

USER MANUAL

Wi-Fi HaLow 802.11ah Module

Model Name: WSG300NRC

Brand: LITEON

FCC Statement

Federal Communication Commission Interference Statement

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 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.

For product available in the USA/Canada market, only channel 1~11 can be operated. Selection of other channels is not possible. This device and its antenna(s) must not be co-located with any other transmitters except in accordance with FCC multi transmitter product procedures. Referring to the multi transmitter policy, multiple transmitter(s) and module(s) can be operated simultaneously without C2PC.

IMPORTANT NOTE: FCC 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 20 cm between the radiator & your body.

IMPORTANT NOTE: This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.

20 cm minimum distance has to be able to be maintained between the antenna and the users for the host this module is integrated into. Under such configuration, the FCC radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

USERS MANUAL OF THE END PRODUCT:

In the user's manual of the end product, the end user has to be informed to keep at least 20 cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the user's manual: This device complies with Part 15 of 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.

LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains FCC ID: PPQ-WSG300NRC". If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of 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.

OEM Integrator Checklist

The party below will implement the LITE-ON Module in host systems in accordance with the instructions specified in this document and the documents referenced herein.

- 1.The OEM integrator will ensure the Module is integrated in a host systems using only the approved antenna model(s) described in this document.
- 2.The OEM integrator will ensure the antenna placement inside the host system will maintain the required spacing to end user for RF Exposure compliance, as specified in this document.
- 3.If other radios are integrated inside the host with the LITE-ON Module, the OEM integrator will contact its test lab, TCB or LITE-ON to determine if additional FCC compliance evaluation is required to meet FCC collocation rules.
- 4.The OEM integrator will ensure end user documentation will contain the specified regulatory wording and ensure the host system and the Module itself are labeled as specified in this

document.

5. The OEM integrator will ensure the Module is programmed in the factory with compliant transmit power not exceeding the levels specified in this document. LITE-ON requests that the OEM integrator acknowledge its receipt of this document and the above instructions. You may contact LITE-ON with any questions concerning this document or the responsibilities of the OEM integrator

Overview

IEEE 802.11ah is a new Wi-Fi standard operating in the Sub 1GHz license-exempt band, offering longer range and lower power connectivity necessary for internet of things (IoT) applications. WSG300NRC contains external RF front end module (FEM) which can increase transmission power up to 23 dBm. Onboard serial flash can be used for OTA software development and with internal 32KB cache memory, it can support execution in place (XIP) feature.

1.1 Module features

The main features are represented as follows:

- Standard
 - IEEE Std 802.11ah™-2016 compliant
 - 1/2/4 MHz channel bandwidth support
 - WPA2 PSK support
 - 150 kbps ~ 15 Mbps data rate
 - AP and STA role support
- Radio frequency
 - -109 dBm minimum receive sensitivity
 - +23 dBm transmit power
 - 920.5~924.5 MHz frequency band

(By replacing RF SAW filter, other frequency band can be supported within 750~950 MHz)

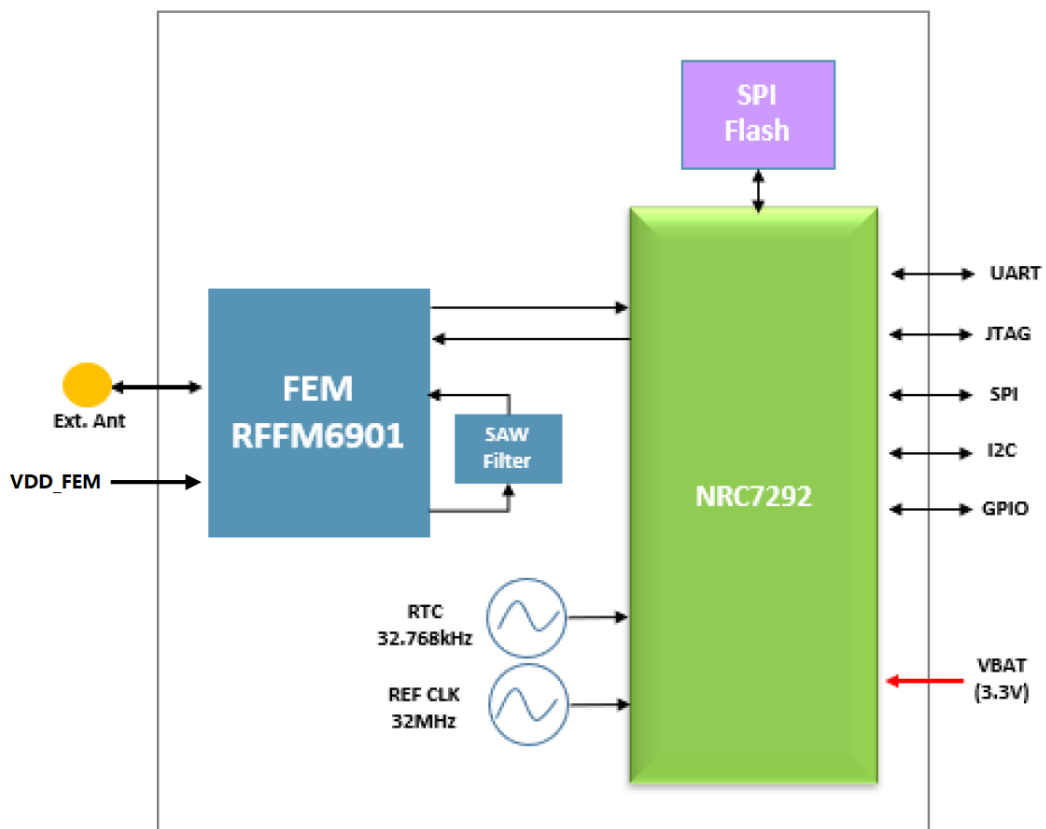
- CPU
 - ARM Cortex-M3 for application
 - ARM Cortex-M0 for IEEE 802.11ah WLAN
 - Clock frequencies for both processor (32/48 MHz)
- Host interface
 - UART and SPI support for host interface
- Peripherals
 - GPIO, ADC, PWM and timers
 - I2C, SPI and UART
- Temperature range
 - -40°C to +125°C

