

## **BCT8321/21B/58/24**

**1MHz, 60uA, Rail-to-Rail I/O CMOS Operational Amplifiers**

### **GENERAL DESCRIPTION**

The BCT83XX is low cost, rail-to-rail input and output voltage feedback amplifiers. It has a wide input common-mode voltage range and output voltage swing, and take the minimum operating supply voltage down to 2.1V. The maximum recommended supply voltage is 5.5V. It's specified over the extended -40°C to 85°C temperature range.

BCT83XX provides 1MHz bandwidth at a low current consumption of 60uA per amplifier. Very low input bias currents of 10pA enable BCT83XX to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail input and output are useful to designers for buffering ASIC in single-supply systems. Applications for this series of amplifiers include safety monitoring, portable equipment, battery and power supply control, and signal conditioning and interfacing for transducers in very low power systems. The BCT83XX comes in the Green SOT23-5/SOP8 /SOP14 packages.

### **FEATURES**



- Supply Voltage Range : 2.1V to 5.5V
- Maxim Offset Voltage :  $\pm 5.6\text{mV}$
- Gain Bandwidth Product : 1MHz
- Slew Rate :  $0.65\text{V}/\mu\text{s}$
- Low Supply Current : 60uA/Amplifier
- Very Low Input Bias Current : 10pA
- Rail-to-Rail Input and Output
- Unity Gain Stable
- Small Packaging:

BCT83XX available in SOT23-5/SOP8/SOP14

### **APPLICATIONS**

ASIC Input or Output Amplifier  
Sensor Interface  
Piezoelectric Transducer Amplifier  
Medical Instrumentation  
Mobile Communication  
Audio Output  
Portable Systems  
Smoke Detectors  
Notebook PC  
Battery-Powered Equipment  
DSP Interface

### ORDERING INFORMATION

Order Number	Package Type	Temperature Range	Marking	QTY/Reel
BCT8321EUK-TR	SOT23-5	-40°C to +85°C	TCXX	3000
BCT8321BEUK-TR	SOT23-5	-40°C to +85°C	TDXX	3000
BCT8358ELA-TR	DFN2x2-8L	-40°C to +85°C	TEXX	3000
BCT8358ESA-TR	SOP8	-40°C to +85°C	 8358 XXXXX	4000
BCT8324ESD-TU	SOP14	-40°C to +85°C	 8324 XXXXX	10000

Note: "XX" & "XXXXX" of Marking is batch code.

### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, VDD to VSS .....-0.3V to +6.0V  
Common-Mode Input Voltage.(VSS)-0.3V to (VDD)+ 0.3V  
Storage Temperature Range.....-65°C to +150°C  
Junction Temperature.....150°C  
Operating Temperature Range.....-40°C to +85°C  
Package Thermal Resistance @ TA=+25°C  
SOT23-5,  $\theta_{JA}$ .....260°C/W  
DFN2x2-8L,  $\theta_{JA}$ .....140°C/W  
SOP8,  $\theta_{JA}$ .....180°C/W  
SOP14,  $\theta_{JA}$ .....110°C/W  
Lead Temperature (Soldering, 10 sec).....260°C  
ESD Susceptibility  
HBM.....4000V

