IMS2 module user manual

Project Name: IMS2
Author: Wistron NeWeb Corporation
Revision: 1.1
Revision Date: 2017/09/13

Contact Information

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Revision History

Rev. #	Author	Summary of Changes	Date
1.0	WNC	First release	2017/07/14
1.1	WNC	Add FCC statement and manual information to the end user in the user manual	2017/09/13

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FCC Statement
Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID:NKRIMS2". Any similar wording that expresses the same meaning may be used.

Manual Information to the End User
The module is limited to OEM installation ONLY.
The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.
The module is limited to installation in mobile application; a separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and difference antenna configurations.
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Contents

1 Product Features

1.1 Features Description

The WNC IMS2 module includes the Sequans SQN3330 Cat. M1 baseband, a complete three LTE band (2/4/12) RF front-end, memory, and required circuitry to fulfill 3GPP E-UTRA (Long Term Evolution - LTE, Release 13 specifications) and AT&T Wireless LTE Cat. M1 UE specifications.
The architecture block diagram of the IMS2 is presented in Figure 1-1 below.

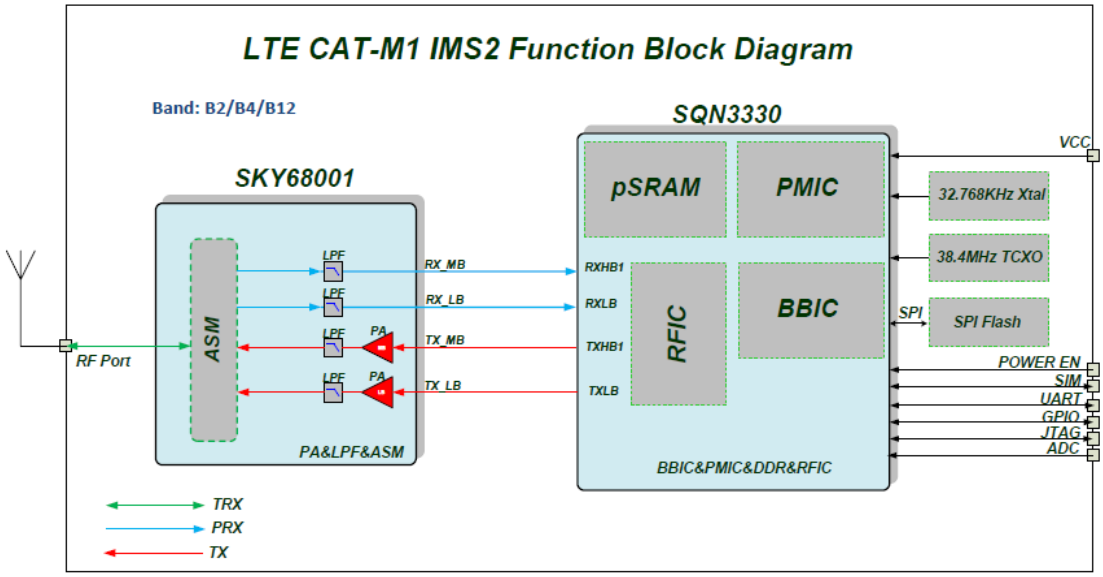


Figure 1-1. IMS2 block diagram

Table 1-1. General features of the IMS2

General interfaces	• JTAG
	• USIM
	• GPIO
	• UART
Supported frequency bands	• LTE Band 2
	• LTE Band 4
	• LTE Band 12
Operating voltage	• V_{CC} (range from 3.3 V to 4.2 V)
Packaging	• LGA module
	• 104 pads (21.5 mm × 16.5 mm × 2.3 mm)
	• RoHS compliant
Operating temperature	• 3GPP compliant: –20 °C to +60 °C (ambient)
	• Operational: –40 °C to +85 °C (functional)

Table 1-2. LTE-related features of the IMS2

Standards compliance	• 3GPP E-UTRA Release 13
PHY	• One UL and one DL transceiver
	• Supports HD-FDD Duplexing
	• Category M1 UE
	• Normal cyclic prefix
	• Supports MPDCCH
	• Modulation
	- DL: QPSK, 16QAM
	- UL: QPSK, 16QAM
	• All coding schemes corresponding to modulations
	• All channel coding (turbo-coding with inter-leaver, tail biting convolutional coding, block and repetition coding) and CRC lengths
	• All power control schemes and DL power allocation schemes
	• UEPCOP (from 3GPP Release 12) Power Saving Mode
MAC	• Random access procedure in normal sub-frames
	• Scheduling request, buffer status reporting, and power headroom reporting
	• Discontinuous reception (DRX, eDRX) with long and short cycles
	• Fast scanning
	• IPv4, IPv6
RLC	• ARQ modes: UM, AM, and TM
PDCP	• Ciphering and deciphering: NULL, AES, SNOW 3G
	• Integrity and protection: AES, SNOW 3G
RRC	• MIB and new SIB1bis
	• Supports up to eight data radio bearers
NAS and above	• NAS
	• SMS over SG
	• LWM2M client

2 Pin Definitions

2.1 LGA Module Pin Diagram

The IMS2 LGA module pin layout is illustrated below.

