

# LEA-4S ANTARIS<sup>®</sup> 4 ROM-Based GPS Module with SuperSense<sup>®</sup>

Data Sheet

PRELIMINARY



## Abstract

Technical description of the low-cost SuperSense ANTARIS 4 GPS Module with USB interface, integrated in the 17 x 22.4 mm housing, and for use with passive and active antennas.

<b>Title</b>	LEA-4S		
<b>Subtitle</b>	ANTARIS® 4 ROM-Based GPS Module with SuperSense®		
<b>Doc Type</b>	Data Sheet	PRELIMINARY	
<b>Doc Id</b>	GPS.G4-MS4-05072-P1		
<b>Revision Index</b>	<b>Date</b>	<b>Name</b>	<b>Status / Comments</b>
P1	11. May 2006	GzB	Preliminary release

We reserve all rights in this document and in the information contained therein. Reproduction, use or disclosure to third parties without express authority is strictly forbidden.

For most recent documents, please visit [www.u-blox.com](http://www.u-blox.com)

<b>Data Sheet Revisions</b>	<b>Identification of applicable hardware</b>	<b>Comments</b>
P1	All data codes	

	<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>
---	---

Semiconductor technology provided by ATMEL.

The specifications in this document are subject to change at u-blox's discretion. u-blox assumes no responsibility for any claims or damages arising out of the use of this document, or from the use of products and services mentioned in this document, including but not limited to claims or damages based on infringement of patents, copyrights or other intellectual property rights. u-blox makes no warranties, either expressed or implied with respect to the information and specifications contained in this document. u-blox does not support any applications in connection with active weapon systems, ammunition, life support and commercial aircraft. Performance characteristics listed in this document are estimates only and do not constitute a warranty or guarantee of product performance.

The copying, distribution and utilization of this document as well as the communication of its contents to others without expressed authorization is prohibited. Offenders will be held liable for the payment of damages. All rights reserved, in particular the right to carry out patent, utility model and ornamental design registrations.

u-blox, the u-blox logo, the TIM type GPS module, Antaris, SuperSense, "your position is our focus", NavLox, u-center, AssistNow, FixNow and EKF are (registered) trademarks of u-blox AG. The u-blox software as well as the design of the LEA type modules is protected by intellectual property rights in Switzerland and abroad. Further information available at [info@u-blox.com](mailto:info@u-blox.com). Copyright © 2006, u-blox AG

# Contents

<b>1</b>	<b>Functional Description .....</b>	<b>4</b>
1.1	Overview .....	4
1.2	Block Diagram .....	4
1.3	Highlights .....	5
1.4	Features.....	5
1.5	Operating Modes.....	6
1.6	Protocols .....	6
1.7	Assisted GPS (A-GPS).....	6
1.8	Boot-Time GPSMODE Configuration.....	6
1.9	Antenna .....	7
<b>2</b>	<b>Performance Specification .....</b>	<b>8</b>
<b>3</b>	<b>Mechanical Specification .....</b>	<b>9</b>
3.1	Dimensions.....	9
3.2	Specification .....	9
3.3	Pin Assignment.....	10
<b>4</b>	<b>Electrical Specification .....</b>	<b>11</b>
4.1	Absolute Maximum Ratings .....	11
4.2	Operating Conditions .....	12
<b>5</b>	<b>Environmental Specification.....</b>	<b>13</b>
<b>6</b>	<b>Product Lineup .....</b>	<b>14</b>
6.1	Default Settings .....	14
6.2	Ordering Information.....	14

# 1 Functional Description

## 1.1 Overview

The LEA-4S module combines high sensitivity, exceptionally low power consumption and a USB port in a small module measuring just 17 x 22 mm. Its -158 dBm tracking sensitivity extends positioning coverage into places where GPS was not possible before and enables solutions using smaller or covert antennas. To reduce costs, the Flash EPROM has been replaced by an internal read-only memory (ROM) in the GPS Baseband chip from which SuperSense runs.

Its small form factor and SMT pads allow for fully automatic assembly processes with standard pick-and-place equipment and reflow soldering, enabling cost-efficient, high-volume production. This makes LEA-4S suitable for price sensitive mass-market end products where high sensitivity, lowest-possible power consumption and low costs are key requirements.

