SAM-M10Q

u-blox M10 standard precision GNSS antenna module

Data sheet

Abstract

This data sheet describes the SAM-M10Q antenna module with concurrent reception of four GNSS (GPS, Galileo, GLONASS, and BeiDou) and a simple design-in requiring no RF expertise.

Document information

Title	**SAM-M10Q**
Subtitle	u-blox M10 standard precision GNSS antenna module
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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.
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	FW version	IN/PCN reference	Product status
SAM-M10Q	SAM-M10Q-00B-01	ROM SPG 5.10	N/A	Prototype

Contents

1 Functional description

1.1 Overview

The SAM-M10Q patch-antenna module features the u-blox M10 standard precision GNSS platform and provides exceptional sensitivity and acquisition time for all L1 GNSS signals.

SAM-M10Q 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 in non-line-of-sight scenarios.

The extremely low power consumption of 37 mW in continuous tracking mode with four concurrent GNSS allows great power autonomy for all battery-operated devices, such as asset trackers, without compromising on GNSS performance.

A front-end SAW filter and an LNA is integrated in the SAM-M10Q module. This setup ensures excellent out-band jamming immunity, for example when a cellular modem is nearby. SAM-M10Q also detects jamming and spoofing attempts and reports them to the host, so that the system can react to such events.

The high-gain 15 x 15 mm^2 patch antenna provides the best balance between performance and small size. The omnidirectional antenna radiation pattern increases flexibility for device installation.

Incorporating the SAM-M10Q module into customer designs is easy and straightforward, thanks to the integrated antenna, robust design, and simple interface. SAM-M10Q is a surface-mount device, enabling simple and automated manufacturing.

SAM-M10Q offers backwards pin-to-pin compatibility with SAM-M8Q module, 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

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[1] Assuming Airborne 4 g platform

[2] 50% at 30 m/s for dynamic operation

Parameter		GPS+GAL+BDS B1C+GLO	GPS+GAL+GLO	GPS+GAL+BDS B1C	GPS+GAL
Maximum navigation update rate[3]		5 Hz	10 Hz	10 Hz	10 Hz
Position accuracy (CEP)[4, 5]		1.5 m	1.5 m	1.5 m	1.5 m
Time To First Fix (TTFF)[4, 6, 7]	Cold start	23 s	23 s	28 s	28 s
	Hot start	1 s	1 s	1 s	1 s
	AssistNow Online[8]	1 s	1 s	1 s	1 s
	AssistNow Offline[9]	TBD	TBD	TBD	TBD
	AssistNow Autonomous[10]	TBD	TBD	TBD	TBD
Sensitivity[11]	Tracking and nav.	-165 dBm	-165 dBm	-165 dBm	-165 dBm
	Reacquisition	-158 dBm	-158 dBm	-158 dBm	-158 dBm
	Cold Start	-146 dBm	-146 dBm	-146 dBm	-146 dBm
	Hot start[6]	-157 dBm	-157 dBm	-157 dBm	-157 dBm

Table 1: SAM-M10Q typical performance in multi-constellation GNSS modes.

Parameter		GPS	GLONASS	GALILEO	BDS B1C
Maximum navigation update rate		18 Hz	18 Hz	18 Hz	18 Hz
Position accuracy (CEP)[4, 5]		1.5 m	4 m	3 m	2 m
Time To First Fix (TTFF)[4, 6, 7]	Cold start	29 s	27 s	41 s	56 s
	Hot start	1 s	1 s	1 s	1 s
	AssistNow Online[8]	1 s	1 s	5 s	TBD
Sensitivity[11]	Tracking and nav.	-165 dBm	-164 dBm	-159 dBm	-161 dBm
	Reacquisition	-158 dBm	-156 dBm	-152 dBm	-154 dBm
	Cold Start	-146 dBm	-145 dBm	-139 dBm	-134 dBm
	Hot start[6]	-157 dBm	-157 dBm	-153 dBm	-155 dBm

Table 2: SAM-M10Q typical performance in single-GNSS modes

1.3 Supported GNSS constellations

SAM-M10Q 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 SAM-M10Q is concurrent reception of GPS, Galileo, GLONASS, and BeiDou B1C with QZSS and SBAS enabled.

