BK3431Q Bluetooth Low Energy Single Mode SoC

Version 1.1

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1 General Description

1.1 Overview

The BK3431Q chip is a highly integrated Bluetooth 4.2 low energy single mode device, with 2 Mbps data rate option. It integrates a high-performance RF transceiver, baseband, ARM9E core, rich feature peripheral units, programmable protocol and profile to support BLE application. The Flash program memory makes it suitable for customized applications.

The BK3431Q is designed with advanced technology process and integrated with switch DCDC regulator, that it has ultra-low power consumption and ultra-low leakage power. The embedded high order interference suppression filter and fast automatic gain control logic make it work well in high interference environment.

1.2 Block Diagram

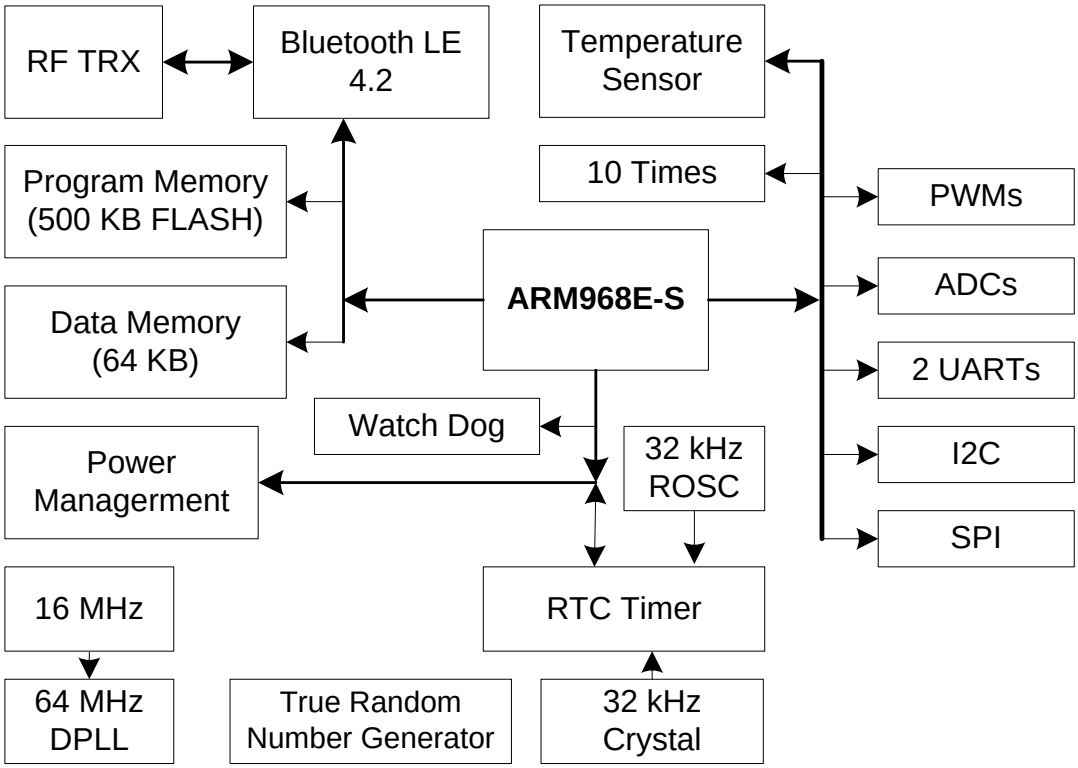


Figure 1 BK3431Q Block Diagram

1.3 Features

- Bluetooth® SIG Bluetooth Low Energy Single-Mode (BLE) compliant
- Low-power 2.4GHz Transceiver
- ARM968E Core Microprocessor integrated
- 500 KB programmable Flash for Program and 64 KB RAM for Data
- Operation voltage from 1.8 V to 3.6 V
- Clock
  - 16 MHz crystal reference clock
  - 64 MHz digital PLL clock
  - 32 kHz ring oscillator
  - External 32KHz crystal oscillator
  - MCU can run with any clock source with internal frequency divider
- Interface and peripheral units
  - Quad IO FLASH programming
  - JTAG, I2C, SPI interface
  - Two UART interface
  - Multi-channels PWM output
  - On-chip high accurate temperature sensor
  - On-chip 10 bit general ADC
  - GPIO with multiplexed interface functions
  - True random number generator
- Typical Package Type
  - 32-pin QFN 4x4

