

# NEO-8Q

## u-blox 8 GNSS module

### Data Sheet

#### Highlights:

- High sensitivity of  $-166$  dBm for single GNSS reception
- Cost-efficient system
- TCXO-based product enables fastest time to first fix
- Low power consumption
- Superior anti-spoofing and anti-jamming



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**Document Information**

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**Document status explanation**

Objective Specification	Document contains target values. Revised and supplementary data will be published later.		
Advance Information	Document contains data based on early testing. Revised and supplementary data will be published later.		
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**This document applies to the following products:**

<b>Product name</b>	<b>Type number</b>	<b>ROM/FLASH version</b>	<b>PCN reference</b>
NEO-8Q	NEO-8Q-0-10	ROM SPG 3.01	N/A

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# 1 Functional description

## 1.1 Overview

The NEO-8Q standard precision GNSS module is built on the reliable performance of the u-blox 8 GNSS engine, which receives GPS, GLONASS, QZSS and SBAS signals. The NEO-8Q delivers high sensitivity and minimal acquisition times in the industry proven NEO form factor.

The NEO-8Q module features low power consumption and supports advanced Power Save Modes. It also provides message integrity protection, geofencing, spoofing detection, and odometer functionalities.

The NEO-8Q module is an economical choice for best performance and easier RF integration. For RF optimization the NEO-8Q module features an additional front-end LNA for easier antenna integration and a front-end SAW filter for increased jamming immunity. The industry proven NEO form factor allows easy migration from previous NEO generations. Sophisticated RF-architecture and interference suppression ensure maximum performance even in GNSS-hostile environments.

The NEO-8Q module combines a high level of robustness and integration capability with flexible connectivity options. The DDC (I2C compliant) interface provides connectivity and enables synergies with most u-blox cellular modules.

The NEO-8Q module uses a u-blox 8 GNSS chip, qualified according to AEC-Q100 and manufactured in ISO/TS 16949 certified sites. Qualification tests are performed as stipulated in the ISO16750 standard: "Road vehicles – Environmental conditions and testing for electrical and electronic equipment".

The u-blox NEO-8Q module can also benefit from the u-blox AssistNow assistance service. The Online service provides GNSS broadcast parameters, e.g. ephemeris, almanac data plus time to reduce the receiver's time to first fix significantly and improve acquisition sensitivity. The extended validity of AssistNow Offline data (up to 35 days) and AssistNow Autonomous data (up to 3 days) provide faster acquisition after a long off time.



See section 1.6 for more information concerning the NEO-8Q related AssistNow Assistance.

## 1.2 Product features

Model	Category	GNSS		Supply	Interfaces		Features				Grade		
	Standard Precision GNSS High Precision GNSS Dead Reckoning Timing	GPS / QZSS GLONASS Galileo BeiDou	Number of Concurrent GNSS	2.7 V – 3.6 V	UART USB SPI DDC (I <sup>2</sup> C compliant)	Programmable (Flash) Data logging Additional SAW Additional LNA RTC crystal Oscillator Built-in antenna Built-in antenna supply and supervisor Timepulse	Standard Professional Automotive						
<b>NEO-8Q</b>	•	• •	1	•	• • • •	• • • • T	•	•	•	•	•	•	•

C = Crystal / T = TCXO

## 1.3 Performance

Parameter	Specification		
Receiver type	72-channel u-blox 8 engine GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1-C/A, GLONASS L1OF		
Accuracy of time pulse	RMS	30 ns	
	99%	60 ns	
Frequency of time pulse	0.25 Hz...10 MHz (configurable)		
Operational limits <sup>1</sup>	Dynamics	≤ 4 g	
	Altitude	50,000 m	
	Velocity	500 m/s	
Velocity accuracy <sup>2</sup>	0.05 m/s		
Heading accuracy <sup>2</sup>	0.3 degrees		
GNSS		GPS	GLONASS
Horizontal position accuracy <sup>3</sup>	Autonomous	2.5 m	4.0 m
	SBAS	2.0 m	
Max navigation update rate <sup>4</sup>		18 Hz	18 Hz
Time-To-First-Fix <sup>5</sup>	Cold start	29 s	30 s
	Hot start	1 s	1 s
	Aided starts <sup>6</sup>	2 s	2 s
Sensitivity <sup>7</sup>	Tracking & Navigation	-166 dBm	-166 dBm
	Reacquisition	-160 dBm	-156 dBm
	Cold start	-148 dBm	-145 dBm
	Hot start	-157 dBm	-156 dBm

**Table 1: NEO-8Q performance in different GNSS modes (default: single reception of GPS incl. QZSS, SBAS)**

<sup>1</sup> Assuming Airborne < 4 g platform

<sup>2</sup> 50% @ 30 m/s

<sup>3</sup> CEP, 50%, 24 hours static, -130 dBm, > 6 SVs

<sup>4</sup> Rates with SBAS and QZSS enabled for > 98% fix report rate under typical conditions

