

7.2. Recommended Footprint

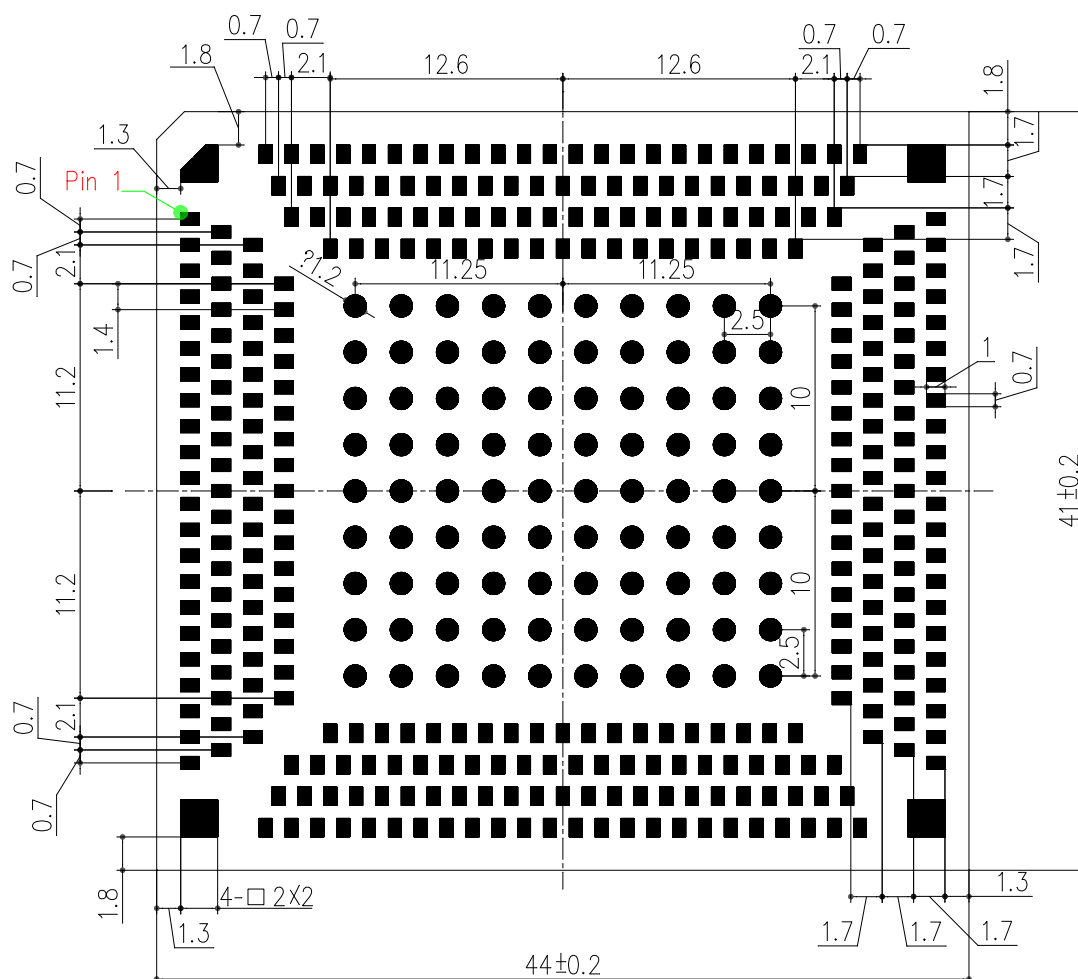


Figure 46: Recommended Footprint

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

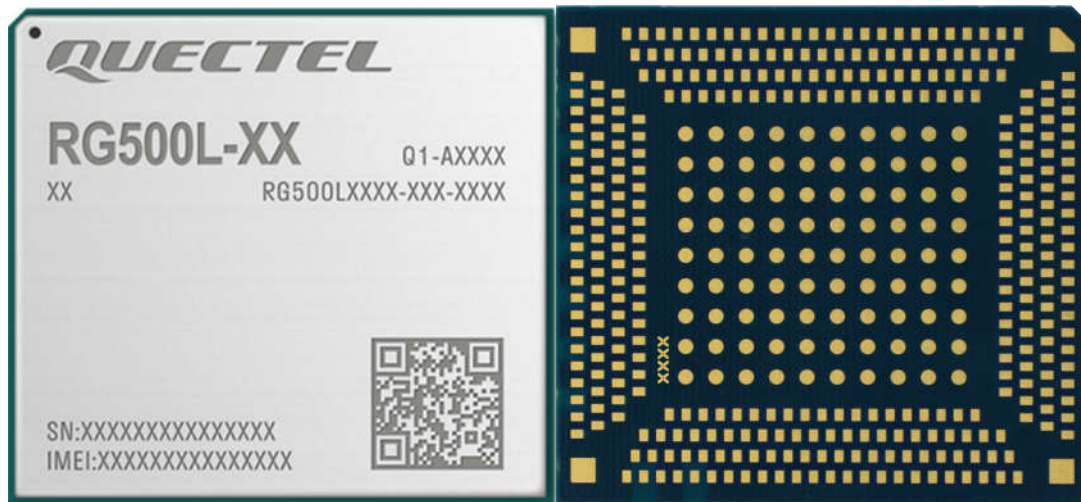


Figure 47: Top and Bottom Views of the Module

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.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

