



ShangHai Ehong Technology Co.,Ltd.

# **QCA4020 Module (WL501)**

## **Product Specification**

WL501

October 31, 2018

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## Revision history

| Revision | Date         | Description     |
|----------|--------------|-----------------|
| A        | October 2018 | Initial release |

# Contents

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|                                                  |           |
|--------------------------------------------------|-----------|
| <b>1 Introduction.....</b>                       | <b>5</b>  |
| <b>2 Hardware specification.....</b>             | <b>7</b>  |
| 2.1 WL501 module pinout.....                     | 7         |
| 2.2 WL501 interface summary.....                 | 12        |
| 2.3 Bootstrap signals.....                       | 13        |
| 2.4 Electrical characteristics.....              | 13        |
| 2.4.1 General DC electrical characteristics..... | 13        |
| 2.4.2 WL501 2.4 GHz power measurements.....      | 14        |
| 2.4.3 WL501 5 GHz power measurements.....        | 14        |
| 2.4.4 BLE power measurements.....                | 15        |
| 2.4.5 802.15.4 power measurements.....           | 15        |
| <b>3 Mechanical interface specification.....</b> | <b>16</b> |
| 3.1 WL501 module dimensions.....                 | 16        |

## Figures

|                                                                 |    |
|-----------------------------------------------------------------|----|
| Figure 1-1 WL501 block diagram.....                             | 5  |
| Figure 2-1 WL501 front view.....                                | 7  |
| Figure 2-2 WL501 back view.....                                 | 8  |
| Figure 2-3 WL501 pinout definition.....                         | 9  |
| Figure 3-1 WL501 module dimensions.....                         | 16 |
| Figure 3-2 WL501 module pinout dimensions (in mm).....          | 17 |
| Figure 3-3 WL501 module pinout dimensions-Detail B (in mm)..... | 18 |

## Tables

|                                                                                                     |    |
|-----------------------------------------------------------------------------------------------------|----|
| Table 2-1 WL501 module non-GPIO pinout definition.....                                              | 9  |
| Table 2-2 WL501 module pinout definition and QCA4024 GPIO assignment.....                           | 10 |
| Table 2-3 Bootstrap mode.....                                                                       | 13 |
| Table 2-4 JTAG mode.....                                                                            | 13 |
| Table 2-5 XTAL mode.....                                                                            | 13 |
| Table 2-6 32.768KHz Sleep Clock Mode.....                                                           | 13 |
| Table 2-7 DC electrical characteristics for digital I/Os.....                                       | 14 |
| Table 2-8 2.4 GHz power measurements at antenna port at 25 °C, 3.3V nominal.....                    | 14 |
| Table 2-9 5 GHz power measurements at antenna port at 25 °C, 3.3V nominal.....                      | 14 |
| Table 2-10 BLE power measurements at antenna port at 25 °C, 3.3V nominal with external PA.....      | 15 |
| Table 2-11 802.15.4 power measurements at antenna port at 25 °C, 3.3V nominal with external PA..... | 15 |

# 1 Introduction

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The WL501 module provides a highly-integrated and flexible platform for developing and evaluating products and applications based on the QCA4020 SoC. The WL501 module can be either used with CDB20 development kit for software development or incorporated into OEM products to enable rapid deployment of Wi-Fi connected systems.

The WL501 module includes the following components:

- QCA4020 chip (WLAN/BLE/15.4)
- A printed antenna
- 32 Mb NOR flash memory

The QCA4020 is a dual band 1x1 802.11 a/b/g/n device optimized for low-power embedded applications with single-stream capability for both Tx and Rx. It has an integrated network processor with a large set of TCP/IP with IPv4/IPv6-based services.

## **WL501 module features**

- Dual-Band IEEE 802.11 a/b/g/n, single stream 1x1
- BLE 5.0
- ZigBee 802.15.4
- Green Tx power saving mode
- Low -power listen mode
- Four-layer PCB design
- Rich set of GPIO(s) and interfaces: I2C, HSUART, UART, SPI, QSPI, SDIO 2.0, I2S, JTAG, Sensor ADC (up to 8 channels, 12bit, 1Msps). Up to 8 PWM optimized for LED lighting applications.
- Secure boot and support for application-level AES encryption and image authentication hash function (SHA256)
- Advancement power management scheme to minimize power dissipation for each use case

## **WL501 manufacturing interface**

- USB 2.0 interface with integrated controller and PHY for manufacturing test and configuration

