



DX-WF24

Wi-Fi/Bluetooth 2-in-1

Module Technical Manual

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contents

1. Module Introduction	5 -
1.1. Overview -	5 -
1.2. Features	5 -
1.3. Application	6 -
1.4. Functional Block Diagram	6 -
1.5. Basic parameters	7 -
2. Application Interface	8 -
2.1. Module pin definition	8 -
2.2. Pin Definition	9 -
2.3. Power supply design	10 -
2.4. Hardware physical interface	12 -
2.5. Reference connection circuit	16 -
3. Electrical characteristics , RF characteristics and reliability	18 -
3.1. Maximum Ratings	18 -
3.2. ESD Rating	18 -
3.3. Recommended conditions of use	18 -
3.4. Digital LDO	19 -
3.5. Electrostatic Protection	19 -
4. Mechanical dimensions and layout recommendations	20 -
4.1. Module Mechanical Ruler	20 -
4.2. Recommended package	20 -
4.3. Module top view/bottom view	21 -
4.4. Hardware Design Layout Recommendations	21 -
5. Storage, production and packaging	22 -
5.1. Storage conditions	22 -
5.2. Module baking process	23 -
5.3. Reflow Oven	23 -
5.4. Packaging Specifications	24 -

Table Index

Table 1 : Basic parameter table	- 7 -
Table 2 : Pin Definition Table	- 9 -
Table 3 : Power Interface Pin Definition Table	- 10 -
Table 4 : CEN pin definition table	- 11 -
Table 5 : KEY pin definition table	- 12 -
Table 7 : Absolute Maximum Ratings Table	- 18 -
Table 8 : ESD Ratings	- 18 -
Table 9 : Recommended operating conditions	- 18 -
Table 10 : Digital LDO	- 19 -
Table 11 : ESD withstand voltage of module pins	- 19 -

Image Index

Figure 1 : Functional Block Diagram	- 7 -
Figure 2 : Module pin definition	- 8 -
Figure 3 : Burst Transmission Power Requirements	- 10 -
Figure 4 : Power supply reference circuit	- 10 -
Figure 5 : Reset Reference Circuit	- 11 -
Figure 6 : Push button reset reference circuit	- 11 -
Figure 7 : KEY Reference Circuit	- 12 -
Figure 8 : KEY reset reference circuit	- 12 -
Figure 9 : I2C communication timing diagram	- 13 -
Figure 10 : I2C Slave Timing Diagram	- 14 -
Figure 11 : SPI communication timing diagram	- 15 -
Figure 12 : SPI Slave Block Diagram	- 15 -
Figure 13 : 8-Byte Control Type	- 15 -
Figure 14 : 4-Byte Control Type	- 15 -
Figure 15 : SPI Slave Timing Diagram	- 16 -
Figure 16 : Typical Application Circuit	- 17 -
Figure 17 : Serial port level conversion reference circuit	- 17 -
Figure 18 : Module top and side view dimensions	- 20 -
Figure 19 : Recommended Package Dimensions	- 20 -
Figure 20 : Module top and bottom views	- 21 -
Figure 21 : Module placement reference position	- 22 -
Figure 22 : Recommended reflow temperature profile	- 24 -
Figure 23 : Carrier tape dimensions (unit: mm)	- 25 -
Figure 24 : Reel dimensions (unit: mm)	- 25 -
Figure 25 : Tape Direction	- 26 -

1. Module Introduction

1.1. Overview

DX- WF24 It is a Wi-Fi / Bluetooth two-in-one module , which is developed by Shenzhen Daxia Longque Technology Co., Ltd. for intelligent wireless data transmission. It uses the BK7238 chip. It is a highly integrated single-chip Wi-Fi 802.11n and Bluetooth low energy (BLE) 5.2 combination solution, designed for applications that require Wi-Fi / Bluetooth two-in-one and compact size. It integrates a powerful 32-bit MCU and a comprehensive set of peripheral interfaces . This module supports interfaces such as UART, SPI, I2C, supports IO port control, ADC acquisition, and has the advantages of low power consumption, high performance, and high speed. In addition to having a wealth of peripheral interfaces, the module also has powerful signal processing capabilities and is suitable for a variety of application scenarios such as the IoT field, such as smart lighting, smart home, indoor positioning, and other complex IoT applications.

1.2. Features

Wi-Fi :

- Features Wi-Fi compliant with IEEE 802.11 b/g/n 1x1 standard
- Supports 20 MHz channels
- Support working modes STA, AP, AP+STA
- Transmit power up to +19 dBm
- Receive sensitivity -99 dBm

Bluetooth BLE :

- Support 5.2 Bluetooth protocol
- Supports Bluetooth Low Energy (LE), 1 Mbps, 2 Mbps, long range (125 kbps and 500 kbps)
- Broadcast Extensions
- Bluetooth Direction Finding: Angle of Arrival (AoA) and Angle of Departure (AoD)
- Supports up to 16 antenna arrays for precise indoor positioning Integrated Bluetooth LE/WLAN coexistence (PTA)



Memory:

- 32-bit MCU, up to 160 MHz
- 2 MB SiP Flash
- 288 KB RAM
- UART/JTAG for downloading and debugging

Clock Management :

- External oscillator: 26 MHz crystal oscillator (X26M)
- Internal oscillator : 26 ~ 160 MHz digitally controlled oscillator (DCO) , 32 kHz ring oscillator (ROSC)
- 480 MHz DPLL

Power Management:

- Operating voltage: 2.7 V ~3.6 V (reference value: 3.3 V)
- On-chip Power-On Reset (POR) and Brown-Out Detector (BOD)
- Embedded LDO Regulator
- Onboard PCB antenna/external antenna optional
- Operating temperature range : -40 ~ +105°C

1.3. application

- Camera video streaming
- Smart Building
- Smart Agriculture
- Health/Medical/Nursing
- Wearable Electronics
- Home Automation
- OTT TV Box/Set-Top Box Devices
- automated industry
- Audio equipment
- Wi-Fi Toys
- Retail & Catering

1.4. Functional Block Diagram

The figure below is the functional block diagram of the DX- WF24 WIFI module, which explains its main functions as follows:

