L86 Hardware Design

GNSS Module Series

Rev. L86_Hardware_Design_V1.0

Date: 2014-09-04

The test result of the antenna is shown as the following figure. This embedded GNSS antenna provides good radiation efficiency, right hand circular polarization and optimized radiation pattern. The antenna is insensitive to surroundings and has high tolerance against frequency shifts.

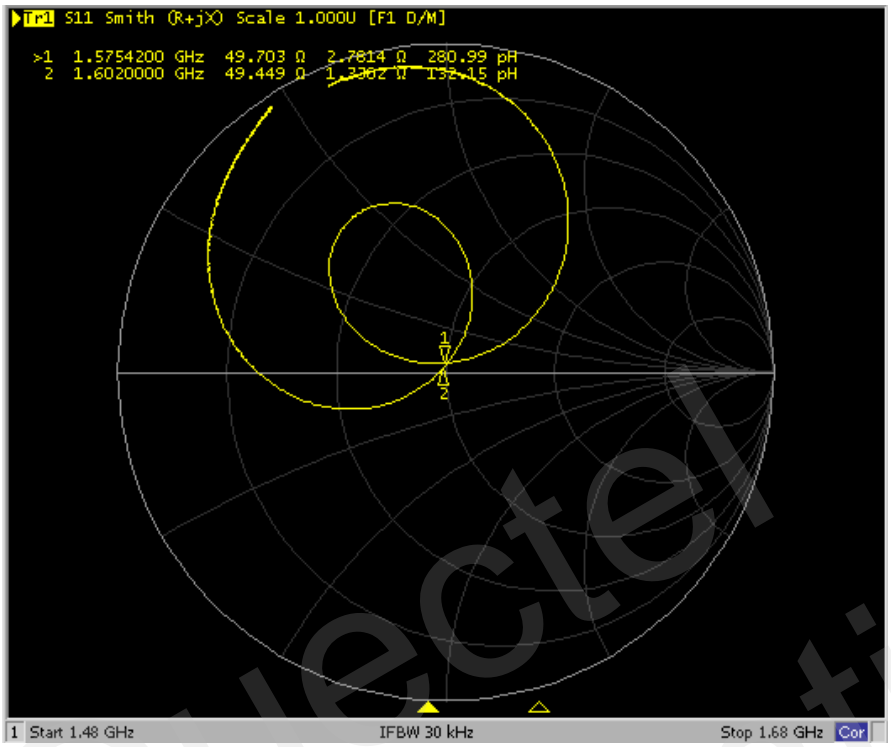

Figure 12: Matching Map of Patch Antenna

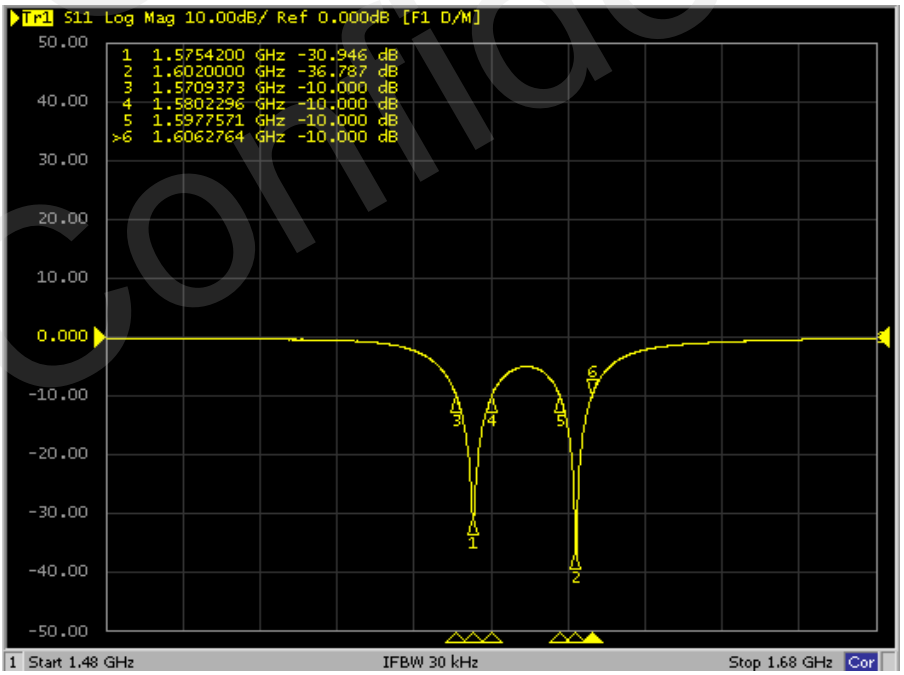

Figure 13: S11 Parameters of Patch Antenna

4.1.2. PCB Design Guide

Radiation characteristics of antenna depend on various factors, such as the size and shape of the PCB, the dielectric constant of components nearby. For the best performance, it is recommended to follow these rules listed as below.

