MIA-M10Q

Standard precision GNSS module

Professional grade

Data sheet

Abstract

This data sheet describes the MIA-M10Q module, an ultra-small form factor and ultra-low-power GNSS receiver for high-performance wearable and asset-tracking applications.

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This document applies to the following products:

Product name	Type number	FW version	IN/PCN reference	Product status
MIA-M10Q	MIA-M10Q-00B-01	SPG 5.10	N/A	Prototype

Contents

1 Functional description

1.1 Overview

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

MIA-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 with small antennas or in non-line-of-sight scenarios.

The extremely low power consumption of less than 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, MIA-M10Q integrates an LNA followed by a SAW filter in the RF path.

The small footprint and highly integrated System-in-Package (SiP) makes MIA-M10Q suitable for compact designs in wearable and tracking applications.

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]	TBD	TBD	TBD	TBD	TBD
	AssistNow Autonomous[10]	TBD	TBD	TBD	TBD	TBD
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: MIA-M10Q 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: MIA-M10Q typical performance in single-GNSS modes

1.3 Supported GNSS constellations

MIA-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 MIA-M10Q is concurrent reception of GPS and Galileo 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 MIA-M10Q

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

MIA-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
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 (similar to previous software backup mode), both with optional RTC
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

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
Data batching	Autonomous tracking up to 10 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
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

