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# FR8003 Datasheet

Bluetooth Low Energy SOC with SIG Mesh integrated

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## Description

FR8003 is a family of SOC (system on chip) for rapid development of Bluetooth Low Energy related products. It contains Bluetooth V5.0 (LE Mode) fully compliant system with Freqchip designed firmware and software stack. Users can develop various applications based on embedded 32-bits high performance MCU.

With Freqchip’s innovational technology, FR8003 integrates, PMU, QSPI flash ROM with XIP mode, I2C, UART, GPIO, ADC, USB OTG, PWM all in a single chip, which provides customer with:

1. competitive power consumption
2. stable connection
3. low-cost BOM

The Bluetooth Smart firmware includes the L2CAP service layer protocols, Security Manager (SM), Attribute Protocol (ATT), the Generic Attribute Profile (GATT) and the Generic Access Profile (GAP). Furthermore, application profiles such as Proximity, Health Thermometer, Heart Rate, Blood Pressure, Glucose, Human Interface Device (HID) and SDK (include drivers, OS API, etc. ) are supported. The SDK has integrated SIG Mesh for networking application.

## Ordering Information

Part Number	Ambient temperature	Embedded Flash	Package	size
FR8003A	-40°C ~ +85°C	4Mb	QFN20	3.0*3.0*0.75, 0.4pitch
FR8003D	-40°Cen ~ +85°C	8Mb	QFN20	3.0*3.0*0.75, 0.4pitch

## Features

- Compliant with Bluetooth Specification V5.0 LE, support 2M, 1M, 500K and 125K data rate
- Embedded 32-bits Processor
  - up to 96Mhz speed
- Memory
  - Internal mask 128KB ROM
  - up to 56KB SRAM
  - Up to 8Mb Flash ROM for user space software and data
- Integrated Battery Charger
- Integrated DC-DC Regulator
- Interface:
  - GPIO
  - UART
  - SPI/QSPI
  - I2C
  - PWM
  - USB OTG
- ROM Software:
  - BLE Profile & Protocol: GATT, LM, LC, etc.
  - Driver API
  - SIG Mesh

## Applications

- Smart Mouse
- Bluetooth Wearable
- SIG Mesh Application
- Smart Locks
- Domestic Appliances