The following GNSS and their signals are supported:

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[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

[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] On a 50 x 50 mm^2 ground plane. Measured at room temperature.

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)
BeiDou	B1C (1575.42 MHz)

Table 3: Supported GNSS and signals on SAM-M10Q

The following GNSS assistance services are supported:

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

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

SAM-M10Q 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
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[12]	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] 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

1.6 Integrated antenna

SAM-M10Q module includes an integrated GNSS patch antenna. The RF signal is further filtered and amplified by an internal SAW filter and a low-noise amplifier (LNA).

☞ The application PCB is a part of the antenna solution and the PCB layout has an impact on the antenna performance.

The antenna is right-hand circular polarized (RHCP) and has a peak gain of 3 dBic. The antenna is insensitive to surroundings and has high tolerance against frequency detuning. However, the antenna gain and radiation efficiency may be reduced on a small ground plane. The optimal radiation pattern is achieved with a 50 x 50 mm^2 ground plane.

The operating frequency of the antenna has been tuned in the antenna production. The tuning involves removing small parts of the antenna metalization, and this may show as shallow scratches in the antenna element.

2 System description

2.1 Block diagram
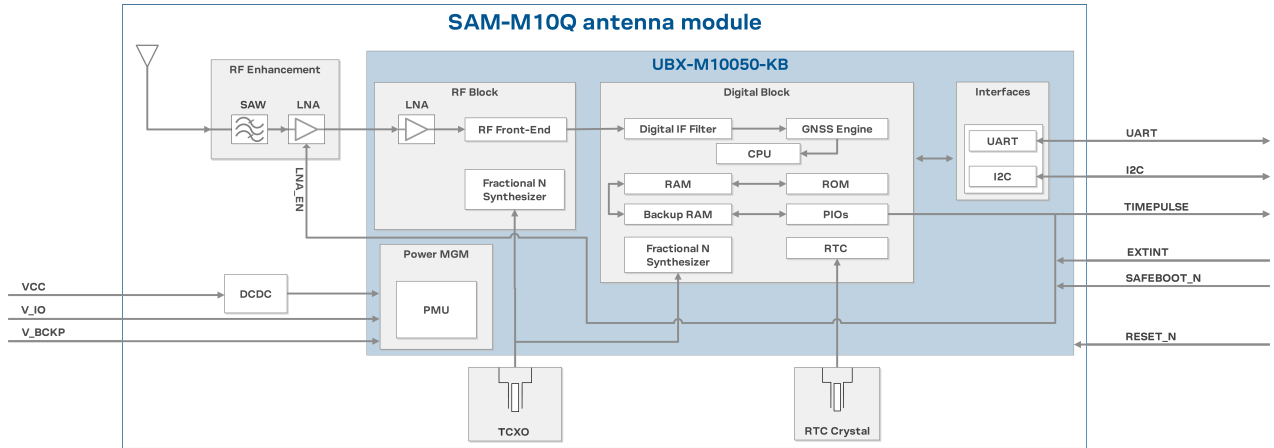
Figure 1: SAM-M10Q block diagram

3 Pin definition

3.1 Pin assignment
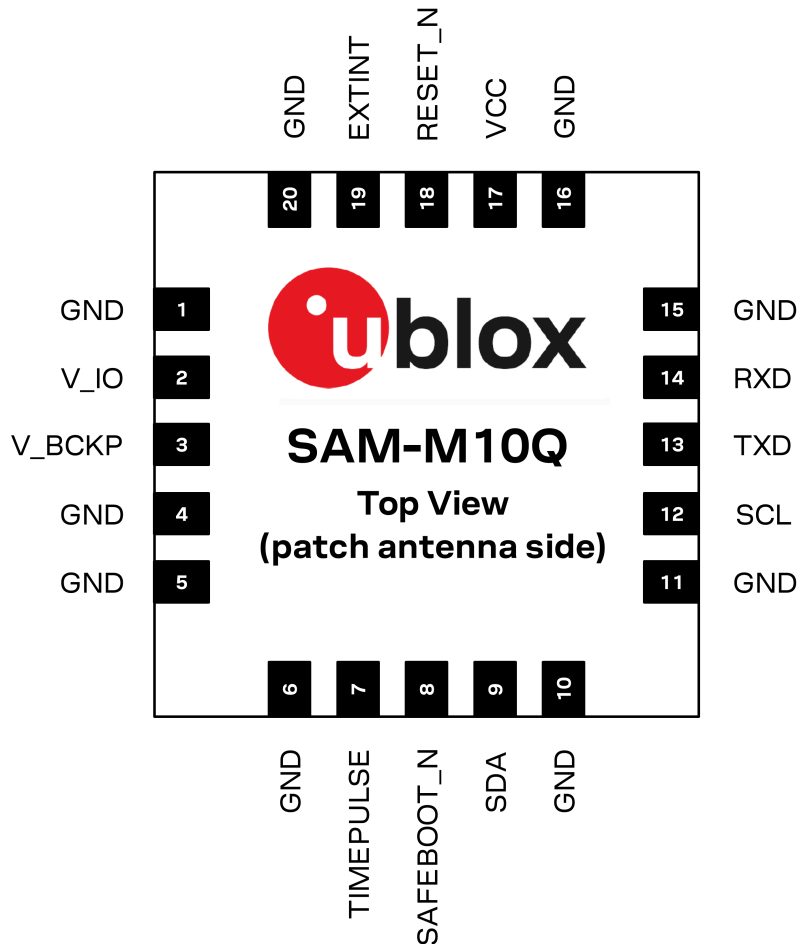
Figure 2: SAM-M10Q pin assignment