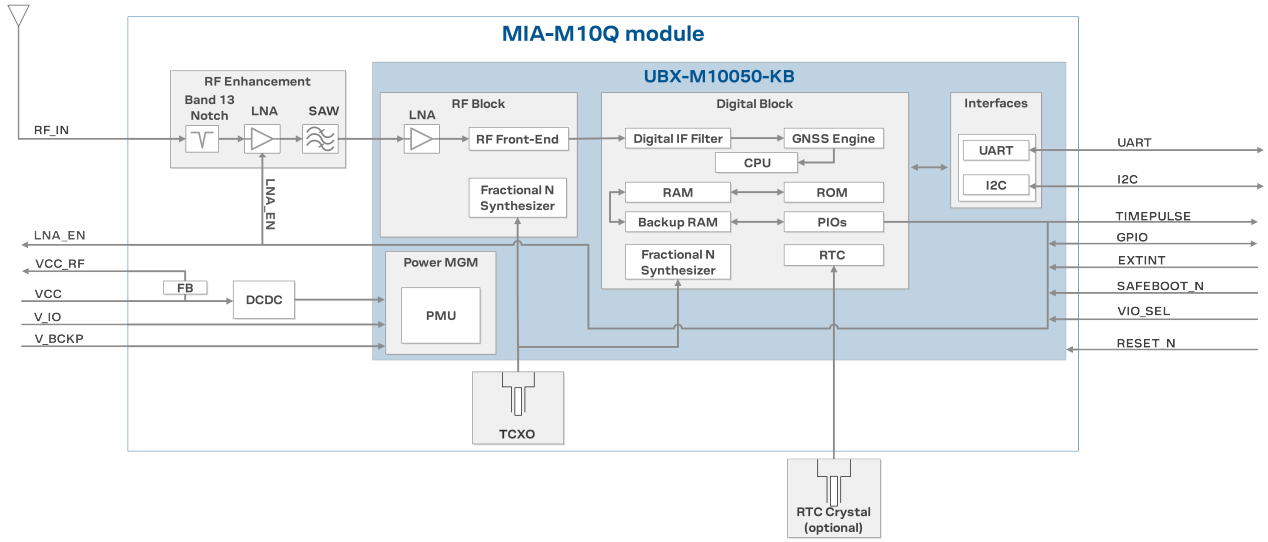

Figure 1: MIA-M10Q block diagram

3 Pin definition

3.1 Pin assignment

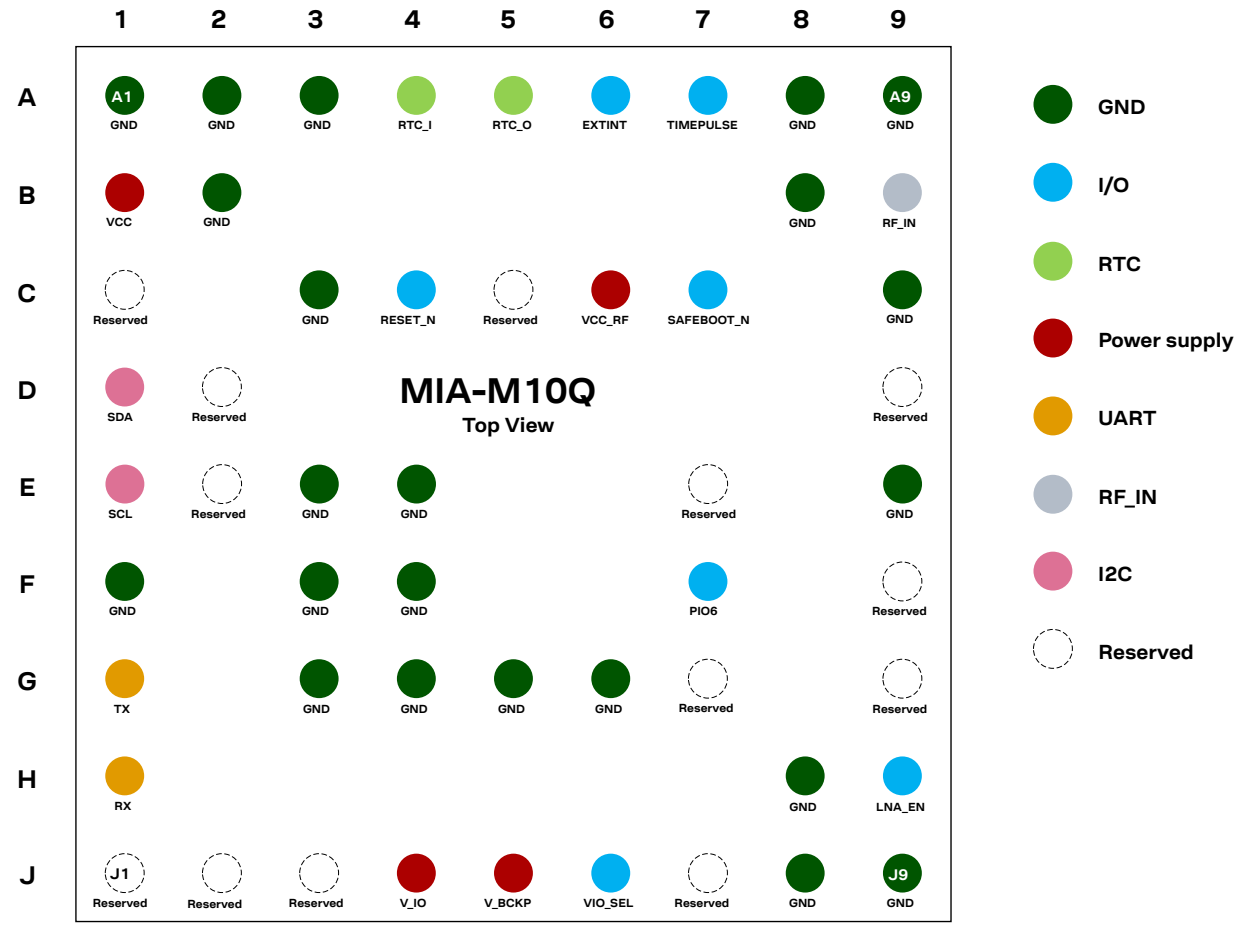

Figure 2: MIA-M10Q pin assignment

Pin no.	Name	PIO no.	I/O	Description
A1	GND	-	-	Connect to GND
A2	GND	-	-	Connect to GND
A3	GND	-	-	Connect to GND
A4	RTC_I	-	I	RTC input (leave open if not used)
A5	RTC_O	-	O	RTC output (connect to GND if not used)
A6	EXTINT	5	I/O	Digital I/O
A7	TIMEPULSE	4	O	Time pulse signal (shared with SAFEBOOT_N pin)[15]
A8	GND	-	-	Connect to GND
A9	GND	-	-	Connect to GND
B1	VCC	-	I	Main power supply input
B2	GND	-	-	Connect to GND
B8	GND	-	-	Connect to GND