## **WL501 host interfaces**

- UART host interface to a remote microcontroller with an AT style command set

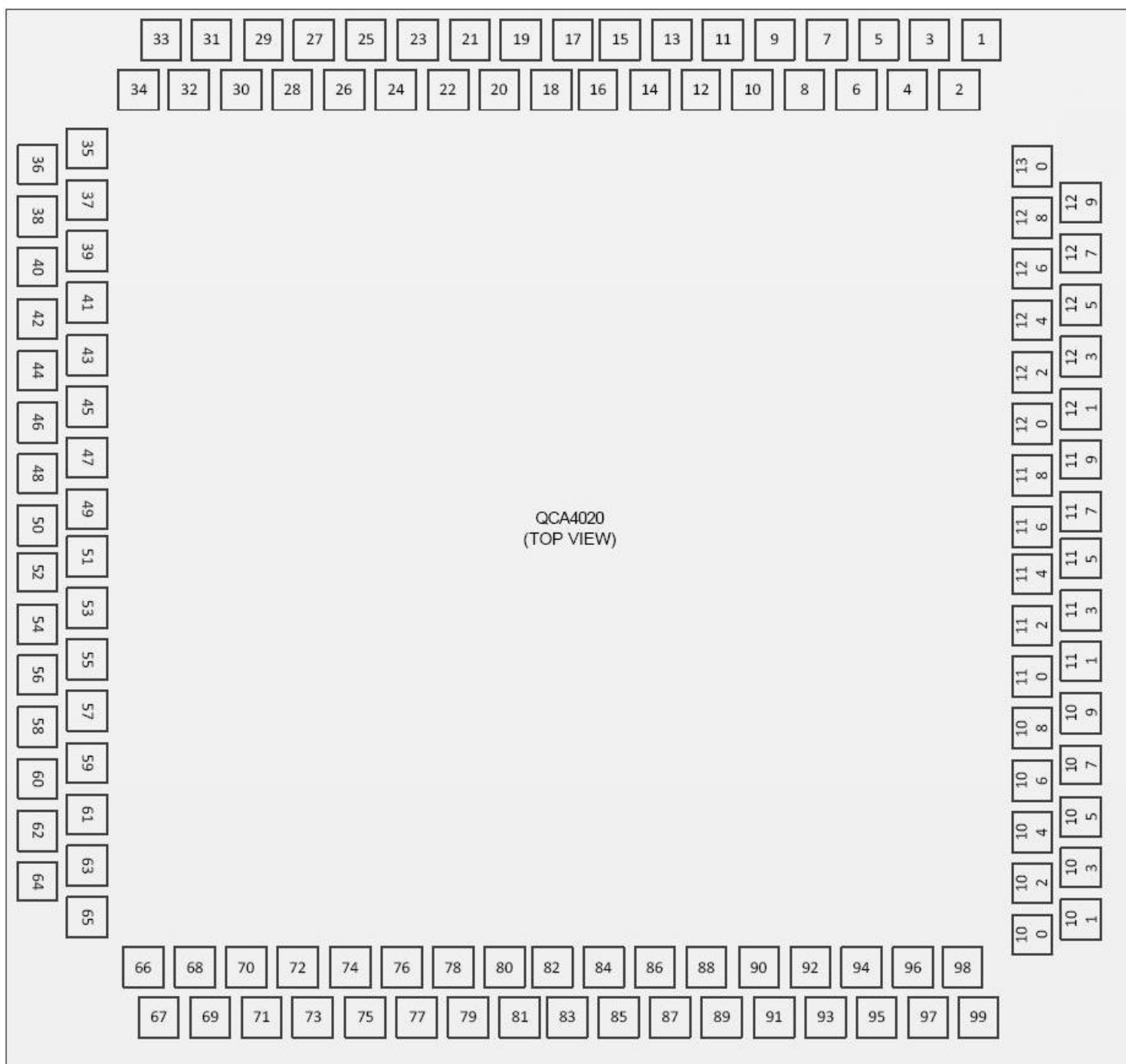
## 2 Hardware specification

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### 2.1 WL501 module pinout



Figure 2-1 WL501 front view



### Figure 2-3 WL501 pinout definition



Table 2-1 WL501 module non-GPIO pinout definition

| Pin #                | Pin Name    | Description               |
|----------------------|-------------|---------------------------|
| <b>Power</b>         |             |                           |
| 2-4                  | VBATT_BE    | 3.3V Input Power          |
| <b>Input Signals</b> |             |                           |
| 22                   | USB20_DM_BE | USB Differential Negative |
| 23                   | USB20_DP_BE | USB Differential Positive |

