

# PAM-7Q

## u-blox 7 GPS Antenna Module

### Data Sheet

#### Highlights:

- Embedded GPS patch antenna
- Excellent antenna performance
- Low power consumption
- Form-factor compatible with UP501
- Easy integration into design



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**Document Information**

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**Document status information**

Objective Specification	Document contains target values. Revised and supplementary data will be published later.
Advance Information	Document contains data based on early testing. Revised and supplementary data will be published later.
Early Production Information	Document contains data from product verification. Revised and supplementary data may be published later.
Production Information	Document contains the final product specification.

This document applies to the following products:

<b>Product name</b>	<b>Type number</b>	<b>ROM/FLASH version</b>	<b>PCN reference</b>
PAM-7Q	PAM-7Q-0-000	ROM1.0	N/A

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# 1 Functional description

## 1.1 Overview

The u-blox PAM-7Q patch antenna module has the exceptional performance of the u-blox 7 engine and delivers high sensitivity and minimal acquisition times in an industry proven form factor.

Incorporating the PAM-7Q into customer designs is simple and straightforward, thanks to the embedded antenna, low power consumption, simple interface, and sophisticated interference suppression that ensures maximum performance even in GPS hostile environments.

The 18 x 18 mm patch antenna of PAM-7Q provides RHCP polarization, which is not achievable with smaller patch antenna elements. The simple design and easy interfacing keeps installation costs to a minimum.

PAM-7Q targets industrial and consumer applications that require small and cost efficient smart antenna solutions. It is form-factor compatible with the UP501 module, allowing the upgrade of existing designs with minimal effort.

PAM-7Q modules use u-blox 7 GPS chips qualified according to AEC-Q100 and are manufactured in ISO/TS 16949 certified sites. Qualification tests are performed as stipulated in the ISO16750 standard: "Road vehicles – Environmental conditions and testing for electrical and electronic equipment".

## 1.2 Product features

Model	Type	Supply	Interfaces	Features	Grade
	GPS / QZSS GLONASS Galileo BeiDou Timing Dead Reckoning Precise Point Positioning Raw Data	2.7 V – 3.6 V Lowest power (DC/DC)	UART USB SPI DDC (I <sup>2</sup> C compliant)	Programmable (Flash) Data logger Additional SAW Additional LNA RTC crystal Internal oscillator Active antenna / LNA supply Active antenna / LNA control Antenna short circuit detection / protection pin Antenna open circuit detection pin Frequency output	Standard Professional Automotive
<b>PAM-7Q</b>	•	• •	• •	• • • • T	<div style="background-color: #008000; width: 100%; height: 10px;"></div> Standard Professional Automotive

T = TCXO

## 1.3 GPS performance

Parameter	Specification	
Receiver type	56 Channels GPS L1C/A SBAS L1C/A QZSS L1C/A	
Time-To-First-Fix <sup>1</sup>	Cold Start	29 s
	Warm Start	28 s
	Hot Start	1 s
	Aided Starts <sup>2</sup>	5 s
Sensitivity <sup>3</sup>	Tracking & Navigation	-161 dBm
	Reacquisition	-159 dBm
	Cold Start	-147 dBm
	Warm Start	-147 dBm
	Hot Start	-155 dBm
Horizontal position accuracy <sup>4</sup>	Autonomous	2.5 m
	SBAS	2.0 m
Accuracy of time pulse signal	RMS	30 ns
	99%	60 ns
Frequency of time pulse signal		0.25 Hz ... 1 kHz (configurable)
Max navigation update rate		10 Hz
Velocity accuracy <sup>5</sup>		0.1 m/s
Heading accuracy <sup>5</sup>		0.5 degrees
Operational limits <sup>6</sup>	Dynamics	≤ 4 g
	Altitude	50,000 m
	Velocity	500 m/s

