

## Features

- Single-Supply Operation from +1.8V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 1.8MHz (Typ. @25°C)
- Low Input Bias Current: 20pA (Typ. @25°C)
- Low Offset Voltage: 30μV (Max. @25°C)
- Quiescent Current: 180μA per Amplifier (Typ)
- Operating Temperature: -45°C ~ +125°C
- Zero Drift: 0.03μV/oC (Typ)
- Embedded RF Anti-EMI Filter
- Small Package:  
CBM8551 Available in SOT23-5 and SOP-8 Packages  
CBM8552 Available in MSOP-8 and SOP-8 Packages  
CBM8554 Available in SOP-14 and TSSOP-14 Packages

## Application

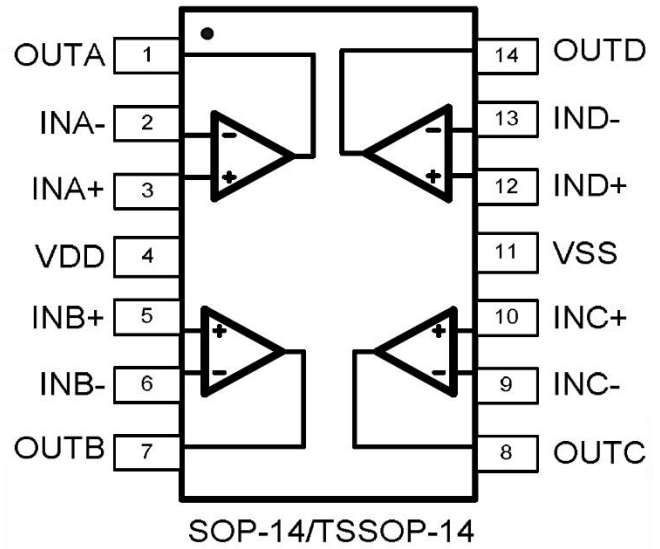
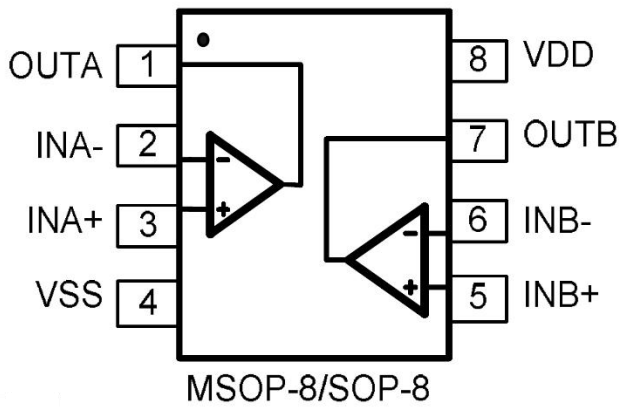
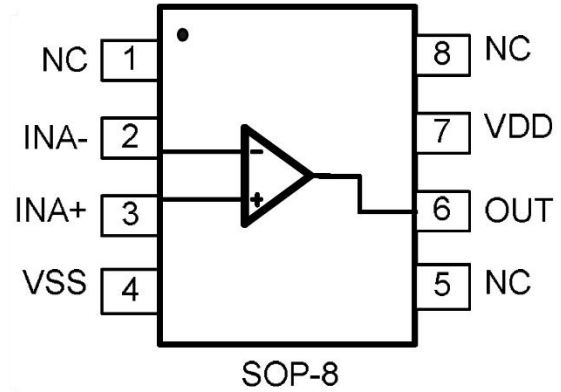
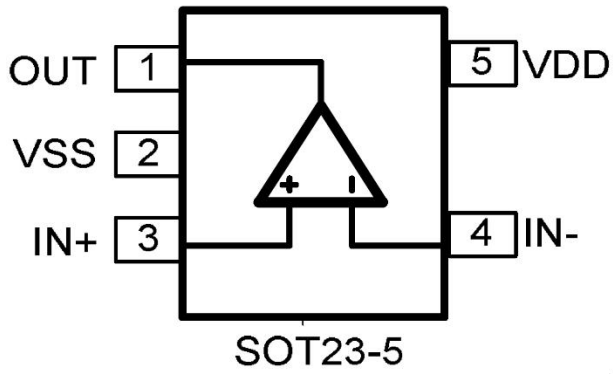
- Transducer Application
- Temperature Measurements
- Electronics Scales
- Handheld Test Equipment
- Battery-Powered Instrumentation

## Description

The CBM855X amplifier is single/dual/quad supply, micro-power, zero-drift CMOS operational amplifiers, the amplifiers offer bandwidth of 1.8MHz, rail-to-rail inputs and outputs, and single-supply operation from 1.8V to 5.5V. CBM855X uses chopper stabilized technique to provide very low offset voltage (less than 5μV maximum) and near zero drift over temperature. Low quiescent supply current of 180μA per amplifier and very low input bias current of 20pA make the devices an ideal choice for low offset, low power consumption and high impedance applications. The CBM855X offers excellent CMRR without the crossover associated with traditional complementary input stages. This design results in superior performance for driving analog-to-digital converters (ADCs) without degradation of differential linearity.