Pin no.	Name	PIO no.	I/O	Description
B9	RF_IN	-	I	RF signal input
C1	Reserved	-	-	Leave open
C3	GND	-	-	Connect to GND
C4	RESET_N	-	I	System reset (active low). Has to be low for at least 1 ms to trigger a reset.
C5	Reserved	-	-	Leave open
C6	VCC_RF	-	O	Filtered power supply for RF active components like external active antenna or LNA, both optional
C7	SAFEBOOT_N	-	I	Safeboot mode (leave open)[15]
C9	GND	-	-	Connect to GND
D1	SDA	2	I/O	I2C data. If not used, leave open.
D2	Reserved	-	-	Connect to E2
D9	Reserved	-	-	Leave open
E1	SCL	3	I	I2C clock. If not used, leave open.
E2	Reserved	-	-	Connect to D2
E3	GND	-	-	Connect to GND
E4	GND	-	-	Connect to GND
E7	Reserved	-	-	Leave open
E9	GND	-	-	Connect to GND
F1	GND	-	-	Connect to GND
F3	GND	-	-	Connect to GND
F4	GND	-	-	Connect to GND
F7	PIO6	6	I/O	Digital I/O
F9	Reserved	-	-	Connect to GND[16]
G1	TX	1	O	UART TX. If not used, leave open.
G3	GND	-	-	Connect to GND
G4	GND	-	-	Connect to GND
G5	GND	-	-	Connect to GND
G6	GND	-	-	Connect to GND
G7	Reserved	-	-	Connect to GND[17]
G9	Reserved	-	-	Leave open
H1	RX	0	I	UART RX. If not used, leave open.
H8	GND	-	-	Connect to GND
H9	LNA_EN	-	O	On/Off external LNA or active antenna
J1	Reserved	-	-	Leave open
J2	Reserved	-	-	Leave open
J3	Reserved	-	-	Leave open
J4	V_IO	-	I	IO voltage supply
J5	V_BCKP	-	I	Backup voltage supply. Leave open if no external backup supply.

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.

16 For future compatibility with the MIA dual-band version, connect this pin to ground by placing a 0 Ω resistor to GND.

17 For future compatibility with the MIA crystal-based version, connect this pin to ground by placing a 0 Ω resistor to GND.

Pin no.	Name	PIO no.	I/O	Description
J6	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.
J7	Reserved	-	-	Leave open
J8	GND	-	-	Connect to GND
J9	GND	-	-	Connect to GND

Table 9: MIA-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[18]	25	35000	µs/V
V_IO	IO supply voltage	–0.3	VCC + 0.3 (max 3.6)	V
	Voltage ramp on V_IO[18]	25	35000	µs/V
V_BCKP	Backup supply voltage	–0.3	3.6	V
RTC_I	Voltage on RTC_I	–0.3	1.155	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[19]	-10	10	mA
P_{rfin}	RF input power on RF_IN[20]		+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.

The V_IO voltage range is selected with the VIO_SEL pin.

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

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.

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

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

20 Test conditions TBC

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		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[21]	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 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 [22]			0.4	V
V_{oh}	High-level output voltage, Iout = 2 mA [22]	V_IO - 0.4			V
$R_{pu, IO}$	Pull-up resistance, Digital IO[23]. VIO_SEL = GND	6	17	72	kΩ
$R_{pu, IO}$	Pull-up resistance, Digital IO[23]. 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[24]	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.

21 The internal LNA gain is configurable.

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

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

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

Symbol (Parameter)	Conditions	GPS	GPS+GAL (default)	GPS+GAL +GLO	GPS+GAL +BDS B1I	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO	Unit
I_{VCC}[25] (Current at VCC)	Acquisition	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)[26]	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)[26]	2	2	2	2	-	-	mA

Table 13: Typical currents for 3.0 V supply at VCC and V_IO

Table 14 shows indicative current consumption for VCC and V_IO with a 1.8 V supply.