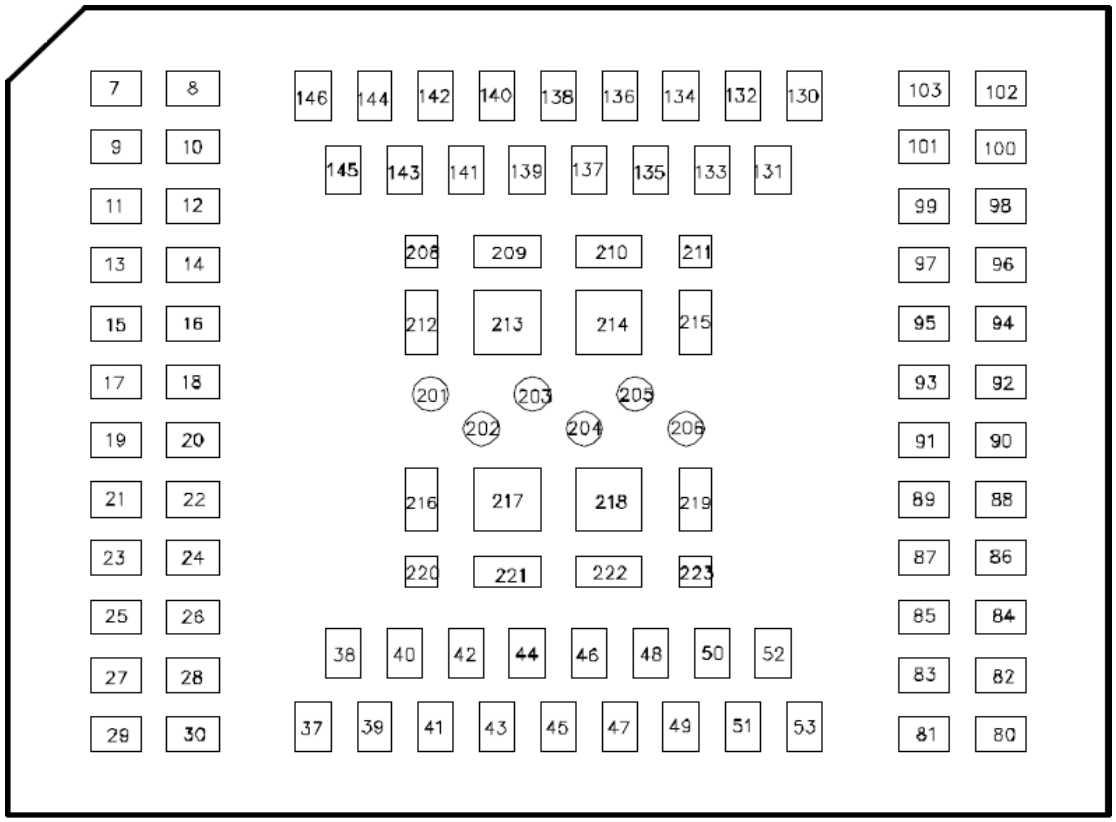


Figure 2-1. IMS2 LGA module pin layout

2.2 LGA Module Pin Definitions

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

Table 2-1. IMS2 module pin definition

Pin No.	Name	Description
7	GND	Ground
8	GND	Ground
9	NC	Not connected
10	GND	Ground
11	GND	Ground
12	GND	Ground
13	GND	Ground
14	GND	Ground

15	Main antenna	Main antenna port
16	GND	Ground
17	GND	Ground
18	GND	Ground
19	GND	Ground
20	GND	Ground
21	NC	Not connected
22	GND	Ground
23	GND	Ground
24	GND	Ground
25	GND	Ground
26	GND	Ground
27	NC	Not connected
28	GND	Ground
29	GND	Ground
30	GND	Ground
37	Power	Power
38	Power	Power
39	Power	Power
40	Power	Power
41	Power	Power
42	Power	Power
43	NC	Not connected
44	GND	Ground
45	GND	Ground
46	GPIO46	General purpose input/output
47	GPIO47	General purpose input/output
48	GPIO48	General purpose input/output
49	GPIO49	General purpose input/output
50	GND	Ground
51	GND	Ground
52	GPIO01	General purpose input/output
53	GPIO02	General purpose input/output
80	UART1_CTS	Clear to send for UART 1
81	UART1_RTS	Request to send for UART 1
82	UART1_Rx	Receive for UART 1
83	UART1_Tx	Transmit for UART 1
84	GND	Ground
85	GND	Ground

86	NC	Not connected
87	NC	Not connected
88	NC	Not connected
89	GND	Ground
90	GND	Ground
91	GND	Ground
92	UART0_CTS	Clear to send for UART 0
93	UART0_TX	Transmit for UART 0
94	UART2_TX	Transmit for UART 2
95	UART0_RX	Receive for UART 0
96	UART2_RX	Receive for UART 2
97	UART0_RTS	Request to send for UART 0
98	UART2_RTS	Request to send for UART 2
99	UART2_CTS	Clear to send for UART 2
100	FFF/FFH mode switch	FFF/FFH mode switch; FFF is normal mode; FFH is for design mode.
101	RFDATA5	RF control interface
102	RFDATA6	RF control interface
103	RFDATA7	RF control interface
130	ADC	Analog-to-digital converter
131	ADC	Analog-to-digital converter
132	GPIO08	General purpose input/output
133	UIM_VCC	SIM card power
134	UIM DATA	SIM card data line
135	UIM CLK	SIM card clock line
136	UIM RESET	SIM card reset line
137	UIM DETECT	SIM card detect line
138	NC	Not connected
139	GND	Ground
140	GND	Ground
141	WWAN_STATE	Wireless WAN radio state
142	Power on	Power on the module
143	WAKEUP_OUT	Module wakes up host.
144	WAKEUP_IN	Host wakes up module.
145	RESET	Main reset line
146	VREF	Reference logic voltage (1.8 V voltage)
201	JTAG TCK	JTAG TCK
202	JTAG TDI	JTAG TDI
203	JTAG TDO	JTAG TDO

204	JTAG_TMS	JTAG_TMS
205	JTAG_SRST_N	JTAG_SRST_N
206	NC	Not connected
208	GND	Ground
209	GND	Ground
210	GND	Ground
211	GND	Ground
212	GND	Ground
213	GND	Ground
214	GND	Ground
215	GND	Ground
216	GND	Ground
217	GND	Ground
218	GND	Ground
219	GND	Ground
220	GND	Ground
221	GND	Ground
222	GND	Ground
223	GND	Ground

3 Electrical Specifications

3.1 Electrical Operating Conditions

3.1.1 Detailed Information

Table 3-1. Electrical operating conditions for the IMS2.

	Direction	Minimum	Typical	Maximum
V_{CC}	In	3.3 V	3.8 V	4.2 V

IMS2 includes an integrated Power Manager enabling single and direct voltage supply from the battery and reducing the overall bill of materials.

