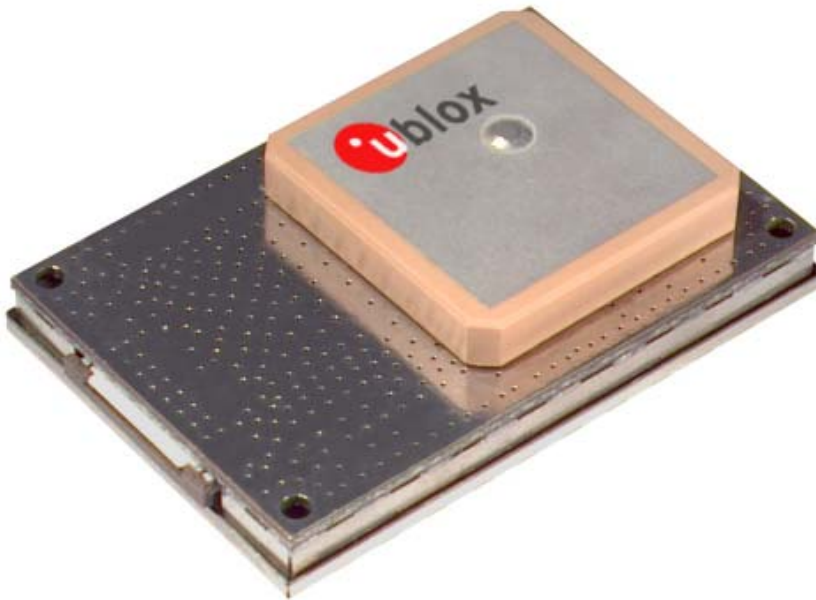


# SAM-LS GPS Smart Antenna Module

## Data Sheet



### Abstract

This document describes the features and specifications of the SAM-LS Smart Antenna Module, a low power GPS receiver macro-component with integrated patch antenna. Based on the ANTARIS® GPS technology, it offers high GPS performance combined with easy and fast system integration

<b>Title</b>	SAM-LS		
<b>Subtitle</b>	GPS Smart Antenna Module		
<b>Doc Type</b>	Data Sheet		
<b>Doc Id</b>	GPS.G3-SA-03002-E		
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P1	03. Mar. 04	GzB	First draft version
- (Initial Release)	06. May 04	GzB	Modified section 5
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B	6. Aug. 04	GzB	Modified table 9, higher sleep mode current
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E	02. Feb. 06	GzB	Modified table 7 (RESET_N)

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<b>Data Sheet Revisions</b>	<b>Identification of applicable hardware</b>	<b>Comments</b>
P1, -, A	SAM-LS with data codes 130000.0100.000, 130000.0120.000	ANTARIS GPS Firmware Version 3.0 inside
B, C, D, E	SAM-LS with data codes 130000.0121.000 and higher	

	<p>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).</p>
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# 1 Functional Description

## 1.1 Overview

The smart antenna SAM-LS combines an ultra-low power GPS receiver module with an integrated patch antenna. The form factor and interfaces are compatible to its predecessor SAM. It provides two 3V serial ports accessible through a connector for flexible flat cables. This all-in-one solution is best suited for a broad spectrum of end products where very fast and straightforward system integration at minimum development costs and risks is a major issue.

The leading ANTARIS<sup>®</sup> GPS Engine, jointly developed by Atmel and u-blox, provides excellent navigation performance under dynamic conditions in areas with limited sky view like urban canyons, high sensitivity for weak signal operation without compromising accuracy, and support of DGPS and multiple SBAS systems like WAAS and EGNOS. The 16 parallel channels and 8192 search bins provide fast start-up times. The low power consumption and FixNow<sup>™</sup> power saving mode make this product suitable for handheld and battery-operated devices.

The SAM-LS provides versatile mounting techniques which include screwing, soldering, gluing and press-fit. Mounting the SAM-LS into a location with good view to satellites, applying power and connecting serial interfaces are the only steps required to commission the GPS receiver.

