

# SKB381 规格书

## 蓝牙模组

# SKB381 Datasheet

## BLE Module

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## 1. 简介 Brief Introduction

SKB381 是一个高度集成的蓝牙 5.0 模组，可用在 2.4GHz ISM 频段内做高速率、短距离无线通信。模组基于 EFR32BG21 蓝牙无线收发芯片，内部集成 32 位 ARM Cortex-M33 处理器，主频 80MHz，同时内置 64kB RAM 和 512kB Flash，支持模拟或者数字外设。SKB381 提供了高性价比的蓝牙传输。

The SKB381 is a highly integrated BLE 5.0 module, designed for high data rate, short-range wireless communication in the 2.4GHz ISM band. The module is based on EFR32BG21 radio transceiver IC, which integrates a 32 bit ARM Cortex-M33 76.8MHz CPU, 64kB Data RAM, 512kB Flash memory and analog and digital peripherals. The SKB381 provides a high cost-effective BLE solution for wireless transmission.



Figure 1: SKB381 Without Shielding

## 2. 特点 Features

- ◆ 主控芯片/ Main Chip: SILICON LABS EFR32BG21A020F512IM32-B
- ◆ 蓝牙低功耗 5.0 协议/ BLE® 5.0 protocol
- ◆ 支持 BLE 全速率模式/ Supported BLE all data rates: 125kbps/500kbps/1Mbps/2Mbps
- ◆ 优秀的射频性能/Superior Radio Performance: TX Power 20dBm / RX sensitivity -104.9dBm@125kbps GFSK
- ◆ 极低功耗/ Ultra Low Power consumption: TX 9.3mA@0dBm, TX 33.8mA@10dBm, TX 60.8mA@20dBm; RX 8.8mA@1Mbps; Sleep current<5.0uA
- ◆ 2 路 16 位定时器+1 路 32 位 RTC 定时器+1 路 24 位低功耗波形发生定时器/  
2x16bit timers+1x32bit RTC timer+1\*24bit Low Energy Timer for waveform generation
- ◆ 12 位 1M 采样率 SAR 型 ADC/ 12-bit 1Msps SAR ADC

- ◆ 高达 16 个带有输出状态保持和异步中断功能的通用 I/O 引脚/Up to 16 general-purpose I/O pins with output state persistence and asynchronous interrupt capabilities
- ◆ 模块接口为通用串口，全双工双向通讯/Module interface for general serial port, full duplex two-way communication;
- ◆ 硬件加密/ HW encryption: AES 128/256, SHA-1, SHA-2, ECC(up to 256bit), ECDSA(up to 256bit), ECDH and J-Pake.
- ◆ 兼容 ROHS（无铅）/ ROHS compliance (Lead-free)

### 3. 应用场景 Applications

- ◆ 蓝牙 5.0 无线麦克风 BLE 5.0 wireless microphone
- ◆ 电脑输入输出外设 Computer peripherals and I/O devices
  - 鼠标 Mouse
  - 键盘 Keyboard
  - 多点触控板 Multi-touch trackpad
- ◆ 交互式娱乐设备 Interactive entertainment devices
  - 遥控器 Remote controller
  - 3D 眼镜 3D Glasses
  - 游戏远程控制器 Gaming remote controller
- ◆ 个人局域网 Personal Area Networks
  - 健康传感及监控设备 Health/fitness sensor and monitor devices
  - 医疗设备 Medical devices
  - 遥控钥匙+手表手环 Key-fobs + wrist watches
- ◆ 遥控玩具 Remote control toys
- ◆ 彩色遥控 LED 灯 Colourful LED Control
- ◆ 楼宇自动化 Building automation
- ◆ 无线传感器网络 Wireless sensor networks.
- ◆ 资产追踪 Asset tracking.

## 4. 应用框图 Application Block Diagram

SKB381 模组内部集成 1.8V DCDC，IO 电平默认使用 3.3V，可以直接用纽扣电池供电。

SKB381 module integrates 1.8V DCDC, and the IO voltage is 3.3V by default. It can be powered by coin battery.

默认贴 32.768kHz 晶体和 32MHz 晶体。

The 32.768kHz and 32MHz crystal is default mounted.

