

钍地半导体
Tudi Semiconductor

Product Specification

TUDI-AD8601/8602/8604

CMOS, single-supply, rail-to-rail input/output, wideband operational amplifier

网址 www.sztdbdt.com

用芯智造·卓越品质

semiconductor device manufacturer

- Design
- research and development
- production
- and sales

Features

- Track-to-track input and output
- Low noise: 18 nV/√ Hz at 1 kHz
- Low power consumption: 550μA (typical value)
- High gain bandwidth: 8MHz
- Power supply voltage range: 2.5V to 5.5V
- Low input bias current: 1 pA (typical value)
- Low input offset voltage: 1.9 mV (maximum value)
- Low offset voltage drift: ±0.5 μV/°C (typical value)
- ESD internal protection: ±4kV Human Body Model (HBM)
- Extended temperature range: -40°C to +125°C

Description

The AD8601, AD8602, and AD8604 are single-channel, dual-channel, quad-channel, rail-to-rail input and output, single-supply amplifiers, respectively, featuring extremely low offset voltage and wide signal bandwidth. These amplifiers utilize a new patented-tuning technology to achieve excellent performance without the need for laser trimming. All devices can be powered by a single 3 V to 5 V supply.

The combination of low offset extremely low input bias current, and high-speed characteristics makes these amplifiers suitable for a wide range of applications. Devices such as filters, integrators, diode amplifiers, shunt sensors,-impedance sensors can all benefit from this combination of features. The wide bandwidth and low distortion characteristics are beneficial for audio and other AC applications. For most cost-sensitive applications, D-series can provide the same AC performance at a lower price point, but with lower DC accuracy.

Specific applications of these amplifiers include: audio amplification for portable devices, portable headsets, barcode scanners, portable instrumentation, cellular PA control, and multi-pole filters.

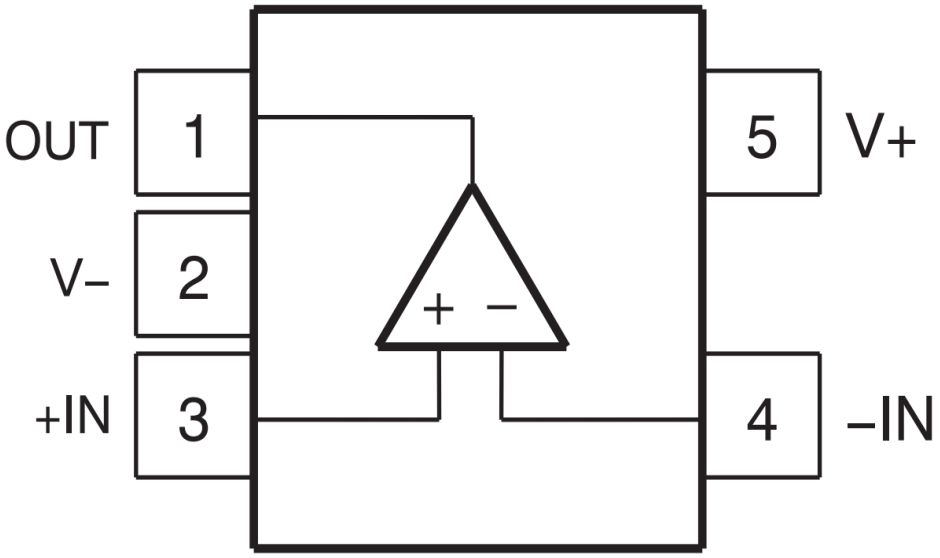
They also feature rail-to-rail input and output swing capabilities, allowing designers to buffer ADCs, DACs, ASICs, and other wide-output-swing devices in single-supply systems.

The rated temperature range of AD8601, AD8602, and AD8604 is 40°C to 125°C industrial temperature range.

Applications

- Battery-powered applications
- electric machine control
- power-supply module
- Audio Receiver
- HVAC: Heating, Ventilation, and Air Conditioning
- medical instruments
- Sensor signal conditioning
- Vehicle infotainment
- active filter
- washing machine
- ice box

