# 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<br>● Modify table format | Renton Tao | N.C Chen |
| C | 2021/06/07 | DCN022198 | ● Update operating temperature<br>● Add the information of RF connector receptacle | Roger Liu | N.C Chen |
| D | 2021/08/13 | | ● Modify pin table<br>● Update power consumption<br>● Update RF specification | Roger Liu | N.C Chen |
| | | | | | |

AzureWave Technologies, Inc.

# Table of Contents

# 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.

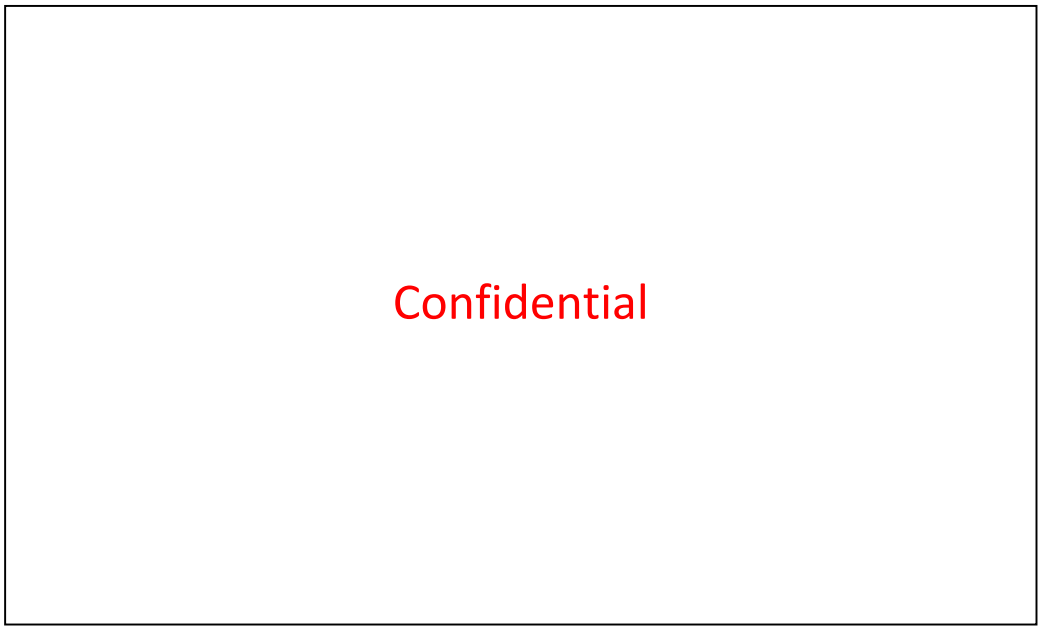
The AW-XM458MA-PUR supports standard interface **PCIe for WLAN** interface connection. High-Speed **UART for BT** interface connection. AW-XM458MA-PUR is suitable for multiple mobile processors for different applications. With the combo functions and the good performance, the AW-XM458MA-PUR is the best 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<br>1Rx | 802.11ax<br>Zero Wait DFS | 80MHz<br>80MHz |
| 3 | 2x2 | 802.11ax | 40MHz | 2x2 | 802.11ac | 40MHz |

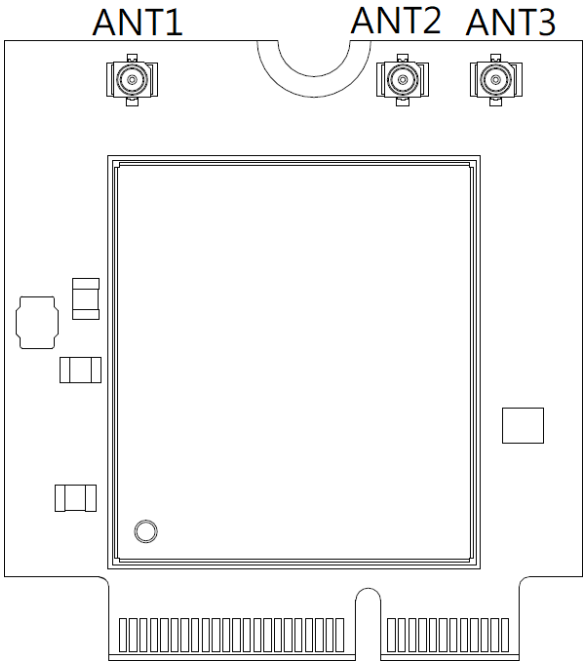
Concurrent 2.4GHz and 5GHz modes supported table

## 1.2 Block Diagram

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




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<br>● PCIe2.0 + UART |
| **Dimension** | 28 mm X 30 mm x 3.95 mm(Max)<br>(Tolerance remarked in mechanical drawing) |
| **Form factor** | Alternative sized M.2 2230 Key E |
| **Antenna** | 2T2R for WiFi, standalone antenna for BT<br>IPEX MHF4 connector Receptacle (20449)<br>ANT1(Main)：WiFi_A → TX/RX<br>ANT2(Aux)：WiFi_B→ TX/RX<br>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<br>5.15-5.25 GHz (FCC UNII-low band) for US/Canada and Europe<br>5.25-5.35 GHz (FCC UNII-middle band) for US/Canada and Europe<br>5.47-5.725 GHz for Europe<br>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:<br>■ USA, NORTH AMERICA, Canada and Taiwan - 1 ~ 11<br>■ China, Australia, Most European Countries - 1 ~ 13<br>■ Japan, 1 ~ 13<br><br>5GHz:<br>■ 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<br>■ Japan - 36,40,44,48,52,56,60,64,100,104,108,112,116,120,124,128,132,136,140 |

