



BCT89318

High efficiency, Low noise Class T Audio Amplifier

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GENERAL DESCRIPTION

BCT89318 is specifically designed to enhance smart mobile phone sound quality, which is an innovative high efficiency, low noise, ultra-low distortion, constant large volume, Class T audio amplifier, Using our unique Digital Power Modulation(DPM) audio algorithm, effectively eliminate audio noise, increase signal Dynamic range which will greatly improve sound quality and volume. With an advance TOP power technology, efficiency reach 93%, and power amplifier's overall efficiency is up to 83%, greatly saves the mobile phone power consumption and prolong the mobile phone usage time. The BCT89318 noise floor is as low as to 43 μ V, with 99dB high signal-to-noise-ratio(SNR). The ultra-low distortion 0.008% and unique Digital Power Modulation technology brings high quality music enjoyment.

BCT89318 has 0.6W, 0.7W, 0.8W, 0.9W, 1W, 1.1W and 1.2W seven selectable speaker-protection output power levels, which is suitable for different rated power speakers. With Digital Power Modulation audio Algorithms, the music is pure nature and melodious. Within lithium battery voltage range (3.3V--4.35V), output power is constant, preventing the voice becomes smaller and smaller during usage of cell phone.

BCT89318 supports the special speaker and receiver two-in-one application. In receiver mode, the output noise floor is as low as 19 μ V, amplifier is in class D mode, powered by VBAT.

BCT89318 has built-in over current protection, over-temperature protection and short circuit protection function, effectively protecting the chip from damage. The BCT89318 uses small 0.4mm pitch 1.58mmx1.63mm WCSP-14L package.

FEATURES

- Digital Power Modulation audio algorithm, effectively eliminate music noise, make sound pure nature
- Power amplifier overall efficiency 83%
- Low noise: 43 μ V
- Ultra-low distortion: 0.008%
- Speaker and Receiver two-in-one application
Receiver: 1V/V, Vn=19 μ V, THD+N=0.02%
Receiver: 3V/V, Vn=22 μ V, THD+N=0.01%
- Selectable speaker-protection power level:
0.6w, 0.7W, 0.8W, 0.9W, 1W, 1.1W, 1.2W
- Within voltage range(3.3V-4.35V), output power is maintained constant
- Support 6ohm speaker
- Excellent pop-click suppression
- One wire pulse control
- High PSRR: -68dB (217Hz)
- ESD protection: \pm 6kV (HBM)
- Small 0.4mm pitch 1.58mmx1.63mm WCSP-14L package

APPLICATIONS

- Cellular Phones
- Portable Audio Devices
- Mini Speakers
- Tablets



BCT89318

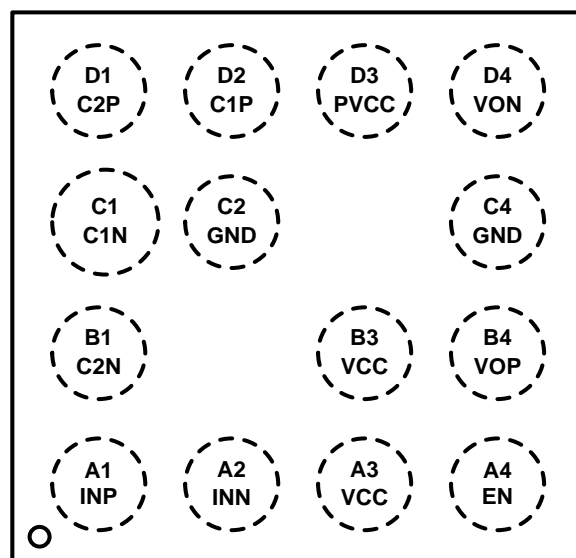
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ORDERING INFORMATION

Order Number	Package Type	Temperature Range	Marking	QTY/Reel
BCT89318EWD-TR	WCSP-14L	-40°C to +85°C	89318 XXXXXX	3000

Note: "XXXXX" in Marking will be appeared as the batch code.

