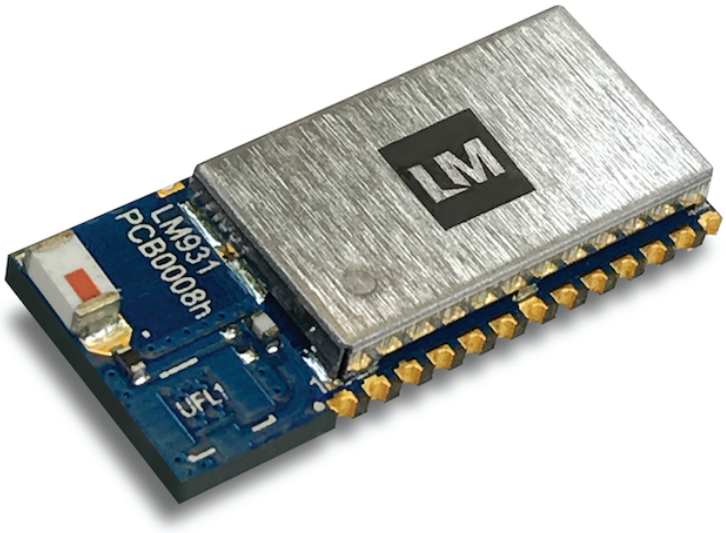
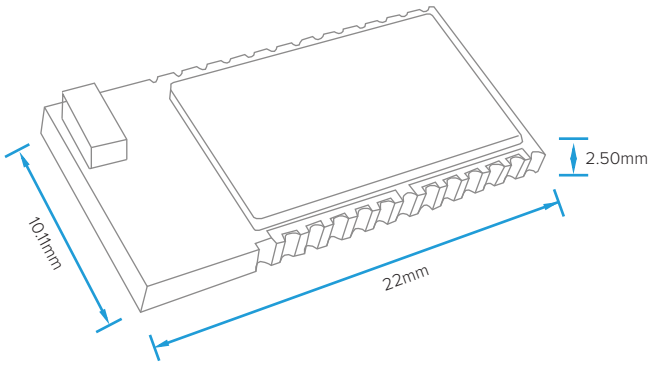
# LM931 Bluetooth® low energy Module

## Standalone (With Embedded Bluetooth® v4.1 Stack)

| | |
|---|---|
| Revised | 24/JAN/2021 |
| Datasheet Version | 1.3 |
| Ordering Options | See last page |




## 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

## 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 512 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.

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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 |

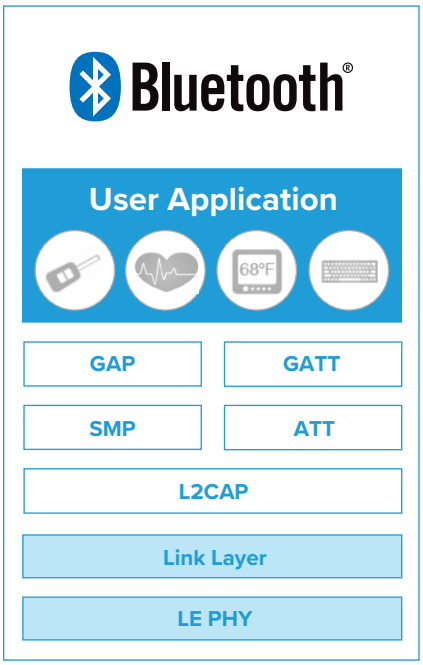
# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## 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)

# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## Radio Frequency Characteristics

### Transmit Power Measurements

**Crystal Trim**

| Specification | Measurement | Unit |
|---|---|---|
| Frequency Offset ±1KHz | 0.75KHz | KHz |
| Trim Value | 12 | - |

**Output Power**

| | Specification | | Measurement | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2402MHz (CH0*) | | 2442MHz (CH20*) | | 2480MHz (CH39*) | | |
| | Ppk | Ppk | Pav | Ppk | Pav | Ppk | Pav | Ppk | |
| Low Energy | <Pav +3 dBm | -20 dBm<Pave<10dBm | 8.1 | 8.4 | 8.4 | 8.6 | 9 | 9.2 | dBm |

### Receive Measurements

**Limitation Sensitivity**

| | Specification | Measurement | | | Unit |
|---|---|---|---|---|---|
| | | 2402MHz (CH0*) | 2442MHz (CH20*) | 2480MHz (CH39*) | |
| Low Energy | BER≤30.8% for receiving power is -70 dBm or better. | -93 | -92 | -93 | dBm |

