BCT8933B

High Power, Low THD+N Class T Audio Amplifier

GENERAL DESCRIPTION

The BCT8933B is a powerful 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.

The BCT8933B includes a built-in 2X charge pump converter which generates a 6.3V supply voltage. This can provide a wider audio signal output range than a Traditional class D amplifier directly connected to the battery. The BCT8933B can provide 2W output power (10% THD+N) into 8Ω load from the 4.2V battery voltage.

The BCT8933B features the DPM function, which adjusts the system gain and output power automatically, protects the speaker from damage at high power levels and brings the most comfortable listening experience to the customers.

The BCT8933B is available in a small 3mm×3mm 20-Pin QFN Package. It is specified over the extended -40℃ to +85℃ temperature range.

FEATURES

- Digital Power Modulation audio algorithm
- 2.0W into 8Ω at 4.2V(10% THD+N)
- Ultra-Low THD+N:0.06%
- 4 Mode selected by one-wire pulse
- 4 Selectable Gain,12dB,16dB,24dB, 27.5dB
- Short-Circuit and Thermal Protection
- ±8KV HBM ESD
- Small 3mm×3mm 20-Pin TQFN Package

APPLICATIONS

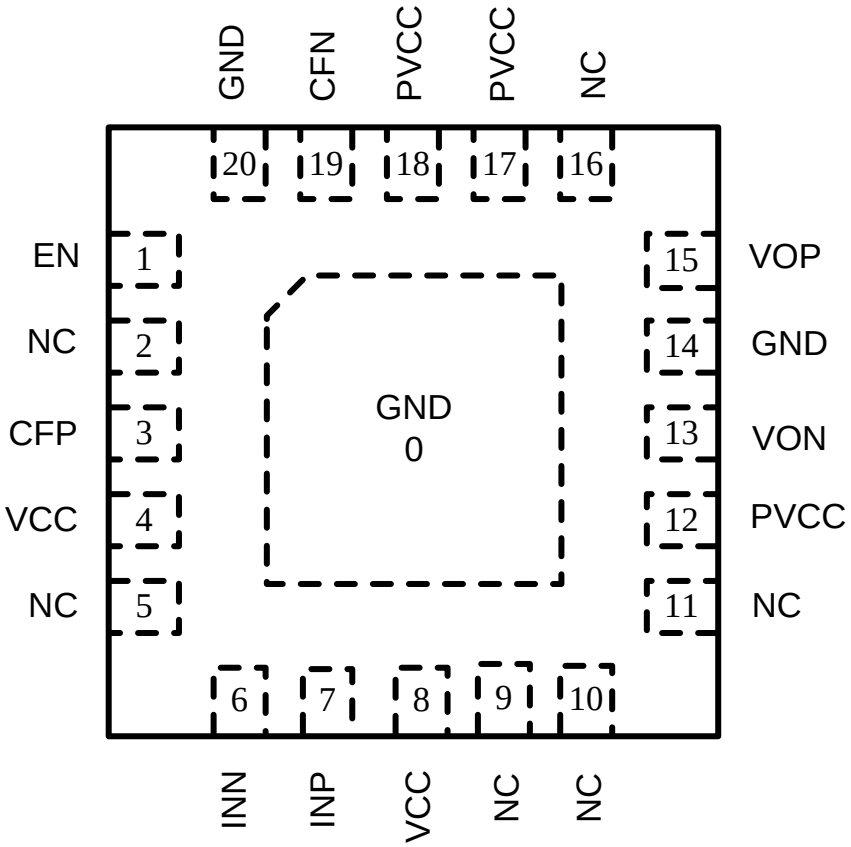
- Smart phone
- Portable Audio Devices
- Mini Speakers

ORDERING INFORMATION

Order Number	Package Type	Temperature Range	Marking	QTY/Reel
BCT8933BEGP-TR	QFN3x3-20L	-40°C to +85°C	XGDDB XXXXX	6000