Layout Suggestion: Each power trace should possess sufficient line width to withstand its respective current listed in Table 3-2 below.

Table 3-2. Power supply reference currency

Net Name	Current Value
VCC(1–6) total	TBD
UIM_VCC	TBD
VREF	TBD

Note: Routing under a 1 A design is desired as it will result in more stable power.

3.1.2 Power Tree

Figure 3-1 provides a representation of the power tree of the IMS2 LGA module

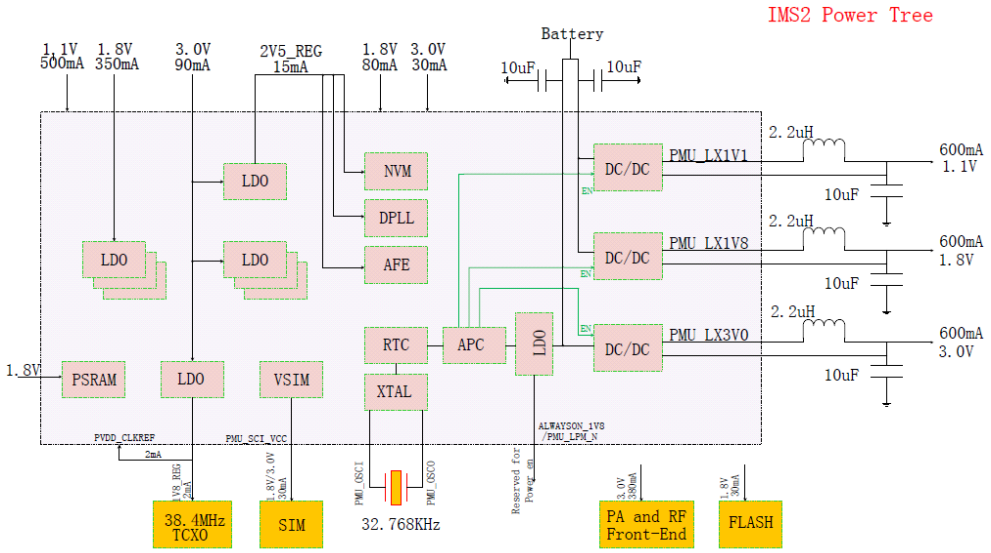


Figure 3-1. IMS2 power tree

3.2 Control Interfaces

This section describes the power-on/off, wake-up, and reset interface for controlling the module.

3.2.1 Power-on Signal (TBD)

The POWER_ON signal 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 among the wakeup, the alarm signal, and the digital control pins.

There are three possible states of the module:

- Module Off: V_{CC} is not present.
- Module Enabled: V_{CC} is supplied, and the module is enabled.
- Module Disabled: V_{CC} is supplied, and the module is disabled.

The state transitions are defined as follows:

- When voltage is applied to V_{CC}, 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 Figure 6; a low pulse (tlow > 0s) on the POWER_ON pad will enable the module after V_{CC} is applied.

3.2.2 Wake-up Interface (TBD)

In applications where power consumption is a major factor in performance metrics (such as battery-operated sensors that are based on an IOT/M2M modem solution and also include a third-party host), definitions are necessary for a simple interface that will enable both the modem and the host to enter low-power states whenever possible and the other side to wake it up once required.

For example, if the host has no data to transmit or any other tasks, it may enter a low-power state according to its own capabilities and configurations. If during that period the host is in a low-power state and the modem suddenly receives data, it must wake-up the host.

A similar requirement exists in the reverse case. For example, if the modem is in a low-power state and suddenly the host must transmit data, it must be able to wake-up the modem.

The interface consists of two signals: One is triggered by the host and received by the modem; the other is triggered by the modem and received by the host.

Each side can wake the other by toggling a wakeup signal high and enabling the

other side to activate sleep mode when not needed by toggling it low.

- "WAKEUP_IN" (Host: Output, Modem: Input):
  - LOW: SoC does not require the MODEM (allowing it to sleep).
  - HIGH: SoC requires the MODEM or acknowledges it is ready following a wakeup request from the MODEM.
- "WAKEUP_OUT" (Host: Input, Modem: Output):
  - LOW: The MODEM does not require the Host (allowing it to sleep).
  - HIGH: The MODEM requires the Host or acknowledges it is ready following a wakeup request from the SoC.

When the IMS2 module functions as a modem, keep WAKEUP_IN high before the system boot process is complete. After the system boot, maintain WAKEUP_IN in a low state. The WAKEUP_IN and WAKEUP_OUT operation in host mode will be discussed according to product specifications.

3.2.3 Reset Signal

The Reset Signal is a hardware reset signal to control the system reset directly. The user can connect it to a key or a control signal. A low pulse after power on will reset the module.

3.3 UART Interface

There are three UART interfaces; these interfaces are 4 bit for high-speed data transfer, and the UART definitions of IMS2 are shown in Figure 3-2.

1. UART0 for data
2. UART1 for debugging the DM tool and software upgrade
3. UART2 for the console

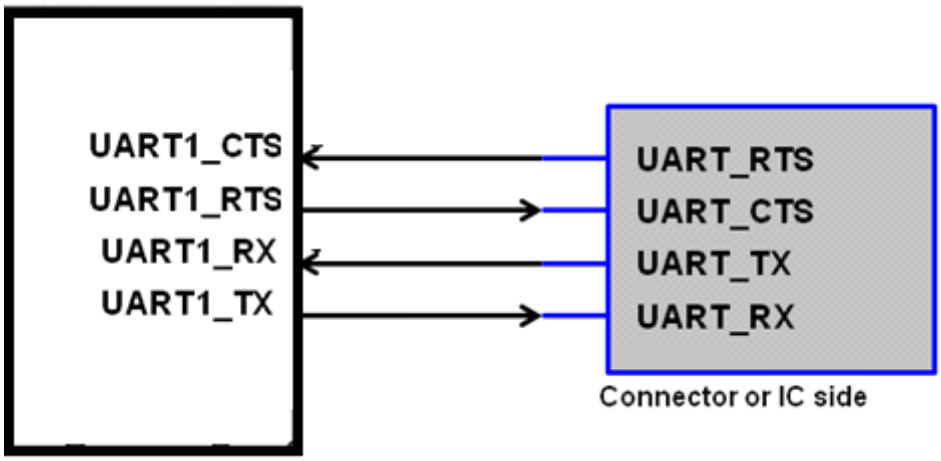


Figure 3-2. UART connection (example)

