

## LMV358

### DESCRIPTION

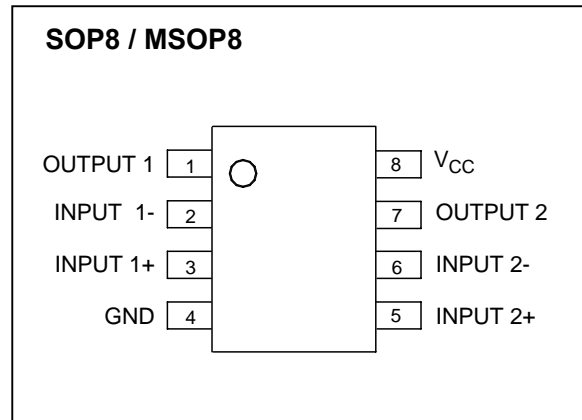
The LMV358(dual) are rail-to-rail input and output voltage feedback amplifiers offering low cost. They have a wide input common-mode voltage range and output voltages swing, and take the minimum operating supply voltage down to 2.1V and the maximum recommended supply voltage is 5.5V. temperature range.

The LMV358 provide 1MHz bandwidth at a low current consumption of 60μA per amplifier. Very low input bias currents of 10pA enable LMV358 to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail inputs and outputs are useful to designers buffering ASIC in single-supply systems. Applications for the series amplifiers include safety monitoring, portable equipment, battery and power supply control, and signal conditioning and interfacing for transducers in very low power systems.

The LMV358 is available in SOP8 and MSOP8 packages.

### Features

- Low Cost
- Rail-to-Rail Input and Output 0.8mV Typical VOS
- Unity Gain Stable
- Gain Bandwidth Product: 1MHz
- Very Low Input Bias Currents:
- Operates on 2.1V to 5.5V Supplies
- Input Voltage Range: -0.1V to +5.6V with  $V_S = 5.5V$
- Low Supply Current: < 60μA/Amplifier
- Small Packaging: LMV358 Available in SOP8, MSOP8



### Applications

- ASIC Input or Output Amplifier
- Sensor Interface
- Piezo Electric Transducer Amplifier
- Medical Instrumentation
- Mobile Communication
- Audio Output
- Portable Systems
- Smoke Detectors
- Notebook PC
- PCMCIA Cards
- Battery – Powered Equipment
- DSP Interface

## LMV358 ELECTRICAL CHARACTERISTICS

### ABSOLUTE MAXIMUM RATINGS

|  |  |
|--|--|
| Supply Voltage, V+ to V-.....                  | 7.5V   |
| Common-Mode Input Voltage.....                 | (-V <sub>S</sub> ) - 0.5V to (+V <sub>S</sub> ) + 0.5V |
| Storage Temperature Range.....                 | -65°C to +150°C  |
| Junction Temperature.....                      | 160°C  |
| Operating Temperature Range.....               | -40°C to +85°C   |
| Lead Temperature Range (Soldering 10 sec)..... | 260°C  |

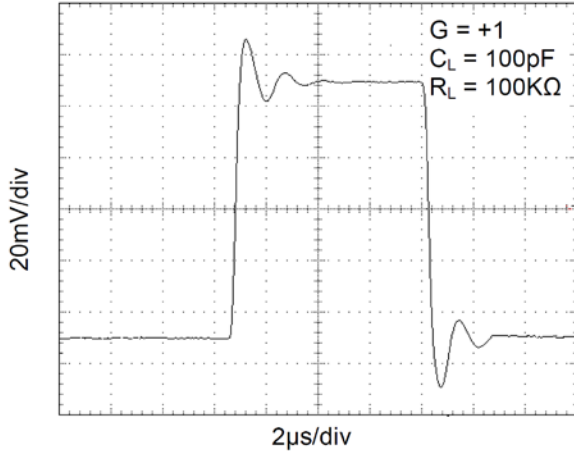
(At R<sub>L</sub> = 100KΩ connected to V<sub>S</sub>/2, and V<sub>OUT</sub> = V<sub>S</sub>/2, V<sub>S</sub>=+5V, unless otherwise noted.)

