AW-XM458 / AW-XM369
AW-XM458MA-XXX / AW-XM369-XXX

IEEE 802.11 2x2 WiFi 6 SU and MU-MIMO DBC Wireless LAN + Bluetooth 5.1 Combo Module

Datasheet

Rev. D

DF

For Standard

Features

WLAN

- Support 2x2 802.11 a/b/g/n/ac/ax
- Dual bands: 2.4 GHz and 5 GHz
- Support 20/40/80 MHz channel Bandwidths.
- 5GHz PHY data rates up to 1.2 Gbps
- 2.4 GHz PHY data rates up to 458 Mbps
- Uplink and downlink OFDMA and MU-MIMO
- Instantaneous 0-DFS

WLAN Dual-Radios

- Dual, independent direct-conversion WLAN radios (with dual-MACs and dual-Basebands) supports true and simultaneous LAN network operation at two different frequency band

Bluetooth

- Bluetooth 5
- Bluetooth class 2
- Bluetooth class 1
- PCM interface for voice applications
- 2Mbit/s LE
- Long range
- LTE/MWS coexistence
- 2 x wide band speech (WBS) calls
- Security: AES

AzureWave Technologies, Inc.

Revision History

Document NO: R2-2458MA-DST-01

Version	Revision Date	DCN NO.	Description	Initials	Approved
A	2020/07/21	DCN019506	● Draft version	Renton Tao	N.C Chen
B	2020/03/18	DCN021908	● Correct pin definition table ● Modify table format	Renton Tao	N.C Chen
C	2021/06/07	DCN022198	● Update operating temperature ● Add the information of RF connector receptacle	Roger Liu	N.C Chen
D	2021/08/13		● Modify pin table ● Update power consumption ● Update RF specification	Roger Liu	N.C Chen

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1. Introduction

1.1 Product Overview

AzureWave Technologies, Inc. introduces the IEEE 802.11a/b/g/n/ac/ax Concurrent Dual Wi-Fi (CDW) and BT, combo module – **AW-XM458MA-PUR.** With High Efficiency Wireless (HEW) and backward compatible with 802.11ac technologies integrated into a module, AW-XM458MA-PUR provides the best and most convenient SMT process. The module is targeted to mobile devices including**,** Tablet PC, Portable Media Players (PMPs), Portable Navigation Devices (PNDs), Personal Digital Assistants (PDAs), Tracking Devices, Gaming Devices which need convenient SMT process, low power consumption.

By using AW-XM458MA-PUR, the customers can easily integrate the Wi-Fi, BT, by a combo module with the benefits of **high design flexibility, high success rate on SMT process, short development cycle, and quick time-to-market.**

Compliance with the IEEE 802.11a/b/g/n/ac/ax standard, the AW-XM458MA-PUR uses **DSSS**, **OFDM**, **DBPSK**, **DQPSK**, **CCK** and **QAM** baseband modulation technologies. A high level of integration and full implementation of the power management functions specified in the IEEE 802.11 standard minimize the system power requirements by using AW-XM458MA-PUR.

The AW-XM458MA-PUR supports standard interface **PCIe for WLAN** interface connection. High-Speed **UART for BT** interface connection. AW-XM458MA-PUR is suitable for multiple mobile processors for different applications. With the combo functions and the good performance, the AW-XM458MA-PUR is the best solution for the consumer electronics and the tablet PC.

Scenario	2.4GHz Band			5GHz Band		
	Mode	Technology	BW	Mode	Technology	BW
1	2x2	802.11n	40MHz	2x2	802.11ax	80MHz
2	2x2	802.11n	40MHz	1x1 1Rx	802.11ax Zero Wait DFS	80MHz 80MHz
3	2x2	802.11ax	40MHz	2x2	802.11ac	40MHz

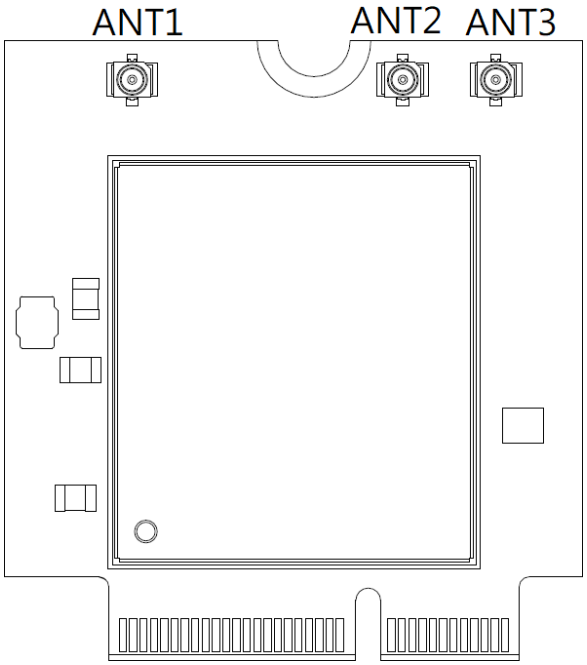
Concurrent 2.4GHz and 5GHz modes supported table

1.2 Block Diagram

A simplified block diagram of the AW-XM458MA-PUR module is depicted in the figure below.

Confidential

AW-XM458 Block Diagram



1.3 Specifications Table

1.3.1 General

Features	Description
Product Description	IEEE 802.11 2X2 WiFi 6 MIMO Wireless LAN + Bluetooth 5.1 Combo LGA Module
Major Chipset	NXP 88W9098 (DR-QFN 148pin)
Host Interface	WiFi + BT ● PCIe2.0 + UART
Dimension	28 mm X 30 mm x 3.95 mm(Max) (Tolerance remarked in mechanical drawing)
Form factor	Alternative sized M.2 2230 Key E
Antenna	2T2R for WiFi, standalone antenna for BT IPEX MHF4 connector Receptacle (20449) ANT1(Main)：WiFi_A → TX/RX ANT2(Aux)：WiFi_B→ TX/RX ANT3(BT): BT
Weight	0.004 kg

1.3.2 WLAN

Features	Description
WLAN Standard	IEEE 802.11 a/b/g/n/ac/ax 2T2R
Frequency Rage	2.4 GHz ISM Bands 2.412-2.472 GHz 5.15-5.25 GHz (FCC UNII-low band) for US/Canada and Europe 5.25-5.35 GHz (FCC UNII-middle band) for US/Canada and Europe 5.47-5.725 GHz for Europe 5.725-5.825 GHz (FCC UNII-high band) for US/Canada
Modulation	DSSS, OFDM, DBPSK, DQPSK, CCK, 16-QAM, 64-QAM, 256QAM, 1024QAM, OFDMA
Number of Channels	2.4GHz: ■ USA, NORTH AMERICA, Canada and Taiwan - 1 ~ 11 ■ China, Australia, Most European Countries - 1 ~ 13 ■ Japan, 1 ~ 13 5GHz: ■ USA, Canada, Most European Countries - 36,40,44,48,52,56,60,64,100,104,108,112,116,120,124,128,132,136,140,149,153,157,161,165 ■ Japan - 36,40,44,48,52,56,60,64,100,104,108,112,116,120,124,128,132,136,140

	■ China - 36,40,44,48,52,56,60,64, 149,153,157,161,165
Output Power	**2.4G**

	Min	Typ	Max	Unit
11b (11Mbps) @EVM<35%	16	18	20	dBm
11g (54Mbps) @EVM≦-27 dB	15.5	17	18.5	dBm
11n (HT20 MCS7) @EVM≦-28 dB	14.5	16	17.5	dBm
11n (HT40 MCS7) @EVM≦-28 dB	14.5	16	17.5	dBm
11ax (HE20 MCS11) @EVM≦-35 dB	12.5	14	15.5	dBm
11ax (HE40 MCS11) @EVM≦-35 dB	12.5	14	15.5	dBm

5G

	Min	Typ	Max	Unit
11a (54Mbps) @EVM≦-27 dB	14	16	18	dBm
11n (HT20 MCS7) @EVM≦-28 dB	14	16	18	dBm
11n (HT40 MCS7) @EVM≦-28 dB	14	16	18	dBm
11ac(VHT20 MCS8) @EVM≦-31 dB	13	15	17	dBm
11ac(VHT40 MCS9) @EVM≦-32 dB	13	15	17	dBm
11ac(VHT80 MCS9) @EVM≦-32 dB	13	15	17	dBm
11ax(HE20 MCS11) @EVM≦-35 dB	10	12	14	dBm
11ax(HE40 MCS11) @EVM≦-35 dB	10	12	14	dBm
11ax(HE80 MCS11) @EVM≦-35 dB	10	12	14	dBm