<table>
<tr><td></td><td>■ China - 36,40,44,48,52,56,60,64, 149,153,157,161,165</td></tr>
<tr><td>Output Power</td><td>
2.4G
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>11b (11Mbps)<br>@EVM<35%</td><td>16</td><td>18</td><td>20</td><td>dBm</td></tr>
<tr><td>11g (54Mbps)<br>@EVM≦-27 dB</td><td>15.5</td><td>17</td><td>18.5</td><td>dBm</td></tr>
<tr><td>11n (HT20 MCS7)<br>@EVM≦-28 dB</td><td>14.5</td><td>16</td><td>17.5</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)<br>@EVM≦-28 dB</td><td>14.5</td><td>16</td><td>17.5</td><td>dBm</td></tr>
<tr><td>11ax (HE20 MCS11)<br>@EVM≦-35 dB</td><td>12.5</td><td>14</td><td>15.5</td><td>dBm</td></tr>
<tr><td>11ax (HE40 MCS11)<br>@EVM≦-35 dB</td><td>12.5</td><td>14</td><td>15.5</td><td>dBm</td></tr>
</table>
5G
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>11a (54Mbps)<br>@EVM≦-27 dB</td><td>14</td><td>16</td><td>18</td><td>dBm</td></tr>
<tr><td>11n (HT20 MCS7)<br>@EVM≦-28 dB</td><td>14</td><td>16</td><td>18</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)<br>@EVM≦-28 dB</td><td>14</td><td>16</td><td>18</td><td>dBm</td></tr>
<tr><td>11ac(VHT20 MCS8)<br>@EVM≦-31 dB</td><td>13</td><td>15</td><td>17</td><td>dBm</td></tr>
<tr><td>11ac(VHT40 MCS9)<br>@EVM≦-32 dB</td><td>13</td><td>15</td><td>17</td><td>dBm</td></tr>
<tr><td>11ac(VHT80 MCS9)<br>@EVM≦-32 dB</td><td>13</td><td>15</td><td>17</td><td>dBm</td></tr>
<tr><td>11ax(HE20 MCS11)<br>@EVM≦-35 dB</td><td>10</td><td>12</td><td>14</td><td>dBm</td></tr>
<tr><td>11ax(HE40 MCS11)<br>@EVM≦-35 dB</td><td>10</td><td>12</td><td>14</td><td>dBm</td></tr>
<tr><td>11ax(HE80 MCS11)<br>@EVM≦-35 dB</td><td>10</td><td>12</td><td>14</td><td>dBm</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>Receiver Sensitivity</td><td>
2.4G
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>11b (11Mbps)</td><td>-</td><td>-88</td><td>-85</td><td>dBm</td></tr>
<tr><td>11g (54Mbps)</td><td>-</td><td>-75</td><td>-72</td><td>dBm</td></tr>
<tr><td>11n (HT20 MCS7)</td><td>-</td><td>-72</td><td>-69</td><td>dBm</td></tr>
<tr><td>11n (HT40 MCS7)</td><td>-</td><td>-70</td><td>-66</td><td>dBm</td></tr>
<tr><td>11ax(HE20 MCS11)</td><td>-</td><td>-62</td><td>-58</td><td>dBm</td></tr>
<tr><td>11ax(HE40 MCS11)</td><td>-</td><td>-59</td><td>-53</td><td>dBm</td></tr>
</table>
5G
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>11a (54Mbps)</td><td>-</td><td>-72</td><td>-68</td><td>dBm</td></tr>
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<tr><td>11ac(VHT20 MCS8)</td><td>-</td><td>-65</td><td>-61</td><td>dBm</td></tr>
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<tr><td>11ac(VHT80 MCS9)</td><td>-</td><td>-59</td><td>-55</td><td>dBm</td></tr>
<tr><td>11ax(HE20 MCS11)</td><td>-</td><td>-60</td><td>-56</td><td>dBm</td></tr>
<tr><td>11ax(HE40 MCS11)</td><td>-</td><td>-57</td><td>-53</td><td>dBm</td></tr>
<tr><td>11ax(HE80 MCS11)</td><td>-</td><td>-55</td><td>-51</td><td>dBm</td></tr>
</table>
</td></tr>
<tr><td>Data Rate</td><td>■ 802.11b: 1, 2, 5.5, 11Mbps<br>■ 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54Mbps<br>■ 802.11n: up to 150Mbps-single<br>■ 802.11n: up to 300Mbps-2x2 MIMO<br>■ 802.11ac:up to 192.6Mbps (20MHz channel)<br>■ 802.11ac:up to 400Mbps (40MHz channel)<br>■ 802.11ac:up to 866.7Mbps (80MHz channel)<br>■ 802.11ax:2.4GHz up to 458Mbps, 5GHz up to 1.2Gbps</td></tr>
<tr><td>Security</td><td>WiFi: WPA/WPA2/WPA3</td></tr>
</table>

* 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<br>Payload 2M: π/4-DQPSK<br>Payload 3M: 8DPSK |

<table>
<tr><td>Output Power</td><td>
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>BDR</td><td>0</td><td>2</td><td>4</td><td>dBm</td></tr>
<tr><td>EDR</td><td>0</td><td>2</td><td>4</td><td>dBm</td></tr>
<tr><td>Low Energy (2MHz)</td><td>0</td><td>2</td><td>4</td><td>dBm</td></tr>
</table>
</td></tr>
<tr><td>Receiver Sensitivity</td><td>
<table>
<tr><th></th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>BDR</td><td></td><td>-90</td><td>-87</td><td>dBm</td></tr>
<tr><td>EDR</td><td></td><td>-87</td><td>-84</td><td>dBm</td></tr>
<tr><td>Low Energy (2MHz)</td><td></td><td>-88</td><td>-85</td><td>dBm</td></tr>
</table>
</td></tr>
</table>

