BK3431 Bluetooth Low Energy Single Mode SoC

Version 1.4

Beken Corporation
3A,1278 Keyuan Rd,Zhangjiang High-Tech Park
Pudong new Distrinct,Shanghai,201203,china
Tel： (86)21 51086811
Fax： (86)21 60871277

This document contains information that may be proprietary to, and/or secrets of, Beken Corporation. The contents of this document should not be disclosed outside the companies without specific written permission.

Disclaimer: Descriptions of specific implementations are for illustrative purpose only, actual hardware implementation may differ.

Revision History

Version	Date	Author(s)	Description
0.1	18/Apr/2012	Weifeng	Initial Draft
	13/July/2012	Weifeng	Update pin list, block diagram and elec. Spec according to initial spec
1.0	2013-08-23	Zhou Guofei	Update Pin mapping and description. Update functional description of digital peripheral units.
	2013-08-26	Weifeng	Add package and order information; Correct syntax error
1.1	2013-11-27	Zhou Guofei	Add 32Pin QFG Package Update the GPIO Pin Configurations
1.2	2014-04-23	Zhou Guofei	Minor change on the literal description
	2014-07-11	Zhou Guofei	Update the power consumption by current measurement of different operation mode Delete the 24MHz DPLL clock and 32KHz internal oscillator
1.3	2014-07-21	Le Guogen	Update Schematic
1.4	2014-07-21	lizhen	Add FLASH protection information

Table of Contents

List of Figures

List of Tables

1 General Description

1.1 Overview

The BK3431 chip is a highly integrated Bluetooth 4.0 low energy single mode device. It integrates a high-performance RF transceiver, baseband, ARM-core Micro processor, rich feature peripheral units, programmable protocol and profile to support BLE application. The Flash program memory makes it suitable for customized applications.