| Pin #                                                                                   | Pin Name           | Description                                             |
|-----------------------------------------------------------------------------------------|--------------------|---------------------------------------------------------|
| 27                                                                                      | SENSEADC_0_BE      | 12bit ADC, ADC 0 input                                  |
| 24                                                                                      | SENSEADC_1_BE      | 12bit ADC, ADC 1 input                                  |
| 37                                                                                      | CHIP_PWD_L_BE      | BLE/802.15.4 Reset Pin                                  |
| <b>Ground</b>                                                                           |                    |                                                         |
| 1, 5, 33, 38, 42, 45, 67-69, 71, 76, 85, 98-101, 104, 109, 111, 115, 119, 124, 127, 130 | GND                | Ground                                                  |
| <b>No Connect</b>                                                                       |                    |                                                         |
| 43,44                                                                                   | VDDIO18_BE         | Not used, NC                                            |
| 39-41                                                                                   | VDD11_SWREG_OUT    | Not used, NC                                            |
| 128, 129                                                                                | VDDIO18_WL         | Not used, NC                                            |
| 117                                                                                     | PWRDWN_OUT_N       | Not used, NC                                            |
| 17                                                                                      | BYPASS_INT_PMU_MSK | Not used, NC                                            |
| 126                                                                                     | IOT_MODE_EN_WL     | Not used, NC                                            |
| 7                                                                                       | WAKEUP_N           | Not used, NC                                            |
| 13                                                                                      | USB_DPOS           | USB Differential Positive, WLAN interface, Not used, NC |
| 14                                                                                      | USB_DNEG           | USB Differential Negative, WLAN interface, Not used, NC |

Table 2-2 WL501 module pinout definition and QCA4024 GPIO assignment

| Pin # | Pin Name  | Primary Function | SPI or I2C or QSPI | SDIO | SD Memory Card | UART           | JTAG         | PWMADC or SenseADC | PTA         | Codec |
|-------|-----------|------------------|--------------------|------|----------------|----------------|--------------|--------------------|-------------|-------|
| 84    | GPIO4_BE  | WL_WKUP_BE       |                    |      |                |                |              |                    |             |       |
| 83    | GPIO5_BE  | GPIO_5           |                    |      |                |                |              |                    | BT_ACTIVE   |       |
| 81    | GPIO6_BE  | GPIO_6           |                    |      |                |                |              |                    | WLAN_ACTIVE |       |
| 79    | GPIO7_BE  | GPIO_7           |                    |      |                |                |              |                    | BT_PRIORITY |       |
| 61    | GPIO8_BE  | GPIO_8           |                    |      |                | M0&M4_UART0_RX | JTAG1_BE_TCK |                    |             |       |
| 58    | GPIO9_BE  | GPIO_9           |                    |      |                | M0&M4_UART0_TX | JTAG1_BE_TDO |                    |             |       |
| 59    | GPIO10_BE | GPIO_10          | I2C0_Master_SCL    |      |                |                | JTAG1_BE_TMS |                    |             |       |
| 56    | GPIO11_BE | GPIO_11          | I2C0_Master_SDA    |      |                |                | JTAG1_BE_TDI |                    |             |       |
| 32    | GPIO12_BE | GPIO_12          |                    |      |                |                |              | pwm_out_0          |             |       |