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

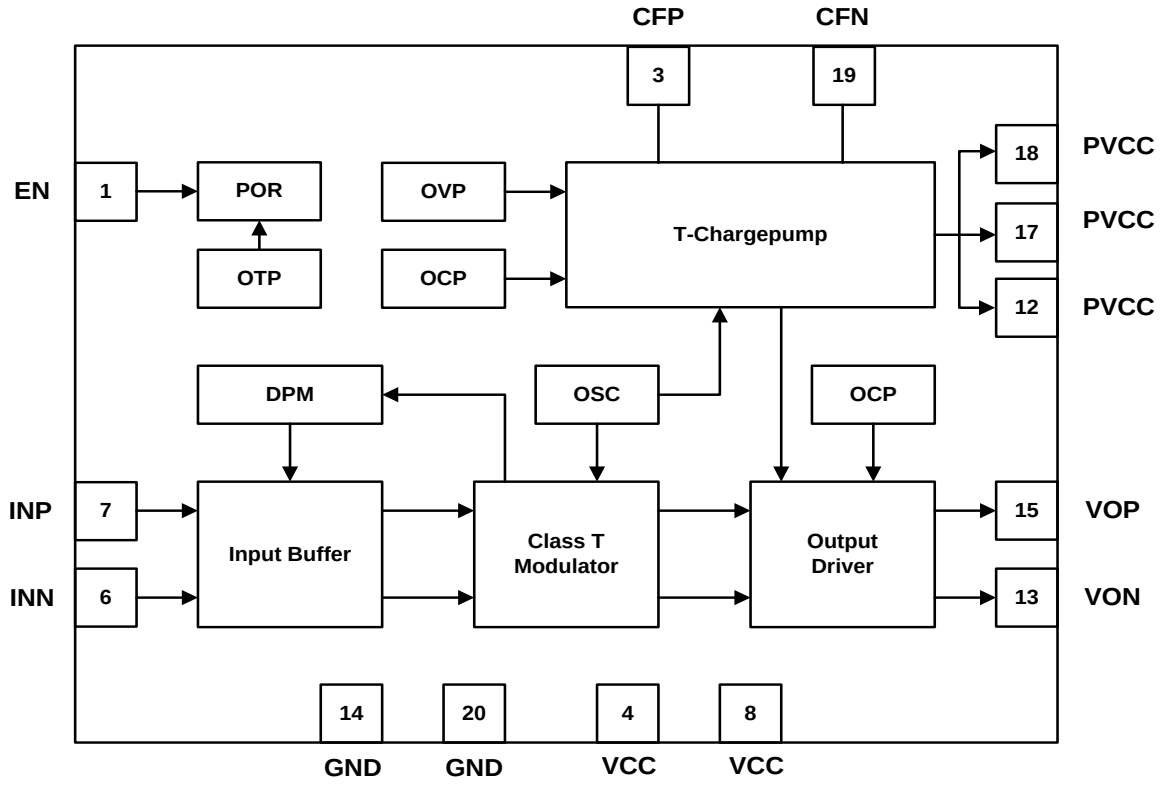
PIN CONFIGURATION (Top View)