1.2 Applications

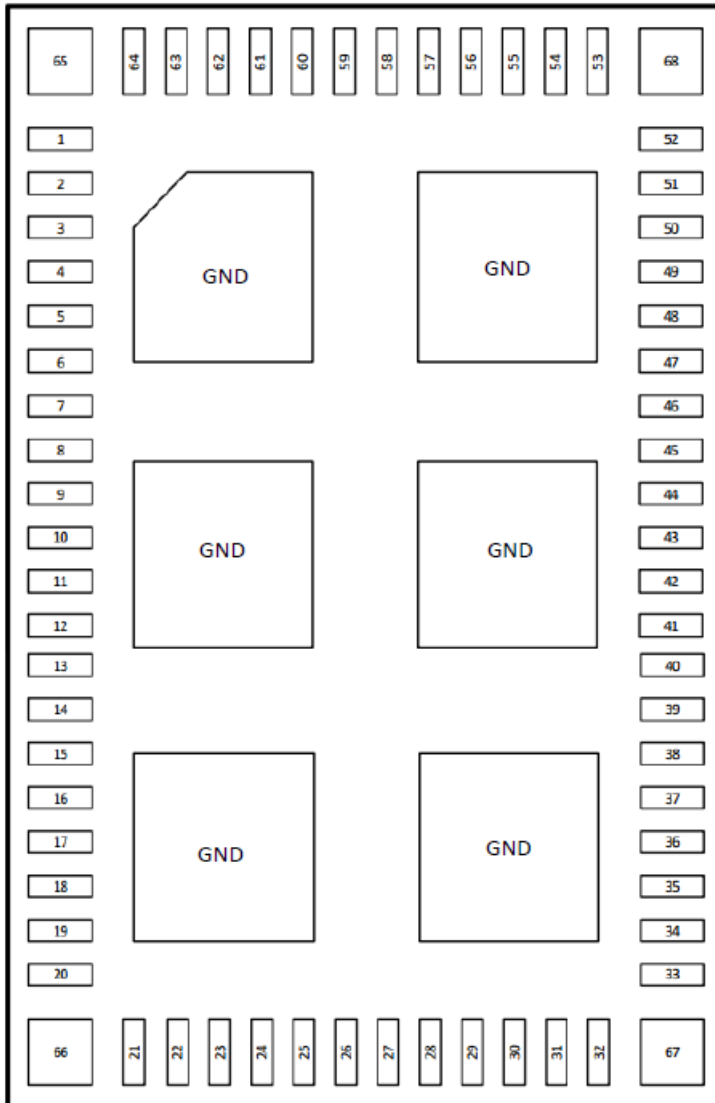
Low to high data rate can be applied in various IoT applications like:

- Wearable
- Home automation
- Healthcare
- Industrial automation
- Safety and security
- Smart grid
- Multimedia streaming

2. Block Diagram



3. Pin Description



Pad no.	Name	Direction	Volt	Description
1	GROUND	GND		
2	GROUND	GND		
3	GROUND	GND		
4	GROUND	GND		
5	VDD_FEM	P		Module power input for FEM
6	VBAT_3.3V	P		Module power input for SYS
7	GROUND	GND		
8	GROUND	GND		
9	MODE_00	I		SW define (When ROM BOOT)
10	MODE_01	I		11: Internal SRAM BOOT
11	MODE_02	I		0: ROM BOOT 1: XIP BOOT
12	MODE_03	I		0: Cortex-M0 Mater 1: Cortex-M3 Mater
13	MODE_04	I		0: Two CPU 1: One CPU
14	GROUND	GND		
15	HSPI_nCS	I		Host SPI-Chip Select (active low)
16	HSPI_CLK	I		Host SPI-Clock
17	HSPI_MISO	O		Host SPI-Mater in Slave out
18	HSPI_MOSI	I		Host SPI-Mater out Slave in
19	HSPI_EIRQ	O		Host SPI-Interrupt
20	GROUND	GND		
21	GROUND	GND		
22	NC	-		
23	NC	-		
24	NC	-		
25	GP_00_UART2_TX	I/O		UART Channel2 Tx
26	GP_01_UART2_RX	I/O		UART Channel2 Rx
27	GP_02_UART2_RTS	I/O		UART Channel2 RTS
28	GP_03_UART2_CTS	I/O		UART Channel2 CTS
29	GP_04_UART0_TX	I/O		UART Channel0 Tx
30	GP_05_UART0_RX	I/O		UART Channel0 Rx
31	GP_06_UART3_TX	I/O		UART Channel3 Tx
32	GP_07_UART3_RX	I/O		UART Channel3 Rx
33	GP_08_UART1_RX	I/O		UART Channel1 Rx
34	GP_11_UART1_TX	I/O		UART Channel1 Tx
35	GP_10_GPIO	I/O		Multiple purpose
36	GP_09_GPIO	I/O		(GPIO, I2C, PWM, SPI, Ext-INT)
37	GP_17_I2C_SDA	I/O		I2C_SDA

