

## Features

- Single-Supply Operation from +1.4V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 14.5KHz (Typ)
- Low Input Bias Current: 1pA (Typ)
- Low Offset Voltage: 3mV (Max)
- Quiescent Current: 600nA per Amplifier (Typ)
- Chip Select with HM8043NH( active High ) and HM8043NL(active Low )

- Operating Temperature: -40°C ~ +125°C
- Embedded RF Anti-EMI Filter
- Small Package:

HM8041 Available in SOT23-5 and SC70-5 Packages

HM8042 Available in SOP-8 and MSOP-8 Packages

HM8043NH Available in SOT23-6 and SC70-6 Packages

HM8043NL Available in SOT23-6 and SC70-6 Packages

## General Description

The HM804X family has a high gain-bandwidth product of 14.5KHz, a slew rate of 6V/ms, and a quiescent current of 600nA/amplifier at 5V. The HM804X family is designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common mode voltage range includes ground, and the maximum input offset voltage is 3mV for HM804X family. They are specified over the extended industrial temperature range (-40°C to +125°C). The operating range is from 1.4V to 5.5V. The HM8041 single is available in Green SC70-5 and SOT23-5 packages. The HM8042 Dual is available in Green SOP-8 and MSOP-8 packages. The HM8043 single is available in Green SC70-6 and SOT23-6 packages.

## Applications

- ASIC Input or Output Amplifier
- Sensor Interface
- Medical Communication
- Smoke Detectors
- Audio Output
- Piezoelectric Transducer Amplifier
- Medical Instrumentation
- Portable Systems

## Pin Configuration

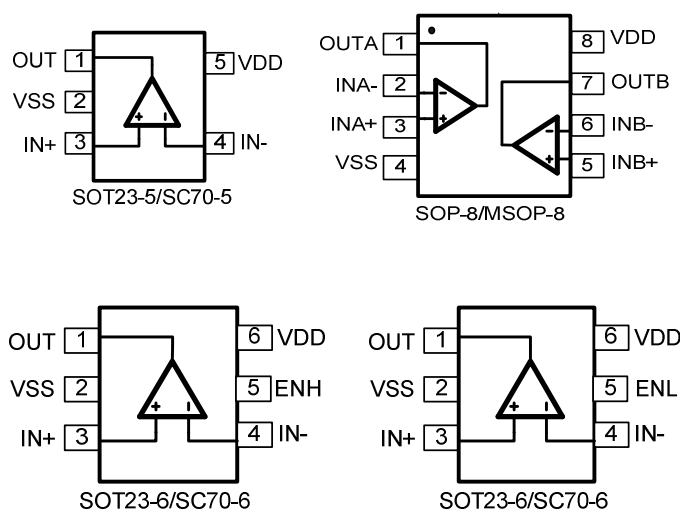


Figure 1. Pin Assignment Diagram

## Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V <sub>DD</sub> to V <sub>SS</sub> )	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	V <sub>SS</sub> -0.5V	V <sub>DD</sub> +0.5V
PDB Input Voltage	V <sub>SS</sub> -0.5V	+7V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+260°C	
Package Thermal Resistance (T <sub>A</sub> =+25°C)		
SOP-8, θ <sub>JA</sub>	125°C/W	
MSOP-8, θ <sub>JA</sub>	216°C/W	
SOT23-5, θ <sub>JA</sub>	190°C/W	
SOT23-6, θ <sub>JA</sub>	190°C/W	
SC70-5, θ <sub>JA</sub>	333°C/W	
SC70-6, θ <sub>JA</sub>	333°C/W	
ESD Susceptibility		
HBM	6KV	
MM	300V	

**Note:** Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## Package/Ordering Information

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
HM8041	Single	HM8041-UR	SC70-5	Tape and Reel,3000	8041
		HM8041-MR	SOT23-5	Tape and Reel,3000	8041
HM8042	Dual	HM8042-SR	SOP-8	Tape and Reel,4000	HM8042
		HM8042-MR	MSOP-8	Tape and Reel,3000	HM8042
HM8043NH	Single	HM8043NH-UR	SC70-6	Tape and Reel,4000	043H
		HM8043NH-MR	SOT23-6	Tape and Reel,3000	043H
HM8043NL	Single	HM8043NL-UR	SC70-6	Tape and Reel,4000	043L
		HM8043NL-MR	SOT23-6	Tape and Reel,3000	043L

