SKU609 规格书
超宽带模块
SKU609 Datasheet
Ultra Wideband Module

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1. 概述/General Description

SKU609 模块基于 DW1000 超宽带（UWB）收发器 IC，这是一个 IEEE 802.15.4-2011 UWB 实现。它集成了 UWB 和蓝牙®天线，所有射频电路，nRF52832 和一个运动传感器。

The SKU609 module is based on Decawave's DW1000 Ultra Wideband (UWB) transceiver IC, which is an IEEE 802.15.4-2011 UWB implementation. It integrates UWB and Bluetooth® antenna, all RF circuitry, Nordic Semiconductor nRF52832 and a motion sensor.

Figure 1-1: SKU609 Top View

2. 应用/Applications

- 医疗保健（定位资产、患者和工作人员）/ Healthcare (locate assets, patients & staff)
- 工业（资产跟踪、工厂自动化）/ Industrial (asset-tracking, factory automation)
- 零售（安全、导航、客户分析）/ Retail (security, navigation, customer analytics)
- 消费者（联网家庭、体育分析）/ Consumer (connected home, sports analytics)

3. 特性/Features

- 精度范围在 10cm 以内/ Ranging accuracy to within 10cm
- 6.8Mbps 数据速率/ 6.8Mbps data rate
- 典型的 60 米视线范围/ 60m line-of-sight range typical
- IEEE 802.15.4-2011 UWB 兼容/ IEEE 802.15.4-2011 UWB compliant
- Nordic Semiconductor nRF52832
- 蓝牙®连接/ Bluetooth® connectivity
- 蓝牙®芯片天线/ Bluetooth® chip antenna

◆ 运动传感器：3 轴加速度计/ Motion sensor: 3-axis accelerometer

◆ 为低功耗睡眠模式优化的电流消耗：<15μA / Current consumption optimised for low power sleep mode: <15μA

◆ 电源电压：2.8 V 至 3.6 V / Supply voltage: 2.8 V to 3.6 V

◆ 尺寸/ Size: 19.1 mm x 26.2 mm x 2.6 mm

3. 主要优势/Key Benefits

◆ 使锚点、标签和网关能够快速启动整个 RTLS 系统并正常运行/ Enables anchors, tags & gateways to quickly get an entire RTLS system up-and-running

◆ 加快产品设计，加快上市时间，降低开发成本/ Accelerates product designs for faster Time-to-Market & reduced development costs

◆ 无线更新/ Over-the-air updates

◆ 用户对 SKU609 固件的 API（可作为一个库），用于用户代码定制/ User API to SKU609 firmware (available as a library) for user code customisation

◆ 车载蓝牙®智能设备，用于连接手机/平板电脑/个人电脑/ On-board Bluetooth® SMART for connectivity to phones/tablets/PCs

◆ 使用 SPI、UART 和蓝牙®API，可从外部设备访问 SKU609 固件/ SPI, UART and Bluetooth® APIs to access SKU609 firmware from an external device

◆ 低功耗硬件设计和软件架构，以延长电池寿命/ Low-power hardware design and software architecture for longer battery life

