L8x&LC86x Series

Difference Introduction

GNSS Module Series

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	The product must be powered by a stable voltage source, and the wiring shall conform to security precautions and fire prevention regulations.
	Proper ESD handling procedures must be followed throughout the mounting, handling and operation of any devices and equipment that incorporate the module to avoid ESD damages.

About the Document

Document Information	
Title	**L8x&LC86x Series Difference Introduction**
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Revision History

Version	Date	Description
-	2022-08-23	Creation of the document
1.0	2022-09-02	First official release
1.1	2023-11-06	1. Added the LC86G (PA) variant and updated the default constellations of LC86G (AA, AB, LA). 2. Added the summary for hardware and software differences (*Chapter 2*). 3. Added the voltage range of L80, L80-R, L86, LC86L series and LC86G (AA, AB, LA) and updated the power consumption, cold start and warm start of TTFF (without AGNSS) for LC86G (AA, AB, LA) (*Table 3* and *Table 4*). 4. Updated the pins of LC86G series as below (*Figure 2*, *Table 5* and *Table 9*): Updated the pin 7 from AP_REQ to RESERVED; Updated the pin 8 from TXD_DBG to AADET_N; Updated the pin 9 from RXD_DBG to RESERVED; Updated the pin 11 from RESERVED to EX_ANT. 5. Updated the RESET_N circuit of LC86G series (*Figure 7*). 6. Updated the weight of LC86G (AA, AB, LA) (*Table 8*). 7. Added the note to explain the details on BDS frequency bands supported by LC86G (LA, PA) (*Chapter 4.1*).

Version	Date	Description
		8. Added default constellations information for the modules (*Table 11*). 9. Added the chapter of UART baud rates (*Chapter 4.2*). 10. Added ZDA, GNS, GST, GRS and RLM for LC86G series (*Table 14*). 11. Updated the PMTK and PAIR messages of the module (*Table 17*). 12. Updated the chapter of PQ messages to the chapters of PQ Versus PQTM Messages and PQ versus PAIR messages (*Chapters 4.4.3* and *4.4.4*).

Contents

Table Index

Figure Index

1 Introduction

This document compares Quectel L80, L80-R, L86, LC86L series, and LC86G series GNSS modules. It provides a brief summary of their most relevant features and characteristics. The intention of this document is to simplify the migration to the new Quectel LC86G series GNSS module. For more information, contact your local FAE.

1.1. Applicable Modules

Table 1: Applicable Modules

Module Series	Model
-	L80
-	L80-R
-	L86
LC86L Series	LC86L (A)
	LC86L (B)
	LC86L (C)
LC86G Series	LC86G (AA)
	LC86G (AB)
	LC86G (LA)
	LC86G (PA)

Based on the latest enhanced chipset, LC86G series includes 4 variants whose pins, reference designs and software protocols are identical.

Differences between versions are listed below:

LC86G (AA): LC86G (AA) has 16.0 mm × 16.0 mm × 6.95 mm patch antenna, which supports GPS + Galileo + BDS by default.

LC86G (AB): LC86G (AB) has 16.0 mm × 16.0 mm × 6.95 mm patch antenna, which supports GPS + GLONASS + Galileo by default.

LC86G (LA): LC86G (LA) has 18.4 mm × 18.4 mm × 6.95 mm patch antenna, which supports GPS + GLONASS + Galileo + BDS + QZSS by default.

LC86G (PA): LC86G (PA) has 16.0 mm × 16.0 mm × 6.95 mm patch antenna, which supports GPS + GLONASS + Galileo + BDS + QZSS by default.

1.2. Special Mark

Table 2: Special Mark

Mark	Definition
●	The symbol indicates that a function or technology is supported by the module(s).

2 Summary

2.1 Summary of Hardware Difference

The main hardware differences between the L80, L80-R, L86, LC86L series and LC86G series are:

1. Power supply range (There are slight differences in the power supply range.):

   - VCC and V_BCKP power supply: All modules have the same typical voltage but different voltage ranges.
   - I/O power supply: Typical 2.8 V for L80, L80-R, L86 and LC86L series, while following VCC for LC86G series.

2. Footprint difference: The LC86G series has 24 more LGA ground pins than the L80, L80-R, L86 and LC86L series, which increase the module reliability.

3. Pin differences:

   - Pin 7:
     - RESERVED pin for L80-R and LC86G series;
     - TIMER pin for L80 which is used to control the on-off of the module's main power supply;
     - FORCE_ON and WAKEUP for L86 and LC86L series respectively which are used to wake up the module from Backup mode.
   - Pin 8:
     - RESERVED pin for L80-R;
     - AADET_N pin for L80, L86, LC86L series and LC86G series as external active antenna open circuit status indication. In addition, keep the pin of LC86G series at low level to switch to the external passive antenna.
   - Pin 11:
     - RESERVED pin for L80-R;
     - EX_ANT pin for L80, L86, LC86L series and LC86G series as external antenna input interface.

For more information, see *document [1]*, *[2]*, *[3]*, *[4]* and *[5] hardware designs*.

2.2 Summary of Software Difference

The main software differences between the L80, L80-R, L86, LC86L series and LC86G series are:

- The default constellation combinations of them are different.
- The default baud rate of them are different.
- AGNSS implementation modes and interface protocols are different.
- Different proprietary messages make the related configuration commands incompatible.

3 Hardware Differences

3.1. Feature Comparison

Table 3: Feature Comparison of Single-Constellation Modules and LC86G Series

Feature		L80	L80-R	LC86G (LA)	LC86G (AA)	LC86G (AB)	LC86G (PA)
GNSS Receiver Type		Single Band	Single Band	Single Band	Single Band	Single Band	Single Band
Constellations		GPS/QZSS	GPS/QZSS	GPS/QZSS, GLONASS, Galileo, BDS	GPS/QZSS, Galileo, BDS	GPS/QZSS, GLONASS, Galileo	GPS/QZSS, GLONASS, Galileo, BDS
Number of Concurrent Satellite Constellations		1 + QZSS	1 + QZSS	4 + QZSS	3 + QZSS	3 + QZSS	4 + QZSS
SBAS (WAAS, EGNOS, MSAS, GAGAN)		Supported	-	Supported	Supported	Supported	Supported
Memory Type		Flash	Flash	Flash	Flash	Flash	Flash
Power Consumption	Constellations	GPS	GPS	GPS + GLONASS + Galileo + BDS + QZSS	GPS + Galileo + BDS	GPS + GLONASS + Galileo	GPS + GLONASS + Galileo + BDS + QZSS
	Acquisition	25 mA	25 mA	34 mA	30 mA	33 mA	11 mA

Feature		L80	L80-R	LC86G (LA)	LC86G (AA)	LC86G (AB)	LC86G (PA)
	Tracking	20 mA	20 mA	34 mA	30 mA	33 mA	11 mA
	Backup mode	7 μA	7 μA	13 μA	13 μA	13 μA	13 μA
Sensitivity	Acquisition	-148 dBm	-148 dBm	-147 dBm	-147 dBm	-147 dBm	-147 dBm
	Reacquisition	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm
	Tracking	-165 dBm	-165 dBm	-166 dBm	-166 dBm	-166 dBm	-166 dBm
TTFF (without AGNSS)	Cold start	35 s	35 s	30 s	30 s	30 s	30 s
	Warm start	30 s	30 s	25 s	28 s	28 s	28 s
	Hot start	1 s	1 s	1 s	1 s	1 s	1 s
TTFF (with EASY)	Cold start	15 s	15 s	12 s	12 s	12 s	12 s
	Warm start	5 s	5 s	2 s	2 s	2 s	2 s
	Hot start	1 s	1 s	1 s	1 s	1 s	1 s
TTFF (with Flash EPO)	Cold start	5 s	-	5 s	5 s	5 s	5 s
Additional LNA		Supported	Supported	Supported	Supported	Supported	Supported
Oscillator		Integrated	Integrated	Integrated	Integrated	Integrated	Integrated
Horizontal Position Accuracy (CEP 50)		2.5 m	2.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Velocity Accuracy		0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s