- Power supply
- Baseband
- Memory
- RF Part
- Peripheral Interface

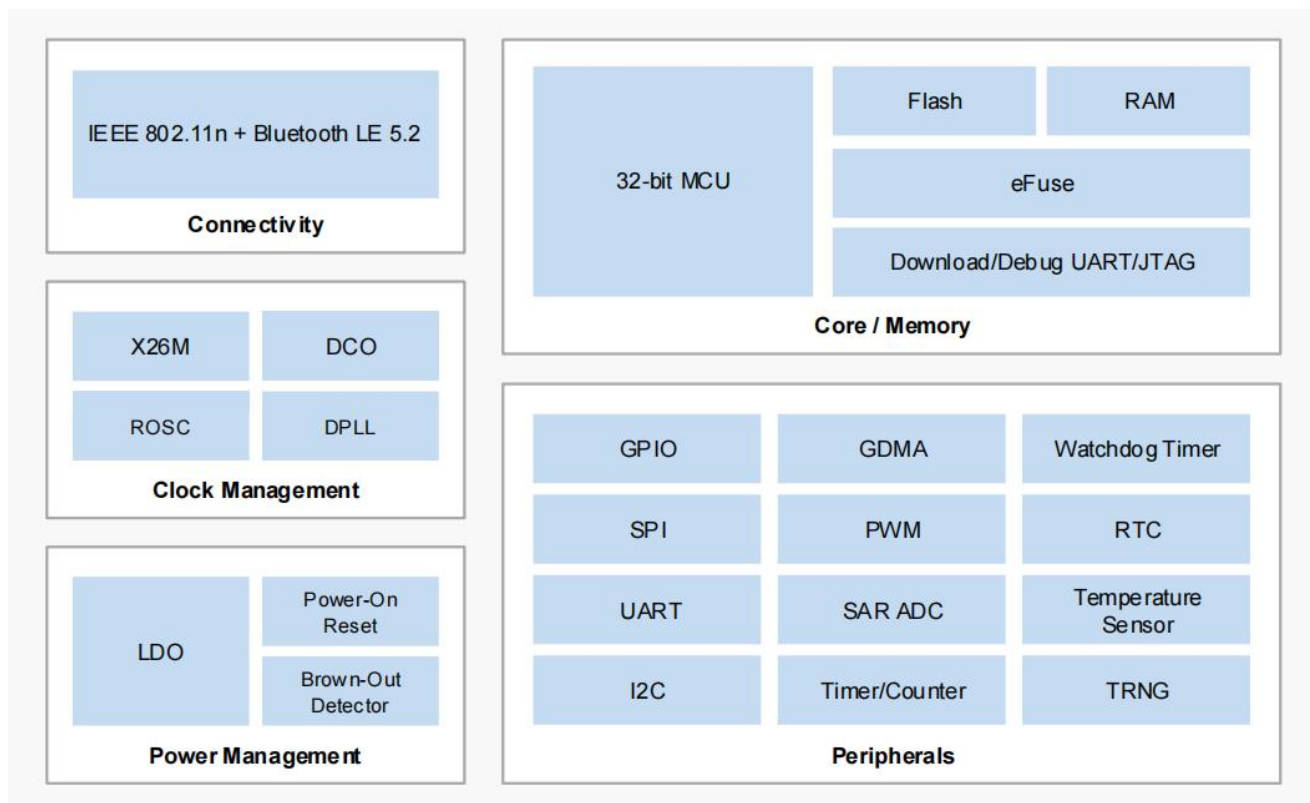


Figure 1 : Functional Block Diagram

1.5. Basic parameters

Table 1 : Basic parameter table

parameter name	Details	parameter name	Details
Chip model	BK7238	Module Model	DX- WF24
Modulation	OFDM, MCS0(GF), MCS7(GF)	Module size	22 (L) × 15.2 (W) × 2.2 (H) mm
Operating Voltage	3.3V	protocol	IEEE 802.11 b/g/n
Sensitivity	-99 dBm	Transmit power	+19 dBm
RF input impedance	50Ω	Frequency band	2402 ~ 2480MHz



Antenna interface	Onboard antenna/External antenna (optional)	Hardware Interface	GDMA, SPI, RTC, PWM, UART, ADC, TRNG, I2C,
Operating temperature	MIN : -40℃ - MAX : + 105 ℃	humidity	10%-95% non-condensing

2. Application Interface

2.1. Module pin definition

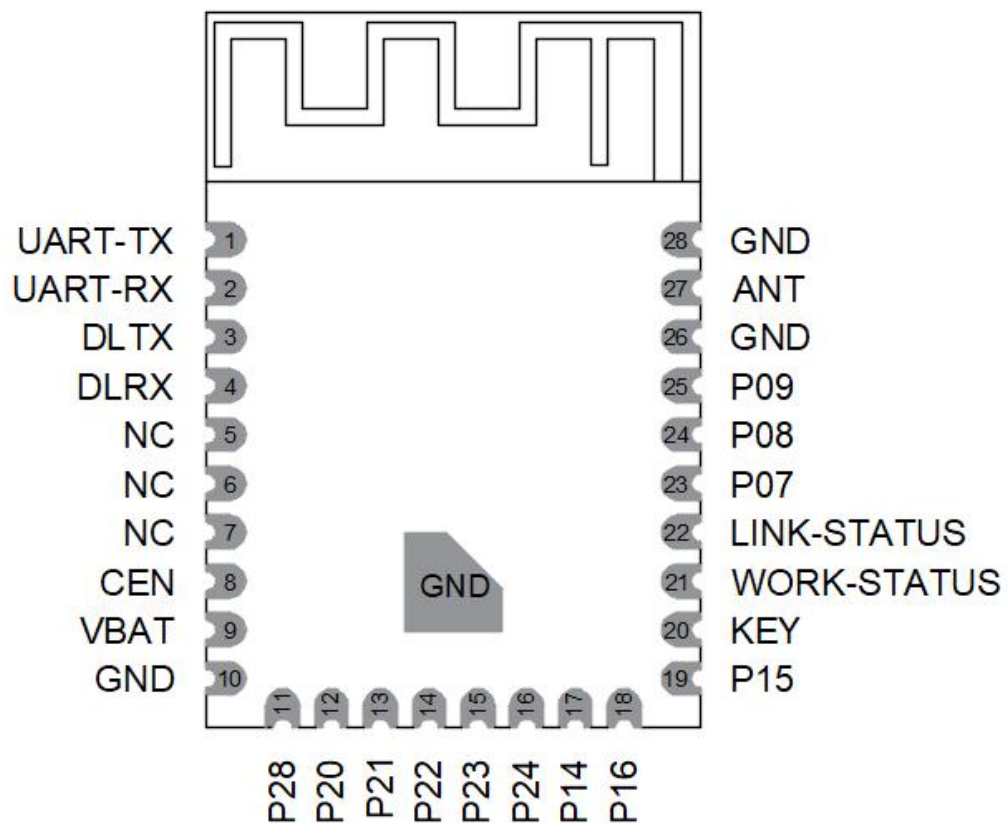


Figure 2 : Module pin definition

2.2. Pin Definition

Table 2 : Pin definition table

Pin number	Pin Name	Pin Function	illustrate
5/6/7	NC	NC	null
10/26/28	GND	GND	Grounding
1	UART-TX	Serial data output	
2	UART-RX	Serial data input	
3	DLTX	Burning port	
4	DLRX	Burning port	
8	CEN	Reset	For details, refer to 2.3.3
9	VBAT	Power input pin	3.3V (typical)
10/26/28	GND	Power Ground	
11	P28	I/O	Programmable input/output pins
12	P20	I/O	Programmable input/output pins
13	P21	I/O	Programmable input/output pins
14	P22	I/O	Programmable input/output pins
15	P23	I/O	Programmable input/output pins
16	P24	I/O	Programmable input/output pins
17	P14	I/O	Programmable input/output pins
18	P16	I/O	Programmable input/output pins
19	P15	I/O	Programmable input/output pins
20	KEY		For details, refer to 2.3.4
21	WORK-STATUS	Module working status output pin	
22	LINK-STATUS	Bluetooth connection status pin	
23	P07	I/O	Programmable input/output pins
24	P08	I/O	Programmable input/output pins
25	P09	I/O	Programmable input/output pins
27	ANT	antenna	Programmable input/output pins

2.3. Power Design

2.3.1. Power interface

Table 3 : Power interface pin definition table

Pin Name	Pin Number	describe	Minimum	Typical Value	Maximum	unit
VBAT	9	Module power supply	2.7	3.3	3.6	V
GND	10/26/28	land	-	0	-	V

2.3.2. Power stability requirements

DX- WF24 is 2.7 ~ 3.6V, and it is necessary to ensure that the input voltage is not lower than 2.7 V. The figure below shows the VBAT voltage drop during RF burst transmission.

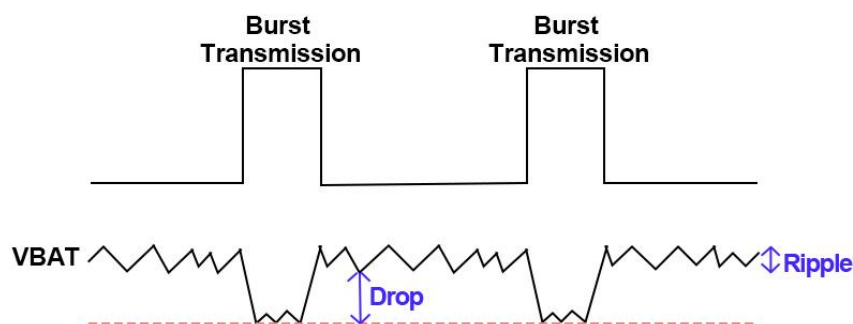


Figure 3 : Burst transmission power requirements

In order to reduce voltage drop, it is recommended to reserve two (100 uF, 0.1uF) chip multilayer ceramic capacitors (MLCC) with the best ESR performance for VBAT, and the capacitors should be placed close to the VBAT pin. The reference circuit is as follows:

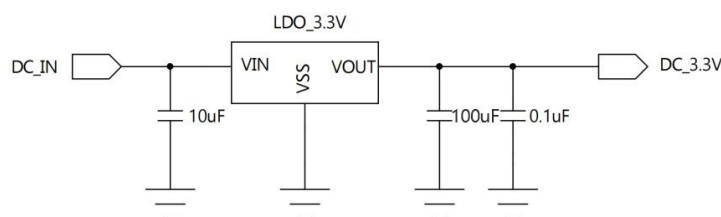


Figure 4 : Power supply reference circuit

2.3.3. CEN reset pin description

Table 4 : CEN pin definition table

Pin Name	Pin Number	I/O	describe	Remark
CEN	8	I	Module reset	Low level reset

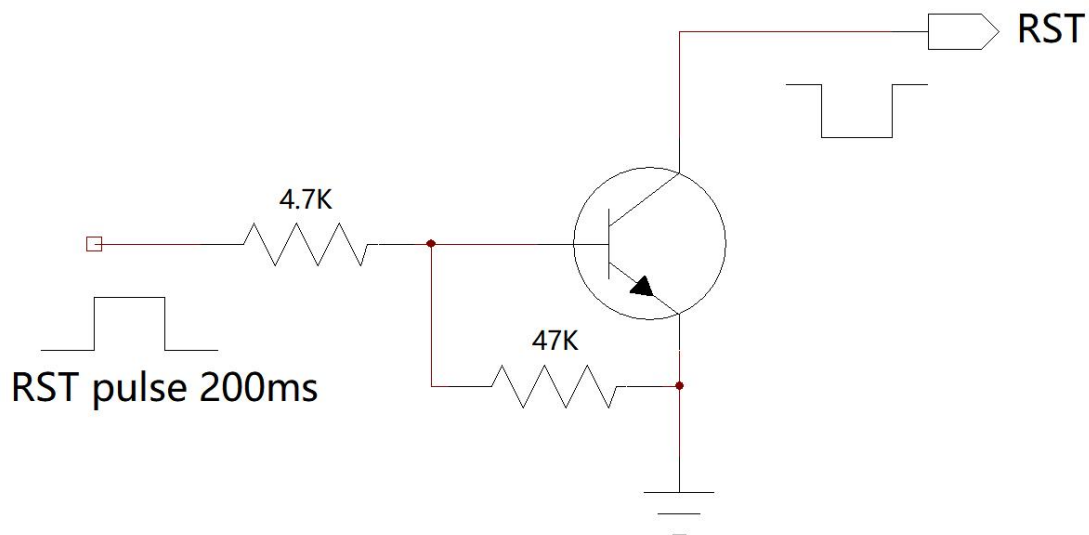


Figure 5 : Reset reference circuit

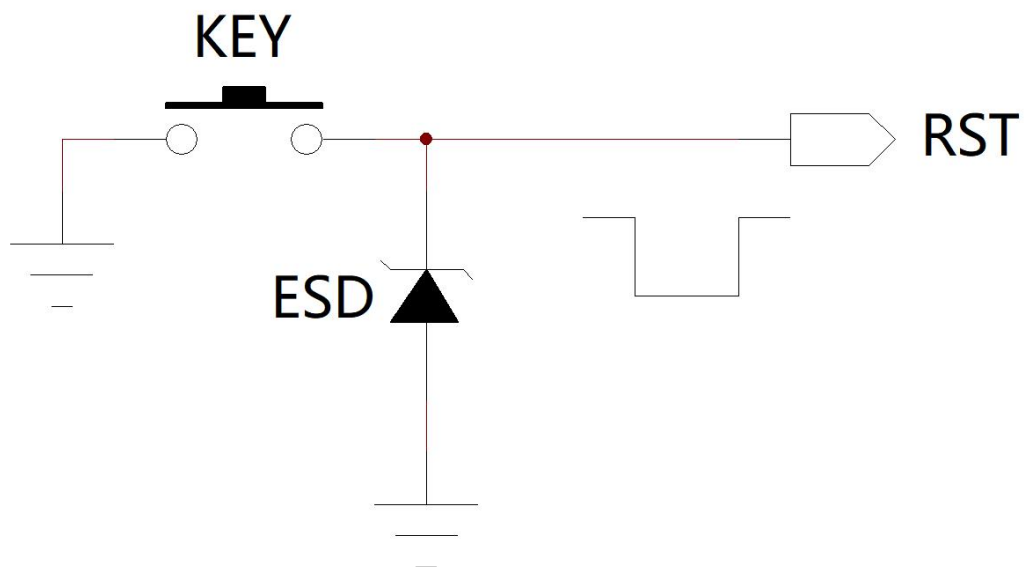


Figure 6 : Push button reset reference circuit

2.3.4. KEY wake-up pin description

Table 5 : KEY Pin definition table

Pin Name	Pin Number	I/O	describe	Remark
KEY	20	DI	Module wake-up	Low level

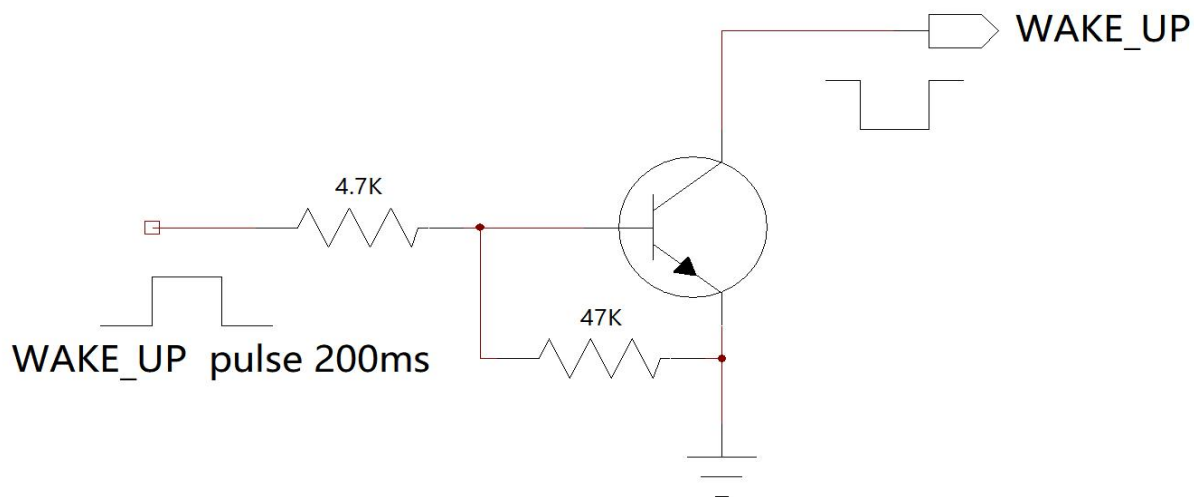


Figure 7 : KEY reference circuit

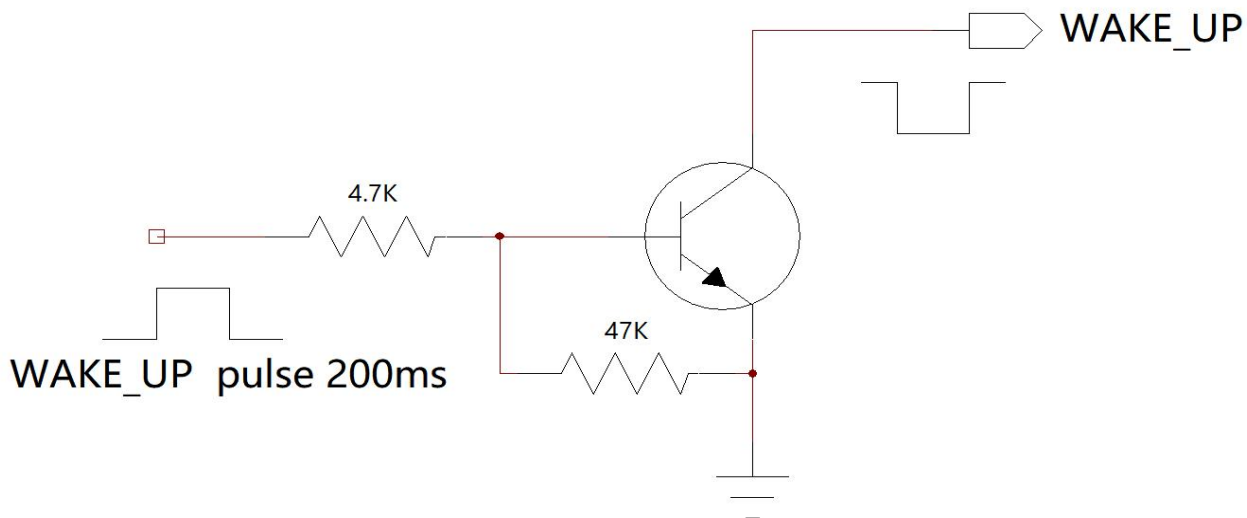


Figure 8 : KEY reset reference circuit

2.4. Hardware physical interface

2.4.1. General digital IO port

7 general digital IO ports defined in the module . All these IO ports can be configured by software to realize various functions, such as button control, LED drive or interrupt signal of main controller. Keep it floating when not in use.