Pin no.	Name	PIO no.	I/O	Description
1	GND	-	-	Connect to GND
2	V_IO	-	I	IO voltage supply
3	V_BCKP	-	I	Backup voltage supply
4	GND	-	-	Connect to GND
5	GND	-	-	Connect to GND
6	GND	-	-	Connect to GND
7	TIMEPULSE	4	O	Time pulse signal (shared with SAFEBOOT_N pin)[13]
8	SAFEBOOT_N	-	I	Safeboot mode (leave open)[13]

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[13] 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.

Pin no.	Name	PIO no.	I/O	Description
9	SDA	2	I/O	I2C data
10	GND	-	-	Connect to GND
11	GND	-	-	Connect to GND
12	SCL	3	I	I2C clock
13	TXD	1	O	UART TX
14	RXD	0	I	UART RX
15	GND	-	-	Connect to GND
16	GND	-	-	Connect to GND
17	VCC	-	I	Main voltage supply
18	RESET_N	-	I	System reset (active low). Has to be low for at least 1 ms to trigger a reset.
19	EXTINT	5	I	External interrupt
20	GND	-	-	Connect to GND

Table 9: SAM-M10Q 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

Symbol	Parameter	Min	Max	Unit
VCC	Main supply voltage	–0.3	3.6	V
	Voltage ramp on VCC[14]	25	35000	µs/V
V_IO	IO supply voltage	–0.3	VCC + 0.3 (max 3.6)	V
	Voltage ramp on V_IO[14]	25	35000	µs/V
V_BCKP	Backup supply voltage	–0.3	3.6	V
V_PIO	Input voltage on RESET_N and digital pins.	–0.3	V_IO + 0.3 (max 3.6)	V
I_PIO	Max source / sink current, digital pins[15]	-10	10	mA
P_{rfin}	RF input power on RF_IN[16]		0	dBm
T_{amb}	Ambient temperature	–40	+85	°C
T_s	Storage temperature	–40	+85	°C

Table 10: 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 11 shows the general operating conditions. Table 12 shows the electrical parameters for digital I/O.

Symbol	Parameter	Min	Typical	Max	Units
VCC	Main supply voltage	2.7	3.0	3.6	V
V_IO	IO supply voltage	2.7	3.0	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

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[14] Exceeding the voltage ramp speed may permanently damage the device.

[15] The SAFEBOOT_N pin has an internal 1 kΩ series resistor.