Feature	L80	L80-R	LC86G (LA)	LC86G (AA)	LC86G (AB)	LC86G (PA)
Acceleration Accuracy	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2
Operating Temperature	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C
Default Baud Rate	9600 bps	9600 bps	115200 bps	115200 bps	115200 bps	115200 bps
VCC Power Supply	2.8–4.3 V	2.8–4.3 V	2.55–3.6 V	2.55–3.6 V	2.55–3.6 V	2.55–3.6 V
V_BCKP Power Supply	2.0–4.3 V	2.0–4.3 V	1.65–3.6 V	1.65–3.6 V	1.65–3.6 V	1.65–3.6 V
I/O Voltage [1]	2.8 V	2.8 V	VCC	VCC	VCC	VCC
Requires External Components	-	-	-	-	-	-

Table 4: Feature Comparison of Multi-Constellation Modules and LC86G Series

Feature	L86	LC86L (A)	LC86L (B)	LC86L (C)	LC86G (LA)	LC86G (AA)	LC86G (AB)	LC86G (PA)
GNSS Receiver Type	Single Band	Single Band	Single Band	Single Band	Single Band	Single Band	Single Band	Single Band
Constellations	GPS/QZSS, GLONASS, Galileo, BDS	GPS/QZSS, GLONASS, BDS	GPS/QZSS, GLONASS, BDS	GPS/QZSS, GLONASS, Galileo, BDS	GPS/QZSS, GLONASS, Galileo, BDS	GPS/QZSS, Galileo, BDS	GPS/QZSS, GLONASS, Galileo	GPS/QZSS, GLONASS, Galileo, BDS
Number of Concurrent Satellite Constellations	4 + QZSS	3 + QZSS	3 + QZSS	4 + QZSS	4 + QZSS	3 + QZSS	3 + QZSS	4 + QZSS
SBAS	WAAS, EGNOS, MSAS, GAGAN							

[1] For L80 and L80-R modules, the I/O voltage is 2.8 V but they could handle up to 3.1 V. See *documents [1]* and *[2] hardware designs* for more information about I/O voltage. It's suggested to use resistors in series for all I/O lines.

Feature		L86	LC86L (A)	LC86L (B)	LC86L (C)	LC86G (LA)	LC86G (AA)	LC86G (AB)	LC86G (PA)
Memory Type		Flash	Flash	Flash	Flash	Flash	Flash	Flash	Flash
Power Consumption	Constellations	GPS + GLONASS	GPS + GLONASS	GPS + BDS	GPS + GLONASS	G3 [2] + BDS + QZSS	G2 [2] + BDS	G3 [2]	G3 [2] + BDS + QZSS
	Acquisition	30 mA	32 mA	33 mA	32 mA	34 mA	30 mA	33 mA	11 mA
	Tracking	26 mA	31 mA	30 mA	30 mA	34 mA	30 mA	33 mA	11 mA
	Backup mode	7 μA	6 μA	6 μA	7 μA	13 μA	13 μA	13 μA	13 μA
Sensitivity	Acquisition	-149 dBm	-148 dBm	-148 dBm	-148 dBm	-147 dBm	-147 dBm	-147 dBm	-147 dBm
	Reacquisition	-161 dBm	-161 dBm	-161 dBm	-162 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm
	Tracking	-167 dBm	-166 dBm	-166 dBm	-166 dBm	-166 dBm	-166 dBm	-166 dBm	-166 dBm
TTFF (without AGNSS)	Cold start	35 s	35 s	35 s	35 s	30 s	30 s	30 s	30 s
	Warm start	30 s	30 s	30 s	30 s	25 s	28 s	28 s	28 s
	Hot start	1 s	2 s	2 s	2 s	1 s	1 s	1 s	1 s
TTFF (with EASY)	Cold start	15 s	15 s	15 s	15 s	12 s	12 s	12 s	12 s
	Warm start	5 s	5 s	5 s	5 s	2 s	2 s	2 s	2 s
	Hot start	1 s	2s	2 s	2 s	1 s	1 s	1 s	1 s
TTFF (with Flash EPO)	Cold start	5 s	4 s	4 s	4 s	5 s	5 s	5 s	5 s

[2] G3 is GPS + GLONASS + Galileo; G2 is GPS + Galileo.

Feature	L86	LC86L (A)	LC86L (B)	LC86L (C)	LC86G (LA)	LC86G (AA)	LC86G (AB)	LC86G (PA)
Additional LNA	Supported	Supported	Supported	Supported	Supported	Supported	Supported	Supported
Oscillator	Integrated	Integrated	Integrated	Integrated	Integrated	Integrated	Integrated	Integrated
Horizontal Position Accuracy (CEP50)	2.5 m	2.5 m	2.5 m	2.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Velocity Accuracy	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s	0.1 m/s
Acceleration Accuracy	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2	0.1 m/s^2
Operating Temperature	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40°C to +85 °C	-40°C to +85 °C
Default Baud Rate	9600 bps	9600 bps	9600 bps	9600 bps	115200 bps	115200 bps	115200 bps	115200 bps
VCC Power Supply	2.8–4.3 V	2.8–4.3 V	2.8–4.3 V	2.8–4.3 V	2.55–3.6 V	2.55–3.6 V	2.55–3.6 V	2.55–3.6 V
V_BCKP Power Supply	2.0–4.3 V	1.5–4.3 V	1.5–4.3 V	1.5–4.3 V	1.65–3.6 V	1.65–3.6 V	1.65–3.6 V	1.65–3.6 V
I/O Voltage [3]	2.8 V	2.8 V	2.8 V	2.8 V	VCC	VCC	VCC	VCC
Requires External Components	-	-	-	-	-	-	-	-

[3] For L86 and LC86L modules, the I/O voltage is 2.8 V but could handle up to 3.1 V. See *documents [3]* and *[4] hardware designs* for more information about I/O voltage. It's suggested to use resistors in series for all I/O lines.

3.2. Module View

The footprint of L80, L80-R, L86 and LC86L series is compatible and interchangeable with LC86G series. LC86G series has extra 24 GND pins, which can be left unconnected when replacing a compatible module on the same PCB. You should modify your PCB design since these additional ground pins provide enhanced mechanical stability for module applications in harsh and high vibration environments.