| Pin # | Pin Name  | Primary Function | SPI or I2C or QSPI | SDIO              | SD Memory Card       | UART            | JTAG         | PWMADC or SenseADC | PTA         | Codec     |
|-------|-----------|------------------|--------------------|-------------------|----------------------|-----------------|--------------|--------------------|-------------|-----------|
| 54    | GPIO13_BE | GPIO_13          |                    |                   |                      |                 |              | pwm_out_7          |             |           |
| 52    | GPIO14_BE | GPIO_14          |                    |                   |                      | HS_UART0_DM_CTS |              |                    |             |           |
| 55    | GPIO15_BE | GPIO_15          |                    |                   |                      | HS_UART0_DM_TXD |              |                    |             |           |
| 53    | GPIO16_BE | SPI0_CS2_N       | I2C1_Master_SCL    |                   |                      | HS_UART0_DM_RFR |              |                    | BT_ACTIVE   |           |
| 51    | GPIO17_BE | SPI0_CS1_N       | I2C1_Master_SDA    |                   |                      | HS_UART0_DM_RXD |              |                    | WLAN_ACTIVE |           |
| 16    | GPIO18_BE | GPIO_18          | SPI_Slave_CLK      | SDIO_Slave_CLK    | SD_Master_CLK (O)    | HS_UART1_DM_CTS |              | pwm_out_6          |             |           |
| 11    | GPIO19_BE | GPIO_19          | SPI_Slave_CS_N     | SDIO_Slave_CMD    | SD_Master_CMD (B)    | HS_UART1_DM_TXD |              | pwm_out_1          |             |           |
| 15    | GPIO20_BE | GPIO_20          | SPI_SLAVE_MISO     | SDIO_Slave_DATA_0 | SD_Master_DATA_0 (B) | HS_UART1_DM_RXD |              | pwm_out_2          |             |           |
| 19    | GPIO21_BE | GPIO_21          |                    | SDIO_Slave_DATA_1 | SD_Master_DATA_1 (B) |                 |              | pwm_out_4          |             |           |
| 26    | GPIO22_BE | GPIO_22          |                    | SDIO_Slave_DATA_2 | SD_Master_DATA_2 (B) |                 |              | pwm_out_3          |             |           |
| 21    | GPIO23_BE | GPIO_23          | SPI_SLAVE_MOSI     | SDIO_Slave_DATA_3 | SD_Master_DATA_3 (B) | HS_UART1_DM_RFR |              | pwm_out_5          |             |           |
| 29    | GPIO24_BE | GPIO_24          | SPI0_Master_CS_N   |                   |                      | M0&M4_UART2_RX  | JTAG2_BE_TCK |                    |             |           |
| 31    | GPIO25_BE | GPIO_25          | SPI0_Master_CLK    |                   |                      | M0&M4_UART2_TX  | JTAG2_BE_TDO |                    |             |           |
| 28    | GPIO26_BE | GPIO_26          | SPI0_Master_MISO   |                   |                      |                 | JTAG2_BE_TMS |                    |             |           |
| 30    | GPIO27_BE | GPIO_27          | SPI0_Master_MISO   |                   |                      |                 | JTAG2_BE_TDI |                    |             |           |
| 46    | GPIO28_BE | GPIO_28          |                    |                   |                      |                 |              |                    |             | I2S_BCLK  |
| 47    | GPIO29_BE | GPIO_29          |                    |                   |                      |                 |              |                    |             | I2S_RXD   |
| 48    | GPIO30_BE | GPIO_30          |                    |                   |                      |                 |              |                    |             | I2S_TXD   |
| 50    | GPIO31_BE | GPIO_31          |                    |                   |                      |                 |              |                    |             | I2S_FSYNC |

| Pin # | Pin Name   | Primary Function | SPI or I2C or QSPI | SDIO | SD Memory Card | UART                | JTAG         | PWMADC or SenseADC | PTA         | Codec    |
|-------|------------|------------------|--------------------|------|----------------|---------------------|--------------|--------------------|-------------|----------|
| 49    | GPIO3_2_BE | GPIO_32          |                    |      |                |                     |              |                    |             | I2S_MCLK |
| 10    | GPIO3_3_BE | CHIP_PWD_L_WL    |                    |      |                |                     |              |                    |             |          |
| 80    | GPIO4_1_BE | PWR_STAUS        |                    |      |                |                     |              |                    |             |          |
| 57    | GPIO4_8_BE | Ext_32K_IN       |                    |      |                |                     |              |                    |             |          |
| 64    | GPIO4_9_BE | GPIO_49          |                    |      |                |                     |              |                    |             |          |
| 78    | GPIO5_0_BE | GPIO_50          |                    |      |                |                     | JTAG3_BE_TCK |                    |             |          |
| 63    | GPIO5_1_BE | GPIO_51          |                    |      |                |                     | JTAG3_BE_TDO |                    |             |          |
| 62    | GPIO5_2_BE | GPIO_52          |                    |      |                |                     | JTAG3_BE_TMS |                    |             |          |
| 60    | GPIO5_3_BE | GPIO_53          |                    |      |                |                     | JTAG3_BE_TDI |                    |             |          |
| 25    | GPIO5_4_BE | GPIO_54          |                    |      |                |                     |              | SENSEADC2          |             |          |
| 20    | GPIO5_5_BE | GPIO_55          |                    |      |                |                     |              | SENSEADC3          |             |          |
| 18    | GPIO5_6_BE | GPIO_56          |                    |      |                |                     |              | SENSEADC4          |             |          |
| 12    | GPIO5_7_BE | GPIO_57          |                    |      |                |                     |              | SENSEADC5          |             |          |
| 9     | GPIO5_8_BE | GPIO_58          |                    |      |                |                     |              | SENSEADC6          |             |          |
| 8     | GPIO5_9_BE | GPIO_59          |                    |      |                | HS_UART2_DM_CTS (I) |              | SENSEADC7          |             |          |
| 82    | GPIO6_0_BE | GPIO_60          |                    |      |                | HS_UART2_DM_TXD (O) |              |                    | BT_PRIORITY |          |

## 2.2 WL501 interface summary

- 2x I2C Master Interface
- 1x High speed UART
- Up to 3Mbps data rate
- 1x UART
- Up to 115200 kbps data rate

