MAX-M10S

Standard precision GNSS module

Professional grade

Data sheet

Abstract

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

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Document information

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Product status	Corresponding content status	
Functional Sample	Draft	For functional testing. Revised and supplementary data will be published later.
In development / prototype	Objective specification	Target values. Revised and supplementary data will be published later.
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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	FW version	IN/PCN reference	Product status
MAX-M10S	MAX-M10S-00B-01	ROM SPG 5.10	UBX-22012689	Initial production

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 time for all L1 GNSS signals.

MAX-M10S supports concurrent reception of 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 availability, in particular under challenging conditions such as in deep urban canyons. u-blox Super-S (Super-Signal) technology offers great RF sensitivity and can improve the dynamic position accuracy with small antennas or in non-line-of-sight scenarios.

The extremely low power consumption of 25 mW in continuous tracking mode allows great power autonomy for all battery-operated devices, such as asset trackers, without compromising on GNSS performance.

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

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 to the advanced low-power u-blox M10 GNSS technology.

1.2 Performance

Parameter	Specification	Value
Receiver type		u-blox M10 receiver
Accuracy of time pulse signal	RMS	30 ns
	99%	60 ns
Frequency of time pulse signal		Default 1PPS (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

Parameter	GPS+GAL	GPS+GAL +GLO	GPS+GAL +BDS B1I	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO
Maximum navigation update rate[3]	10 Hz	10 Hz	10 Hz	10 Hz	5 Hz
Position accuracy (CEP)[4, 5]	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m

1 Assuming Airborne 4 g platform

2 50% at 30 m/s for dynamic operation

3 For high navigation update rates, increase the communication baud rate and reduce the number of enabled messages.

4 GPS is always in combination with SBAS and QZSS.

5 CEP, 50%, 24 hours static, -130 dBm, > 6 SVs for each GNSS system

Parameter		GPS+GAL	GPS+GAL +GLO	GPS+GAL +BDS B1I	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO
Time To First Fix (TTFF)[4, 6, 7]	Cold start	28 s	23 s	27 s	28 s	23 s
	Hot start	1 s	1 s	1 s	1 s	1 s
	AssistNow Online[8]	1 s	1 s	1 s	1 s	1 s
	AssistNow Offline[9]	2 s	2 s	3 s	2 s	2 s
	AssistNow Autonomous[10]	3 s	4 s	4 s	4 s	4 s
Sensitivity[11]	Tracking and nav.	-167 dBm	-167 dBm	-167 dBm	-167 dBm	-167 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[6]	-159 dBm	-159 dBm	-159 dBm	-159 dBm	-159 dBm

Table 1: MAX-M10S typical performance in multi-constellation GNSS modes.

Parameter		GPS	GLONASS	BDS B1I	GALILEO	BDS B1C
Maximum navigation update rate		18 Hz	18 Hz	18 Hz	18 Hz	18 Hz
Position accuracy (CEP)[4, 5]		1.5 m	4 m	2 m	3 m	2 m
Time To First Fix (TTFF)[4, 6, 7]	Cold start	29 s	27 s	30 s	41 s	56 s
	Hot start	1 s	1 s	1 s	1 s	1 s
	AssistNow Online[8]	1 s	1 s	1 s	5 s	TBD
Sensitivity[11]	Tracking and nav.	-167 dBm	-166 dBm	-160 dBm	-161 dBm	-163 dBm
	Reacquisition	-160 dBm	-158 dBm	-158 dBm	-154 dBm	-156 dBm
	Cold Start	-148 dBm	-147 dBm	-146 dBm	-141 dBm	-136 dBm
	Hot start[6]	-159 dBm	-159 dBm	-159 dBm	-155 dBm	-157 dBm

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

1.3 Supported GNSS constellations

MAX-M10S is a concurrent GNSS receiver that can receive and track multiple GNSS systems. The single RF front-end architecture enables concurrent reception of multiple GNSS constellations. The receiver can be configured for a subset of GNSS constellations to achieve lower power consumption.