**Table 1: GPS performance of PAM-7Q**

<sup>1</sup> All satellites at -130 dBm

<sup>2</sup> Dependent on aiding data connection speed and latency

<sup>3</sup> Measured conducted without antenna

<sup>4</sup> CEP, 50%, 24 hours static, -130 dBm, > 6 SVs

<sup>5</sup> 50% @ 30 m/s

<sup>6</sup> Assuming Airborne < 4 g platform

## 1.4 Block diagram

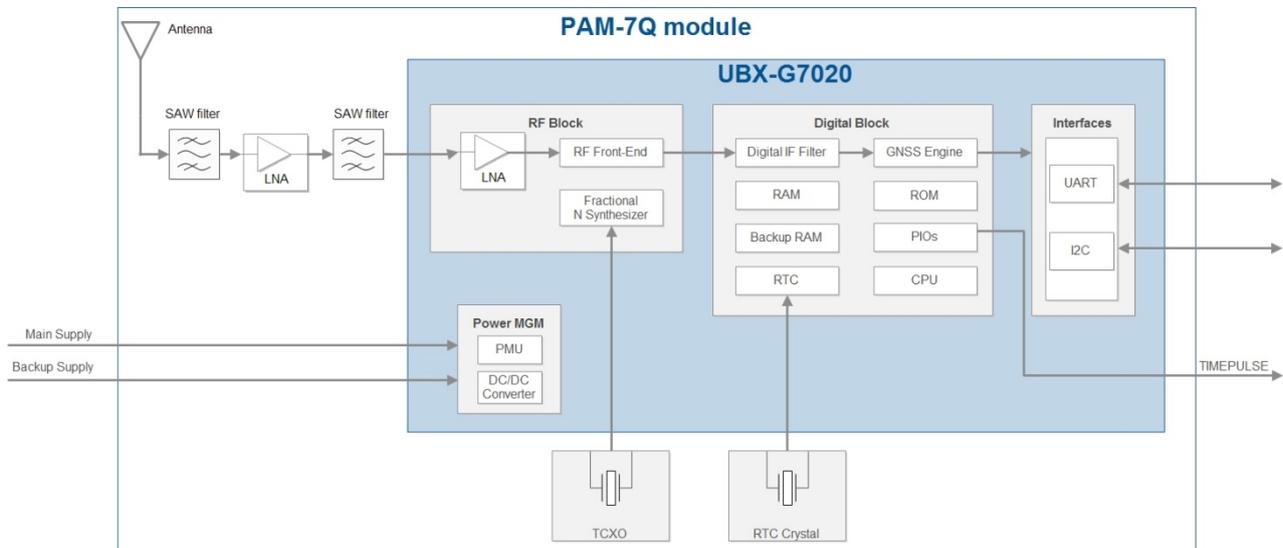


Figure 1: PAM-7Q block diagram

## 1.5 GNSS

### 1.5.1 GPS

u-blox PAM-7Q receivers are designed to receive and track the L1C/A signals provided at 1575.42 MHz by the Global Positioning System (GPS).

### 1.5.2 QZSS

The Quasi-Zenith Satellite System (QZSS) is a navigation satellite overlay system for the Pacific region covering Japan and Australia that transmits additional GPS L1C/A signals. PAM 7Q positioning modules are able to receive and to track these signals simultaneously with GPS, resulting in better availability, especially under bad signal conditions e.g. in urban canyons.

## 1.6 Augmented GPS

### 1.6.1 Assisted GPS (A-GPS)

A-GPS improves GPS performance by delivering aiding data to the GPS receiver via wireless networks or the Internet. Supplying information such as ephemeris, almanac, approximate last position, time and satellite status and an optional time synchronization signal significantly reduces Time to First Fix (TTFF) and improves acquisition sensitivity.

AssistNow Online and AssistNow Offline are u-blox' end-to-end A-GPS services for devices with or without network connectivity. AssistNow Online and AssistNow Offline can either be used alone or in combination. They are very easy to implement, require no additional hardware, and generate virtually no CPU load. PAM-7Q modules support u-blox' AssistNow Online, AssistNow Offline and AssistNow Autonomous A-GPS services, and are OMA SUPL compliant.

#### AssistNow Online

With AssistNow Online, an internet-connected GPS device downloads assistance data from u-blox' AssistNow Online Service at system start-up. AssistNow Online is network operator independent and globally available.

u-blox only sends ephemeris data for those satellites currently visible to the device requesting the data, thus minimizing the amount of data transferred.

### AssistNow Offline

With AssistNow Offline, users download u-blox' Differential Almanac Correction Data from the Internet at their convenience. The correction data can be stored in the memory of the application processor. Therefore, the service requires no connectivity at system start-up and enables a position fix within seconds, even when no network is available.