## 1.2 Block Diagram

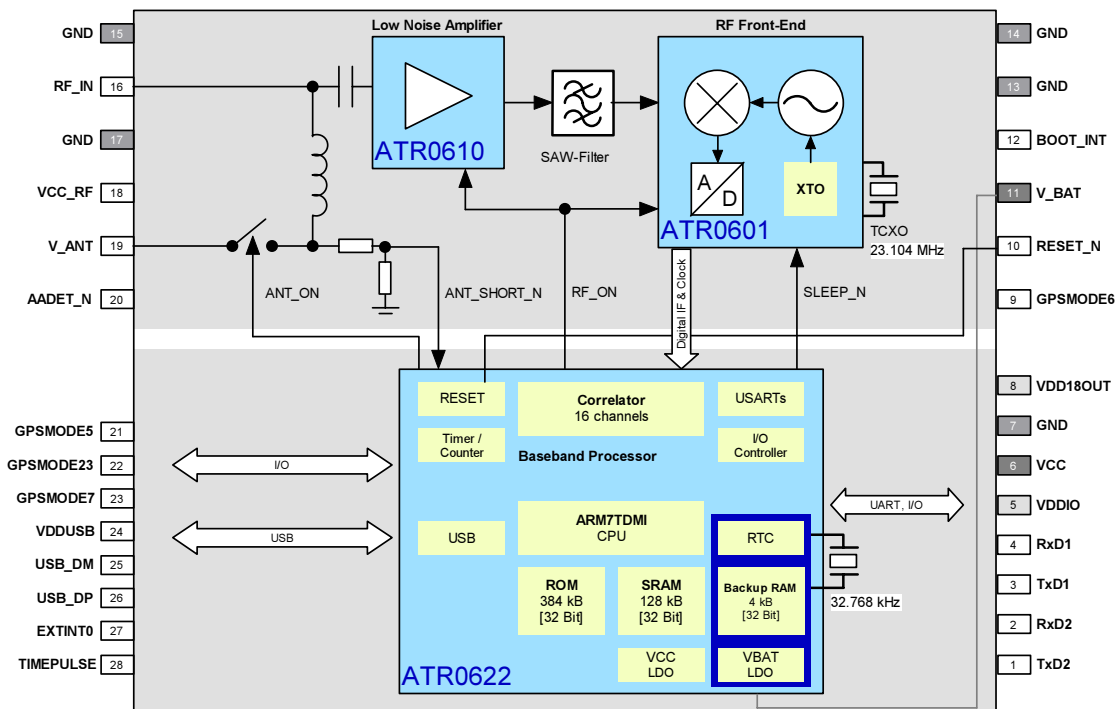


Figure 1: Block Diagram

## 1.3 Highlights

- **SuperSense Indoor GPS**
- **Cost-optimized architecture (No Flash EPROM)**
- **Ultra low power consumption**
- **A-GPS and Autonomous GPS operation, AssistNow™ ready**
- **4 Hz position update rate**
- **1 USB and 2 UART ports**

## 1.4 Features

- 16 channel ANTARIS 4 positioning engine
- Supports DGPS, WAAS, EGNOS and MSAS
- Power saving modes
- 5  $\mu$ A backup current
- 4 Boot time configuration pins
- Configurable I/O and UART voltage levels
- Supports passive and active antennas
- Antenna short and open circuit detection and protection
- Power brown-out protection: No external reset hardware needed
- Operating temperature range:  $-40$  to  $85^{\circ}\text{C}$
- RoHS compliant (lead-free)

## 1.5 Operating Modes

The ANTARIS 4 GPS Technology supports following Operating Modes:

Operating Modes	Description
<b>Continuous Tracking Mode (CTM)</b>	In this mode, the Autonomous Power Management (APM) automatically optimizes power consumption. It powers off parts of the receiver when they are not used. Also, the CPU speed is reduced when the CPU workload is low.
<b>Power Saving Modes</b>	A configurable power saving mode is available where the GPS is put into sleep mode and activated up on a selectable time interval or upon external request (signal activity on serial port or EXTINT input). This mode is ideally suited in applications with stringent power budget requirements in mobile and battery operated end products.

**Table 1: Operating Modes**

For more information see the *System Integration Manual for ANTARIS 4* [1].

## 1.6 Protocols

The LEA-4S supports different serial protocols.

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

**Table 2: Available Protocols**

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

## 1.7 Assisted GPS (A-GPS)

The ANTARIS 4 GPS engine supports both MS assisted (output of raw tracking information for position computation by the service provider) and MS based (accelerated acquisition and position computation in the GPS receiver) 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.

