

LEA-5

u-blox 5 Modules for GPS and GALILEO

Data Sheet



Abstract

Technical data sheet describing the cost effective, high-performance u-blox 5 based LEA 5 series of GPS/GALILEO modules.

Features include A-GPS support, low power consumption, SuperSense® Indoor GPS providing best-in-class acquisition and tracking sensitivity, precision timing and an innovative jamming-resistant RF architecture. The compact 17.0 x 22.4 mm form factor of the highly successful LEA-4 series is maintained, enabling easy migration. The LEA 5 series supports passive and active antennas.

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P3	12/12/07	TG	Update of Configuration Messages, Features Table
P4	7/01/2008	TG	Update of Pin Diagram
P5	16/04/2008	TG	Addition of LEA-5Q, LEA-5M, LEA-5T, Current Consumption, Power Modes, Pin Table



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Data Sheet Revisions	Identification of applicable hardware	Comments
-	All data codes	

Data sheet status	
Objective Specification	This data sheet contains target or goal specification for product development.
Preliminary	This data sheet contains preliminary data, revised and supplementary data may be published later.
Released	This data sheet contains the final product specification.

	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).
	This is an Electrostatic Sensitive Device (ESD). Observe precautions for handling.

1 Functional Description

1.1 Overview

The LEA-5 module series by u-blox sets a new standard for GPS and GALILEO receiver modules. Featuring the high performance 50-channel u-blox 5 technology, these modules provide excellent performance and flexibility at an economical price. A 32-channel acquisition engine with over 1 million effective correlators is capable of massive parallel searches. This enables a Time To First Fix (TTFF) of less than 1 second, while long correlation/dwell times make possible the best-in-class acquisition and tracking sensitivity. An available functionality is KickStart, a new feature enabling accelerated acquisition of weak signals. Once acquired, satellites are passed on to a power-optimized dedicated tracking engine. This arrangement allows the GPS and GALILEO engine to simultaneously track up to 16 satellites while searching for new ones. u-blox 5's advanced jamming suppression mechanism and innovative RF architecture provide a high level of immunity to jamming, ensuring maximum GPS and GALILEO performance.

The LEA-5 series maintains the compact 17.0 x 22.4 mm form factor of the highly successful LEA-4 modules. The modules have been designed with backwards compatibility in mind, enabling ease of upgrade and reducing engineering and design costs. A USB port is available for faster data transmission and more flexibility. The optional FLASH EPROM provides capacity to store user-specific configuration settings and allows for future updates. LEA-5 modules are not designed for life saving or supporting devices or for aviation and should not be used in products that could in any way negatively impact the security or health of the user or third parties or that could cause damage to goods.

1.2 Highlights and Features

Highlights

- Time To First Fix (TTFF): < 1 sec
- Best-in-class acquisition and tracking sensitivity
- Receives GPS and GALILEO signals
- A-GPS: Supports u-blox AssistNow Online and Offline, OMA SUPL compliant
- High immunity to jamming
- UART serial port, USB, DDC (I²C® compatible)
- Precision Timing option

Features

	Voltage Range (V)	Thickness (mm)	50-channel engine	KickStart	SuperSense	FW Update / FLASH	Low Power Modes	UART	USB	SPI	DDC	AssistNow Online	AssistNow Offline	Dead Reckoning	Raw Data	Precision Timing	1PPS	CFG Pins	Reset Input	Antenna Supply	Antenna Supervisor
LEA-5H	2.7-3.6	3.0	✓	✓	✓	✓	P	1	1		1	✓	✓				✓		✓	✓	✓
LEA-5S	2.7-3.6	3.0	✓	✓	✓		P	1	P		1	✓	✓				✓	1	✓	✓	✓
LEA-5A	2.7-3.6	3.0	✓		✓		P	1	P		1	✓	✓				✓	1	✓	✓	✓
LEA-5Q	2.7-3.6	2.4	✓	✓	✓		P	1	1	1	1	✓	✓				✓	3	✓		
LEA-5M	2.7-3.6	2.4	✓		✓		P	1	1		1	✓	✓				✓	2	✓		
LEA-5T	2.7-3.6	3.0	✓	✓	✓	✓		1	1		1	✓	✓			✓	✓		✓	✓	✓

