

SINGLE-CHIP BROADCAST FM RADIO RECEIVER

Features

- Support 64~108 MHz band ¹
- Automatic gain control(AGC)
- Automatic frequency control(AFC)
- Seek tuning
- Channel quality assessment
- Digital FM stereo decoder
- Automatic stereo/mono switching
- Automatic noise suppression
- 75us de-emphasis
- 2.3 ~ 5.5 V supply voltage
- Active current 22 mA
- 32.768KHz crystal oscillator
- 4x4 mm 24-pin QFN package and 16-pin SOP package

Notes

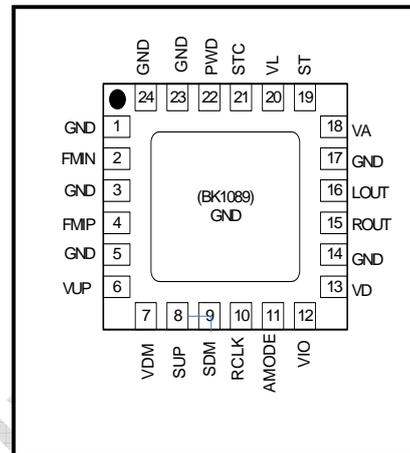
1. Band is selected by internal bonding , default is 87.5-108MHz.

Applications

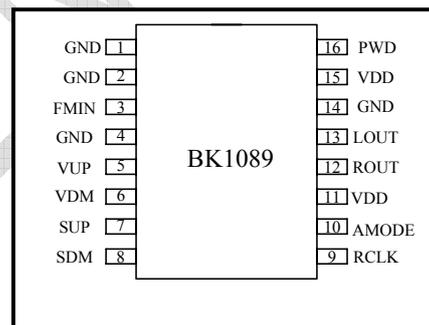
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General Description

The BK1089 single-chip FM receiver employs a low-IF architecture, mixed signal image rejection and all digital demodulation technology. The station scan of BK1089 searches radio stations based on both the channel RSSI estimation and signal quality assessment, increases the number of receivable stations while avoids false stops. BK1089 enables FM radio reception with low power, small board space and minimum number of external components.

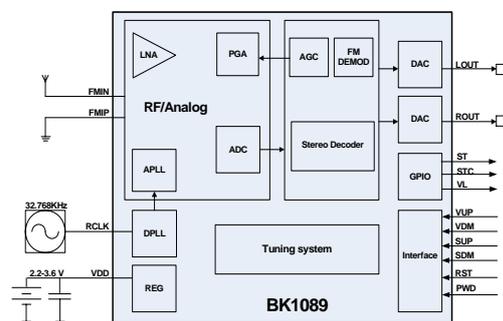


QFN 24 Pin Assignments (Top View)



SOP 16 Pin Assignments (Top View)

