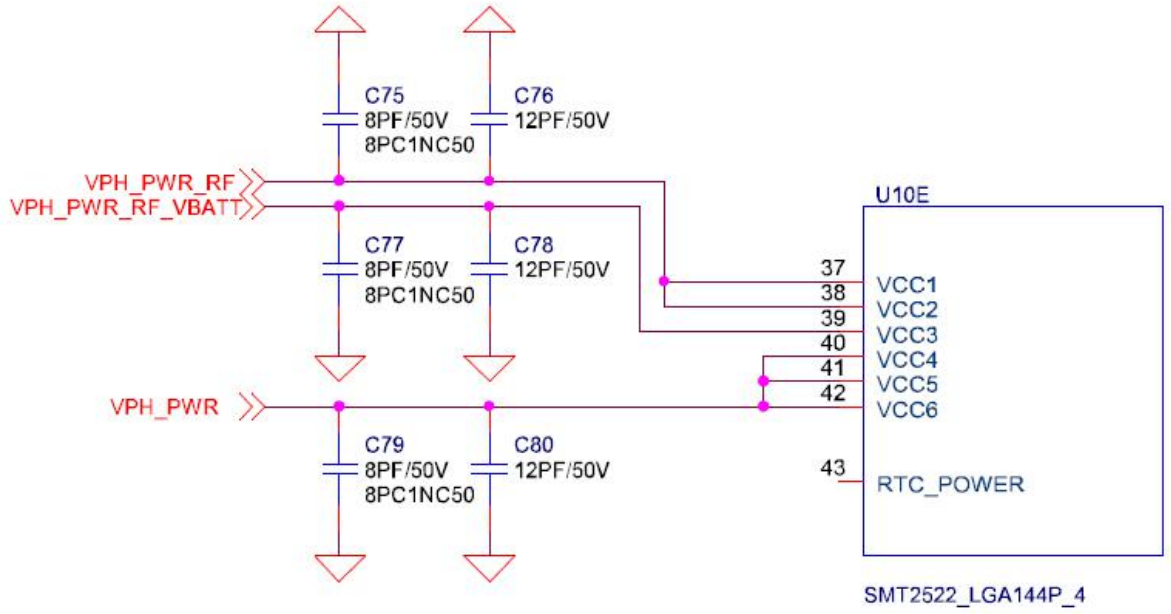
Table 13. Power supply voltage level

Power	Pin Name	Pads	Description	Voltage Level (V)		
				Min.	Typ.	Max.
VCC	VCC1 to VCC6	Nos. 37 to 42	Main Power Supply	3.3	3.8	4.2

The IMQ3 series module include an integrated power manager enabling single and direct voltage supply from the battery, reducing the overall bill of materials. The typical voltage 3.8V is recommended.

Schematic suggestion: Must to separate module power supply to three paths to keep power clean as below for TX spurious performance. The VPH_PWR is for Baseband and RF transceiver, the VPH_PWR_RF is for RF PA, the VPH_PWR_RF_VBATT is for RF PA control circuit.





Layout Suggestion: The 22µF, 0.1uF, 12pF and 8pF capacitors are required to place near VCC pins as close as possible. Each power trace should possess sufficient line width to withstand its respective current listed in the table below:

Net Name	Current Value
VCC(1–2) total	1A
VCC(3) total	100mA
VCC(4–6) total	1A
UIM_VCC	150 mA
VREF	300 mA

6.2. Thermal design

Grade	Operating	3GPP compliant	Functional work	Storage
Commercial	–25 °C~+75 °C	–20 °C~+60 °C	–25 °C~+75 °C	–40 °C~+85 °C
Industrial	–40 °C~+85 °C	–20 °C~+60 °C	–40 °C~+85 °C	–40 °C ~+85 °C

Note: The temperature above refers to ambient temperature.

The case temperature of module shielding cover must be < 85 °C when integrated to prevent damage.

Design points used to improve the thermal performance:

- It's better to add a naked copper area onto IMQ3 modules' back side of the PCB. If the thermal performance becomes an issue in the customer's product, add thermal solutions for improvement such as a thermal pad or a heat sink.
- It's recommended to have a thermal pad or a heat sink on shielding cover to help transfer heat.
- If systems with IMQ3 series modules embedded intend to work under ambient temperatures as low as -40°C, it's suggested that:
  1. SIM Card need to be well arranged to make sure it is functional at the condition of ambient temperature as low as -40°C.
  2. Adding heating circuit on board design, the circuit mainly consists of temperature sensing unit, heating element and control unit.

6.3. USB design

The layout design of this circuit on the carrier board should comply with the USB 2.0 high-speed protocol.

Layout suggestion:

- Differential impedance: 90 Ω
- Space to other signals should be at least 20 mils
- Intra-lane length difference should be less than 150 mils
- Maximum length for each trace:150 mm

Signals lengths on modules are tuned as below:

Function	Net	Length (mil)
USB		
	USB_Dp	545.54
	USB_Dn	503.04

6.4. RF connection

The IMQ3 series modules have three RF pads; developers must connect them via 50 Ω traces to the main board.

