# NEO-M8

## u-blox M8 concurrent GNSS modules

## Data Sheet

**Highlights:**

- Concurrent reception of up to 3 GNSS (GPS, Galileo, GLONASS, BeiDou)
- Industry leading −167 dBm navigation sensitivity
- Security and integrity protection
- Supports all satellite augmentation systems
- Advanced jamming and spoofing detection Backward compatible with NEO-7, NEO-6 and NEO-5 families

## Document Information

| | |
|---|---|
| **Title** | **NEO-M8** |
| **Subtitle** | u-blox M8 concurrent GNSS modules |
| **Document type** | Data Sheet |
| **Document number** | UBX-15031086 |
| **Revision and Date** | R03                          05-Aug-2016 |
| **Document status** | Product Information |

| 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. |
| Early Production Information | Document contains data from product verification. Revised and supplementary data may be published later. |
| Production Information | Document contains the final product specification. |

## This document applies to the following products:

| Product name | Type number | ROM/FLASH version | PCN reference |
|---|---|---|---|
| NEO-M8N | NEO-M8N-0-10 | Flash FW SPG 3.01 | UBX-15030279 |
| NEO-M8Q | NEO-M8Q-0-10 | ROM SPG 3.01 | UBX-16013121 |
| NEO-M8M | NEO-M8M-0-10 | ROM SPG 3.01 | UBX-16013121 |

# Contents

# 1 Functional description

## 1.1 Overview

The NEO-M8 series of concurrent GNSS modules is built on the high performing u-blox M8 GNSS engine in the industry proven NEO form factor.

The NEO-M8 series utilizes concurrent reception of up to three GNSS systems (GPS/Galileo together with BeiDou or GLONASS), recognizes multiple constellations simultaneously and provides outstanding positioning accuracy in scenarios where urban canyon or weak signals are involved. For even better and faster positioning improvement, the NEO-M8 series supports augmentation of QZSS, GAGAN and IMES together with WAAS, EGNOS, MSAS. The NEO-M8 series also supports message integrity protection, geofencing, and spoofing detection with configurable interface settings to easily fit to customer applications. The NEO form factor allows easy migration from previous NEO generations.

The NEO-M8M is optimized for cost sensitive applications, while NEO-M8N/M8Q provides best performance and easier RF integration. The NEO-M8N offers high performance also at low power consumption levels. The future-proof NEO-M8N includes an internal Flash that allows future firmware updates. This makes NEO-M8N perfectly suited to industrial and automotive applications.

The DDC (I2C compliant) interface provides connectivity and enables synergies with most u-blox cellular modules. For RF optimization the NEO-M8N/Q features an additional front-end LNA for easier antenna integration and a front-end SAW filter for increased jamming immunity.

u-blox M8 modules use GNSS chips qualified according to AEC-Q100, are manufactured in ISO/TS 16949 certified sites, and fully tested on a system level. 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-M8 modules can also benefit from the u-blox AssistNow assistance service. The Online service provides GNNS broadcast parameters, e.g. ephemeris, almanac plus time or rough position 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 6 days) provide faster acquisition after a long off time.

☞ See section 1.6 for more information concerning the NEO-M8 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 | 1.65 V – 3.6 V | 2.7 V – 3.6 V | UART | USB | SPI | DDC (I²C 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 |
| NEO-M8N | • | | | | • | • | • | • | 3 | | • | • | • | • | • | • | • | • | • | • | T | | | 1 | | ▮ | |
| NEO-M8Q | • | | | | • | • | • | • | 3 | | • | • | • | • | • | | | • | • | • | T | | | 1 | | ▮ | |
| NEO-M8M | • | | | | • | • | • | • | 3 | • | | • | • | • | • | | | | | • | C | | | 1 | | ▮ | |

C = Crystal / T = TCXO

## 1.3 Performance

| Parameter | Specification | | | | |
|---|---|---|---|---|---|
| Receiver type | 72-channel u-blox M8 engine<br>GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1 SAIF, GLONASS L1OF, BeiDou B1I, Galileo E1B/C | | | | |
| Accuracy of time pulse signal | RMS<br>99% | 30 ns<br>60 ns | | | |
| Frequency of time pulse signal | | 0.25 Hz…10 MHz<br>(configurable) | | | |
| Operational limits [1] | Dynamics | £ 4 g | | | |
| | Altitude | 50,000 m | | | |
| | Velocity | 500 m/s | | | |
| Velocity accuracy [2] | | 0.05m/s | | | |
| Heading accuracy [2] | | 0.3 degrees | | | |
| GNSS | | GPS & GLONASS | GPS | GLONASS | BeiDou | Galileo |
| Horizontal position accuracy [3] | | 2.5 m | 2.5 m | 4 m | 3 m | TBC[4] |