- 1x I2S
- 1x JTAG
- 1x ADC Sense
- 1x USB2.0 interface
- 1x SPI Interface

## 2.3 Bootstrap signals

Table 2-3 Bootstrap mode

| GPIO9_BE | GPIO22_BE | Description                                        |
|----------|-----------|----------------------------------------------------|
| 0        | 0         | Force M4 to load image from flash memory (Default) |
| 0        | 1         | Force M4 to boot in EDL (Emergency Download Mode). |

Table 2-4 JTAG mode

| GPIO9_BE | GPIO25_BE | GPIO18_BE | Description                 |
|----------|-----------|-----------|-----------------------------|
| 0        | 0         | 0         | No JTAG enabled             |
| 0        | 0         | 1         | JTAG Pins on GPIO[53:50]_BE |
| 0        | 1         | 0         | JTAG Pins on GPIO[11:8]_BE  |
| 0        | 1         | 1         | JTAG Pins on GPIO[27:24]_BE |
| 1        | X         | X         | Not Allowed                 |

Table 2-5 XTAL mode

| GPIO23_BE | Description |
|-----------|-------------|
| 0         | 40MHz Xtal  |
| 1         | Not Allowed |

Table 2-6 32.768KHz Sleep Clock Mode

| GPIO21_BE | GPIO20_BE | Description                                           |
|-----------|-----------|-------------------------------------------------------|
| 0         | 0         | Chip Internal LPO                                     |
| 0         | 1         | External Crystal 32.768KHz                            |
| 1         | 0         | External 32.768KHz TCXO Clock connected to GPIO_48_BE |
| 1         | 1         | Not Allowed                                           |

## 2.4 Electrical characteristics

### 2.4.1 General DC electrical characteristics

These conditions apply to all DC characteristics unless otherwise specified:  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,

$V_{BATT\_BE} = 3.3\text{ V}$

Table 2-7 DC electrical characteristics for digital I/Os

| Symbol          | Parameter            | Conditions | Min  | Typ | Max | Unit |
|-----------------|----------------------|------------|------|-----|-----|------|
| V <sub>IH</sub> | High level I voltage | –          | 2.4  | –   | 3.6 | V    |
| V <sub>IL</sub> | Low level I voltage  | –          | -0.3 | –   | 0.3 | V    |
| V <sub>OH</sub> | High level O voltage | –          | 3.0  | –   | 3.3 | V    |
| V <sub>OL</sub> | Low level O voltage  | –          | -0.3 | –   | 0.4 | V    |

## 2.4.2 WL501 2.4 GHz power measurements

Table 2-8 2.4 GHz power measurements at antenna port at 25 °C, 3.3V nominal

| Standard     | Typical Tx Compliant Power <sup>1</sup> | Rx Sensitivity | Unit |
|--------------|-----------------------------------------|----------------|------|
| 802.11b      | 22.86                                   | -87            | dBm  |
|              |                                         |                | dBm  |
|              |                                         |                | dBm  |
|              |                                         |                | dBm  |
| 802.11g      | 23.53                                   | -91.5          | dBm  |
|              |                                         |                | dBm  |
| 802.11n HT20 | 23.35                                   | -92            | dBm  |
|              |                                         |                | dBm  |
| 802.11n HT40 | 21.62                                   | -89.5          | dBm  |
|              |                                         |                | dBm  |

## 2.4.3 WL501 5 GHz power measurements

Table 2-9 5 GHz power measurements at antenna port at 25 °C, 3.3V nominal

| Standard     | Typical Tx Compliant Power <sup>2</sup> | Rx Sensitivity | Unit |
|--------------|-----------------------------------------|----------------|------|
| 802.11a      | B1:21.16<br>B4:18.57                    | -89.5          | dBm  |
|              |                                         |                | dBm  |
| 802.11n HT20 | B1:21.98<br>B4:18.46                    | -89.5          | dBm  |
|              |                                         |                | dBm  |
| 802.11n HT40 | B1:21.44<br>B4:18.73                    | -86.5          | dBm  |
|              |                                         |                | dBm  |

<sup>1</sup> Numbers shown based on OLPC per board calibration

<sup>2</sup> Numbers shown based on OLPC per board calibration

## 2.4.4 BLE power measurements

**Table 2-10 BLE power measurements at antenna port at 25 C, 3.3V nominal with external PA**

| Parameter      | Description | Typical | Unit |
|----------------|-------------|---------|------|
| Tx Power       | BT LE 1M    | 2.10    | dBm  |
|                | BT LE 2M    | 1.11    | dBm  |
| Rx Sensitivity | BT LE 1M    | -93     | dBm  |
|                | BT LE 2M    | -93     | dBm  |