The CBM8551 is available in SOT23-5 and SOP-8 packages. And the CBM8552 is available in MSOP-8 and SOP-8 packages. The CBM8554 Quad is available in Green SOP-14 and TSSOP-14 packages. The extended temperature range of -45°C to +125°C over all supply voltages offers additional design flexibility.

**PIN CONFIGURATIONS**



**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	
<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.


**ESD SENSITIVITY CAUTION**

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.

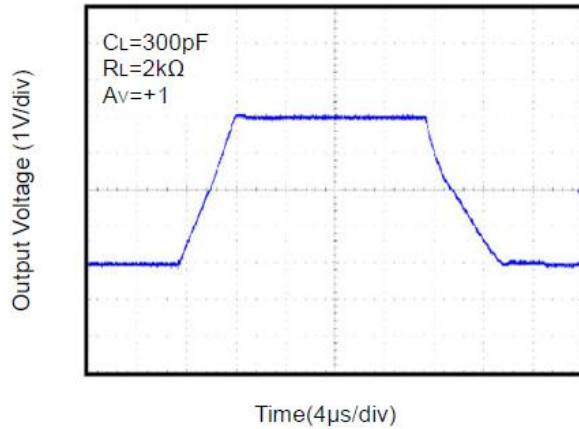
## ELECTRICAL CHARACTERISTICS

$V_S = +5V$ ,  $V_{CM} = +2.5V$ ,  $V_O = +2.5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.

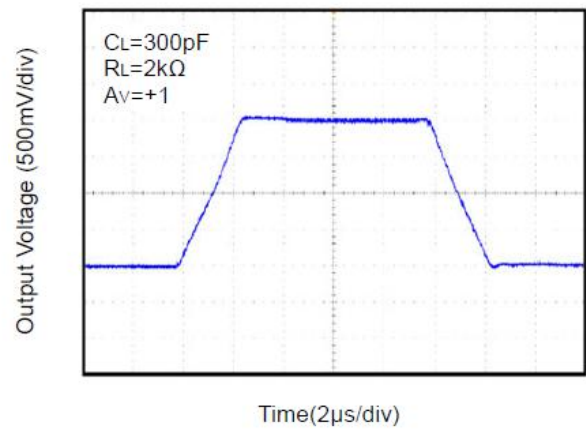
PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
<b>INPUT CHARACTERISTICS</b>					
Input Offset Voltage ( $V_{OS}$ )			1	30	$\mu V$
Input Bias Current ( $I_B$ )			20		$\mu A$
Input Offset Current ( $I_{OS}$ )			10		$\mu A$
Common-Mode Rejection Ratio (CMRR)	$V_{CM} = 0V$ to $5V$		110		dB
Large Signal Voltage Gain ( $A_{VO}$ )	$R_L = 10k\Omega$ , $V_O = 0.3V$ to $4.7V$		145		dB
Input Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ )			30		$nV/^\circ C$
<b>OUTPUT CHARACTERISTICS</b>					
Output Voltage High ( $V_{OH}$ )	$R_L = 100k\Omega$ to $-V_S$		4.998		V
	$R_L = 10k\Omega$ to $-V_S$		4.994		V
Output Voltage Low ( $V_{OL}$ )	$R_L = 100k\Omega$ to $+V_S$		2		mV
	$R_L = 10k\Omega$ to $+V_S$		5		mV
Short Circuit Limit ( $I_{SC}$ )	$R_L = 10\Omega$ to $-V_S$		60		mA
Output Current ( $I_O$ )			65		mA
<b>POWER SUPPLY</b>					
Power Supply Rejection Ratio (PSRR)	$V_S = 2.5V$ to $5.5V$		115		dB
Quiescent Current ( $I_Q$ )	$V_O = 0V$ , $R_L = 0\Omega$		180		$\mu A$
<b>DYNAMIC PERFORMANCE</b>					
Gain-Bandwidth Product (GBP)	$G = +100$		1.8		MHz
Slew Rate (SR)	$R_L = 10k\Omega$		0.95		$V/\mu s$
Overload Recovery Time			0.10		ms
<b>NOISE PERFORMANCE</b>					
Voltage Noise ( $e_n$ p-p)	0Hz to 10Hz		0.3		$\mu V_{p-p}$
Voltage Noise Density ( $e_n$ )	$f = 1kHz$		38		$nV/\sqrt{Hz}$

