

## Features

- Single-Supply Operation from +2.5V ~ +5.5V
- Rail-to-Rail Output
- -3dB Bandwidth(G=+1): 350MHz (Typ.)
- Low Input Bias Current: 1pA (Typ.)
- Quiescent Current: 4.2mA/Amplifier (Typ.)
- Operating Temperature: -40°C ~ +125°C
- Small Package:

CBM8091 Available in SOT23-5 and SC70-5 Packages

CBM8092 Available in SOP-8 and MSOP-8 Packages

CBM8094 Available in SOP-14 and TSSOP-14 Packages

CBM8091N Available in SOT23-6 and SC70-6 Packages

CBM8092N Available in MSOP-10 Packages

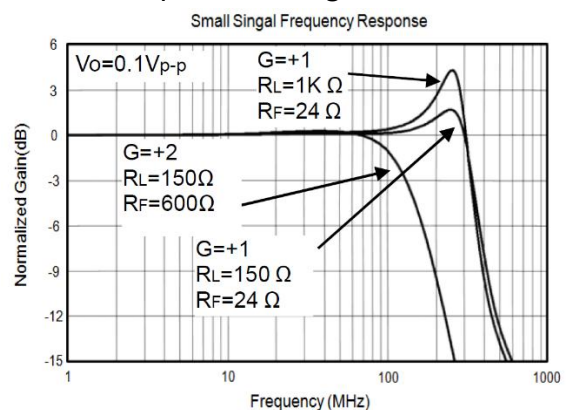
## Application

- Imaging
- Photodiode Preamp
- DVD/CD
- Filters
- Professional Video and Cameras
- Hand Sets
- Base Stations
- to-D Driver

## Description

The CBM8091/1N(single), CBM8092/2N(dual), CBM8094(quad) are rail-to-rail output voltage feedback amplifiers offering ease of use and low cost. They have bandwidth and slew rate typically found in current feedback amplifiers. All have a wide input common-mode voltage range and output voltage swing, making them easy to use on single supplies as low as 2.5V. Despite being low cost, the CBM8091 series provide excellent overall performance. They offer wide bandwidth to 350MHz (G = +1) along with 0.1dB flatness out to 58MHz (G = +2) and offer a typical low power of 4.2mA/amplifier.

The CBM8091 series is low distortion and fast settling make it ideal for buffering high speed A/D or D/A converters. The CBM8091/2N has a power-down disable feature that reduces the supply current to 75μA. These features make the CBM8091/2N ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended -40°C to +125°C temperature range.



## PIN CONFIGURATIONS

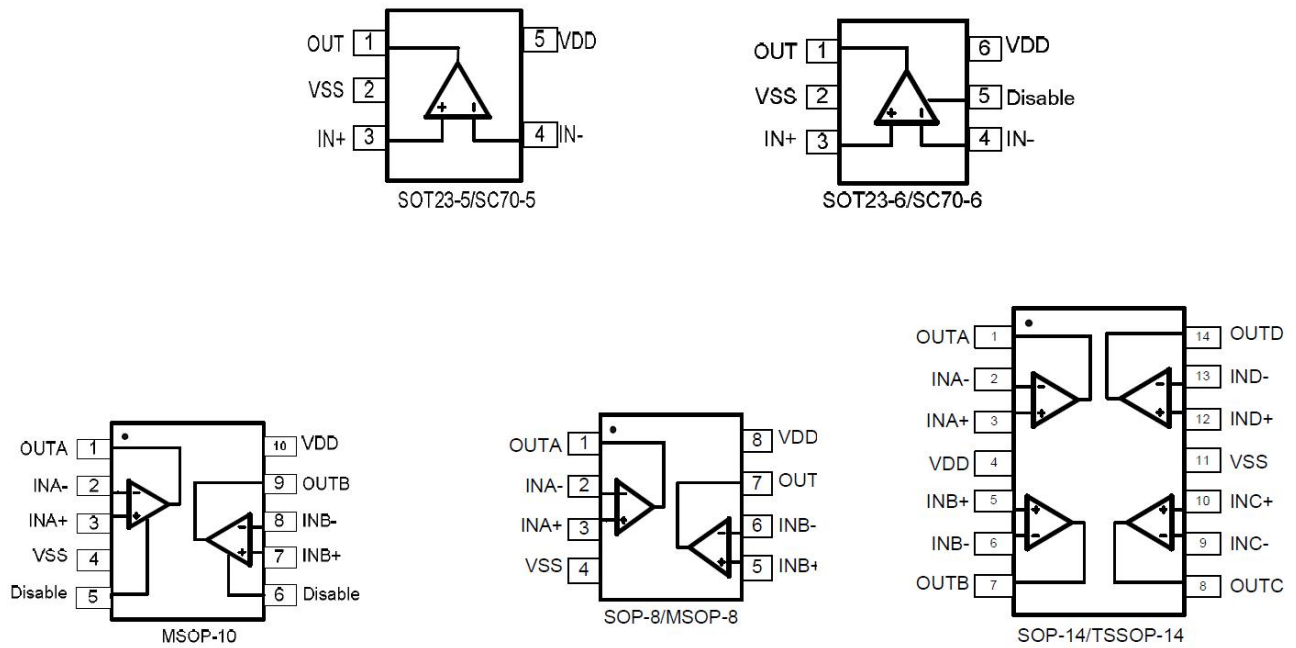


Figure 1. Pin Assignment Diagram

**ABSOLUTE MAXIMUM RATINGS**

Condition	Min	Max
Power Supply Voltage ( $V_{DD}$ to $V_{SS}$ )	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	$V_{SS}-0.5V$	$V_{DD}+0.5V$
PDB Input Voltage	$V_{SS}-0.5V$	+7V
Operating Temperature Range	-45°C	+125°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+260°C	
<b>Package Thermal Resistance (TA= +25°C)</b>		
SOP-8, $\theta_{JA}$	125°C/W	
MSOP-8, $\theta_{JA}$	216°C/W	
SOT23-5, $\theta_{JA}$	190°C/W	
SOT23-6, $\theta_{JA}$	190°C/W	
SC70-5, $\theta_{JA}$	333°C/W	
<b>ESD Susceptibility</b>		
HBM	6KV	
MM	400V	

**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.

## ELECTRICAL CHARACTERISTICS

(G= +2, R<sub>F</sub>=600Ω, R<sub>G</sub>=600Ω, and R<sub>L</sub>=150Ω connected to V<sub>S</sub>/2, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.)