Pin Diagram and Functions

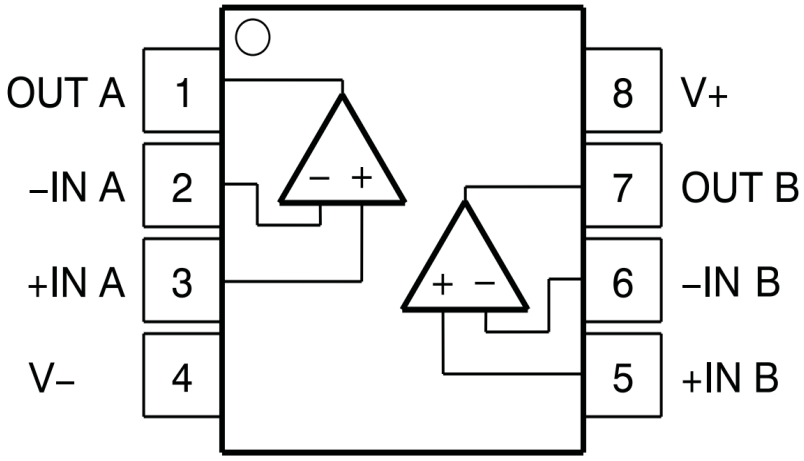


AD8601 SOT23-5 Pin Diagram

NO.	Name	Description
4	-IN	Inverse input
3	+IN	Non-inverting input
1	OUT	Output
2	V-	Negative(minimum)power supply or grounding (for single power supply)
5	V+	Maximum power supply

AD8601 Functions

Pin Diagram and Functions

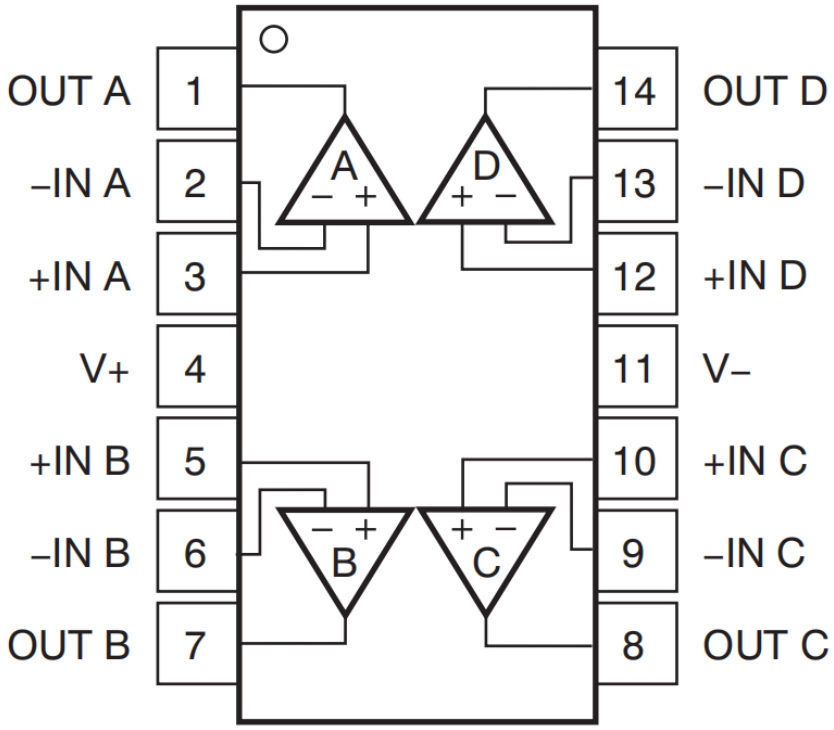


AD8602 SOP8/MSOP8/DIP8/TSSOP8 Pin Diagram

NO.	Name	Description
2	-IN A	Reverse input,Channel A
3	+IN A	Same-phase input,channel A
6	-IN B	Reverse-phase input,channel B
5	+IN B	Same-phase input,channel B
1	OUT A	Output,Channel A
7	OUT B	Output,Channel B
4	V-	Negative(minimum)power supply or grounding(for single power supply)
8	V+	Maximum power supply

AD8602 Functions

Pin Diagram and Functions



AD8604 SOP14/TSSOP14/DIP14 Pin Diagram

NO.	Name	Description
2	-IN A	Reverse input,Channel A
3	+IN A	Same-phase input,channel A
6	-IN B	Reverse-phase input,channel B
5	+IN B	Same-phase input,channel B
9	-IN C	Inverted input,channel C
10	+IN C	Same-phase input,channel C
13	-IN D	Reverse input,Channel D
12	+IN D	Same-phase input,channel D

1	OUT A	Output,Channel A
7	OUT B	Output,Channel B
8	OUT C	Output,Channel C
14	OUT D	Output,Channel D
11	V-	Negative(minimum)power supply or grounding(for single power supply)
4	V+	Maximum power supply

AD8604 Functions

Product Specification

Parameter	Rating	Unit
DC Supply Voltage	2.5V-5.5V	V
Input common-mode voltage range	-Vs～+Vs	V
Operating ambient temperature	-40 to 125	℃