38	GP_16_I2C_SCL	I/O	I2C_SCL
39	GP_15_SSP0_CLK	O	SPIO_Clock
40	PD_14_SSP0_CS	O	SPIO_Chip Enable (active low)
41	PD_13_SSP0_MOSI	O	SPIO_Mater out Slave in
42	PD_12_SSP0_MISO	I	SPIO_Mater in Slave out
43	RESET	I	Reset (active high)
44	GROUND	GND	
45	JTAG_TRSTN	I	JTAG reset
46	JTAG_TMS	I	JTAG mode selection
47	JTAG_TCK	I	JTAG clock
48	JTAG_TDI	O	JTAG data input
49	JTAG_TDO	I	JTAG data output
50	GROUND	GND	
51	VDDIO	P	Module I/O supply input
52	GROUND	GND	
53	GROUND	GND	
54	AUXADCIN3	I	AUXADC input 3
55	AUXADCIN2	I	AUXADC input 2
56	AUXADCIN1	I	AUXADC input 1
57	GROUND	GND	
58	NC	-	
59	NC	-	
60	GROUND	GND	
61	GROUND	GND	
62	RF_ANT	I/O	RF IN/OUT
63	GROUND	GND	
64	GROUND	GND	
65	GROUND	GND	
66	GROUND	GND	
67	GROUND	GND	
68	GROUND	GND	

4. Absolute Maximum Rating

Symbol	Rating	Min	Max	Units
Storage Temperature		-40	+125	°C
Supply Voltage	VBAT	-0.5	3.8	V
	VDDIO	-0.5	3.8	V

NOTE: Stresses above those listed in Absolute Maximum Rating may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

5. Operating Condition

5.1 Operating condition

Symbol	Rating	Min	Typ	Max	Units
Operating Temperature Range		-40	-	+85	°C
Operating Voltage	VBAT	2.8	3.3	3.6	V
	VDDIO	1.8	3.3	VBAT	V

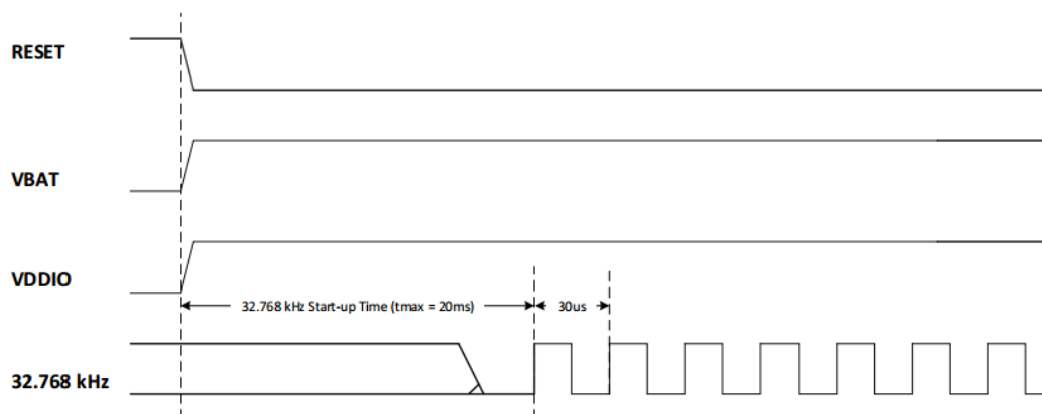
NOTE: To ensure WLAN performance, ripple on the 2.1- to 3.3-V supply must be less than ± 300 mV and ripple on the 1.8-V supply must be less than 2% (± 40 mV).

5.2 Current consumption

Mode	DUT Status	Band (MHz)	VBAT=3.3V, Ta=27°C
802.11ah (1Mhz BW)	TX@18dBm	922	200
	Continuous RX@-80dBm		41
802.11ah (2Mhz BW)	TX@18dBm	922	200
	Continuous RX@-80dBm		41
802.11ah (4Mhz BW)	TX@18dBm	922	200
	Continuous RX@-80dBm		42