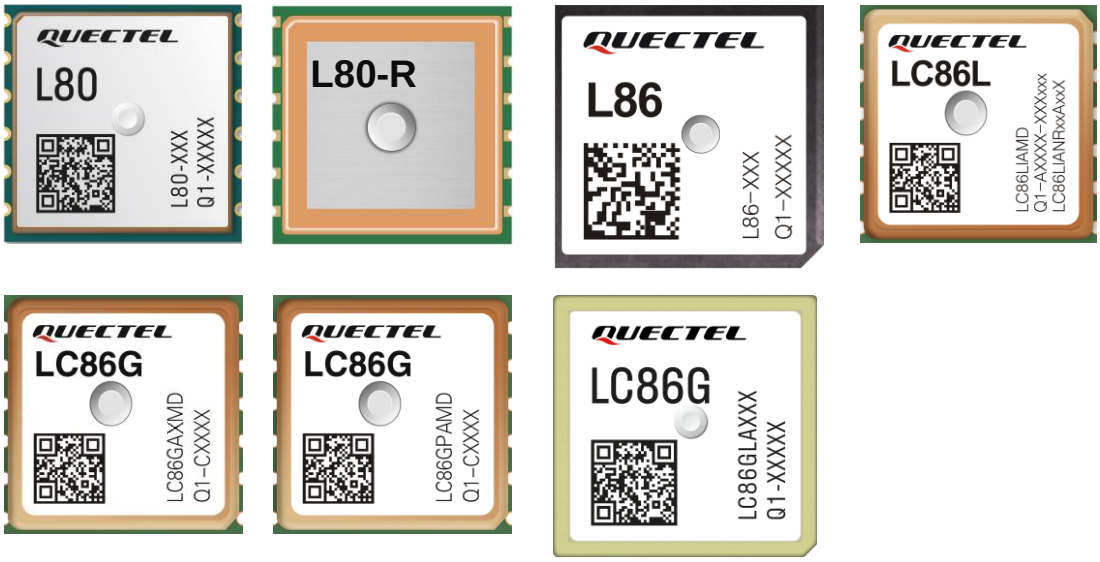


Figure 1: Module View

3.3. Pin Comparison

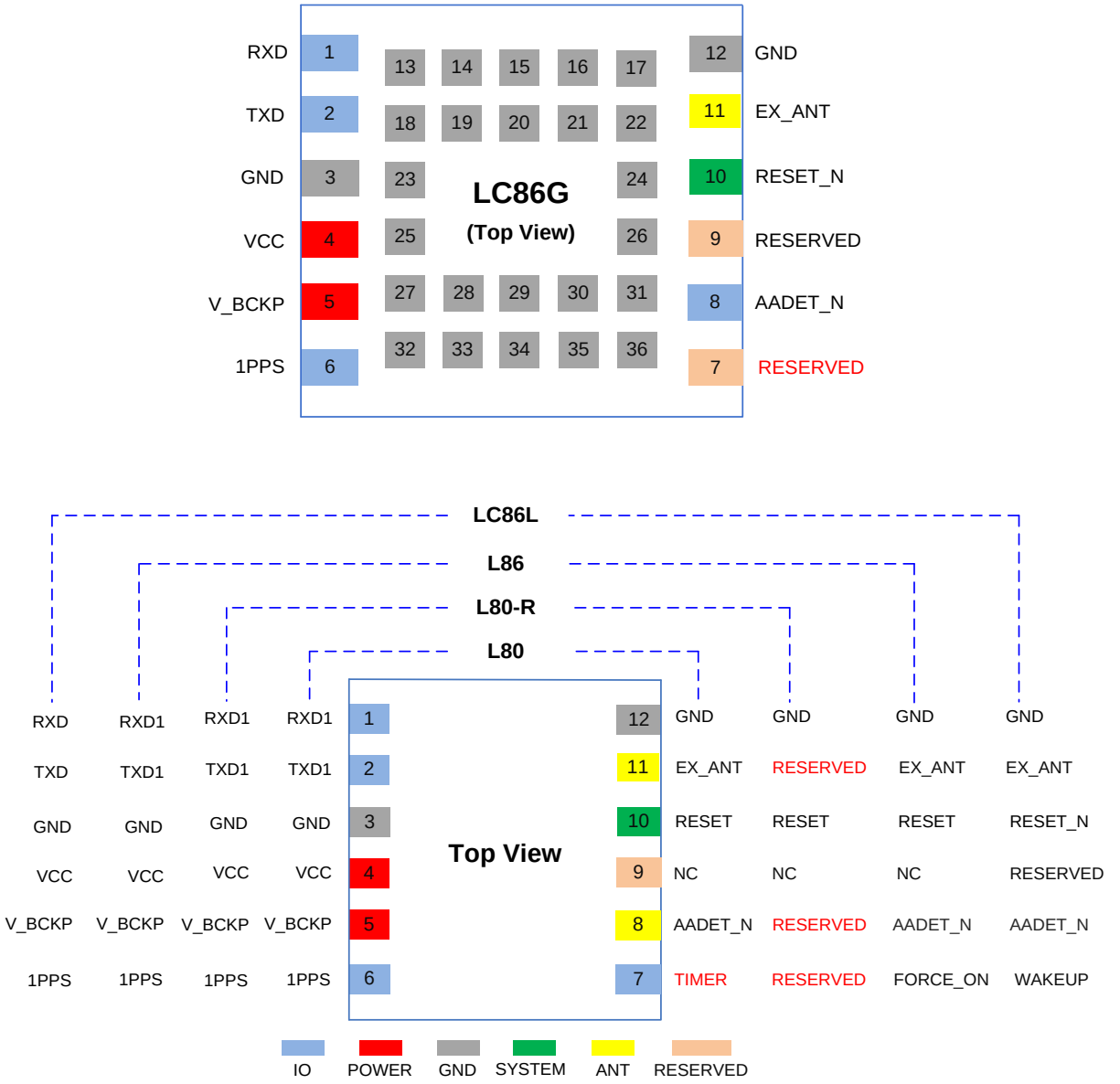


Figure 2: L80, L80-R, L86, LC86L Series and LC86G Series Pin Assignment

Table 5: Pin Comparison

Pin	L80	L80-R	L86	LC86L Series	LC86G Series
1	RXD1	RXD1	RXD1	RXD	RXD
2	TXD1	TXD1	TXD1	TXD	TXD
3	GND	GND	GND	GND	GND
4	VCC	VCC	VCC	VCC	VCC
5	V_BCKP	V_BCKP	V_BCKP	V_BCKP	V_BCKP
6	1PPS	1PPS	1PPS	1PPS	1PPS
7	TIMER	RESERVED	FORCE_ON	WAKEUP	RESERVED
8	AADET_N	RESERVED	AADET_N	AADET_N	AADET_N
9	NC	NC	NC	RESERVED	RESERVED
10	RESET	RESET	RESET	RESET_N	RESET_N
11	EX_ANT	RESERVED	EX_ANT	EX_ANT	EX_ANT
12	GND	GND	GND	GND	GND
13–36	-	-	-	-	GND

NOTE

1. For details on pin assignment and description of the dedicated module, see *documents [1], [2], [3], [4]* and *[5] hardware designs*.
2. The pin differences among the modules are indicated in red.

3.4. V_BCKP Power Supply

The same backup power supply can be applied to all modules. To ensure the correct power-up sequence, the backup unit should start up no later than the PMU. Hence, the V_BCKP must be powered simultaneously with the VCC or before it.

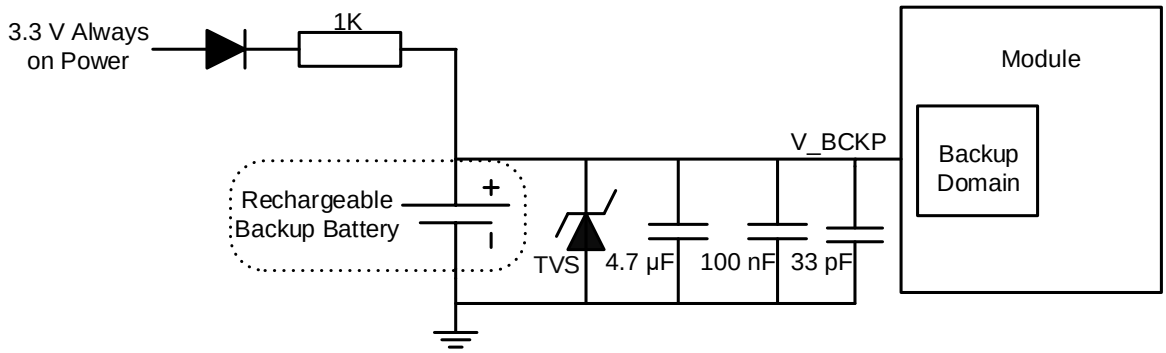


Figure 3: Decoupling Components for V_BCKP Power Supply

The V_BCKP must be connected to power supply at startup, and it should always be powered if hot (warm) start is needed. For more information on power-up sequence, see *documents [1], [2], [3], [4]* and *[5] hardware designs* for the dedicated module.

3.5. VCC Power Supply

Please apply the same filter to all GNSS modules. A Zener will protect module input from voltage peaks and surges. Capacitors should be placed close to the module to filter out all unwanted frequencies on the supply line.

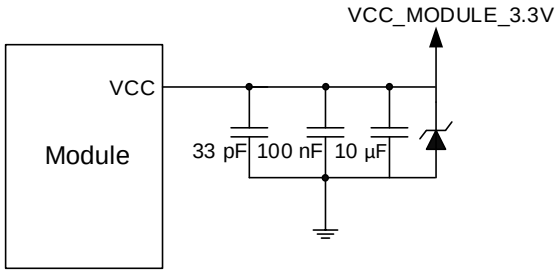


Figure 4: Decoupling Components for VCC Power Supply

3.6. TIMER Versus FORCE_ON Versus WAKEUP

L80 module uses TIMER (pin 7) signal to control an external power switch for low power operation. L86 and LC86L series use the signal from the host (FORCE_ON/WAKEUP) to put the integrated power switch to ON position. LC86G series has no pin to control power switch.

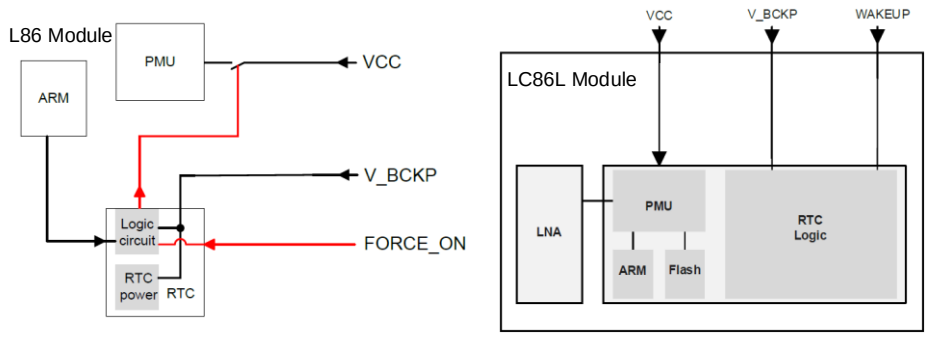


Figure 5: TIMER, FORCE_ON and WAKEUP Control Circuits

3.7. RESET_N

RESET_N is used to reset the modules from an unknown state. We have seen numerous customer designs without protection against power surges or undervoltage protection, designs not allowed for power switching, or designs with inadequate decoupling, etc. Therefore, it is strongly recommended to include the reset functionality in your design.