# 1. Hardware Details

## 1.1 Block Diagram

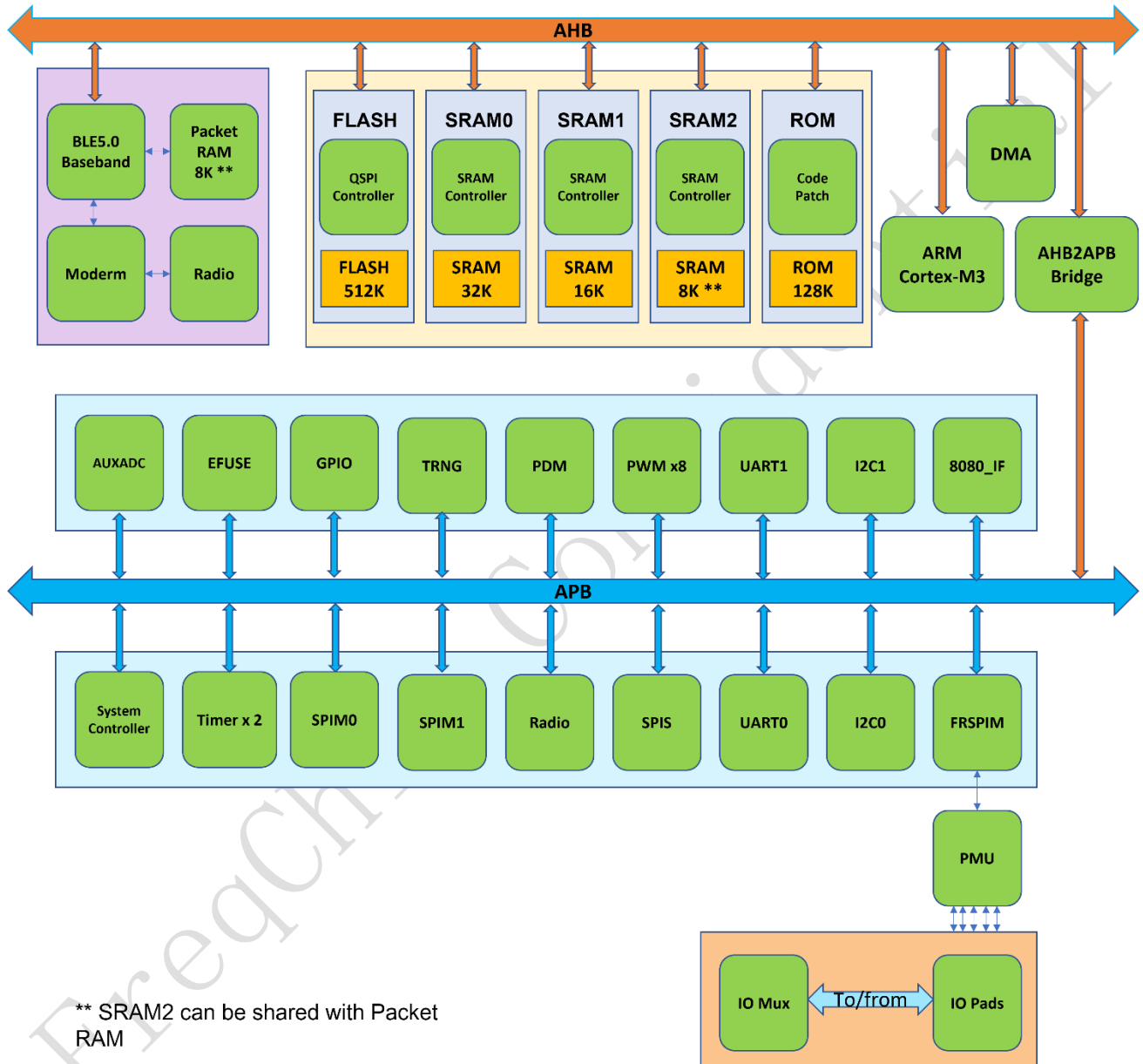


Figure 1-1 Block Diagram

## 1.2 Bluetooth Radio

- On-chip balun (50Ω impedance in TX and RX modes)
- No external trimming is required in production
- Qualified to Bluetooth v5.0 LE specification
- Up to 10dBm RF transmit power
- -97dBm (1M) receiver sensitivity
- Integrated channel filters
- Digital demodulator for improved sensitivity and co-channel rejection
- Real time digitized RSSI

## 1.3 Bluetooth Controller

- All device classes support (Broadcaster, Central, Observer, Peripheral)
- All packet types (Advertising / Data / Control)
- Encryption (AES / CCM)
- Bit stream processing (CRC, Whitening)
- Frequency hopping calculation
- Low power modes supporting internal 32.0 kHz RC oscillator
- Supports power down of the baseband during the protocol's idle periods

## 1.4 Peripheral Interfaces

- UART port for Debugging and AT Commands
- I2C interface to support external EEPROM or other devices (like G-SENSOR)
- Up to 12 general purpose IOs (12 IOs can be set in interrupt mode)
- General purpose 10-bits ADC used for basic analog signal measurement
- 8-channel PWM controller, with dead time control
- General purpose programmable timer for various task
- Watchdog used for tracking unexpected exception

## 1.5 Integrated Power Control and Regulation

- Embedded Power-On-Reset
- On-chip high efficiency switch-mode power supply, 1.8v to 4.3v input direct from battery and programmable output voltage
- On-chip Low Dropout (LDO) Linear Regulator for internal Digital, RF and Analog circuit
- Power management features include software shutdown and hardware wake-up
- Power-on-reset cell detects low supply voltage
- Internal voltage level detector

## 1.6 Battery Charger

- Lithium ion/Lithium polymer battery charger
- Embedded LVD(low voltage detect)
- Programmable charging current. Fast charging support up to 200mA with no external components

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## 2. Package and Pin Information