#### 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

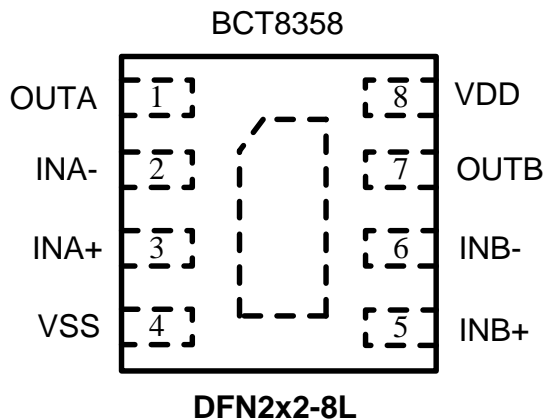
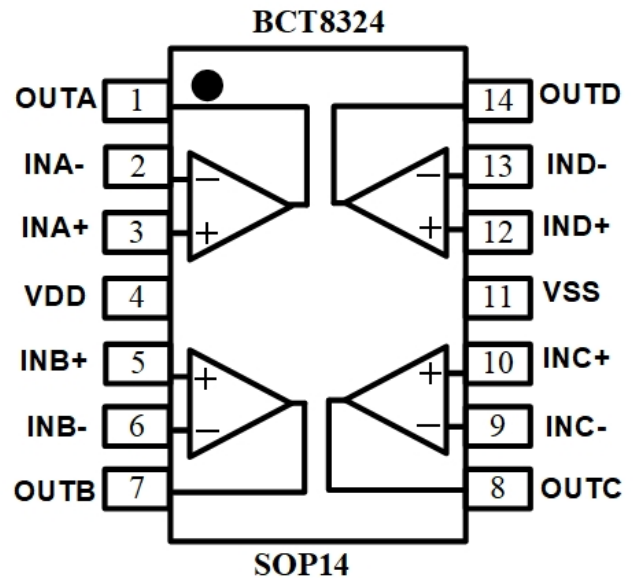
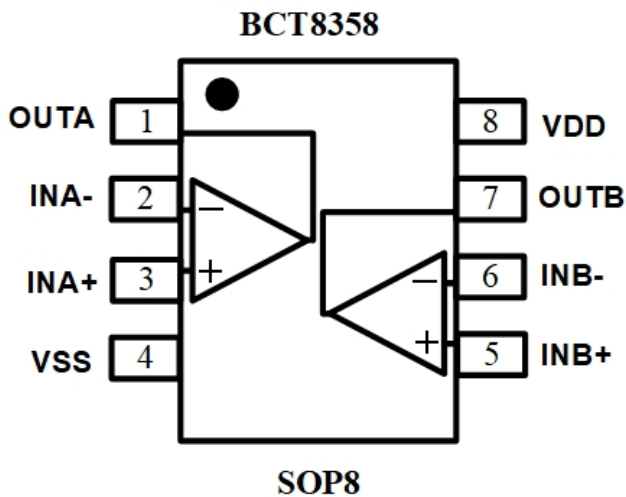
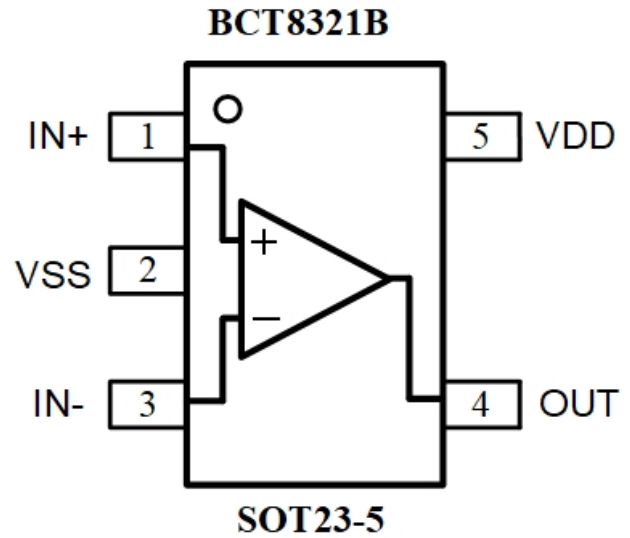
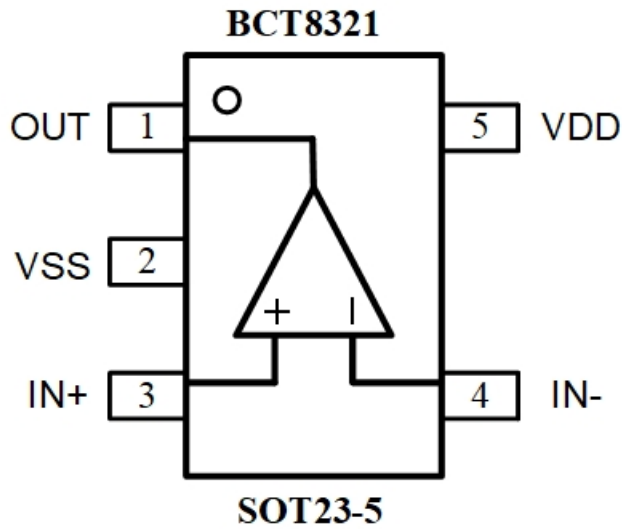
not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. BCTICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

Broadchip reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact Broadchip sales office to get the latest datasheet.

## PIN CONFIGURATION (TOP VIEW)



### PIN DESCRIPTION

#### BCT8321

Pin	Name	Function
1	OUT	Amplifier Output
2	VSS	Negative Supply Input. Connect to ground for single-supply operation.
3	IN+	Non inverting Input to Amplifier
4	IN-	Inverting Input to Amplifier
5	VDD	Positive Supply Input

#### BCT8321B

Pin	Name	Function
1	IN+	Non inverting Input to Amplifier
2	VSS	Negative Supply Input. Connect to ground for single-supply operation.
3	IN-	Inverting Input to Amplifier
4	OUT	Amplifier Output
5	VDD	Positive Supply Input

#### BCT8358

SOP8 Pin	DFN2x2-8L Pin	Name	Function
1	1	OUTA	Amplifier A Output
2	2	INA-	Inverting Input to Amplifier A
3	3	INA+	Non inverting Input to Amplifier A
4	4	VSS	Negative Supply Input. Connect to ground for single-supply operation.
5	5	INB+	Non inverting Input to Amplifier B
6	6	INB-	Inverting Input to Amplifier B
7	7	OUTB	Amplifier B Output
8	8	VDD	Positive Supply Input
	EXPOSED PAD	NC	No connect, Should be floating or connect to VSS.