The reset function is implemented the same way for all modules. Inside the module, it is pulled up with a 10 kΩ resistor to an internal voltage domain. **Therefore, it cannot be driven by a host directly and a transistor or FET circuit is needed.**

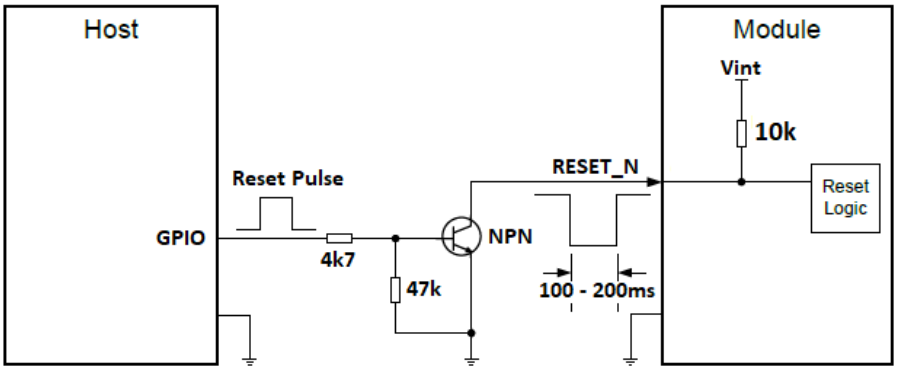


Figure 6: RESET_N Reference Circuit for All Modules

In addition, LC86G series module has internal pull-up on RESET_N pin which can be connected to an isolated diode. The pin can also be connected to the GPIOX of the MCU through a 0 Ω resistor (R1) or a triode (Q1) which is not mounted by default. Therefore, reference circuit presented in figure above is applied to all modules, whereas the circuit presented on figure below applies only to LC86G series.

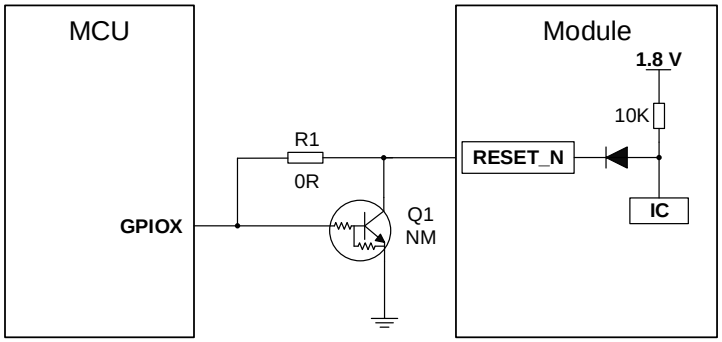
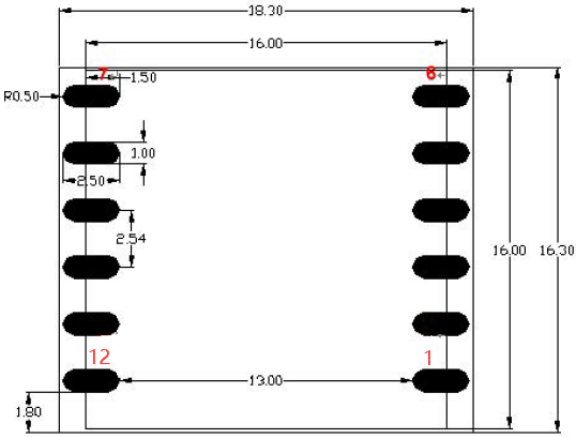
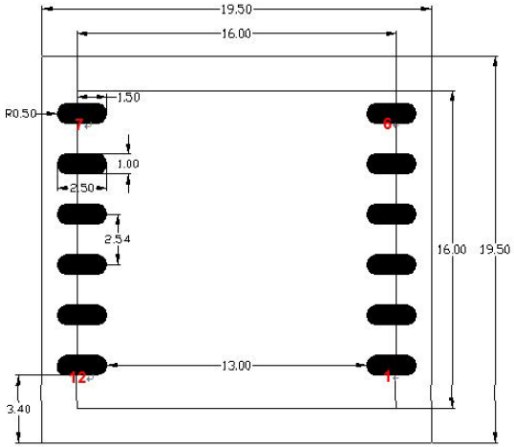


Figure 7: RESET_N Reference Circuit for LC86G Series

3.8. Mechanical Comparison

The following tables present the mechanical differences between the modules. For more information, please refer to their hardware design documents.

Table 6: L80, L80-R and L86 Mechanical Comparison

Mechanical Characteristics		
	L80/L80-R	**L86**
Footprint		

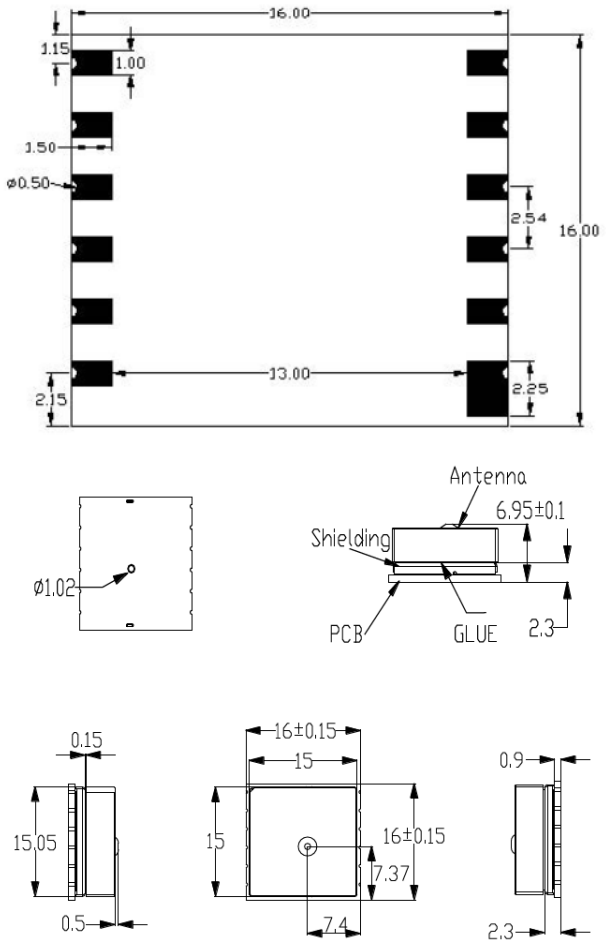
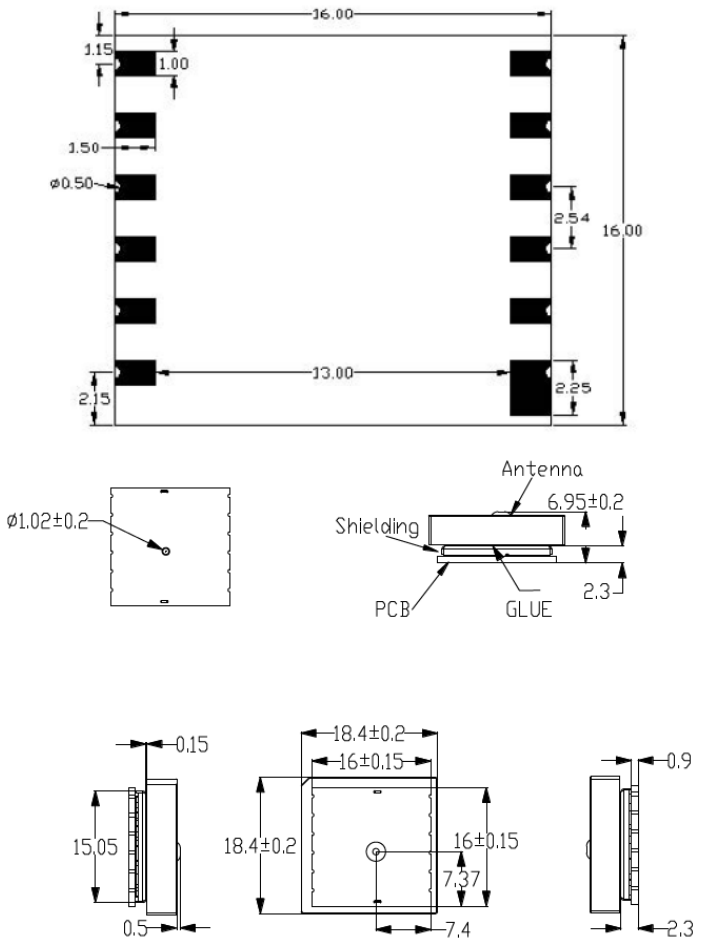
Mechanical Characteristics		
Drawing		
Length	16 mm	18.4 mm
Width	16 mm	18.4 mm
Height	6.95 mm	6.95 mm

