GPS

locate, communicate, accelerate

MAX-6

u-blox 6 GPS Modules

Data Sheet

Abstract

Technical data sheet describing the ultra miniature u-blox 6 based MAX-6 series of GPS modules.
These compact u-blox6 GPS receivers provide high performance and a high level of integration capability in a tiny package. This makes them perfectly suited for end products with strict size and cost requirements.

10.1 x 9.7 x 2.5 mm

Document Information	
Title	MAX-6
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Document status information	
Objective Specification	This document contains target values. Revised and supplementary data will be published later.
Advance Information	This document contains data based on early testing. Revised and supplementary data will be published later.
Preliminary	This document contains data from product verification. Revised and supplementary data may be published later.
Released	This document contains the final product specification.

This document applies to the following products:

Name	Type number	ROM/FLASH version	PCN reference
MAX-6G	MAX-6G-0-000	ROM7.03	N/A
MAX-6Q	MAX-6Q-0-000	ROM7.03	N/A

Contents

1 Functional description

1.1 Overview

The MAX-6 module series brings the high performance of the u-blox 6 position engine in the ultra miniature MAX form factor. These receivers provide high performance and a high level of integration capability in a tiny package. This makes them perfectly suited for mass-market end products with strict size and cost requirements.

The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with over 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses interference sources and mitigates multipath effects, giving MAX-6 GPS receivers excellent navigation performance even in the most challenging environments.

MAX-6 allows simple integration with u-blox wireless modules. All MAX-6 modules are manufactured in ISO/TS 16949 certified sites.

1.2 Product features

Model	Type				Supply		Interfaces				Features						
	Standalone GPS	Capture & Process	Timing & Raw Data	Dead Reckoning	1.75 V - 2.0 V	2.7 V - 3.6 V	UART	USB	SPI	DDC (I²C compliant)	Programmable (Flash) FW update	TCXO	RTC crystal	Antenna supply and supervisor	Configuration pins	Timepulse	External interrupt/ Wakeup
MAX-6G	●				●		●			●		●	●	○		1	●
MAX-6Q	●					●	●			●		●	●	○		1	●

○ = Requires external components and integration on application processor

Table 1: Features of the MAX-6 Series

1.3 GPS performance

Parameter	Specification	
Receiver type	50 Channels GPS L1 frequency, C/A Code SBAS: WAAS, EGNOS, MSAS	
Time-To-First-Fix[1]	Cold Start (without aiding)	26 s
	Warm Start (without aiding)	26 s
	Hot Start (without aiding)	1 s
	Aided Starts[2]	1 s
Sensitivity[3]	Tracking & Navigation	-161 dBm
	Reacquisition	-160 dBm
	Cold Start (without aiding)	-148 dBm
Maximum Navigation update rate		5 Hz
Horizontal position accuracy[4]	GPS	2.5 m
	GPS + SBAS	2.0 m
Configurable Timepulse frequency range		0.25 Hz to 1 kHz
Accuracy for Timepulse signal[5]	RMS	30 ns
	99%	<60 ns
	Granularity	21 ns
Velocity accuracy[5]		0.1m/s
Heading accuracy[5]		0.5 degrees
Operational Limits	Dynamics	≤ 4 g
	Altitude[6]	50,000 m
	Velocity[6]	500 m/s

Table 2: MAX-6 GPS performance

[1] All satellites at -130 dBm
[2] Dependent on aiding data connection speed and latency
[3] Demonstrated with a good active antenna
[4] CEP, 50%, 24 hours static, -130dBm
[5] Under good GPS signal conditions
[6] Assuming Airborne <4g platform