The default configuration on MAX-M10S is concurrent reception of GPS, Galileo, and BeiDou B1I with QZSS and SBAS enabled.

The following GNSS and their signals are supported:

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

6 Commanded starts.

7 All satellites at -130 dBm. Measured at room temperature.

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

9 Using seven days old AsisstNow Offline data.

10 Using two days old orbital predicted data.

11 Demonstrated with a good external LNA. Measured at room temperature.

System	Signals
BeiDou[12]	B1I (1561.098 MHz), B1C (1575.42 MHz)

Table 3: Supported GNSS and signals on MAX-M10S

The following GNSS assistance services are supported:

Service	Support
AssistNow™ Online	GPS L1C/A, QZSS L1C/A, Galileo E1, GLONASS L1OF, BeiDou B1I
AssistNow™ Offline	GPS L1C/A, GLONASS L1OF
AssistNow™ Autonomous	GPS L1C/A, QZSS L1C/A, Galileo E1, GLONASS L1OF, BeiDou B1I

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

The following augmentation systems are supported:

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

MAX-M10S supports the following protocols:

Protocol	Type
UBX	Input/output, binary, u-blox proprietary
NMEA versions 2.1, 2.3, 4.0, 4.10 and 4.11 (default).	Input/output, ASCII

Table 6: Supported protocols

1.5 Firmware features

Feature	Description
Antenna supervisor[13]	Antenna supervisor for active antenna control and short detection
CloudLocate GNSS	Extends the life of energy-constrained IoT applications. Small payload messages supported.
Assisted GNSS	AssistNow Online, AssistNow Offline and AssistNow Autonomous
Backup modes	Hardware backup mode and software standby mode
Power save modes[14]	On/off, cyclic tracking
Super-S	Improved dynamic position accuracy with small antennas
Protection level	Real-time position accuracy estimate with 95% confidence level
Galileo return link messages	Galileo search and rescue (SAR) return link messages (RLM) via Galileo satellite signal
Data batching	Autonomous tracking up to 10 minutes at 1 Hz

12 BeiDou B1I cannot be enabled simultaneously with BeiDou B1C or GLONASS L1OF

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

14 The power save modes are not available if BeiDou B1C is enabled.

Feature	Description
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
Anti-spoofing	Spoofing detection and reporting
Configuration lockdown	Receiver configuration can be locked by command
Message integrity	All messages are cryptographically signed
Secure boot	Only signed firmware images executed