| PARAMETER                                       | CONDITIONS  | LMV358       |                          |             |       |         |
|---|---|--------------|--------------------------|-------------|-------|---------|
|   |   | TYP          | MIN/MAX OVER TEMPERATURE |             |       |         |
|   |   | +25°C        | +25°C                    | 0°C to 75°C | UNITS | MIN/MAX |
| <b>INPUT CHARACTERISTICS</b>                    |   |              |                          |             |       |         |
| Input Offset Voltage (VOS)                      |   | ±0.8         | ±5                       | ±6          | mV    | MAX     |
| Input Bias Current (I <sub>B</sub> )            |   | 10           |                          |             | pA    | TYP     |
| Input Offset Current (IOS)                      |   | 10           |                          |             | pA    | TYP     |
| Common-Mode Voltage Range (V <sub>CM</sub> )    | V <sub>S</sub> =5.5V  | -0.1 to +5.6 |                          |             | V     | TYP     |
| Common-Mode Rejection Ratio (CMRR)              | V <sub>S</sub> =5.5V, V <sub>CM</sub> =-0.1V to 4V                              | 70           | 62                       | 62          | dB    | MIN     |
|   | V <sub>S</sub> = 5.5V, V <sub>CM</sub> =-0.1V to 5.6V                           | 68           | 56                       | 55          | dB    | MIN     |
| Open-Loop Voltage Gain (AOL)                    | R <sub>L</sub> = 5KΩ, V <sub>o</sub> =0.1V to 4.9V                              | 80           | 70                       | 70          | dB    | MIN     |
|   | R <sub>L</sub> =100KΩ, V <sub>o</sub> =0.035V to 4.965V                         | 84           | 80                       | 80          | dB    | MIN     |
| <b>OUTPUT CHARACTERISTICS</b>                   |   |              |                          |             |       |         |
| Output Voltage Swing from Rail                  | R <sub>L</sub> = 100KΩ  | 0.008        |                          |             | V     | TYP     |
| Output Current (I <sub>OUT</sub> )              | R <sub>L</sub> = 10KΩ   | 0.08         |                          |             | V     | TYP     |
|   |   | 27           | 20                       | 18.8        | mA    | MIN     |
| <b>POWER SUPPLY</b>                             |   |              |                          |             |       |         |
| Operating Voltage Range                         |   |              | 2.1                      | 2.5         | V     | MIN     |
|   |   |              | 5.5                      | 5.5         | V     | MAX     |
| Power Supply Rejection Ratio (PSRR)             | V <sub>S</sub> = +2.5V to + 5.5V<br>V <sub>CM</sub> = (-V <sub>S</sub> ) + 0.5V | 82           | 60                       | 58          | dB    | MIN     |
| Quiescent Current / Amplifier (I <sub>Q</sub> ) | I <sub>OUT</sub> = 0  | 60           | 80                       | 86          | μA    | MAX     |
| <b>DYNAMIC PERFORMANCE</b>                      |   |              |                          |             |       |         |
| Gain-Bandwidth Product (GBP)                    | CL= 100pF   | 1            |                          |             | MHz   | TYP     |
| Slew Rate (SR)                                  | G = +1, 2V Output Step  | 0.52         |                          |             | V/μs  | TYP     |
| Settling Time to 0.1% (t <sub>S</sub> )         | G = +1, 2V Output Step  | 5.3          |                          |             | μs    | TYP     |
| Overload Recovery Time                          | V <sub>IN</sub> · Gain = V <sub>S</sub>   | 2.6          |                          |             | μs    | TYP     |
| <b>NOISE PERFORMANCE</b>                        |   |              |                          |             |       |         |
| Voltage Noise Density (e <sub>n</sub> )         | f = 1kHz  | 27           |                          |             | n√Hz  | TYP     |
|   | f = 10kHz   | 20           |                          |             | n√Hz  | TYP     |

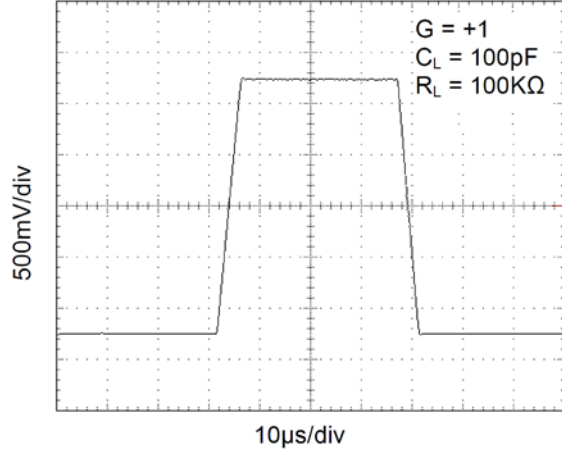
## TYPICAL PERFORMANCE CHARACTERISTICS

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.