4. 应用框图/Applications Block Diagram

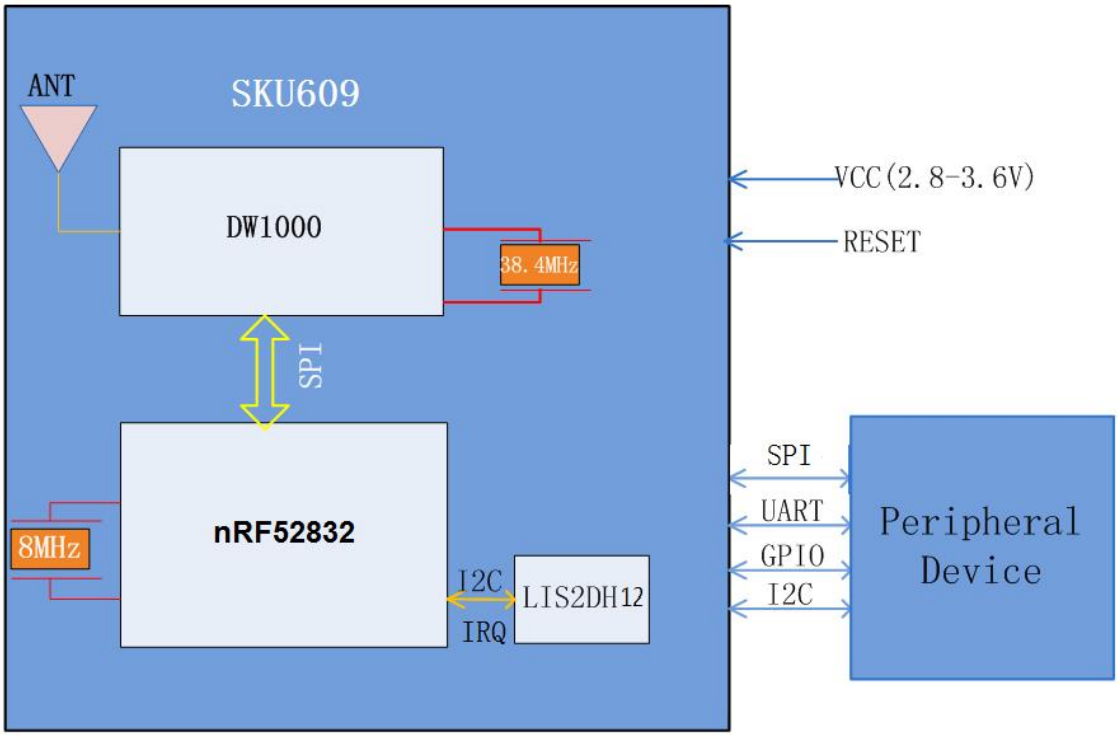

Figure 4-1: SKU609 Block Diagram

5. 电器特性/Electrical Specification

下表给出了 SKU609 模块的详细规格说明。Tamb = 25℃，适用于所有规格。

The following tables give detailed specifications for the SKU609 module. Tamb = 25 ˚C for all specifications given.

5.1 工作条件/ Operating Conditions

Table 5-1: SKU609 工作条件/SKU609 Operating Conditions

参数/Parameter	Min.	Type	MAX.	Units	条件和注意事项/Condition/Note
Operating temperature	-40		+85	℃	
Supply voltage VCC	2.8	3.3	3.6	V	正常工作/Normal operation
Voltage on VDDIO for programming OTP	3.7	3.8	3.9	V	电源连接到 SKU609 中的 OTP，该电源连接到位于 PCB 下面的 VDDIO 测试点/Supply is connected to the OTP in the SKU609 this supply is connected to the VDDIO test point which is underneath the PCB

5.2 直流特性/ DC Characteristics

Table5-2: SKU609 Receiver DC Characteristics

参数/Parameter	Min.	Type	Max.	Units	条件和注意事项/Condition/Note
Supply current in DEEPSLEEP mode		4		μA	所有外设在最低功耗模式可实现，RTC 和加速计被禁用与自定义固件。/ All peripherals in lowest power consumption mode Achievable where RTC and accelerometer are disabled with custom firmware.
Supply current in DEEP SLEEP mode		12		μA	RTC 和加速度计运行，所有其他外设在最低功耗模式/ RTC and accelerometer operational, all other peripherals in lowest power consumption mode
Supply current in IDLE mode		13		mA	MCU 和 DW1000 唤醒/ MCU and DW1000 awake
TX peak current		111		mA	
TX mean current		82		mA	
RX peak current		154		mA	
RX mean current		134		mA	
Current in Bluetooth® discovery mode		6		mA	
Digital input voltage high	0.7		VCC	V	
Digital input voltage low	GND		0.3	V	
Digital output voltage high	0.7		VCC	V	
Digital output voltage low	GND		0.3	V	

5.3 接收机交流特性/Receiver AC Characteristic

Table 5-3: SKU609 接收机交流特性/SKU609 Receiver AC Characteristic

参数/Parameter	Min.	Type	Max.	Units	条件和注意事项/Condition/Note
Frequency range	6240		6739.2	MHz	Centre Frequency 6489.6 MHz (only in china）
Frequency range	3774		4243.2	MHz	Centre Frequency 3993.6 MHz

5.4 接收机灵敏度特性/Receiver Sensitivity Characteristics

测试条件 25℃，20 字节 payload 长度。天线增益 0dBi，方向应根据天线方向性调整到 SKU609 合适的位置。

Tamb = 25 ˚C, 20 byte payload. These sensitivity figures assume an antenna gain of 0 dBi and should be modified by the antenna characteristics, depending on the orientation of the SKU609.

Table 5-4: SKU609 Typical Receiver Sensitivity Characteristics

丢包率/ Packet Error Rate	数据速率/ Data Rate	接收灵敏度/ Receiver Sensitivity	单位/ Units	测试条件备注/ Condition/Note		
1%	6.8Mbps	-98*(-92)	dBm/500 MHz	Preamble 128	Carrier frequency offset ±10ppm	所有测试基于通道 5，PRF64MHz/ All measurements performed on Channel 5, PRF 64MHz
10%	6.8Mbps	-99*(-93)	dBm/500 MHz	Preamble 128		

*智能发射增益使能后的等效灵敏度. 标准固件默认打开。

*equivalent sensitivity with Smart TX Power enabled. This is enabled in the onboard firmware.

5.5 发射机交流特性/Transmitter AC Characteristics

Table 5-5: SKU609 Transmitter AC Characteristics

参数/ Parameter	最小值/ Min.	典型值/Typ.	最大值/ Max.	单位/ Units	备注/ Note
Output power spectral density			-41.3*	dBm/MHz	
Output Channel Power		-17		dBm/500MHz	

*如果使用预先集成到模块中的软件。

* If using the pre-loaded embedded firmware of the SKU609 module.