## 1.8 Boot-Time GPSMODE Configuration

The LEA-4S provides four GPSMODE pins for boot-time configuration. They become effective immediately after start-up. Once the LEA-4S has started, the configuration settings may 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 (with CFG-CFG message), then the modified configuration will be retained, as long backup battery supply is not interrupted.

GPSMODE	
<b>23</b>	<b>GPS sensitivity settings</b>
0	Auto mode
<b>1</b>	<b>High sensitivity mode</b>

GPSMODE	
<b>7</b>	<b>USB power settings</b>
0	Bus-Powered USB Interface
<b>1</b>	<b>Self-Powered USB Interface</b>

The other sensitivity settings can be enabled with configuration messages.

GPSMODE		Activated Message Set See Table 4	Serial Port 1 and USB		Serial Port 2	
6	5		Baud Rate	Protocol	Baud Rate	Protocol
0	0	High	19.2 Kbaud	NMEA	57.6 Kbaud	UBX
0	1	Low	4.8 Kbaud	NMEA	19.2 Kbaud	UBX
<b>1</b>	<b>0</b>	<b>Medium (default)</b>	<b>9.6 Kbaud</b>	<b>NMEA</b>	<b>38.4 Kbaud</b>	<b>UBX</b>
1	1	Reserved for factory use	115.2 Kbaud	UBX	19.2 Kbaud	NMEA

**Table 3: Supported GPSMODE settings (Default settings apply if not connected and are boldfaced)**

Protocol	Low	Medium (additional messages)	High (additional messages)
<b>UBX</b>	NAV-SOL NAV-SVINFO UBX-INF	+ NAV-POSECEF, NAV-POSLLH, NAV-STATUS, NAV-DOP, NAV-VELECEF, NAV-VELNED, NAV-TIMEGPS, NAV-TIMEUTC, NAV-CLOCK	+ MON-SCHD MON-IO MON-IPC
<b>NMEA</b>	GGA, RMC, TXT	+ GSA, GSV, GLL, VTG, ZDA	+ GRS, GST, PUBX00, PUBX03, PUBX04

**Table 4: Message Sets**

For more information see the *System Integration Manual for ANTARIS 4* [1].

## 1.9 Antenna

This GPS receiver is designed for use with passive and active antennas. An antenna supervisor is provided. If activated, the GPS receiver is capable of detecting short circuits to the active antenna by checking the bias voltage level and can shut down the voltage bias immediately. A series resistor is needed in front of the **V\_ANT** input. UBX and NMEA messages are provided to report the condition of the antenna supply. Open circuit detection can also be supported with an additional external circuit. For details, please refer to the *System Integration Manual for ANTARIS 4* [1].

Parameter	Specification	
Antenna Type	Passive and active antenna	
Active Antenna Recommendations	Minimum gain	15 - 20 dB (to compensate signal loss in RF cable)
	Maximum noise figure	1.5 dB
	Maximum gain	50 dB
Antenna Supply	Using <b>VCC_RF</b> or external voltage source	
Antenna Supervisor	Short circuit detection	Built-in
	Open circuit detection	Enabled with external circuit

**Table 5: Antenna Specification**

## 2 Performance Specification

Parameter	Specification				
Receiver Type	L1 frequency, C/A Code, 16-Channels 8192 time / frequency search windows				
Max Navigation Update Rate	4 Hz				
Accuracy	Position	2.5 m CEP <sup>2</sup>	5.0 m SEP <sup>3</sup>		
	Position DGPS / SBAS <sup>1</sup>	2.0 m CEP	3.0 m SEP		
Acquisition <sup>4,5</sup>	GPS Mode (UBX-CFG Msg):	Fast Acquisition Mode	Normal Mode	High Sensitivity Mode	Auto Mode
	Cold Start	34 s	36 s	41 s	34 s
	Warm Start	33 s			
	Hot Start	<3.5 s			
	Reacquisition	<1 s			
Sensitivity <sup>6</sup>	Tracking	-158 dBm			
	Acquisition & Reacquisition	-148 dBm			
	Cold Starts	-142dBm			
Accuracy of Timepulse Signal	RMS	50 ns			
	99%	<100 ns			
	Granularity	43 ns			
Dynamics	Strong signals	≤ 4 g			
	Weak signals	typ. 1 g			
Operational Limits (COCOM)	Altitude	18,000 m			
	Velocity	515 m/s			
	One of the limits may be exceeded but not both.				