PIN CONFIGURATION (Top View)



PIN DESCRIPTION

PIN	NAME	FUNCTION
A1	INP	Positive audio input pin
A2	INN	Negative audio input pin
A3	VCC	Power supply
A4	EN	Chip enable pin, active high; one wire pulse control;
B1	C2N	Negative side of the external charge pump flying capacitor C2
B3	VCC	Power supply
B4	VOP	Positive audio output pin
C1	C1N	Negative side of the external charge pump flying capacitor C1
C2, C4	GND	Ground
D1	C2P	Positive side of the external charge pump flying capacitor C2
D2	C1P	Positive side of the external charge pump flying capacitor C1
D3	PVCC	1.5X Boost charge pump output voltage
D4	VON	Negative audio output pin

BLOCK DIAGRAM

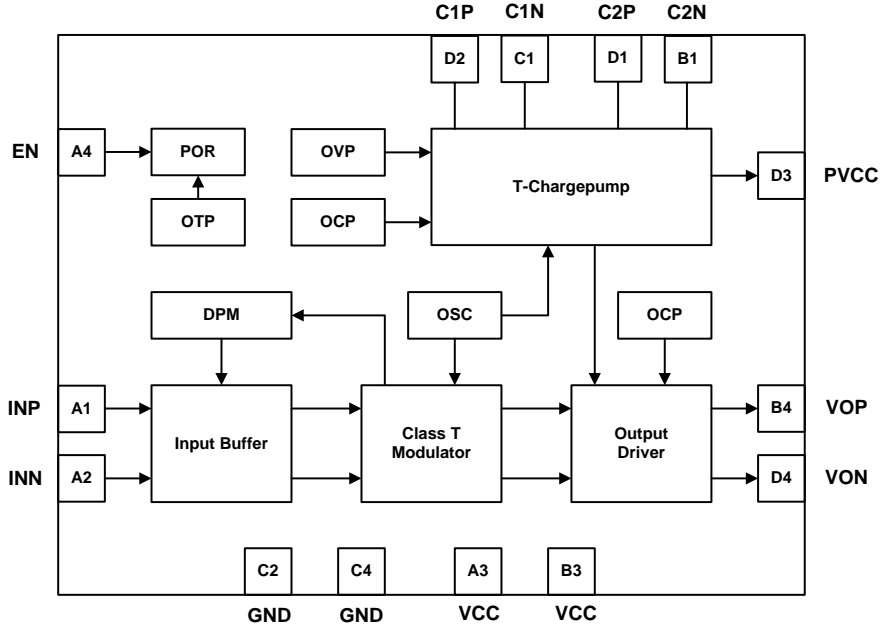


Figure 1 Functional block diagram

TYPICAL APPLICATION CIRCUIT

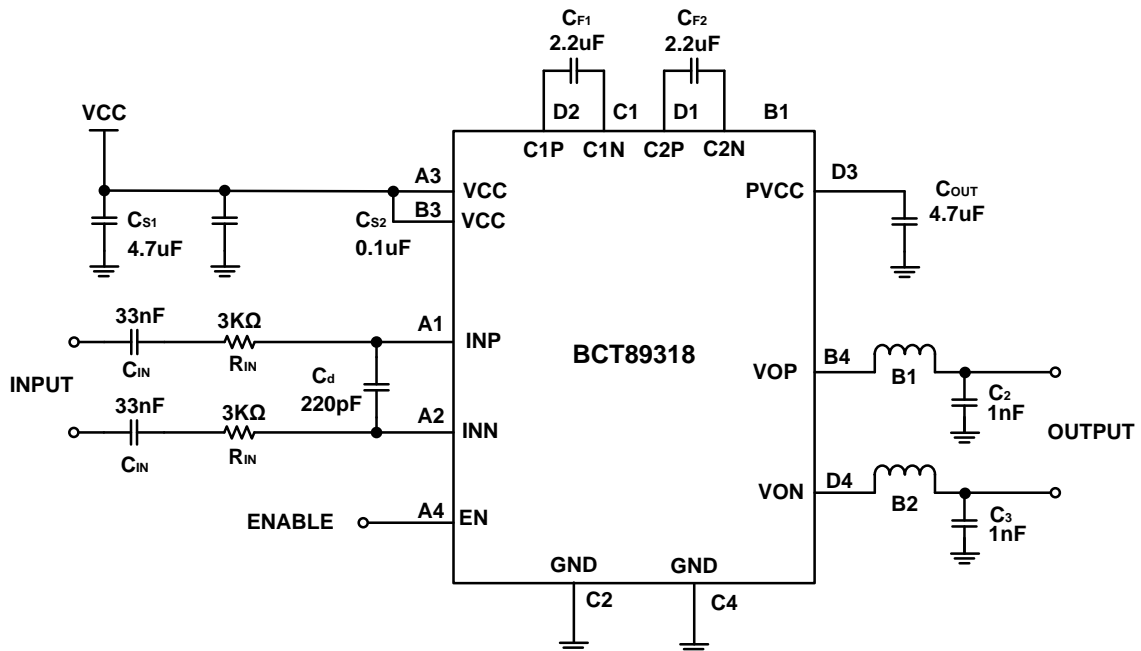


Figure 2 Typical application circuit



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MODE DESCRIPTION

Mode	Enable Signal	Gain (V/V)	DPM Power (W)				Multi-Level DPM Function	Receiver Mode
			RL=8Ω +33μH	RL=6Ω + 33μH	RL=4Ω +15μH	RL=3Ω +15μH		
Mode1		16.6	1.2	1.6	—	—	√	
Mode2		16.6	1.1	1.5	—	—	√	
Mode3		16.6	1.0	1.3	2.0	—	√	
Mode4		16.6	0.9	1.2	1.8	—	√	
Mode5		16.6	0.8	1.0	1.6	2.0	√	
Mode6		16.6	0.7	0.9	1.4	1.8	√	
Mode7		16.6	0.6	0.8	1.2	1.6	√	
Mode8		1						√
Mode9		3						√
Mode10		16.6	1.75W @ THD=1%	2.05W @ THD=1%	2.4W @ THD=1%	2.35W @ THD=1%		

ABSOLUTE MAXIMUM RATINGS

VCC, Supply Voltage Range.....	-0.3V to 6V
Charge pump output voltage PVCC.....	-0.3V to 7V
VOP, VON, C1P, C2P Input Voltage Range.....	-0.3V to PVCC+0.3V
INP, INN, C1N, C2N Input Voltage Range.....	-0.3V to VCC+0.3V
Package Thermal Resistance θ_{JA}	85°C/W
Operating Temperature Range.....	-40°C to +85°C
Junction Temperature.....	150°C
Storage Temperature Range.....	-65°C to +150°C
Lead Temperature (Soldering, 10sec).....	260°C
ESD HBM (human body model)	±6KV

NOTE:

- Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute Maximum rating conditions for extended periods may affect device reliability.



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ELECTRICAL CHARACTERISTICS

Test condition: TA=25°C, Vcc=3.6V, RL=8Ω+33μH, f=1kHz (unless otherwise noted)

Parameter		Test conditions	Min	Typ	Max	Units
VCC	Power supply voltage		3.0		5.5	V
VIH	EN high input voltage		1.3		VCC	V
VIL	EN low input voltage		0		0.35	V
VOs	Output offset voltage	Vin=0V, Vcc=3.0V to 5.5V	-30	0	30	mV
ISD	Shutdown current	Vcc=3.6V, EN=0V			1	μA
T _{TG}	Thermal DPM start temperature threshold			150		°C
T _{TGR}	Thermal DPM exit temperature threshold			130		°C
T _{SD}	Over temperature protection threshold			160		°C
T _{SDR}	Over temperature protection recovery threshold			120		°C
T _{ON}	Start-up time			40		ms
T-Charge pump						
PVCC	Output voltage	Vcc=3.0V to 4V		1.5* VCC		V
		Vcc>4V		6.05		V
V _{hys}	OVP hysteresis	Vcc >4V		50		mV
F _{CP}	Charge Pump frequency	Vcc=3.0V to 5.5V	0.8	1.06	1.33	MHz
η _{CP}	Charge pump efficiency	Vcc=3.6V, I _{load} =200mA		93		%
I _L	Current limit when PVCC short to ground			300		mA
Class T power amplifier (Mode1-Mode7, Mode10)						
I _q	Quiescent current	Vcc=4.2V, Vin=0, no load		10	15	mA
η	Efficiency	Vcc=3.6V, Po=1.0W, RL=8Ω+33μH		83		%
		Vcc=3.6V, Po=1.0W, RL=6Ω+33μH		83		
F _{osc}	Modulation frequency	Vcc=3.0V to 5.5V	600	800	1000	kHz
A _v	gain	external input resistance=3kΩ		16.6		V/V
V _{in}	Recommend input voltage	Vcc=3.0V to 5.5V			1	V _{rms}
R _{INI}	Inner input resistance	Mode1-Mode7, Mode10		6.6		kΩ
f _{HPF}	Input high pass filter corner frequency	Cin=33nF, external input resistance=3kΩ		502		Hz
P _{DPM}	Mode1 DPM power	Vcc=4.2V, RL=8Ω+33μH	1.08	1.2	1.32	W
		Vcc=4.2V, RL=6Ω+33μH	1.44	1.6	1.76	W
		Vcc=4.2V, RL=4Ω+15μH	2.16	2.4	2.64	W
	Mode2 DPM power	Vcc=4.2V, RL=3Ω+15μH	2.16	2.4	2.64	W
		Vcc=4.2V, RL=8Ω+33μH	0.99	1.1	1.21	W
		Vcc=4.2V, RL=6Ω+33μH	1.35	1.5	1.65	W
		Vcc=4.2V, RL=4Ω+15μH	1.98	2.2	2.42	W



