



# BCT89318F

## High efficiency, Low noise Class T Audio Amplifier

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#### High efficiency, Low noise Class T Audio Amplifier

##### GENERAL DESCRIPTION

BCT89318F 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 BCT89318F noise floor is as low as to 43 $\mu$ V, with 99dB high signal-to-noise-ratio(SNR). The ultra-low distortion 0.08% and unique Digital Power Modulation technology brings high quality music enjoyment.

BCT89318F 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.

BCT89318F supports the special speaker and receiver two-in-one application. In receiver mode, the output noise floor is as low as 19 $\mu$ V, amplifier is in class D mode, powered by VBAT.

BCT89318F has built-in over current protection, over-temperature protection and short circuit protection function, effectively protecting the chip from damage. The BCT89318F 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  $\mu$  V
- Ultra-low distortion: 0.08%
- Speaker and Receiver two-in-one application  
Receiver: 1V/V, Vn=19 $\mu$ V, THD+N=0.02%  
Receiver: 3V/V, Vn=22 $\mu$ 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

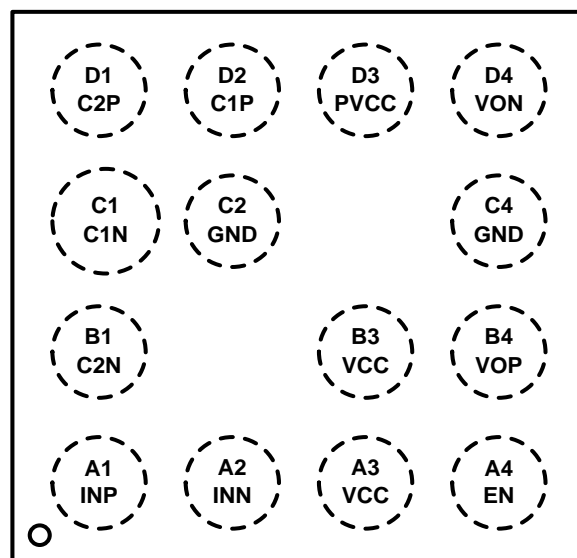
- Cellular Phones
- Portable Audio Devices
- Mini Speakers
- Tablets

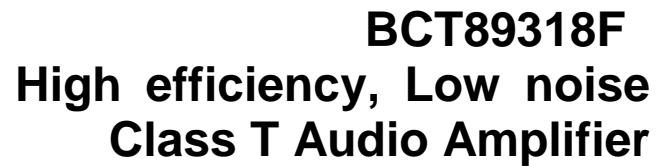
### ORDERING INFORMATION

Order Number	Package Type	Temperature Range	Marking	QTY/Reel
BCT89318FEWD-TR	WCSP-14L	-40°C to +85°C	 89318 XXXXX	3000

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

### PIN CONFIGURATION (Top View)





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

The diagram illustrates the internal architecture of the T-charge pump circuit. It is a multi-pin device with the following components and connections:

- Power and Control Pins:** EN (Enable), INN (Input Negative), INP (Input Positive), and various configuration pins (C1P, C1N, C2P, C2N, D1, B1, D2, C2, C4, A3, B3, D3, B4, D4).
- Core Blocks:**
  - Input Buffer:** Receives INN and INP signals. It is controlled by DPM and OSC.
  - Class T Modulator:** Receives signals from the Input Buffer and is controlled by OSC.
  - Output Driver:** Receives signals from the Class T Modulator and is controlled by OCP.
  - T-Chargepump:** Receives signals from OVP and OCP. It is controlled by C1P, C1N, C2P, and C2N. It outputs to D3.
- Protection and Monitoring:**
  - POR (Programmable Open-Regulator):** Receives A4 and is controlled by OTP.
  - OVP (Over-Voltage Protection):** Receives signals from the T-Chargepump.
  - OCP (Over-Current Protection):** Receives signals from the T-Chargepump and the Output Driver.
  - DPM (Digital Power Manager):** Receives signals from the Input Buffer and the T-Chargepump.
  - OSC (Oscillator):** Receives signals from the Input Buffer and the T-Chargepump.
- Outputs:** VOP (Output Positive) and VON (Output Negative).

REV1.8  
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### TYPICAL APPLICATION CIRCUIT