## Electrical Characteristics

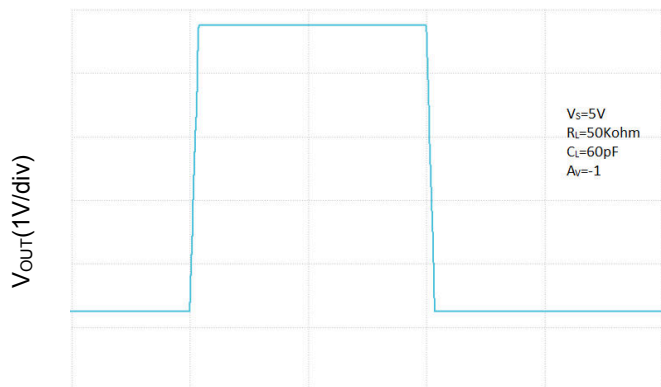
(At  $V_S = +5V$ ,  $R_L = 1M\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	HM8041/8042/8043			
			TYP	MIN	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage	V <sub>OS</sub>	V <sub>CM</sub> = V <sub>S</sub> /2	0.4		3	mV
Input Bias Current	I <sub>B</sub>		1			pA
Input Offset Current	I <sub>OS</sub>		1			pA
Common-Mode Voltage Range	V <sub>CM</sub>	V <sub>S</sub> = 5.5V	-0.1 to +5.6			V
Common-Mode Rejection Ratio	CMRR	V <sub>S</sub> = 5V, V <sub>CM</sub> = -0.1V to 2.5V	78	66		dB
		V <sub>S</sub> = 5V, V <sub>CM</sub> = -0.1V to 5.1V	84	67		
Open-Loop Voltage Gain	A <sub>OL</sub>	Vs=1.4V, R <sub>L</sub> = 50kΩ, V <sub>O</sub> = Vs-0.1V	86	75		dB
		Vs=5V, R <sub>L</sub> = 50kΩ, V <sub>O</sub> = Vs-0.1V	93	84		
Input Offset Voltage Drift	ΔV <sub>OS</sub> /ΔT		2.5			μV/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V <sub>OH</sub>	Vs=1.4V, R <sub>L</sub> = 50kΩ	1.395	1.390		V
	V <sub>OL</sub>		4.5		10	mV
	V <sub>OH</sub>	Vs=5V, R <sub>L</sub> = 50kΩ	4.997	4.990		V
	V <sub>OL</sub>		3.5		10	mV
Output Current	I <sub>SOURCE</sub>	R <sub>L</sub> = 10Ω to V <sub>S</sub> /2	20			mA
	I <sub>SINK</sub>		20			
POWER SUPPLY						
Operating Voltage Range			1.4			V
			5.5			V
Power Supply Rejection Ratio	PSRR	V <sub>S</sub> = +1.4V to +5.5V, V <sub>CM</sub> = +0.5V	80	77		dB
Quiescent Current / Amplifier	I <sub>Q</sub>		600			nA
Shutdown Current / Amplifier	I <sub>Q_off</sub>	HM8043NH / HM8043NL	54			nA
DYNAMIC PERFORMANCE (CL = 100pF)						
Gain-Bandwidth Product	GBP		14.5			KHz
Slew Rate	SR	G = +1, 2V Output Step	6			V/ms

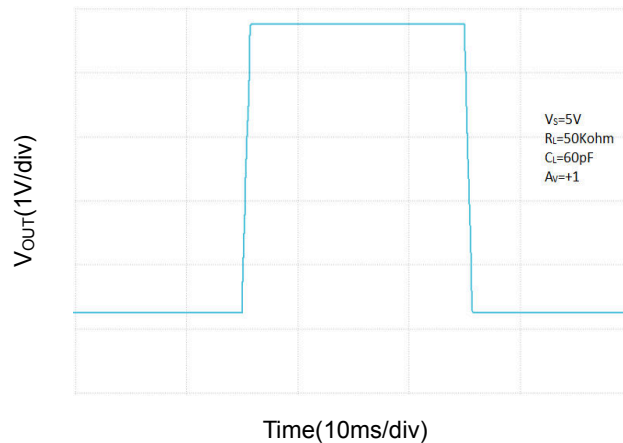
## Typical Performance characteristics

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +5\text{V}$ , and  $R_L = 100\text{K}\Omega$  connected to  $V_S/2$ , unless otherwise noted.

