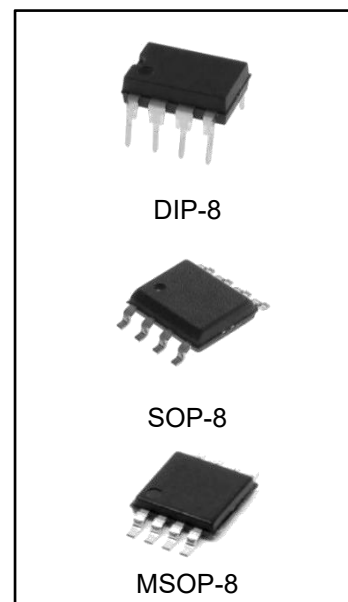


## 36V, 8MHz, Precision Low-Noise Operational Amplifiers

### Features

- Low Offset Voltage: 50 $\mu$ V (Max.)
- Low Drift: 0.12 $\mu$ V/ $^{\circ}$ C
- Gain Bandwidth Product: 8MHz
- Wide Supply Range:  $\pm$ 2.25V ~  $\pm$ 18V
- Low Quiescent Current: 1.2mA
- Slew Rate: 2.8V/ $\mu$ s
- Unity Gain Stable
- Input Over-Voltage Protection
- Extended Temperature Ranges From -40 $^{\circ}$ C to +125 $^{\circ}$ C
- Available in SOP-8/MSOP-8/DIP-8



### Package and Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing Qty
OP27IN	DIP-8	OP27I	TUBE	2000pcs/box
OP27CN	DIP-8	OP27C	TUBE	2000pcs/box
OP27IM/TR	SOP-8	OP27I	REEL	2500pcs/reel
OP27CM/TR	SOP-8	OP27C	REEL	2500pcs/reel
OP27IMM/TR	MSOP-8	OP27I	REEL	3000pcs/reel
OP27CMM/TR	MSOP-8	OP27C	REEL	3000pcs/reel

## General Description

The OP27 is low power, precision operational amplifiers operated on  $\pm 2.25\text{V}$  to  $\pm 18\text{V}$  supplies. It has very low input offset voltage ( $50\mu\text{V}$ ) maximum that is obtained by trimming at the wafer stage.

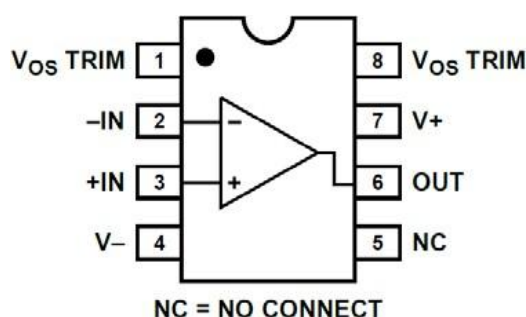
These low offset voltages generally eliminate any need for external nulling. OP27 also features low input bias current and high open-loop gain. The low offset and high open-loop gain make OP27 particularly useful for high gain instrumentation applications.

The wide input voltage range of  $\pm 13\text{V}$  minimum combined with a high CMRR of 110dB and high input impedance provide high accuracy in the noninverting circuit configuration. Excellent linearity and gain accuracy can be maintained even at high closed-loop gains. Stability of offsets and gain with time or variations in temperature is excellent. The accuracy and stability of the OP27, even at high gain, combined with the freedom from external nulling have made the OP27 an ideal choice for instrumentation applications.

## Applications

- Sensors and Controls:
  - Thermocouples
  - Resistor thermal detectors (RTDs)
  - Strain bridges
  - Shunt current measurements
- Precision Filters
- Data Acquisition
- Medical Instrumentation
- Optical Network Control Circuits
- Wireless Base Station Control Circuits

## Pin Configuration



## Pin Functions

Name	Description	Note
+Vs	Positive power supply	A bypass capacitor of 0.1 $\mu$ F as close to the part as possible should be placed between power supply pins or between supply pins and ground.
-Vs	Negative power supply or ground	If it is not connected to ground, bypass it with a capacitor of 0.1 $\mu$ F as close to the part as possible.
-IN	Negative input	Inverting input of the amplifier. Voltage range of this pin can go from -Vs to +Vs
+IN	Positive input	Non-inverting input of the amplifier. This pin has the same voltage range as -IN.
OUT	Output	The output voltage range extends to within millivolts of each supply rail.
TRIM	V <sub>OS</sub> Trim	Optional, place an offset nulling resistor (e.g. 20k $\Omega$ ) between pin 1 & 8
NC	No connection	