PARAMETER	CONDITIONS	CBM8091-CBM8092-CBM8094-CBM8091N-CBM8092N						
		TYP	MIN/MAX OVER TEMPERATURE					
		+25°C	+25°C	0°C to 70°C	-40°C to 85°C	-40°C to 125°C	UNITS	MIN/ MAX
<b>DYNAMIC PERFORMANCE</b>								
3dB Small Signal Bandwidth	G = +1, V <sub>o</sub> = 0.1Vp-p, R <sub>F</sub> =24Ω, R <sub>L</sub> =150Ω	335					MHz	TYP
	G = +1, V <sub>o</sub> = 0.1Vp-p, R <sub>F</sub> =24Ω, R <sub>L</sub> = 1kΩ	330					MHz	TYP
	G = +2, V <sub>o</sub> = 0.1V p-p, R <sub>L</sub> = 50Ω	79					MHz	TYP
	G = +2, V <sub>o</sub> = 0.1V p-p, R <sub>L</sub> = 150Ω	130					MHz	TYP
	G = +2, V <sub>o</sub> = 0.1V p-p, R <sub>L</sub> = 1kΩ	165					MHz	TYP
	G = +2, V <sub>o</sub> = 0.1V p-p, R <sub>L</sub> = 10kΩ	172					MHz	TYP
Gain-Bandwidth Product	G = +10, R <sub>L</sub> = 150Ω	180					MHz	TYP
	G = +10, R <sub>L</sub> = 1kΩ	195					MHz	TYP
Bandwidth for 0.1dB Flatness	G = +2, V <sub>o</sub> = 0.1V p-p, R <sub>L</sub> =150Ω, R <sub>F</sub> =600Ω	71					MHz	TYP
Slew Rate	G = +1, 2V Output Step	119/-232					V/μs	TYP
	G = +2, 2V Output Step	135/-180					V/μs	TYP
	G = +2, 4V Output Step	142/-206					V/μs	TYP
Rise-and-Fall Time	G = +2, V <sub>o</sub> = 0.2Vp-p, 10% to 90%	3.5					ns	TYP
	G = +2, V <sub>o</sub> = 2Vp-p, 10% to 90%	8.5					ns	TYP
Settling Time to 0.1%	G = +2, 2V Output Step	35					ns	TYP
Overload Recovery Time	V <sub>IN</sub> ·G = +VS	14.5					ns	TYP
<b>NOISE/DISTORTION PERFORMANCE</b>								
Input Voltage Noise	f = 1MHz	4.3					nV/Hz	TYP
Differential Gain Error (NTSC)	G = +2, R <sub>L</sub> = 150Ω	0.004					%	TYP
Differential Phase Error (NTSC)	G = +2, R <sub>L</sub> = 150Ω	0.08					degree	TYP

DC PERFORMANCE								
Input Offset Voltage ( $V_{OS}$ )		$\pm 2$	$\pm 8$	$\pm 8.5$	$\pm 9$	$\pm 9.3$	mV	MAX
Input Offset Voltage Drift		2					$\mu V/^{\circ}C$	TYP
Input Bias Current ( $I_B$ )		1					PA	TYP
Input offset Current ( $I_{OS}$ )		2					PA	TYP
Open-Loop Gain ( $A_{OL}$ )	$V_O = 0.3V$ to $4.7V$ , $R_L = 150\Omega$	80	75	74	74	70	dB	MIN
	$V_O = 0.2V$ to $4.8V$ , $R_L = 1k\Omega$	104	91	91	91	80	dB	MIN
INPUT CHARACTERISTICS								
Input Common-Mode Voltage Range ( $V_{CM}$ )		-0.2 to +3.8						
Common-Mode Rejection Ratio (CMRR)	$V_{CM} = -0.1V$ to $+3.5V$	80	66	65	65	62	V dB	TYP MIN

## Electrical Performance Characteristics

( $G = +2$ ,  $R_F = 600\Omega$ ,  $R_G = 600\Omega$ , and  $R_L = 150\Omega$  connected to  $V_S/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .)

PARAMETER	CONDITIONS	CBM8091-CBM8092-CBM8094-CBM8091N-CBM8092N							
		TYP	MIN/MAX OVER TEMPERATURE					UNITS	MIN/ MAX
		+25°C	+25°C	0°C to 70°C	-40°C to 85°C	-40°C to 125°C			
<b>OUTPUT CHARACTERISTICS</b>									
Output Voltage Swing from Rail	RL = 150Ω	0.12						V	TYP
	RL = 1kΩ	0.03						V	TYP
Output Current		120	100	98	93	87		mA	MIN
Closed-Loop Output Impedance	f < 100kHz	0.045						Ω	TYP
<b>POWER-DOWN DISABLE</b>									
(CBM8091/2N only)									
Turn-On Time		108						ns	TYP
Turn-Off Time		60						ns	TYP
DISABLE Voltage-Off			0.8					V	MAX
DISABLE Voltage-On			2					V	MIN
<b>POWER SUPPLY</b>									
Operating Voltage Range			2.5	2.7	2.7	2.7		V	MIN
			5.5	5.5	5.5	5.5		V	MAX
Quiescent Current (per amplifier)		4.2	5.3	5.6	5.7	6.1		mA	MAX
Supply Current when Disabled per amplifier (CBM8091/2N only)		75	120	130	132	137		μA	MAX
Power Supply Rejection Ratio (PSRR)	$\Delta V_S = +2.7\text{V to } +5.5\text{V}$ , $V_{CM} = (-V_S) + 0.5$	80	67	67	65	62		dB	MIN

## TYPICAL CHARACTERISTICS

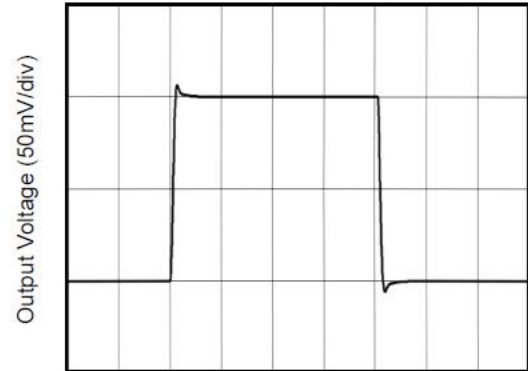
( $V_s = +5V, G = +2, R_f = 600\Omega, R_g = 600\Omega,$  and  $R_L = 150\Omega$  connected to  $V_s/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .)