## 1.2 Block Diagram

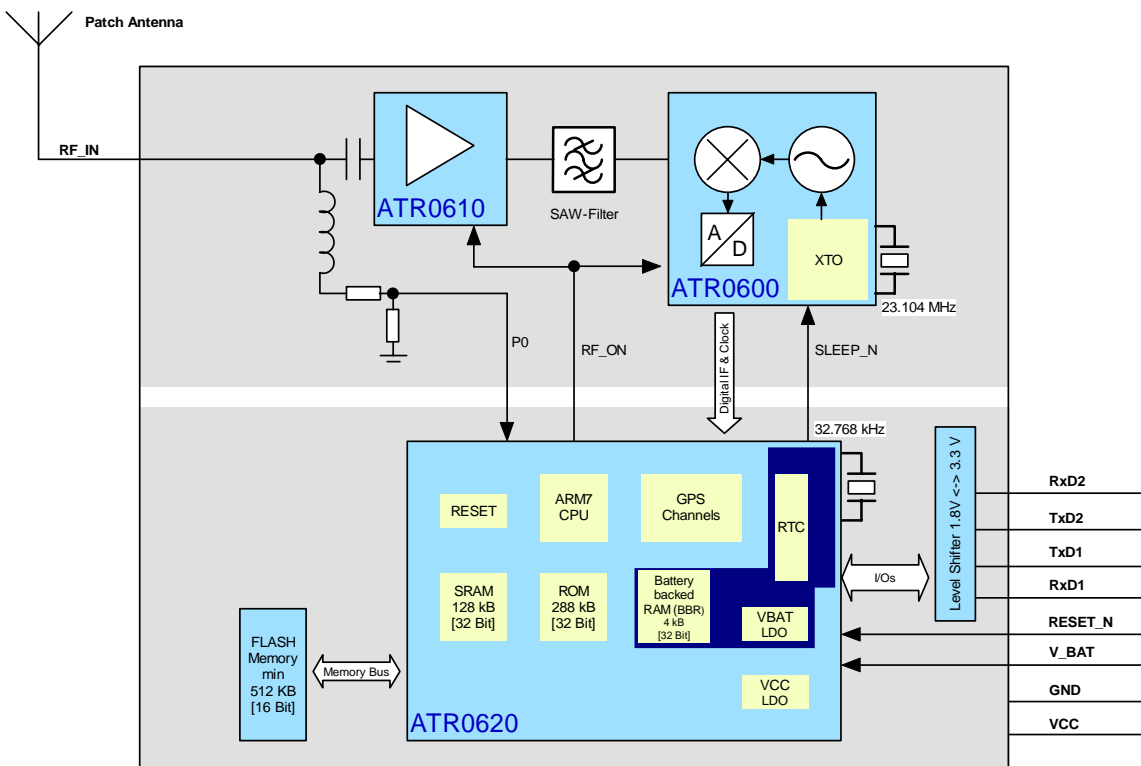


Figure 1: Block Diagram

### 1.3 Benefits

- All-in-one GPS receiver with patch antenna
- High acquisition and tracking sensitivity
- Ultra-low power consumption
- Excellent GPS performance
  - Excellent navigation accuracy, even at low signal levels
  - Active multipath detection and removal
  - Fast Time-to-First-Fix (TTFF)
- Versatile mounting techniques
  - Screw-mount, snap-in, soldering, press-fit
  - Allows simple and effortless integration with little time, low cost and minimum design risks
- Maximum flexibility:
  - Extensively configurable
- Fully EMI shielded

### 1.4 Features

- 16 channel GPS receiver
- 8192 simultaneous time-frequency search bins
- 4 Hz position update rate
- ANTARIS Positioning Engine
  - ATR0600 RF front-end IC
  - ATR0620 Baseband IC with ARM7TDMI inside
  - ATR0610 Low noise amplifier IC
- FLASH memory (min. 4 Mbit)
- DGPS and SBAS (WAAS, EGNOS) support
- FixNOW™ power saving mode
- Operating voltage 2.7 to 3.3 V
- Battery supply pin for internal backup memory and real time clock
- Industrial operating temperature range –40 to 85°C
- Small size
  - Size 31.5 x 47 x 9.5 mm
  - Weight 23 g

## 1.5 Operating Modes

The ANTARIS GPS Technology defines the following Operating Modes:

Operating Modes	Description
<b>Continuous Tracking Mode (CTM)</b>	The Continuous Tracking Mode is configured for optimal position accuracy. This mode is optimized for power consumption based on the ANTARIS Autonomous Power Management (APM) saving as parts of the receiver are switched off when they are not required; also the CPU clock speed is reduced when the CPU is not loaded. There is no need for a user to configure this mode as it is built into the architecture of the module.
<b>Power Saving Modes</b>	
<b>FixNOW™ (FXN)</b>	FixNOW™ Mode allows an application a navigation solution on request. It includes additional Power Saving Functions and is the best mode for any Mobile, Tracking Unit application where low power consumption requirements are primary consideration. This mode can be configured to meet application requirements.