2.4.2. UART

DX-WF24 has a universal asynchronous receive/transmit (UART) interface that provides full-duplex, asynchronous serial communication with baud rates up to 6 Mbps. They support 5/6/7/8-bit data, odd, even or no parity , and the stop bit can be set to 1 or 2 bits. UART1 supports Flash download.

2.4.3. I2C Interface

DX-WF24 has an I2C interface that requires only two buses, the serial data (SDA) and the serial clock line (SCL). The I2C interface can be used as a master or slave mode. It supports standard (up to 100kbps) and fast (up to 400kbps) modes with 7-bit addressing. If the low level on SCL or the bus idle duration is greater than the programmable threshold, an interrupt will be generated to the MCU.

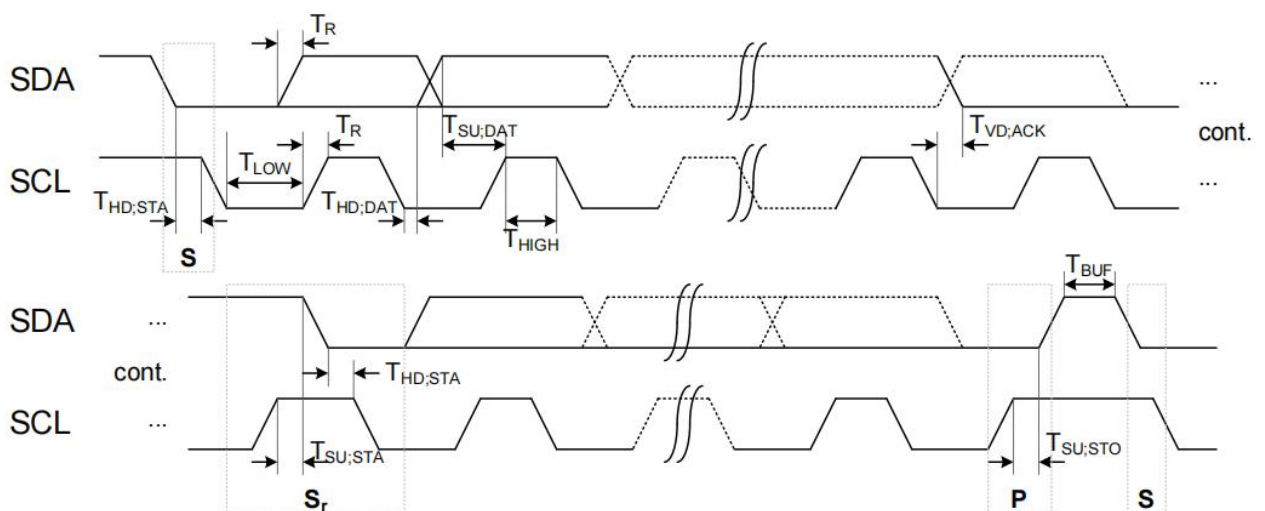


Figure 9 : I2C communication timing diagram

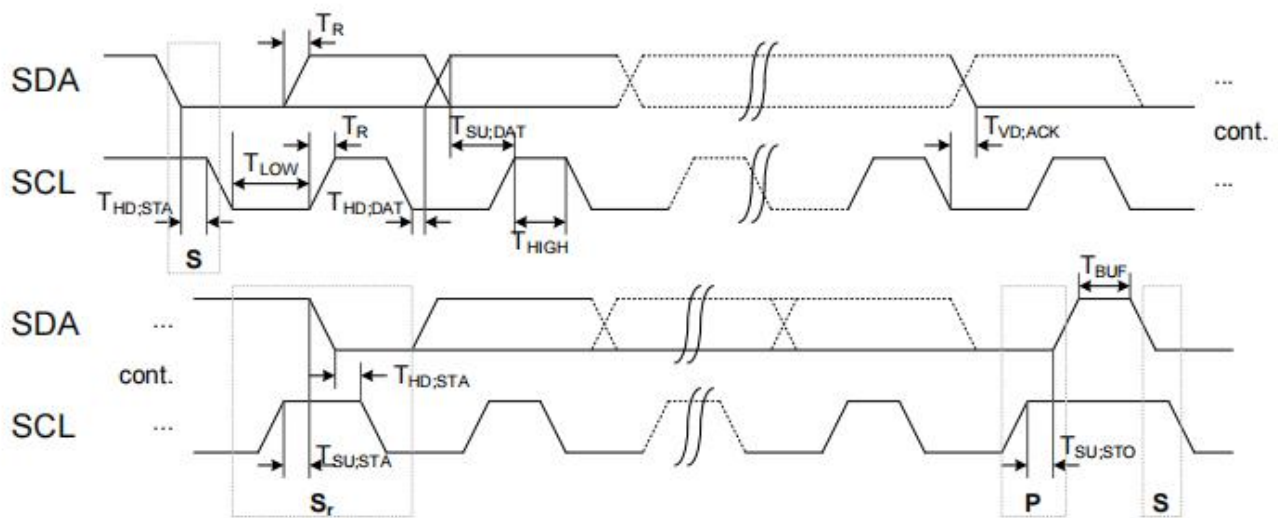


Figure 10 : I2C slave timing diagram

2.4.4. PWM

DX-WF24 has 6 32-bit PWM channels, labeled PWM0-PWM 5 (supports timer mode). Each PWM channel has three modes: timer mode, PWM mode, and capture mode. The mode of each channel is multiplexed with 32-bit counts, and the PWM operation clock can select high-speed clock or low-power clock. Each PWM runs independently and has an independent duty cycle.

2.4.5. SPI interface

The DX-WF24 has an SPI interface that can operate in master or slave mode. The SPI interface allows clock frequencies up to 30 MHz in master mode and up to 20 MHz in slave mode. The SPI interface supports configurable 8-bit or 16-bit data width. The SPI interface supports 4-wire and 3-wire modes (without CSN pin), 64-bit RX FIFO, and 64-bit TX FIFO with DMA function. Receive data can be latched on the rising or falling edge of the clock signal. Transmit data can be set by MSB or LSB.