Non-Inverting Large-Signal Step Response



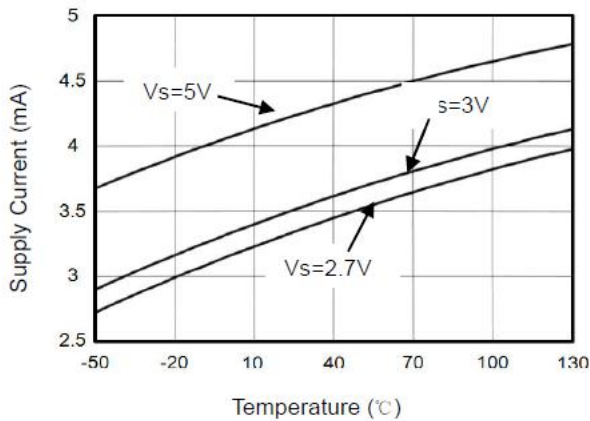
Time (50ns/div)

Non-Inverting Small-Signal Step Response



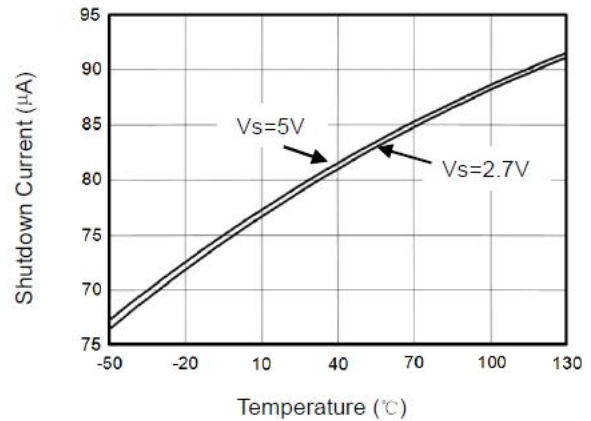
Time (50ns/div)

Supply Current vs. Temperature



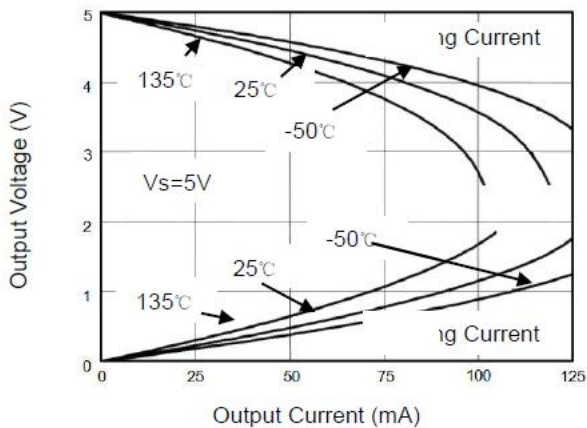
Temperature ( $^\circ\text{C}$ )

Shutdown Current vs. Temperature



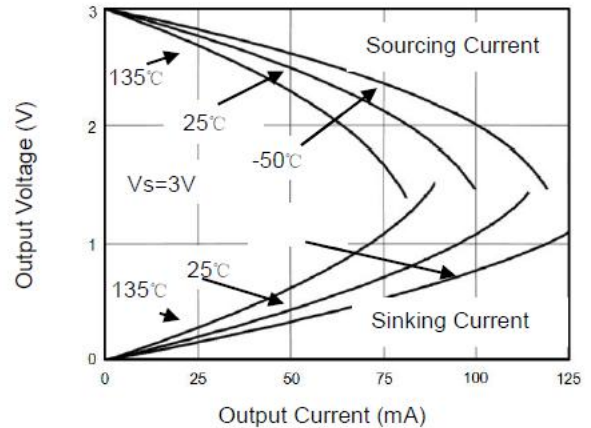
Temperature ( $^\circ\text{C}$ )

Output Voltage Swing vs. Output Current



Output Current (mA)