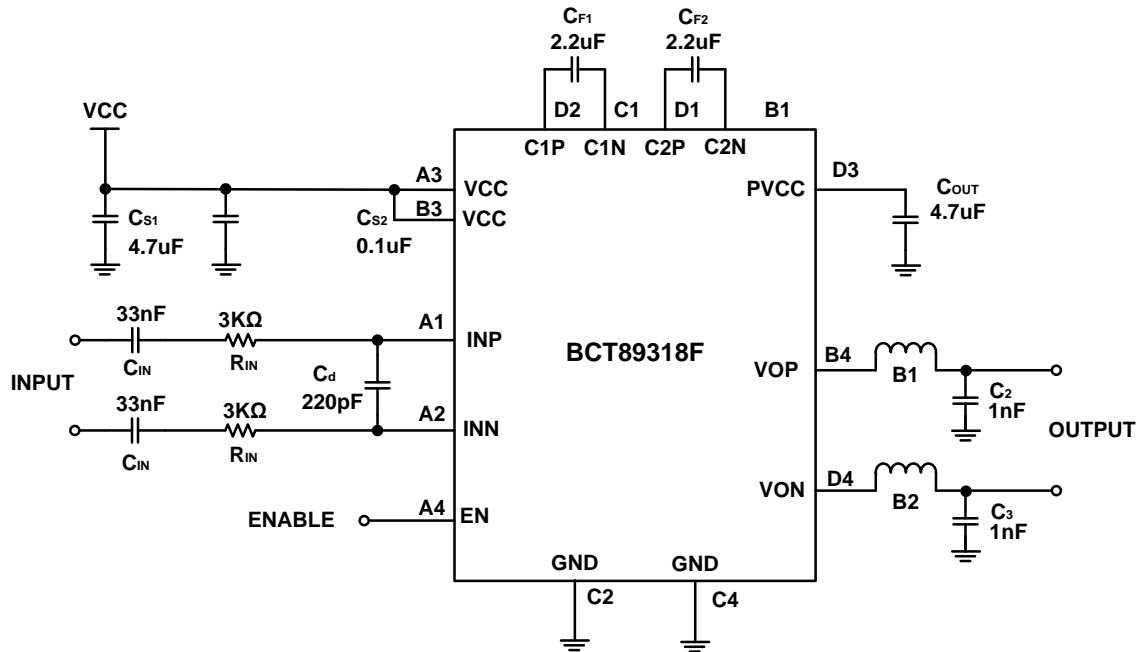

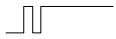


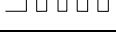
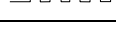
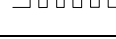





Figure 2 Typical application circuit

### 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 $\theta_{JA}$ .....	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.

### 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 <sub>TG</sub>	Thermal DPM start temperature threshold			150		°C
T <sub>TGR</sub>	Thermal DPM exit temperature threshold			130		°C
T <sub>SD</sub>	Over temperature protection threshold			160		°C
T <sub>SDR</sub>	Over temperature protection recovery threshold			120		°C
T <sub>ON</sub>	Start-up time			40		ms
<b>T-Charge pump</b>						
PVCC	Output voltage	VCC=3.0V to 4V		1.5* VCC		V
		VCC>4V		6.05		V
V <sub>hys</sub>	OVP hysteresis	VCC >4V		50		mV
F <sub>CP</sub>	Charge Pump frequency	VCC=3.0V to 5.5V	0.8	1.06	1.33	MHz
η <sub>CP</sub>	Charge pump efficiency	VCC=3.6V, I <sub>load</sub> =200mA		93		%
I <sub>L</sub>	Current limit when PVCC short to ground			300		mA
<b>Class T power amplifier (Mode1-Mode7, Mode10)</b>						
I <sub>q</sub>	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 <sub>osc</sub>	Modulation frequency	VCC=3.0V to 5.5V	600	800	1000	kHz
A <sub>v</sub>	gain	external input resistance=3kΩ		16.6		V/V
V <sub>in</sub>	Recommend input voltage	VCC=3.0V to 5.5V			1	Vrms
R <sub>INI</sub>	Inner input resistance	Mode1-Mode7, Mode10		6.6		kΩ
f <sub>HPF</sub>	Input high pass filter corner frequency	Cin=33nF, external input resistance=3kΩ		502		Hz
P <sub>DPM</sub>	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
		VCC=4.2V, RL=3Ω+15μH	2.16	2.4	2.64	W
	Mode2 DPM power	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