Keep at least 10mm away from the nearest edge of the mother board. It is better for L86 module to be placed in the center of the mother board.

Keep enough distance between L86 module antenna and tall components, the height of which is more than 6mm, and the minimum distance (d) is 10mm.

Put L86 module on the top of the main PCB, which can guarantee antenna to face to open sky and achieve good receiving performance during operation.

Device enclosure should be made of non-metal materials especially around antenna area. The minimum distance between antenna and enclosure is 1mm.

It is recommended that the mother board is bigger than 80mm×40mm for the better performance. And pour ground copper on the whole mother board.

Other antennas such as BT\WIFI\GSM should be kept minimum 10mm distance far away from the embedded patch antenna in L86 module.

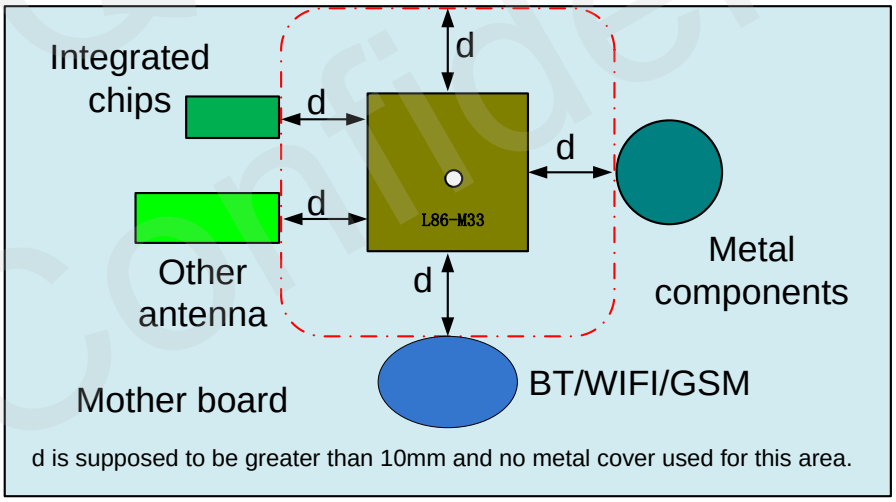

Figure 14: L86 Module Placement Guide

4.2. External Active Antenna

The following figure is a typical reference design with active antenna. In this mode, DC on the EX_ANT pin is powered by VCC and supplies power to the external active antenna.

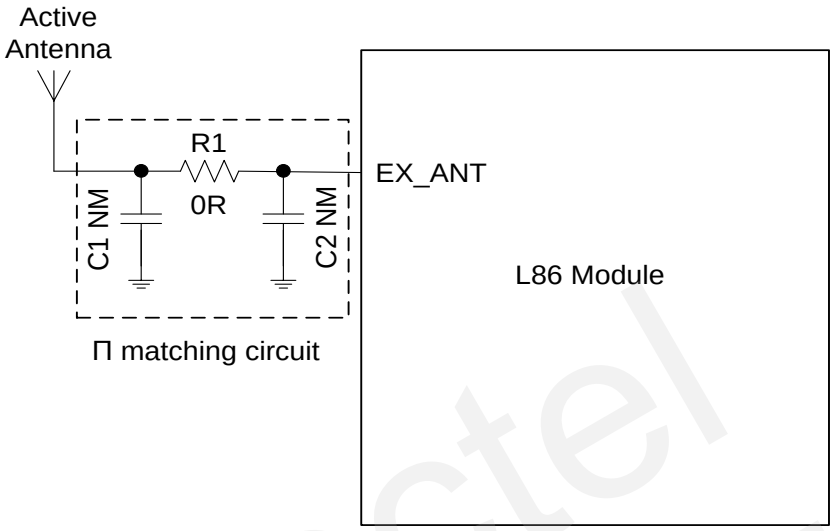

Figure 15: Reference Design for Active Antenna

C1, R1, C2 are reserved matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted, R1 is 0 ohm. In this mode, R1 must not be capacitance, as current will stream through R1 to the active antenna. C1 and C2 must not be inductance or resistance to avoid short circuit.