**BCT8324**

Pin	Name	Function
1	OUTA	Amplifier A Output
2	INA-	Inverting Input to Amplifier A
3	INA+	Non inverting Input to Amplifier A
4	VDD	Positive Supply Input
5	INB+	Non inverting Input to Amplifier B
6	INB-	Inverting Input to Amplifier B
7	OUTB	Amplifier B Output
8	OUTC	Amplifier C Output
9	INC-	Inverting Input to Amplifier C
10	INC+	Non inverting Input to Amplifier C
11	VSS	Negative Supply Input. Connect to ground for single-supply operation.
12	IND+	Non inverting Input to Amplifier D
13	IND-	Inverting Input to Amplifier D
14	OUTD	Amplifier D Output

### ELECTRICAL CHARACTERISTICS

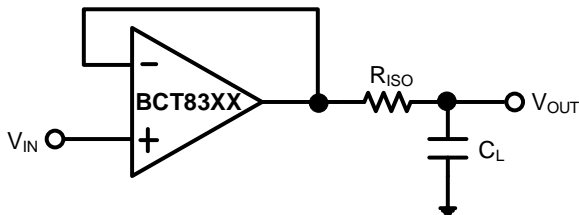
(VDD= +5V, RL= 100kΩ connected to VDD/2, and VOUT=VDD/2, unless otherwise specified.)

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage	V <sub>OS</sub>	V <sub>CM</sub> =VDD/2		±0.8	±5.6	mV
Input Bias Current	I <sub>B</sub>			10		pA
Input Offset Current	I <sub>OS</sub>			10		pA
Common-Mode Voltage Range	V <sub>CM</sub>		VSS-0.1		VDD+0.1	V
Common-Mode Rejection Ration	CMRR	VDD=5.5V , VCM=0V to 5V	60	80		dB
Open-Loop Voltage Gain	A <sub>OL</sub>	R <sub>L</sub> =100kΩ, Vo=+0.1V to +4.9V	80	95		dB
Input Offset Voltage Drift	Δ V <sub>OS</sub> / Δ T			2.7		uV/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V <sub>OH</sub>	RL=100kΩ	4.997			V
	V <sub>OL</sub>	RL=100kΩ			5	mV
	V <sub>OH</sub>	RL=10kΩ	4.992			V
	V <sub>OL</sub>	RL=10kΩ			8	mV
Output Current	I <sub>SOURCE</sub>	R <sub>L</sub> =10Ω to VDD/2	40	50		mA
	I <sub>SINK</sub>		60	75		
POWER SUPPLY						
Operating Voltage Range	VDD		2.1		5.5	V
Power Supply Rejection Ration	PSRR	VDD=+2.5V to +5.5V, VCM=+0.5V	60	80		dB
Quiescent Current/Amplifier	I <sub>Q</sub>	BCT8321/8321B	90	120	150	uA
		BCT8358/8324	45	60	75	uA
DYNAMIC PERFORMANCE(C <sub>L</sub> =100pF)						
Gain-Bandwidth Product	GBP			1		MHz
Slew Rate	SR	G=+1, 2V Output Step		0.65		V/uS
Setting Time to 0.1%	ts	G=+1, 2V Output Step		5.3		us
Overload Recovery Time		V <sub>IN</sub> GAIN=VDD		2.6		us
NOISE PERFORMANCE						
Voltage Noise Density	e <sub>n</sub>	f=1kHz		45		nV/√Hz
		f=10kHz		35		nV/√Hz

### APPLICATION NOTES

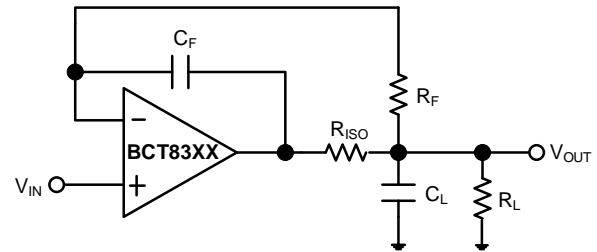
#### Driving Capacitive Loads

The BCT83XX can directly drive 250pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive driving capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure1. The isolation resistor  $R_{ISO}$  and the load capacitor  $C_L$  form a zero to increase stability. The bigger the  $R_{ISO}$  resistor value, the more stable  $V_{OUT}$  will be. Note that this method results in a loss of gain accuracy because  $R_{ISO}$  forms a voltage divider with  $R_{LOAD}$ .