### 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 <sub>DPM</sub>	Mode2 DPM power	V <sub>CC</sub> =4.2V, R <sub>L</sub> =3Ω+15μH	2.16	2.4	2.64	W
P <sub>DPM</sub>	Mode3 DPM power	V <sub>CC</sub> =4.2V, R <sub>L</sub> =8Ω+33μH	0.9	1.0	1.1	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =6Ω+33μH	1.17	1.3	1.43	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =4Ω+15μH	1.8	2.0	2.2	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =3Ω+15μH	2.16	2.4	2.64	W
	Mode4 DPM power	V <sub>CC</sub> =4.2V, R <sub>L</sub> =8Ω+33μH	0.81	0.9	0.99	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =6Ω+33μH	1.08	1.2	1.32	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =4Ω+15μH	1.62	1.8	1.98	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =3Ω+15μH	2.16	2.4	2.64	W
	Mode5 DPM power	V <sub>CC</sub> =4.2V, R <sub>L</sub> =8Ω+33μH	0.72	0.8	0.88	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =6Ω+33μH	0.9	1.0	1.1	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =4Ω+15μH	1.44	1.6	1.76	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =3Ω+15μH	1.8	2.0	2.2	W
	Mode6 DPM power	V <sub>CC</sub> =4.2V, R <sub>L</sub> =8Ω+33μH	0.63	0.7	0.77	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =6Ω+33μH	0.81	0.9	0.99	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =4Ω+15μH	1.26	1.4	1.54	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =3Ω+15μH	1.62	1.8	1.98	W
	Mode7 DPM power	V <sub>CC</sub> =4.2V, R <sub>L</sub> =8Ω+33μH	0.54	0.6	0.66	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =6Ω+33μH	0.72	0.8	0.88	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =4Ω+15μH	1.08	1.2	1.32	W
		V <sub>CC</sub> =4.2V, R <sub>L</sub> =3Ω+15μH	1.44	1.6	1.76	W
PSRR	Power supply rejection ratio	V <sub>CC</sub> =4.2V, V <sub>p-p sin</sub> =200mV	217Hz		-68	dB
			1kHz		-68	dB
SNR	Signal-to-noise ratio	V <sub>CC</sub> =4.2V, P <sub>O</sub> =1.75W, THD+N=1%, R <sub>L</sub> =8Ω+33μH, A <sub>v</sub> =8V/V		99		dB
		V <sub>CC</sub> =4.2V, P <sub>O</sub> =1.75W, THD+N=1%, R <sub>L</sub> =6Ω+33μH, A <sub>v</sub> =8V/V		98.5		dB
V <sub>n</sub>	Output noise voltage	V <sub>CC</sub> =4.2V, f=20Hz to 20kHz, input ac grounded, A <sub>v</sub> =8V/V	A-weighting	43		μVrms
		V <sub>CC</sub> =4.2V, f=20Hz to 20kHz, input ac grounded, 12V/V		48		μVrms
		V <sub>CC</sub> =4.2V, f=20Hz to 20kHz, input ac grounded, 16V/V		57		μVrms
THD+N	Total harmonic distortion+noise	V <sub>CC</sub> =3.6V, P <sub>O</sub> =1W, R <sub>L</sub> =8Ω+33μH, f=1kHz, Mode1		0.08		%
		V <sub>CC</sub> =3.6V, P <sub>O</sub> =1W, R <sub>L</sub> =6Ω+33μH, f=1kHz, Mode10		0.08		%

### ELECTRICAL CHARACTERISTICS

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

Parameter		Test conditions		Min	Typ	Max	Units
P <sub>O</sub>	Mode10 output power	THD+N=10%, f=1kHz, R <sub>L</sub> =8Ω+33μH, V <sub>CC</sub> =4.2V			2.15		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =8Ω+33μH, V <sub>CC</sub> =4.2V			1.75		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =8Ω+33μH, V <sub>CC</sub> =3.6V			1.6		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =8Ω+33μH, V <sub>CC</sub> =3.6V			1.28		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =6Ω+33μH, V <sub>CC</sub> =4.2V			2.52		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =6Ω+33μH, V <sub>CC</sub> =4.2V			2.05		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =6Ω+33μH, V <sub>CC</sub> =3.6V			1.82		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =6Ω+33μH, V <sub>CC</sub> =3.6V			1.5		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =4Ω+15μH, V <sub>CC</sub> =4.2V			2.8		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =4Ω+15μH, V <sub>CC</sub> =4.2V			2.4		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =4Ω+15μH, V <sub>CC</sub> =3.6V			2.02		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =4Ω+15μH, V <sub>CC</sub> =3.6V			1.68		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =3Ω+15μH, V <sub>CC</sub> =4.2V			2.63		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =3Ω+15μH, V <sub>CC</sub> =4.2V			2.35		W
		THD+N=10%, f=1kHz, R <sub>L</sub> =3Ω+15μH, V <sub>CC</sub> =3.6V			1.85		W
		THD+N=1%, f=1kHz, R <sub>L</sub> =3Ω+15μH, V <sub>CC</sub> =3.6V			1.65		W
Receiver (Mode8-Mode9)							
I <sub>q</sub>	Quiescent current	V <sub>CC</sub> =4.2V, V <sub>in</sub> =0, no load			5	7.5	mA
η	Efficiency	V <sub>CC</sub> =3.6V, P <sub>o</sub> =0.8W, R <sub>L</sub> =8Ω+33μH, Mode9			86		%
Fosc	Modulation frequency	V <sub>CC</sub> =3.0V to 5.5V		600	800	1000	kHz
A <sub>v</sub>	gain	external input resistance=3kΩ, Mode8			1		V/V
		external input resistance=3kΩ, Mode9			3		V/V
R <sub>INI</sub>	Inner input resistance	Mode8			106.6		kΩ
		Mode9			36.6		kΩ
f <sub>HPF</sub>	Input high pass filter corner frequency	C <sub>in</sub> =33nF, external input resistance=3kΩ,Mode8			44		Hz
		C <sub>in</sub> =33nF, external input resistance=3kΩ,Mode9			122		Hz
V <sub>n</sub>	Output noise voltage	V <sub>CC</sub> =4.2V, f=20Hz to 20kHz, input ac grounded, A <sub>v</sub> =1V/V	A-weighting		19		μVrms
		V <sub>CC</sub> =4.2V, f=20Hz to 20kHz, input ac grounded, A <sub>v</sub> =3V/V			22		μVrms
THD+N	Total harmonic distortion+noise	V <sub>CC</sub> =4.2V,P <sub>o</sub> =0.1W,R <sub>L</sub> =8Ω+33μH,f=1kHz, Mode8			0.02		%
		V <sub>CC</sub> =4.2V,P <sub>o</sub> =0.4W,R <sub>L</sub> =8Ω+33μH,f=1kHz, Mode9			0.01		%
One wire pulse control							
T <sub>H</sub>	EN high level duration time	V <sub>CC</sub> =3.0V to 5.5V		0.75	2	10	μs
T <sub>L</sub>	EN low level duration time	V <sub>CC</sub> =3.0V to 5.5V		0.75	2	10	μs