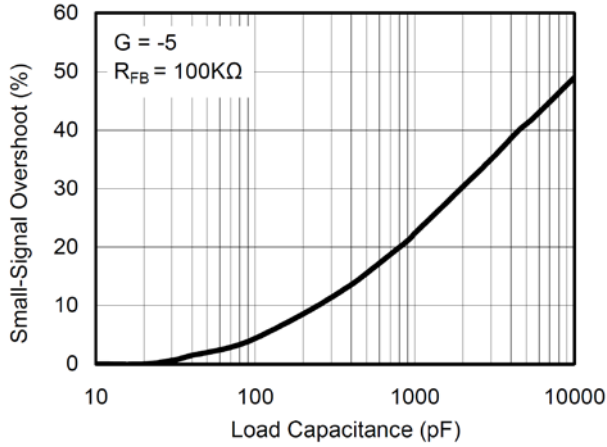
Small-Signal Step Response



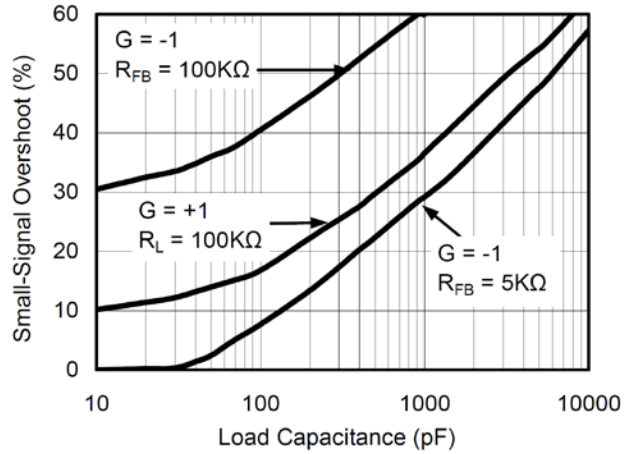
Large-Signal Step Response



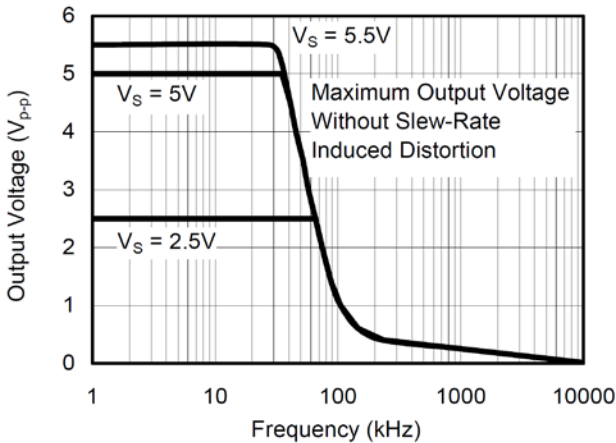
Small-Signal Overshoot vs. Load Capacitance



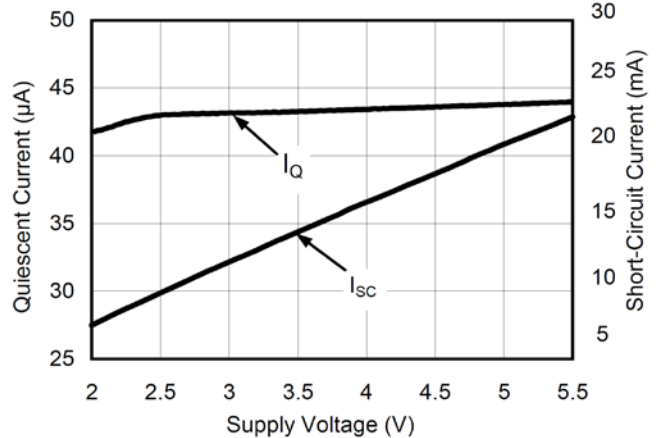
Small-Signal Overshoot vs. Load Capacitance