## 2.4.5 802.15.4 power measurements

**Table 2-11 802.15.4 power measurements at antenna port at 25 C, 3.3V nominal with external PA**

| Parameter      | Description | Typical | Unit |
|----------------|-------------|---------|------|
| Tx power       | O-QPSK DSSS | 1.98    | dBm  |
| Rx Sensitivity | O-QPSK DSSS | -101    | dBm  |

## 3 Mechanical interface specification

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### 3.1 WL501 module dimensions

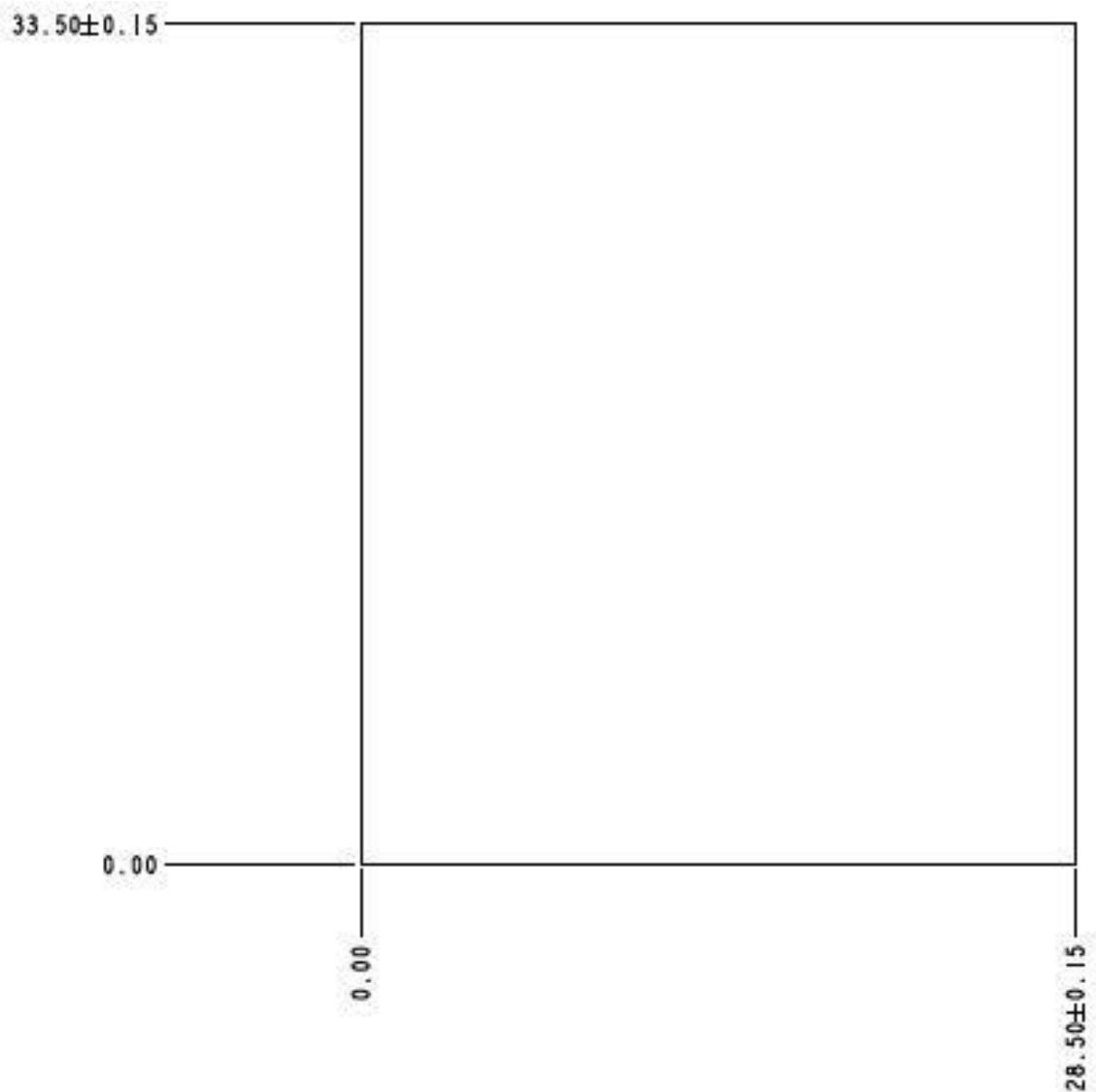


Figure 3-1 WL501 module dimensions



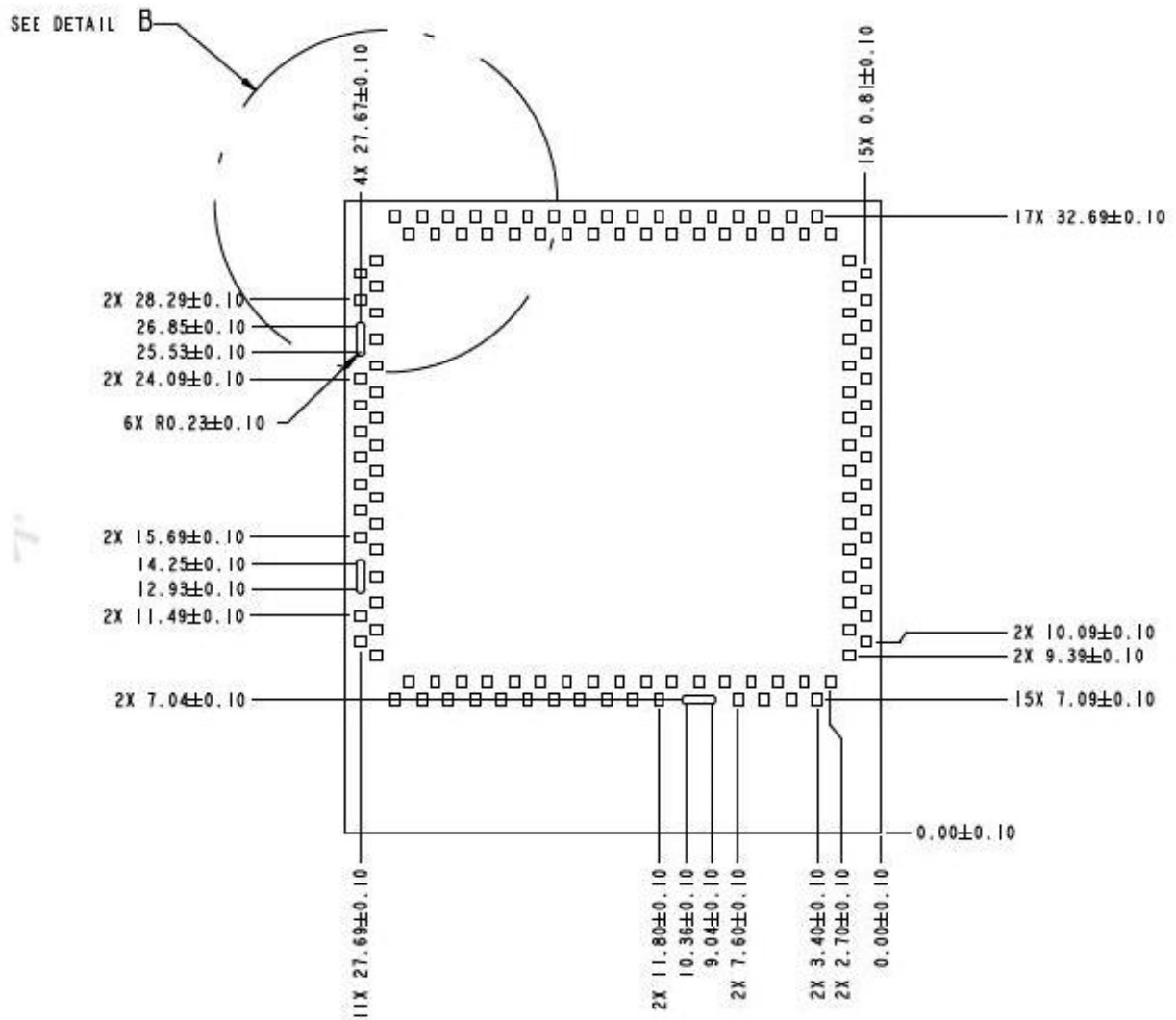


Figure 3-2 WL501 module pinout dimensions (in mm)