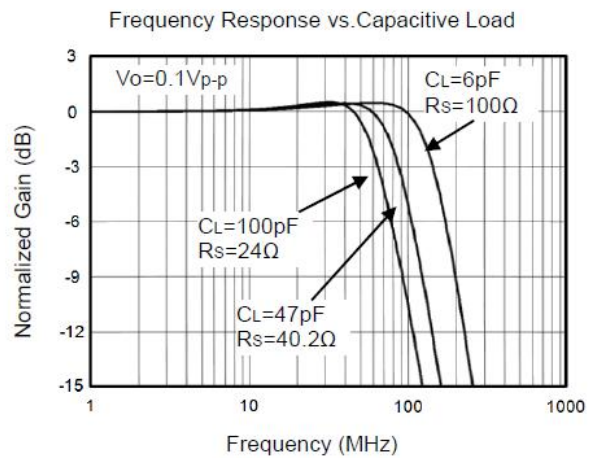
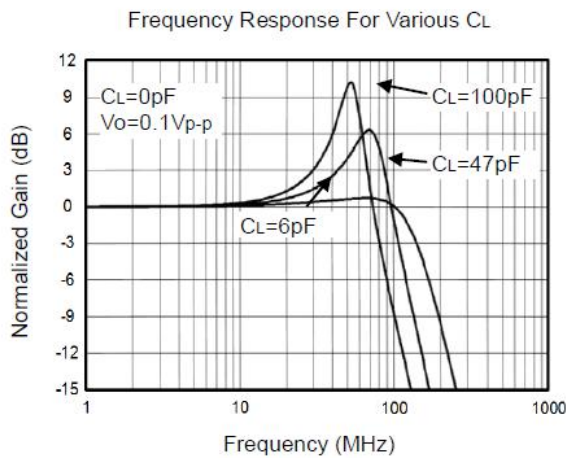
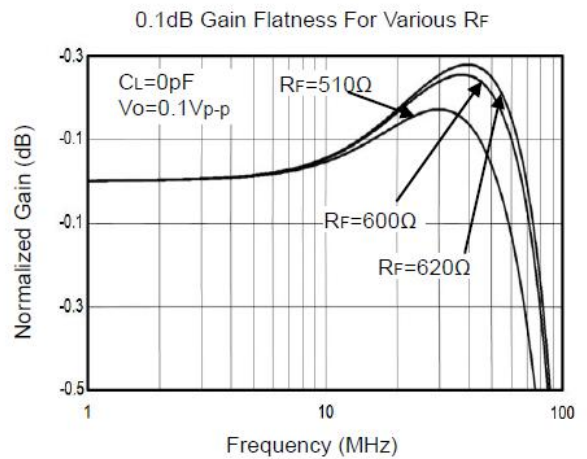
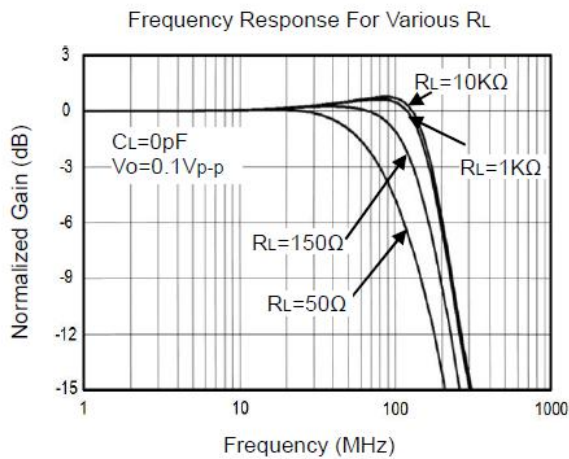
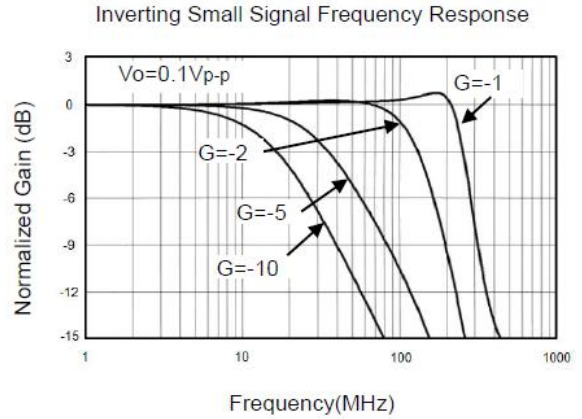
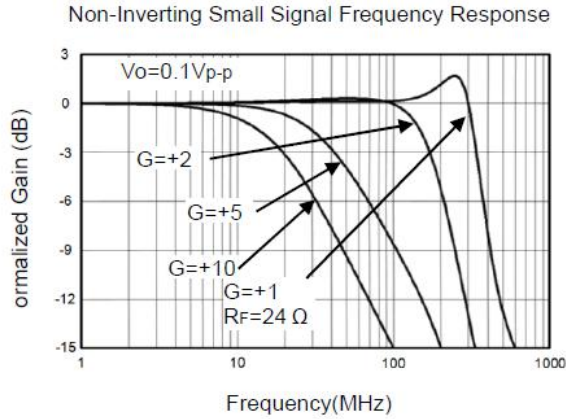
Output Voltage vs. Output Current



Output Current (mA)

## TYPICAL CHARACTERISTICS

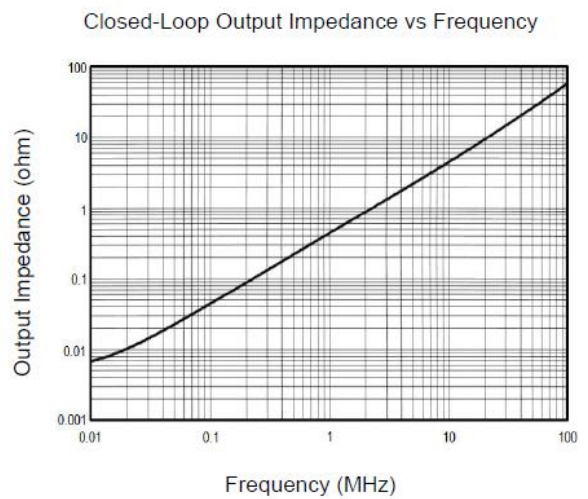
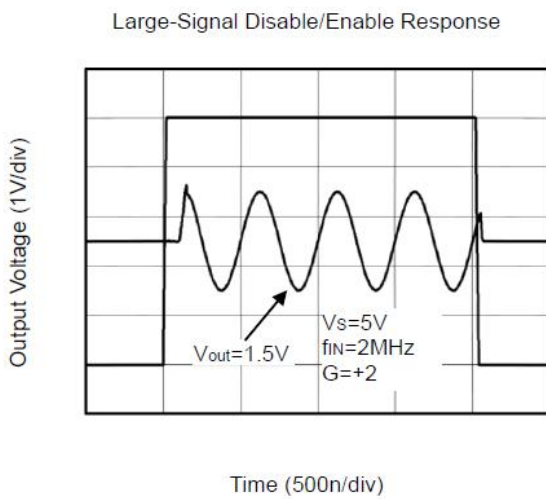
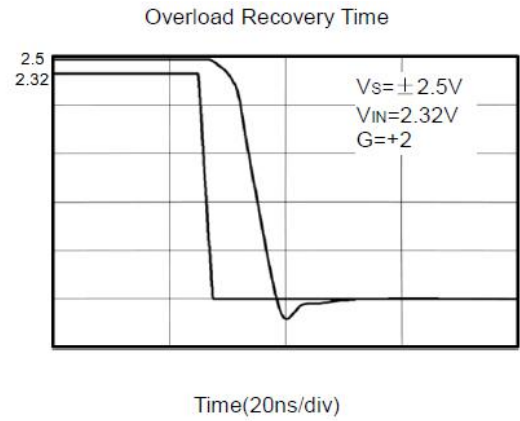
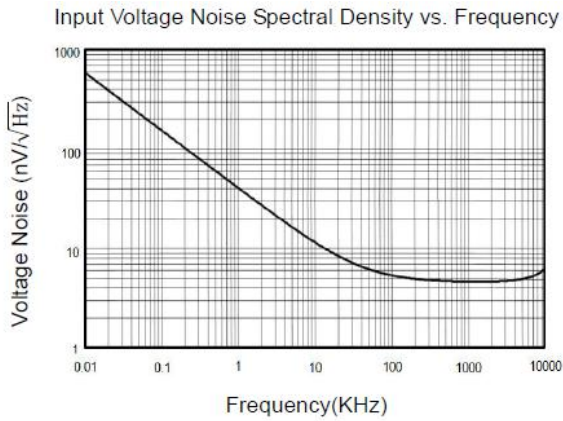
( $V_s = +5V, G = +2, R_F = 600\Omega, R_G = 600\Omega,$  and  $R_L = 150\Omega$  connected to  $V_s/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .)





