## 7.2. Recommended Footprint
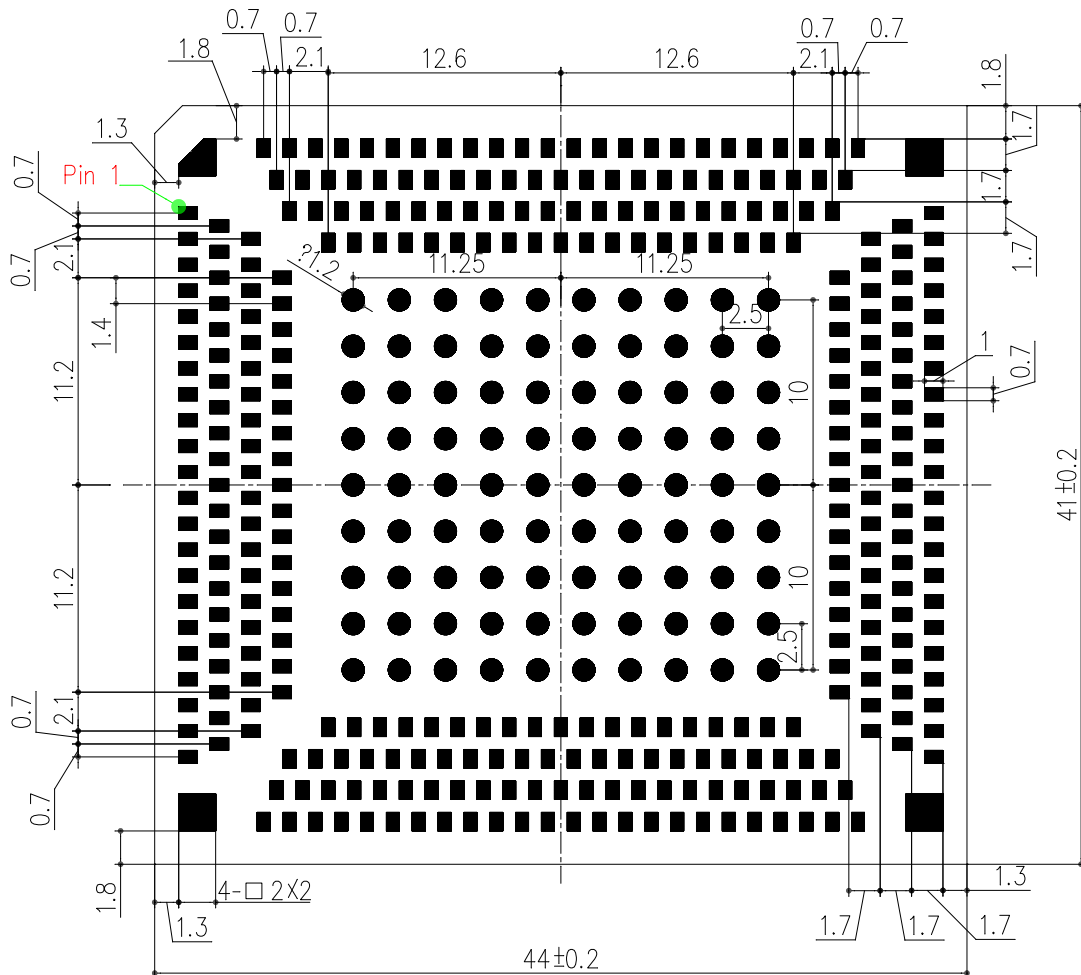


**Figure 46: Recommended Footprint**

> **NOTE**
>
> Keep at least 3 mm between the module and other components on the motherboard to improve soldering quality and maintenance convenience.
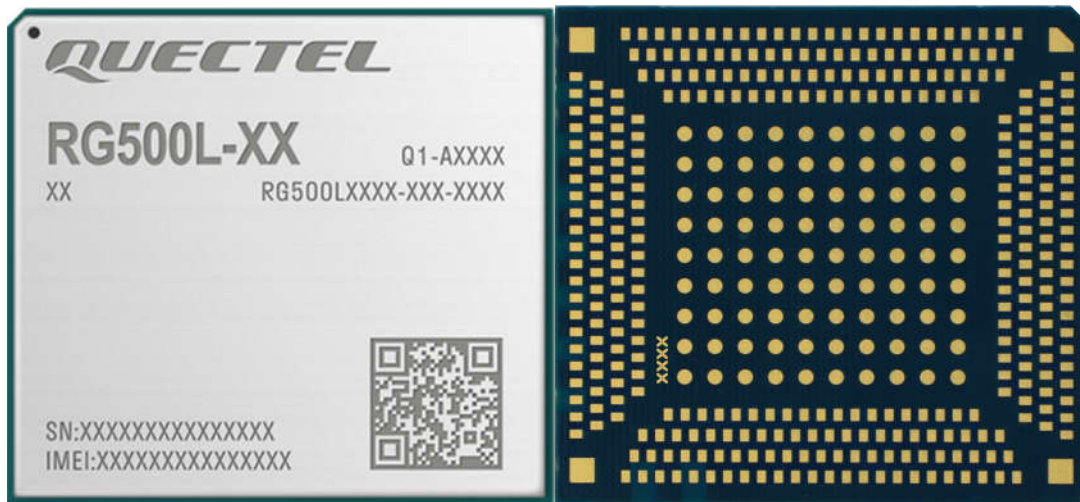
## 7.3. Top and Bottom Views



**Figure 47: Top and Bottom Views of the Module**

| NOTE |
| --- |

Images above are for illustration purpose only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.

# 8 Storage, Manufacturing & Packaging

## 8.1. Storage Conditions

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: the temperature should be 23 ±5 °C and the relative humidity should be 35–60 %.