**Maximum Input Level**

| | Specification | Measurement | | | Unit |
|---|---|---|---|---|---|
| | | 2402MHz (CH0*) | 2442MHz (CH20*) | 2480MHz (CH39*) | |
| Low Energy | PER≤30.8% for receiving power is -10 dBm or better. | 0 | 0 | 0 | % |

### Current Consumption Test

#### Test Condition

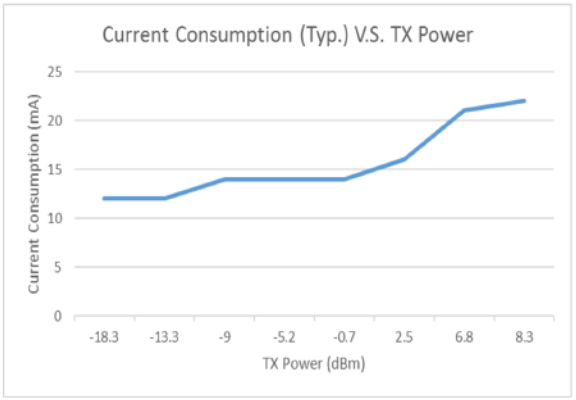
(BLE PRBS9 Channel 2442MHz Package Length 37)

Continuous Tx: 14 mA (at 0 dBm), 15.9mA (at 3dBm) and <25 mA (at 9dBm)

Continuous Rx: 22 mA (typ.)

Power Boot Up: 3 mA (typ.)

Figure:



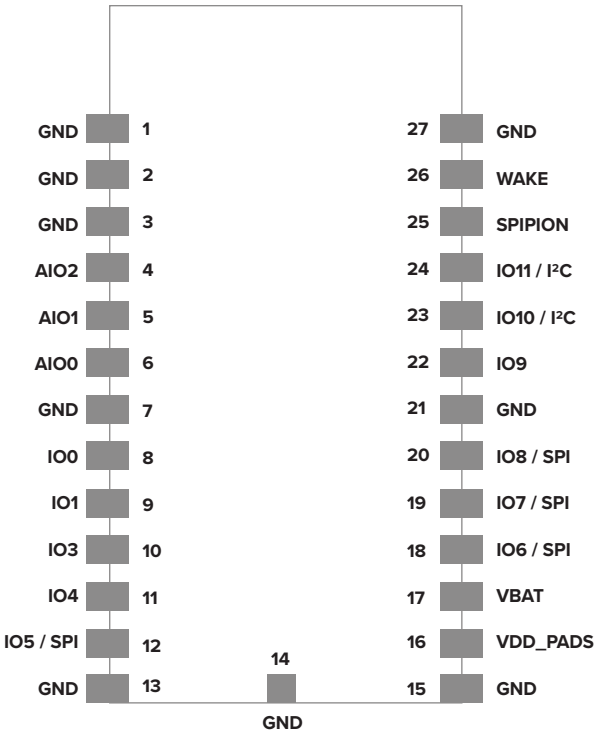
# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## Powering

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

## Pin Out



# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## Pin Assignments

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

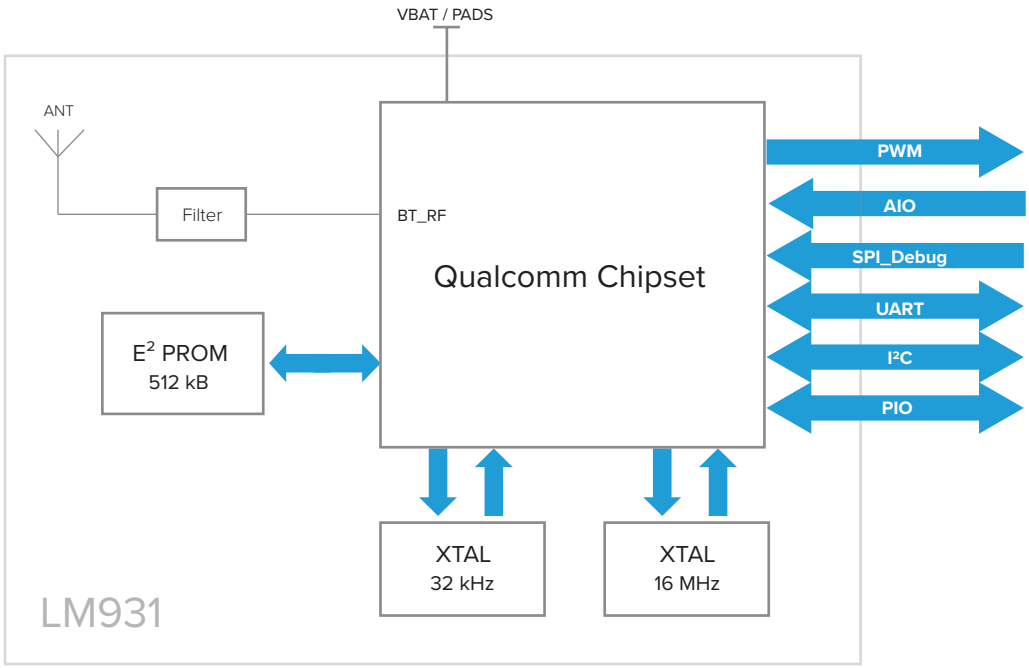
* for SPI at P12, P18, P19 and P20 set P25 to High.

