LEA-6
u-blox 6 GPS Modules
Data Sheet

Abstract

Technical data sheet describing the cost effective, high-performance u-blox 6 based LEA-6 series of GPS modules, that bring the high performance of the u-blox 6 position engine to the industry standard LEA form factor.

These versatile, stand-alone receivers combine an extensive array of features with flexible connectivity options. Their ease of integration results in fast times-to-market for a wide range of automotive, consumer and industrial applications with strict size and cost requirements.

17.0 x 22.4 x 2.4mm

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Document Information

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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
LEA-6H	LEA-6H-0-000	FW6.02	N/A
LEA-6S	LEA-6S-0-000	ROM6.02	N/A
LEA-6A	LEA-6A-0-000	ROM6.02	N/A
LEA-6R	LEA-6R-0-000	FW DR 1.0	N/A
LEA-6T	LEA-6T-0-000	ROM6.02	N/A

Contents

1 Functional description

1.1 Overview

The LEA-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These versatile receivers feature an extensive and flexible range of functionality, connectivity and cost savings options. LEA-6 modules maintain the industry standard 17.0 x 22.4mm form factor of the LEA-5 series and have been designed to allow simple migration. Their ease of integration results in reduced costs and short time to market for a wide range of automotive, consumer and industrial applications.

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 LEA-6 GPS receivers excellent navigation performance even in the most challenging environments.

1.2 Product features

Model	Type				Supply		Interfaces				Features						
	Standalone GPS	Capture & Process	Timing & Raw Data	Dead Reckoning	1.75 - 2.0 V	2.7 - 3.6 V	UART	USB	SPI	DDC (I²C compliant)	Programmable (Flash) FW update	TCXO (KickStart)	RTC Crystal	Antenna supply and supervisor	Configuration pins	Timepulse	External interrupt / Wakeup
LEA-6H	•					•	•	•		•	•	•	•	•		1	•
LEA-6S	•					•	•	•		•		•	•	•	1	1	•
LEA-6A	•					•	•	•		•			•	•	1	1	•
LEA-6R	•			•		•	•	•	S		•		•	•		1	•
LEA-6T	•	•				•	•	•		•	F	•	•	•		2	•

F = Serial Flash memory available for storage of configuration, S = SPI available for communication with external sensors only

Table 1: Features of the LEA-6 Series

☞ All LEA-6 modules are based on AEC-Q100 qualified GPS chips. See Chapter 5.1 for further information.

1.3 GPS performance

Parameter	Specification			
Receiver type	50 Channels GPS L1 frequency, C/A Code GALILEO Open Service capable[1] SBAS: WAAS, EGNOS, MSAS, GAGAN			
Time-To-First-Fix[2]		LEA-6H/ LEA-6S/ LEA-6T	LEA-6A/ LEA-6R	
	Cold Start (Autonomous)	29 s	32 s	
	Warm Start (Autonomous)	29 s	32 s	
	Hot Start (Autonomous)	<1 s	<1 s	
	Aided Starts[3]	<1 s	<3 s	
Sensitivity[4]		LEA-6H/ LEA-6S/ LEA-6T	LEA-6A/ LEA-6R	
	Tracking & Navigation	-160 dBm	-160 dBm	
	Reacquisition	-160 dBm	-160 dBm	
	Cold Start (Autonomous)	-147 dBm	-146 dBm	
Max. Navigation update rate		LEA-6A/ LEA-6S/ LEA-6T	LEA-6H	LEA-6R
		5 Hz	2 Hz	1 Hz
Horizontal position accuracy[5]	Autonomous	2.5 m		
	SBAS	2.0 m		
Configurable Timepulse frequency range		LEA-6H/ LEA-6S/ LEA-6A/ LEA-6R	LEA-6T	
		0.1 Hz to 1 kHz	1/60 Hz to 10 MHz	
Accuracy for Timepulse signal for LEA-6T[6]	RMS	30 ns		
	99%	<60 ns		
	Compensated[7]	15 ns		
Velocity accuracy		0.1 m/s		
Heading accuracy		0.5 degrees		
Operational Limits	Dynamics	≤ 4 g		
	Altitude[8]	50,000 m		
	Velocity[8]	500 m/s		

Table 2: LEA-6 GPS performance

[1] Via FW update on LEA-6H
[2] All satellites at -130 dBm
[3] Dependant on aiding data connection speed and latency
[4] Demonstrated with a good active antenna
[5] CEP, 50%, 24 hours static, -130 dBm, SEP: < 3.5 m
[6] Under good GPS signal conditions
[7] Quantization error information can be used to compensate the granularity related error of the timepulse signal
[8] Assuming Airborne < 4g platform

