



a module solution provider

WG3221-00

WLAN Dual-Band 1x1 802.11ac + Bluetooth 5.0
M.2 Type 1216, Wireless Module

Qualcomm QCA9377-3 Solution

Datasheet Revision 0.1

| Prepared By | Reviewed By | Approved By |
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1. OVERVIEW

The WG3221-00 is a wireless local area network (WLAN) and Bluetooth (BT) combination module to support 1x1 IEEE 802.11a/b/g/n/ac WLAN standards and BT5.0, enabling seamless integration of WLAN/BT and low-energy technology. This module is based on Qualcomm QCA9377-3 single-die chip that WLAN function is connected to the host processor via a SDIO interface, and the Bluetooth is connected via a UART interface.

1.1. General Features

- Integrated Crystal, power inductor, filter and diplexer on a single module.
- Supports a low-power SDIO 3.0 interface for WLAN and a UART/PCM interface for BT.
- Supports 20 MHz/40 MHz at 2.4 GHz and supports 20 MHz, 40 MHz, or 80 MHz at 5 GHz.
- Supports BT 5.0, BLE and backward compatibility with BT 1.x and BT 2.x + Enhanced Data Rate.
- Supports a single-ended RF port I-PEX MHF4 connector.
- Supports BT-WLAN coexistence and ISM-LTE coexistence
- Operates on one 3.3V power supply and an I/O supply of 3.3V or 1.8V. Both WLAN and BT power management use advanced power-saving techniques such as:
 - Gating clocks to idle or inactive blocks
 - Voltage scaling to specific blocks in certain states
 - Fast start and settling circuits to reduce Tx
 - Active duty cycles
 - Processor frequency scaling
 - Other techniques to optimize power consumption across all operating states
- Includes additional features such as:
 - Low-density parity check (LDPC).
 - 1.5 KB of on-chip one-time programmable (OTP) memory to eliminate the need for an external flash and to further reduce the external component count and BOM cost.
 - Available in a M.2 type 1216 package.
 - Uses an internal PA and internal LNA to support the datasheet specifications.
- Dimension 16mm(L) x 12mm(W) x 2.1mm(H)
- RoHS Compliance

2. FUNCTIONAL FEATURES

2.1. Module Block Diagram

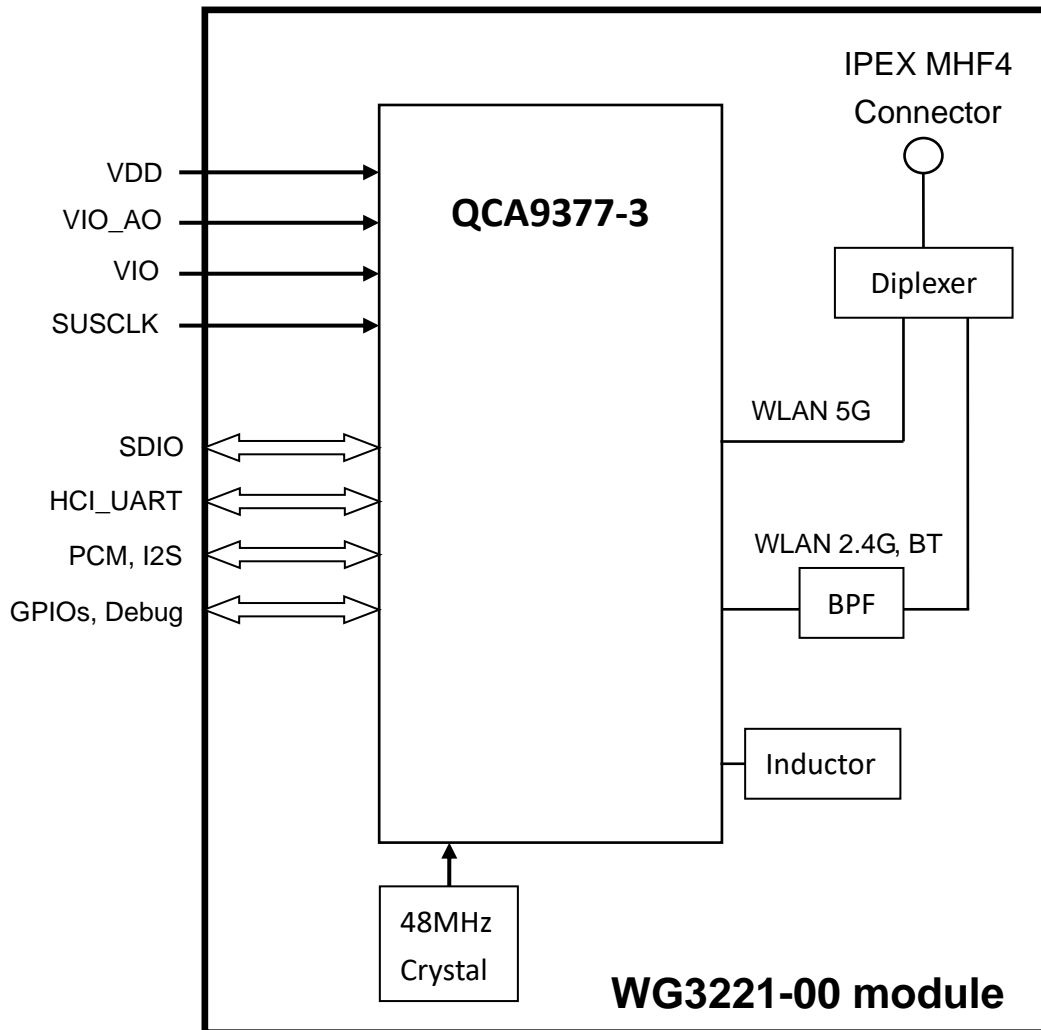


Figure 2-1. WG3221-00 Block Diagram

3. MODULE OUTLINE

3.1. Signal Layout (Top View)

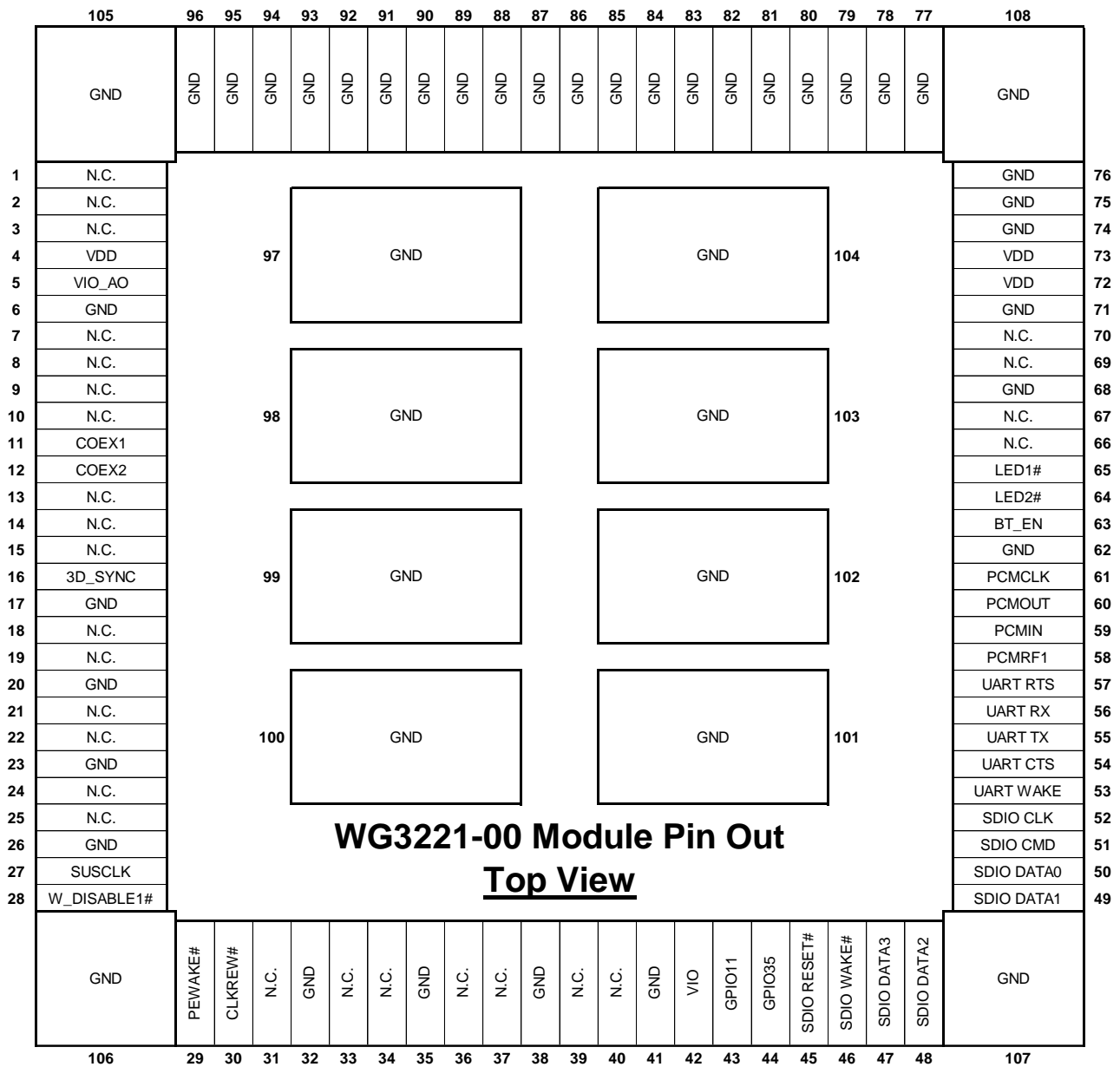


Figure 3-1. Module Pin Ofut (Top View)