Large Signal Inverting Pulse Response

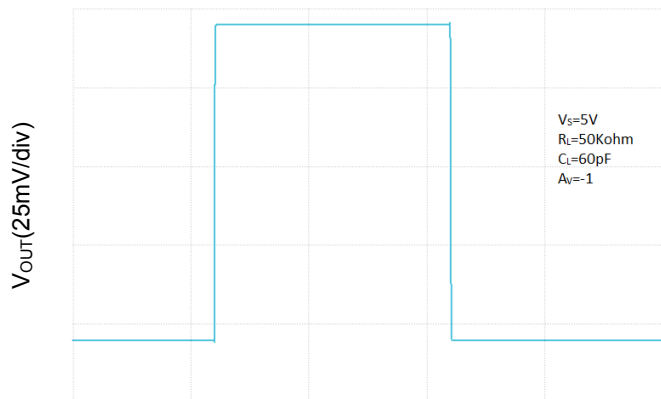


Large Signal Non-Inverting Pulse Response

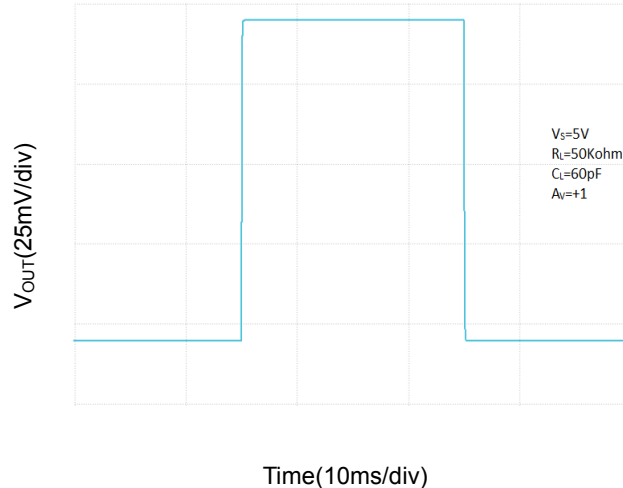


Time(10ms/div)

Small Signal Inverting Pulse Response



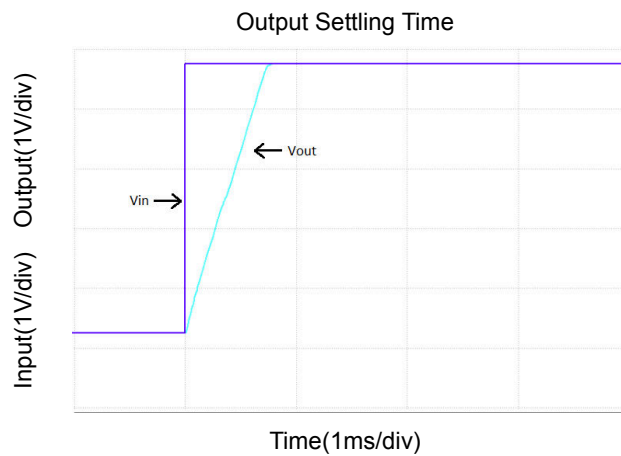
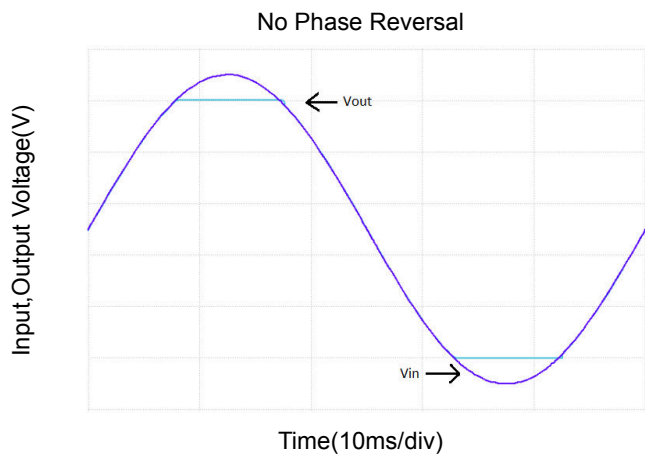
Small Signal Non-Inverting Pulse Response



