Overview

The LM931 Bluetooth® low energy module is designed for use within embedded systems. It is implemented as a peripheral device within a product, while saving the developer valuable PCB space. The LM931 enables wireless communication with other nearby Bluetooth® low energy devices (e.g. iOS and Android) using a highly power efficient connection. The transmission output power ranges from 0 dBm to 9 dBm and can be configured to provide an extended battery life or a longer communication range.

This single core standalone module combines a Bluetooth® low energy radio using a Bluetooth® v4.1 stack, plus a microcontroller with 912 kB EEPROM for running the application. The LM931 incorporates 27 pin outs including UART and I²C for interfacing with a wide range of peripheral devices like sensors. It’s SMT side and bottom pads allow for easy manufacture and placement into your product. Application firmware and configuration settings can be preloaded to the module before supply.

LM offer bespoke integration into your product by supporting your developer. We can also assist in the development of new applications for the module. IoT Applications such as Serial over GATT, iBeacon™ and Key Fob (with RGB LED Controller) are available with the module’s LM53X development kits. The firmware is customisable to meet your requirements.

Features

- Bluetooth® v4.1 specification
- 14 mA Current Consumption (at 0 dBm Tx Output Power)
- IC Antenna Onboard (Peak Gain = 0.5 dBi)
- 9 dBm Tx Output Power (Max) and -92 dBm Rx Sensitivity
- Over-the-Air Upgrade (OTAU) available
- Application Firmware Support
- IoT Applications available including Serial over GATT, Eddystone™ Beacon and Cloud Sensor & Cloud Collector
- Fully integrated module with no additional components required
- I²C and UART
- 9 digital and 3 analogue I/O (10-bit ADC)
- Wake-up interrupt and Watchdog timer
- 4 PWM channels
- 22mm x 10.11mm x 2.50mm
- SMT Side and Bottom Pads for easy production
- See our website for this products certifications
- RoHS, REACH and WEEE Compliant Solution
LM931 Bluetooth® low energy Module
Standalone (With Embedded Bluetooth® v4.1 Stack)

General Specification

Wireless
Bluetooth® Standard v4.1
Module Type Standalone (Embedded Bluetooth® Stack)
Profiles GATT-Based

Hardware
Chipset Qualcomm®
Antenna IC Antenna Onboard
Microcontroller (MCU) 16-bit RISC
EEPROM Memory 512 kB
RAM 64 kB
Programming Interface SPI
Interfaces I²C, UART, AIO and PIO
Power Supply 3V3 (3V6 Max)
Crystal Oscillators 32 kHz and 16 MHz
Development Kit LM53X

RF Characteristics
Tx Output Power 0 dBm to 9 dBm
Rx Sensitivity -92 dBm (Typical)
Current Consumption (Continuous Tx) 14 mA (at 0 dBm), 15.9 mA (at 3 dBm) and <25 mA (at 9 dBm)
Current Consumption (Continuous Rx) 22 mA (Typical)
Range (in open space) Up to 55m
Data Rate Up to 1 Mbps
Frequency 2.4 GHz to 2.485 GHz

Physical Characteristics
Operating Temperature -30°C to +85°C
Dimensions (L x W x H) 22mm x 10.11mm x 2.50mm
Weight 0.87g +/- 0.25g tolerance
Certifications See our website for this products certifications
Compliance RoHS, REACH and WEEE Compliant Solution
**IoT Applications**

The LM931 standalone module is capable of running your Bluetooth® low energy application. Requiring no external hardware and supports a wide range of applications such as:

- Alert Tag
- Automotive Key Fob
- Beacon
- Blood Pressure Sensor
- Cycling Speed and Cadence Sensor
- Environment Sensor
- Health Thermometer
- Heart Rate Sensor
- Keyboard & Mouse
- Multifunction Steering Wheel
- Security Tag
- Serial Communication
- Time Client
- Temperature and Pressure
- Weight Scale

LM Technologies offer application support, including assisting the developer and creating new applications. LM provide firmware that can be customised to your specification.

