MAX-M10S

u-blox M10 standard precision GNSS module

Data sheet

Abstract
This data sheet describes the MAX-M10S, an ultra-low-power GNSS receiver for high-performance asset-tracking applications.

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Document information

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In development / prototype	Objective specification	Target values. Revised and supplementary data will be published later.
Engineering sample	Advance information	Data based on early testing. Revised and supplementary data will be published later.
Initial production	Early production information	Data from product verification. Revised and supplementary data may be published later.
Mass production / End of life	Production information	Document contains the final product specification.

This document applies to the following products:

Product name	Type number	Firmware version	PCN reference
MAX-M10S	MAX-M10S-00B-00	SPG 5.00	N/A

Contents

1 Functional description

1.1 Overview

The MAX-M10S module features the u-blox M10 standard precision GNSS platform and provides exceptional sensitivity and acquisition times for all L1 GNSS signals.

The extremely low power consumption in continuous tracking mode allows great power autonomy for all battery-operated devices, such as asset trackers, without compromising on GNSS performance.

The MAX-M10S supports concurrent reception of up to four GNSS (GPS, GLONASS, Galileo, and BeiDou). The high number of visible satellites enables the receiver to select the best signals. This maximizes the position accuracy, in particular under challenging conditions such as in deep urban canyons. In the firmware described here, however, the number of concurrently received GNSS is limited to three. u-blox Super-S (Super-Signal) technology offers great RF sensitivity.

The MAX-M10S integrates an LNA followed by a SAW filter in the RF path for maximum sensitivity in passive antenna designs.

The MAX-M10S offers backwards pin-to-pin compatibility with products from the previous u-blox generations, which saves the designer's effort and reduces costs when upgrading designs.

1.2 Performance

Parameter	Specification	
Receiver type	u-blox M10 receiver	
Accuracy of time pulse signal	RMS 99%	30 ns 60 ns
Frequency of time pulse signal		0.25 Hz to 10 MHz (configurable)
Operational limits[1]	Dynamics	≤ 4 g
	Altitude	80,000 m
	Velocity	500 m/s
Velocity accuracy[2]		0.05 m/s
Dynamic heading accuracy[2]		0.3 deg

GNSS		GPS+GAL	GPS+GLO	GPS+BDS	GPS+GLO+GAL	GPS+GAL+BDS
Acquisition[3]	Cold start	29 s	26 s	27 s	24 s	27 s
	Hot start	1 s	1 s	1 s	1 s	1 s
	Aided start[4]	1 s	1 s	1 s	1 s	1 s
Nav. update rate	PVT	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz

1 Assuming Airborne 4 g platform

2 50% at 30 m/s for dynamic operation

3 Commanded starts. All satellites at -130 dBm. GPS always in combination with QZSS and SBAS. Measured at room temperature.

4 Dependent on the speed and latency of the aiding data connection, commanded starts.

GNSS		GPS+GAL	GPS+GLO	GPS+BDS	GPS+GLO+GAL	GPS+GAL+BDS
Sensitivity[5]	Tracking and nav.	-166 dBm	-167 dBm	-167 dBm	-167 dBm	-166 dBm
	Reacquisition	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm
	Cold start	-148 dBm	-148 dBm	-148 dBm	-148 dBm	-148 dBm
	Hot start	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm
Position accuracy	PVT	2 m CEP	2 m CEP	2 m CEP	2 m CEP	2 m CEP

Table 1: MAX-M10S typical performance in multi-constellation GNSS modes. Default configuration: concurrent reception of GPS and Galileo with QZSS, SBAS.