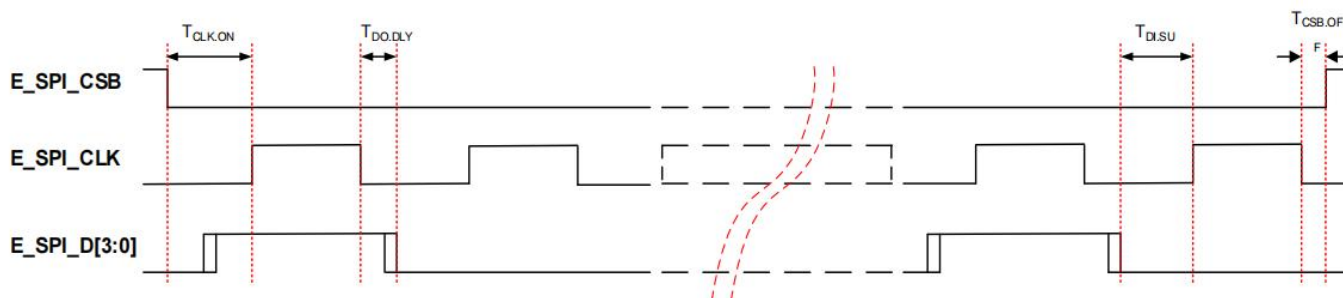


Figure 11 : SPI communication timing diagram

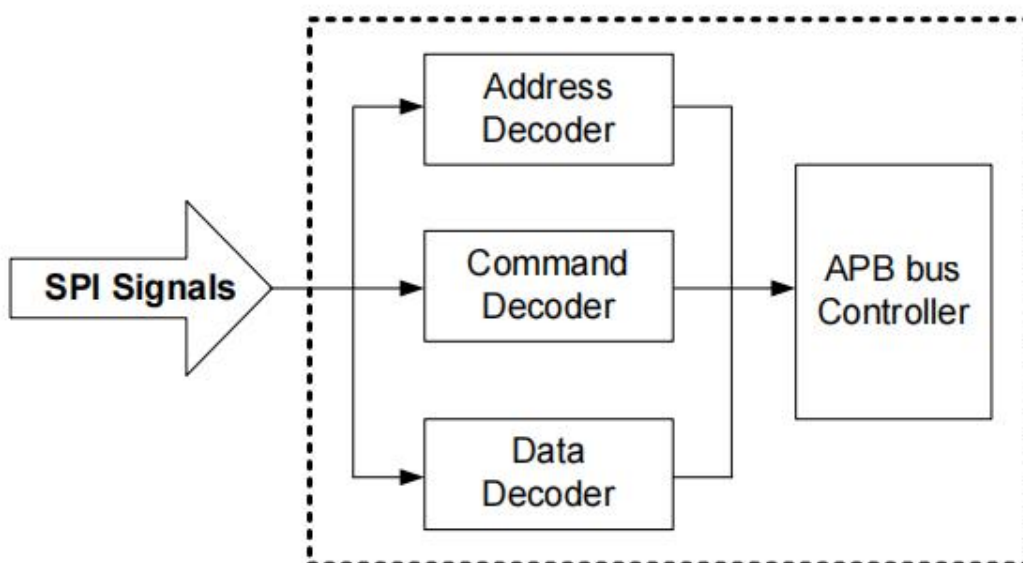


Figure 12 : SPI Slave Block Diagram

The communication protocol of the SPI slave interface uses 4-byte or 8-byte control signals. Between the two available communication protocols, the CPU selects one before starting control.

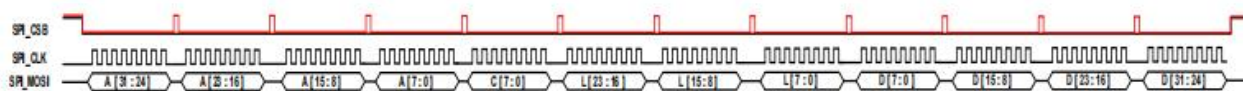


Figure 13 : 8-byte control type

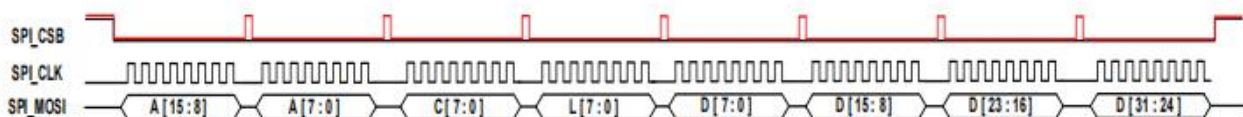


Figure 14 : 4-byte control type

The 8-byte control type uses a 4-byte address, a 1-byte control, and a 3-byte length. The 4-byte address shows the address of the register that is accessed internally. The 1-byte control is used for communication control, and the 3-byte length shows the length of the data



that is accessed continuously in bytes. Therefore, when the 8-byte control type is applied, the maximum length of the data that can be accessed continuously is 16 MB. The 4-byte control type uses a 2-byte address, a 1-byte control, and a 1-byte length. The 2-byte address shows the address of the register that is accessed internally. The 1-byte control is used for communication control, and the 1-byte length shows the length of the data that is accessed continuously in bytes. Since a 32-bit address map is used internally, a 2-byte address is not enough to express everything. Therefore, specify the upper 2-byte base address first, and then use the lower 2-byte address.