Table 7: LC86L Series and LC86G Series Mechanical Comparison

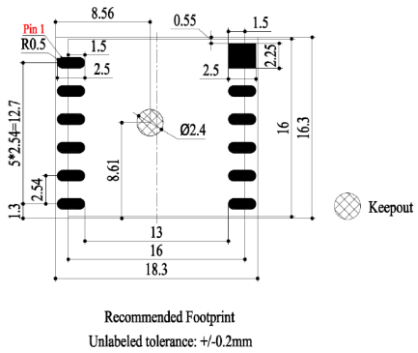
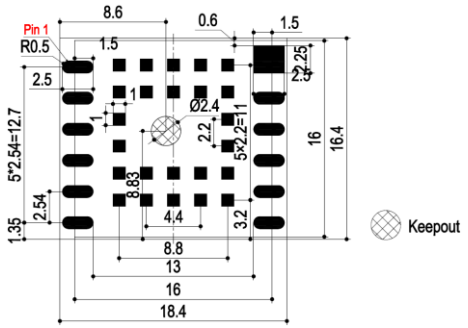
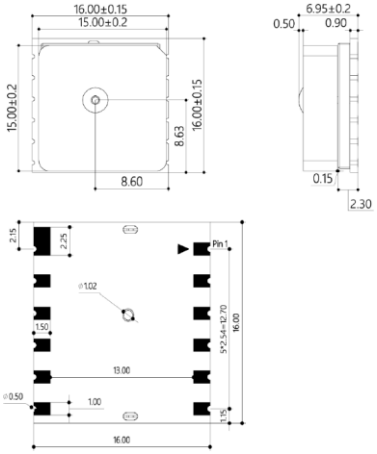
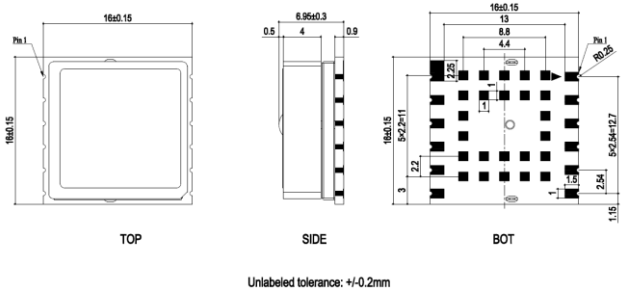
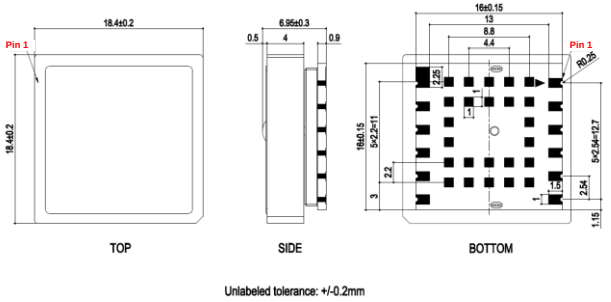
Mechanical Characteristics			
	LC86L Series	**LC86G (AA, AB, LA, PA)**	
Footprint	 Recommended Footprint Unlabeled tolerance: +/-0.2mm	 Unlabeled tolerance: +/-0.2mm	
Drawing		**LC86G (AA, AB, PA)**  Unlabeled tolerance: +/-0.2mm	**LC86G (LA)**  Unlabeled tolerance: +/-0.2mm
Length	16 mm	16 mm	18.4 mm
Width	16 mm	16 mm	18.4 mm
Height	6.95 mm	6.95 mm	6.95 mm

Table 8: Weight Specification

Module	L80/L80-R/LC86L Series	L86	LC86G (AA, AB, PA)	LC86G (LA)
Weight (g)	6.0	7.6	5.9	8.0

3.9. Electrical Compatibility

Voltage levels of L8x series and LC86x series are fully compatible. LC86G series has the I/O's at the power supply level, which will simplify communication circuits and reduce an LDO in the BOM.

Table 9: Voltage Tolerance Comparison

Voltage Level [4]	L80	L80-R	L86	LC86L Series	LC86G Series
VCC	2.8–4.3 V	2.8–4.3 V	2.8–4.3 V	2.8–4.3 V	2.55–3.6 V
V_BCKP	2–4.3 V	2–4.3 V	2–4.3 V	1.5–4.3 V	1.65–3.6 V
RESET_N [5]	-0.3–0.8 V	-0.3–0.8 V	-0.3–0.7 V	-0.3–0.7 V	-0.3–0.45 V
RXD	2.8 V	2.8 V	2.8 V	2.8 V	VCC
TXD	2.8 V	2.8 V	2.8 V	2.8 V	VCC
EX_ANT	VCC	-	VCC	VCC	VCC
TIMER	1.1–3.1 V	-	-	-	-
FORCE_ON/ WAKEUP	-	-	2.8 V	2.8 V	-
1PPS	2.8 V	2.8 V	2.8 V	2.8 V	VCC
AADET_N	2.8 V	-	2.8 V	2.8 V	VCC

[4] For L80, L80-R, L86, and LC86L, the I/O voltage is 2.8 V, but they could handle up to 3.1 V, see *documents [1], [2], [3]* and *[4] hardware designs*. It's suggested to use resistors in series for all I/O lines.
[5] RESET_N is internally pulled up and requires an external transistor driver.

4 Software Difference

4.1. Constellations

Table 10: Supported Constellations

System	L80	L80-R	L86	LC86L (A, B)	LC86L (C)	LC86G (LA, PA)	LC86G (AA)	LC86G (AB)
GPS	●	●	●	●	●	●	●	●
GLONASS	-	-	●	●	●	●	-	●
Galileo	-	-	●	-	●	●	●	●
BDS	-	-	●	●	●	●	●	-
QZSS	●	●	●	●	●	●	●	●
SBAS	●	-	●	●	●	●	●	●

NOTE

1. LC86G (PA) supports BDS B1I and B1C by default.
2. LC86G (LA) supports BDS B1I by default and it can support BDS B1I and B1C by executing the relevant command.

Table 11: Supported Constellation Combinations

Module	Combinations
L80/L80-R	● GPS ● GPS + QZSS (Default)
L86	● GPS ● GPS + QZSS ● GPS + BDS ● GPS + BDS + QZSS ● GPS + GLONASS

Module	Combinations
	● GPS + GLONASS + QZSS (Default) ● GPS + GLONASS + Galileo ● GPS + GLONASS + Galileo + QZSS ● GPS + Galileo ● GPS + Galileo + QZSS
LC86L (A)	● GPS ● GPS + QZSS ● GPS + BDS ● GPS + BDS + QZSS ● GPS + GLONASS (Default) ● GPS + GLONASS + QZSS
LC86L (B)	● GPS ● GPS + QZSS ● GPS + BDS (Default) ● GPS + BDS + QZSS ● GPS + GLONASS ● GPS + GLONASS + QZSS
LC86L (C)	● GPS ● GPS + QZSS ● GPS + BDS ● GPS + BDS + QZSS ● GPS + GLONASS ● GPS + GLONASS + QZSS (Default) ● GPS + GLONASS + Galileo ● GPS + GLONASS + Galileo + QZSS ● GPS + Galileo ● GPS + Galileo + QZSS
LC86G (LA, PA)	● GPS ● GPS + QZSS ● GPS + BDS ● GPS + BDS + QZSS ● GPS + GLONASS ● GPS + GLONASS + QZSS ● GPS + GLONASS + Galileo + BDS ● GPS + GLONASS + Galileo + BDS + QZSS (Default) ● GPS + Galileo ● GPS + Galileo + QZSS
LC86G (AA)	● GPS ● GPS + QZSS ● GPS + BDS ● GPS + BDS + QZSS ● GPS + Galileo