#### 1.6.2 AssistNow Autonomous

AssistNow Autonomous provides functionality similar to Assisted-GPS without the need for a host or external network connection. It is an embedded feature available free-of-charge that accelerates GPS positioning by capitalizing on the periodic nature of GPS satellite orbits. GPS orbit predictions are directly calculated by the GPS receiver and no external aiding data or connectivity is required. AssistNow Autonomous can be used alone, or together with AssistNow Online or AssistNow Offline for increased positioning speed and accuracy.



For more details see the *u-blox 7 Receiver Description Including Protocol Specification* [1].

#### 1.6.3 Satellite-Based Augmentation System (SBAS)

PAM-7Q positioning modules support SBAS. These systems supplement GPS data with additional regional or wide area GPS augmentation data. The system broadcasts augmentation data via satellite, the data which can be used by GPS receivers to improve the resulting GPS precision. SBAS satellites can be used as additional satellites for ranging (navigation), further enhancing precision. The following SBAS are supported with PAM-7Q: WAAS, EGNOS and MSAS.



For more details see the *u-blox 7 Receiver Description Including Protocol Specification* [1].

## 1.7 TIMEPULSE

A configurable time pulse signal is available with PAM-7Q modules.

The TIMEPULSE output generates pulse trains synchronized with GPS or UTC time grid with intervals configurable over a wide frequency range. Thus it may be used as a low frequency time synchronization pulse or as a high frequency reference signal.

By default the time pulse signal is configured to 1 pulse per second. For more information see the *u-blox 7 Receiver Description including Protocol Specification* [1].

## 1.8 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 2: Available Protocols**



PAM-7Q is a GPS only module with one UART and one I<sup>2</sup>C interface. Some features mentioned in *u-blox 7 Receiver Description Including Protocol Specification* [1] might not supported by PAM-7Q because of unsupported interfaces.

All protocols are available on UART and DDC (I<sup>2</sup>C compliant). For specification of the various protocols see the *u-blox 7 Receiver Description Including Protocol Specification* [1].

## 1.9 Interfaces

A number of interfaces are provided either for data communication or memory access. The embedded firmware uses these interfaces according to their respective protocol specifications.

### 1.9.1 UART

PAM-7Q modules include one UART interface, which can be used for communication to a host. It supports configurable baud rates. For supported baud rates see the *u-blox 7 Receiver Description Including Protocol Specification* [1].

### 1.9.2 Display Data Channel (DDC)

An I<sup>2</sup>C compliant DDC interface is available for communication with an external host CPU. The interface can be operated in slave mode only. The DDC protocol and electrical interface are fully compatible with the Fast-Mode of the I<sup>2</sup>C industry standard. Since the maximum SCL clock frequency is 400 kHz, the maximum transfer rate is 400 kb/s.

The DDC interface is I<sup>2</sup>C Fast Mode compliant. For timing parameters consult the I<sup>2</sup>C standard.



The maximum bit rate is 400 kb/s. The interface stretches the clock when slowed down while serving interrupts, so real bit rates may be slightly lower.

## 1.10 Clock generation

### 1.10.1 Oscillators

PAM-7Q GPS modules are available in TCXO version. TCXO option allows accelerated weak signal acquisition, enabling faster start and reacquisition times.

### 1.10.2 Real-Time Clock (RTC)

The RTC is driven by a 32 kHz oscillator, which makes use of an external RTC crystal. If the main supply voltage fails and a battery is connected to V\_BCKP, parts of the receiver switch off, but the RTC still runs providing a timing reference for the receiver. This operating mode is called Hardware Backup Mode, which enables all relevant data to be saved in the backup RAM to allow a hot or warm start later.

## 1.11 Power management

u-blox PAM-7Q technology offers a power optimized architecture with built-in autonomous power saving functions to minimize power consumption at any given time. Furthermore, the receiver can be used in two operating modes: Continuous mode for best performance or Power Save Mode for optimized power consumption respectively. In addition a high efficiency DC/DC converter is integrated to allow low power consumption even for higher main supply voltages.

### 1.11.1 DC/DC converter

PAM-7Q modules integrate a DC/DC converter, allowing reduced power consumption by up to 50% especially when using a main supply voltage above 2.5 V.



For more information see the *PAM-7Q Hardware Integration Manual* [2].