Functional Block Diagram



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2 Functional Description

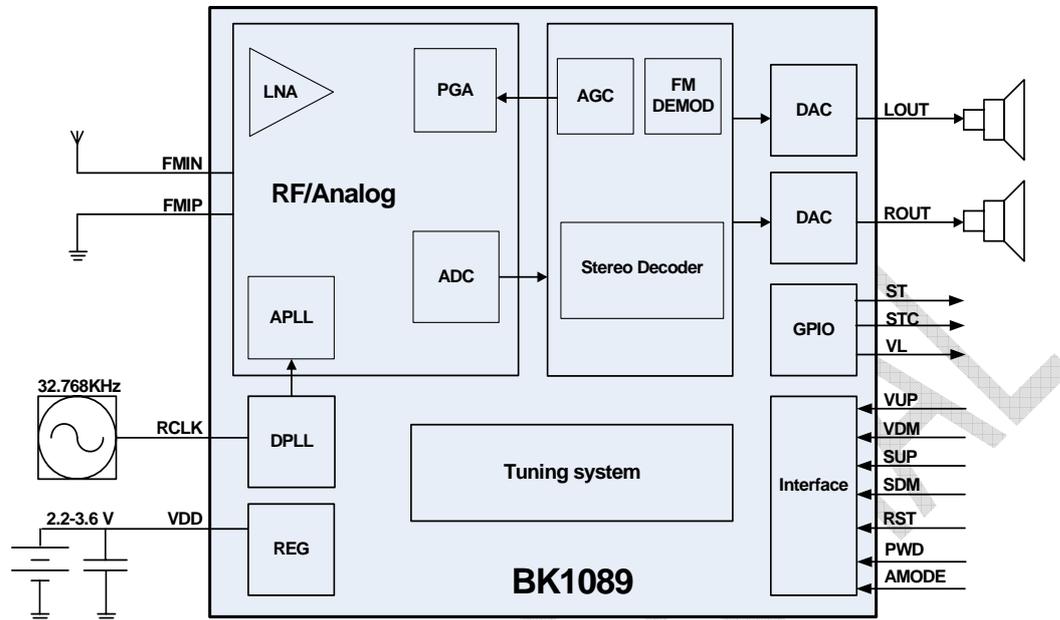


Figure 1. Functional Block Diagram

2.1 FM Receiver

The receiver employs a digital low-IF architecture that reduces external components, and integrates a low noise amplifier (LNA) supporting the worldwide FM broadcast band (65 to 108MHz), an automatic gain control (AGC) circuit controls the gain of the LNA to optimize sensitivity and rejection of strong interferers, an image-reject mixer down converts the RF signal

to low-IF, The mixer output is amplified by a programmable gain control (PGA), and digitized by a high resolution analog-to-digital converters (ADCs). An audio DSP finishes the channel selection, FM demodulation, stereo MPX decoder and output audio signal. The MPX decoder can autonomous switch from stereo to mono to limit the output noise.

2.2 Stereo Audio Processing

The output of the FM demodulator is a stereo multiplexed (MPX) signal. MPX signal format consists of left + right (L+R) audio, left -right (L-R) audio, a

19 kHz pilot tone.

The BK1089 has integrated stereo decoder automatically decodes the MPX signal. The 0 to 15 kHz (L+R) signal is the mono output of the FM tuner. Stereo is generated from the (L+R), (L-R), and a 19 kHz pilot tone. The pilot tone is used as a reference to recover the (L-R) signal. Separate left and right channels are obtained by adding and subtracting the (L+R) and (L-R) signals, respectively. Adaptive noise suppression is employed to gradually combine the stereo left and right audio channels to a mono (L+R) audio signal as the signal quality degrades to maintain optimum sound fidelity under varying reception conditions. Stereo/mono status can be monitored with the pin ST..

BK1089 uses pre-emphasis and de-emphasis to improve the signal-to-noise ratio of FM receivers by reducing the effects of high frequency interference and noise. When the FM signal is transmitted, a pre-emphasis filter is applied to accentuate the high audio frequencies. All FM receivers incorporate a de-emphasis filter which attenuates high frequencies to restore a flat frequency response. The de-emphasis time constant is internal set to 75 μ s.

High-fidelity stereo digital-to-analog converters (DACs) and audio amplifier drive analog audio signals onto the LOUT and ROUT pins. 8 Ω speaker can be driven with 250mW max output power directly.. Volume can be adjusted with VUP and VDM Pin. The internal soft mute feature is available to attenuate the audio outputs and minimize audible noise in very weak signal conditions.

2.3 Seeking System

Channel spacing of 100 KHz is used by the BK1089. The bottom of the band is set to 64, 76 or 87MHz by internal bonding... The station scan of BK1089 searches radio stations based on both the channel RSSI estimation and signal quality assessment, increases the number of receivable stations while avoids false stops. Seek begins at the current channel, and goes in the direction specified by pin SUP and SDW. Seek operation stops when a channel is qualified as valid according to the seek parameters. Seeking is wrap at the upper or lower band limit and continue seeking. The pin STC bit is set high when the seek operation completes

3 Design Specification

3.1 Recommended Operating Conditions

Table 1 Recommended Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Digital Supply Voltage	V _D		2.3	—	5.5	V
Analog Supply Voltage	V _A		2.3	—	5.5	V
Interface Supply Voltage	V _{IO}		1.6	—	3.6	V
Ambient Temperature	T _A		-20	25	85	°C

Notes:
 All minimum and maximum specifications are guaranteed and apply across the recommended operating conditions. Typical values apply at V_D = V_A = 3.3 V and 25 °C unless otherwise stated. Parameters are tested in production unless otherwise stated.
 For BK1080 QFN24-2 and BK1080 SOP16&TSSOP16 package ,Supply Voltage range is 2.7V-3.6V