ANT0_TRX pad (Pin15) – Primary RX/TX path

ANT_GNSS pad (Pin9) – GNSS path (optional)

It is recommended that grounds not be present under the surface of the RF pads in the layout. Details are included below. Layer2 has the same keep out size as Layer1

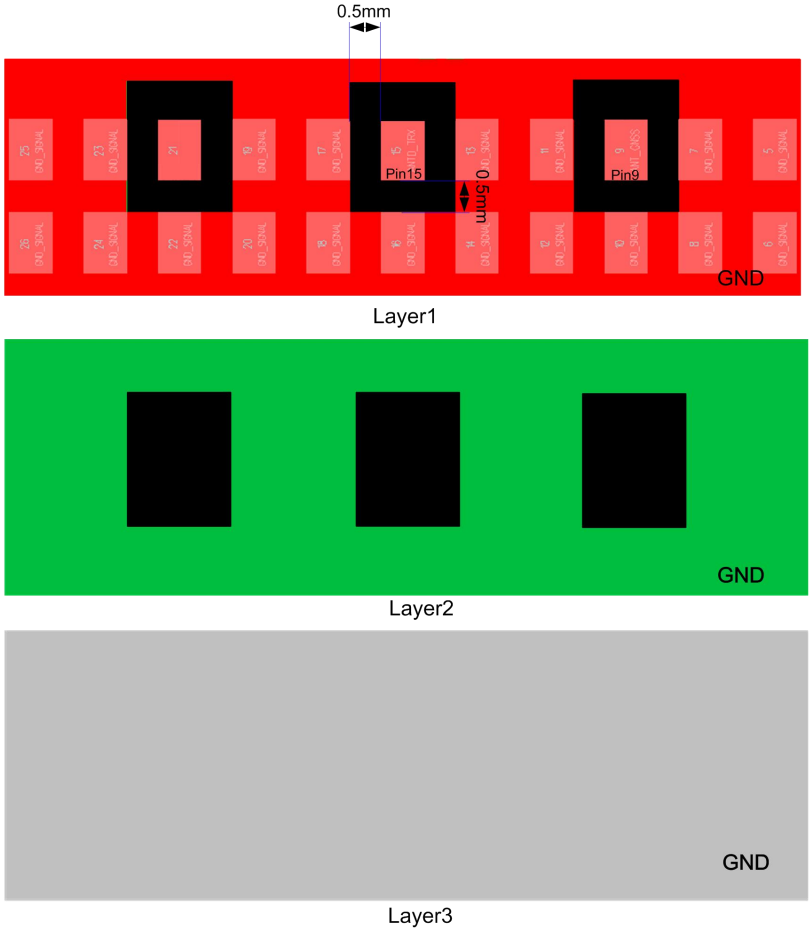


Figure 19. RF pad layout suggestion

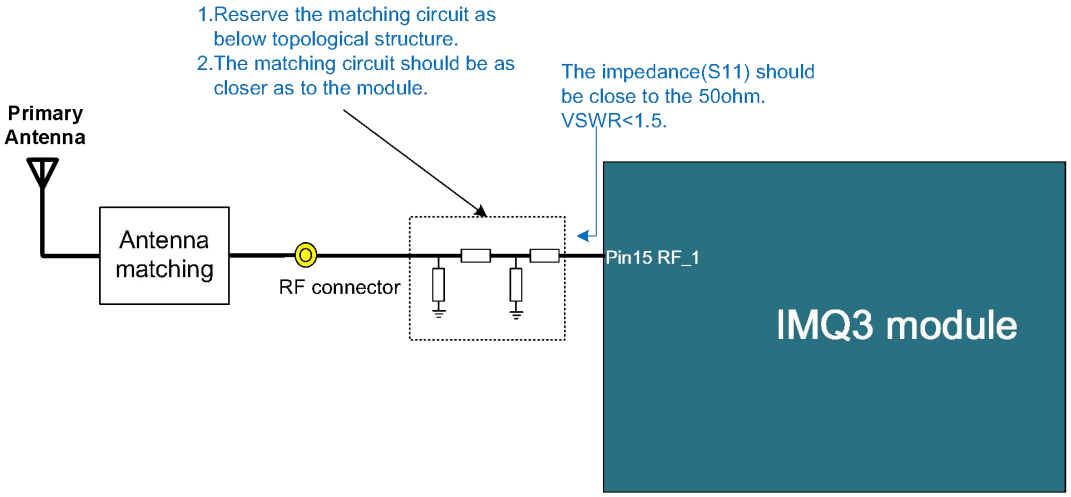


Figure 20. RF matching guide

6.5. Interference and sensitivity

This section includes tips to assist developers in identifying the interference that may affect IMQ3 series modules when used in systems.