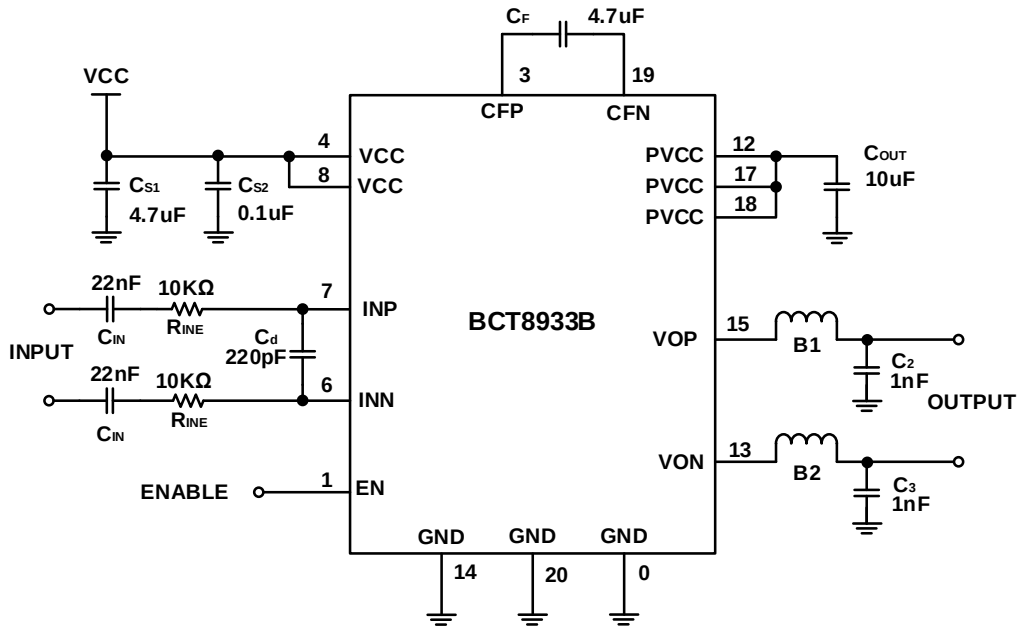
PIN DESCRIPTION

PIN	NAME	FUNCTION
1	EN	Enable and one-wire control pin
2,5,9,10,11,16	NC	No Connect
3	CFP	Positive Terminal of Flying capacitor
4,8	VCC	Supply Voltage.
6	INN	Negative Amplifier Input
7	INP	Positive Amplifier Input
12,17,18	PVCC	2x Charge-Pump Output.
13	VON	Negative Amplifier output
14,20,21	GND	Ground
15	VOP	Positive Amplifier Output
19	CFN	Negative Terminal of Flying capacitor.

BLOCK DIAGRAM



TYPICAL APPLICATION CIRCIUT



ABSOLUTE MAXIMUM RATINGS

VCC, Supply Voltage Range..... -0.3V to 6V
Charge pump output voltage PVCC..... -0.3V to 7V
INP, INN, EN Input Voltage Range..... -0.3V to VCC+0.3V
Package Thermal Resistance θ_{JA}..... 54℃/W
Operating Temperature Range..... -40℃ to +85℃
Junction Temperature..... 150℃
Storage Temperature Range..... -65℃ to +150℃
Lead Temperature (Soldering, 10sec)..... 260℃
ESD HBM（human body model）..... ±8KV

NOTE:

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

Parameter		Conditions		Min	TYP	Max	Units
VCC	Power Supply			2.5		5.5	V
I_q	Quiescent current				10		mA
I_{SD}	Shutdown current	VCC=3.6V, EN=0V			0.1		μA
V_{IH}	EN high-level input			1.2		VCC	V
V_{IL}	EN low-level input			0		0.35	V
I_{IH}	EN high-level input current	VCC=5.5V,V_{EN}=5.8V			100		μA
I_{IL}	EN low-level input current	VCC=5.5V,V_{EN}=-0.3V			5		μA
T_{SD}	Thermal Protect level				160		℃
T_{SDH}	Thermal Hysteresis				40		℃
Charge Pump							
PVCC	Output Voltage	VCC =3.3V to 5.5V,no load		5.8	6.3	7	V
F1	Switching Frequency	VCC=3V to 5.5V			600		kHz
T_{ST}	Soft-start time	No load, COUT=10uF			0.5		ms
I_L	PVCC short to GND current limit				300		mA
Class T							
$\|V_{OS}\|$	Output offset voltage	V_{IN}=0V, no load			0	30	mV
Rini	Internal impedance	Mode1 and Mode2			30		kΩ
		Mode3 and Mode4			5		
Fosc	Modulation Frequency	VCC=2.5V to 5.5V			370		kHz
PSRR	Power supply rejection ratio	VCC=4.2V,Vp-p_sin=200mV	217Hz		-70		dB
			1kHz		-68		dB
T_{ON}	Start-up time				28		ms
THD+N	Total harmonic distortion plus noise	VCC=4.2V,Po=1W,f=1kHz			0.06		%
		VCC=3.6V,Po=0.5W,f=1kHz			0.07		%
P_O	Output power	THD+N=10%,f=1kHz,VCC=4.2V			2		W
		THD+N=1%,f=1kHz,VCC=4.2V			1.7		W
One-wire Pulse Control							
T_H	EN high level hold time	VCC=2.5V to 5.5V		0.75	2	10	μs
T_L	EN low level hold time	VCC=2.5V to 5.5V		0.75	2	10	μs
T_{OFF}	EN delay time	VCC=2.5V to 5.5V				500	μs
DPM							
T_{AT}	Attack time	f_{sin}=1kHz			40		ms
T_{RL}	Release time				1.2		s
A_{MAX}	Maximum attenuation gain				-13		dB