3.2 Power Consumption Specification

Table 2 Power Consumption Specification

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Current BK1080	I _S	ENABLE = 1 DISABLE = 0	—	22	24	mA
Power down Current	I _{PD}	ENABLE = 0 DISABLE = 1	—	20	30	μA
Interface Power down Current	I _{pIO}	SCLK, RCLK inactive ENABLE = 0	—	1.9	5	μA

3.3 Receiver Characteristics

Table 3 Receiver Characteristics

Parameter	Test Condition	Min	Typ	Max	Unit
Input Frequency		65	—	108	MHz
Sensitivity with Headphone Network[2, 3, 4,5]	(S+N)/N = 26 dB	—	1.8	2.5	μV EMF
LNA Input Resistance[7]		2.5	3	3.5	kΩ
Input IP3[8]			88	—	dBμV EMF
AM Suppression[2, 3, 4, 5, 7]	m = 0.3	40	45	—	dB
Adjacent Channel Selectivity	±200 kHz		40	—	dB
Alternate Channel Selectivity	±400 kHz		50	—	dB
Audio Output Voltage[2, 3, 7, 10]		—	110		mV
Audio Stereo Separation[2, 5, 7,10]		—	30	—	dB
Audio Mono S/N[2, 3, 4, 5, 7, 13]			55	—	dB
Audio Stereo S/N[2, 3, 4, 5, 7, 13]			50	—	dB
Audio THD[2, 3, 5, 7, 10]		—	0.2	—	%
Audio Common Mode Voltage[12]	ENABLE = 1	1.1	1.2	1.3	V
Audio Output Load Resistance	Single-ended	8	—	—	Ω
Seek/Tune Time		—	—	60	ms/chan

Notes:

1. Volume = maximum for all tests
2. $F_{MOD} = 1$ kHz, 75 μ s de-emphasis
3. MONO = 1, and L = R unless noted otherwise
4. $\Delta f = 22.5$ kHz
5. $B_{AF} = 300$ Hz to 15 kHz, A-weighted
6. Sensitivity without matching network
7. Measured at $V_{EMF} = 1$ mV, $f_{RF} = 76$ to 108 MHz
8. $|f_2 - f_1| > 1$ MHz, $f_0 = 2 \times f_1 - f_2$. AGC is disabled by setting AGCD = 1
9. The channel spacing is selected with the SPACE [1:0] bits
10. $\Delta f = 75$ kHz
11. The de-emphasis time constant is selected with the DE bit
12. At LOUT and ROUT pins
13. Guaranteed by reference clock performance

4 Pin Assignment

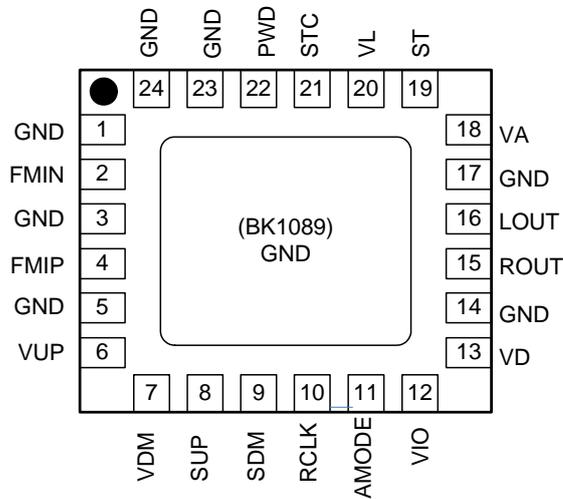


Figure 1 Pin assignment for BK1089 QFN24 4x4 mm package (top view)

Table 4 BK1089 QFN24 pin assignment

Pin Number(s)	Name	Type	Description
1,5,14,17,23,24, GND PAD	GND	GND	Ground. Connect to ground plane on PCB
2	FMIN ¹	RF	FM RF input negative port.
3	RFGND	GND	RF ground.
4	FMIP ¹	RF	FM RF input positive port.
6	VUP	I	Volume up. Negative pulse trigger
7	VDM	I	Volume down. Negative pulse trigger
8	SUP	I	Seek up. Negative pulse trigger
9	SDM	I	Seek down. Negative pulse trigger
10	RCLK	I	32.768kHz reference input/32.768kHz crystal
11	AMODE	I	Audio output mode selection, high volumn mode = 0
12	VIO	P	Power supply for I/O.
13	VD	P	Power supply for digital.
15	ROUT ²	AC	Right audio output.
16	LOUT ²	AC	Left audio output.
18	VA	P	Power supply for analog.
19	ST	O	Stereo/Mono indicator
20	VL	O	Valid station indicator
21	STC	O	Seek stop indicator
22	PWD	I	Global power down when PWD=1