Symbol (Parameter)	Conditions	GPS	GPS+GAL (default)	GPS+GAL +GLO	GPS+GAL +BDS B1I	GPS+GAL +BDS B1C	GPS+GAL +BDS B1C +GLO	Unit
I_{VCC}[25] (Current at VCC)	Acquisition	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)[26]	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)[26]	2	2	2	2	-	-	mA

Table 14: 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 15 shows current consumptions for the backup modes.

Symbol	Parameter	Conditions	Typ.	Unit
I_{V_BCKP}[27]	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 15: Backup currents

All values in Table 13, Table 14, and Table 15 are measured at 25 °C ambient temperature and with the internal LNA set to low gain. SBAS and QZSS are activated in all measurements.

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

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

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

4.4 Oscillator parameters

Table 16 shows the electrical parameters for the RTC (optional).

Parameter	Min	Typical	Max	Unit
RTC oscillator frequency		32768		Hz
RTC startup time		250	700	ms
RTC crystal ESR			100	kΩ
RTC input capacitance at RTC_I, RTC_O (per pin to GND)	7	10	14	pF
RTC_I input voltage, external clock				
V_{il_RTC}	0		0.22	V
V_{ih_RTC}	0.71		1.1	V

Table 16: RTC parameters

5 Communication interfaces

The receiver allows communication over UART and I2C[28] 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-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[29].

☞ 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	• 38400 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 18: Default interface settings