**Figure 1. Indirectly Driving Heavy Capacitive Load**

An improved circuit is shown in Figure 2. It provides DC accuracy as well as AC stability.  $R_F$  provides the DC accuracy by connecting the inverting signal with the output.  $C_F$  and  $R_{ISO}$  serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

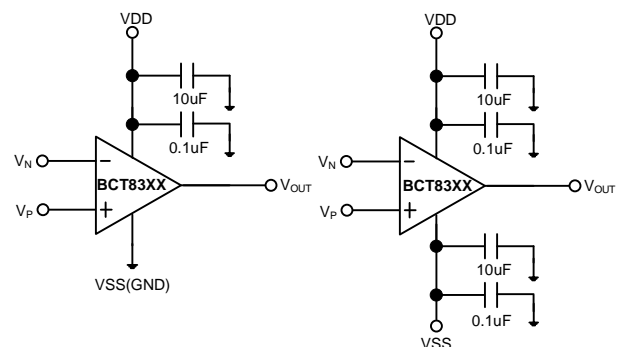


**Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy**

For non-buffer configuration, there are two other ways to increase the phase margin: (a) by increasing the amplifier's gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

#### Power-Supply Bypassing and Layout

The BCT83XX can operate from either a single +2.1V to +5.5V supply or dual  $\pm 1.05V$  to  $\pm 2.75V$  supplies. For single-supply operation, bypass the power supply VDD with a 0.1uF ceramic capacitor which should be placed close to the VDD pin. For dual supply operation, both the VDD and the VSS supplies should be bypassed to ground with separate 0.1uF ceramic capacitors. 2.2uF tantalum capacitor can be added for better performance.



**Figure 3. Amplifier with Bypass Capacitors**

### TYPICAL APPLICATION

#### CIRCUITS

##### Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistor ratios are equal to  $(R_4/R_3=R_2/R_1)$ . Then

$$V_{OUT}=(V_P-V_N)*R_2/R_1+V_{REF}.$$

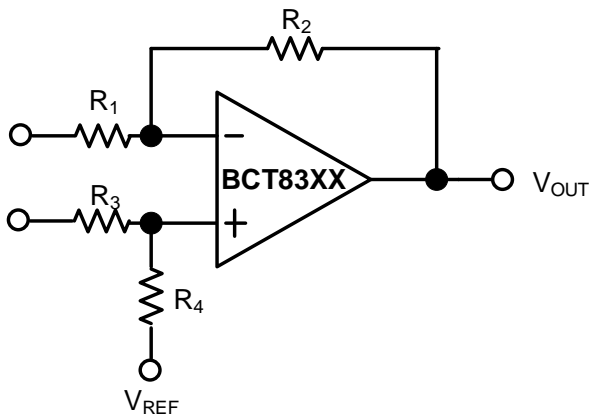


Figure 4. Differential Amplifier

##### Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with a high input impedance.

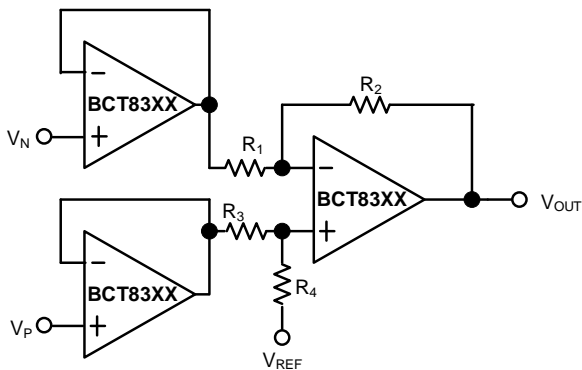


Figure 5. Instrumentation Amplifier

##### Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of  $(-R_2/R_1)$  and the -3dB corner frequency is  $1/2\pi R_2 C$ . Make sure the filter bandwidth is within the bandwidth of the amplifier. The large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.

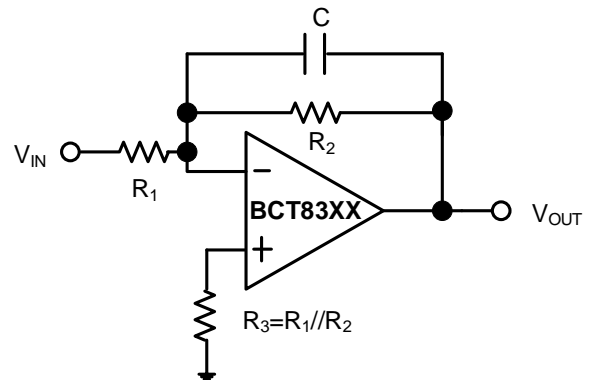
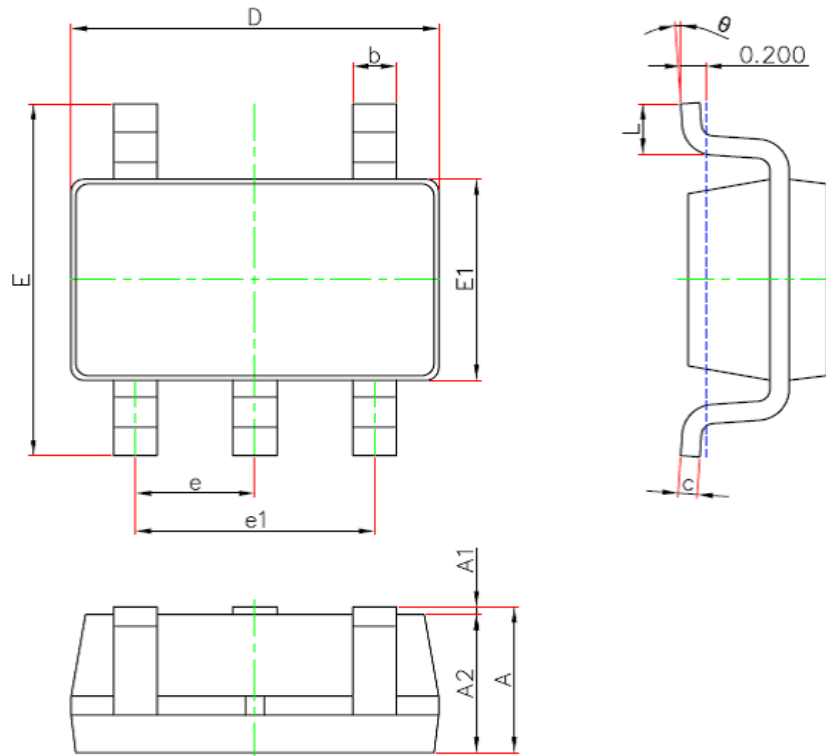