- Interference from other wireless devices
  - Harmonics, inter-modulated signal generated from wireless devices that fall in RX ranges of the modules, may result in degraded RX performance.
  - It is highly recommended to check RX performance of entire systems within the shielding environment.
- Interference from host interface
  - High-speed signal-switching elements in systems can easily couple noise into the module (Ex.: DDR memory, LCD modules, DC-DC converter, PCM signal).
- Methods to avoid sources of interference
  - Antenna location is important; we recommend directing the antenna away from high-speed switching signals. Furthermore, the trace from the

module to the antenna should be as short as possible and must be shielded by complete grounding.

– The IMQ3 series modules are well shielded; the high-speed elements

(Ex.: DDR memory, LCD modules, DC-DC converter, PCM signal) on a system should have shielding reserved during the early stages of development.

Caution: DDR bus, LCD bus, DC-DC switching and PCM signals are easily to influence the WWAN and GPS receiver performance, these signals must to be routed in the inner layer of the PCB and far away from the WWAN and GPS receiver path.

6.6. GNSS external circuit design

One GNSS SAW filter, LNA, and another GNSS SAW filter need to be used between the module and antenna. Detail design guide as below.

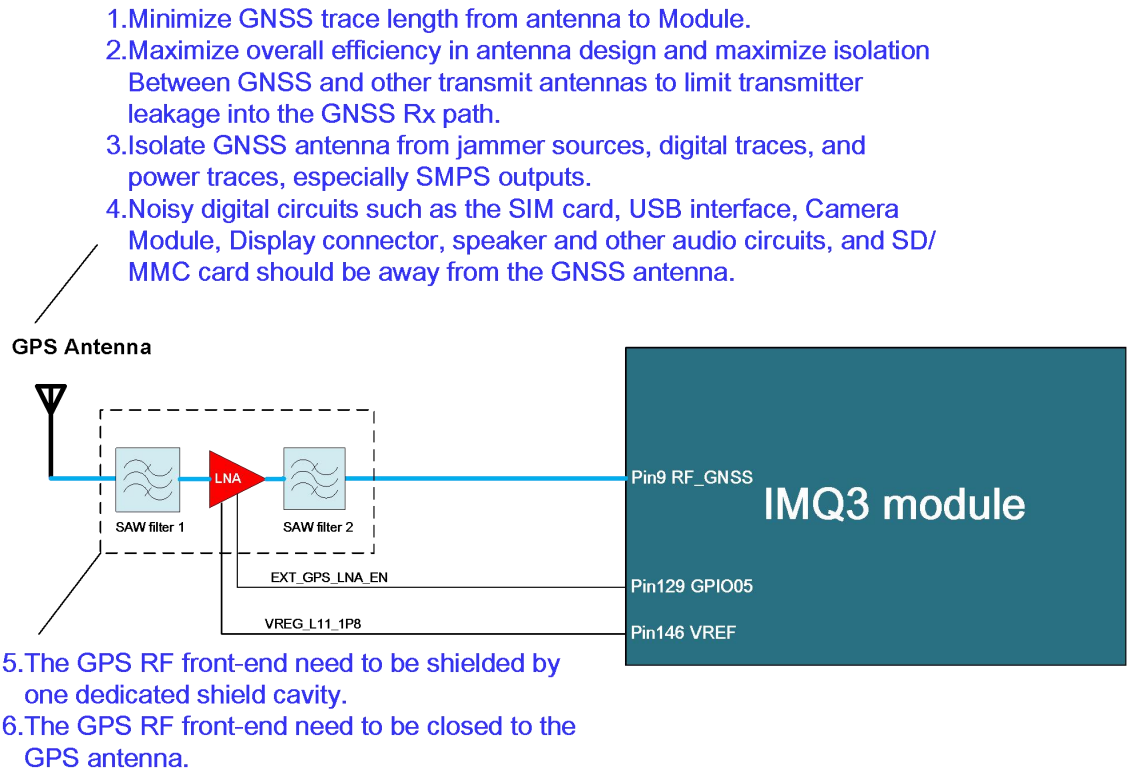


Figure 21. GNSS design suggestion

The following SAW filter and LNA components have been implemented by WNC development board.