* 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

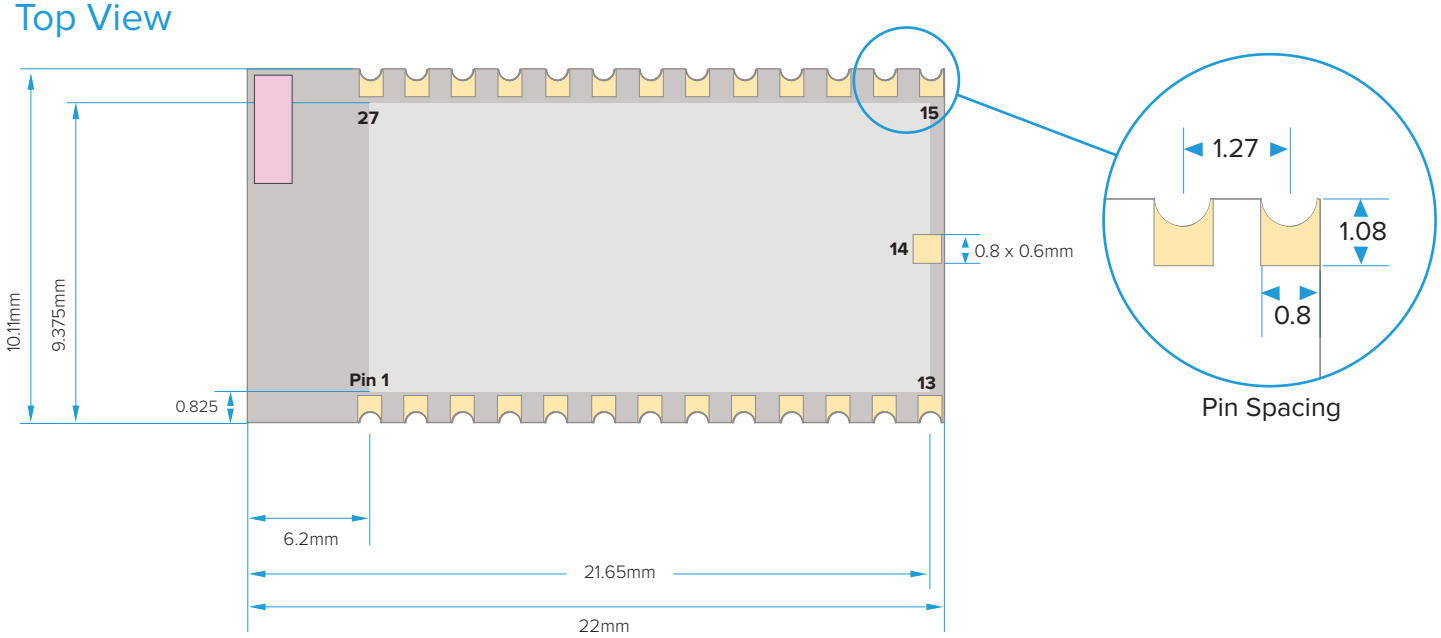


# LM931 Bluetooth® low energy Module

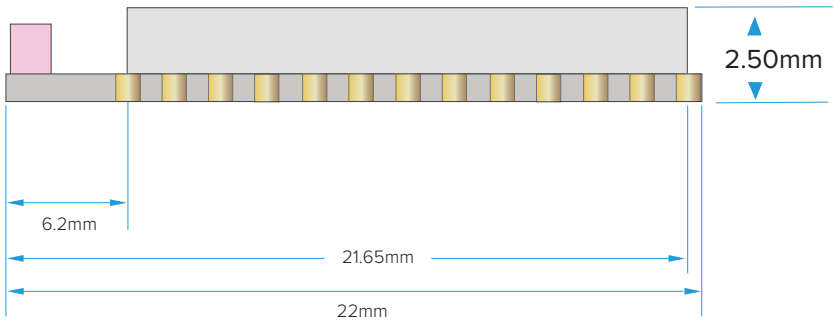
Standalone (With Embedded Bluetooth® v4.1 Stack)