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ELECTRICAL CHARACTERISTICS

Test condition: TA=25°C, VCC=3.6V, RL=8Ω+33μH, f=1kHz (unless otherwise noted)

Parameter		Test conditions	Min	Typ	Max	Units
P _{DPM}	Mode2 DPM power	V _{CC} =4.2V, R _L =3Ω+15μH	2.16	2.4	2.64	W
P _{DPM}	Mode3 DPM power	V _{CC} =4.2V, R _L =8Ω+33μH	0.9	1.0	1.1	W
		V _{CC} =4.2V, R _L =6Ω+33μH	1.17	1.3	1.43	W
		V _{CC} =4.2V, R _L =4Ω+15μH	1.8	2.0	2.2	W
		V _{CC} =4.2V, R _L =3Ω+15μH	2.16	2.4	2.64	W
	Mode4 DPM power	V _{CC} =4.2V, R _L =8Ω+33μH	0.81	0.9	0.99	W
		V _{CC} =4.2V, R _L =6Ω+33μH	1.08	1.2	1.32	W
		V _{CC} =4.2V, R _L =4Ω+15μH	1.62	1.8	1.98	W
		V _{CC} =4.2V, R _L =3Ω+15μH	2.16	2.4	2.64	W
	Mode5 DPM power	V _{CC} =4.2V, R _L =8Ω+33μH	0.72	0.8	0.88	W
		V _{CC} =4.2V, R _L =6Ω+33μH	0.9	1.0	1.1	W
		V _{CC} =4.2V, R _L =4Ω+15μH	1.44	1.6	1.76	W
		V _{CC} =4.2V, R _L =3Ω+15μH	1.8	2.0	2.2	W
	Mode6 DPM power	V _{CC} =4.2V, R _L =8Ω+33μH	0.63	0.7	0.77	W
		V _{CC} =4.2V, R _L =6Ω+33μH	0.81	0.9	0.99	W
		V _{CC} =4.2V, R _L =4Ω+15μH	1.26	1.4	1.54	W
		V _{CC} =4.2V, R _L =3Ω+15μH	1.62	1.8	1.98	W
Mode7 DPM power	V _{CC} =4.2V, R _L =8Ω+33μH	0.54	0.6	0.66	W	
	V _{CC} =4.2V, R _L =6Ω+33μH	0.72	0.8	0.88	W	
	V _{CC} =4.2V, R _L =4Ω+15μH	1.08	1.2	1.32	W	
	V _{CC} =4.2V, R _L =3Ω+15μH	1.44	1.6	1.76	W	
PSRR	Power supply rejection ratio	V _{CC} =4.2V, V _{p-p} _{sin} =200mV	217Hz		-68	dB
			1kHz		-68	dB
SNR	Signal-to-noise ratio	V _{CC} =4.2V, P _O =1.75W, THD+N=1%, R _L =8Ω+33μH, A _v =8V/V		99		dB
		V _{CC} =4.2V, P _O =1.75W, THD+N=1%, R _L =6Ω+33μH, A _v =8V/V		98.5		dB
V _n	Output noise voltage	V _{CC} =4.2V, f=20Hz to 20kHz, input ac grounded, A _v =8V/V	A-weighting	43		μVrms
		V _{CC} =4.2V, f=20Hz to 20kHz, input ac grounded, 12V/V		48		μVrms
		V _{CC} =4.2V, f=20Hz to 20kHz, input ac grounded, 16V/V		57		μVrms
THD+N	Total harmonic distortion+noise	V _{CC} =3.6V, P _O =1W, R _L =8Ω+33μH, f=1kHz, Mode1		0.008		%
		V _{CC} =3.6V, P _O =1W, R _L =6Ω+33μH, f=1kHz, Mode10		0.008		%



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Test condition: TA=25°C, VCC=3.6V, RL=8Ω+33μH, f=1kHz (unless otherwise noted)