GNSS		GPS	GLONASS	BEIDOU	GALILEO
Acquisition[3]	Cold start	29 s	27 s	30 s	38 s
	Hot start	1 s	1 s	1 s	1 s
	Aided start[4]	1 s	1 s	1 s	5 s
Nav. update rate	PVT	18 Hz	18 Hz	18 Hz	18 Hz
Sensitivity[5]	Tracking and nav.	-166 dBm	-166 dBm	-160 dBm	-159 dBm
	Reacquisition	-160 dBm	-154 dBm	-158 dBm	-154 dBm
	Cold start	-148 dBm	-147 dBm	-146 dBm	-141 dBm
	Hot start	-160 dBm	-156 dBm	-159 dBm	-154 dBm
Position accuracy	PVT	2 m CEP	4 m CEP	3 m CEP	3 m CEP

Table 2: MAX-M10S typical performance in single-GNSS modes

1.3 Supported GNSS constellations

The MAX-M10S is a concurrent GNSS receiver which can receive and track multiple GNSS systems. The single RF front-end architecture enables three major GNSS constellations to be received concurrently. The receiver can be configured for a sub-set of GNSS constellations to achieve lower power consumption.

The following GNSS and their signals are supported:

System	Signals
GPS	L1C/A (1575.42 MHz)
Galileo	E1-B/C (1575.42 MHz)
GLONASS	L1OF (1602 MHz + k*562.5 kHz, k = –7,..., 5, 6)
BeiDou	B1I (1561.098 MHz)

Table 3: Supported GNSS and signals on MAX-M10S

The following GNSS assistance services are supported:

Service	Support
AssistNow™ Online	Supported
AssistNow™ Offline	Supported
AssistNow™ Autonomous	Supported

Table 4: Supported Assisted GNSS (A-GNSS) services

The following augmentation systems are supported:

[5] Demonstrated with a good external LNA. Measured at room temperature.

System	Support
SBAS	EGNOS, GAGAN, MSAS and WAAS
QZSS	L1S (SLAS)

Table 5: Supported augmentation systems

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

1.4 Supported protocols

The MAX-M10S supports the following protocols:

Protocol	Type
UBX	Input/output, binary, u-blox proprietary
NMEA versions 2.1, 2.3, 4.0, and 4.10. (default 4.10)	Input/output, ASCII

Table 6: Supported protocols

1.5 Firmware features

Feature	Description
Antenna supervisor[6]	Antenna supervisor for active antenna control and short detection
Assisted GNSS	AssistNow Online, AssistNow Offline and AssistNow Autonomous supported
Backup modes	Hardware backup mode and software standby mode (similar to older software backup mode), both with RTC
Data batching	Autonomous tracking up to 5 minutes at 1 Hz
Odometer	Measure traveled distance with support for different user profiles

Table 7: Firmware features

Feature	Description
Anti-jamming	RF interference and jamming detection and reporting; Active GNSS in-band filtering
Anti-spoofing	Spoofing detection and reporting
Message integrity	All messages are cryptographically signed

Table 8: Security features

6 External components required, some pins need to be reconfigured.

2 System description

2.1 Block diagram

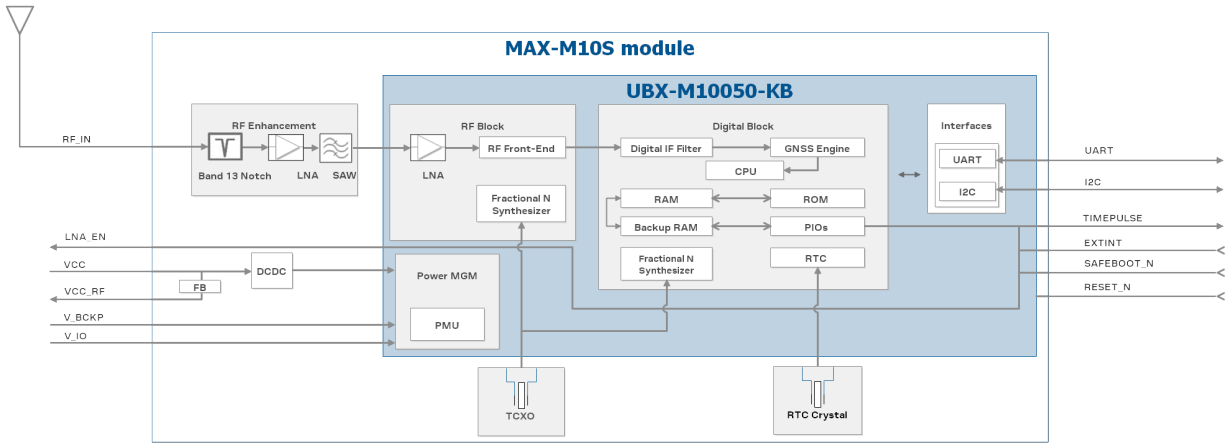


Figure 1: MAX-M10S block diagram

The GPIOs can be programmed for different uses such as external interrupt, LNA enable, TX-ready, data batching indicator, and antenna supervisor.

