



# LEA-M8S

## u-blox M8 concurrent GNSS module

### Data Sheet



#### Abstract

Technical data sheet describing the LEA-M8S module, which provides concurrent reception of up to 3 GNSS (GPS, Galileo, GLONASS, BeiDou). LEA-M8S is pin-compatible to LEA-6 modules.

# Document Information

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This document applies to the following products:

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# 1 Functional description

## 1.1 Overview

The LEA-M8S module delivers concurrent GNSS location capability together with high-performance u-blox M8 positioning technology in the industry proven LEA form factor.

With its dual-frequency RF front-end, the u-blox M8 concurrent GNSS engine is able to intelligently use the highest number of visible satellites from up to three GNSS systems (GPS/Galileo together with GLONASS or BeiDou) for more reliable positioning. The LEA-M8S provides exceptional performance with low system power, and is optimized for cost sensitive applications. It also supports message integrity protection, geofencing, and spoofing detection.

The LEA-M8S module has sophisticated RF-architecture and interference suppression ensuring maximum performance even in GNSS hostile environments. It features very low power GLONASS functionality. This 6th generation module in the LEA form factor allows simple migration from LEA-6x GPS and LEA-6N GPS/GLONASS modules.

The LEA-M8S module combines a high level of robustness and integration capability with flexible connectivity options. The DDC (I<sup>2</sup>C compliant) interface provides connectivity and enables synergies with most u-blox cellular modules. For RF optimization, the LEA-M8S features a front-end SAW filter for increased jamming immunity.

LEA-M8S module uses u-blox GNSS chips qualified according to AEC-Q100 and are 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 LEA-M8S module can also benefit from the u-blox AssistNow assistance service. The Online service provides GNSS 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 3 days) provide faster acquisition after a long off time.

 See section 1.6 for more information concerning the LEA-M8S module 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											
LEA-M8S	•	• • • •	3	•	• • •	• • • • • T •	•	1										

C = Crystal / T = TCXO

## 1.3 Performance

Parameter	Specification					
Receiver type	72-channel u-blox M8 engine GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1 SAIF, GLONASS L1OF, BeiDou B1I, Galileo E1B/C					
Accuracy of time	RMS	30 ns				
pulse signal	99%	60 ns				
Frequency of time pulse signal	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>	0.05m/s					
Heading accuracy <sup>2</sup>	0.3 degrees					
Horizontal position accuracy <sup>3</sup>	GNSS	GPS & GLONASS	GPS	GLONASS	BeiDou	Galileo
		2.5 m	2.5 m	4.0 m	3.0 m	TBC <sup>4</sup>
Max navigation update rate		10 Hz	18 Hz	18 Hz	18 Hz	18 Hz
Time-To-First-Fix <sup>5</sup>	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 <sup>6</sup>	2 s	2 s	2 s	3 s	7 s
Sensitivity <sup>7</sup>	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

**Table 1: LEA-M8S performance in different GNSS modes (default: concurrent reception of GPS and GLONASS incl. QZSS, SBAS)**

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

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

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

<sup>4</sup> To be confirmed when Galileo reaches full operational capability

<sup>5</sup> All satellites at -130 dBm, except Galileo at -127 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