3.4 UIM Interface

IMS2 modules provide a UIM_DETECT input pin for UIM connectors to detect a UIM card. When a UIM card is present, UIM_DETECT should be high (1.8 V). If the UIM card is absent, UIM_DETECT should be low. This is required to pull UIM_DETECT to VREF with a 470 kΩ resistor. A 0.1 µF and a 33 pF capacitor are recommended to place between UIM_VCC and Ground in parallel. We recommend placing a 33 pF capacitor between UIM_RESET, UIM_CLK, and UIM_DATA and Ground in parallel. (Refer to Figure 5.)
An 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 illustrates an example UIM card circuit. The default configuration is active high.

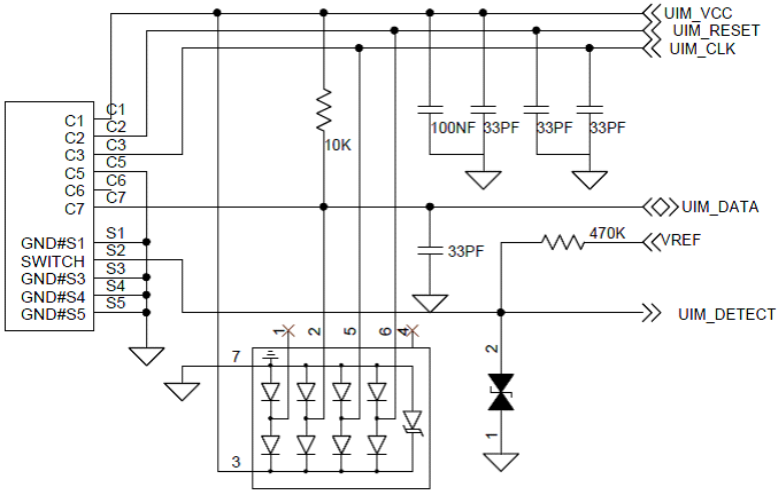


Figure 3-3. Example UIM card circuit

3.5 I/O Characteristics

The voltage and current characteristics of the various IO pads of the IMS2 versus IO bank supply voltage are illustrated in Table 3-3 below.

Table 3-3. DC characteristics for digital IOs, voltage 1.8 V - BIDIR and IN types

Parameter	Drive Strength	Min.	Nom.	Max.	Unit
VIL Input low voltage		VSS		0.3 × PVDD_1V8	V
VIH Input high voltage		0.7 × PVDD_1V8		PVDD_1V8	V

VOL Output low voltage		VSS		0.2 × PVDD_1V8	V
VOH Output high voltage		0.8 × PVDD_1V8		PVDD_1V8	V
IRPU Input pull-up resistor current		15			µA
RPU Input pull-up resistance				32.4	kΩ
IRPD Input pull-down resistor current		15			µA
RPD Input pull-down resistance				32.4	kΩ
VH Input hysteresis		0.1 × PVDD_1V8			V
IPAD Input leakage current, non-tolerant		–1		1	µA
IOZ Off-state leakage current				1	µA
IOL Sink current at VOL (max)	2 mA		1.11		mA
	4 mA		2.25		mA
	8 mA		4.48		mA
	12 mA		6.72		mA
IOH Source current at VOH (max)	2 mA		1.1		mA
	4 mA		2.2		mA
	8 mA		4.4		mA
	12 mA				

3.6 JTAG Interface

The IMS2 series contains one JTAG interface; leave JTAG pins floating if they are not used.

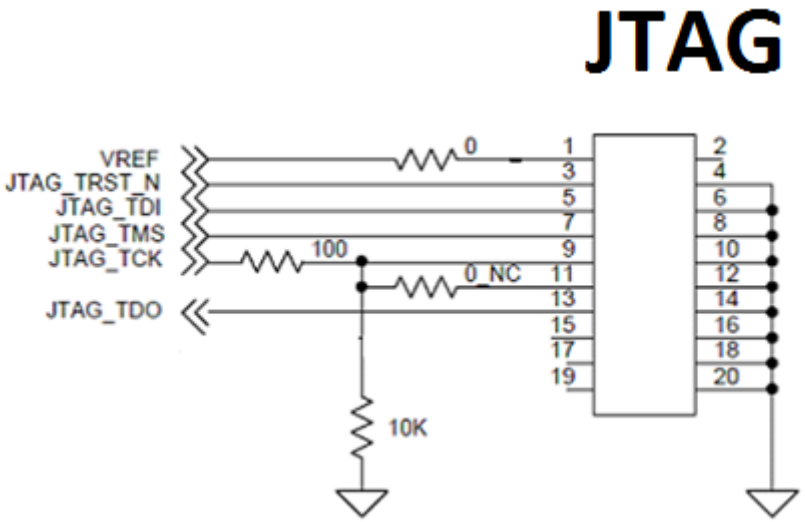


Figure 3-4. JTAG schematic

3.7 Power Consumption

This section describes the typical power consumption of the IMS2 (for reference).

Table 3-4. LTE power consumption

Working Mode	Conditions	Result
Airplane mode		
	Only the module; no other devices	TBD
Power saving mode		
	TBD	TBD
	TBD	TBD
	TBD	TBD
LTE Band2 working mode		
	TBD	TBD
LTE Band4 working mode		
	TBD	TBD
LTE Band12 working mode		
	TBD	TBD
Powering on	**Conditions**	**Result**
Peak power consumption		
	Power consumption peak when the module is powering on	TBD

Power off	Conditions	Result
Power off consumption		
	The module is powered off.	TBD

3.8 RF Performance

Each IMS2 module has only one RF pad; developers must connect it via 50 Ω traces to the main board.