3 Pin definition

3.1 Pin assignment

The pin assignment of the MAX-M10S is shown below:

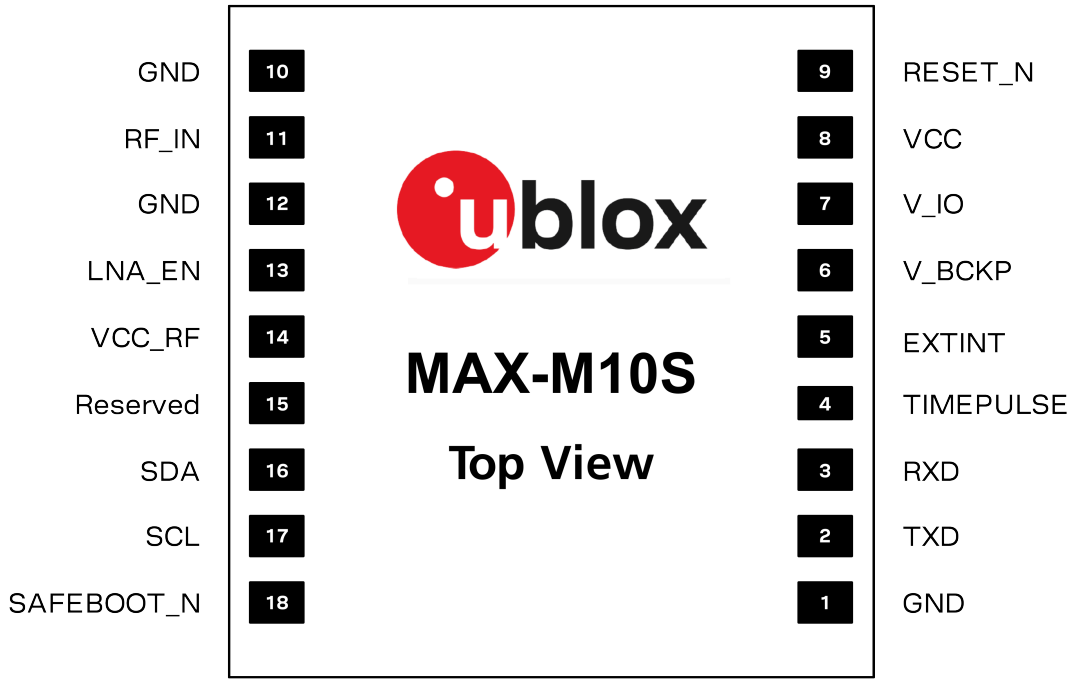


Figure 2: MAX-M10S pin assignment

Pin no.	Name	PIO no.	I/O	Description
1	GND	-	-	Connect to GND
2	TXD	1	O	UART TX
3	RXD	0	I	UART RX
4	TIMEPULSE	4	O	Time pulse signal
5	EXTINT	5	I	External interrupt
6	V_BCKP	-	I	Backup voltage supply
7	V_IO	-	I	IO voltage supply, must be connected to VCC
8	VCC	-	I	Main voltage supply
9	RESET_N	-	I	System reset (active low). Has to be low for at least 1 ms to trigger a reset.
10	GND	-	-	Connect to GND
11	RF_IN	-	I	GNSS signal input
12	GND	-	-	Connect to GND
13	LNA_EN	-	O	On/Off external LNA or active antenna
14	VCC_RF	-	O	Output voltage RF section
15	Reserved	-	-	Reserved
16	SDA	2	I/O	I2C data

Pin no.	Name	PIO no.	I/O	Description
17	SCL	3	I	I2C clock
18	SAFEBOOT_N	-	I	Safeboot mode (leave OPEN)

Table 9: MAX-M10S pin assignment

4 Electrical specifications

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. Operation of the device at these or at any other conditions above those given below is not implied. Exposure to limiting values for extended periods may affect device reliability.