1.2 Block Diagram

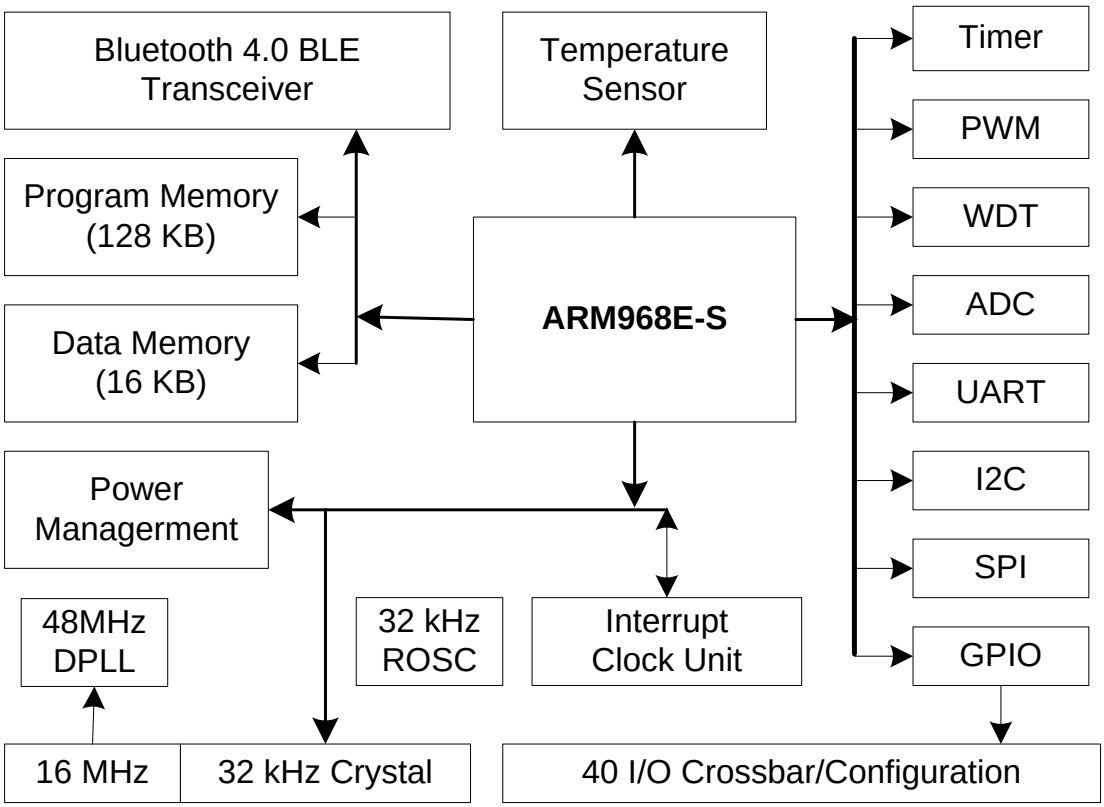


Figure 1 BK3431 Block Diagram

1.3 Features

- Bluetooth® SIG Bluetooth Low Energy Single-Mode (BLE) compliant
- Low-power 2.4GHz Transceiver
- ARM968 Core Micro processor integrated
- 128KB programmable Flash for Program and 16KB RAM for Data
- Operation voltage from 1.8 V to 3.6 V
- -89 dBm sensitivity at 1 Mbps data rate and +4dBm transmit power
- Current consumption
  - Rx operation active at sensitivity level: 21mA
  - Tx operation active with 0dBm output power: 16mA
  - Tx operation active with 4dBm output power: 18mA
  - MCU running with 16MHz clock without Tx/Rx: 5.2mA
  - MCU IDLE Mode with instantly wake-up: 820uA
  - MCU IDLE Mode with 1.5ms wake-up time: 10uA
  - Deep-Sleep Mode with GPIO wake-up: 4uA
- Clock
  - 16 MHz crystal reference clock
  - External 32KHz crystal oscillator as optional low-power clock source
- Interface and peripheral units
  - FLASH programming, JTAG, I2C, SPI and UART interface
  - On-chip high accurate temperature sensor
  - On-chip 7-channel 10bit general ADC
- Package Type
  - 32-pin QFN 4mmx4mm package
  - 16 GPIO pins with perpheral functions are available for various function usages such as HID, Remote Control and Wireless Beacon.

2 PIN information

The following figure shows QFN32 format packet type including 16 GPIO pins. The pin description is given in Table 1.