### 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.<br>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

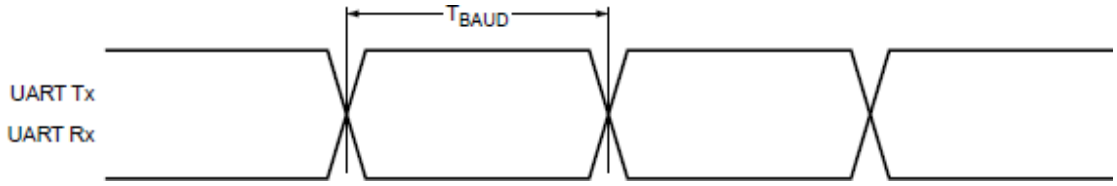
| Symbol | Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| UI | Unit interval<br>Each UI is 400 ps ±300 PPM.<br>UI does not account for SSC dictated variations. | 399.98 | 400 | 400.12 | ps |
| $V_{Tx\_DIFFpp}$ | Differential peak-to-peak output voltage<br>$V_{Tx\_DIFFpp} = 2*\|V_{TX-D+} - V_{TX-D-}\|$ | 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<br>Each UI is 400 ps ±300 ppm.<br>UI does not account for SSC dictated variations. | 399.98 | 400 | 400.12 | ps |
| $V_{Rx\_DIFFpp}$ | Differential peak-to-peak voltage<br>$V_{Rx\_DIFFpp} = 2*\|V_{RX-D+} - V_{RX-D-}\|$ | 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

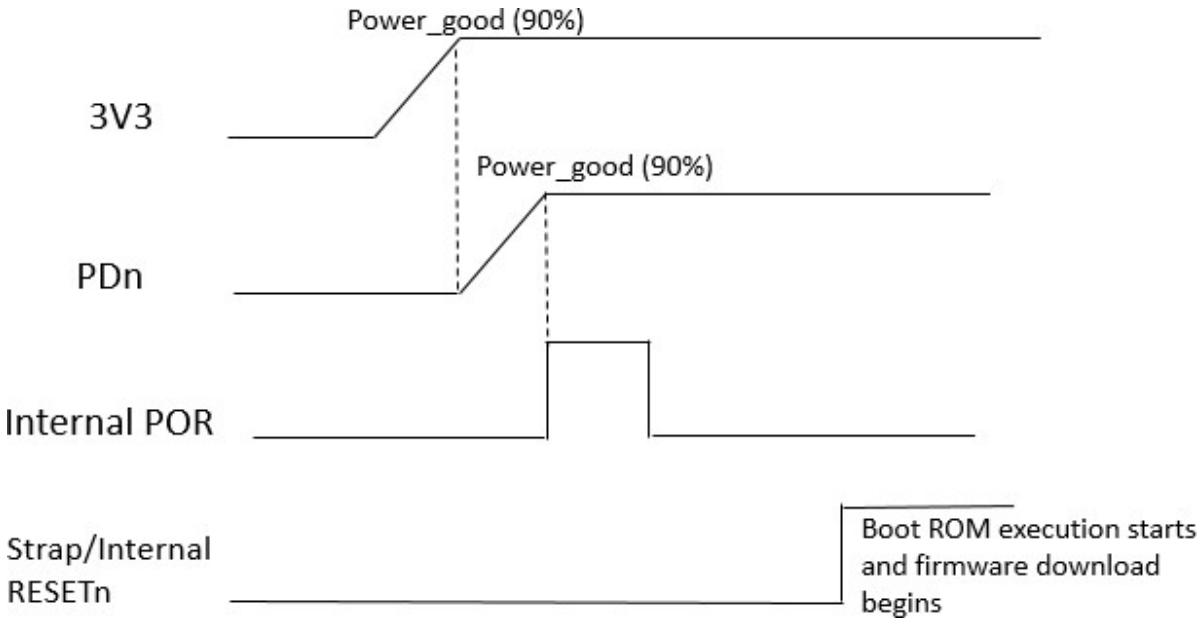
The AW-XM458MA-PUR supports a high-speed Universal Asynchronous Receiver/Transmitter (UART) interface, compliant to the industry standard 16550 specification. High-speed baud rates are supported to provide the physical transport between the device and the host for exchanging Bluetooth data.