5.6 绝对最大额定参数/Absolute Maximum Ratings

Table 5-6: SKU609 Absolute Maximum Ratings

Parameter	Min.	Max.	Units
供电电压/ Supply voltage	2.8	3.9	V
接收电平/ Receiver power		0	dBm
存储温度/ Storage temperature	-40	+125	˚C
工作温度/ Operating temperature	-40	+85	˚C
ESD (Human Body Model)		2000	V
除 VBAT，3V3_OUT，GND 外其他脚的电平/ SKU609 pins other than VCC, VDDIO and GND		3.6	Note that 3.6 V is the max voltage that may be applied to these pins

超出上述电压、功率、温度范围时，可能会导致模块永久失效。上述仅仅是极限参数，正常工作范围外极限范围内的操作条件本规格书不提供保证。长时间暴露在这些条件下可能影响到设备的可靠性。

Stresses beyond those listed in this table may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions beyond those indicated in the operating conditions of the specification is not implied. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

6 模块引脚介绍/Module Pinout and Pin Description

6.1 引脚分布/Module Pinout

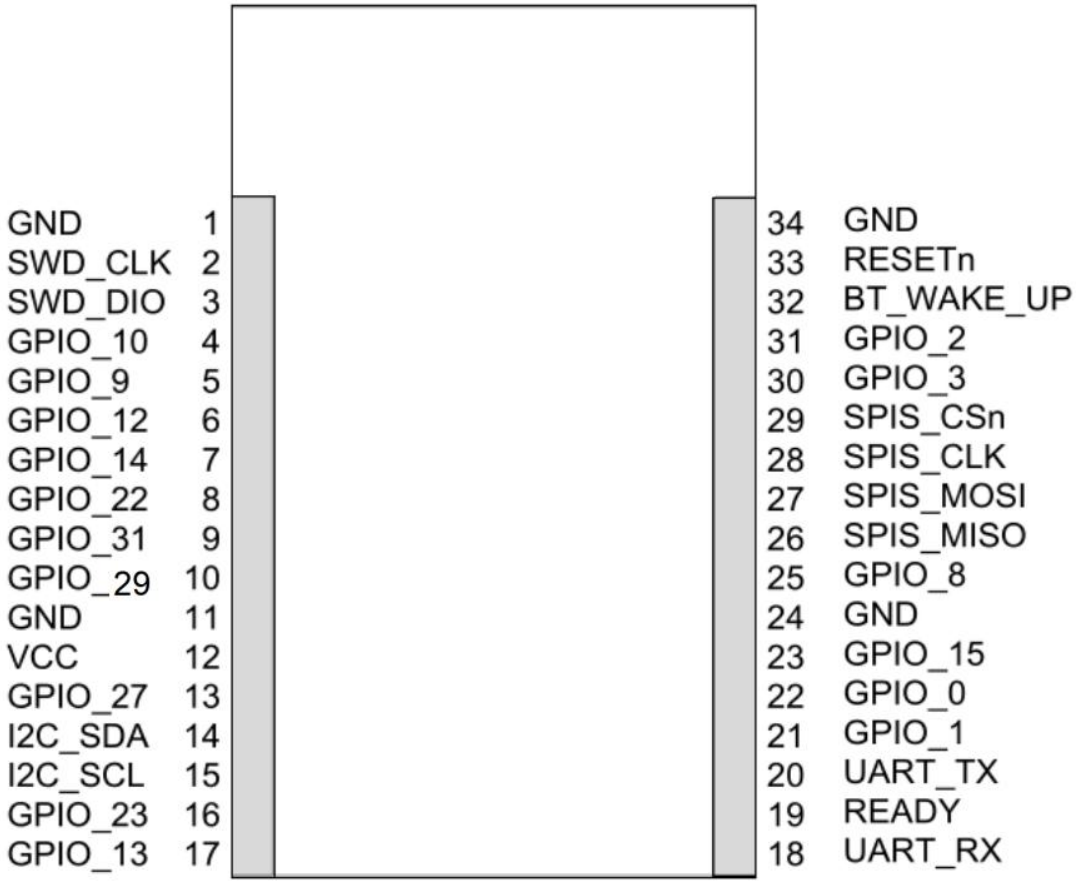

Figure 6-1: SKU609 Module Pinout (TOP View)

6.2 引脚描述/Pin Description

Table 6-1: SKU609 Pin Description

Pin No.	Pin Name	I/O	Description
1	GND	G	接地/ Common ground
2	SWD_CLK	P	处理器调试和编程的串行线调试时钟输入。/ Serial wire debug clock input for debug and programming of Nordic Processor.
3	SWD_DIO	DIO	处理器调试和编程的串行线调试 I/O / Serial wire debug I/O for debug and programming of Nordic Processor
4	P0.10	DIO	通用 I/O 引脚/ General purpose I/O pin.
5	P0.09	DIO	通用 I/O 引脚/ General purpose I/O pin.
6	P0.12	DIO	通用 I/O 引脚/ General purpose I/O pin.
7	P0.14	DIO	通用 I/O 引脚/ General purpose I/O pin.
8	P0.22	DIO	通用 I/O 引脚/ General purpose I/O pin.