Parameter		Test conditions	Min	Typ	Max	Units
Po	Mode10 output power	THD+N=10%, f=1kHz, RL=8Ω+33μH, VCC=4.2V		2.15		W
		THD+N=1%, f=1kHz, RL=8Ω+33μH, VCC=4.2V		1.75		W
		THD+N=10%, f=1kHz, RL=8Ω+33μH, VCC=3.6V		1.6		W
		THD+N=1%, f=1kHz, RL=8Ω+33μH, VCC=3.6V		1.28		W
		THD+N=10%, f=1kHz, RL=6Ω+33μH, VCC=4.2V		2.52		W
		THD+N=1%, f=1kHz, RL=6Ω+33μH, VCC=4.2V		2.05		W
		THD+N=10%, f=1kHz, RL=6Ω+33μH, VCC=3.6V		1.82		W
		THD+N=1%, f=1kHz, RL=6Ω+33μH, VCC=3.6V		1.5		W
		THD+N=10%, f=1kHz, RL=4Ω+15μH, VCC=4.2V		2.8		W
		THD+N=1%, f=1kHz, RL=4Ω+15μH, VCC=4.2V		2.4		W
		THD+N=10%, f=1kHz, RL=4Ω+15μH, VCC=3.6V		2.02		W
		THD+N=1%, f=1kHz, RL=4Ω+15μH, VCC=3.6V		1.68		W
		THD+N=10%, f=1kHz, RL=3Ω+15μH, VCC=4.2V		2.63		W
		THD+N=1%, f=1kHz, RL=3Ω+15μH, VCC=4.2V		2.35		W
		THD+N=10%, f=1kHz, RL=3Ω+15μH, VCC=3.6V		1.85		W
		THD+N=1%, f=1kHz, RL=3Ω+15μH, VCC=3.6V		1.65		W
Receiver (Mode8-Mode9)						
Iq	Quiescent current	VCC=4.2V, Vin=0, no load		5	7.5	mA
η	Efficiency	VCC=3.6V, Po=0.8W, RL=8Ω+33μH, Mode9		86		%
Fosc	Modulation frequency	VCC=3.0V to 5.5V	600	800	1000	kHz
Av	gain	external input resistance=3kΩ, Mode8		1		V/V
		external input resistance=3kΩ, Mode9		3		V/V
RINI	Inner input resistance	Mode8		106.6		kΩ
		Mode9		36.6		kΩ
fHPF	Input high pass filter corner frequency	Cin=33nF, external input resistance=3kΩ, Mode8		44		Hz
		Cin=33nF, external input resistance=3kΩ, Mode9		122		Hz
Vn	Output noise voltage	VCC=4.2V, f=20Hz to 20kHz, input ac grounded, Av=1V/V	A-weighting		19	μVrms
		VCC=4.2V, f=20Hz to 20kHz, input ac grounded, Av=3V/V			22	μVrms
THD+N	Total harmonic distortion+noise	VCC=4.2V, Po=0.1W, RL=8Ω+33μH, f=1kHz, Mode8		0.02		%
		VCC=4.2V, Po=0.4W, RL=8Ω+33μH, f=1kHz, Mode9		0.01		%
One wire pulse control						
TH	EN high level duration time	VCC=3.0V to 5.5V	0.75	2	10	μs
TL	EN low level duration time	VCC=3.0V to 5.5V	0.75	2	10	μs



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ELECTRICAL CHARACTERISTICS

Test condition: TA=25°C, VCC=3.6V, RL=8Ω+33μH, f=1kHz (unless otherwise noted)

Parameter		Test conditions	Min	Typ	Max	Units
T _{LATCH}	EN turn on delay time	V _{CC} =3.0V to 5.5V	150		500	μs
T _{OFF}	EN turn off delay time	V _{CC} =3.0V to 5.5V	150		500	μs
Digital Power Modulation ^(Note 4)						
T _{ATF}	Fast attack time	-13.5dB gain attenuation completed		1.5		ms
T _{ATS}	Slow attack time	-13.5dB gain attenuation completed		6		ms
T _{ATT}	Total attack time	-13.5dB gain attenuation completed		7.5		ms
T _{RL}	Release time	13.5dB gain release completed		280		ms
A _{MAX}	Maximum attenuation			-13.5		dB

Note 4: Attack time points to 13.5dB gain attenuation time; Release time points to 13.5dB gain recovery time.