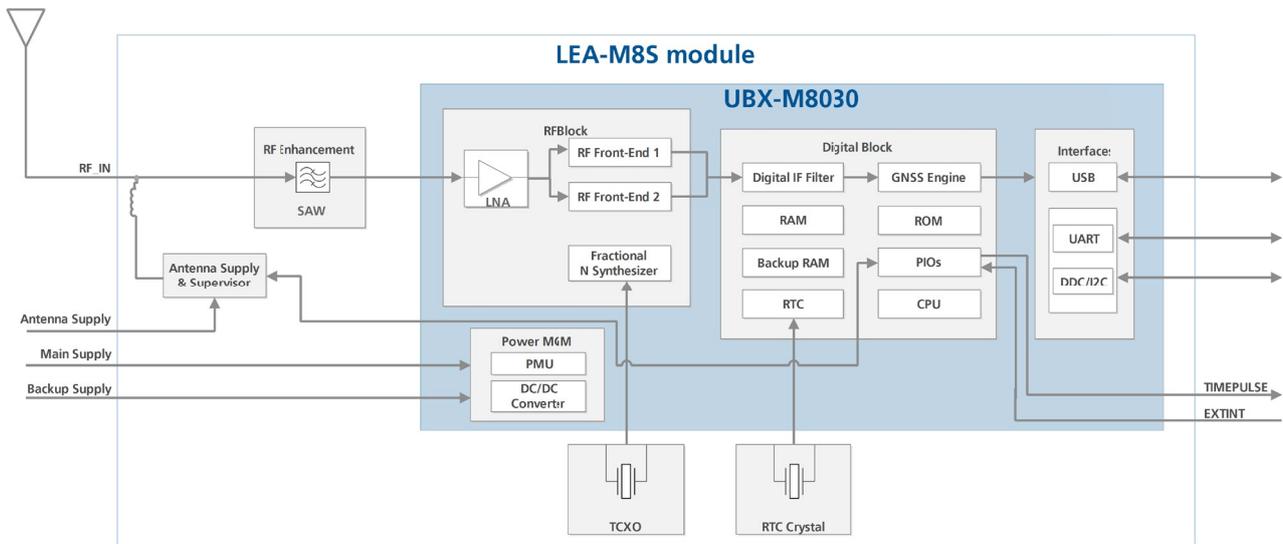


Figure 1: LEA-M8S block diagram

## 1.5 Supported GNSS Constellations

The LEA-M8S GNSS module is a concurrent GNSS receiver 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 LEA-M8S GNSS module is 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 LEA-M8S module can receive and process the GLONASS satellite system as an alternative to GPS. The u-blox LEA-M8S positioning module is designed to receive and track the L1OF signals GLONASS transmits 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 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 LEA-M8S / M8T Hardware Integration Manual [1] for u-blox design recommendations.

## 1.5.3 BeiDou

The LEA-M8S GNSS module can receive and process BeiDou concurrently with GPS or GLONASS. u-blox LEA-M8S module is designed to receive and track the B1 signals provided at 1561.098 MHz by the BeiDou Navigation Satellite System. The ability to receive and track BeiDou B1 satellite signals in conjunction with GPS results in higher coverage, improved reliability and better accuracy. Global coverage is scheduled for 2020.

## 1.5.4 Galileo

The LEA-M8S positioning module 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.

 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 aiding information, such as ephemeris, almanac, rough user position and time, will reduce the time to first fix significantly and improve the acquisition sensitivity. All u-blox M8 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 SQL 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 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 LEA-M8S module, AssistNow Autonomous can calculate GPS only orbit predictions for up to 3 days.

u-blox's AssistNow Autonomous benefits are:

- Faster fix in situations where GNSS satellite signals are weak
- No connectivity required
- Compatible with AssistNow Online (can work stand-alone, or in tandem with the AssistNow Online service)
- 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].

 For best AssistNow Autonomous performance, it is recommended to use u-blox M8 flash-based receivers.

## 1.7 Augmentation Systems

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

The LEA-M8S 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 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. The LEA-M8S positioning 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 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. The LEA-M8S module 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.

### 1.7.4 IMES reception is disabled by default. Differential GPS (D-GPS)

The LEA-M8S module supports Differential-GPS data according to RTCM 10402.3: "RECOMMENDED STANDARDS FOR DIFFERENTIAL GNSS". The use of Differential-GPS data improves GPS position accuracy. RTCM cannot be used together with SBAS. 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**

 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 LEA-M8S 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) [5]. For more details see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification [2].

### 1.9 Odometer

The odometer provides information on travelled ground distance (in meters) based on the position and Doppler-based velocity output from the navigation solution. For each computed travelled 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 Geofencing

The LEA-M8S 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 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.

## 1.11 Message Integrity Protection

The LEA-M8S module provides a function to detect third party interference with the UBX message stream 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.

## 1.12 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 LEA-M8S module includes 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.

## 1.13 EXTINT: External interrupt

**EXTINT0**, **EXTINT1** are external interrupt pins with fixed input voltage thresholds with respect to VCC. They can be used for control of the receiver or for aiding time or frequency.

### 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 nominated **EXTINT** pin.

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

### 1.13.2 Aiding

The **EXTINT** pins 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 a nominated **EXTINT** pin.

Frequency aiding can be implemented by connecting a periodic rectangular signal with a frequency of up to 500 kHz and arbitrary duty cycle (the low/high phase duration must be greater than 50 ns) to the nominated **EXTINT** pin. The applied aiding frequency value is given to the receiver using UBX messages.