Table 8: Security features

2 System description

2.1 Block diagram

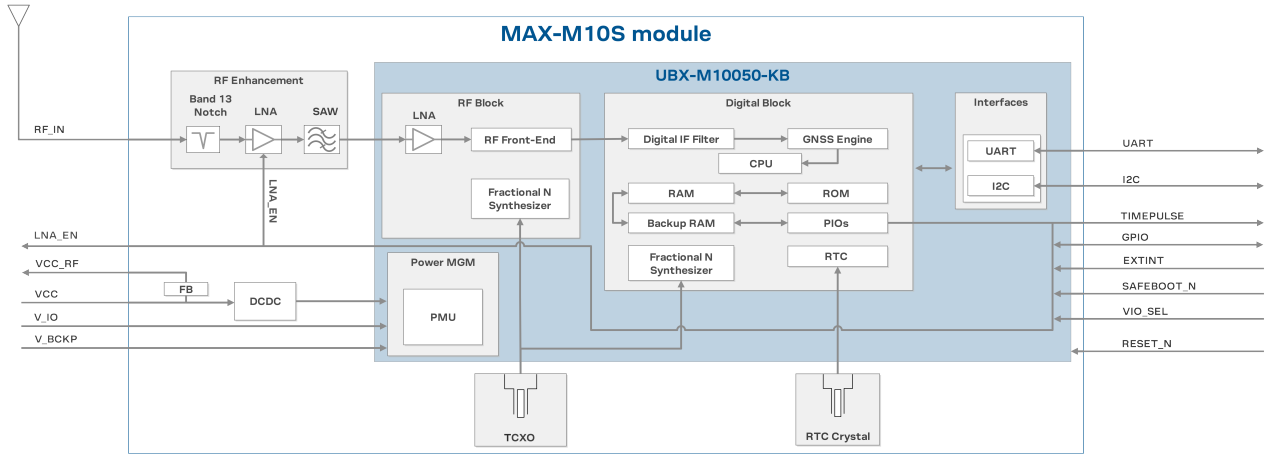


Figure 1: MAX-M10S block diagram

3 Pin definition

3.1 Pin assignment

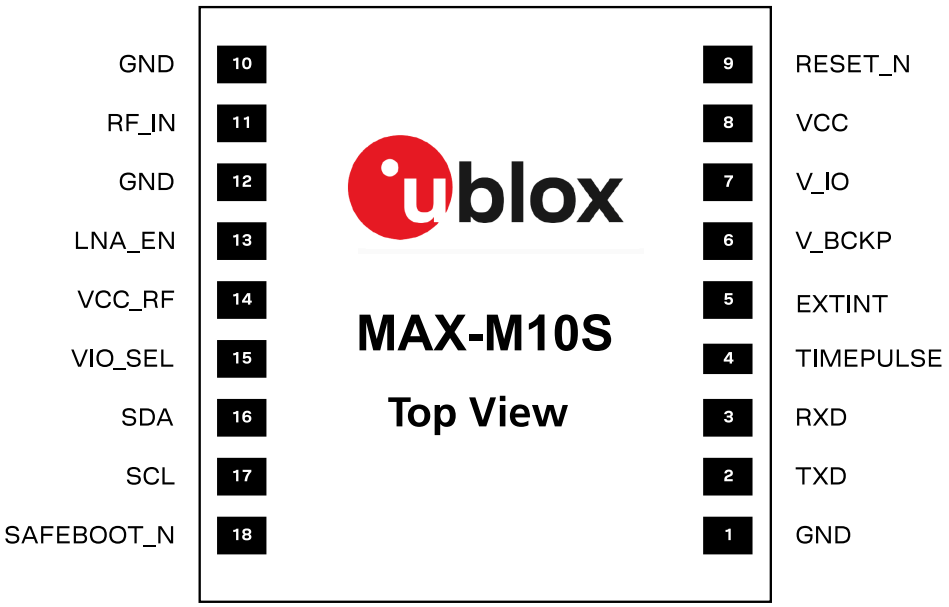


Figure 2: MAX-M10S pin assignment

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 (shared with SAFEBOOT_N pin)[15]
5	EXTINT	5	I	External interrupt
6	V_BCKP	-	I	Backup voltage supply
7	V_IO	-	I	IO voltage supply
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	VIO_SEL	-	I	Voltage selector for V_IO supply. Connect to GND for 1.8 V supply, or leave open for 3.3 V supply.
16	SDA	2	I/O	I2C data
17	SCL	3	I	I2C clock
18	SAFEBOOT_N	-	I	Safeboot mode (leave open)[15]

Table 9: MAX-M10S pin assignment

[15] The receiver enters safeboot mode if this pin is low at start up. The SAFEBOOT_N pin is internally connected to TIMEPULSE pin through a 1 kΩ series resistor.

3.2 Pin state

Table 10 defines the state of the PIOs and RESET_N pins in different modes. The functions of the PIOs are as defined in the default configuration.

PIO no.	Pin no.	Default function	Continuous mode	Software standby mode	Safe boot mode
0	3	RXD	Input pull-up	Input pull-up	Input pull-up
1	2	TXD	Output	Input pull-up	High Z
2	16	SDA	Input pull-up	Input pull-up	Input pull-up
3	17	SCL	Input pull-up	Input pull-up	Input pull-up
4	18	SAFEBOOT_N	Output	Input pull-down	High Z
	4	TIMEPULSE	Output	Input pull-down	High Z

Table 10: Pins state

☞ In reset mode (RESET_N = low), all PIOs are configured as input pull-up.

☞ In hardware backup mode (VCC = 0 V and V_IO = 0 V), PIOs must not be driven.