2 PIN information

2.1 QFN32

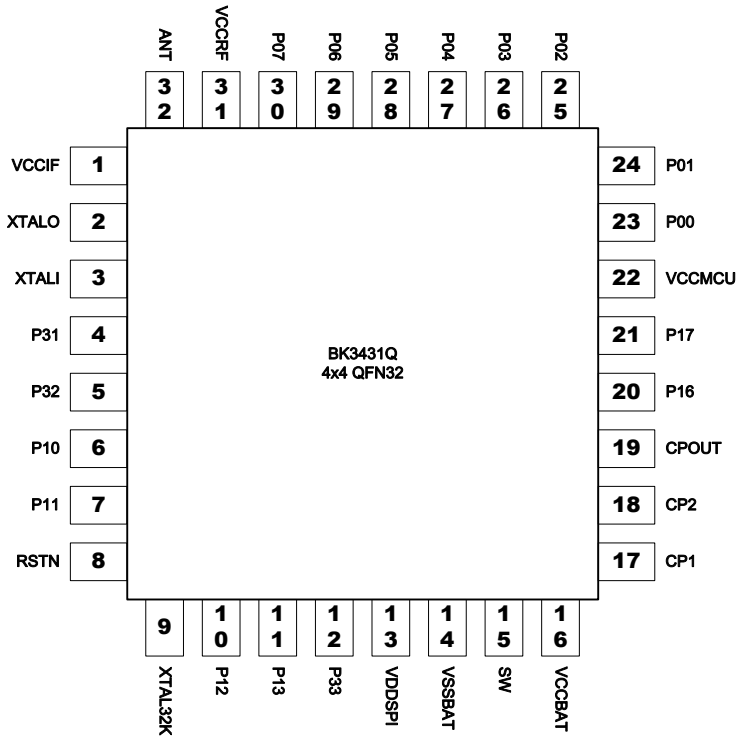


Figure 2 BK3431Q QFN32 pin assignment

Table 1 BK3431Q QFN32 Pin Description

PIN	Name	Pin Function	Description
1	VCCIF	Power	IF power
2	XTALO	Analog	16 MHz crystal output
3	XTALI	Analog	16 MHz crystal input
4	P31	Digital I/O	General purpose IO
5	P32	Digital I/O	General purpose IO
6	P10	Digital I/O	General purpose IO
7	P11	Digital I/O	General purpose IO
8	RSTN	Analog	Active low pin reset
9	XTAL32K	Analog	32kHz Crystal input
10	P12	Analog	Microphone bias voltage output
11	P13	Analog	Microphone input N
12	P33	Digital I/O	General purpose IO
13	VDDSPI	Analog	LDO output
14	VSSBAT	Ground	Ground

15	SW	Analog	Switch regulator pin for two battery mode
16	VCCBAT	Power	Power
17	CP1	Analog	Charge pump component for FLASH
18	CP2	Analog	Charge pump component for FLASH
19	CPOUT	Power	Charge pump output voltage for FLASH
20	P16	Digital I/O	General purpose IO
21	P17	Digital I/O	General purpose IO
22	VCCMCU	Power	Power
23	P00	Digital I/O	General purpose IO
24	P01	Digital I/O	General purpose IO
25	P02	Digital I/O	General purpose IO
26	P03	Digital I/O	General purpose IO
27	P04	Digital I/O	General purpose IO
28	P05	Digital I/O	General purpose IO
29	P06	Digital I/O	General purpose IO
30	P07	Digital I/O	General purpose IO
31	VCCRF	Power	RF power
32	ANT	RF	RF signal port