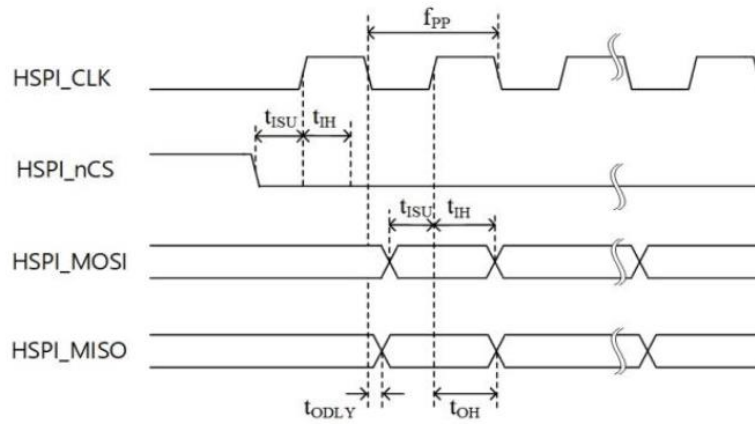
Note: Unless otherwise specified, TA=27°C, VBAT=3.6V, using internal PMU. Measurements are done at antenna port, which is directly connect to the device.

5.3 Power on sequence



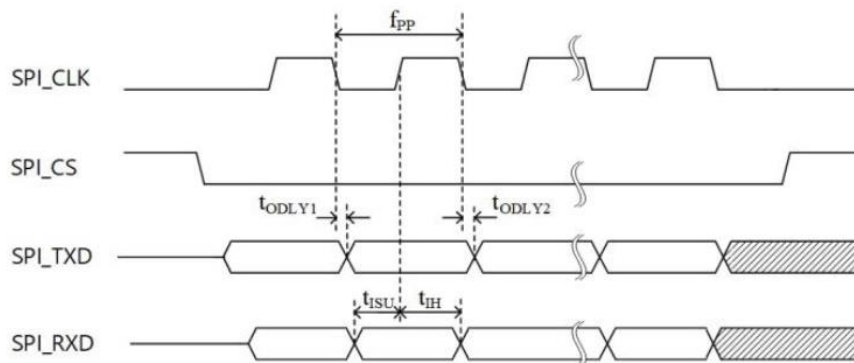
6. AC Specifications

6.1 HSPI timing



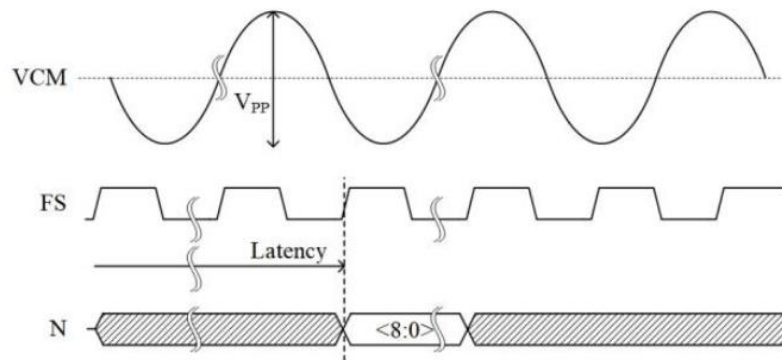
Symbol	Parameter	Min	Typ	Max	Unit
f_{PP}	Frequency	-	-	25	MHz
t_{ODLY}	Output delay time	6	-	-	ns
t_{OH}	Output hold time	2	-	-	ns
t_{ISU}	Input setup time	-	-	14	ns
t_{IH}	Input hold time	2.5	-	-	ns

6.2 SPI Timing



Symbol	Parameter	Min	Typ	Max	Unit
f_{PP}	Frequency				
	master	-	-	24	MHz
	slave	-	-	4	MHz
t_{ODLY1}	Output delay time1	0	-	10	ns
t_{ODLY2}	Output delay time2	0	-	10	ns
t_{ISU}	Input setup time	18	-	-	ns
t_{IH}	Input hold time	20	-	-	ns

6.3 AUXADC Timing



Symbol	Parameter	Min	Typ	Max	Unit
V _{CM}	Input common-mode voltage	0.25	0.28	0.31	V
V _{pp}	Input Swing	-	0.5	-	V _{pp}
FS	Sampling Clock	-	32	-	MHz
Latency	Conversion latency(1 cycle = 31.25 ns)	-	11	-	cycle
N	Resolution	-	9	-	Bit
R _{IN}	Input impedance	-	1	-	Mohms
I _{active}	Current consumption (1.2V supply)	-	-	300	uA
I _{down}	Power-down current (1.2V supply)	-	-	1	uA

7. 11ah WLAN RF Specifications and Performance

7.1 Transmitter Specifications

Parameter	Conditions	Min	Typ	Max	Unit
RF Output Frequency Range ⁽¹⁾		920.5		924.5	MHz
EVM compliant Output Power	13.5 Mbps (MCS7, 4 MHz BW)		18		dBm
EVM at 0 dBm output power			33		dB
Transmitter Spurious Signal Emissions	< 700 MHz		<-36		dBm/MHz
	> 1 GHz		<-45		
RF Output Return Loss	Single ended output port		-10		dB
Output 1dB Gain Compression	0.4 MHz CW signal input		25		dBm
Gain Control Range		30			dB
Gain Control Step			1		dB
Unwanted Sideband	Over RF channel, RF frequency, and baseband frequency at 0 dBm output power		<-40		dBc

Note: Unless otherwise specified, TA=27°C, VBAT=3.6V, RF input/output specifications are referenced not device pins and do not include 1dB loss from EV kit OCB and SMA connector.