**NEO-M8N/Q**

| | | GPS & GLONASS | GPS | GLONASS | BeiDou | Galileo |
|---|---|---|---|---|---|---|
| Max navigation update rate | NEO-M8N | 5 Hz | 10 Hz | 10 Hz | 10 Hz | 10 Hz |
| | NEO-M8Q | 10 Hz | 18 Hz | 18 Hz | 18 Hz | 18 Hz |
| Time-To-First-Fix [5] | Cold start | 26 s | 29 s | 30 s | 34 s | 45 s |
| | Hot start | 1 s | 1 s | 1 s | 1 s | 1 s |
| | Aided starts [6] | 2 s | 2 s | 2 s | 3 s | 7 s |
| Sensitivity[7] | Tracking & Navigation | –167 dBm | –166 dBm | -166 dBm | -160 dBm | -159 dBm |
| | Reacquisition | –160 dBm | –160 dBm | -156 dBm | -157 dBm | -153 dBm |
| | Cold start | –148 dBm | –148 dBm | -145 dBm | -143 dBm | -138 dBm |
| | Hot start | –157 dBm | –157 dBm | -156 dBm | -155 dBm | -151 dBm |

**NEO-M8M**

| | | GPS & GLONASS | GPS | GLONASS | BeiDou | Galileo |
|---|---|---|---|---|---|---|
| Max navigation update rate | | 10 Hz | 18 Hz | 18 Hz | 18 Hz | 18 Hz |
| Time-To-First-Fix [5] | Cold start | 26 s | 30 s | 33 s | 39 s | 57 s |
| | Hot start | 1 s | 1 s | 1 s | 1 s | 1 s |
| | Aided starts [6] | 3 s | 3 s | 3 s | 7 s | 7 s |
| Sensitivity[7] | Tracking & Navigation | -164 dBm | -164 dBm | -163 dBm | -160 dBm | -154 dBm |
| | Reacquisition | -160 dBm | -159 dBm | -156 dBm | -155 dBm | -152dBm |
| | Cold start | -148 dBm | -147 dBm | -145 dBm | -143 dBm | -133 dBm |
| | Hot start | -157 dBm | -156 dBm | -155 dBm | -155 dBm | -151 dBm |

**Table 1: NEO-M8 performance in different GNSS modes (default: concurrent reception of GPS and GLONASS incl. QZSS, SBAS)**

---

[1] Assuming Airborne < 4 g platform
[2] 50% @ 30m/s
[3] CEP, 50%, 24 hours static, -130 dBm, > 6 SVs
[4] To be confirmed when Galileo reaches full operational capability
[5] All satellites at -130 dBm, except Galileo at -127 dBm
[6] Dependent on aiding data connection speed and latency
[7] Demonstrated with a good external LNA