9	P0.31	DIO	通用 I/O 引脚。nRF52 的 ADC 功能/ General purpose I/O pin. ADC function of nRF52
10	P0.29	DIO	通用 I/O 引脚。nRF52 的 ADC 功能/ General purpose I/O pin. ADC function of nRF52
11	GND	G	接地/ Common ground
12	VCC	P	外部电源: 2.8V - 3.6V / External supply for the module. 2.8V - 3.6V
13	GPIO_27	DIO	通用 I/O 引脚/ General purpose I/O pin
14	I2C_SDA (Master)	DIO	P0.30；主 I2C 数据线。内部连接到 LIS2DH12 SDA。如果不使用，请保持悬空。/ P0.30; Master I2C Data Line.Internal connected to LIS2DH12 SDA.Leave unconnected if not used.
15	I2C_SCL (Master)	DO	P0.28；主 I2C 时钟线。内部连接到 LIS2DH12 SCL。如果不使用，请保持悬空。/ P0.28; Master I2C Clock Line.Internal connected to LIS2DH12 SCL.Leave unconnected if not used.
16	P0.23	DIO	通用 I/O 引脚。如果不使用，请保持悬空。/ General purpose I/O pin. Leave unconnected if not used.
17	P0.13	DIO	通用 I/O 引脚。如果不使用，请保持悬空。/ General purpose I/O pin. Leave unconnected if not used.
18	UART_RX	DI	UART_RX
19	READY	DO	从设备中产生的中断。指示诸如 SPI 数据就绪或位置数据就绪等事件。/ Generated interrupt from the device.Indicates events such as SPI data ready, or location data ready.
20	UART_TX	DIO	ADC 功能 / This is also the ADC function of the nRF52832
21	GPIO1	DIO	DW1000 的通用 I/O 引脚。它可以被配置为作为 SFDLED 驱动销，当接收器找到 SFD（开始帧分隔器）时，可用于点亮 LED。如果不使用，请保持悬空。/ General purpose I/O pin of the DW1000.It may be configured for use as a SFDLED driving pin that can be used to light a LED when SFD (Start Frame Delimiter) is found by the receiver. Leave unconnected if not used.
22	GPIO0	DIO	DW1000 的通用 I/O 引脚。它可以被配置为 RX OK LED 驱动针，可用于在接收到良好的帧时点亮 LED。如果不使用，请保持悬空。/ General purpose I/O pin of the DW1000.It may be configured for use as a RX OK LED driving pin that can be used to light a LED on reception of a good frame. Leave unconnected if not used.
23	P0.15	DIO	通用 I/O 引脚。如果不使用，请保持悬空。/ General purpose I/O pin. Leave unconnected if not used.

24	GND	G	接地/ Common GND
25	P0.08	DIO	通用 I/O 引脚。如果不使用，请保持悬空。/ General purpose I/O pin. Leave unconnected if not used.
26	SPIS_MISO (P0.07)	DIO	配置为 SPI 从端，此引脚是 SPI 数据输出。如果不使用，请保持悬空。/ Configured as a SPI slave this pin is the SPI data output. Leave unconnected if not used.
27	SPIS_MOSI (P0.06)	DO	配置为 SPI 从端，该引脚是 SPI 数据输入。如果不使用，请保持悬空。/ Configured as a SPI slave this pin is the SPI data input. Leave unconnected if not used.
28	SPIS_CLK (P0.04)	DI	被配置为一个 SPI 从属程序，这个引脚是 SPI 时钟。这也是 nRF52 的 ADC 函数。如果不使用，请保持悬空。/ Configured as a SPI slave this pin is the SPI clock. This is also the ADC function of the nRF52.Leave unconnected if not used.
29	SPIS_CSn (P0.03)	DI	配置为一个 SPI 从属器，这个引脚是 SPI 芯片的选择。这是一个活动的低启用输入。SPICSn 上的高到低转换标志着一个新的 SPI 事务的开始。这也是 nRF52 和深度睡眠状态的 ADC 功能，可能导致虚假中断，除非拉低。如果不使用，请保持悬空。/ Configured as a SPI slave this pin is the SPI chip select. This is an active low enable input. The high-to-low transition on SPICSn signals the start of a new SPI transaction. This is also the ADC function of the nRF52 and DEEPSLEEP states and may cause spurious interrupts unless pulled low.Leave unconnected if not used.
30	GPIO3	DO	它可以被配置为作为 TXLED 驱动针，可用于照亮传输后的 LED。如果不使用，请保持悬空。/ It may be configured for use as a TXLED driving pin that can be used to light a LED following a transmission.Leave unconnected if not used.
31	GPIO2	DO	此针配置为 TXLED 驱动针，可用于在发射模式期间点亮 LED。如果不使用，请保持悬空。/ This pin is configured for use as a TXLED driving pin that can be used to light a LED during transmit mode.Leave unconnected if not used.
32	BT_WAKE_ UP (P0.02)	DI	当该引脚被断言为其活动低状态时，蓝牙设备将通过广播广告包来宣传其可用性 20 秒。这也是 nRF52832 的 ADC 函数。如果不使用，请保持悬空。/ When this pin is asserted to its active low state the Bluetooth device will advertise its availability for 20 seconds by broadcasting advertising packets. This is also the ADC function of the nRF52832.Leave unconnected if not used.

