Product user manual

Project Name: M18QAG

Author: Wistron NeWeb Corporation

Revision: 0.3

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Contact Information

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Revision History

Rev. #	Author	Summary of Changes	Date
0.1	WNC	First release	2020/11/09
0.2	WNC	Delete function block diagram and change FCC/IC statement	2020/11/17
0.3	WNC	Add Interference and sensitivity,Update Labeling	2020/11/20

Contents

1. Introduction

The M18QAG module is LTE modems which incorporate an application CPU subsystem and peripheral interfaces and functions uniquely designed to address the power/performance/cost requirements of IoT and M2M applications. The CPU is based on Qualcomm's MDM architecture which offers OFDMA-related software based signal processing capabilities that significantly exceed traditional communications ARM cores. M18QAG module provides a variety of interfaces including USB 2.0, SGMII, SPI, UART, PCM, I2C, UIM & SDIO.

1.1. Abbreviation

Table 1.   Abbreviation

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
PC	Personal Computer
PCM	Pulse Code Modulation

PIN	Personal Identification Number
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
WCDMA	Wideband Code Division Multiple Access
WNC	Wistron NeWeb Corporation

1.2. Features

This section lists main features of M18QAG module support. For wireless technology and band support information among different modules, please refer to table2 for detail information.

Table 2.   M18QAG Series module overview

Module	Category	LTE B2/4/5/12/14	WCDMA B2/5	GNSS	Temperature Grade
M18QAG	4	√	√	√	Industrial

Note: 1.Refer to section6.6 for more information about industrial grade.

      2." √ " indicates supporting. " ✕ " indicates not supporting.

Feature list:

- ■ LTE 3GPP release 10 without Carrier Aggregation
- ■ M18QAG: 3GPP, LTE Cat. 4 with 150/50 Mbps for DL/UL
- ■ Supports LTE B2/4/5/12/14
- ■ Supports WCDMA B2/5, 3GPP release 8
- ■ GPS & GLONASS
- ■ 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

    − SGMII interface

    − Dual UART interfaces (4 bit and 2 bit) for data transfer and diagnostic tools

    − SDC1/First SPI interface

    − I2C/Second SPI interface

    − USIM interface

    − GPIOs

    − ADC

    − PCM/I2S

    − JTAG interface

1.3. Environmental Specifications and Certifications

1.3.1. Environmental Specifications

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

Condition	Temperature Range	Remark
Normal operating temperature range	−20 °C to 60 °C	Fully functional and in compliance with 3GPP specifications
Extended operating temperature range	−40 °C to 85°C	RF performance may be affected outside the normal range, but the module will still function.
Storage	−40 °C to 85 °C	

Table 3.   Temperature range

Note: All temperatures above refer to ambient temperatures.

1.3.2. Certifications

The M18QAG module is certified to be compliant with PTCRB, FCC, IC.

1.3.3. Green Product Compliance

RoHS (2011/65/EU)