Time(10ms/div)

## Typical Performance characteristics

At  $T_A=+25^{\circ}\text{C}$ ,  $V_S=+5\text{V}$ , and  $R_L=100\text{K}\Omega$  connected to  $V_S/2$ , unless otherwise noted.



## Application Note

### Size

HM804X family series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the HM804X family packages save space on printed circuit boards and enable the design of smaller electronic products.

### Power Supply Bypassing and Board Layout

HM804X family series operates from a single 1.4V to 5.5V supply or dual  $\pm 0.7V$  to  $\pm 2.75V$  supplies. For best performance, a 0.1 $\mu F$  ceramic capacitor should be placed close to the  $V_{DD}$  pin in single supply operation. For dual supply operation, both  $V_{DD}$  and  $V_{SS}$  supplies should be bypassed to ground with separate 0.1 $\mu F$  ceramic capacitors.

### Low Supply Current

The low supply current (typical 600nA per channel) of HM804X family will help to maximize battery life. They are ideal for battery powered systems.

### Operating Voltage

HM804X family operates under wide input supply voltage (1.4V to 5.5V). In addition, all temperature specifications apply from  $-40^{\circ}C$  to  $+125^{\circ}C$ . Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

### Rail-to-Rail Input

The input common-mode range of HM804X family extends 100mV beyond the supply rails ( $V_{SS}-0.1V$  to  $V_{DD}+0.1V$ ). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

### Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of HM804X family can typically swing to less than 50mV from supply rail in light resistive loads ( $>50k\Omega$ ).

### Capacitive Load Tolerance

The HM804X family is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 2. shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

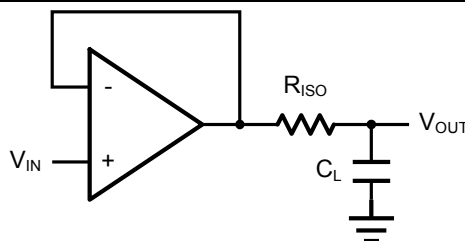


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the  $R_{ISO}$  resistor value, the more stable  $V_{OUT}$  will be. However, if there is a resistive load  $R_L$  in parallel with the capacitive load, a voltage divider (proportional to  $R_{ISO}/R_L$ ) is formed, this will result in a gain error.

The circuit in Figure 3 is an improvement to the one in Figure 2.  $R_F$  provides the DC accuracy by feed-forward the  $V_{IN}$  to  $R_L$ .  $C_F$  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 the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of  $C_F$ . This in turn will slow down the pulse response.

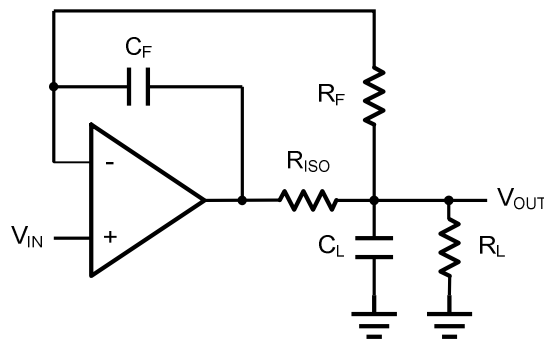


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

## Typical Application Circuits

### Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 4. shown the differential amplifier using HM804X family.