Where application information is given, it is advisory only and does not form part of the specification.

4.1 Absolute maximum ratings

VCC and V_IO must be connected together.

Symbol	Parameter	Min	Max	Unit
VCC, V_IO	Supply voltages	–0.3	3.6	V
	Voltage ramp on VCC, V_IO[7]	25	35000	µs/V
V_BCKP	Supply voltage, backup domain	–0.3	3.6	V
	Voltage ramp on V_BCKP[7]	25		µs/V
Vin	Input voltage, digital pins	–0.3	V_IO + 0.3 (max 3.6)	V
Ipin	Max source / sink current, digital pins[8]	-10	10	mA
ICC_RF	Max source current, VCC_RF		100	mA
P_{rfin}	RF input power on RF_IN[9]		+15	dBm
T_{amb}	Ambient temperature	–40	+85	°C
T_s	Storage temperature	–40	+85	°C

Table 10: Absolute maximum ratings

The product is not protected against overvoltage or reversed voltages. Voltage spikes exceeding the power supply voltage specification, given in the table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

4.2 Operating conditions

Table 11 shows the general operating conditions. Table 12 shows the electrical parameters for digital I/O.

VCC and V_IO must be connected together.

Symbol	Parameter	Min	Typical	Max	Units
VCC, V_IO	Supply voltages	2.7	3.0	3.6	V
V_BCKP	Supply voltage, backup domain	1.65		3.6	V
VCC_RF	VCC_RF output voltage		VCC-0.1		V
ICC_RF	VCC_RF output current			50	mA
NF_{tot}	Receiver chain noise figure		1.5		dB

7 Exceeding the voltage ramp speed may permanently damage the device.

8 SAFEBOOT_N pin has an internal 1 kΩ series resistor. With a 3.3 V supply, the current is limited to 3.3 mA.

9 Test conditions TBC

Symbol	Parameter	Min	Typical	Max	Units
Ext_gain[10]	External gain at RF_IN, low gain mode (default)			30	dB
	External gain at RF_IN, bypass mode			40	dB
T_{opr}	Operating temperature	-40		+85	°C

Table 11: General operating conditions

Symbol	Parameter	Min	Typical	Max	Units
V_{in}	Input pin voltage range	0		V_IO	V
V_{il}	Low-level input voltage			0.63	V
V_{ih}	High-level input voltage	0.68 x V_IO			V
V_{ol}	Low-level output voltage, Iout = -2 mA			0.4	V
V_{oh}	High-level output voltage, Iout = 2 mA	V_IO - 0.4			V
$R_{pu, IO}$	Pull-up resistance, Digital IO[11]	5	17	72	kΩ
$R_{pu, SAFEBOOT\_N}$	Pull-up resistance, SAFEBOOT_N[12]	5	17	72	kΩ
$R_{pu, RESET\_N}$	Pull-up resistance, RESET_N	7	10	13	kΩ

Table 12: Digital IO

Operation beyond the specified operating conditions can affect device reliability.

4.3 Indicative power requirements

Table 13 lists examples of the total system supply current for VCC and V_IO. Table 14 shows current consumptions for the backup modes.

These values are provided for customer information only, as an example of typical current requirements. They are characterized on samples using a cold start command. Actual power requirements can vary depending on FW version used, external circuitry, number of satellites tracked, signal strength, type and time of start, duration, internal LNA gain mode, and test conditions.