2.2 QFN40

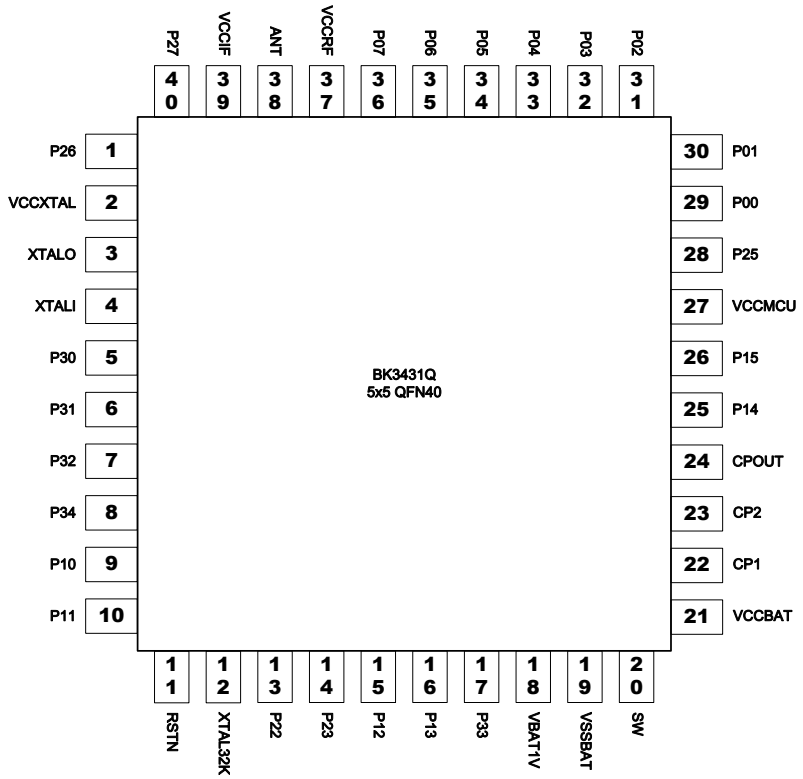


Figure 3 BK3431Q QFN40 pin assignment

Table 2 BK3431Q QFN40 Pin Description

PIN	Name	Pin Function	Description
1	P26	Digital I/O	General purpose IO
2	VCCXTAL	Power	XTAL power
3	XTALO	Analog	16 MHz crystal output
4	XTALI	Analog	16 MHz crystal input
5	P30	Digital I/O	General purpose IO
6	P31	Digital I/O	General purpose IO
7	P32	Digital I/O	General purpose IO
8	P34	Digital I/O	General purpose IO
9	P10	Digital I/O	General purpose IO
10	P11	Digital I/O	General purpose IO
11	RSTN	Analog	Active low pin reset
12	XTAL32K	Analog	32kHz Crystal input
13	P22	Analog	Microphone bias voltage output
14	P23	Analog	Microphone input P
15	P12	Digital I/O	General purpose IO
16	P13	Analog	LDO output
17	P33	Digital I/O	General purpose IO
18	VBAT1V	Analog	One battery mode (battery input) or two battery mode (Ground)
19	VSSBAT	Ground	Ground
20	SW	Analog	Switch regulator pin for two battery mode
21	VCCBAT	Power	Power
22	CP1	Analog	Charge pump component for FLASH
23	CP2	Analog	Charge pump component for FLASH
24	CPOUT	Power	Charge pump output voltage for FLASH
25	P14		
26	P15		
27	VCCMCU	Power	Power
28	P25	Digital I/O	General purpose IO
29	P00	Digital I/O	General purpose IO
30	P01	Digital I/O	General purpose IO
31	P02	Digital I/O	General purpose IO
32	P03	Digital I/O	General purpose IO
33	P04	Digital I/O	General purpose IO
34	P05	Digital I/O	General purpose IO
35	P06	Digital I/O	General purpose IO
36	P07	Digital I/O	General purpose IO
37	VCCRF	Power	RF power
38	ANT	RF	RF signal port
39	VCCIF	Power	IF power
40	P27	Digital I/O	General purpose IO

3 Functional Description

3.1 GPIO

The BK3431Q has many GPIO pins, which can be configured as either input or output. There are secondary functions available for GPIO pins and configurable by firmware.

At the beginning of the chip starts up, the chip will enter programming mode, JTAG mode or normal according received command from Mode Selecting Pin.