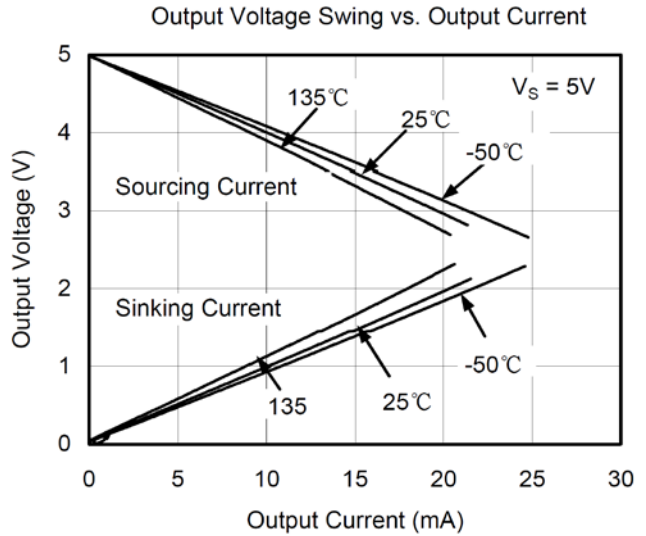
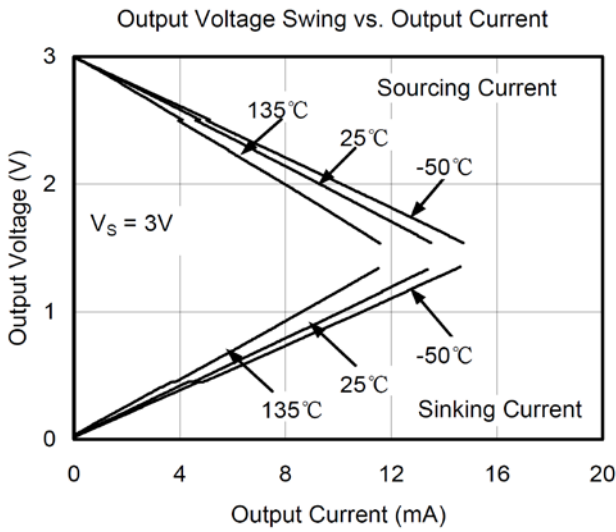


Maximum Output Voltage vs. Frequency



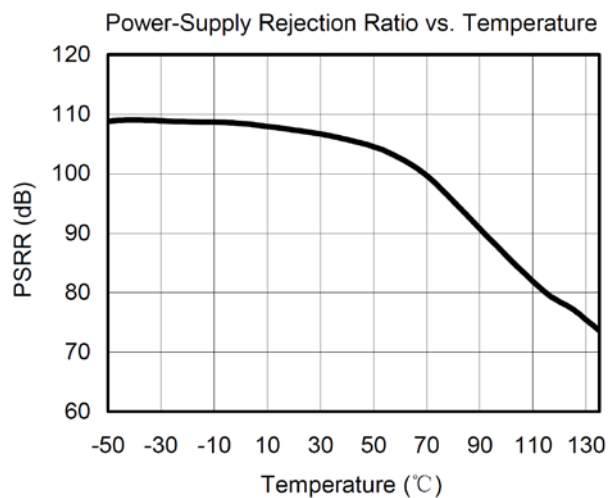
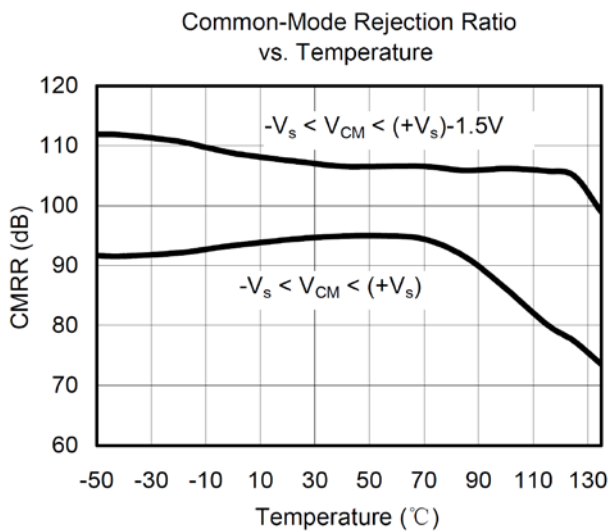
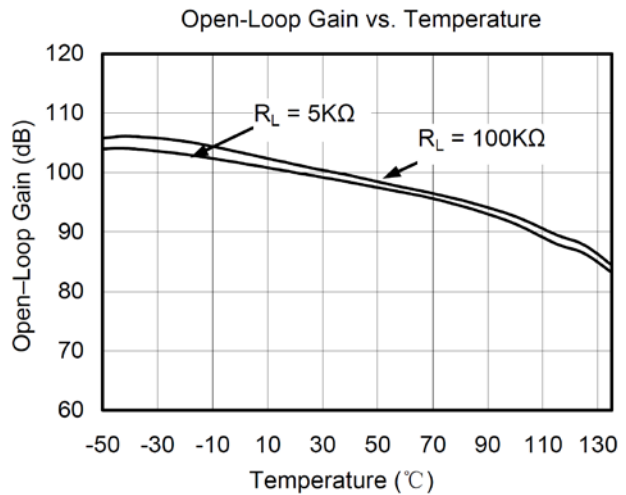
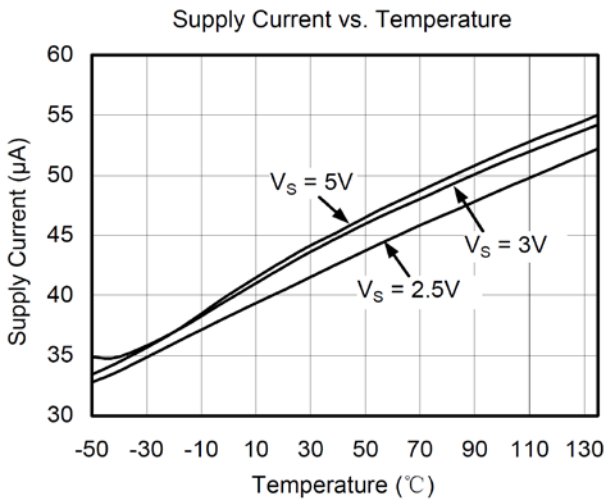
Quiescent and Short-Circuit Current vs. Supply Voltage