Firmware available:

- Cloud Sensor
- Cloud Collector
- Eddystone™ Beacon
- URL Beacon
- iBeacon™
- Serial Server
- Console
- Key Fob (with RGB LED Controller)
Radio Frequency Characteristics

Transmit Power Measurements

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Offset ±1KHz</td>
<td>0.75KHz</td>
<td>KHz</td>
</tr>
<tr>
<td>Trim Value</td>
<td>12</td>
<td>-</td>
</tr>
</tbody>
</table>

Output Power

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Energy</td>
<td>Ppk</td>
<td>Ppk</td>
</tr>
<tr>
<td>&lt;Pav +3 dBm</td>
<td>-20 dBm &lt;Pave &lt;10 dBm</td>
<td>dBm</td>
</tr>
</tbody>
</table>

Receive Measurements

Limitation Sensitivity

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Energy</td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>BER ≤ 3.8% for receiving power is -70 dBm or better.</td>
<td>-93</td>
<td>-92</td>
</tr>
</tbody>
</table>

Current Consumption Test

Test Condition

(BLE PRBS9 Channel 2442MHz Package Length 37)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Tx:</td>
<td>14 mA (at 0 dBm), 15.9 mA (at 3 dBm) and &lt;25 mA (at 9 dBm)</td>
</tr>
<tr>
<td>Continuous Rx:</td>
<td>22 mA (typ.)</td>
</tr>
<tr>
<td>Power Boot Up:</td>
<td>3 mA (typ.)</td>
</tr>
</tbody>
</table>
Powering

Use VDD_PADS (Pin 16) or VBAT (Pin 17) to power the module.

Pin Out
<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>AIO2</td>
<td>Input</td>
<td>Analogue Input Output</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>AIO1</td>
<td>Input</td>
<td>Analogue Input Output</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>AIO0</td>
<td>Input</td>
<td>Analogue Input Output</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>IO0</td>
<td>I/O</td>
<td>UART TX</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>IO1</td>
<td>I/O</td>
<td>UART RX</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>IO3</td>
<td>I/O</td>
<td>Programmable Input Output (PIO)</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>IO4</td>
<td>I/O</td>
<td>Programmable Input Output (PIO)</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12*</td>
<td>IO5 / SPI</td>
<td>I/O</td>
<td>Programmable Input Output (PIO) / DEBUG_CLK</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>VDD_PADS</td>
<td>Power</td>
<td>Positive supply for all digital and analogue I/O Pins</td>
<td>1V2</td>
<td>3V3</td>
<td>3V6</td>
</tr>
<tr>
<td>17</td>
<td>VBAT</td>
<td>Power</td>
<td>Module battery power supply DC</td>
<td>1V8</td>
<td>3V3</td>
<td>3V6</td>
</tr>
<tr>
<td>18*</td>
<td>IO6 / SPI</td>
<td>I/O</td>
<td>Programmable Input Output (PIO) / DEBUG_CS#</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19*</td>
<td>IO7 / SPI</td>
<td>I/O</td>
<td>Programmable Input Output (PIO) / DEBUG_MOSI</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20*</td>
<td>IO8 / SPI</td>
<td>I/O</td>
<td>Programmable Input Output (PIO) / DEBUG_MISO</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>IO9</td>
<td>I/O</td>
<td>Programmable Input Output (PIO)</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>IO10 / I2C</td>
<td>I/O</td>
<td>Programmable Input Output (PIO) / SDA</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>IO11 / I2C</td>
<td>I/O</td>
<td>Programmable Input Output (PIO) / SCL</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>SPIPION</td>
<td>Input</td>
<td>High to enable the SPI debug interface, Low to enable PIO</td>
<td>VDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>WAKE</td>
<td>Input</td>
<td>Toggle to wake from Dormant Mode</td>
<td>VDD_BAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>GND</td>
<td>Ground</td>
<td>Common Ground</td>
<td>0V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* for SPI at P12, P18, P19 and P20 set P25 to High.
* for PIO at P12, P18, P19 and P20 set P25 to Low.
LM931 Bluetooth® low energy Module
Standalone (With Embedded Bluetooth® v4.1 Stack)

Module Block Diagram

- LM931 Bluetooth® low energy Module
- Standalone (With Embedded Bluetooth® v4.1 Stack)
- Filter
- XTAL 32 kHz
- 512 kB
- Qualcomm Chipset
- LM931
- BT_RF
- VBAT / PADS
- E² PROM 512 kB
- PWM
- AIO
- SPI_Debug
- UART
- I²C
- PIO
- XTAL 32 kHz
- XTAL 16 MHz
**Physical Dimensions**

**Top View**

- Pin 1
- 101mm
- 9.375mm
- 8.25mm
- 6.2mm
- 2165mm
- 22mm

**Front View**

- 2.50mm
- 6.2mm
- 2165mm
- 22mm

**Side View**

- 2.50mm
- 0.825mm
- 9.375mm
- 10.11mm
LM931 Bluetooth® low energy Module
Standalone (With Embedded Bluetooth® v4.1 Stack)

PCB Footprint

Optimal Placement Position

EDGE OF HOST PCB
( Optimal )

Placement Note
If the optimal placement position cannot be achieved, ensure there is no metal beneath the highlighted part of module.