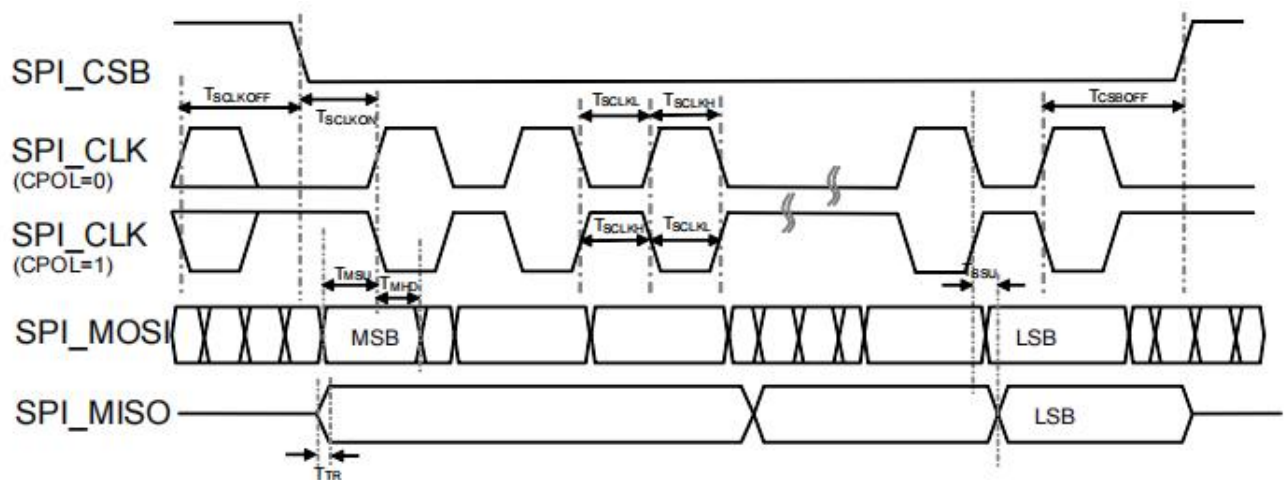


Figure 15 : SPI slave timing diagram

2.5. Reference connection circuit

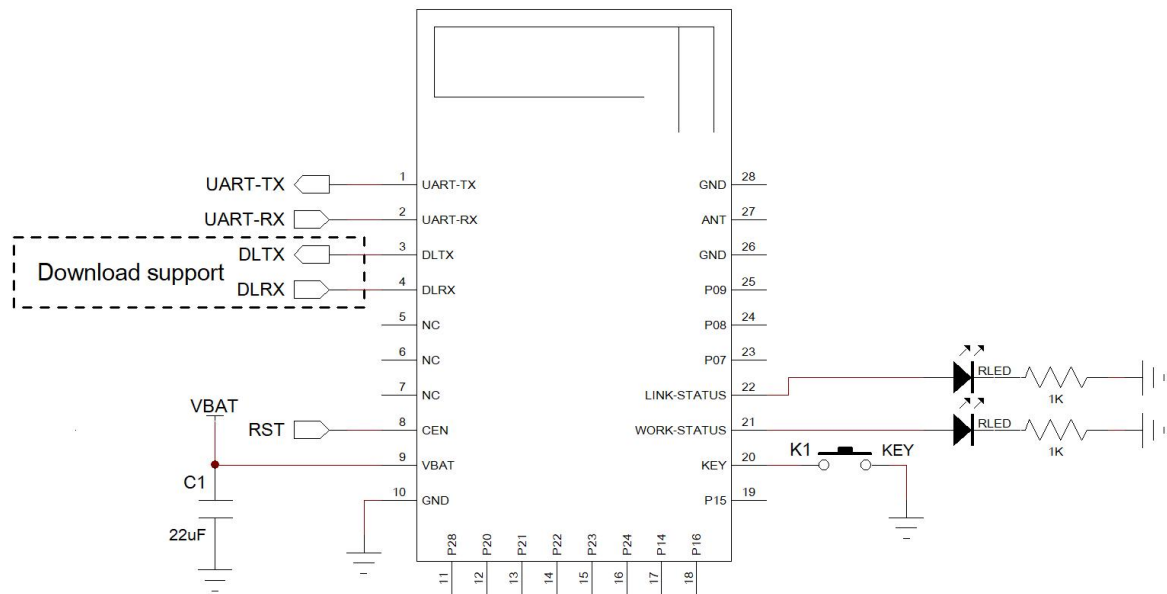


Figure 16 : Typical application circuit

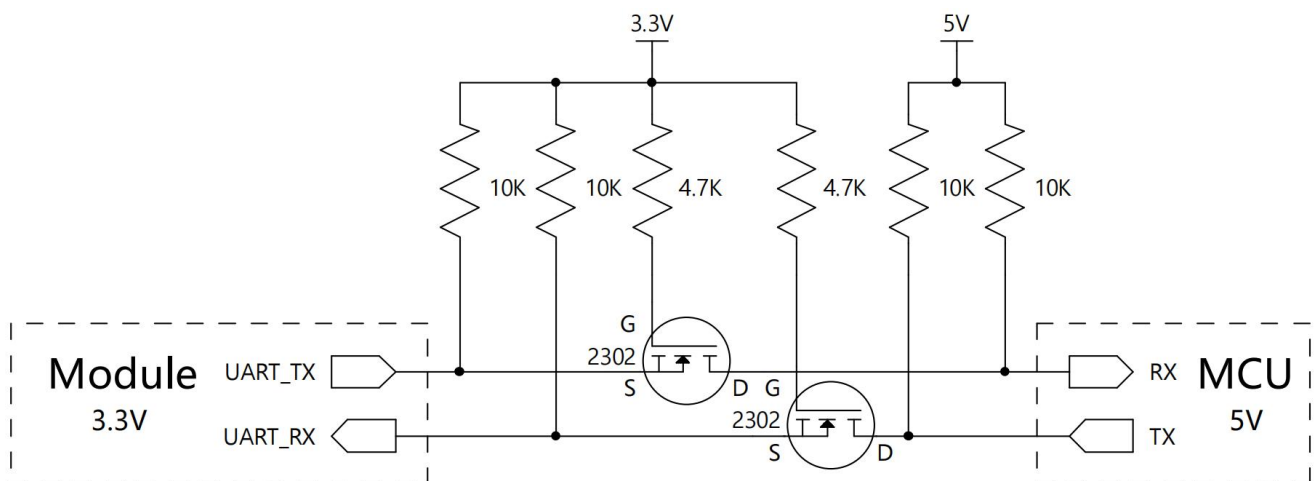


Figure 17 : Serial port level conversion reference circuit

3. Electrical characteristics , RF characteristics and reliability

3.1. Maximum Ratings

Stresses exceeding the absolute maximum ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 7 : Absolute Maximum Ratings

parameter	describe	Minimum	Maximum	unit
VBAT	Battery regulator supply voltage	-0.3	3.6	V
PRX	RX input power	-	10	dBm
TSTR	Storage temperature range	-55	150	°C

3.2. ESD Rating

Table 8 : ESD Ratings

parameter	describe	Typical Value	unit
ESD HBM	Human Model	±2000	V
VDD_DIO2	Charged Device Model	±500	V

3.3. Recommended conditions of use

Table 9 : Recommended operating conditions

parameter	describe	Minimum	Typical Value	Maximum	unit
VBAT	Battery/regulator supply voltage	2.7	-	3.6	V

VCCIF	IF supply voltage	2.7	-	3.6	V
VCCRFE	RX supply voltage	2.7	-	3.6	V
VCCPA	PA supply voltage	2.7	-	3.6	V
VCCTX	TX supply voltage	2.7	-	3.6	V
VDDAON	Digital LDO output voltage is always on	0.5	0.9	1.0	V
VDD_FLASH	External flash supply voltage	2.7	-	3.6	V

3.4. Digital LDO

Table 10 : Digital LDO

parameter	describe	Minimum	Typical Value	Maximum	unit
VDDAON	Digital output voltage	0.5	0.9	1.0	V
Load current		-	-	50	mA

3.5. Static Protection

In module applications, static electricity generated by human static electricity, charged friction between microelectronics, etc., is discharged to the module through various channels, which may cause certain damage to the module. Therefore, ESD protection should be taken seriously. ESD protection measures should be taken during the R&D, production assembly and testing processes, especially in product design. For example, anti-static protection should be added at the interfaces of circuit design and points that are susceptible to damage or impact from electrostatic discharge, and anti - static gloves should be worn during production.

Table 11 : ESD withstand voltage of module pins

Test interface	Contact discharge	Air discharge	unit
VBAT and GND	+4	+8	kV
Main antenna interface	+2.5	+4	kV



4. Mechanical dimensions and layout recommendations

This section describes the mechanical dimensions of the module. All dimensions are in millimeters. All dimensions without tolerances are ± 0.3 mm.

4.1. Module mechanical ruler

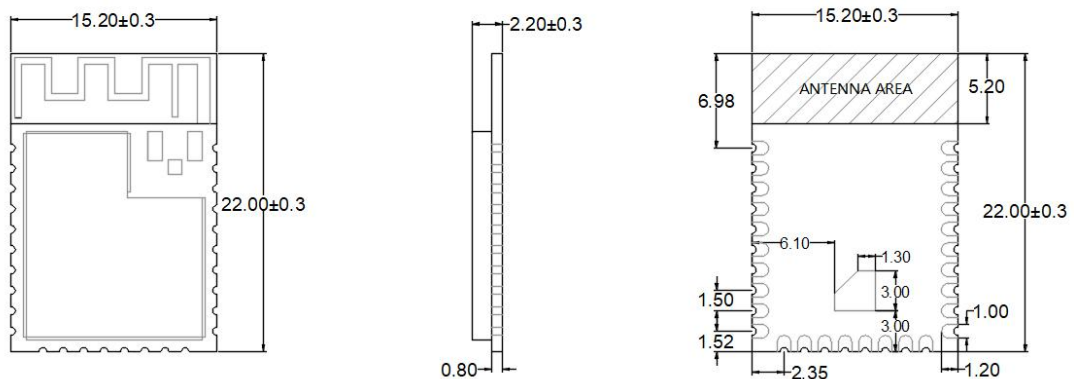


Figure 18 : Module top and side view dimensions

4.2. Recommended package

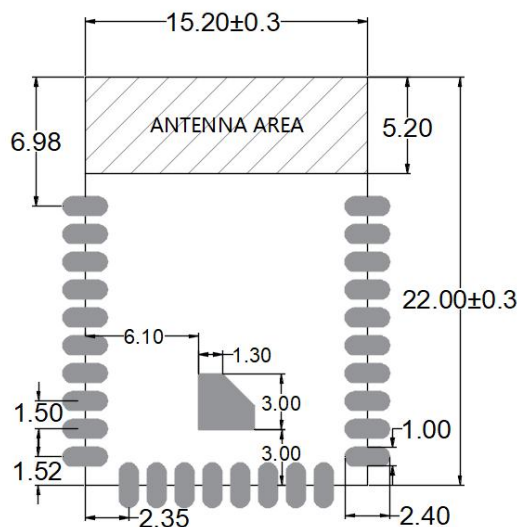


Figure 19 : Recommended package dimensions



4.3. Module top view/bottom view

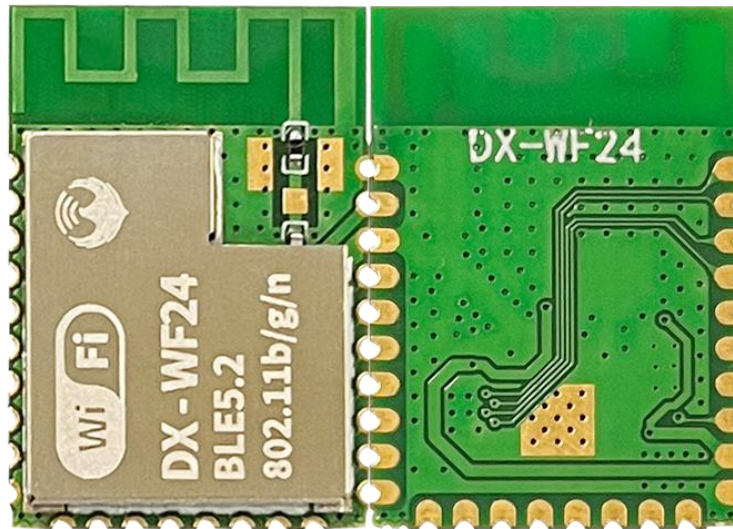


Figure 20 : Module top and bottom views

Remark

The above picture is for reference only. For the actual product appearance and label information, please refer to the actual module.

4.4. Hardware Design Layout Recommendations

DX-WF20 Bluetooth module works in the 2.4G wireless frequency band and uses an onboard antenna. The VSWR and efficiency of the antenna depend on the patch position. Various factors affecting the wireless transceiver signal should be avoided as much as possible. Note the following points:

1. Avoid using metal for the product shell surrounding Bluetooth. When using a partial metal shell, keep the module antenna away from the metal part as much as possible. The metal connecting wires or metal screws inside the product should be kept away from the module antenna as much as possible.
2. The module antenna should be placed against the edge of the PCB or directly exposed from the PCB. It is not allowed to be placed in the middle of the board. There should be at least 5mm of free space in the direction of the antenna, and the PCB under the antenna should be milled out. Copper laying and routing are not allowed in the direction parallel to the antenna.