## TYPICAL PERFORMANCE CHARACTERISTICS

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



## APPLICATION NOTES

### Driving Capacitive Loads

The LMV358 can directly drive 250pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive drive capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 1. The isolation resistor  $R_{ISO}$  and the load capacitor  $C_L$  form a zero to increase stability. The bigger the  $R_{ISO}$  resistor value, the more stable  $V_{OUT}$  will be. Note that this method results in a loss of gain accuracy because  $R_{ISO}$  forms a voltage divider with the  $R_{LOAD}$ .

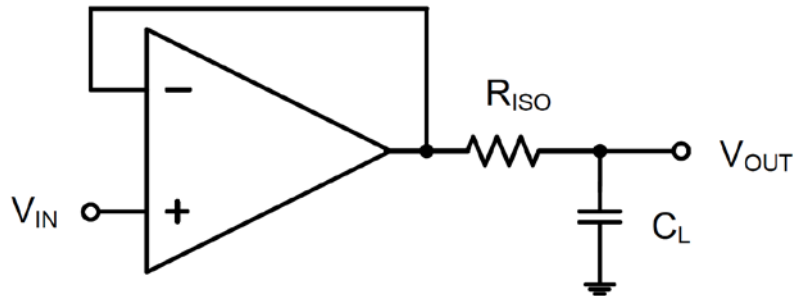


Figure 1. Indirectly Driving Heavy Capacitive Load

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.

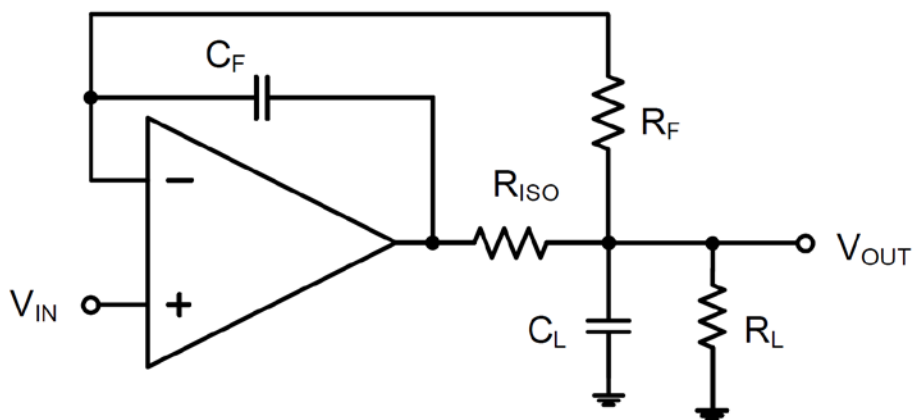


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For no-buffer 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.