1.4 Block diagram

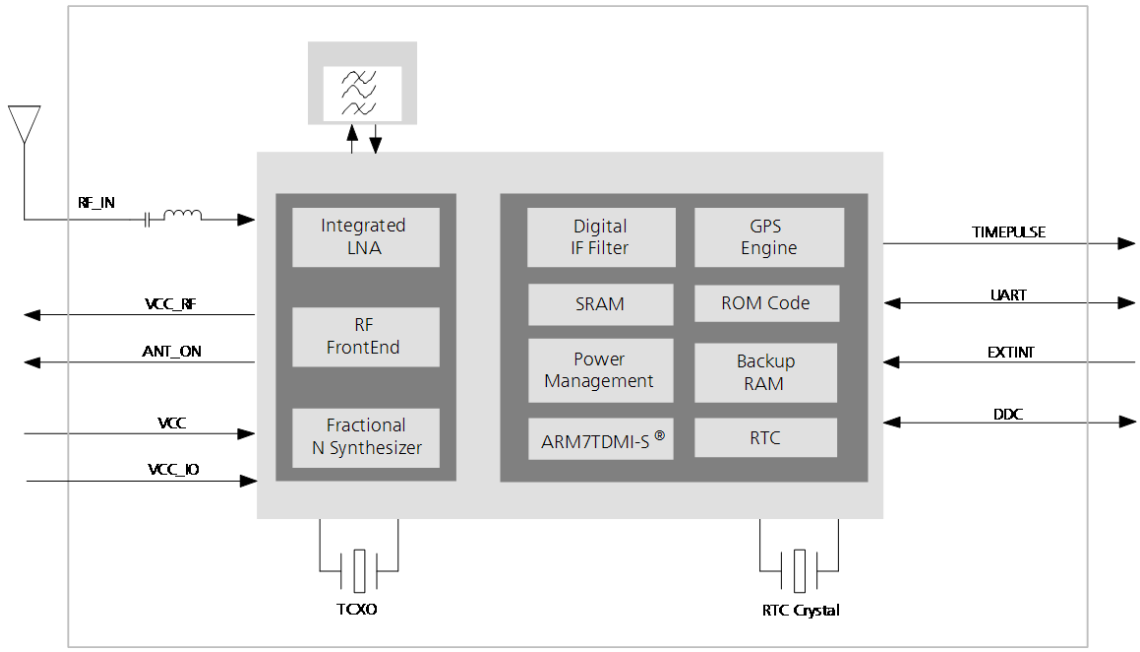


Figure 1: Block diagram (For available options refer to the product features table in section 1.2)c

1.5 Assisted GPS (A-GPS)

Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status and an optional time synchronization signal will reduce time to first fix significantly and improve the acquisition sensitivity. All MAX-6 modules support the u-blox AssistNow Online and AssistNow Offline A-GPS services[7] and are OMA SUPL compliant.

1.6 AssistNow Autonomous

AssistNow Autonomous provides functionality similar to Assisted-GPS without the need for a host or external network connection. Based on previously broadcast satellite ephemeris data downloaded to and stored by the GPS receiver, AssistNow Autonomous automatically generates accurate satellite orbital data ("AssistNow Autonomous data") that is usable for future GPS position fixes. AssistNow Autonomous data is reliable for up to 3 days after initial capture.

u-blox' AssistNow Autonomous benefits are:

- Faster position fix particularly under weak signal conditions
- No connectivity required
- Complementary with AssistNow Online and Offline services
- No integration effort, calculations are done in the background

☞ For more details see the u-blox 6 Receiver Description including Protocol Specification [2].

[7] AssistNow Offline equires external memory on the Host

1.7 Protocols and interfaces

Protocol	Type
NMEA	Input/output, ASCII, 0183, 2.3 (compatible to 3.0)
UBX	Input/output, binary, u-blox proprietary
RTCM	Input, 2.3

Table 3: Available protocols

All listed protocols are available on UART and DDC. For specification of the various protocols see the u-blox 6 Receiver Description including Protocol Specification [2].

MAX-6 modules support a number of peripheral interfaces for serial communication. The embedded firmware uses these interfaces according to their respective protocol specifications. For specific applications, the firmware also supports the connection of external memories.

1.7.1 UART

MAX-6 modules include one configurable UART interface for serial communication. For configuration information see the u-blox 6 Receiver Description including Protocol Specification [2].

1.7.2 Display Data Channel (DDC)

The I^2C compatible DDC interface can be used either to access external devices with a serial interface EEPROM or to interface with a host CPU. It is capable of master and slave operation. The DDC interface is I^2C Standard Mode compliant. For timing parameters consult the I^2C standard.

☞ The DDC Interface supports serial communication with u-blox wireless modules. See the specification of the applicable wireless module to confirm compatibility.

☞ The maximum bandwidth is 100kbit/s.

1.7.3 Data ready indication: TX Ready

With FW 7.03 u-blox 6 GPS modules include a data ready indication function for serial interfaces. The TX Ready signal[8, 9] indicates that the receiver has data to transmit at the specified serial interface.