Main antenna pad (Pin15) – Primary RX/TX path

3.8.1 RF Pad Design

We recommended that a ground not be present under the surface of the RF pads in the layout. Details are included below. Layer2 has the same exclusion area as Layer1.

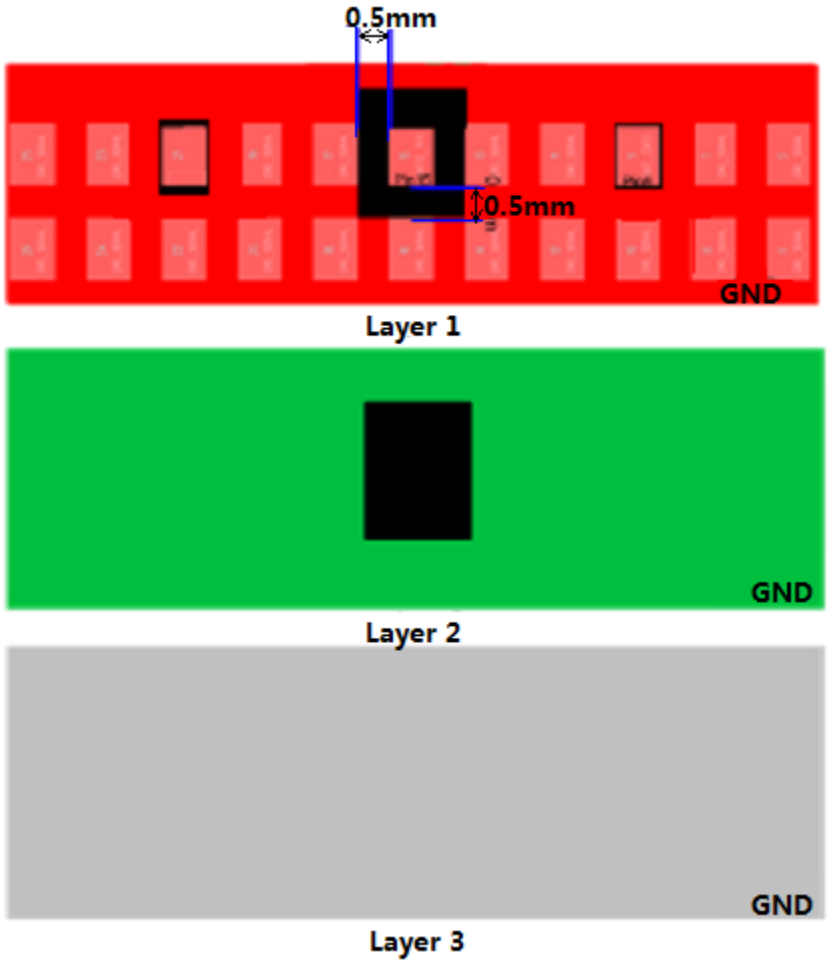
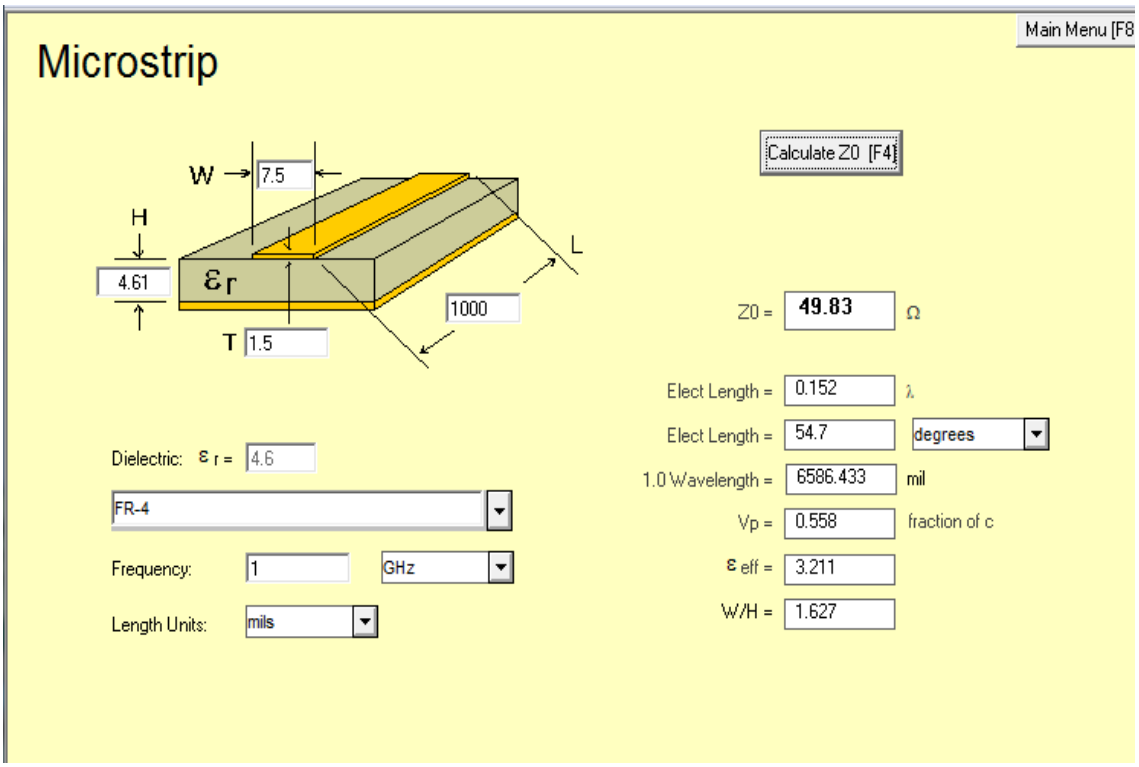
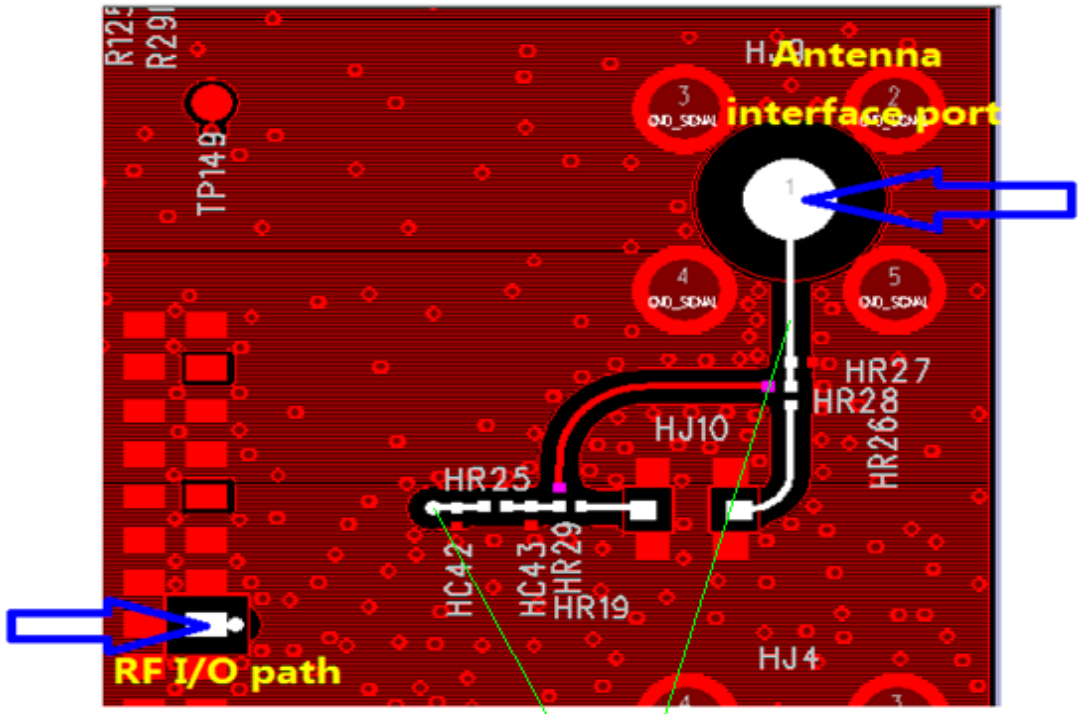
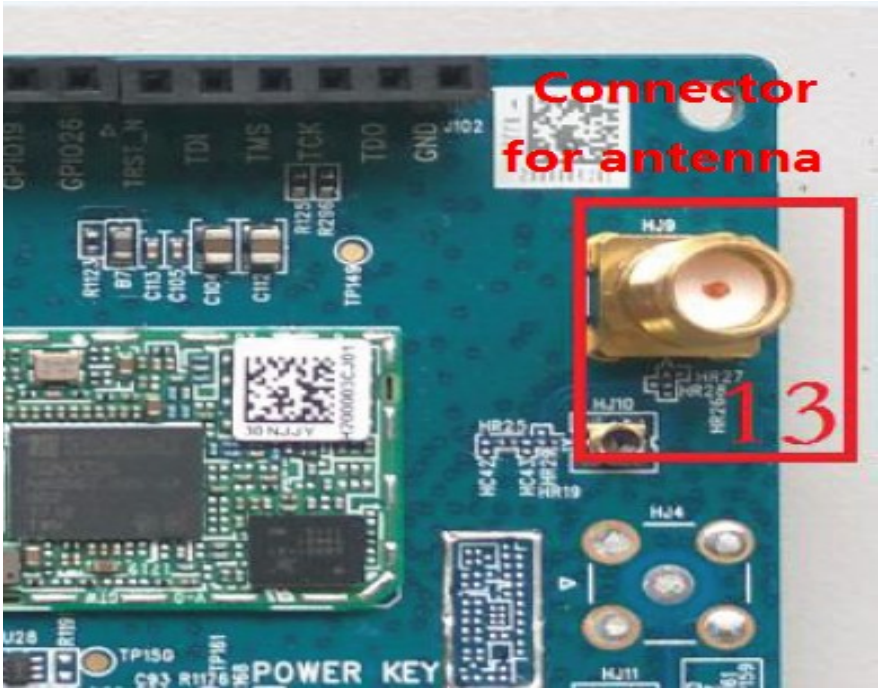