Symbol	Parameter	Conditions	GPS	GPS+GAL	GPS+GAL +GLO	GPS+GAL +BEI	Unit
I_{PEAK}	Peak current	Acquisition	25	25	25	25	mA
I_{VCC} [13]	Current at VCC	Acquisition	6.5	7.0	9.0	10.5	mA
		Tracking (Continuous mode)	6.0	6.0	7.0	8.0	mA
I_{V_IO} [14]	Current at V_IO	Acquisition	2.2	2.2	2.3	2.3	mA
		Tracking (Continuous mode)	2.2	2.2	2.3	2.3	mA

Table 13: Typical currents to calculate the indicative power requirements

Symbol	Parameter	Conditions	Typ.	Unit
I_{V_BCKP}	Total current in hardware backup mode	V_BCKP = 3.3 V / V_IO = VCC = 0 V	32	µA

10 The internal LNA gain is configurable.

11 TXD, RXD, TIMEPULSE, EXTINT, SCL, SDA, and LNA_EN.

12 The SAFEBOOT_N pin has an additional 1 kΩ series resistor.

13 Voltage at VCC = 3.0 V. Internal LNA set to low gain. Simulated signal using power levels of -130 dBm.

14 Voltage at V_IO = 3.0 V.

Symbol	Parameter	Conditions	Typ.	Unit
I_{VCC, V_IO} [15]	Total current in software standby mode	V_IO = 3.3 V / VCC = 3.3 V	46	µA

Table 14: Backup currents to calculate the indicative power requirements

All values in Table 13 and Table 14 are measured at 25 °C ambient temperature and with the internal LNA set to low gain.

SBAS and QZSS are activated in all measurements.

[15] I_{VCC, V_IO} includes currents flowing into VCC and V_IO.

5 Communication interfaces

The receiver allows communication over UART and I2C[16] interface.

All the inputs have internal pull-up resistors in normal operation and can be left open if not used. All the PIOs are supplied by V_IO, therefore all the voltage levels of the PIO pins are related to V_IO supply voltage.

5.1 UART

The UART interface supports configurable baud rates. Hardware flow control is not supported.

Symbol	Parameter	Min	Max	Unit
R_u	Baud rate	4800	921600	bit/s
Δ_{Tx}	Tx baud rate accuracy	-1%	+1%	-
Δ_{Rx}	Rx baud rate tolerance	-2.5%	+2.5%	-

Table 15: UART specifications

5.2 I2C

An I2C-compliant interface is available for communication with an external host CPU. The interface is compatible with the Fast-mode of the I2C industry standard, allowing a maximum bit rate of 400 kbit/s[17].

5.3 Default interface settings

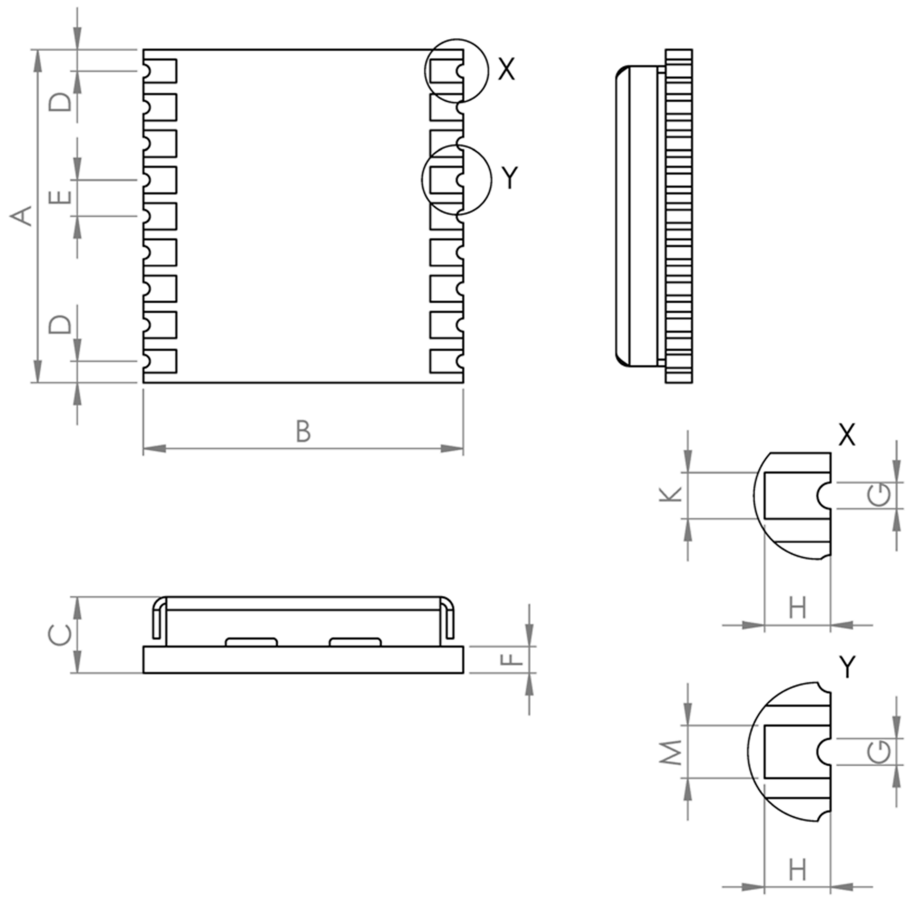
Interface	Settings
UART	• 9600 baud, 8 bits, no parity bit, 1 stop bit. • Input messages: NMEA and UBX. • Output messages: NMEA GGA, GLL, GSA, GSV, RMC, VTG and TXT.
I2C	• 7-bit I2C address (0x42). • Input messages: NMEA and UBX. • Output messages: NMEA GGA, GLL, GSA, GSV, RMC, VTG and TXT.