Module	Combinations
	● GPS + Galileo + QZSS ● GPS + Galileo + BDS (Default) ● GPS + Galileo + BDS + QZSS
LC86G (AB)	● GPS ● GPS + QZSS ● GPS + GLONASS ● GPS + GLONASS + QZSS ● GPS + GLONASS + Galileo (Default) ● GPS + GLONASS + Galileo + QZSS ● GPS + Galileo ● GPS + Galileo + QZSS

4.2. UART Baud Rates

Table 12: Supported UART Baud Rates by Default

AGNSS	Band Rate
L80	9600 bps
L80-R	9600 bps
L86	9600 bps
LC86L (A)	9600 bps
LC86L (B)	115200 bps
LC86L (C)	115200 bps
LC86G Series	115200 bps

4.3. AGNSS

Table 13: Supported AGNSS

AGNSS	L80	L80-R	L86	LC86L Series	LC86G Series
EASY	●	●	●	●	●
Flash EPO	●	-	●	●	●
Host EPO	●	●	●	●	●

4.4. NMEA Protocol Differences

4.4.1. Standard NMEA Message Differences

- L80, L86, LC86L series and LC86G series are compatible with NMEA 0183 V4.10 protocol.
- L80-R is compatible with NMEA 0183 V3.01 protocol.

Table 14: Supported NMEA Messages

Message	L80	L80-R	L86	LC86L Series	LC86G Series
RMC	●	●	●	●	●
GGA	●	●	●	●	●
GSV	●	●	●	●	●
GSA	●	●	●	●	●
VTG	●	●	●	●	●
GLL	●	●	●	●	●
TXT	●	-	●	●	-
GBS	-	-	●	●	-
DTM	●	-	●	●	-
ZDA	–	-	–	–	●
GNS	–	-	–	–	●

Message	L80	L80-R	L86	LC86L Series	LC86G Series
GST	–	-	–	–	●
GRS	–	-	–	–	●
RLM	–	-	–	–	●

NOTE

The modules support the same NMEA sentence format.

Table 15: Difference on NMEA Talker ID

GNSS Constellation Configuration	TalkerID (NMEA 0183 V3.01)	TalkerID (NMEA 0183 V4.10)		
	L80-R	L80	L86/LC86L Series	LC86G Series
GPS	GP	GP	GP	GP
GLONASS	-		GL	GL
Galileo	-		GA	GA
BDS	-		BD	GB
QZSS	GP	GP	GP	GP
Combination of Multiple Satellite Systems	GP	GP	GN	GN

On L86, the Talker ID of position fixed is shown in the table below. The Talker ID is always **GP** if the position is not fixed.

Table 16: Talker ID of Position Fixed for L86

Constellation Combinations	RMC	GGA	GSA	GLL	VTG
GPS + GLONASS	GN	GP	GN	GN	GP
GPS + BDS	GP	GP	GP	GP	GP
GPS + Galileo	GN	GP	GN	GN	GP

Constellation Combinations	RMC	GGA	GSA	GLL	VTG
GPS + GLONASS + Galileo	GN	GP	GN	GN	GP

4.4.1.1. RMC

Recommended Minimum Specific GNSS Data. Time, date, position, course, and speed data provided by a GNSS receiver.

Type:

Output

Synopsis:

```
$<TalkerID>RMC,<UTC>,<Status>,<Lat>,<N/S>,<Lon>,<E/W>,<SOG>,<COG>,<Date>,<MagVar>,<MagVarDir>,<ModeInd>,<NavStatus>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Note
$	character	-
<TalkerID>	String, 2 characters	-
RMC	String, 3 characters	-
<UTC>	hhmmss.sss	-
<Status>	Character	-
<Lat>	ddmm.mmmmmm	L80, L80-R, and L86: Default length of minute decimal fraction is 4 digits. LC86L series and LC86G series: Default length of minute decimal fraction is 6 digits.
<N/S>	Character	-
<Lon>	dddmm.mmmmmm	L80, L80-R, and L86: Default length of minute decimal fraction is 4 digits. LC86L series and LC86G series: Default length of minute decimal fraction is 6 digits.
<E/W>	Character	-
<SOG>	Numeric	-

Field	Format	Note
<COG>	Numeric	-
<Date>	ddmmyy	-
<MagVar>	-	-
<MagVarDir>	-	-
<ModeInd>	Character	-
<NavStatus>	Character	L80-R: This field does not exist.
<Checksum>	Hexadecimal	-
<CR><LF>	Character	-

4.4.1.2. GGA

Global Positioning System Fix Data. Time, position, and fix-related data for a GNSS receiver.

Type:

Output

Synopsis:

```
$<TalkerID>GGA,<UTC>,<Lat>,<N/S>,<Lon>,<E/W>,<Quality>,<NumSatUsed>,<HDOP>,<Alt>,M,<Sep>,M,<DiffAge>,<DiffStation>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Note
$	character	-
<TalkerID>	String, 2 characters	-
GGA	String, 3 characters	-
<UTC>	hhmmss.sss	-
<Lat>	ddmm.mmmmmm	L80, L80-R, and L86: Default length of minute decimal fraction is 4 digits. LC86L series and LC86G series: Default length of minute decimal fraction is 6 digits.

Field	Format	Note
<N/S>	Character	-
<Lon>	dddmm.mmmmmm	L80, L80-R, and L86: Default length of minute decimal fraction is 4 digits. LC86L series and LC86G series: Default length of minute decimal fraction is 6 digits.
<E/W>	Character	-
<Quality>	Numeric, 1 digit	-
<NumSatUsed>[1)]	Numeric, 2 digits	-
<HDOP>	Numeric	-
<Alt>	Numeric	L80, L80-R, and L86: Default length of decimal fraction is 1 digit. LC86L series and LC86G series: Default length of decimal fraction is 3 digits.
M	Character	-
<Sep>	Numeric	L80, L80-R, and L86: Default length of decimal fraction is 1 digit. LC86L series and LC86G series: Default length of decimal fraction is 3 digits.
M	Character	-
<DiffAge>	-	-
<DiffStation>	-	-
<Checksum>	Hexadecimal	-
<CR><LF>	Character	-

NOTE

1. The NMEA 0183 specification indicates that the **GGA** message is GPS specific. However, when the receiver is configured for multi-constellations, the content of **GGA** message will be generated from the multi-constellation solution.
2. [1)] According to the NMEA 0183 specification, the number of satellites in use is between 00 and 12. However, in the multi-constellation solution, the number of satellites in use may exceed 12.

4.4.1.3. GSV

GNSS Satellites in View. The **GSV** sentence provides the number of satellites in view (SV), satellite ID numbers, elevation, azimuth, and SNR value, and it contains maximum four satellites per transmission. Therefore, it may take several sentences to get complete information. The total number of sentences being transmitted and the sentence number are indicated in the first two data fields.