Recommended Operating Conditions

Electrical Characteristics

(+Vs=+5V,-Vs=0,VeM=Vs/2,TA=+25℃,RL=10kQto Vs/2,unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Out Characteristics						
Output Voltage Swing from Rail		RL=100kΩ		1		mV
		RL=10kΩ		8		mV
		RL=2kΩ		40		mV
Short-Circuit Current	IoUT	Sourcing		21		mA
		Sinking		22		mA
Input Characteristics						
Input Offset Voltage	Vos			±0.6	±5	mV
Input Offset Voltage Drift	△Vos/△T	-40 to 125℃		±2.0		μV℃
Input Bias Current	IB			±2.5		pA
Input Offset Current	los			±2.5		pA
Common-Mode Voltage Range	VcM	Vs =5.5V	-0.1		5.6	V
Common-Mode Rejection Ratio	CMRR	VcM=0.1V to 4.9V		125		dB
Open-Loop Voltage Gain	AOL	Vo=0.2V to 4.8V		120		dB
Dynamic Performance						
Gain Bandwidth Product	GBWP	G=+1		10		MHz
Slew Rate	SR	G=+1,2V Output Step		7.5		V/μs
Noise Performance						
Voltage Noise Density	en	f=1kHz		12		nVI √Hz
Power Supply						
Operating Voltage Range			2.5		5.5	V
Power Supply Rejection Ratio	PSRR	VS = 2.1V-5.5V	80	100		dB
Quiescent Current /Amplifier	lo				550	μA

Absolute Maximum Ratings

Parameter	Rating	Units
Power Supply:+Vs to-Vs	6.0	V
Input Voltage	-Vs -0.5V to+Vs+0.5V	V
Input Current(2)	10	mA
Storage Temperature Range	-65 to 150	℃
Junction Temperature	150	℃
Operating Temperature Range	-40 to 125	℃
ESD Susceptibility,HBM	2000	V

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.

Application Notes

Driving Capacitive Loads

Driving large capacitive loads can cause staility problems for voltage feedback op amps.As the load capacitance increases,the feedback loop's phase margin decreases,and the closed loop bandwidth is reduced.This produces gain peaking in the frequency response,with overshoot and ringing in the step response.A unity gain buffer(G=+1)is the most sensitive to capacitive loads, butall gains show the same general behavior.
When driving large capacitive loads with these op amps(e.g.,>100 pF when G=+1),a small series resistor at the output (RISO in Figure 1)improves the feedback loop's phase margin(stability) bymaking the output load resistive at higher frequencies.It does not,however,improve the bandwidth.To select RISO,check the frequency response peaking(or step response overshoot)on the bench.If the response is reasonable,you do not need RISO.Otherwise,start Riso at 1kΩ and modify its valueuntil the response is reasonable.

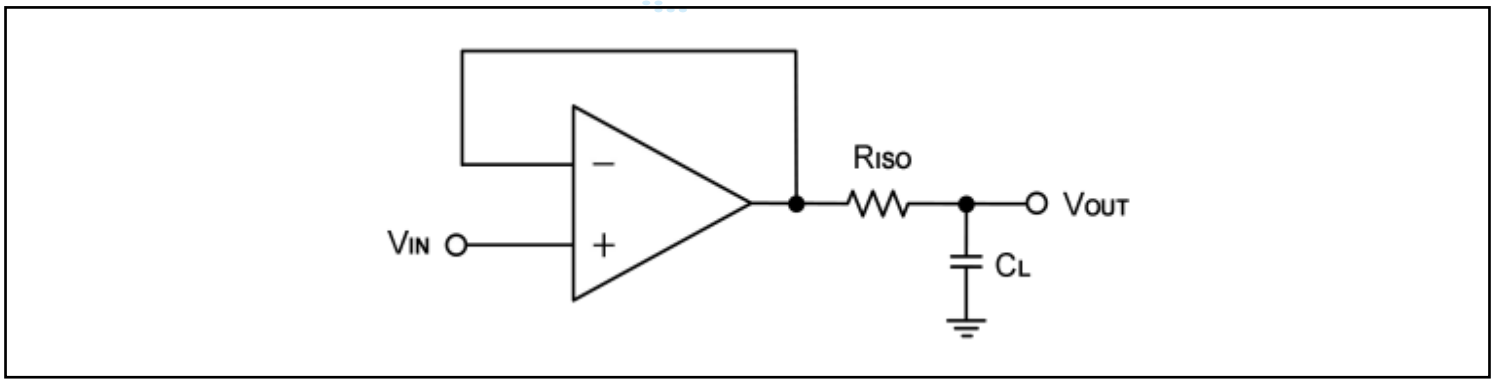


Figure 1. Indirectly Driving Heavy Capacitive Load

An improvement 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.