Table 1: Operating Modes

For specification of the various protocols see the *ANTARIS System Integration Manual [1]*.

## 1.6 Protocols

The SAM-LS supports different serial protocols. These can be assigned to any serial interface port.

Protocol	Type	Runs on
NMEA	Input/output, ASCII, 0183, 2.3 (compatible to 3.0)	All Serial ports
UBX	Input/output, binary, u-blox proprietary	All Serial ports
RTCM	Input, message 1,2,3,9	All Serial ports

Table 2: Available Protocols

For specification of the various protocols see the *Protocol Specification [2]*.

## 1.7 Antenna

The SAM-LS is equipped with a RHCP patch antenna. The printed circuit board around the antenna serves as a ground plane.

Parameter	Specification
Gain <sup>1</sup>	at zenith                      typ. +5 dBic
	10° elevation                      typ. -1 dBic
Built-in LNA	Atmel ATR0610

Table 3: Antenna Specification

<sup>1</sup> According to manufacturer's specification for patch antenna. Ground plane and enclosure design may affect the directivity pattern.

## 2 Performance Specification

Parameter	Specification			
Receiver Type	L1 frequency, C/A Code, 16-Channels 8192 search bins			
Max Update Rate	4 Hz			
Accuracy (Selective Availability off)	Position	2.5 m CEP <sup>3</sup>	5.0 m SEP <sup>4</sup>	
	Position DGPS / SBAS <sup>2</sup>	2.0 m CEP	3.0 m SEP	
Acquisition <sup>5</sup>	Cold Start <sup>6</sup> Warm Start Hot Start	Fast Acquisition Mode	Normal Mode	High Sensitivity Mode
		34 s	36 s	41 s
		33 s		
		<3.5 s		
Signal Reacquisition	<1 s			
Sensitivity	Acquisition Tracking	Fast Acquisition Mode	Normal Mode	High Sensitivity Mode
		-132 dBm -141 dBm	-136 dBm -144 dBm	-138 dBm -147 dBm
Dynamics	≤ 4 g			
Operational Limits	COCOM restrictions			

**Table 4: Performance Specification**

<sup>2</sup> Depends on accuracy of correction data of DGPS or SBAS service

<sup>3</sup> CEP = Circular Error Probability: The radius of a horizontal circle, centered at the antenna's true position, containing 50% of the fixes.

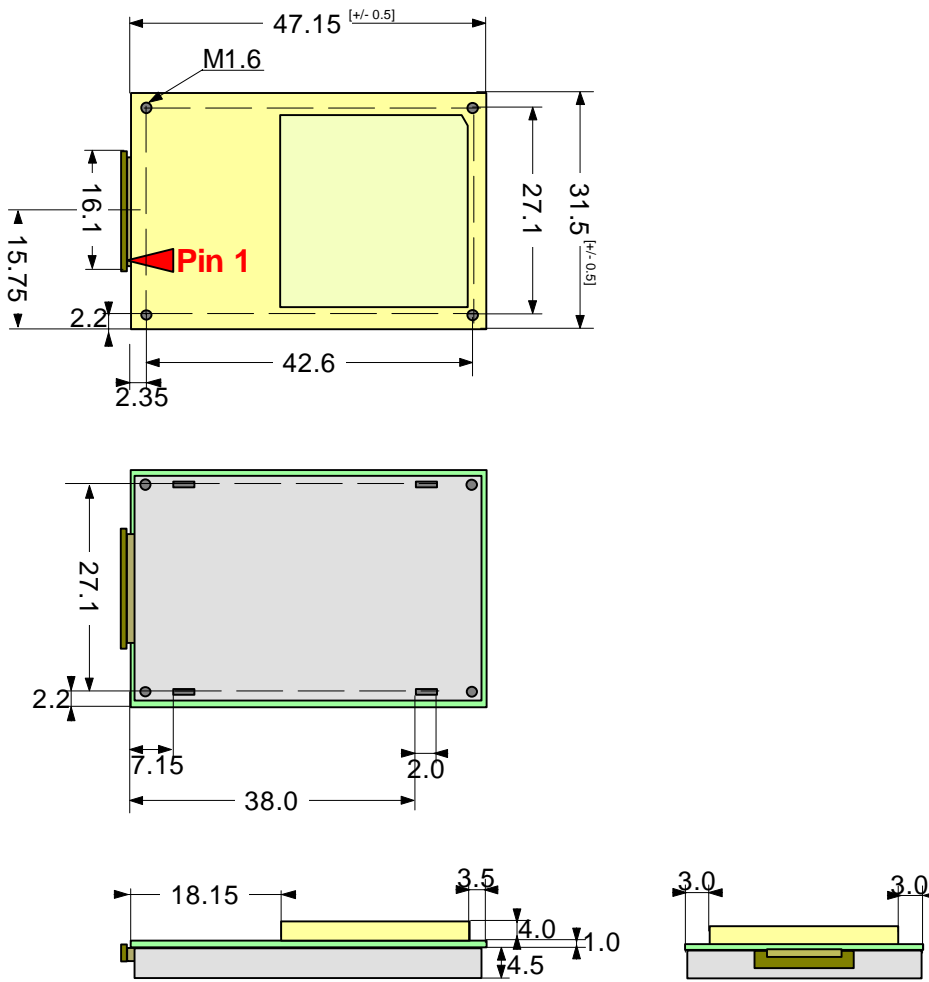
<sup>4</sup> SEP = Spherical Error Probability. The radius of the sphere, centered at the true position, contains 50% of the fixes.