## TYPICAL CHARACTERISTICS

( $V_s = +5V, G = +2, R_F = 600\Omega, R_G = 600\Omega,$  and  $R_L = 150\Omega$  connected to  $V_s/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .)



### APPLICATION NOTES

#### Size

CBM809X series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the CBM809X series packages save space on printed circuit boards and enable the design of smaller electronic products.

#### Power Supply Bypassing and Board Layout

CBM809X series operates from a single 2.5V to 5.5V supply or dual  $\pm 1.25\text{V}$  to  $\pm 2.75\text{V}$  supplies. For best performance, a  $0.1\mu\text{F}$  ceramic capacitor should be placed close to the VDD pin in single supply operation. For dual supply operation, both VDD and VSS supplies should be bypassed to ground with separate  $0.1\mu\text{F}$  ceramic capacitors.

#### Low Supply Current

The low supply current (typical 4.2mA per channel) of CBM809X series will help to maximize battery life. They are ideal for battery powered systems.

#### Operating Voltage

CBM809X series operate under wide input supply voltage (2.5V to 5.5V). In addition, all temperature specifications apply from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

#### Rail-to-Rail 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 CBM809X series can typically swing to less than 30mV from supply rail in light resistive loads ( $>1\text{k}\Omega$ ), and 120mV of supply rail in moderate resistive loads ( $150\Omega$ ).

#### Capacitive Load Tolerance

The CBM809X 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.

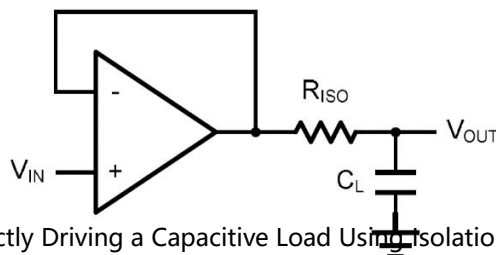


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

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.

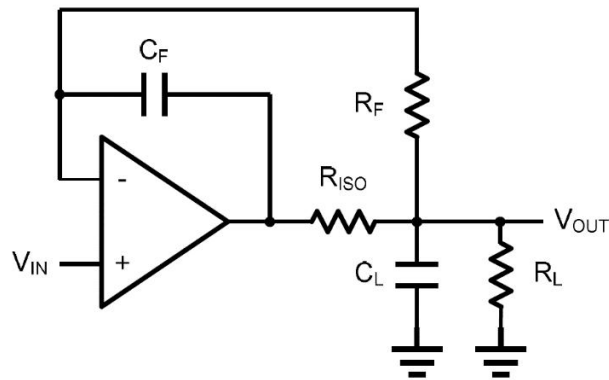


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

## Typical Application Circuits

### Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common to 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 CBM809X.

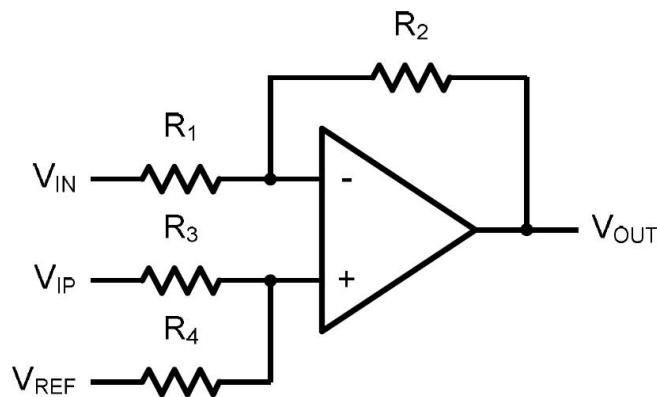


Figure 4. Differential Amplifier

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

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  $f_c=1/(2\pi R_3C_1)$ .

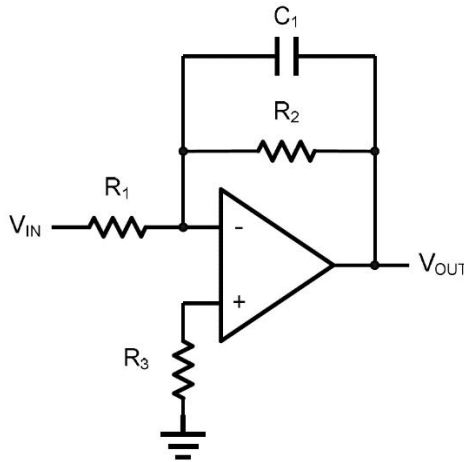


Figure 5. Low Pass Active Filter

**Driving Video**

The CBM809X can be used in video applications like in Figure 6.