## Physical Dimensions

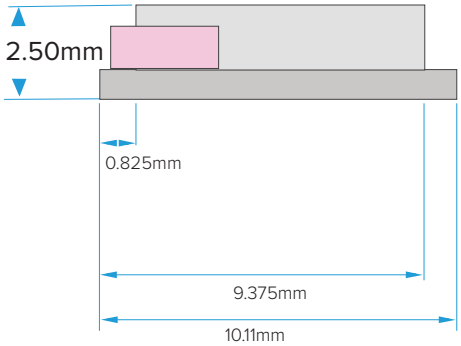
### Top View




### Front View



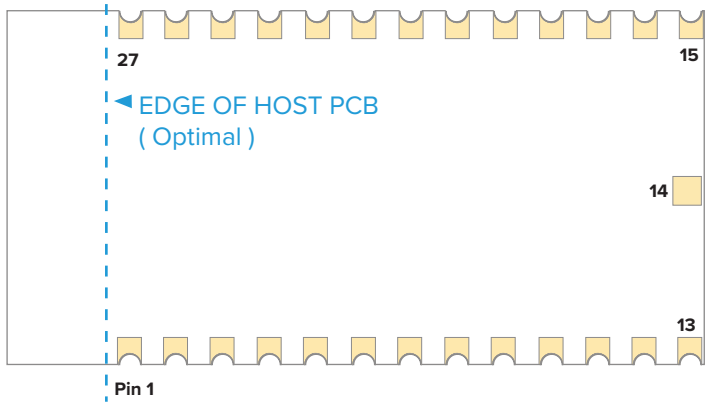

### Side View



# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## PCB Footprint



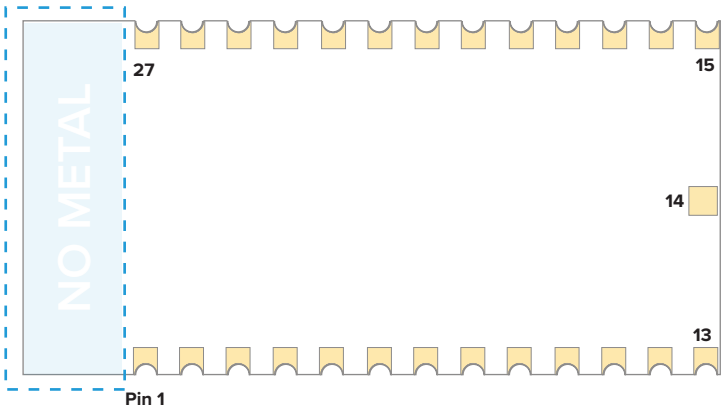