## TYPICAL CHARACTERISTICS

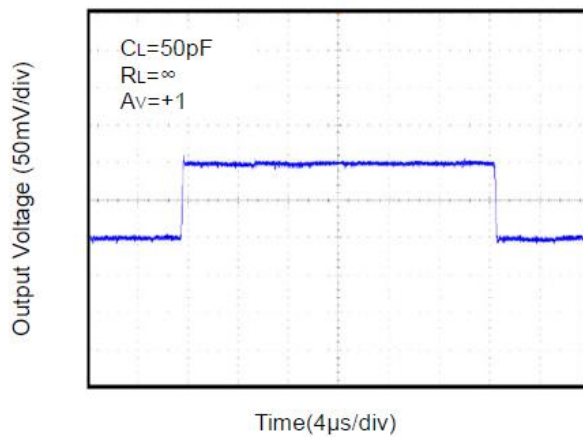
Large Signal Transient Response at +5V



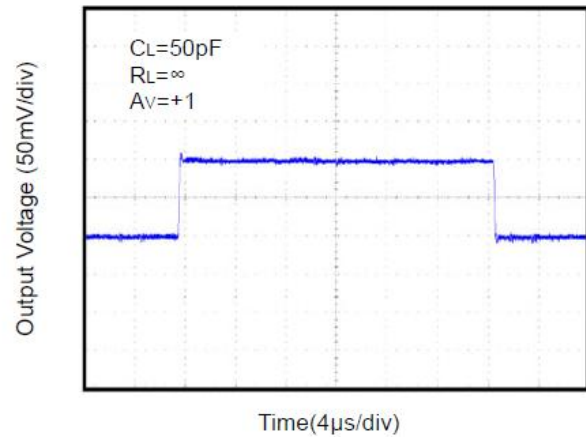
Large Signal Transient Response at +2.5V



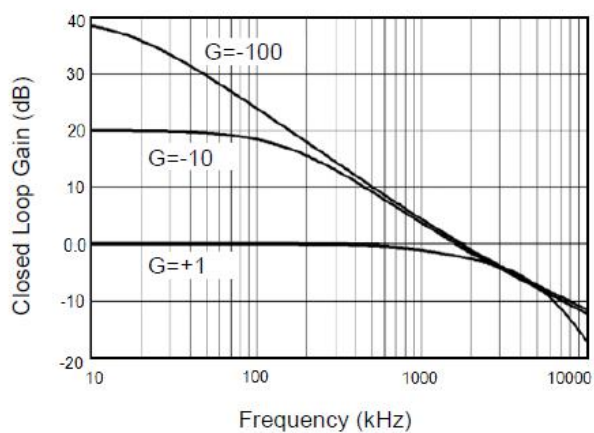
Small Signal Transient Response at +5V



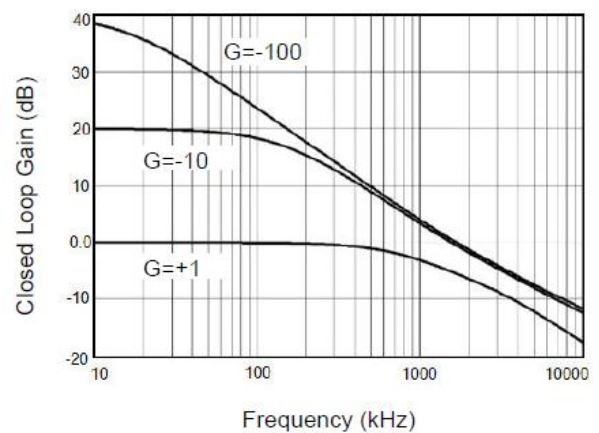
Small Signal Transient Response at +2.5V