### 1.11.2 Operating modes

PAM-7Q modules have two operating modes:

- Continuous Mode for best GPS performance
- Power Save Mode to optimize power consumption

### 1.11.2.1 Continuous Mode

Continuous Mode uses the acquisition engine at full performance resulting in the shortest possible TTFF and the highest sensitivity. It searches for all possible satellites until the almanac is completely downloaded. The receiver then switches to the tracking engine to lower power consumption.

Thus, a lower tracking current consumption level will be achieved when:

- A valid GPS position is obtained
- The entire almanac has been downloaded
- The ephemeris for each satellite in view is valid

### 1.11.2.2 Power Save Mode

For power sensitive applications u-blox PAM-7Q receivers provide a Power Save Mode for reduced power consumption.

Power Save Mode provides two dedicated methods called ON/OFF and Cyclic tracking, that reduce average current consumption in different ways to match the needs of the specific application. These options can be set by using a specific UBX message.

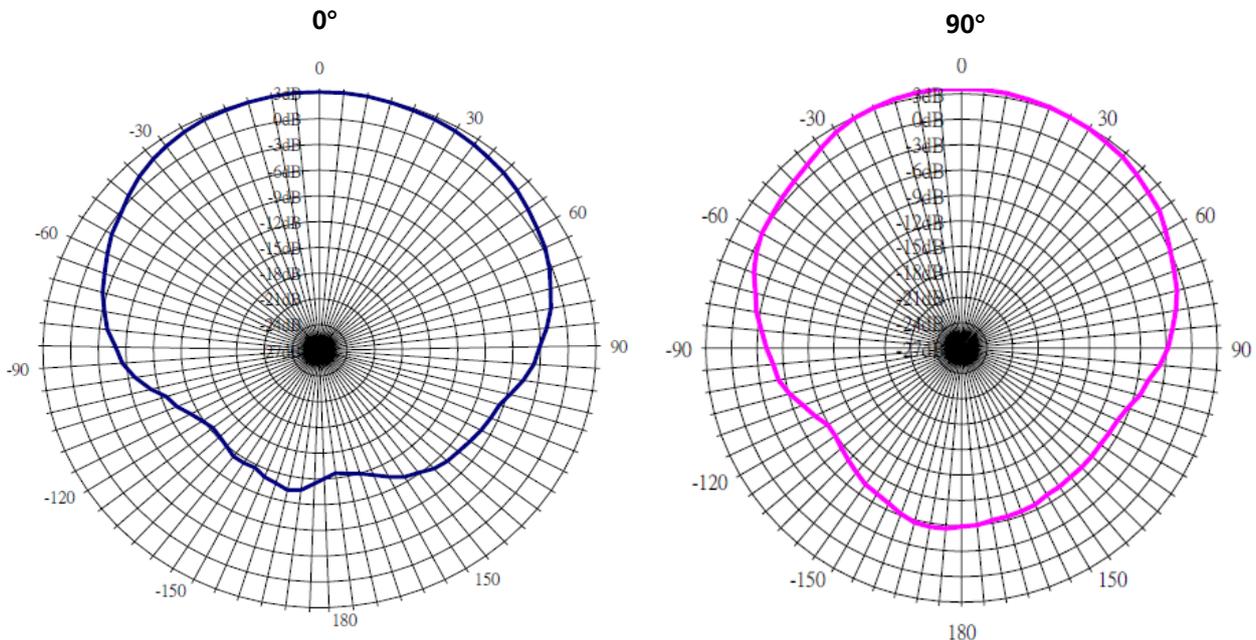


For more information about power management strategies, see the *u-blox 7 Receiver Description Including Protocol Specification* [1].

## 1.12 Antenna

PAM-7Q modules are designed with integrated 18 x 18 mm patch antenna provides RHCP polarization. PAM-7Q antenna modules are relatively wideband and tuned a few MHz above L1, customer housing (plastic) usually will de-tune center frequency back to L1.

Figure 2 illustrates the normalized patch antenna gain for PAM-7Q.



**TX: Right hand circular polarized signal Frequency = 1580MHz  
Radiation Pattern (with 50mm square ground plane)**

**Figure 2: The Normalized Antenna Gain Chart (For Example: 1580MHz)**



In order to maintain good performance for the on-board patch antenna of the PAM-7Q, some design rules should be followed. For more information see the *PAM-7Q Hardware Integration Manual* [2].