Optimal Placement Position

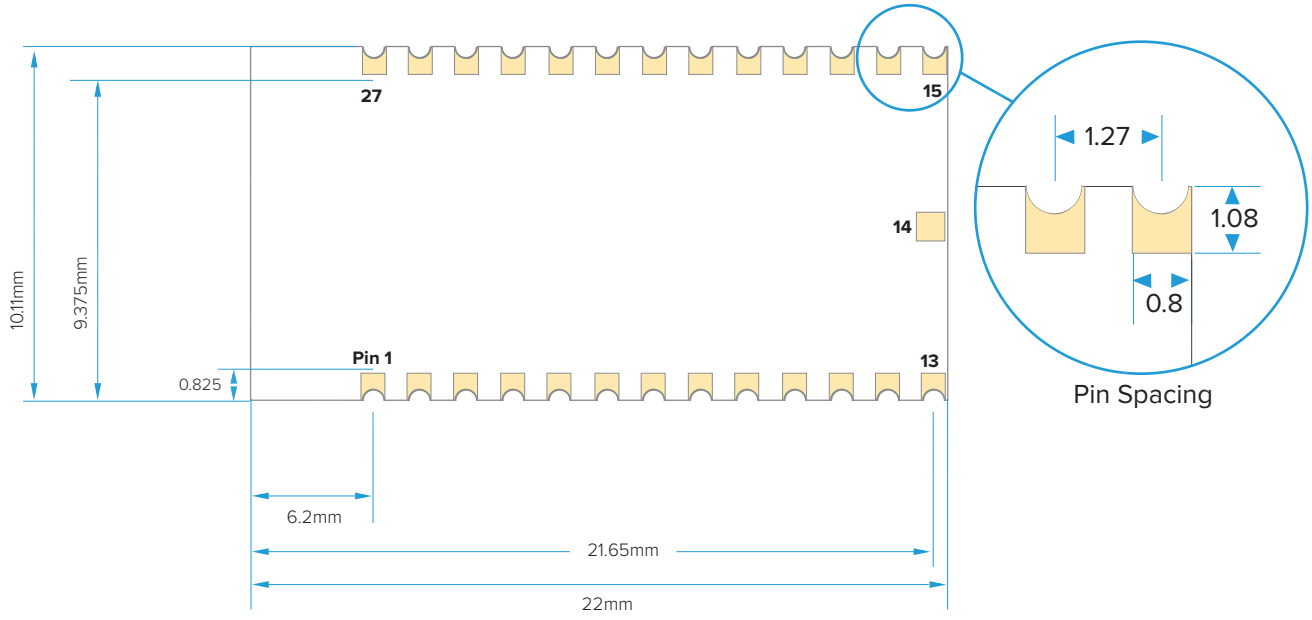
Placement Note

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.)



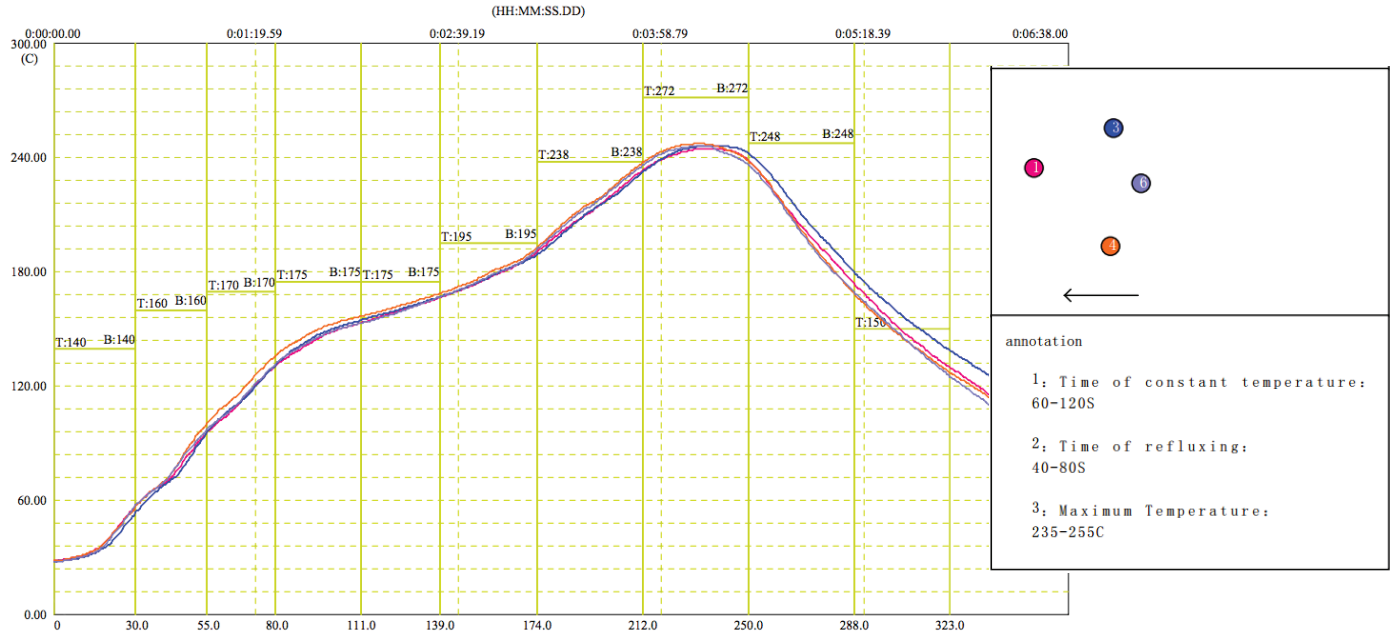
# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## 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