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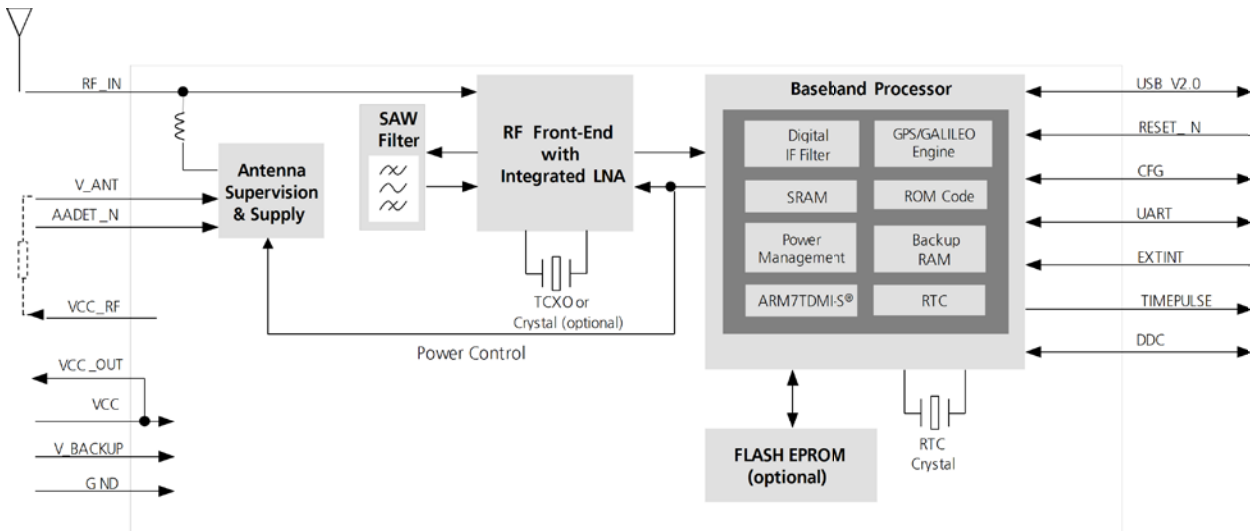
Figure 1 Block diagram (For available options refer to the product features table in section 1.2.)

1.5 Assisted GPS (A-GPS)

Supply of aiding information like ephemeris, almanac, approximate previous position and time, satellite status and an optional time synchronization signal will reduce time to first fix significantly and improve the acquisition sensitivity. All LEA-6 modules support the u-blox AssistNow Online and AssistNow Offline A-GPS services[9] and are OMA SUPL compliant.

1.6 SuperSense Indoor GPS

All LEA-6 modules come with SuperSense, providing improved acquisition/reacquisition and tracking sensitivity. SuperSense enables high performance tracking and navigation even in difficult signal environments such as urban canyons or indoor locations.

1.7 KickStart / Oscillators

An available feature is KickStart. This functionality uses a TCXO to accelerate weak signal acquisition, enabling faster start and reacquisition times. KickStart is available with the LEA-6H, LEA-6S and LEA-6T.

1.8 GALILEO

When GALILEO-L1 signals become available, LEA-6H receivers will be capable of receiving and processing them via a firmware upgrade. The ability to receive and track GALILEO satellite signals will result in higher coverage, improved reliability and better accuracy.

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[9] Requires external memory

1.9 Protocols and interfaces

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

Table 3: Available protocols

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

LEA-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.

1.9.1 UART

LEA-6 modules include one configurable UART interface for serial communication (for information about configuration see section 1.12).

1.9.2 USB

LEA-6 modules provide a USB version 2.0 FS (Full Speed, 12Mbit/s) interface as an alternative to the UART. The pull-up resistor on USB_DP is integrated to signal a full-speed device to the host. The VDDUSB pin supplies the USB interface.

u-blox provides a Microsoft® certified USB driver for Windows XP, Windows Vista and Windows 7 operating systems.

Operating System	Support level
Windows XP	Certified
Windows Vista	Certified
Windows 7	Certified

Table 4: Operating systems supported by USB driver

1.9.3 SPI (LEA-6R)

LEA-6R includes a Serial Peripheral Interface (SPI) for connecting external sensors. The interface can be operated in SPI master mode only. Two chip select signals are available to select external slaves.

LEA-6R default SPI clock is 870 kHz. As LEA-4R default value is 460 kHz, migrating from LEA-4R to LEA-6R will require a bandwidth verification of the SPI circuits.

1.9.4 Display Data Channel (DDC)

The I²C compatible DDC interface can be used either to access external devices with a serial interface or to interface with a host CPU. It is capable of master and slave operation. DDC is not available with LEA-6R. The DDC interface is I²C Standard Mode compliant. For timing parameters consult the I²C standard.

The DDC Interface is compatible with LEON DDC from version LEON-G100-05S/ LEON-G200-05S and above

☞ The maximum bandwidth is 100kbit/s.

1.9.4.1 External serial EEPROM

LEA-6A and LEA-6S modules allow an optional external serial EEPROM to be connected to the DDC interface. This can be used to store Configurations permanently.

☞ For more information see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

1.10 Antenna

LEA-6 modules are designed for use with passive and active antennas.

An antenna supervisor is available with all LEA-6 Modules. In the default operation mode the antenna supervisor is activated and enables the receiver to detect short circuits at 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 *LEA-6/NEO-6 Hardware Integration Manual* [1].

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 5: Antenna specifications

1.11 Power management

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

1.11.1 Operating modes

LEA-6 modules have two continuous operating modes (Maximum Performance and Eco Mode) and one intermittent operating mode (Power Save Mode). Maximum Performance mode freely uses the acquisition engine, resulting in the best possible TTFF, while Eco mode optimizes the use of the acquisition engine to deliver lower current consumption. At medium to strong signals, there is almost no difference for acquisition and tracking performance in these modes.