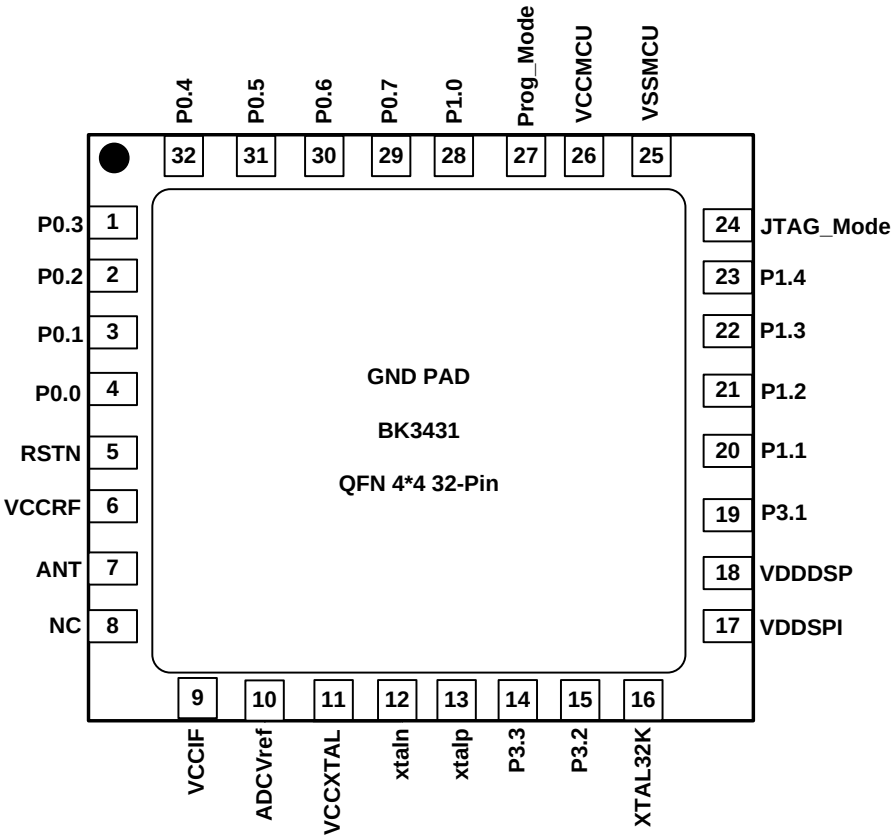


Figure 2 BK3431 QFN32 pin assignment

Table 1 BK3431 QFN32 Pin Description

PIN	Name	Pin Function	Description
1	P0.3	Digital I/O	General I/O for JTAG_Mode=0 JTAG Reset for JTAG_Mode=1 or data I/O for SMBUS (I2C)
2	P0.2	Digital I/O	General I/O, or clock for I2C
3	P0.1	Digital I/O	General I/O, or input for UART
4	P0.0	Digital I/O	General I/O, or output for UART
5	RSTN	Digital In	Reset for chip, active low
6	VCCRF	Power supply	3v supply
7	ANT	Antenna port	Connection of antenna to Tx and Rx
8	NC	NC	NC
9	VCCIF	Power supply	3V power supply of receiver IF path
10	ADCVREF	Analog pin	ADC reference voltage decoupling pin
11	VCCXTAL	Power output	3V power supply for crystal oscillator
12	XTALO	Analog output	Oscillator output
13	XTALI	Analog In	Oscillator input
14	P3.3	Digital I/O or analog In	General I/O, or input of General ADC ch3
15	P3.2	Digital I/O or analog In	General I/O, or input of General ADC ch2
16	XTAL32K	Analog In	32 KHz crystal input
17	VDDSPI	Analog pin	1.5V low power digital LDO output
18	VDDDSP	Analog pin	1.5V digital LDO output
19	P3.1	Digital I/O or analog In	General I/O, or input of General ADC ch1
20	P1.1	Digital I/O	General I/O, or enable for PWM1
21	P1.2	Digital I/O	General I/O, or enable for PWM2
22	P1.3	Digital I/O	General I/O, or enable for PWM3
23	P1.4	Digital I/O	General I/O, or enable for PWM4
24	JTAG_Mode	Digital In	JTAG Mode selection: 0: Disable, 1: Enable
25	VSSMCU	Power supply	Power ground for digital
26	VCCMCU	Power supply	Power supply for digital
27	Prog_Mode	Digital In	Flash Program Mode selection 0: Flash in normal mode 1: Flash in program mode
28	P1.0	Digital I/O	General I/O, or enable for PWM0
29	P0.7	Digital I/O	General IO for Prog_Mode/JTAG_Mode=0 SPI Enable for Prog_Mode=1 JTAG TMS for JTAG_Mode=1
30	P0.6	Digital I/O	General IO for Prog_Mode/JTAG_Mode=0 SPI Clock for Prog_Mode=1 JTAG Clock for JTAG_Mode=1
31	P0.5	Digital I/O	General IO for Prog_Mode/JTAG_Mode=0 SPI MISO for Prog_Mode=1 JTAG TDO for JTAG_Mode=1
32	P0.4	Digital I/O	General IO for Prog_Mode/JTAG_Mode=0 SPI MOSI for Prog_Mode=1 JTAG TDI for JTAG_Mode=1

3 Functional Description

3.1 GPIO

The BK3431 has totally 16 available GPIO pins for QFN32 package type, which can be configured as either input or output. There are secondary functions available for GPIO pins and configurable by firmware.

Table 2 BK3431 GPIO function mapping

GPIO	Program Mode	JTAG Mode	Secondary Function
GPIO P0.0			UART TXD
GPIO P0.1			UART RXD
GPIO P0.2			I2C Clock
GPIO P0.3		JTAG Reset	I2C Data IO
GPIO P0.4	SPI MOSI	JTAG TDI	SPI Interface Clock
GPIO P0.5	SPI MISO	JTAG TDO	SPI Interface MOSI
GPIO P0.6	SPI Clock	JTAG Clock	SPI Interface MISO
GPIO P0.7	SPI Enable	JTAG TMS	SPI Interface Enable
GPIO P1.0			PWM0
GPIO P1.1			PWM1
GPIO P1.2			PWM2
GPIO P1.3			PWM3
GPIO P1.4			PWM4
GPIO P3.1			ADC Channel 1
GPIO P3.2			ADC Channel 2
GPIO P3.3			ADC Channel 3

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.