Figure 6. Low Pass Active Filter



### PACKAGE OUTLINE DIMENSIONS

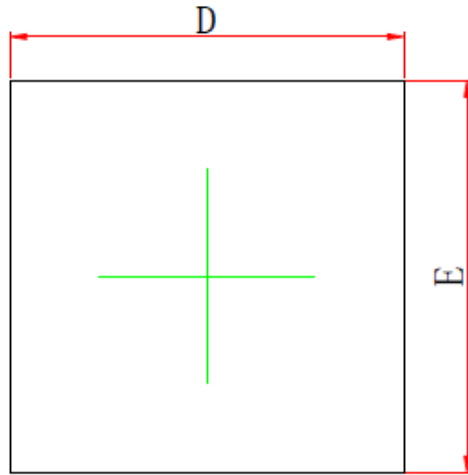
#### SOT23-5



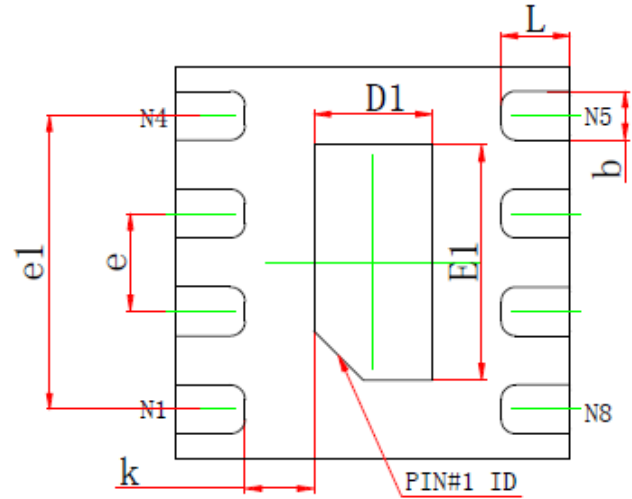
Symbol	Dimensions In Millimeters	
	Min	Max
A	1.05	1.3
A1	0	0.15
A2	1.05	1.15
b	0.28	0.5
c	0.1	0.23
D	2.82	3.02
E1	1.5	1.7
E	2.65	3.05
e	0.95(BSC)	
e1	1.8	2
L	0.3	0.6
θ	0	8°

SOT23-5 Surface Mount Package

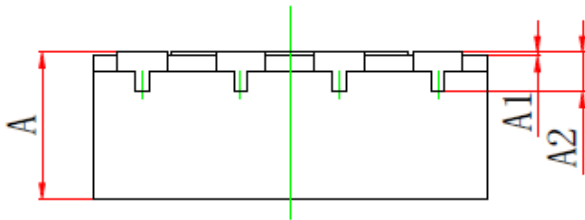
### DFN2x2-8L



TOP VIEW  
[顶视图]