3.2. Pin Description

Table 3-1. Pin Description

| Pin No. | Pin Name | Type ⁽¹⁾ | Description |
|---------|----------|---------------------|---|
| 1 | NC | NC | No connection. |
| 2 | NC | NC | No connection. |
| 3 | NC | NC | No connection. |
| 4 | VDD | Power | 3.3V main power supply |
| 5 | VIO_AO | Power | Always-on I/O supply for power management and real-time clock. 1.8V or 3.3V supply. |
| 6 | GND | GND | Ground |
| 7 | NC | NC | No connection. |
| 8 | NC | NC | No connection. |
| 9 | NC | NC | No connection. |
| 10 | NC | NC | No connection. |
| 11 | COEX1 | PU | LTE coexistence signal. LTE_UART_RXD or LTE_FS. |
| 12 | COEX2 | DO | LTE coexistence signal. LTE_UART_TXD or LTE_PRI. |
| 13 | NC | NC | No connection. |
| 14 | NC | NC | No connection. |
| 15 | NC | NC | No connection. |
| 16 | 3D_SYNC | PD | Frame sync signal from TV to sync with 3D glass via Bluetooth. |
| 17 | GND | GND | Ground |
| 18 | NC | NC | No connection. |
| 19 | NC | NC | No connection. |
| 20 | GND | GND | Ground |
| 21 | NC | NC | No connection. |
| 22 | NC | NC | No connection. |
| 23 | GND | GND | Ground |
| 24 | NC | NC | No connection. |
| 25 | NC | NC | No connection. |
| 26 | GND | GND | Ground |
| 27 | SUSCLK | PD | External low-power 32.768 kHz clock input |

| | | | |
|----|-------------|-------|--|
| 28 | W_DISABLE1# | PU | Turn off WLAN RF analog and front-end. Active low. |
| 29 | PEWAKE# | OD | PCI Express host wakeup function to wake up the host on WLAN activity. Not used, leave N.C. |
| 30 | CLKREW# | OD | PCI Express clock request signal. Not used, leave N.C. |
| 31 | NC | NC | No connection. |
| 32 | GND | GND | Ground |
| 33 | NC | NC | No connection. |
| 34 | NC | NC | No connection. |
| 35 | GND | GND | Ground |
| 36 | NC | NC | No connection. |
| 37 | NC | NC | No connection. |
| 38 | GND | GND | Ground |
| 39 | NC | NC | No connection. |
| 40 | NC | NC | No connection. |
| 41 | GND | GND | Ground |
| 42 | VIO | Power | I/O voltage supply. 1.8V or 3.3V supply. |
| 43 | GPIO11 | DO | Clock request output. Not used, leave N.C. |
| 44 | GPIO35 | OD | This signal can be used to enable for external Wireless charging UART circuit. Not used, leave N.C. |
| 45 | SDIO RESET# | PD | WLAN enable. Active high |
| 46 | SDIO WAKE# | DO | WLAN SDIO interrupt signal. |
| 47 | SDIO DATA3 | B | WLAN SDIO data bus D3 |
| 48 | SDIO DATA2 | B | This pin is a boot strap signal. It must keep high for normal operation during power on reset. WLAN SDIO data bus D2 |
| 49 | SDIO DATA1 | B | WLAN SDIO data bus D1 |
| 50 | SDIO DATA0 | B | WLAN SDIO data bus D0 |
| 51 | SDIO CMD | DI | WLAN SDIO CMD line signal |
| 52 | SDIO CLK | OD | WLAN SDIO clock signal. |
| 53 | UART WAKE | OD | Bluetooth wakeup host. Active high. Shared for BT LED. |
| 54 | UART CTS | DI | Bluetooth HCI UART CTS signal |
| 55 | UART TX | DO | Bluetooth HCI UART TXD signal |

| | | | |
|--------|----------|-------|---|
| 56 | UART RX | DI | Bluetooth HCI UART RXD signal |
| 57 | UART RTS | DO | Bluetooth HCI UART RTS signal |
| 58 | PCMR1 | B | Bluetooth PCM_SYNC signal |
| 59 | PCMIN | OD | Bluetooth PCM_IN signal |
| 60 | PCMOUT | DO | Bluetooth PCM_OUT signal |
| 61 | PCMCLK | PD | Bluetooth PCM_CLK signal |
| 62 | GND | GND | Ground |
| 63 | BT_EN | PD | Bluetooth enable. Active high |
| 64 | LED2# | OD | Connected internally to pin 53 (UART WAKE) |
| 65 | LED1# | OD | Connected internally to pin 30 (CLKREW#) |
| 66 | NC | NC | No connection. |
| 67 | NC | NC | No connection. |
| 68 | GND | GND | Ground |
| 69 | NC | NC | No connection. |
| 70 | NC | NC | No connection. |
| 71 | GND | GND | Ground |
| 72 | VDD | Power | 3.3V main power supply |
| 73 | VDD | Power | 3.3V main power supply |
| 74~108 | GND | GND | Ground |

(1) Type:

Power: Voltage supply

GND: Ground

NC: No connection

PU: Input signals with weak internal pull-up, to prevent signals from floating when left open

PD: Input signals with weak internal pull-down, to prevent signals from floating when left open

B: Bidirectional digital with CMOS input

DI: Digital input (CMOS)

DO: Digital output signal

OD: A digital output signal with open drain

4. MODULE SPECIFICATIONS

We reserve the right to amend the design and/or specifications of our products without notice.

4.1. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)

Table 4-1. Absolute Maximum Ratings

| Parameter | Conditions | MIN | MAX | Units |
|--------------------------------------|--|------|------------------------|-------|
| Supply voltage, VDD | | -0.3 | 3.65 | V |
| Supply voltage, VIO | | -0.3 | 4.0 | |
| 3.3V I/O VIH MAX 1.8V I/O VIH MAX | Maximum digital I/O input voltage for 3.3V I/O supply Maximum digital I/O input voltage for 1.8V I/O supply | | VIO + 0.3 VIO + 0.2 | |
| VIH MIN | Minimum digital I/O input voltage for 3.3V or 1.8V I/O supply | -0.3 | | |
| Input RF level | Maximum RF input | | +10 | dBm |
| ESD | Electrostatic discharge tolerance | 2000 | | V |
| Storage temperature range | | -40 | +85 | °C |

4.2. Recommended Operating Conditions

Table 4-2. Recommended Operating Conditions

| Parameter | Conditions | MIN | Typ. | MAX | Units |
|--------------------------------|---------------------|--------------|------------|-------|-------|
| Ambient temperature range | | -30 | - | 85 | °C |
| Operating supply voltage (VDD) | 3.3V supply | 3.135 | 3.3 | 3.465 | V |
| Operating supply voltage (VIO) | 1.8V or 3.3V supply | 1.71 3.14 | 1.8 3.3 | 3.46 | |

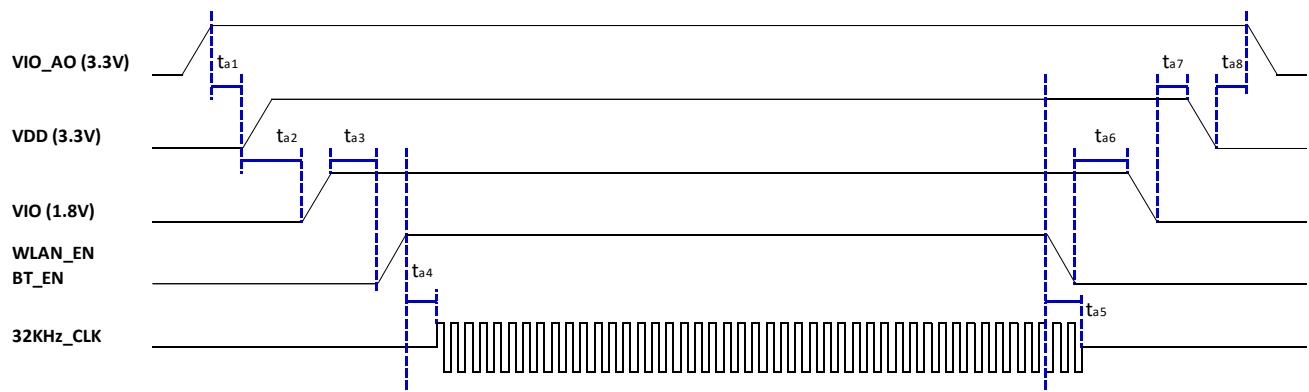
4.3. Power Sequencing:

Case-1: 3.3V power down after 1.8V

If the battery source can be removed from the end user device (battery removed, AC/DC plugged in), this is the recommended power sequence. It will avoid violating the power off sequence by allowing the 3.3V rail to shut down after the 1.8V rail.

