BK4819

Analog Two Way Radio IC

Features

- World wide band: 18 MHz ~ 660 MHz, 840 MHz ~1300 MHz
- 12.5/25/6.25/20 kHz channel spacing
- On chip 7 dBm RF PA
- 2.6 V to 3.6 V power supply
- CTCSS tone receiver with tail CTCSS frequency detector
- 23/24 bit programmable DCS code
- Standard DTMF and programmable in-band dual tone
- SELCALL and programmable in-band single tone
- FSK data modem
- Frequency inversion scrambler
- Voice activated switch (VOX)
- RF Signal strength measurement
- TX Audio signal strength indication and RX audio signal strength indication
- 3-wires interface with MCU with maximum 8 Mbps clock rate
- QFN 4x4 32-Pin package

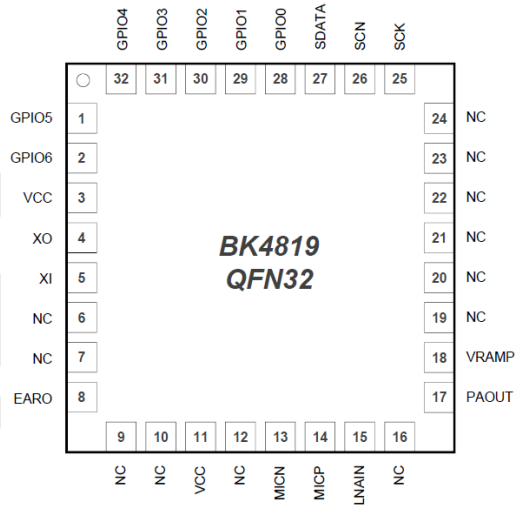
Applications

- Personal Radio Service
- Baby Monitor
- Toys

General Description

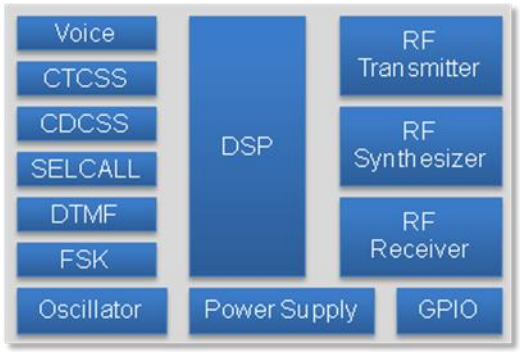
The BK4819 is a half duplex TDD FM transceiver operating within 18 MHz ~ 660 MHz, 840 MHz ~1300 MHz band range for worldwide personal radio. Besides speech communication, the BK4819 on-chip FSK data modem supports F2D and F1W emission to be used in both FRS and DPMR band for text message and GPS information exchange.

The BK4819 is a complete, small form factor solution optimized for low-power, low-cost, and highly integrated mobile and portable consumer electronic devices, requiring only a few external decoupling capacitors and an external inductor for input matching.



QFN 20 Pin Assignments (Top View)

Functional Block Diagram



1 Functional Description

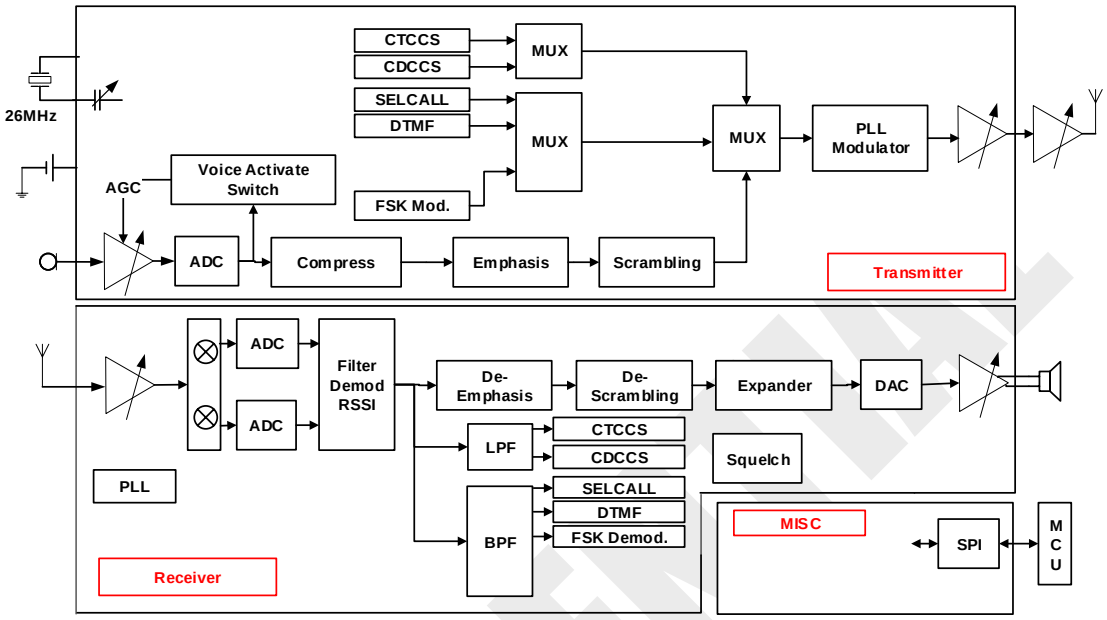


Figure 1. Functional Block Diagram

1.1 Overview

The BK4819 integrates high performance PLL, ADC, DAC, and advanced digital signal processing capability on a single chip. The digital low-IF image rejection architecture enables it to work with a very simple MCU as a two way radio communication system. On-chip flexible and precise continuous and discrete tone generator and detector enable a secure link and digital signaling.