<sup>5</sup> All satellites at -130 dBm

<sup>6</sup> Dependent on aiding data connection speed and latency

<sup>7</sup> Demonstrated with a good external LNA

## 1.4 Block diagram

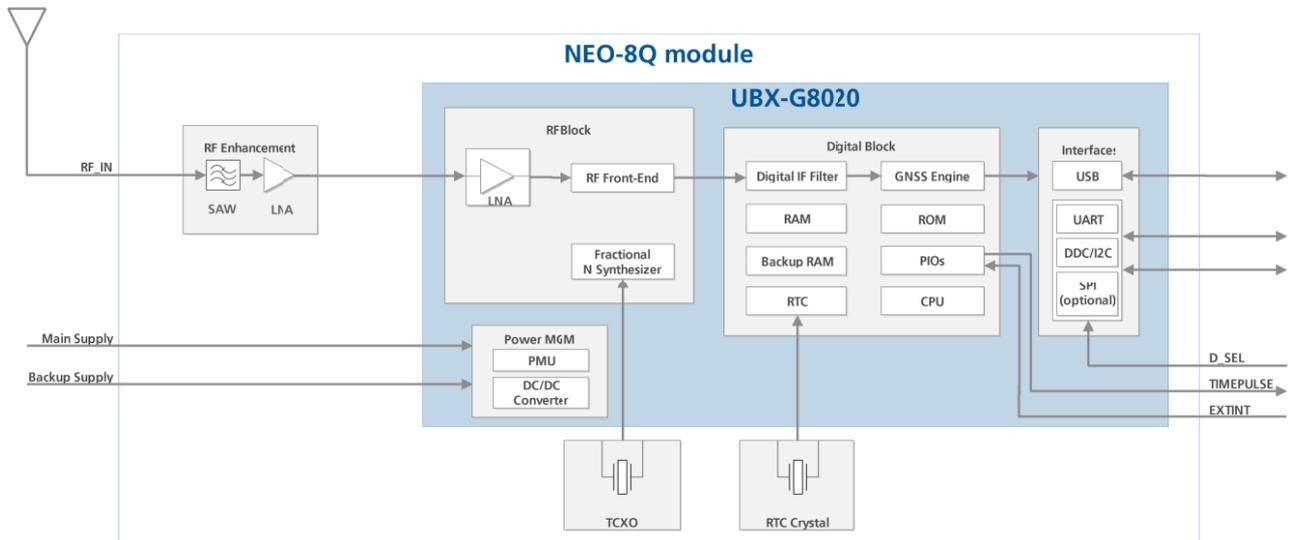


Figure 1: NEO-8Q block diagram

## 1.5 Supported GNSS Constellations

The NEO-8Q module is a single GNSS receiver, which can receive and track either GPS or GLONASS signals. By default the receiver is configured for GPS, including SBAS and QZSS reception.



The augmentation systems: SBAS and QZSS can be enabled only if GPS operation is configured.

### 1.5.1 GPS

The NEO-8Q module is designed to receive and track the L1C/A signals provided at 1575.42 MHz by the Global Positioning System (GPS). The NEO-8Q module can receive and process GPS concurrently with QZSS and SBAS signals.

### 1.5.2 GLONASS

The NEO-8Q module can receive and process the GLONASS satellite system as an alternative to the GPS. The u-blox NEO-8Q module is designed to receive and track the L1OF signals GLONASS provides at  $1602 \text{ MHz} + k \cdot 562.5 \text{ kHz}$ , where  $k$  is the satellite's frequency channel number ( $k = -7, \dots, 5, 6$ ). The ability to process GLONASS L1OF satellite signals allows design of GLONASS receivers where required by regulations.

To take advantage of GPS and GLONASS, dedicated hardware preparation must be made during the design-in phase. See the NEO-8Q / NEO-M8 Hardware Integration Manual [1] for u-blox design recommendations.

## 1.6 Assisted GNSS (A-GNSS)

Supply of GNSS receiver assistance information, such as ephemeris, almanac, rough user position and time, will reduce the time to first fix significantly and improve acquisition sensitivity. All u-blox G8020 based products support the u-blox AssistNow Online and AssistNow Offline A-GNSS services, support AssistNow Autonomous, and are OMA SUPL compliant.

### 1.6.1 AssistNow™ Online

With AssistNow Online, an Internet connected host downloads assistance data from the u-blox AssistNow Online service to the receiver at system start-up. The Multi-GNSS Assistance (MGA) service is an HTTP protocol based network operator independent service.

Supplying assistance information, such as ephemeris, almanac, a rough last position and time, can reduce the time to first fix significantly and improve acquisition sensitivity.



The AssistNow Online service provides data for GPS, GLONASS and QZSS.

### 1.6.2 AssistNow™ Offline

With AssistNow Offline service, users can download long-term orbit data over the Internet at their convenience. The orbit data can be stored in the memory of the application processor for subsequent down-load to the NEO-8Q module. Thus the function enables a position fix within seconds, even when no network is available. AssistNow Offline offers augmentation for up to 35 days.



The AssistNow Offline service provides data for GPS and GLONASS.

### 1.6.3 AssistNow™ Autonomous

AssistNow Autonomous operation provides aiding information without the need for a host or external network connection. Based on previous broadcast satellite ephemeris data downloaded to and stored by the GNSS receiver, AssistNow Autonomous automatically generates accurate predictions of satellite orbital data ("AssistNow Autonomous data") that is usable for future GNSS position fixes. The concept capitalizes on the periodic nature of GNSS satellite orbits by capturing strategic ephemeris data at specific times of the day. For NEO-8Q modules, AssistNow Autonomous can calculate GPS only orbit predictions for up to 3 days.

u-blox' AssistNow Autonomous benefits are:

- Faster fix in situations where GNSS satellite signals are weak
- No connectivity required
- Compatible with AssistNow Online and Offline (can work stand-alone, or in tandem with these services)
- No integration effort; calculations are done in the background, transparent to the user.



For more details on A-GNSS see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2].

## 1.7 Augmentation Systems

### 1.7.1 Satellite-Based Augmentation System (SBAS)

The u-blox NEO-8Q module supports reception of SBAS broadcast signals. These systems supplement GNSS data with additional regional or wide area GPS augmentation data. The system broadcasts range correction and integrity information via satellite which can be used by GNSS receivers to improve resulting precision. SBAS satellites can also be used as additional signals for ranging (navigation), further enhancing availability. The following SBAS types are supported: EGNOS, MSAS, and WAAS



For more details see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2].

### 1.7.2 QZSS

The Quasi-Zenith Satellite System (QZSS) is a regional navigation satellite system that transmits additional GPS L1C/A signals for the Pacific region covering Japan and Australia. The NEO-8Q module is able to receive and track these signals concurrently with GPS signals, resulting in better availability especially under challenging signal conditions, e.g. in urban canyons.



The L1-SAIF signal provided by QZSS is not supported

### 1.7.3 Differential GPS (D-GPS)

u-blox receivers support Differential-GPS (D-GPS) data according to RTCM specification 10402.3 [4]: The use of D-GPS improves GPS position accuracy. The RTCM implementation supports the following RTCM 2.3 messages.

Message Type	Description
1	Differential GPS Corrections
2	Delta Differential GPS Corrections
3	GPS Reference Station Parameters
9	GPS Partial Correction Set

**Table 2: Supported RTCM 2.3 messages**



RTCM corrections cannot be used together with SBAS.