Notes:

1. The module VIO voltage should match VIO voltage from the host.
2. In this case, both WLAN_EN and BT_EN of WG3221 are at 3.3V due to using the VIO_AO power rail. If the host VIO voltage is 1.8V, it must have level shifters to interface with host.
3. All host interface signals must stay floating or low before valid power on sequence (WLAN_EN and BT_EN goes high).



| Symbol | Parameter | Min | Max | Units |
|----------|---|-----|-----|-------|
| t_{a1} | No requirement if VIO_AO connected to 3.3V | 0 | - | μs |
| t_{a2} | 90% of 3.3V to 10% of 1.8V | 0 | 0 | |
| t_{a3} | 90% of VIO to 0.7 V of both WLAN_EN and BT_EN | 10 | - | |
| t_{a4} | WLAN_EN valid to SUSCLK input | 0 | - | |
| t_{a5} | WLAN_EN de-assert ("low") to SUSCLK de-assert (tristate or low) | 0 | - | |
| t_{a6} | Both WLAN_EN = low and BT_EN = low to 90% of 1.8V | 10 | - | |
| t_{a7} | 3.3V always higher than 1.8V during operation, with power off by removing battery or unplugging AC/DC | 0 | | |
| t_{a8} | VIO_AO should be connected to 3.3V power rail | 0 | | |

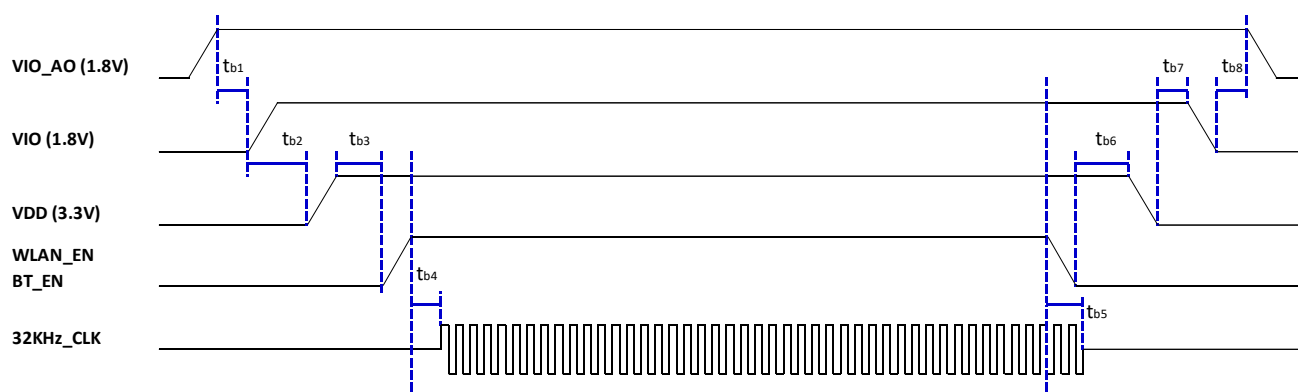
Figure 4-1. Power Sequence (3.3V power down after 1.8V)

Case-2: 1.8V power down after 3.3V

If the battery source cannot be removed from the end user device, this is the recommended power sequence for this application. This sequence allows the software to control the power on/off sequence.

Notes:

1. The module VIO voltage should match VIO voltage from the host.
2. Both WLAN_EN and BT_EN of WG3221 are 1.8V. If host VIO voltage is 1.8V, it does not need level shifter to interface with host.
3. All host interface signals must stay floating or low before WLAN_EN/BT_EN =high, and after WLAN_EN/BT_EN = Low.



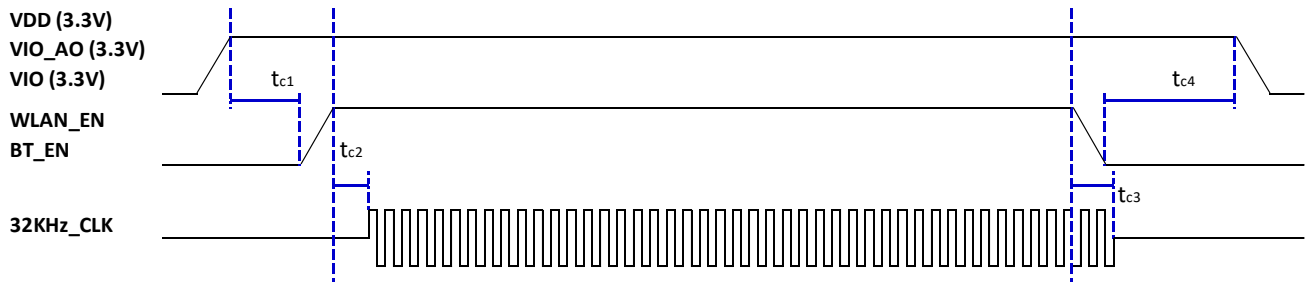
| Symbol | Parameter | Min | Max | Units |
|-----------------|---|-----|-----|-------|
| t _{b1} | No requirement if VIO_AO connected to 1.8V | 0 | - | μs |
| t _{b2} | 90% of 1.8V to 10% of 3.3V | 0 | - | |
| t _{b3} | 90% of 3.3V to 0.7 V of both WLAN_EN and BT_EN | 10 | - | |
| t _{b4} | WLAN_EN valid to SUSCLK input | 0 | - | |
| t _{b5} | WLAN_EN de-assert ("low") to SUSCLK de-assert (tristate or low) | 0 | - | |
| t _{b6} | Both WLAN_EN = low and BT_EN = low to 90% of 3.3V | 10 | - | |
| t _{b7} | 10% of 3.3V to 90% of 1.8V | 0 | - | |
| t _{b8} | VIO_AO should be connected to 1.8V power rail | 0 | - | |

Figure 4-2. Power Sequence (1.8V power down after 3.3V)

Case-3: All power rails supplied 3.3V

All power pins are connected to 3.3V only include VDD、VIO_AO and VIO.

Notes: All host signals are either GND or floating before WLAN_EN/BT_EN =high, and after WLAN_EN/BT_EN = Low.



| Symbol | Parameter | Min | Max | Units |
|-----------------|---|-----|-----|-------|
| t _{c1} | 90% of 3.3V to 0.7 V of both WLAN_EN and BT_EN | 0 | - | μs |
| t _{c2} | WLAN_EN valid to SUSCLK input | 0 | - | |
| t _{c3} | WLAN_EN de-assert ("low") to SUSCLK de-assert (tristate or low) | 0 | - | |
| t _{c4} | Both WLAN_EN = low and BT_EN = low to 90% of 3.3V | 10 | - | |

Figure 4-3. Power Sequence (All power rails supplied 3.3V)

4.4. Digital Logic Characteristics

General DC electrical characteristics (for VDD=3.3V, I/O operation). Tc = 25°C

Table 4-3. Digital Logic Characteristics

| Symbol | Parameter | Comments | Min | Typ. | Max | Units | |
|--------|---------------------------|-----------------------------|-----------|------|-----------|-------|----|
| VIH | High-level input voltage | | 0.7 x VIO | - | VIO + 0.3 | V | |
| VIL | Low-level input voltage | | -0.3 | | 0.3 x VIO | V | |
| IIL | Input low leakage current | VIN = 0 V, Supply = VIO max | -5.0 | - | 5.0 | μA | |
| RPULL | Input pull resistor | Up or down | 1.8V VIO | - | 120 | - | kΩ |
| | | | 3.3V VIO | - | 70 | - | |
| VOH | High-level output voltage | | 0.9 x VIO | - | VIO | V | |
| VOL | Low-level output voltage | | 0 | - | 0.1 x VIO | V | |
| IOH | High-level output current | | 3 | - | - | mA | |
| IOL | Low-level output current | | - | - | -11 | mA | |
| CIN | Input capacitance | | - | - | 3 | pF | |

4.5. External 32.768KHz clock

The 32.768kHz clock is used in low-power modes such as IEEE power-save and sleep. It serves as a timer to determine when to wake up to receive beacons in various power-save schemes and to maintain basic logic operations when in sleep.

The WG3221 module does not require an external 32 kHz clock. By default, the module utilizes its internal 200 kHz clock shared with the WLAN and BT subsystem.