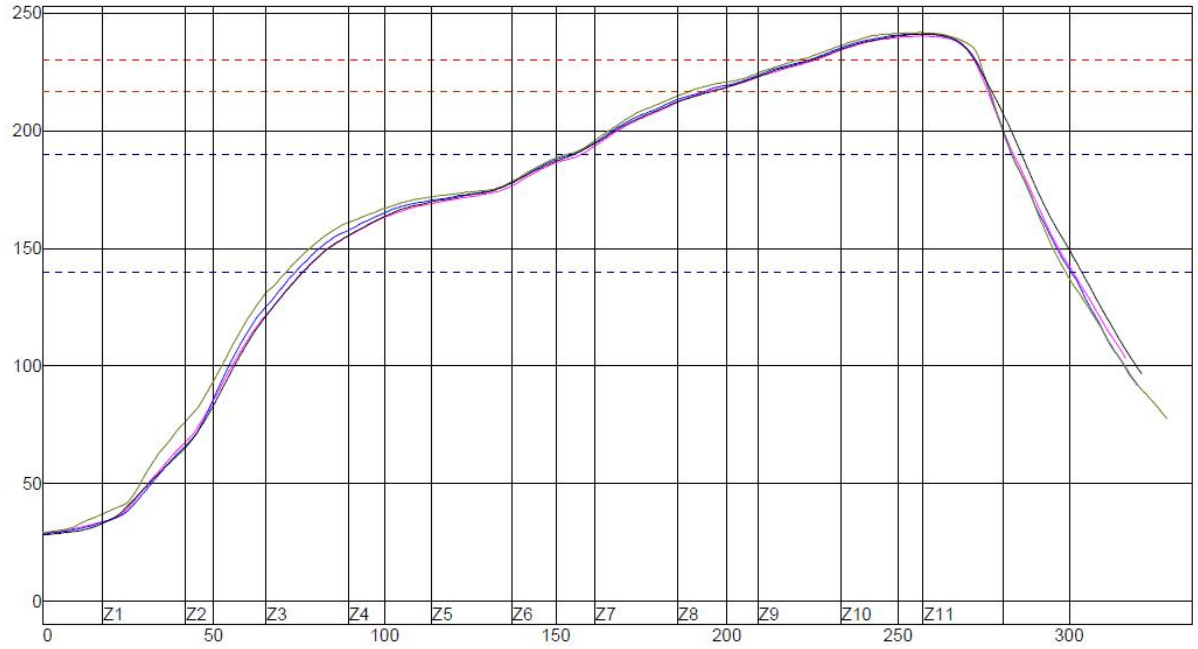
- SAW filter1: Murata SAFFB1G56KB0F0AR15
- LNA: INFINEON BGA824N6
- SAW fiter2: Murata SAFFB1G56KB0F0AR15

In the reference design, Pin146 (VREF,1.8V) of module supply to the LNA BGA824N6 for power supply. Pin129 (GPIO05) of module is feed to LNA enable control pin. It is as default in the module FW.

6.7. Reflow

This section details the recommended reflow profile when the module is mounted onto other boards.

Temp. Region	1	2	3	4	5	6	7	8	9	10	11
Upper temp. region	160	170	180	180	180	205	225	230	240	250	245
Lower temp. region	160	170	180	180	180	205	225	230	240	250	245
Conveyer band speed	90 cm/minute										



PWI = 48%	U10-1	T1-2	J3-3	U42-4	Temp. Difference
Preheat from 140–190°C					

	81.48	81.13	81.94	79.07	2.87
	–34%	–36%	–32%	–48%	
Melt-out Time/230°C					
	46.91	49.26	53.50	48.18	6.59
	-31%	-7%	35%	–18%	
Max Temp					
	240.40	241.34	241.84	241.32	1.44
	4%	13%	18%	13%	
Total Time/217°C					
	81.18	82.95	87.61	81.24	6.43
	-15%	-8%	10%	–15%	
Gradient1 (100–150°C)					
	1.88	1.91	1.87	1.86	0.05
	25%	28%	25%	24%	

Process limit:

Solder Paste	**Lead-free**		
Profile feature	Min.	Max.	Unit
Gradient1 (Target = 1.5) (100 °C–150 °C) (Time period = 20 s)	0	3	°C/S
Preheat time from 140 °C to 190 °C	70	105	S
Time maintained above 230 °C	40	60	S
Peak package body temperature	230	250	°C
Time maintained above 217 °C	60	110	S

6.8. PCB pad design

Non solder mask defined (NSMD) type is recommended for the solder pads of the PCB on which IMQ3 series modules will be mounted, this kind of design is good to soldering reliability in SMT process.