2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours [24] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement mentioned above;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

---

[24] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. Do not unpack the modules in large quantities until they are ready for soldering.

## 8.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see **document [5]**.

The recommended peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted only after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.
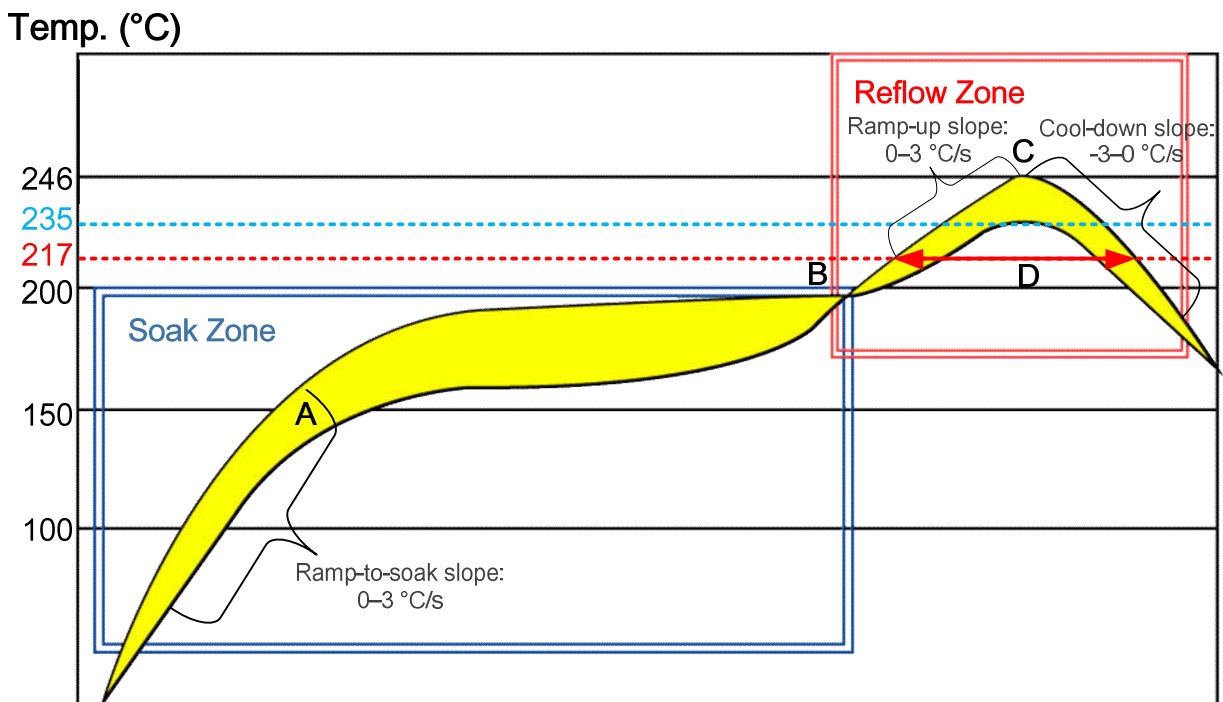