If the end application has a more accurate 32 kHz clock, then it can be supplied externally via the SUSCLK pin. The SUSCLK pin must be grounded when using the default internal clock mode. If an external 32 kHz clock is used, the requirements are:

| Symbol | Parameter | Min | Typ. | Max | Units |
|--------|--------------------------------|---------|--------|---------|-------|
| CK1 | Clock rate | - | 32.768 | - | KHz |
| CK2 | Fail time | 1 | - | 100 | Ns |
| CK3 | Rise time | 1 | - | 100 | Ns |
| CK4 | Duty cycle (high to low ratio) | 15 | - | 85 | % |
| CK5 | Frequency stability | -200 | - | 200 | Ppm |
| CK6 | Input high voltage | 0.8xVIO | - | VIO+0.2 | V |
| CK7 | Input low voltage | -0.3 | - | | V |

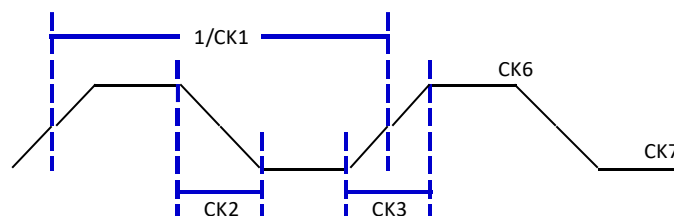


Figure 4-4. External 32.768KHz clock information

4.6. WLAN RF Characteristics

Transmit power at 2.4 GHz:

Transmit power with IEEE 802.11 EVM and spectral mask compliance.

| Standard | Modulation | Data rates | MIN | Typ. | MAX | Units |
|----------------|------------|------------|-----|------|-----|-------|
| 802.11b (1) | BPSK | 1 Mbps | 15 | 18 | - | dBm |
| | QPSK | 2 Mbps | 15 | 18 | - | |
| | CCK | 5.5 Mbps | 15 | 18 | - | |
| | CCK | 11 Mbps | 15 | 18 | - | |
| 802.11g (1) | BPSK | 6 Mbps | 14 | 17 | - | |
| | BPSK | 9 Mbps | 14 | 17 | - | |
| | QPSK | 12 Mbps | 14 | 17 | - | |
| | QPSK | 18 Mbps | 14 | 17 | - | |
| | 16 QAM | 24 Mbps | 13 | 16 | - | |
| | 16 QAM | 36 Mbps | 13 | 16 | - | |
| | 64 QAM | 48 Mbps | 12 | 15 | - | |
| | 64 QAM | 54 Mbps | 12 | 15 | - | |

| Standard | Modulation | Data rates | 20 MHz | | | 40MHz | | | Units |
|----------------|------------|------------|--------|------|-----|-------|------|-----|-------|
| | | | MIN | Typ. | MAX | MIN | Typ. | MAX | |
| 802.11n (1) | BPSK | MCS0 | 13.5 | 16.5 | - | 12.5 | 15.5 | - | dBm |
| | QPSK | MCS1 | 13.5 | 16.5 | - | 12.5 | 15.5 | - | |
| | QPSK | MCS2 | 13.5 | 16.5 | - | 12.5 | 15.5 | - | |
| | 16 QAM | MCS3 | 13 | 16 | - | 12.5 | 15.5 | - | |
| | 16 QAM | MCS4 | 13 | 16 | - | 12.5 | 15.5 | - | |
| | 64 QAM | MCS5 | 12 | 15 | - | 11.5 | 14.5 | - | |
| | 64 QAM | MCS6 | 12 | 15 | - | 11.5 | 14.5 | - | |
| | 64 QAM | MCS7 | 11 | 14 | - | 10.5 | 13.5 | - | |

(1) Regulatory constraints limit the module output power to the following:

- Channel 1, 11 @ 11B and 11G data rates is **15dBm** typical to comply with the FCC/IC/NCC.
- Channel 3, 9 @ MCS0 to MCS4 of 11N 40MHz is **14.5dBm** typical to comply with the FCC/IC/NCC.
- Channel 1, 13, 14 @ 11B and 11G data rates is **15dBm** typical to comply with the TELEC.

- Channel 3, 11 @ MCS0 to MCS4 of 11N 40MHz is 14.5dBm typical to comply with the TELEC.
- Channel 1-13 @ 1Mbps to 36Mbps data rates is 15dBm typical to comply with the ETSI EIRP.
- Channel 1-13 @ MCS0 to MCS4 of 11N 20MHz is 15dBm typical to comply with the ETSI EIRP.
- Channel 3-11 @ MCS0 to MCS4 of 11N 40MHz is 14.5dBm typical to comply with the ETSI EIRP.

Transmit power at 5 GHz:

Transmit power with IEEE 802.11 EVM and spectral mask compliance.

| Standard | Modulation | Data rates | MIN | Typ. | MAX | Units |
|----------------|------------|------------|------|------|-----|-------|
| 802.11a (1) | BPSK | 6 Mbps | 12 | 15 | - | dBm |
| | BPSK | 9 Mbps | 12 | 15 | - | |
| | QPSK | 12 Mbps | 12 | 15 | - | |
| | QPSK | 18 Mbps | 12 | 15 | - | |
| | 16 QAM | 24 Mbps | 11.5 | 14.5 | - | |
| | 16 QAM | 36 Mbps | 10 | 13 | - | |
| | 64 QAM | 48 Mbps | 9 | 12 | - | |
| 64 QAM | 54 Mbps | 7.5 | 10.5 | - | | |

| Standard | Modulation | Data rates | 20 MHz | | | 40MHz | | | Units |
|----------------|------------|------------|--------|------|-----|-------|------|-----|-------|
| | | | MIN | Typ. | MAX | MIN | Typ. | MAX | |
| 802.11n (1) | BPSK | MCS0 | 12 | 15 | - | 10.5 | 13.5 | - | dBm |
| | QPSK | MCS1 | 12 | 15 | - | 10.5 | 13.5 | - | |
| | QPSK | MCS2 | 12 | 15 | - | 10.5 | 13.5 | - | |
| | 16 QAM | MCS3 | 10.5 | 13.5 | - | 9.5 | 12.5 | - | |
| | 16 QAM | MCS4 | 10.5 | 13.5 | - | 9.5 | 12.5 | - | |
| | 64 QAM | MCS5 | 9.5 | 12.5 | - | 8.5 | 11.5 | - | |
| | 64 QAM | MCS6 | 8.5 | 11.5 | - | 7.5 | 10.5 | - | |
| 64 QAM | MCS7 | 7.5 | 10.5 | - | 6.5 | 9.5 | - | | |

| Standard | Modulation | Data Rates | 20 MHz | | | 40MHz | | | 80MHz | | | Units |
|-----------------|------------|------------|--------|------|-----|-------|------|-----|-------|------|-----|-------|
| | | | Min | Typ. | Max | Min | Typ. | Max | Min | Typ. | Max | |
| 802.11ac (1) | BPSK | MCS0 | 11.5 | 14.5 | - | 10 | 13 | - | 10 | 13 | - | dBm |
| | QPSK | MCS1 | 11.5 | 14.5 | - | 10 | 13 | - | 10 | 13 | - | |
| | QPSK | MCS2 | 11.5 | 14.5 | - | 10 | 13 | - | 10 | 13 | - | |
| | 16 QAM | MCS3 | 10 | 13 | - | 9 | 12 | - | 8.5 | 11.5 | - | |
| | 16 QAM | MCS4 | 10 | 13 | - | 9 | 12 | - | 8.5 | 11.5 | - | |
| | 64 QAM | MCS5 | 9 | 12 | - | 8 | 11 | - | 7.5 | 10.5 | - | |
| | 64 QAM | MCS6 | 8 | 11 | - | 7 | 10 | - | 6.5 | 9.5 | - | |
| | 64 QAM | MCS7 | 7 | 10 | - | 6 | 9 | - | 5.5 | 8.5 | - | |
| | 256 QAM | MCS8 | 6.5 | 9.5 | - | 6 | 9 | - | 5.5 | 8.5 | - | |
| | 256 QAM | MCS9 | - | - | - | 5 | 8 | - | 4 | 7 | - | |

(1) Regulatory constraints limit the module output power to the following:

- Channel 149-165 @ 11A and 11N data rate is 8.5dBm typical to comply with the ETSI EIRP.
- Channel 149-165 @ MCS0 to MCS8 of 11AC is 8.5dBm typical to comply with the ETSI EIRP.

Receive minimum input level sensitivity at 2.4 GHz:

| Standard | Modulation | Data rates | Typ. | Max | Units |
|----------|------------|------------|------|-----|-------|
| 802.11b | BPSK | 1 Mbps | -94 | -90 | dBm |
| | CCK | 11 Mbps | -87 | -83 | |
| 802.11g | BPSK | 6 Mbps | -89 | -85 | |
| | 64 QAM | 54 Mbps | -72 | -68 | |

| Standard | Modulation | Data rates | 20 MHz | | 40MHz | | Units |
|----------|------------|------------|--------|-----|-------|-----|-------|
| | | | Typ. | Max | Typ. | Max | |
| 802.11n | BPSK | MCS0 | -88.5 | -84 | -86.5 | -82 | dBm |
| | 64 QAM | MCS7 | -69 | -65 | -67.5 | -63 | |

Receive minimum input level sensitivity at 5 GHz:

| Standard | Modulation | Data rates | Typ. | Max | Units |
|----------|------------|------------|-------|-----|-------|
| 802.11a | BPSK | 6 Mbps | -88.5 | -84 | dBm |
| | 64 QAM | 54 Mbps | -72 | -68 | |

| Standard | Modulation | Data rates | 20 MHz | | 40MHz | | Units |
|----------|------------|------------|--------|-----|-------|-----|-------|
| | | | Typ. | Max | Typ. | Max | |
| 802.11n | BPSK | MCS0 | -88.5 | -84 | -85.5 | -81 | dBm |
| | 64 QAM | MCS7 | -69 | -65 | -67 | -63 | |

| Standard | Modulation | Data rates | 20 MHz | | 40MHz | | 80MHz | | Units |
|----------|------------|------------|--------|-----|-------|-----|-------|-----|-------|
| | | | Typ. | Max | Typ. | Max | Typ. | Max | |
| 802.11ac | BPSK | MCS0 | -88 | -84 | -85.5 | -81 | -83 | -79 | dBm |
| | 256 QAM | MCS8 | -65 | -61 | -62.5 | -58 | -60 | -56 | |
| | 256 QAM | MCS9 | - | - | -60.5 | -56 | -57.5 | -53 | |

4.7. BT RF Characteristics

Bluetooth and Low-Energy Transmit power:

| Parameter | Min | Typ. | Max | Units |
|--------------------------------|-----|------|-----|-------|
| BR output power ⁽¹⁾ | 8 | 10.5 | - | dBm |
| EDR output power | 5 | 7.5 | - | |
| BLE output power | 3.5 | 6 | - | |

- (1) Regulatory constraints limit the module output power to the following:
- The Bluetooth BR is 5dBm typical to comply with the ETSI 10-dBm EIRP.
 - The Bluetooth EDR is 5dBm typical to comply with the ETSI 10-dBm EIRP.