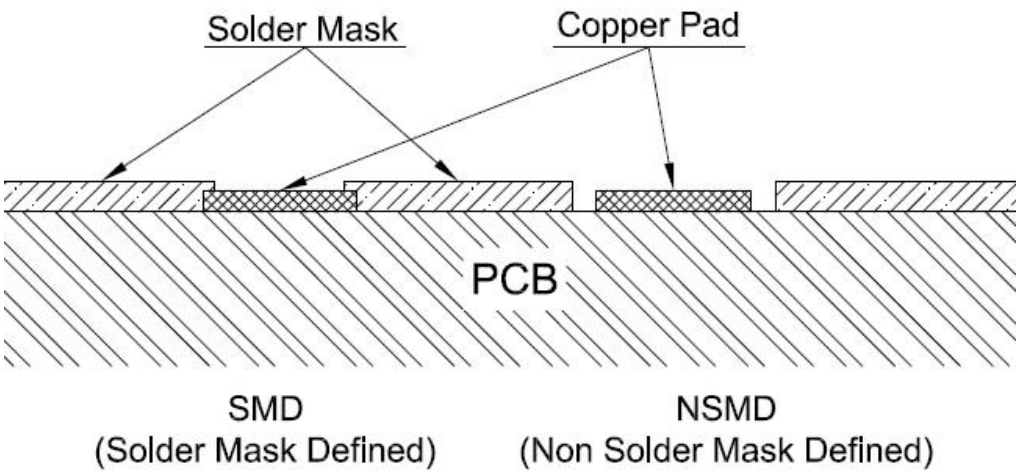
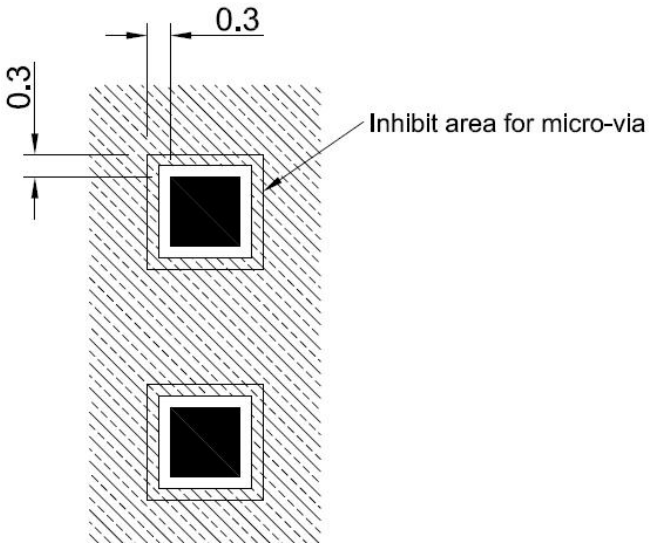


Figure 22. NSMD solder pad design

It is not recommended to place via or micro-via not covered by solder resist in an area of 0.3 mm around the pads unless it carries the same signal of the pad itself, see following figure.



Holes in pad are allowed only for blind holes and not for through holes.

6.9. Stencil

0.15mm stencil-foil thickness is recommended to obtain the best performance to prevent voids during SMT reflow, 0.12mm is the minimum requirement if there is any restrictions.