## 2 Pin Definition

### 2.1 Pin assignment

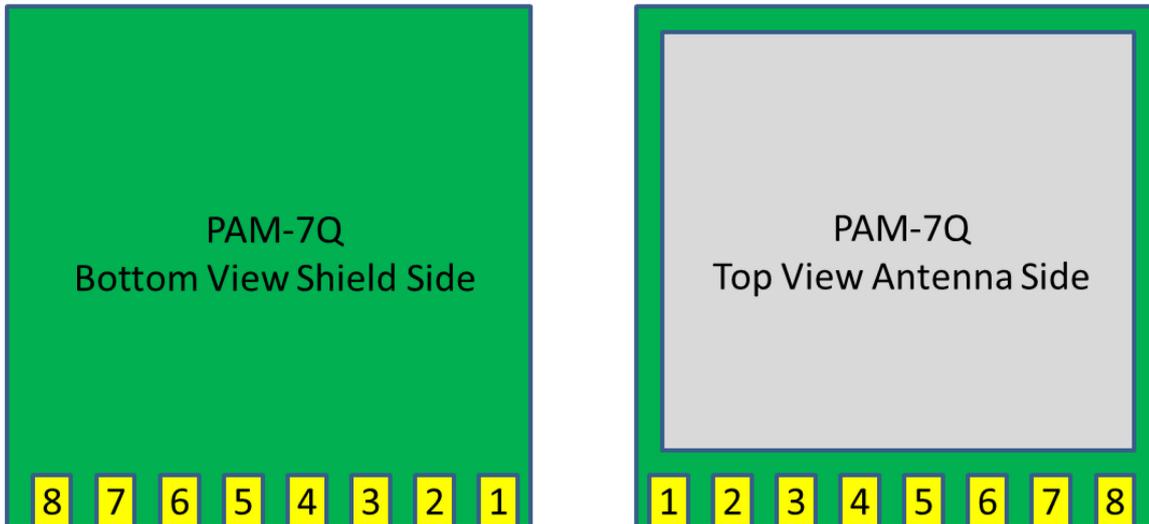


Figure 3: Pin Assignment of PAM-7Q

No	Name	I/O	Description
1	RXD	I	Serial Port
2	TXD	O	Serial Port
3	GND		Ground
4	VCC		Supply voltage
5	V_BCKP		Backup voltage supply
6	TIMEPULSE	O	Time pulse (1PPS)
7	SDA	I/O	DDC Data
8	SCL	I/O	DDC Clock

Table 3: Pinout for PAM-7Q



For more information about Pinouts see the *PAM-7Q Hardware Integration Manual* [2].

### 3 Configuration management

Configuration settings can be modified with UBX configuration messages. The modified settings remain effective until power-down or reset. If these settings have been stored in battery-backup RAM, then the modified configuration will be retained, as long as the backup battery supply is not interrupted.



For more information about configuration management, see the *u-blox 7 Receiver Description including Protocol Specification* [1].

## 4 Electrical specification



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, and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to these limits for extended periods may affect device reliability.



Where application information is given, it is advisory only and does not form part of the specification. For more information see the *PAM-7Q Hardware Integration Manual* [2].

### 4.1 Absolute maximum rating

Parameter	Symbol	Module	Condition	Min	Max	Units
Power supply voltage	VCC	All		-0.5	3.6	V
Backup battery voltage	V_BCKP	All		-0.5	3.6	V
Input pin voltage	V <sub>in</sub>	All		-0.5	3.6	V
DC current through any digital I/O pin (except supplies)	I <sub>pin</sub>				10	mA
Input power at RF_IN	P <sub>rfin</sub>	All	source impedance = 50 Ω, continuous wave <sup>7</sup>		13	dBm
Storage temperature	T <sub>stg</sub>	All		-40	85	°C