**Figure 48: Recommended Reflow Soldering Thermal Profile**

**Table 56: Recommended Thermal Profile Parameters**

| Factor | Recommended Value | |
|---|---|---|
| **Soak Zone** | | |
| Ramp-to-soak slope | 0–3 °C/s | |
| Soak time (between A and B: 150 °C and 200 °C) | 70–120 s | |
| **Reflow Zone** | | |
| Ramp-up slope | 0–3 °C/s | |
| Reflow time (D: over 217°C) | 40–70 s | |
| Max temperature | 235–246 °C | |
| Cool-down slope | -3–0 °C/s | |
| **Reflow Cycle** | | |
| Max reflow cycle | 1 | |

**NOTE**

1.  The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2.  If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
3.  Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
4.  Due to the complexity of the SMT process, please contact Quectel Technical Supports in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in *document [5]*.

## 8.3. Packaging Specifications

This chapter describes only the key parameters and process of packaging. All figures below are for reference only. The appearance and structure of the packaging materials are subject to the actual delivery.

The module adopts carrier tape packaging and details are as follow:

### 8.3.1. Carrier Tape

Dimension details are as follows:
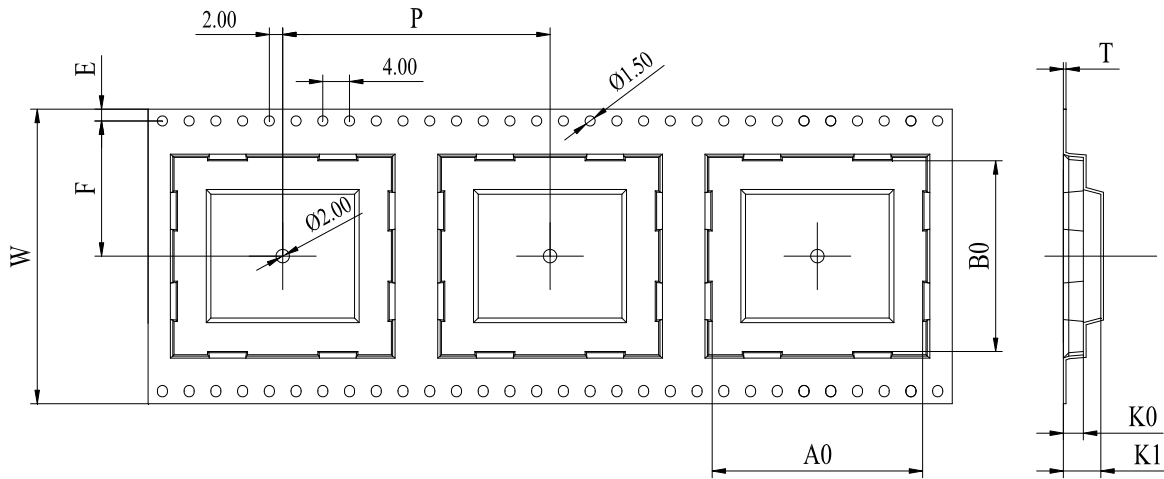


**Figure 49: Carrier Tape Dimension Drawing**

**Table 57: Carrier Tape Dimension Table (Unit: mm)**

| W | P | T | A0 | B0 | K0 | K1 | F | E |
|---|---|---|----|----|----|----|---|---|
| 72 | 56 | 0.4 | 44.7 | 41.7 | 4.2 | 5.2 | 34.2 | 1.75 |