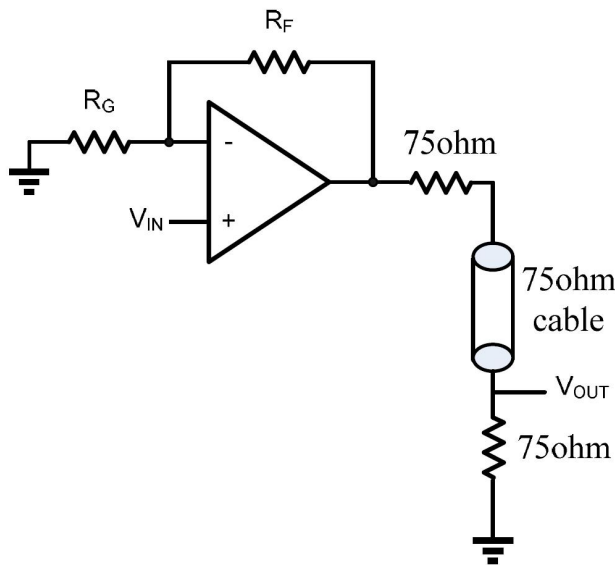
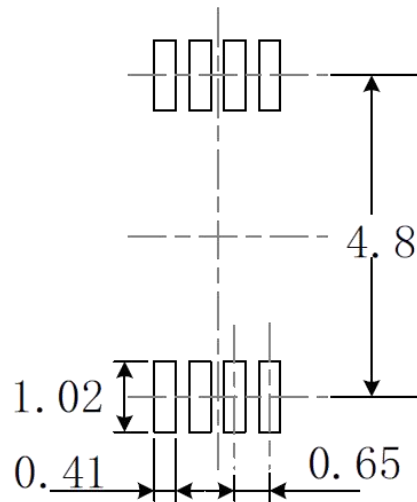
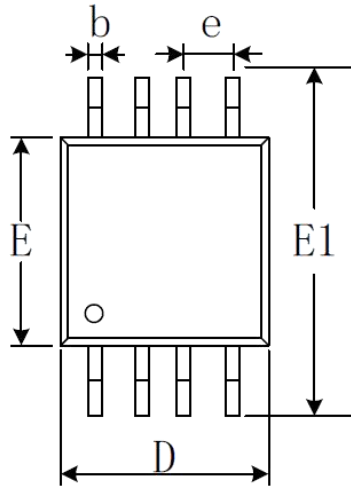


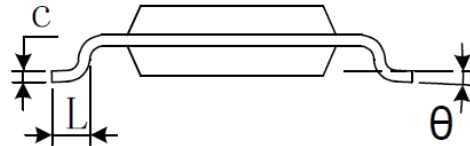
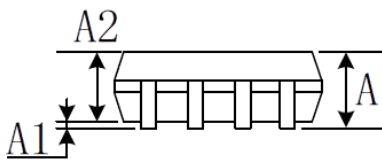
Figure 6. Typical video driving

## Package Information

### MSOP-8

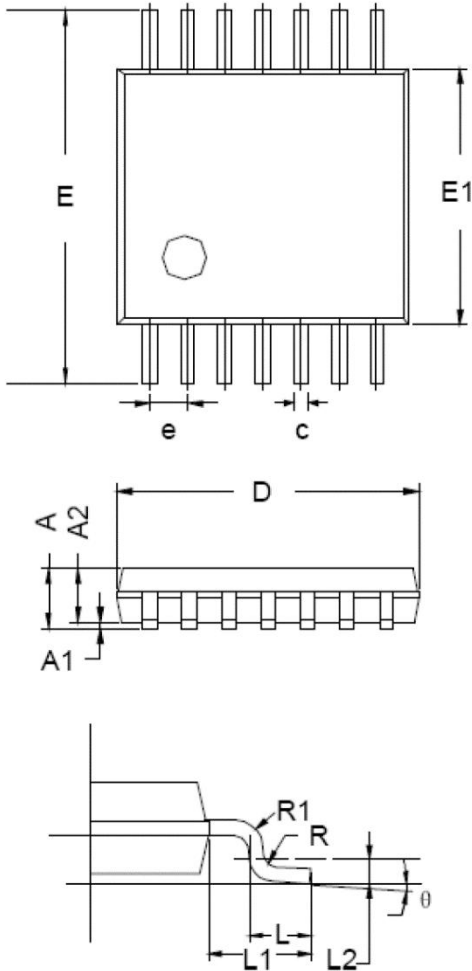


RECOMMENDED LAND PATTERN (Unit: mm)



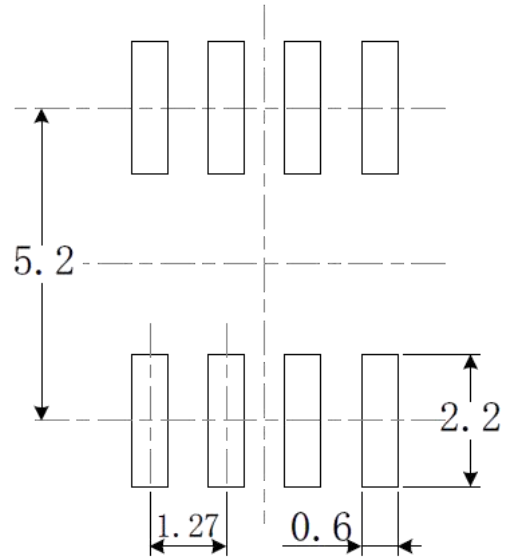
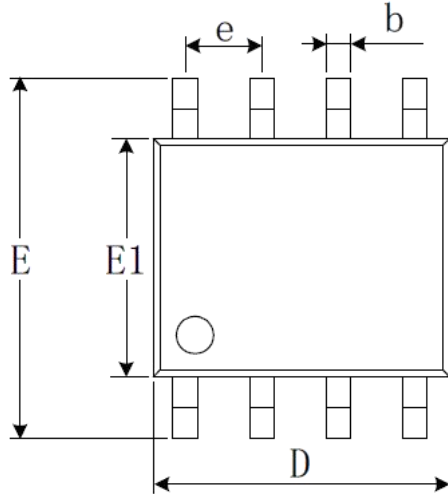
Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC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

## TSSOP-14

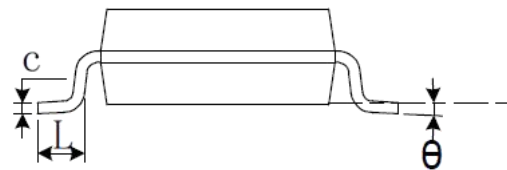
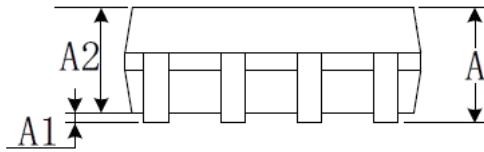


Symbol	Dimensions In Millimeters		
	Min	TYP	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
b	0.20	-	0.28
c	0.10	-	0.19
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.650 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
$\theta$	0°	-	8°