33	RESETn	DI	重置引脚。活动低输入。如果不使用，请保持悬空。/ Reset pin. Active Low Input. Leave unconnected if not used.
34	GND	G	接地/ Common ground.

(1) P：电源/ Power supply

(2) DI：默认输入/ Default Input

(3) DO：默认输出/ Default Output

(4) DIO：默认输入/输出/ Default Input/Output

(5) G：接地/ Ground

Table 6-2: Internal nRF52832 pins used and their function

nRF52832 Pin	Function
P0.19	DW_IRQ
P0.16	DW_SCK
P0.20	DW_MOSI
P0.18	DW_MISO
P0.17	DW_SPI_CS
P0.24	DW_RST
P0.25	ACC_IRQ
P0.30	I2C_SDA
P0.28	I2C_SCL

DW1000 的 GPIOs 5，6 控制 DW1000 SPI 模式的配置。在 DWM1001 模块中，这些 GPIO 未连接并将在内部下拉。因此，SPI 将被设置为模式 0。

DW1000's GPIOs 5, 6 control the DW1000 SPI mode configuration. Within the DWM1001 module, those GPIOs are unconnected and will be internally pulled down. Consequently, SPI will be set to mode 0.

Table6-3: I2C slave devices address I2C

I2C slave device	Address
LIS2DH12	0X19

7 PCB 设计指南/PCB Design Guide

在设计将 SKU609 焊接的 PCB 时，需要仔细考虑 SKU609 板载陶瓷单极子天线与金属和其他非射频透明材料的接近程度。下面是两种建议的安置方案。在“隔离区域”标记区域，两侧上方或下方不得应有金属（例如不要将电池放置在天线下方）。图 7-1 中的放置方案显示了一个在隔离区域没有非射频透明材料的应用板，或一个天线突出离开隔离板的应用板，使隔离区域处于自由空间。在这第二种方案中，在系统实现中，不要将金属组件放置在天线的上方或下方仍然是很重要的。

When designing the PCB onto which SKU609 will be soldered, the proximity of the SKU609 on-board ceramic monopole antenna to metal and other non-RF transparent materials needs to considered carefully. Two suggested placement schemes are shown below. In the areas marked “Keep-Out Area” there should be no metal either side, above or below (e.g. do not place battery under antenna).The placement schemes in Figure 7-1 show an application board with no non-RF transparent material in the keep-out area, or an application board with the antenna projecting off of the board so that the keep out area is in free-space. In this second scheme it is still important not to place metal components above or below the antenna in a system implementation.