(1) RF output frequency range depends on RF SAW filter on the module. The NRC7292 chipset by itself can support frequency range from 750 to 950 MHz.

7.2 Receiver Specifications

Parameter	Conditions	Min	Typ	Max	Unit
RF Input Frequency Range ⁽¹⁾		920.5		924.5	MHz
RF Input Return Loss	For LNA high/mid/low gain modes	-10	-12	-15	dB
Total Voltage Gain Range	Analog + Digital Gain	-10		92	dB
RF Gain Step	From high gain mode to medium gain mode		6		dB
RX Gain Step	From RF to Analog		1		dB
DSB Noise Figure	LNA max gain mode		3.5		dB
IIP3	LNA with high gain mode		-17		dBm
	LNA with low gain mode		24		

Baseband Filters for Receiver (Analog + Digital Filter)					
Baseband -3dB Low-pass Corner Frequency (Controllable)	1 MHz channel		0.5		MHz
	2 MHz channel		1.0		MHz
	4 MHz channel		2.0		MHz

Note: Unless otherwise specified, TA=27°C, VBAT=3.6V, RF input/output specifications are referenced not device pins and do not include 1dB loss from EV kit OCB and SMA connector.

(1) RF output frequency range depends on RF SAW filter on the module. The NRC7292 chipset by itself can support frequency range from 750 to 950 MHz.

7.3 Transmitter Performance

DR/MCS/BW (Mbps/ /MHz)	IEEE Relative constellation error (dB)	EVM (%) (IEEE)	EVM (%) (NRM7292A)	Comments
0.15/MCS10/1	-4	63.1	3.1	BPSK Peak
0.30/MCS0/1	-5	56.2	3.1	BPSK Peak
0.60/MCS1/1	-10	31.6	3.1	18 dBm OFDM, RMS
0.90/MCS2/1	-13	22.4	3.1	18 dBm OFDM, RMS
1.20/MCS3/1	-16	15.8	3.1	18 dBm OFDM, RMS
1.80/MCS4/1	-19	11.2	3.1	18 dBm OFDM, RMS
2.40/MCS5/1	-22	7.9	3.1	18 dBm OFDM, RMS
2.70/MCS6/1	-25	5.6	3.1	18 dBm OFDM, RMS
3.00/MCS7/1	-27	4.5	3.1	18 dBm OFDM, RMS
0.65/MCS0/2	-5	56.2	2.9	BPSK Peak
1.30/MCS1/2	-10	31.6	2.9	18 dBm OFDM, RMS
1.95/MCS2/2	-13	22.4	2.9	18 dBm OFDM, RMS
2.60/MCS3/2	-16	15.8	2.9	18 dBm OFDM, RMS
3.90/MCS4/2	-19	11.2	2.9	18 dBm OFDM, RMS
5.20/MCS5/2	-22	7.9	2.9	18 dBm OFDM, RMS
5.85/MCS6/2	-25	5.6	2.9	18 dBm OFDM, RMS
6.50/MCS7/2	-27	4.5	2.9	18 dBm OFDM, RMS
1.35/MCS0/4	-5	56.2	3.0	BPSK Peak
2.70/MCS1/4	-10	31.6	3.0	18 dBm OFDM, RMS
4.05/MCS2/4	-13	22.4	3.0	18 dBm OFDM, RMS
5.40/MCS3/4	-16	15.8	3.0	18 dBm OFDM, RMS
8.10/MCS4/4	-19	11.2	3.0	18 dBm OFDM, RMS
10.80/MCS5/4	-22	7.9	3.0	18 dBm OFDM, RMS
12.15/MCS6/4	-25	5.6	3.0	18 dBm OFDM, RMS
13.50/MCS7/4	-27	4.5	3.0	18 dBm OFDM, RMS

Note: <Conditions> supply voltage VBAT 2.6~3.6V, TA=25°C, Signal within spectrum mask.