SOP8

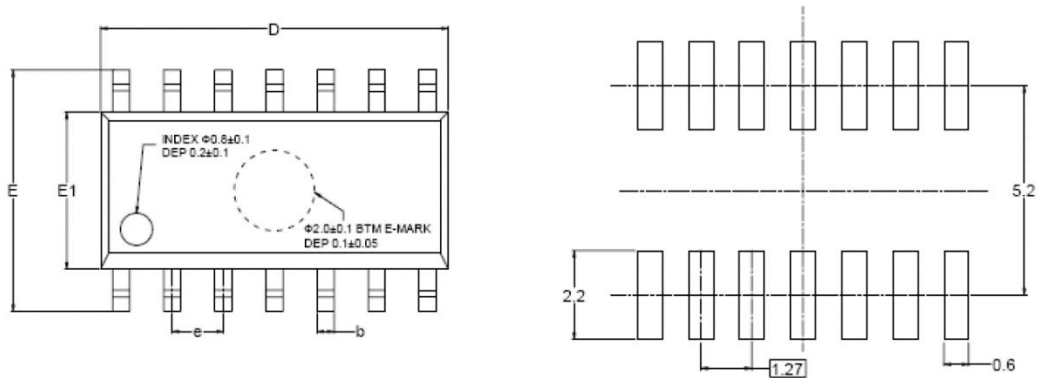


RECOMMENDED LAND PATTERN (Unit: mm)

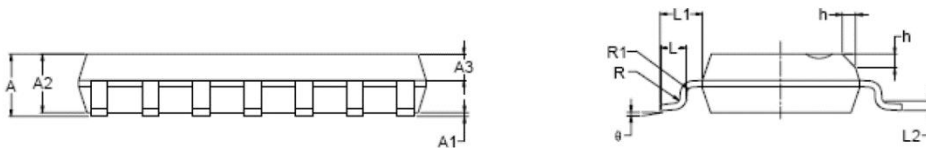


Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 BSC		0.050 BSC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

SOP14



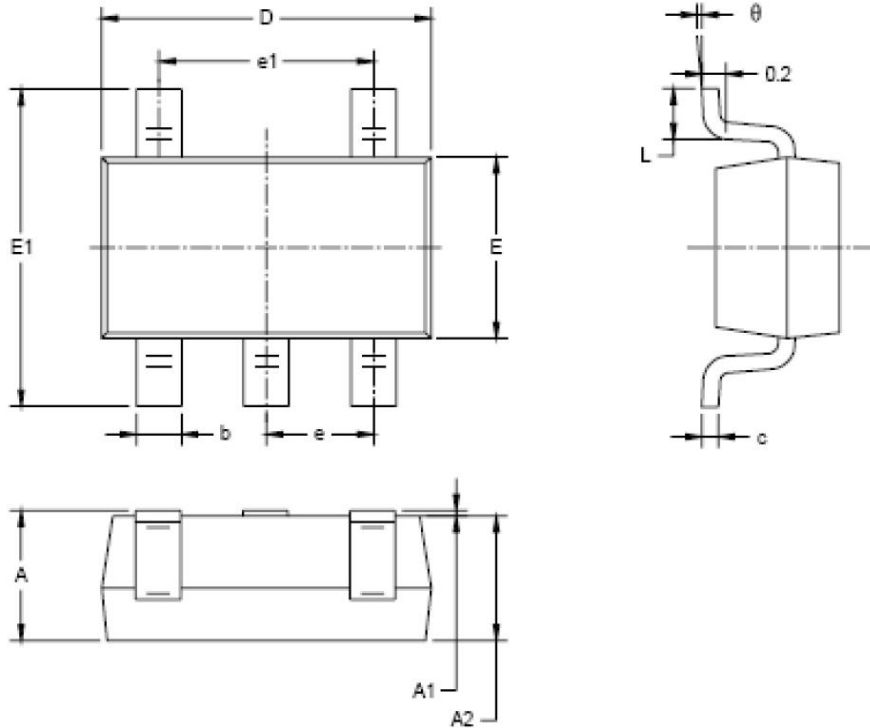
RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.250	1.650	0.049	0.065
A3	0.550	0.750	0.022	0.030
b	0.360	0.490	0.014	0.019
D	8.530	8.730	0.336	0.344
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	0.450	0.800	0.018	0.032
L1	1.040 REF		0.040 REF	
L2	0.250 BSC		0.010 BSC	
R	0.070		0.003	
R1	0.070		0.003	
h	0.300	0.500	0.012	0.020
$\theta$	0°	8°	0°	8°