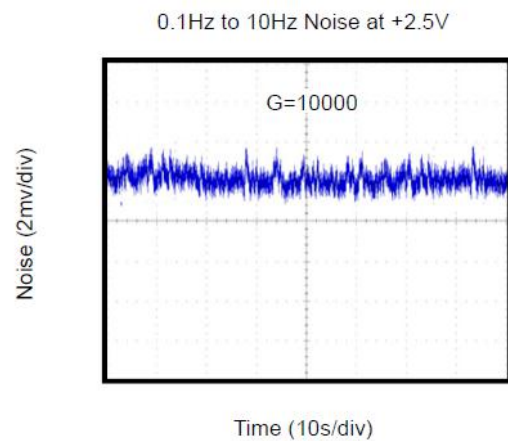
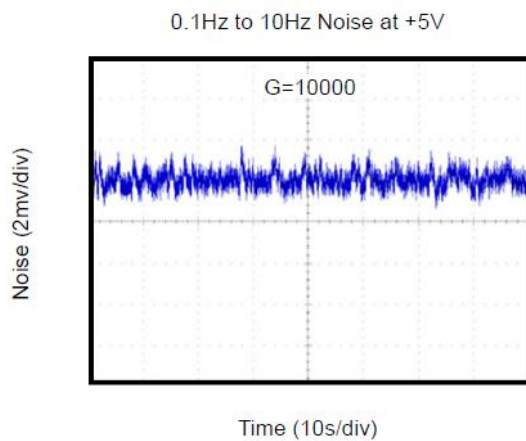
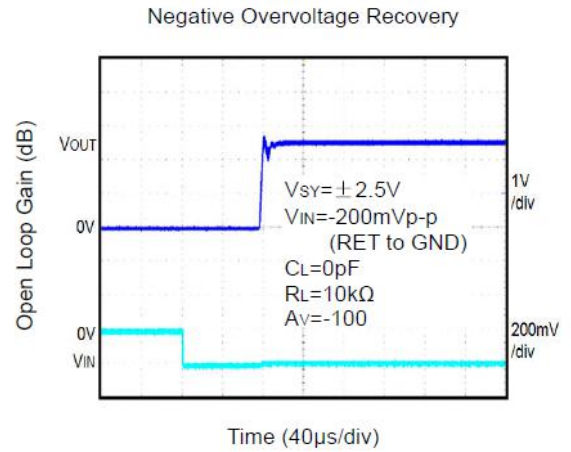
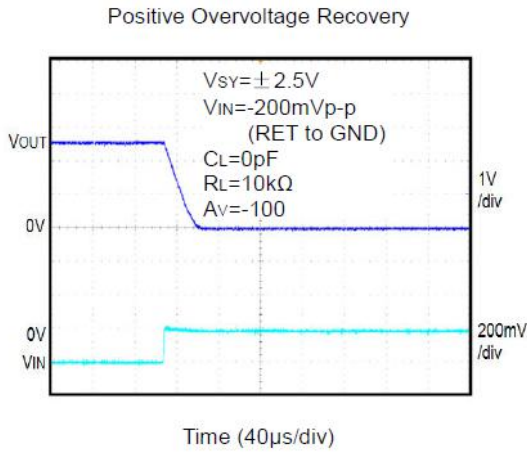
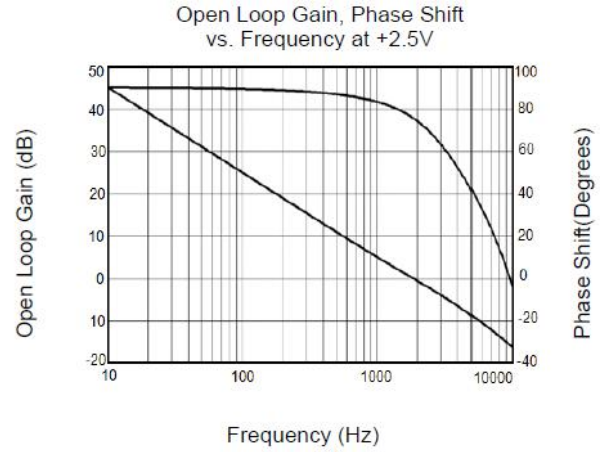
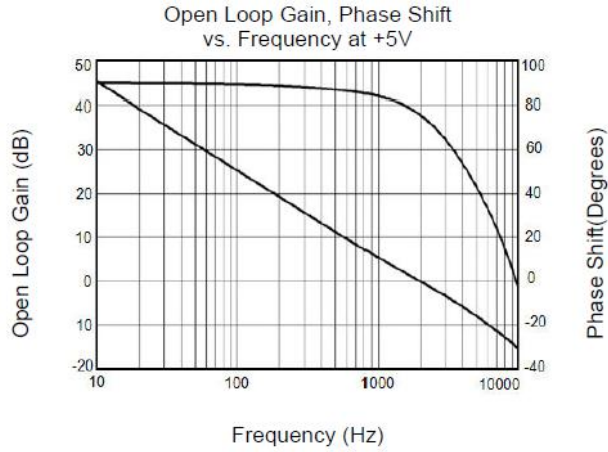
Closed Loop Gain vs. Frequency at +5V



Closed Loop Gain vs. Frequency at +2.5V



## TYPICAL CHARACTERISTICS



### APPLICATION NOTES

#### Size

CBM855X series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the CBM855X series packages save space on printed circuit boards and enable the design of smaller electronic products.

