LM931 Bluetooth BLE 4.1 Smart Module
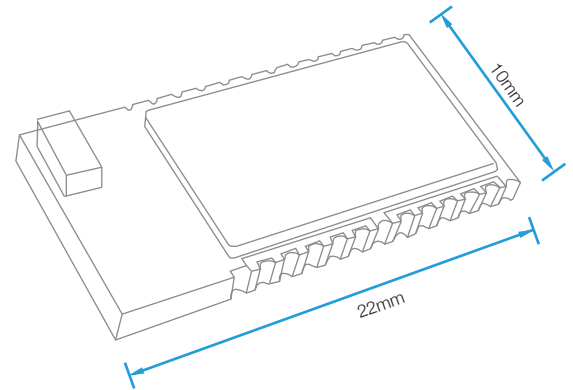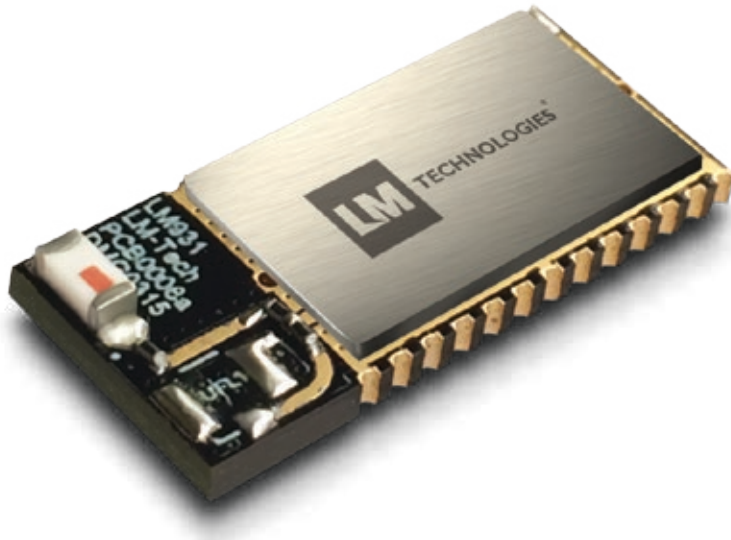## UART Class 1 with Onboard Antenna

Product   LM931
Part No   931-0636
Revised   19/MAY/2015

iBeacon   OSX   Linux   Android   Win CE 7   Win XP   Win Vista   Win 7   Win 8   RaspberryPi

10mm

22mm

Features

- 128KB memory: 64KB RAM and 64KB ROM

- Bluetooth ® v4.1 specification

- Low energy maximum transmit output power

- Support for Bluetooth v4.1 specification host stack including ATT, GATT, SMP, L2CAP, GAP

- RSSI monitoring for proximity applications

- <900nA current consumption in dormant mode

- Low Power 32kHz and 16MHz crystal

- Switch-mode power supply

- Receiver Sensitivity 92.5 dBm

- 12 digital PIOs

- 3 analogue AIOs

- UART

- 4 PWM modules

- 10-bit ADC

- Programmable general purpose PIO controller

- Wake-up interrupt and watchdog timer

Overview

The LM931 Series of modules are BLE-only modules that run on their own host stack under the BT4.1 Standard. In addition to the host stack running on the module, a range of fully programmable BLE applications can be configured to run on the module.

LM can develop such applications to your own requirements and/or add your own firmware to our module.

We can pre-configure any applications that may require specific settings to be pre-loaded and provide modules with pre-detemined device names if required.

With a battery added to the LM931 and placed into a housing, this module can also act as an iBeacon device awaiting instruction/data, or to pass on instruction/data automatically when in range of other BLE enabled devices.
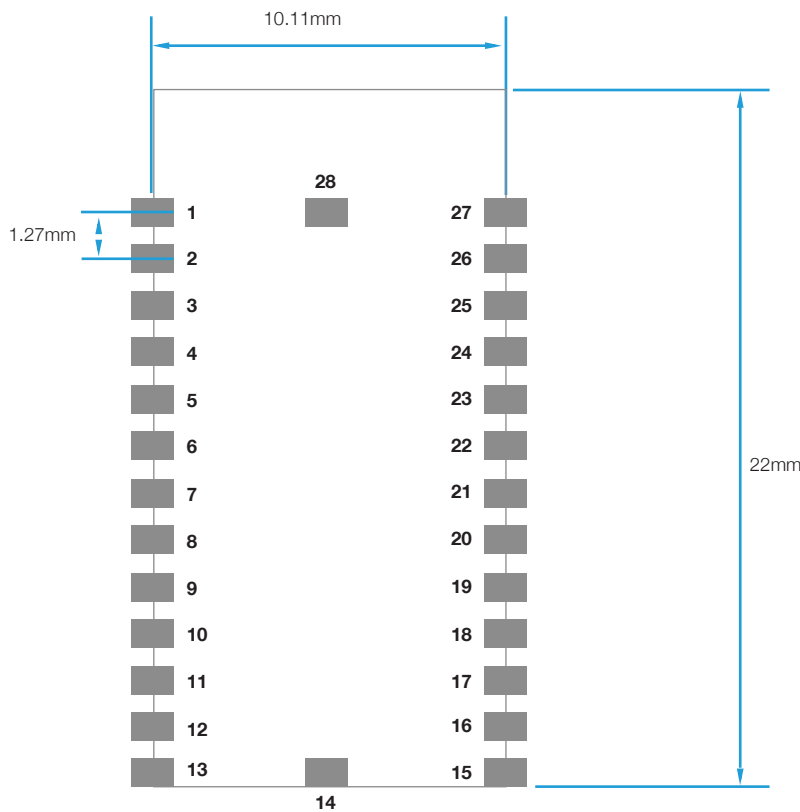
LM931 Bluetooth BLE 4.1 Smart Module
UART Class 1 with Onboard Antenna