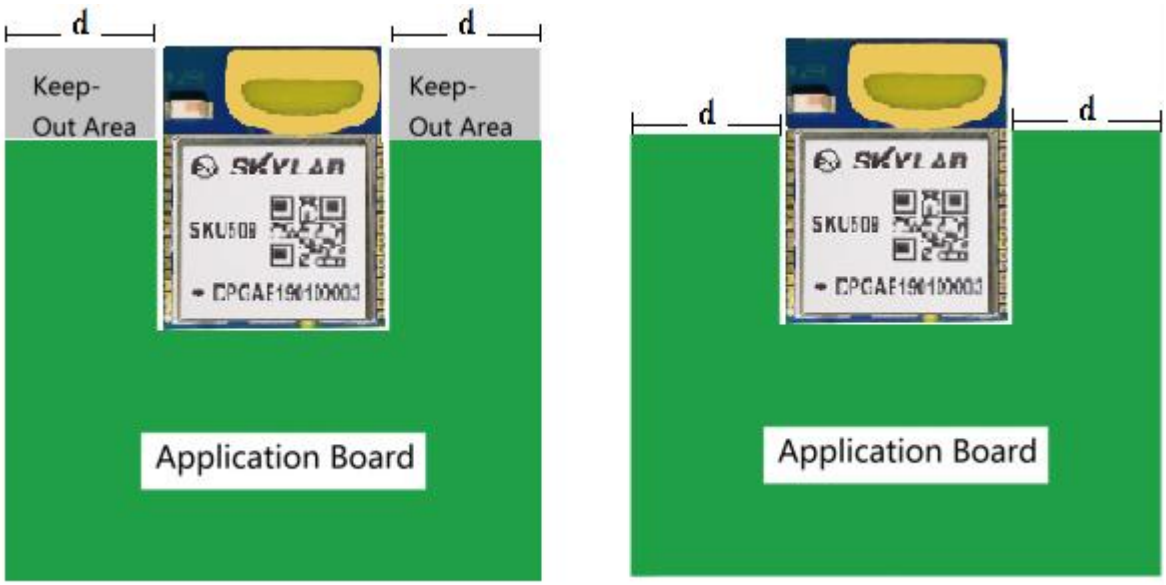

Figure 7-1: SKU609 Typical Lead-free Soldering Profile

8 PCB 封装和尺寸/PCB Footprint and Dimensions

8.1 模块尺寸图/Module Drawings

所有的测量值都以毫米为单位。/ All measurements are given in millimetres.

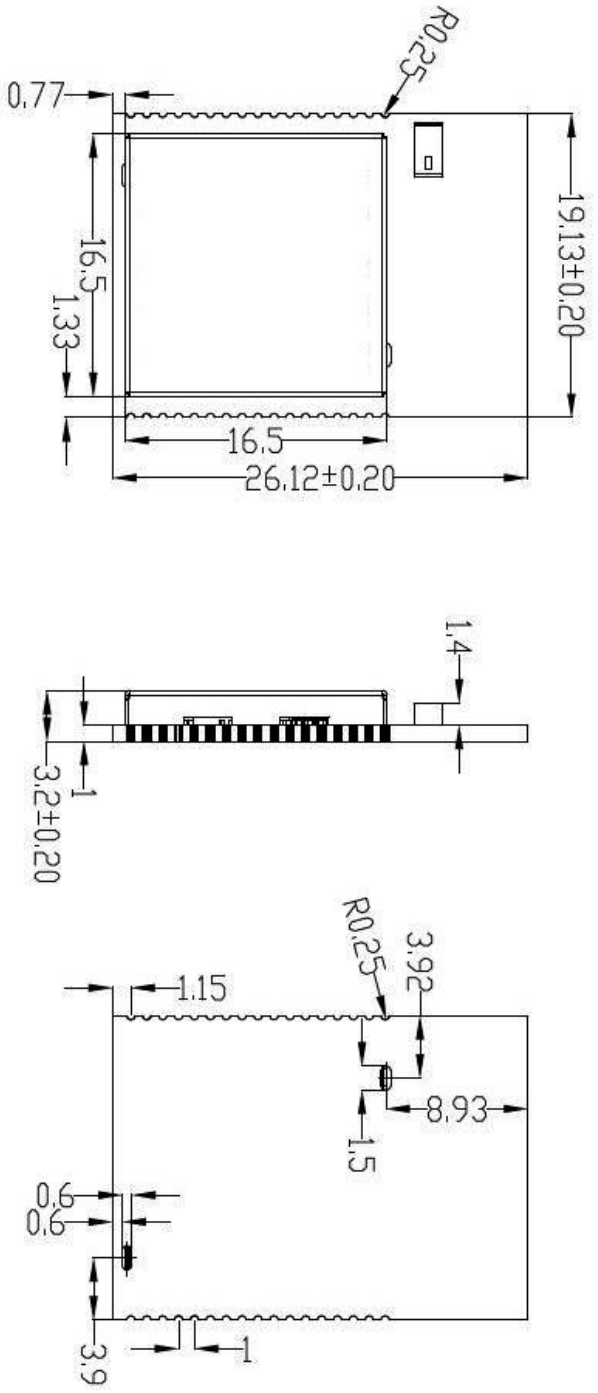

Figure 8-1: SKU609 PCB Footprint and Dimensions(units: mm)