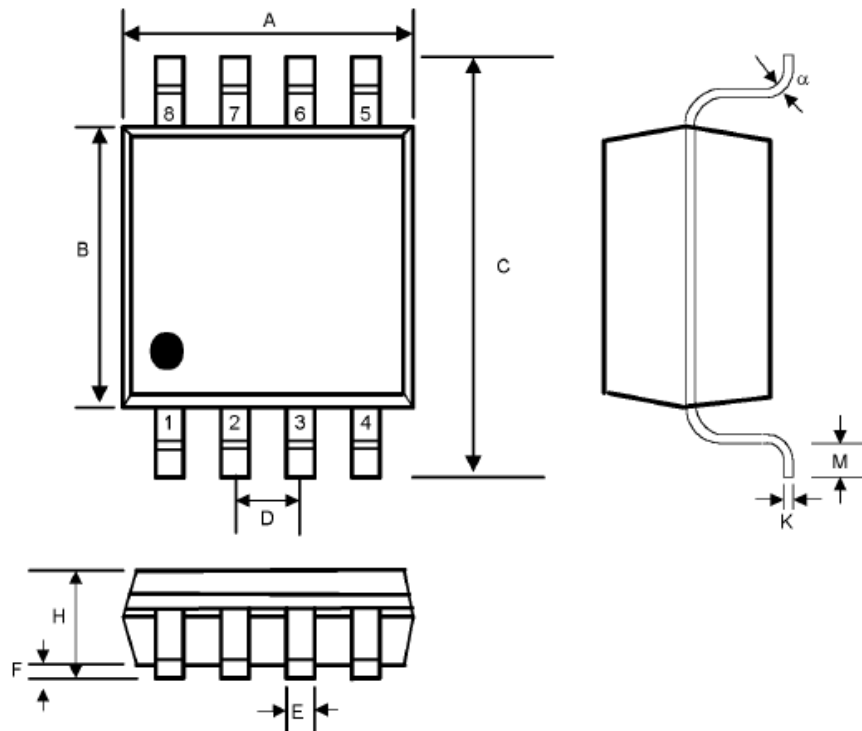
BOTTOM VIEW  
[背视图]



SIDE VIEW  
[侧视图]

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203REF.		0.008REF.	
D	1.924	2.076	0.076	0.082
E	1.924	2.076	0.076	0.082
D1	0.550	0.650	0.022	0.026
E1	1.150	1.250	0.045	0.049
b	0.200	0.300	0.008	0.012
e	0.500BSC.		0.020BSC.	
e1	1.450	1.550	0.057	0.061
k	0.300	0.400	0.012	0.016
L	0.300	0.400	0.012	0.016

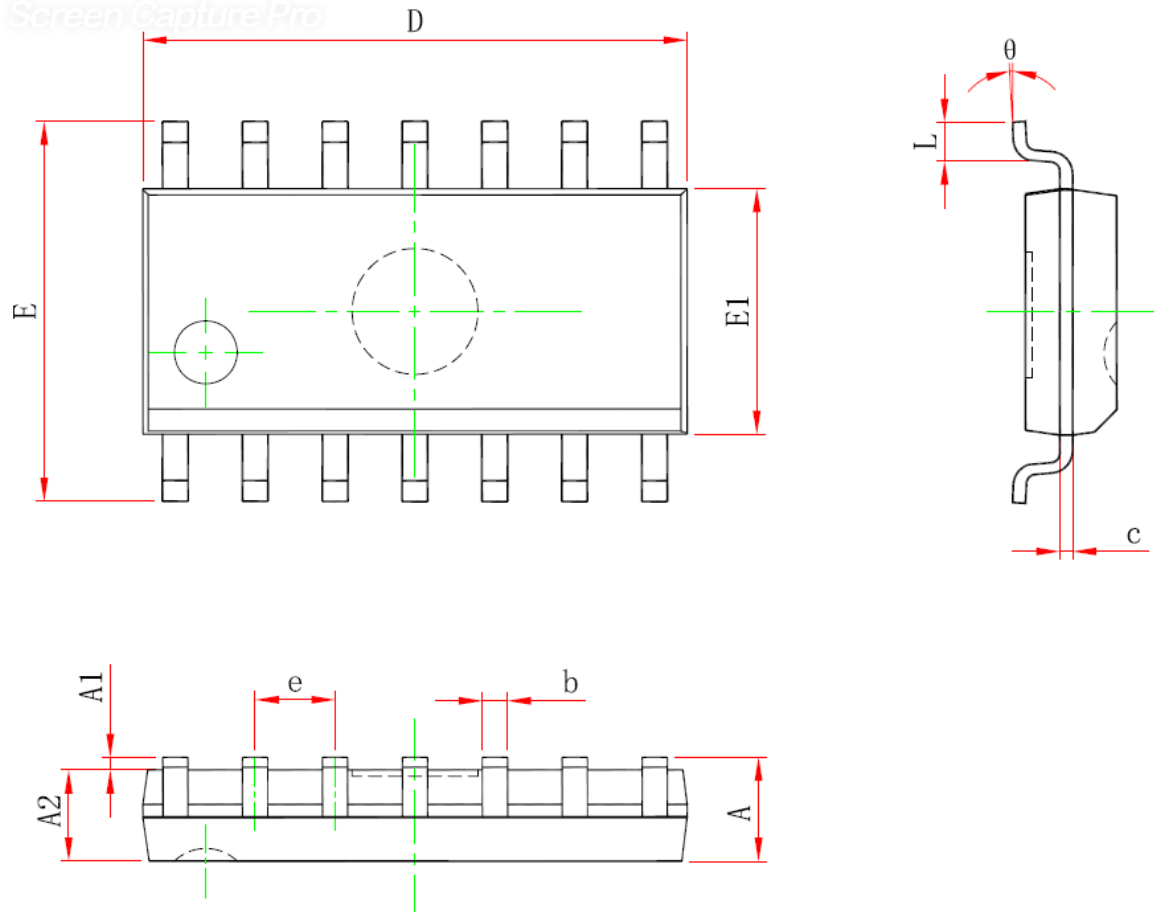
### SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.80	5.00	0.188	0.197
B	3.80	4.00	0.149	0.158
C	5.80	6.20	0.228	0.244
D	1.27 BSC		0.050	
E	0.33	0.51	0.013	0.020
F	0.10	0.25	0.004	0.010
H	1.35	1.75	0.053	0.069
K	0.19	0.25	0.007	0.010
M	0.40	1.27	0.016	0.050
$\alpha$	0°	8°	0°	8°