P= Planned availability Q1/09

Table 1: Features of the LEA-5 Series

1.3 GPS Performance

Parameter	Specification
Receiver Type	50 Channels GPS L1 frequency, C/A Code GALILEO Open Service L1 frequency
Time-To-First-Fix ¹	LEA-5H/ LEA-5S/ LEA-5T LEA-5A
	Cold Start (Autonomous) 29 s 32s
	Warm Start (Autonomous) 29 s 32s
	Hot Start (Autonomous) <1 s <1s
Aided Starts ² <1 s <3s	
Sensitivity ³	LEA-5H/ LEA-5S/ LEA-5T/ LEA-5Q LEA-5A/ LEA-5M
	Tracking & Navigation -160 dBm -160 dBm
	Reacquisition -160 dBm -160 dBm
Cold Start (Autonomous) -144 dBm -143 dBm	
Horizontal Position Accuracy ⁴	Autonomous < 2.5 m
	SBAS < 2.0 m
Accuracy of Timepulse Signal	RMS 30 ns
	99% <60 ns
	Compensated ⁵ (LEA-5T) 15 ns ³
Time Pulse	Configurable: 0.25 ... 1000 Hz
Max Navigation Update Rate	4 Hz
Velocity Accuracy ⁶	0.1m/s
Heading Accuracy ⁶	0.5 degrees
Dynamics	≤ 4 g
Operational Limits	Velocity 515 m/s (1000 knots)

Table 2: LEA-5 GPS Performance

¹ All satellites at -130 dB

² Dependent on aiding data connection speed and latency

³ Demonstrated with a good active antenna

⁴ CEP, 50%, 24 hours static, -130dBm

⁵ Quantization error information can be used to compensate the granularity related error of the time pulse signal.

⁶ 50% @ 30 m/s

1.4 Block Diagram

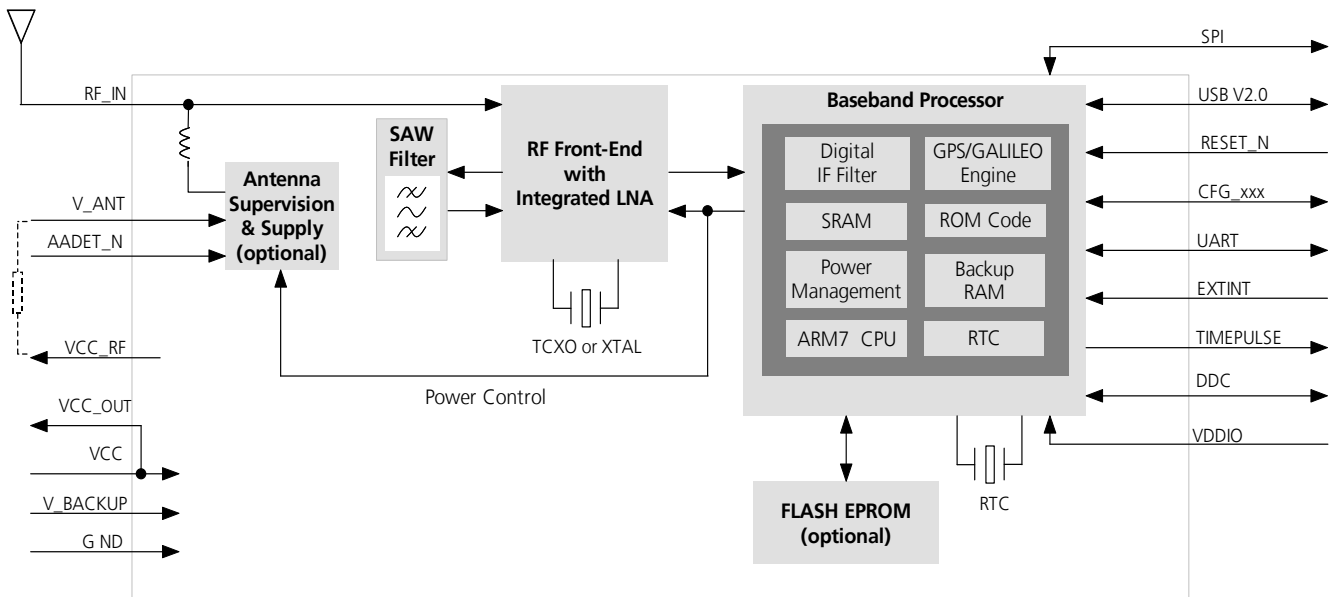


Figure 1: Hardware Block Schematic

1.5 Assisted GPS (A-GPS)

Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status and an optional time synchronization signal will reduce time to first fix significantly and improve the acquisition sensitivity. All LEA-5 modules support the u-blox AssistNow Online and AssistNow Offline A-GPS services and are OMA SUPL compliant.