7.4 Receiver Performance

7.4.1 Receiver Sensitivity

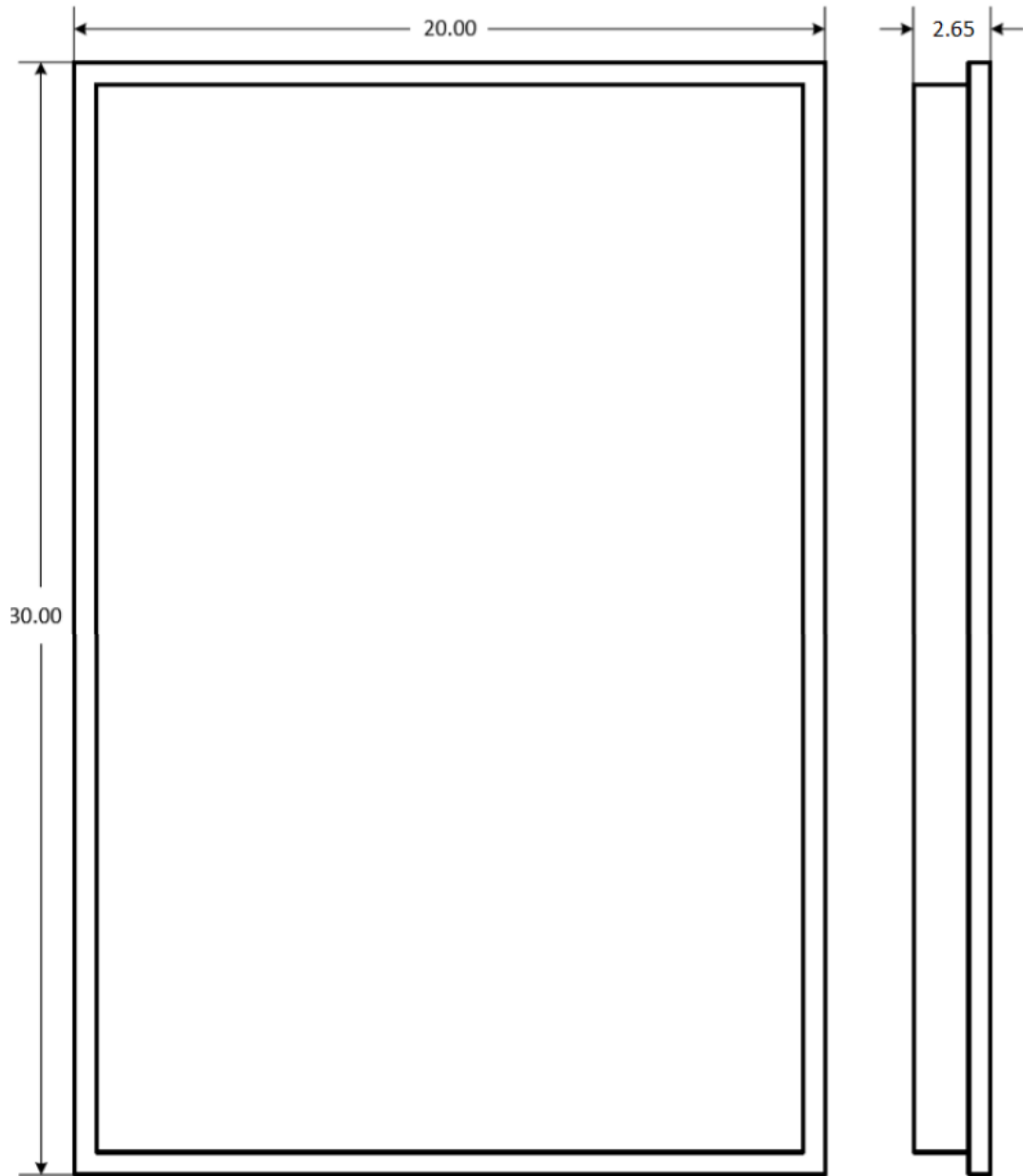
Band	BW	Rate	Modulation/Coding Rate	Conditions/Conditions	Chip Port Specification [dBm]		
		kbps			Min	Typ	Max
920.5~ 924.5M Hz	1 MHz	300	BPSK 1/2	@ PER<10%, 256 bytes Full Operating Temperature; Full Battery Voltage Range; Load Z : 50 Ohms;		-105	
		600	QPSK 1/2			-103	
		900	QPSK 3/4			-100	
		1200	16QAM 1/2			-97	
		1800	16QAM 3/4			-94	
		2400	64QAM 2/3			-90	
		2700	64QAM 3/4			-88	
		3000	64QAM 5/6			-87	
		150	BPSK 1/2 rep. 2x			-108	
	2 MHz	650	BPSK 1/2	@ PER<10%, 256 bytes Full Operating Temperature; Full Battery Voltage Range; Load Z : 50 Ohms;		-101	
		1300	QPSK 1/2			-98	
		1950	QPSK 3/4			-95	
		2600	16QAM 1/2			-92	
		3900	16QAM 3/4			-89	
		5200	64QAM 2/3			-85	
		5850	64QAM 3/4			-83	
		6500	64QAM 5/6			-82	
	4 MHz	1350	BPSK 1/2	@ PER<10%, 256 bytes Full Operating Temperature; Full Battery Voltage Range; Load Z : 50 Ohms;		-98	
		2700	QPSK 1/2			-95	
		4050	QPSK 3/4			-92	
		5400	16QAM 1/2			-89	
		8100	16QAM 3/4			-86	
		10800	64QAM 2/3			-82	
		12150	64QAM 3/4			-80	
		13500	64QAM 5/6			-79	