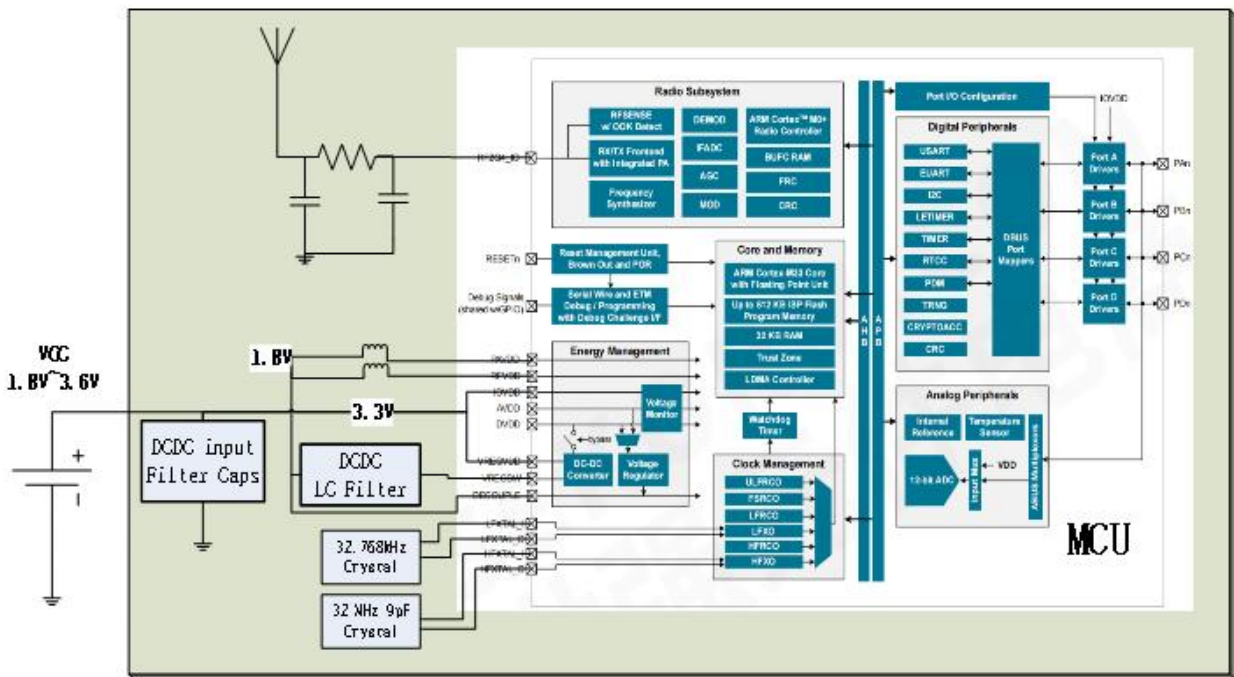


Figure 4: SKB381 Block Diagram

## 5. 管脚定义 Pinout Description

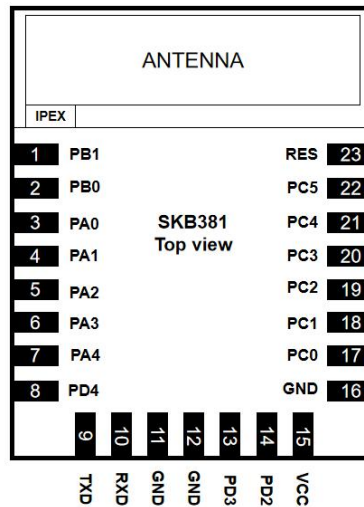


Figure 5: SKB381 Module Pinout

Pin No	Pin Name	Type	Description
1	PB1	I/O	通用 GPIO
2	PB0	I/O	通用 GPIO
3	PA0	I/O	通用 GPIO
4	PA1	I/O	SWDCLK; 串行调试编程接口时钟
5	PA2	I/O	SWDIO; 串行调试编程接口数据
6	PA3	I/O	通用 GPIO
7	PA4	I/O	通用 GPIO
8	PD4	I/O	通用 GPIO
9	TXD	DO	PA5; UART TXD
10	RXD	DI	PA6; UART RXD
11	GND	DG	电源地
12	GND	DG	电源地
13	PD3	I/O	通用 GPIO
14	PD2	I/O	通用 GPIO
15	VCC	DV	电源 3.3V
16	GND	DG	电源地
17	PC0	I/O	通用 GPIO

18	PC1	I/O	通用 GPIO
19	PC2	I/O	通用 GPIO
20	PC3	I/O	通用 GPIO
21	PC4	I/O	通用 GPIO
22	PC5	I/O	通用 GPIO
23	RES	I/O	Reset 复位脚； 低电平有效；