Figure 3-5. Sample RF pad layout

The RF trace between RF pads and antenna should as shorter as possible with 50ohm characteristic impedance.
The characteristic impedance depends on the dielectric of PCB, the track width and the ground plane spacing. Microstrip type is required. The detail simulation as below.







The antenna should be 50ohm characteristic impedance with the return loss of better than -10dB at the operation band. The antenna gain would affect the radiated power and regulator test result.

3.8.2 RF Matching Guide

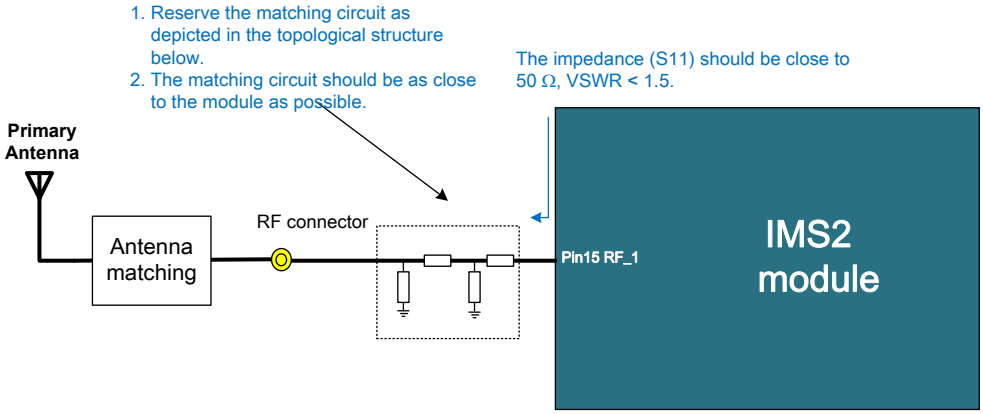


Figure 3-6. RF matching guide

3.8.3 Interference and Sensitivity

This section includes tips to help developers identify interferences that may affect the IMS2 module when used in systems.