7.4.2 Adjacent Channel Rejection (ACR)

Band	BW	Rate	Modulation/Coding Rate	Conditions/Conditions	ACR [dB]		
		kbps			Min	Typ	Max
920.5~ 924.5M Hz	1 MHz	300	BPSK 1/2	@ PER<10%, $P_{desired}=P_{sensitivity} + 3dB,$ $P_{interfere}]@ N+1 channel$		32	
		600	QPSK 1/2			30	
		900	QPSK 3/4			29	
		1200	16QAM 1/2			28	
		1800	16QAM 3/4			25	
		2400	64QAM 2/3			24	
		2700	64QAM 3/4			23	
		3000	64QAM 5/6			22	
		150	BPSK 1/2 rep. 2x			35	
	2 MHz	650	BPSK 1/2	@ PER<10%, $P_{desired}=P_{sensitivity} + 3dB,$ $P_{interfere}]@ N+1 channel$		30	
		1300	QPSK 1/2			28	
		1950	QPSK 3/4			27	
		2600	16QAM 1/2			26	
		3900	16QAM 3/4			23	
		5200	64QAM 2/3			21	
		5850	64QAM 3/4			19	
		6500	64QAM 5/6			17	
	4 MHz	1350	BPSK 1/2	@ PER<10%, $P_{desired}=P_{sensitivity} + 3dB,$ $P_{interfere}]@ N+1 channel$		28	
		2700	QPSK 1/2			26	
		4050	QPSK 3/4			25	
		5400	16QAM 1/2			23	
		8100	16QAM 3/4			20	
		10800	64QAM 2/3			18	
		12150	64QAM 3/4			15	
		13500	64QAM 5/6			12	