## 6. 接口简介 Interfaces Introduction

**注：**以下接口，模块硬件支持，但要和技术确认是否软件支持，默认软件是串口透传，使用 UART TXD, UART RXD。如果用到其他接口，请和我司 FAE 确认，必要时建议回传原理图确认。

**Note:**The following interfaces are supported by the module hardware, but the software support shall be confirmed with our technology support. The default software is serial port transparent transmission, using UART TXD, UART RXD. If other interfaces are used, please confirm with our FAE. If necessary, it is recommended to send back the schematic diagram for confirmation.

### 6.1 数字输入输出引脚 Digital I/Os

SKB381 共有 16 个 GPIO，(含 2 个 SWD 调试端口复用 GPIO：PA1\_SWDCCLK, PA2\_SWDDIO)。

SKB381 has 16 GPIOs (including 2 SWD multiplexed GPIOs: PA1\_SWDCCLK, PA2\_SWDDIO) .

每个 GPIO 引脚可单独配置为输出或输入。可为每个 GPIO 引脚配置更高级的配置，包括开漏、开源和故障过滤。

Each GPIO pin can be individually configured as either an output or input. More advanced configurations including open-drain, open-source, and glitch-filtering can be configured for each individual GPIO pin.

GPIO 引脚可以被外围连接覆盖，如 SPI 通信。每个外围连接都可以路由到设备上的几个 GPIO 引脚。GPIO 引脚的输入值可以通过外围反射系统传送到其他外围设备。GPIO 子系统支持异步外部引脚中断。The GPIO pins can be overridden by peripheral connections, like SPI communication. Each peripheral connection can be routed to several GPIO pins on the device. The input value of a GPIO pin can be routed through the Peripheral Reflex System to other peripherals. The GPIO subsystem supports asynchronous external pin interrupts.



端口 A 和端口 B 上的所有引脚都支持 EM2(EM 解释见备注)。这些引脚可由 EM2/3 中的低能外围设备使用，也可用作 EM2/3 引脚唤醒。端口 C 和 D 上的引脚在进入 EM2 时锁定/保持在其当前状态，直到 EM2 退出，内部外围设备可以再次驱动这些端口。

All of the pins on ports A and port B are EM2 capable (EM explain see note) . These pins may be used by Low-Energy peripherals in EM2/3 and may also be used as EM2/3 pin wake-ups. Pins on ports C and D are latched/retained in their current state when entering EM2 until EM2 exit upon which internal peripherals could once again drive those ports.

一些 GPIO 还具有 EM4 唤醒功能。这些引脚列在备用功能表中。

A few GPIOs also have EM4 wake functionality. These pins are listed in the Alternate Function Table.

Table 6-1 SKB381 GPIO alternate function

GPIO	Altemate Function		
PC0	GPIO.EM4WU6	GPIO.THMSW_EN	GPIO.THMSW_HALFSWITCH
PC5	GPIO.EM4WU7		
PC7	GPIO.EM4WU8		
PB3	GPIO.EM4WU4		
PB1	GPIO.EM4WU3		
PB0	IADC0.VREFP		
PA0	IADC0.VREFP		
PA1	GPIO.SWDCLK		
PA2	GPIO.SWDIO		
PA3	GPIO.WWV	GPIO.TDO	GPIO.TRACEDA-TA0
PA4	GPIO.TDI	GPIO.TRACECLK	
PA5	GPIO.EM4WU0		
PD2	GPIO.EM4WU9		
PD1	LFX0.LFXTAL_I	LFX0.LF_EXTCLK	
PD0	LFX0.LFXTAL_O		

注：EM 指 Energy Mode 低功耗模式。M2/EM3 操作仅端口 A/B 上的数字外设 I/O 支持。EM0 和 EM1 中的数字外设操作所有 GPIO 端口都支持

**Note:** EM stand for Energy Mode. EM2 and EM3 operation is only supported for digital peripheral I/O on Port A and Port B. All GPIO ports support digital peripheral operation in EM0 and EM1.