## 1.4 Block diagram
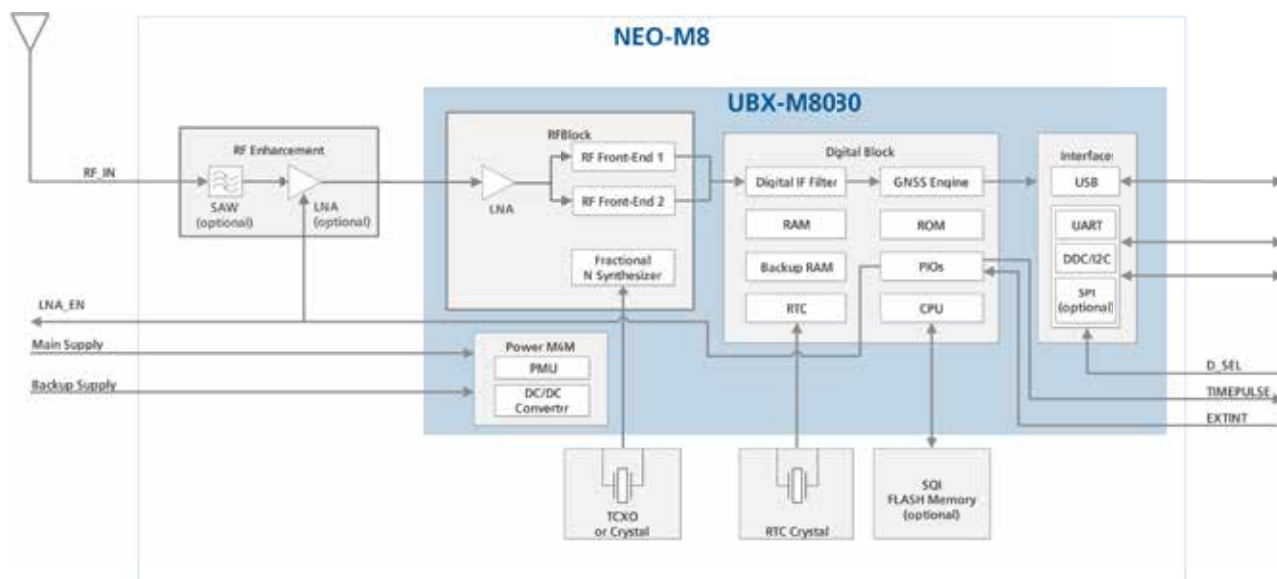


**Figure 1: NEO-M8 block diagram**

## 1.5 Supported GNSS Constellations

The NEO-M8 GNSS modules are concurrent GNSS receivers which can receive and track multiple GNSS systems: GPS, Galileo, GLONASS and BeiDou. Owing to the dual-frequency RF front-end architecture, either GLONASS or BeiDou can be processed concurrently with GPS and Galileo signals providing reception of three GNSS systems. By default the M8 receivers are configured for concurrent GPS and GLONASS, including SBAS and QZSS reception. If power consumption is a key factor, then the receiver should be configured for a single GNSS operation using GPS, Galileo, GLONASS or BeiDou and disabling QZSS and SBAS.  The module can be configured to receive any single GNSS constellation or within the set of permissible combinations shown below.

| GPS | Galileo | GLONASS | BeiDou |
|---|---|---|---|
| • | • | – | – |
| • | • | • | – |
| • | • | – | • |
| • | – | • | – |
| • | – | – | • |
| – | • | • | – |
| – | • | – | • |
| – | – | • | • |

**Table 2 Permissible GNSS combinations (• = enabled)**

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

☞   Galileo is not enabled as the default configuration.

### 1.5.1 GPS

The NEO-M8 positioning modules are designed to receive and track the L1C/A signals provided at 1575.42 MHz by the Global Positioning System (GPS).

### 1.5.2 GLONASS

The NEO-M8 modules can receive and process the GLONASS satellite system as an alternative to the US-based Global Positioning System (GPS). u-blox NEO-M8 positioning modules are designed to receive and track the L1OF signals GLONASS provides at 1602 MHz + k*562.5 kHz, where k is the satellite's frequency channel number (k = –7,..., 5, 6). The ability to receive and track 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.

### 1.5.3 BeiDou

The NEO-M8 modules can receive and process the B1I signals broadcast at 1561.098 MHz from the BeiDou Navigation Satellite System. The ability to receive and track BeiDou signals in conjunction with another constellation results in higher coverage, improved reliability and better accuracy. Currently, BeiDou is not fully operational globally and provides Chinese regional coverage only. Global coverage is scheduled for 2020.

### 1.5.4 Galileo

The NEO-M8 positioning modules can receive and track the E1-B/C signals centered on the GPS L1 frequency band. GPS and Galileo signals can be processed concurrently together with either BeiDou or GLONASS signals, enhancing coverage, reliability and accuracy. The SAR return link message (RLM) parameters for both short and long versions are decoded by the receiver and made available to users via UBX proprietary messages.

☞ Galileo has been implemented according to ICD release 1.2 (November 2015) and verified with live signals from the Galileo in-orbit validation campaign. Since the Galileo satellite system has not yet reached Initial (IOC) nor Full Operational Capability (FOC), changes to the Galileo signal specification (OS SIS ICD) remain theoretically possible. u-blox therefore recommends to use Flash memory in designs utilizing Galileo signals in order to allow for a FW update in the unlikely event of a change to the Galileo signal specification (OS SIS ICD).

☞ Galileo reception is by default disabled, but can be enabled by sending a configuration message (UBX-CFG-GNSS) to the receiver. See the *u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification* [2] for more information.

## 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 M8030 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, BeiDou, Galileo and QZSS

### 1.6.2 AssistNow™ Offline

With the AssistNow Offline service, users can download long-term orbit data over the Internet at their convenience. The orbit data can be stored in the GNSS receiver's SQI flash memory or alternatively within the memory of the application processor. The function requires no connectivity at system start-up, enabling a position fix within seconds, even when no network is available. AssistNow Offline offers augmentation for up to 35 days.