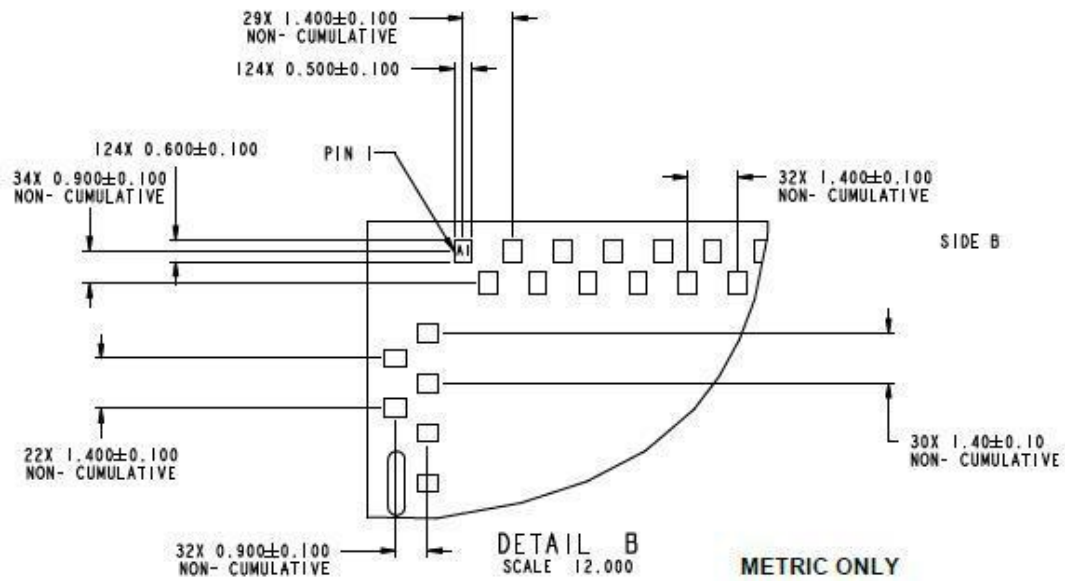


Figure 3-3 WL501 module pinout dimensions-Detail B (in mm)

**FCC Statement:**

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's 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.

Note: 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.

## OEM Guidance

### 1. Applicable FCC rules

This device complies with part 15.247/15.407 of the FCC Rules.

### 2. The specific operational use conditions

This module can be used in IoT devices. The input voltage to the module is nominally 3.3 V DC. The operational ambient temperature of the module is 0 °C ~ 85 °C. the embedded PCB antenna is allowed. Any other external antenna is prohibited.

### 3. Limited module procedures

N/A

### 4. Trace antenna design

N/A

### 5. RF exposure considerations

The 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 and your body. If the equipment built into a host as a portable usage, the additional RF exposure evaluation may be required as specified by 2.1093.

6. Antenna

Antenna type: PCB antenna Peak gain : 1.0dBi

7. Label and compliance information

An exterior label on OEM's end product can use wording such as the following:

"Contains Transmitter Module FCC ID: 2ACCRWL501" or "Contains FCC ID: 2ACCRWL501"

8. Information on test modes and additional testing requirements

a)The modular transmitter has been fully tested by the module grantee on the required number of channels, modulation types, and modes, it should not be necessary for the host installer to re-test all the available transmitter modes or settings. It is recommended that the host product manufacturer, installing the modular transmitter, perform some investigative measurements to confirm that the resulting composite system does not exceed the spurious emissions limits or band edge limits (e.g., where a different antenna may be causing additional emissions).

b)The testing should check for emissions that may occur due to the intermixing of emissions with the other transmitters, digital circuitry, or due to physical properties of the host product (enclosure). This investigation is especially important when integrating multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration. It is important to note that host product manufacturers should not assume that because the modular transmitter is certified that they do not have any responsibility for final product compliance.

c)If the investigation indicates a compliance concern the host product manufacturer is obligated to mitigate the issue. Host products using a modular transmitter are subject to all the applicable individual technical rules as well as to the general conditions of operation in Sections 15.5, 15.15, and 15.29 to not cause interference. The operator of the host product will be obligated to stop operating the device until the interference have been corrected .

9. Additional testing, Part 15 Sub part B disclaimer The final host / module combination need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The host integrator installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation and should refer to guidance in KDB 996369. For host products with certified modular transmitter, the frequency range of investigation of the composite system is specified by rule in Sections 15.33(a)(1) through (a)(3), or the range applicable to the digital device, as shown in Section 15.33(b)(1), whichever is the higher frequency range of investigation

When testing the host product, all the transmitters must be operating. The transmitters can be enabled by using publicly-available drivers and turned on, so the transmitters are active. In certain conditions it might be appropriate to use a technology-specific call box (test set) where accessory 50 devices or drivers are not available. When testing for emissions from the unintentional radiator, the transmitter shall be placed in the receive mode or idle mode, if possible. If receive mode only is not possible then, the radio shall be passive (preferred) and/or active scanning. In these cases, this would need to enable activity on the communication BUS (i.e., PCIe, SDIO, USB) to ensure the unintentional radiator circuitry is enabled. Testing laboratories may need to add attenuation or filters depending on the signal strength of any active beacons (if applicable) from the enabled radio(s). See ANSI C63.4, ANSI C63.10 and ANSI C63.26 for further general testing details.

The product under test is set into a link/association with a partnering device, as per the normal intended use of the product. To ease testing, the product under test is set to transmit at a high duty cycle, such as by sending a file or streaming some media content.