<sup>5</sup> The different start-up modes like cold, warm and hot start are described in the System Integration Manual [1]

<sup>6</sup> Measured with good visibility and -125 dBm signal strength

### 3 Mechanical Specification

#### 3.1 Dimensions



All Dimension are in mm.  
All Tolerances +/- 0.2mm, if not indicated differently.

Figure 2: SAM-LS Dimensions

#### 3.2 Interface Specification

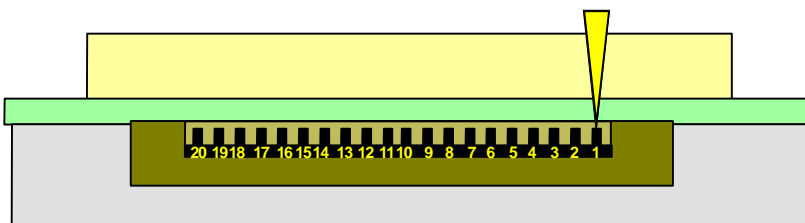


Figure 3: SAM-LS Interface and Pin Assignment



Connector:

Flat flex cable (FFC) connector, 20 pins, 0.5 mm pitch. Contacts face to printed circuit board.

Cable:

FFC cable, 20 pins, 0.5 mm pitch.



Figure 4: Flat Flexible Connector (FFC) Cable

Suitable flat flex cables:

Manufacturer	Connector Types	Partnumber	Internet
Axon	0.5mm Flat Flexible Cable,20pin Length 156mm with both sides reinforcement tapes	FFC0.50A20/0156L3-3-6-6-SBBB	<a href="http://www.axon-cable.com/">http://www.axon-cable.com/</a>
Young Shin	0.5mm Flat Flexible Cable,20pin, 20pinLength 140mm with both sides reinforcement tapes	0.5x20x110xC(3/3/6/6)x(0.1x0.3)	<a href="http://www.youngshinffc.com/">http://www.youngshinffc.com/</a>
Imperial Connector Systems	0.5mm Flat Flexible Cable,20pin Length 140mm with both sides reinforcement tapes	0.5x20x110xC(3/3/6/6)x(0.1x0.3)	<a href="http://www.imperial-connect.co.uk/">http://www.imperial-connect.co.uk/</a>

Table 5: Suppliers of FFC type Cables

Suitable flat flex connectors for host side:

Manufacturer	Connector Types	Partnumber	Internet
Molex	0.5mm pitch FFC/FPC connector, 20pin	Recommended: 52746-2090	<a href="http://www.molex.com">http://www.molex.com</a>
AVX		See AVX's 0.5mm product selector guide	<a href="http://www.avx.com">http://www.avx.com</a>
Harwin		F05 Series	<a href="http://www.harwin.com">http://www.harwin.com</a>
AMP		Look for "Flexible Film Connectors"	<a href="http://www.amp.com">http://www.amp.com</a>
FCI		Look for "Flex PCB Connectors"	<a href="http://www.fciconnect.com">http://www.fciconnect.com</a>

Table 6: Suppliers of FFC type Connectors

Smart Antenna Adapter Board:

To make system integration as simple as possible, u-blox provides a Smart Antenna Adapter Board with FFC cable. It consists of a small PCB board with 20-pin 2.54 mm grid two-row receptacle. See [3] for details.