☞ AssistNow Offline service provides data for GPS and GLONASS only, BeiDou and Galileo are not currently supported

### 1.6.3 AssistNow™ Autonomous

AssistNow Autonomous 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 satellites; by capturing strategic ephemeris data at specific times of the day. The Flash memory based NEO-M8N module can predict accurate satellite ephemeris for up to six days after initial reception. The ROM based NEO-M8M/Q modules can use only GPS satellites with a prediction time of up to three days.

u-blox AssistNow Autonomous benefits are:
- Faster fix in situations where 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-M8 modules support 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 be used as additional satellites for ranging (navigation), further enhancing availability. The following SBAS types are supported: GAGAN, WAAS, EGNOS and MSAS.

☞ 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 L1 C/A signals for the Pacific region covering Japan and Australia. NEO-M8 positioning modules are 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 can be enabled for reception via a GNSS configuration message.

### 1.7.3 IMES

The Japanese Indoor MEssaging System (IMES) system is used for indoor position reporting using low-power transmitters which broadcast a GPS–like signal. NEO-M8 modules can be configured to receive and demodulate the signal to provide an in-door location estimate.

☞ This service is authorized and available only in Japan.

☞ IMES reception is disabled by default

### 1.7.4 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 3: 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 Broadcast navigation data and satellite signal measurements

The NEO-M8 modules can output all the GNSS broadcast data upon reception from tracked satellites. This includes all the supported GNSS signals plus the augmentation services SBAS, QZSS and IMES. 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].

## 1.9 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].

## 1.10 Data logging (NEO-M8N)

The NEO-M8N module can be used in data logging applications. The data logging feature enables continuous storage of position, velocity and time information to an onboard SQI flash memory (at least 16 Mbit). It can also log the distance from the odometer. The information can be downloaded from the receiver later for further analysis or for conversion to a mapping tool. For more information see the *u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification* [2].

## 1.11 Geofencing

The u-blox NEO-M8 modules support up to four circular Geofencing areas defined on the Earth's surface using a 2D model. Geofencing is active when at least one Geo-fence is defined, the current status can be found by polling the receiver. A GPIO pin can be nominated to indicate status to e.g. wake up a host on activation.

## 1.12 Message Integrity Protection

The NEO-M8 modules provide a function to detect third party interference with the UBX message steam sent from receiver to host. The security mechanism "signs" nominated messages via a subsequent UBX message. This message signature is then compared with one generated by the host to determine if the message data has been altered. The signature algorithm seed can use one fixed secret ID-key set by eFuse in production and a dynamic ID-key set by the host, enabling users to detect "man-in-the-middle" style attacks.

## 1.13 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, NEO-M8 modules include spoofing detection 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 to detect all spoofing attacks.

## 1.14 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].

### 1.14.1 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.

### 1.14.2 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.

## 1.15 TIMEPULSE

A configurable time pulse signal is available with all u-blox M8 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].

## 1.16 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 4: Available Protocols**

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

## 1.17 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.

### 1.17.1 UART

The NEO-M8 modules include 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, updates and reconfiguration.

### 1.17.2 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.

### 1.17.3 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 125kB/s and the maximum SPI clock frequency is 5.5 MHz. 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 3.1).

### 1.17.4 Display Data Channel (DDC)

An I²C 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 I²C industry standard. Since the maximum SCL clock frequency is 400 kHz, the maximum transfer rate is 400 kb/s.

## 1.18  Clock generation

### 1.18.1 Oscillators

NEO-M8 GNSS modules are available in TCXO and crystal versions. The TCXO allows accelerated weak signal acquisition, enabling faster start and reacquisition times.

Oscillators used on NEO-M8 modules 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.

### 1.18.2 Real-Time Clock (RTC)

The RTC is driven by a 32 kHz 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.

## 1.19  Power management

u-blox M8 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.

### 1.19.1 DC/DC converter

The NEO-M8 modules integrate 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].

### 1.19.2 Power Mode Setup

u-blox M8 modules can be configured to run in either continuous 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 1.19.4

The u-blox M8 modules' 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 1Hz cyclic tracking mode for aggressive power reduction
- Choice of 2 or 4 Hz[8] cyclic tracking modes for typical wearable applications
- ON/OFF interval mode

### 1.19.3 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

### 1.19.4 Power Save Mode

For specific power saving applications outside the typical preset power mode setups, users can configure a tailored Power Save Mode.

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].