2. Electrical Specifications

2.1. Host interface pin assignments

2.1.1. LGA Pad Diagram
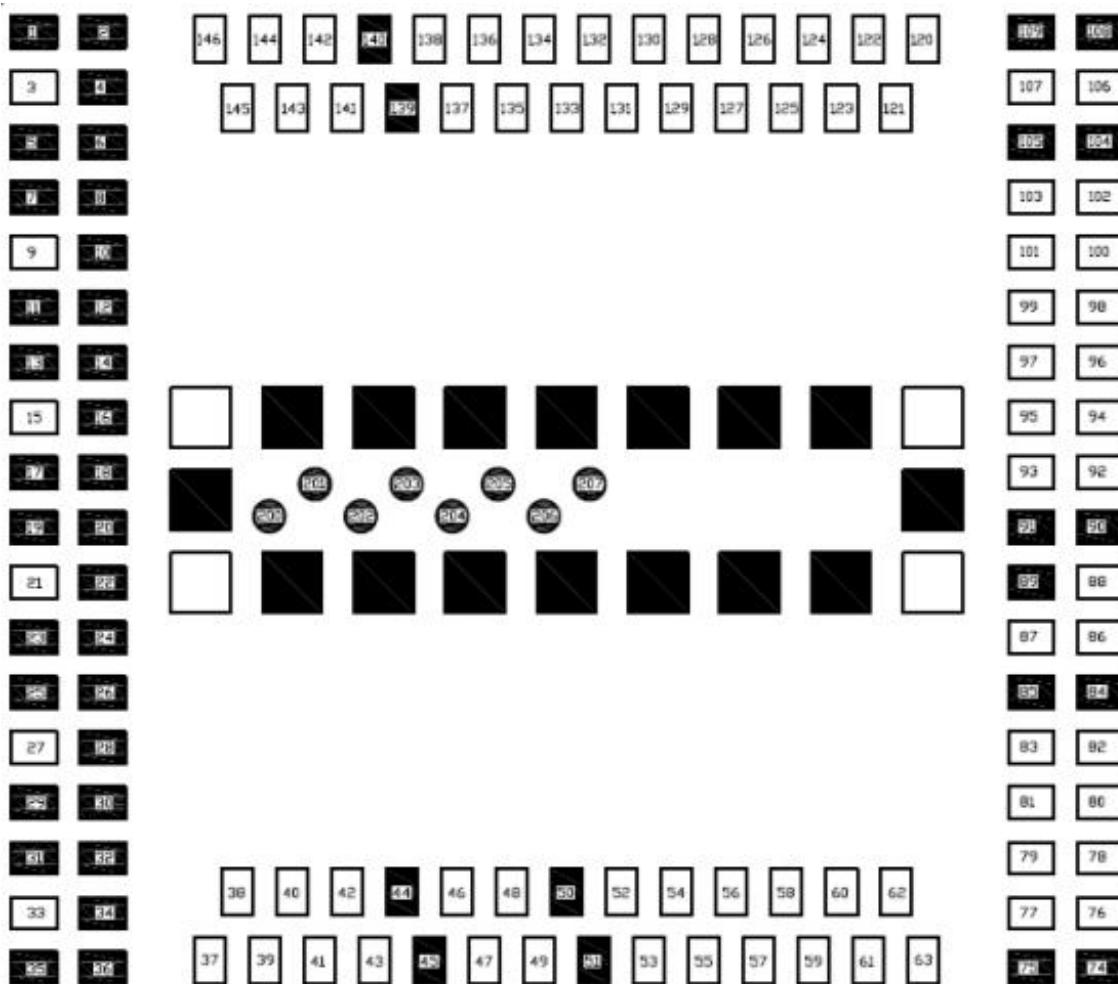
Figure 1. LGA pad diagram (top view)

2.1.2. Pin Assignments

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_2	Diversity antenna	AI
	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- SGMII			
	SGMII_RX_P	SGMII receive - plus	DI
	SGMII_RX_M	SGMII receive - minus	DI
	SGMII_TX_P	SGMII transmit - plus	DO
	SGMII_TX_M	SGMII transmit - minus	DO
	SGMII_MDIO	SGMII Management data	DI/DO
	SGMII_MDC	SGMII Management data clock	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/2nd_ SPI		
I2C_SDA	Data in/out	DI/DO
2nd_SPI_EN_1	2nd_SPI chip select	DO
I2C_SCL	Clock signal	DO
2nd_SPI_CLK	2nd_SPI serial clock	DO
SPI_MOSI	2nd_SPI master out slave in	DO
NC	NC	-
SPI_MISO	2nd_SPI master in slave out	DI
Data Interfaces- SDC1/1st_SPI		
SDC1_DATA_3	SDC1_DATA_3	DI/DO
1st_SPIM_MOSI	1st_SPI master out slave in	DO
SDC1_DATA_2	SDC1_DATA_2	DI/DO
1st_SPIM_MISO	1st_SPI master in slave out	DI
SDC1_DATA_1	SDC1_DATA_1	DI/DO
1st_SPIM_EN_1	1st_SPI chip select	DO
SDC1_DATA_0	SDC1_DATA_0	DI/DO
1st_SPIM_CLK	1st_SPI serial clock	DO
SDC1_CMD	SDC1_CMD	DI/DO
SDC1_CLK	SDC1_CLK	DO
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			
	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- JTAG			
	JTAG_SRST_N	JTAG reset for debug	DI
	JTAG_TCK	JTAG clock input	DI
	JTAG_TDI	JTAG data input	DI
	JTAG_TDO	JTAG data output	DO
	JTAG_TMS	JTAG mode select input	DI
	JTAG_TRST_N	JTAG reset	DO
	PS_HOLD	PS_HOLD	DI
Debug- Force_USB_BOOT			
	Force_USB_BOOT_CONFIG	Force USB BOOT CONFIG	DI

Table 5.　Pin Assignments

Pin No.	Modem mode	Host Mode	Voltage Level (V)		
			Min.	**Typ.**	**Max.**
1	GND	GND	-	0	-
2	GND	GND	-	0	-
3	NC	NC	-	-	-
4	GND	GND	-	0	-
5	GND	GND	-	0	-
6	GND	GND	-	0	-
7	GND	GND	-	0	-
8	GND	GND	-	0	-
9	RF_GNSS	RF_GNSS	-	-	-
10	GND	GND	-	0	-

11	GND	GND	-	0	-
12	GND	GND	-	0	-
13	GND	GND	-	0	-
14	GND	GND	-	0	-
15	RF_1	RF_1	-	-	-
16	GND	GND	-	0	-
17	GND	GND	-	0	-
18	GND	GND	-	0	-
19	GND	GND	-	0	-
20	GND	GND	-	0	-
21	RF_2	RF_2	-	-	-
22	GND	GND	-	0	-
23	GND	GND	-	0	-
24	GND	GND	-	0	-
25	GND	GND	-	0	-
26	GND	GND	-	0	-
27	NC	NC	-	-	-
28	GND	GND	-	0	-
29	GND	GND	-	0	-
30	GND	GND	-	0	-
31	GND	GND	-	0	-
32	GND	GND	-	0	-
33	NC	NC	-	-	-
34	GND	GND	-	0	-
35	GND	GND	-	0	-
36	GND	GND	-	0	-
37	VCC1	VCC1	3.3	3.8	4.2
38	VCC2	VCC2	3.3	3.8	4.2
39	VCC3	VCC3	3.3	3.8	4.2
40	VCC4	VCC4	3.3	3.8	4.2
41	VCC5	VCC5	3.3	3.8	4.2
42	VCC6	VCC6	3.3	3.8	4.2
43	NC	NC	-	-	-
44	GND	GND	-	0	-
45	GND	GND	-	0	-
46	PCM_SYNC/GPIO46	PCM_SYNC/GPIO46	1.7	1.8	1.9

47	PCM_DIN/GPIO47	PCM_DIN/GPIO47	1.7	1.8	1.9
48	PCM_DOUT/GPIO48	PCM_DOUT/GPIO48	1.7	1.8	1.9
49	PCM_CLK/GPIO49	PCM_CLK/GPIO49	1.7	1.8	1.9
50	GND	GND	-	0	-
51	GND	GND	-	0	-
52	GPIO01/Force USB BOOT Config[8]	GPIO01/Force USB BOOT Config[8]	1.7	1.8	1.9
53	GPIO02	GPIO02	1.7	1.8	1.9
54	GPIO03	GPIO03	1.7	1.8	1.9
55	GPIO04	GPIO04	1.7	1.8	1.9
56	NC	SGMII_TX_P	-	Note5	-
57	NC	SGMII_TX_M	-	Note5	-
58	NC	SGMII_RX_P	-	Note5	-
59	NC	SGMII_RX_M	-	Note5	-
60	I2C_SDA	I2C_SDA/ 2nd_SPI_EN_1	1.7	1.8	1.9
61	I2C_SCL	I2C_SCL/ 2nd_SPI_CLK	1.7	1.8	1.9
62	NC	2nd_SPI_MOSI	1.7	1.8	1.9
63	NC	2nd_SPI_MISO	1.7	1.8	1.9
74	GND	GND	-	0	-
75	GND	GND	-	0	-
76	RFFE1_DATA	RFFE1_DATA	-	-	-
77	RFFE1_CLK	RFFE1_CLK	-	-	-
78	NC	NC	-	-	-
79	NC	NC	-	-	-
80	UART1_CTS (UART 1)	UART1_CTS (UART 1)	1.7	1.8	1.9
81	UART1_RTS (UART 1)	UART1_RTS (UART 1)	1.7	1.8	1.9
82	UART1_RX (UART 1)	UART1_RX (UART 1)	1.7	1.8	1.9
83	UART1_TX (UART 1)	UART1_TX (UART 1)	1.7	1.8	1.9
84	GND	GND	-	0	-
85	GND	GND	-	0	-
86	USB_Dp	USB_Dp	-	Note6	-
87	USB Detect[7]	USB Detect[7]	1.7	1.8	1.9
88	USB_Dn	USB_Dn	-	Note6	-
89	GND	GND	-	0	-