Type:

Output

Synopsis:

```
$<TalkerID>GSV,<TotalNumSen>,<SenNum>,<TotalNumSat>{,<SatID>,<SatElev>,<SatAz>,<SatCN0>},<SignalID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Note
$	character	-
<TalkerID>	String, 2 characters	-
GSV	String, 3 characters	-
<TotalNumSen>	Numeric	L80-R: Number of messages. Range: 1–3. L80, L86, LC86L series, and LC86G series: Number of messages. Range: 1–9.
<SenNum>	Numeric	-
<TotalNumSat>	Numeric	-
Start of repeat block. Repeat times: 1–4.		
<SatID>	Numeric	-
<SatElev>	Numeric	-
<SatAz>	Numeric	-
<SatCN0>	Numeric	-
End of repeat block.		
<SignalID>	Numeric	L80-R: This field does not exist.
<Checksum>	Hexadecimal	-

Field	Format	Note
<CR><LF>	Character	-

NOTE

GN cannot be used for **GSV** sentences. If satellites of multiple constellations are in view, use separate **GSV** sentences with the corresponding **<Talker ID>** for each constellation.

4.4.1.4. GSA

GNSS DOP and Active Satellites. GNSS receiver operating mode, satellites used in the navigation solution reported by the **GGA** sentence, and DOP values.

Type:

Output

Synopsis:

```
$<TalkerID>GSA,<Mode>,<FixMode>{,<SatID>},<PDOP>,<HDOP>,<VDOP><SystemID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Note
$	character	-
<TalkerID>	String, 2 characters	L80 and L80-R: Always "GP". L86, LC86L series, and LC86G series: See *Table 15: Difference on NMEA Talker ID*
GSA	String, 3 characters	-
<Mode>	Character	-
<FixMode>	Numeric	-
Start of repeat block. Repeat times: 12.		
<SatID>	Numeric	-
End of repeat block.		
<PDOP>	Numeric	-

Field	Format	Note
<HDOP>	Numeric	-
<VDOP>	Numeric	-
<SystemID>	Numeric	L80-R: This field does not exist.
<Checksum>	Hexadecimal	-
<CR><LF>	Character	-

NOTE

1. L80, L80-R, L86, LC86L series: If less than 12 satellites are used for navigation, the remaining **<SatID>** fields are left empty. If more than 12 satellites are used for navigation, only the IDs of the first 12 are output.
2. LC86G series: None of the above restrictions apply.

4.4.1.5. VTG

Course Over Ground & Ground Speed. The actual course and speed relative to the ground.

Type:

Output

Synopsis:

```
$<TalkerID>VTG,<COGT>,T,<COGM>,M,<SOGN>,N,<SOGK>,K,<ModeInd>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Note
$	character	-
<TalkerID>	String, 2 characters	-
VTG	String, 3 characters	-
<COGT>	Numeric	L80-R: Default length of minute decimal fraction is 1 digit. L80, L86, LC86L series and LC86G series: Default length of minute decimal fraction is 2 digits.

Field	Format	Note
T	Character	-
<COGM>	Numeric	-
M	Character	-
<SOGN>	Numeric	L80-R: Default length of minute decimal fraction is 1 digit. L80, L86, LC86L series, and LC86G series: Default length of minute decimal fraction is 2 digits.
N	Character	-
<SOGK>	Numeric	L80-R: Default length of minute decimal fraction is 1 digit. L80, L86, LC86L series, and LC86G series: Default length of minute decimal fraction is 2 digits.
K	Character	-
<ModeInd>	Character	-
<Checksum>	Hexadecimal	-
<CR><LF>	Character	-

4.4.1.6. GLL

Geographic Position – Latitude/Longitude. Latitude and longitude of the GNSS receiver position, the time of position fix and status.

Type:

Output

Synopsis:

```
$<TalkerID>GLL,<Lat>,<N/S>,<Lon>,<E/W>,<UTC>,<Status>,<ModeInd>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Note
$	character	-
<TalkerID>	String, 2 characters	-
GLL	String, 3 characters	-
<Lat>	ddmm.mmmmmm	L80, L86, and L80-R: Default length of minute decimal fraction is 4 digits. LC86L series and LC86G series: Default length of minute decimal fraction is 6 digits.
<N/S>	Character	-
<Lon>	dddmm.mmmmmm	L80, L86, and L80-R: Default length of minute decimal fraction is 4 digits. LC86L series and LC86G series: Default length of minute decimal fraction is 6 digits.
<E/W>	Character	-
<UTC>	hhmmss.sss	-
<Status>	Character	-
<ModeInd>	Character	-
<Checksum>	Hexadecimal	-
<CR><LF>	Character	-

4.4.2. PMTK Versus PAIR Messages

PMTK messages are supported by Quectel L80, L80-R, L86, and LC86L series.

PAIR messages are supported by LC86G series.

Table 17: Differences between PMTK and PAIR Messages

L80	L80-R	L86	LC86L Series	LC86G Series	Description
PMTK001	PMTK001	PMTK001	PMTK001	PAIR001	Acknowledges message.
-	-	-	-	PAIR002	Powers on the GNSS system.

L80	L80-R	L86	LC86L Series	LC86G Series	Description
-	-	-	-	PAIR003	Powers off the GNSS system.
PMTK161	PMTK161	PMTK161	PMTK161	-	Enables/disables Standby mode.
PMTK101	PMTK101	PMTK101	PMTK101	PAIR004	Performs a hot start.
PMTK102	PMTK102	PMTK102	PMTK102	PAIR005	Performs a warm start.
PMTK103	PMTK103	PMTK103	PMTK103	PAIR006	Performs a cold start.
PMTK104	PMTK104	PMTK104	PMTK104	PAIR007	Performs a cold start and clears system and user configurations at the start.
PMTK010	PMTK010	PMTK010	PMTK010	PAIR010	Notifies the expiration of GNSS aiding data stored on the module.
PMTK011	PMTK011	PMTK011	PMTK011	PAIR011	Automatically outputs text message when the modules are powered up.
PMTK220	PMTK220	PMTK220	PMTK220	PAIR050	Sets position fix interval.
-	PMTK500 PMTK400	-	-	PAIR051	Gets the position fix interval.
-	-	PMTK306	PMTK306	PAIR058	Sets the minimum SNR of satellites in use.
-	-	-	-	PAIR059	Gets the minimum SNR of satellites in use.
PMTK314	PMTK314	PMTK314	PMTK314	PAIR062	Sets the output rate of standard NMEA sentence.
PMTK414 PMTK514	PMTK414 PMTK514	PMTK414 PMTK514	PMTK414 PMTK514	PAIR063	Gets the output rate of standard NMEA sentence.
PMTK351 PMTK352	-	PMTK351 PMTK352 PMTK353	PQTM351 PMTK352 PMTK353	PAIR066	Sets the GNSS search mode.
-	-	-	-	PAIR067	Gets the GNSS search mode.
PMTK386	PMTK386	PMTK386	PMTK386	PAIR070	Sets the static navigation speed threshold.
-	-	-	-	PAIR071	Gets the static navigation speed threshold.
-	-	PMTK311	PMTK311	PAIR072	Sets satellite elevation mask.
-	-	-	-	PAIR073	Gets satellite elevation mask.
PMTK286	PMTK286	PMTK286	PMTK286	PAIR074	Enables/disables AIC function.

L80	L80-R	L86	LC86L Series	LC86G Series	Description
-	-	-	-	PAIR075	Queries AIC function.
PMTK886	PMTK886	PMTK886	PMTK886	PAIR080	Sets navigation mode.
-	-	-	-	PAIR081	Gets navigation mode.
-	-	-	-	PAIR086	Enables/disables debug log output in binary format.
-	-	-	-	PAIR087	Queries the debug log output setting.
				PAIR098	Sets the decimal places for the position displayed in NMEA.
				PAIR099	Gets the decimal places for the position displayed in NMEA.
-	-	-	-	PAIR154	Enables/disables outputting of RLM message at 1 Hz
-	-	-	--	PAIR155	Queries RLM message output setting.
-	-	-	-	PAIR158	Enables/disables tracking of BDS B1C satellite band.
-	-	-	-	PAIR159	Queries tracking of BDS B1C band status.
-	-	-	-	PAIR382	Enables/disables system sleep status locking.
PMTK838	-	-	-	PAIR391	Enables/disables jamming detection.
PMTK301	PMTK301	PMTK301	PMTK301	PAIR400	Sets the source mode of DGPS correction data.
PMTK401 PMTK501	PMTK401 PMTK501	PMTK401 PMTK501	PMTK401 PMTK501	PAIR401	Queries the setting of DGPS mode.
PMTK313	-	PMTK313	PMTK313	PAIR410	Enables/disables the searching of SBAS satellites.
PMTK413 PMTK513	-	PMTK413 PMTK513	PMTK413 PMTK513	PAIR411	Queries the status of SBAS satellite search.
-	-	-	-	PAIR432	Sets RTCM output mode.
-	-	-	-	PAIR433	Queries RTCM output mode.
-	-	-	-	PAIR434	Enables/disables outputting stationary antenna reference in RTCM format.