Figure 5: Smart Antenna Adapter Board

### 3.3 Pinout

All GND pins need to be connected to ground for sufficient grounding.

Standard Function				Remarks
Pin	Name	I/O	Description	
1	GND	I	Ground	
2	Reserved		Not supported	Leave open
3	GND	I	Ground	
4	RESET_N	I	Reset (Active low)	Concerning use of RESET_N signal, please refer to the ANTARIS System Integration Manual [1]
5	GND	I	Ground	
6	V_BAT	I	Backup voltage supply	Connect to GND if not used
7	GND	I	Ground	
8	RxD2	I	Serial Port 2	Pull up if not used
9	GND	I	Ground	
10	TxD2	O	Serial Port 2	Leave open if not used
11	GND	I	Ground	
12	TxD1	O	Serial Port 1	Leave open if not used
13	GND	I	Ground	
14	RxD1	I	Serial Port 1	Pull up if not used
15	GND	I	Ground	
16	Reserved		Not supported	Leave open
17	GND	I	Ground	
18	VCC	I	Supply voltage	
19	GND	I	Ground	
20	GND	I	Ground	

Table 7: Signals and Module Interface

## 4 Electrical Specification

### 4.1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
<b>Power Supply (VCC and V_BAT)</b>				
Power supply voltage	Vcc	-0.3	3.6	V
<b>Input Pins</b>				
Input pin voltage (all except RESET_N)	Vin	-0.3	Vcc + 0.3	V
Input pin voltage of RESET_N	Vin_reset	-0.3	1.95	V
<b>Environment</b>				
Storage temperature	Tstg	-40	125	°C

**Table 8: Absolute Maximum Ratings**

- ! Warning** 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.

## 4.2 Operating Conditions

Parameter <sup>7</sup>	Symbol	Condition	Min	Typ	Max	Units
<b>Power Supply</b>						
Power supply voltage	Vcc		2.7		3.3	V
Power supply voltage ripple	Vcc_PP				50	mV
Sustained supply current <sup>8</sup>	Icc	Vcc = 3.0 V		56		mA
Peak supply current <sup>9</sup>	Iccp	Vcc = 3.3 V			125	mA
Sleep mode current	Iccs	Vcc = 3.0 V		2000		µA
Backup battery voltage	Vbat		1.95		3.6	V
Backup battery current	Ibat	Vbat = 3.3 V		16	40	µA
<b>Digital I/O (All signals except RESET_N)</b>						
Input pin voltage range	Vin		0V		Vcc	V
Input pin Low voltage	Vin_low				0.15	V
Input pin high voltage	Vin_high		Vcc - 0.4			V
Output pin voltage range	Vout		0V		Vcc	V
Output pin low voltage	Vout_low	Iout < 1mA (sink)			0.4	V
Output pin high voltage	Vout_high	Iout < 20µA (source)	0.67 × Vcc			V
Output pin current at low voltage	Iout_low	Vout_low = 0.4 V			1	mA
Output pin current at high voltage	Iout_high	Vout_high = 0.67 × Vcc			20	µA
<b>RESET_N Input</b>						
Input Pin voltage range	VinR		0		1.8	V
Input pin low voltage	Vin_lowR				0.45	V
Input pin high voltage	Vin_highR		1.4			V
<b>Environment</b>						
Operating temperature	Topr		-40		85	°C

**Table 9: Operating Conditions**

Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability. The technical data apply to products where standard ANTARIS firmware is running.

<sup>7</sup> All specification are at an ambient temperature of 25°C.

<sup>8</sup> Average current drawn during Continuous Tracking Mode with 1 Hz update rate, using 6 satellites for tracking and navigation. Use this figure to determine required battery capacity

<sup>9</sup> Peak current drawn during initial acquisition phase. Use this figure to dimension maximum current capability of power supply

## 5 Environmental Specification

Detailed description of the test series:

Test	Standard
Visual inspection	IPC-A-610 "Acceptability of electronic assemblies" I.T.R.I. Publication No. 700 IPC-SM-840B Class 2.
Thermal shock	-40°C...+125°C, 100 cycles
Function test at various temperatures	-40°C/2 hours; RT/2 hours; +85°C/2 hours; function tests at stable temperature
Lifespan test	+85°C/1000 hours, in function
Damp heat, cyclic	+25°C...+55°C; >90% rH
Vibration	10-500 Hz; 2 hours/axis; 5g
Shock	30g/11ms (half sine); 3 Shock/axis; no function
Metallographic investigations	IPC-QE-650