90	GND	GND	-	0	-
91	GND	GND	-	0	-
92	NC	GPIO92	1.7	1.8	1.9
93	GPIO93	GPIO93	1.7	1.8	1.9
94	GPIO94	GPIO94	1.7	1.8	1.9
95	GPIO95	GPIO95	1.7	1.8	1.9
96	GPIO96	GPIO96	1.7	1.8	1.9
97	GPIO97	GPIO97	1.7	1.8	1.9
98	NC	GPIO98	1.7	1.8	1.9
99	NC	NC	-	-	-
100	NC	NC	-	-	-
101	NC	GPIO101	1.7	1.8	1.9
102	NC	GPIO102	1.7	1.8	1.9
103	NC	EPHY_RST_N	1.7	1.8	1.9
104	GND	GND	-	0	-
105	GND	GND	-	0	-
106	UART2_RX (UART 2)	UART2_RX (UART 2)	1.7	1.8	1.9
107	UART2_TX (UART 2)	UART2_TX (UART 2)	1.7	1.8	1.9
108	GND	GND	-	0	-
109	GND	GND	-	0	-
120	NC	SGMII_MDC	-	Note5	-
121	NC	SGMII_MDIO	-	Note5	-
122	AD Converter	AD Converter	0.1	-	1.7
123	NC	SDC1_CMD	1.7	1.8	1.9
124	NC	SDC1_CLK	1.7	1.8	1.9
125	1st_SPI_MOSI	SDC1_DATA_3/ 1st _SPIM_MOSI	1.7	1.8	1.9
126	1st _SPI_MISO	SDC1_DATA_2/ 1st _SPIM_MISO	1.7	1.8	1.9
127	1st _SPI_EN_1	SDC1_DATA_1/ 1st _SPIM_EN_1	1.7	1.8	1.9
128	1st _SPI_CLK	SDC1_DATA_0/ 1st _SPIM_CLK	1.7	1.8	1.9
129	GPIO05	GPIO05	1.7	1.8	1.9
130	GPIO06	GPIO06	1.7	1.8	1.9
131	GPIO07	GPIO07	1.7	1.8	1.9

132	GPIO08	EPHY_INT_N/GPIO08	1.7	1.8	1.9
133	UIM_VCC	UIM_VCC	1.7/2.7	1.8/3.0	1.9/3.3
134	UIM_DATA	UIM_DATA	1.7/2.7	1.8/3.0	1.9/3.3
135	UIM_CLK	UIM_CLK	1.7/2.7	1.8/3.0	1.9/3.3
136	UIM_RESET	UIM_RESET	1.7/2.7	1.8/3.0	1.9/3.3
137	UIM_DETECT	UIM_DETECT	1.7	1.8	1.9
138	NC	NC	-	-	-
139	GND	GND	-	0	-
140	GND	GND	-	0	-
141	WWAN_STATE	WWAN_STATE	1.7	1.8	1.9
142	POWER_ON[4]	POWER_ON[4]	1.7	1.8	1.9
143	WAKEUP_OUT[2]	WAKEUP_OUT[2]	1.7	1.8	1.9
144	WAKEUP_IN[3]	WAKEUP_IN[3]	1.7	1.8	1.9
145	RESET	RESET	1.7	1.8	1.9
146	VREF	VREF	1.7	1.8	1.9
200	JTAG_SRST_N	JTAG_SRST_N	1.7	1.8	1.9
201	JTAG TCK	JTAG TCK	1.7	1.8	1.9
202	JTAG TDI	JTAG TDI	1.7	1.8	1.9
203	JTAG TDO	JTAG TDO	1.7	1.8	1.9
204	JTAG_TMS	JTAG_TMS	1.7	1.8	1.9
205	JTAG TRST_N	JTAG TRST_N	1.7	1.8	1.9
206	PS_HOLD	PS_HOLD	1.7	1.8	1.9
207	NC	NC	-	-	-

Notes:

*1. Refer to SGMII standard for more electronic characteristics.

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

*3. 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.

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

*5. Do not pull pin143 WAKEUP_OUT to high; otherwise boot will fail.

*6. Leave unused pins floating

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

*8. 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.

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Table 6.   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 7.   I/O default setting table

Pin No.	Signal Name	Type	Default setting in Normal mode
46	PCM_SYNC/GPIO46	DI /DO	PD
47	PCM_IN/GPIO47	DI /DO	PD
48	PCM_OUT/GPIO48	DI /DO	PD
49	PCM_CLK/GPIO49	DI /DO	PD
52	GPIO01	DI/DO	PD
53	GPIO02	DI/DO	PD
54	GPIO03	DI/DO	PD
55	GPIO04	DI/DO	PD
60	I2C_SCL/ 2nd_SPI_CLK	DI/DO	PD
61	I2C_SDA/ 2nd_SPI_EN_1	DI/DO	PD

62	2nd_SPI_MOSI	DI/DO	PD
63	2nd_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
103	GPIO103	DI/DO	PD
106	UART2_RX (UART2)	DI/DO	PD
107	UART2_TX (UART2)	DI/DO	PD
120	GPIO120	DI/DO	PD
123	GPIO123	DI/DO	PD
124	GPIO124	DI/DO	NP
125	SPIM_MOSI	DI/DO	PD
126	SPIM_MISO	DI/DO	PD
127	SPIM_EN	DI/DO	PD
128	SPIM_CLK	DI/DO	PD
129	GPIO05	DI/DO	PD
130	GPIO06	DI/DO	PD
131	GPIO07	DI/DO	PU
132	GPIO08	DI/DO	PD
141	WWAN_STATE	DI/DO	PD
143	WAKEUP_OUT	DI/DO	PD

3. Electrical Specifications

3.1. Power supply

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

Table 8.   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 M18QAG includes 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.