SOP8 Surface Mount Package

### SOP14

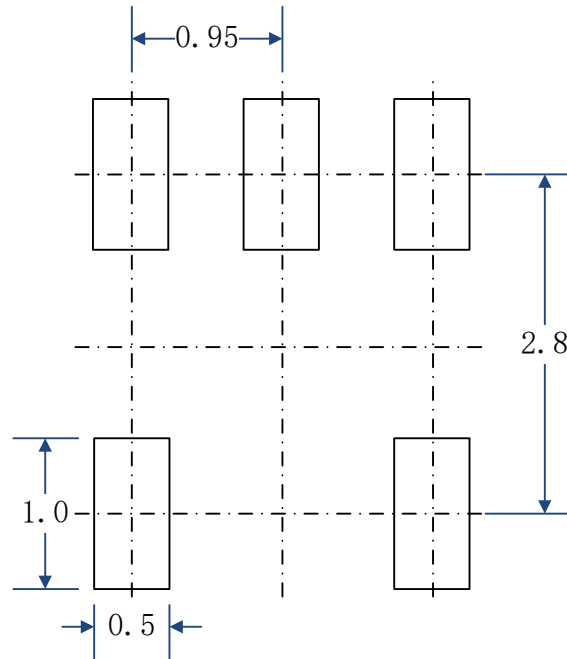


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	— —	1.750	— —	0.069
A1	0.100	0.250	0.004	0.010
A2	1.250	— —	0.049	— —
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOP14 Surface Mount Package