---

[8] Single GNSS constellation configuration only

## 1.20  Antenna

NEO-M8 modules are designed for use with passive[9] and active[10] 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 | $50^{11}$ dB / $30^{12}$ dB |
| | Maximum noise figure | 1.5 dB |

**Table 5: Antenna Specifications for NEO-M8 modules**

## 1.21 LNA_EN

The LNA_EN pin provides optional control for switching off power to an active antenna or separate LNA. This facility is provided to help minimize power consumption in power save mode operation. See the *NEO-8Q / NEO-M8 Hardware Integration Manual* [1] *for more information.*

---

[9]  For integration of NEO-M8 modules with Cellular products, see the *NEO-8Q / NEO-M8 Hardware Integration Manual* [1].
[10]  For information on using active antennas with NEO-M8 modules, see the *NEO-8Q / NEO-M8 Hardware Integration Manual* [1].
[11]  NEO-M8M
[12]  NEO-M8N/Q

# 2 Pin Definition

## 2.1 Pin assignment
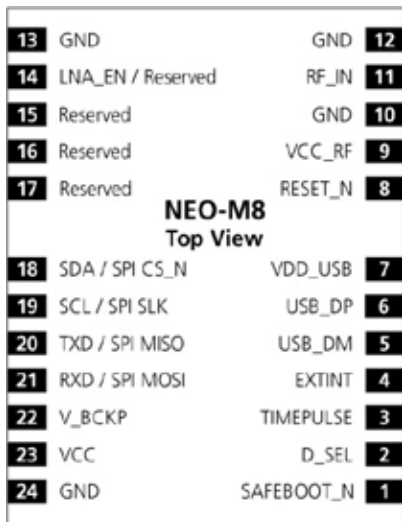


**Figure 2: Pin Assignment**

| No | Name | I/O | Description |
|---|---|---|---|
| 1 | SAFEBOOT_N | I | SAFEBOOT_N (for future service, updates 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 / Reserved | O | LNA_EN (NEO-M8N/Q): Antenna/LNA control<br>Reserved (NEO-M8M): Reserved |
| 15 | Reserved | - | Reserved |
| 16 | Reserved | - | Reserved |
| 17 | Reserved | - | Reserved |
| 18 | SDA /<br>SPI CS_N | I/O | DDC Data if D_SEL =1 (or open)<br>SPI Chip Select if D_SEL = 0 |
| 19 | SCL /<br>SPI CLK | I/O | DDC Clock if D_SEL =1(or open)<br>SPI Clock if D_SEL = 0 |
| 20 | TXD /<br>SPI MISO | O | Serial Port if D_SEL =1(or open)<br>SPI MISO if D_SEL = 0 |
| 21 | RXD /<br>SPI MOSI | I | Serial Port if D_SEL =1(or open)<br>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 of NEO-M8**

☞ Pins designated Reserved should not be used. For more information about Pinouts see the *NEO-8Q / NEO-M8 Hardware Integration Manua* [1].

## 2.2 Pin name changes

Selected pin names have been updated to agree with a common naming convention across u-blox modules. The pins have not changed their operation and are the same physical hardware but with updated names. The table below lists the pins that have changed name along with their old and new names.

| No | Previous Name | New name |
|---|---|---|
| 1 | Reserved | SAFEBOOT_N |
| 14 | ANT_ON | LNA_EN |
| 20 | TxD<br>SPI MISO | TXD /<br>SPI MISO |
| 21 | RxD<br>SPI MOSI | RXD /<br>SPI MOSI |

**Table 7: Pin name changes**

# 3  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.

With the NEO-M8, configuration settings modified with UBX configuration messages can be saved permanently. In this case, the modified settings remain effective even after power-down and do not require backup battery supply.

## 3.1   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-M8 module series 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 8: Data interface selection by D_SEL**

# 4 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 Manua* [1].

## 4.1 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 trough 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 W, continuous wave | | 15 | dBm |
| Storage temperature | Tstg | | −40 | 85 | °C |

**Table 9: 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.**

## 4.2 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 | 2.7 | 3.0 | 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 | | 30 | | µA | VCC = 3 V |
| Input pin voltage range | Vin | 0 | | VCC | V | |
| Digital IO Pin Low level input voltage | Vil | 0 | | 0.2*VCC | V | |
| Digital IO Pin High level input voltage | Vih | 0.7*VCC | | VCC | V | |
| Digital IO Pin Low level output voltage | Vol | | | 0.4 | V | Iol = 4mA |
| Digital IO Pin High level output voltage | Voh | VCC–0.4 | | | V | Ioh = 4mA |
| Pull-up resistor for RESET_N (internal) | Rpu | | 11 | | kW | |
| USB_DM, USB_DP | VinU | 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 [13] | NFtot | | 2.0 | | dB | |
| Operating temperature | Topr | –40 | | 85 | °C | |

**Table 10: Operating conditions**

☞ Operation beyond the specified operating conditions can affect device reliability.

---

[13] Only valid for the GPS band

## 4.3 Indicative current requirements

Table 11 lists examples of the total system supply current for a possible application.