1.11.2 Maximum Performance mode

In Maximum Performance mode, u-blox 6 receivers use the acquisition engine at full performance to search for all possible satellites until the Almanac is completely downloaded.

As a consequence, tracking current consumption level will be achieved when:

- A valid GPS position is fixed
- Almanac is entirely downloaded
- Ephemeris for all satellites in view are valid

1.11.3 Eco mode

In Eco mode, u-blox 6 receivers use the acquisition engine to search for new satellites *only when needed* for navigation:

- In cold starts, u-blox 6 searches for enough satellites to navigate and optimizes use of the acquisition engine to download their ephemeris.
- In non-cold starts, u-blox 6 focuses on searching for visible satellites whose orbits are known from the Almanac.

In Eco mode, the u-blox 6 acquisition engine limits use of its searching resources to minimize power consumption. As a consequence the time to find some satellites at weakest signal level might be slightly increased in comparison to the Max. Performance mode.

u-blox 6 deactivates the acquisition engine as soon as a position is fixed and a sufficient number (at least 4) of satellites are being tracked. The tracking engine continues to search and track new satellites without orbit information.

Eco mode is not supported by LEA-6R.

1.11.4 Power Save mode

LEA-6 modules include intelligent power management that allows reducing the average tracking current consumption by periodically switching off parts of or the complete GPS receiver and waking it up at configurable intervals from one second to one week. This can be done by using a hardware interrupt or by sending a serial command.

Power Save mode is not available with LEA-6R.

1.12 Configuration

1.12.1 Boot-time configuration (LEA-6A, LEA-6S)

LEA-6A and LEA-6S modules provide **CFG_COM1** for boot-time configuration. This pin becomes effective immediately after start-up. Once the module has started, the 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.

UART settings can be can be configured as seen in Table 6 with the **CFG_COM1** pin. Default settings in bold.

CFG_COM1	Protocol	Messages	UARTBaud rate
1	**NMEA**	**GSV, RMC, GSA, GGA, GLL, VTG, TXT**	**9600**
0	NMEA	GSV[10], RMC, GSA, GGA, VTG, TXT	4800

Table 6: Supported CFG_COM1 settings (LEA-6A, LEA-6S)

1.12.2 Configuration (LEA-6H, LEA-6R, LEA-6T)

With the LEA-6H, LEA-6R and LEA-6T, configuration settings modified with UBX configuration messages can be saved permanently. In this case the modified settings remain effective even after power-down and don't require backup battery supply.

Saving full configurations might take several seconds to store on LEA-6T. Do not power down the Module before receiving the acknowledge.

For more information, see the *u-blox 6 Receiver Description including Protocol Specification* [2].

1.13 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 Hardware Integration Manual* [1].

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[10] Every 5th fix.

1.14 Dead Reckoning (LEA-6R)

LEA-6R receivers supplement the GPS information with an incoming signal from a gyroscope (turn rate sensor) and odometer pulses to do dead reckoning navigation through periods of poor GPS reception. Depending on the quality of the available GPS signals, the LEA-6R uses an algorithm specially developed by u-blox in order to compute the next positions accurately by using an automatically weighted average of the GPS and sensor inputs. This provides precise navigation in locations with no or impaired GPS reception, for example in tunnels, indoor car parks and deep urban canyons.

The LEA-6R is a low power dead reckoning GPS receiver module. It is the ideal solution for high-volume applications requiring a cost-effective and tightly integrated product that provides a continuous and reliable position fix 100% of the time.

1.14.1 Supported peripheral components (LEA-6R)

The LEA-6R supports the following peripheral components:

A/D converters with SPI interface	digital temperature sensors with SPI interface
Linear Technology, LTC1860, 12-bit A/D converter	National Semiconductors, LM70, precision: 10 bits plus sign

Table 7: Supported peripheral components

Gyroscopes should at least meet the requirements listed below:

Parameter	Specification
Supply Voltage	5.0 V ± 0.25 V
Zero Point	2.5 V ± 0.4 V
Sensitivity	25 mV/°/s ± 5 mV/°/s
Dynamic Range	± 60°/s to ± 125°/s
Linearity	± 0.5% (Full scale)
Recommended operating temperature range	-40 to +85°C

Table 8: Required Specifications for Gyroscopes

Gyroscopes with a sensitivity of lower than 20 mV/°/s may work but the performance will be degraded. For this reason u-blox does not recommend using gyroscopes with a lower sensitivity.

For implementation details as well as a list of supported gyroscopes that u-blox is currently aware of, or for more information about Dead Reckoning and other special features of the LEA-6R refer to the *LEA-6R Integration Application Note* [3].

1.15 Precision Timing & Raw Data (LEA-6T)

1.15.1 Time mode

LEA-6T provides a special Time Mode to provide higher timing accuracy. The LEA-6T is designed for use with stationary antenna setups. The Time Mode features three different settings described in Table 9: Disabled, Survey-In and Fixed Mode. For optimal performance entering the position of the antenna (when known) is recommended as potential source of errors will be reduced

Time Mode Settings	Description
Disabled	Standard PVT operation
Survey-In	The GPS receiver computes the average position over an extended time period until a predefined maximum standard deviation has been reached. Afterwards the receiver will be automatically set to Fixed Mode and the timing features will be activated.
Fixed Mode	In this mode, a fixed 3D position and known standard deviation is assumed and the timing features are activated. Fixed Mode can either be activated directly by feeding pre-defined position coordinates (ECEF - Earth Center Earth Fixed format) or by performing a Survey-In. In Fixed mode, the timing errors in the TIMEPULSE signal which otherwise result from positioning errors are eliminated. Single-satellite operation is supported. For details, please refer to the *u-blox 6 Receiver Description including Protocol Specification [2]*.