3.2. RF Specification

3.2.1.   Band support

Table 9.   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 5	824–849	869–894
LTE Band 12	699–716	729–746
LTE Band 14	788-798	758-768
Band	**Uplink (MHz)**	**Downlink (MHz)**
WCDMA Band 2	1,850–1910	1,930–1,990
WCDMA Band 5	824–849	869–894

3.2.2. Bandwidth support

Table 10. 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 5	✓	✓	✓	✓	-	-
LTE Band 12	✓	✓	✓	✓	-	-
LTE Band 14	-	-	✓	✓	-	-

3.2.3. RF Transmit Specification

Table 11. Conductive Tx output power

Band	Items	Parameter	Unit	Min.	Typ.	Max.
LTE Band 2	Max. TX Power	10 MHz 12 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 4	Max. TX Power	10 MHz 12 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 5	Max. TX Power	10 MHz 12 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 12	Max. TX Power	10 MHz 12 RBs/QPSK	dBm	20.3	23	25.7
LTE Band 14	Max. TX Power	10 MHz 12 RBs/QPSK	dBm	20.3	23	25.7
Band	**Items**	**Parameter**	**Unit**	**Min.**	**Typ.**	**Max.**
WCDMA Band 2	Max. TX power	-	dBm	20.3	24	25.7
WCDMA Band 5	Max. TX power	-	dBm	20.3	24	25.7

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

2. M18QAG meets 3GPP TS 36.521-1/TS 34.121-1 test standard.

3.2.4. RF Receiver Specification

Table 12. Conductive Rx sensitivity-3GPP

Band	Items	Parameter	Unit	Typ.	3GPP standard limit
LTE Band 2	RX Sensitivity	10 MHz with 50 RBs	dBm		−94.3
LTE Band 4	RX Sensitivity	10 MHz with 50 RBs	dBm		−96.3
LTE Band 5	RX Sensitivity	10 MHz with 50 RBs	dBm		−94.3
LTE Band 12	RX Sensitivity	10 MHz with 50 RBs	dBm		−93.3
LTE Band 14	RX Sensitivity	10 MHz with 50 RBs	dBm		−93.3
Band	**Items**	**Parameter**	**Unit**	**Typ.**	**Max.**

WCDMA Band 2	RX Sensitivity	-	dBm	−104.7
WCDMA Band 5	RX Sensitivity	-	dBm	−104.7

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

2. Meet 3GPP TS 36.521-1/TS 34.121-1 test standard.

3.2.5. GNSS receiver specifications

Two GNSS SAW filter, LNA need to be used between the module and antenna.

4. Software Interface

4.1. Support tools

The M18QAG module is compatible with the following support tools:
- WNC M18QAG Series Connection Manager (WNCCM)

4.2. USB interface

The M18QAG module supports 3GPP standard AT commands and proprietary AT commands; the MAL Manager SDK is also supported for Linux platforms.

5. Mechanical and Environmental Certifications

5.1. PCBA Form Factor

M18QAG Series modules have the same dimensions:

