

#### FEATURES

- Fast Settling Time ..... 1 $\mu$ sec to 0.1% Max.
- High Slew Rate ..... 12V/ $\mu$ sec Min.
- Power Bandwidth ..... 150kHz Min.
- Internally Compensated

#### APPLICATIONS

- D/A Converters
- Pin-for-Pin High-Performance 741 Replacement
- Fast Inverting Amplifier

#### DESCRIPTION

The OP-01 is an internally compensated, inverting, high-speed, high-slew rate amplifier with fast settling time and excellent DC characteristics. The OP-01 has input and output protection. Its use as a direct replacement for 741 operation amplifier results in significant performance enhancement without the need for circuit redesign. Military temperature devices, OP-01 and OP-01G, are available in 8-pin hermetic packages. Commercial temperature range devices, OP-01C and OP-01H, are also available in 8-pin plastic DIP packages.

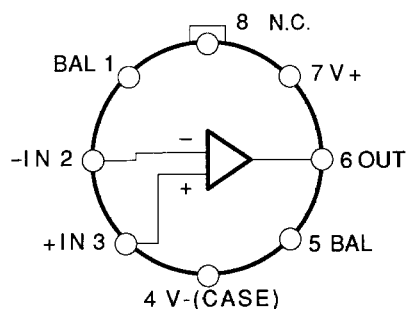
#### ORDERING INFORMATION†

| T <sub>A</sub> =25°C<br>$\Delta V_{OS}$ MAX<br>(mV) | PACKAGE                    |                          |                         |                          | OPERATING<br>TEMPERATURE<br>RANGE |
|---|----------------------------|--------------------------|-------------------------|--------------------------|-----------------------------------|
|   | HERMETIC<br>TO-99<br>8-PIN | HERMETIC<br>DIP<br>8-PIN | PLASTIC<br>DIP<br>8-PIN | PLASTIC<br>SOIC<br>8-PIN |                                   |
| 0.7   | OP01J*                     | OP01Z*                   |                         |                          | MIL                               |
| 0.7   | OP01JH                     | OP01HZ                   | OP01HP                  | OP01HS                   | COM                               |
| 5.0   | OP01GJ*                    | OP01GZ*                  |                         |                          | MIL                               |
| 5.0   | OP01CJ                     | OP01CZ                   | OP01CP                  | OP01CS                   | COM                               |

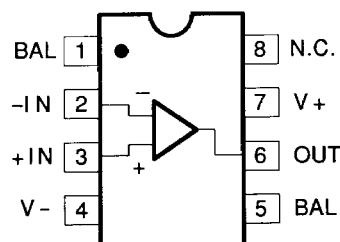
\*For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

†All commercial and industrial temperature range parts are available with burn-in.

#### Pin Connections (Top View)



TO-99 (J-Suffix)



EPOXY MINI-DIP (P-Suffix)  
8-PIN HERMETIC DIP (Z-Suffix)  
8-PIN PLASTIC SOIC (S-Suffix)

**ABSOLUTE MAXIMUM RATINGS (Note 2)**

Total Supply Voltage, OP-01, OP-01H, OP-01N, OP-01NT,  
OP-01G, OP-01GT .....  $\pm 22V$   
OP-01G, OP-01C, OP-01GR .....  $\pm 20V$   
Power Dissipation (Note 1) ..... 500mW  
Differential Input Voltage .....  $\pm 30V$   
Input Voltage (Note 3) .....  $\pm 15V$   
Short-Circuit Duration ..... Indefinite  
Operating Temperature Range  
OP-01, OP-01G .....  $-55^{\circ}C$  to  $+125^{\circ}C$   
OP-01H, OP-01C .....  $0^{\circ}C$  to  $+70^{\circ}C$   
DICE Junction Temperature ( $T_j$ ) .....  $-65^{\circ}C$  to  $+150^{\circ}C$   
Storage Temperature Range  
J and Z Packages .....  $-65^{\circ}C$  to  $+150^{\circ}C$   
P Package .....  $-65^{\circ}C$  to  $+125^{\circ}C$   
Lead Temperature (Soldering, 60 sec.) .....  $300^{\circ}C$

**NOTES:**

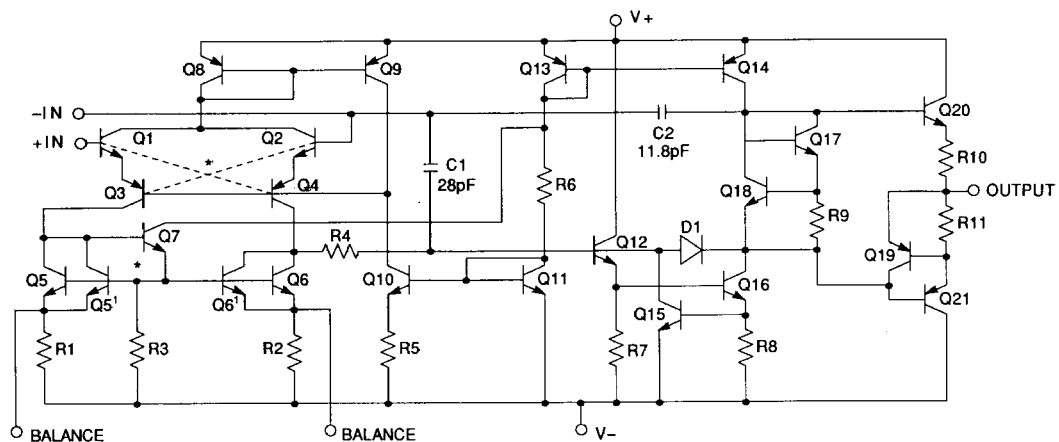
1. See table for maximum ambient temperature rating and derating factor.