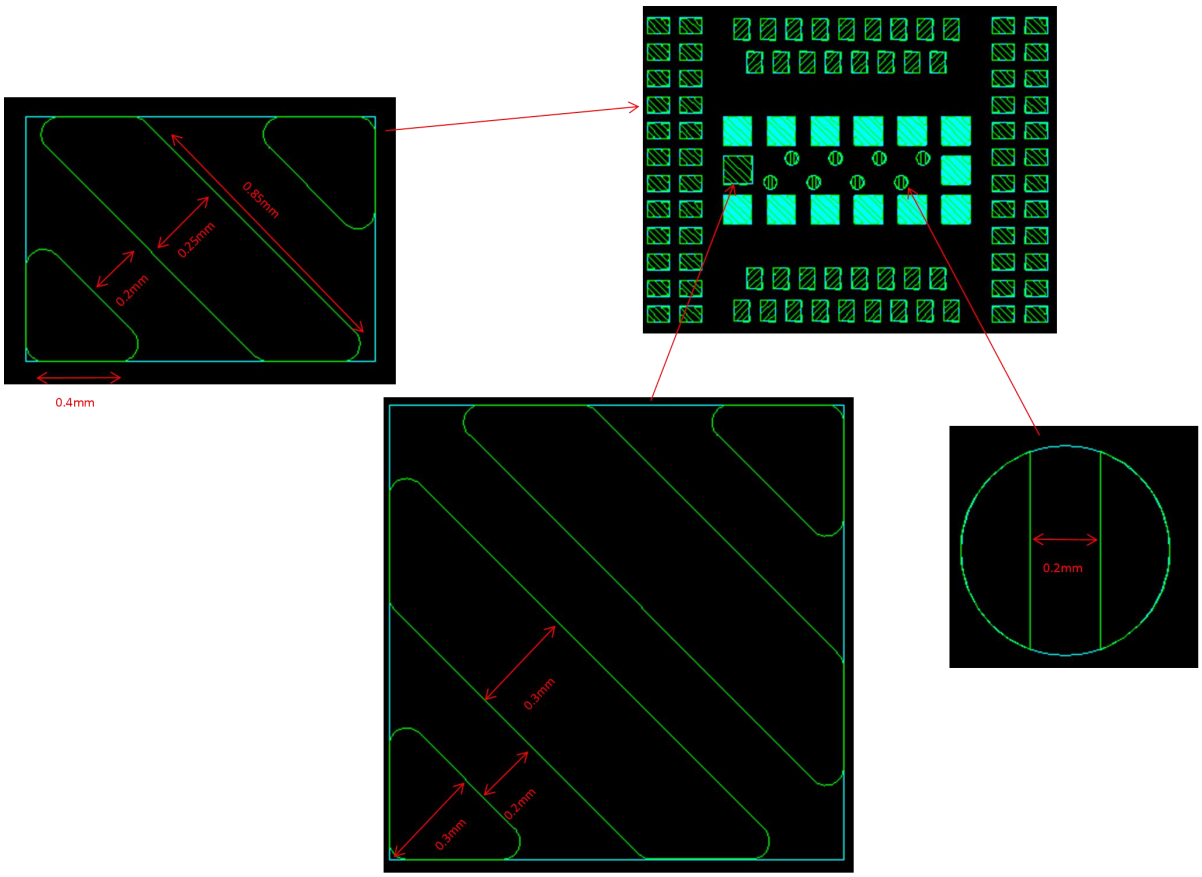


Figure 23. Label drawing

6.10. Antenna design requirement

The antenna need meet below specification

ANTENNA REQUIREMENTS for IMQ3	
Frequency range	LTE Band High Band : 1710MHz-2170MHz, LTE Low Band : 699MHz-960MHz
Polarization	Linear
Radiation pattern	Omni-directional
Impedance	50 ohm
Input power	> 24dBm Average power in LTE
VSWR absolute max	≤ 3:1
VSWR absolute recommended	≤ 2:1
Antenna ruggedness(Output RF load mismatch ruggedness at ANT pins)	10:1 (max) VSWR

7. Labeling and Packaging

7.1. Labeling

Figure25 shows label drawing of IMQ3 series modules.

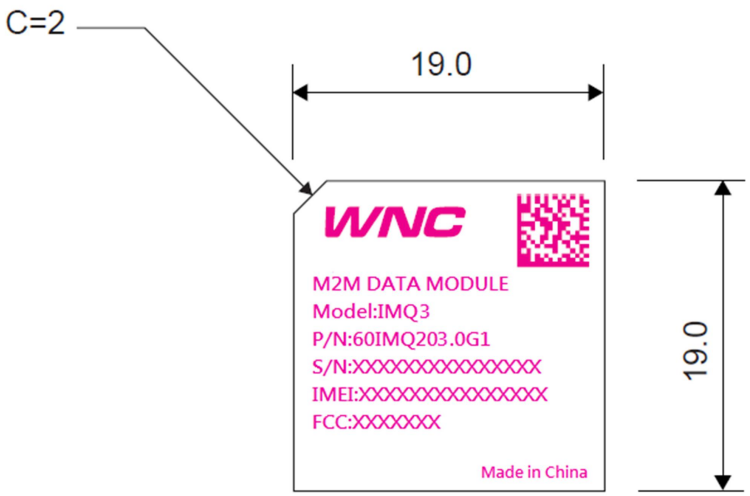


Figure 24. Label drawing

7.2. Packing

Tape-and-Reel Package

The module is delivered in tape-and-reel based on MPQ (500 pcs./reel).4 reel/carton.