Receiver Sensitivity

2.4G

	Min	Typ	Max	Unit
11b (11Mbps)	-	-88	-85	dBm
11g (54Mbps)	-	-75	-72	dBm
11n (HT20 MCS7)	-	-72	-69	dBm
11n (HT40 MCS7)	-	-70	-66	dBm
11ax(HE20 MCS11)	-	-62	-58	dBm
11ax(HE40 MCS11)	-	-59	-53	dBm

5G

	Min	Typ	Max	Unit
11a (54Mbps)	-	-72	-68	dBm
11n (HT20 MCS7)	-	-70	-66	dBm
11n (HT40 MCS7)	-	-68	-64	dBm
11ac(VHT20 MCS8)	-	-65	-61	dBm
11ac(VHT40 MCS9)	-	-62	-58	dBm
11ac(VHT80 MCS9)	-	-59	-55	dBm
11ax(HE20 MCS11)	-	-60	-56	dBm
11ax(HE40 MCS11)	-	-57	-53	dBm
11ax(HE80 MCS11)	-	-55	-51	dBm

Data Rate

- 802.11b: 1, 2, 5.5, 11Mbps
- 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54Mbps
- 802.11n: up to 150Mbps-single
- 802.11n: up to 300Mbps-2x2 MIMO
- 802.11ac:up to 192.6Mbps (20MHz channel)
- 802.11ac:up to 400Mbps (40MHz channel)
- 802.11ac:up to 866.7Mbps (80MHz channel)
- 802.11ax:2.4GHz up to 458Mbps, 5GHz up to 1.2Gbps

Security

WiFi: WPA/WPA2/WPA3

* If you have any certification questions about output power please contact FAE directly.

1.3.3 Bluetooth

Features	Description
Bluetooth Standard	Bluetooth 5.1
Bluetooth VID/PID	N/A
Frequency Rage	2402MHz~2483MHz
Modulation	Header GFSK Payload 2M: π/4-DQPSK Payload 3M: 8DPSK

		Min	Typ	Max	Unit
Output Power	BDR	0	2	4	dBm
	EDR	0	2	4	dBm
	Low Energy (2MHz)	0	2	4	dBm
Receiver Sensitivity	BDR		-90	-87	dBm
	EDR		-87	-84	dBm
	Low Energy (2MHz)		-88	-85	dBm

1.3.4 Operating Conditions

Features	Description
Operating Conditions	
Voltage	3.3V+-5%
Operating Temperature	-40℃~ 85℃
Operating Humidity	less than 85% R.H.
Storage Temperature	-40℃~ 85℃
Storage Humidity	less than 60% R.H.

2.1 Pin Table

Pin No.	Definition	Basic Description	Voltage	Type
1	GND	Ground.		GND
2	VDD33	3.3V power supply	3.3V	VCC
3	NC	NC		Floating
4	VDD33	3.3V power supply	3.3V	VCC
5	NC	NC		Floating
6	NC	NC		Floating
7	GND	Ground.		GND
8	PCM_CLK	PCM_CLK, GPIO Mode : GPIO[6].	1.8V	I/O
9	NC	NC		Floating
10	PCM_SYNC	PCM_SYNC, GPIO Mode : GPIO[7].	1.8V	I/O
11	NC	NC		Floating
12	PCM_OUT	PCM_OUT, GPIO Mode : GPIO[5].	1.8V	I/O
13	NC	NC		Floating
14	PCM_DIN	PCM_DIN, GPIO Mode : GPIO[4].	1.8V	I/O
15	NC	NC		Floating
16	NC	NC		Floating
17	NC	NC		Floating
18	GND	Ground.		GND
19	NC	NC		Floating
20	UART WAKE#	BT WAKE HOST, GPIO Mode : GPIO[16].	3.3V	I
21	NC	NC		Floating
22	UART_TX	UART SOUT pin	1.8V	Output
23	NC	NC		Floating
32	UART_RX	UART SIN.pin	1.8V	Input
33	GND	Ground.		GND
34	UART_RTSn	UART Mode: UART_RTSn (active low)	1.8V	Output
35	PERp0	PCIe Differential receive.	1.8V	Input
36	UART_CTSn	UART Mode: UART_CTSn (active low)	1.8V	Input
37	PERn0	PCIe Differential receive.	1.8V	Input
38	JTAG_TDO	JTAG_TDO, GPIO Mode :GPIO[31]	1.8V	O
39	GND	Ground.		GND
40	WLAN WAKE	DEV WLAN WAKE, GPIO Mode :GPIO[12]	1.8V	O
41	PETp0	PCIe Differential transmit.	1.8V	Output
42	BT WAKE	DEV BT WAKE, GPIO Mode :GPIO[1]	1.8V	O
43	PETn0	PCIe Differential transmit.	1.8V	Output
44	JTAG_TDI	JTAG_TDI, GPIO Mode :GPIO[30]	1.8V	I
45	GND	Ground.		GND
46	JTAG_TCK	JTAG_TCK, GPIO Mode :GPIO[28]	1.8V	I/O
47	REFCLKP	PCIe Differential reference clock.	1.8V	Input
48	JTAG_TMS	JTAG_TMS, GPIO Mode :GPIO[29]	1.8V	I/O
49	REFCLKN	PCIe Differential reference clock.	1.8V	Input

50	NC	NC		Floating
51	GND	Ground.		GND
52	PERST0	PCI Express Reset Signal: active low.	3.3V	Input
53	CLKREQ0	Reference clock request	3.3V	Output
54	W_DISABLE2_N	BT_INDEPENDENT_RESET	1.8V	I/O
55	PEWAKE#	Open Drain active Low signal. This signal is used to request that the system return from a sleep/suspended state to service a function initiated wake event.	3.3V	OUT
56	W_DISABLE1#	Pull power down for WLAN/BT	3.3V	IN
57	GND	Ground.		GND
58	NC	NC		Floating
59	NC	NC		Floating
60	NC	NC		Floating
61	NC	NC		Floating
62	NC	NC		Floating
63	GND	Ground.		GND
64	NC	NC		Floating
65	NC	NC		Floating
66	NC	NC		Floating
67	NC	NC		Floating
68	NC	NC		Floating
69	GND	Ground.		GND
70	NC	NC		Floating
71	NC	NC		Floating
72	VDD33	3.3V power supply	3.3V	VCC
73	NC	NC		Floating
74	VDD33	3.3V power supply	3.3V	VCC
75	GND	Ground.		GND
76	GND	Ground.		GND

3. Electrical Characteristics

3.1 Absolute Maximum Ratings

Symbol	Parameter	Minimum	Typical	Maximum	Unit
3V3	DC supply for the 3.3V input	-	3.3	3.63	V

3.2 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
3.3V	DC supply for the 3.3V input	3.14	3.3	3.46	V

3.3 Digital IO Pin DC Characteristics

3.3.1 1.8V Operation (VIO)

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V_{IH}	Input high voltage	0.7*VIO	-	VIO+0.4	V
V_{IL}	Input low voltage	-0.4	-	0.3*VIO	
V_{OH}	Output high voltage	VIO-0.4	-	-	
V_{OL}	Output low voltage	-	-	0.4	
V_{HYS}	Input Hysteresis	100			mV

3.3.2 1.8V Operation (VIO_SD)

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V_{IH}	Input high voltage	0.7*VIO_SD	-	VIO_SD+0.4	V
V_{IL}	Input low voltage	-0.4	-	0.3*VIO_SD	
V_{OH}	Output High Voltage	VIO_SD-0.4	-	-	
V_{OL}	Output Low Voltage	-	-	0.4	
V_{HYS}	Input Hysteresis	100			mV