**Table 6: Performance Specification**

<sup>1</sup> Depends on accuracy of correction data of DGPS or SBAS service

<sup>2</sup> CEP = Circular Error Probability: The radius of a horizontal circle, centered at the antenna's true position, containing 50% of the fixes.

<sup>3</sup> SEP = Spherical Error Probability. The radius of the sphere, centered at the true position, contains 50% of the fixes.

<sup>4</sup> The different start-up modes like cold, warm and hot start are described in the System Integration Manual [1]

<sup>5</sup> Measured with good visibility and -125 dBm signal strength

<sup>6</sup> Demonstrated with a good active antenna



## 3 Mechanical Specification

### 3.1 Dimensions

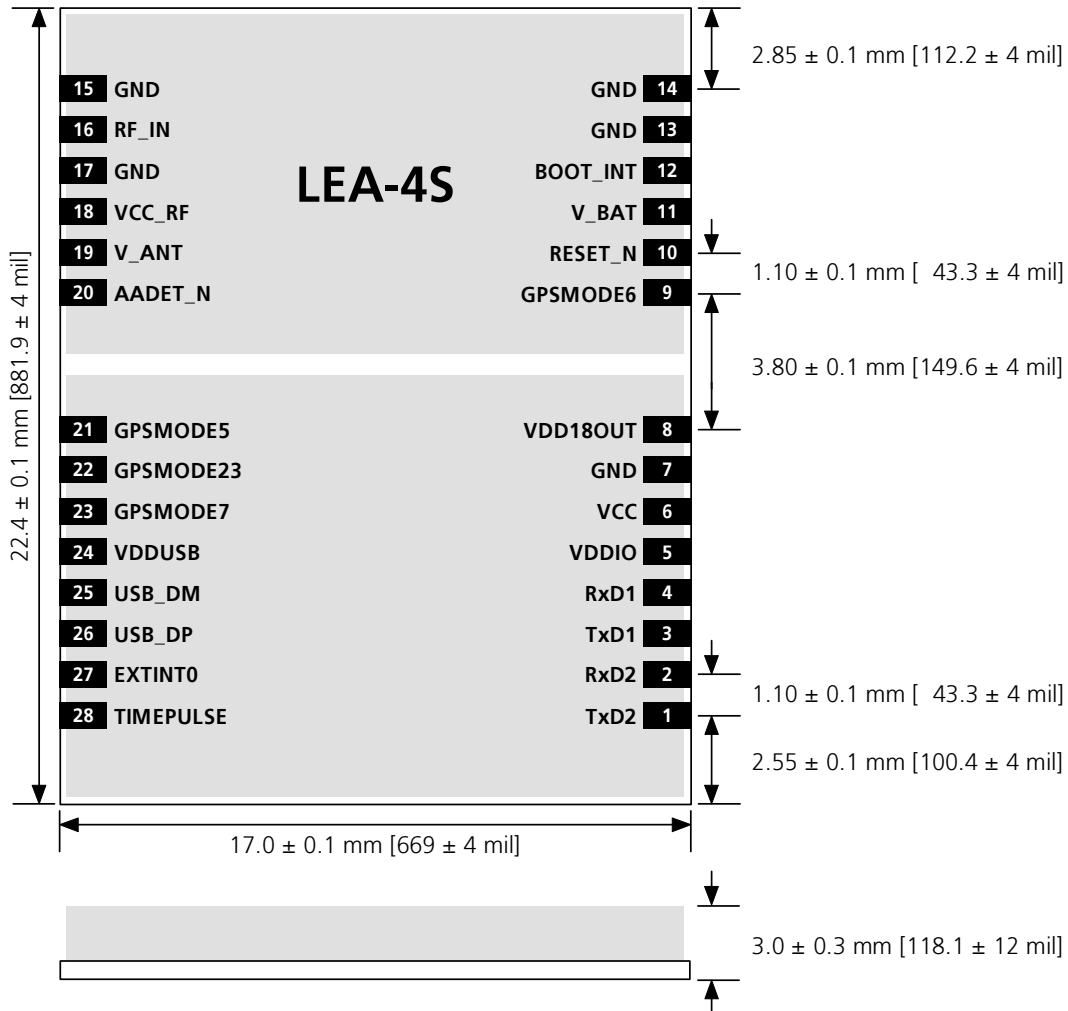


Figure 2: LEA-4S Dimensions

### 3.2 Specification

Parameter	Specification	Tolerance	Unit
Length	22.4	$\pm 0.1$	mm
Width	17.0	$\pm 0.1$	mm
Thickness	3.0	$\pm 0.3$	mm
Pitch RF pins	1.1	$\pm 0.1$	mm
Pitch Digital pins	1.1	$\pm 0.1$	mm
Weight	2.1		g