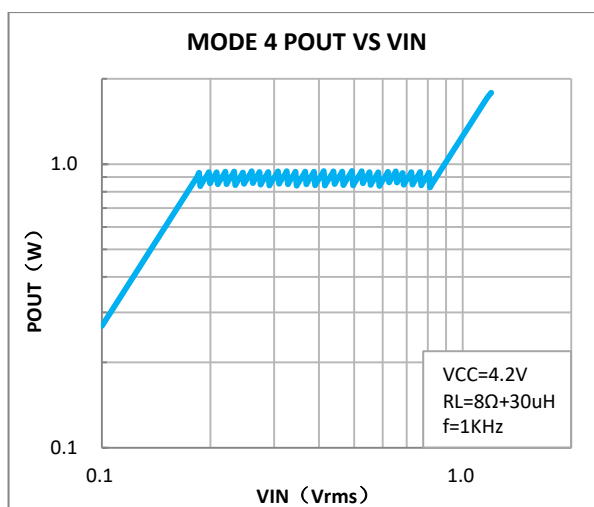
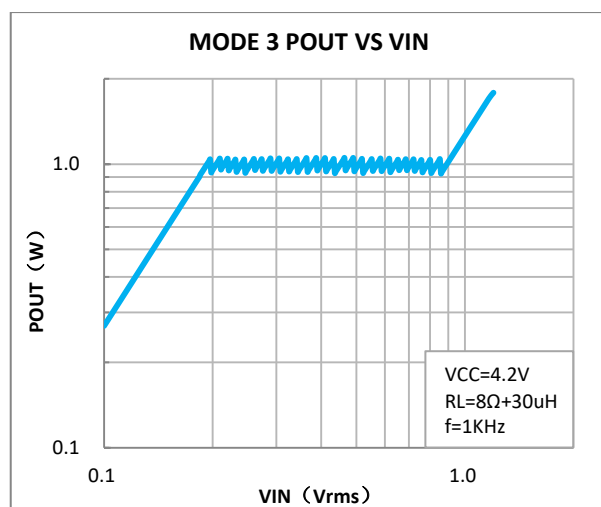
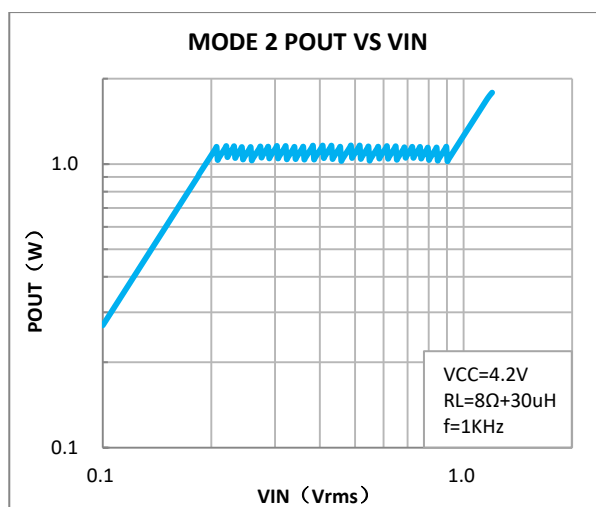
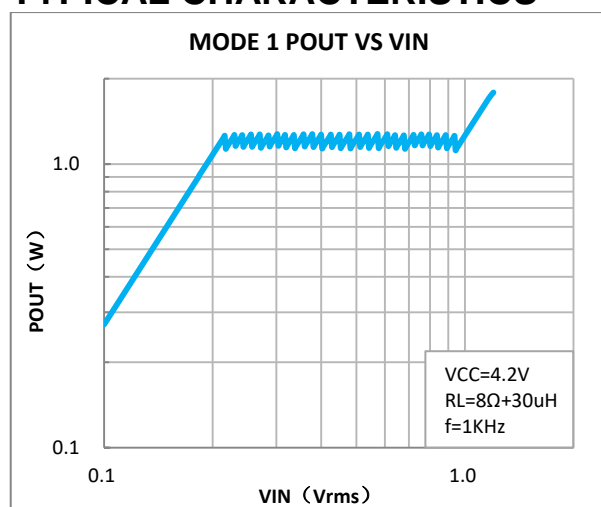
### ELECTRICAL CHARACTERISTICS