1.2 RF Transceiver

BK4819 includes an integrated RF transceiver which is compliant with the specification most country in the world. The RF transceiver requires the following external components to operate:

1) A 26MHz crystal;
2) Simple input matching and output matching;
3) Several SMD capacitors for decoupling and DC blocking.

1.2.1 FM Receiver

The receiver implements a low-IF image rejection architecture, which is composed with two parts: RF front-end and IF part. The RF front-end comprises a LNA and a quadrature mixer. The IF part comprises a low-pass filter (LPF) for

channel filtering, a variable gain amplifier (VGA) and a high precision analog-to-digital converter(ADC). The block diagram of the FM receiver is shown in Figure 2.

At the RF front-end part, the LNA is a differential low-noise amplifier with single-ended input. The LNA is followed by a quadrature mixer that down-converts the RF signal directly to IF signal. Low-IF image rejection architecture is implemented in order to eliminate the external SAW filters.

At the IF part, the down-converted in-phase IF signal (IF/I) and quadrature-phase IF signal(IF/Q)are first filtered by the BPF, and then amplified by the VGA.The Sigma-Delta ADC sample analog IF signal from VGA, and convert it to digital IF signal. Then the digital signal will be send to DSP for second down-conversion and audio processing.

To avoid serious distortion with high-level input power, AGC function is added to automatically adjust the gain of LNA and the gain of VGA.

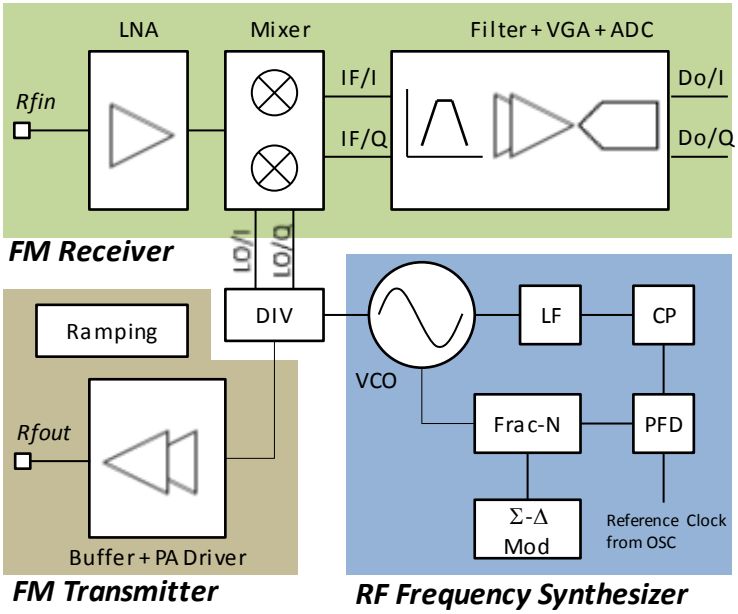


Figure 2. Radio Block Diagram

1.2.2 FM Transmitter

The transmitter is a single-ended amplifier including a buffer and a PA driver. The block diagram of the transmitter is shown in Figure 2. Due to FM modulation is of constant envelope, the amplifier works in saturated mode to save current consumption.

The output power of FM transmitter can be programmed from -24dBm to +7dBm through 3-wire SPI interface.

1.2.3 RF Frequency Synthesizer

An RF synthesizer is implemented to generate local oscillator(LO) signals. It includes a voltage controlled oscillator(VCO), a fractional-N divider(frac-N), a phase-frequency detector(PFD), a charge pump(CP) and a loop filter(LF). The RF synthesizer is shared for RX mode and TX mode. The block diagram of the synthesizer is shown in Figure 2.

In RX mode, the RF frequency synthesizer generates unmodulated LO signal. And the unmodulated LO signal is then divided by an integer N_{div} for down-conversion mixer in the FM receiver. In TX mode, FM modulation is realized in the RF frequency synthesizer.

In RX mode, the locked frequency of the synthesizer is equal to N_{div} x (f_{wanted}-f_{IF}). While in TX mode, the locked frequency of the synthesizer is equal to N_{div} x f_{wanted}.

Channel selection is also implemented by programming the value of fraction-N through 3-wire SPI interface. On power up or channel reselection, the synthesizer takes less than 0.3m sec to settle.

For BK4819, the default crystal is 26MHz. The frequency tolerance of the crystal should be within ±2.5ppm to keep a reliable communication.

1.2.4 Input/output Matching

Since the LNA input and the PA output are of single-ended, external balun is not necessary. Both the input matching and the output matching can be implemented using low-cost discrete inductors and capacitors. The schematic of input/output matching is shown in Figure 3.

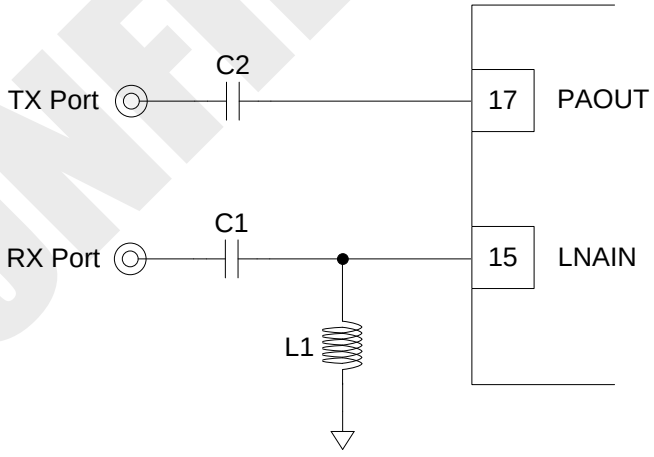


Figure 3. Schematic of Input/Output matching

As for input matching, capacitor C1 is used for DC-blocking. The recommended value of C1 is 4.7pF. The DC voltage at PIN15 is about 0V in RX mode. Inductor L1 is used for impedance transformation. The recommended value of L1 is NC.