**Note:** This specification is preliminary and yet subject to confirmation.

**Table 10: Environmental Specification**

## 6 Product Lineup

### 6.1 Default Settings

Interface	Settings
Serial Port 1 Output	<p>9600 Baud, 8 bits, no parity bit, 1 stop bit</p> <p>Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up:</p> <p><b>GGA, GLL, GSA, GSV, RMC, VTG, ZDA, TXT</b></p> <p>Additional messages can be activated with appropriate input messages.</p>
Serial Port 1 Input	<p>9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled</p> <p>Automatically accepts following protocols without need of explicit configuration:</p> <p><b>UBX, NMEA, RTCM</b></p> <p>The GPS receiver supports interleaved UBX and NMEA messages.</p>
Serial Port 2 Output	<p>57600 Baud, 8 bits, no parity bit, 1 stop bit</p> <p>Configured to transmit both NMEA and UBX protocols, but only following UBX and no NMEA messages have been activated at start-up:</p> <p><b>NAV-POSLH, NAV-SOL, NAV-SVINFO, NAV-STATUS</b>            MON-IO, MON-SCHD, MON-TXBUF,            INF-Warning, INF-Error, INF-Notice</p> <p>Additional messages can be activated with appropriate input messages.</p>
Serial Port 2 Input	<p>57600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled</p> <p>Automatically accepts following protocols without need of explicit configuration:</p> <p><b>UBX, NMEA, RTCM</b></p> <p>The GPS receiver supports interleaved UBX and NMEA messages.</p>

Table 11: Available Protocols

### 6.2 Ordering Information

Ordering No.	Product
SAM-LS-0-000-0	<p>SAM-LS GPS Smart Antenna Module</p> <p><u>Delivery Packing</u></p> <p><b>0</b> = Single samples  <b>2</b> = Packing unit (200 pieces)</p>
SAB-ST-0-000-0	Accessory: SAM Adapter Board with Flat Flex Cable for easy interfacing

Table 12: Ordering Information

Parts of this product are patent protected.

## Related Documents

- [1] ANTARIS TIM-Lx GPS Modules, System Integration Manual, Docu. No GPS.G3-MS3-01001
- [2] ANTARIS GPS Technology - Protocol Specification, Docu. No GPS.G3-X-03002
- [3] SAB - Smart Antenna Adapter Board, Product Summary and Specification, Docu. No. GPS-X-04005

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

## Contact

For further info, please contact us:

### Headquarters

#### u-blox AG

Zuercherstrasse 68  
CH-8800 Thalwil  
Switzerland

Phone: +41 44 722 74 44  
Fax: +41 44 722 74 47  
E-mail: [info@u-blox.com](mailto:info@u-blox.com)

[www.u-blox.com](http://www.u-blox.com)

### Sales Offices

#### North, Central and South America

##### u-blox America, Inc.

13800 Coppermine Road  
Herndon, VA 20171  
USA

Phone: +1 (703) 234 5290  
Fax: +1 (703) 234 5770  
E-mail: [info\\_us@u-blox.com](mailto:info_us@u-blox.com)

##### Regional Office West Coast:

8600 Lemon Ave #1  
La Mesa, CA 91941  
USA

Phone: +1 (619) 741 3011  
Fax: +1 (619) 741 4334  
E-mail: [info\\_us@u-blox.com](mailto:info_us@u-blox.com)

##### Technical Support:

Phone: +1 (703) 234 5290  
E-mail: [support\\_us@u-blox.com](mailto:support_us@u-blox.com)

#### Europe, Middle East, Africa

##### u-blox AG

Zuercherstrasse 68  
CH-8800 Thalwil  
Switzerland

Phone: +41 44 722 74 77  
Fax: +41 44 722 74 47  
E-mail: [info@u-blox.com](mailto:info@u-blox.com)

##### Technical Support:

Phone: +41 44 722 74 74  
E-mail: [support@u-blox.com](mailto:support@u-blox.com)

#### Asia, Australia, Pacific

##### u-blox Asia Pacific Ltd.

435 Orchard Road  
#19-02, Wisma Atria,  
Singapore 238877

Phone: +65 6734 3811  
Fax: +65 6736 1533  
E-mail: [info\\_ap@u-blox.com](mailto:info_ap@u-blox.com)

##### Technical Support:

Phone: +852 3111 1913  
E-mail: [support\\_ap@u-blox.com](mailto:support_ap@u-blox.com)