| 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

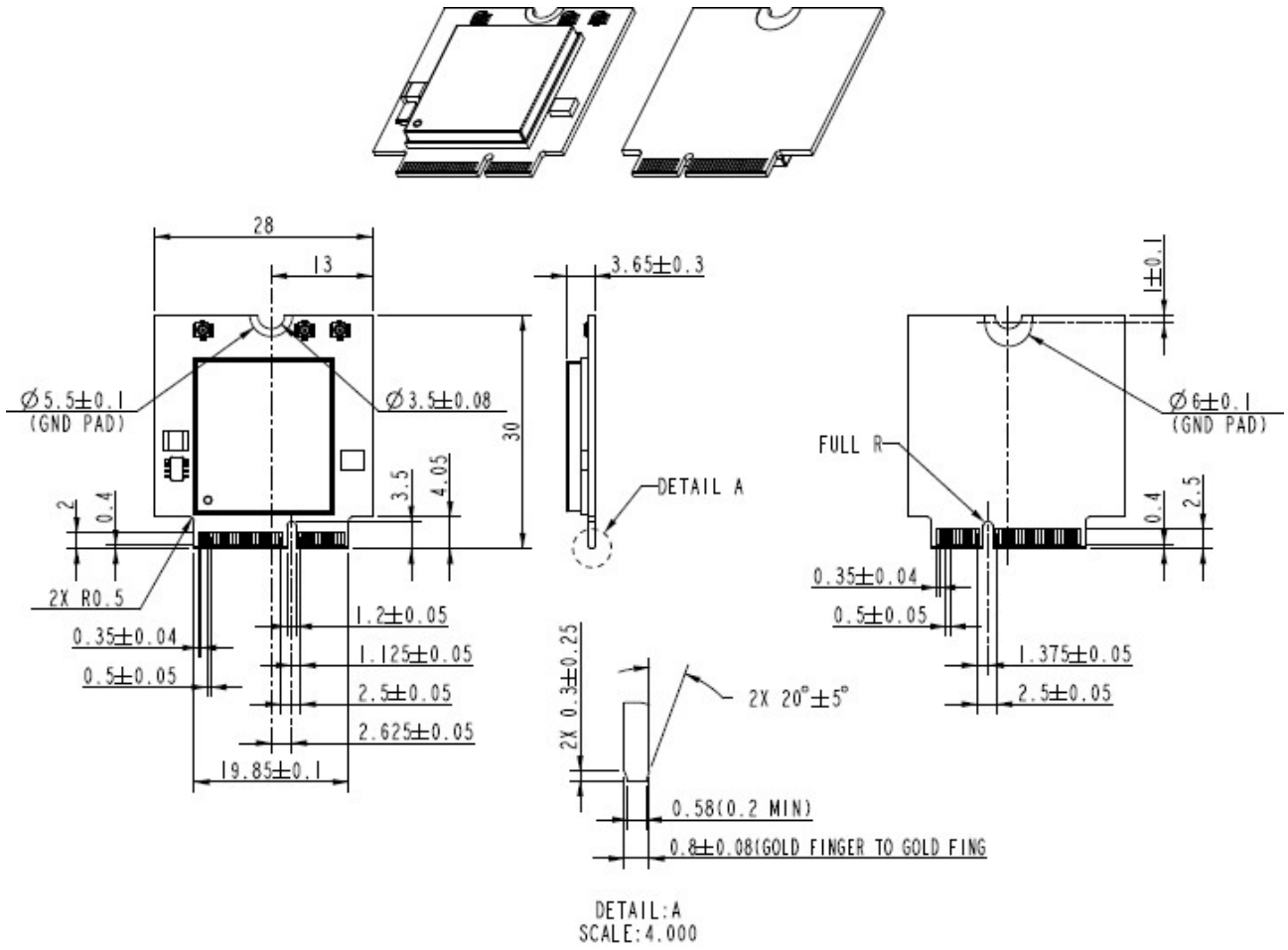
| No. | Item | | | 3.3V(mA) | | |
|---|---|---|---|---|---|---|
| | | | | Max. | Avg. | |
| 1 | Power down | | | 0.254 | | |
| 2 | DeepSleep (Not associated with AP) | | | 1.77 | 1.69 | |
| 3 | Power Save (2.4GHz) | | | 124 | 5.45 | |
| 4 | Power Save (5GHz) | | | 165 | 4.18 | |
| Band (GHz) | Mode | 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)**<br>+<br>11ax@MCS0 NSS2**(5G)** | 40<br>+<br>80 | 16<br>+<br>14 | 1312 | 1288 | 96 |
| | 11ac@MCS0 NSS2 **(5G)**<br>+<br>11ax@MCS0 NSS2**(2.4G)** | 40<br>+<br>40 | 15<br>+<br>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




TOLERANCES UNLESS OTHERWISE SPECIFIED:±0.15mm

(Draft drawing)

**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.

## 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

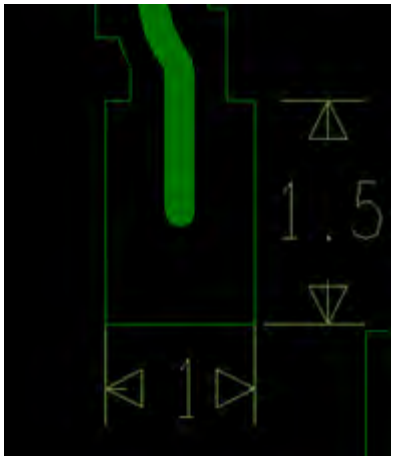
Please follow power and ground layout guidelines. Here are some general rules for customers' reference.

- 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.

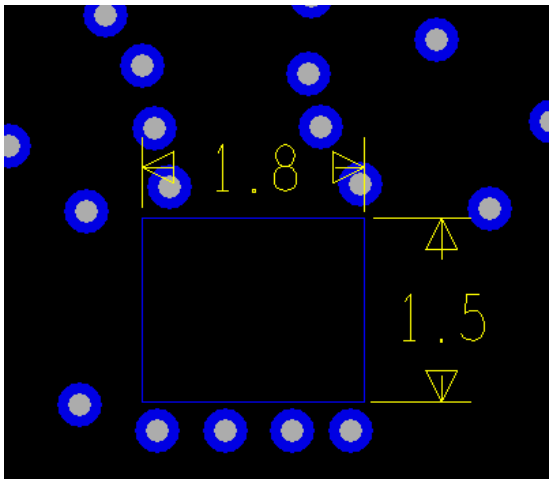
# 5. RF pad and layout pattern

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.

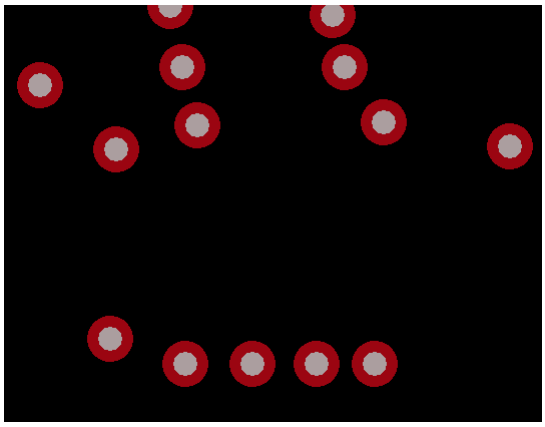
A. Top Layer design




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.