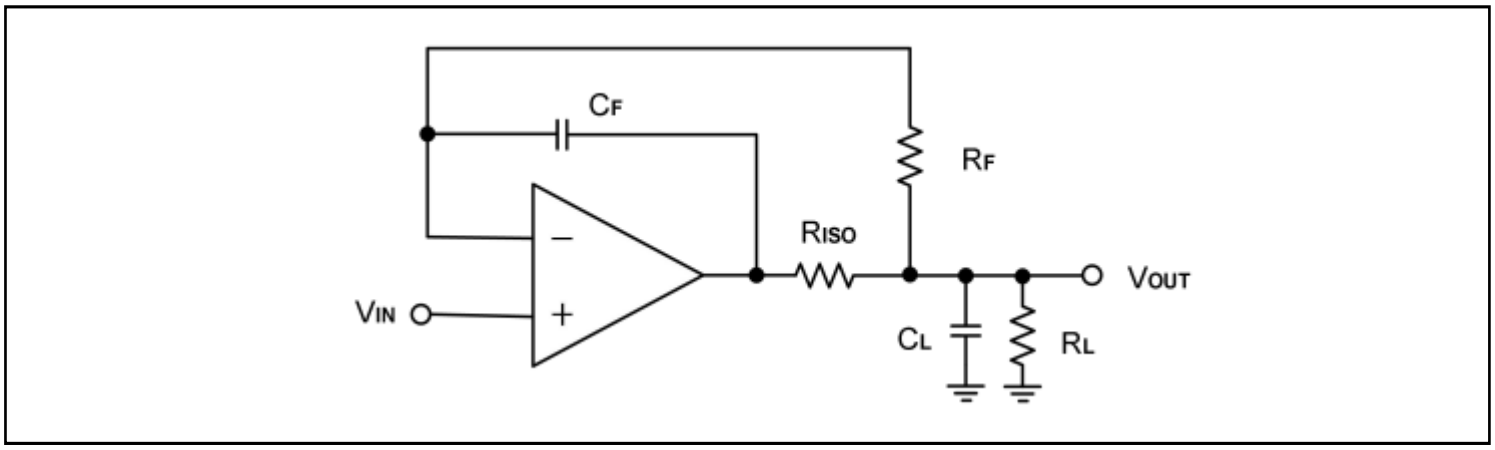


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-inverting configuration, there are two others 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, as shown in Figure 3.

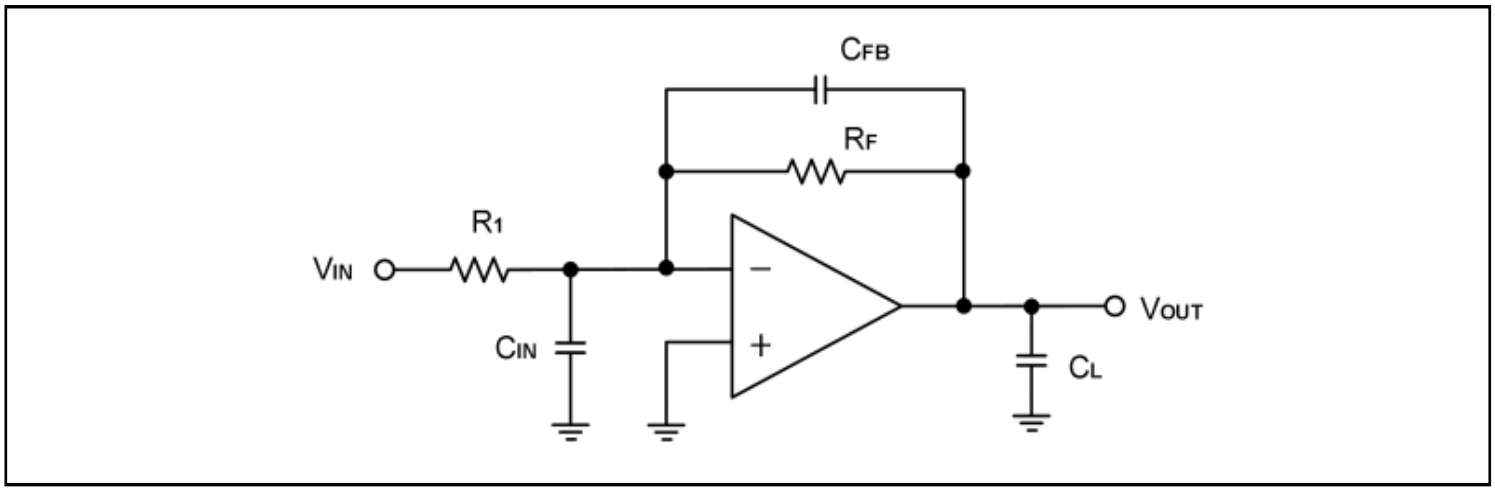


Figure 3. Adding a Feedback Capacitor in the Non-inverting Configuration

Power-Supply Bypassing and Layout

The AD860x operates from a single +2.5V to +5.5V supply or dual ±1.05V to ±2.75V supplies. For single-supply operation, bypass the power supply +Vs with a 0.1μF ceramic capacitor which should be placed close to the +Vs pin. For dual-supply operation, both the +Vs and the -Vs supplies should be bypassed to ground with separate 0.1μF ceramic capacitors. 2.2μF tantalum capacitor can be added for better performance.
The length of the current path is directly proportional to the magnitude of parasitic inductances and thus the high frequency impedance of the path. High speed currents in an inductive ground return create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance. Thus a ground plane layer is important for high speed circuit design.