Table 3 BK3431Q GPIO function mapping

	Description		I/O	PROGRAM Mode	Mode Selection Pin	Jtag mode
P00	UART1	UART_TX	O			
P01		UART_RX	I			
P02	I2C	SCL	I/O	HOLD_FLA		
P03		SDA	I/O	WP_FLA		JTAG_NTRST
P04	SPI	SPI_SCK	I/O	SI_FLA (Output To FLASH)	SPI_MOSI	JTAG_TDI
P05		SPI_MOSI	I/O	SO_FLA	SPI_MISO	JTAG_TDO
P06		SPI_MISO	I/O	SCK_FLA	SPI_SCK	JTAG_TCK
P07		SPI_NSS	I/O	CSN_FLA	SPI_CS	JTAG_TMS
P10	PWM	PWM[0]（20mA）	O			
P11		PWM[1]（20mA）	O			
P12		PWM[2]	O			
P13		PWM[3]	O			
P16	UART2	UART2_TX	O			
P17		UART2_RX	O			
P31		Ch1	I			
P32		Ch2	I			
P33		Ch3	I			

Each GPIO pin can be the source to wake up MCU from shut down state. In the shutdown state, any voltage level change on the pre-configured GPIO pin will trigger the wake-up procedure.

3.2 Timers

3.2.1 16bits Timers

There are six 16 bits PWM timers. The clock of PWM timers can be selected as 32 KHz clock or 16 MHz clock by register.

There are two modes of PWM timers. One is timer mode and another is PWM mode. The timer mode can generate interrupt to MCU. The PWM mode can generate PWM waveform and output to GPIO pins to drive external device such as LED. Four GPIO pins can be used to output PWM waveform separately.

3.2.2 22bits Timers

There are four 22 bits timers, who run with 16 MHz clock.

3.2.3 Watch dog timer and RTC timer

The watch dog timer and RTC timer run on the always on power domain, whose clock source is 32 kHz clock.

The 16 bits watch dog timer runs with 4 kHz frequency that its period can be up to 16 second. After watch dog timer is expired, it will reset the whole chip.

The 32 bits RTC timer in always on power domain run with ROSC frequency that its period can be up to one day. After RTC timer is expired, it will wake up the MCU.

3.3 ADC

A 10-bit generic ADC is integrated in BK3431Q. Total three external channels and two internal channels can be selected for ADC transfer. It supports both single and continuous mode.

ADC Channel Number	ADC Source
Channel 1	GPIO31
Channel 2	GPIO32
Channel 3	GPIO33
Internal Channel 0	Temperature Sensor
Internal Channel 1	VCCBAT-pin

3.4 UART, I2C and SPI

There are two set UARTs, one set I2C and one set SPI interface, which support both master and slave mode.

The UART baud rate can be up to 3.2 MHz, and the SPI clock speed can be up to 4 MHz。

3.5 True random number generator

By using device noise variation characteristic, it provides one bit true random number generator.

4 Electrical Specifications

Table 4 BK3431Q RF Characteristics

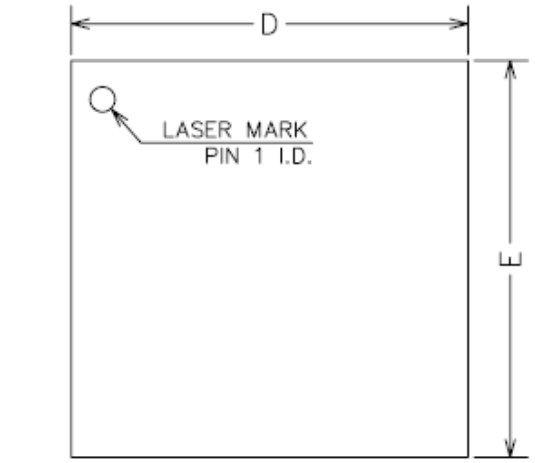
Name	Parameter (Condition)	Min	Typical	Max	Unit	Comment
	Operating Condition					
VCC	Voltage	0.9	3.0	3.6	V	
TEMP	Temperature	-40	+27	+125	ºC	
	Digital input Pin					
VIH	High level	VCC-0.3		VCC+0.3	V	
VIL	Low level	VSS		VSS+0.3	V	
	Digital output Pin					
VOH	High level (IOH=-0.25mA)	VCC- 0.3		VCC	V	
VOL	Low level(IOL=0.25mA)	VSS		VSS+0.3	V	
	Normal condition					
IVDD	Deep sleep		TBD		uA	
IVDD	Sleep current (RF OFF, 32 kHz clock, DIG Retention)		2		uA	
IVDD	Active RX (3.3 V)		5.2		mA	With DCDC regulator
IVDD	Active TX @ -1 dBm (3.3 V)		5		mA	With DCDC regulator
	Normal RF condition					
FOP	Operating frequency	2400		2480	MHz	
FXTAL	Crystal frequency		16		MHz	
RFSK	Air data rate		1	2	Mbps	
	Transmitter (1 Mbps mode)					
PRF	Output power	-20	-1	+4	dBm	
PBW	Modulation 20 dB bandwidth			1	MHz	
PRF1	Out of band emission 2 MHz		-20		dB	
PRF2	Out of band emission 3 MHz		-58		dB	