Notes:

1. For single-ended input, one of FMIN and FMIP should be connected to ground
2. When use speaker mode, ROUT and LOUT are defined as the differential mono audio signal.

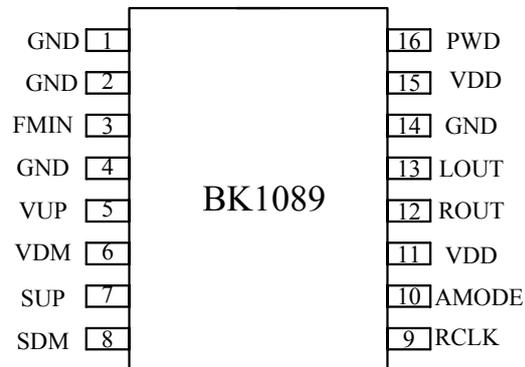


Figure 3 Pin assignment for BK1089 SOP16 package (top view)

Table 5 BK1089 SOP16 pin assignment

Pin Number(s)	Name	Type	Description
1,2,4,11,14	GND	GND	Ground. Connect to ground plane on PCB
3	FMIN	RF	FM RF input
5	VUP	I	Volume up. Negative pulse trigger
6	VDM	I	Volume down. Negative pulse trigger
7	SUP	I	Seek up. Negative pulse trigger
8	SDM	I	Seek down. Negative pulse trigger
9	RCLK	I	32.768kHz reference input/32.768kHz crystal
10	AMODE	I	Audio output mode selection, high volumn mode = 0
11,15	VDD	P	Power supply
12	ROUT ¹	AC	Right audio output.
13	LOUT ¹	AC	Left audio output.
16	PWD	I	Global power down when PWD=1

Notes:

1. When use speaker mode, ROUT and LOUT are defined as the differential mono audio signal.

5 Typical Application Schematic

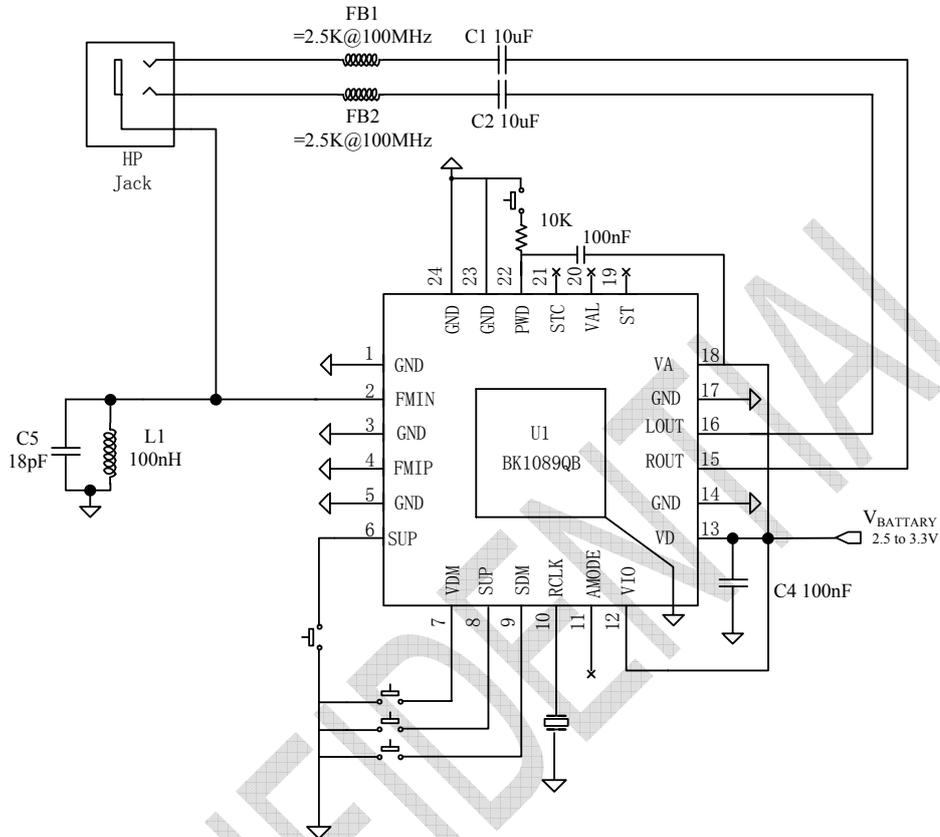


Figure 4. BK1089QB with Headphone Antenna Application

Notes:

1. J1: Common 32Ω resistance headphone.
2. U1: BK1089 chip
3. FM choke (L1 and C5) for LNA input match with the headphone.
4. Place C4 close to chip pin.
5. All grounds connect directly to GND plane on PCB.
6. Keep the FMIN trace as short as possible.
7. Keep the wire from FMIN to headphone as short as possible and must put it on the surface of the PCB.

6 Package information

QFN 4x4 24pin and SOP 16pin packages are available for BK1089. Detail information of the package follows:

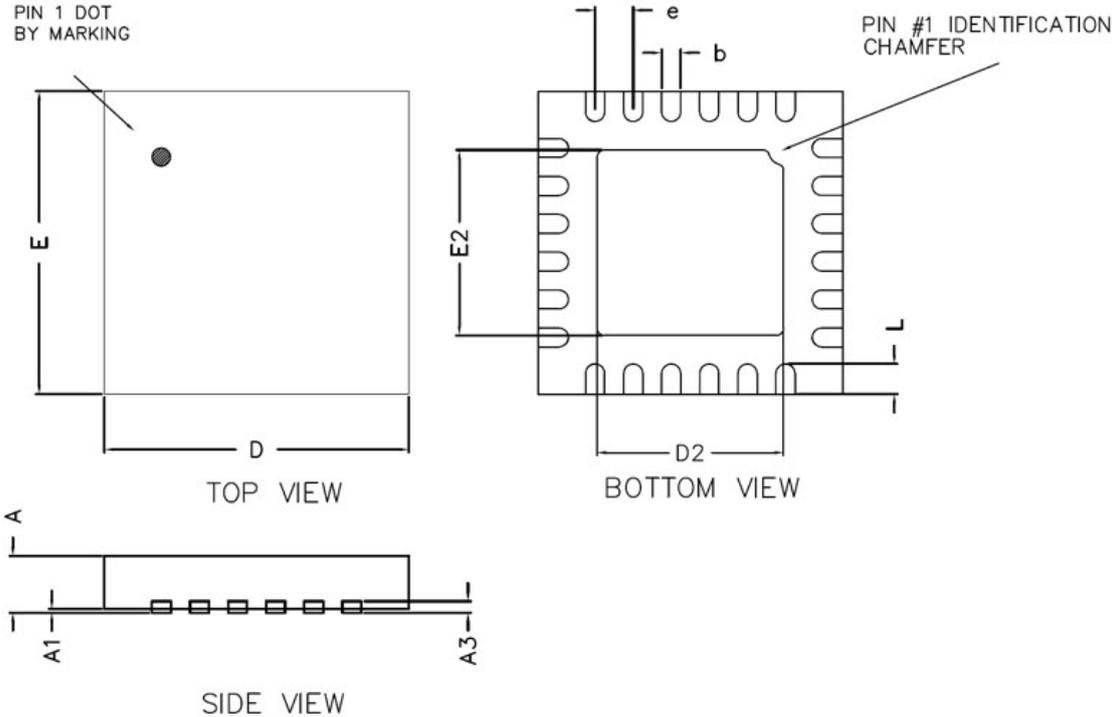


Figure 2 QFN 4x4 24 Pin Package diagram

Table 6 QFN 4x4 24 Pin Package dimensions

Parameter	Min	Typ	Max	Unit
A	0.70	0.75	0.80	mm
A1	0.00	-	0.05	mm
A3	0.20 REF			mm
D	3.95	4.00	4.05	mm
E	3.95	4.00	4.05	mm
b	0.20	0.25	0.30	mm
L	0.35	0.40	0.45	mm
D2	2.30	2.45	2.55	mm
E2	2.30	2.45	2.55	mm
e	0.50 REF			mm