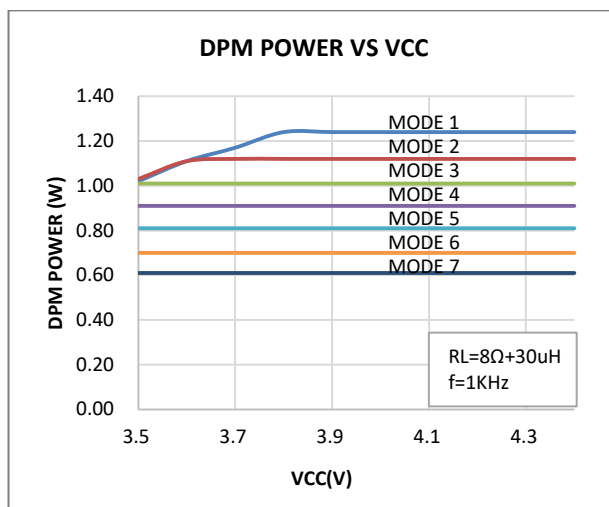
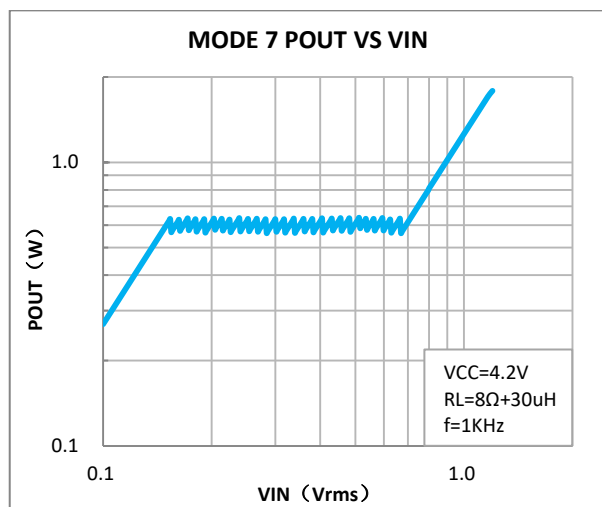
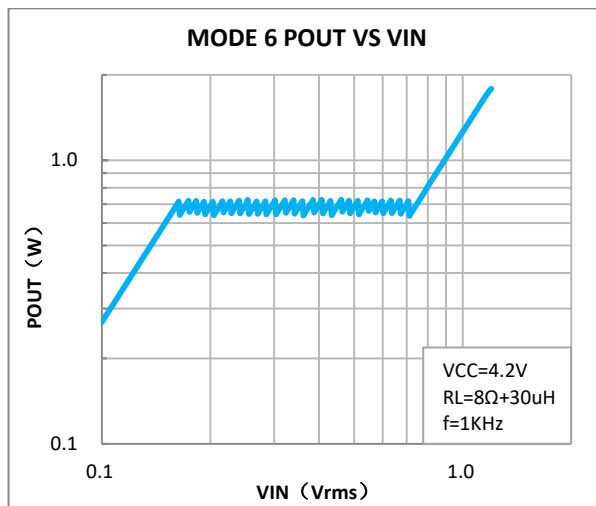
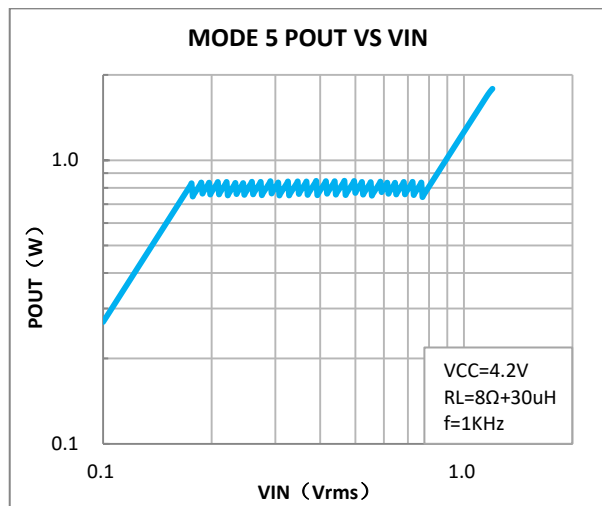
Test condition:  $T_A=25^{\circ}\text{C}$ ,  $V_{CC}=3.6\text{V}$ ,  $R_L=8\Omega+33\mu\text{H}$ ,  $f=1\text{kHz}$  (unless otherwise noted)

Parameter		Test conditions	Min	Typ	Max	Units
$T_{\text{LATCH}}$	EN turn on delay time	$V_{CC}=3.0\text{V}$ to $5.5\text{V}$	150		500	$\mu\text{s}$
$T_{\text{OFF}}$	EN turn off delay time	$V_{CC}=3.0\text{V}$ to $5.5\text{V}$	150		500	$\mu\text{s}$
<b>Digital Power Modulation</b> (Note 4)						
$T_{\text{ATF}}$	Fast attack time	-13.5dB gain attenuation completed		1.5		ms
$T_{\text{ATS}}$	Slow attack time	-13.5dB gain attenuation completed		6		ms
$T_{\text{ATT}}$	Total attack time	-13.5dB gain attenuation completed		7.5		ms
$T_{\text{RL}}$	Release time	13.5dB gain release completed		280		ms
$A_{\text{MAX}}$	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.