34.5 mm (typ.) × 25.0 mm (typ.) × 2.45 mm (typ.)
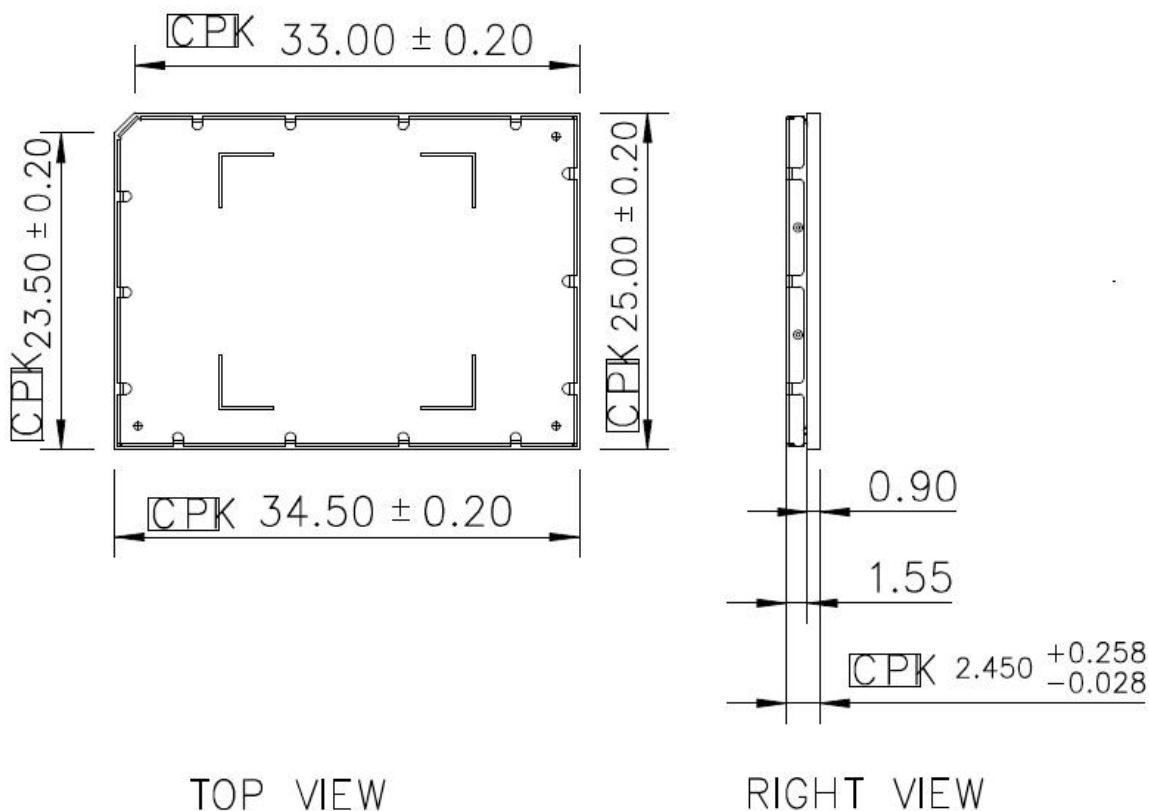
Figure 2. PCBA dimension
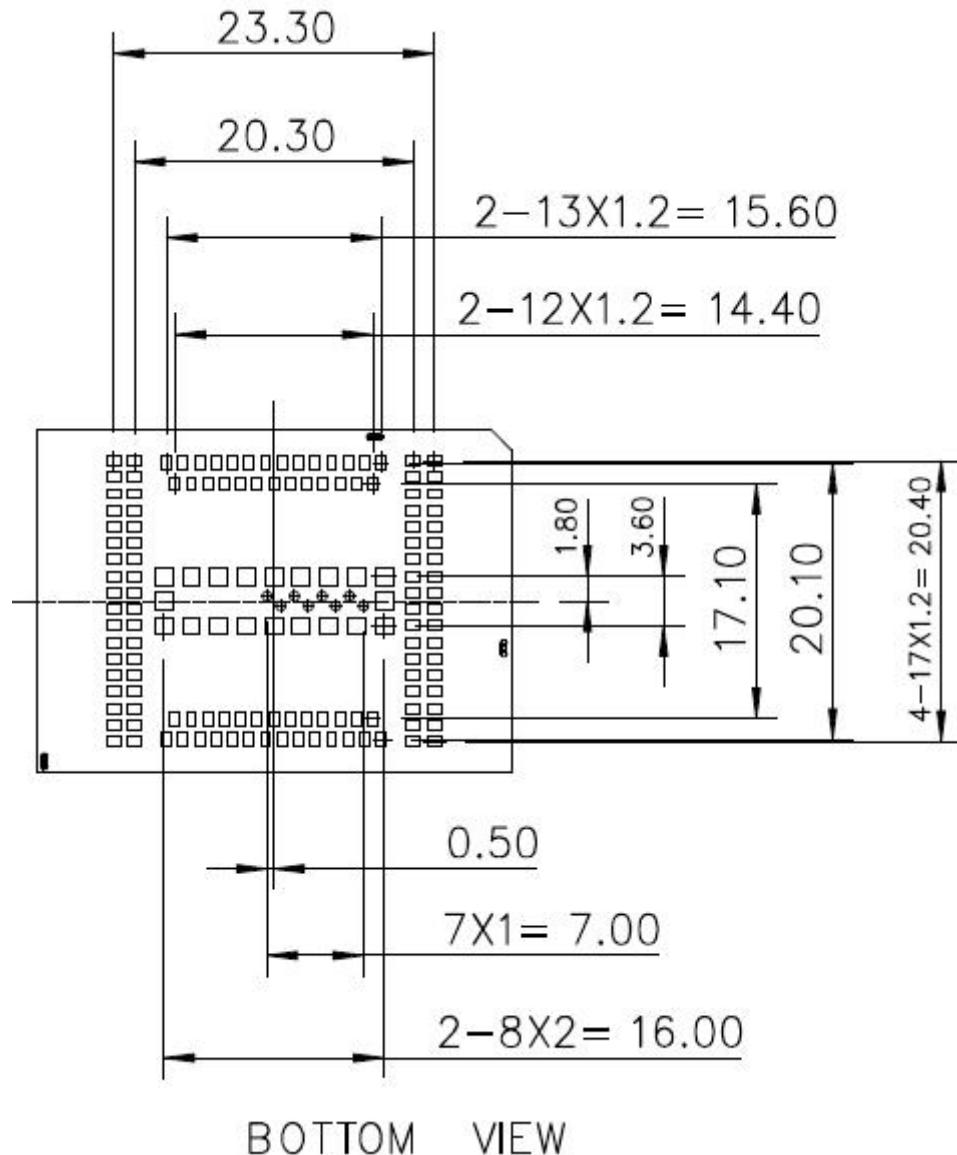
Figure 3. Pad dimension(Bottom view)
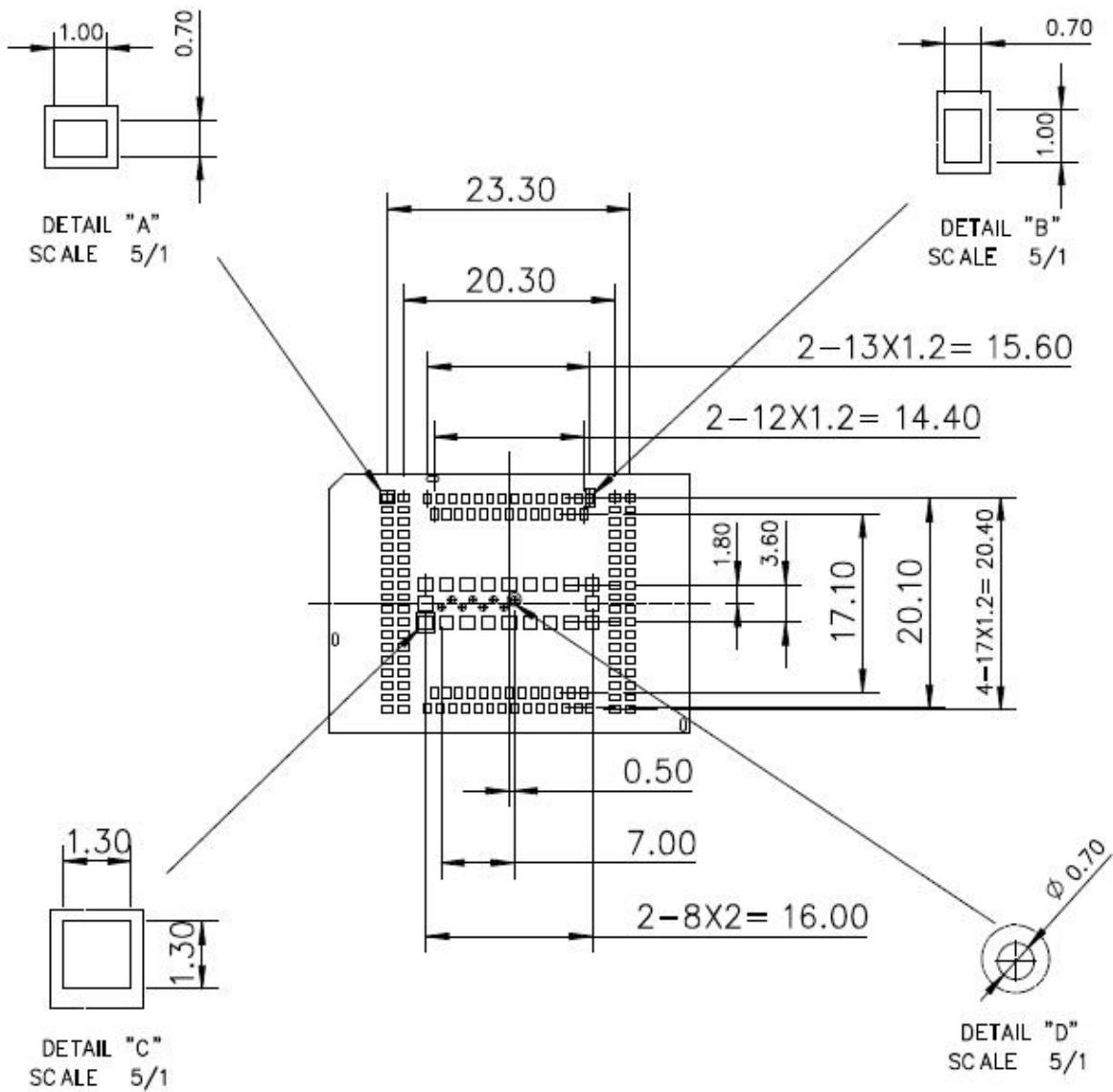
Figure 4. PCB footprint suggestion