## 6.2 通用同步/异步接收机/发射机 Universal Synchronous/Asynchronous Receiver/Transmitter

通用同步/异步接收器/发射器是一个灵活的串行 I/O 模块。它支持带硬件流量控制的全双工异步 UART 通信以及 RS-485、SPI、MicroWire 和 3 线。它还可以与支持以下功能的设备连接：ISO7816 SmartCards / IrDA / I2S。

The Universal Synchronous/Asynchronous Receiver/Transmitter is a flexible serial I/O module. It supports full duplex asynchronous UART communication with hardware flow control as well as RS-485, SPI, MicroWire and 3-wire. It can also interface with devices supporting: ISO7816 SmartCards / IrDA / I2S.

## 6.3 两线双向通信接口（兼容 I2C）Two-wire Interface (I2C Compatible)

I2C 模块在 MCU 和串行 I2C 总线之间提供接口。它能够同时充当主总线和从总线，并支持多主总线。支持标准模式、快速模式和快速模式加速度，允许传输速率从 10kbit/s 高达 1Mbit/s。还提供从属仲裁和超时，允许实施符合 SMBus 的系统。I2C 模块为软件提供的接口允许对传输过程进行精确的定时控制和高度自动化的传输。在活动 and 低能模式下提供从机地址的自动识别。请注意，并非所有 I2C 实例在所有能量模式下都是可用的。

The I2C module provides an interface between the MCU and a serial I2C bus. It is capable of acting as both a master and a slave and supports multi-master buses. Standard-mode, fast-mode and fast-mode plus speeds are supported, allowing transmission rates from 10kbit/s up to 1Mbit/s. Slave arbitration and timeouts are also available, allowing implementation of an SMBus-compliant system. The interface provided to software by the I2C module allows precise timing control of the transmission process and highly automated transfers. Automatic recognition of slave addresses is provided in active and low energy modes. Note that not all instances of I2C are available in all energy modes.

## 6.4 程序烧录口 Flash Program I/Os

SKB381 有两个烧录管脚，分别是 SWDCLK 和 SWDIO。这个双线串行调试接口提供了一个调试访问接口（DAP），为程序代码的非侵入性调试提供了一个灵活而强大的机制，可以支持断点调试和步进调试。建议设计时留出 4pin 接口（VCC, GND, SWDCLK, SWDIO）。

SKB381 has two programmer pins, respectively SWDCLK pin and SWDIO pin. The two pin Serial Wire Debug (SWD) interface provided as a part of the Debug Access Port (DAP) offers a flexible and powerful mechanism for non-intrusive debugging of program code. Breakpoints and single stepping are part of this support. It is suggested that a 4-pin interface (VCC,GND,SWDCLK,SWDIO) should be reserved on your design.

## 6.5 脉冲密度调制接口 Pulse Density Modulation(PDM) Interface

PDM 模块为脉冲密度调制 (PDM) 话筒、隔离的 Sigma-delta ADC、数字传感器和其他 PDM 或 Sigma-delta 位流外围设备提供串行接口和抽取滤波器。可编程级联积分器梳状 (CIC) 滤波器用于抽取输入比特流。PDM 支持立体声或单声道输入数据和 DMA 传输。

The PDM module provides a serial interface and decimation filter for Pulse Density Modulation (PDM) microphones, isolated Sigma delta ADCs, digital sensors and other PDM or sigma delta bit stream peripherals. A programmable Cascaded Integrator Comb (CIC) filter is used to decimate the incoming bit streams. PDM supports stereo or mono input data and DMA transfer.

## 6.6 模数转换 Analog to Digital Converter

IADC 是一种混合架构，结合了 SAR 和 Delta-Sigma 转换器的技术。它的分辨率高达 12 位，最高可达 1Msps。硬件过采样减少了多个前端采样的系统级噪声。空间碎片协委会包括综合电压基准。输入可从多种来源选择，包括可配置为单端或差分的引脚。

The IADC is a hybrid architecture combining techniques from both SAR and Delta-Sigma style converters. It has a resolution of up to 12bits at up to 1Msps. Hardware oversampling reduces system-level noise over multiple front-end samples. The IADC includes integrated voltage references. Inputs are selectable from a wide range of sources, including pins configurable as either single-ended or differential.