DETAILED FUNCTIONAL DESCRIPTION

BCT89318 is specifically designed to eliminate mobile phone Audio noise, to enhance overall sound quality, which is a new high efficiency, low noise, ultra-low distortion, constant large volume, upgrading Class T audio amplifier, Using Digital Power Modulation audio algorithm, effectively eliminate Audio noise, improve sound quality and volume. Using a unique T-Charge pump technology, efficiency reach 93%, power amplifier's overall efficiency is up to 83%, greatly prolong the mobile phone usage time. The BCT89318 noise floor is as low as to 43μV, with 99dB high-signal-to-noise ratio(SNR). The ultra-low distortion 0.008% and unique Digital Power Modulation technology brings high quality music enjoyment.

BCT89318 has 0.6W, 0.7W, 0.8W, 0.9W, 1W, 1.1W and 1.2W seven selectable speaker-protection output power levels, Which is suitable for different rated power speakers, with Digital Power Modulation audio algorithms, the music is pure nature and melodious. Within supply voltage range (3.3V--4.35V), output power is kept constant, preventing the voice becomes smaller and smaller during usage of cell phone.

BCT89318 can also support speaker and receiver two-in-one application. In receiver mode, the output noise is as low as to 19uV, amplifier is in class D mode, powered by VBAT.

The BCT89318 has built-in excellent pop-click noise suppression algorithms effectively avoids pop-click noise during shutdown, wakeup, and power-up/down operation of BCT89318.

BCT89318 has built-in over current protection, over-temperature protection and short circuit protection function, effectively protect the chip from damage. The BCT89318 uses small 0.4mm pitch 1.58mmx1.63mm WCSP-14L package. The BCT89318 is specified over the industrial temperature range of -40°C to 85°C.

CONSTANT OUTPUT POWER

In the mobile phone audio applications, the DPM function to enhance music volume and quality is very effective, but as the supply voltage drops, the power amplifier output power will reduce gradually, leads to smaller and smaller music volume. So, it is hard to provide high quality music within the wide supply voltage range. The BCT89318 uses Digital Power Modulation audio algorithm, within supply voltage range(3.3V--4.35V), output power is kept constant, the output power will not reduce along with supply voltage drop down. Even if the supply voltage drops, BCT89318 can still provide high quality large volume music enjoyment. BCT89318 has ten operation modes, first seven modes have Digital Power Modulation function, the output power level is 1.2W, 1.1W, 1W, 0.9W, 0.8W, 0.7W, 0.6W, respectively.

One Wire Pulse Control

BCT89318 select each mode through the detection of number of the pulse signal rising edge of EN pin, as shown in figure 3: When EN pin pull high from shutdown mode, there is only a rising edge, BCT89318 enter into mode 1, Digital Power Modulation output power is 1.2W; When high-low-high signal set to EN pin, there are two rising edges, BCT89318 enter into mode 2, Digital Power Modulation output power is 1.1W; When there are three rising edges, BCT89318 enter into mode 3, Digital Power Modulation output power is 1W; When there are four rising edges, BCT89318 enter into mode 4, Digital Power Modulation output power is 0.9W...; BCT89318 has ten operation modes, the number of the rising edges does not allow more than ten.

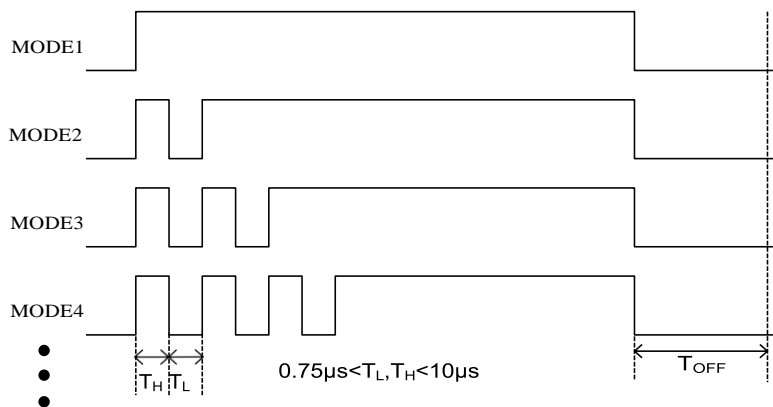


Figure 3 One Wire Pulse Control

When BCT89318 needs to work in different mode, PIN EN should be pull low longer than T_{OFF} first(recommended 1ms) which make the BCT89318 shut down, Then send series pulse make the BCT89318 enter into right mode, as shown in figure 4.