Bluetooth and Low-Energy Receive sensitivity:

| Parameter | Condition | Typ. | Max | Units |
|---------------------------------------|---------------------|------|-----|-------|
| BT BR, EDR sensitivity Dirty TX on | BR, BER = 0.1% | -92 | -72 | dBm |
| | EDR2, BER = 0.1% | -92 | -72 | |
| | EDR3, BER = 0.1% | -86 | -72 | |
| BLE sensitivity | 1M bps, PER = 30.8% | -95 | -72 | |

4.8. Typical Power Consumption

All measurements are performed with VDD、VIO_AO and VIO=3.3V. Temperature at 25°C.

Power consumption for continuous **Rx 2.4 GHz.**

| Data rates | Typ | Units |
|--------------|-----|-------|
| 11b, 1 Mbps | 57 | mA |
| 11b, 11 Mbps | 58 | |
| 11g, 6 Mbps | 58 | |
| 11g, 54 Mbps | 59 | |
| MCS0, HT20 | 58 | |
| MCS7, HT20 | 60 | |
| MCS0, HT40 | 63 | |
| MCS7, HT40 | 67 | |

Power consumption for continuous **Tx 2.4 GHz**

| Data rates | Typ | Units |
|------------------------|-----|-------|
| 11b, 1 Mbps at 18 dBm | 348 | mA |
| 11b, 11 Mbps at 18 dBm | 326 | |
| 11g, 6 Mbps at 17 dBm | 314 | |
| 11g, 54 Mbps at 15 dBm | 228 | |
| MCS0, HT20 at 16.5 dBm | 308 | |
| MCS7, HT20 at 14 dBm | 214 | |
| MCS0, HT40 at 15.5 dBm | 279 | |
| MCS7, HT40 at 13.5 dBm | 179 | |

Power consumption for continuous **Rx 5 GHz.**

| Data rates | Typ | Units |
|-------------|-----|-------|
| MCS0, HT20 | 80 | mA |
| MCS7, HT20 | 82 | |
| MCS0, VHT20 | 81 | |
| MCS8, VHT20 | 83 | |
| MCS0, VHT40 | 86 | |
| MCS9, VHT40 | 90 | |
| MCS0, VHT80 | 94 | |
| MCS9, VHT80 | 97 | |

 Power consumption for continuous **Tx 5 GHz**

| Data rates | Typ | Units |
|-------------------------|-----|-------|
| MCS0, HT20 at 15 dBm | 388 | mA |
| MCS7, HT20 at 10.5 dBm | 265 | |
| MCS0, VHT20 at 14.5 dBm | 393 | |
| MCS8, VHT20 at 9.5 dBm | 258 | |
| MCS0, VHT40 at 13 dBm | 366 | |
| MCS9, VHT40 at 8 dBm | 216 | |
| MCS0, VHT80 at 13 dBm | 332 | |
| MCS9, VHT80 at 7 dBm | 193 | |

 Power consumption for **Bluetooth.**

| Mode | Typ | Units |
|-------------------------------|-----|-------|
| Continuous Rx DH5 | 26 | mA |
| Continuous Tx DH5 at 10.5 dBm | 59 | |

5. DESIGN RECOMMENDATIONS

5.1. Reference Schematic

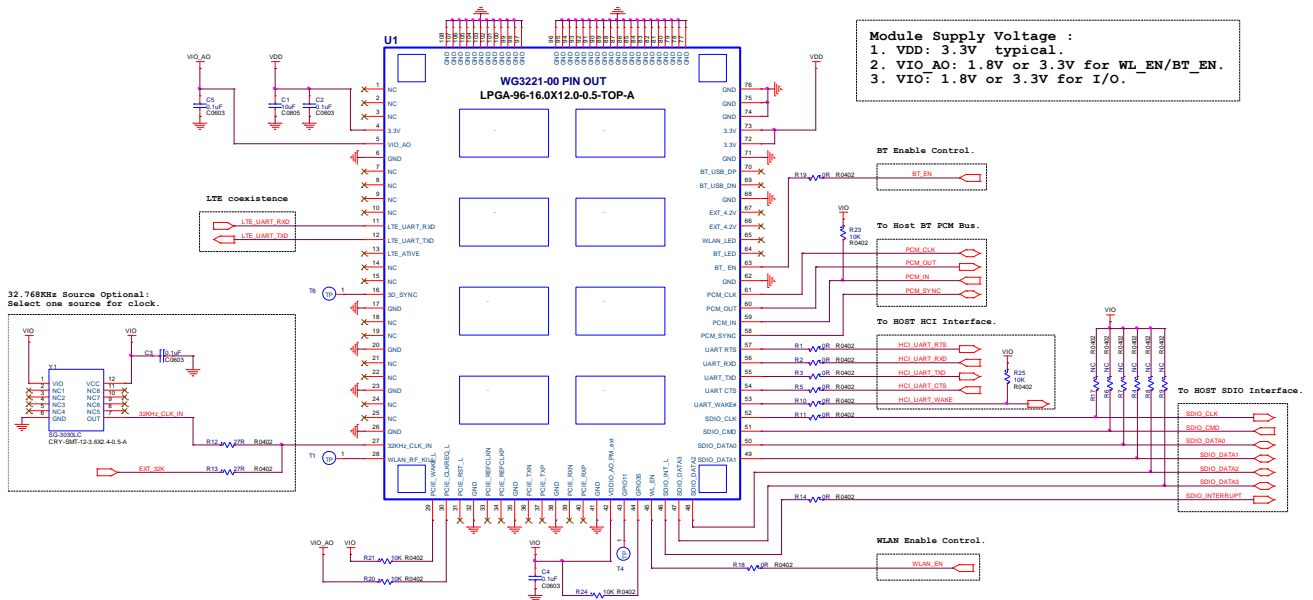
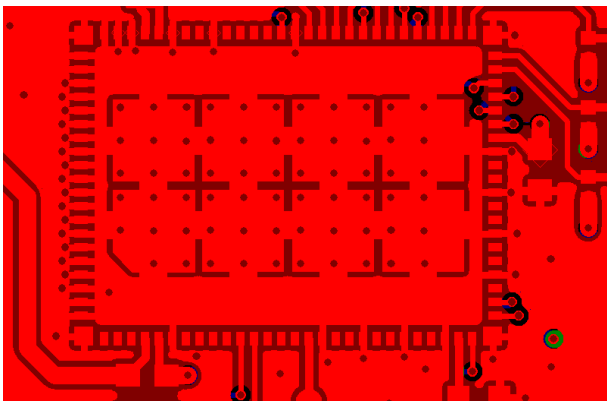


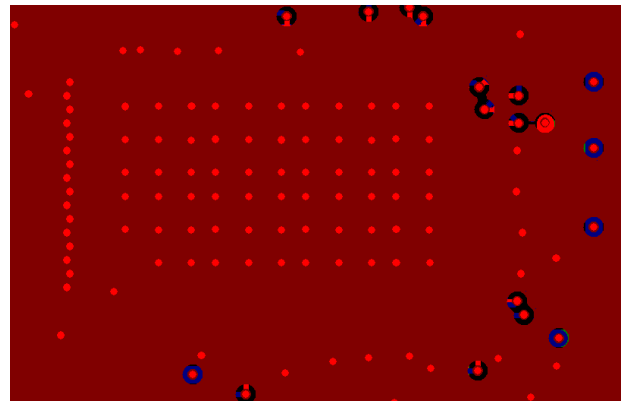
Figure 5-1. WG3221-00 module reference circuit

5.2. Layout Recommendation

1. The proximity of ground vias must be close to the pad.
2. The signal traces must not be run underneath the module on the layer where the module is mounted.
3. Have a complete ground pour in layer-2 for thermal dissipation.
4. The signal traces can be run on layer-3 under the ground layer.
5. The power trace for VDD must be at least 40-mil wide.
6. The SDIO signals traces must be routed in parallel to each other and as short as possible (**less than 20cm**).
7. The SDIO and digital clock signals (especially for the SDIO_CLK) are a source of noise. Keep the traces of these signals as short as possible and away from the other digital or analog signal traces.