### TYPICAL CHARACTERISTICS







# **BCT89318F**

## **High efficiency, Low noise Class T Audio Amplifier**

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### **DETAILED FUNCTIONAL DESCRIPTION**

BCT89318F 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 BCT89318F noise floor is as low as to 43 $\mu$ V, with 99dB high-signal-to-noise ratio(SNR). The ultra-low distortion 0.08% and unique Digital Power Modulation technology brings high quality music enjoyment.

BCT89318F 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.

BCT89318F can also support speaker and receiver two-in-one application. In receiver mode, the output noise is as low as to 19 $\mu$ V, amplifier is in class D mode, powered by VBAT.

The BCT89318F has built-in excellent pop-click noise suppression algorithms effectively avoids pop-click noise during shutdown, wakeup, and power-up/down operation of BCT89318F.

BCT89318F has built-in over current protection, over-temperature protection and short circuit protection function, effectively protect the chip from damage. The BCT89318F uses small 0.4mm pitch 1.58mmx1.63mm WCSP-14L package. The BCT89318F is specified over the industrial temperature range of -40 $^{\circ}$ C to 85 $^{\circ}$ C.



# **BCT89318F**

## **High efficiency, Low noise Class T Audio Amplifier**

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### **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 BCT89318F 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, BCT89318F can still provide high quality large volume music enjoyment. BCT89318F 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.

### **Digital Power Modulation**

In the actual audio application, system output power tends to be more than rated power of speaker, if there is no output power control, the overload signal can cause damage to the speaker. The audio power amplifier with DPM function can protect the speaker effectively, with the increase of input signal, the output power increases. When output power exceeds the setting threshold, the DPM function reduces the internal gain of amplifier and restricts the output power under the set threshold.

The DPM function has the attack time setting, which is the tradeoff between auditory effect and crack distortion noise, if the attack time is longer, the audio volume will be greater, but crack distortion will also increase; if the attack time is shorter, the crack distortion will decrease, but the audio volume will be reduced. General music has large peak factor, when playing music, the big peak signal output exceeds the maximum output amplitude, there will be more crack distortion, and obvious noise will be heard in some music, so it is need to use multi-level AGC to dynamically adjust the audio power amplifier. BCT89318F integrated Broadchip proprietary Digital Power Modulation algorithm technology, effectively eliminating the noise in the music, make sound pure natural, and greatly enhancing the sound volume.

### **PVCC Voltage Control**

T-charge pump's output voltage PVCC is a multiple of the input voltage VCC, which provide a high voltage rail for internal power amplifier circuits, allowing the amplifiers provide greater output dynamic range in the lithium battery voltage range, so as to realize the large volume, high quality class T audio enjoyment. T-charge pump has integrated the voltage control loop, when the input voltage VCC is greater than 4V, the output voltage PVCC is no longer a multiple of VCC, but is controlled by voltage loop and is stable in 6.05V, and the hysteresis voltage is about 50mV.

### One Wire Pulse Control

One wire pulse control technology only needs a single GPIO port to operate the chip, complete a variety of functions. When the control signal line is longer, because of the signal integrity or radio frequency interference problem, it will produce the narrow glitch signal. Broadchip one wire pulse control technology integrated the Deglitch circuit in internal control pin, which can effectively eliminate the influence of the glitch signal.

BCT89318F 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, BCT89318F 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, BCT89318F enter into mode 2, Digital Power Modulation output power is 1.1W; When there are three rising edges, BCT89318F enter into mode 3, Digital Power Modulation output power is 1W; When there are four rising edges, BCT89318F enter into mode 4, Digital Power Modulation output power is 0.9W...; BCT89318F has ten operation modes, the number of the rising edges does not allow more than ten.

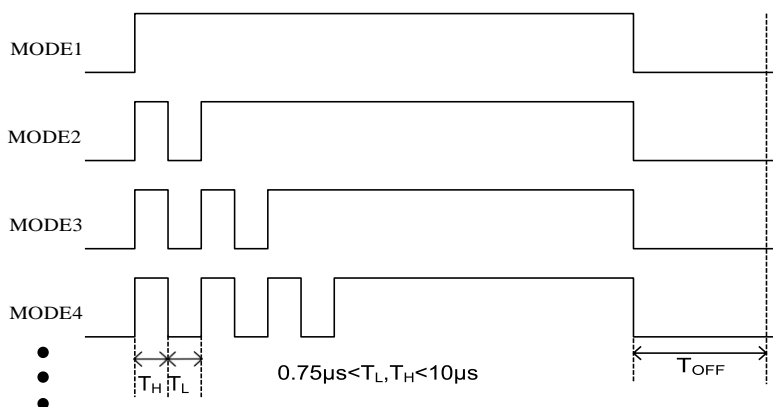


Figure 3 One Wire Pulse Control

When BCT89318F needs to work in different mode, PIN EN should be pull low longer than  $T_{OFF}$  first(recommended 1ms) which make the BCT89318F shut down, Then send series pulse make the BCT89318F enter into right mode, as shown in figure 4.