Each GPIO has its own configuration register bits as following. There are 40 GPIO configurations for BK3431 but only 16 GPIO pins are available for QFN32 package type.

Table 3 BK3431 GPIO configuration registers (Base address: 0x00806500)

Address Offset	Configuration	Description
0x10	GPIO_WU_TYPE	GPIO Wake-up Mode: 1: Wake-up at positive edge 0: Wake-up at negative edge Bit[7:0] for GPIO P0.0~P0.7 Bit[15:8] for GPIO P1.0~P1.7 Bit[23:16] for GPIO P2.0~P2.7 Bit[31:24] for GPIO P3.0~P3.7
0x11	GPIO_WU_TYPE	GPIO Wake-up Mode: 1: Wake-up at positive edge 0: Wake-up at negative edge Bit[7:0] for GPIO P4.0~P4.7
0x12	GPIO_WU_ENABLE	GPIO Wake-up function enable: 1: Enable 0: Disable Bit[7:0] for GPIO P0.0~P0.7 Bit[15:8] for GPIO P1.0~P1.7 Bit[23:16] for GPIO P2.0~P2.7 Bit[31:24] for GPIO P3.0~P3.7
0x13	GPIO_WU_ENABLE	GPIO Wake-up function enable: 1: Enable 0: Disable Bit[7:0] for GPIO P4.0~P4.7
0x14	GPIO_WU_STAT	GPIO Wake-up Status. Write 1 to clear after wake-up. 1: Status active 0: None Bit[7:0] for GPIO P0.0~P0.7 Bit[15:8] for GPIO P1.0~P1.7 Bit[23:16] for GPIO P2.0~P2.7 Bit[31:24] for GPIO P3.0~P3.7
0x15	GPIO_WU_STAT	GPIO Wake-up Status. Write 1 to clear after wake-up. 1: Status active 0: None Bit[7:0] for GPIO P4.0~P4.7

3.2 PWM and Watch Dog Timer

There are five PWM timers. The clock of PWM timers can be selected as 32KHz clock or 16MHz clock by ICU 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. Five GPIO pins can be used to output PWM waveform separately.

The watch dog timer runs with 32 kHz clock, with period from 0.6 ms to 38 second.

3.3 ADC

A 10-bit generic ADC is integrated in BK3431. Total 8 channels can be selected for ADC transfer. All other 7 channels can be configured for different purposes except the channel 0 which is used for digitize the output of on-chip temperature sensor. The ADC supports continue mode and single transfer mode, and the sample rate can be 1 kHz to 32 kHz. In single transfer mode, it will generate interrupt every time after transform.

The ADC have four work mode, they are sleep mode, single mode, software mode and continue mode.

- Sleep mode (mode==00): ADC is power down now
- Single mode (mode==01): The system will enter sleep mode when transfer is done and waiting MCU to read the result. You should write mode=1 again for another transfer.
- Controlled by software (mode==10): In this mode, interrupt will be triggered after transfer and wait MCU to read. The interrupt will be cleared after MCU read, and then the transfer will start again.
- Continue mode (mode==11):The ADC will work at the sample rate set by register. The sample rate can be calculated by the next formula:
  - F_sample = input ADC clock/(2^(ADC_CLK_RATE+2) / 36(or 18))
  - The highest sample rate is 32k

The local interrupt flag of ADC need not be cleared by software; it will be set after transform and be cleared after the result has been read out. But the ADC INT stored ICU should be cleared after the ADC INT service finished.

The range of input voltage is from 0v to 1.5V. If the input voltage more than 1.5V, a resistor can be added to decrease the input voltage like the next diagram.

3.4 UART

The UART interface has 128 bytes FIFO for both TX and RX. It will generate interrupt request when there is risk or event of FIFO underflow or overflow. For the RX, it will generate interrupt if found parity bit check error or stop bit check error.

The wake-up function of UART Rx line is not available of current BK3431 project.

3.5 Program space

128K bytes FLASH memory is used for storing program. You can access the space with a simple SPI interface. Four GPIO P0.4, P0.5, P0.6 and P0.7 are used for program FLASH in program mode. You can read, write or erase the FLASH space with different SPI command. For detail information, please refer to the relevant file.