### Power-Supply Bypassing and Layout

The LMV358 family operates from either a single +2.5V to +5.5V supply or dual  $\pm 1.25\text{V}$  to  $\pm 2.75\text{V}$  supplies. For single-supply operation, bypass the power supply VDD with a  $0.1\mu\text{F}$  ceramic capacitor which should be placed close to the VDD pin. For dual-supply operation, both the VDD and the VSS 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.

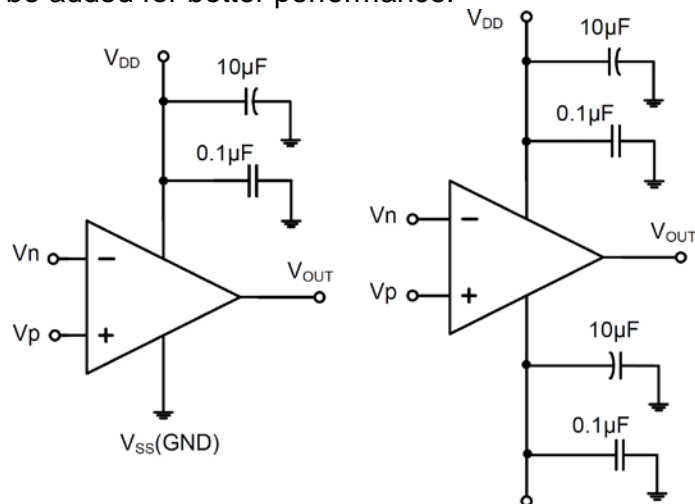


Figure 3. Amplifier with Bypass Capacitors

## TYPICAL APPLICATION CIRCUITS

### Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistors ratios are equal ( $R4 / R3 = R2 / R1$ ), then  $V_{OUT} = (V_p - V_n) \times R2 / R1 + V_{REF}$ .

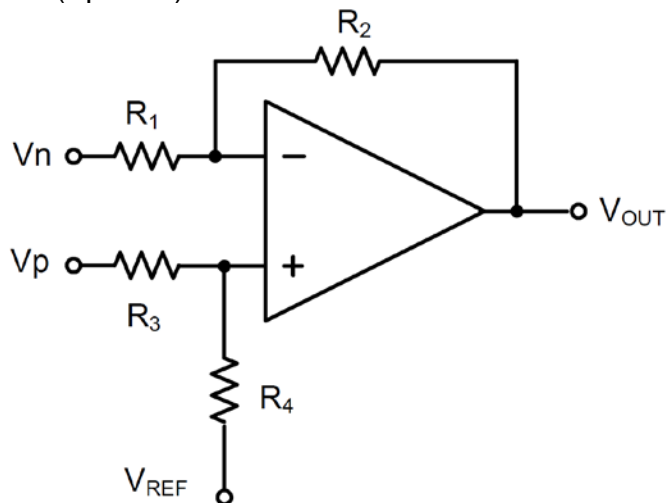


Figure 4. Differential Amplifier

### Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with the high input impedance.

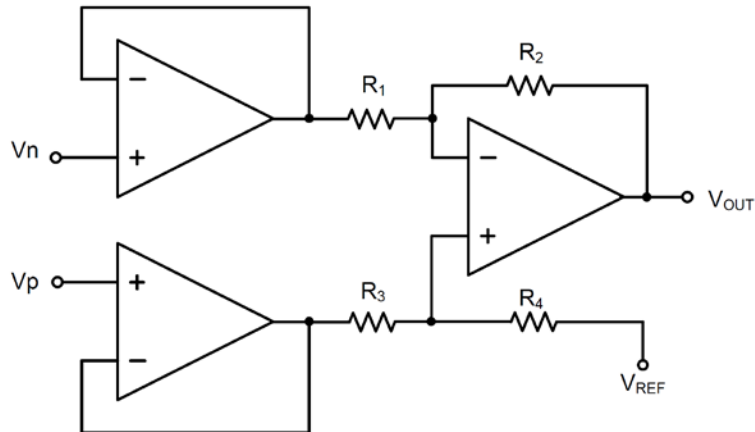


Figure 5. Instrumentation Amplifier

### Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of  $(-R_2 / R_1)$  and the  $-3\text{dB}$  corner frequency is  $1/2\pi R_2 C$ . Make sure the filter is within the bandwidth of the amplifier. 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.