As for output matching, capacitor C2 is used for DC-blocking, too.

1.2.5 Crystal Oscillator

BK4819 integrates a low-power amplitude-regulated 26MHz crystal oscillator. The 26MHz crystal oscillator not only provides the reference frequency for the RF synthesizer, but also provides clock for digital part. The circuit diagram of the 26MHz crystal oscillator is shown in Figure 4.

The 26 MHz crystal oscillator is designed for use with a quartz crystal in parallel resonant mode. To achieve correct oscillation frequency, the load capacitance must match the specification in the crystal datasheet. Figure 4 on next page shows how the crystal is connected to the 26 MHz crystal oscillator. C1 and C2 are ceramic SMD (Surface Mount Device) capacitors connected between each crystal terminal and ground. Cvar is an adjustable capacitor for frequency calibration.

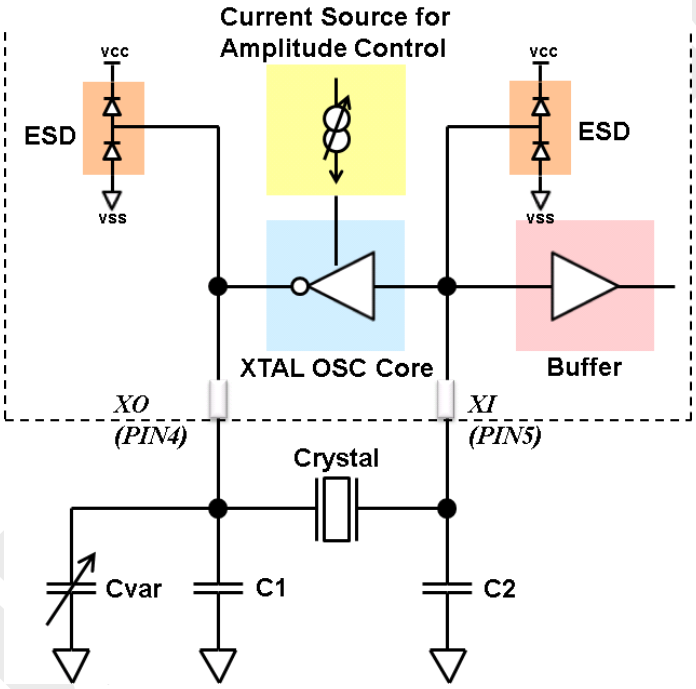


Figure 4. Circuit Diagram of the 26MHz Crystal Oscillator

$$C_{load} = \frac{C_1' \times C_2'}{C_1' + C_2'}$$
$$C_1' = C_1 + C_{var} + C_{par}$$
$$C_2' = C_2 + C_{par}$$

in which, Cpar is parasitic capacitance including PCB trace capacitance and pin input capacitance. The value of Cpar is about 1pF.

1.2.6 Power Supply Decoupling

Proper power-supply decoupling must be used for optimum performance. The placement and size of the decoupling capacitors and the power supply filtering are very important to achieve the best performance in an application.

1.3 SPI Interface

The BK4819 has 3-wires SPI interface. These 3 wires are SCK(*PIN25*), SCN(*PIN26*, SDATA(*PIN27*) for data exchange. SCK and SCN are input pins, while SDATA is bi-direction pin.

BK4819 always latch data at the SCK rising edge and output its data at SCK falling edge.

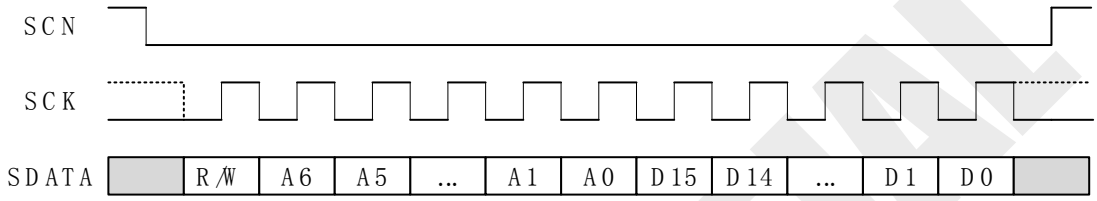


Figure 5. Three-wires Interface Timing

2 Electrical Specifications

2.1 Absolute Maximum Ratings

Maximum ratings are the extreme limits to which BK4819 can be exposed without permanently damaging it. Exposure to absolute maximum ratings for prolonged periods of time may affect BK4819's reliability. Table 1 specifies the absolute maximum ratings for BK4819.

Table 1. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{DD}	-0.3	—	+3.6	V
I/O pin voltage	V_{IO}	-0.3	—	V_{DD}+0.3	V
Storage Temperature	T_S	–40	25	105	°C

2.2 Recommended Operating Conditions

The operating conditions are the physical parameters that BK4819 can operate within. The operating conditions for BK4819 are defined in Table 2.

Table 2. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{DD}	3.0	—	3.6	V
Operating Temperature	T_O	–30	25	85	°C

Notes:
All minimum and maximum specifications are guaranteed and apply across the recommended operating conditions. Typical values apply at V_{DD}=3.3 V and 25 °C unless

otherwise stated. Parameters are tested in production unless otherwise stated.
For QFN4x4 24pin package, VDD range is 2.6-3.6V.
The range of operating temperature mainly depends on the specification of the crystal. The frequency tolerance of the crystal should be within +/-2.5ppm during all operating conditions.