For more details see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2].

## 1.8 Odometer

The odometer function provides information on travelled ground distance (in meters) based on the position and Doppler-based velocity output from the navigation solution. For each computed distance since the last odometer reset, the odometer estimates a 1-sigma accuracy value. The total cumulative ground distance is maintained and saved in the BBR memory.



The odometer feature is disabled by default. For more details see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2].

## 1.9 Broadcast navigation data and satellite signal measurements

u-blox 8 receivers can output all the GNSS broadcast data upon reception from tracked satellites. This includes all the supported GNSS signals plus the augmentation services SBAS and QZSS. The receiver also makes available the tracked satellite signal information, i.e. raw code phase and Doppler measurements in a form aligned to the ETSI mobile cellular location services protocol (RRLP) [6]. For more details see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2].

## 1.10 Geofencing

The u-blox NEO-8Q module supports up to four circular Geofencing areas defined on the Earth's surface using a 2D model. Geofencing is active when at least one Geofence is defined, the current status can be found by polling the receiver. A PIO pin can be nominated to indicate status to e.g. wake up a host on activation.

## 1.11 Message Integrity Protection

The NEO-8Q module provides a function to prevent a third party interfering with the UBX message stream sent from receiver to host. The security mechanism essentially "signs" nominated messages with a following message containing an md5 generated hash of the nominated message. This message signature is then compared with one generated by the host to determine if the message data has been altered. The hash algorithm seed can use one fixed secret ID-key set by eFuse in production or a dynamic ID-key set by host enabling users to detect "Man-in-the-middle" style attacks.

## 1.12 Spoofing Detection

Spoofing is a process whereby a malicious third party tries to control the reported position via a "fake" GNSS broadcast signal. This may result in the form of reporting incorrect position, velocity or time. To combat against this the NEO-8Q module includes anti-spoofing measures to alert the host when signals appear to be suspicious. The receiver combines a number of checks on the received signals looking for inconsistencies across several parameters.



This feature does not guarantee detection of all spoofing attacks

## 1.13 EXTINT: External interrupt

**EXTINT** is an external interrupt pin with fixed input voltage thresholds with respect to VCC. It can be used for control of the receiver or for aiding.

For more information about how to implement and configure these features, see the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [2] and the NEO-8Q / NEO-M8 Hardware Integration Manual [1].

### 1.13.1 Pin Control

The pin control feature allows overriding the automatic active/inactive cycle of Power Save Mode. The state of the receiver can be controlled through the **EXTINT** pin.

The receiver can also be forced OFF using **EXTINT** when Power Save Mode is not active.

### 1.13.2 Aiding

The **EXTINT** pin can be used to supply time or frequency aiding data to the receiver.

For time aiding, hardware time synchronization can be achieved by connecting an accurate time pulse to the **EXTINT** pin.

Frequency aiding can be implemented by connecting a periodic rectangular signal with a frequency up to 500 kHz and arbitrary duty cycle (low/high phase duration must not be shorter than 50 ns) to the **EXTINT** pin. Provide the applied frequency value to the receiver using UBX messages.

## 1.14 TIMEPULSE

A configurable time pulse signal is available with all u-blox NEO modules. The TIMEPULSE output generates pulse trains synchronized with GPS or UTC time grid with intervals configurable over a wide frequency range. Thus it may be used as a low frequency time synchronization pulse or as a high frequency reference signal.

By default the time pulse signal is configured to 1 pulse per second. For more information see the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [2].

## 1.15 Protocols and interfaces

Protocol	Type
NMEA 0183, version 4.0 (V2.1 V2.3 or V4.1 configurable)	Input/output, ASCII
UBX	Input/output, binary, u-blox proprietary
RTCM	Input message, 1, 2, 3, 9

**Table 3: Available Protocols**

All protocols are available on UART, USB, DDC (I<sup>2</sup>C compliant) and SPI. For specification of the various protocols see the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [2].

## 1.16 Interfaces

A number of interfaces are provided either for data communication or memory access. The embedded firmware uses these interfaces according to their respective protocol specifications.

### 1.16.1 UART

The NEO-8Q module includes one UART interface, which can be used for communication to a host. It supports configurable baud rates. For supported baud rates see the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [2].



Designs must allow access to the UART and the **SAFEBOOT\_N** function pin for future service and reconfiguration.

### 1.16.2 USB

A USB interface, which is compatible to USB version 2.0 FS (Full Speed, 12 Mbit/s), can be used for communication as an alternative to the UART. The pull-up resistor on pin USB\_DP is integrated to signal a full-speed device to the host. The VDD\_USB pin supplies the USB interface. The u-blox USB (CDC-ACM) driver supports Windows Vista plus Windows 7 and 8 operating systems. A separate driver (CDC-ACM) is not required for Windows 10 which has a built-in USB-serial driver. However, plugging initially into an internet connected Windows 10 PC, will down-load the u-blox combined sensor and VCP driver package.

USB drivers can be down-loaded from the u-blox web site, [www.u-blox.com](http://www.u-blox.com).

### 1.16.3 SPI

The SPI interface is designed to allow communication to a host CPU. The interface can be operated in slave mode only. The maximum transfer rate using SPI is 125 kB/s and the maximum SPI clock frequency is 5.5 MHz, see Figure 3. Note that SPI is not available in the default configuration, because its pins are shared with the UART and DDC interfaces. The SPI interface can be enabled by connecting D\_SEL (Pin 2) to ground (see section 1.20.1).

### 1.16.4 Display Data Channel (DDC)

An I<sup>2</sup>C compliant DDC interface is available for communication with an external host CPU or u-blox cellular modules. The interface can be operated in slave mode only. The DDC protocol and electrical interface are fully compatible with Fast-Mode of the I<sup>2</sup>C industry standard. Since the maximum SCL clock frequency is 400 kHz, the maximum transfer rate is 400 kb/s.

## 1.17 Clock generation

### 1.17.1 TCXO Oscillator

NEO-8Q module uses a TCXO reference oscillator. The TCXO allows accelerated weak signal acquisition, enabling faster start and reacquisition times.

Oscillators used on the NEO-8Q module are carefully selected and screened for stability and against frequency perturbations across the full operating range (−40° to +85°C).