### 8.3.2. Plastic Reel
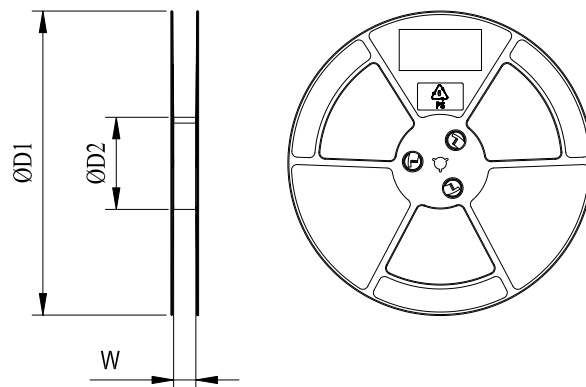


**Figure 50: Plastic Reel Dimension Drawing**

**Table 58: Plastic Reel Dimension Table (Unit: mm)**

| øD1 | øD2 | W |
|-----|-----|---|
| 380 | 180 | 72.5 |

### 8.3.3. Mounting Direction
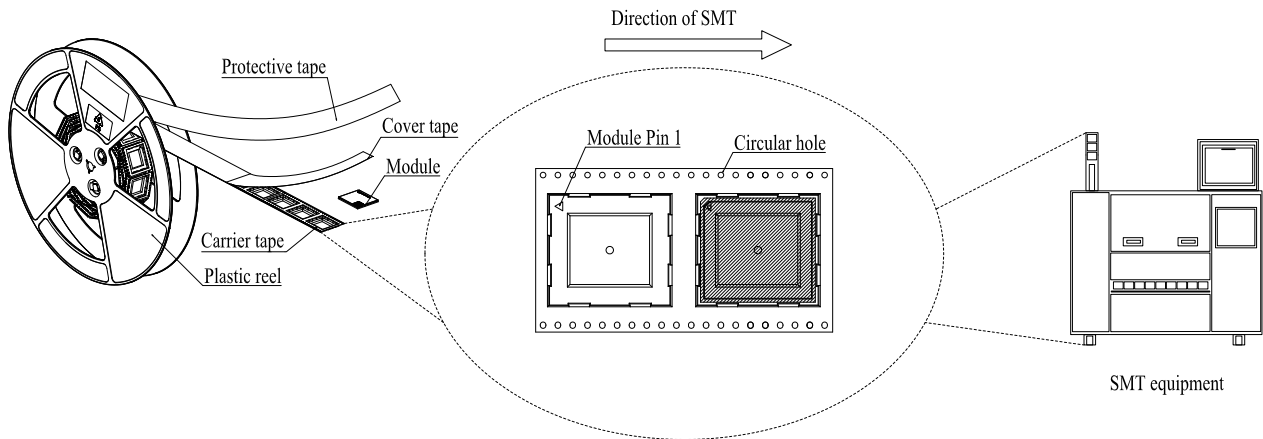


**Figure 51: Mounting Direction**

### 8.3.4. Packaging Process
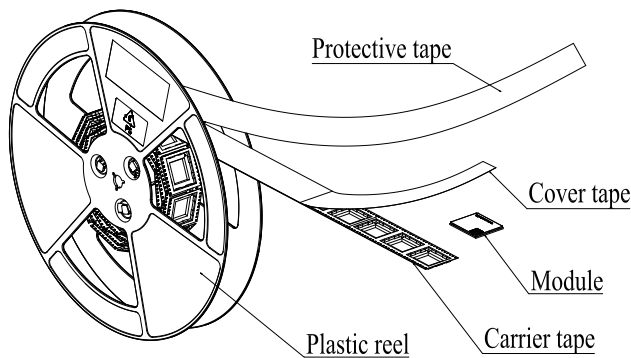


Place the module into the carrier tape and use the cover tape to cover it; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. 1 plastic reel can load 200 modules.

Place the packaged plastic reel, 1 humidity indicator card and 1 desiccant bag into a vacuum bag, vacuumize it.
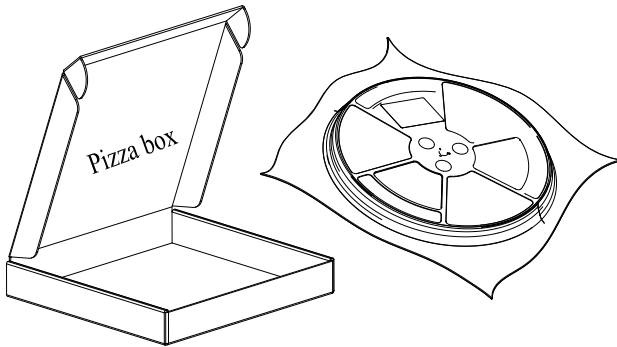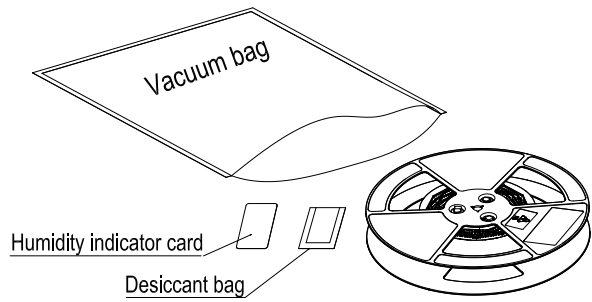
Place the vacuum-packed plastic reel into the pizza box.