3.4 Host Interface

3.4.1 PCI Express Interface

3.4.1.1 Differential Tx Output Electricals

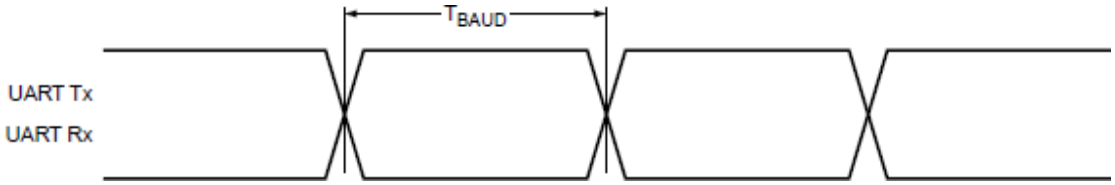
Symbol	Parameter	Min	Typ	Max	Units
UI	Unit interval Each UI is 400 ps ±300 PPM. UI does not account for SSC dictated variations.	399.98	400	400.12	ps
V_{Tx_DIFFpp}	Differential peak-to-peak output voltage $V_{Tx_DIFFpp} = 2*\|V_{TX-D+} - V_{TX-D-}\|$	0.800	--	1.2	V
$V_{Tx_DE_RATIO}$	De-emphasized differential output voltage (ratio)	-3.0	-3.5	-4.0	db
T_{Rx_EYE}	Minimum Tx eye width	0.75	--	--	UI
$T_{Rx_EYE_MEDIAN_MAX_JIT}$	Maximum time between jitter median and maximum deviation from median	--	--	0.125	UI
T_{Tx_RISE}, T_{Tx_FALL}	D+/D- Tx output rise/fall time	0.125	--	--	UI
$V_{Tx_CM_DC_ACTIVE_IDLE_DELTA}$	Absolute delta of DC common mode voltage during L0 and electrical idle	0-	-	100	mV
$V_{Tx_CM_DC_LINE_DELTA}$	Absolute delta of DC common mode voltage between D+ and D-	0-	-	25	mV
$V_{Tx_IDLE_DIFFp}$	Electrical idle differential peak output voltage	0	--	20	mV
$V_{Tx_RCV_DETECT}$	Voltage change allowed during receiver detection	--	--	600	mV
$V_{Tx_DC_CM}$	Tx DC common mode voltage	--	--	3.6	V
I_{Tx_SHORT}	Tx short circuit current limit	--	--	90	mA
$T_{Tx_IDLE_MIN}$	Minimum time spent in electrical idle	50	--	--	UI
$T_{Tx_IDLE_SET_TO_IDLE}$	Maximum time to transition to a valid electrical idle after sending an electrical idle ordered set	--	--	20	UI
$T_{Tx_IDLE_TO_DIFF_DATA}$	Maximum time to transition to valid Tx specifications after leaving an electrical idle condition	--	--	20	UI
RL_{Tx_DIFF}	Differential return loss	10	--	--	dB
RL_{Tx_CM}	Common mode return loss	6	--	--	dB
C_{Tx}	AC coupling capacitor	75	--	200	nF
$T_{Crosstalk}$	Crosstalk random timeout	0	--	1	ms

3.4.1.2 Differential Rx Input Electricals

Symbol	Parameter	Min	Typ	Max	Units
UI	Unit interval Each UI is 400 ps ±300 ppm. UI does not account for SSC dictated variations.	399.98	400	400.12	ps
V_{Rx_DIFFpp}	Differential peak-to-peak voltage $V_{Rx_DIFFpp} = 2*\|V_{RX-D+} - V_{RX-D-}\|$	0.175	--	1.2	V
T_{Rx_EYE}	Minimum receiver eye width	0.4	--	--	UI
$T_{Rx_EYE_MEDIAN_MAX_JIT}$	Maximum time between jitter median and maximum deviation from median	--	--	0.3	UI
$V_{Rx_CM_ACp}$	AC peak common mode input voltage	--	--	150	mV
RL_{Rx_DIFF}	Differential return loss	10	--	--	dB
RL_{Rx_CM}	Common mode return loss	6	--	--	dB
$Z_{Rx_DIFF_DC}$	DC differential input impedance	80	100	120	Ω
Z_{Rx_DC}	DC input impedance	40	50	60	Ω
$Z_{Rx_HIGH_IMP_DC_POS}$	Powered down DC input impedance positive	50	--	--	k
$Z_{Rx_HIGH_IMP_DC_NEG}$	Powered down DC input impedance negative	1	--	--	kΩ
$V_{Rx_IDLE_DET_DIFFpp}$	Electrical idle detect threshold	65	--	175	mV
$T_{Rx_IDLE_DET_DIFF_ENTERTIME}$	Unexpected electrical idle enter detect threshold integration time	--	--	10	ms
L_{Rx_SKEW}	Total skew	---	-2	0	ns

3.4.2.High-Speed UART Interface

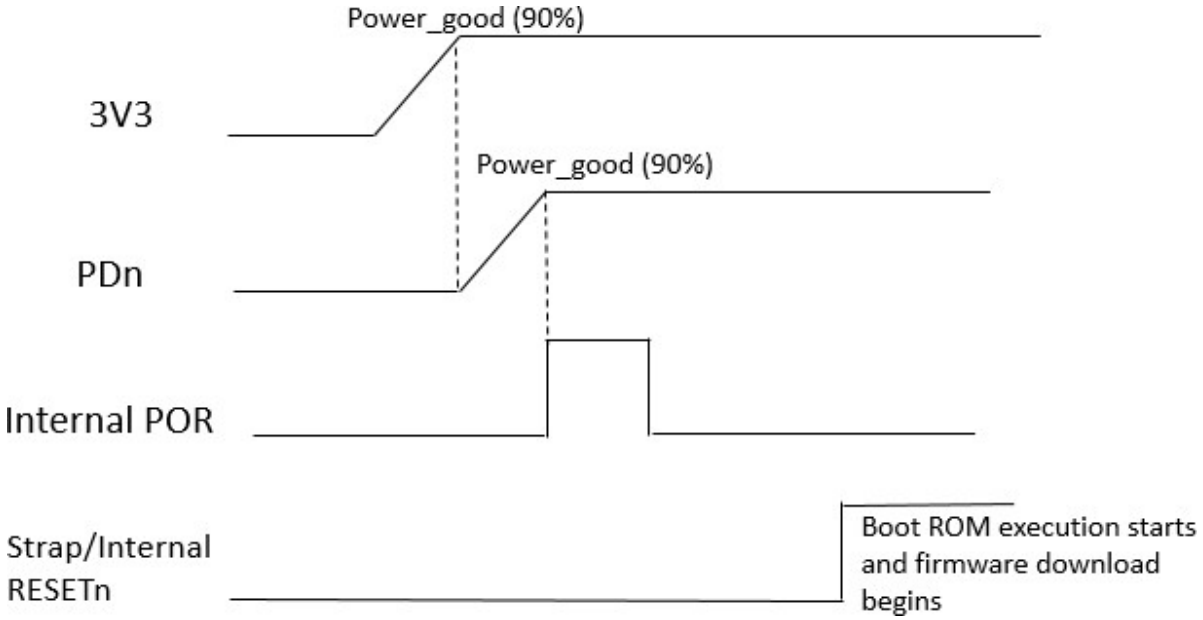
The AW-XM458MA-PUR supports a high-speed Universal Asynchronous Receiver/Transmitter (UART) interface, compliant to the industry standard 16550 specification. High-speed baud rates are supported to provide the physical transport between the device and the host for exchanging Bluetooth data.



Symbol	Parameter	Condition	Min	Typ	Max	Units
T_{BAUD}	Baud rate	26MHz input clock	250	-	-	ns

3.5 Timing Sequence

AW-XM458MA-PUR power up timing sequence.