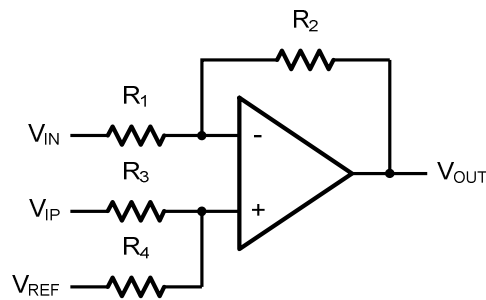


Figure 4. Differential Amplifier

$$V_{OUT} = \left( \frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_4}{R_1} V_{IN} - \frac{R_2}{R_1} V_{IP} + \left( \frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_3}{R_1} V_{REF}$$

If the resistor ratios are equal (i.e.  $R_1 = R_3$  and  $R_2 = R_4$ ), then

$$V_{OUT} = \frac{R_2}{R_1} (V_{IP} - V_{IN}) + V_{REF}$$

### Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by  $-R_2/R_1$ . The filter has a -20dB/decade roll-off after its corner frequency  $f_c = 1/(2\pi R_3 C_1)$ .

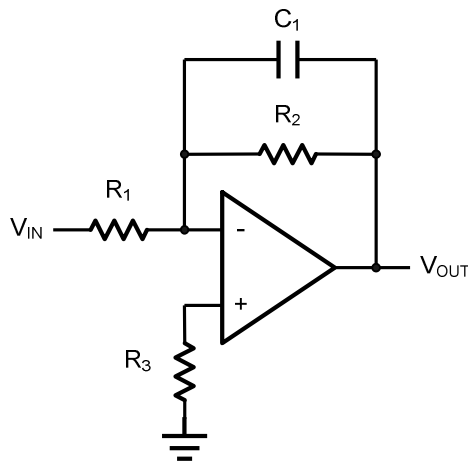


Figure 5. Low Pass Active Filter



### Instrumentation Amplifier

The triple HM804X family can be used to build a three-op-amp instrumentation amplifier as shown in Figure 6. The amplifier in Figure 6 is a high input impedance differential amplifier with gain of  $R_2/R_1$ . The two differential voltage followers assure the high input impedance of the amplifier.

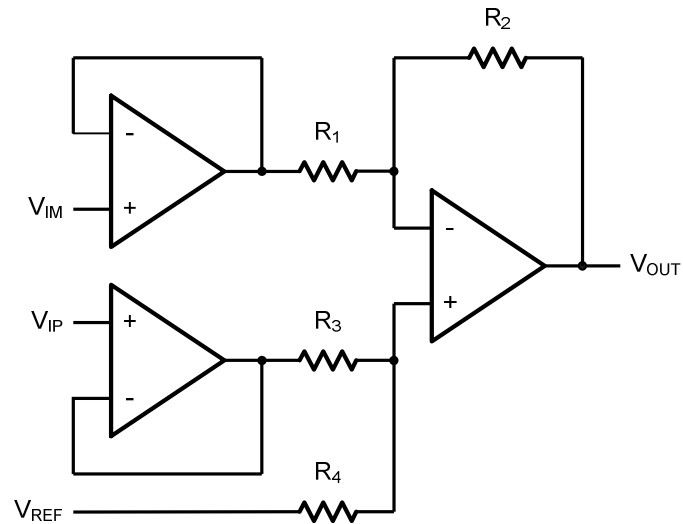
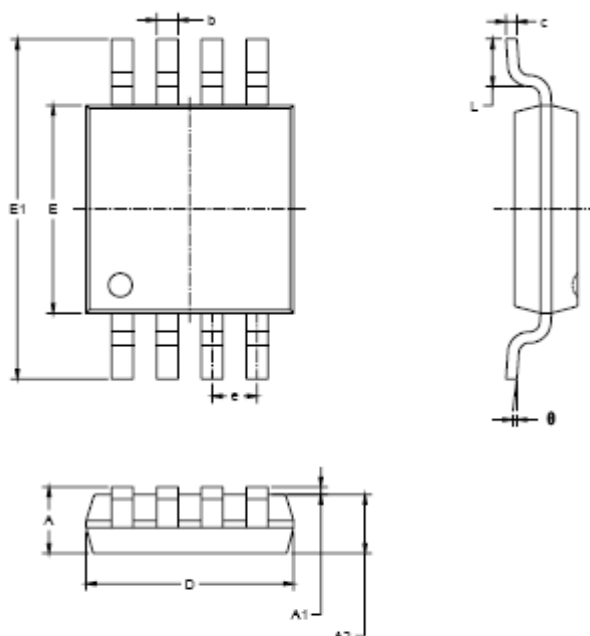