The impedance of RF trace line in main PCB should be controlled by 50 Ohm, and the length should be kept as short as possible.

Table 9: Recommended Active Antenna Specification

Antenna Type	Specification
Active Antenna	GPS frequency: 1575.42±2MHz GLONASS frequency: 1602±4MHz VSWR: <2 (Typ.) Polarization: RHCP or Linear Noise figure: <1.5dB Gain (antenna): >-2dBi Gain (embedded LNA): 20dB (Typ.)Total gain: >18dBi (Typ.)

NOTE

In order to ensure the short protection function can work effectively, please select a DC-open (DC-impedance between the SMA's inner signal needle and outside ground) GNSS active antenna. You can measure the DC-impedance with a common and simple multimeter on few samples, and the value is generally in M ohm level.

4.3. Antenna Status Indicator

L86 module supports automatic antenna switching function. The GPTXT sentence can be used to identify the status of external active antenna.

If **ANTSTATUS=OPEN**, it means external active antenna is not connected or has poor contact with antenna feeding point and the internal antenna is used.

If **ANTSTATUS=OK**, it means external active antenna is connected and the module will use external active antenna.

If **ANTSTATUS=SHORT**, it means active antenna is short circuited and the internal patch antenna will be used automatically.

NOTE

Because antenna short protection is enabled by default, L86 module will switch to embedded patch antenna automatically in case that external active antenna is short-circuited, which will avoid L86 module from damage. Meanwhile, you need to check the external active antenna.

Example:
"OPEN" is displayed in the GPTXT sentence as below:

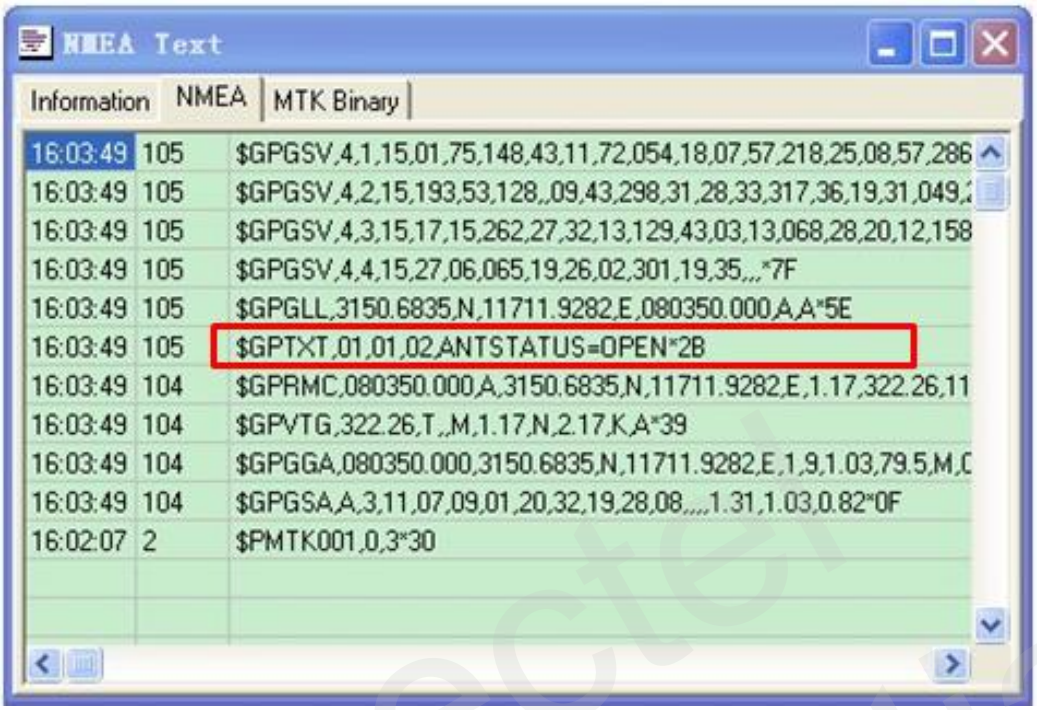

Figure 16: Active Antenna Status Description in GPTXT

Table 10: GPTXT - Status of Antenna

GPTXT Display	Ext Active Antenna Status	Inner Patch Antenna Status	Attention
OPEN	Unused	Working	You need to check the external active antenna status if the active antenna is used.
OK	Working	Unused	
SHORT	Short	Working	Please check the external active antenna

The pin "AADET_N" also can be used to indicate the status of active antenna. When active antenna is not connected to EX_ANT or has poor contact with antenna feeding point, AADET_N will keep a high level to indicate the absence of the active antenna. AADET_N will change to a low level when active antenna is connected well.