3.6 Power Consumption*

3.6.1 WLAN

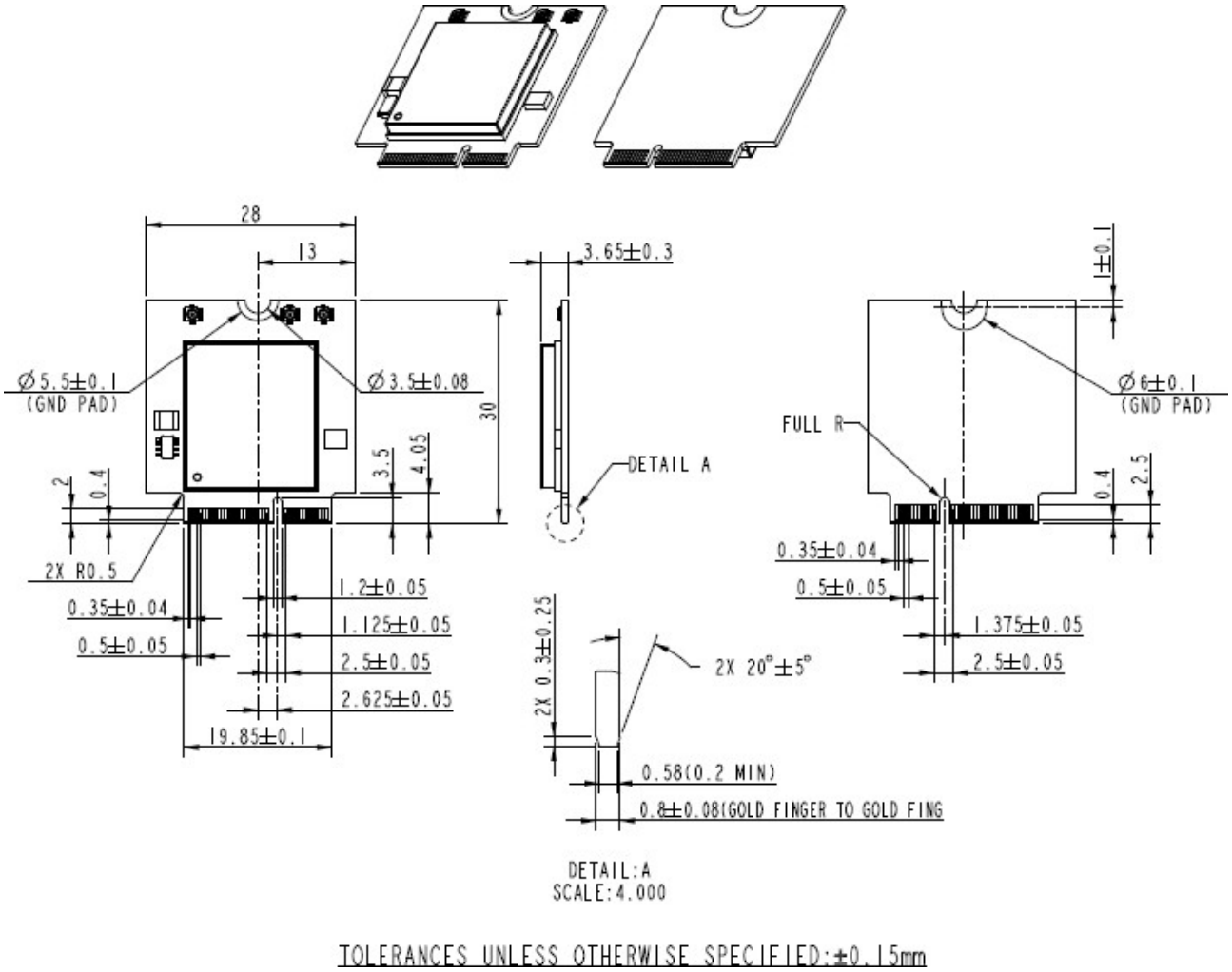
No.	Item			3.3V(mA)		
				Max.	Avg.	
1	Power down			0.254		
2	DeepSleep (Not associated with AP)			1.77	1.69	
3	Power Save (2.4GHz)			124	5.45	
4	Power Save (5GHz)			165	4.18	
Band (GHz)	**Mode**	**BW (MHz)**	**RF Power (dBm)**	**Transmit**		
				Max.	**Avg.**	**Duty (%)**
2.4	11b@1Mbps	20	18	467	466	99
	11g@6Mbps	20	17	428	427	99
	11n@MCS8 MIMO	40	16	648	641	88
	11n@MCS15 MIMO	40	16	584	582	70
	11ax@MCS11 NSS2	40	14	544	542	75
5	11a@6Mbps	20	16	488	485	99
	11n@MCS8 MIMO	40	16	870	856	88
	11n@MCS15 MIMO	40	16	785	784	70
	11ac@MCS0 NSS2	80	15	844	835	88
	11ac@MCS9 NSS2	80	15	752	750	66
	11ax@MCS0 NSS2	80	12	820	816	80
	11ax@MCS11 NSS2	80	12	751	750	57
Concurrent	11n@MCS0 MIMO**(2.4G)** + 11ax@MCS0 NSS2**(5G)**	40 + 80	16 + 14	1312	1288	96
	11ac@MCS0 NSS2 **(5G)** + 11ax@MCS0 NSS2**(2.4G)**	40 + 40	15 + 16	1215	1198	96
Band (GHz)	**Mode**	**BW(MHz)**		**Receive**		
				Max.	**Avg.**	
2.4	11b@1Mbps	20		194	167	
	11ax@MCS0	40		211	203	
5	11a@6Mbps	20		231	225	
	11ax@MCS0 NSS1	80		248	242	

3.6.2 Bluetooth

No.	Mode	RF Power (dBm)	3.3V(mA)	
			Max.	Avg.
1	Deepsleep	N/A	17.8	1.78
2	Transmit (DH5)	2	30.0	29.0
3	Receiver (3DH5)	N/A	30.1	27.2

4. Mechanical Information

4.1 Mechanical Drawing



(Draft drawing)

AzureWave Technologies, Inc.

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 market, only channel 1~11 can be operated. Selection of other channels is not possible.

This device is restricted for indoor use.

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 20cm between the radiator & your body.

IMPORTANT NOTE:
This module is intended for OEM integrator. This module is only FCC authorized for the specific rule parts listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.
Additional testing and certification may be necessary when multiple modules are used.

USERS MANUAL OF THE END PRODUCT:
In the users manual of the end product, the end user has to be informed to keep at least 20cm 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.
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 TX FCC ID: TLZ-XM9098".

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.

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs / récepteurs exempts de licence qui sont conformes au (x) RSS (s) exemptés de licence d'Innovation, Sciences et Développement économique Canada. L'opération est soumise aux deux conditions suivantes:
(1) Cet appareil ne doit pas provoquer d'interférences.
(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.

The device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems.
les dispositifs fonctionnant dans la bande 5150-5250 MHz sont réservés uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux.

For indoor use only.
Pour une utilisation en intérieur uniquement.

IMPORTANT NOTE:
IC Radiation Exposure Statement:
This equipment complies with IC RSS-102 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.
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.

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.

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 users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the IC 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. Operation is subject to the following two conditions: (1) this device may not cause harmful interference (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 IC: 6100A-XM9098 ".
The Host Model Number (HMN) must be indicated at any location on the exterior of the end product or product packaging or product literature which shall be available with the end product or online.

AzureWave Technologies, Inc.

Ant list

Ant.	Port		Brand	Model Name	Antenna Type	Connector	Gain (dBi)
	2.4GHz	5GHz					
1	1	1	MAG. LAYERS	MSA-4008-25GC1-A2	PIFA	I-PEX	Note 1
2	2	2	MAG. LAYERS	MSA-4008-25GC1-A2	PIFA	I-PEX	Note 1
3	1	1	MAG. LAYERS	MSA-4008-25GC1-A2	PIFA	I-PEX	Note 1

Note1:

Ant.	Port		Antenna Gain (dBi)		
	2.4GHz	5GHz	WLAN 2.4GHz	WLAN 5GHz	Bluetooth
1	1	1	2.98	5.16	-
2	2	2	2.98	5.16	-
3	1	1	-	-	2.98

AzureWave Technologies, Inc.

Layout Guide

Rev. D

(For Standard)

Revision History

Version	Revision Date	Description	Initials	Approved
A	2020/06/01	● Initial Version	Renton Tao	N.C. Chen
B	2020/11/30	● Update pin out drawing	Renton Tao	N.C. Chen
C	2021/05/14	● Update BT specification to 5.1	Roger Liu	N.C. Chen
D	2021/08/26	● Update RF trace layout rules	Roger Liu	N.C. Chen

INTRODUCTION

This document provides key guidelines and recommendations to be followed when creating AW-XM458 layout. It is strongly recommended that layouts be reviewed by the AzureWave engineering team before being released for fabrication.

The following is a summary of the major items that are covered in detail in this application note. Each of these areas of the layout should be carefully reviewed against the provided recommendations before the PCB goes to fabrication.

- GENERAL RF GUIDELINES
- Ground Layout
- Power Layout
- Digital Interface
- RF Pad and layout pattern
- RF Trace
- Antenna
- Antenna Matching
- GENERAL LAYOUT GUIDELINES
- THE OTHER LAYOUT GUIDE INFORMATION

. GENERAL RF GUIDELINES

Follow these steps for optimal WLAN performance.

1. Control WLAN 50 ohm RF traces by doing the following:
   - Route traces on the top layer as much as possible and use a continuous reference ground plane underneath them.
   - Verify trace distance from ground flooding. At a minimum, there should be a gap equal to the width of one trace between the trace and ground flooding. Also keep RF signal lines away from metal shields. This will ensure that the shield does not detune the signals or allow for spurious signals to be coupled in.
   - Keep all trace routing inside the ground plane area by at least the width of a trace.
   - Check for RF trace stubs, particularly when bypassing a circuit.