Table 16: Default interface settings

16 I2C is a registered trademark of Philips/NXP.

17 External pull-up resistors are needed to achieve 400 kbit/s communication speed as the internal pull-up resistance can be very large.

6 Mechanical specifications



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	10.0	10.1	10.7
B	9.6	9.7	9.8
C	2.2	2.5	2.7
D	0.55	0.65	0.95
E	1.0	1.1	1.2
F		0.76	
G	0.3	0.4	0.5
H	0.9	1.0	1.1
K	0.6	0.7	0.8
M	0.7	0.8	0.9
Weight		0.6g	

Figure 3: MAX-M10S mechanical drawing

7 Labeling and ordering information

This section provides information about product labeling and ordering.

7.1 Product labeling

The labeling of the MAX-M10S package provides product information and revision information. For more information contact u-blox sales.

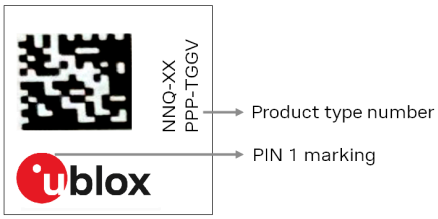


Figure 4: Location of product type number on MAX-M10S label

7.2 Explanation of product codes

Three product code formats are used. The **Product name** is used in documentation such as this data sheet and identifies all u-blox 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 17 details these three different formats for the MAX-M10S.

Format	Structure	Product code
Product name	PPP-TGGV	MAX-M10S
Ordering code	PPP-TGGV-NNQ	MAX-M10S-00B
Type number	PPP-TGGV-NNQ-XX	MAX-M10S-00B-00

Table 17: Product code formats

The parts of the product code are explained in Table 18 .

Code	Meaning	Example
PPP	Product family	MAX
TGG	Platform	M10 = u-blox M10
V	Variant	S = Standard precision, ROM, LNA, and SAW filter
NNQ	Option / Quality grade	NN: Option [00...99] Q: Grade, A = Automotive, B = Professional
XX	Product detail	Describes hardware and firmware versions

Table 18: Part identification code

7.3 Ordering codes

Ordering code	Product	Remark
MAX-M10S-00B	u-blox MAX-M10S module, professional grade	

Table 19: Product ordering codes

Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs) see our website at: https://www.u-blox.com/en/product-resources.

Related documents

[1] MAX-M10S Integration manual, UBX-20053088

[2] u-blox M10 SPG 5.00 Interface description, UBX-20053845

☞ For regular updates to u-blox documentation and to receive product change notifications please register on our homepage https://www.u-blox.com.

Revision history

Revision	Date	Name	Status / comments
R01	21-Dec-2020	imar, jesk, msul, rmak	Objective Specification
R02	20-Apr-2021	rmak	Advance information. Updated Firmware features, Pin assignment, Absolute maximum ratings, Operating conditions, Indicative power requirements, and Product labeling. Minor revision.

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