Typical Application Circuits

Differential Amplifier

The circuit shown in Figure 4 performs the differential function. If the resistors ratios are equal ($R_4/R_3 = R_2/R_1$), then $V_{OUT} = (V_{IP} - V_{IN}) \times R_2/R_1 + V_{REF}$.

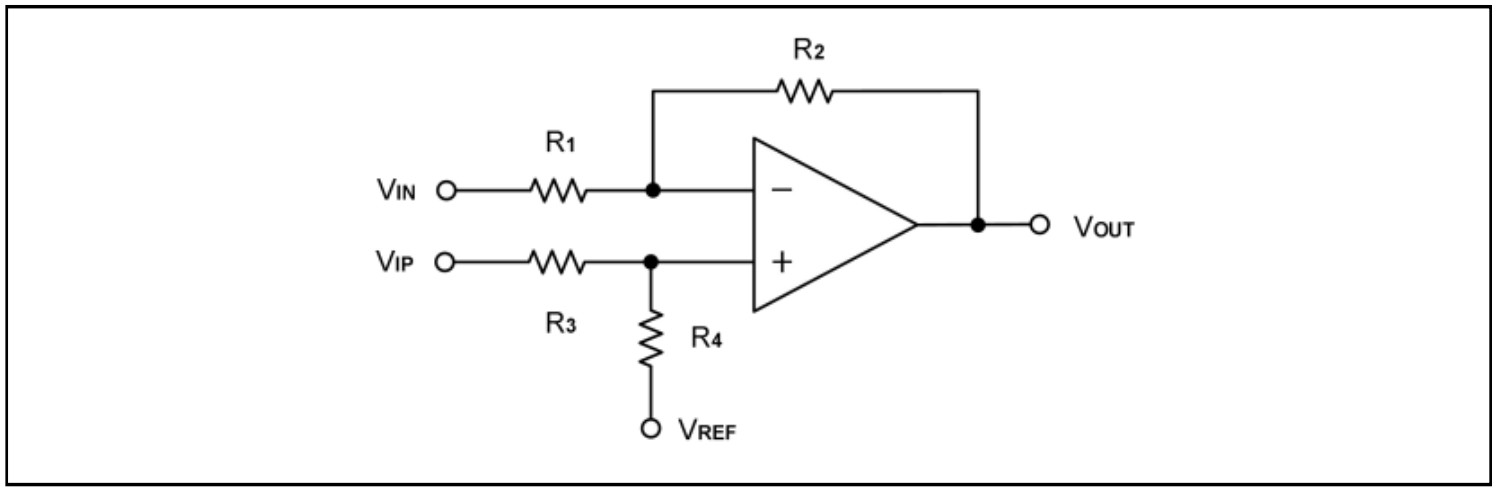


Figure 4. Differential Amplifier

Low Pass Active Fiter

When receiving low-level signals, limiting the bandwidth of the incoming signals into the system is often required. The simplest way to establish this limited bandwidth is to place an RC filter at the noninverting terminal of the amplifier. If even more attenuation is needed, a multiple pole filter is required. The Sallen-Key filter can be used for this task, as Figure 5. For best results, the amplifier should have a bandwidth that is 8 to 10 times the filter frequency bandwidth. Failure to follow this guideline can result in reduction of phase margin. 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 resistors value as low as possible and consistent with output loading consideration.