Table 9: Time mode settings

1.15.2 Timepulse and frequency reference

LEA-6T not only features the new u-blox 6 engine with its extra acquisition sensitivity, it also comes with a 2nd time pulse output, which can be configured from 1/60 Hz up to 10 MHz. One time pulse can be used for time synchronization (i.e. 1 pulse per second), while the 2nd time pulse can be used as a reference frequency in the MHz range. This brings cost savings for LEA-6T customers since it is no longer necessary to generate an additional reference frequency with their circuitry.

1.15.3 Time mark

LEA-6T can be used for precise time measurements with sub-microsecond resolution using the external interrupt (EXTINT0). Rising and falling edges of these signals are time-stamped to the GPS or UTC time and counted. The Time Mark functionality can be enabled with the UBX-CFG-TM2 message

For details, please refer to the *u-blox 6 Receiver Description including Protocol Specification* [2].

1.15.4 Raw data

The LEA-6T supports raw data output at an update rate of 5 Hz. The UBX-RXM-RAW message includes carrier phase with half-cycle ambiguity resolved, code phase and Doppler measurements, which can be used in external applications that offer precision positioning, real-time kinematics (RTK) and attitude sensing.

2 Pin Definition

2.1 Pin assignment

Figure 2 LEA-6 Pin Assignement

	Module	Name	I/O	Description
1	LEA-6A, LEA-6S, LEA-6H, LEA-6T	SDA2	I/O	DDC Data
	LEA-6R	SPI_MOSI	O	SPI MOSI
2	LEA-6A, LEA-6S, LEA-6H, LEA-6T	SCL2	I/O	DDC Clock
	LEA-6R	SPI_MISO	I	SPI MISO
3	All	TxD1	O	Serial Port 1
4	All	RxD1	I	Serial Port 1
5	All	NC		Not Connected
6	All	VCC	I	Supply voltage
7	All	GND	I	Ground (digital)
8	All	VCC_OUT	O	Output voltage
9	LEA-6A, LEA-6S	CFG_COM1	I	Configuration Pin
	LEA-6H	NC		Not Connected
	LEA-6R	SPI_SCS2_N	O	SPI Chip Select 2
	LEA-6T	TIMEPULSE2	I	2nd Timepulse (1PPS)
10	All	RESET_N	I	External Reset
11	All	V_BCKP	I	Backup voltage supply
12	All	Reserved	I	Do not drive low
13	All	GND	I	Ground
14	All	GND	I	Ground
15	All	GND	I	Ground
16	All	RF_IN	I	GPS signal input
17	All	GND	I	Ground
18	All	VCC_RF	O	Output Voltage RF section
19	All	V_ANT	I	Antenna Bias voltage
20	All	AADET_N	I	Active Antenna Detect

	Module	Name	I/O	Description
21	LEA-6A, LEA-6S, LEA-6H, LEA-6T	Reserved		Not Connected
	LEA-6R	FWD	I	Direction indication (1 = forward)
22	LEA-6A, LEA-6S, LEA-6H, LEA-6T	Reserved		Not Connected
	LEA-6R	SPI_SCS1_N	O	SPI Chip Select 1
23	LEA-6A, LEA-6S, LEA-6H, LEA-6T	Reserved		Not Connected
	LEA-6R	SPI_SCK	O	SPI Clock
24	All	VDDUSB	I	USB Supply
25	All	USB_DM	I/O	USB Data
26	All	USB_DP	I/O	USB Data
27	LEA-6A, LEA-6S, LEA-6H, LEA-6T	EXTINT0	I	External Interrupt Pin
	LEA-6R	SPEED	I	Odometer Speedpulses
28	All	TIMEPULSE	O	Timepulse (1PPS)

Table 10: Pinout

☞ Pins designated Reserved should only be used with caution. For more information about Pinouts see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

3 Electrical specifications

3.1 Absolute maximum ratings

Parameter	Symbol	Condition	Min	Max	Units
Power supply voltage	VCC		-0.5	3.6	V
Backup battery voltage	V_BCKP		-0.5	3.6	V
USB supply voltage	VDDUSB		-0.5	3.6	V
Input pin voltage	Vin		-0.5	3.6	V
	Vin_usb		-0.5	VDDUSB	V
DC current trough any digital I/O pin (except supplies)	Ipin			10	mA
VCC_RF output current	ICC_RF			100	mA
Input power at RF_IN	Prfin	source impedance = 50 Ω, continuous wave		-5	dBm
Antenna bias voltage	V_ANT			6	V
Antenna bias current	I_ANT			100	mA
Storage temperature	Tstg		-40	85	°C

Table 11: Absolute maximum ratings

⚠ **GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. For more information see section 6.2.6.**