NOTE

Active antenna is ONLY available when the voltage of AADET_N ≤ 0.7 V.

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital pins of the module are listed in the following table.

Table 11: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Power Supply Voltage (VCC)	-0.3	4.5	V
Backup Battery Voltage (V_BCKP)	-0.3	4.5	V
Input Voltage at Digital Pins	-0.3	3.6	V
Input Power at EX_ANT		15	dBm
Storage Temperature	-45	125	°C

NOTE

Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage. These are stress ratings only. The product is not protected against over voltage or reversed voltage. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

5.2. Operating Conditions

Table 12: The Module Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VCC	Supply voltage	Voltage must stay within the min/max values, including voltage drop, ripple, and spikes.	3.0	3.3	4.3	V
I_{VCCP}	Peak supply current	VCC=3.3V			100	mA
V_BCKP	Backup voltage supply		1.5	3.3	4.3	V
TOPR	Normal operating temperature		-40	25	85	°C

NOTES

1. The figure I_{VCCP} can be used to determine the maximum current capability of power supply.
2. Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect the device's reliability.

5.3. Current Consumption

The values for current consumption are shown in the following table.

Table 13: The Module Current Consumption

Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{VCC} @Acquisition	VCC=V_BCKP=3.3V (GPS)		26		mA
I_{VCC} @Tracking	VCC=V_BCKP=3.3V (GPS)		22		mA
I_{VCC} @Acquisition	VCC=V_BCKP=3.3V (GPS+GLONASS)		30		mA
I_{VCC} @Tracking	VCC=V_BCKP=3.3V (GPS+GLONASS)		26		mA
I_{VCC} @Standby	VCC=V_BCKP=3.3V		1.0		mA
I_{BCKP} @Backup	V_BCKP=3.3V		7		uA

NOTE

The tracking current is tested in the following conditions:

- For Cold Start, 10 minutes after First Fix.
- For Hot Start, 15 seconds after First Fix.

5.4. Reliability Test

Table 14: Reliability Test

Test Item	Conditions	Standard
Thermal Shock	-30°C...+80°C, 144 cycles	GB/T 2423.22-2002 Test Na IEC 68-2-14 Na
Damp Heat, Cyclic	+55°C; >90% Rh 6 cycles for 144 hours	IEC 68-2-30 Db Test
Vibration Shock	5~20Hz, 0.96m2/s3; 20~500Hz, 0.96m2/s3-3dB/oct, 1hour/axis; no function	2423.13-1997 Test Fdb IEC 68-2-36 Fdb Test
Heat Test	85°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Cold Test	-40°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Heat Soak	90°C, 72 hours, non-operational	GB/T 2423.2-2001 Bb IEC 68-2-2 Test B
Cold Soak	-45°C, 72 hours, non-operational	GB/T 2423.1-2001 A IEC 68-2-1 Test

6 Mechanics

This chapter describes the mechanical dimensions of the module.

