# Operational Amplifiers

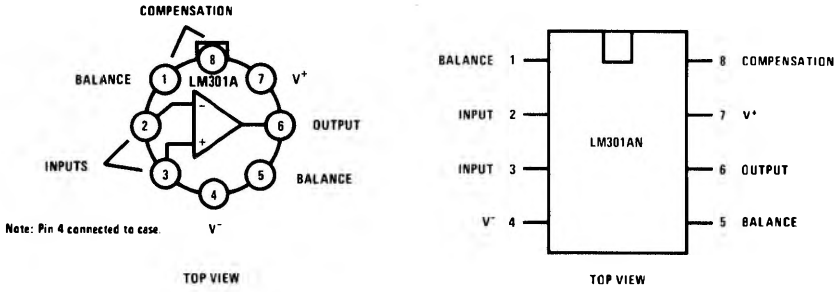
## LM301A operational amplifier general description

The LM301A is a general-purpose operational amplifier which features improved performance over the 709C and other popular amplifiers. Advanced processing techniques make possible an order of magnitude reduction in input currents, and a redesign of the biasing circuitry reduces the temperature drift of input current.

This amplifier offers many features which make its application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, freedom from oscillations and compensation with a single 30 pF capacitor. It has advantages over internally compensated amplifiers in that the compensation can be tailored to the particular application. For example, as a summing amplifier, slew rates of 10 V/$\mu$s and bandwidths of 10 MHz can be realized. In addition, the circuit can be used as a comparator with differential inputs up to ±30V; and the output can be clamped at any desired level to make it compatible with logic circuits.

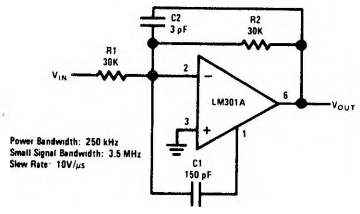
The LM301A provides better accuracy and lower noise than its predecessors in high impedance circuitry. The low input currents also make it particularly well suited for long interval integrators or timers, sample and hold circuits and low frequency waveform generators. Further, replacing circuits where matched transistor pairs buffer the inputs of conventional IC op amps, it can give lower offset voltage and drift at reduced cost.

## connection diagrams

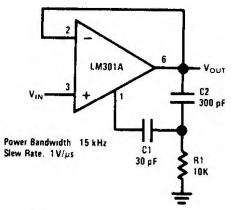



## typical applications

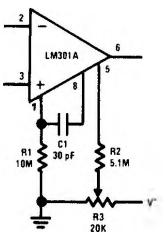
**Fast Summing Amplifier**



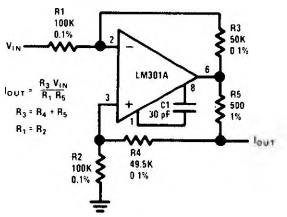

**Fast Voltage Follower**



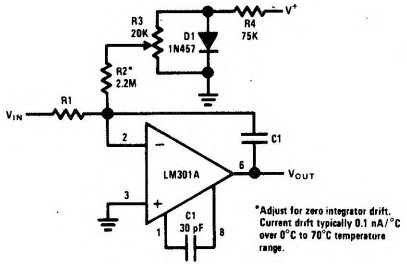

**Standard Compensation and Offset Balancing Circuit**



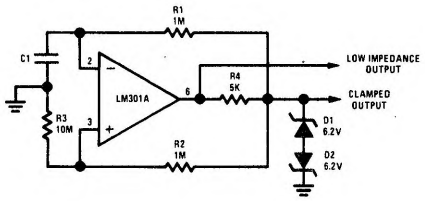

**Bilateral Current Source**



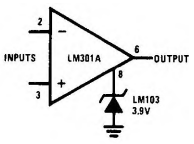

**Integrator with Bias Current Compensation**




**Low Frequency Square Wave Generator**




**Voltage Comparator for Driving DTL or TTL Integrated Circuits**



## absolute maximum ratings

| | |
|---|---|
| Supply Voltage | ±18V |
| Power Dissipation (Note 1) | 500 mW |
| Differential Input Voltage | ±30V |
| Input Voltage (Note 2) | ±15V |
| Output Short-Circuit Duration (Note 3) | Indefinite |
| Operating Temperature Range | 0°C to 70°C |
| Storage Temperature Range | −65°C to 150°C |
| Lead Temperature (Soldering, 60 sec) | 300°C |