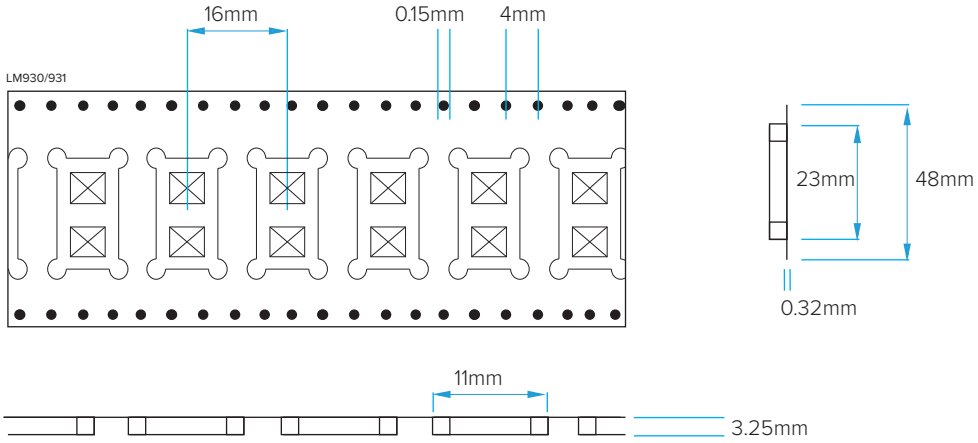

| | Preheat zone slope | | Immersion time 150 to 180℃ | | Refluxing time 220℃ | | Maximum Temperature | | cooling zone slope | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ■ | 1.60 | -26.67% | 63.50 | -91.25% | 65.50 | 27.50% | 245.2 | 34.67% | -1.79 | -48.47% | -- | -- | -- | -- | -- | -- |
| ■ | 1.60 | -26.67% | 65.50 | -86.25% | 68.50 | 42.50% | 246.7 | 44.67% | -1.59 | -56.38% | -- | -- | -- | -- | -- | -- |
| ■ | 1.60 | -26.67% | 67.50 | -81.25% | 69.00 | 45.00% | 247.6 | 50.67% | -1.68 | -52.95% | -- | -- | -- | -- | -- | -- |
| ■ | 1.70 | -20.00% | 62.50 | -93.75% | 67.50 | 37.50% | 246.3 | 42.00% | -1.48 | -60.73% | -- | -- | -- | -- | -- | -- |

# LM931 Bluetooth® low energy Module

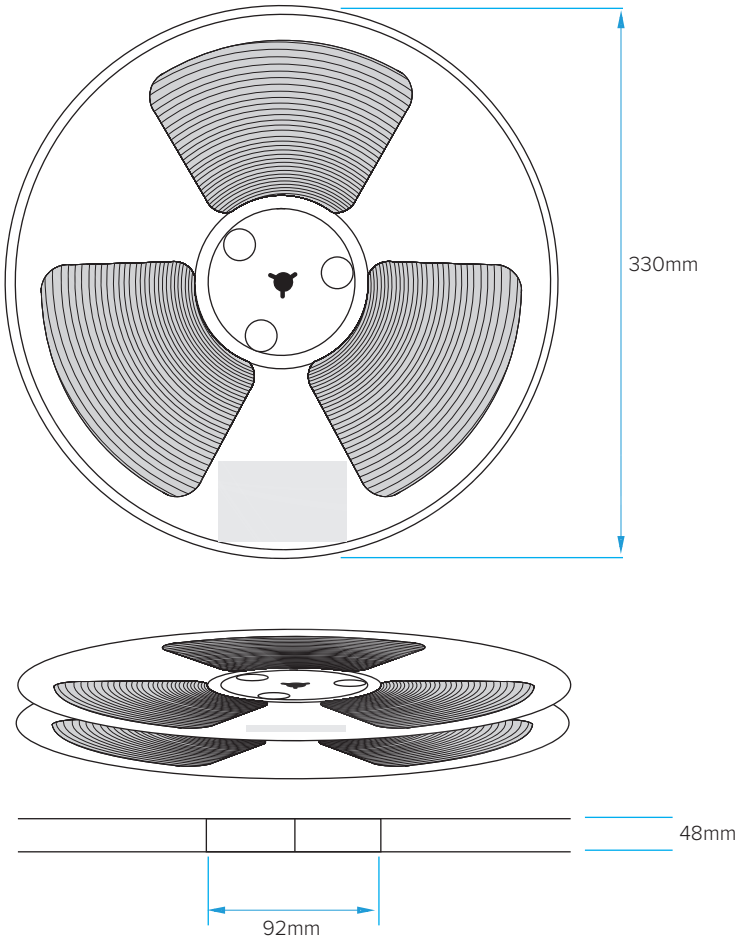
Standalone (With Embedded Bluetooth® v4.1 Stack)