NB
Aim to place the module away from interference. (i.e: place the module at the edge of the board.)

Pin Spacing

Pin 1

101.1mm
9.375mm
0.825
6.2mm
21.65mm
22mm

1.27
1.08
0.8
PCB Drying Conditions

Please refer below to the conditions for drying before the solder reflow processes. (Extracted from IPC/JEDEC J-STD-033B.1)

Soldering Reflow Chart

<table>
<thead>
<tr>
<th>Product zone slope</th>
<th>Immersion time (s) to 120°C</th>
<th>Reflowing time (s) at 225°C</th>
<th>Maximum temperature</th>
<th>Cooling zone slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.60</td>
<td>120.00</td>
<td>90.00</td>
<td>360.00</td>
<td>4.79</td>
</tr>
<tr>
<td>1.60</td>
<td>60.00</td>
<td>60.00</td>
<td>240.00</td>
<td>2.56</td>
</tr>
<tr>
<td>1.60</td>
<td>45.00</td>
<td>45.00</td>
<td>185.00</td>
<td>1.88</td>
</tr>
<tr>
<td>1.70</td>
<td>60.00</td>
<td>60.00</td>
<td>240.00</td>
<td>2.56</td>
</tr>
</tbody>
</table>

1. Time of constant temperature: 60–120s
2. Time of reflowing: 60–80s
3. Maximum Temperature: 233–239°C
**LM931 Bluetooth® low energy Module**

Standalone (With Embedded Bluetooth® v4.1 Stack)

**Tape and Reel Packaging**

**Tape Dimensions**

![Tape Dimensions Diagram]

**Reel Dimensions**

![Reel Dimensions Diagram]

**Notes**
- Carton Dimensions (L x W x H): 360mm x 290mm x 370mm

**Quantities**
- 1250 modules per Tape
- 4 Boxes per Carton
- 5000 modules per Carton
LM931 Bluetooth® low energy Module
Standalone (With Embedded Bluetooth® v4.1 Stack)

Tray Packaging

Tray Dimensions

Notes
- Anti-Static PS Tray, Black
- Electrical Resistance: 1 MΩ < R < 100 MΩ
- Thickness: T = 0.8 mm
- Carton Dimensions (L x W x H):
  360mm x 325mm x 160mm

Quantities
- 60 modules per Tray
- 600 modules per Box
- 4 Boxes per Carton
- 2400 modules per Carton
Packaging for Tape & Reel / Tray

The trays/reels are stacked and inserted into an anti-static vacuum bag with a Humidity Indicator Card. On the outside of the bag are labels for Anti-Static, Model Name and Moisture Sensitivity Levels.

The vacuum bag is placed inside the box and a model name label affixed on the front-side of each box.

Each carton contains 4 boxes.
**Datasheet Version Notes**

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1.0</td>
<td>13 MAR 2018</td>
<td>Added version notes to datasheet.</td>
</tr>
<tr>
<td>v1.1</td>
<td>13 MAR 2018</td>
<td>MSL Description text improvement in the PCB Drying Conditions section.</td>
</tr>
<tr>
<td>v1.2</td>
<td>04 JUL 2018</td>
<td>MSL Description text improvement in the PCB Drying Conditions section. Packing information addition.</td>
</tr>
</tbody>
</table>
LM931 Bluetooth® low energy Module
Standalone (With Embedded Bluetooth® v4.1 Stack)

LM931 Packaging Options

<table>
<thead>
<tr>
<th>Part No</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>931-0551</td>
<td><strong>LM931 Module</strong></td>
</tr>
<tr>
<td></td>
<td>MOD SMT PROG BT4.1 SMART uE, Fw.3.16v , 9.dBm IC-ANT PCS</td>
</tr>
<tr>
<td>931-0552</td>
<td><strong>LM931 Module</strong></td>
</tr>
<tr>
<td></td>
<td>MOD SMT PROG BT4.1 SMART uE, Fw.3.16v , 9.dBm IC-ANT TRAY</td>
</tr>
<tr>
<td>931-0636</td>
<td><strong>LM931 Module</strong></td>
</tr>
<tr>
<td></td>
<td>MOD SMT PROG BT4.1 SMART uE, Fw.3.16v , 9.dBm IC-ANT T&amp;R</td>
</tr>
</tbody>
</table>