## electrical characteristics (Note 4)

| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| Input Offset Voltage | $T_A = 25°C$, $R_S \leq 50\ k\Omega$ | | 2.0 | 7.5 | mV |
| Input Offset Current | $T_A = 25°C$ | | 3 | 50 | nA |
| Input Bias Current | $T_A = 25°C$ | | 70 | 250 | nA |
| Input Resistance | $T_A = 25°C$ | 0.5 | 2 | | MΩ |
| Supply Current | $T_A = 25°C$, $V_S = \pm 15V$ | | 1.8 | 3.0 | mA |
| Large Signal Voltage Gain | $T_A = 25°C$, $V_S = \pm 15V$<br>$V_{OUT} = \pm 10V$; $R_L \geq 2\ k\Omega$ | 25 | 160 | | V/mV |
| Input Offset Voltage | $R_S \leq 50\ k\Omega$ | | | 10 | mV |
| Average Temperature Coefficient of Input Offset Voltage | | | 6.0 | 30 | μV/°C |
| Input Offset Current | | | | 70 | nA |
| Average Temperature Coefficient of Input Offset Current | $25°C \leq T_A \leq 70°C$<br>$0°C \leq T_A \leq 25°C$ | | 0.01<br>0.02 | 0.3<br>0.6 | nA/°C<br>nA/°C |
| Input Bias Current | | | | 300 | nA |
| Large Signal Voltage Gain | $V_S = \pm 15V$, $V_{OUT} = \pm 10V$<br>$R_L \geq 2\ k\Omega$ | 15 | | | V/mV |
| Output Voltage Swing | $V_S = \pm 15V$, $R_L = 10\ k\Omega$<br>$R_L = 2\ k\Omega$ | ±12<br>±10 | ±14<br>±13 | | V<br>V |
| Input Voltage Range | $V_S = \pm 15V$ | ±12 | | | V |
| Common Mode Rejection Ratio | $R_S \leq 50\ k\Omega$ | 70 | 90 | | dB |
| Supply Voltage Rejection Ratio | $R_S \leq 50\ k\Omega$ | 70 | 96 | | dB |

**Note 1:** For operating at elevated temperatures, the device must be derated based on a 100°C maximum junction temperature and a thermal resistance of 150°C/W junction to ambient or 45°C/W junction to case.

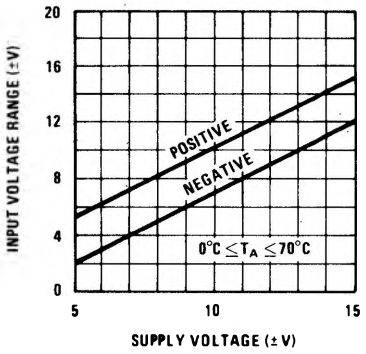
**Note 2:** For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

**Note 3:** Continuous short circuit is allowed for case temperatures to 70°C and ambient temperatures to 55°C.

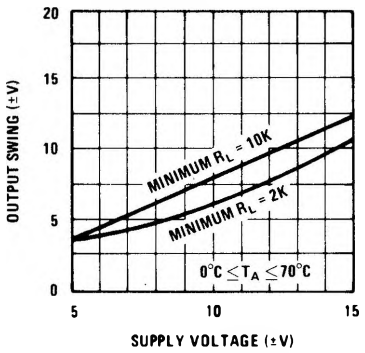
**Note 4:** These specifications apply for $0°C \leq T_A < 70°C$, $\pm 5V \leq V_S \leq \pm 15V$ and C1 = 30 pF unless otherwise specified.