## Absolute Maximum Ratings (1)

Parameter	Rating	Units
Power Supply: +Vs to -Vs	36	V
Differential Input Voltage Range	$\pm 0.5$	V
Common Mode Input voltage Range <sup>(2)</sup>	-Vs to +Vs	V
Output Current	50	mA
Storage Temperature Range	-65 to 150	°C
Junction Temperature	150	°C
Operating Temperature Range	OP27I: -40 to 125	°C
	OP27C: 0 to +70	°C
ESD Susceptibility, HBM	2000	V
Lead Temperature (Soldering, 10 seconds)	245	°C

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.

**Thermal Data**

Parameter	Rating	Unit
Package Thermal Resistance	190 (SOT-23-5) 206 (MSOP-8) 155 (SOP-8)	°C/W

**Recommended Operating Conditions**

Parameter	Rating	Unit
DC Supply Voltage	$\pm 2.25V \sim \pm 18V$	V
Input common-mode voltage range	$-V_{s+2} \sim +V_{s-2}$	V
Operating ambient temperature	OP27I: -40 to +85	°C
	OP27C: 0 to +70	°C

## Electrical Characteristics

(+V<sub>S</sub>=+15V, -V<sub>S</sub>=-15V, T<sub>A</sub>=+25°C, R<sub>L</sub>=10kΩ to V<sub>S</sub>/2, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>Input Characteristics</b>						
Input Offset Voltage	VOS			±15	±50	μV
Input Offset Voltage Drift	ΔVOS/ΔT	-40 to 125°C		0.12	0.6	μV/°C
Input Bias Current	IB			±4	±8	nA
Input Offset Current	IOS			±0.5	±2	nA
Common-Mode Voltage Range	VCM		±13	±14		V
Common-Mode Rejection Ratio	CMRR		80	110		dB
Open-Loop Voltage Gain	AOL	R <sub>L</sub> ≥ 2kΩ, V <sub>O</sub> = ±10V	90	120		dB
<b>Out Characteristics</b>						
Output Voltage Swing	VO(PP)	R <sub>L</sub> ≥ 10kΩ	±12	±13.8		V
Short-Circuit Current	ISC			±28		mA
<b>Power Supply</b>						
Operating Voltage Range			±2.25		±18	V
Power Supply Rejection Ratio	PSRR		100	120		dB
Quiescent Current / Amplifier	IQ			1.2	1.5	mA
<b>Dynamic Performance</b>						
Gain Bandwidth Product	GBWP	CL=100pF, RL=10kΩ	5.0	8.0		MHz
Slew Rate	SR	CL=100pF, RL=10kΩ, Av=1		2.8		V/μs
<b>Noise Performance</b>						
Voltage Noise Density	en	f=1kHz		3.0		nV/√Hz

## Application Notes

### Driving Capacitive Loads

Driving large capacitive loads can cause stability 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, but all 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 ( $R_{ISO}$  in Figure 1) improves the feedback loop's phase margin (stability) by making the output load resistive at higher frequencies. It does not, however, improve the bandwidth.

To select  $R_{ISO}$ , check the frequency response peaking (or step response overshoot) on the bench. If the response is reasonable, you do not need  $R_{ISO}$ . Otherwise, start  $R_{ISO}$  at  $1$  k $\Omega$  and modify its value until the response is reasonable.

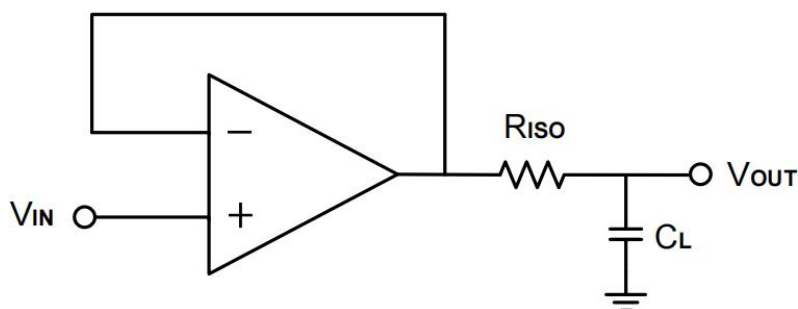


Figure 1. Indirectly Driving Heavy Capacitive Load

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.