1.7.4 VDCC_IO

The voltage level of all IO pins (except ANTON) is referenced to the VCC_IO supply. In most cases, the VCC_IO is shorted to the neighboring VCC pin of the module. However, VCC and VCC_IO may be chosen at different levels—allowing for example 1.8V module operation and 3V IO levels.

1.8 Antenna

MAX-6 modules are designed for use with passive and active[8] 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 4: Antenna Specifications for all MAX-6 modules

[8] For more information see the LEA-6/NEO-6/MAX-6 Hardware Integration Manual [1].
[9] For more information see the u-blox 6 Receiver Description including Protocol Specification [2].

1.8.1 Active antenna control (ANTON)

The ANTON Pin can be used to turn on and off an external LNA or an active antenna. This reduces power consumption in Power Save Mode (Backup mode) [10].

1.9 Power Management

u-blox receivers support different power modes. These modes represent strategies[11] of how to control the acquisition and tracking engines in order to achieve either the best possible performance or good performance with reduced power consumption.

☞ For more information about power management strategies, see the u-blox 6 Receiver Description including Protocol Specification [2].

1.9.1 Maximum Performance Mode

During a Cold start, a receiver in Maximum Performance Mode continuously deploys the acquisition engine to search for all satellites. Once the receiver has a position fix (or if pre-positioning information is available), the acquisition engine continues to be used to search for all visible satellites that are not being tracked.

1.9.2 Eco Mode

During a Cold start, a receiver in Eco Mode works exactly as in Maximum Performance Mode. Once a position can be calculated and a sufficient number of satellites are being tracked, the acquisition engine is powered off resulting in significant power savings. The tracking engine continuously tracks acquired satellites and acquires other available or emerging satellites.
Note that even if the acquisition engine is powered off, satellites continue to be acquired.

1.9.3 Power Save Mode

Power Save Mode (PSM) allows a reduction in system power consumption by selectively switching parts of the receiver on and off.

1.10 Design-in

In order to obtain the necessary information to conduct a proper design-in, u-blox strongly recommends consulting the LEA-6/NEO-6/MAX-6 Hardware Integration Manual [1].

[10] For more information see the LEA-6/NEO-6/MAX-6 Hardware Integration Manual [1].
[11] For more information see the u-blox 6 Receiver Description including Protocol Specification [2].

2 Pin Definition

2.1 Pin assignment

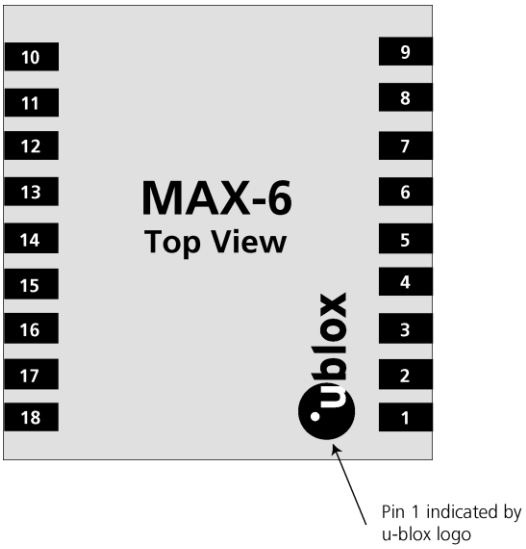


Figure 2: Pin Assignment

No	Module	Name	I/O	Description
1	All	GND		Ground
2	All	TXD1	O	UART, leave open if not used, Voltage level referred VCC_IO. Can be configured as Data ready[12] indication for the DDC interface.
3	All	RXD1	I	UART, leave open if not used, Voltage level referred VCC_IO
4	All	TIMEPULSE	O	Pulse output at 1pulse per second aligned to the GPS signal. Leave open if not used, Voltage level referred VCC_IO
5	All	EXTINT0	I	Can be used as an external wakeup signal. Leave open if not used, Voltage level referred VCC_IO
6	All	V_BCKP		Backup voltage input pin. Connect to GND if not used.
7	All	VCC_IO		IO supply voltage Input must be always supplied. Usually connect to VCC Pin 8
8	All	VCC		Power supply of module (1.8V for MAX-6G or 3.0V for MAX-6Q/C)
9	All	VRESET	I	Must be connected to VCC always. Can be used as reset input pin with additional circuit (connected to VCC by 3k3 resistor)
10	All	GND		Ground
11	All	RF_IN	I	Matched RF-Input, DC block inside.
12	All	GND		Ground
13	All	ANTON	O	Active antenna or ext. LNA control pin in power save mode
14	All	VCC_RF	O	Can be used for active antenna or external LNA supply.
15	All	RESERVED	-	Leave open.
16	All	SDA2	I/O	DDC Communication interface. Leave open if not used.
17	All	SCL2	I/O	DDC Communication interface. Leave open if not used.
18	All	RESERVED	-	Leave open.