### 2.1 Packag

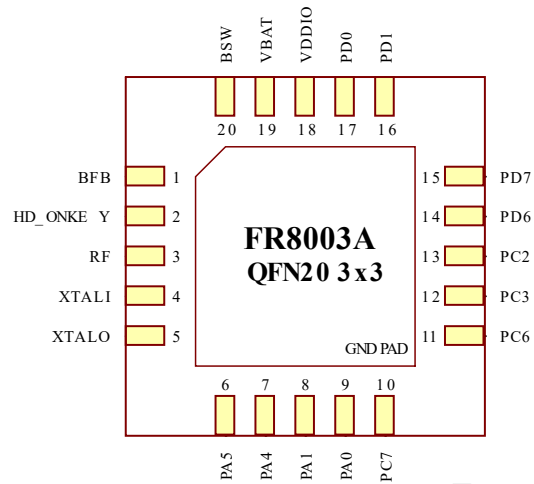


Figure 2-1 FR8003A package

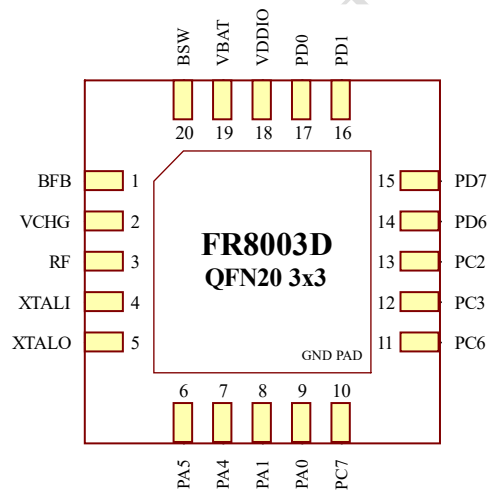


Figure 2-2 FR8003D package

## 2.2 Package Physical Dimensions

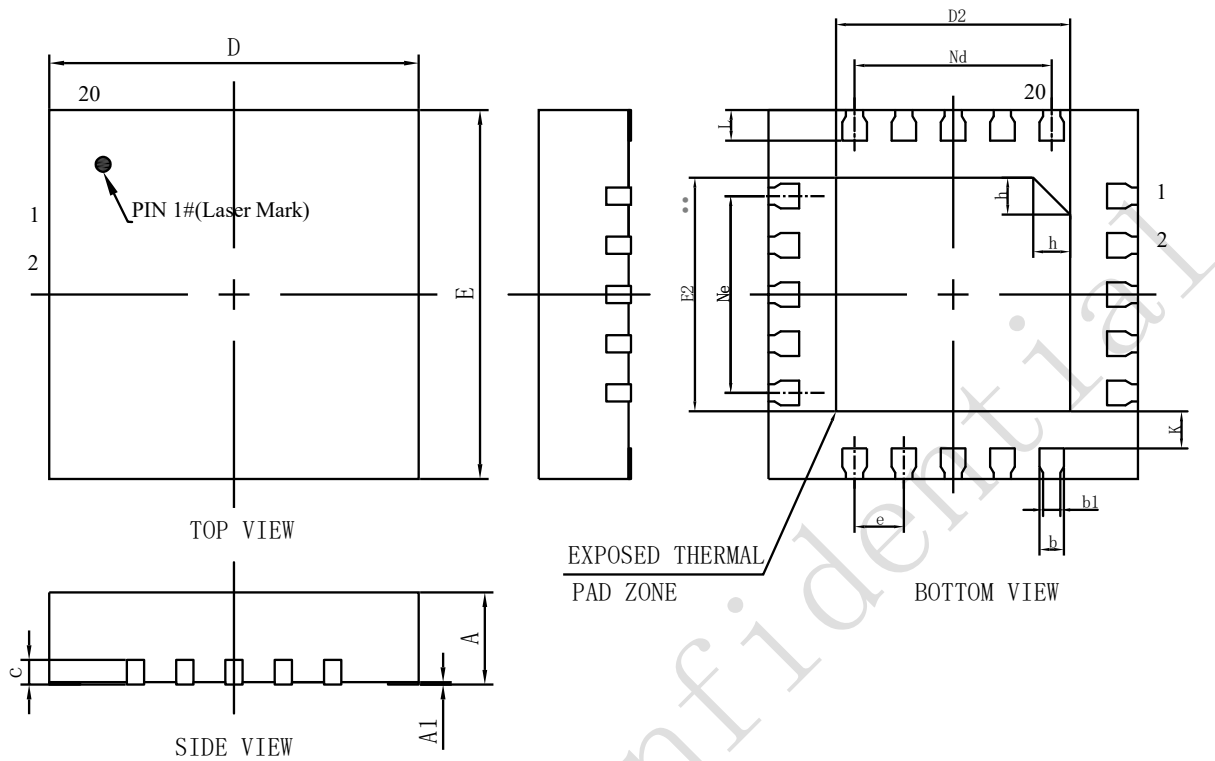


Figure 2-3 package physical dimensions

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.15	0.20	0.25
b1	0.14REF		
c	0.203REF		
D	2.90	3.00	3.10
D2	1.80	1.90	2.00
e	0.40BSC		
Ne	1.60BSC		
Nd	1.60BSC		
E	2.90	3.00	3.10
E2	1.80	1.90	2.00
L	0.20	0.25	0.30
h	0.25	0.30	0.35
K	0.30REF		