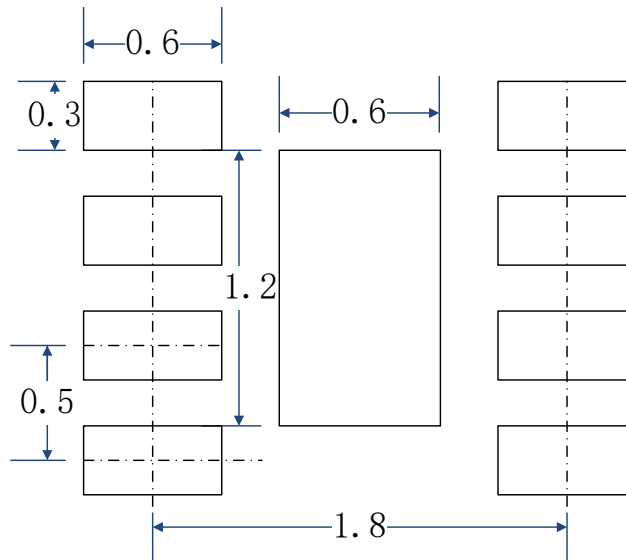
## LAND PATTERN DATA

### SOT23-5

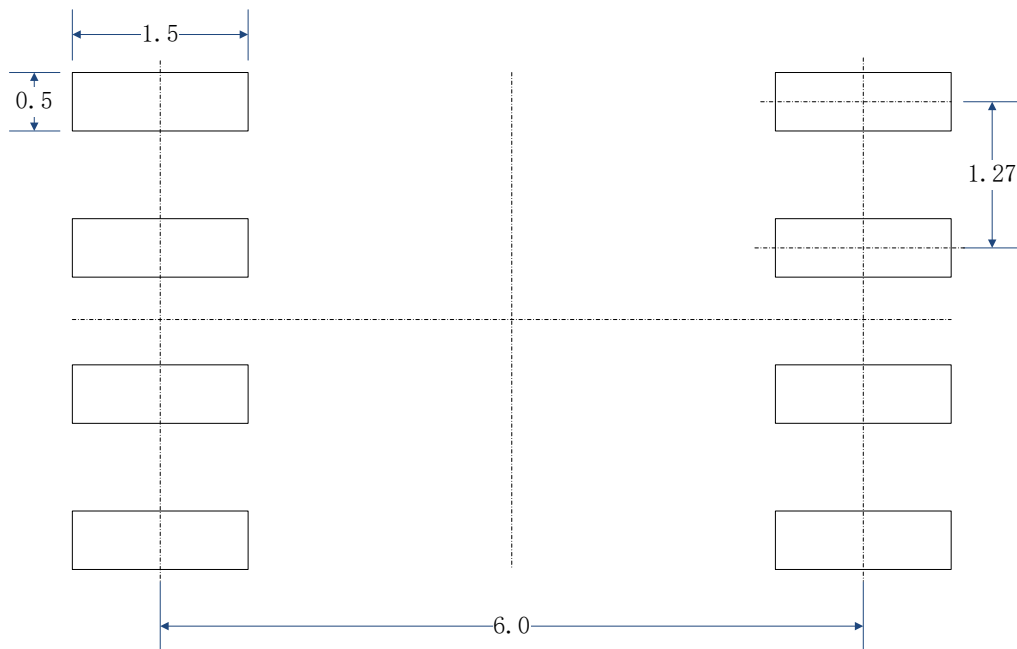


### RECOMMENDED PCB LAYOUT PATTERN (Unit: mm)

### DFN2x2-8L

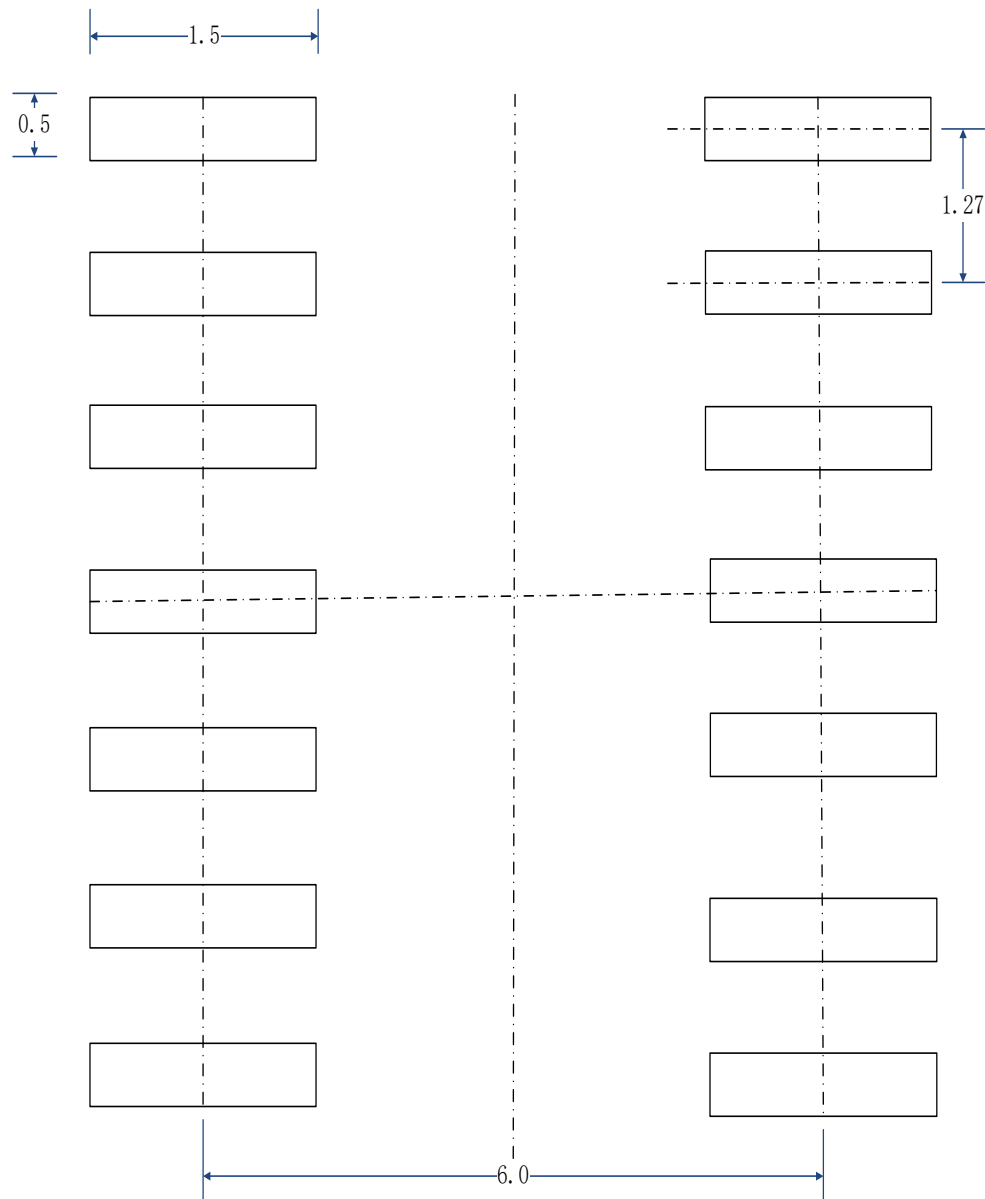


**SOP8**



**RECOMMENDED PCB LAYOUT PATTERN (Unit: mm)**

## SOP14



**RECOMMENDED PCB LAYOUT PATTERN (Unit: mm)**