8.2 模块封装图/Module Land Pattern

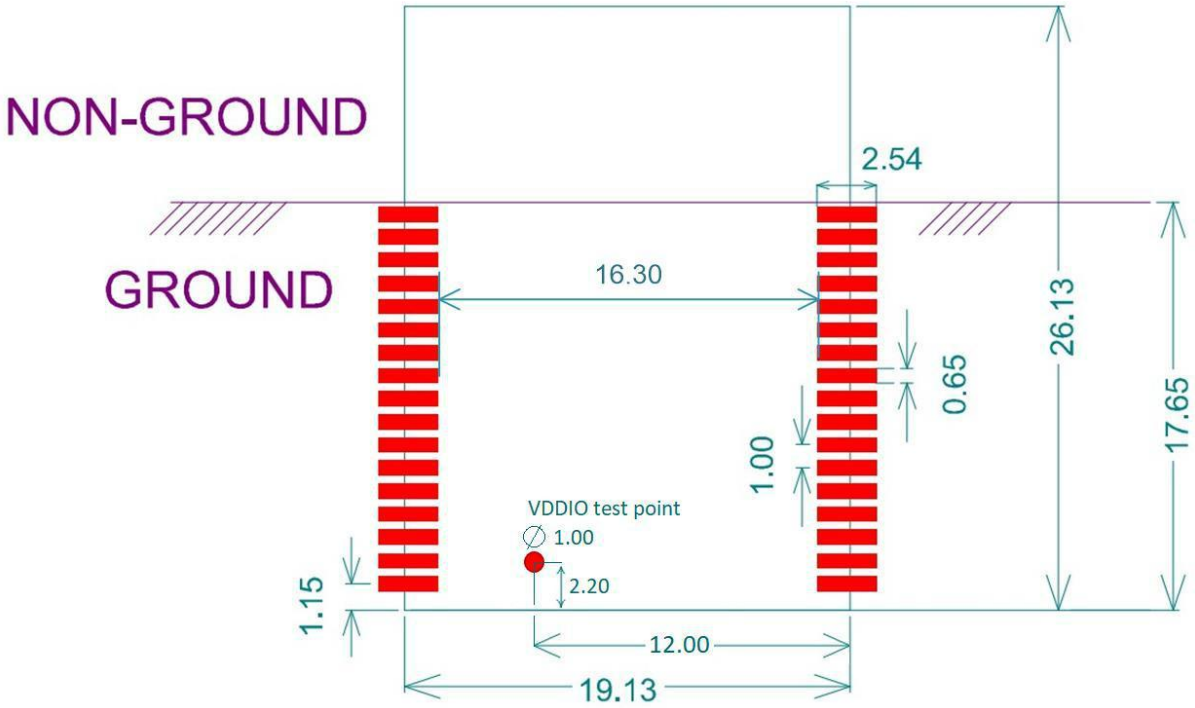

Figure 8-2: SKU609 Module Land Pattern (units: mm)