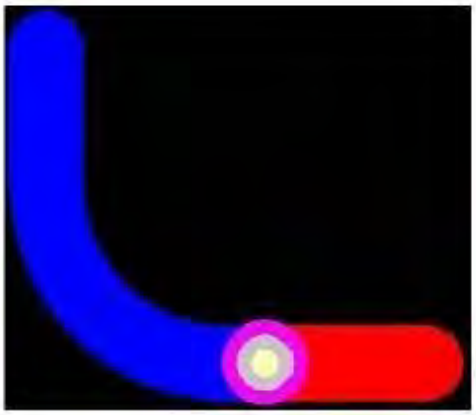
- The RF trace impedance should be 50Ω between ANT port and antenna matching network.
- The length of the RF trace should be minimized.
- To reduce the signal loss, RF trace should laid on the top of PCB and avoid any via on it.
- The CPW (coplanar waveguide) design and the microstrip line are both recommended; 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.

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

**Correct RF trace**

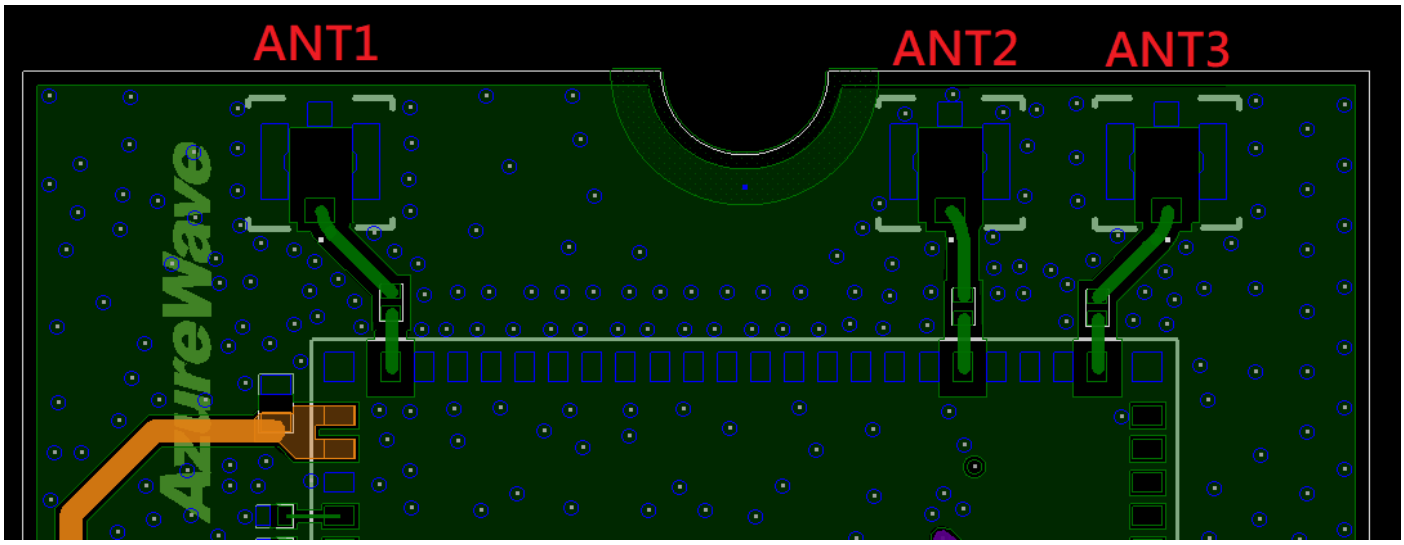
Right-angled corner



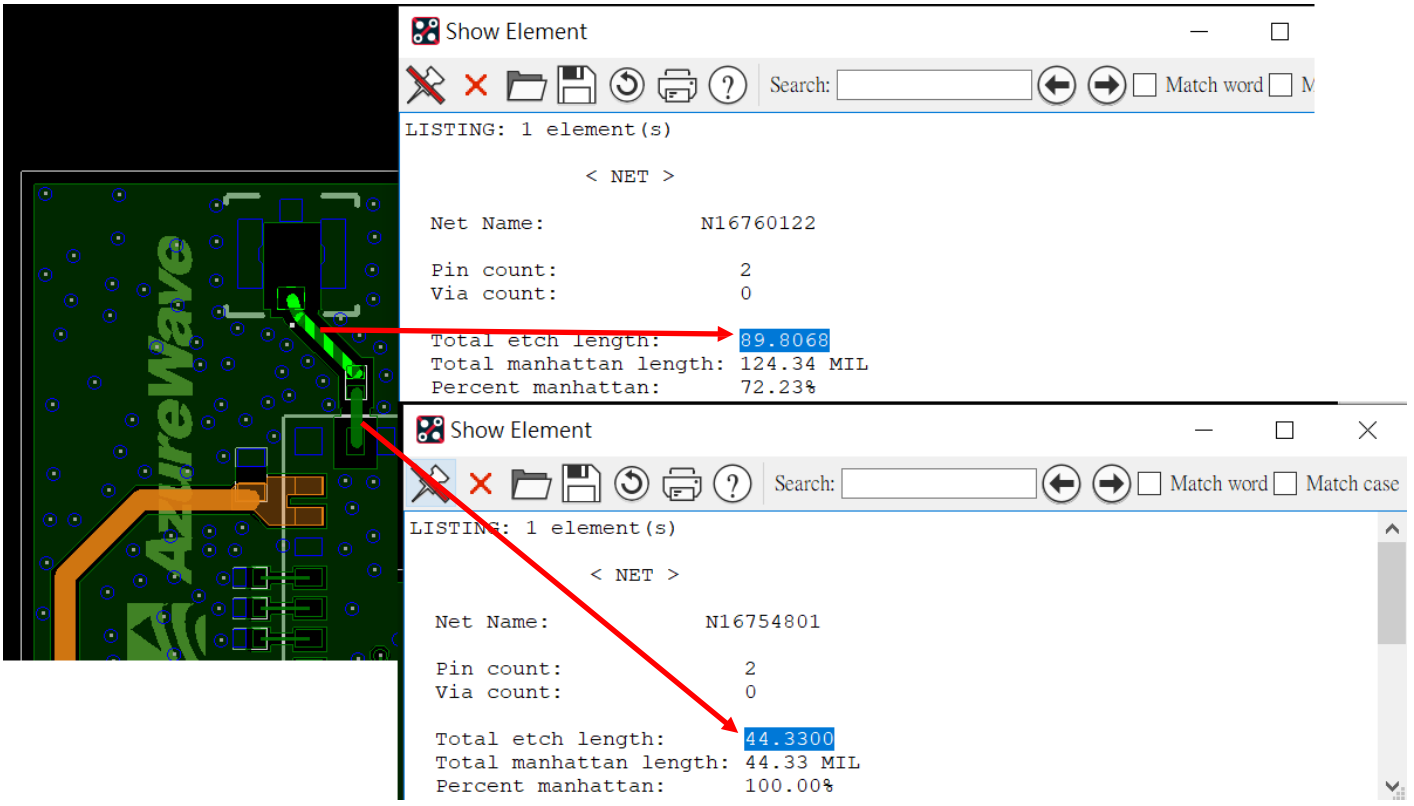
Via on RF trace

**Incorrect RF trace**

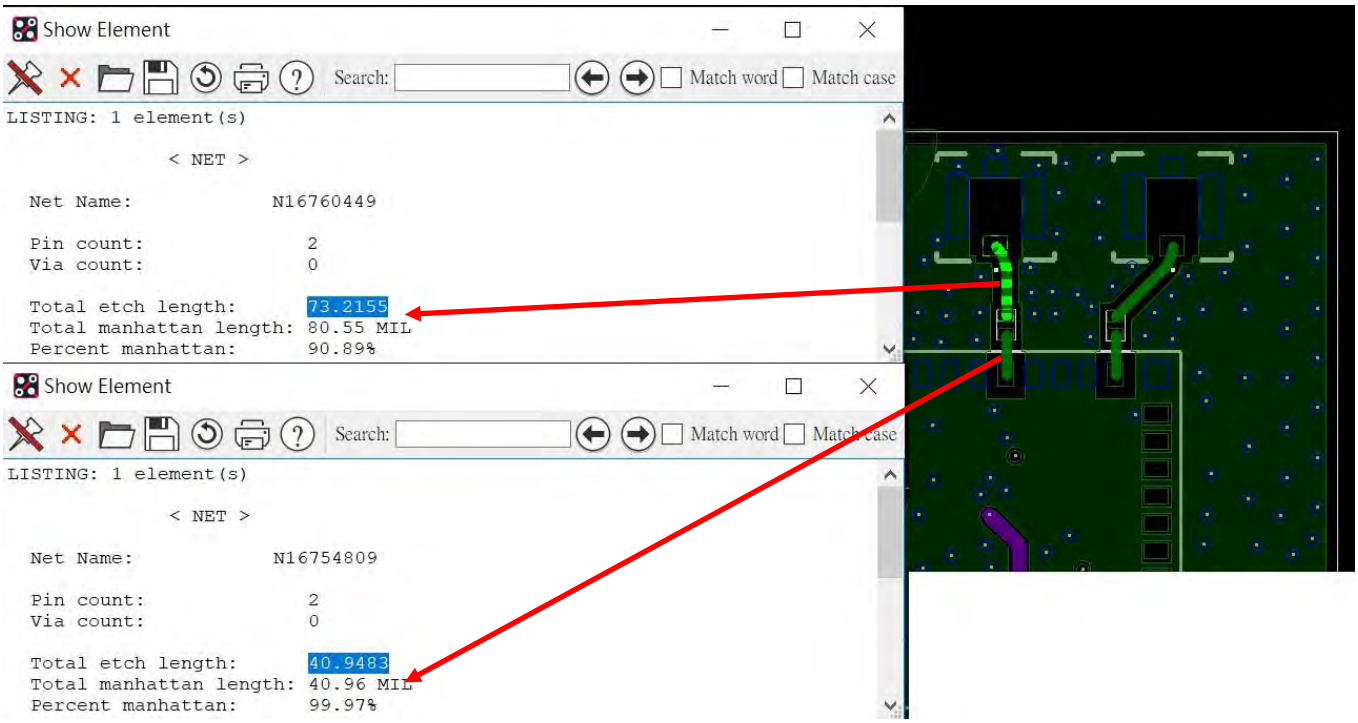
AW-XM458 RF trace should be follow the rules as below