- Interference from other wireless devices
  - Harmonics, inter-modulated signals generated from wireless devices within the RX ranges of the modules may result in degraded RX performance.
  - We highly recommend checking the RX performance of entire systems within the shielding environment.
- Interference from the host interface
  - High-speed signal-switching elements in systems can easily couple noise into the module (ex.: DDR memory, LCD modules, DC-DC converters, PCM signals).
- 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 IMS2 module is well shielded; high-speed elements (Ex.: DDR memory, LCD modules, DC-to-DC converters, PCM signals) on a system should have shielding reserved during the early stages of development.

3.8.4 Band Support

Table 3-5. Band support

Band	Uplink (MHz)	Downlink (MHz)
LTE Band 2	1,850–1,910	1,930–1,990
LTE Band 4	1,710–1,755	2,110–2,155
LTE Band 12	699–716	729–746

3.8.5 Bandwidth Support

Table 3-6. Bandwidth support

Band	Bandwidth					
	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
LTE Band 2	-	-	✓	✓	✓	✓
LTE Band 4	-	-	✓	✓	✓	✓
LTE Band 12	-	-	✓	✓	-	-

Note: The IMS2 supports 1.4 MHz and 3 MHz (not default settings).

3.8.6 RF Transmission Specifications

Table 3-7. Conductive Tx output power

Band	Items	Parameter	Unit	Min.	Typ.	Max.
LTE Band 2	Max. TX Power	20 MHz 1 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 4	Max. TX Power	20 MHz 1 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 12	Max. TX Power	10 MHz 1 RBs/QPSK	dBm	20.3	23	25.7

Notes: 1.The RF transmission specification is defined at the LGA pad.

2. IMS2 fulfills 3GPP test standards.

3.8.7 RF Receiver Specifications

Table 3-7. Conductive Rx sensitivity-3GPP

Band	Items	Parameter	Unit	Min.	Typ.	Max.
		5 MHz with 4 RBs				–99.5
LTE Band 4	RX Sensitivity	5 MHz with 4 RBs	dBm			–101.5
LTE Band 12	RX Sensitivity	5 MHz with 4 RBs	dBm			–98.5

Notes: 1. The RF receiver specification is defined at the LGA pad.
2. IMS2 fulfills 3GPP test standards.

3.9 Temperature

- 3GPP compliance: –20 °C to +60 °C (ambient)
- Functional: –40 °C to +85 °C
- Storage: –40 °C to +85 °C

3.10 LTE Power Saving Mode

Note: Details will be provided in a future revision of this document.

3.11 Serial Number and IMEI

Serial number and IMEI data can be written to the module only once; these two data

points cannot be rewritten on the SQN3330 platform.

4 Mechanical Information

4.1 Physical Dimensions

Device dimensions illustrated in Figure 4-1 and Figure 4-2 below.

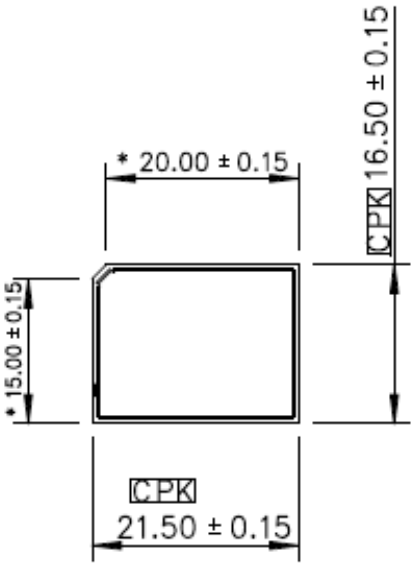


Figure 4-1. Top view

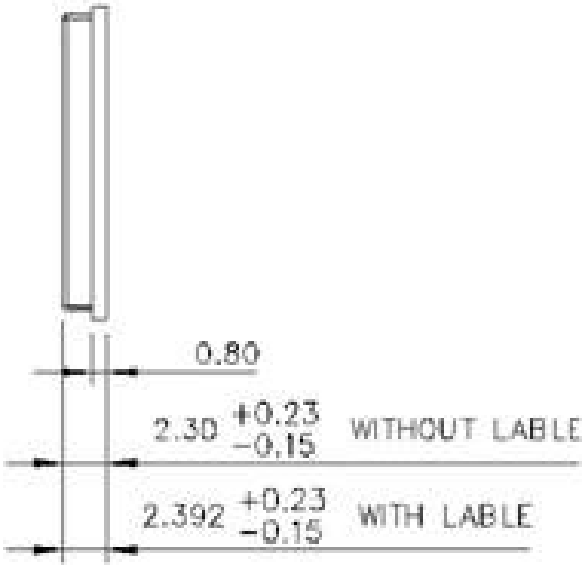


Figure 4-2. Right view

4.2 Pin Dimensions

The dimensions are illustrated in Figure 4-3, Figure 4-4, and Figure 4-5 below.

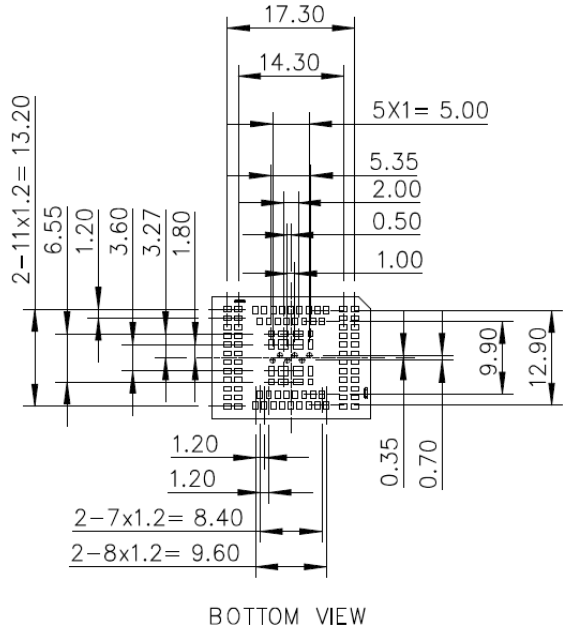


Figure 4-3. PIN dimensions (bottom view)