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 °C, with 246 °C 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.

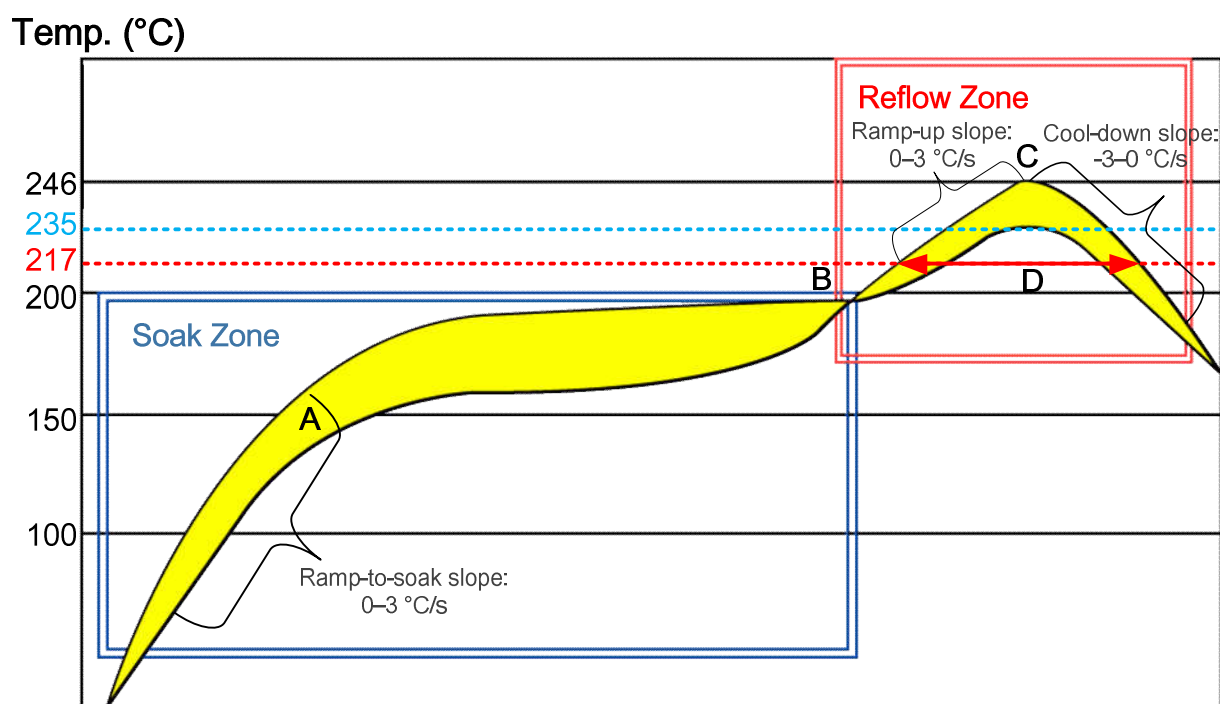


Figure 48: Recommended Reflow Soldering Thermal Profile

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:

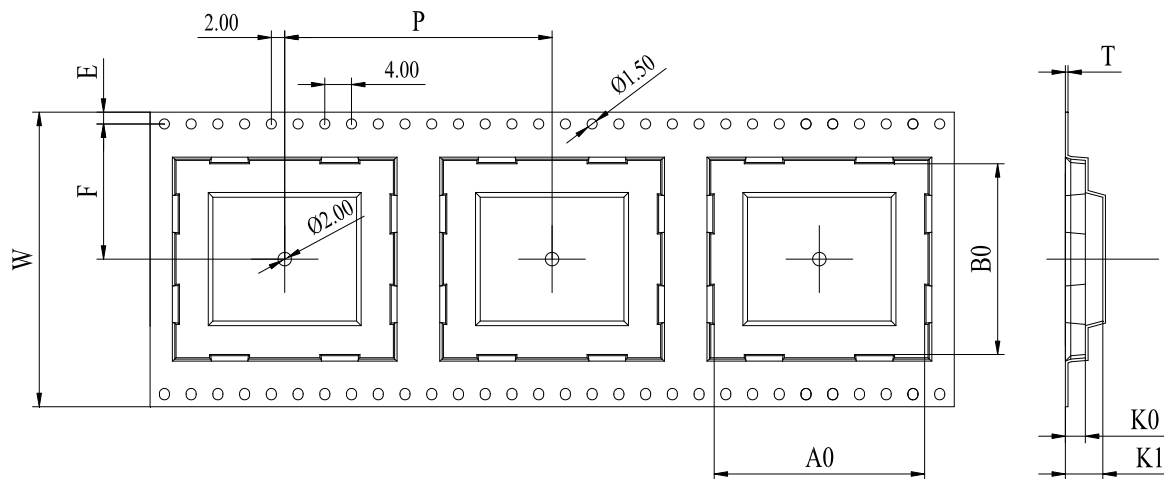


Figure 49: Carrier Tape Dimension Drawing

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

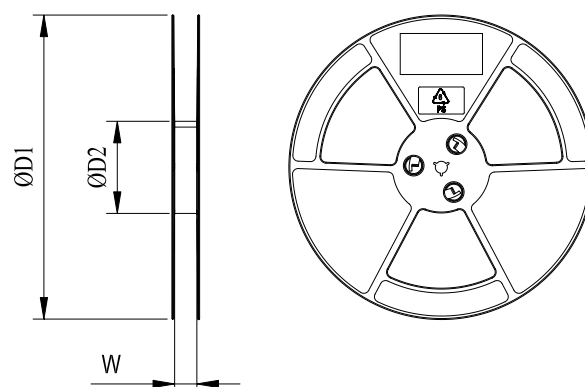


Figure 50: Plastic Reel Dimension Drawing

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

$\varnothing D1$	$\varnothing D2$	W
380	180	72.5

8.3.3. Mounting Direction

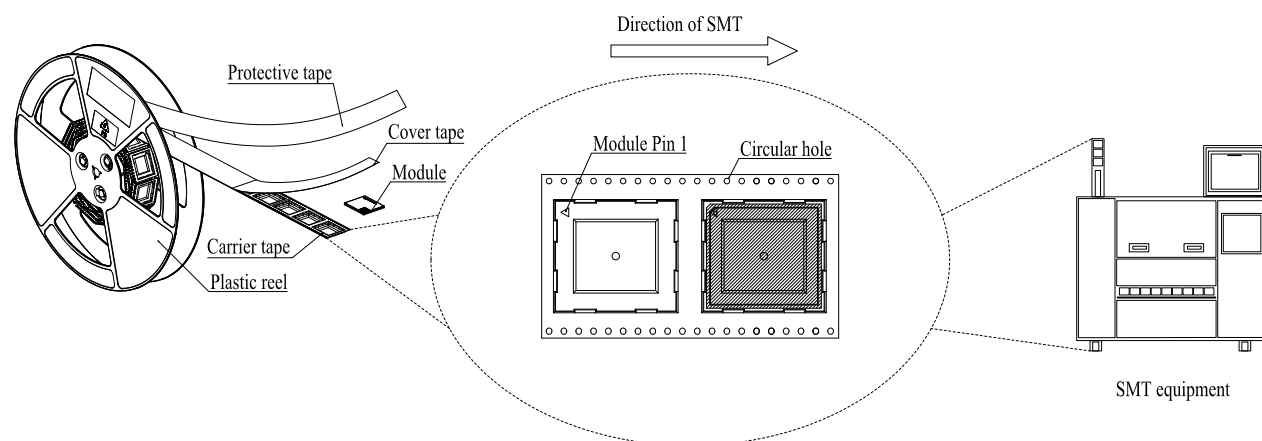
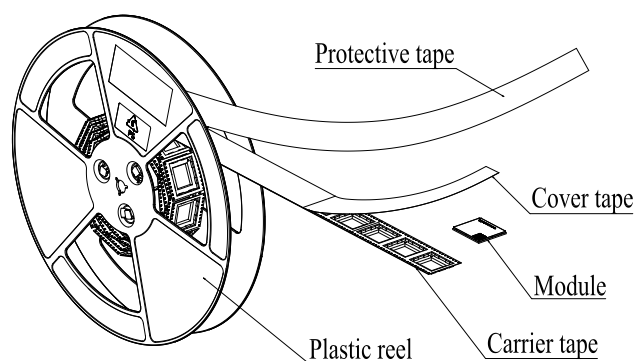