Figure 6. Instrument Amplifier

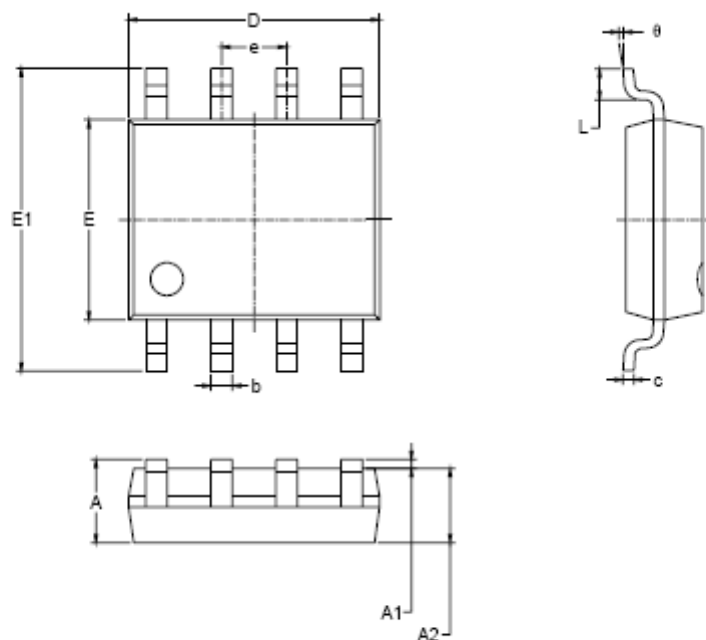
## Package Information

### MSOP-8



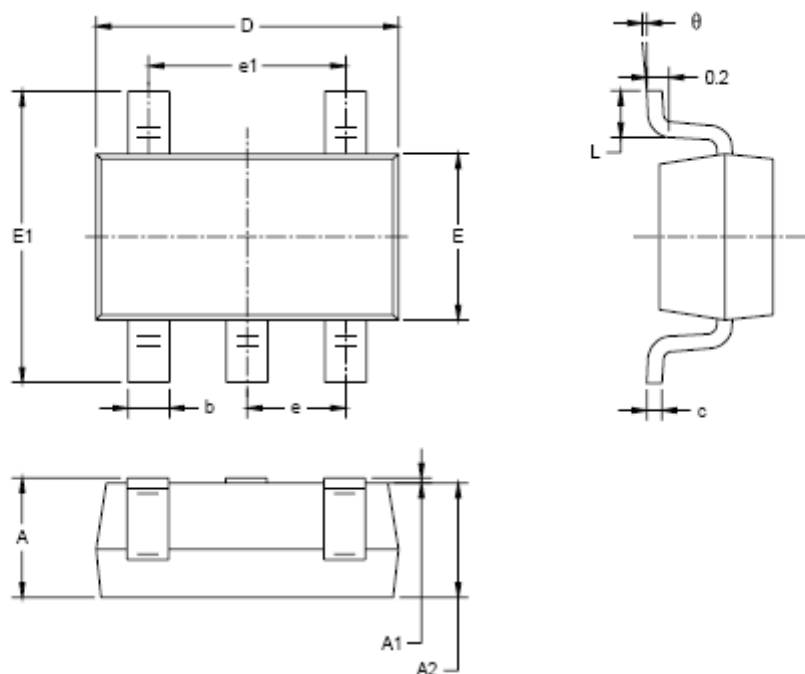
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

**SOP-8**



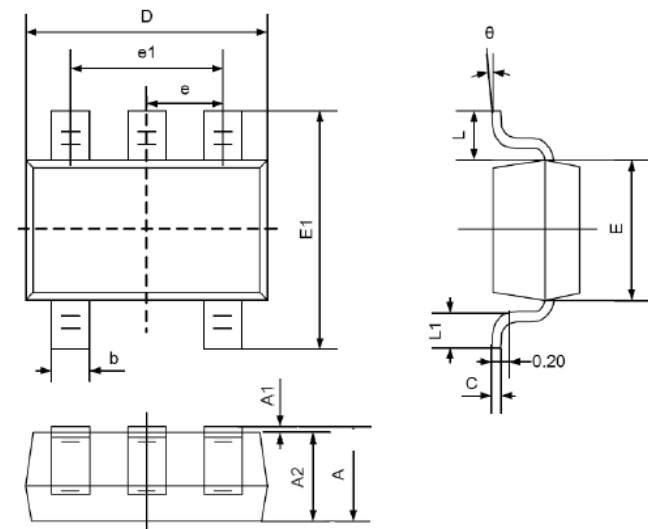
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