2.3 Power Consumption Specification

Table 3. Power Consumption Specification

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Current (RX Mode)	I_{RX}	RF_Rxon	—	42	—	mA
Supply Current (TX Mode)	I_{TX}	RF_Txon	—	34	—	mA
Power Down Current	I_{PD}	RF_Sleep	—	200	—	μA

2.4 Receiver Characteristics

Table 4. Receiver Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Operating Frequency	F_{OP}	1	840	-	1300	MHz
		2	18	-	660	
Sensitivity	RXSENS	1, 4, 5	-123	-123	-123	dBm
Adjacent Channel Selectivity	ACS	2, 4	68	68	68	dB
Blocking	BLK	3, 4	82	85	85	dB
Inter-modulation	IMD	4	65.5	66	66	dB
Audio						
Earpiece output level	EARO	5		146		mVrms
SINAD	ASNR	5, 6	53	53	53	dB
Amplitude response	ARES		-3		3	dB
Audio noise floor	ANF			81		dBm
CTCSS						
CTCSS sensitivity	CTSEN			-123		dBm
CTCSS response time	CTRES		75		125	ms
Frequency range	SAF		62.5		250.3	Hz
DCS						
CDCSS sensitivity	CDSEN			-123		
CDCSS response time	CDRES			171		ms
Code length	CLEN		23		24	Bit
Bit rate	BRATE			134.4		Hz
SELCALL						
SELCALL sensitivity	SELSEN			-123		dBm
SELCALL response time	SELRES			30		ms
Frequency range	IBSF		400		3000	Hz
DTMF						
DTMF sensitivity	DTSEN			-123		dBm
DTMF response time	DTRES			20		ms
High band frequency range	FH		1209		1633	Hz

Low band frequency range	FL		697		941	Hz

Test Condition:
1. 12 dB SINAD
2. 1st adjacent channel (±12.5kHz)
3. Frequency offset > 1MHz
4. According to ETSI standard (EN 300 296-1 V1.4.1)
5. 1kHz tone, 1.5kHz deviation
6. -50dBm input power

2.5 Transmitter Characteristics

Table 5. Transmitter Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Operating Frequency	F_{OP}	1	840	-	1300	MHz
		2	18	-	660	
Output Power	POUT	1	-24	0	7	dBm
Adjacent Channel Power Rejection	ACPR 1st		68	69	69	dBc
Alternate Channel Power Rejection	ACPR 2nd		76	77	77	dBc
Microphone Sensitivity	MICSENS	2		12		mV
SINAD	TSINAD	3		51		dB

Test Condition:
1. Depend on output matching and register settings
2. 1.5kHz deviation
3. At sensitivity level

2.6 SPI Control Interface Characteristics

Table 6. SPI Control Interface Characteristics

Parameter	Symbol	Min.	Typ.	Max.
SCK Frequency	fSCK	0 MHz	—	8 MHz
SCK High Time	tHIGH	25 ns	—	—
SCK Low Time	tLOW	25 ns	—	—
SDATA Input, SCN to SCK ↑ Setup	tS	20 ns	—	—
SDATA Input to SCK ↑ Hold	tHSDATA	10 ns	—	—
SCN Input to SCK ↓ Hold	tHSCN	10 ns	—	—
SCK ↓ to SDATA Output Valid	tCDV	2 ns	—	25 ns
SCK ↓ to next SCK ↑ after Address In	tNXT	1 us	—	—
SCK, SCN, SDATA, Rise/Fall Time	tR,tF	—	—	10 ns