#### Power Supply Bypassing and Board Layout

CBM855X series operates from a single 1.8V to 5.5V supply or dual  $\pm 0.9V$  to  $\pm 2.75V$  supplies. For best performance, a 0.1 $\mu F$  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 $\mu F$  ceramic capacitors.

#### Low Supply Current

The low supply current (typical 180 $\mu A$  per channel) of CBM855X series will help to maximize battery life. They are ideal for battery powered systems

#### Operating Voltage

CBM855X series operate under wide input supply voltage (1.8V 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 CBM855X series extends 100mV beyond the supply rails (VSS-0.1V to VDD+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 CBM855X series can typically swing to less than 5mV from supply rail in light resistive loads ( $>100k\Omega$ ), and 60mV of supply rail in moderate resistive loads (10k $\Omega$ ).

#### Capacitive Load Tolerance

The CBM855X 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.

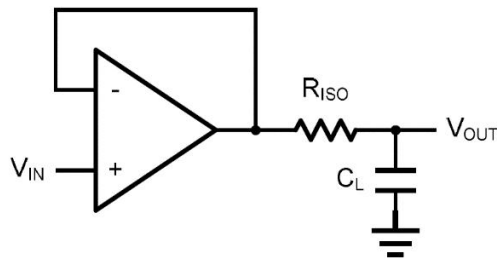


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

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.

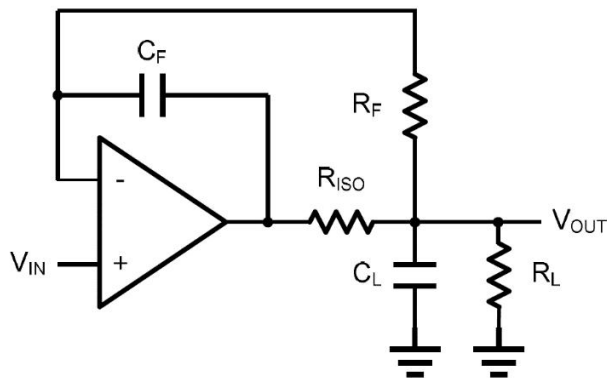


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy



## 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 CBM855X.

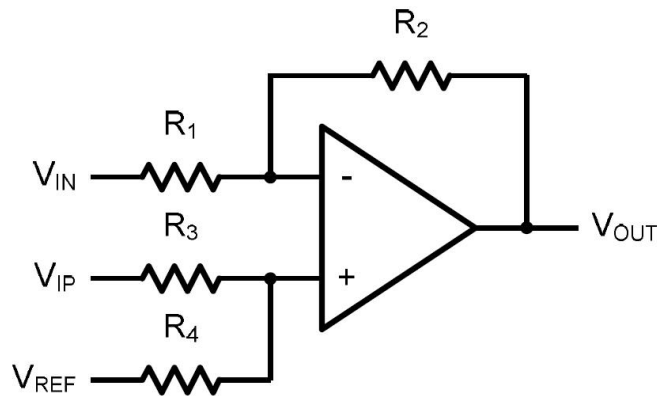


Figure 4. Differential Amplifier

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

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  $f_c = 1/(2\pi R_3 C_1)$ .

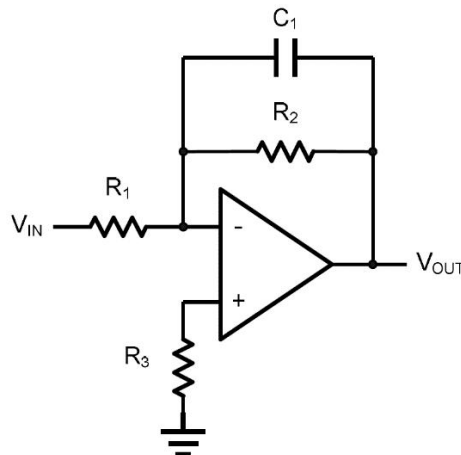


Figure 5. Low Pass Active Filter

### Instrumentation Amplifier

The triple CBM855X 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.