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

Symbol	Parameter	Min	Max	Unit
VCC	Main supply voltage	–0.3	3.6	V
	Voltage ramp on VCC[16]	25	35000	µs/V
V_IO	IO supply voltage	–0.3	VCC + 0.3 (max 3.6)	V
	Voltage ramp on V_IO[16]	25	35000	µs/V
V_BCKP	Backup supply voltage	–0.3	3.6	V
V_PIO	Input voltage on RESET_N and digital pins. VIO_SEL = GND.	–0.3	V_IO + 0.3 (max 1.98)	V
	Input voltage on RESET_N and digital pins. VIO_SEL = open.	–0.3	V_IO + 0.3 (max 3.6)	V
I_PIO	Max source / sink current, digital pins[17]	-10	10	mA
ICC_RF	Max source current, VCC_RF		100	mA
P_{rfin}	RF input power on RF_IN[18]		0	dBm
T_{amb}	Ambient temperature	–40	+85	°C
T_s	Storage temperature	–40	+85	°C

Table 11: Absolute maximum ratings

V_IO supply voltage must not be higher than VCC + 0.3 V.

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 12 shows the general operating conditions. Table 13 shows the electrical parameters for digital I/O.

The V_IO voltage range is selected with the VIO_SEL pin.

For designs with 1.8 V supply at V_IO, switch off V_IO supply 100 ms before VCC when transitioning to hardware backup mode. Alternatively, send a UBX-RXM-PMREQ message before switching off V_IO and VCC.

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

17 The SAFEBOOT_N pin has an internal 1 kΩ series resistor.

18 Test conditions: source impedance = 50 Ω, continuous wave.

Symbol	Parameter	Min	Typical	Max	Units
VCC	Main supply voltage	1.76	1.8, 3.3	3.6	V
V_IO	IO supply voltage, VIO_SEL = GND	1.76	1.8	VCC (max 1.98)	V
	IO supply voltage, VIO_SEL = open	2.7	3.3	VCC (max 3.6)	V
V_BCKP	Supply voltage, backup domain	1.65		3.6	V
V_IO_{SWITCH}	V_IO voltage threshold to switch an internal supply for the backup domain from V_IO to V_BCKP		1.45		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
Ext_gain[19]	External gain at RF_IN, low gain mode (default)			30	dB
	External gain at RF_IN, bypass mode	10		40	dB
T_{opr}	Operating temperature	-40		+85	°C

Table 12: 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 [20]			0.4	V
V_{oh}	High-level output voltage, Iout = 2 mA [20]	V_IO - 0.4			V
$R_{pu, IO}$	Pull-up resistance, Digital IO[21]. VIO_SEL = GND	6	17	72	kΩ
$R_{pu, IO}$	Pull-up resistance, Digital IO[21]. VIO_SEL = open	8	18	40	kΩ
$R_{pd, IO}$	Pull-down resistance, Digital IO	21	80	180	kΩ
$R_{pu, SAFEBOOT\_N}$	Pull-up resistance, SAFEBOOT_N[22]	6	17	72	kΩ
$R_{pu, RESET\_N}$	Pull-up resistance, RESET_N	7	10	13	kΩ

Table 13: Digital IO

Operation beyond the specified operating conditions can affect device reliability.

4.3 Indicative power requirements

Table 14 shows indicative current consumption for VCC and V_IO with a 3.0 V supply.

19 The internal LNA gain is configurable.

20 TIMEPULSE (PIO4) has 4 mA current drive/sink capability.

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

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

Symbol (Parameter)	Conditions	GPS	GPS+GAL	GPS+GAL +GLO	GPS+GAL +BDS B1I (default)	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO	Unit
I_{VCC}[23] (Current at VCC)	Acquisition[24]	8	10	12	11.5	11	13	mA
	Tracking (Continuous mode)	7.5	8	9	9.5	8.5	10	mA
	Tracking (Power save mode)[25]	4.5	5	5	5	-	-	mA
I_{V_IO} (Current at V_IO)	Acquisition and Tracking (Continuous mode)	2.1	2.2	2.3	2.3	2.2	2.3	mA
	Tracking (Power save mode)[25]	2	2	2	2	-	-	mA

Table 14: Typical currents for 3.0 V supply at VCC and V_IO

Table 15 shows indicative current consumption for VCC and V_IO with a 1.8 V supply.