2. Keep RF traces properly isolated by doing the following:
   - Do not route any digital or analog signal traces between the RF traces and the reference ground.
   - Keep the balls and traces associated with RF inputs away from RF outputs. If two RF traces are close each other, then make sure there is enough room between them to provide isolation with ground fill.
   - Verify that there are plenty of ground vias in the shield attachment area. Also verify that there are no non-ground vias in the shield attachment area. Avoid traces crossing into the shield area on the shield layer.

3. Consider the following RF design practices:
   - Confirm antenna ground keep-outs.
   - Verify that the RF path is short, smooth, and neat. Use curved traces or microwave corners for all turns; never use 90-degree turns. Avoid width discontinuities over pads. If trace widths differ significantly from component pad widths, then the width change should be mitered. Verify there are no stubs.
   - Do not use thermals on RF traces because of their high loss.
   - The RF traces between AW-XM458 WLAN/BT_ANT pin and antenna must be made using 50Ω controlled-impedance transmission line.

2. Ground Layout

Please follow general ground layout guidelines. Here are some general rules for customers' reference.

- The layer 2 of PCB should be a complete ground plane. The rule has to be obeyed strictly in the RF section while RF traces are on the top layer.
- Each ground pad of components on top layer should have via drilled to PCB layer 2 and via should be as close to pad as possible. A bulk decoupling capacitor needs two or more.
- Don't place ground plane and route signal trace below printed antenna or chip antenna to avoid destroying its electromagnetic field, and there is no organic coating on printed antenna. Check antenna chip vendor for the layout guideline and clearance.
- Move GND vias close to the pads.

3. Power Layout

Please follow general power layout guidelines. Here are some general rules for customers' reference.

- A 4.7uF capacitor is used to decouple high frequency noise at digital and RF power terminals. This capacitor should be placed as close to power terminals as possible.
- In order to reduce PCB's parasitic effects, placing more via on ground plane is better.

4. Digital Interface

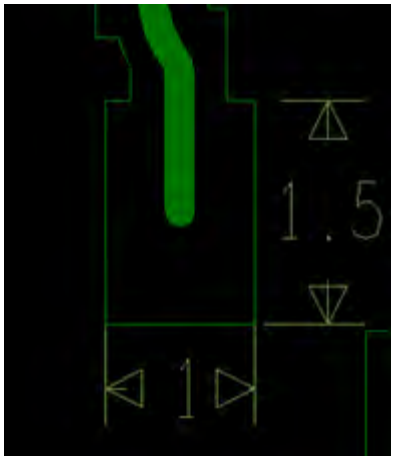
Please follow power and ground layout guidelines. Here are some general rules for customers' reference.

- The digital interface to the module must be routed using good engineering practices to minimize coupling to power planes and other digital signals.
- The digital interface must be isolated from RF trace.

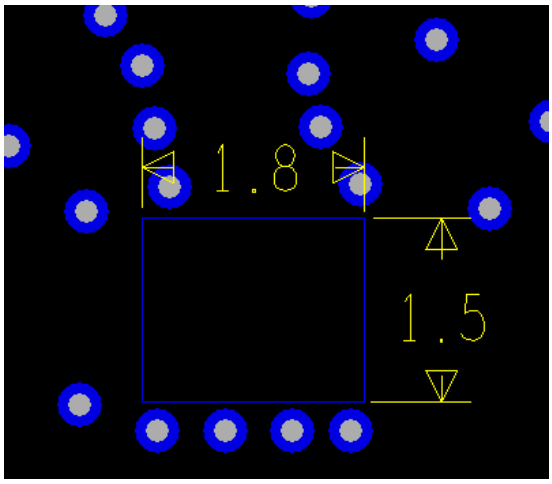
5. RF pad and layout pattern

To ensure impedance to be 50Ω from AW-XM458 module RF pad to host PCBA RF pad, customer needs to follow below pattern design concept.

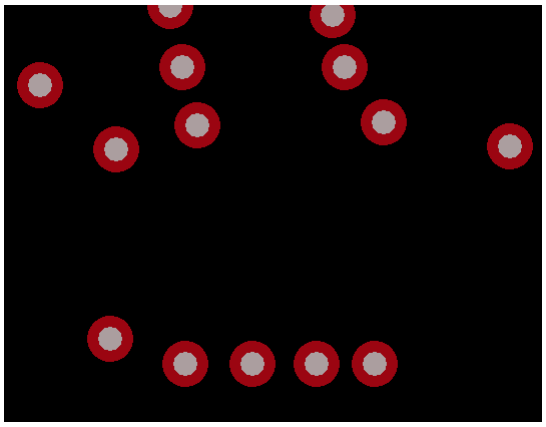
A. Top Layer design



B. Inner layer design



C. Bottom layer design



6. RF Trace

The RF trace is the critical to route. Here are some general rules for customers' reference.

- The RF trace impedance should be 50Ω between ANT port and antenna matching network.
- The length of the RF trace should be minimized.
- To reduce the signal loss, RF trace should laid on the top of PCB and avoid any via on it.
- The CPW (coplanar waveguide) design and the microstrip line are both recommended; the customers can choose either one depending on the PCB stack of their products.
- The RF trace must be isolated with aground beneath it. Other signal traces should be isolated from the RF trace either by ground plane or ground vias to avoid coupling.
- To minimize the parasitic capacitance related to the corner of the RF trace, the right angle corner is not recommended.

If the customers have any problem in calculation of trace impedance, please contact AzureWave.

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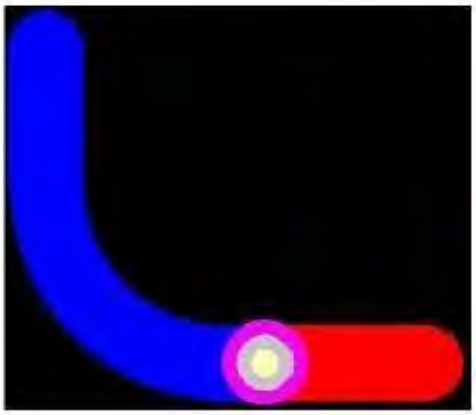
Correct RF trace