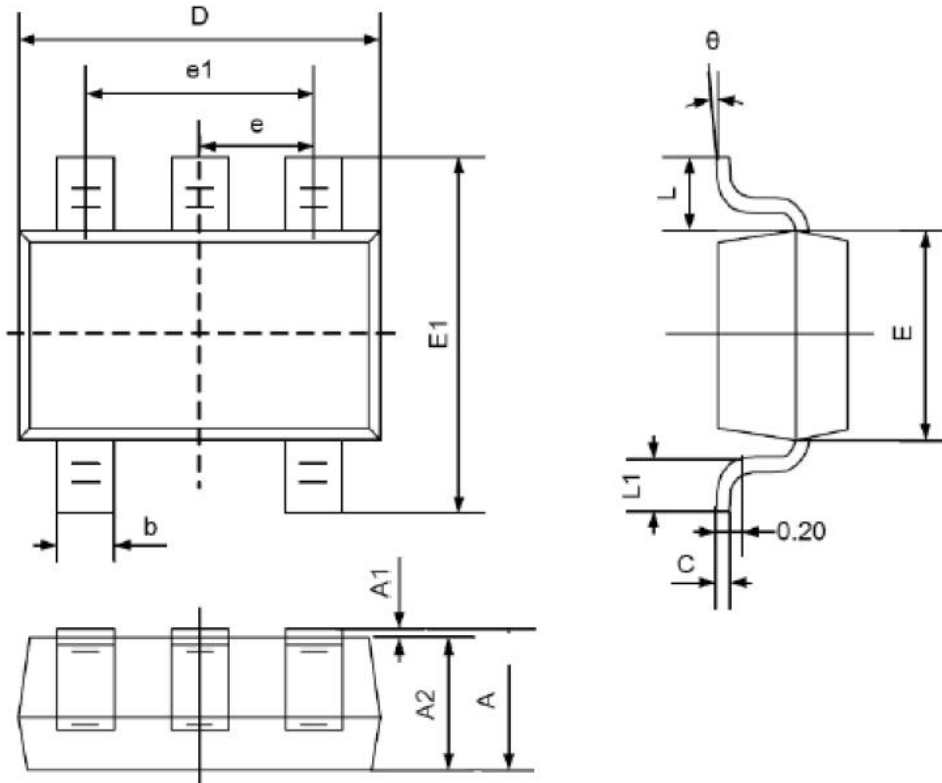


SOT23-5



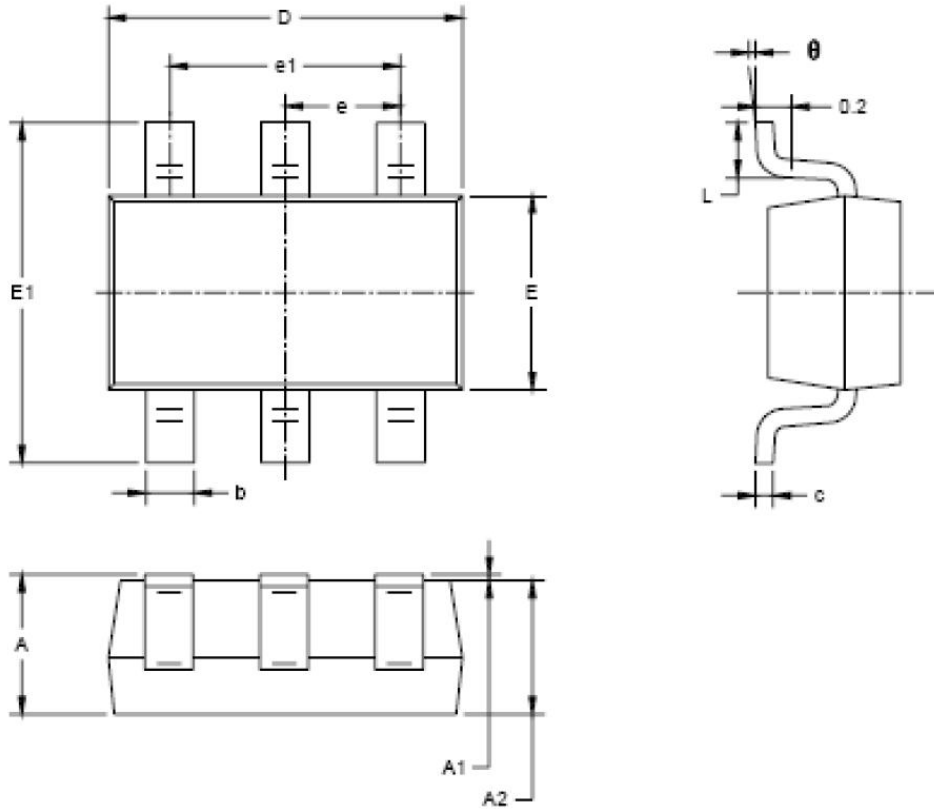
Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC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

SC70-5



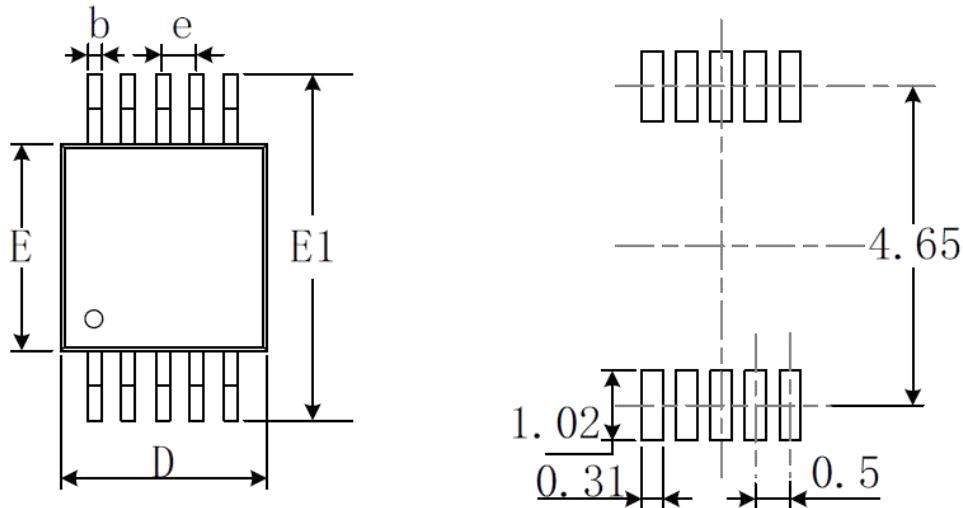
Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650 TYP		0.026TYP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

SOT23-6

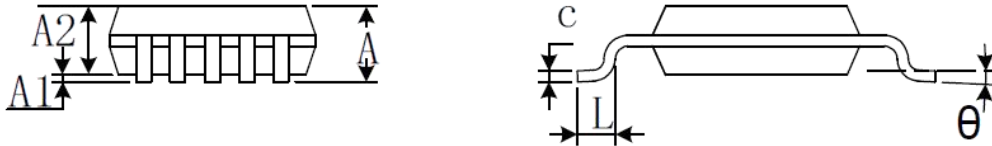


Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC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

MSOP-10



RECOMMENDED LAND PATTERN (Unit: mm)



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	0.180	0.280	0.007	0.011
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	0.500 BSC		0.020 BSC	
L	0.400	0.800	0.016	0.031
$\theta$	0°	6°	0°	6°

## PACKAGE/ORDERING INFORMATION

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
CBM8091	Single	CBM8091AC5	SC70-5	Tape and Reel,3000	8091
		CBM8091AST5	SOT23-5	Tape and Reel,3000	8091
CBM8092	Dual	CBM8092AS8	SOP-8	Tape and Reel,4000	CBM8092
		CBM8092AMS8	MSOP-8	Tape and Reel,3000	CBM8092
CBM8094	Quad	CBM8094ATS14	TSSOP-14	Tape and Reel,3000	CBM8094
		CBM8094AS14	SOP-14	Tape and Reel,2500	CBM8094
CBM8091N	Single With shutdown	CBM8091NC6	SC70-6	Tape and Reel,3000	8091N
		CBM8091NST6	SOT23-6	Tape and Reel,3000	8091N
CBM8092N	Dual With shutdown	CBM8092NMS10	MSOP-10	Tape and Reel,2500	CBM8092N

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