Figure 2-4 package physical dimensions value

## 2.3 Pins Description

FR8003A is a CMOS device. Floating level on input signals will cause unstable device operation and abnormal current consumption. Pull-up or Pull-down resistors should be used appropriately for input or bidirectional pins.

Table 2-1 pin abbreviations

Notation	Description
AI	Analog input
AO	Analog output
IO	Bidirectional(digital)
PWR	Power
GND	Ground

Table 2-2 pins description

Pin No.	Pin Name	Type	Description
1	BFB	AI	BUCK feedback input
2	HD_ONKEY(FR8003A) VCHG(FR8003D)	AI	Wake up input pin (while in power off mode FR8003A) Charger supply input(FR8003D)
3	RF	AI/O	RF input and output
4	XTALI	AI	24MHz Crystal oscillator input
5	XTALO	AO	24MHz Crystal oscillator output
6	PA5	IO	Multi-function input/output digital IO
7	PA4	IO	Multi-function input/output digital IO
8	PA1	IO	Multi-function input/output digital IO
9	PA0	IO	Multi-function input/output digital IO
10	PC7	IO	Multi-function input/output digital IO
11	PC6	IO	Multi-function input/output digital IO
12	PC3	IO	Multi-function input/output digital IO
13	PC2	IO	Multi-function input/output digital IO
14	PD6	IO	Multi-function input/output digital IO
15	PD7	IO	Multi-function input/output digital IO
16	PD1	IO	Multi-function input/output digital IO
17	PD0	AI	Multi-function input/output digital IO
18	VDDIO	AO	Analog linear regulator output
19	VBAT	PWR	Battery positive supply input or charger output
20	BSW	AO	BUCK Switch output