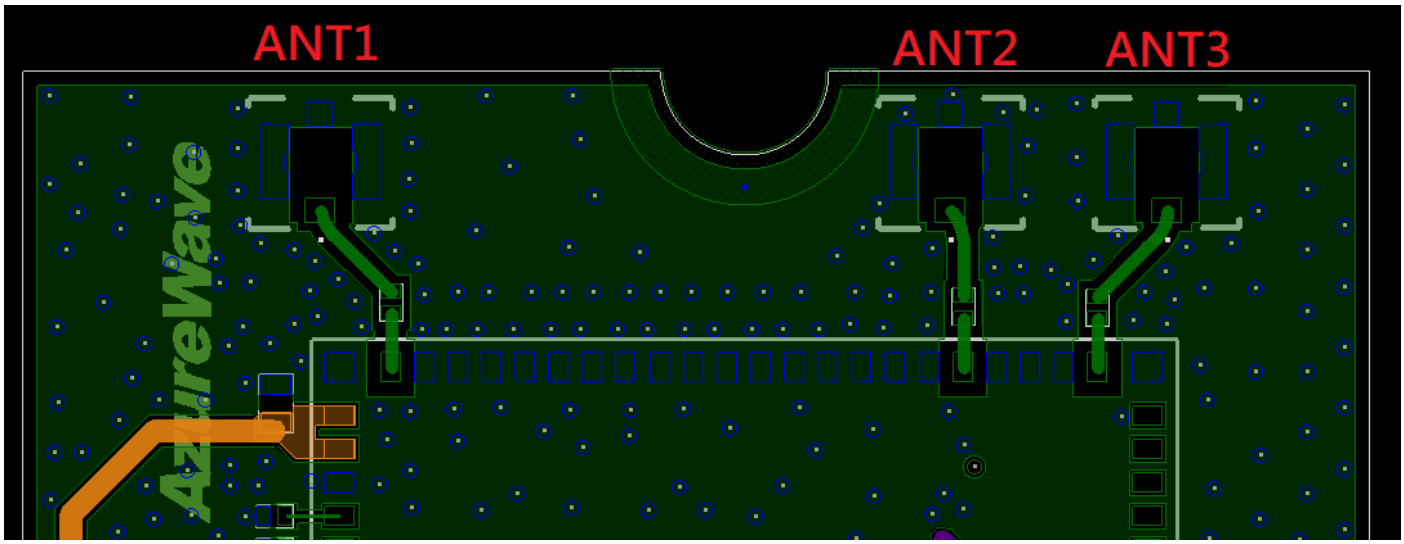
Right-angled corner



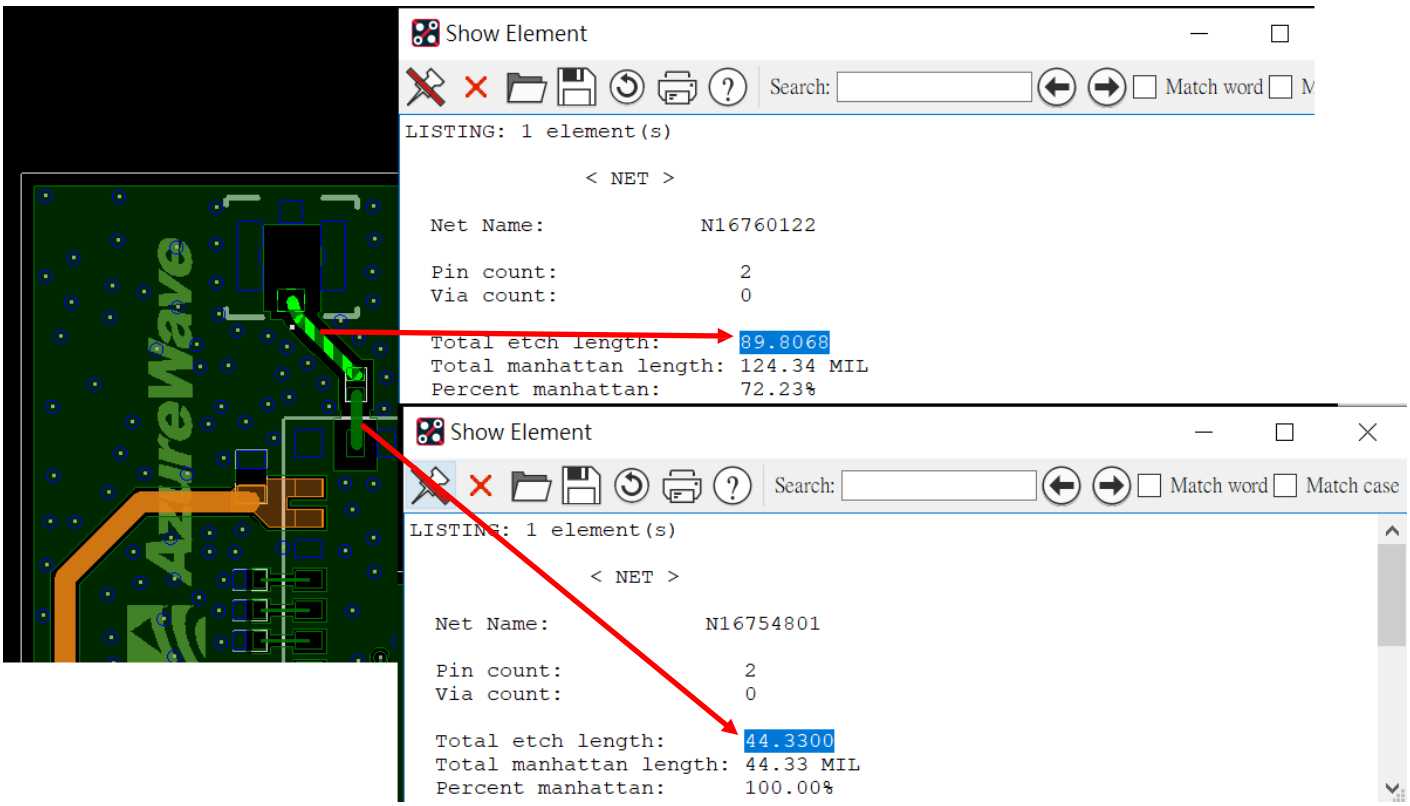
Via on RF trace

Incorrect RF trace

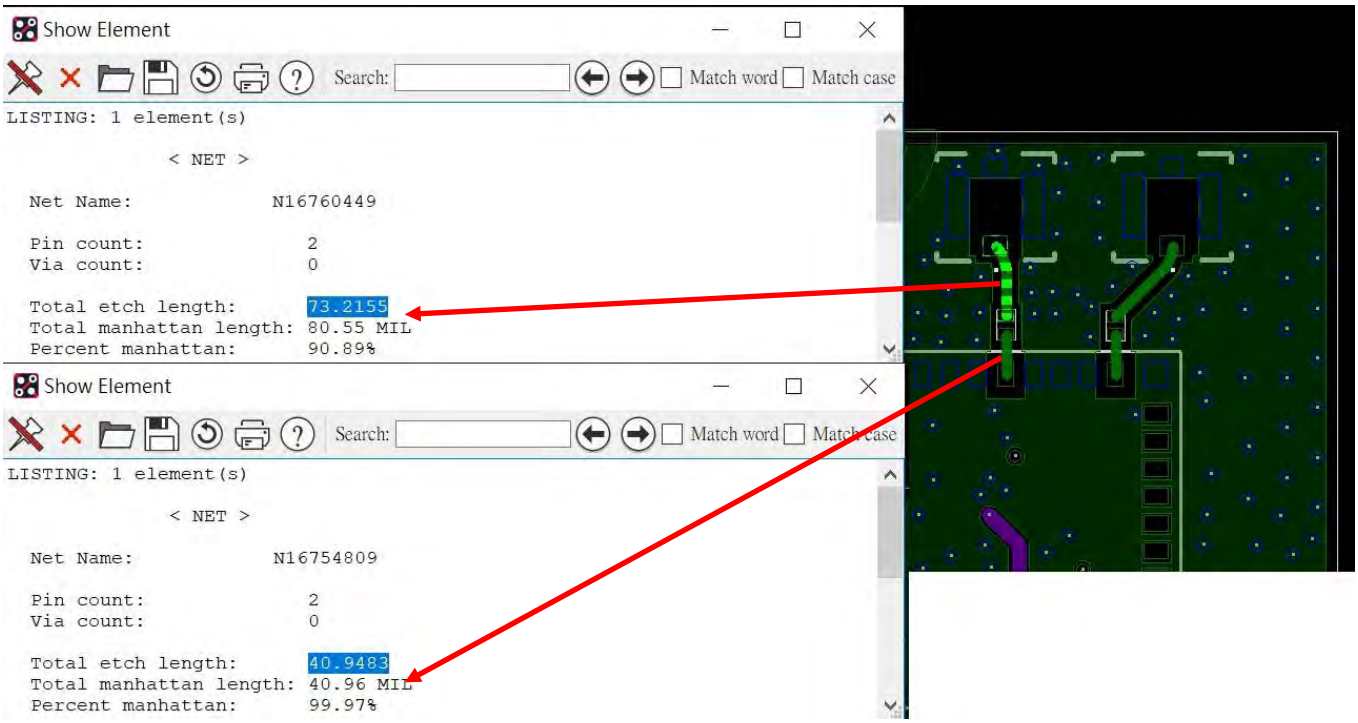
AW-XM458 RF trace should be follow the rules as below



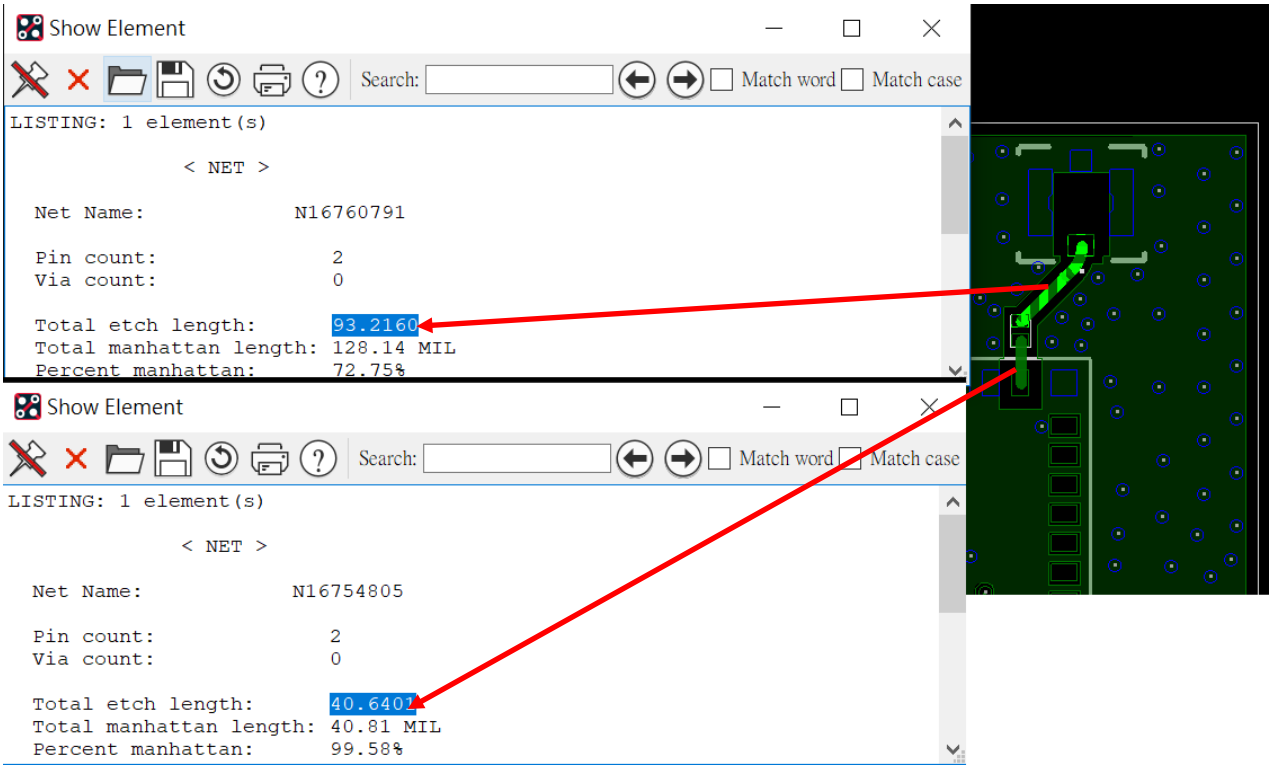
a. Trace length of ANT1 is about 89.8 mil and 44.3 mil.