6.1. Mechanical View of the Module

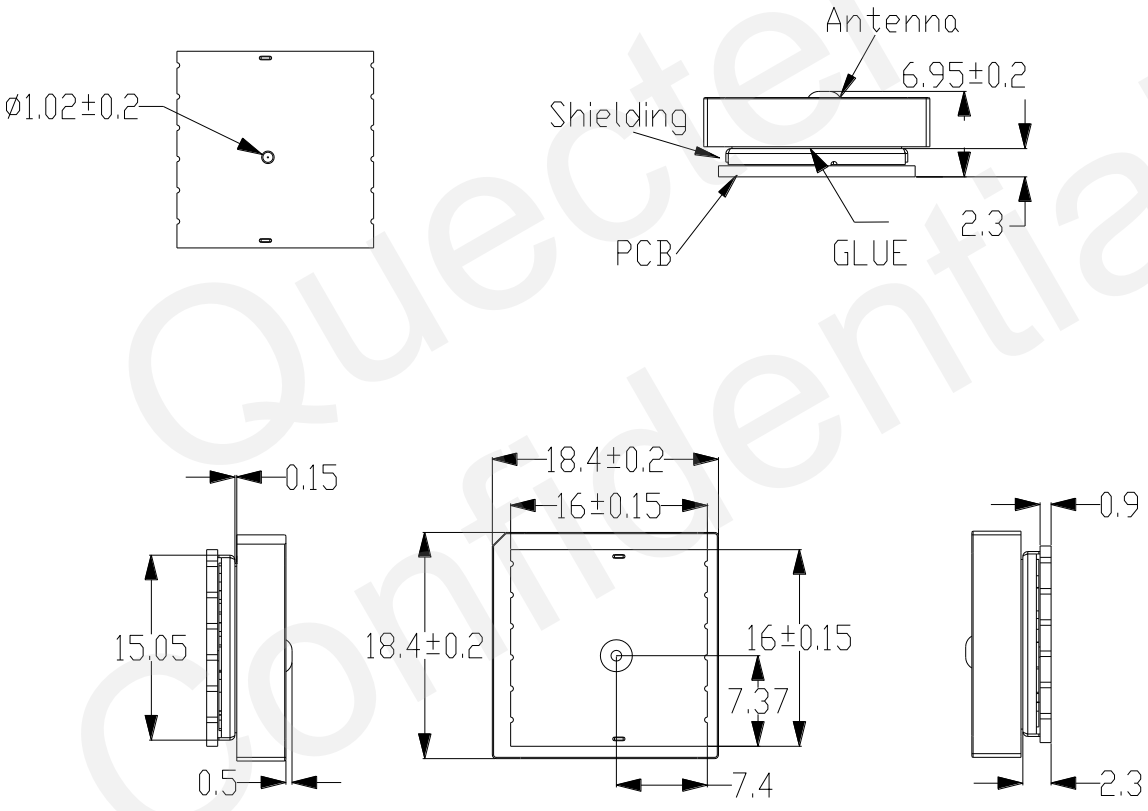

Figure 17: Mechanical View (Unit: mm)

6.2. Bottom Dimension and Recommended Footprint

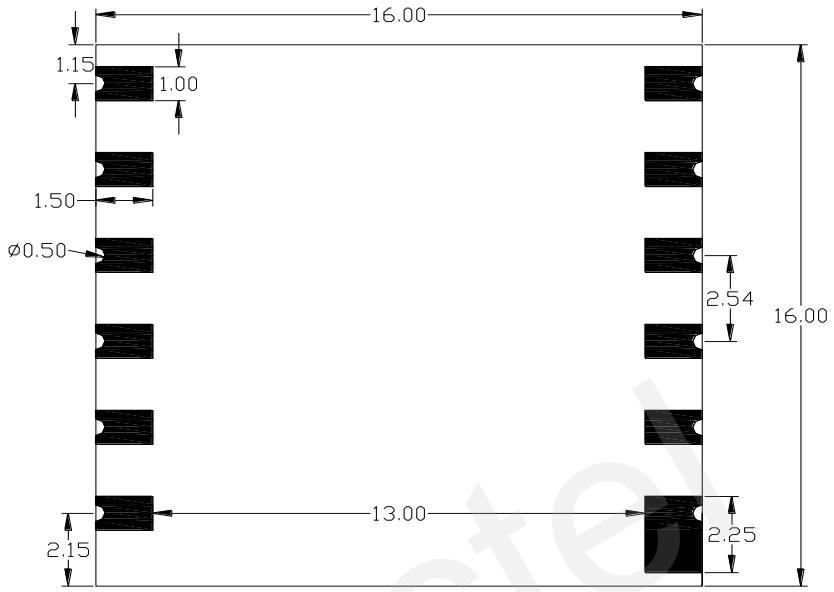

Figure 18: Bottom Dimension (Unit: mm)