## Tape and Reel Packaging

### Tape Dimensions




### Reel Dimensions




### Notes

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

### Quantities

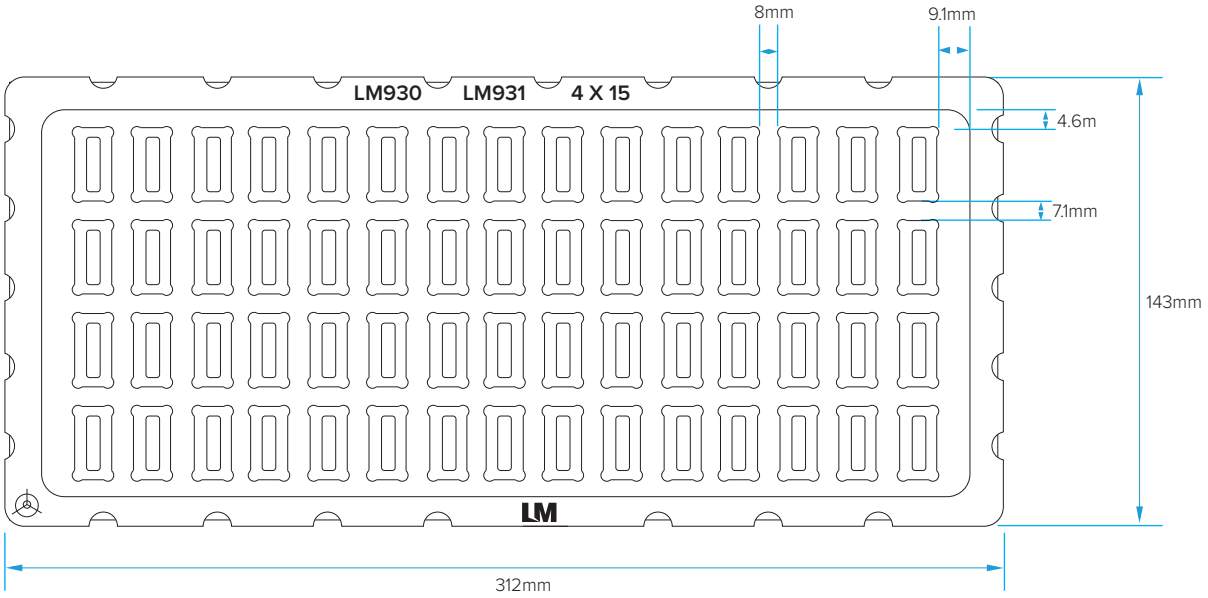
- 1250 modules per Tape
- 4 Boxes per Carton
- 5000 modules per Carton

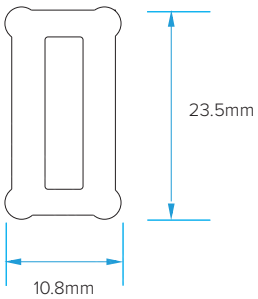
# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

## Tray Packaging

### Tray Dimensions




### Notes

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

### Quantities

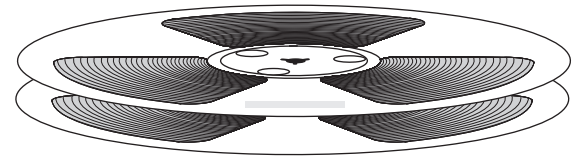
- 60 modules per Tray
- 600 modules per Box
- 4 Boxes per Carton
- 2400 modules per Carton

# LM931 Bluetooth® low energy Module
Standalone (With Embedded Bluetooth® v4.1 Stack)

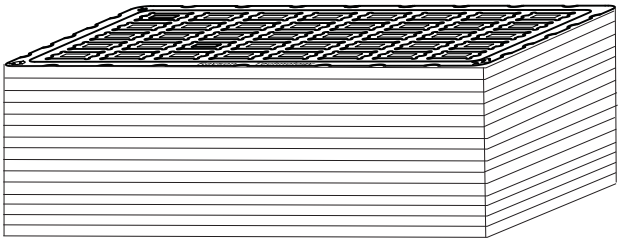
## Packaging for Tape & Reel / Tray

The trays/reels are stacked and inserted into an anti-static vacuum bag with a Humidity Indicator Card.

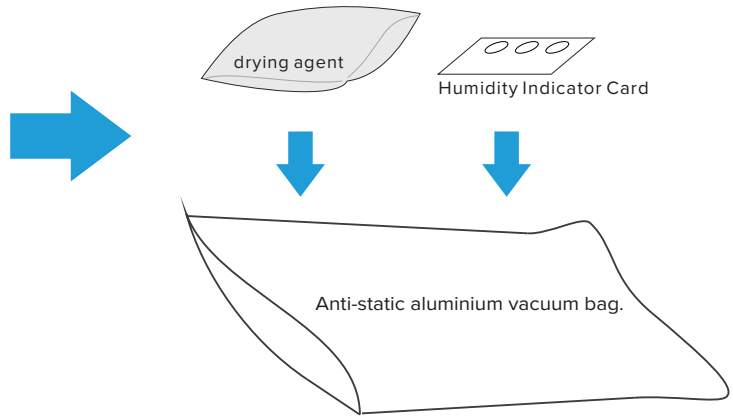
On the outside of the bag are labels for Anti-Static, Model Name and Moisture Sensitivity Levels.