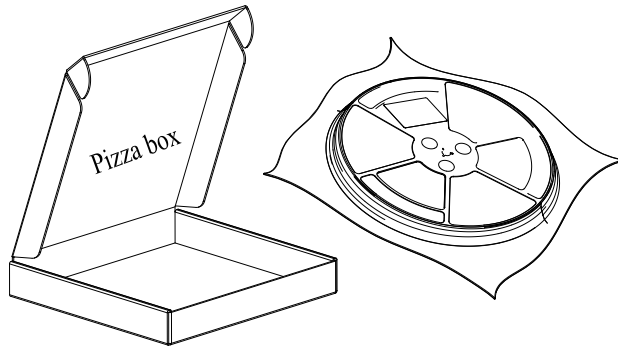
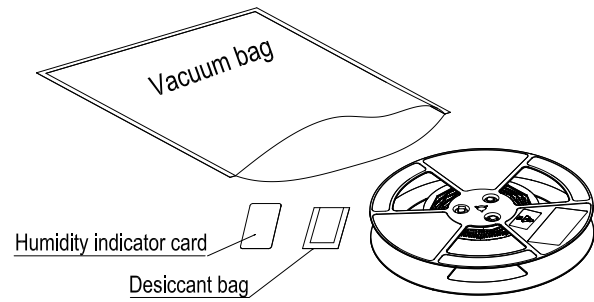
Figure 51: Mounting Direction

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.

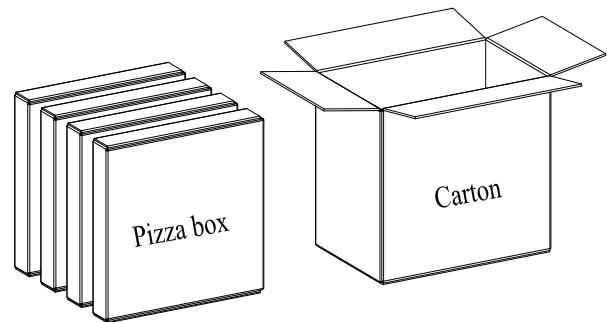


Figure 52: Packaging Process

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 AT+CFUN=?	Response +CFUN: (list of supported <fun>s),(list of supported <rst>s) OK
Read Command AT+CFUN?	Response +CFUN: <fun> OK
Write Command AT+CFUN=<fun>[,<rst>]	Response OK If there is any error related to MT functionality: +CME ERROR: <err> Or 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)
1	Full functionality
4	Airplane mode (Disable RF function)
15	Reboot the modem and AP synchronously
<rst>	Integer type.
0	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 compliant 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 AT+QSCLK=?	Response +QSCLK: (list of supported <n>s) OK
Read Command AT+QSCLK?	Response +QSCLK: <n> 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 AT+QADC=?	Response +QADC: (range of supported <port>s) OK
Read Command AT+QADC=<port>	Response +QADC: <status>,<value> 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)
V _{max}	Maximum Voltage Value
V _{nom}	Nominal Voltage Value
V _{min}	Minimum Voltage Value
V _{IHmax}	Maximum Input High Level Voltage Value
V _{IHmin}	Minimum Input High Level Voltage Value
V _{ILmax}	Maximum Input Low Level Voltage Value
V _{ILmin}	Minimum Input Low Level Voltage Value
V _I max	Absolute Maximum Input Voltage Value
V _I min	Absolute Minimum Input Voltage Value
V _{OHmax}	Maximum Output High Level Voltage Value
V _{OHmin}	Minimum Output High Level Voltage Value
V _{OLmax}	Maximum Output Low Level Voltage Value
V _{OLmin}	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 circuitry), 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