**Table 4: Absolute maximum ratings of PAM-7Q**



**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.**

<sup>7</sup> Measured conducted

## 4.2 Operating conditions



All specifications are at an ambient temperature of 25°C. Extreme operating temperatures can significantly impact specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Parameter	Symbol	Min	Typ	Max	Units	Condition
Power supply voltage	VCC	+2.7	+3.0	+3.6	V	
Backup battery voltage	V_BCKP	+1.4		+3.6	V	
Backup battery current	I_BCKP		15		µA	V_BCKP = 3.0 V VCC = 0 V
SW backup current	I_SWBCKP		35		µA	VCC = 3.0 V
Input pin voltage range	V <sub>in</sub>	0		VCC	V	
Digital IO Pin Low level input voltage	V <sub>il</sub>	0		0.2*VCC	V	
Digital IO Pin High level input voltage	V <sub>ih</sub>	0.7*VCC		VCC+0.5V	V	
Digital IO Pin Low level output voltage	V <sub>ol</sub>			0.4	V	I <sub>ol</sub> = 4 mA
Digital IO Pin High level output voltage	V <sub>oh</sub>	VCC-0.4			V	I <sub>oh</sub> = 4 mA
Receiver Chain Noise Figure	NF <sub>tot</sub>		2.0		dB	
Operating temperature	T <sub>opr</sub>	-40		+85	°C	

**Table 5: Operating conditions**



Operation beyond the specified operating conditions can affect device reliability.

## 4.3 Indicative power requirements

Table 6 lists examples of the total system supply current for a possible application.



Values in Table 6 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.

Parameter	Symbol	Min	Typ	Max	Units
Max. supply current <sup>8</sup>	I <sub>ccp</sub>			71	mA
	I <sub>cc</sub> Acquisition <sup>11</sup>		26.0		mA
Average supply current <sup>9, 10</sup>	I <sub>cc</sub> Tracking (Continuous mode)		21.5		mA
	I <sub>cc</sub> Tracking (Power Save mode / 1 Hz)		6.0		mA

**Table 6: Indicative power requirements at 3.0 V**



For more information about power requirements, see the *PAM-7Q Hardware Integration Manual* [2].

<sup>8</sup> Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.

<sup>9</sup> Use this figure to determine required battery capacity.

<sup>10</sup> Simulated constellation of 8 satellites is used. All signals are at -130 dBm.

<sup>11</sup> Average current from start-up until the first fix.



## 6 Reliability tests and approvals

### 6.1 Reliability tests



PAM-7Q antenna modules are based on AEC-Q100 qualified GPS chips.

Tests for product qualifications are according to ISO 16750 "Road vehicles – Environmental conditions and testing for electrical and electronic equipment", and appropriate standards.

### 6.2 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).

u-blox PAM-7Q GPS antenna modules are RoHS compliant.