Put 4 packaged pizza boxes into 1 carton box and seal it. 1 carton box can pack 800 modules.
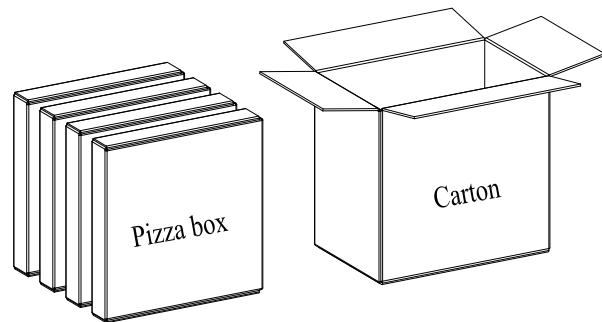
**Figure 52: Packaging Process**

# 9 Related AT Commands

## 9.1. AT+CFUN　Set UE Functionality

This command controls the functionality level. It can also be used to reset the UE.

- **AT+CFUN=0** turns off radio and (U)SIM power.
- **AT+CFUN=1,1** or **AT+CFUN=4,1** can reset the UE.
- **AT+CFUN=1** enters full functionality mode.
- **AT+CFUN=4** enters airplane mode.

| AT+CFUN　Set UE Functionality | |
|---|---|
| Test Command<br>**AT+CFUN=?** | Response<br>**+CFUN: (**list of supported **<fun>**s)**,(**list of supported **<rst>**s)<br><br>**OK** |
| Read Command<br>**AT+CFUN?** | Response<br>**+CFUN: <fun>**<br><br>**OK** |
| Write Command<br>**AT+CFUN=<fun>[,<rst>]** | Response<br>**OK**<br><br>If there is any error related to MT functionality:<br>**+CME ERROR: <err>**<br>Or<br>**ERROR** |
| Maximum Response Time | 15 s, determined by the network. |
| Characteristics | / |
| Reference | *3GPP TS 27.007* |

## Parameter

| | |
|---|---|
| **\<fun\>** | Integer type. Functionality level. |
| | 0      Minimum functionality (Disable RF function and (U)SIM function) |
| | <u>1</u>      Full functionality |
| | 4      Airplane mode (Disable RF function) |
| | 15      Reboot the modem and AP synchronously |
| **\<rst\>** | Integer type. |
| | <u>0</u>      Do not reset the UE before setting it to **\<fun\>** power level (Default value when **\<rst\>** is omitted) |
| | 1      Reset the UE before setting it to **\<fun\>** power level |
| **\<err\>** | Error code. |

## Example

```
AT+CFUN=0                          //Switch UE to minimum functionality.
OK
AT+CFUN=1                          //Switch UE to full functionality.
OK
```

---

**NOTE**

1. **AT+CFUN=1,1** or **AT+CFUN=4,1** can only reset the UE, which is not fully compliable with *3GPP TS 27.007*.
2. The execution of **AT+CFUN** command will not affect GNSS function.