1.6 SuperSense Indoor GPS

All u-blox 5 ICs come with SuperSense, providing ultra-fast acquisition/reacquisition and exceptional tracking sensitivity. SuperSense enables best-in-class tracking and navigation in difficult signal environments such as urban canyons or indoor locations.

1.7 KickStart

A new feature available with u-blox 5 receiver modules is KickStart. This functionality uses a TCXO to accelerate weak signal acquisition, enabling faster start and reacquisition times. KickStart is available with the LEA-5H, LEA-5S, and LEA-5T.

1.8 GALILEO

The u-blox 5 is a GNSS chip that receives and tracks GPS and GALILEO signals simultaneously, enhancing accuracy and coverage. When GALILEO-L1 signals become available, u-blox 5 receivers equipped with FLASH memory will be capable of receiving and processing them via a simple upgrade. The ability to receive and track GALILEO satellite signals will result in higher coverage, improved reliability and better accuracy.

1.9 Protocols

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, DDC and SPI. For specification of the various protocols see the *u-blox 5 Protocol Specification* [2].

1.10 Antenna

LEA-5 modules are designed for use with passive and active antennas.

An optional antenna supervisor is available with the LEA-5H, LEA-5S, LEA-5A and LEA-5T. In the default operation mode the antenna supervisor is activated and enables the receiver to detect 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 *LEA-5 Hardware Integration Manual* [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	30 dB

Table 4: Antenna Specifications for all LEA-5 Modules

Parameter	Specification	
Antenna Supply	Using VCC_RF or external voltage source	
Antenna Supervisor	Short circuit detection	Built-in
	Open circuit detection	Enabled with external circuit

Table 5: Antenna Supervisor Specifications for LEA-5H, LEA-5S, LEA-5A and LEA-5T

1.11 Configuration

1.11.1 Power Modes

u-blox 5 technology offers power optimized architecture with built-in autonomous power saving functions that minimize power consumption at any given time.

u-blox 5 can be operated in two different power modes: Maximum Performance and Eco Mode. In both cases, the receiver is operated in continuous mode. The difference lies in how the acquisition engine is used. Maximum Performance Mode freely uses the acquisition engine, resulting in the best possible TTFF at weak signals. With Eco Mode the use of the acquisition engine is optimized to deliver lower current consumption.

Low Power Modes are planned for Q1/09.

For more information, see the *u-blox 5 Protocol Specification [2]*.

1.11.2 Boot-Time Configuration (LEA-5A, LEA-5M, LEA-5Q, LEA-5S)

ROM-based modules provide up to 3 pins (**CFG_COM0**, **CFG_COM1**, **CFG_GPS0**) for boot-time configuration. These become 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.

LEA-5A and LEA-5S include only **CFG_COM1** and can be configured as seen in Table 6.

CFG_COM1	Protocol	Messages	UART Baud rate
1	NMEA	GSV, RMC, GSA, GGA, GLL, VTG, TXT	9600
0		GSV ⁷ , RMC, GSA, GGA, VTG, TXT	4800

Table 6: Supported CFG_COM1 settings (LEA-5A, LEA-5S)

LEA-5Q and LEA-5M include both **CFG_COM0** and **CFG_COM1** pins and can be configured as seen in Table 7.

CFG_COM1	CFG_COM0	Protocol	Messages	UART Baud rate	USB Power
1	1	NMEA	GSV, RMC, GSA, GGA, GLL, VTG, TXT	9600	BUS Powered ⁸
1	0			38400	Self Powered
0	1		GSV ⁷ , RMC, GSA, GGA, VTG, TXT	4800	BUS Powered ⁸
0	0	UBX	NAV-SOL, NAV-STATUS, NAV-SVINFORM, NAV-CLOCK, INF, MON-EXCEPT	57600	BUS Powered ⁸

Table 7: Supported COM settings (LEA-5Q, LEA-5M)

LEA-5Q includes a **CFG_GPS0** pin, which enables the boot-time configuration of the power mode. These settings are described in Table 9.

CFG_GPS0	Power Mode
0	Eco Mode
1	Maximum Performance Mode

Table 9: Supported CFG_GPS0 settings (LEA-5Q)



Static activation of the **CFG_COM** pins is not compatible with use of the SPI interface.