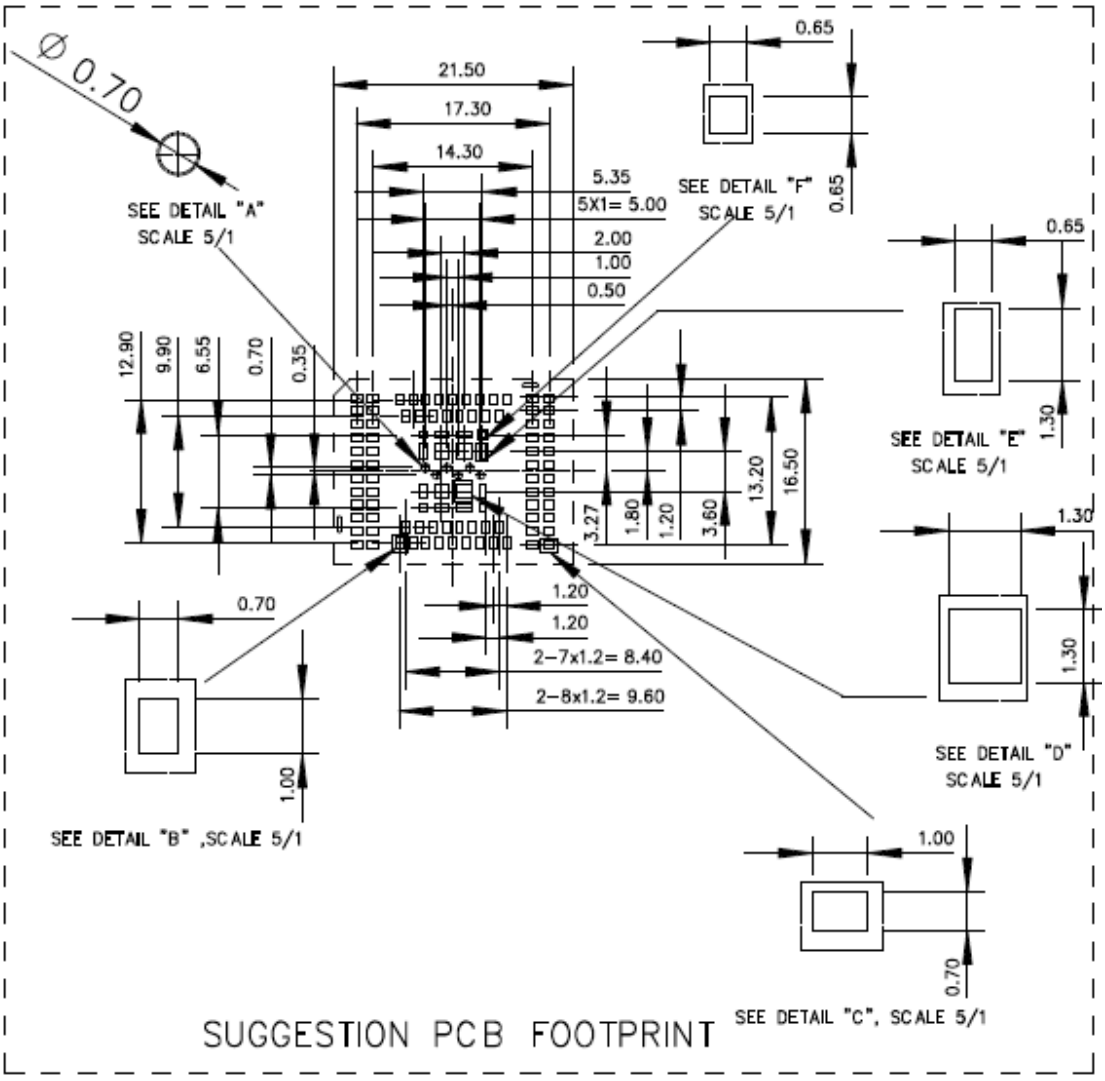


Figure 4-4. PIN dimensions

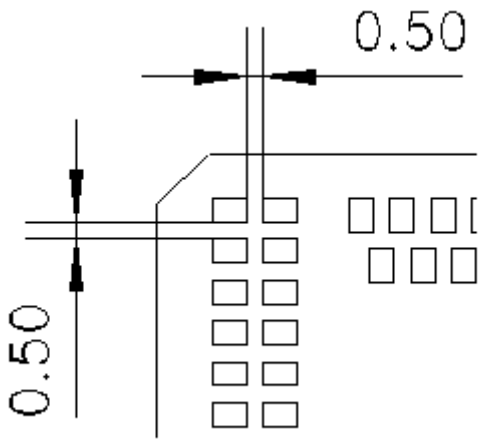


Figure 4-5. PIN dimensions

4.3 Marking Information

Note: Details will be provided in a future version of this document.

5 Packing Information

5.1 Packing Information

The module is delivered in tape-and-reel based on MPQ.
Note: Module packing details will be provided in a future revision of this document.

5.2 Storage Conditions

Note: Details will be provided in a future revision of this document.

6 PCB Mounting Guidelines

6.1 Mounting Considerations

This section details the recommended reflow profile when the module is mounted onto other boards.
Note: Details will be provided in a future revision of this document.

7 Regulatory and Industry Approval

7.1 Certification Testing

PTCRB, FCC, and AT&T TA

7.2 GP Compliance

RoHS (2011/65/EU)

Initialisms

Initialisms and Definitions

Initialism	Definition
AC	Alternating Current
DC	Direct Current
ETSI	European Telecommunications Standards Institute
GND	Ground
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
N/A	Not/Applicable
OS	Operating System
PIN	Personal Identification Number
SIM	Subscriber Identity Module
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver-Transmitter
UIM	User Identity Module
USB	Universal Serial Bus
Vref	Voltage reference
WNC	Wistron NeWeb Corporation