Layer-1


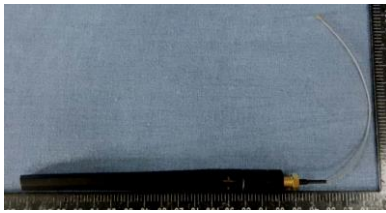
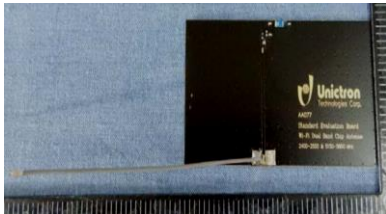


Layer-2

Figure 5-2. Recommend Layout of WG3221-00 module

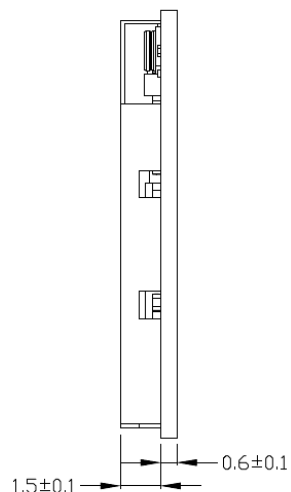
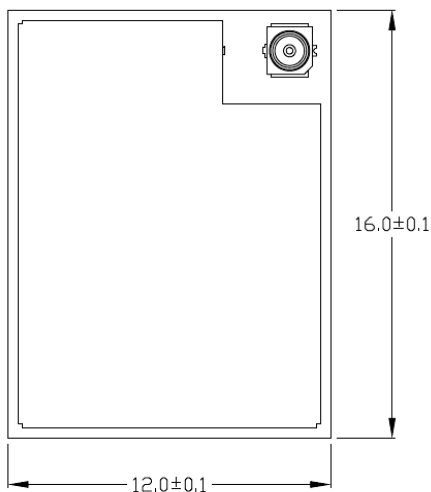
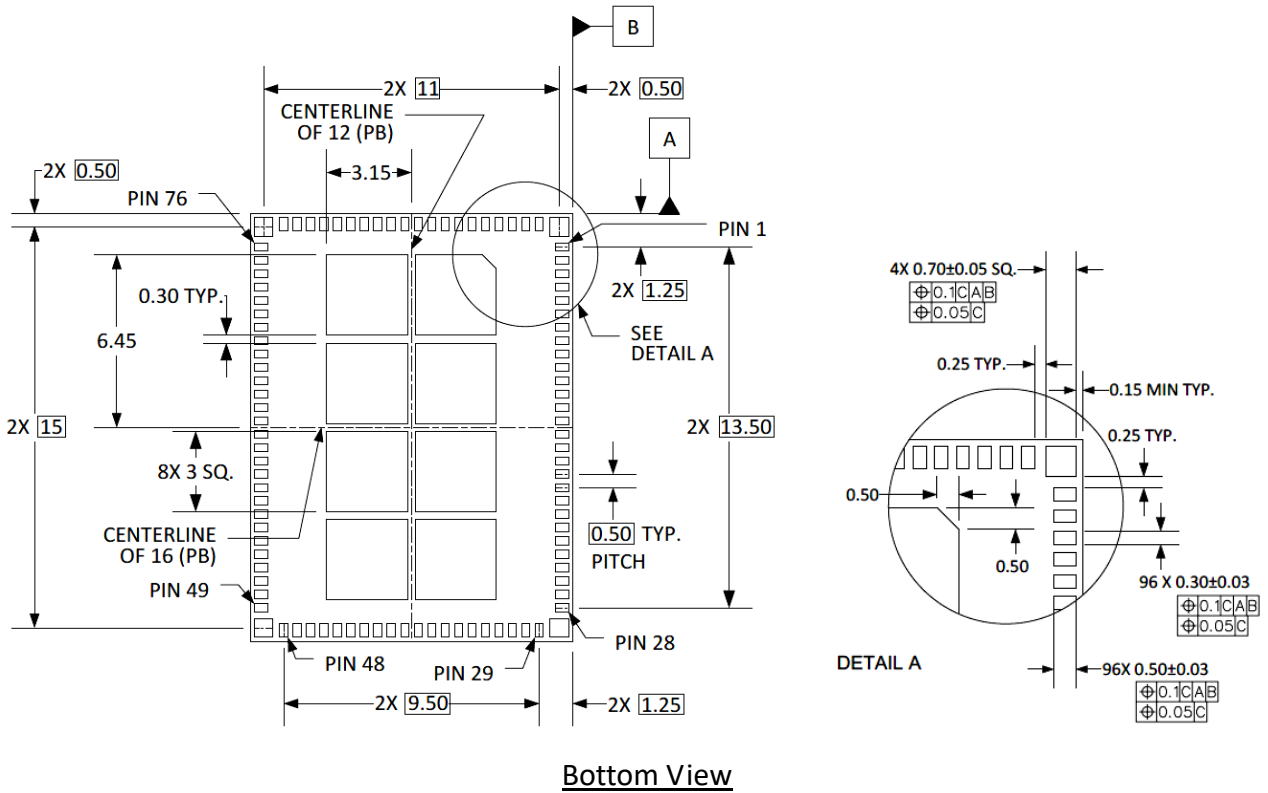
5.3. Antenna Recommendation

The recommend Antenna of the WG3221-00 module list as below:

| Trade Name | Model Number | Type | Drawing | Band | Peak Gain (dBi) |
|--|-----------------|--------|--|---------|-----------------|
| Unictron Technologies Corp. | AA222 | PCB |  | 2.4G | 3.73 |
| | | | | UNII-1 | 3.46 |
| | | | | UNII-2A | 3.3 |
| | | | | UNII-2C | 3.79 |
| | | | | UNII-3 | 3.91 |
| Joinsoon Electronics Manufacturing CO., LTD. | WiFi3dB Antenna | Dipole |  | 2.4G | 2.45 |
| | | | | UNII-1 | 2.71 |
| | | | | UNII-2A | 2.57 |
| | | | | UNII-2C | 2.02 |
| | | | | UNII-3 | 2.3 |
| Unictron Technologies Corp. | AA077 | Chip |  | 2.4G | 1.4 |
| | | | | UNII-1 | 2.3 |
| | | | | UNII-2A | 2.3 |
| | | | | UNII-2C | 2.3 |
| | | | | UNII-3 | 2.3 |