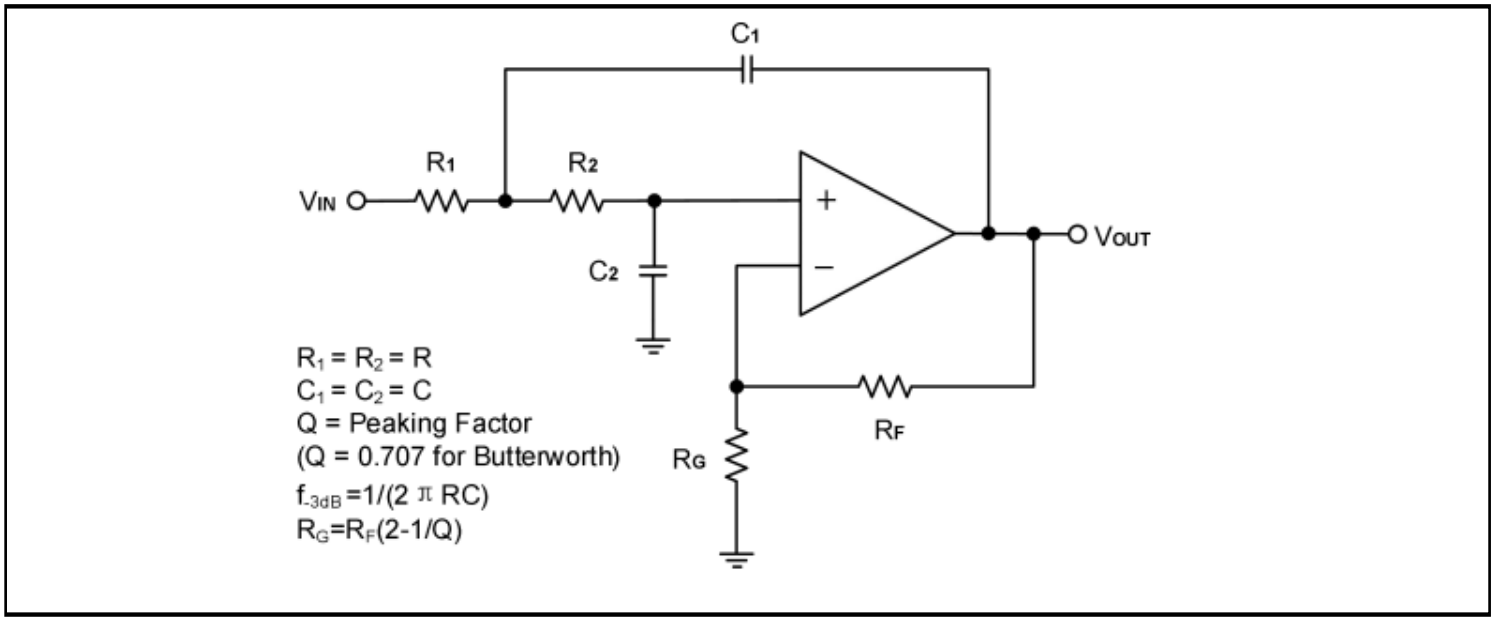
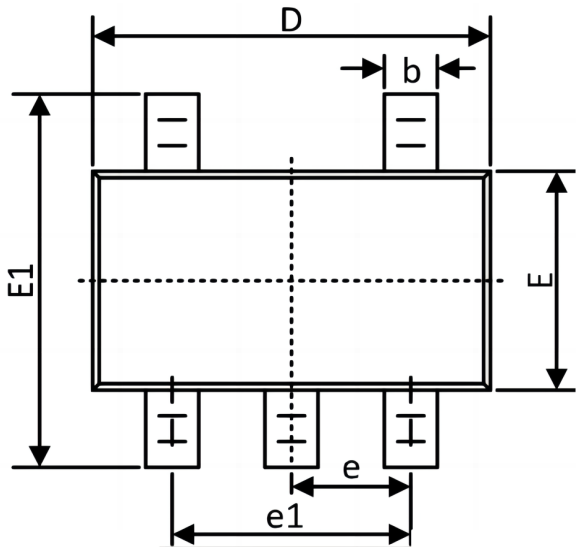
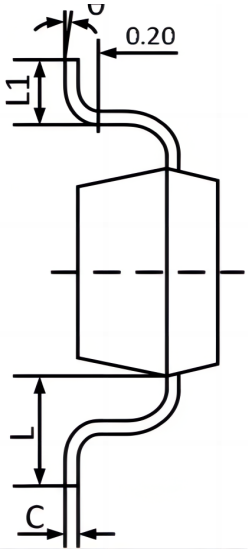
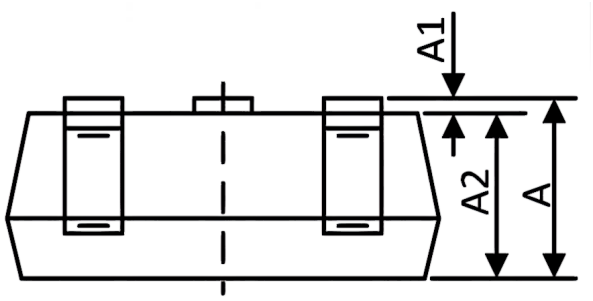