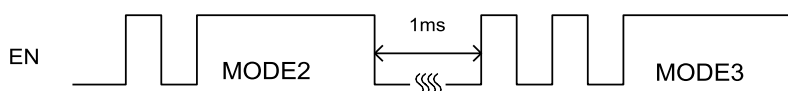


Figure 4 One Wire Pulse Control Switching Sequence



# **BCT89318F**

## **High efficiency, Low noise Class T Audio Amplifier**

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### **RF TDD Noise Suppression**

GSM radios transmit using time-division multiple access with 217Hz intervals. The result is an RF signal with strong amplitude modulation at 217Hz and its harmonics that is easily demodulated by audio amplifiers. In RF applications, improvements to both layout and component selection decrease the BCT89318F's susceptibility to RF noise and prevent RF signals from being demodulated into audible noise. Minimizing the trace lengths prevents them from functioning as antennas and coupling RF signals into the BCT89318F. Additional RF immunity can also be obtained from relying on the self-resonant frequency of capacitors as it exhibits the frequency response similar to a notch filter. Depending on the manufacturer, 10pF to 20pF capacitors typically exhibit self-resonance at RF frequencies. These capacitors, when placed at the input pins, can effectively shunt the RF noise at the inputs of the BCT89318F. For these capacitors to be effective, they must have a low-impedance, low-inductance path to the ground plane. Some RF energy will couple onto audio traces regardless of the effort to prevent this phenomenon from occurring, form audible TDD Noise. The BCT89318F features a unique RNS technology, which effectively reduces RF energy, attenuate the RF TDD-noise, an acceptable audible level to the customer

### APPLICATION INFORMATION

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

The BCT89318F 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:

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

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

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

#### 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:

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

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

follows:

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

### Supply Decoupling Capacitor (C<sub>S</sub>)

The BCT89318F 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 BCT89318F 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<sub>F</sub>)

The value of the flying capacitor (C<sub>F</sub>) affects the load regulation and output resistance of the charge pump. A C<sub>F</sub> value that is too small degrades the device's ability to provide sufficient current drive. Increasing the value of C<sub>F</sub> 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<sub>OUT</sub>)

The output capacitor value and ESR directly affect the ripple at PVCC. Increasing C<sub>OUT</sub> reduces output ripple. Likewise, decreasing the ESR of C<sub>OUT</sub> reduces both ripple and output resistance. A 4.7μF@10V capacitor is recommended.

### Optional Ferrite Bead Filter

The BCT89318F 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.