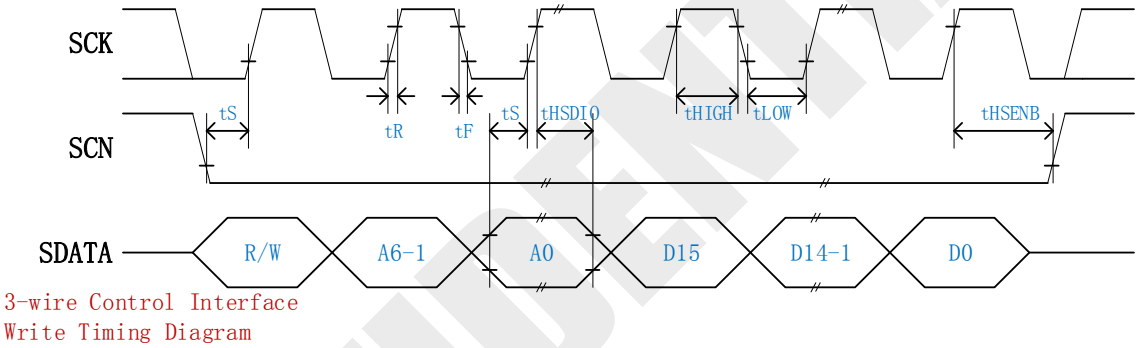


Figure 6. 3-Wire Control Interface Write Timing Diagram

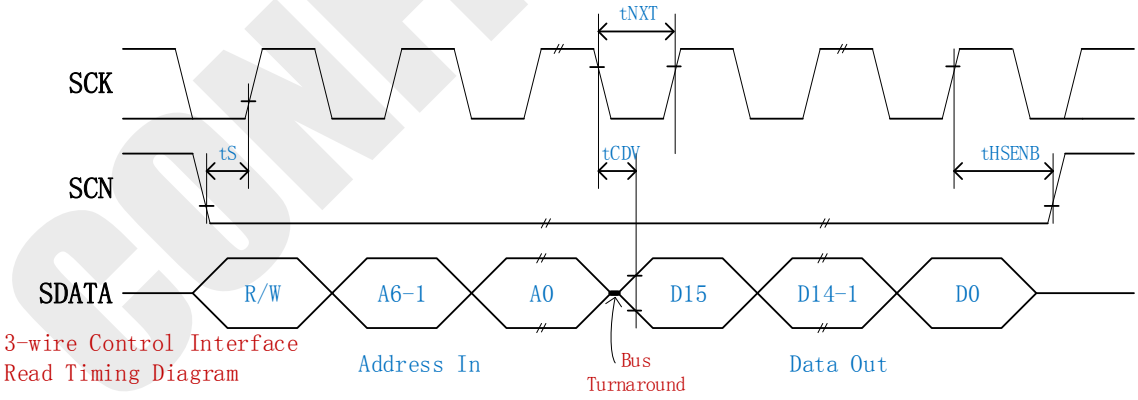


Figure 7. 3-Wire Control Interface Read Timing Diagram

3 Pin Assignment

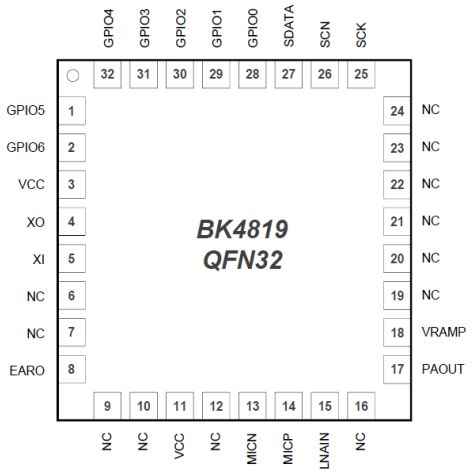


Figure 8. BK4819 Pin Assignment (Top View)

Table 7. BK4819 4mmx4mm 20-Pin Definition

Pin #	Name	Direction	Function
1	GPIO5	I/O	General purpose input/output - there is internal pull-down on this port.
2	GPIO6	I/O	General purpose input/output - there is internal pull-down on this port.
3	VCC	Input	Digital Power Supply, 2.6 V~ 3.6 V
4	XO	Output	Crystal oscillator port, output
5	XI	Input	Crystal oscillator port, input
6	NC		
7	NC		
8	EARO	Output	Earpiece output
9	NC		
10	NC		
11	VCC	Input	Analog Power supply, 2.6 V to 3.6 V
12	NC		
13	MICN	Input	Microphone input, negative
14	MICP	Input	Microphone output, positive
15	LNAIN	Input	Input of low noise amplifier
16	NC		
17	PAOUT	Output	Output of power amplifier
18	VRAMP	Output	PA regulator output
19	NC		
20	NC		
21	NC		
22	NC		
23	NC		
24	NC		
25	SCK	Input	SPI clock

26	SCN	Input	SPI enable
27	SDATA	I/O	SPI data
28	GPIO0	I/O	General purpose input/output - there is internal pull-down on this port.
29	GPIO1	I/O	General purpose input/output - there is internal pull-down on this port.
30	GPIO2	I/O	General purpose input/output - there is internal pull-down on this port.
31	GPIO3	I/O	General purpose input/output - there is internal pull-down on this port.
32	GPIO4	I/O	General purpose input/output - there is internal pull-down on this port.