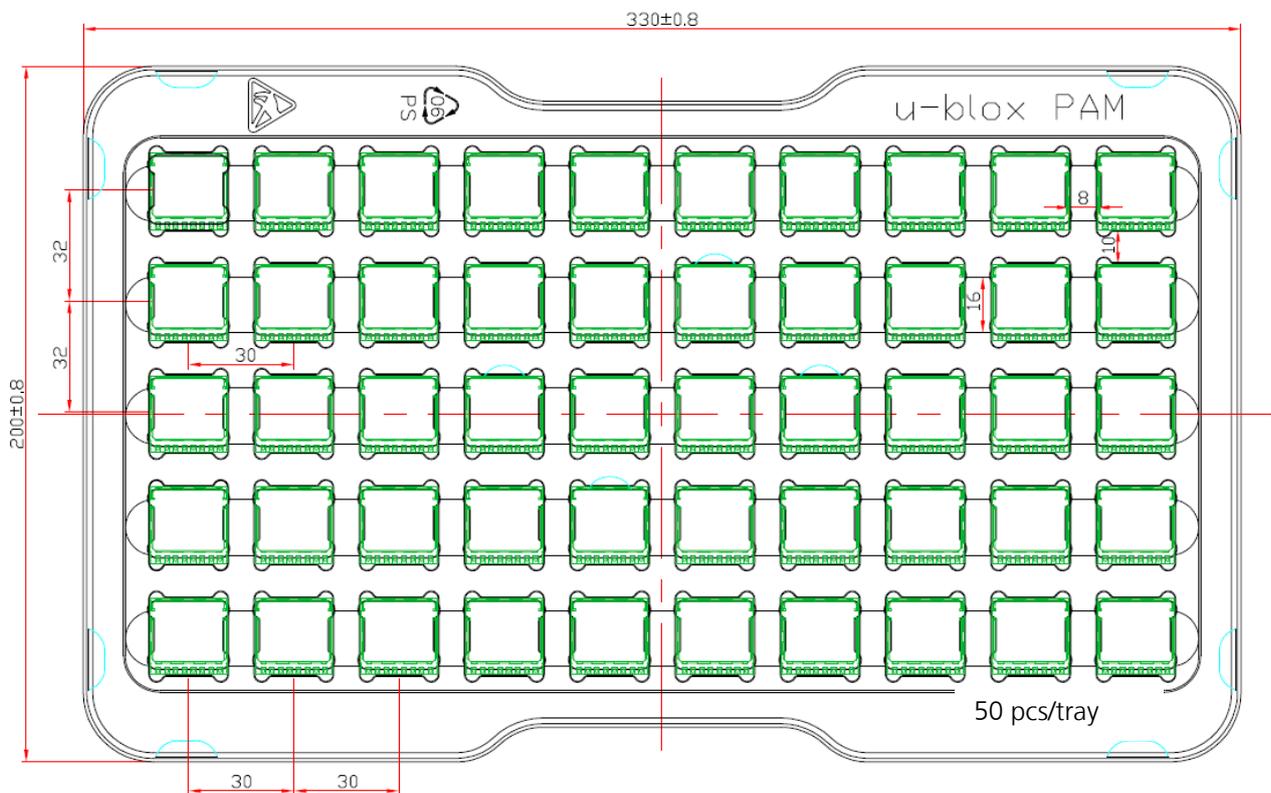
# 7 Product handling & soldering

## 7.1 Packaging

PAM-7Q GPS antenna modules are delivered on trays, with 50 pcs of modules on each tray. Table 7 describes the module quantity in a standard shipment package of PAM-7Q. The dimensions of the trays and tray packages in a carton are specified in Figure 5 and Figure 6.

	Quantity
PAM-7Q module in one shipment package	500 pcs
Trays in one shipment package	10 trays
PAM-7Q modules on Trays	50 pcs/tray

**Table 7: Package information of PAM-7Q GPS antenna module**



**Figure 5 : PAM-7Q tray dimensions (unit : mm)**

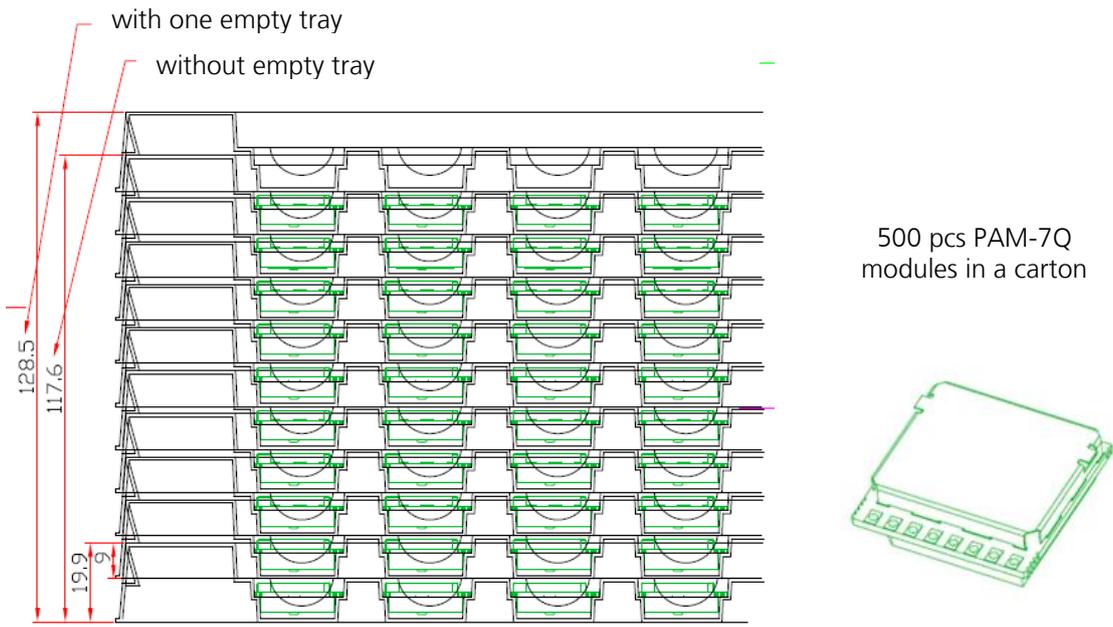


Figure 6: Tray arrangement in a carton (unit: mm)

## 7.2 Shipment, storage and handling

For important information regarding shipment, storage and handling, see the *u-blox Package Information User Guide* [3].