## 7. 模组参数 Module Specifications

硬件特性/Hardware Features	
模块/Model	SKB381
天线类型/Antenna Type	PCB Antenna/ External Antenna(UF.L IPEX-1)
芯片/Chip-set Solution	EFR32BG21A020F512IM32-B

电压/Voltage	1.71V~3.8V
尺寸/Dimension(L×W×H)	20.0×12.0×2.4 mm
<b>无线特性/Wireless Features</b>	
无线标准/Wireless Standards	Bluetooth 5.0
频率范围/Frequency Range	2400MHz---2483.5MHz
传输速率/Data Rates	125kbps,500kbps,1Mbps,2Mbps(Bluetooth ® 5.0)
通讯距离/Communication distance	TBD
广播距离/broadcast distance	TBD
无线安全/Wireless Security	AES HW Encryption
发射功率/Transmit Power	+0dBm to +20dBm
调制/Modulation	GFSK
接收灵敏度/Receive Sensitivity	-97.5dBm sensitivity @ 1Mbit/s GFSK1 -94.4dBm sensitivity @ 2Mbit/s GFSK -104.9dBm sensitivity @ 125kbps GFSK
工作模式/Work Mode	Central/ Peripheral (Master/ Slave device in BLE connection)
<b>功耗参数/Power Consumption</b>	
默认发射功率/Default TX	20dBm
空闲模式/Idle mode	5.0uA(EM2 Deep Sleep current [96kB RAM retention and RTC running from LFXO])
发射功耗/Transmit power consumption	60.8mA ( f=2.4 GHz, CW, 20dBm PA, 10dBm output power, PAVDD = 3.0 V )
广播功耗/Broadcast power consumption	TBD
数据连接功耗/Data connection power consumption	TBD
	TBD
	TBD
<b>其它/Others</b>	
认证/Certification	ROHS
环境/Environment	Operating Temperature: -40℃~85℃
	Storage Temperature: -40℃~125℃
	Operating Humidity: 10%~50% Non-condensing
	Storage Humidity: 5%~90% Non-condensing

**注 Note :**

1.灵敏度数值为传导测试，接入匹配网络末端。

Values collected with conducted measurements performed at the end of the matching network.

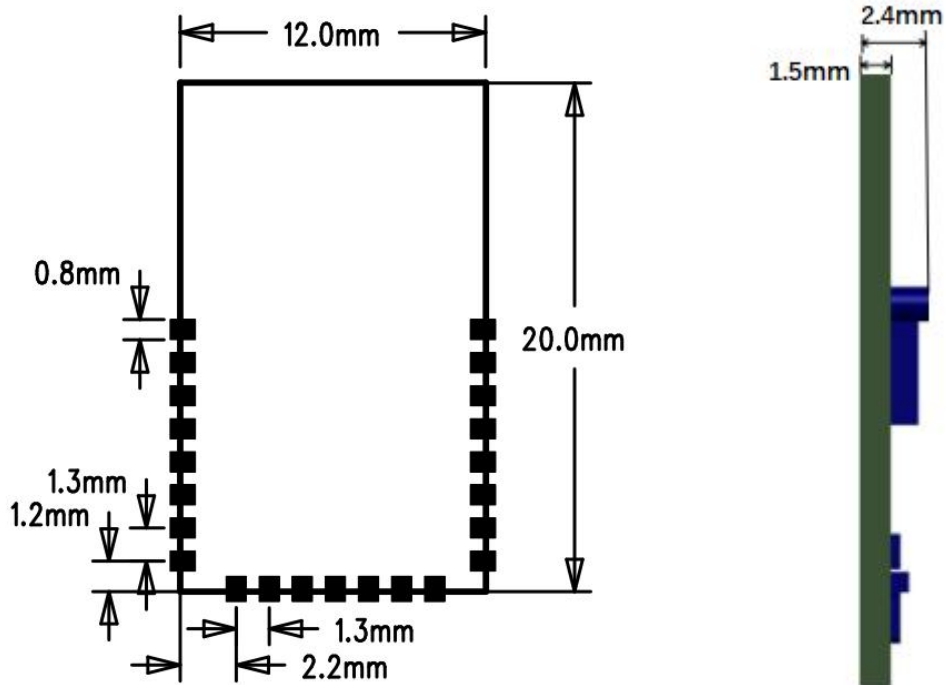
**Table9-1: 极限参数 Absolute Maximum Ratings**

Parameter	Condition	Min.	Max.	Unit	Note
Storage Temperature	T <sub>A</sub>	-40	125	°C	
Operating Temperature	T <sub>J</sub>	-40	85	°C	
Humidity	RH	0	50	%	Non-condensing, Non-biased
ESD Protection (HBM)	V <sub>ESD</sub>	TBD	TBD	V	Module pin has no internal ESD protection component. Please put them on the exposed pins (i.e. button,LED directly drive)
Supply Voltage	VCC	-0.3	3.8	V	
Voltage On Any I/O Pin	VCC <sub>IO</sub>	-0.3	VCC+0.3	V	