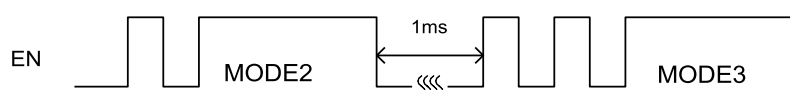


Figure 4 One Wire Pulse Control Switching Sequence

APPLICATION INFORMATION

External Input Resistor- R_{ine} (Gain setting)

The BCT89318 is a differential audio amplifier. The IC integrates two internal input resistors, which is $R_{ini}=6.6k\Omega$. Take external input resistor $R_{ine}=3k\Omega$ for an example, gain setting as follows:

Class T mode:

$$A_V = \frac{159.5k\Omega}{R_{ine} + R_{ini}} = \frac{159.5k\Omega}{3k\Omega + 6.6k\Omega} = 16.6V/V$$

Receiver 1V/V mode:

$$A_V = \frac{110k\Omega}{R_{ine} + R_{ini}} = \frac{110k\Omega}{3k\Omega + 106.6k\Omega} = 1V/V$$

Receiver 3V/V mode:

$$A_V = \frac{110k\Omega}{R_{ine} + R_{ini}} = \frac{110k\Omega}{3k\Omega + 36.6k\Omega} = 2.8V/V$$

Input Capacitor- C_{in} (input high-pass cutoff frequency)

The input coupling capacitor blocks the DC voltage at the amplifier input terminal. The input capacitors and input resistors form a high-pass filter with the corner frequency:

$$f_H(-3dB) = \frac{1}{2 * \pi * R_{in} * C_{in}} \text{ (Hz)}$$

Setting the high-pass filter point high can block the 217Hz GSM noise coupled to inputs. Better matching of the input capacitors improves performance of the circuit and also helps to suppress pop-click noise.

Take typical application in Figure 2 as an example:

$$f_H(-3dB) = \frac{1}{2 * \pi * R_{in} * C_{in}} \text{ (Hz)} = \frac{1}{2 * \pi * 9.6k\Omega * 33nF} = 502\text{Hz}$$

Take 1V/V receiver mode application as example, the input high-pass corner frequency is:

$$f_H(-3dB) = \frac{1}{2 * \pi * R_{in} * C_{in}} \text{ (Hz)} = \frac{1}{2 * \pi * 109.6k\Omega * 33nF} = 44\text{Hz}$$

Differential input filter capacitor C_d (input low-pass cutoff frequency)

Input differential input filter capacitor and input resistor together to form a low-pass filter, could be used to attenuate high frequency components of the input signal. When the musical sounds screechy, this low-pass filter can be appropriately attenuate the high frequency part of the input signal, so that the music signal sounds soft and comfortable. -3dB cutoff frequency of the low-pass filter is as follows:

$$f_H(-3dB) = \frac{1}{2 * \pi * (R_{ini}/R_{ine}) * 2 * C_d} \text{ (Hz)}$$

With input resistance $R_{ine} = 3k\Omega$, differential capacitance 220pF, for example, the low-pass cutoff frequency is as

follows:

$$f_H(-3dB) = \frac{1}{2 * \pi * (R_{ini} // R_{ine}) * C_d} \text{ (Hz)} = \frac{1}{2 * \pi * 2.06k\Omega * 2 * 220pF} \text{ (Hz)} = 175.7kHz$$

Supply Decoupling Capacitor (C_S)

The BCT89318 is a high-performance audio amplifier that requires adequate power supply decoupling. Place a low equivalent-series-resistance (ESR) ceramic capacitor, typically 0.1μF. This choice of capacitor and placement helps with higher frequency transients, spikes, or digital hash on the line. Additionally, placing this decoupling capacitor close to the BCT89318 is important, as any parasitic resistance or inductance between the device and the capacitor causes efficiency loss. In addition to the 0.1μF ceramic capacitor, place a 10μF capacitor on the VBAT supply trace. This larger capacitor acts as a charge reservoir, providing energy faster than the board supply, thus helping to prevent any droop in the supply voltage.

Flying Capacitor (C_F)

The value of the flying capacitor (C_F) affects the load regulation and output resistance of the charge pump. A C_F value that is too small degrades the device's ability to provide sufficient current drive. Increasing the value of C_F improves load regulation and reduces the charge pump output resistance to an extent. A 2.2μF@6.3V upper capacitor is recommended.

Output Capacitor (C_{OUT})

The output capacitor value and ESR directly affect the ripple at PVCC. Increasing C_{OUT} reduces output ripple. Likewise, decreasing the ESR of C_{OUT} reduces both ripple and output resistance. A 4.7μF@10V capacitor is recommended.