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].

The **EXTINT1** pin can also be configured as an active antenna open circuit detection function (**ANT\_DET\_N**). For further information see 1.19.1 and the LEA-M8S / M8T Hardware Integration Manual [1].

## 1.14 TIMEPULSE

A configurable time pulse signal is available with the LEA-M8S module.

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 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 2.3	Input, message 1, 2, 3, 9

**Table 4: Available Protocols**

All protocols are available on UART, USB and DDC (I2C compliant). 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 LEA-M8S 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 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.

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.

## 1.17 Clock generation

### 1.17.1 TCXO Oscillator

The LEA-M8S module uses a TCXO reference oscillator. The TCXO allows accelerated weak signal acquisition, enabling faster start and reacquisition times.

Oscillators used on the LEA-M8S 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 32 kHz oscillator using an external 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

The LEA-M8S GNSS module 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 LEA-M8S 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 LEA-M8S / M8T Hardware Integration Manual [1]

### 1.18.2 Power Mode Setup

The u-blox LEA-M8S 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 more information, see section 1.18.4.

The u-blox M8 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<sup>8</sup> cyclic tracking modes for typical wearable applications

### 1.18.3 Continuous Mode

Continuous Mode uses the acquisition engine at full performance resulting in the shortest possible TTFB 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.

---

<sup>8</sup> Single GNSS constellation configuration only

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 M8 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 LEA-M8S module is designed for use with passive 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	50 dB
	Maximum noise figure	1.5 dB

Table 5: Antenna Specifications for LEA-M8S module

### 1.19.1 Antenna supervisor and short circuit detection

An antenna supervisor is available with LEA-M8S receiver. The antenna supervisor enables the receiver to detect short circuits at the active antenna and shut down the voltage bias immediately. A resistor is needed in series with the **V\_ANT** input to enable checking of the antenna bias voltage. UBX and NMEA messages are provided to report the condition of the antenna supply. Open circuit detection can also be supported with an additional external circuit.

 Antenna open circuit detection can be connected to the **EXTINT1** pin after a configuration change. For more information see the LEA-M8S / M8T Hardware Integration Manual [1].

<sup>9</sup> For information on using active antennas with LEA-M8S module, see the *LEA-M8S/M8T Hardware Integration Manual*[1].

## 2 Pin Definition

### 2.1 Pin assignment

15	GND	GND	14
16	RF_IN	GND	13
17	GND	SAFEBOOT_N	12
18	VCC_RF	V_BCKP	11
19	V_ANT	RESET_N	10
20	EXTINT1	Reserved	9
<b>TOP VIEW</b>			
21	Reserved	VCC_OUT	8
22	Reserved	GND	7
23	Reserved	VCC	6
24	VDD_USB	Reserved	5
25	USB_DM	RXD	4
26	USB_DP	TXD	3
27	EXTINT0	SCL	2
28	TIMEPULSE	SDA	1

Figure 2: Pin Assignment

No	Name	I/O	Description
1	SDA	I/O	DDC Data
2	SCL	I/O	DDC Clock
3	TXD	O	Serial Port 1
4	RXD	I	Serial Port 1
5	Reserved		Not Connected
6	VCC	I	Supply voltage
7	GND	I	Ground (digital)
8	VCC_OUT	O	Output voltage
9	Reserved		Not Connected
10	RESET_N	I	External Reset
11	V_BCKP	I	Backup voltage supply
12	SAFEBOOT_N	I	SAFEBOOT_N (for future service and reconfiguration, leave OPEN)
13	GND	I	Ground
14	GND	I	Ground
15	GND	I	Ground
16	RF_IN	I	GNSS signal input
17	GND	I	Ground
18	VCC_RF	O	Output Voltage RF section
19	V_ANT	I	Antenna Bias voltage
20	EXTINT1	I	External Interrupt, can be configured as active antenna open circuit detection pin: ANT_DET_N
21	Reserved		Not Connected
22	Reserved		Not Connected
23	Reserved		Not Connected
24	VDD_USB	I	USB Supply
25	USB_DM	I/O	USB Data
26	USB_DP	I/O	USB Data
27	EXTINT0	I	External Interrupt Pin
28	TIMEPULSE	O	Timepulse (1 PPS)

Table 6: Pinout

 Pins designated Reserved should only be used with caution. For more information about pinouts see the LEA-M8S / M8T Hardware Integration Manual [1].