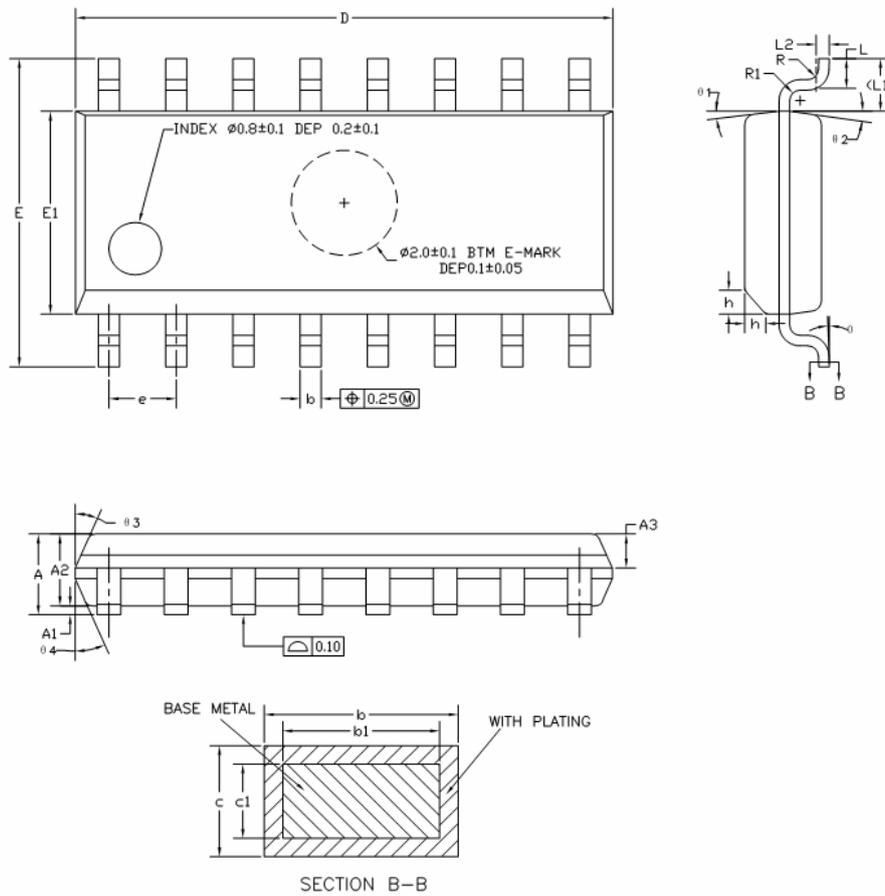


Figure 3 SOP 16 Pin Package diagram

Parameter	Min	Typ	Max	Unit
A	1.35	1.60	1.75	mm
A1	0.10	0.15	0.25	mm
A2	1.25	1.45	1.65	mm
A3	0.55	0.65	0.75	mm
b	0.36	-	0.51	mm
b1	0.35	0.40	0.45	mm
c	0.17	-	0.25	mm
c1	0.17	0.20	0.23	mm
D	9.80	9.90	10.00	mm
E	5.80	6.00	6.20	mm
E1	3.80	3.90	4.00	mm
e	1.27 BSC			mm
L	0.45	0.60	0.80	mm

L1	1.04 REF			mm
L2	0.25 BSC			mm
R	0.07	-	-	mm
R1	0.07	-	-	mm
h	0.30	0.40	0.50	mm
θ	0	-	8	$^{\circ}$
$\theta 1$	6	8	10	$^{\circ}$
$\theta 2$	6	8	10	$^{\circ}$
$\theta 3$	5	7	9	$^{\circ}$
$\theta 4$	5	7	9	$^{\circ}$

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7 Order information

Table 7 BK1089 order information

Part number	Package	Packing	MOQ (ea)
BK1089QB	QFN24	Tape Reel	3K
BK1089SB	SOP16	Tape Reel	3K

Remark:

MOQ: Minimum Order Quantity

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8 Revision History

Version	Change Summary	Data	Author
Rev.0.1	Initial draft	09-12-2009	JW
Rev.0.2		22-04-2010	JW

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