General Specification

Chipset	CSR 1012
Class	BLE Smart Class 1
Speed / Bandwidth	Up to 1Mbps (0.27Mbps throughput)
Range	0m - 100m in open space
Interface	I²C / SPI for EEPROM / flash memory ICs and peripherals
Standard Bluetooth	4.1
Frequency	2.400 to 2.4835 GHz
Hopping	Adaptive/sec 2MHz channel space
Profiles Supported	BLE Smart App's Only
Firmware	Fully programmable (Onboard stack)
Antenna Gain	Max 2 dBi
Power Supply	1.8-3.6 VBATT and 1.2-3.6 VDD PAD
Operating Temperature	-30°C to 85°C
Storage Temperature	-40°C to +85°C
Dimensions	22mm x 10mm x 2.8mm

Pin Outs

Pin Assignments

Pin	Name	Type	Description
1	GND	Ground	Common Ground
2	GND	Ground	Common Ground
3	GND	Ground	Common Ground
4	AIO2	I/O	Programmable Input Output
5	AIO1	I/O	Programmable Input Output
6	AIO0	I/O	Programmable Input Output
7	GND	Ground	Common Ground
8	IO0	I/O	UART TX
9	IO1	I/O	UART RX
10	IO3	I/O	Programmable Input Output
11	IO4	I/O	Programmable Input Output
12	IO5	I/O	DEBUG_CLK
13	GND	Ground	Common Ground
14	GND	Ground	Common Ground
15	GND	Ground	Common Ground
16	PADS	Power	Positive supply for all digital I/O Ports
17	VBATT	Power	Module input supply, 3.3V DC
18	IO6	I/O	DEBUG_CS#
19	IO7	I/O	DEBUG_MOSI
20	IO8	I/O	DEBUG_MISO
21	GND	Ground	Common Ground
22	IO9	I/O	Programmable Input Output
23	IO10	I/O	Programmable Input Output
24	IO11	I/O	Programmable Input Output
25	SPIPION	Input	High to enable the SPI debug interface
26	WAKE	Input	Wake from Hibernate
27	GND	Ground	Common Ground
28	GND	Ground	Common Ground

8   Electrical Characteristics

8.1   Absolute Maximum Ratings

Rating	Min	Max	Unit
Storage temperature	-40	85	°C
Battery (VDD_BAT) operation	1.8	4.4	V
I/O supply voltage	-0.4	4.4	V
Other terminal voltages[a]	VSS - 0.4	VDD + 0.4	V

[a] VDD = Terminal Supply Domain

8.2   Recommended Operating Conditions

Operating Condition	Min	Typ	Max	Unit
Operating temperature range	-30	-	85	°C
Battery (VDD_BAT) operation[a]	1.8	-	3.6	V
I/O supply voltage (VDD_PADS)[b]	1.2	-	3.6	V

LM931 Bluetooth BLE 4.1 Smart Module
UART Class 1 with Onboard Antenna

8.3 Input/Output Terminal Characteristics

8.3.1 Switch-mode Regulator

Switch-mode Regulator	Min	Typ	Max	Unit
Input voltage[a]	1.8	-	3.6	V
Output voltage	0.65	1.35	1.35	V
Temperature coefficient	-200	-	200	ppm/°C
Normal Operation				
Output noise, frequency range 100Hz to 100kHz	-	-	0.4	mV rms
Settling time, settling to within 10% of final value	-	-	30	µs
Output current (I_{max})	-	-	50	mA
Quiescent current (excluding load, $I_{load} < 1mA$)	-	-	20	µA
Ultra Low-power Mode				
Output current (I_{max})	-	-	100	µA
Quiescent current	-	-	1	µA

[a] CSR1012 QFN is reliable and qualifiable to 4.3V (idle, active and deep sleep modes) and 3.8V (all modes), but there are minor deviations in performance relative to published performance values for 1.8V to 3.6V. For layout guidelines for 4.3V operation, see *CSR1012 Hardware Design Review Template*.

8.3.2 Low-voltage Linear Regulator

Normal Operation	Min	Typ	Max	Unit
Input voltage	0.65	-	1.35	V
Output voltage	0.65	-	1.20	V

Important Note:

This regulator is only for CSR internal use. Section 7 shows CSR's recommended circuit connection.