---

## 9.2. AT+QSCLK    Enable/Disable Sleep Mode

This command controls whether MT enters sleep mode. When entering into sleep mode is enabled, the MT can directly enter sleep mode.

| AT+QSCLK    Enable/Disable Sleep Mode | |
|---|---|
| Test Command<br>**AT+QSCLK=?** | Response<br>**+QSCLK: (**list of supported **\<n\>**s**)**<br><br>**OK** |
| Read Command<br>**AT+QSCLK?** | Response<br>**+QSCLK: \<n\>**<br><br>**OK** |
| Write Command | Response |

| AT+QSCLK=<n> | OK |
|---|---|
| Maximum Response Time | 300 ms |
| Characteristics | / |

**Parameter**

| <n> | Integer type. Enable/disable sleep mode. |
|---|---|
| | 0   Disable |
| | 1   Enable |

---

**NOTE**

1. **AT+QSCLK=1** enables the module to enter sleep mode. At this time, the USB is powered down and the module's modem part enters airplane mode.
2. **AT+QSCLK=0** disables the module to enter sleep mode. At this time, the USB is powered up and the module's modem part is in normal operating mode. Under such condition, the module will never go into sleep mode.

## 9.3. AT+QADC   Read ADC Value

This command reads the voltage value of specified ADC channel.

| AT+QADC   Read ADC Value | |
|---|---|
| Test Command<br>**AT+QADC=?** | Response<br>**+QADC: (**range of supported **<port>**s**)**<br><br>**OK** |
| Read Command<br>**AT+QADC=<port>** | Response<br>**+QADC: <status>,<value>**<br><br>**OK** |
| Maximum Response Time | 300 ms |
| Characteristics | / |

**Parameter**

| | |
|---|---|
| **\<port\>** | Integer type. Channel number of the ADC. |
| | 0    ADC channel 0 |
| | 1    ADC channel 1 |
| | 2    ADC channel 2 |
| **\<status\>** | Integer type. Indicates whether the ADC value read is successful. |
| | 0    Failed |
| | 1    Successful |
| **\<value\>** | Integer type. The voltage of specified ADC channel. Unit: mV. |

# 10 Appendix References

**Table 59: Related Documents**

| Document Name |
| --- |
| [1]  Quectel_RG500L_EVB_User_Guide |
| [2]  Quectel_RG500L_Series_Quecopen_GNSS_Application_Note |
| [3]  Quectel_RF_Layout_Application_Note |
| [4]  RG500L_Series_QuecOpen_Thermal_Design_Guide |
| [5]  Quectel_Module_SMT_Application_Note |

**Table 60: Terms and Abbreviations**

| Abbreviation | Description |
| --- | --- |
| ADC | Analog-to-Digital Converter |
| bps | Bits Per Second |
| CA | Carrier Aggregation |
| CHAP | Challenge Handshake Authentication Protocol |
| CPE | Customer-Premises Equipment |
| CS | Coding Scheme |
| CTS | Clear To Send |
| DC-HSDPA | Dual-carrier High Speed Downlink Packet Access |
| DL | Downlink |
| DRX | Discontinuous Reception |
| ESD | Electrostatic Discharge |
| FDD | Frequency Division Duplex |

| | |
|---|---|
| FR | Full Rate |
| GLONASS | Global Navigation Satellite System (Russia) |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HB | High Band |
| HPUE | High Power User Equipment |
| HR | Half Rate |
| HSDPA | High Speed Downlink Packet Access |
| HSPA | High Speed Packet Access |
| HSUPA | High Speed Uplink Packet Access |
| IC | Integrated Circuit |
| I2C | Inter-Integrated Circuit |
| I2S | Inter-IC Sound |
| I/O | Input/Output |
| LB | Low Band |
| LED | Light Emitting Diode |
| LGA | Land Grid Array |
| LNA | Low Noise Amplifier |
| LTE | Long Term Evolution |
| MAC | Media Access Control |
| MB | Middle Band |
| MCU | Microcontroller Unit |
| MDC | Management Data Clock |
| MDIO | Management Data Input/Output |
| MHB | Middle/High Band |
| MIMO | Multiple Input Multiple Output |
| NR | New Radio |

| NSA | Non-Stand Alone |
|---|---|
| PA | Power Amplifier |
| PAP | Password Authentication Protocol |
| PC | Personal Computer |
| PCB | Printed Circuit Board |
| PCIe | Peripheral Component Interconnect Express |
| PCM | Pulse Code Modulation |
| PDU | Protocol Data Unit |
| PHY | Physical Layer |
| PMIC | Power Management Integrated Circuit |
| PRX | Primary Receive |
| QAM | Quadrature Amplitude Modulation |
| QPSK | Quadrature Phase Shift Keying |
| RF | Radio Frequency |
| RHCP | Right Hand Circularly Polarized |
| RX | Receive |
| SA | Stand Alone |
| SCS | Sub-Carrier Space |
| SD | Secure Digital |
| SIMO | Single Input Multiple Output |
| SMD | Surface Mount Device |
| SMS | Short Message Service |
| SPI | Serial Peripheral Interface |
| TDD | Time Division Duplexing |
| TRX | Transmit & Receive |
| TX | Transmit |
| UART | Universal Asynchronous Receiver/Transmitter |