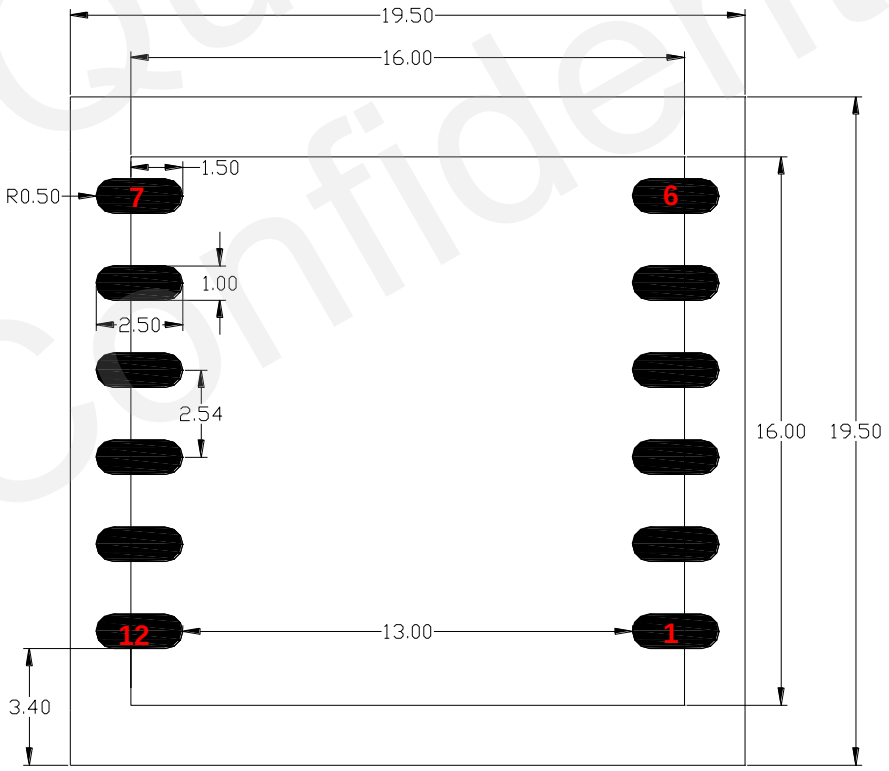

Figure 19: Footprint of Recommendation (Unit: mm)

NOTE

For easy maintenance, please keep a distance of no less than 3mm between the module and other components in host board.

6.3. Top View of the Module

Figure 20: Top View of the Module

6.4. Bottom View of the Module

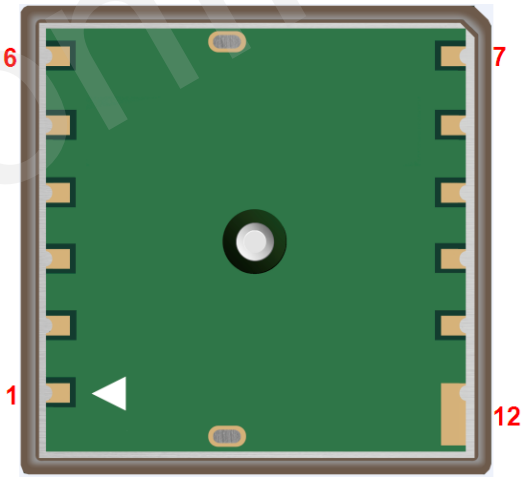

Figure 21: Bottom View of the Module

7 Manufacturing

7.1. Assembly and Soldering

L86 module is intended for SMT assembly and soldering in a Pb-free reflow process on the top side of the PCB. It is suggested that the minimum height of solder paste stencil is 100um to ensure sufficient solder volume. Pad openings of paste mask can be increased to ensure proper soldering and solder wetting over pads. It is suggested that peak reflow temperature is 235~245ºC (for SnAg3.0Cu0.5 alloy). Absolute max reflow temperature is 260ºC. To avoid damage to the module when it is repeatedly heated, it is suggested that the module should be mounted after the first panel has been reflowed. The following picture is the actual diagram which we have operated.