DETAILED FUNCTIONAL DESCRIPTION

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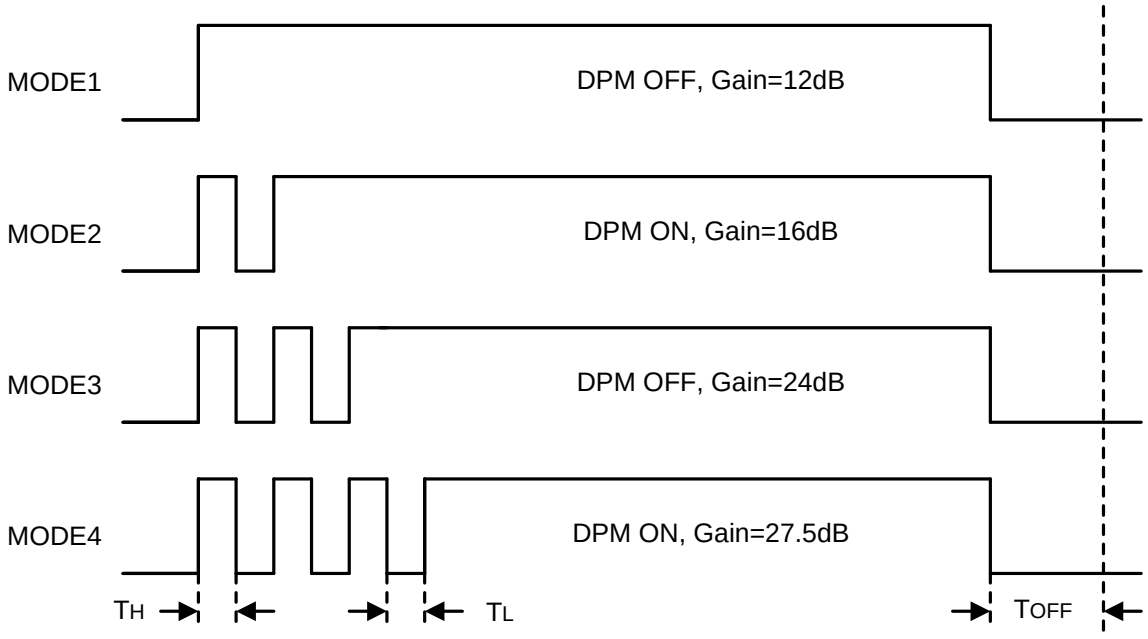
One Wire Pulse Control

BCT8933B select each mode by one-wire pulse control, When EN pin pull high from shutdown mode, there is one rising edge, BCT8933B start to work and set Gain=12dB. When high-low-high signal set to EN pin, there are two rising edges, BCT8933B open DPM function and set Gain=16dB. When there are three rising edges, BCT8933B close DPM function and set Gain=24dB. When there are four rising edges, BCT8933B open DPM function and set Gain=27.5dB.

When EN pull down above 500μs, BCT8933B will enter shutdown mode.