4 Typical Application Schematic

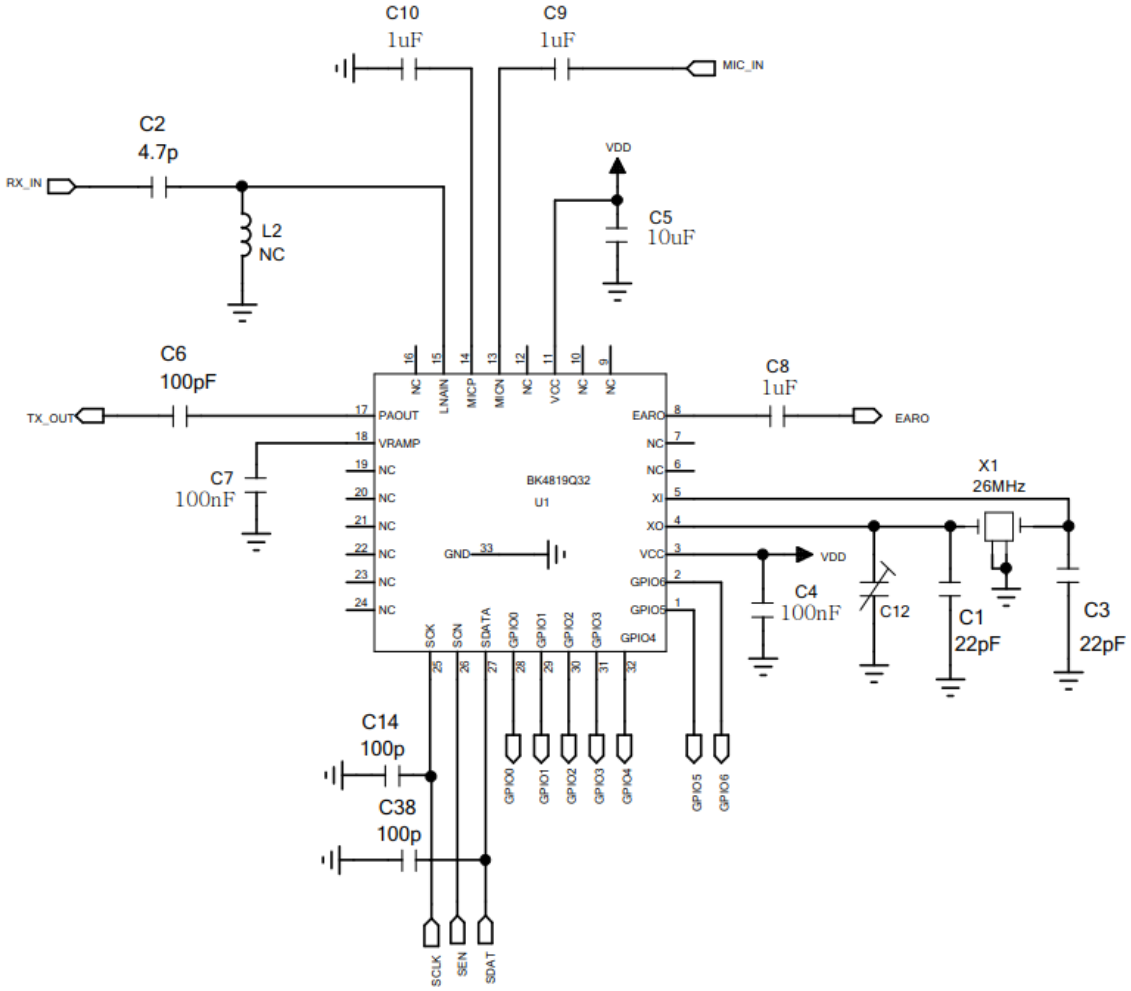


Figure 9. BK4819 Application

5 Package Information

QFN 4mmx4mm 32pin package is available for BK4819. Detail information of the package is shown below:

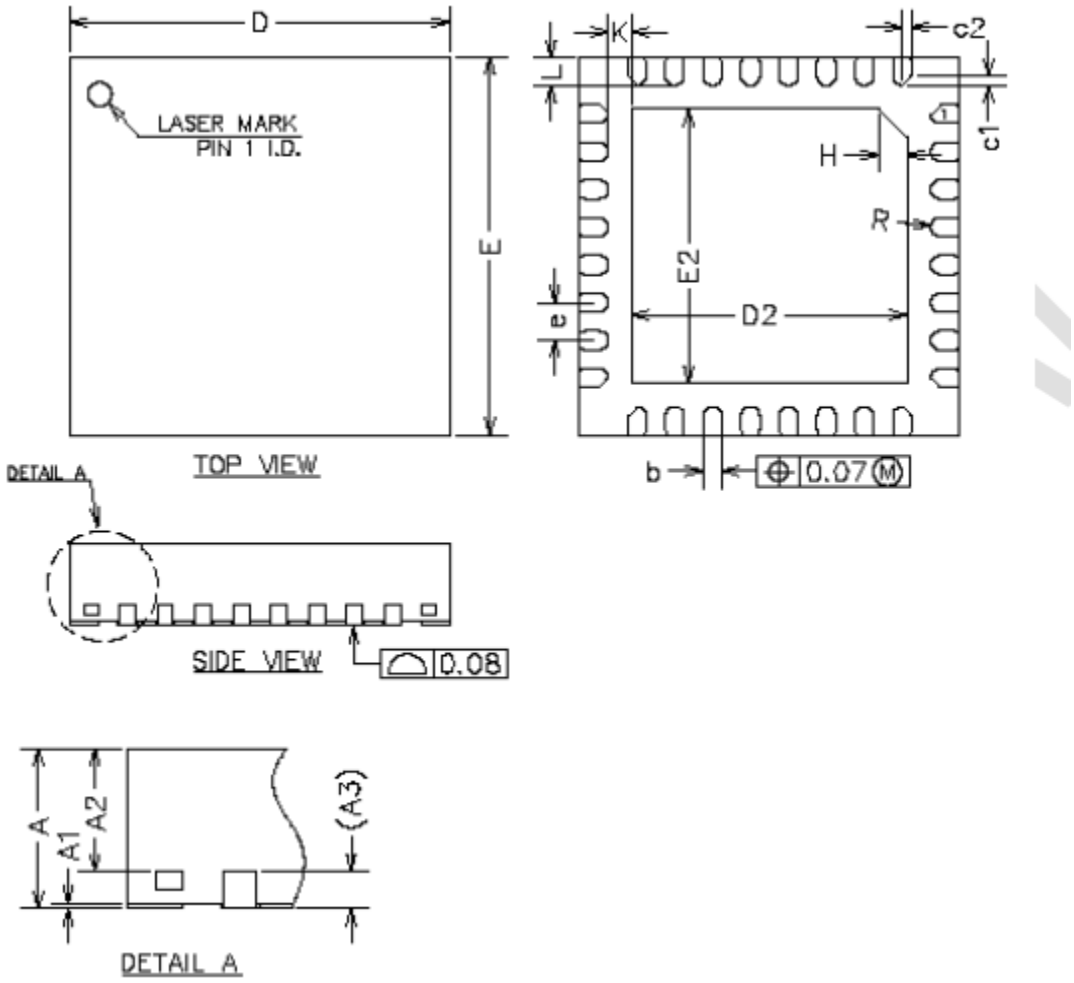


Figure 10. QFN 4x4 32 Pin Package diagram

Table 8. QFN 4x4 32 Pin Package dimensions

Parameter	Min	Typ	Max	Unit
A	0.80	0.85	0.90	mm
A1	0.00	0.02	0.05	mm
A2	0.60	0.65	0.70	mm
A3		0.20 REF		mm
b	0.15	0.20	0.25	mm
D	3.90	4.00	4.10	mm
E	3.90	4.00	4.10	mm
D2	2.80	2.90	3.00	mm
E2	2.80	2.90	3.00	mm
e	0.30	0.40	0.50	mm
H		0.30 REF		mm
K		0.25 REF		mm
L	0.25	0.30	0.35	mm
R	0.09	–	–	mm
c1	–	0.10	–	mm
c2	–	0.10	–	mm

Storage Caution

1. Calculated shelf life in vacuum sealed bag 12 months at<40℃ and 90% relative humidity (RH).
2. Peak package body temperature 260℃.
3. After vacuum sealed bag is opened ,devices that will be subjected to reflow solder or other high temperature process must
   a) Mounted within 168 hours of factory conditions<40℃/60%.
   b) Stored at 10% RH.