3. It is recommended to use insulating materials to isolate the module mounting position on the substrate, such as placing a whole piece of silk screen (TopOverLay) at this position.

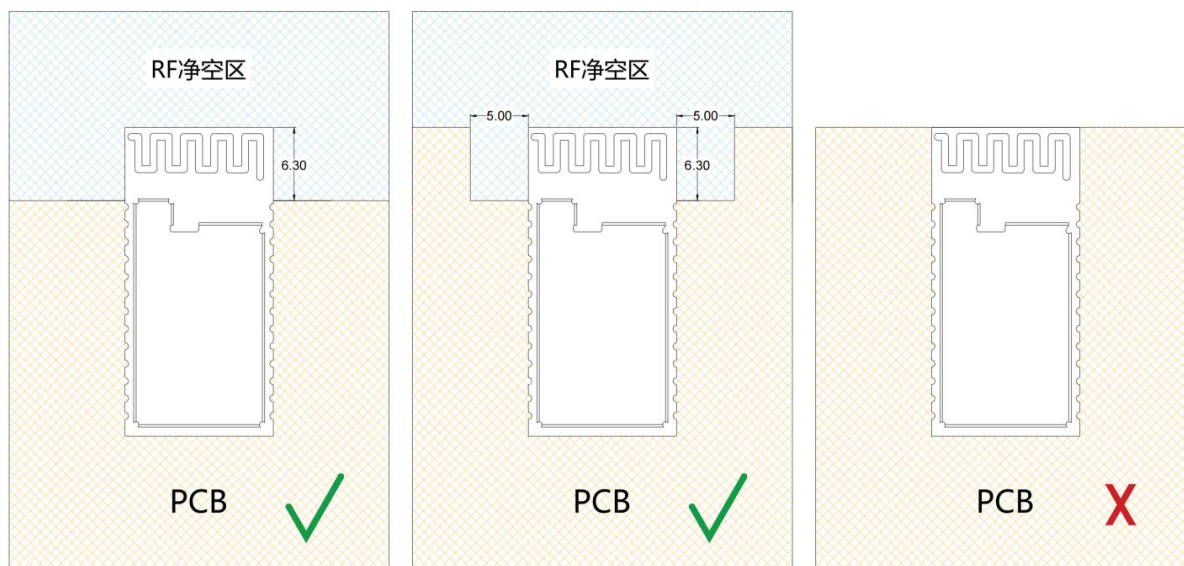


Figure 21 : Module placement reference position

5. Storage, production and packaging

5.1. Storage conditions

The module is shipped in a vacuum sealed bag. The module has a moisture sensitivity level of 3 (MSL 3) and its storage must comply with the following conditions:

1. Recommended storage conditions: temperature $23 \pm 5^{\circ}\text{C}$ and relative humidity 35~60%.
2. Under recommended storage conditions, modules can be stored in vacuum sealed bags for 12 months.
3. Under workshop conditions of $23 \pm 5^{\circ}\text{C}$ and relative humidity below 60%, the workshop life of the module after unpacking is 168 hours. Under this condition, the module can be directly subjected to reflow production or other high-temperature operations. Otherwise, the module needs to be stored in an environment with a relative humidity of less than 10% (for example, a moisture-proof cabinet) to keep the module dry.
4. If the module is in the following conditions, it is necessary to pre-bake the module to prevent

the module from absorbing moisture and then causing PCB blistering, cracks and delamination after high-temperature soldering:

- The storage temperature and humidity do not meet the recommended storage conditions;
- The module fails to be manufactured or stored in accordance with the above clause 3 after being unpacked;
- Vacuum packaging leaks, materials are in bulk;
- Before module repair ;

5.2. Module baking process

- It needs to be baked at $120\pm5^{\circ}\text{C}$ for 8 hours;
- 24 hours after baking , otherwise they still need to be stored in a drying oven ;

Remark

1. In order to prevent and reduce the occurrence of poor welding such as blistering and delamination of the module due to moisture, strict control should be exercised. It is not recommended to expose the module to the air for a long time after opening the vacuum packaging.
2. Before baking, the module needs to be taken out of the package and placed on a high temperature resistant device to prevent high temperature from damaging the plastic tray or reel; the module for secondary baking must be soldered within 24 hours after baking, otherwise it needs to be stored in a drying oven. Please pay attention to ESD protection when unpacking and placing the module, for example, wear anti-static gloves .

5.3. Reflow

Use a printing scraper to print solder paste on the stencil so that the solder paste leaks through the stencil opening onto the PCB. The strength of the printing scraper needs to be adjusted appropriately. To ensure the quality of the module printing paste, the recommended steel mesh thickness corresponding to the module pad part is 0.1~0.15mm.

The recommended reflow temperature is $235\sim 250^{\circ}\text{C}$, and the maximum temperature should not exceed 250°C . To avoid damage to the module due to repeated heating, it is strongly recommended that customers mount the module after completing the reflow soldering of the

first side of the PCB board. The recommended furnace temperature curve (lead-free SMT reflow soldering) and related parameters are shown in the following chart:

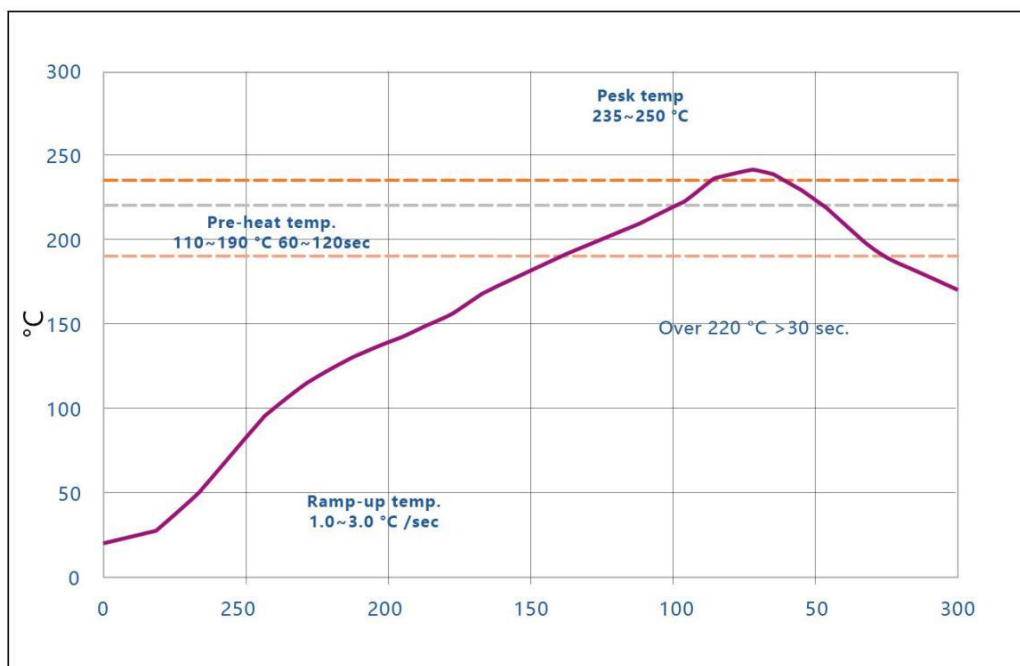


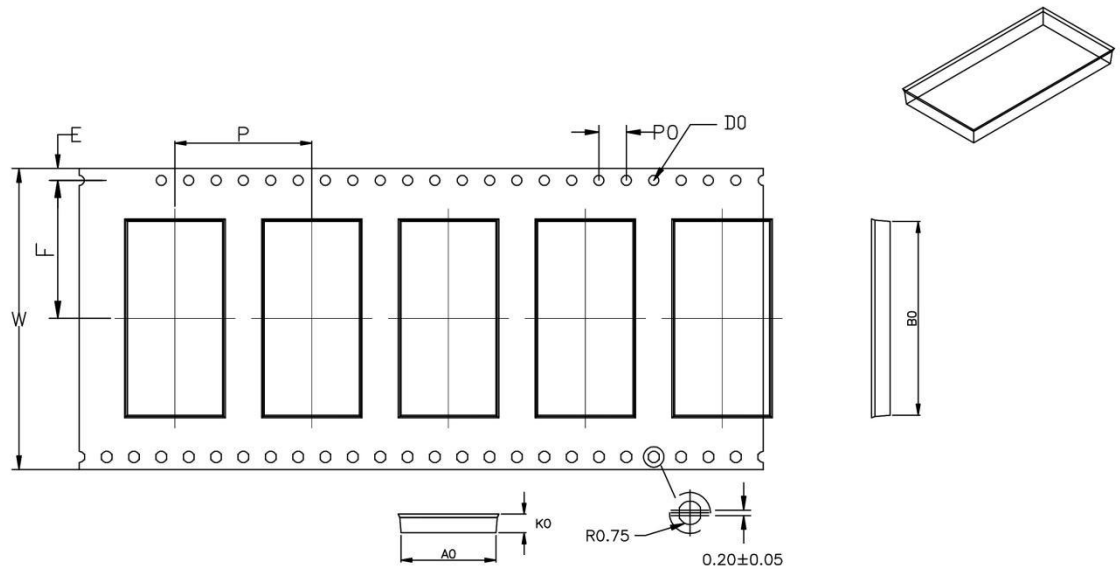
Figure 22 : Recommended reflow temperature profile