Optional Ferrite Bead Filter

The BCT89318 passed FCC and CE radiated emissions with no ferrite chip beads and capacitors. Use ferrite chip beads and capacitors if device near the EMI sensitive circuits and/or there are long leads from amplifier to speaker, placed as close as possible to the output pin.

In the T class mode, the output is a square wave signal, which causing switch current at the output capacitor, increasing static power consumption, and therefore output capacitor should not be too large, 1nF ceramic capacitors is recommended.

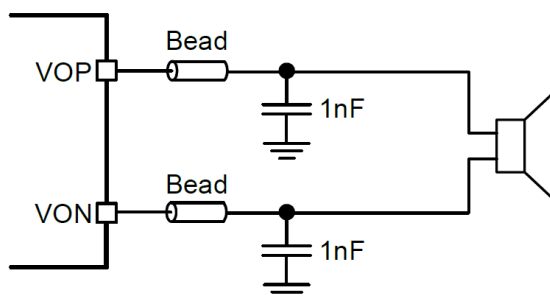
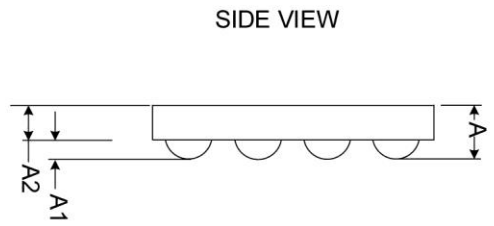
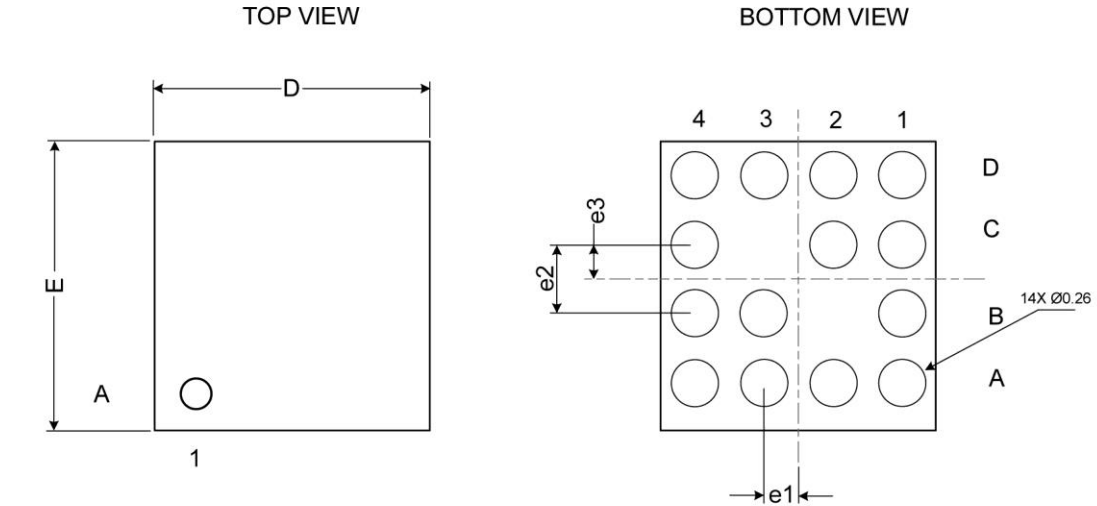


Figure 5 Ferrite Chip Bead and capacitor

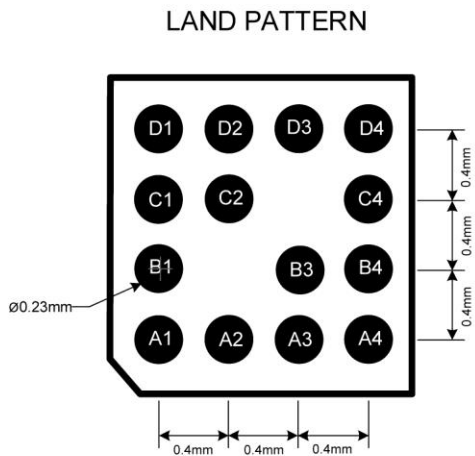
PACKAGE OUTLINE DIMENSIONS

WCSP-14L



Symbol	Min	Typ	Max
A	0.515	0.546	0.576
A1	0.186	0.206	0.226
A2	0.327	0.340	0.353
D	1.61	1.63	1.65
E	1.56	1.58	1.60
e1		0.200	
e2		0.400	
e3		0.200	

Unit: mm



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