The careful selection and qualification of critical parts, such as GNSS oscillators, has resulted in u-blox modules being the most reliable positioning modules in the industry, particularly in challenging conditions.

### 1.17.2 Real-Time Clock (RTC)

The RTC is driven by a 32768 Hz oscillator using an RTC crystal. If the main supply voltage fails, and a battery is connected to V\_BCKP, parts of the receiver switch off, but the RTC still runs providing a timing reference for the receiver. This operating mode is called Hardware Backup Mode, which enables all relevant data to be saved in the backup RAM to allow a hot or warm start later.

## 1.18 Power management

u-blox 8 technology offers a power-optimized architecture with built-in autonomous power saving functions to minimize power consumption at any given time. Furthermore, the receiver can be used in two operating modes: Continuous mode for best performance or Power Save Mode for optimized power consumption respectively

### 1.18.1 DC/DC converter

The NEO-8Q module integrates a DC/DC converter, allowing reduced power consumption especially when using a main supply voltage above 2.5 V.



For more information see the NEO-8Q / NEO-M8 Hardware Integration Manual [1]

### 1.18.2 Power Mode Setup

The u-blox NEO-8Q module can be configured to run in either continuous mode or a choice of Power Save mode configurations. A template of power mode settings can be used to easily select typical power mode setups to cover the majority of users' requirements.

For specific power saving applications, the user has the option to fully configure via the power save mode configuration. For more information see section 1.18.4.

The u-blox 8 receivers' power mode setup offers a choice of continuous operation and preset Power Save Mode Configurations:

- Continuous (default) mode for best GNSS performance vs power consumption
- Continuous with no compromise in power consumption
- A 1 Hz cyclic tracking mode for aggressive power reduction
- Choice of 2 or 4 Hz cyclic tracking modes for typical wearable applications
- ON/OFF interval mode

### 1.18.3 Continuous Mode

Continuous Mode uses the acquisition engine at full performance resulting in the shortest possible TTFF and the highest sensitivity. It searches for all possible satellites until the Almanac is completely downloaded. The receiver then switches to the tracking engine to lower power consumption.

Thus, a lower tracking current consumption level will be achieved when:

- A valid GNSS position is obtained
- The entire Almanac has been downloaded
- The Ephemeris for each satellite in view is valid

### 1.18.4 Power Save Mode

For power sensitive applications, u-blox 8 receivers provide a Power Save Mode for reduced power consumption. Power Save Mode provides two dedicated methods, ON/OFF and Cyclic tracking, that reduce average current consumption in different ways to match the needs of the specific application. These operations can be set by using a specific UBX message.



For more information about power management strategies, see the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [2].

## 1.19 Antenna

The NEO-8Q module is designed for use with passive<sup>8</sup> and active<sup>9</sup> antennas.

Parameter	Specification	
Antenna Type	Passive and active antenna	
Active Antenna Recommendations	Minimum gain	15 dB (to compensate signal loss in RF cable)
	Maximum gain	30 dB
	Maximum noise figure	1.5 dB

**Table 4: Antenna Specifications for NEO-8Q module**

### 1.19.1 Active antenna control (LNA\_EN)

The LNA\_EN pin can be used to turn on and off an external LNA or an active antenna. This reduces power consumption in Power Save Mode (Backup mode). This pin is available on the NEO-8Q module.

<sup>8</sup> For integrating NEO-8Q module with Cellular products, see the NEO-8Q / NEO-M8 Hardware Integration Manual [1].

<sup>9</sup> For information on using active antennas with NEO-8Q module, see the NEO-8Q / NEO-M8 Hardware Integration Manual [1].

## 1.20 Configuration management

Configuration settings can be modified with UBX configuration messages. The modified settings remain effective until power-down or reset. If these settings have been stored in battery-backup RAM, then the modified configuration will be retained, as long as the backup battery supply is not interrupted.

### 1.20.1 Interface Selection (D\_SEL)

At startup Pin 2 (D\_SEL) determines which data interfaces are used for communication. If D\_SEL is set high or left open, UART and DDC become available. If D\_SEL is set low, i.e. connected to ground, the NEO-8Q module can communicate to a host via SPI.

PIN #	D_SEL="1" (left open)	D_SEL ="0" (connected to GND)
20	UART TX	SPI MISO
21	UART RX	SPI MOSI
19	DDC SCL	SPI CLK
18	DDC SDA	SPI CS_N

**Table 5: Data interface selection by D\_SEL**

## 2 Pin Definition

### 2.1 Pin assignment



Figure 2: Pin Assignment

No	Name	I/O	Description
1	SAFEBOOT_N	I	For future service and reconfiguration, leave OPEN
2	D_SEL	I	Interface select
3	TIMEPULSE	O	Time pulse (1PPS)
4	EXTINT	I	External Interrupt Pin
5	USB_DM	I/O	USB Data
6	USB_DP	I/O	USB Data
7	VDD_USB	I	USB Supply
8	RESET_N	I	RESET_N
9	VCC_RF	O	Output Voltage RF section
10	GND	I	Ground
11	RF_IN	I	GNSS signal input
12	GND	I	Ground
13	GND	I	Ground
14	LNA_EN	O	Antenna / External LNA control
15	Reserved	-	Reserved
16	Reserved	-	Reserved
17	Reserved	-	Reserved
18	SDA / SPI CS_N	I/O	DDC Data if D_SEL = 1 (or open) SPI Chip Select if D_SEL = 0
19	SCL / SPI CLK	I/O	DDC Clock if D_SEL = 1(or open) SPI Clock if D_SEL = 0
20	TXD / SPI MISO	O	Serial Port if D_SEL = 1(or open) SPI MISO if D_SEL = 0
21	RXD / SPI MOSI	I	Serial Port if D_SEL = 1(or open) SPI MOSI if D_SEL = 0
22	V_BCKP	I	Backup voltage supply
23	VCC	I	Supply voltage
24	GND	I	Ground

Table 6: Pinout



Pins designated Reserved should not be used. For more information about pinouts, see the NEO-8Q / NEO-M8 Hardware Integration Manual [1].