L80	L80-R	L86	LC86L Series	LC86G Series	Description
-	-	-	-	PAIR435	Queries the setting of stationary antenna reference point.
-	-	-	-	PAIR436	Enables/disables outputting satellite ephemeris information in RTCM format.
-	-	-	-	PAIR437	Queries the status of outputting satellite ephemeris.
PMTK869	PMTK869	PMTK869	PMTK869	PAIR490	Enables/disables EASY function.
-	-	-	-	PAIR491	Queries the status of EASY function.
-	-	-	-	PAIR511	Saves current navigation data from RTC RAM to flash.
-	-	-	-	PAIR513	Saves the current configurations from RTC RAM to flash.
PMTK225	-	PMTK225	PMTK225	PAIR650	Puts the module to Backup mode.
-	-	-	-	PAIR680	Enables/disables GPS Low Power (GLP) mode
-	-	-	-	PAIR681	Queries GPS Low Power (GLP) mode setting.
PMTK225	-	PMTK225	PMTK225	PAIR690	Sets the modules to Periodic mode for power saving.
-	-	-	-	PAIR691	Queries Periodic Power Saving m ode configurations.
-	-	-	-	PAIR730	Enables/disables Fitness Low Power (FLP) mode.
-	-	-	-	PAIR731	Queries FLP mode setting.
-	-	-	-	PAIR732	Enables/disables adaptive low power (ALP) mode.
-	-	-	-	PAIR733	Queries adaptive low-power (ALP) mode configuration setting.
PMTK285	PMTK285	PMTK285	PMTK285	PAIR752	Sets PPS configurations.
-	-	-	-	PAIR864	Sets the baud rate of UART interface.
-	-	-	-	PAIR865	Gets the baud rate of UART interface.
PMTK185	-	PMTK185	PMTK185	PAIR900	Stops or starts LOCUS data logging.

L80	L80-R	L86	LC86L Series	LC86G Series	Description
PMTK183	-	PMTK183	PMTK183	PAIR901 PAIR903 PAIR905	Queries the LOCUS logging status.
-	-	-	-	PAIR902	Sets LOCUS saving mode.
-	-	-	-	PAIR904	Sets LOCUS mode threshold.
PMTK184	-	PMTK184	PMTK184	PAIR906	Erases the LOCUS logger flash data.
-	-	-	-	PAIR907	Saves current fix data in flash.
PMTK622	-	PMTK622	PMTK622	PAIR908	Dumps LOCUS Data
-	-	-	-	PAIR909	Queries total number of recorded LOCUS data

NOTE

The default configurations of the modules are different, and you need to check the protocol document for detailed command introduction. See *documents [6], [7]* and *[8] protocol specifications* for details.

4.4.3. PQ Versus PQTM Messages

PQ messages are supported by Quectel L80, L86, and LC86L series.

PQTM message are supported by Quectel LC86G series.

Table 18: Differences Between PQ and PQTM Messages

L80	L86	LC86L Series	LC86G Series	Description
PQEPE	PQEPE	PQEPE	PQTMEPE	EPE message outputting.
-	-	-	PQTMCFGMSGRATE	Configures message output rate on the current port.
PQ1PPS	PQ1PPS	PQ1PPS	PQTMCFGPPS	Sets the type and pulse width of 1PPS output.
PQTXT	PQTXT	PQTXT	PQTMANTENNASTATUS	Antenna detection feature
PQECEF	PQECEF	PQECEF	-	Enables/disables ECEFPOSVEL message outputting.

L80	L86	LC86L Series	LC86G Series	Description
ECEFPOSVEL	ECEFPOSVEL	ECEFPOSVEL	-	This message is automatically output when PQECEF is enabled.
PQODO	PQODO	PQODO	PQTMODO	Starts/stops odometer reading.
PQPZ90	PQPZ90	PQPZ90	-	Enables/disables switching from WGS84 to PZ-90.11.
PQVEL	PQVEL	PQVEL	-	Enables/disables PQVEL message outputting.
PQGEO	PQGEO	PQGEO	PQTMCFGGEOFENCE	Configures Geo-fence parameters.
-	-	-	PQTMGEOFENCESTATUS	Outputs the geofences status.
-	PQGBS	PQGBS	-	Enables/disables the outputting of the GBS sentence used to support receiver autonomous integrity monitoring (RAIM).
PQVERNO	PQVERNO	PQVERNO	PQTMVERNO	Queries the information about firmware version.
-	-	-	PQTMSAVEPAR	Saves the configurations set via $PQTM commands to NVM.
-	-	-	PQTMREATOREPAR	Restores all parameters set via $PQTM to default values.
-	-	-	PQTMCFGANTENNA	Configures the antenna working mode.
-	-	-	PQTMPVT	Outputs the PVT (GNSS only) result.

4.4.4. PQ Versus PAIR Messages

PQ messages are supported by Quectel L80, L86, and LC86L series.

PAIR messages are supported by Quectel LC86G series.

Table 19: Differences Between PQ and PAIR Messages

L80	L86	LC86L Series	LC86G Series	Description
PQBAUD	PQBAUD	PQBAUD	PAIR864	Sets NMEA port default baud rate.
PQFLP	-	-	PAIR730 PAIR731	Sets the modules to FLP mode and gets whether the FLP mode

L80	L86	LC86L Series	LC86G Series	Description
				is enabled.
-	PQGLP	PQGLP	PAIR680 PAIR681	Sets the modules to GLP mode and gets whether the GLP mode is enabled.
PQJAM	PQJAM	PQJAM	PAIR391	Enables/disables jamming detection function.
-	PQRLM	PQRLM	PAIR154	Enables/disables the return link message outputting.
-	PQPREC	PQPREC	PAIR098 PAIR099	Sets/Gets NMEA position shown digit mode.

NOTE

Among LC86L (A), LC86L (B) and LC86L (C), only LC86L (C) supports **PQRLM**.

5 Appendix A References

Table 20: Related Documents

Document Name
[1] Quectel_L80_Hardware_Design
[2] Quectel_L80-R_Hardware_Design
[3] Quectel_L86_Hardware_Design
[4] Quectel_LC86L_Hardware_Design
[5] Quectel_LC86G_Series_Hardware_Deisgn
[6] Quectel_Lx0&Lx6&LC86L&LG77L_GNSS_Protocol_Specification
[7] Quectel_L80-R_GPS_Protocol_Specification
[8] Quectel_LC26G&LC26G-T&LC76G&LC86G_Series_GNSS_Protocol_Specification

Table 21: Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted GNSS (Global Navigation Satellite System)
AIC	Active Interference Cancellation
BDS	BDS Satellite Navigation System
BOM	Bill of Materials
bps	bit(s) per second
CEP	Circular Error Probable
COGM	Course over Ground (in Magnetic North Course Direction)
COGT	Course over Ground (in True North Course Direction)

Abbreviation	Description
DGPS	Differential Global Positioning System
DTM	Datum Reference
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
FET	Field Effect Transistor
GAGAN	GPS Aided Geo Augmented Navigation
Galileo	Galileo Satellite Navigation System (EU)
GBS	GNSS Satellite Fault Detection
GGA	Global Positioning System Fix Data
GLL	Geographic Position - Latitude and Longitude
GLONASS	Global Navigation Satellite System (Russia)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	GNSS DOP and Active Satellites
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
I/O	Input/Output
LDO	Low-dropout Regulator
LNA	Low-Noise Amplifier
MSAS	Multi-functional Satellite Augmentation System (Japan)
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
PMU	Power Management Unit
1PPS	One Pulse Per Second
QZSS	Quasi-Zenith Satellite System

Abbreviation	Description
RF	Radio Frequency
RMC	Recommended Minimum Specific GNSS Data
RTC	Real-Time Clock
RXD	Receive Data (Pin)
SBAS	Satellite-Based Augmentation System
SNR	Signal to Noise Ratio
SOG	Speed over Ground
TBD	To Be Determined
TTFF	Time to First Fix
TXD	Transmit Data (Pin)
TXT	Text Transmission
UART	Universal Asynchronous Receiver/Transmitter
UTC	Coordinated Universal Time
VCC	Supply Voltage
VTG	Course Over Ground & Ground Speed
WAAS	Wide Area Augmentation System
WGS84	World Geodetic System 1984

6 Appendix B GNSS Numbering

Table 22: GNSS Constellations Information

GNSS Type	System ID	Satellite ID	Signal ID
GPS	1	1–32	1 = L1 C/A
GLONASS	2	65–96	1 = G1 C/A
Galileo	3	1–36	7 = E1
BDS	4	1–63	1 = B1I 3 = B1C
QZSS	5	193–199	1 = L1 C/A
SBAS	-	33–64	-

NOTE

This GNSS Numbering is only applicable to LC86G series and may vary depending on modules. For more information, see GNSS protocol specification document for the dedicated module.