28 I2C is a registered trademark of Philips/NXP.

29 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

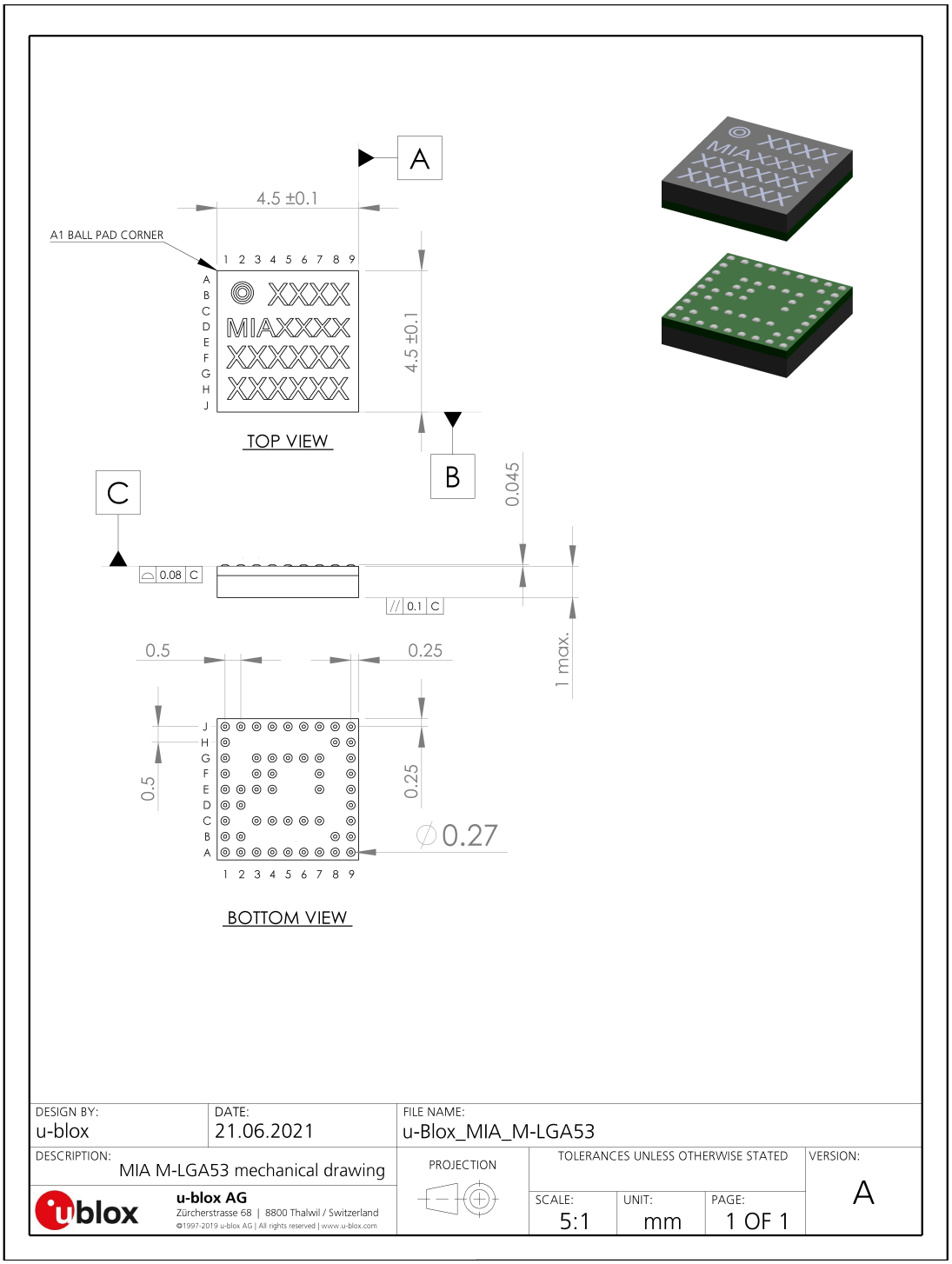

Figure 3: MIA-M10Q mechanical drawing

7 Product handling

7.1 Moisture sensitivity level

The moisture sensitivity level (MSL) relates to the packaging and handling precautions required. MIA-M10Q SiPs are rated at MSL level 3 . 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 MIA-M10Q package provides product information and revision information. For more information contact u-blox sales.

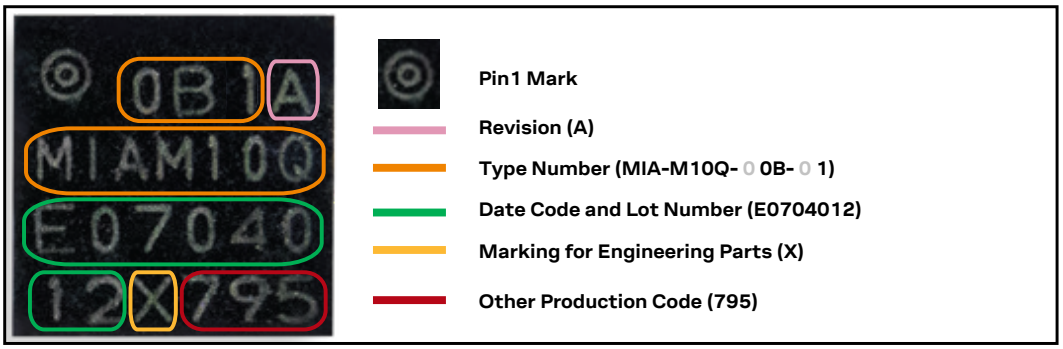

Figure 4: Location of product type number on MIA-M10Q label

The eight-digit Date Code and Lot Number includes the production date and lot number information.

Date Code and Lot Number	Meaning
YWWLLXXX	Y = production year, A = 2017, B = 2018, C = 2019, D = 2020, E = 2021 etc. WW = calendar week LL = lot number XXX = other production information

Table 19: Production date and lot number information

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 20 details these three different formats for the MIA-M10Q module.

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

Table 20: Product code formats

The parts of the product code are explained in Table 21 .

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

Code	Meaning	Example
NNQ	Option / Quality grade	NN: Option [00...99] Q: Grade, A = Automotive, B = Professional
XX	Product detail	Describes hardware and firmware versions

Table 21: Part identification code

8.3 Ordering codes

Ordering code	Product	Remark
MIA-M10Q-00B	u-blox M10 GNSS receiver module, professional grade	

Table 22: 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	15-Jun-2022	imar, jesk, msul, oola	Objective specification

Contact

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