## 3 Electrical specification



The limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the characteristics sections of the specification is not implied. Exposure to these limits for extended periods may affect device reliability.



Where application information is given, it is advisory only and does not form part of the specification. For more information see the NEO-8Q / NEO-M8 Hardware Integration Manual [1].

### 3.1 Absolute maximum rating

Parameter	Symbol	Condition	Min	Max	Units
Power supply voltage	VCC		-0.5	3.6	V
Backup battery voltage	V_BCKP		-0.5	3.6	V
USB supply voltage	VDD_USB		-0.5	3.6	V
Input pin voltage	Vin		-0.5	VCC+0.5	V
	Vin_usb		-0.5	VDD_USB	V
DC current through any digital I/O pin (except supplies)	Ipin			10	mA
VCC_RF output current	ICC_RF			100	mA
Input power at RF_IN	Prfin	source impedance = 50 Ω, continuous wave		15	dBm
Storage temperature	Tstg		-40	85	°C

**Table 7: Absolute maximum ratings**

**⚠ Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. 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.**

## 3.2 Operating conditions



All specifications are at an ambient temperature of 25°C. Extreme operating temperatures can significantly impact specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Parameter	Symbol	Min	Typical	Max	Units	Condition
Power supply voltage	VCC	1.65		3.6	V	
Supply voltage USB	VDDUSB	3.0	3.3	3.6	V	
Backup battery voltage	V_BCKP	1.4		3.6	V	
Backup battery current	I_BCKP		15		μA	V_BCKP = 1.8 V, VCC = 0 V
SW backup current	I_SWBCKP		22		μA	VCC = 3 V
			30		μA	VCC = 3 V
Input pin voltage range	V <sub>in</sub>	0		VCC	V	
Digital IO Pin Low level input voltage	V <sub>il</sub>	0		0.2*VCC	V	
Digital IO Pin High level input voltage	V <sub>ih</sub>	0.7*VCC		VCC	V	
Digital IO Pin Low level output voltage	V <sub>ol</sub>			0.4	V	I <sub>ol</sub> = 4mA
Digital IO Pin High level output voltage	V <sub>oh</sub>	VCC-0.4			V	I <sub>oh</sub> = 4mA
Pull-up resistor for RESET_N (internal)	R <sub>pu</sub>		11		kΩ	
USB_DM, USB_DP	V <sub>inU</sub>	Compatible with USB with 27 Ω series resistance				
VCC_RF voltage	VCC_RF		VCC-0.1		V	
VCC_RF output current	ICC_RF			50	mA	
Receiver Chain Noise Figure	N <sub>Ftot</sub>		2.0		dB	
Operating temperature	T <sub>opr</sub>	-40		85	°C	

**Table 8: Operating conditions**



Operation beyond the specified operating conditions can affect device reliability.

## 3.3 Indicative current requirements

Table 9 lists examples of the total system supply current for a possible application.



Values in Table 9 are provided for customer information only as an example of typical power requirements. Values are characterized on samples, actual power requirements can vary depending on FW version used, external circuitry, number of SVs tracked, signal strength, type of start as well as time, duration and conditions of test.

Parameter	Symbol	Typ	Typ	Max	Units	Condition
		GPS / QZSS / SBAS	GLONASS			
Max. supply current <sup>10</sup>	I <sub>ccp</sub>			67	mA	Estimated at 3 V
	I <sub>cc</sub> Acquisition <sup>11</sup>	23	23		mA	Estimated at 3 V
Average supply current <sup>12, 13</sup>	I <sub>cc</sub> Tracking (continuous)	22	21		mA	Estimated at 3 V
	I <sub>cc</sub> Tracking (Power Save mode / 1 Hz)	10.2	10.2		mA	Estimated at 3 V

**Table 9: Indicative power requirements at 3.0 V**



For more information about power requirements, see the NEO-8Q / NEO-M8 Hardware Integration Manual [1].



For more information on how to noticeably reduce current consumption, see the Power Management Application Note [5].

<sup>10</sup> Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.

<sup>11</sup> Average current from start-up until the first fix.

<sup>12</sup> Use this figure to determine required battery capacity.

<sup>13</sup> Simulated GNSS constellation using power levels of -130 dBm. VCC = 3.0 V

### 3.4 SPI timing diagrams

In order to avoid incorrect operation of the SPI, the user needs to comply with certain timing conditions. The following signals need to be considered for timing constraints:

Symbol	Description
SPI CS_N (SS_N)	Slave select signal
SPI CLK (SCK)	Slave clock signal

Table 10: Symbol description

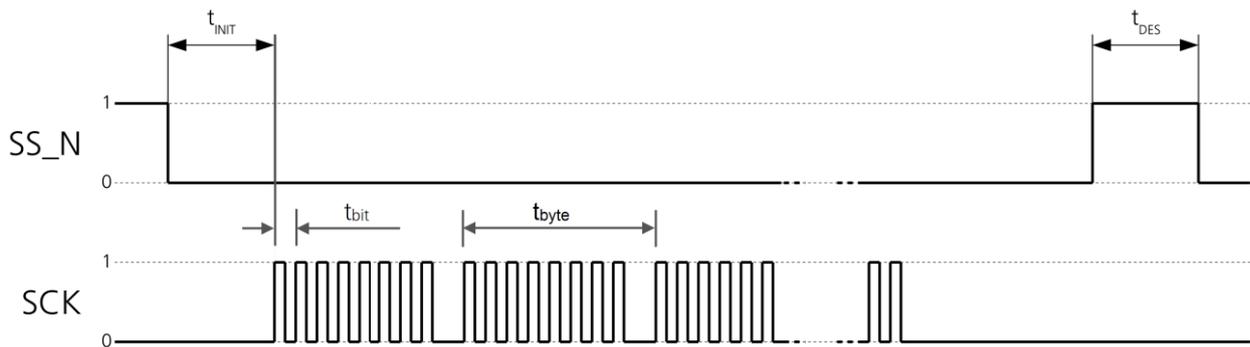


Figure 3: SPI timing diagram

#### 3.4.1 Timing recommendations

The SPI timing recommendations are given below.