⁷ Every 5th fix.

⁸ Planned availability Q1/09

1.11.3 Configuration (LEA-5H, LEA-5T)

With the LEA-5H and LEA-5T, configuration settings modified with UBX configuration messages can be saved to the FLASH memory. In this case the modified settings remain effective even after power-down and don't require backup battery supply.

For more information, see the *u-blox5 Protocol Specification [2]*.

1.12 LEA-5T

1.12.1 Time Mode

LEA-5T provides a special Time Mode to provide higher timing accuracy. The LEA-5T is designed for use with stationary antenna setups. The Time Mode features three different settings described in Table 10: Disabled, Survey-In and Fixed Mode.

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 <i>u-blox5 Protocol Specification [2]</i> .

Table 10: Time Mode Settings

1.12.2 Time Mark

LEA-5T 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-blox5 Protocol Specification [2]*.

2 Mechanical Specifications

Parameter	Specification	
A	22.4 +0.6/-0.1mm	[882 +24/-4mil]
B	17.0 ±0.1mm	[669 ±4mil]
C	3.0 ⁹ /2.4 ¹⁰ ±0.3mm	[118 ⁹ /97 ¹⁰ ±12mil]
D	2.55 +0.3/-0.1mm	[100 +18/-4mil]
E	1.1 ±0.1mm	[43 ±4mil]
F	3.80 ±0.1mm	[150 ±4mil]
G	1.10 ±0.1mm	[75 ±4mil]
H	2.85 +0.3/-0.01mm	[112 +18/-4mil]
Weight	2.1 g	

Table 11: Dimensions

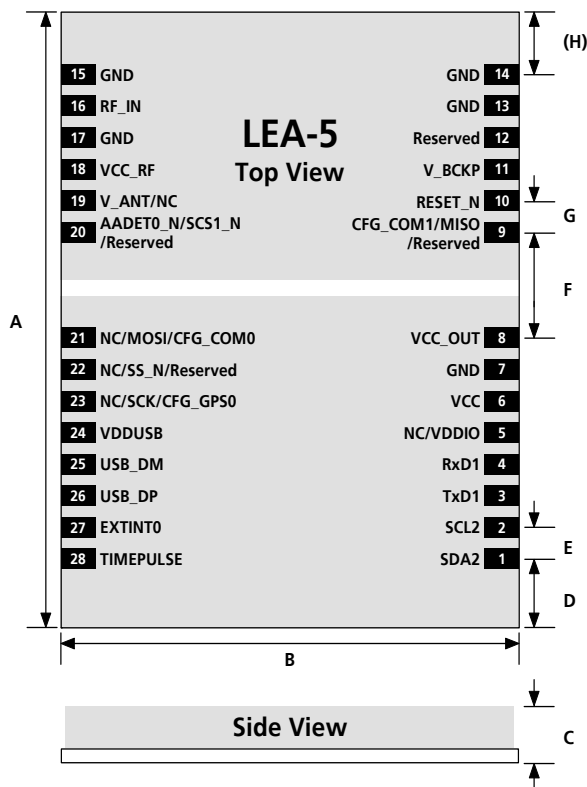


Figure 2: Dimensions



For information regarding the Paste Mask and Footprint see the *LEA-5 Hardware Integration Manual* [1].