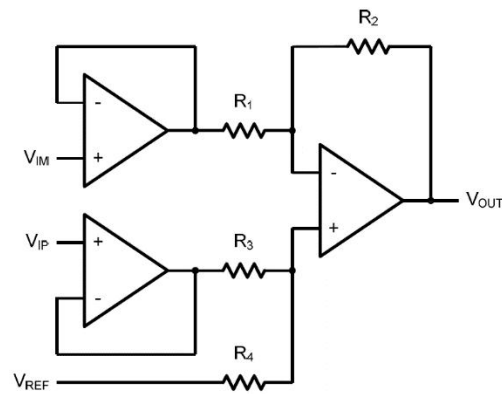
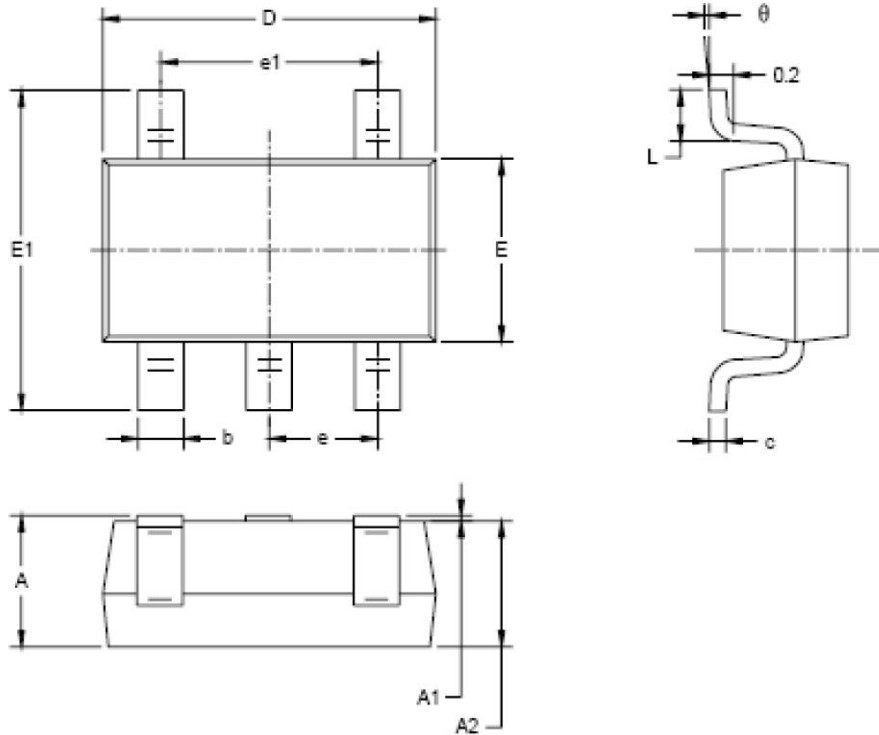


Figure 6. Instrument Amplifier

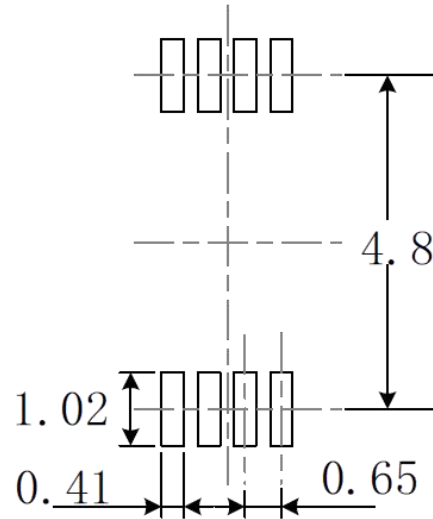
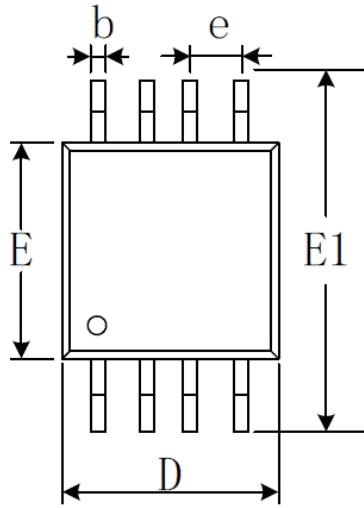
## PACKAGE OUTLINE DIMENSIONS