APPLICATION INFORMATION

External Input Resistor-Rin（Gain setting）

The BCT8933B is a differential audio amplifier. The IC integrates two internal input resistors, which 30kΩ in mode1 and mode2, 5kΩ in mode3 and mode4. Take external input resistor Rine=10kΩ for an example,

Mode 1 ： $A_V = \frac{160k\Omega}{R_{ine}+R_{ini}} = \frac{160k\Omega}{10k\Omega+30k\Omega} = 4V/V$

Mode 2 ： $A_V = \frac{240k\Omega}{R_{ine}+R_{ini}} = \frac{240k\Omega}{10k\Omega+30k\Omega} = 6V/V$

Mode 3 ： $A_V = \frac{240k\Omega}{R_{ine}+R_{ini}} = \frac{240k\Omega}{10k\Omega+5k\Omega} = 16V/V$

Mode 4 ： $A_V = \frac{360k\Omega}{R_{ine}+R_{ini}} = \frac{360k\Omega}{10k\Omega+5k\Omega} = 24V/V$

Input Capacitor-Cin（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:

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

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 1 as an example:

Mode 1, Mode 2:

$$f_H(-3dB) = \frac{1}{2 * \pi * R_{in} * C_{in}}(Hz) = \frac{1}{2 * \pi * 40k\Omega * 22nF} = 181Hz$$

Mode 3, Mode 4:

$$f_H(-3dB) = \frac{1}{2 * \pi * R_{in} * C_{in}}(Hz) = \frac{1}{2 * \pi * 15k\Omega * 22nF} = 482Hz$$

APPLICATION INFORMATION (Continued)

Supply Decoupling Capacitor（C_S）

The BCT8933B 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 BCT8933B 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）

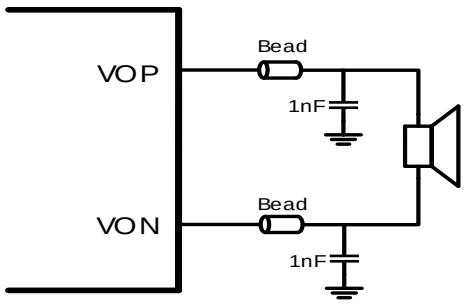
The value of the flying capacitor (C_F) affects the load regulation and output resistance of the charge pump. A CF value that is too small degrades the device's ability to provide sufficient current drive. Increasing the value of CF improves load regulation and reduces the charge pump output resistance to an extent. A 4.7μF 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 COUT reduces both ripple and output resistance. A 10μF@10V capacitor is recommended.

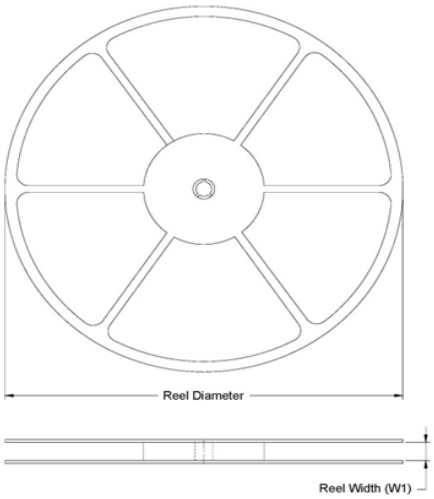
Optional Ferrite Bead Filter

The BCT8933B 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.