⚠ **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 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	All	2.7	3.0	3.6	V	
Supply voltage USB	VDDUSB	All	3.0	3.3	3.6	V	
Backup battery voltage	V_BCKP	All	1.4		3.6	V	
Backup battery current	I_BCKP	All		22		µA	V_BCKP = 1.8V, VCC = 0V
Input pin voltage range	Vin	All	0		VCC	V	
Digital IO Pin Low level input voltage	Vil	All	0		0.2*VCC	V	
Digital IO Pin High level input voltage	Vih	All	0.7*VCC		VCC	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 -0.4V			V	Ioh=4mA
USB_DM, USB_DP	VinU	All	Compatible with USB with 22 Ohms series resistance				
V_ANT antenna bias voltage	V_ANT	All	2.7		5.5	V	I_{ANT} < -50 mA
Antenna bias voltage drop	V_ANT_DROP	All		0.1		V	ICC_RF =50mA
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	LEA-6S/ LEA-6A/ LEA-6T/ LEA-6H		3.2		dB	
		LEA-6R		1.5		dB	
Operating temperature	Topr	All	-40		85	°C	

Table 12: Operating conditions

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

3.3 Indicative power requirements

Table 13 lists examples of the total system supply current for a possible application.

Parameter	Symbol	Module	Min	Typ	Max	Units	Condition
Peak supply current [11]	Iccp	All			67	mA	VCC = 3.6V
Average supply current [12]	Icc Acquisition	All		47[13]		mA	VCC = 3.0V
	Icc Tracking (Max Performance mode)	LEA-6H / LEA-6S / LEA-6T		40[14]		mA	VCC = 3.0V
		LEA-6A/ LEA-6R		39[14]		mA	VCC = 3.0V
	Icc Tracking (Eco mode)	LEA-6H / LEA-6S / LEA-6T		38[14]		mA	VCC = 3.0V
		LEA-6A/ LEA-6R		37[14]		mA	VCC = 3.0V
	Icc Tracking (Power Save Mode) Update rate: 1 s	LEA-6H / LEA-6S / LEA-6T		18[14]		mA	Vcc = 3.0V
		LEA-6A		17.5[14]		mA	VCC = 3.0V

Table 13: Indicative power requirements

☞ Values in Table 13 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.

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[11] Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.
[12] Use this figure to determine required battery capacity.
[13] FW 6.02, >8 SVs in view, CNo >40 dBHz, current average of 30 sec after cold start.
[14] FW 6.02, with strong signals, all orbits available. For Cold Starts typical 12 min after First Fix. For Hot Starts typical 15 sec after First Fix.
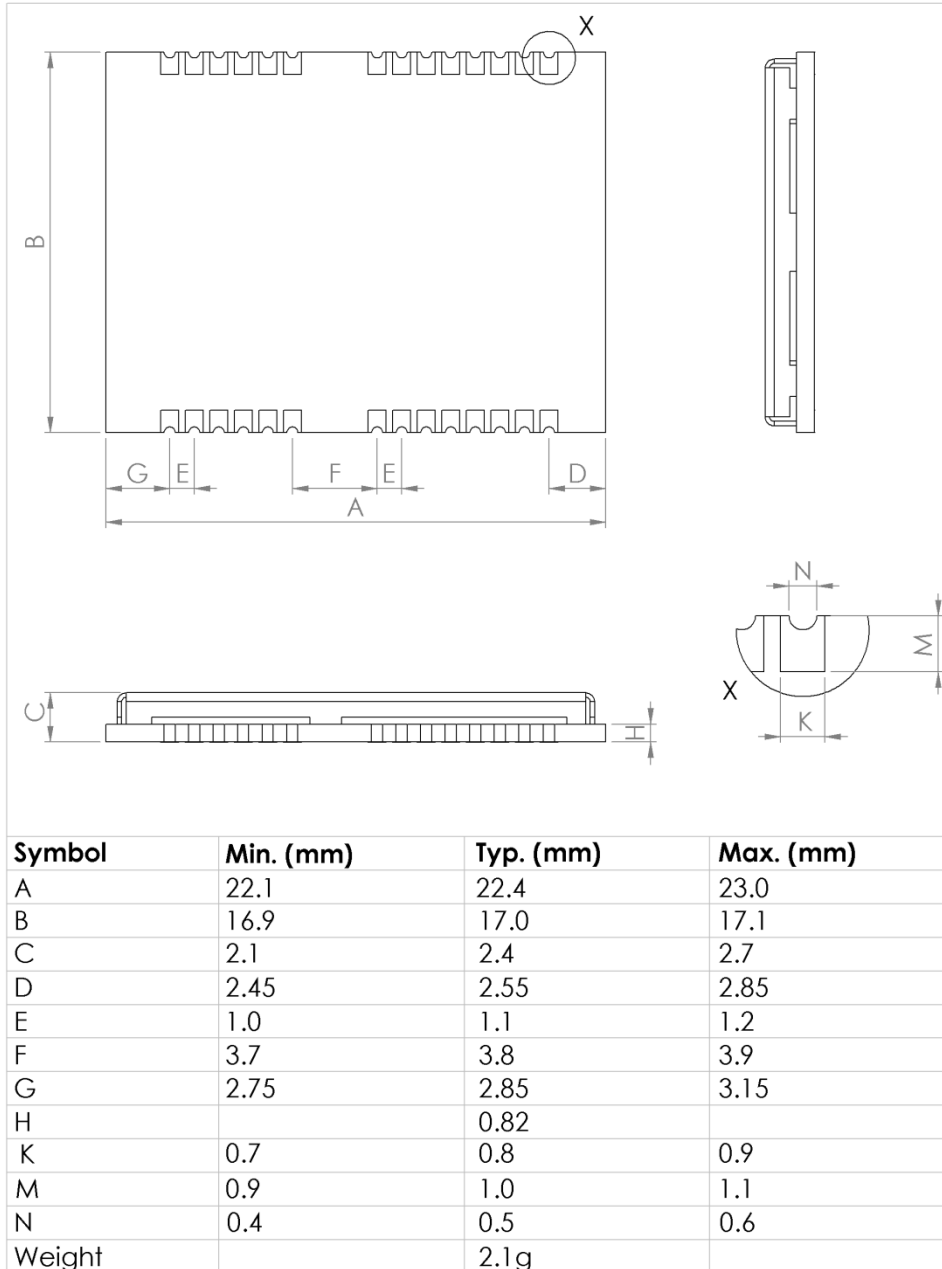
4 Mechanical specifications

Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	22.1	22.4	23.0
B	16.9	17.0	17.1
C	2.1	2.4	2.7
D	2.45	2.55	2.85
E	1.0	1.1	1.2
F	3.7	3.8	3.9
G	2.75	2.85	3.15
H		0.82	
K	0.7	0.8	0.9
M	0.9	1.0	1.1
N	0.4	0.5	0.6
Weight		2.1g	

Figure 3: Dimensions

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

5 Qualification and certification

5.1 Reliability tests

☞ All LEA-6 modules are based on AEC-Q100 qualified GPS chips.

Tests for product family qualifications according to ISO 16750 "Road vehicles - Environmental conditions and testing for electrical and electronic equipment", and appropriate standards (see Table 14).

Test	Reference	Test Conditions
Temperature step test	ISO16750-4 IEC60068-2-1 IEC60068-2-2	Function tests at stable temperature. The temperature has to decrease in 5K steps from RT to -40°C followed by increase to +85°C in 5K steps.
Temperature cycling	IEC60068-2-14 Na	-40°C / +125°C, 300 cycles, air to air No function
Dry heat I ("desert")	IEC60068-2-2	+60°C / 5%rH,Toper max, Vccmax, 1000 hours, in function
Damp heat II ("tropical")	IEC60068-2-3	+60°C/95%rH, Toper max, Vccmax, 1000 hours, in function
High Temp.Operating Life (Life span)	IEC60068-2-2	1000hrs @ 85°C Ta Toper max, Vccmax
Dry heat II	IEC60068-2-2	+125°C, 1000 hours, no function
Function test at Umin, Unom, Umax	ISO16750-4 IEC60068-2-1 IEC60068-2-2	Function test at Umin, Unom, Umax 1 hour / voltage level Test at -40°C, RT, +85°C
Damp heat cyclic	IEC60068-2-30 Db Variation 1	+25°C…+55°C; >90% rH 6 cycles of 24 hours
Vibration in function	IEC60068-2-6	5-500 Hz; 5g; 2.5 hrs/axis at –40°C 2.5 hrs/axis at +85°C 3 hrs/axis at RT Total: 24 hours, function supervision
Mechanical Shock	IEC60068-2-27 Ea	30g/11ms (halfsine), 3 Shocks/axis, no function
Robustness of terminations of Surface Mounted Devices	IEC60068-2-21 Ue1	1mm/s +/- 0.5mm/s D>2mm 1 Bending cycle Duration on Dmax: 20s +/- 1s
ESD (HBM)	JESD22-A114 AEC-Q100-002	Voltage level: 2000V
ESD (MM)	JESD22-A115 AEC-Q100-003	Voltage level: 200V

Table 14: u-blox qualification requirements

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

LEA-6 modules are delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down.

Figure 4: Reeled u-blox modules

6.1.1 Reels

LEA-6 GPS modules are deliverable in quantities of 250pcs on a reel. The dimensions of the reel are shown in Figure 5.
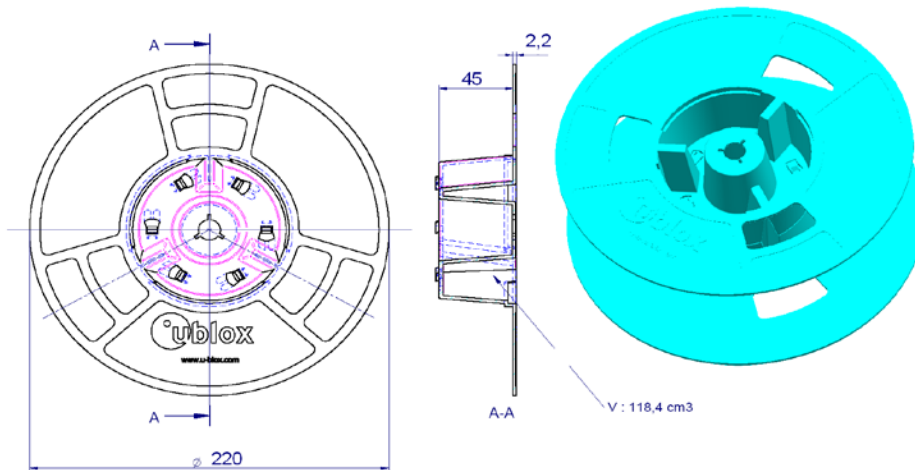

Figure 5: Dimension of reel for 250 pieces (dimensions unless otherwise specified in mm)

6.1.2 Tapes

The dimensions and orientations of the tapes for LEA-6 modules are specified in Figure 6.