Parameter	Description	Recommendation
$t_{INIT}$	Minimum Initialization Time	10 $\mu$ s
$t_{DES}$	Deselect Time	1 ms.
$t_{bit}$	Minimum bit time	180 ns (5.5 MHz max bit frequency)
$t_{byte}$	Minimum byte period	8 $\mu$ s (125 kHz max byte frequency)

Table 11: SPI timing recommendations



The values in the above table result from the requirement of an error-free transmission. By allowing just a few errors and disabling the glitch filter, the bit rate can be increased considerably.

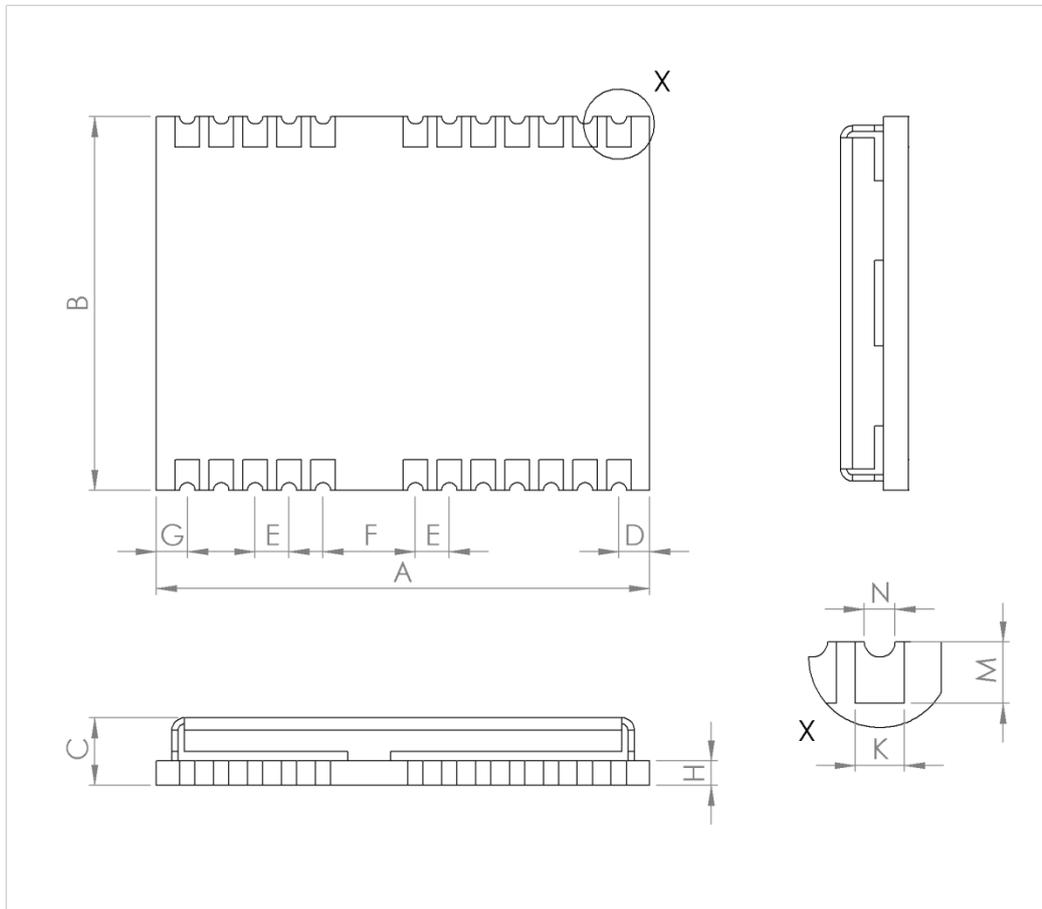
### 3.5 DDC timing diagrams

The DDC interface is I<sup>2</sup>C Fast Mode compliant. For timing parameters consult the I<sup>2</sup>C standard.



The maximum bit rate is 400 kb/s. The interface stretches the clock when slowed down when serving interrupts, so real bit rates may be slightly lower.

## 4 Mechanical specifications



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	15.9	16.0	16.6
B	12.1	12.2	12.3
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
G	0.9	1.0	1.3
H		0.82	
K	0.7	0.8	0.9
M	0.8	0.9	1.0
N	0.4	0.5	0.6
Weight		1.6g	

Figure 4: Dimensions



For information about the paste mask and footprint, see the NEO-8Q / NEO-M8 Hardware Integration Manual [1].

## 5 Reliability tests and approvals

### 5.1 Reliability tests



All NEO-8Q modules are based on AEC-Q100 qualified GNSS chips.

Tests for product family qualifications are according to ISO 16750 "Road vehicles – environmental conditions and testing for electrical and electronic equipment", and appropriate standards.

### 5.2 Approvals



Products marked with this lead-free symbol on the product label comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS).

All u-blox 8 GNSS modules are RoHS compliant.

## 6 Product handling & soldering

### 6.1 Packaging

The NEO-8Q modules are delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down. For more information see the u-blox Package Information Guide [3].

#### 6.1.1 Reels

Each reel has 250 NEO-8Q modules. The NEO-8Q modules are shipped on Reel Type B, as specified in the u-blox Package Information Guide [3].

#### 6.1.2 Tapes

The dimensions and orientations of the tapes for NEO-8Q modules are specified in Figure 5.