b. Trace length of ANT2 is about 73.2 mil and 40.9 mil.

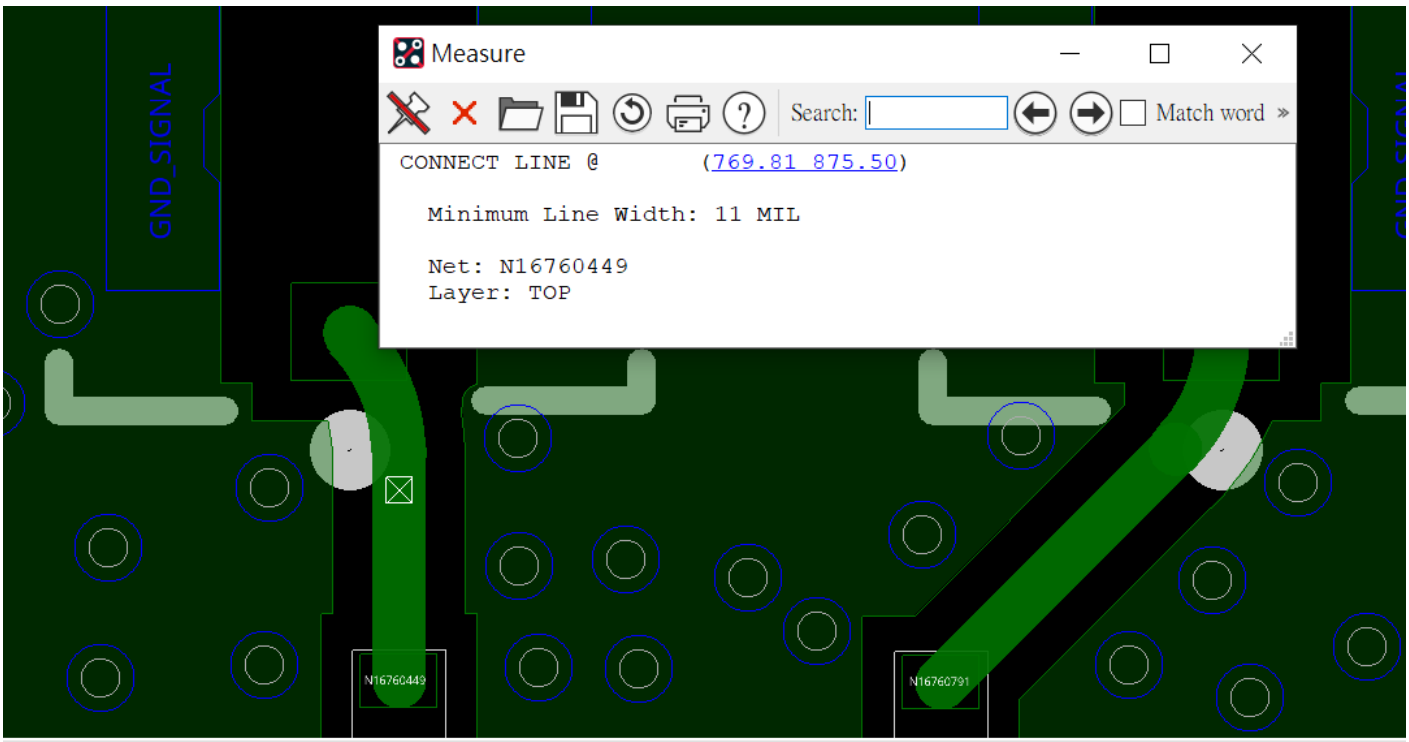


c. Trace length of ANT3 is about 93.2 mil and 40.6 mil.



d. Air gap between RF trace and ground is about 8 mil.

e. Trace width of all RF trace is all about 11 mil.



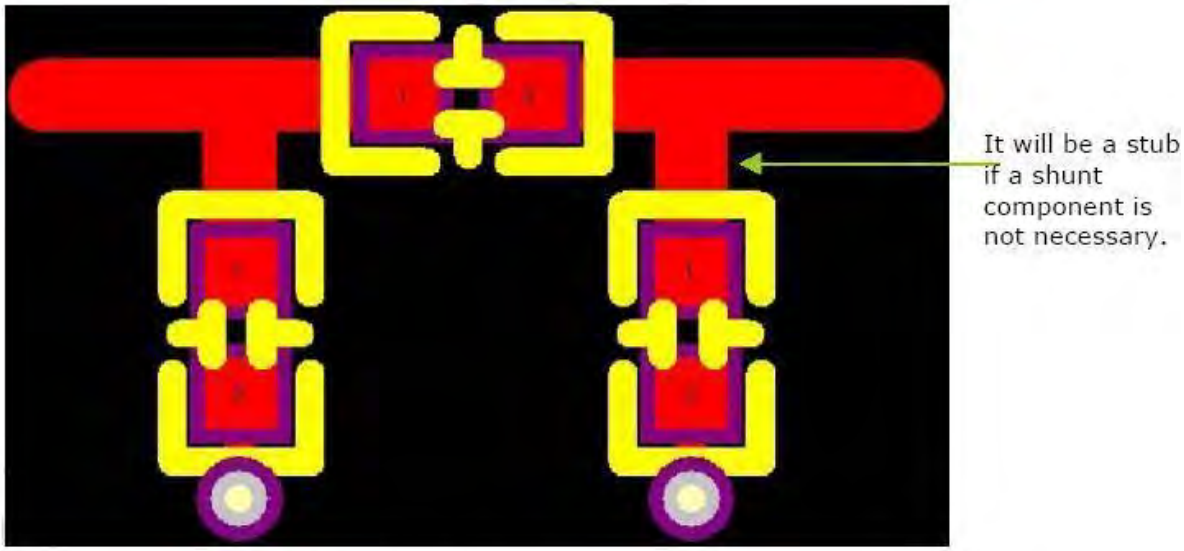
7. Antenna

All the high-speed traces should be moved far away from the antenna. For the best radiation performance, check antenna chip vendor for the layout guideline and clearance.

8. Antenna Matching

PCB designer should reserve an antenna matching network for post tuning to ensure the antenna performance in different environments. Matching components should be close to each other. Stubs should also be avoided to reduce parasitic while no shunt component is necessary after tuning.

Correct layout for antenna matching



Incorrent layut for antenna matching

9. SHIELDING CASE

Magnetic shielding, ferrite drum shielding, or magnetic-resin coated shielding is highly recommended to prevent EMI issues.

10. GENERAL LAYOUT GUIDELINES

Follow these guidelines to obtain good signal integrity and avoid EMI:

1. Place components and route signals using the following design practices:
   - Keep analog and digital circuits in separate areas.
   - Identify all high-bandwidth signals and their return paths. Treat all critical signals as current loops. Check each critical loop area before the board is built. A small loop area is more important than short trace lengths.
   - Orient adjacent-layer traces so that they are perpendicular to one another to reduce crosstalk.
   - Keep critical traces on internal layers, where possible, to reduce emissions and improve immunity to external noise.