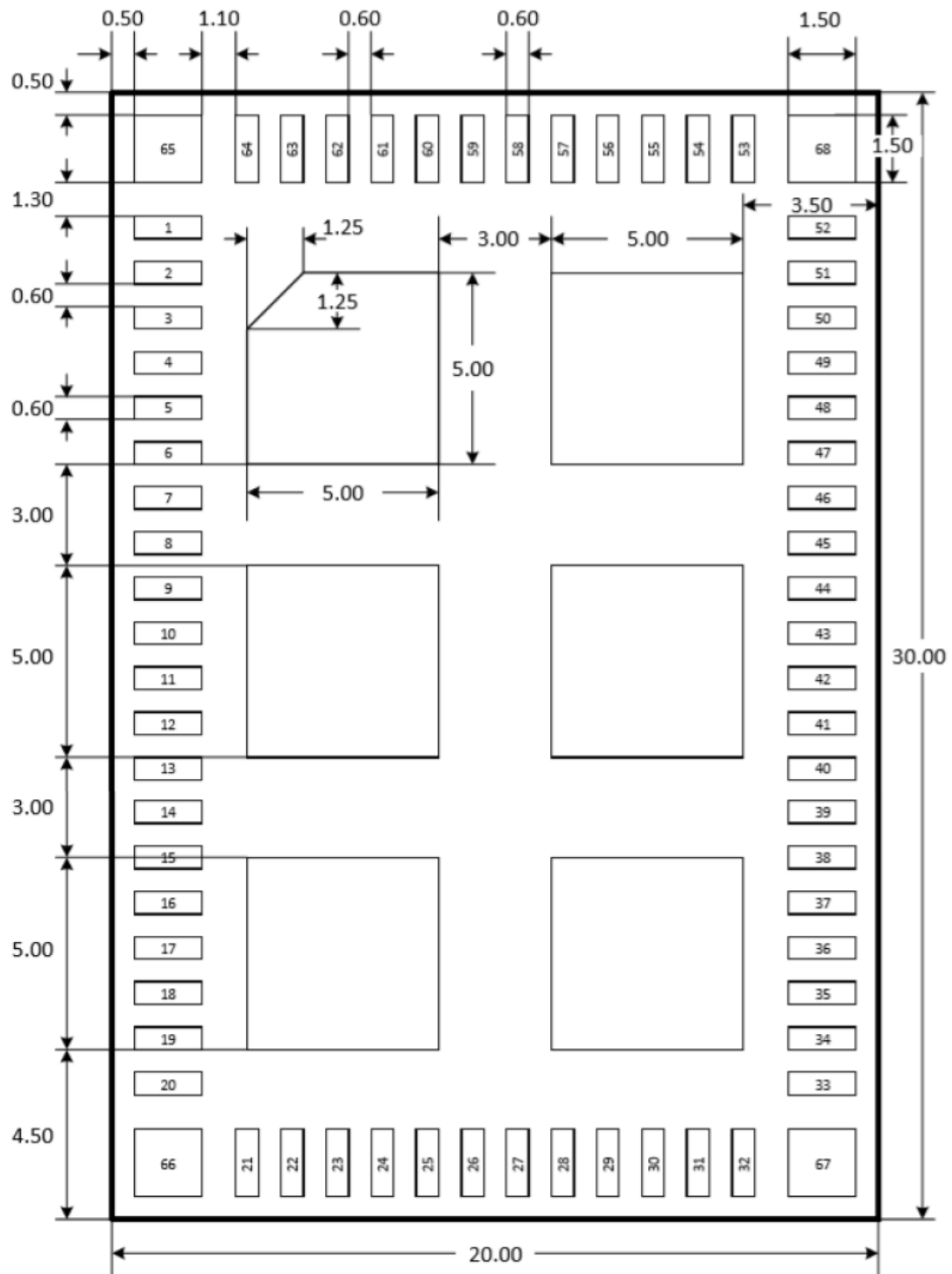
8. Product Characteristic

8.1 Product Dimension



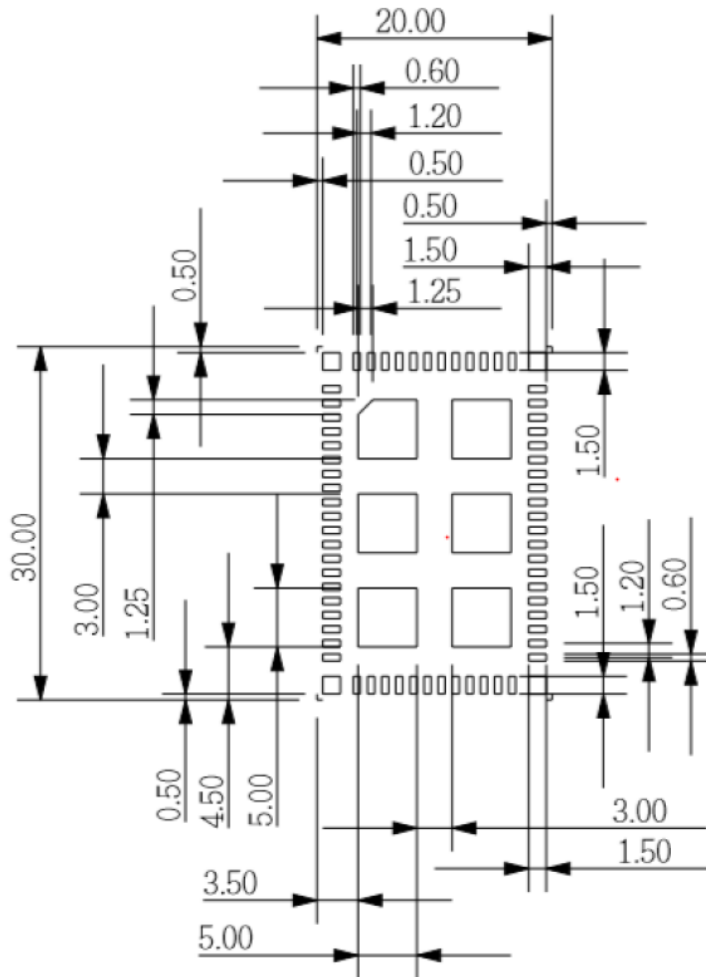
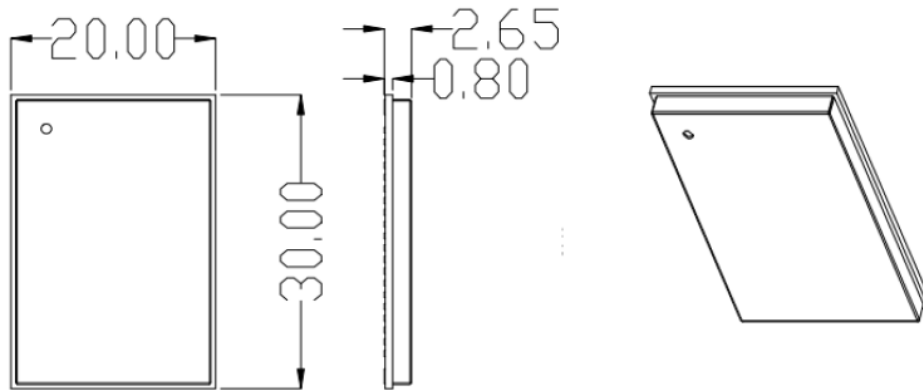
Physical dimension (top view) Unit: mm

8.2 PAD Dimension

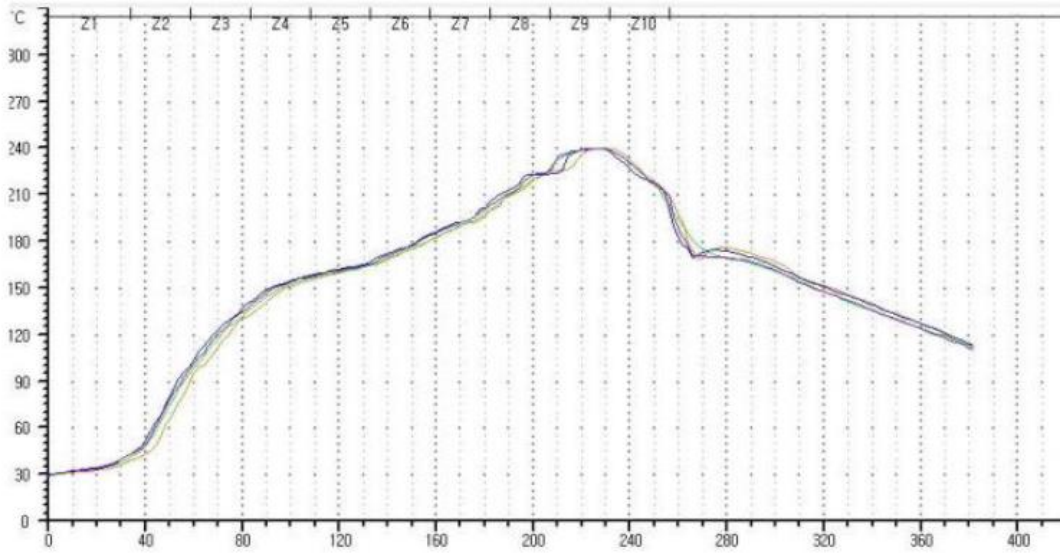


Physical dimension (top view) Unit: mm

8.3 Recommend footprint



9. SMT Temperature Sequence (Pb-free)



Reflow profile