**SOT23-5**



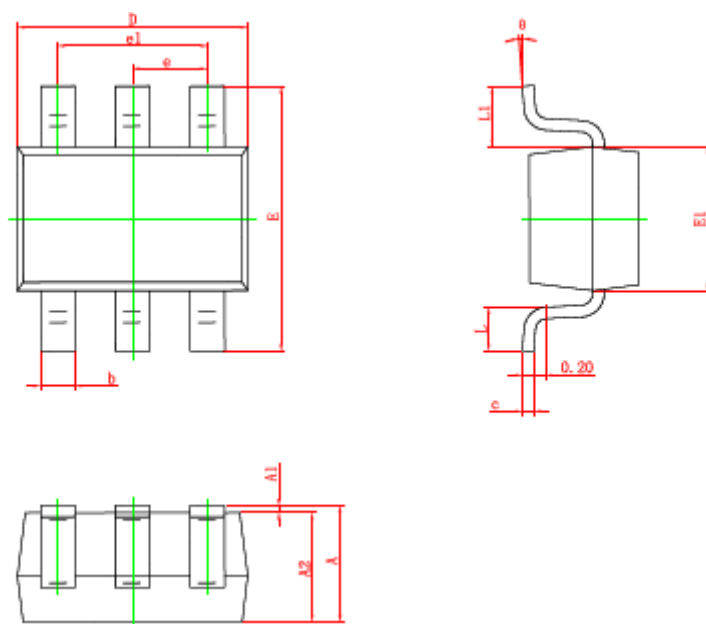
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
$\theta$	0°	8°	0°	8°

SC70-5



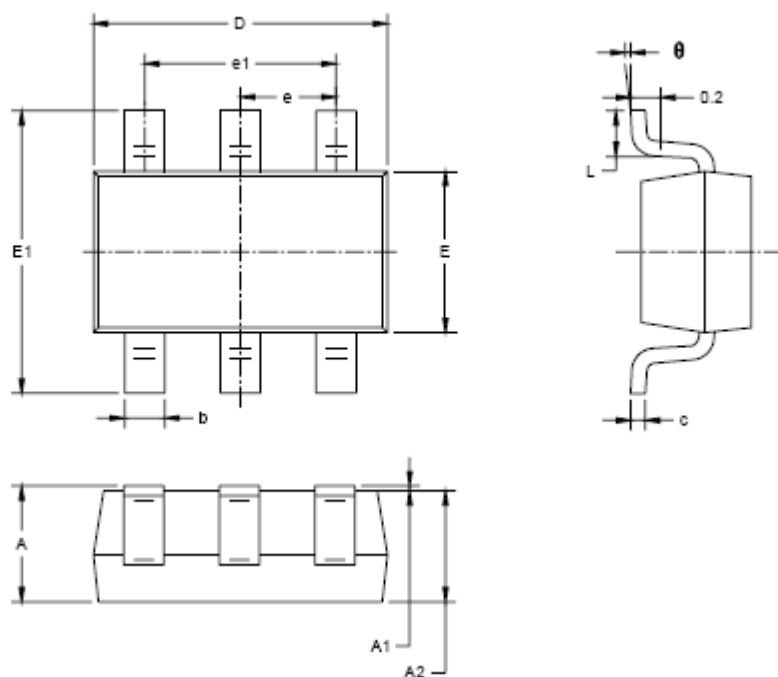
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
e1	1.200	1.400	0.047	0.055
L	0.525REF		0.021REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

SC70-6



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 TYP.		0.026 TYP.	
e1	1.200	1.400	0.047	0.055
L	0.260	0.460	0.010	0.018
L1	0.525 REF.		0.021 REF.	
$\theta$	0°	8°	0°	8°

**SOT23-6**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°