**Table9-2 推荐参数 Recommended Operation Ratings**

Parameter	Symbol	Min.	Type	Max.	Unit
Power Supply	VCC	1.71	3.3	3.8	V
Input Low Voltage	V <sub>IL</sub>	0	-	0.3*VCC	V
Input High Voltage	V <sub>IH</sub>	0.7*VCC	-	VCC	V
Sink/Source Current per IO pin	I <sub>IO</sub> MAX	-	-	50	mA
Sink/Source Current for all IO pins	I <sub>IO</sub> ALLMAX	-	-	200	mA

## 8. PCB 设计参考 PCB Design Guide



(PCB 板厚度也可做 1.0mm /The PCB board thickness can also be made of 1.0mm)

Figure 9 SKB381 Recommended PCB Footprint

**注:** 为加快您的设计, 我司可提供标准原理图和 PCB 封装。如有必要, 也可以回传设计图请我司技术支持人员确认。

**Note:** In order to speed up your design, we can provide standard schematic diagram and PCB package. If necessary, the design drawing can also be sent back for confirmation by our technical support personnel.

## 9. 生产过程推荐 Manufacturing Process Recommendations

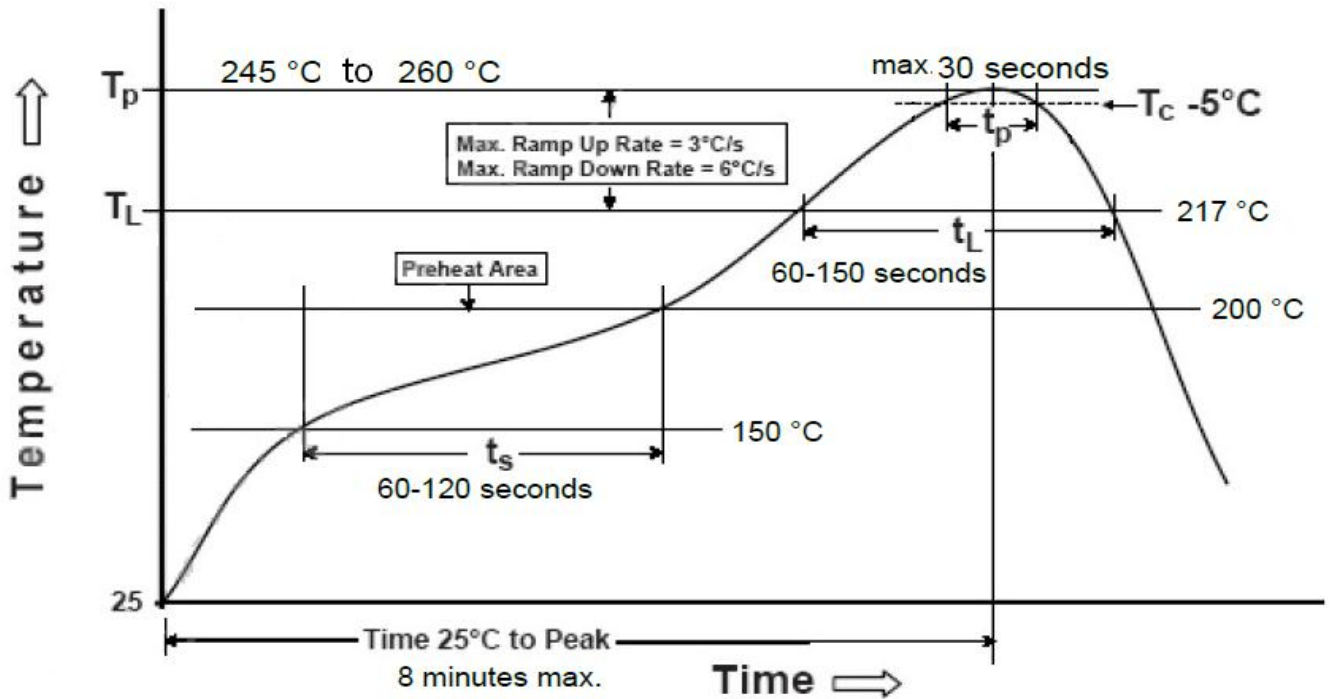


Figure 10: SKB381 Typical Lead-free Soldering Profile

### 注意:

- 1.最终的炉温曲线取决于工厂的其他因素，如锡膏的种类、尺寸、厚度、模组基板的性质等。
- 2.超出推荐炉温曲线的最高温度可能会损坏模组！

### Note:

1. The final re-flow soldering temperature map chosen at the factory depends on additional external factors, for example, choice of soldering paste, size, thickness and properties of the module's baseboard etc.
2. Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module!