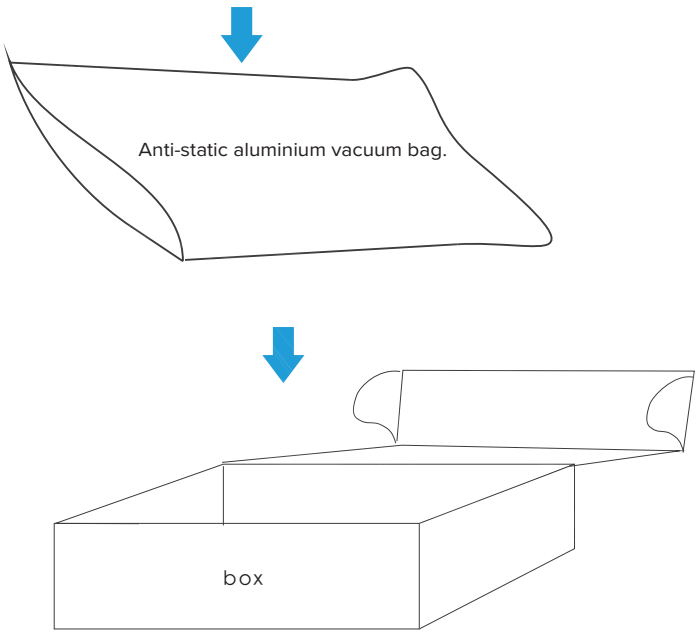
Reels are place within a vacuum bag.

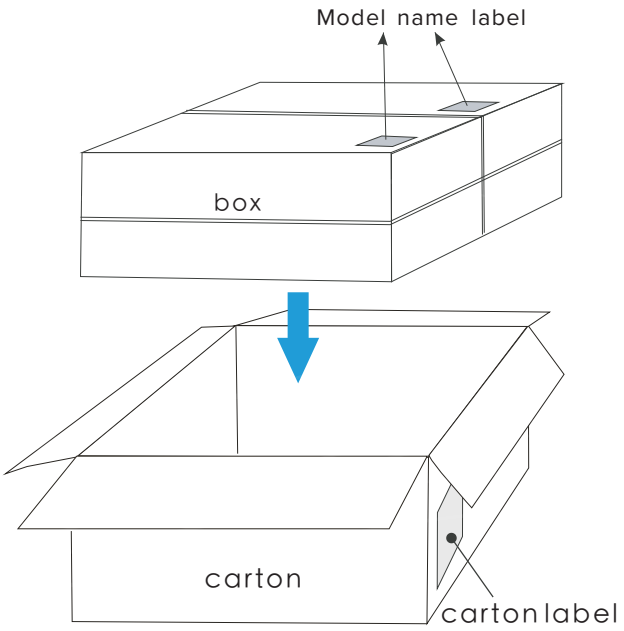


Trays are stacked up with an empty tray on the top.




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.

# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

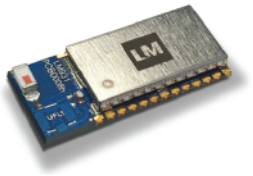
## Datasheet Version Notes

| | | |
|---|---|---|
| v1.0 | 13 MAR 2018 | Added version notes to datasheet. |
| v1.1 | 13 MAR 2018 | MSL Description text improvement in the PCB Drying Conditions section. |
| v1.2 | 04 JUL 2018 | MSL Description text improvement in the PCB Drying Conditions section.<br>Packing information addition. |
| v1.3 | 24 JAN 2021 | Datasheet branding update. |

# LM931 Bluetooth® low energy Module

Standalone (With Embedded Bluetooth® v4.1 Stack)

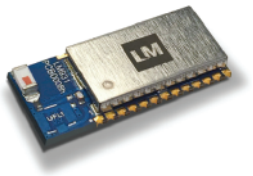
## Ordering Options



931-0551

**LM931 Module**

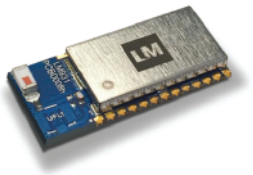
MOD SMT PROG BT4.1 SMART uE, Fw.3.16v ,9.dBm IC-ANT PCS



931-0552

**LM931 Module**

MOD SMT PROG BT4.1 SMART uE, Fw.3.16v , 9.dBm IC-ANT TRAY



931-0636

**LM931 Module**

MOD SMT PROG BT4.1 SMART uE, Fw.3.16v , 9.dBm IC-ANT T&R