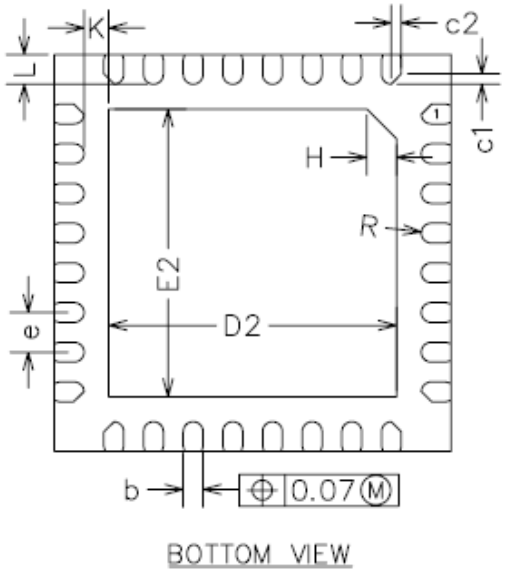
Dev	Transmit FM deviation	185	250	300	kHz	
Drift	Transmit drift in any position			400	Hz/us	
	Receiver					
Max Input	1 E-3 BER		-10		dBm	
RXSENS	1 E-3 BER sensitivity		-96	-97	dBm	
Intermodulation	Pin=-64 dBm; Punwant=-50 dBm; f0=2f1-f2, f2-f1=3 MHz or 4 MHz or 5 MHz		-25	-22	dBm	
C/ICO	Co-channel C/I		7		dB	
C/I1ST	ACS C/I 1MHz	-9		-6	dB	
C/I2ND	ACS C/I 2MHz		-44		dB	
C/I3RD	ACS C/I 3MHz		-50		dB	
C/I1STI	ACS C/I Image channel		-25		dB	
C/I2NDI	ACS C/I 1 MHz adjacent to image channel		-35		dB	
Block	Block @ 2399,and 2484		-15		dBm	
Block	Block @ 2 GHz and 3 GHz		-15		dBm	
Leakage	Leakage @ < 1GHz		-71		dBm	
Leakage	Leakage @ >1GHz		-56		dBm	

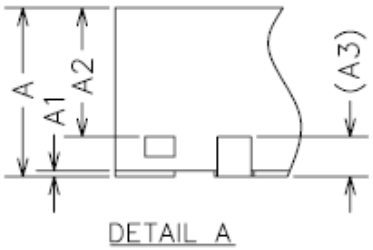
5 Package Information

5.1 QFN 4x4 32-Pin

The BK3431Q 32-Pin uses the 4mmx4mm QFN package.







COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0	0.02	0.05
A2	0.60	0.65	0.70
A3		0.20REF	
b	0.15	0.20	0.25
D	3.90	4.00	4.10
E	3.90	4.00	4.10
D2	2.80	2.90	3.00
E2	2.80	2.90	3.00
e	0.30	0.40	0.50
H		0.30REF	
K		0.25REF	
L	0.25	0.30	0.35
R	0.09	–	–
c1	–	0.10	–
c2	–	0.10	–

6 Order Information

Part number	Package	Packing	Minimum Order Quantity
BK3431QQN32A	QFN 4mmx4mm 32-Pin	Tape Reel	3K
BK3431QQN40A	QFN 5mmx5mm 40-Pin		

Revision History

Version	Date	Author(s)	Description
1.0	2017.09.01	MS	Initial
		WF	Update
1.1	2018.08.29	MS	Added the QFN 40 information