Table 5: Pinout

[12] See chapter 1.7.3 for more information

3 Electrical specifications

3.1 Absolute maximum ratings

Parameter	Symbol	Module	Condition	Min	Max	Units
Power supply voltage	VCC	MAX-6G		-0.5	2.0	V
		MAX-6Q		-0.5	3.6	V
Supply Voltage I/O ring	VCC_IO	All		-0.5	3.6	V
Reset input voltage	V_RESET	All		-0.5	3.6	V
Backup supply voltage	V_BCKP	All		-0.5	3.6	V
IO Supply voltage	VCC_IO	All		-0.5	3.6	V
Input pin voltage	Vin	All		-0.5	3.6	V
DC current trough any digital I/O pin (except supplies)	Ipin				10	mA
VCC_RF output current	ICC_RF	All			100	mA
Input power at RF_IN	Prfin	All	source impedance = 50 Ω, continuous wave		15	dBm
Storage temperature	Tstg	All		-40	85	°C

Table 6: Absolute maximum ratings

GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. For more information see chapter 6.4.

Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes. For more information see the *LEA-6/NEO-6/MAX-6 Hardware Integration Manual* [1].

3.2 Operating conditions

☞ All specifications are at an ambient temperature of 25°C.

Parameter	Symbol	Module	Min	Typ	Max	Units	Condition
Power supply voltage	VCC	MAX-6G	1.75	1.8	2.0	V	
		MAX-6Q	2.5	3.0	3.6	V	
Supply Voltage I/O ring	VCC_IO	All	1.65	3.0	3.6	V	
Backup battery voltage	V_BCKP	All	1.4		3.6	V	
Backup battery current	I_BCKP	All		22		µA	V_BCKP = 1.8 V, VCC_IO = 0V
Input pin voltage range	Vin	All	0		VCC_IO	V	
Digital IO Pin Low level input voltage	Vil	All	0		0.2*VCC_IO	V	
Digital IO Pin High level input voltage	Vih	All	0.7*VCC_IO		VCC_IO	V	
Digital IO Pin Low level output voltage	Vol	All			0.4	V	Iol=4mA
Digital IO Pin High level output voltage	Voh	All	VCC_IO -0.4V			V	Ioh=4mA
ANTON Pin Low level output voltage		All	0		0.2*VCC_RF		Iol=4uA
ANTON Pin High level output voltage		All	0.7*VCC_RF		VCC_RF		Ioh=4uA
VCC_RF voltage	VCC_RF	All		VCC-0.1		V	
VCC_RF output current	ICC_RF	All			50	mA	
Antenna gain	Gant	All			50	dB	
Receiver Chain Noise Figure	NFtot	All		3.2		dB	
Operating temperature	Topr	All	-40		85	°C	

Table 7: Operating conditions

☞ Operation beyond the specified operating conditions can affect device reliability.

3.3 Indicative power requirements

Table 8 lists examples of the total system supply current for a possible application.