     However, RF traces should be routed on outside layers to avoid the use of vias on these traces.
   - Keep all trace lengths to a practical minimum. Keep traces, especially RF traces, straight wherever possible. Where turns are necessary, use curved traces or two 45-degree turns. Never use 90-degree turns.
2. Consider the following with respect to ground and power supply planes:
   - Route all supply voltages to minimize capacitive coupling to other supplies. Capacitive coupling can occur if supply traces on adjacent layers overlap. Supplies should be separated from each other in the stack-up by a ground plane, or they should be coplanar (routed on different areas of the same layer).
   - Provide an effective ground plane. Keep ground impedance as low as possible. Provide as much ground plane as possible and avoid discontinuities. Use as many ground vias as possible to connect all ground layers together.
   - Maximize the width of power traces. Verify that they are wide enough to support target currents, and that they can do so with margin. Verify that there are enough vias if the traces

need to change layers.

3. Consider these power supply decoupling practices:

• Place decoupling capacitors near target power pins. If possible, keep them on the same side as the IC they decouple to avoid vias that add inductance. If a filter component cannot be directly connected to a given power pin with a very short and fat etch, do not connect it by a copper trace. Instead, make the connection directly to the associated planes using vias.

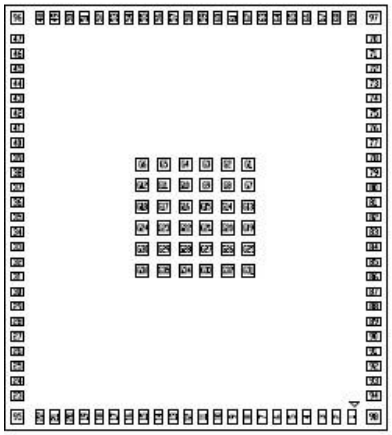
• Use appropriate capacitance values for the target circuit, and consider each capacitor's self-resonant frequency.

11. The other layout guide Information

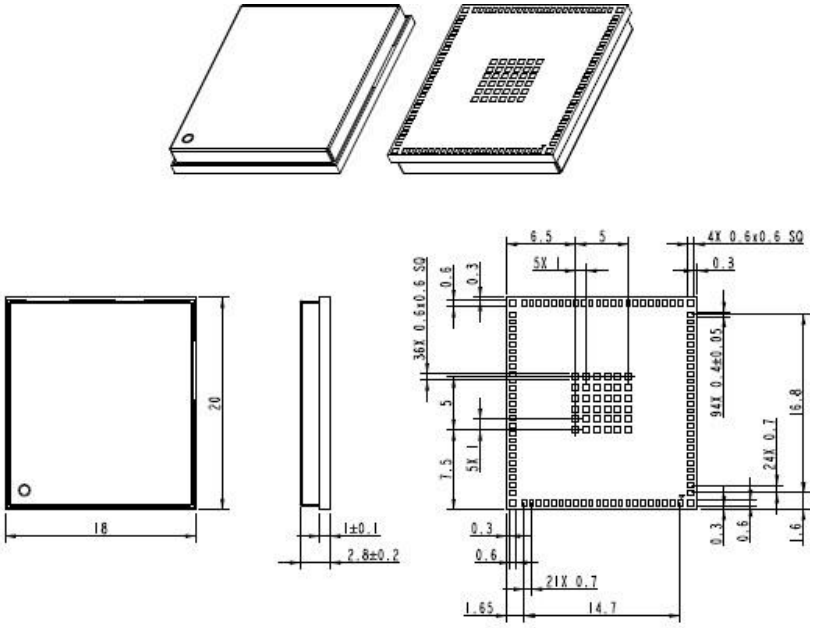
- Make sure every power traces have good return path (ground path).
- Connect the input pins of unused internal regulators to ground.
- Leave the output pins of unused internal regulators floating.
  - High speed interface (i.e. UART/SDIO/HSIC) shall have equal electrical length. Keep them away from noise sensitive blocks.
- Good power integrity of VDDIO will improve the signal integrity of digital interfaces.
  - Good return path and well shielded signal can reduce crosstalk, EMI emission and improve signal integrity.
  - RF IO is around 50 ohms, reserve Pi or T matching network to have better signal transition from port to port.
  - Smooth RF trace help to reduce insertion loss. Do not use 90 degrees turn (use two 45 degrees turns or one miter bend instead).
  - Well arranged ground plane near antenna and antenna itself will help to reduce near field coupling between other RF sources (e.g. GSM/CDMA … antennas).
- Discuss with AzureWave Engineer after you finish schematic and layout job.

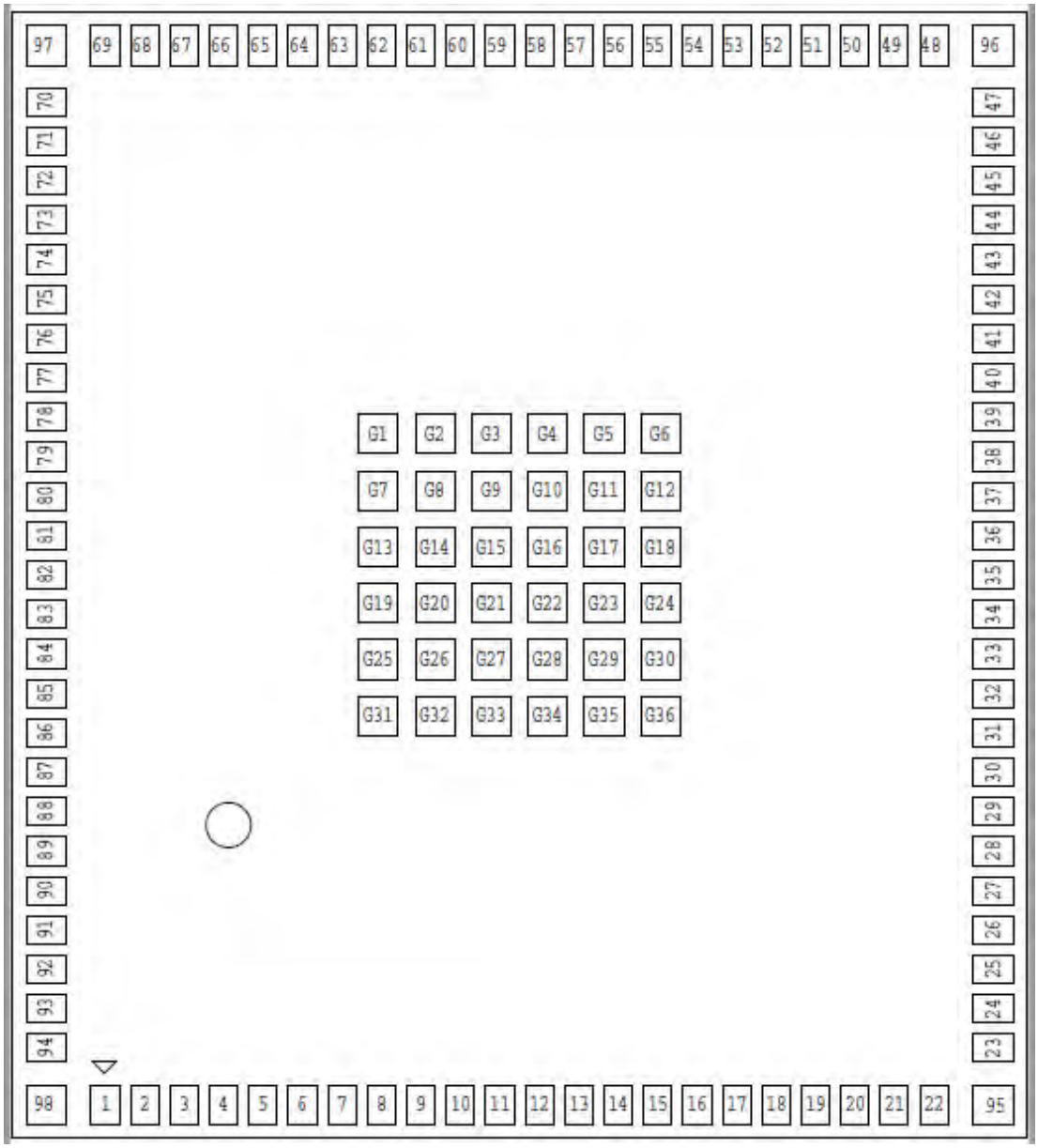
12. Mechanical Drawing

•Package Outline Drawing



PIN DEFINED (BOTTOM VIEW)



TOLERANCE UNLESS OTHERWISE SPECIFIED:±0.1mm

·Top View of PCB Layout Foot Print