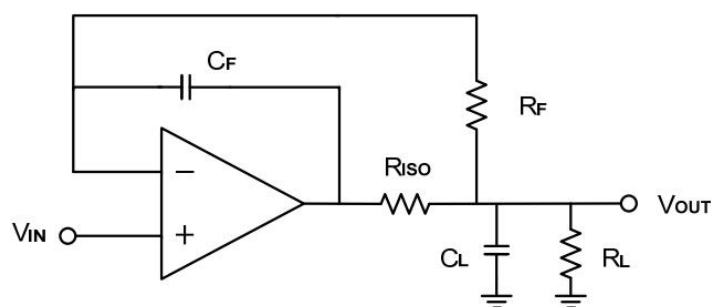


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For noninverting 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.

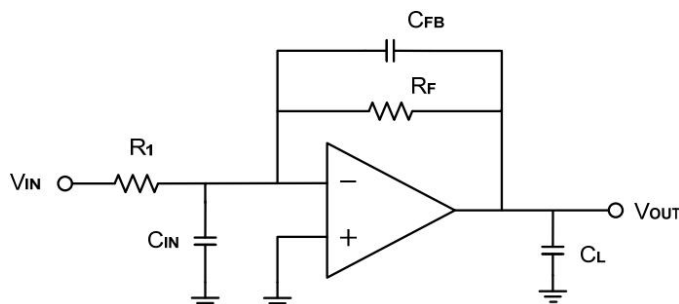


Figure 3. Adding a Feedback Capacitor in the Noninverting Configuration

## Power-Supply Bypassing and Layout

The OP27 operates from a single +4.5V to +36V supply or dual  $\pm 2.25\text{V}$  to  $\pm 18\text{V}$  supplies. For single-supply operation, bypass the power supply +Vs with a  $0.1\mu\text{F}$  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  $0.1\mu\text{F}$  ceramic capacitors.  $2.2\mu\text{F}$  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  $V_{OUT} = (V_{IP} - V_{IN}) \times R_2 / R_1 + V_{REF}$ .

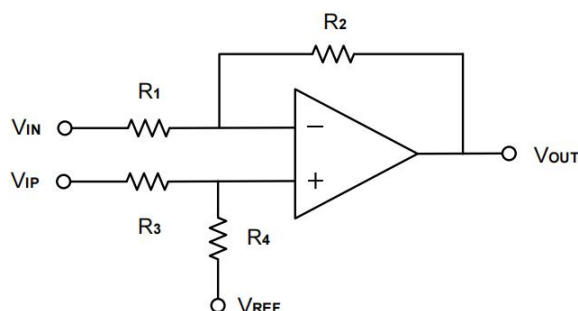


Figure 4. Differential Amplifier

## Low Pass Active Filter

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.

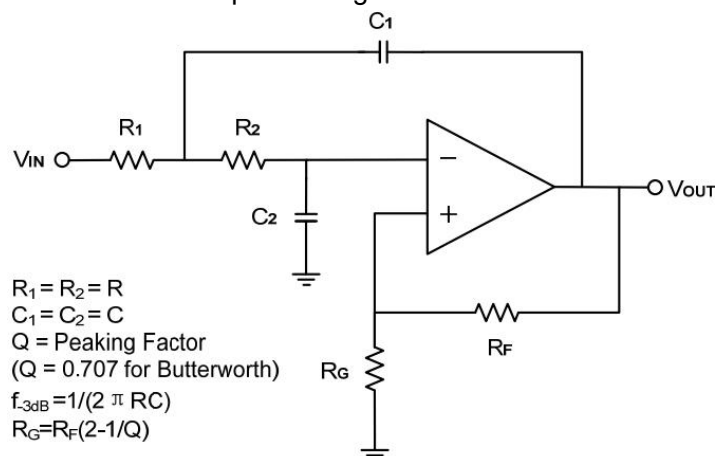
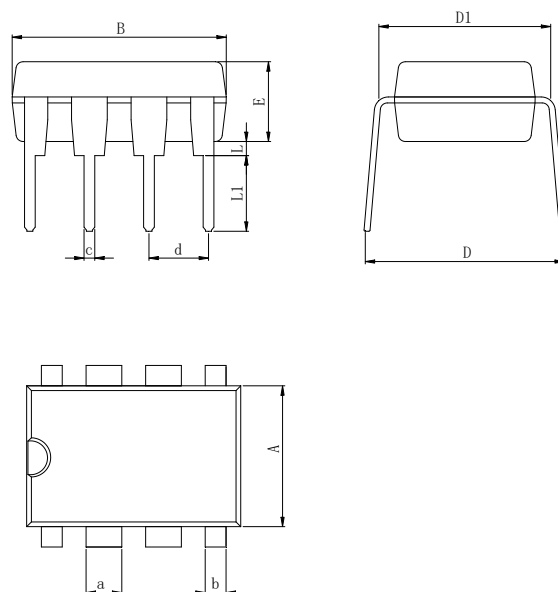