6 Tape and Reel Information

All dimensions are in millimeters by default.

6.1 Tape Information

The figure below shows the dimensions of the tape for the BK4819 QFN.

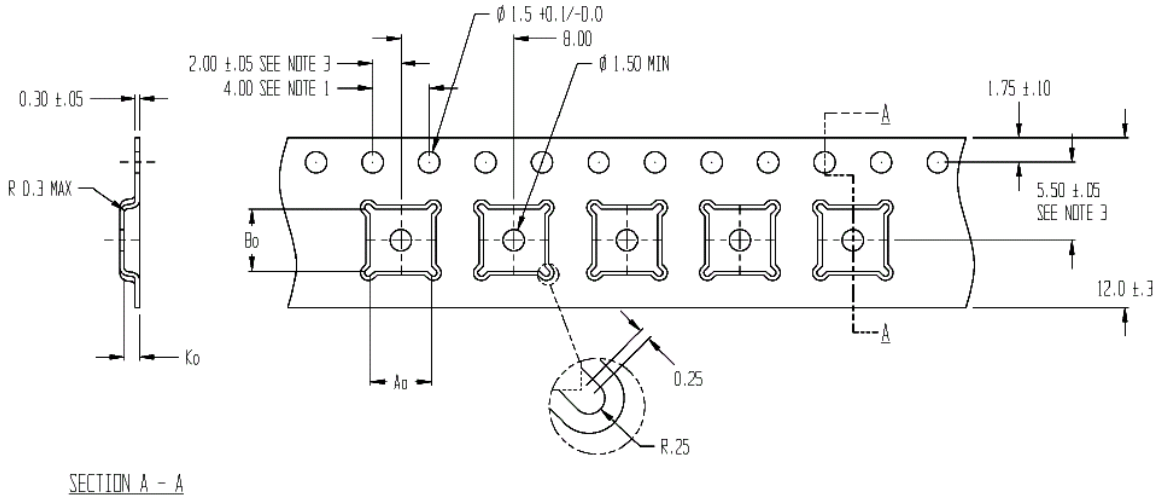


Figure 11. Tape Dimensions

A_0	B_0	K_0	Unit	Notes
4.35	4.35	1.1	mm	1. 10 sprocket hole pitch cumulative tolerance ±0.2. 2. Camber in compliance with EIA 481. 3. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

6.2 Cover Information

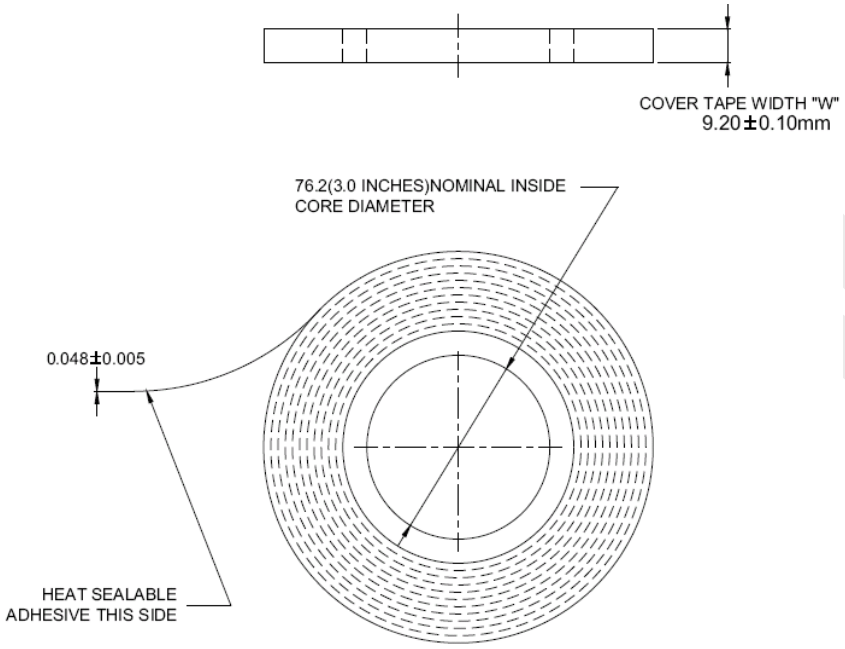


Figure 12. Cover Dimensions

Note:

1. Reel to contain 300 meters of splice free material.
2. Material: Polyester film with antistatic coating and adhesive coating.
3. Color: Transparent, natural