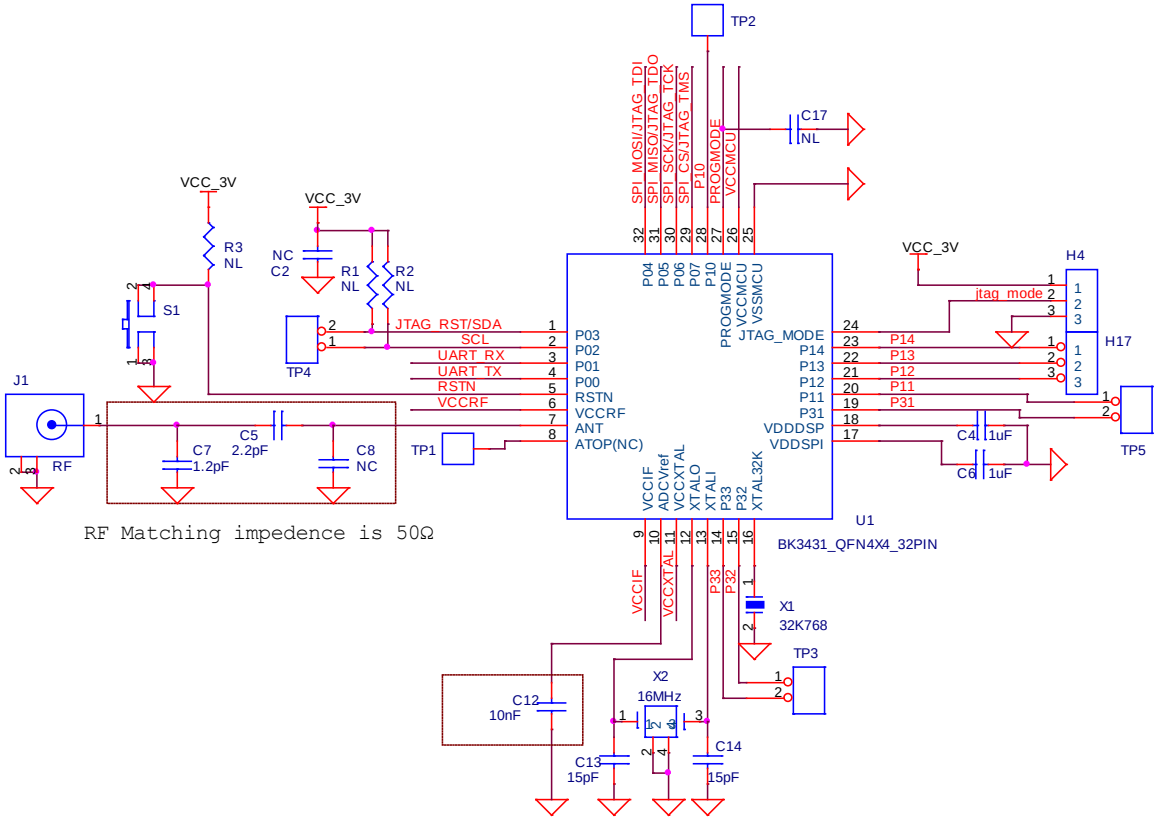
After erase, all the data in the FLASH are 0xFF, customer can write their program into the FLASH. Also, the data in the FLASH can be read out for debug. Once the developing process is done, the access for the FLASH can be forbbided by writing 0xAAAA into the last four addresses. ([128k-4]~[128k])