| | |
|---|---|
| UL | Uplink |
| UMTS | Universal Mobile Telecommunications System |
| USB | Universal Serial Bus |
| (U)SIM | Universal Subscriber Identity Module |
| VBAT | Voltage at Battery (Pin) |
| Vmax | Maximum Voltage Value |
| Vnom | Nominal Voltage Value |
| Vmin | Minimum Voltage Value |
| $V_{IH}max$ | Maximum Input High Level Voltage Value |
| $V_{IH}min$ | Minimum Input High Level Voltage Value |
| $V_{IL}max$ | Maximum Input Low Level Voltage Value |
| $V_{IL}min$ | Minimum Input Low Level Voltage Value |
| $V_{I}max$ | Absolute Maximum Input Voltage Value |
| $V_{I}min$ | Absolute Minimum Input Voltage Value |
| $V_{OH}max$ | Maximum Output High Level Voltage Value |
| $V_{OH}min$ | Minimum Output High Level Voltage Value |
| $V_{OL}max$ | Maximum Output Low Level Voltage Value |
| $V_{OL}min$ | Minimum Output Low Level Voltage Value |
| VSWR | Voltage Standing Wave Ratio |
| WCDMA | Wideband Code Division Multiple Access |
| WLAN | Wireless Local Area Network |
| WWAN | Wireless Wide Area Network |

# 11 Warning statements

## 11.1. FCC

### 11.1.1. Important Notice to OEM integrators

1. This module is limited to OEM installation ONLY.

2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).

3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations

4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part

15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are complaint with the transmitter(s) rule(s). The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

### 11.1.2. Important Note

notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to XXXX that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

### 11.1.3. End Product Labeling

When the module is installed in the host device, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: "Contains FCC ID: XMR2023RG500LLA"

The FCC ID can be used only when all FCC compliance requirements are met.

### 11.1.4. Antenna Installation

(1) The antenna must be installed such that 20 cm is maintained between the antenna and users,

(2) The transmitter module may not be co-located with any other transmitter or antenna.

(3) Only antennas of the same type and with equal or less gains as shown below may be used with this module. Other types of antennas and/or higher gain antennas may require additional authorization for operation.

| RG500L-LA: Dipole antenna &FPC Antenna & PCB Antenna | | |
|---|---|---|
| Band | Frequency (MHz) | Gain (dBi) |
| WCDMA B2/LTE-FDD B2 | 1850-1910 | 0.75 |
| 5G NR n2 | 1850-1910 | 0.73 |
| WCDMA B4 | 1710-1755 | 0.33 |
| LTE FDD B4 | 1710-1755 | 3.1 |
| WCDMA B5 | 824-849 | -10.68 |
| LTE-FDD B5 | 824–849 | 1.6 |
| 5G NR n5 | 824–849 | -10.68 |
| LTE-FDD B7 | 2500–2570 | 4.0 |
| 5G NR n7 | 2500–2570 | 1.42 |
| LTE-FDD B8 | 880-915 | -8.6 |
| LTE-FDD B28/5G NR n28 | 703-748 | -8.7 |
| LTE-FDD B42 | 3400-3600 | -4.29 |
| LTE-FDD B66 | 1710-1780 | 3.1 |
| 5G NR n66 | 1710-1780 | -0.2 |
| 5G NR n78 | 3300–3800 | 6.5 |

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot 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 FCC authorization.

### 11.1.5. 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.

### 11.1.6. Federal Communication Commission Interference Statement

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.

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.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

## 11.1.7. List of applicable FCC rules

This module has been tested and found to comply with part 22, part 24, part 27, part 90, 15.247 and 15.407 requirements for Modular Approval.
The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) 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. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

## 11.1.8. This device is intended only for OEM integrators under the following

### conditions:(For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.
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.

## 11.1.9. Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

# trace design