6.3 Reel Information

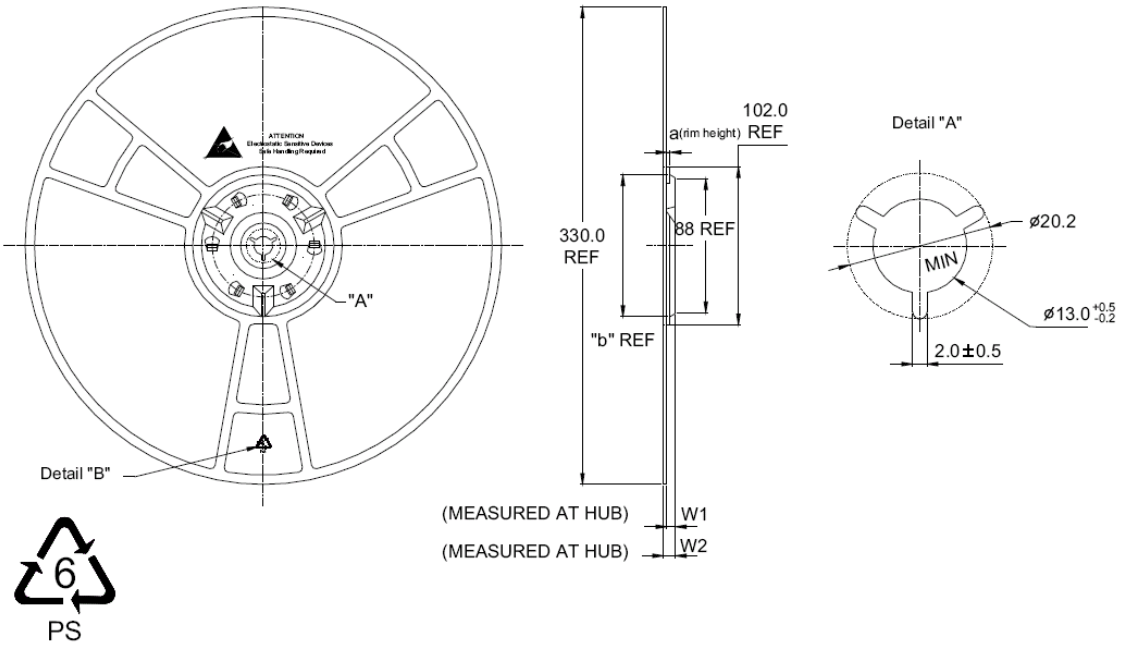
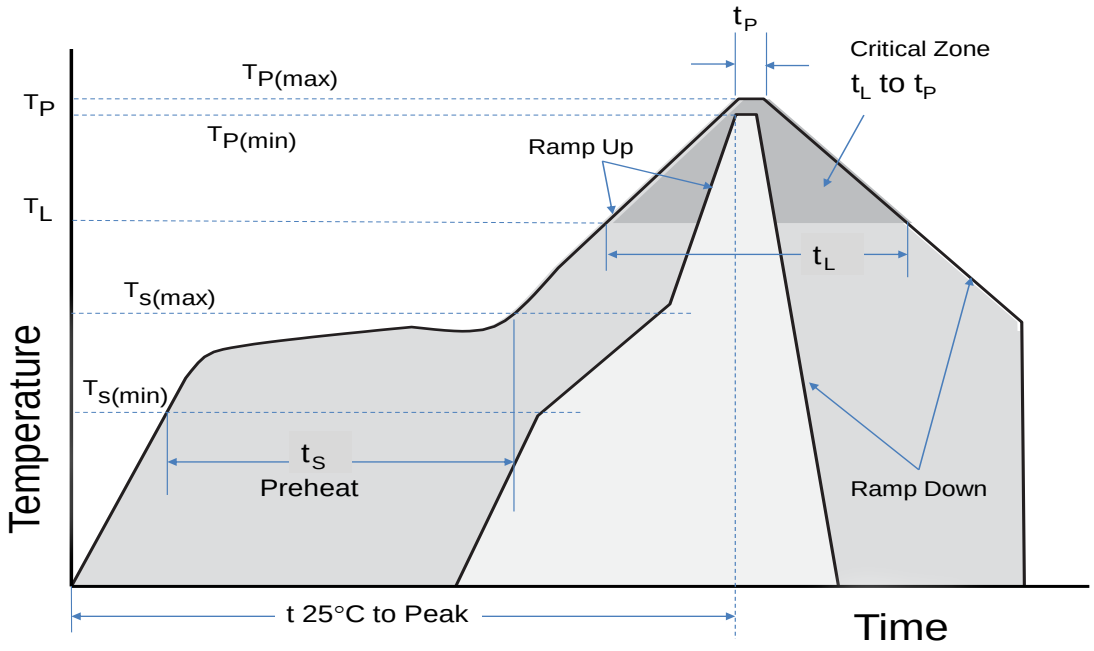


Figure 13. Reel Dimensions

Nominal Hub Width	W1 +0.6mm -0.4mm	W2 MAX	a	b	Unit
12	12.8	18.2	1.5	96.5	mm

7 Solder Reflow Profile



Fi

gure 14. Classification Reflow Profile

Profile Feature		Specification
Average Ramp-Up Rate (tsmax to tp)		3°C/second max.
Pre_heat	Temperature Min (Tsmin)	150°C
	Temperature Max (Tsmax)	200°C
	Time (ts)	60-180 seconds
Time Maintained above	Temperature (TL)	217°C
	Time (tL)	60-150 seconds
Peak/Classification Temperature (Tp)		260°C
Time within 5°C of Actual Peak Temperature (tp)		20-40 seconds
Ramp-Down Rate 6		6°C/second max.
Time 25°C to Peak Temperature 8		8 minutes max.

RoHS Compliant

The product does not contain lead, mercury, cadmium, hexavalent chromium, PBB&PBDE content in accordance with directive 2002/95/EC(RoHS).

ESD Sensitivity

Integrated circuits are ESD sensitive and can be damaged by static electricity. Proper ESD techniques should be used when handling these devices.

8 Order Information

Part number	Package	Packing	MOQ (ea)
BK4819	QFN	Tape Reel	3 k

Remark:
MOQ: Minimum Order Quantity

9 Additional Reference Resources

- Application Notes
- Register Table
- Schematic & Layout

10 Revision History

Version	Change Summary	Date	Author
Rev.1.0	Initial Release	2020/8/18	
Rev.1.1			
Rev.1.2			
Rev.1.3			

11 Contact Information

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