### 2.1.1 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
3	TxD	TXD
4	RxD	RXD
12	Reserved	SAFEBOOT_N
20	AADET_N	EXTINT1

**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.

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

## 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 LEA-M8S / M8T Hardware Integration Manual [1].

### 4.1 Absolute maximum rating

**CAUTION.** Risk of device damage. Exceeding the absolute maximum ratings may affect the lifetime and reliability of the device or permanently damage it. Do not exceed the absolute maximum ratings.

This product is not protected against overvoltage or reversed voltages. Use appropriate protection to avoid device damage from voltage spikes exceeding the specified boundaries.

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	Vidig	Input voltage on Configurable Inputs, RESET_N if VCC < 3.1 V	-0.5	VCC+0.5	V
		Input voltage on Configurable Inputs, RESET_N if VCC > 3.1 V	-0.5	3.6	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
Antenna bias voltage	V_ANT			6	V
Antenna bias current	I_ANT			100	mA
Storage temperature	Tstg		-40	85	°C

**Table 8: Absolute maximum ratings**

### 4.2 Operating conditions

All specifications in this section have been measured at an ambient temperature of +25 °C. Extreme operating temperatures can significantly impact the specified values. If an application operates near the min or max temperature limits, ensure the specified values are not exceeded.

Parameter	Symbol	Min	Typical	Max	Units	Condition
Power supply voltage	VCC	2.7	3.0	3.6	V	
Supply voltage USB	VDD_USB	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
Input pin voltage range	Vin	0		VCC	V	

Parameter	Symbol	Min	Typical	Max	Units	Condition
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		kΩ	
USB_DM, USB_DP	VinU	Compatible with USB with 27 Ω series resistance				
V_ANT antenna bias voltage	V_ANT	2.7		5.5	V	IANT < -50 mA
Antenna bias voltage drop	V_ANT_DROP		0.1		V	ICC_RF = 50 mA
VCC_RF voltage	VCC_RF		VCC-0.1		V	
VCC_RF output current	ICC_RF			50	mA	
Receiver Chain Noise Figure <sup>10</sup>	NFtot		4.0		dB	
Operating temperature	Topr	-40		85	°C	

**Table 9: Operating conditions**

Operation beyond the specified operating conditions can affect device reliability.

### 4.3 Indicative current requirements

Table 10 lists examples of the total system supply current for a possible application.

Values in Table 10 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 & GLONASS / QZSS / SBAS	GPS / QZSS / SBAS			
Max. supply current <sup>11</sup>	Iccp			67	mA	
Average supply current <sup>12, 13</sup>	Icc Acquisition <sup>14</sup>	24	18		mA	Estimated at 3 V
	Icc Tracking (Continuous mode)	22	17		mA	Estimated at 3 V
	Icc Tracking (Power Save mode / 1 Hz)	6.2	5.7		mA	Estimated at 3 V

**Table 10: Indicative power requirements at 3.0 V**

For more power requirement information, see LEA-M8S / M8T Hardware Integration Manual [1].

For more information on how to noticeably reduce current consumption, see the Power Management Application Note [4].

<sup>10</sup> Only valid for the GPS band

<sup>11</sup> Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.

<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

<sup>14</sup> Average current from start-up until the first fix.