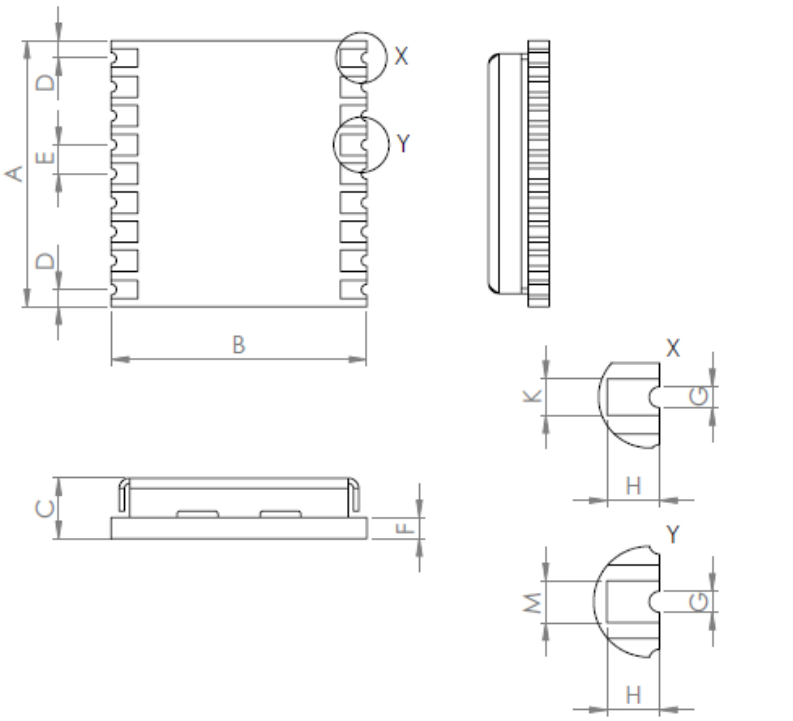
Parameter	Symbol	Min	Typ	Max	Units	Condition
Max. supply current [13]	Iccp			67	mA	VCC = 3.6 V[14] / 1.95 V[15]
Average supply current[16]	Icc Acquisition		47[17]		mA	VCC = 3.0 V[14] / 1.8 V[15]
	Icc Tracking (Max Performance mode)		41[18]		mA	
	Icc Tracking (Eco mode)		39[18]		mA	
	Icc Tracking[19] (Power Save mode)		12[18]		mA	

Table 8: Indicative power requirements

☞ Values in Table 8 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.

[13] Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.
[14] MAX-6Q
[15] MAX-6G
[16] Use this figure to determine required battery capacity.
[17] >8 SVs in view, CNo >40 dBHz, current average of 30 sec after cold start.
[18] With strong signals (>130 dBm), all visible satellites are tracked (>7 SV). For Cold Starts typical 12 min after First Fix. For Hot Starts typical 15 sec after First Fix.
[19] Cyclic operation: Update rate 1 s.

4 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		tbd	

Figure 3: Dimensions

For information regarding the Paste Mask and Footprint see the LEA-6/NEO-6/MAX-6 Hardware Integration Manual [1].

5 Qualification and certification

5.1 Reliability tests

Tests for product family qualifications according to ISO 16750 "Road vehicles - environmental conditions and testing for electrical and electronic equipment", and appropriate standards.

5.2 Approvals

Products marked with this lead-free symbol on the product label comply with the Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).

All u-blox 6 GPS modules are RoHS compliant.

6 Product handling & soldering

6.1 Packaging

MAX-6 modules are delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down. For more information about packaging, see the u-blox Package Information Guide [3].

Figure 4: Reeled MAX- 6 modules

6.1.1 Reels

MAX-6 GPS modules are deliverable in quantities of 500pcs on a reel. Sample quantities of less than 500pcs will not be delivered as hermetically sealed, reeled tapes. MAX-6 modules are delivered using reel Type C as described in the u-blox Package Information Guide [3].

Parameter	Specification
Reel Type	C
Delivery Quantity	500

Table 9: Reel information for MAX-6 modules

6.1.2 Tapes

Figure 5 shows the position and orientation of MAX-6 modules as they are delivered on tape. The dimensions of the tapes are specified in Figure 6.