6. PACKAGE INFORMATION

6.1. Module Mechanical Outline



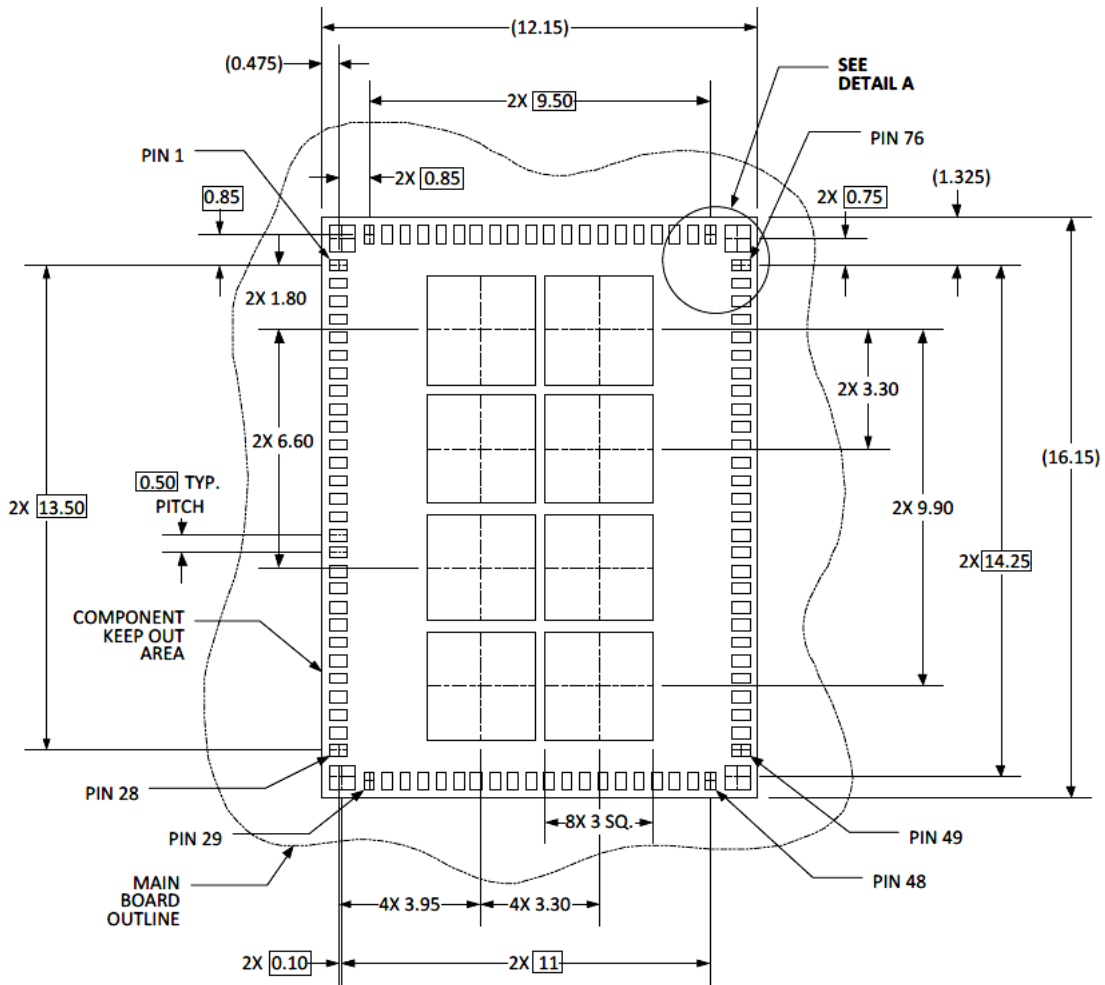
Units: mm

Top View

Side View

Figure 6-1 WG3221-00 Mechanical Outline Drawing

6.2. Recommended Land Pattern



Units: mm

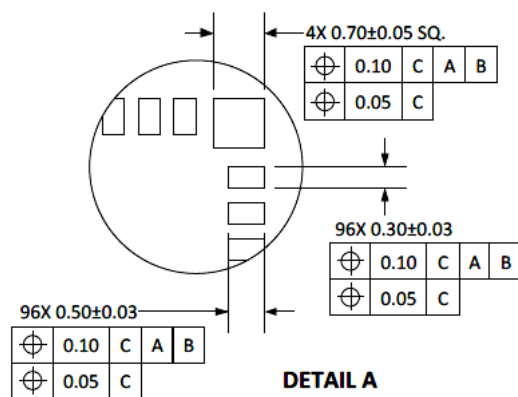
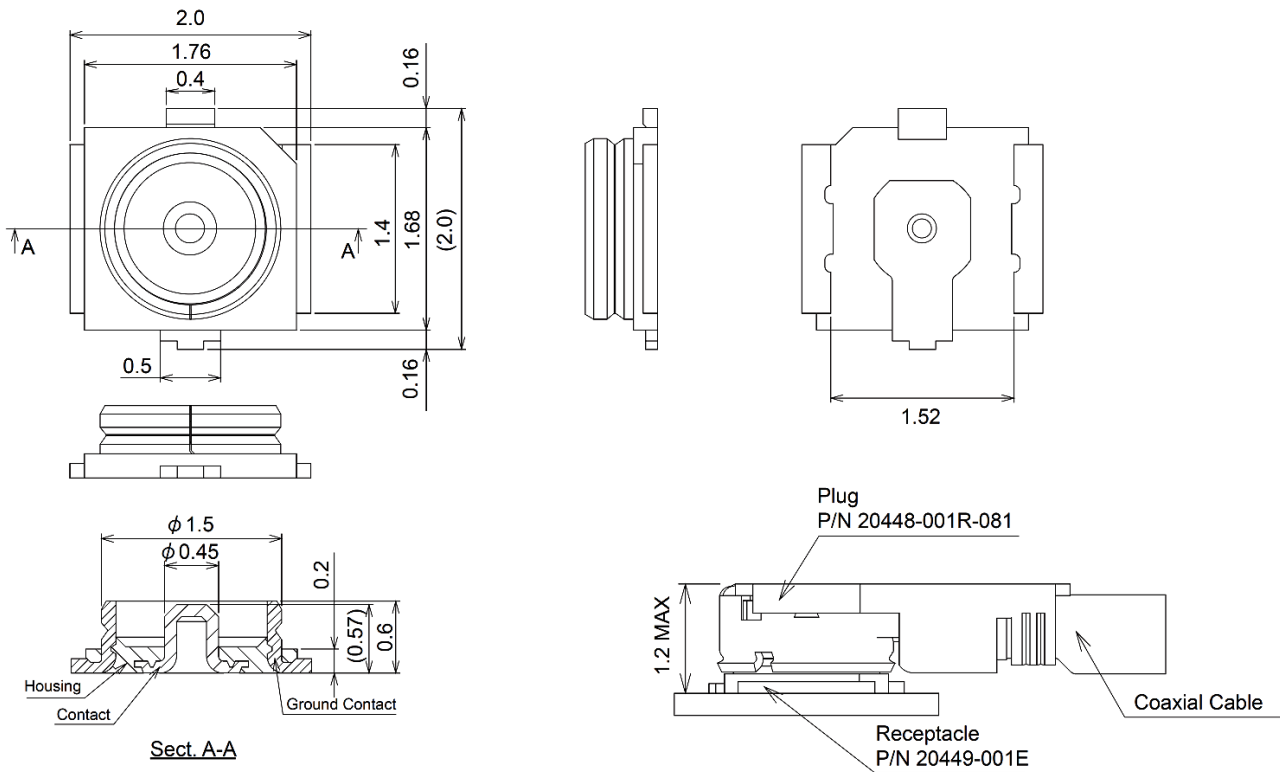


Figure 6-2 Recommended Land Pattern for Module Type 1216

6.3. RF Connector



※ P/N : 20449-001E (MHF4 series) from I-PEX

Figure 6-3 RF Connect drawing

6.4. Ordering Information

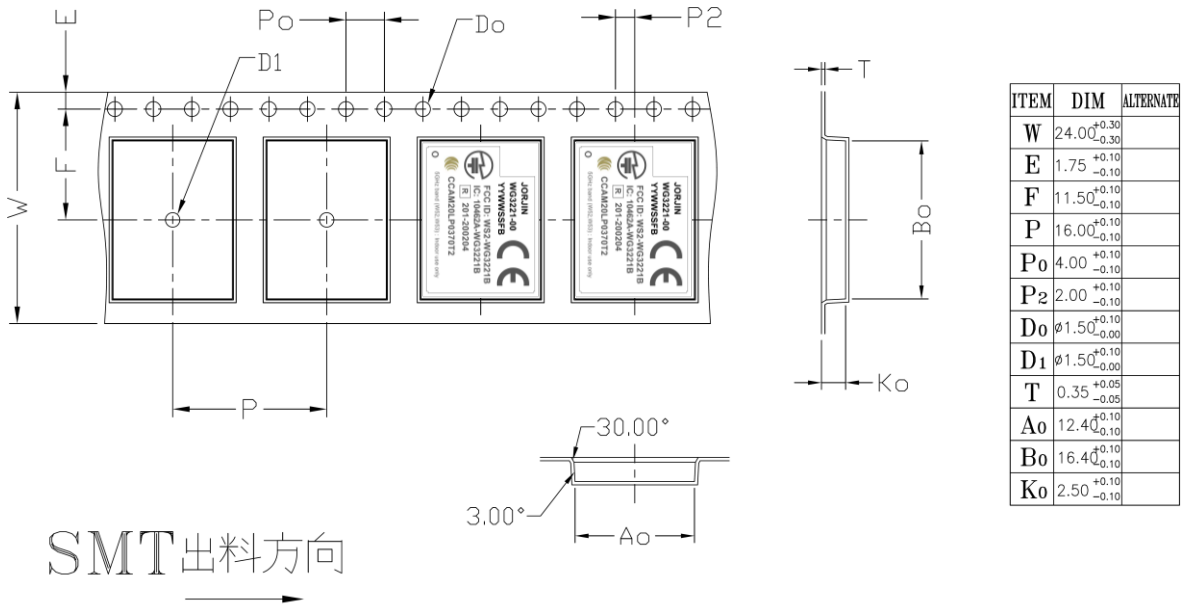
| Order Number | Package |
|--------------|---------------|
| WG3221-00 | M.2 type 1216 |

6.5. Package Marking



| Marking | Description |
|-----------------------|--|
| JORJIN | Brand name |
| WG3221-00 | Model name |
| YYWWSSFBX | YY = Digit of the year, ex: 2019=19 WW = Week (01~52) SS = Serial number from 01 ~99 match to manufacture's lot number F = Reverse for internal use. B = Module version. X = Chip version |
| WS2-WG3221B | FCC grant ID |
| 10462A-WG3221B | IC grant ID |
| 201-200204 | MIC grant ID |
| CCAM20LP0370T2 | NCC grant ID |

6.6. Tape Reel information



Reel : 1500 pcs per reel



Pizza Box : 1 reel per pizza box

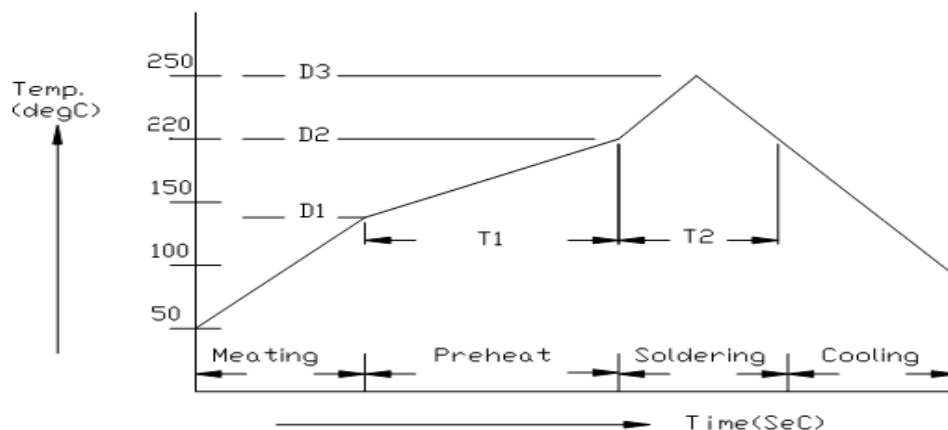
7. SMT AND BAKING RECOMMENDATION

7.1. Baking Recommendation

- Baking condition :
 - Follow MSL Level 4 to do baking process.
 - After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be
 - a. Mounted within 72 hours of factory conditions <30°C/60% RH, or
 - b. Stored at <10% RH.
 - Devices require bake, before mounting, if Humidity Indicator Card reads >10%
 - If baking is required, Devices may be baked for 8 hrs at 125 °C.