### 7.2.1 Hand soldering

For detailed instructions concerning hand soldering, see *PAM-7Q Hardware Integration Manual* [2].



PAM-7Q modules are hand soldering devices, Moisture Sensitivity Level (MSL) is therefore not applicable.

### 7.2.2 Antenna ageing

Antenna electrode metallization is unprotected silver and will tarnish during storage due to sulphuric compounds present in the atmosphere. Elevated temperature and humidity will accelerate this process. Human skin contact, wool etc. will also cause tarnishing. This has no effect on the electrical performance of the antenna. u-blox accepts no warranty claims for tarnished products due to this normal and to be expected process.

### 7.2.3 ESD handling precautions

**⚠ PAM-7Q modules are Electrostatic Sensitive Devices (ESD). Observe handling precautions! 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. Exercise care when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, take the following measures 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
- 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 to the receiver's I/O connections, make sure to use an ESD safe soldering iron (tip).



## 8 Default messages

Interface	Settings
UART Output	9600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only the following NMEA (no UBX) messages have been activated at start-up: <b>GGA, GLL, GSA, GSV, RMC, VTG, TXT</b>
UART Input	9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled Automatically accepts following protocols without need of explicit configuration: UBX, NMEA The GPS receiver supports interleaved UBX and NMEA messages.
TIMEPULSE (1Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100 ms

**Table 8: Default messages**



Refer to the *u-blox 7 Receiver Description including Protocol Specification* [1] for information about further settings.

## 9 Labeling and ordering information

### 9.1 Product labeling

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

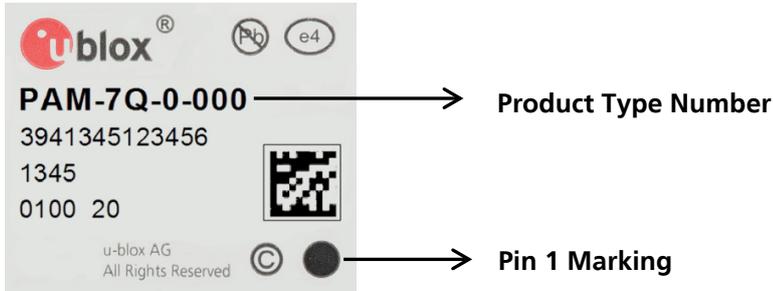


Figure 7: Location of product type number on PAM-7Q module label

### 9.2 Explanation of codes

Three different 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 9 below details these three different formats:

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

Table 9: Product code formats

The parts of the product code are explained in Table 10.

Code	Meaning	Example
PPP	Product Family	PAM
TG	Technology & Generation	7 = u-blox 7
V	Variant	Function set (A-Z)
T	Grade or functional element	Describes standardized functional element or quality grade 0 = Default variant, A = Automotive
XXX	Product Detail	Describes product details or options such as hard- and software revision, cable length, etc.

Table 10: Part identification code

### 9.3 Ordering codes

Ordering No.	Product
PAM-7Q-0	u-blox 7 GPS Antenna Module, TCXO, ROM, SAW, LNA 22 x 22 mm, 50 pcs/tray

Table 11: Product ordering codes for professional grade modules



Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs), see our website.

## Related documents

- [1] u-blox 7 Receiver Description including Protocol Specification, Docu. No. GPS.G7-SW-12001
- [2] PAM-7Q Hardware Integration Manual, Docu. No. UBX-13003143
- [3] u-blox Package Information User Guide, Docu. No. UBX-14001652



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

## Revision history

Revision	Date	Name	Status / Comments
R01	06-Nov-2013	julu	Objective Specification
R02	09-Jan-2013	julu	Advance Information. Updated product picture in cover page (patch antenna side) and product feature table (section 1.2), updated Figure 4 (mechanical drawing) and Figure 7 (product label with correct "Pin 1 Marking").
R03	11-Apr-2014	julu	Early Production Information. Updated Related documents section (new UBX document number for u-blox Package Information User Guide). Aligned product selector table in section 1.2; added SW backup current to Table 5.
R04	17-Nov-2014	julu	Updated section 1.2 (added product grade information to selector table), added note in section 7.2.1 (MSL not applicable for PAM-7Q modules)
R05	06-Nov-2015	julu	Removed "green/halogen free" from section 1.1

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