## 2.4 Application circuit

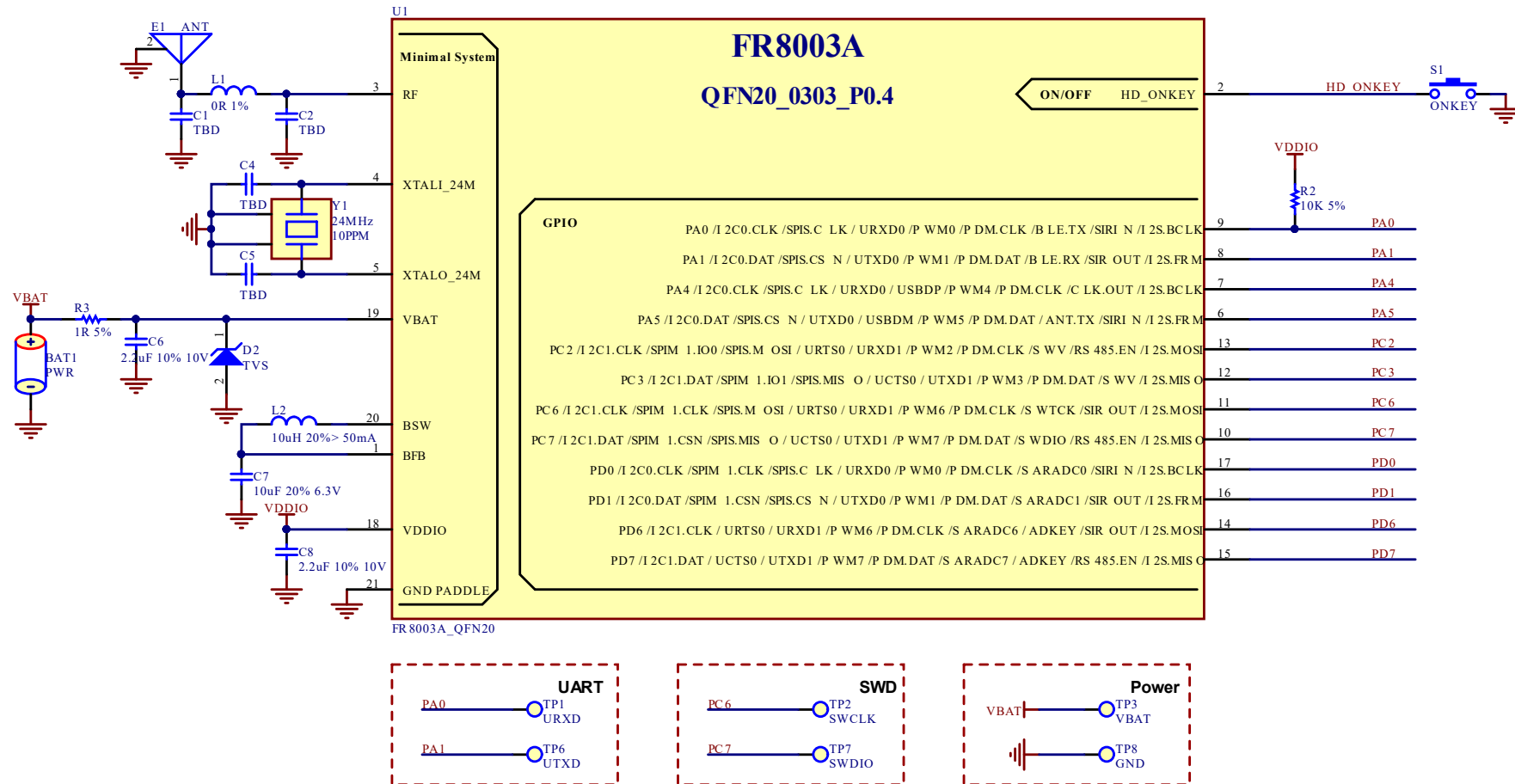


Figure 2-5 FR8003A application circuit

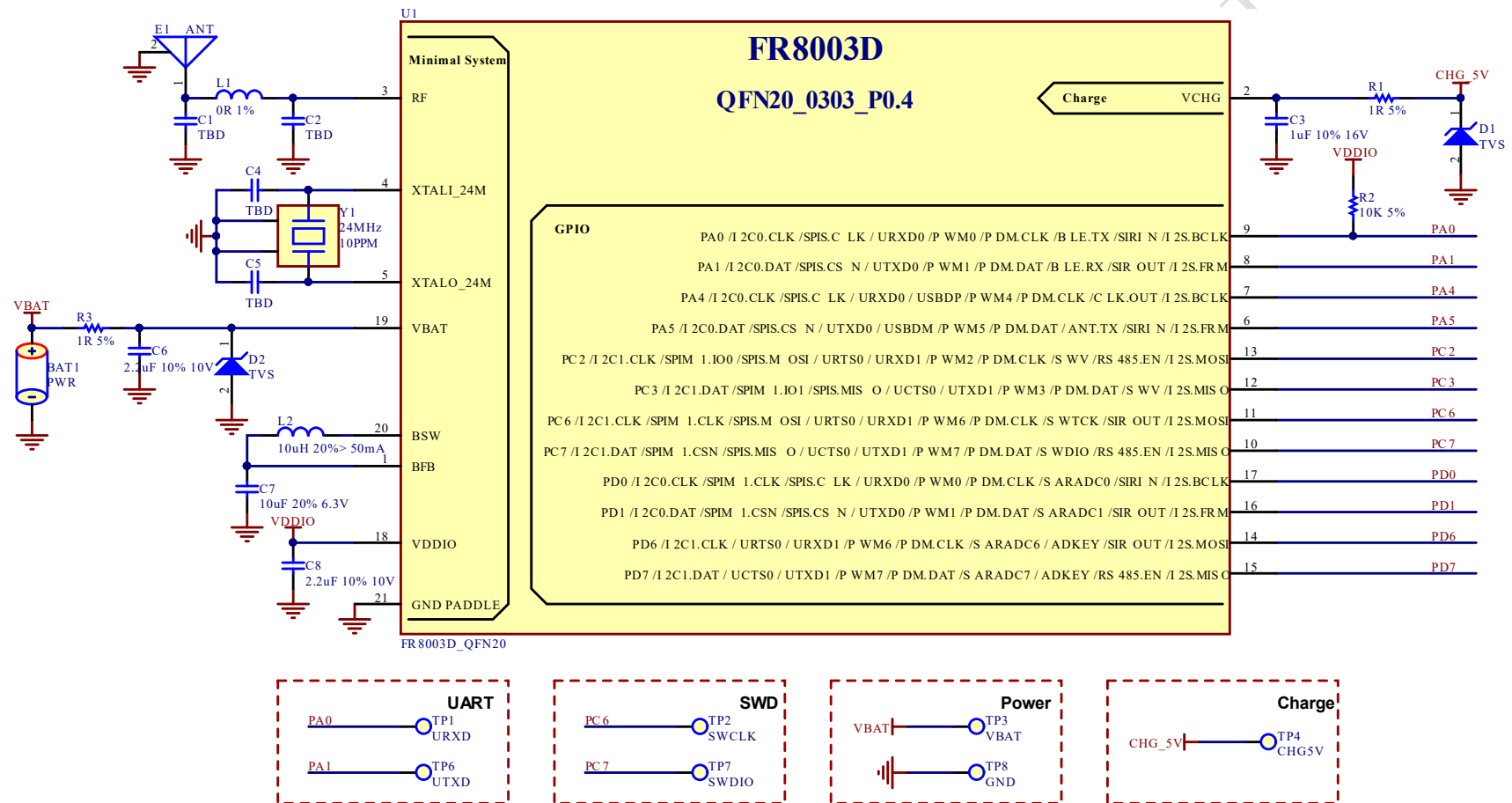


Figure 2-6 FR8003D application circuit

## 3. Electrical Characteristics

### 3.1 Absolute Maximum Ratings

Continuous operation at or beyond these conditions may permanently damage the device.

Table 3-1 Absolute Maximum Ratings

Rating		Min	Max	Unit
Storage Temperature		-40	125	°C
Core Supply Voltage		0.9	1.2	V
I/O Voltage	VDDIO	1.6	3.3	V
Supply Voltage	VBAT	1.8	4.3	V
	VCHG	4.75	5.25	V

### 3.2 Recommended Operating Conditions

Table 3-2 recommended operating conditions

Operating Condition		Min	Typ	Max	Unit
Operating Temperature Range		-40	25	85	°C
Core Supply Voltage		0.9	1.1	1.2	V
I/O Voltage	VDDIO	1.6	1.8	3.3	V
Supply Voltage	VBAT	1.8	3.3	4.3	V
Charge input voltage	VCHG	4.75	5	5.25	V

VDDIO : Power-on default value is 1.8, user configurable later

### 3.3 Power Consumption

Table 3-3 power consumption

Operation Mode	Average	Max	Unit
TX peek current (0dB)		6.2	mA
RX peek current		6.5	mA
Deep sleep current (include 64K retention RAM)	<5		μA
Power off	<1		μA

### 3.4 Crystal oscillator

Clock Source	Min	Typ	Max	Unit