☞ Values in Table 11 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 | Module | Typ<br>GPS & GLONASS | Typ<br>GPS | Max | Units | Condition |
|---|---|---|---|---|---|---|---|
| Max. supply current [14] | Iccp | All | | | 67 | mA | |
| Average supply current [15, 16] | Icc Acquisition[17] | NEO-M8N | 32 | 25 | | mA | Estimated at 3 V |
| | | NEO-M8M | 24 | 19 | | mA | |
| | | NEO-M8Q | 30 | 24 | | mA | |
| | Icc Tracking<br>(Continuous mode) | NEO-M8N | 30 | 23 | | mA | Estimated at 3 V |
| | | NEO-M8M | 21 | 17 | | mA | |
| | | NEO-M8Q | 28 | 23 | | mA | |
| | Icc Tracking<br>(Power Save mode / 1 Hz) | NEO-M8N | 13 | 12 | | mA | Estimated at 3 V |
| | | NEO-M8M | 5.3 | 4.8 | | mA | |
| | | NEO-M8Q | 11.5 | 11.1 | | mA | |

**Table 11: Indicative power requirements at 3.0 V**

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

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

---

[14] Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.
[15] Use this figure to determine required battery capacity.
[16] Simulated GNSS constellation using power levels of -130 dBm. VCC = 3.0 V
[17] Average current from start-up until the first fix.

## 4.4 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 12: Symbol description**
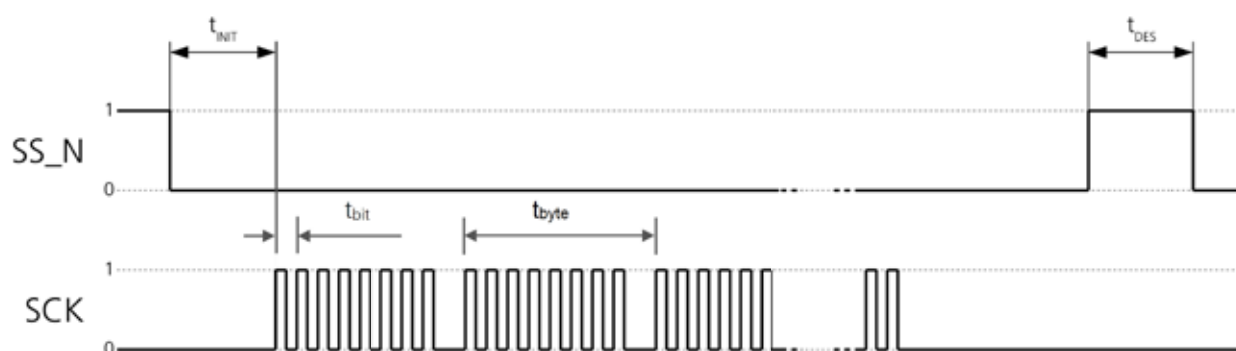


**Figure 3: SPI timing diagram**

### 4.4.1 Timing recommendations

The recommendations below are based on a firmware running from Flash memory.

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

**Table 13: 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.

## 4.5 DDC timing diagrams

The DDC interface is I²C Fast Mode compliant. For timing parameters consult the I²C 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.