⁹ LEA-5H, LEA-5S, LEA-5A, LEA-5T

¹⁰ LEA-5Q, LEA-5M

2.1 Pin Assignment

No	Module	Name	I/O	Description
1	All	SDA2	I/O	DDC Data
2	All	SCL2	I/O	DDC Clock
3	All	TxD1	O	Serial Port 1
4	All	RxD1	I	(do not leave open)
5	LEA-5H, LEA-5S, LEA-5A, LEA-5T	NC		Not Connected
	LEA-5Q, LEA-5M	VDDIO	I	Supply voltage
6	All	VCC	I	Supply voltage
7	All	GND	I	Ground (digital)
8	All	VCC_OUT	O	Output voltage
9	LEA-5A, LEA-5S, LEA-5M	CFG_COM1	I	Configuration Pin
	LEA-5Q	MISO CFG_COM1	I	SPI MISO Configuration Pin
	LEA-5H, LEA-5T	Reserved	I	
10	All	RESET_N	I	
11	All	V_BCKP	I	Backup voltage supply
12	All	Reserved	I	
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	LEA-5H, LEA-5S, LEA-5A, LEA-5T	V_ANT	I	Antenna Bias voltage
	LEA-5Q, LEA-5M	NC		Not Connected
20	LEA-5H, LEA-5S, LEA-5A, LEA-5T	AADET0_N	I	Active Antenna Detect
	LEA-5Q	SCS1_N	O	SPI Chip Select
	LEA-5M	Reserved		Do not connect. Do not pull low.
21	LEA-5H, LEA-5S, LEA-5A, LEA-5T	NC		Not Connected
	LEA-5Q	MOSI CFG_COM0	I/O	SPI MOSI Configuration Pin
	LEA-5M	CFG_COM0	I	Configuration Pin
22	LEA-5H, LEA-5S, LEA-5A, LEA-5T	NC		Not Connected
	LEA-5Q	SS_N	I	SPI Slave Select
	LEA-5M	Reserved	I	
23	LEA-5H, LEA-5T, LEA-5A, LEA-5S	NC		Not Connected
	LEA-5Q	SCK CFG_GPS0		SPI Clock Power Mode Configuration Pin
	LEA-5M	Reserved		Do not connect. Do not pull low.
24	All	VDDUSB	I	USB Supply
25	All	USB_DM	I/O	USB Data
26	All	USB_DP	I/O	USB Data
27	All	EXTINT0	I	External Interrupt Pin
28	All	TIMEPULSE	O	Time pulse (1PPS)

Table 12: Pinout



Pins designated Reserved should only be used with caution. For more information about Pinouts see the *LEA-5 Hardware Integration Manual* [1].

3 Electrical Specifications

3.1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Power supply voltage (VCC)	Vcc	-0.5	3.6	V
Backup battery voltage (V_BCKP)	Vbckp	-0.5	4.8	V
Input pin voltage	Vin	-0.5	3.6	V
	Vin_usb	-0.5	Vddusb +0.5	V
VCC_RF output current	Iccrf		100	mA
Antenna bias voltage	Vant		6	V
Antenna bias current ¹¹	Iant		100	mA
Storage temperature	Tstg	-40	85	°C

Table 13: Absolute Maximum Ratings



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.

¹¹ Applied via V_ANT

3.2 Operating Conditions

Parameter ¹²	Symbol	Min	Typ	Max	Units	Condition
Power supply voltage (VCC)	Vcc	2.7		3.6	V	
Peak supply current ¹³	Iccp			150	mA	Vcc = 3.6 V
Sustained supply current ¹⁴	Maximum Performance Mode	Icc Acquisition	102		mA	Vcc = 3.0 V
		Icc Tracking	55 ¹⁵			
	Eco Mode	Icc Acquisition	67			
		Icc Tracking	42 ¹⁶			
Backup battery voltage	Vbckp	1.3		4.8	V	
Backup battery current	Ibckp		25		μA	Vbckp = 1.8V
Input pin voltage range	Vin			Vcc +0.5	V	
Input pin low voltage	Vin_low_1			0.2x Vcc	V	
Input pin high voltage	Vin_high_1	0.7x Vcc			V	
Input pin low voltage for EXTINT0 and RxD1	Vin_low_2			0.22	V	
Input pin high voltage for EXTINT0 and RxD1	Vin_high_2	0.91			V	
Output pin low voltage	Vout_low			0.4	V	Iout = 4 mA
Output pin high voltage	Vout_high	Vcc – 0.4			V	Iout = -4 mA
VDDUSB (Pin 24) for USB operation	Vddusb1	3.0 ¹⁷		3.6	V	
USB_DM, USB_DP	VinU	Compatible with USB with 27 Ohms series resistance				
Antenna gain	Gant			30	dB	
V_ANT antenna bias voltage	Vant	2.7		5.5	V	I _{ANT} < -50 mA
Antenna bias voltage drop	Vant_drop		0.1		V	Iccrf=50mA
VCC_RF voltage	Vccrf		Vcc-0.1		V	
VCC_RF output current	Iccrf			50	mA	
Operating temperature	Topr	-40		85	°C	

Table 14: Operating Conditions



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

¹² All specification are at an ambient temperature of 25°C.

¹³ Use this figure to dimension maximum current capability of power supply.

¹⁴ Use this figure to determine required battery capacity.

¹⁵ All orbits available.

¹⁶ Typical 1 minute after First Fix.