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 M18QAG Series 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.
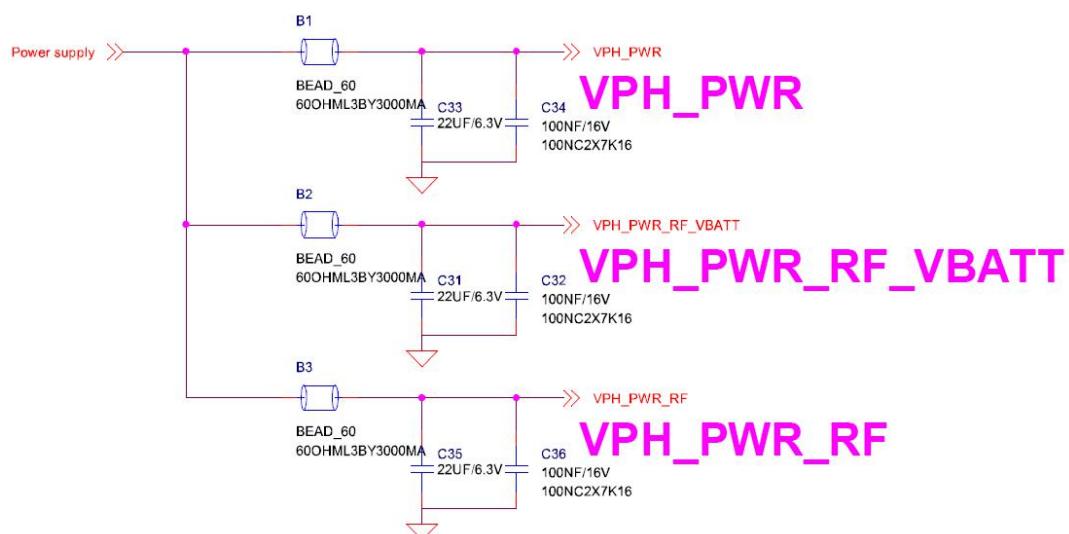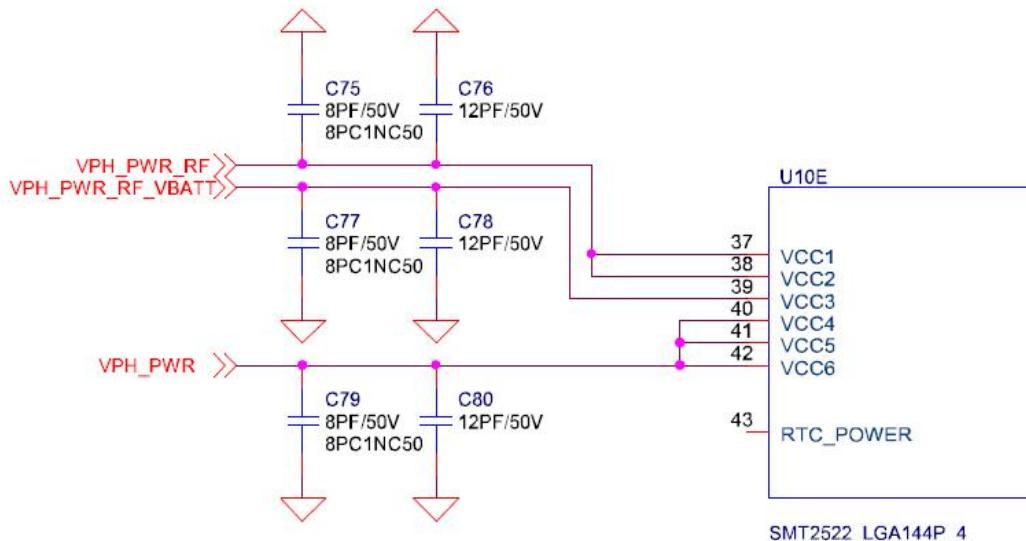
Layout Suggestion: The 22µF, 0.1uF, 12pF and 8pF capacitors are required to place near VCC pins as close as possible. Each power trace should possess sufficient line width to withstand its respective current listed in the table below:

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

6.2. RF connections

The M18QAG module has three RF pads; developers must connect them via 50 Ω traces to the main board.

ANT0_TRX pad (Pin15) – Primary RX/TX path

ANT1_DRX pad (Pin21) – Diversity path

ANT_GNSS pad (Pin9) – GNSS path

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
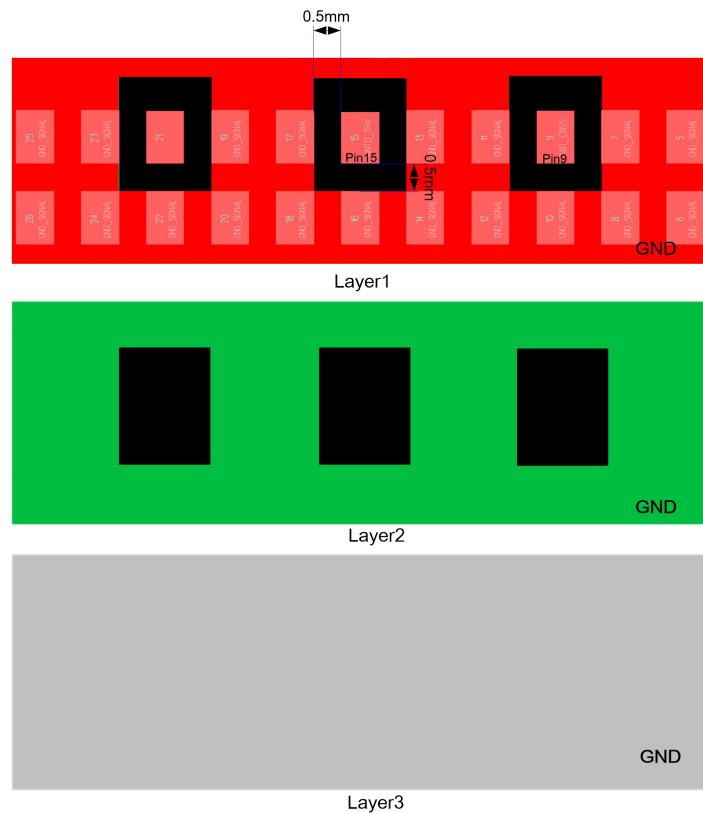
Figure 5. RF pad layout suggestion