17.6mm   4.00mm   Feed Direction

23.0mm

20.20 (±0.15)mm

40.40 (±0.10)mm

44.00 (±0.30)mm

24.0mm   Feed Direction

1 = orientation of Modules
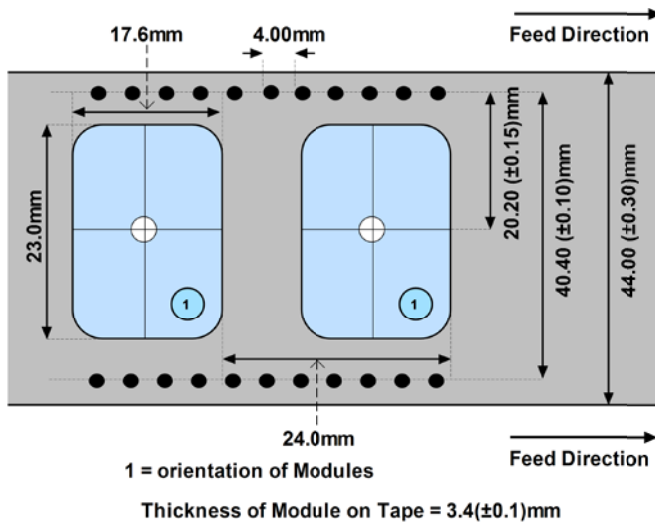
Thickness of Module on Tape = 3.4(±0.1)mm

Figure 6: Dimensions and orientation for LEA-6 modules on tape

6.2 Shipment, storage and handling

LEA 6 modules are designed and packaged to be processed in an automatic assembly line, and are shipped in Tape-and-Reel.

⚠ **LEA 6 modules are Moisture Sensitive Devices (MSD) in accordance to the IPC/JEDEC specification. Appropriate MSD handling instructions and precautions are summarized in Sections 6.2.1 to 6.2.3. Read them carefully to prevent permanent damage due to moisture intake.**

⚠ **GPS receivers contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling LEA 6 modules without proper ESD protection may destroy or damage them permanently. See Section 6.2.6 for ESD handling instructions.**

6.2.1 Moisture Sensitivity Levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. LEA 6 modules are rated at MSL level 4.

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

6.2.2 Shipment

Table 15 summarizes the dry pack requirements for different MSL levels in the IPC/JEDEC specification.

MSL Level	Dry Pack Requirement
1	Optional
2	Required
2a	Required
3	Required
4	Required

Table 15: JEDEC specification of dry pack requirements

According to IPC/JEDEC specification J-STD-020, if a device passes MSL level 1, it is classified as not moisture sensitive and does not require dry pack. If a device fails level 1 but passes a higher numerical level, it is classified as moisture sensitive and must be dry packed in accordance with J-STD-033.

LEA 6 modules are delivered on Tape-and-Reels in a hermetically sealed package ("dry bag") to prevent moisture intake and protect against electrostatic discharge. For protection from physical damage, the reels are individually packed in cartons.

Carrier materials such as trays, tubes, reels, etc., that are placed in the Moisture Barrier Bag (MBB) can affect the moisture level within the MBB. Therefore, the effect of these materials is compensated by adding additional desiccant in the MBB to ensure the shelf life of the SMD packages.

The dry bag provides an IPC/JEDEC compliant MSD label describing the handling requirements to prevent humidity intake. IPC/JEDEC specifications require that MSD sensitive devices be packaged together with a Humidity Indicator Card (HIC) and desiccant to absorb humidity. If no moisture has been absorbed, the three fields in the HIC indicate blue color. Figure 7 shows examples of an MSD label and HIC.
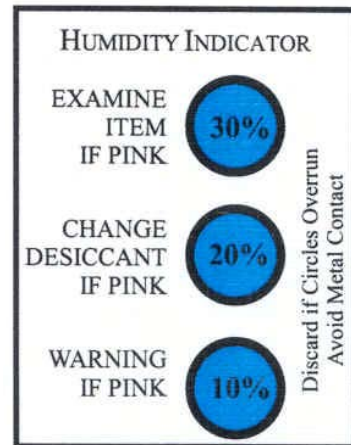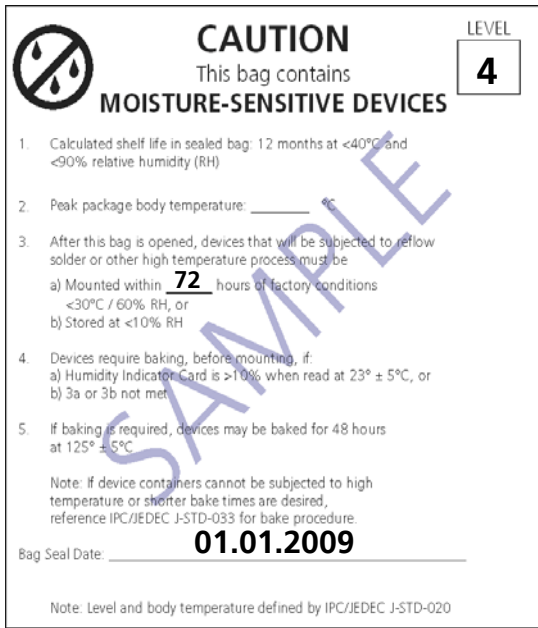