## 5 Mechanical specifications

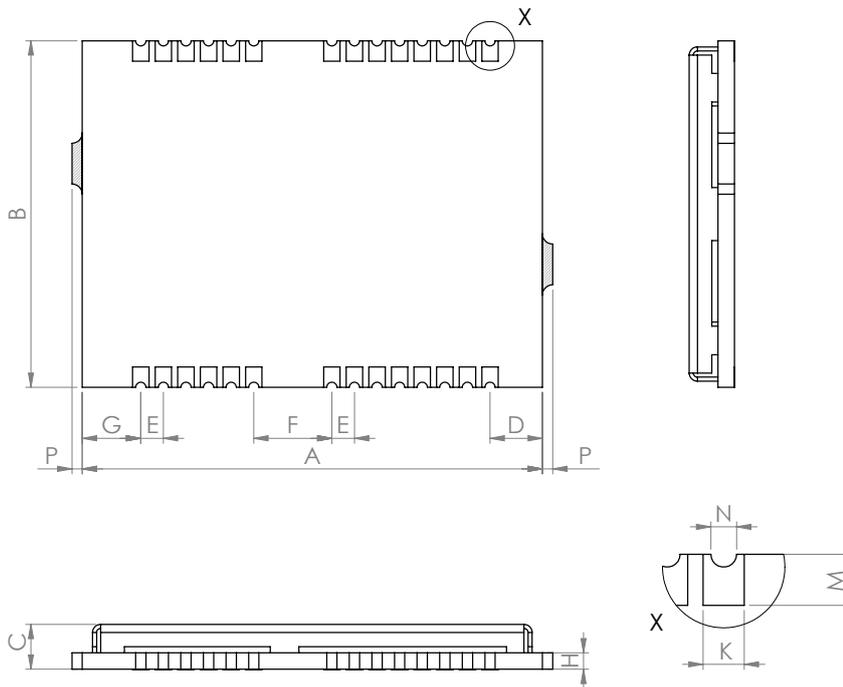


Figure 3 LEA-M8S mechanical drawing

Symbol	Min [mm]	Typ. [mm]	Max [mm]	
A	22.3	22.4	22.5	
B	16.9	17.0	17.1	
C	2.1	2.4	2.7	
D	2.45	2.55	2.65	
E	1.0	1.1	1.2	
F	3.7	3.8	3.9	
G	2.75	2.85	2.95	
H	-	0.82	-	
K	0.7	0.8	0.9	
M	0.9	1.0	1.1	
N	0.4	0.5	0.6	
P*	0.0		0.3	The de-paneling residual tabs are located on both sides of the module
Weight		2.1 g		

Table 11 LEA-M8S mechanical dimensions

-  The mechanical picture of the de-paneling residual tabs (P\*) is an approximate representation. The shape and position of the residual tab may vary.
-  When designing the component keep-out area, note that the de-paneling residual tabs are located on both sides of the module.
-  For information about the paste mask and footprint, see the LEA-M8S / M8T Hardware Integration Manual [1].

## 6 Reliability tests and approvals

### 6.1 Reliability tests

 LEA-M8S 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



The LEA-M8S module complies with the Directives 2011/65/EU and 2015/863/EU of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances (RoHS).

## 7 Product handling & soldering

### 7.1 Packaging

The LEA-M8S GNSS modules are delivered as hermetically sealed, reeled tapes to enable efficient production, production lot set-up and tear-down. For more information, see the u-blox Product Packaging Reference Guide [3].

#### 7.1.1 Reels

The LEA-M8S GNSS modules are deliverable in quantities of 250 pcs on a reel. The LEA-M8S receivers are shipped on Reel Type B, as specified in the u-blox Product Packaging Reference Guide[3]

#### 7.1.2 Tapes

The dimensions and orientations of the tapes for LEA-M8S modules are specified in Figure 4.