### SOT23-5

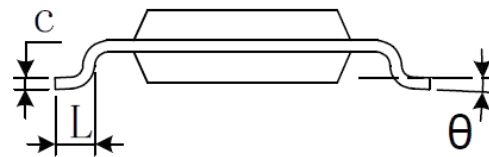
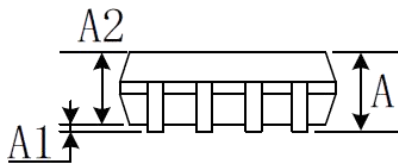


Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC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

## MSOP-8

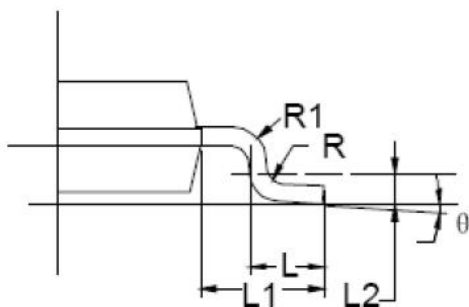
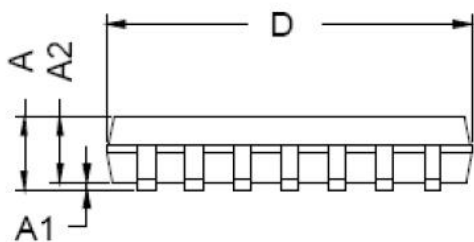
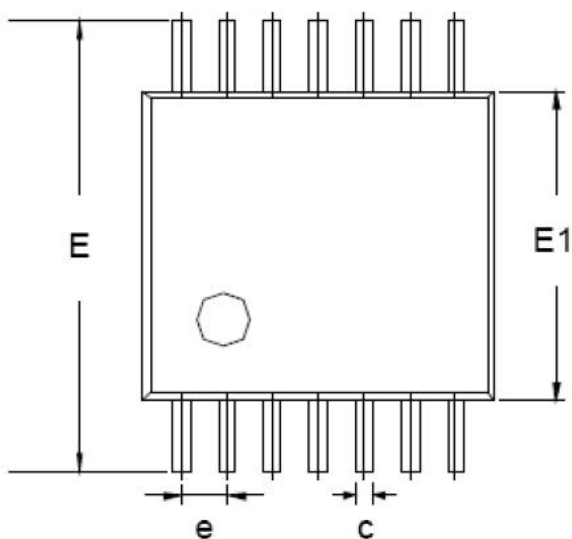


RECOMMENDED LAND PATTERN (Unit: mm)



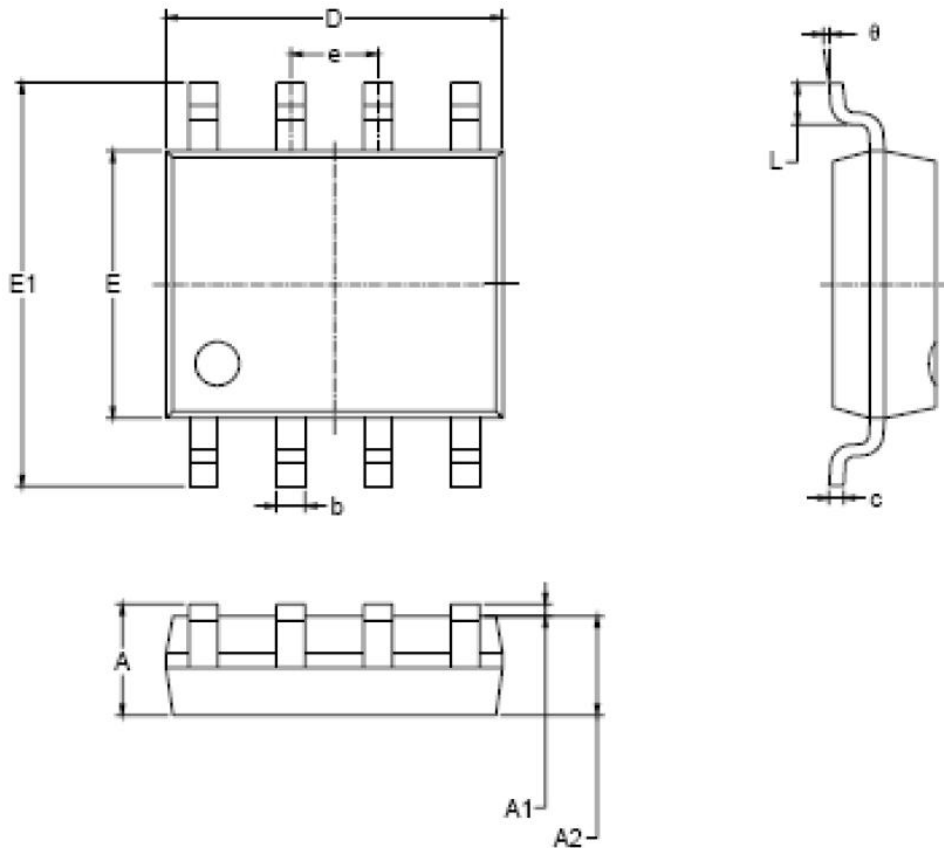
Symbol	Dimensions In Millimeters		Dimensions Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC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