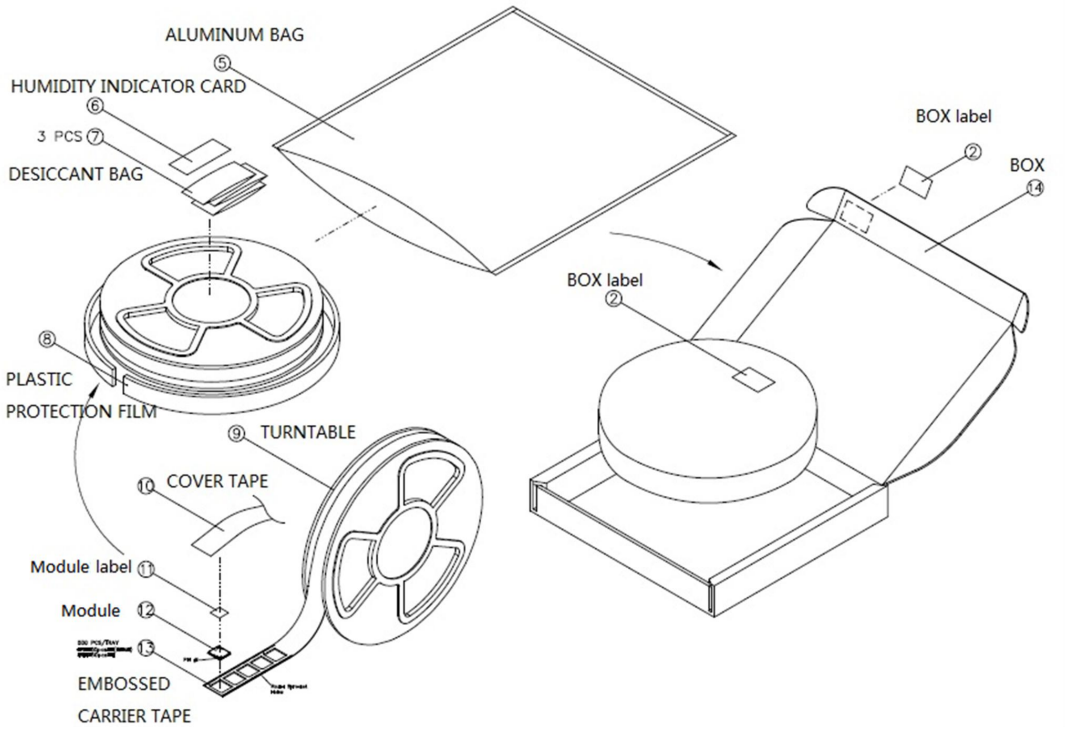


Figure 25. Packing--tape

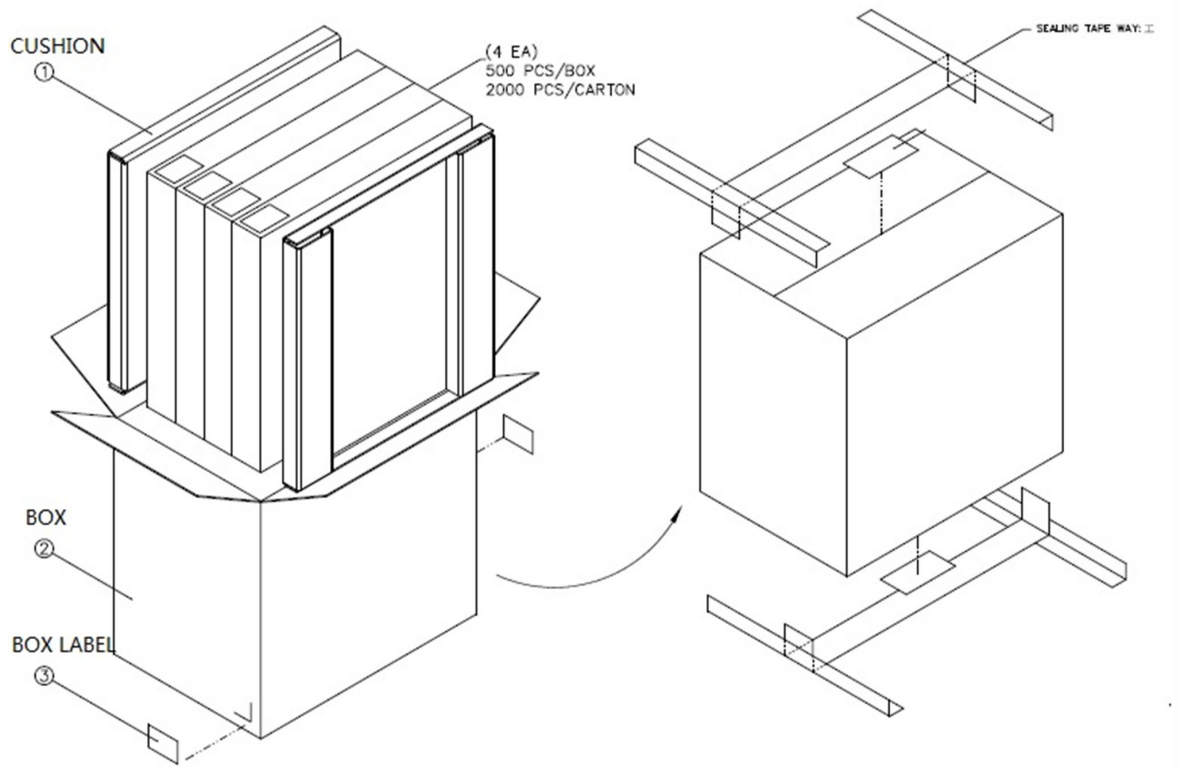


Figure 26. Packing—reel

Single Packaging for Samples

50 pcs./box; no vacuum packaging; must be baked for 8 hours at 85 °C before SMT at least.