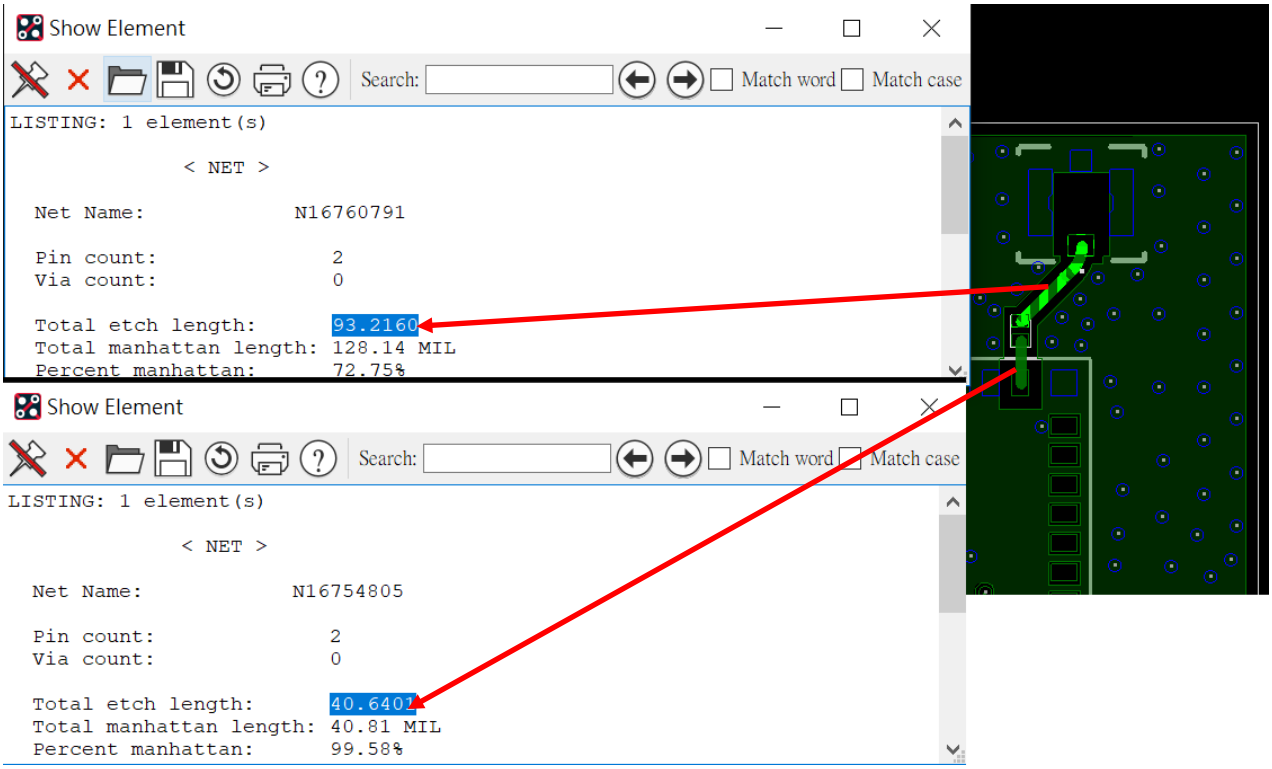

a. Trace length of ANT1 is about 89.8 mil and 44.3 mil.



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

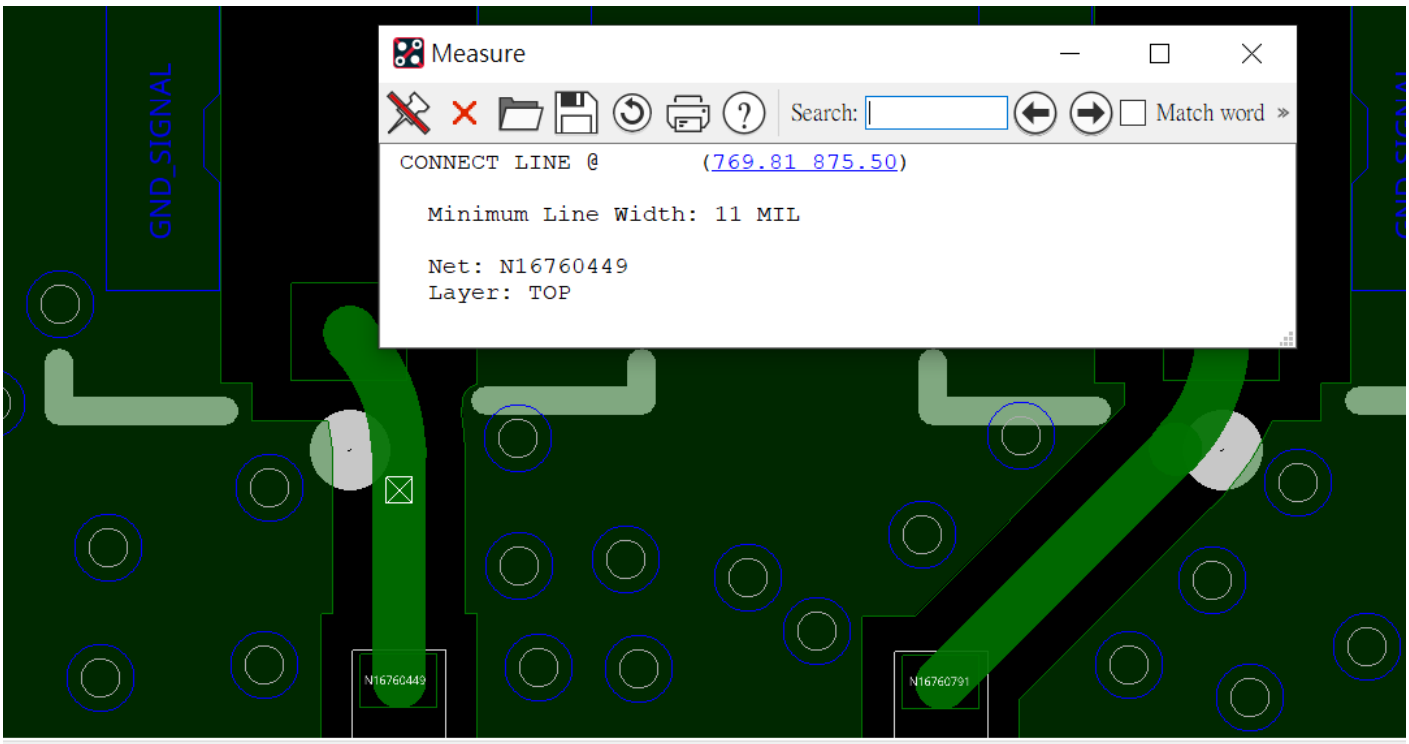



c. Trace length of ANT3 is about 93.2 mil and 40.6 mil.