## 10. 包装信息 Packaging Specification

SKB381 模块以卷轴的形式运输，每卷轴有 1040 个。每个托盘都是烘干后真空包装。

SKB381 modules are shipped in reel and with 1040 units per reel. Each tray is 'dry' and vacuum packaging.

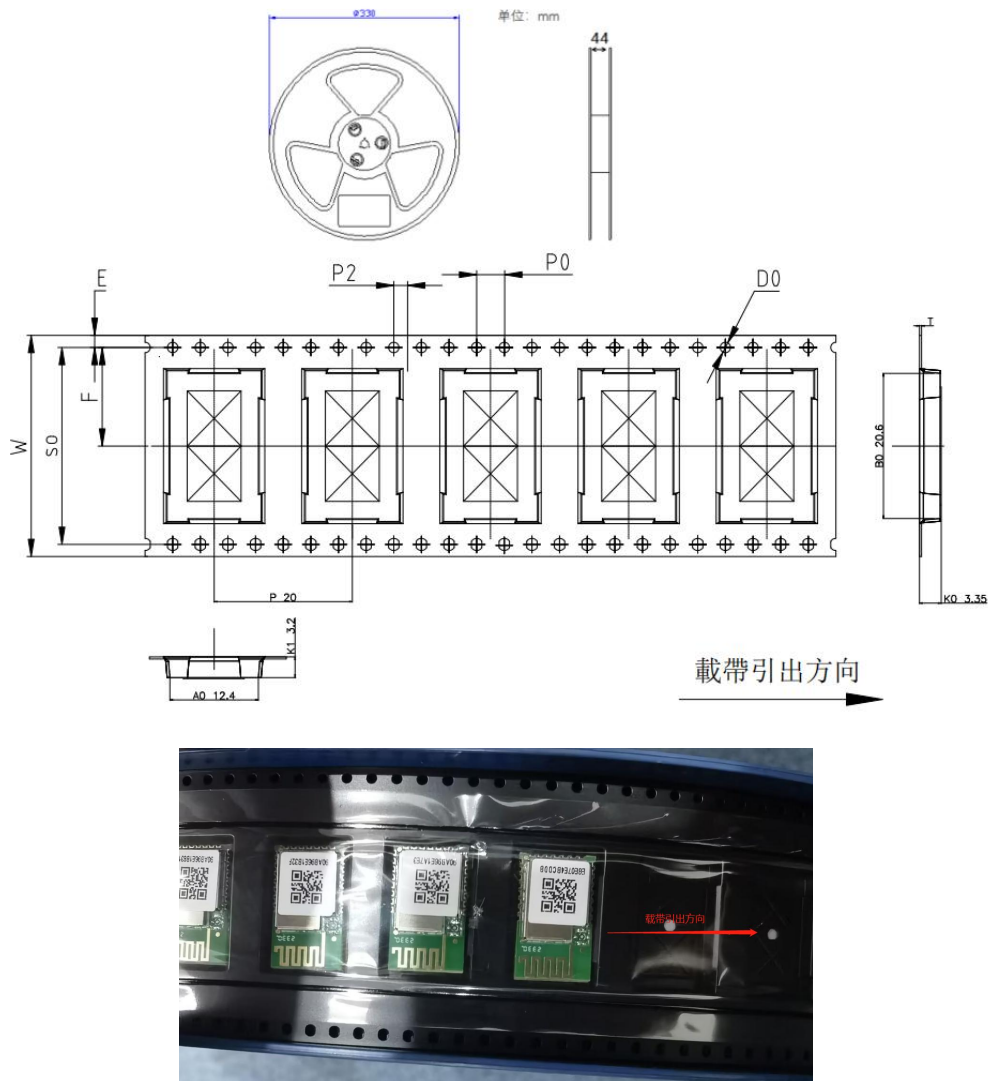


Figure 11: SKB381 Packaging

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