Figure 7: Examples of MSD label and Humidity Indicator Card

6.2.3 Storage and floor life

The calculated shelf life for dry packed SMD packages is a minimum of 12 months from the bag seal date, when stored in a noncondensing atmospheric environment of <40°C/90% RH.

Table 16 lists floor life for different MSL levels in the IPC/JDEC specification.

MSL level	Floor life (out of bag) at factory ambient ≤30°C/60% RH or as stated
1	Unlimited at ≤30°C/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours

Table 16: JEDEC specification of floor life

The parts must be processed and soldered within the time specified for the MSL level. If this time is exceeded, or the humidity indicator card in the sealed package indicates that they have been exposed to moisture, the devices need to be pre-baked before the reflow solder process.

6.2.4 Drying

Both encapsulant and substrate materials absorb moisture. IPC/JEDEC specification J-STD-020 must be observed to prevent cracking and delamination associated with the "popcorn" effect during reflow soldering. The popcorn effect can be described as miniature explosions of evaporating moisture. Baking before processing is required in the following cases:

- Humidity indicator card: At least one circular indicator is no longer blue
- Floor life or environmental requirements after opening the seal have been exceeded, e.g. exposure to excessive seasonal humidity.

Refer to Section 4 of IPC/JEDEC J-STD-033 for recommended baking procedures. Table 4-1 of the specification lists the required bake times and conditions for drying. For example, a module that has exceeded its floor life by >72 hours shall be baked at 125°C for 48 hours. (Floor life begins counting at time = 0 after bake).

⚠️ **Do not attempt to bake LEA modules while contained in tape and rolled up in reels. For baking, place parts individually onto oven tray.**

⚠️ **Oxidation Risk: Baking SMD packages may cause oxidation and/or intermetallic growth of the terminations, which if excessive can result in solderability problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solderability considerations. The cumulative bake time at a temperature greater than 90°C and up to 125°C shall not exceed 96 hours. If the bake temperature is not greater than 90°C, there is no limit on bake time. Bake temperatures higher than 125°C are not allowed.**

6.2.5 Reflow soldering

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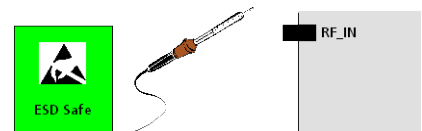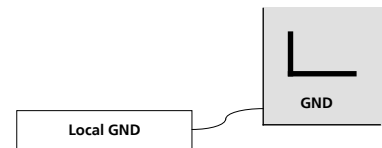
6.2.6 ESD handling precautions

⚠️ **LEA-6 modules 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 shall 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** (in addition to the 6 standard NMEA messages the LEA-6T includes **ZDA)**
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 (in addition to the 6 standard NMEA messages the LEA-6T includes **ZDA**)
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

Table 17: Available Protocols.

Refer to the *LEA-6/NEO-6 Hardware Integration Manual* [1] 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 8.

Figure 8: Location of product type number on u-blox 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 18 below details these 3 different formats:

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

Table 18: Product Code Formats

The parts of the product code are explained in Table 19.

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

Table 19: part identification code

8.3 Ordering information

Ordering No.	Product
LEA-6A-0	ROM-based u-blox 6 GPS Module, 17x22mm, 250 pcs/reel
LEA-6H-0	Progr. u-blox 6 GPS Module with TCXO, 17 x 22mm, 250 pcs/reel
LEA-6S-0	ROM-based u-blox 6 GPS Module with TCXO, 17x22mm, 250 pcs/reel
LEA-6R-0	u-blox 6 GPS Module w. Dead Reckoning, 17 x 22mm, 250 pcs/reel
LEA-6T-0	u-blox 6 GPS Module w. Precision Timing, 17 x 22mm, 250 pcs/reel

Table 20: 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 Hardware Integration Manual, Docu. GPS.G6-HW-09007

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

[3]	LEA-6R Integration Application Note, Docu. GPS.G6-HW-10028

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
	08/31/2009	tgri	Initial Release
1	09/21/2009	tgri	update of section 1.3 GPS performance, section 1.4 block diagram, section 3.2 peak supply current
A	5/02/2010	tgri	Change of status to Advance Information. Update of section 1.9.2, removed reference to Vddio – added USB driver certification. Update of section 3.2 table 11: average supply current & TTFF, section 5.1: addition of table 12.
B	4/23/2010	tgri	Inclusion of LEA-6R.
C	6/24/2010	dhur	Change of status to Preliminary. Update of section 1.3, 1.9.4, 1.12.2, 3.1, 3.2 and chapter 2 and 4. General clean-up and consistency check.

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