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


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



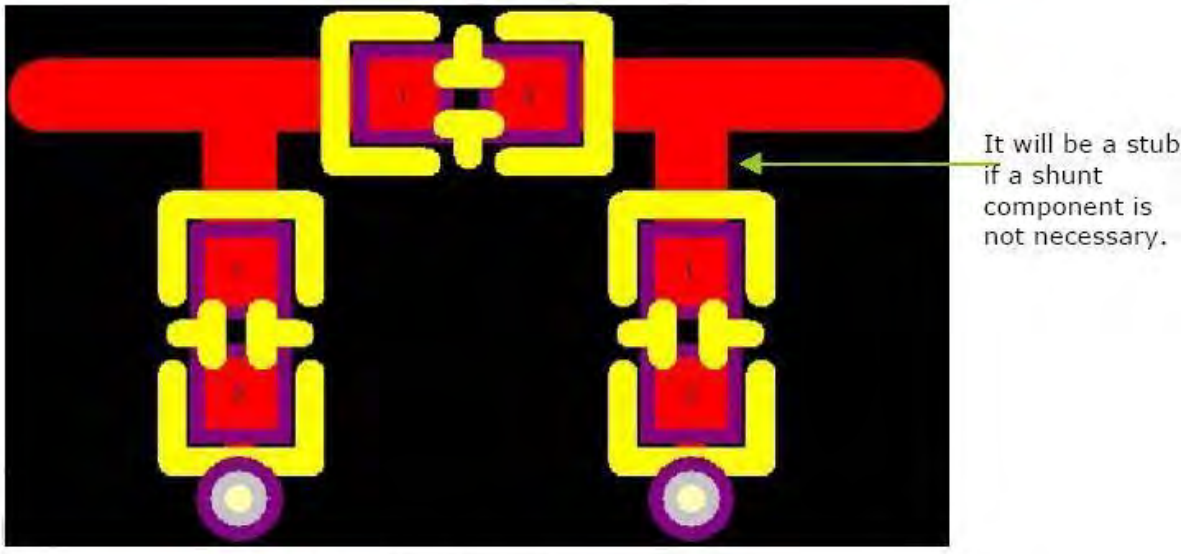
## 7. Antenna

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.

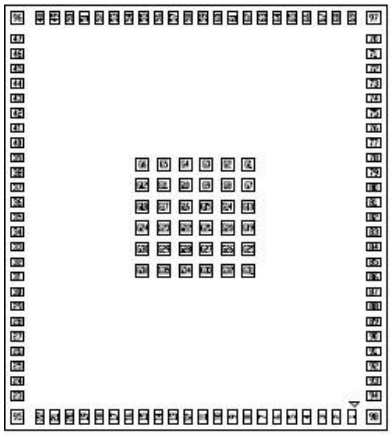
• Use appropriate capacitance values for the target circuit, and consider each capacitor's self-resonant frequency.

## 11. The other layout guide Information

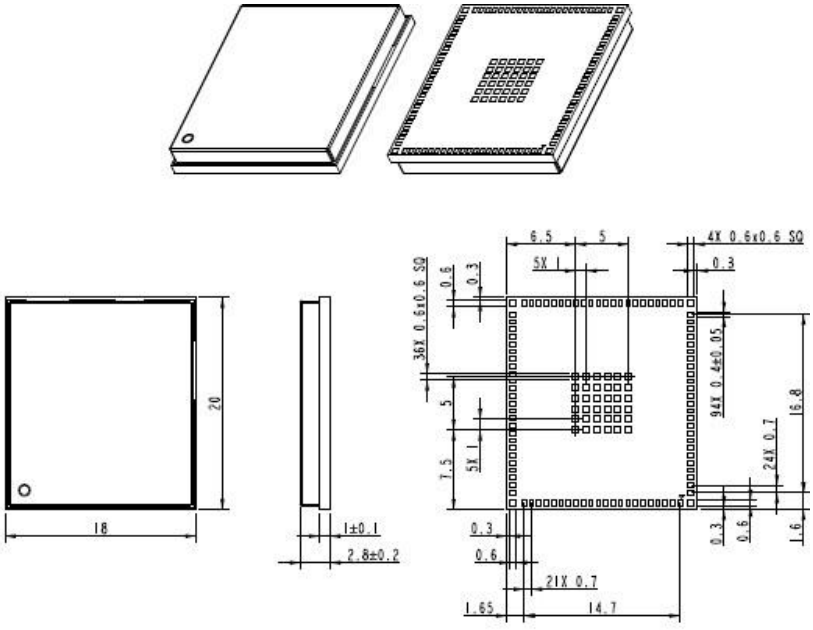
- Make sure every power traces have good return path (ground path).
- Connect the input pins of unused internal regulators to ground.
- Leave the output pins of unused internal regulators floating.
  - High speed interface (i.e. UART/SDIO/HSIC) shall have equal electrical length. Keep them away from 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