# 5 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 | |
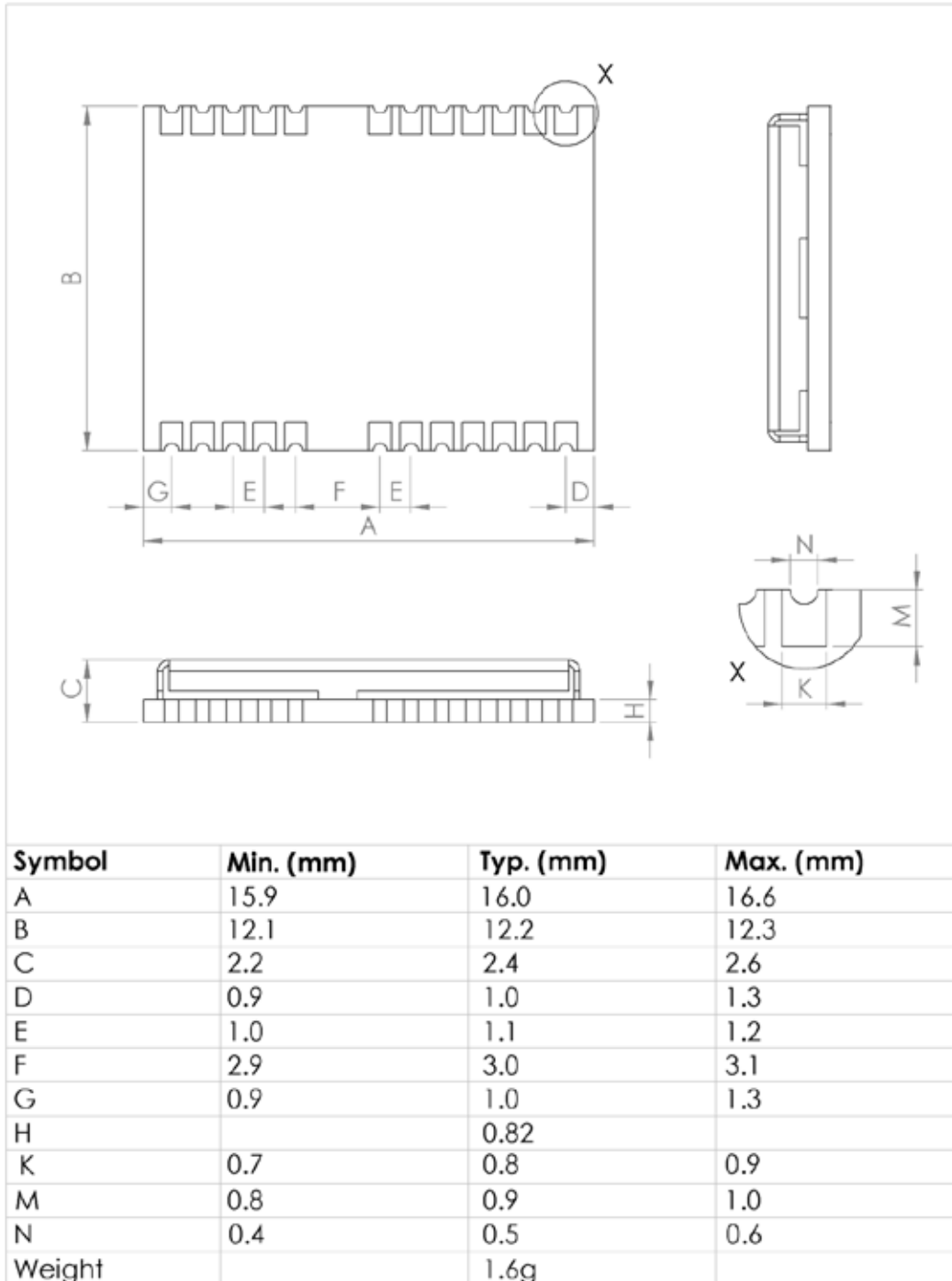
**Figure 4: Dimensions**

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

# 6 Reliability tests and approvals

## 6.1 Reliability tests

☞ All NEO-M8 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.

## 6.2 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 M8 GNSS modules are RoHS compliant.

# 7 Product handling & soldering

## 7.1 Packaging

The NEO-M8 GNSS 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].

### 7.1.1 Reels

The NEO-M8 GNSS modules are deliverable in quantities of 250 pcs on a reel. The NEO-M8 modules are shipped on Reel Type B, as specified in the *u-blox Package Information Guide* [3].

### 7.1.2 Tapes

The dimensions and orientations of the tapes for NEO-M8 modules are specified in Figure 5.



**Figure 5: Dimensions and orientation for NEO-M8 modules on tape**

## 7.2 Shipment, storage and handling

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

### 7.2.1 Moisture Sensitivity Levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. The NEO-M8 modules are rated at MSL level 4.

☞ For MSL standard see IPC/JEDEC J-STD-020, which can be downloaded from www.jedec.org.

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

### 7.2.2 Reflow soldering

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

### 7.2.3 ESD handling precautions

⚠ **NEO-M8 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).

# 8 Default messages

| Interface | Settings |
|---|---|
| UART Output | 9600 Baud, 8 bits, no parity bit, 1 stop bit<br>Configured to transmit both NMEA and UBX protocols, but only the following NMEA (and no UBX) messages have been activated at start-up:<br>**GGA, GLL, GSA, GSV, RMC, VTG, TXT** |
| 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:<br>**GGA, GLL, GSA, GSV, RMC, VTG, TXT**<br>USB Power Mode: Bus Powered |
| UART Input | 9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled<br>Automatically accepts following protocols without need of explicit configuration:<br>UBX, NMEA, RTCM<br>The GNSS receiver supports interleaved UBX and NMEA messages. |
| USB Input | Automatically accepts following protocols without need of explicit configuration:<br>UBX, NMEA<br>The GPS receiver supports interleaved UBX and NMEA messages.<br>USB Power Mode: Bus Powered |
| DDC | Fully compatible with the I²C industry standard, available for communication with an external host CPU or u-blox cellular modules, operated in slave mode only. Default messages activated.<br>NMEA and UBX are enabled as input messages, only NMEA as output messages.<br>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<br>(1 Hz Nav) | 1 pulse per second, synchronized at rising edge, pulse length 100 ms |