## TSSOP-14



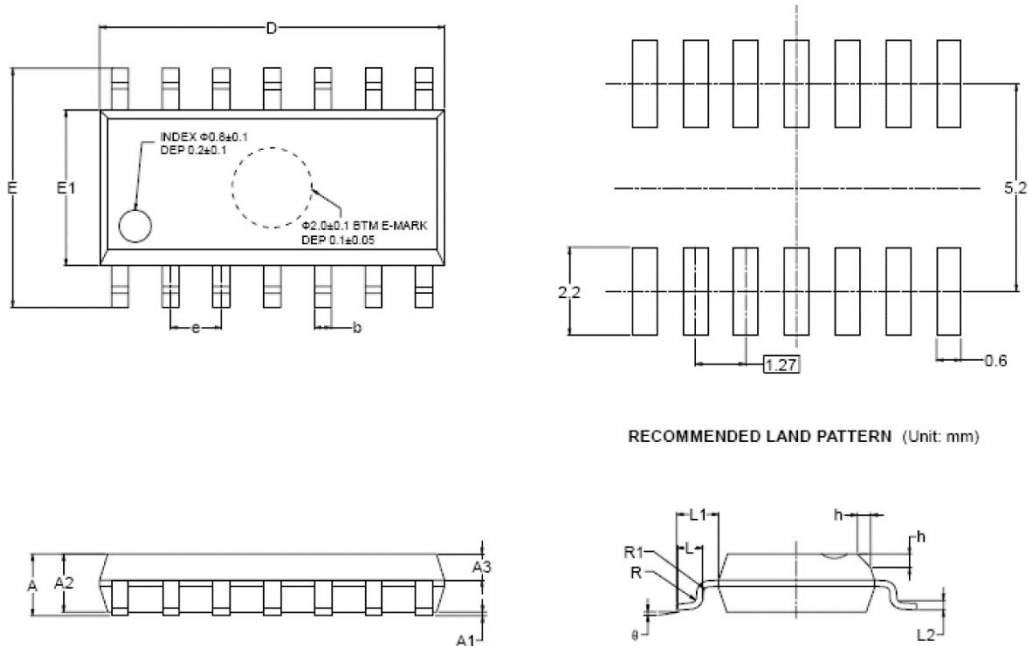
Symbol	Dimensions In Millimeters		
	Min	TYP	Max
A			1.200
A1	0.050		0.150
A2	0.900	1.000	1.050
b	0.200		0.280
c	0.100		0.190
D	4.860	4.960	5.060
E	6.200	6.400	6.600
E1	4.300	4.400	4.500
e	0.650 BSC		
L	0.450	0.600	0.750
L1	1.000 REF		
L2	0.250 BSC		
R	0.090		
$\theta$	1°		8°

## SOIC-8(SOP8)



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	5.80	6.200	0.228	0.244
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

## SOIC-14(SOP14)



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°

## PACKAGE/ORDERING INFORMATION

PRODUCT	ORDERING NUMBER	TEMPRANGE	PACKAGE	PAKEAGE MARKING	TRANSPOT MEDIA,QUANTILY
CBM8551	CBM8551AST5	-40°C~125°C	SOT23-5	8551	Tape and Reel,3000
	CBM8551AS8	-40°C~125°C	SOIC-8(SOP8)	CBM8551	Tape and Reel,2500
CBM8552	CBM8552AS8	-40°C~125°C	SOIC-8(SOP8)	CBM8552	Tape and Reel,2500
	CBM8552AMS8	-40°C~125°C	MSOP-8	CBM8552	Tape and Reel,3000
CBM8554	CBM8554ATS14	-40°C~125°C	TSSOP-14	CBM8554	Tape and Reel,2500
	CBM8554AS14	-40°C~125°C	SOIC-14(SOP14)	CBM8554	Tape and Reel,2500