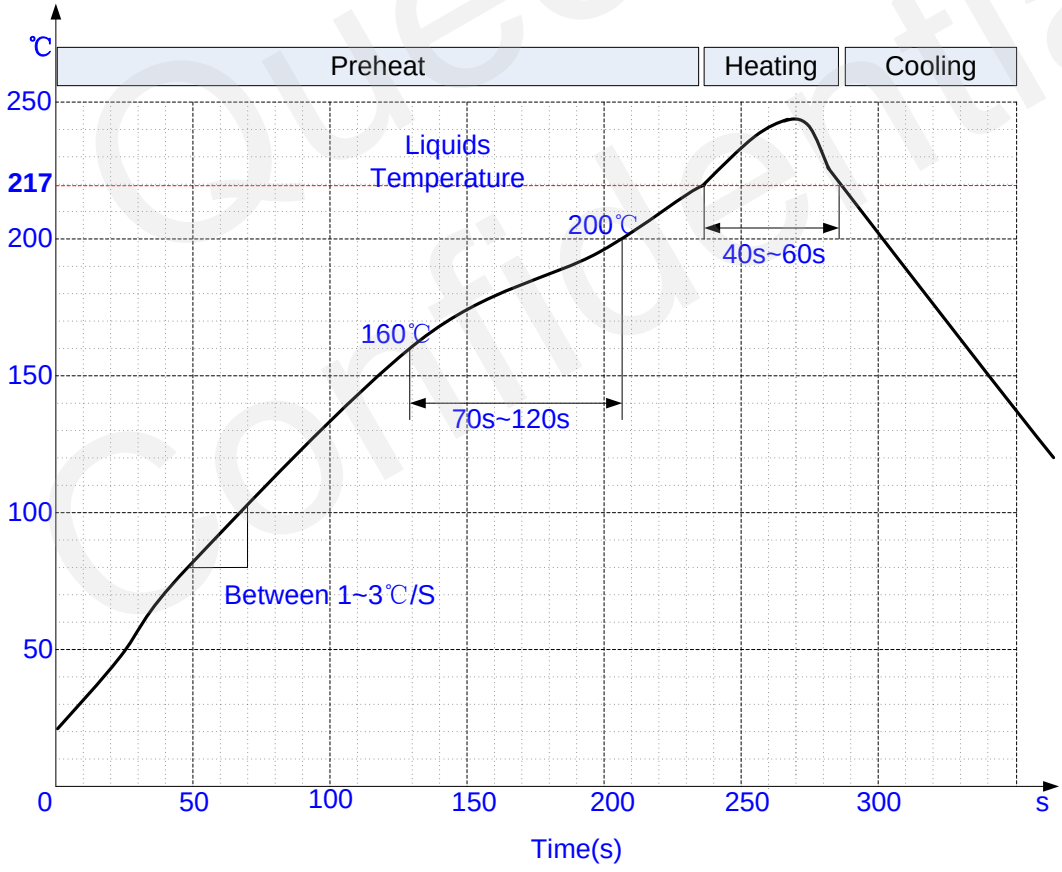

Figure 22: Ramp-soak-spike-reflow of Furnace Temperature

7.2. Moisture Sensitivity

L86 module is sensitivity to moisture absorption. To prevent L86 module from permanent damage during reflow soldering, baking before reflow is required in following cases:

- Humidity indicator card: At least one circular indicator is no longer blue.
- The seal is opened and the module is exposed to excessive humidity.

L86 module should be baked for 192 hours at temperature 40°C+5°C/-0°C and <5% RH in low-temperature containers, or 24 hours at temperature 125°C±5°C in high-temperature containers. Care should be taken that plastic tape is not heat resistant. L86 module should be taken out before preheating, otherwise, the tape maybe damaged by high-temperature heating.

7.3. ESD Protection

L86 module is an ESD sensitive device. ESD protection precautions should be emphasized. Proper ESD handing and packaging procedures must be applied throughout the processing, handling and operation of any application. Please note the following measures are good for ESD protection when L86 module is handled.

- Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact shall always be between the local GND and PCB GND when handling the PCB.
- Before mounting with the RF_IN pad, please make sure the GND of the module has been connected.
- Do not contact any charged capacitors and materials which can easily develop or store charges (such as patch antenna, coax cable, soldering iron) when handling with the RF_IN pad.
- To prevent electrostatic discharge from the RF input, please do not touch any exposed area of the mounted patch antenna.
- Make sure to use an ESD safe soldering iron (tip) when soldering the RF_IN pin.