4 Electrical Specifications

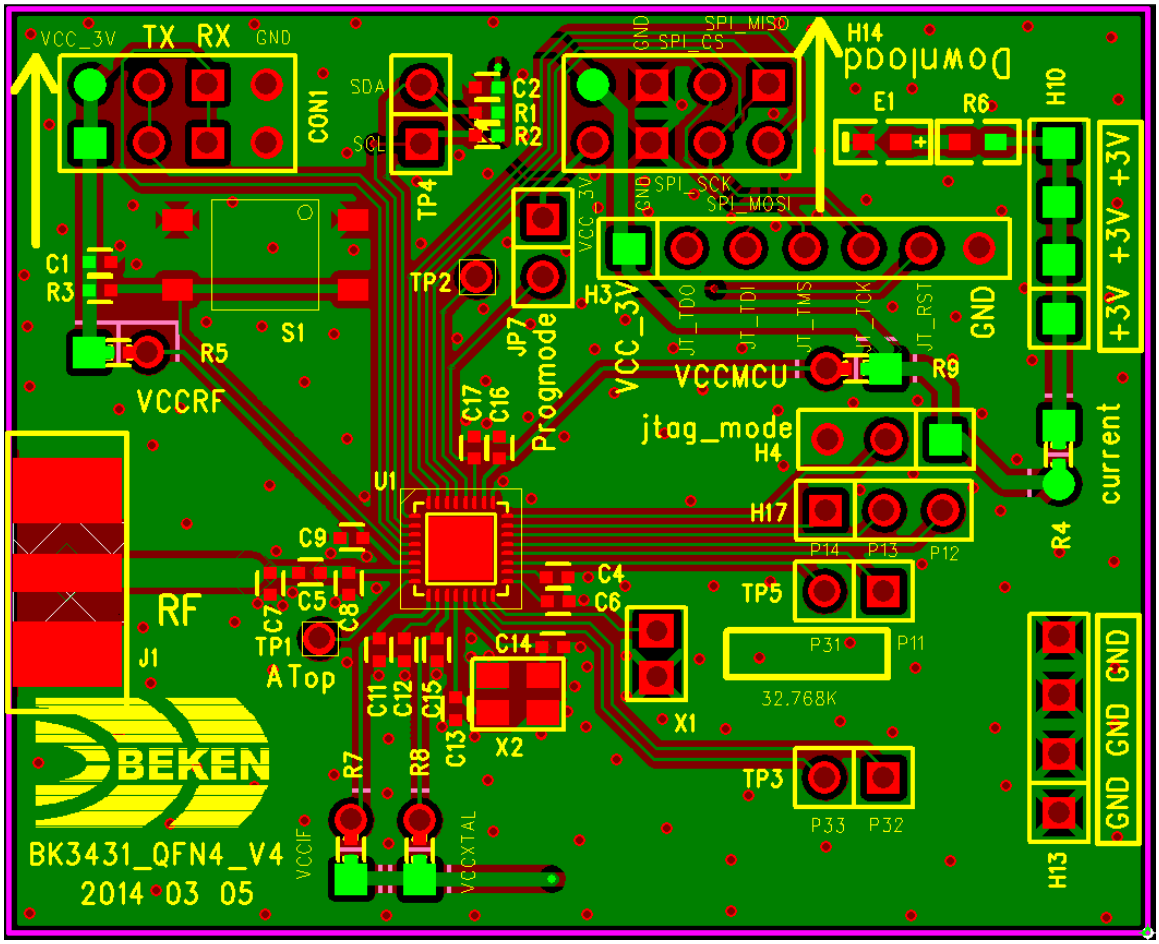
Table 4 BK3431 RF Characteristics

Name	Parameter (Condition)	Min	Typical	Max	Unit	Comment
	Operating Condition					
VCC	Voltage	1.8	3.0	3.6	V	
TEMP	Temperature	-20	+27	+85	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	Power Off		0.3	0.5	uA	
IVDD	Sleep current (RF OFF, 32 kHz clock)			2	uA	
IVDD	Active RX (1.8 V, 3 V)	10	13	13.5	mA	
IVDD	Active TX @ 0 dBm (1.8 V, 3 V)	9	10	11	mA	
	Normal RF condition					
FOP	Operating frequency	2400		2480	MHz	
FXTAL	Crystal frequency		16		MHz	
RFSK	Air data rate		1		Mbps	
	Transmitter					
PRF	Output power	-20	0	+4	dBm	
PBW	Modulation 20 dB bandwidth			1	MHz	
PRF1	Out of band emission 2 MHz		-20		dBm	
PRF2	Out of band emission 3 MHz		-30		dBm	
Dev	Transmit FM deviation	185	250	300	kHz	
Drift	Transmit drift in any position			400	Hz/us	20 kHz/ 50 us
	Receiver					
Max Input	1 E-3 BER			-10	dBm	
RXSENS	1 E-3 BER sensitivity	-91	-89	-86	dBm	
Intermodulation	Pin=-64 dBm; Punwant=-50 dBm; f0=2f1-f2, f2-f1=3 MHz or 4 MHz or 5 MHz	-25	-20	-18	dBm	
C/ICO	Co-channel C/I	8	9	10	dB	
C/I1ST	ACS C/I 1MHz	1	2	4	dB	
C/I2ND	ACS C/I 2MHz	-30	-29	-26	dB	
C/I3RD	ACS C/I 3MHz	-44	-42	-40	dB	
C/I1STI	ACS C/I Image channel	-14	-12	-11	dB	
C/I2NDI	ACS C/I 1 MHz □adjacent to image channel	-26	-25	-22	dB	
Block	Block @ 2399,and 2484	-16	-14	-13	dBm	
Block	Block @ 2 GHz and 3 GHz	-16	-14	-13	dBm	