Figure 5. Two-Pole Low-Pass Sallen-Key Active Filter



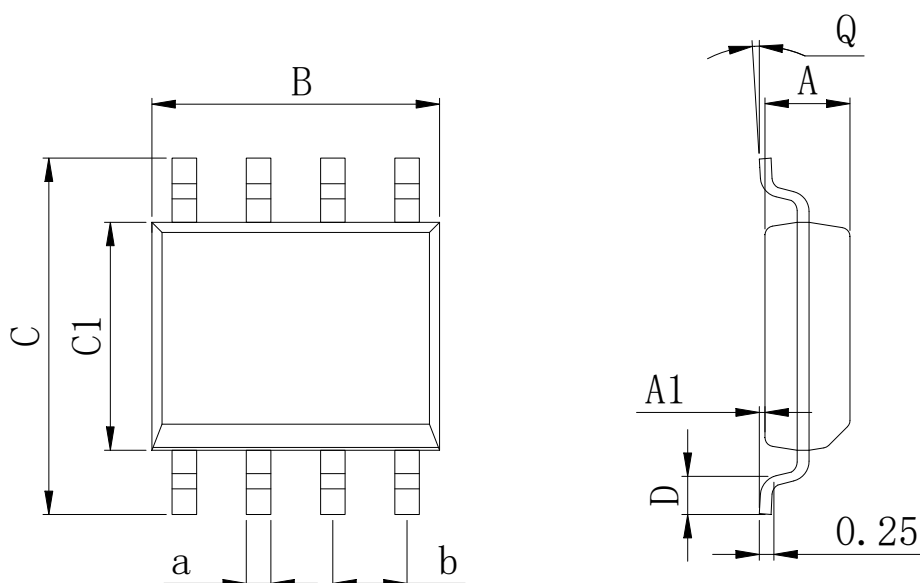
## Physical Dimensions

### DIP-8



Dimensions In Millimeters(DIP-8)											
Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	9.00	8.10	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	9.50	10.9	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

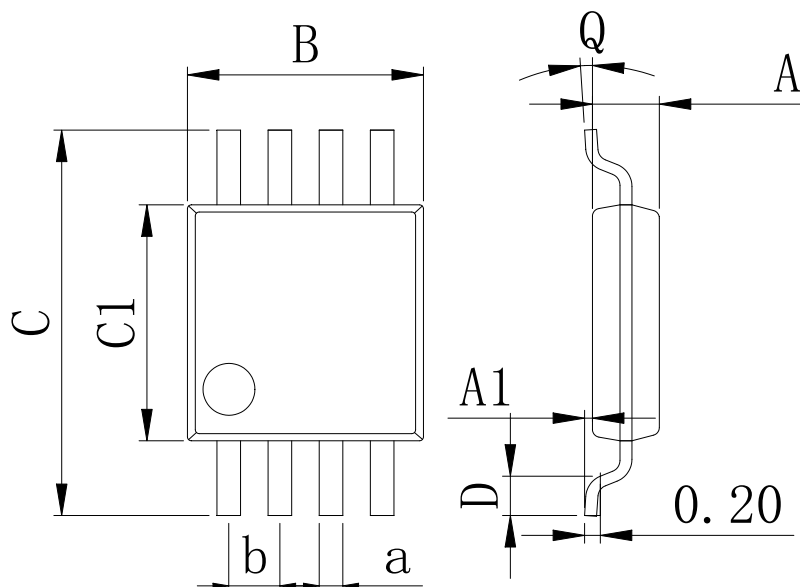
### SOP-8



Dimensions In Millimeters(SOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

## Physical Dimensions

MSOP-8



Dimensions In Millimeters(MSOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.80	0.05	2.90	4.75	2.90	0.35	0°	0.25	0.65 BSC
Max:	0.90	0.20	3.10	5.05	3.10	0.75	8°	0.35	

## Revision History

DATE	REVISION	PAGE
2015-11-4	New	1-12
2023-8-28	Update encapsulation type、Update Lead Temperature、Updated DIP-8 dimension	3、9、13

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