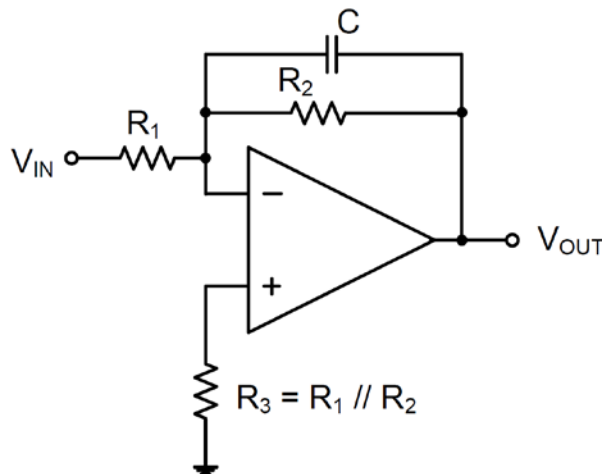
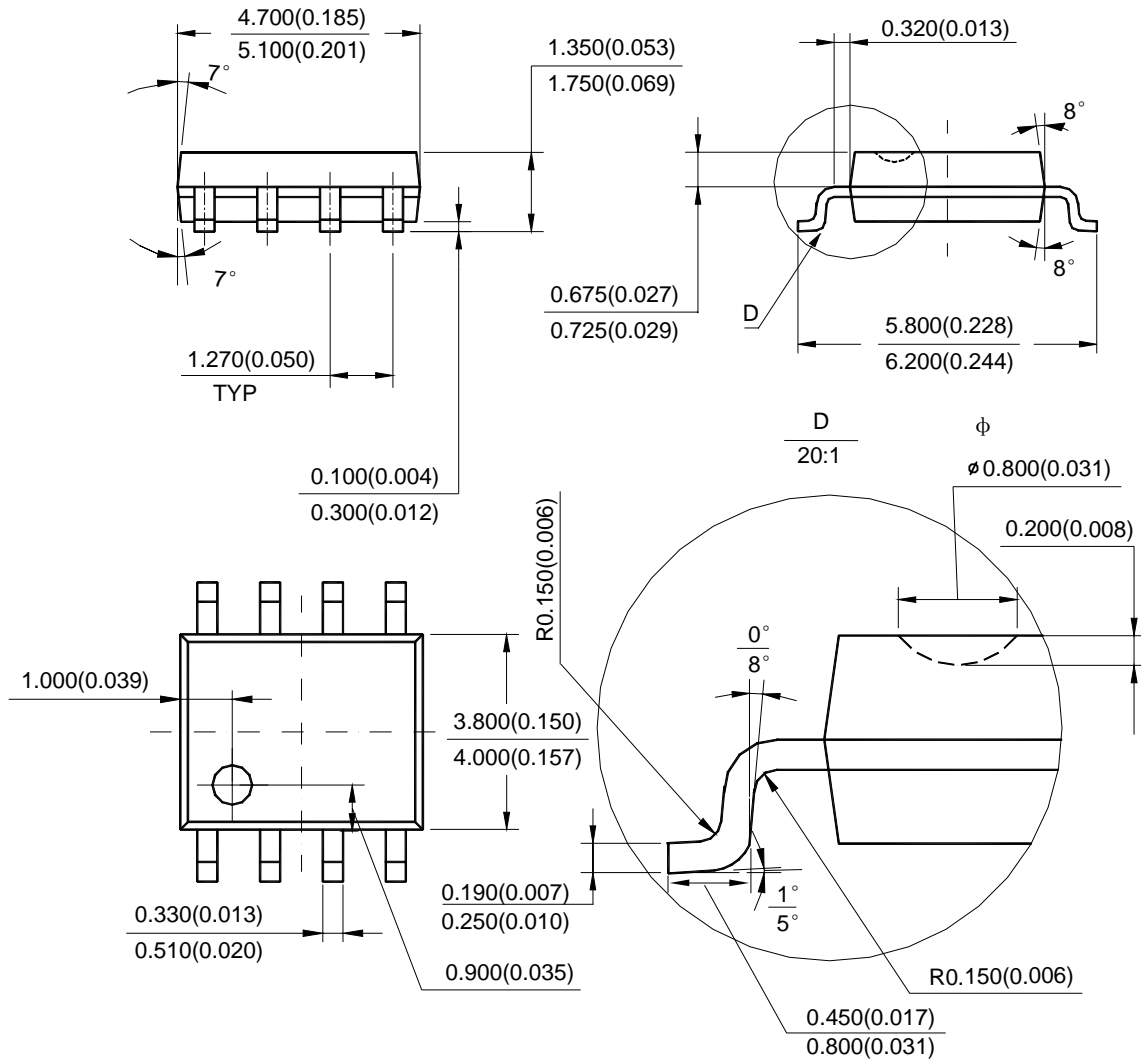