7.4. Tape and Reel

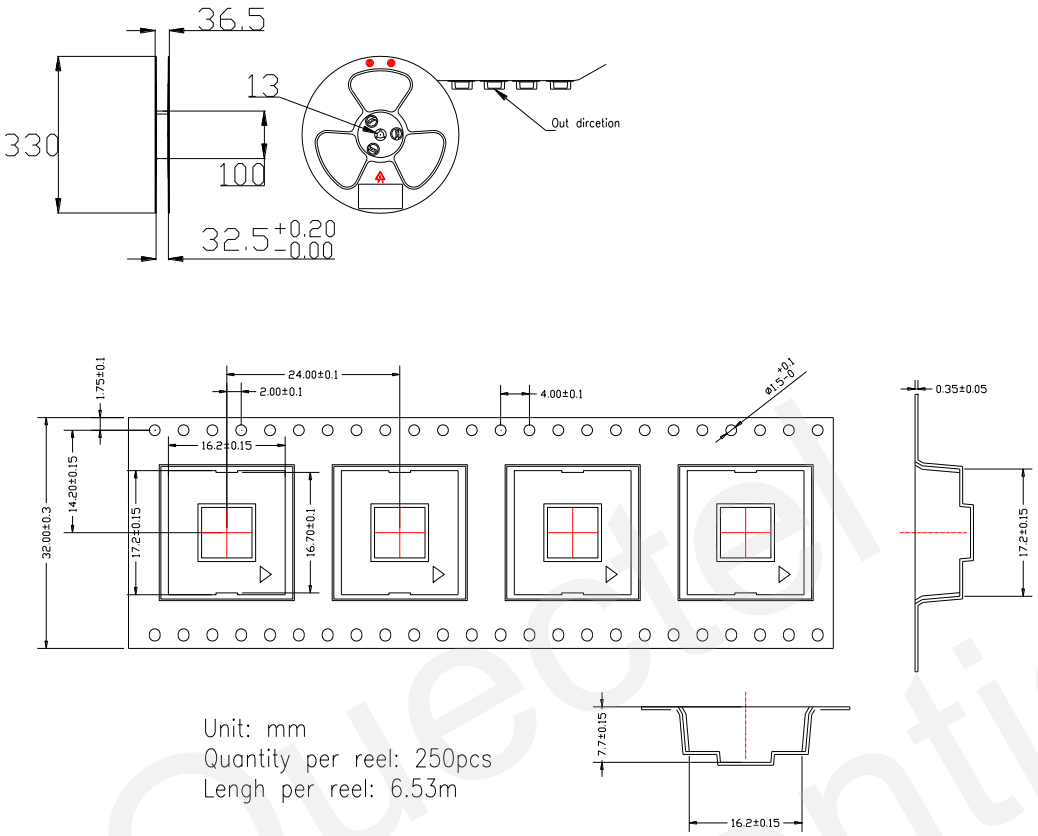

Figure 23: Tape and Reel Specification

Table 15: Reel Packing

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Packagex4=1000pcs
L86	250pcs	Size: 370mm × 350mm × 56mm N.W: 1.5kg G.W: 2.25kg	Size: 380mm × 250mm × 365mm N.W: 6.1kg G.W: 9.4kg

7.5. Ordering Information

Table 16: Ordering Information

Model Name	Ordering Code
L86	L86-M33

8 Appendix Reference

Table 17: Related Documents

SN	Document Name	Remark
[1]	Quectel_L86_EVB_User Guide	L86 EVB User Guide
[2]	Quectel_L86_GNSS_Protocol_Specification	L86 GNSS Protocol Specification
[3]	Quectel_L80&L86_Reference_Design	L80&L86 Reference Design
[4]	Quectel_GNSS_Modules_with_MTK_Engine_AN	GNSS Modules with MTK Engine Application Note

Table 18: Terms and Abbreviations

Abbreviation	Description
AGPS	Assisted GPS
AIC	Active Interference Cancellation
CEP	Circular Error Probable
DGPS	Differential GPS
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GGA	GPS Fix Data
GLL	Geographic Position – Latitude/Longitude

GLONASS	Global Navigation Satellite System
GSA	GNSS DOP and Active Satellites
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
I/O	Input/Output
Kbps	Kilo Bits Per Second
LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation System
MOQ	Minimum Order Quantity
NMEA	National Marine Electronics Association
PDOP	Position Dilution of Precision
PMTK	MTK Proprietary Protocol
PPS	Pulse Per Second
PRN	Pseudo Random Noise Code
QZSS	Quasi-Zenith Satellite System
RHCP	Right Hand Circular Polarization
RMC	Recommended Minimum Specific GNSS Data
SBAS	Satellite-based Augmentation System
SAW	Surface Acoustic Wave
SPDT	Single-Pole Double-Throw
TTFF	Time To First Fix
UART	Universal Asynchronous Receiver & Transmitter
VDOP	Vertical Dilution of Precision
VTG	Course over Ground and Ground Speed, Horizontal Course and Horizontal Velocity
WAAS	Wide Area Augmentation System
Inom	Nominal Current

Imax	Maximum Load Current
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value