¹⁷ If USB not used connect to GND

4 Reliability Tests

Tests for product family qualifications:

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 (halfsine); 3 Shock/axis; no function	IEC 68-2-27
Metallographic investigations		IPC-QE-650

Table 15: Reliability Tests



This specification is preliminary and subject to confirmation.

5 Design-In

In order to obtain the necessary information to conduct a proper design-in, u-blox strongly recommends consulting the *LEA-5 Hardware Integration Manual* [1].

6 Default Settings

Interface	Settings
Serial Port 1 Output	9600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up: GGA, GLL, GSA, GSV, RMC, VTG, TXT
USB Output	Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up: GGA, GLL, GSA, GSV, RMC, VTG, TXT USB Power Mode: Bus-Powered ¹⁸
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 ¹⁸
TIMEPULSE (1Hz Nav)	1 pulse per second, synchronized at rising edge, pulse length 100ms
Power Mode	LEA-5H, LEA-5Q, LEA-5S, LEA-5T: Maximum Performance Mode LEA-5A, LEA-5M: Eco Mode

Table 16: Available Protocols.

Please refer to the *LEA-5 Hardware Integration Manual* [1] for information about further settings.

¹⁸ Planned availability Q1/09 for ROM-based modules (LEA-5S, LEA-5A, LEA-5Q, LEA-5M)

7 Ordering Information

Ordering No.	Product
LEA-5A-0	LEA-5A GPS/GALILEO Module, Tape on reel, 250 pieces per reel
LEA-5H-0	LEA-5H GPS/GALILEO Module, Tape on reel, 250 pieces per reel
LEA-5S-0	LEA-5S GPS/GALILEO Module, Tape on reel, 250 pieces per reel
LEA-5M-0	LEA-5M GPS/GALILEO Module, Tape on reel, 250 pieces per reel
LEA-5Q-0	LEA-5Q GPS/GALILEO Module, Tape on reel, 250 pieces per reel
LEA-5T-0	LEA-5T GPS/GALILEO Module, Tape on reel, 250 pieces per reel
EVK-5A-0	u-blox 5 Evaluation Kit
EVK-5H-0	u-blox 5 Evaluation Kit with KickStart
EVK-5T-0	u-blox 5 Evaluation Kit with Precision Timing

Table 17: Ordering Information

Related Documents

[1] LEA-5 Hardware Integration Manual, Docu. No GPS.G5-MS5-07005

[2] u-blox5 Protocol Specification, Docu. No GPS.G5-X-07036

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.

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

www.u-blox.com

Offices

North, Central and South America

u-blox America, Inc.

1902 Campus Commons Drive
Suite 310
Reston, VA 20191
USA

Phone: +1 (703) 483 3180
Fax: +1 (703) 483 3179
E-mail: 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

Technical Support:

Phone: +1 (703) 483 3185
E-mail: support_us@u-blox.com

Europe, Middle East, Africa

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

Technical Support:

Phone: +41 44 722 74 74
E-mail: support@u-blox.com

Asia, Australia, Pacific

u-blox Singapore Pte. Ltd.

435 Orchard Road
#17-01, Wisma Atria,
Singapore 238877

Phone: +65 6734 3811
Fax: +65 6736 1533
E-mail: info_ap@u-blox.com
Support: support_ap@u-blox.com

Regional Office China:

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

Phone: +86 10 68 133 545
Fax: +86 10 68 217 890
E-mail: info_cn@u-blox.com
Support: support_cn@u-blox.com

Regional Office Japan:

22F Shibuya Mark City West,
1-12-1 Dogenzaka Shibuya-ku
Tokyo 150-0043 Japan

Phone: +81 3 4360 5343
Fax: +81 3 4360 5301
E-mail: info_jp@u-blox.com
Support: +81 3 4360 5344
support_jp@u-blox.com

Regional Office Korea:

Room 501, Gyeong Hui Building 109-18,
Samseong-Dong,
GangNam-Gu,
Seoul, Korea 135-090

Phone: +82 2 542 0861
Fax: +82 2 542 0862
E-mail: info_kr@u-blox.com
Support: support_kr@u-blox.com

Regional Office Taiwan:

Room 305
3F, #181, ZouTze Street
Neihu Dis.
Taipei, Taiwan

Phone: +886 2 2657 1090
Fax: +886 2 2657 1097
E-mail: info_tw@u-blox.com
Support: support_tw@u-blox.com