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.
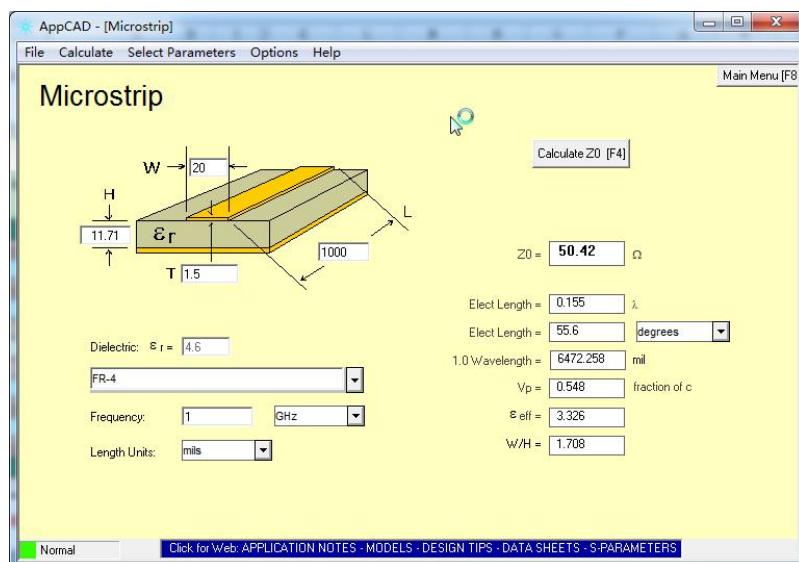
The RF trace of the test board which was used in the FCC test is defined as below.

Microstrip trace
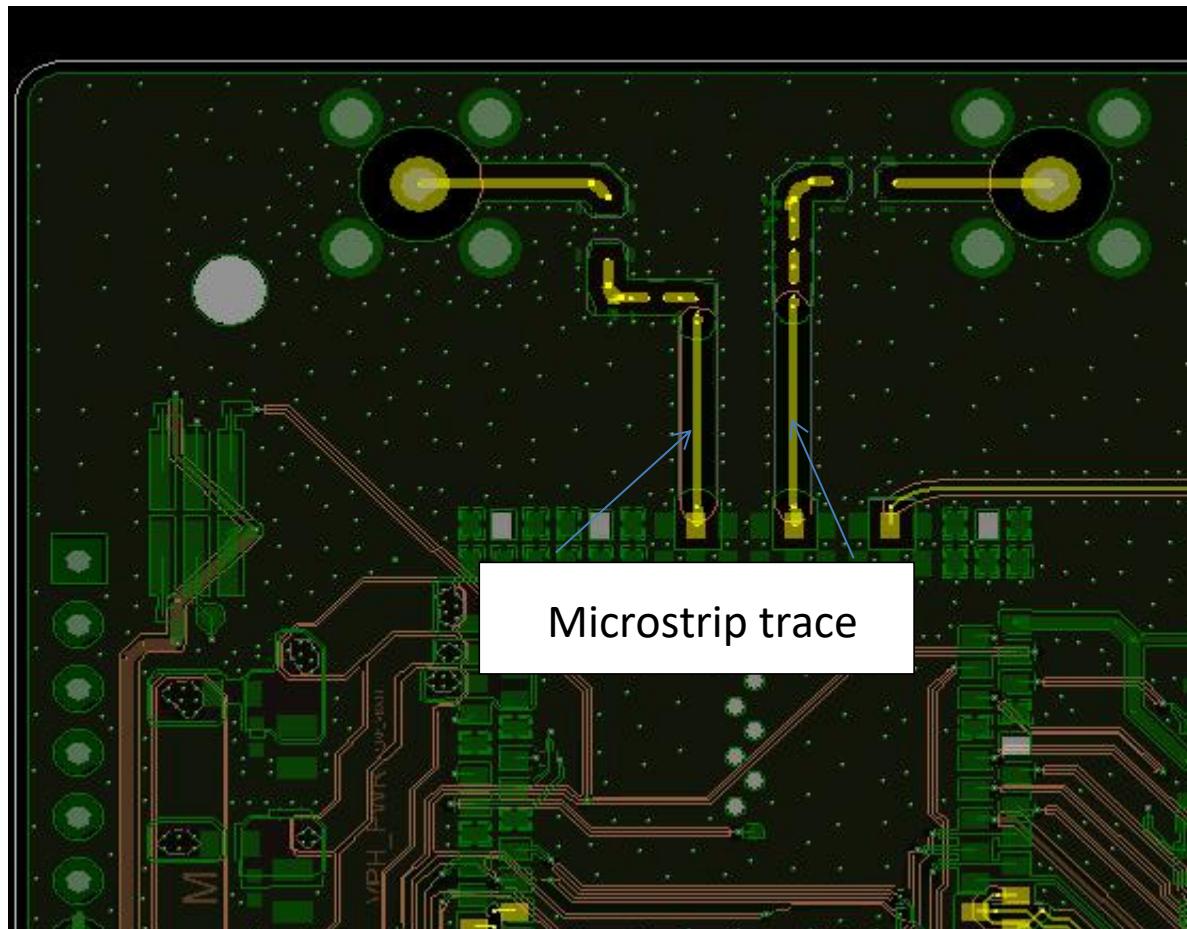
6.3. Interference and sensitivity

This section includes tips to assist developers in identifying the interference that may affect M18QAG 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 M18QAG 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.

- trace impedance for connection external shall be 50 ohms.

- trace should be kept as short as possible and avoid possible nearby unwanted signal pick up and transmitted by the antenna.
- System integrator should verify if unwanted radiated signal still complies with the relevant rule(s) requirements.