**Table 14: Default messages**

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

# 9 Labeling and ordering information

## 9.1 Product labeling

The labeling of u-blox NEO-M8 GNSS modules includes important product information. The location of the NEO-M8 product type number is shown in Figure 6.
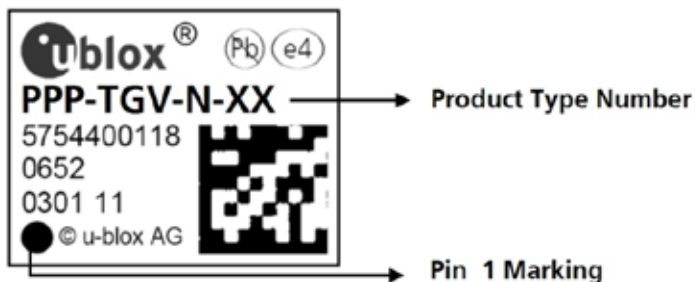


**Figure 6: Location of product type number on u-blox NEO-M8 module label**

## 9.2 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 15 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 15: Product Code Formats**

The parts of the product code are explained in Table 16.

| Code | Meaning | Example |
|---|---|---|
| PPP | Product Family | NEO |
| TG | Platform | M8 = u-blox M8 |
| V | Variant | Function set (A-Z), T = Timing, R = DR, etc. |
| N | Option / Quality Grade | Describes standardized functional element or quality grade<br>0 = Default variant, A = Automotive |
| XX | Product Detail | Describes product details or options such as hard- and software revision, cable length, etc. |

**Table 16: part identification code**

## 9.3 Ordering codes

| Ordering No. | Product |
|---|---|
| NEO-M8M-0 | u-blox M8 Concurrent GNSS LCC Module, crystal, ROM, 12.2x16 mm, 250 pcs/reel |
| NEO-M8N-0 | u-blox M8 Concurrent GNSS LCC Module, TCXO, flash, SAW, LNA, 12.2x16 mm, 250 pcs/reel |
| NEO-M8Q-0 | u-blox M8 Concurrent GNSS LCC Module, TCXO, ROM, SAW, LNA, 12.2x16 mm, 250 pcs/reel |

**Table 17: Product ordering codes for professional grade modules**

☞ 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 (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 | 28-Jan-2016 | byou | Advance Information |
| R02 | 01-Jun-2016 | byou | Added NEO-M8M and NEO-M8Q variant information, pin name change advisory |
| R03 | 05-Aug-2016 | byou | Product Information |

# Contact

For complete contact information visit us at 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

**Regional Office West Coast:**
Phone:      +1 408 573 3640
E-mail:      info_us@u-blox.com

**Technical Support:**
Phone:      +1 703 483 3185
E-mail:      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
Support:    support@u-blox.com

**Asia, Australia, Pacific**

**u-blox Singapore Pte. Ltd.**
Phone:      +65 6734 3811
E-mail:      info_ap@u-blox.com
Support:    support_ap@u-blox.com

**Regional Office Australia:**
Phone:      +61 2 8448 2016
E-mail:      info_anz@u-blox.com
Support:    support_ap@u-blox.com

**Regional Office China (Beijing):**
Phone:      +86 10 68 133 545
E-mail:      info_cn@u-blox.com
Support:    support_cn@u-blox.com

**Regional Office China (Chongqing):**
Phone:      +86 23 6815 1588
E-mail:      info_cn@u-blox.com
Support:    support_cn@u-blox.com

**Regional Office China (Shanghai):**
Phone:      +86 21 6090 4832
E-mail:      info_cn@u-blox.com
Support:    support_cn@u-blox.com

**Regional Office China (Shenzhen):**
Phone:      +86 755 8627 1083
E-mail:      info_cn@u-blox.com
Support:    support_cn@u-blox.com

**Regional Office India:**
Phone:      +91 80 4050 9200
E-mail:      info_in@u-blox.com
Support:    support_in@u-blox.com

**Regional Office Japan (Osaka):**
Phone:      +81 6 6941 3660
E-mail:      info_jp@u-blox.com
Support:    support_jp@u-blox.com

**Regional Office Japan (Tokyo):**
Phone:      +81 3 5775 3850
E-mail:      info_jp@u-blox.com
Support:    support_jp@u-blox.com

**Regional Office Korea:**
Phone:      +82 2 542 0861
E-mail:      info_kr@u-blox.com
Support:    support_kr@u-blox.com

**Regional Office Taiwan:**
Phone:      +886 2 2657 1090
E-mail:      info_tw@u-blox.com
Support:    support_tw@u-blox.com