Figure 5. Two-Pole Low-Pass Sallen-Key Active Filter

Package SOT23-5

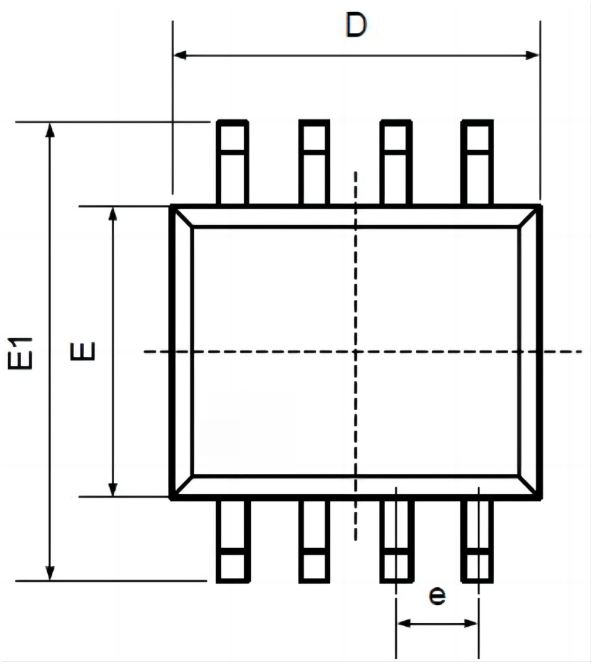


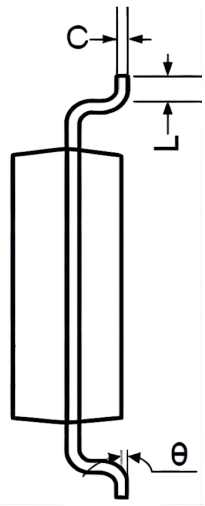


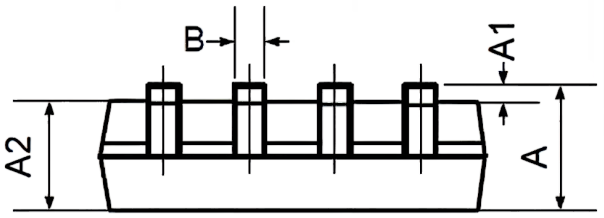


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Package SOP8

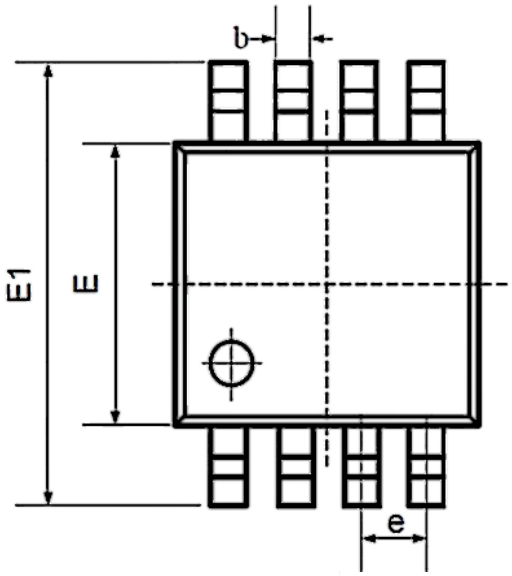


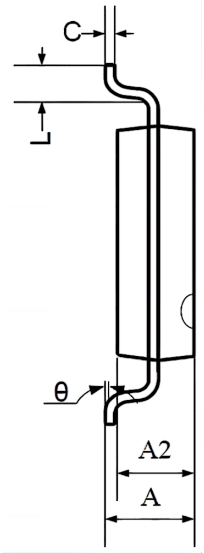


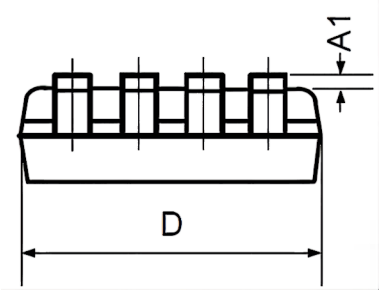


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package MSOP8

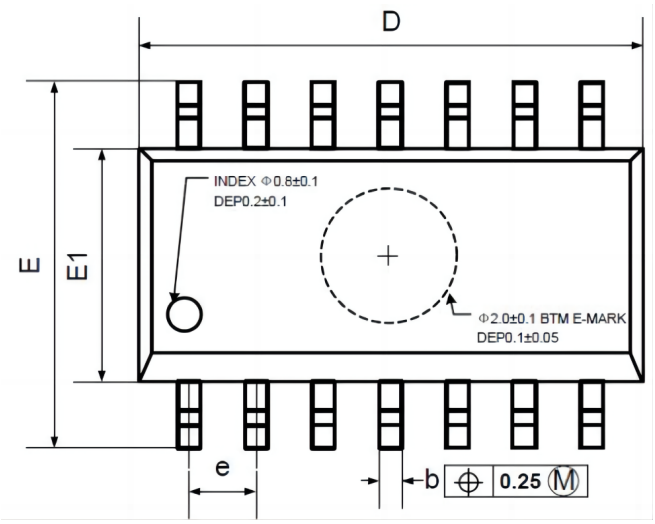


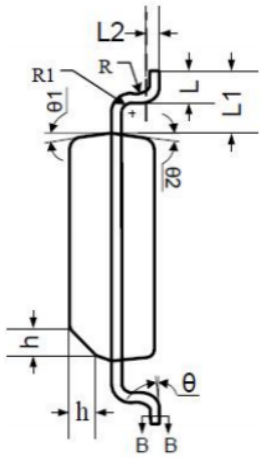


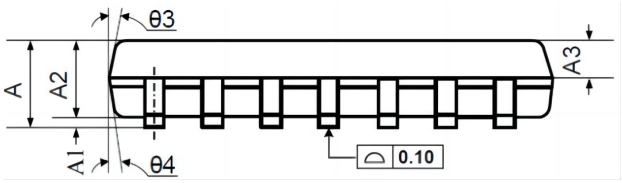


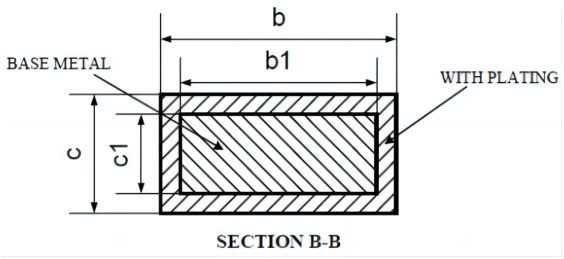
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°

Package SOP14



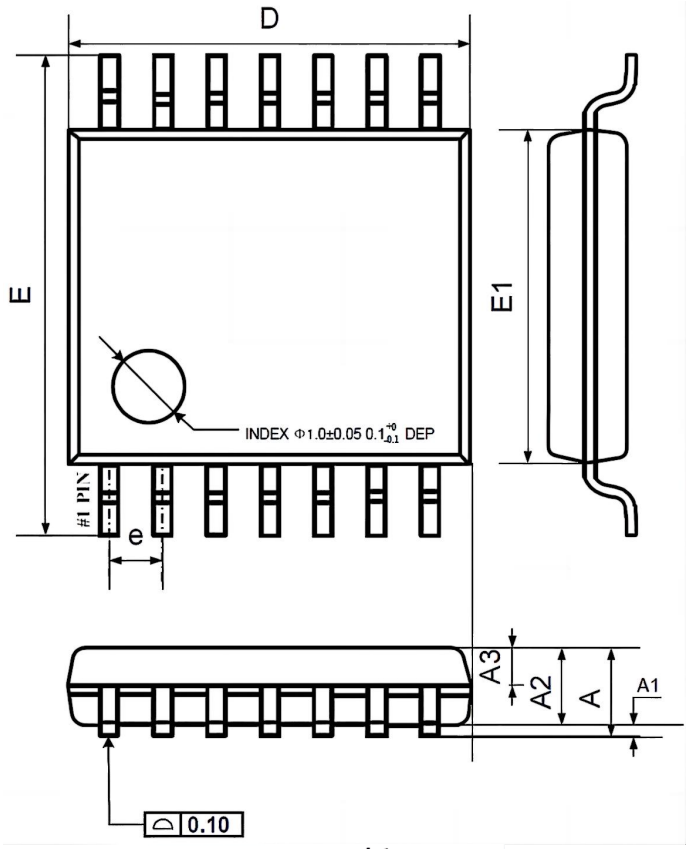


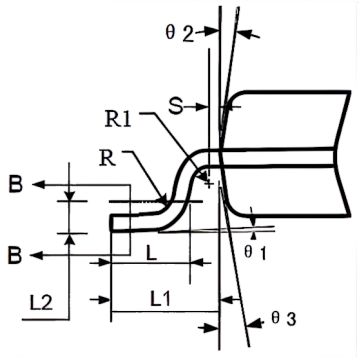