Symbol (Parameter)	Conditions	GPS	GPS+GAL	GPS+GAL +GLO	GPS+GAL +BDS B1I (default)	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO	Unit
I_{VCC}[23] (Current at VCC)	Acquisition[24]	10.5	15.5	17.5	16.5	16	18.5	mA
	Tracking (Continuous mode)	9.5	11	12.5	13	11.5	14	mA
	Tracking (Power save mode)[25]	5.5	6.0	6.5	6.5	-	-	mA
I_{V_IO} (Current at V_IO)	Acquisition and Tracking (Continuous mode)	2.1	2.1	2.2	2.2	2.1	2.2	mA
	Tracking (Power save mode)[25]	2	2	2	2	-	-	mA

Table 15: Typical currents for 1.8 V supply at VCC and V_IO

☞ 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 firmware version used, external circuitry, number of satellites tracked, signal strength, type and time of start, duration, internal LNA gain mode, and test conditions.

☞ The inrush current at startup can go up to 100 mA. Ensure that the external power supply is able to deliver up to 100 mA.

Table 16 shows current consumptions for the backup modes.

Symbol	Parameter	Conditions	Typ.	Unit
I_{V_BCKP}[26]	Total current in hardware backup mode	V_BCKP = 3.3 V, V_IO = VCC = 0 V	32	µA
$I_{VCC} + I_{V\_IO}$	Total current in software standby mode	V_IO = 1.8 V, VCC = 1.8 V	37	µA
		V_IO = 3.3 V, VCC = 3.3 V	46	µA

Table 16: Backup currents

23 Internal LNA set to low gain. Simulated signal using power levels of -130 dBm.

24 Average current from start-up until the first fix.

25 Power save mode in cyclic tracking operation, 1-second update period. GNSS configurations that include BeiDou B1C do not support this mode.

26 I_{V_BCKP} current in normal operation (V_BCKP = 3.3 V, V_IO = VCC = 3.3 V) is ~3 µA.

All values in Table 14, Table 15, and Table 16 are measured at 25 °C ambient temperature and with the internal LNA set to low gain. SBAS and QZSS are activated in all measurements.

5 Communication interfaces

The receiver allows communication over UART and I2C[27] interfaces.

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. UART specifications are described in Table 17.

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 17: UART specifications

5.2 I2C

An I2C 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[28].

☞ The interface stretches the clock when slowed down while serving interrupts, therefore the real bit rates may be slightly lower. The maximum clock stretching time that the host can expect is 20 ms.

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[29], RMC, VTG and TXT.
I2C	• 7-bit I2C address (0x42). • Input messages: NMEA and UBX. • Output messages: NMEA GGA, GLL, GSA, GSV[29], RMC, VTG and TXT.