5 Application Schematic

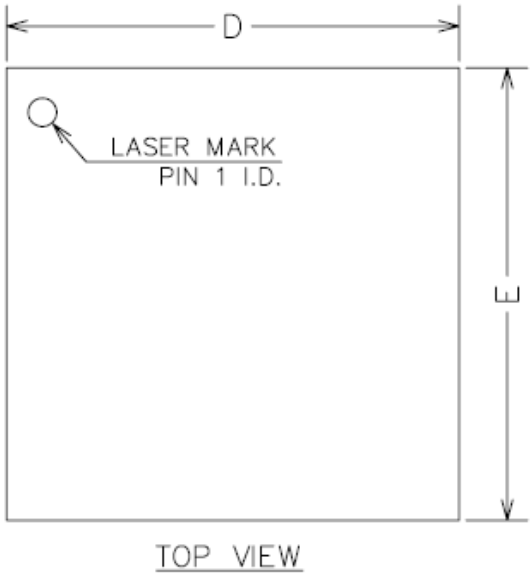


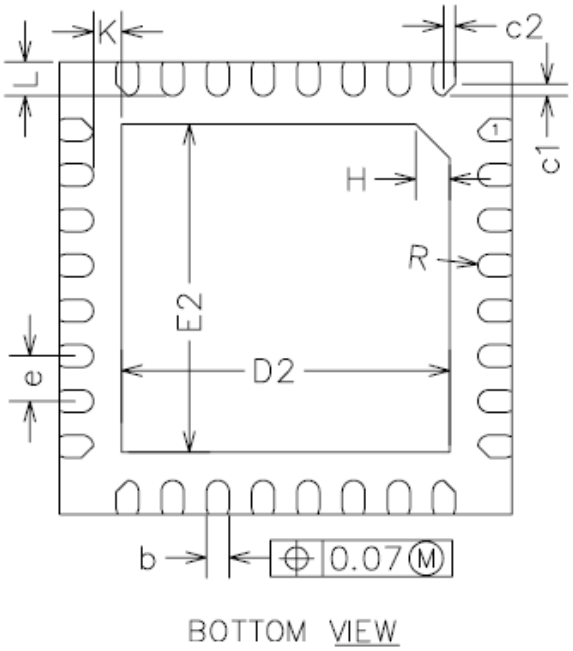
6 Application PCB Layout

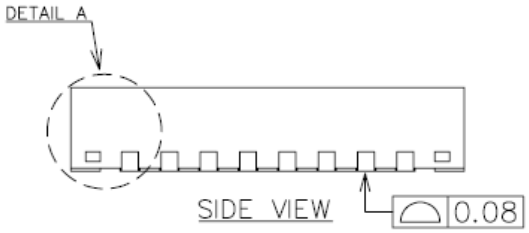


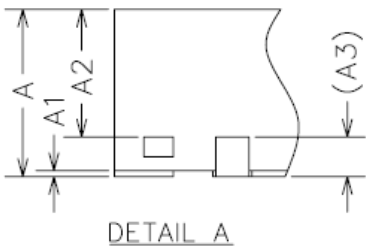
7 Package Information

The BK3431 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	–

8 Ordering Information

Part number	Package	Packing	MOQ (ea)
BK3431Q32	QFN 4mmx4mm 32-Pin	Tape Reel	10 k

Remark:

MOQ: Minimum Order Quantity