8.3.3 Digital Terminals

Input Voltage Levels	Min	Typ	Max	Unit
V_{IL} input logic level low	-0.4	-	0.3 x VDD_PADS	V
V_{IH} input logic level high	0.7 x VDD_PADS	-	VDD_PADS + 0.4	V
T_r/T_f	-	-	25	ns

LM931 Bluetooth BLE 4.1 Smart Module
UART Class 1 with Onboard Antenna

Product   LM931
Part No   931-0636
Revised   19/MAY/2015

Output Voltage Levels	Min	Typ	Max	Unit
V_{OL} output logic level low, I_{OL} = 4.0mA	-	-	0.4	V
V_{OH} output logic level high, I_{OH} = -4.0mA	0.75 x VDD_PADS	-	-	V
T_r/T_f	-	-	5	ns

Input and Tristate Currents	Min	Typ	Max	Unit
With strong pull-up	-150	-40	-10	µA
I²C with strong pull-up	-250	-	-	µA
With strong pull-down	10	40	150	µA
With weak pull-up	-5.0	-1.0	-0.33	µA
With weak pull-down	0.33	1.0	5.0	µA
C_I input capacitance	1.0	-	5.0	pF

8.3.4   AIO

Input/Output Voltage Levels	Min	Typ	Max	Unit
Input voltage	0	-	VDD_AUX	V
Output voltage	0	-	VDD_AUX	V

8.3.4.1   Auxiliary ADC

Auxiliary ADC		Min	Typ	Max	Unit
Resolution		-	-	10	Bits
Input voltage range[a]		0	-	VDD_AUX	V
Accuracy (Guaranteed monotonic)	INL	-1	-	1	LSB
	DNL	0	-	1	LSB
Offset		-1	-	1	LSB
Gain error		-0.8	-	0.8	%
Input bandwidth		-	100	-	kHz
Conversion time		1.38	1.69	2.75	µs
Sample rate[b]		-	-	700	Samples/s

8.4   ESD Protection

Apply ESD static handling precautions during manufacturing.

Table 8.1 shows the ESD handling maximum ratings.

Condition	Class	Max Rating
Human Body Model Contact Discharge per JEDEC EIA/JESD22-A114	2	2000V (all pins)
Charged Device Model Contact Discharge per JEDEC EIA/JESD22-C101	III	500V (all pins)

Table 8.1: ESD Handling Ratings

9   Current Consumption

Table 9.1 shows CSR1012 QFN total typical current consumption measured at the battery.

Mode	Description	Total Typical Current at 3V
Dormant	All functions are shut down. To wake them up, toggle the WAKE pin.	<900nA
Hibernate	VDD_PADS = ON, REFCLK = OFF, SLEEPCLK = ON, VDD_BAT = ON	<1.9µA
Deep sleep	VDD_PADS = ON, REFCLK = OFF, SLEEPCLK = ON, VDD_BAT = ON, RAM = ON, digital circuits = ON, SMPS = ON (low-power mode), 2.2ms wake-up time	<5µA
Idle	VDD_PADS = ON, REFCLK = ON, SLEEPCLK = ON, VDD_BAT = ON, RAM = ON, digital circuits = ON, MCU = IDLE, <1µs wake-up time	~1mA
RX / TX active	-	~16mA @ 3V peak current

FCC Warning

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: Any changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.

Note 1: This module certified that complies with RF exposure requirement under mobile or fixed condition, this module is to be installed only in mobile or fixed applications.

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 centimeter separation requirement.

A fixed device is defined as a device is physically secured at one location and is not able to be easily moved to another location.

Note 2: Any modifications made to the module will void the Grant of Certification, this module is limited to OEM installation only and must not be sold to end-users, end-user has no manual instructions to remove or install the device, only software or operating procedure shall be placed in the end-user operating manual of final products.

Note 3: Additional testing and certification may be necessary when multiple modules are used.

Note 4: To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. Since this may depend on the details of how the module is integrated with the host, LM Technologies Ltd. shall provide guidance to the host manufacturer for compliance with the Part 15B requirements.

Note 5: FCC ID label on the final system must be labeled with "Contains FCC ID: VVX-LM931-XXXX" or "Contains transmitter module FCC ID: VVX-LM931-XXXX".

IC WARNING

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:
(1) This device may not cause interference; and
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IC Radiation Exposure Statement:

This device and its antenna(s) must not be co-located with any other transmitters except in accordance with IC multi-transmitter product procedures. Referring to the multi-transmitter policy, multiple-transmitter(s) and module(s) can be operated simultaneously without reassessment permissive change.

Cet appareil et son antenne (s) ne doit pas être co-localisés ou fonctionnement en association avec une autre antenne ou transmetteur.

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20cm de distance entre la source de rayonnement et votre corps.

This module is limited to OEM installation only and must not be sold to end-users, end-user has no manual instructions to remove or install the device, only software or operating procedure shall be placed in the end-user operating manual of final products. Additional testing and certification may be necessary when multiple modules are used.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

The final end product must be labeled in a visible area with the following " Contains IC: 10531A-LM931XXXX".