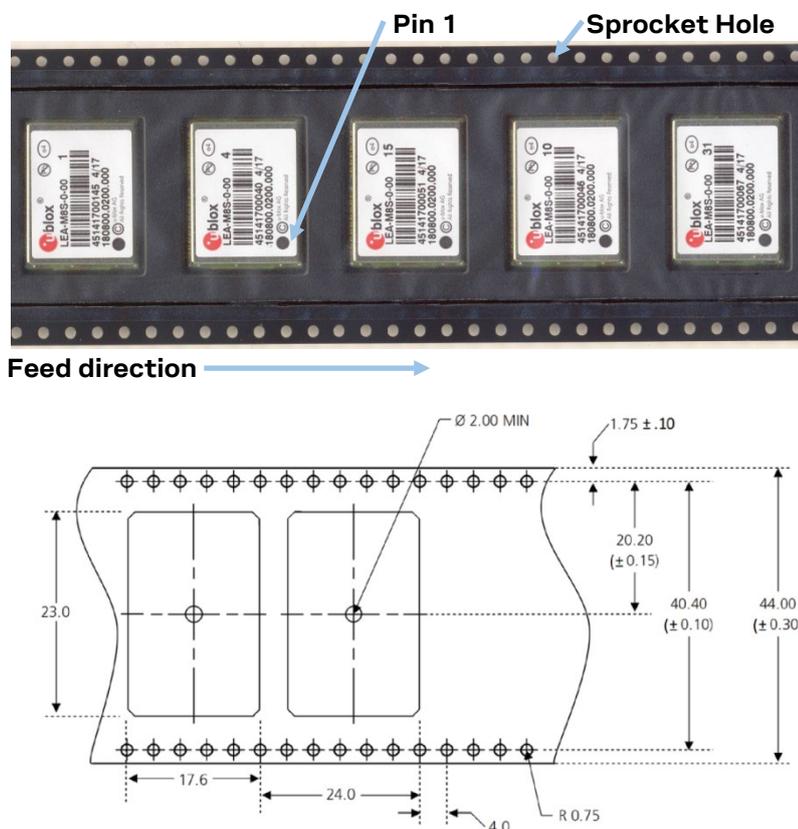


Figure 4: Dimensions and orientation for LEA-M8S modules on tape

### 7.2 Shipment, storage and handling

For important information regarding shipment, storage and handling see the u-blox Product Packaging Reference Guide [3].

#### 7.2.1 Moisture Sensitivity Levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. The LEA-M8S 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 Product Packaging Reference Guide [3].

## 7.2.2 Reflow soldering

Reflow profiles are to be selected according u-blox recommendations (see the LEA-M8S / LEA-M8T Hardware Integration Manual [1]).

## 7.2.3 ESD handling precautions

LEA-M8S module is 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 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.
TIMEPULSE (1 Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100 ms.

**Table 12: 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 M8 GNSS modules includes important product information. The location of the LEA-M8S product type number is shown in Figure 5.

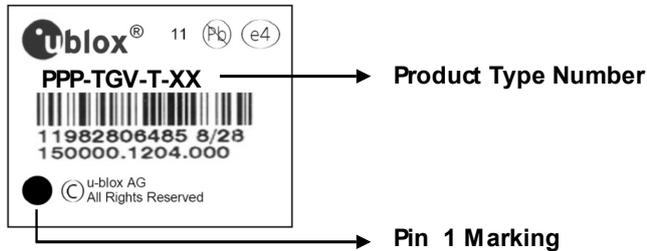


Figure 5: Location of product type number on u-blox LEA-M8S module label

### 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 13 shows the structure of these three different formats.

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

Table 13: Product Code Formats

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

Code	Meaning	Example
PPP	Product Family	LEA
TG	Platform	M8 = u-blox M8
V	Variant	Function set (A-Z), T = Timing, R = DR, etc.
T	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

### 9.3 Ordering codes

Ordering No.	Product
LEA-M8S-0	u-blox M8 Concurrent GNSS LCC Module, TCXO, ROM, SAW, 17.0x22.4 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.

# Appendix

## A Glossary

Abbreviation	Definition
ASCII	American Standard Code for Information Interchange
ARM	Arm (Advanced RISC Machines) Holdings
AEC	Automotive Electronics Council
BBR	Battery Backed RAM
BER	Bit Error Rate
CPU	Central Processing Unit
UTC	Coordinated Universal Time
DCE	Data Circuit-terminating Equipment* / Data Communication Equipment*
DTE	Data Terminal Equipment
DC	Direct Current
DRX	Discontinuous Reception
DDC	Display Data Channel
DL	Down Link (Reception)
XYZ	This table can be automatically constructed using the custom macro.

**Table 16: Explanation of the abbreviations and terms used**

Some text to describe whatever it is that is relevant here.

## Related documents

- [1] LEA-M8S / M8T Hardware Integration Manual, [UBX-15030060](#)
- [2] u-blox 8 / u-blox M8 Receiver Description including Protocol Specification, [UBX-13003221](#)
- [3] u-blox Product Packaging Reference Guide, [UBX-14001652](#)
- [4] Power Management Application Note, [UBX-13005162](#)
- [5] 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 ([www.u-blox.com](http://www.u-blox.com)).

## Revision history

Revision	Date	Name	Comments
R01	20-Jun-2016	byou	Advance Information
R02	05-Aug-2016	byou	Production Information
R03	28-Jan-2019	rmak	Updated Sections 1.6.3 (AssistNow autonomous), 4.1 (Absolute maximum rating), 6.2 (RoHS statement)
R04	11-Oct-2023	skar	Chapter Mechanical specifications updated with information on de-paneling residual tabs

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