Figure 6. Low Pass Active Filter

# SOP8 Package Outline Dimensions

Unit: mm(inch)

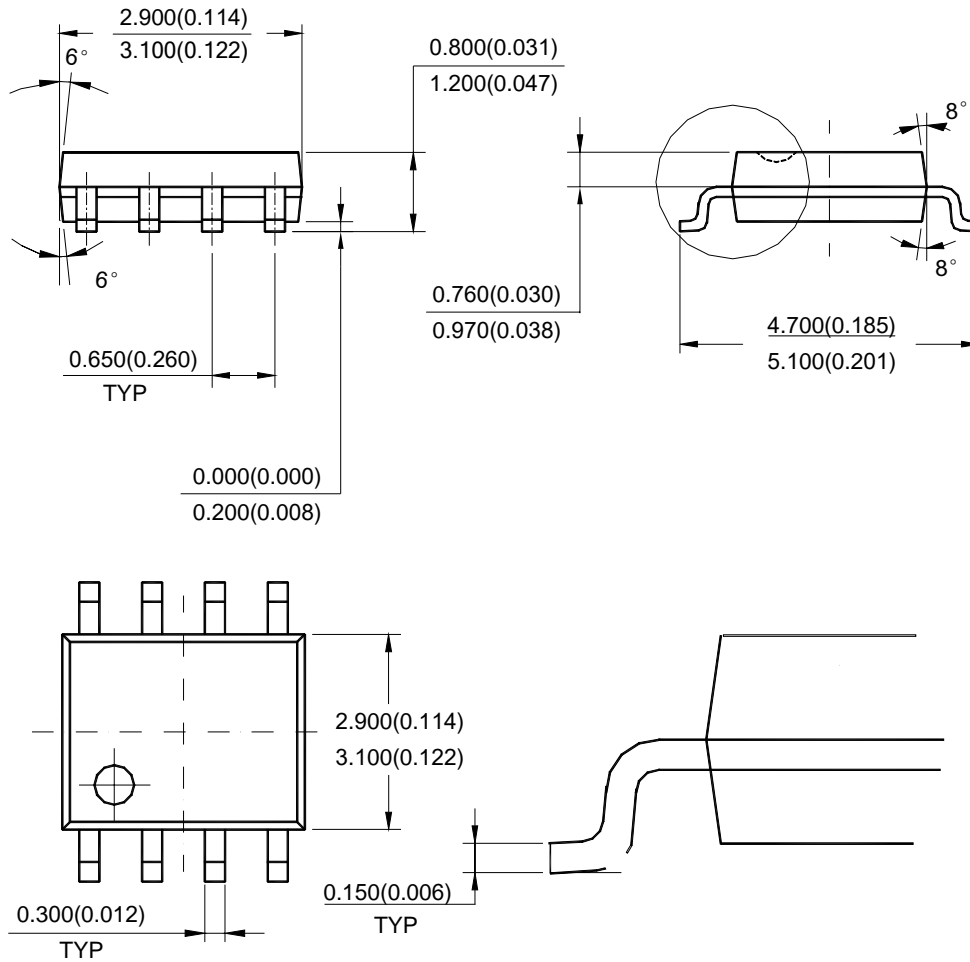


Note: Eject hole, oriented hole and mold mark is optional.



# MSOP8 Package Outline Dimensions

Unit: mm(inch)



Note: Eject hole, oriented hole and mold mark is optional.

# DISCLAIMER

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