Main Crystal OSC(24MHz) for Bluetooth RF application				
Clock Frequency	24	24	24	MHz
Tolerance		+/-10		ppm

### 3.5 IO Resistor

Peripheral	Port Num	Mode	VDD	Value
GPIO	-	Pull-up	3.3V	8.1K
		Pull-down		6.5K
I2C	-	Pull-up	3.3V	3K
		Pull-down		6.5K
USB	-	Pull-up	3.3V	1.5K
		Pull-down		15K

### 3.6 ESD

Pin name	Human body model(HBM)	Charged-device model(CDM)
RF	± 2000V	± 200V
XTALI	± 2000V	± 500V
XTALO	± 2000V	± 500V
OTHERS	± 2000V	± 2000V

## Abbreviations

Abbreviations	Descriptions
AEC	acoustic echo cancellers
AGC	Automatic Gain Control
ANS	Automatic Noise Suppression
ADC	Analog-to-Digital-Converter
DAC	Digital-to-Analog-Converter
GPIO	General Purpose Input Output
MIC	Microphone
PMU	Power Management Unit
OSC	Oscillator
PA	Power Amplifier
SoC	system on chip



## Contact Information

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## Revision History

### Feedback:

Freqchip welcomes feedback on this product and this document. If you have comments or suggestions, please send an email to [docs@freqchip.com](mailto:docs@freqchip.com).

Reversion Number	Reversion Date	Description
V0.4	2022.3.17	Initial Draft
V0.4.2	2022.5.17	Add IO resistor Information
V0.4.3	2022.6.10	Add ESD Information