⚠️

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

6.4. 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										
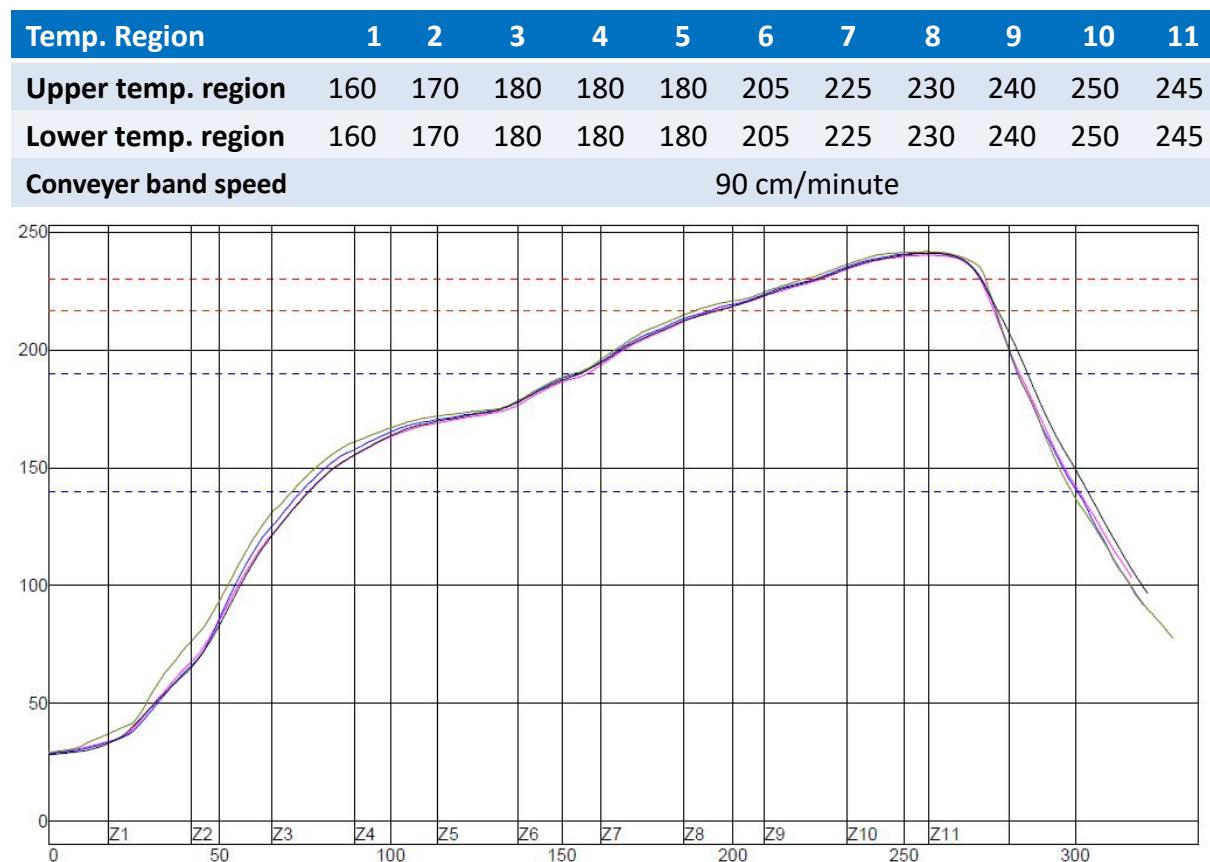
PWI = 48%	U10-1	T1-2	J3-3	U42-4	Temp. Difference
Preheat from 140–190°C					
	81.48	81.13	81.94	79.07	2.87

−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

7. Labeling

Figure26 shows label drawing of M18QAG Series modules.

Figure 6. Label drawing

8. Safety Recommendation

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.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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 module is intended for OEM integrators only. Per FCC KDB 996369 D03 OEM Manual v01 guidance, the following conditions must be strictly followed when using this certified module:

KDB 996369 D03 OEM Manual v01 rule sections:

2.2 List of applicable FCC rules

This module has been tested for compliance to FCC Part 22, 24, 27, 90

2.3 Summarize the specific operational use conditions

The module is tested for standalone mobile RF exposure use condition. Any other usage conditions such as co-location with other transmitter(s) or being used in a portable condition will need a separate reassessment through a class II permissive change application or new certification.

2.4 Limited module procedures

Not applicable.

2.5 Trace antenna designs

Not applicable.

2.6 RF exposure considerations

This equipment complies with FCC mobile 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. If the module is installed in a portable host, a separate SAR evaluation is required to confirm compliance with relevant FCC portable RF exposure rules.

2.7 Antennas

The following antennas have been certified for use with this module; antennas of the same type with equal or lower gain may also be used with this module. The antenna must be installed such that 20 cm can be maintained between the antenna and users.

For GPS					
Antenna No.	Band	Freq. Range (MHz)	Antenna Net Gain (dBi)	Antenna Type	Connector Type
1	GPS	1602	2.24	Dipole	SMA
For WWAN					
Antenna No.	Band	Freq. Range (MHz)	Antenna Net Gain (dBi)	Antenna Type	Connector Type
2	LTE / WCDMA (2)	1850~1910	1.56	Dipole	SMA
	LTE / WCDMA (4)	1710~1755	1.62	Dipole	SMA
	LTE / WCDMA (5)	824~849	3.2	Dipole	SMA
	LTE / WCDMA (12)	699~716	1.49	Dipole	SMA
	LTE / WCDMA (14)	788~798	1.66	Dipole	SMA

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: "Contains FCC ID: **NKRM18QAG**". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

2.9 Information on test modes and additional testing requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) or portable use will require a separate class II permissive change re-evaluation or new certification.

2.10 Additional testing, Part 15 Subpart B disclaimer

This transmitter module is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement applicable to the final host. The final host will still need to be reassessed for compliance to this portion of rule requirements if applicable.

As long as all 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 <u>can not</u> 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.

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.

OEM/Host manufacturer responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment

Industry Canada statement:

This device complies with ISED's licence-exempt RSSs. 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.

Le présent appareil est conforme aux CNR d' ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement

indésirable.

Radiation Exposure Statement:

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

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé à plus de 20 cm entre le radiateur et votre corps.

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

1) The antenna must be installed and operated with greater than 20cm 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 installé et exploité avec plus de 20 cm 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 and operated with greater than 20cm between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 4441A-M18QAG".

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un appareil où l'antenne peut être installée et utilisée à plus de 20 cm entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 4441A-M18QAG".

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.

This radio transmitter (IC: 4441A-M18QAG / Model: M18QAG) has been approved by ISED to operate with the antenna type listed below with maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (IC: 4441A-M18QAG / Model: M18QAG) a été approuvé par ISED pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Antenna list

For GPS					
Antenna No.	Band	Freq. Range (MHz)	Antenna Net Gain (dBi)	Antenna Type	Connector Type
1	GPS	1602	2.24	Dipole	SMA
For WWAN					
Antenna No.	Band	Freq. Range (MHz)	Antenna Net Gain (dBi)	Antenna Type	Connector Type
2	LTE / WCDMA (2)	1850~1910	1.56	Dipole	SMA
	LTE / WCDMA (4)	1710~1755	1.62	Dipole	SMA
	LTE / WCDMA (5)	824~849	3.2	Dipole	SMA
	LTE / WCDMA (12)	699~716	1.49	Dipole	SMA
	LTE / WCDMA (14)	788~798	1.66	Dipole	SMA