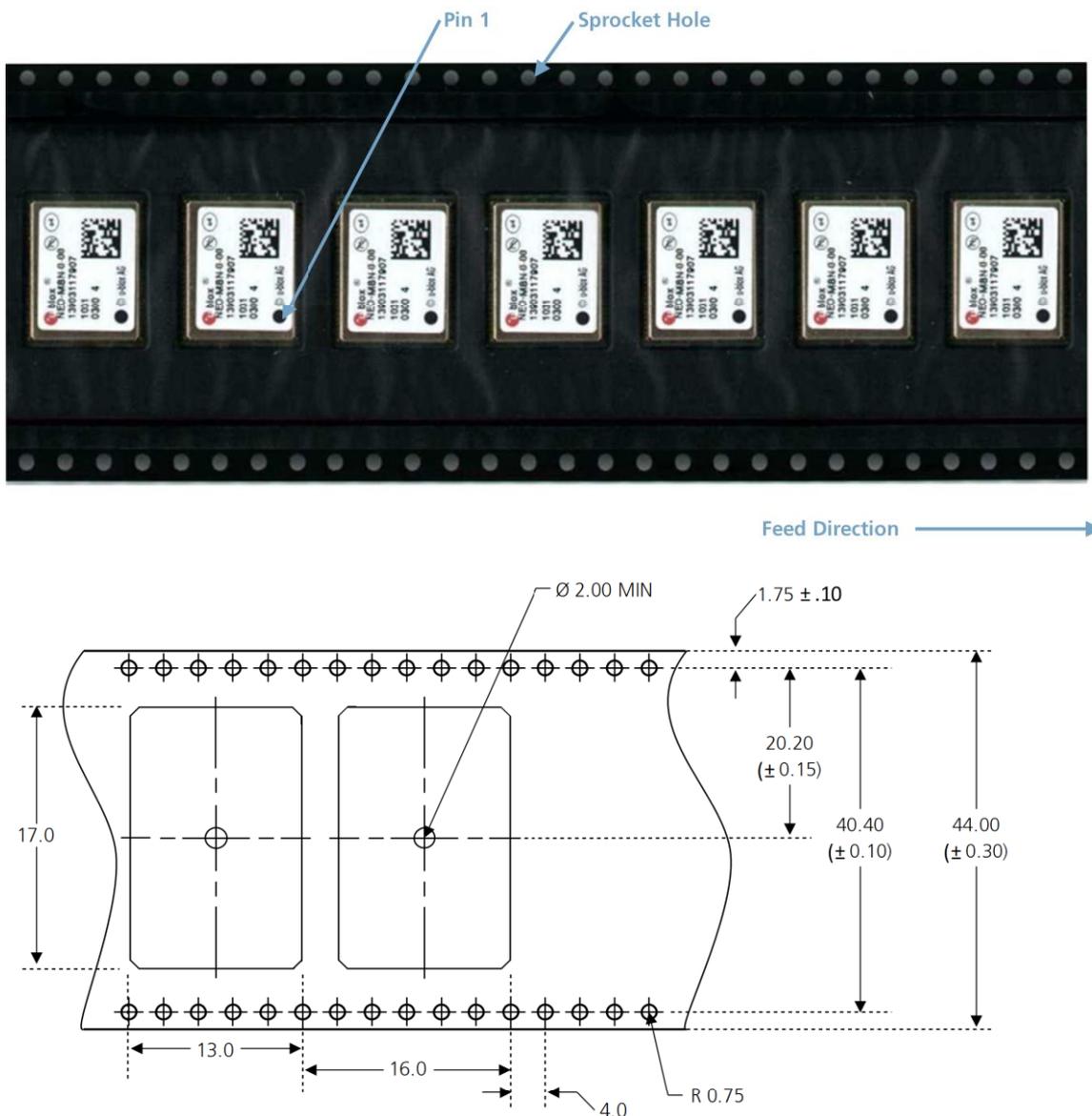


Figure 5: Dimensions and orientation for NEO-8Q modules on tape

## 6.2 Shipment, storage and handling

For important information regarding shipment, storage and handling see the u-blox Package Information Guide [3].

### 6.2.1 Moisture Sensitivity Levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. The NEO-8Q modules are rated at MSL level 4.



For MSL standard see IPC/JEDEC J-STD-020, which can be downloaded from [www.jedec.org](http://www.jedec.org).



For more information regarding MSL see the u-blox Package Information Guide [3].

### 6.2.2 Reflow soldering

Reflow profiles are to be selected according u-blox recommendations (see the NEO-8Q / NEO-M8 Hardware Integration Manual [1]).

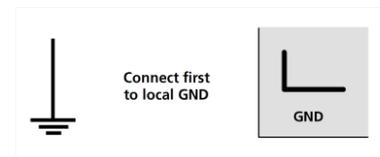
### 6.2.3 ESD handling precautions



**NEO-8Q modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GNSS receiver!**

GNSS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

- Unless there is a galvanic coupling between the local GND (i.e. the work table) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.
- Before mounting an antenna patch, connect ground of the device
- When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10 pF, coax cable ~50-80 pF/m, soldering iron, ...)
- To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non ESD protected work area, implement proper ESD protection measures in the design.
- When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD safe soldering iron (tip).



## 7 Default messages

Interface	Settings
UART Output	9600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only the following NMEA (and no UBX) messages have been activated at start-up: <b>GGA, GLL, GSA, GSV, RMC, VTG, TXT</b>
USB Output	Configured to transmit both NMEA and UBX protocols, but only the following NMEA (and no UBX) messages have been activated at start-up: <b>GGA, GLL, GSA, GSV, RMC, VTG, TXT</b> USB Power Mode: Bus Powered
UART Input	9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled Automatically accepts following protocols without need of explicit configuration: UBX, NMEA, RTCM The GNSS receiver supports interleaved UBX and NMEA messages.
USB Input	Automatically accepts following protocols without need of explicit configuration: UBX, NMEA The GPS receiver supports interleaved UBX and NMEA messages. USB Power Mode: Bus Powered
DDC	Fully compatible with the I <sup>2</sup> C industry standard, available for communication with an external host CPU or u-blox cellular modules, operated in slave mode only. Default messages activated. NMEA and UBX are enabled as input messages, only NMEA as output messages. Maximum bit rate 400 kb/s.
SPI	Allow communication to a host CPU, operated in slave mode only. Default messages activated. SPI is not available in the default configuration.
TIMEPULSE (1 Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100ms

**Table 12: Default messages**



Refer to the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2] for information about further settings.

## 8 Labeling and ordering information

### 8.1 Product labeling

The labeling of u-blox NEO GNSS modules includes important product information. The location of the NEO-8Q product type number is shown in Figure 6.