Table 20: Recommended reflow temperature

Statistical name	Lower limit	Upper limit	unit
Slope 1 (target = 2.0) between 30.0 and 70.0	1	3	Degree/second
Slope 2 (target = 2.0) between 70.0 and 150.0	1	3	Degree/second
Slope 3 (target = -2.8) between 220.0 and 150.0	-5	-0.5	Degree/second
Constant temperature time 110-190°C	60	120	Second
@220°C reflow time	30	65	Second
Peak temperature	235	250	Celsius
Total time @ 235°C	10	30	Second

5.4. Packing Specifications

DX- WF20 modules are packaged in tape and reel and sealed in vacuum sealed bags with desiccant and humidity card. Each carrier is 20 meters long and contains 1000 modules. The reel diameter is 330 mm. The specific specifications are as follows :



I T E M	W	A ₀	A ₁	A ₂	K ₀	S ₀	F	E	D ₀	P	P ₀	P ₂	B ₀	B ₁	B ₂
D I M	44.0 ^{+0.30} _{-0.30}	13.9 ^{+0.10} _{-0.10}			2.7 ^{+0.10} _{-0.10}	—	20.15 ^{+0.10} _{-0.10}	1.75 ^{+0.10} _{-0.10}	1.50 ^{+0.10} _{-0.10}	20.0 ^{+0.10} _{-0.10}	4.00 ^{+0.10} _{-0.10}	2.00 ^{+0.10} _{-0.10}	28.30 ^{+0.10} _{-0.10}		
ALTERNATE															

Figure 23 : Carrier tape dimensions (unit: mm)

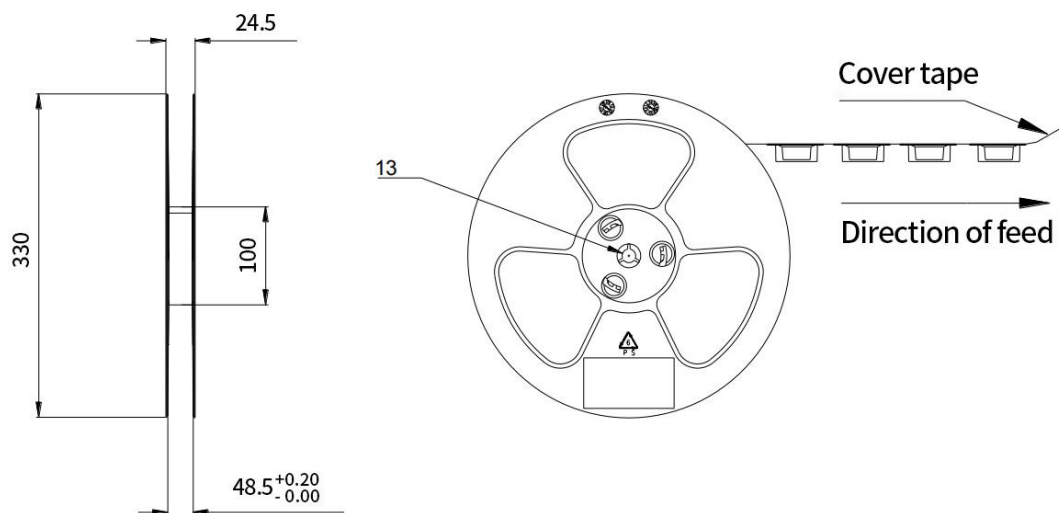


Figure 24 : Reel dimensions (unit: mm)

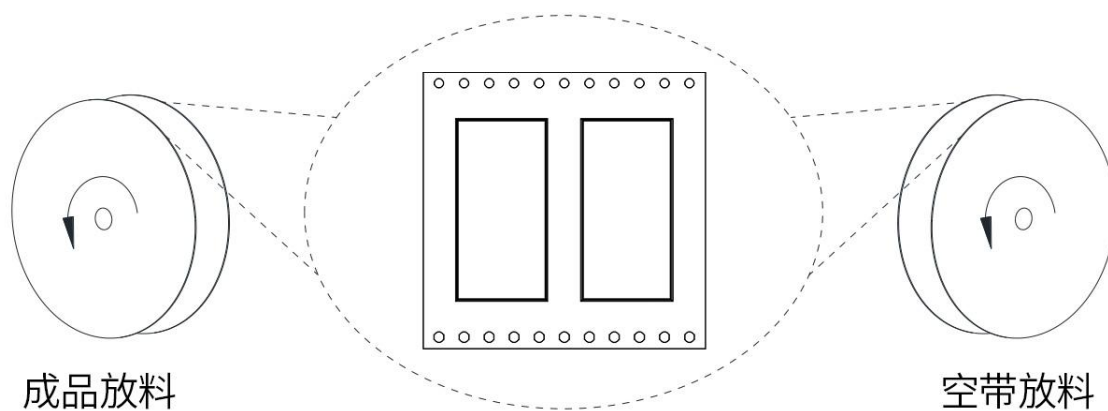


Figure 25 : Tape Direction

FCC Statement

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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This modular has been tested and found to comply with part 15 requirements for Modular Approval.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

2.2 List of applicable FCC rules

CFR 47 FCC Part 15 Subpart C and Subpart F has been investigated. It is applicable to the modular transmitter

2.3 Specific Operational Use Conditions - Antenna Placement Within the Host Platform

The module is tested for standalone mobile RF exposure use condition.

- The antenna must be installed such that 20cm is maintained between the antenna and users,
- The transmitter module may not be co-located with any other transmitter or antenna.

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

2.4 Limited Module Procedures

Not applicable

2.5 Trace Antenna Designs

Not applicable

2.6 RF Exposure Considerations

This device complies with FCC 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.

2.7 Antenna Type and Gain

The following antennas have been certified for use with this module.

Only antennas of the same type with equal or lower gain may also be used with this module.

Other types of antennas and/or higher gain antennas may require the additional authorization for operation.

Antenna Specification list below:

Antenna Type	Antenna Model No.	Maximum Antenna Gain (dBi)	Frequency Range
PCB Antenna	DX-WF24	-0.1	2402– 2480MHz

2.8 End Product Labelling Compliance Information

When the module is installed in the host device, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text: "Contains FCC ID: **2BLPG-DX-WF24**". The FCC ID can be used only when all FCC compliance requirements are met.

2.9 Information on Test Modes and Additional Testing Requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) class II permissive change re-evaluation or new FCC authorization.

Host manufacturer installed this modular with single modular approval should perform the test of radiated emission and spurious emission according to FCC part 15C, 15.209, 15.207 requirement, only if the test result comply with FCC part 15C, 15.209, 15.207 requirement, then the host can be sold legally.

2.10 Additional testing, Part 15 Subpart B Disclaimer

This transmitter modular is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B rules requirement applicable to the final host. The final host will still need to be reassessed for compliance to this portion of rules requirements if applicable.

As long as all conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this modular installed.

2.11 Manual Information to The End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The host integrator must follow the integration instructions provided in this document and ensure that the composite system end product complies with the requirements by a technical assessment or evaluation to the rules and to KDB Publication 996369.

The host integrator installing this module into their product must ensure that the final composite product complies with the requirements by a technical assessment or evaluation to the rules, including the transmitter operation and should refer to

guidance in KDB Publication 996369.

OEM/Host Manufacturer Responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and RF Exposure essential requirements of the FCC rules.

2.12 How to Make Changes - Important Note

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.