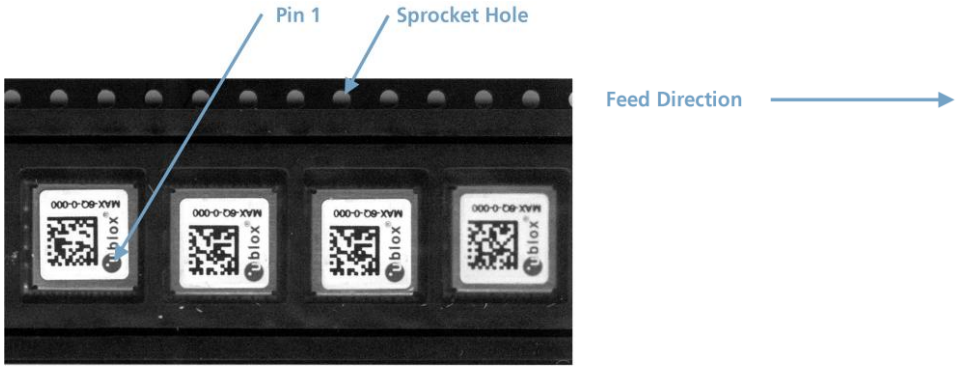


Figure 5: MAX-6 Tape and module orientation

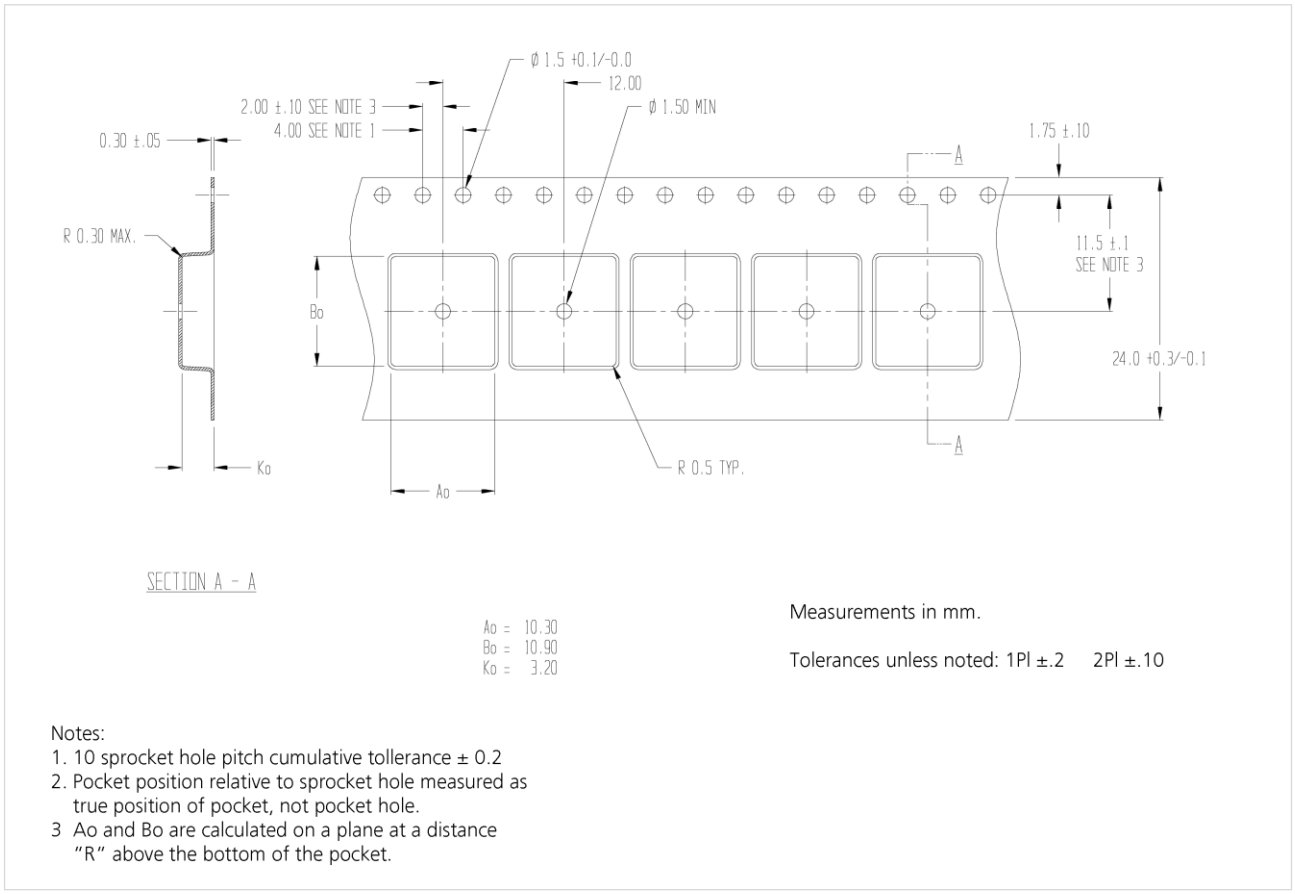


Figure 6: MAX-6 Tape dimensions

6.2 Moisture Sensitivity Levels

MAX-6 modules are Moisture Sensitive Devices (MSD) in accordance to the IPC/JEDEC specification.