Table 7: Mechanical Specification

### 3.3 Pin Assignment

Standard Function				Remarks
No	Name	I/O	Description	
1	TxD2	O	Serial Port 2	
2	RxD2	I	Serial Port 2	Internal pull-up
3	TxD1	O	Serial Port 1	
4	RxD1	I	Serial Port 1	Internal pull-up
5	VDDIO	I	Pad voltage supply	
6	VCC	I	Supply voltage	
7	GND	I	Ground	
8	VDD18OUT	O	1.8V output	
9	GPSMODE6	I	Boot-time config. pin	Internal pull-up
10	RESET_N	I/O	Reset	Open drain, do not drive high
11	V_BAT	I	Backup voltage supply	
12	BOOT_INT	I	Boot mode	Default configuration: Input, internal pull-down
13	GND	I	Ground	
14	GND	I	Ground	
15	GND	I	Ground	
16	RF_IN	I	GPS signal input	Apply no DC through this pin
17	GND	I	Ground	
18	VCC_RF	O	Output Voltage RF section	
19	V_ANT	I	Antenna Bias voltage	
20	AADET_N	I	Active Antenna Detect	Default configuration: Input, internal pull-down
21	GPSMODE5	I	Boot-time config. pin	Internal pull-down
22	GPSMODE23	I	Boot-time config. pin	Internal pull-up
23	GPSMODE7	I	Boot-time config. pin	Internal pull-up
24	VDDUSB	I	USB Supply	
25	USB_DM	I/O	USB Data	
26	USB_DP	I/O	USB Data	
27	EXTINT0	I	External Interrupt Pin	Internal pull-up
28	TIMEPULSE	O	Time pulse (1PPS)	

**Table 8: Signals and Module Interface**

For more information see the *System Integration Manual for ANTARIS 4* [1].

## 4 Electrical Specification

### 4.1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
<b>Power Supply</b>				
Power supply voltage (VCC)	Vcc	-0.3	3.6	V
I/O supply voltage (VDDIO)	Vddio	-0.3	3.6	V
Backup battery voltage (V_BAT)	Vbat	-0.3	3.6	V
<b>Input Pins</b>				
Digital input pin voltage (except RESET_N, VDDUSB, USB_DP, USB_DM)	Vin	-0.3	5	V
Input pin voltage of RESET_N	Vin_reset	-0.3	1.95	V
Input pin voltage VDDUSB	Vin_usb	-0.3	3.6	V
Input pin voltage USB_DP, USB_DM	Vin_usbio	-1	4.6	V
<b>Voltage Supply output for Active Antenna and RF Section</b>				
VCC_RF output current	Iccrf		50	mA
<b>RF Input</b>				
Antenna bias voltage (applied via V_ANT)	Vant	0	6	V
Antenna bias current (applied via V_ANT)	Iant		100	mA
Input power at RF_IN (source impedance 50Ω, continuous wave)	Prfin		-5	dBm
<b>Environment</b>				
Storage temperature	Tstg	-40	125	°C