## guaranteed performance

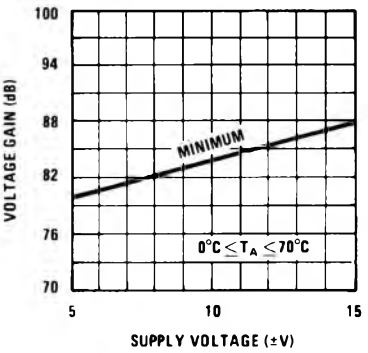
Input Voltage Range




Output Swing

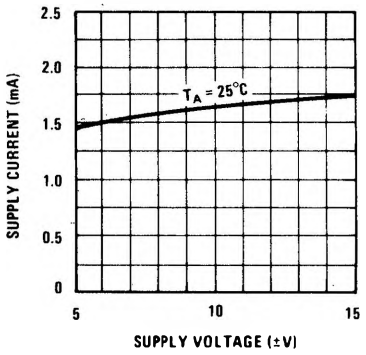



Voltage Gain

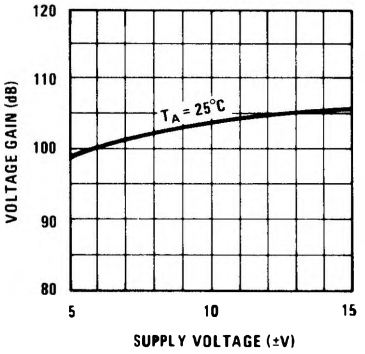



## typical performance

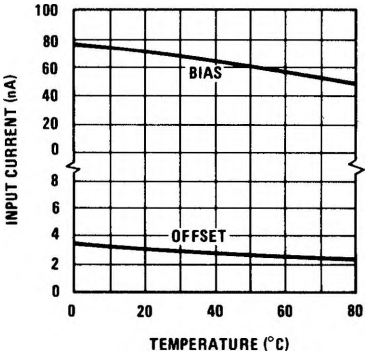
Supply Current



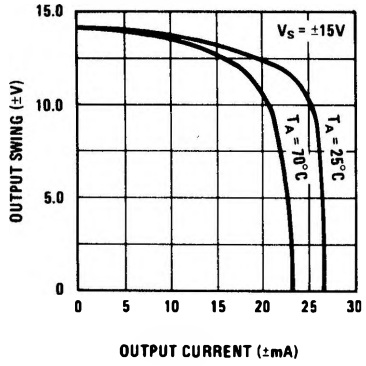

Voltage Gain



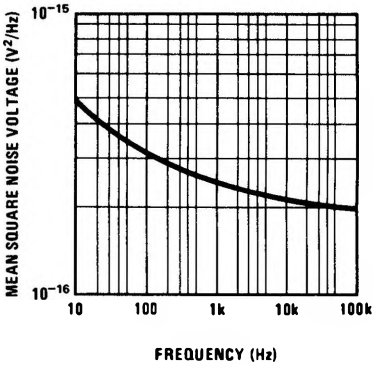

Input Current



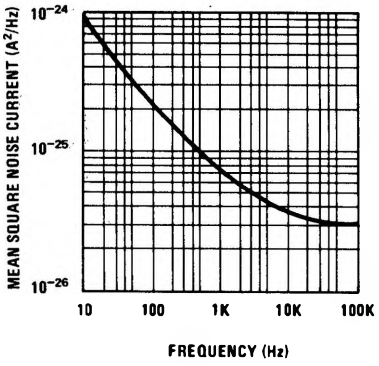

Current Limiting



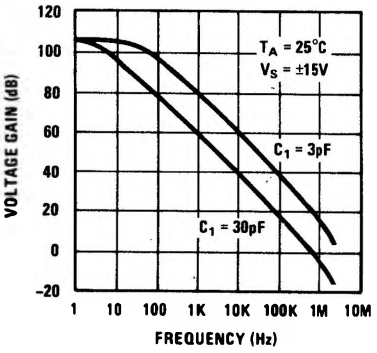

Input Noise Voltage



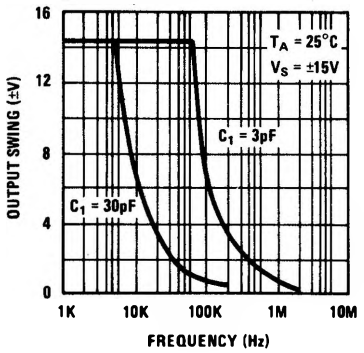

Input Noise Current




Open Loop
Frequency Response




Large Signal
Frequency Response




Voltage Follower
Pulse Response