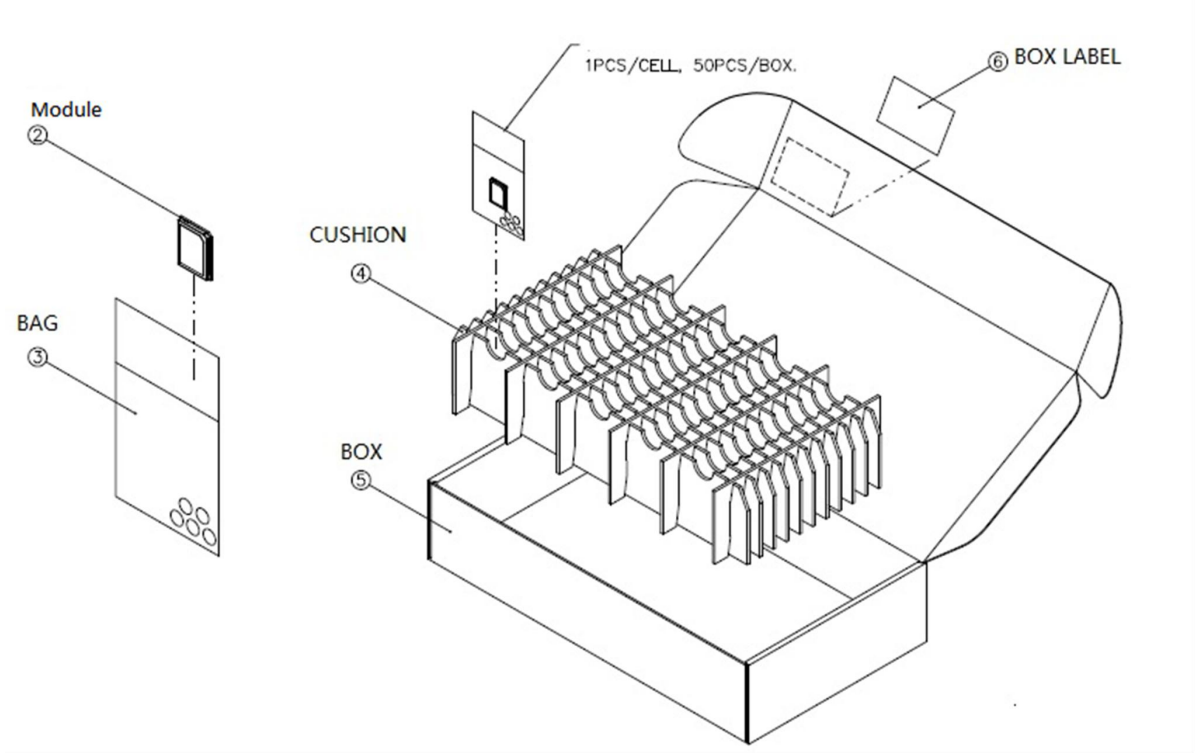


Figure 27. Packing—carton

7.3. MSL level

The IMS2 module MSL level is 3.

8. Safety Recommendation

Be sure the use of this product is allowed in the country and in the environment required. The use of this product may be dangerous and must be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, and aircraft
- Where there is a risk of explosion such as gasoline stations and oil refineries

It is the responsibility of the user to comply with his or her country's regulations and the specific environmental regulations.

Do not disassemble the product; any mark of tampering will compromise the warranty's validity.

We recommend following the instructions of the hardware user guides for a correct wiring of the product. The product must be supplied with a stabilized voltage source, and the wiring must conform to the security and fire-prevention regulations.

This product must be handled with care; avoid any contact with the pins because electrostatic discharge may damage the product. Same caution must be taken regarding the UIM card; carefully check the instructions for its use. Do not insert or remove the UIM when the product is in power-saving mode.

The system integrator is responsible of the functioning of the final product; therefore, care must be taken for the external components of the module as well as for project or installation issues—there may be a risk of disturbing the GSM network or external devices or of having an impact on device security. If you have any doubts, please refer to the technical documentation and the relevant regulations in force.

Every module must be equipped with a proper antenna with specific characteristics. The antenna must be installed with care in order to avoid any interference with other electronic devices.

Federal Communication Commission Interference Statement

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

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution:

- Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains FCC ID: NKRIMQ3”. The grantee's FCC ID can be used only when all FCC compliance requirements are met.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Industry Canada statement

❶ This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1) this device may not cause interference, and

2) this device must accept any interference, including interference that may cause undesired operation of the device.

❶ Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1) l'appareil ne doit pas produire de brouillage, et

2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

❹ This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter, except tested built-in radios.

❹ Cet appareil et son antenne ne doivent pas être situés ou fonctionner en conjonction avec une autre antenne ou un autre émetteur, exception faites des radios intégrées qui ont été testées.

❺ The County Code Selection feature is disabled for products marketed in the US/

Canada.

❺ La fonction de sélection de l'indicatif du pays est désactivée pour les produits commercialisés aux États-Unis et au Canada.

Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

<For modular Approval>

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and

2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre

l'antenne et les utilisateurs, et

2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:
Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains IC: 4441A-IMQ3”.

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 441A-IMQ3".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

Initialisms

Table 14. Initialisms and Definitions

Abbreviation	Definition
AC	Alternating Current
DC	Direct Current
ETSI	European Telecommunications Standards Institute
GND	GrouND
GPS	Global Positioning System
GNSS	Any single or combined satellite navigation system (GPS, GLONASS and combined GPS/GLONASS)
GPIO	General Purpose Input Output
I/O	Input/Output
IoT	Internet of Things
I2C	Inter-Integrated Circuit
LGA	Land Grid Array
LTE	Long Term Evolution
Mbps	Megabits per second
MIPS	Millions of Instructions Per Second
N/A	Not/Applicable
OS	Operating System
PCM	Pulse Code Modulation
SIM	Subscriber Identity Module
SMA	Surface Mount Antenna
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver-Transmitter
UIM	User Identity Module
USB	Universal Serial Bus
Vref	Voltage reference
WNC	Wistron NeWeb Corporation
RFU	Reserved For Future Use