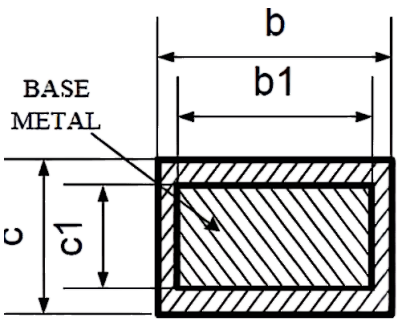


Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
θ1	6°	8°	10°
θ2	6°	8°	10°
θ3	5°	7°	9°
θ4	5°	7°	9°

Package TSSOP14







Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	—	0.28
b1	0.20	0.22	0.24
C	0.10	—	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	—	—
R1	0.09	—	—
S	0.20	—	—
θ1	0°	—	8°
θ2	10°	12°	14°
θ3	10°	12°	14°

Order information

Order Number	Package	Package Quantity	Marking On The park	Temperature
AD8601ARTZ-REEL-TUDI	SOT23-5	Tape,Reel,3000	AAA	-40℃ to +125℃
AD8602ARZ-REEL-TUDI	SOP8	Tape,Reel,4000	8602A	
AD8602ARMZ-REEL-TUDI	MSOP8	Tape,Reel,4000	ABA	
AD8604ARZ-REEL-TUDI	SOP14	Tape,Reel,4000	AD8604A	
AD8604ARUZ-REEL-TUDI	TSSOP14	Tape,Reel,4000	AD8604A	

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