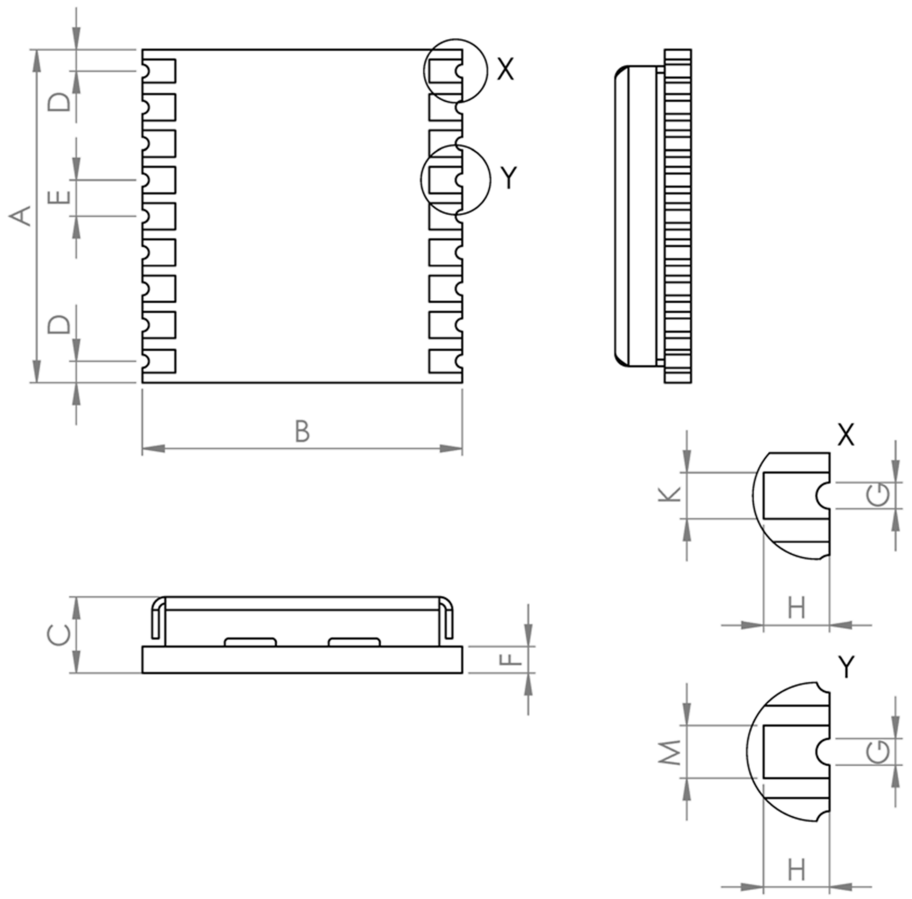
Table 18: Default interface settings

27 I2C is a registered trademark of Philips/NXP.

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

29 In the default configuration, the NMEA-GSV messages are sent at 5-second intervals to avoid overflow in the TX buffer.

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 Approvals

The MAX-M10S is designed for the presumption of conformity with the essential requirements and other relevant provisions of Radio Equipment Directive (RED) 2014/53/EU.

The MAX-M10S complies with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

The Declaration of Conformity (DoC) is available at u-blox website within Support > Product Resources > Conformity Declaration.

8 Product handling

8.1 Moisture sensitivity level

The moisture sensitivity level (MSL) relates to the packaging and handling precautions required. MAX-M10S LCC (professional grade) package is rated at MSL level 4. For MSL standard, see IPC/JEDEC J-STD-020 [3].

9 Labeling and ordering information

This section provides information about product labeling and ordering.

9.1 Product labeling

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

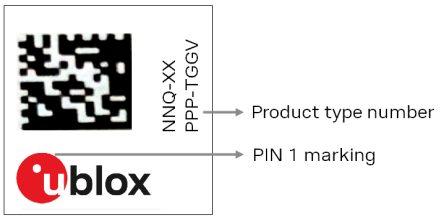


Figure 4: Location of product type number on MAX-M10S label

9.2 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 19 details these three different formats for the MAX-M10S module.

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-01

Table 19: Product code formats

The parts of the product code are explained in Table 20 .

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 20: Part identification code

9.3 Ordering codes

Ordering code	Product	Remark
MAX-M10S-00B	u-blox M10 GNSS receiver module, professional grade	

Table 21: 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 5.10 Interface description, UBX-21035062
[3] MSL standard IPC/JEDEC J-STD-020, www.jedec.org

☞ 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.
R03	28-Jun-2022	imar, oola	New product type number for MAX-M10S-00B-01 with ROM SPG 5.10 firmware. Updated Document information, Pin definition, Performance figures and Indicative power requirements with new GNSS configurations. Updated Electrical specifications, Operating conditions, and Absolute maximum ratings. Added configuration lock and power save modes features, maximum I2C clock stretching time, MSL specification and Reliability tests and approvals.

Contact

For further support and contact information, visit us at www.u-blox.com/support.