**Table 9: 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)	Vcc		2.7		3.3	V
I/O supply voltage (VDDIO)	Vddio		1.65		3.6	V
Power supply voltage ripple	Vcc_PP				50	mV
Sustained supply current <sup>8</sup>	Icc	Vcc = 3.0 V		38		mA
Peak supply current <sup>9</sup>	Iccp	Vcc = 3.3 V			70	mA
Sleep mode current	Iccs	Vcc = 3.0 V		80		µA
Backup battery voltage	Vbat		1.5		3.6	V
Backup battery current	Ibat	Vbat = 3.3V		5		µA
1.8V output voltage (VDD18OUT pin)	Vdd18out		1.65	1.8	1.95	V
1.8V output current (VDD18OUT pin)	Idd18out				30	mA
<b>UART and all I/O Signals<sup>10</sup></b>						
Input pin voltage range	Vin		0		5	V
Input pin low voltage	Vin_low				0.41	V
Input pin high voltage	Vin_high		1.46			V
Output pin voltage range	Vout		0		VDDIO	V
Output pin low voltage	Vout_low	Iout = 0.3 mA			0.1	V
Output pin high voltage	Vout_high	Iout = 0.3 mA	VDDIO-0.1			V
<b>USB</b>						
VDDUSB (Pin 24) for USB operation	Vddusb1		3.0		3.6	V
VDDUSB (Pin 24) if USB not used (low)	Vddusb0		0		2	V
USB_DM, USB_DP	VinU	Compatible with USB with 27 Ohms series resistance				
<b>RESET_N Input (Open-Drain I/O)</b>						
Input and output pin voltage range	VinR		0		VDD18OUT	V
Input pin low voltage	Vin_lowR				0.46	V
Input pin high voltage	Vin_highR		1.3			V
Output pin low voltage	Vout_lowR	Iout = 0.3 mA			0.1	V
Output pin high voltage	Vout_highR	Iout = 0.1 mA	VDD18OUT -0.2			V
<b>RF input</b>						
Antenna gain	Gant				50	dB
V_ANT antenna bias voltage (must connect to ground if not used)	Vant		2		6	V
Antenna bias voltage drop	Vant_drop	Iant=10mA		20	50	mV
VCC_RF voltage	Vccrf			Vcc - 0.1		V
VCC_RF output current	Iccrf			20	50	mA
<b>Environment</b>						
Operating temperature	Topr		-40		85	°C

**Table 10: Operating Conditions**

Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.

<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 9 channels for tracking and navigation and 3 channels for searching satellites (= acquisition). 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.

<sup>10</sup> RxD1, RxD2 and EXTINT0 provide internal pull-up to V\_BAT18 (Battery supply regulated to 1.8V) and not VCC.

## 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	IEC 68-2-14
Function at various temperatures	-40°C/2 hours; RT/2 hours; +85°C/2 hours; function tests at stable temperature	IEC 68-2-1 and IEC 68-2-2
Lifespan test	+85°C/1000 hours, in function	IEC 68-2-2
Damp heat, cyclic	+25°C...+55°C; >90% rH	IEC 68-2-30
Vibration	10-500 Hz; 2 hours/axis; 5g	IEC 68-2-6
Shock	30g/11ms (half sine); 3 Shock/axis; no function	IEC 68-2-27
Metallographic investigations		IPC-QE-650

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

**Table 11: Environmental Specification**

## 6 Product Lineup

### 6.1 Default Settings

Following default settings apply if GPSPIN5 = '0' and GPSPIN6 = '1' (applicable if these GPSPIN pins are left open). Please refer to the *System Integration Manual for ANTARIS 4* [1] for information about further 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: <b>GGA, GLL, GSA, GSV, RMC, VTG, ZDA, TXT</b> Additional messages can be activated with appropriate input messages or with GPSPIN pins.
Serial Port 1 Input	9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled Automatically accepts following protocols without need of explicit configuration: <b>UBX, NMEA, RTCM</b> The GPS receiver supports interleaved UBX and NMEA messages.
USB Output	Same protocol and message set as via Serial Port 1
USB Input	Same protocol and message set as via Serial Port 1
TIMEPULSE	1 pulse per second, synchronized at rising edge, pulse length 100ms

**Table 12: Available Protocols**

### 6.2 Ordering Information

Ordering No.	Product
LEA-4S-0-000-0	LEA-4S ROM-Based GPS Module with SuperSense <u>Delivery Packing</u> 0 = Single samples 1 = Tape on reel (100 pieces)

**Table 13: Ordering Information**

Parts of this product are patent protected.

## Related Documents

- [1] System Integration Manual for ANTARIS 4, Docu. No GPS.G4-MS4-05007
- [2] ANTARIS 4 Protocol Specification, Docu. No GPS.G3-X-03002

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)

##### Regional Office Korea:

1258 Ho, Shinhan MetroKhan  
#1115, BisanDong  
DongAn-Ku  
Anyang-si  
KyungKi-do, Korea

Phone: +82 11 1708 2584  
Fax: +65 6736 1533  
E-mail: [info\\_ap@u-blox.com](mailto:info_ap@u-blox.com)

##### Regional Office China:

Room 716-718  
No. 65 Fuxing Road  
Beijing, 100036, China

Phone: +86 1390 1163 970  
Fax: +65 6736 1533  
E-mail: [info\\_ap@u-blox.com](mailto:info_ap@u-blox.com)

##### Technical Support:

Phone: +65 6734 3811  
E-mail: [support\\_ap@u-blox.com](mailto:support_ap@u-blox.com)