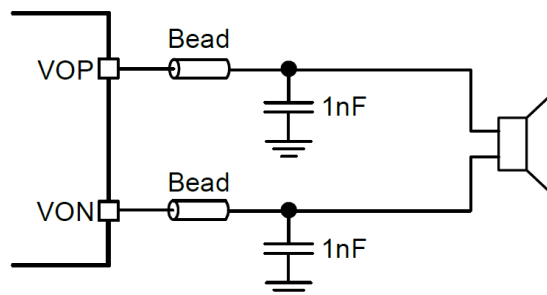


Figure 5 Ferrite Chip Bead and capacitor



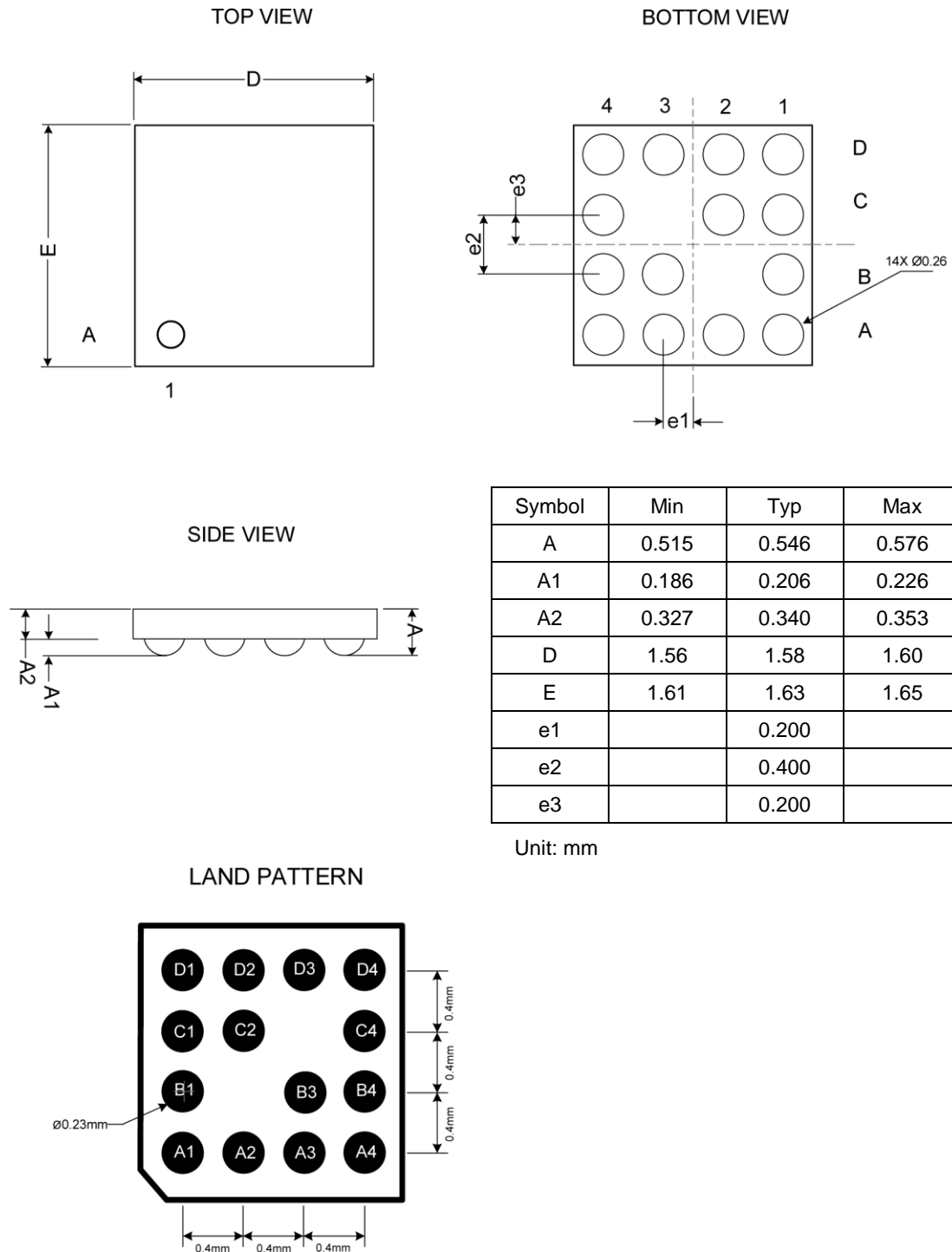
#### **PCB LAYOUT CONSIDERATION**

In order to obtain excellent performance of BCT89318F, PCB layout must be carefully considered. The design consideration should follow the following principles:

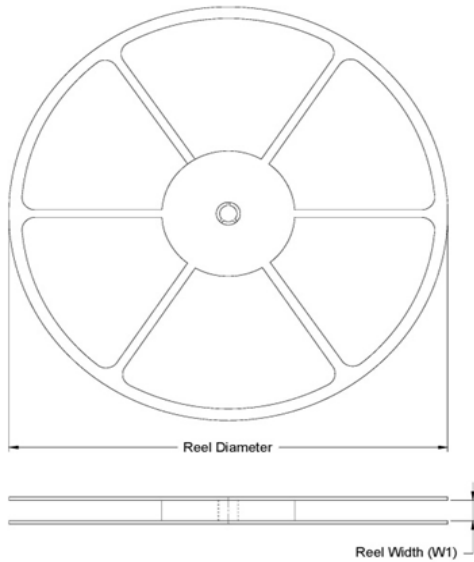
1. Try to provide a separate short and thick power line to BCT89318F. The decoupling capacitors CS1 and CS2 should be placed as close as possible to power supply pin.
2. The flying capacitors CF1, CF2 should be placed as close as possible to C1N, C1P and C2N, C2P, so the same to the output capacitor COUT, it should be close to PVCC pin. The connection from capacitor to PVCC pin should be short and thick.
3. The input capacitors and resistors should be close to BCT89318F INN and INP input pin, the input line should be parallel to suppress noise coupling.
4. The beads and capacitor should be placed near to BCT89318F VON and VOP pin. The output line from BCT89318F to speaker should be as short and thick as possible.

### PACKAGE OUTLINE DIMENSIONS

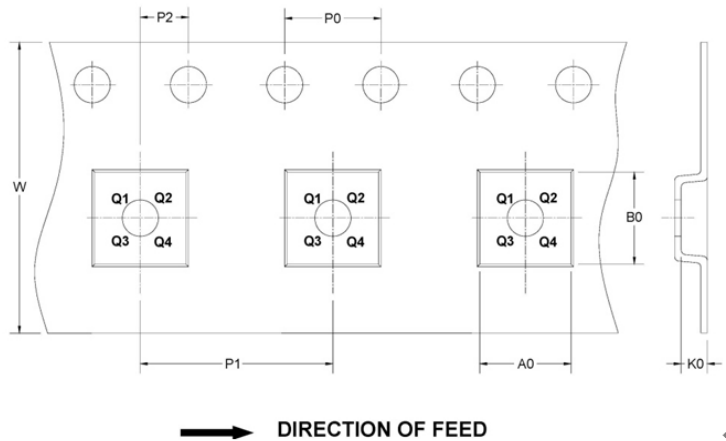
WCSP-14L



### REEL DIMENSIONS



### TAPE DIMENSIONS



### KEY PARAMETER LIST OF TAPE AND REEL

Device Name	Package Type	Reel Diameter	Unit: mm								Pin 1 Quadrant	Reel Q'ty
			Reel Width W1	A0	B0	K0	P0	P1	P2	W		
BCT89318FEWD-TR	WCSP-14L	7"	9.5	1.78	1.78	0.69	4	4	2	8	Q1	3000