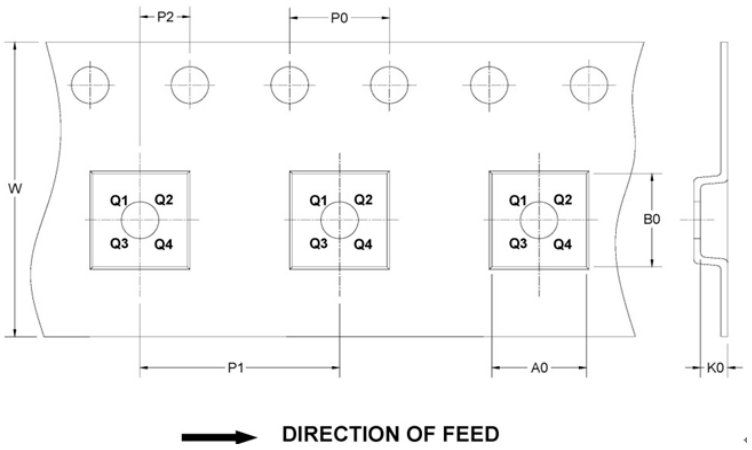


TAPE AND REEL INFORMATION

REEL DIMENSIONS



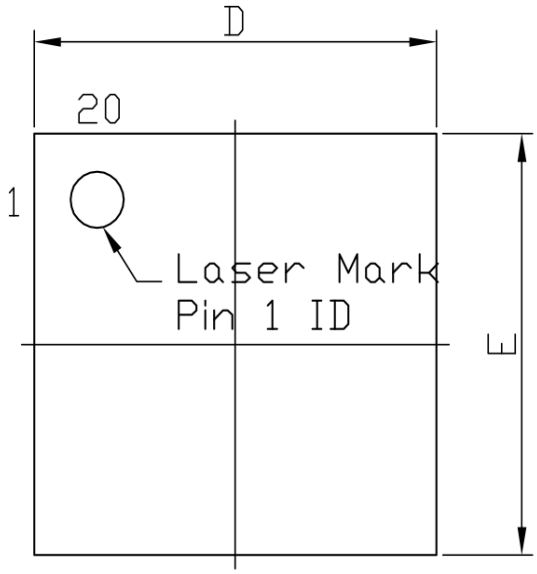
DIMENSIONS



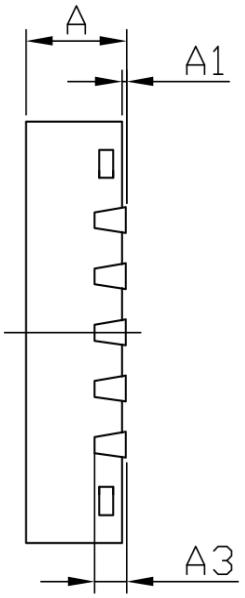
Device Name	Package Type	Reel Diameter	Unit: mm								Pin 1 Quadrant	Reel QTY
			Reel Width W1	A0	B0	K0	P0	P1	P2	W		
BCT8933BEGP-TR	QFN3x3-20L	13"	12	3.3	3.3	1.1	4	4	2	12	Q1	6000

PACKAGE OUTLINE DIMENSIONS

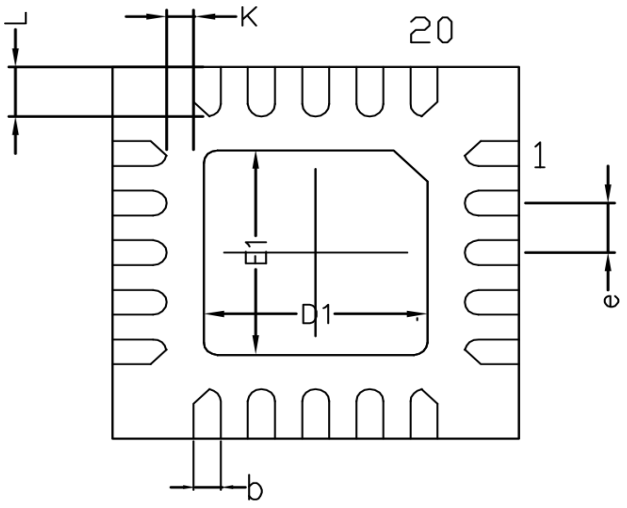
QFN3x3-20L



Top View



Side View



bottom View

Symbol	Dimensions In Millimeters		
	Min	Nom	Max
A	0.70	0.75	0.80
A1	0.00	--	0.05
A3	0.203REF		
b	0.15	--	0.25
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D1	1.55	1.65	1.75
E1	1.55	1.65	1.75
e	0.40TYP		
K	0.20	--	--
L	0.30	0.40	0.50