7.2. SMT Recommendation

- **Stencil thickness** : Recommended 0.1~ 0.13 mm
- **Soldering paste (without Pb)** :
Recommended SENJU N705-GRN3360-K2-V can get better soldering effects.
- **Recommended Reflow profile** :



| No. | Item | Temperature (°C) | Time (sec) |
|-----|------------|-------------------|---------------|
| 1 | Pre-heat | D1: 140 ~ D2: 200 | T1: 80 ~ 120 |
| 2 | Soldering | D2: = 220 | T2: 60 +/- 10 |
| 3 | Peak-Temp. | D3: 250 °C max | |

Note: (1) Reflow soldering is recommended two times maximum.

(2) Add Nitrogen while Reflow process : SMT solder ability will be better.

8. REGULATORY INFORMATION

This section outlines the regulatory information for the following countries:

- United States
- Canada
- Japan
- Europe
- Taiwan

8.1 United States

FCC WARNING 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 or more 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.

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the 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.

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

According to FCC 15.407(e), the device is intended to operate in the frequency band of 5.15GHz to 5.25GHz under all conditions of normal operation. Normal operation of this device is restricted to indoor used only to reduce any potential for harmful interference to co-channel MSS operations

Notice to OEM integrator

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user manual of the end product. The user manual which is provided by OEM integrators for end users must include the following information in a prominent location.

1. In the users manual of the end of 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.
2. The antenna(s) used for this transmitter must not be collocated or operating in conjunction with any other antenna or transmitter within a host device, except in accordance with FCC multi-transmitter product procedures.
3. Only those antennas with same type and lesser gain filed under this FCC ID number can be used with this device.

| Trade Name | Model Number | Antenna Type | Band | Peak Gain (dBi) |
|--|-----------------|--------------|---------|-----------------|
| Unictron Technologies Corp. | AA222 | PCB | 2.4G | 3.73 |
| | | | UNII-1 | 3.46 |
| | | | UNII-2A | 3.3 |
| | | | UNII-2C | 3.79 |
| | | | UNII-3 | 3.91 |
| Joinsoon Electronics Manufacturing CO., LTD. | WiFi3dB Antenna | Dipole | 2.4G | 2.45 |
| | | | UNII-1 | 2.71 |
| | | | UNII-2A | 2.57 |
| | | | UNII-2C | 2.02 |
| | | | UNII-3 | 2.3 |
| Unictron Technologies Corp. | AA077 | Chip | 2.4G | 1.4 |
| | | | UNII-1 | 2.3 |
| | | | UNII-2A | 2.3 |
| | | | UNII-2C | 2.3 |
| | | | UNII-3 | 2.3 |

4. The regulatory label on the final system must include the statement: “Contains **FCC ID: WS2-WG3221B**”.
5. The final system integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system.
6. If the end product integrating this module is going to be operated in 5.15~5.25GHz frequency range, the warning statement in the user manual of the end product should include the restriction of operating this device in indoor could void the user’s authority to operate the equipment.
7. The final system integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system.
8. The final host manual shall include the following regulatory statement: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of 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. If not installed and used in accordance with the instructions, it 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 tuning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:
 - Reorient or relocate the receiving antenna
 - Increase the distance between the equipment and the receiver.
 - Connect the equipment to outlet on a circuit different from that to which the receiver is connected.
 - Consult the dealer or an experienced radio/TV technician for help.

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.

8.2 Canada

Industry Canada statement:

This device complies with ISED's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter **10462A-WG3221B** has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

FOR MOBILE DEVICE USAGE (>20cm/low power)

Radiation Exposure Statement:

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

Déclaration d'exposition aux radiations:

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

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

- 1) The antenna must be installed and operated with greater than 20cm between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

| Trade Name | Model Number | Antenna Type | Band | Peak Gain (dBi) |
|--|-----------------|--------------|---------|-----------------|
| Unictron Technologies Corp. | AA222 | PCB | 2.4G | 3.73 |
| | | | UNII-1 | 3.46 |
| | | | UNII-2A | 3.3 |
| | | | UNII-2C | 3.79 |
| | | | UNII-3 | 3.91 |
| Joinsoon Electronics Manufacturing CO., LTD. | WiFi3dB Antenna | Dipole | 2.4G | 2.45 |
| | | | UNII-1 | 2.71 |
| | | | UNII-2A | 2.57 |
| | | | UNII-2C | 2.02 |
| | | | UNII-3 | 2.3 |
| Unictron Technologies Corp. | AA077 | Chip | 2.4G | 1.4 |
| | | | UNII-1 | 2.3 |
| | | | UNII-2A | 2.3 |
| | | | UNII-2C | 2.3 |
| | | | UNII-3 | 2.3 |

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

- 1) L'antenne doit être installé et exploité avec plus de 20 cm entre l'antenne et les utilisateurs, et
- 2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling FOR MOBILE DEVICE USAGE (>20cm/low power)

This transmitter module is authorized only for use in device where the antenna may be installed and operated with greater than 20cm between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: **10462A-WG3221B**".

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un appareil où l'antenne peut être installée et utilisée à plus de 20 cm entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: **10462A-WG3221B**".

End Product Labeling FOR PORTABLE DEVICE USAGE (<20m from body/SAR needed)

The product can be kept as far as possible from the user body or set the device to lower output power if such function is available. The final end product must be labeled in a visible area with the following: "Contains IC: **10462A-WG3221B**".

Plaque signalétique du produit final

L'appareil peut être conservé aussi loin que possible du corps de l'utilisateur ou que le dispositif est réglé sur la puissance de sortie la plus faible si une telle fonction est disponible. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: **10462A-WG3221B**".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

Caution :

- (i) 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;
- (ii) for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit; (detachable antenna only)
- (iii) for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate; (detachable antenna only)
- (iv) where applicable, antenna type(s), antenna models(s), and worst-case tilt angle(s) necessary to remain compliant with the e.i.r.p. elevation mask requirement set forth in section 6.2.2.3 shall be clearly indicated.

Avertissement:

Le guide d'utilisation des dispositifs pour réseaux locaux doit inclure des instructions précises sur les restrictions susmentionnées, notamment :

- (i) 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;
- (ii) pour les dispositifs munis d'antennes amovibles, le gain maximal d'antenne permis pour les dispositifs utilisant les bandes de 5250 à 5350 MHz et de 5475 à 5725 MHz doit être conforme à la limite de la p.i.r.e; (detachable antenna only)
- (iii) pour les dispositifs munis d'antennes amovibles, le gain maximal d'antenne permis (pour les dispositifs utilisant la bande de 5725 à 5850 MHz) doit être conforme à la limite de la p.i.r.e. spécifiée, selon le cas; (detachable antenna only)
- (iv) lorsqu'il y a lieu, les types d'antennes (s'il y en a plusieurs), les numéros de modèle de l'antenne et les pires angles d'inclinaison nécessaires pour rester conforme à l'exigence de la p.i.r.e. applicable au masque d'élévation, énoncée à la section 6.2.2.3, doivent être clairement indiqués

8.3 Japan

The WG3221-00 is certified as a module with type certification number 201-200204. End products that integrate this module do not need additional MIC Japan certification for the end product.

- 5GHz band (W52, W53) : Indoor use only.
- End product can display the certification label of the embedded module.



8.4 Europe

Jorjin Technologies Inc. declares that the radio equipment type RF module is in compliance with Directive 2014/53/EU.

The compliance has been verified in the operating frequency band of 2400 MHz to 2480 MHz 、 5180 MHz to 5320 MHz 、 5500 MHz to 5700MHz 、 5745 MHz to 5825 MHz. Developers and integrators that incorporate the WG3221-00 Module in any end products are responsible for obtaining applicable regulatory approvals for such end product.

The WG3221-00 has been tested the frequency at 3.3 V across the temperature range -40°C to +85°C and tolerance as below :

1. 2400 MHz to 2480MHz band with maximum peak power of 19.99 dBm EIRP.
2. 5180 MHz to 5320 MHz band with maximum peak power of 22.58 dBm EIRP.
3. 5500 MHz to 5700 MHz band with maximum peak power of 21.71 dBm EIRP.
4. 5745 MHz to 5825 MHz band with maximum peak power of 13.42 dBm EIRP.

Labeling and User Information Requirements

As a result of the conformity assessment procedure described in Annex III of the Directive 2014/53/EU, the end-customer equipment should be labeled as follows:



8.5 NCC 警語

根據 NCC 低功率電波輻射性電機管理辦法規定：

- 第十二條

經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

- 第十四條

低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前項合法通信，指依電信法規定作業之無線電通信。

低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

9. HISTORY CHANGE

| Revision | Date | Description |
|----------|------------|----------------------------|
| R01 | 2020.05.14 | Official version released. |
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