[16] At antenna feed point. Test conditions: source impedance = 50 Ω, continuous wave.

Symbol	Parameter	Min	Typical	Max	Units
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 = -1 mA [17]			0.4	V
V_{oh}	High-level output voltage, Iout = 1 mA [17]	V_IO - 0.4			V
$R_{pu, IO}$	Pull-up resistance, Digital IO[18]	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[19]	6	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 shows indicative current consumption for VCC and V_IO with a 3.0 V supply.

Symbol (Parameter)	Conditions	GPS	GPS+GAL	GPS+GAL +GLO	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO (default)	Unit
I_{VCC}[20] (Current at VCC)	Acquisition	8	10	12	11	13	mA
	Tracking (Continuous mode)	7.5	8	9	8.5	10	mA
	Tracking (Power save mode)[21]	4.5	5	5	-	-	mA
I_{V_IO} (Current at V_IO)	Acquisition and Tracking (Continuous mode)	2.1	2.2	2.3	2.2	2.3	mA
	Tracking (Power save mode)[21]	2	2	2	-	-	mA

Table 13: Typical currents for 3.0 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.

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[17] TIMEPULSE (PIO4) has 2 mA current drive/sink capability.

[18] TXD, RXD, TIMEPULSE, EXTINT, SCL, SDA, and LNA_EN.

[19] The SAFEBOOT_N pin has an additional 1 kΩ series resistor.

[20] Simulated signal using power levels of -130 dBm.

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

☞ 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 14 shows current consumptions for the backup modes.

Symbol	Parameter	Conditions	Typ.	Unit
I_{V_BCKP}[22]	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 = 3.3 V, VCC = 3.3 V	46	µA

Table 14: Backup currents

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.

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

5 Communication interfaces

The receiver allows communication over UART and I2C[23] 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 15.

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 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[24].

☞ 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, 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

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23 I2C is a registered trademark of Philips/NXP.

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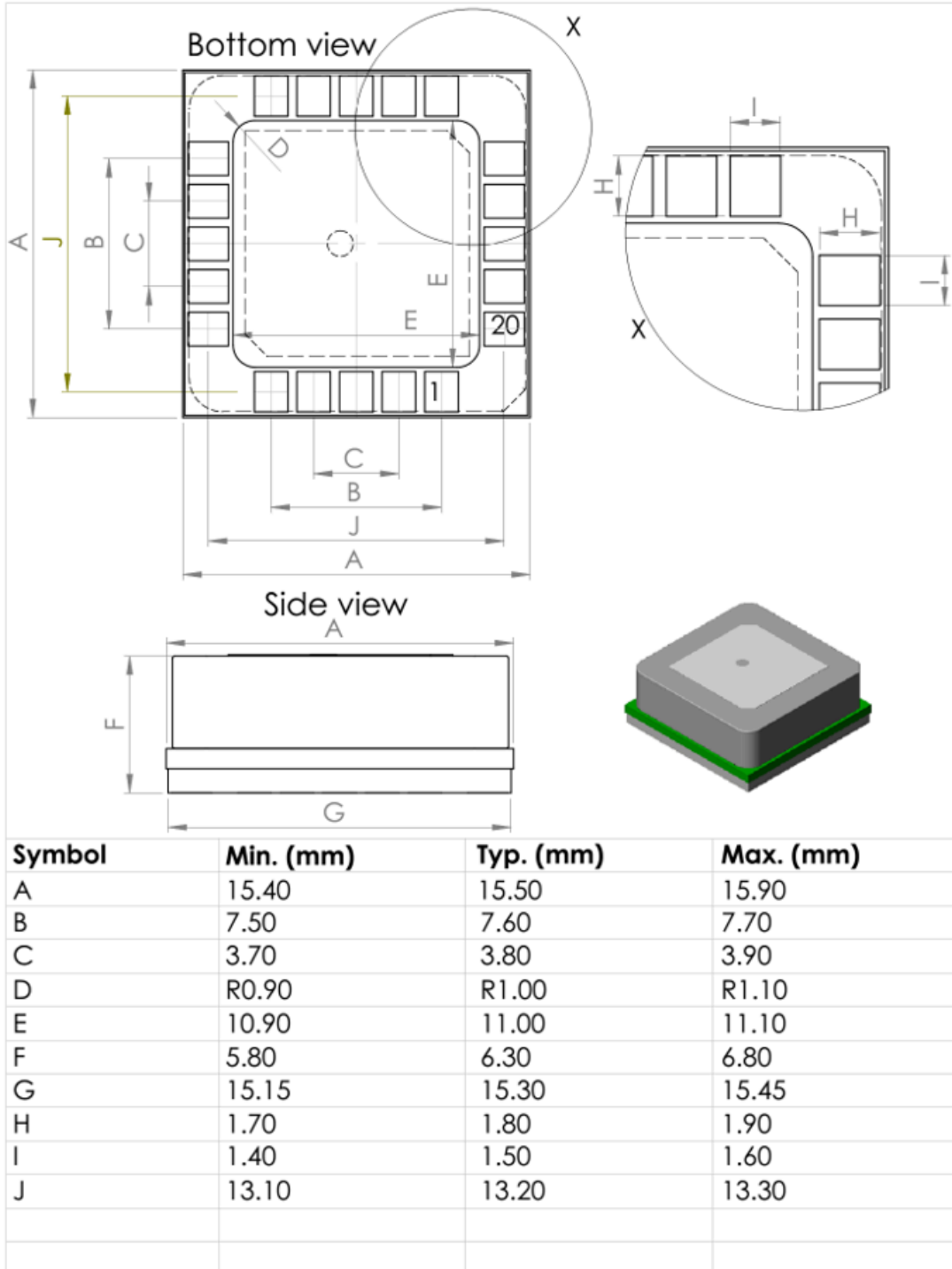
6 Mechanical specifications

Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	15.40	15.50	15.90
B	7.50	7.60	7.70
C	3.70	3.80	3.90
D	R0.90	R1.00	R1.10
E	10.90	11.00	11.10
F	5.80	6.30	6.80
G	15.15	15.30	15.45
H	1.70	1.80	1.90
I	1.40	1.50	1.60
J	13.10	13.20	13.30

Figure 3: SAM-M10Q mechanical drawing

7 Product handling

7.1 Moisture sensitivity level

The moisture sensitivity level (MSL) relates to the packaging and handling precautions required. SAM-M10Q LCC (professional grade) package is rated at MSL level 4. For MSL standard, see IPC/JEDEC J-STD-020 [4].

8 Labeling and ordering information

This section provides information about product labeling and ordering.

8.1 Product labeling

The labeling of the SAM-M10Q package provides product information and revision information. For more information contact u-blox sales.
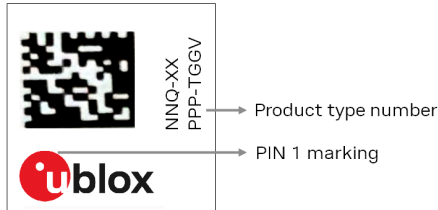

Figure 4: Location of product type number on SAM-M10Q label

8.2 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 SAM-M10Q module.

Format	Structure	Product code
Product name	PPP-TGGV	SAM-M10Q
Ordering code	PPP-TGGV-NNQ	SAM-M10Q-00B
Type number	PPP-TGGV-NNQ-XX	SAM-M10Q-00B-01

Table 17: Product code formats

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

Code	Meaning	Example
PPP	Product family	SAM
TGG	Platform	M10 = u-blox M10
V	Variant	Q = Standard precision, ROM, TCXO, SAW filter, and LNA
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

8.3 Ordering codes

Ordering code	Product	Remark
SAM-M10Q-00B	u-blox SAM-M10Q GNSS antenna 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]   u-blox M10 SPG 5.10 Release notes, UBX-22001426
[2]   u-blox M10 SPG 5.10 Interface description, UBX-21035062
[3]   u-blox Package Information Guide, UBX-14001652
[4]   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	Comments
R01	27-Jun-2022	jesk, rmak	Initial release

Contact

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