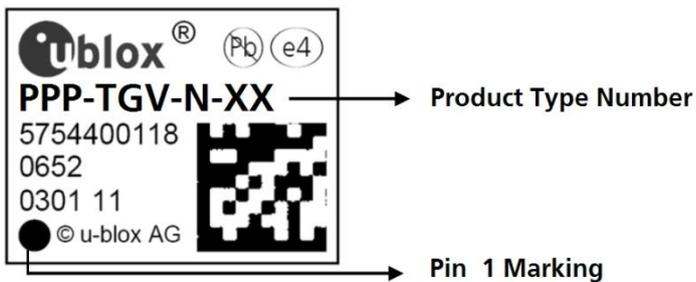


Figure 6: Location of product type number on u-blox NEO-8Q module label

### 8.2 Explanation of codes

Three different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox M8 products, independent of packaging and quality grade. The **Ordering Code** includes options and quality, while the **Type Number** includes the hardware and firmware versions. Table 13 shows the structure of these three different formats.

Format	Structure
Product Name	PPP-TGV
Ordering Code	PPP-TGV-N
Type Number	PPP-TGV-N-XX

Table 13: Product Code Formats

The parts of the product code are explained in Table 14.

Code	Meaning	Example
PPP	Product Family	NEO
TG	Platform	8 = u-blox 8
V	Variant	Function set (A-Z), T = Timing, R = DR, etc.
N	Option / Quality Grade	Describes standardized functional element or quality grade 0 = Default variant, A = Automotive
XX	Product Detail	Describes product details or options such as hard- and software revision, cable length, etc.

Table 14: part identification code

### 8.3 Ordering codes

Ordering No.	Product
NEO-8Q-0	u-blox 8 GNSS LCC Module, TCXO, SAW, LNA, 12.2x16 mm, 250 pcs/reel

Table 15: Product ordering codes for professional grade module



Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs) see our website.

## Related documents

- [1] NEO-8Q / NEO-M8 Hardware Integration Manual, Doc. No. UBX-15029985
- [2] u-blox 8 / u-blox M8 Receiver Description including Protocol Specification v15.00-18.00 (Public version), Doc. No. UBX-13003221
- [3] u-blox Package Information Guide, Doc. No. UBX-14001652
- [4] RTCM 10402.3 Recommended Standards for Differential GNSS, Ver. 2.3, RTCM AUG. 20, 2001
- [5] Power Management Application Note, Doc. No. UBX-13005162
- [6] Radio Resource LCS Protocol (RRLP), (3GPP TS 44.031 version 11.0.0 Release 11)



For regular updates to u-blox documentation and to receive product change notifications, register on our homepage (<http://www.u-blox.com>).

## Revision history

Revision	Date	Name	Status / Comments
R01	25-Apr-2016	byou	Objective Specification.
R02	25-May-2016	julu	Advance Information.
R03	26-Jul-2016	byou	Production Information

# Contact

For complete contact information visit us at [www.u-blox.com](http://www.u-blox.com)

## u-blox Offices

### North, Central and South America

#### u-blox America, Inc.

Phone: +1 703 483 3180  
E-mail: [info\\_us@u-blox.com](mailto:info_us@u-blox.com)

#### Regional Office West Coast:

Phone: +1 408 573 3640  
E-mail: [info\\_us@u-blox.com](mailto:info_us@u-blox.com)

#### Technical Support:

Phone: +1 703 483 3185  
E-mail: [support\\_us@u-blox.com](mailto:support_us@u-blox.com)

### Headquarters Europe, Middle East, Africa

#### u-blox AG

Phone: +41 44 722 74 44  
E-mail: [info@u-blox.com](mailto:info@u-blox.com)  
Support: [support@u-blox.com](mailto:support@u-blox.com)

### Asia, Australia, Pacific

#### u-blox Singapore Pte. Ltd.

Phone: +65 6734 3811  
E-mail: [info\\_ap@u-blox.com](mailto:info_ap@u-blox.com)  
Support: [support\\_ap@u-blox.com](mailto:support_ap@u-blox.com)

#### Regional Office Australia:

Phone: +61 2 8448 2016  
E-mail: [info\\_au@u-blox.com](mailto:info_au@u-blox.com)  
Support: [support\\_ap@u-blox.com](mailto:support_ap@u-blox.com)

#### Regional Office China (Beijing):

Phone: +86 10 68 133 545  
E-mail: [info\\_cn@u-blox.com](mailto:info_cn@u-blox.com)  
Support: [support\\_cn@u-blox.com](mailto:support_cn@u-blox.com)

#### Regional Office China (Chongqing):

Phone: +86 23 6815 1588  
E-mail: [info\\_cn@u-blox.com](mailto:info_cn@u-blox.com)  
Support: [support\\_cn@u-blox.com](mailto:support_cn@u-blox.com)

#### Regional Office China (Shanghai):

Phone: +86 21 6090 4832  
E-mail: [info\\_cn@u-blox.com](mailto:info_cn@u-blox.com)  
Support: [support\\_cn@u-blox.com](mailto:support_cn@u-blox.com)

#### Regional Office China (Shenzhen):

Phone: +86 755 8627 1083  
E-mail: [info\\_cn@u-blox.com](mailto:info_cn@u-blox.com)  
Support: [support\\_cn@u-blox.com](mailto:support_cn@u-blox.com)

#### Regional Office India:

Phone: +91 80 4050 9200  
E-mail: [info\\_in@u-blox.com](mailto:info_in@u-blox.com)  
Support: [support\\_in@u-blox.com](mailto:support_in@u-blox.com)

#### Regional Office Japan (Osaka):

Phone: +81 6 6941 3660  
E-mail: [info\\_jp@u-blox.com](mailto:info_jp@u-blox.com)  
Support: [support\\_jp@u-blox.com](mailto:support_jp@u-blox.com)

#### Regional Office Japan (Tokyo):

Phone: +81 3 5775 3850  
E-mail: [info\\_jp@u-blox.com](mailto:info_jp@u-blox.com)  
Support: [support\\_jp@u-blox.com](mailto:support_jp@u-blox.com)

#### Regional Office Korea:

Phone: +82 2 542 0861  
E-mail: [info\\_kr@u-blox.com](mailto:info_kr@u-blox.com)  
Support: [support\\_kr@u-blox.com](mailto:support_kr@u-blox.com)

#### Regional Office Taiwan:

Phone: +886 2 2657 1090  
E-mail: [info\\_tw@u-blox.com](mailto:info_tw@u-blox.com)  
Support: [support\\_tw@u-blox.com](mailto:support_tw@u-blox.com)