9 制造工艺的建议/Manufacturing Process Recommendations

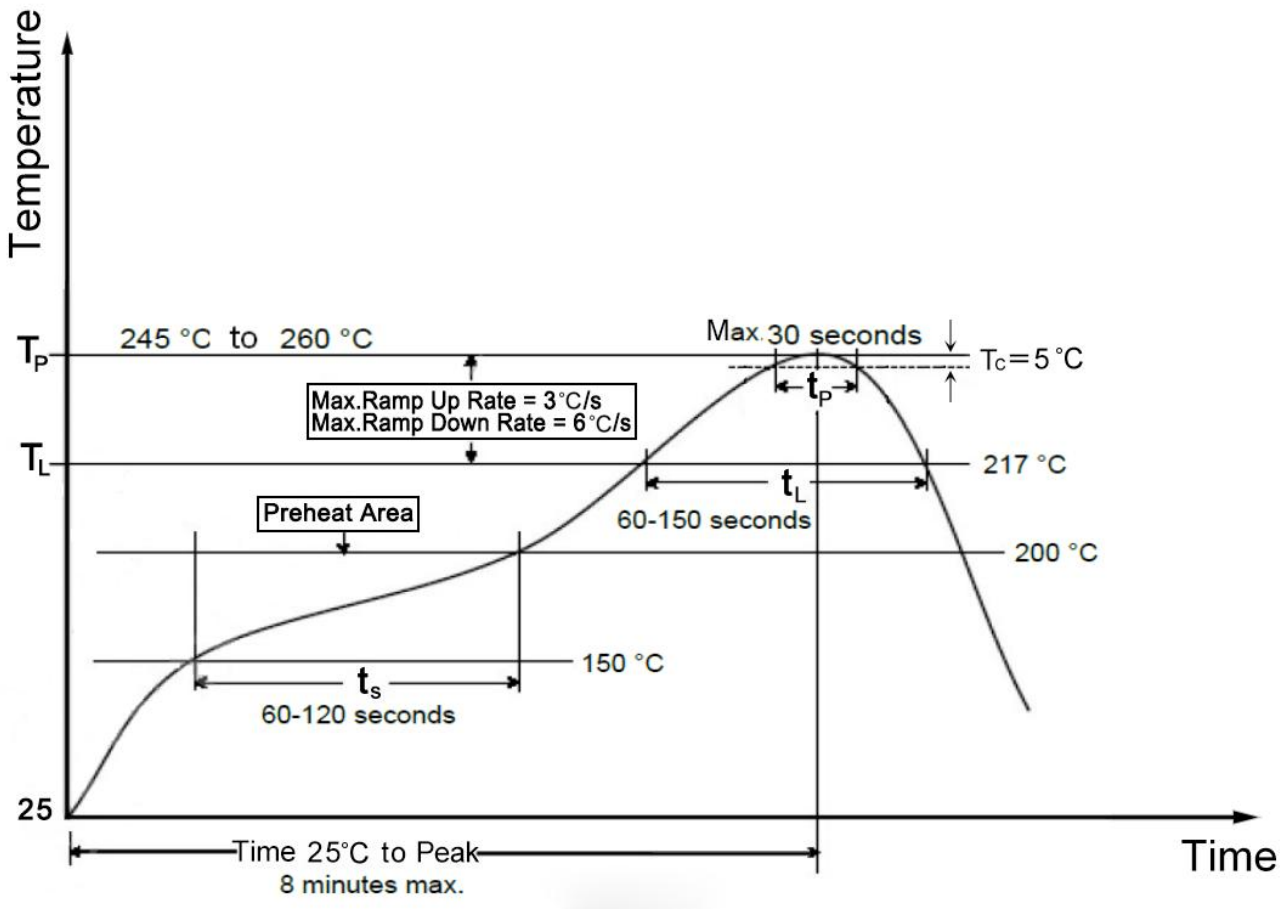

Figure 9-1: SKU609 Typical Lead-free Soldering Profile

注：在工厂选择的最终再流焊接温度图取决于其他外部因素，例如，焊膏的选择、尺寸、厚度和模块底板的性能等。超过推荐焊接轮廓线中的最大焊接温度可能会永久损坏模块。

Note： 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. Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module.

10 包装规范/Packaging Specification

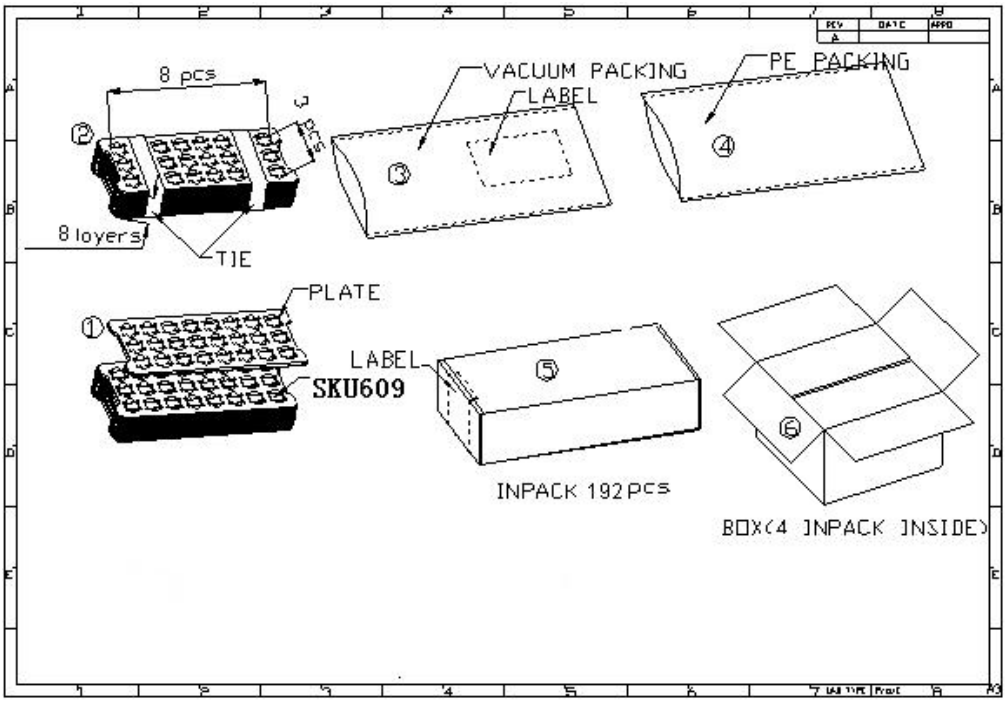

Figure10-1: SKU609 Packaging

SKU609 模块被放入托盘中，每个托盘有 528 个单元。每个托盘都是“干燥的”和真空包装的。SKU609 系列模块是静电敏感设备，在处理时需要特殊的注意事项。

SKU609 modules are put into tray and 528 units per tray. Each tray is ‘dry’ and vacuum packaging. SKU609 series modules are Electrostatic Sensitive Devices and require special precautions while handling.

ESD 预防措施/ESD precautions

SKU609 模块包含高灵敏度的电子电路，是静电敏感器件（ESD）。在没有适当的 ESD 保护的情况下处理 SKU609 模块可能会永久破坏或损坏它们。

The SKU609 modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling the SKU609 modules without proper ESD protection may destroy or damage them permanently.

SKU609 模块是静电敏感器件（ESD），需要特殊的 ESD 预防措施，通常适用于 ESD 敏感组件。在任何包含 SKU609 模块的应用程序的处理、处理、运输和操作过程中，都必须采用适当的 ESD 处理和包装程序。不要用手或非防静电焊铁接触模块，以免损坏模块。

The SKU609 modules are electrostatic sensitive devices (ESD) and require special ESD precautions typically applied to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling, transportation and operation of any application that incorporates the SKU609 module. Don't touch the module by hand or solder with non-anti-static soldering iron to avoid damage to the module.

11 联系信息/Contact Information

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