MAX-6 modules are rated at MSL level 4. For more information regarding moisture sensitivity levels, labeling, storage and drying see the u-blox Package Information Guide [3].

For MSL standard see IPC/JEDEC J-STD-020, which can be downloaded from www.jedec.org.

6.3 Reflow soldering

Reflow profiles are to be selected according to u-blox recommendations (see LEA-6/NEO-6/MAX-6 Hardware Integration Manual [1]).

6.4 ESD handling precautions

MAX-6 modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GPS receiver!

GPS 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 ~10pF, coax cable ~50-80pF/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).

7 Default settings

Interface	Settings
Serial Port 1 Output	9600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up: **GGA, GLL, GSA, GSV, RMC, VTG, TXT**
USB Output	Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up: **GGA, GLL, GSA, GSV, RMC, VTG, TXT** USB Power Mode: Bus-Powered
Serial Port 1 Input	9600 Baud, 8 bits, no parity bit, 1 stop bit Automatically accepts following protocols without need of explicit configuration: **UBX, NMEA** The GPS 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
TIMEPULSE (1Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100ms
Power Mode	Maximum Performance mode
AssistNow Autonomous	Disabled

Table 10: Default settings

Refer to the u-blox 6 Receiver Description including Protocol Specification [2] for information about further settings.

8 Labeling and ordering information

8.1 Product labeling

The labeling of u-blox 6 GPS modules includes important product information. The location of the product type number is shown in Figure 7.

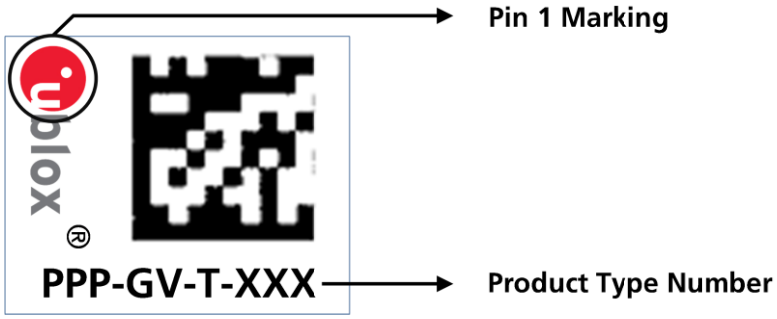


Figure 7: Location of product type number on MAX-6 module label

8.2 Explanation of codes

3 different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox 6 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 11 below details these 3 different formats:

Format	Structure
Product Name	PPP-GV
Ordering Code	PPP-GV-T
Type Number	PPP-GV-T-XXX

Table 11: Product Code Formats

The parts of the product code are explained in Table 12.

Code	Meaning	Example
PPP	Product Family	MAX
G	Product Generation	6 = u-blox6
V	Variant	T = Timing, R = DR, etc.
T	Option / Quality Grade	Describes standardized functional element or quality grade such as Flash size, automotive grade etc.
XXX	Product Detail	Describes product details or options such as hard- and software revision, cable length, etc.

Table 12: part identification code

8.3 Ordering information

Ordering No.	Product
MAX-6G-0	u-blox 6 GPS Module, 1.8V, TCXO, 9.7x10.1 mm, 500 pcs/reel
MAX-6Q-0	u-blox 6 GPS Module, TCXO, 9.7x10.1 mm, 500 pcs/reel

Table 13: 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: http://www.u-blox.com/en/notifications.html

Related documents

[1] LEA-6/NEO-6/MAX-6 Hardware Integration Manual , Docu. No GPS.G6-HW-09007

[2] u-blox 6 Receiver Description including Protocol Specification, Docu. No GPS-SW-09017

[3] u-blox Package Information Guide, Docu. No GPS-X-11004

All these documents are available on our homepage (http://www.u-blox.com).

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

Revision history

Revision	Date	Name	Status / Comments
	18/2/2011	dhur	Initial Version
A	16/9/2011	cbib	Update for Advance Information
A1	7/10/2011	cbib	Section 6.1.2 Figure 5: Corrected orientation of module on tape.
B	19/12/2012	dhur	Added Pin 1 Marking in chapter 8.1. Updated Table 1. Changed document status to preliminary.

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