| PACKAGE TYPE           | MAXIMUM AMBIENT TEMPERATURE FOR RATING | DERATE ABOVE MAXIMUM AMBIENT TEMPERATURE |
|------------------------|--|--|
| TO-99 (J)              | $80^{\circ}C$                          | $7.1mW/^{\circ}C$                        |
| 8-Pin Hermetic DIP (Z) | $75^{\circ}C$                          | $6.7mW/^{\circ}C$                        |
| 8-Pin Plastic DIP (P)  | $35^{\circ}C$                          | $5.6mW/^{\circ}C$                        |

2. Absolute maximum ratings apply to both packaged parts and DICE, unless otherwise noted.

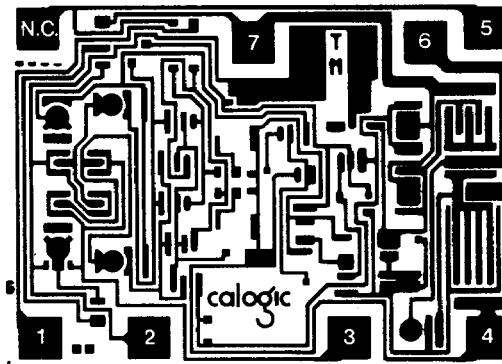
3. For supply voltages less than  $\pm 15V$ , the maximum input voltage is the supply voltage.

**Simplified Schematic Diagram**



\* Q1, Q2, Q3, AND Q4 FORM A THERMALLY CROSS-COUPLED QUAD. Q5, Q5', Q6, AND Q6' COMPRISE A SIMILAR THERMALLY CROSS-COUPLED QUAD.

**Die Dimensions and Pad Connections**



1. BALANCE
2. (-) INPUT
3. (+) INPUT
4. V-
5. BALANCE
6. OUTPUT
7. V+

DIE SIZE 0.063x0.047 inch, 2961 sq. mils  
(1.6x1.194mm, 1.91 sq. mm)

**ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 15V$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

| PARAMETER                                  | SYMBOL   | CONDITIONS   | OP-01, OP-01H            |                          |      | OP-01G, OP-01C           |                          |      | UNITS      |
|--|----------|--|--------------------------|--------------------------|------|--------------------------|--------------------------|------|------------|
|  |          |  | MIN.                     | TYP.                     | MAX. | MIN.                     | TYP.                     | MAX. |            |
| Input Offset Voltage                       | $V_{OS}$ | $R_S \leq 20k\Omega$                               | —                        | 0.3                      | 0.7  | —                        | 2.0                      | 5.0  | mV         |
| Input Offset Current                       | $I_{OS}$ |  | —                        | 0.5                      | 2.0  | —                        | 2.0                      | 20   | nA         |
| Input Bias Current                         | $I_B$    |  | —                        | 18                       | 30   | —                        | 25                       | 100  | nA         |
| Input Voltage Range                        | IVR      |  | $\pm 12$                 | $\pm 13$                 | —    | $\pm 12$                 | $\pm 13$                 | —    | V          |
| Common-Mode Rejection Ratio                | CMRR     | $V_{CM} = \pm 10V$ , $R_S \leq 20k\Omega$          | 85                       | 110                      | —    | 80                       | 100                      | —    | dB         |
| Power Supply Rejection Ratio               | PSRR     | $V_S = \pm 5V$ to $\pm 20V$ , $R_S \leq 20k\Omega$ | —                        | 10                       | 60   | —                        | 100                      | 150  | $\mu V/V$  |
| Output Voltage Swing                       | $V_O$    | $R_L \geq 5k\Omega$<br>$R_L \geq 2k\Omega$         | $\pm 12.5$<br>$\pm 12.0$ | $\pm 13.5$<br>$\pm 13.0$ | —    | $\pm 12.5$<br>$\pm 12.0$ | $\pm 13.5$<br>$\pm 13.0$ | —    | V          |
| Large-Signal Voltage Gain                  | $A_{VO}$ | $R_L \geq 2k\Omega$ , $V_O = \pm 10V$              | 50                       | 100                      | —    | 25                       | 75                       | —    | V/mV       |
| Power Consumption                          | $P_d$    | $V_{OUT} = 0$                                      | —                        | 50                       | 90   | —                        | 50                       | 90   | mW         |
| Settling Time to 0.1% (Summing Node Error) | $t_S$    | $A_V = -1$ (Notes 1, 2), $V_{IN} = 5V$             | —                        | 0.7                      | 1.0  | —                        | 0.7                      | 1.0  | $\mu s$    |
| Slew Rate (Notes 2, 3)                     | SR       | $A_V = -1$ , $R_S = 3k$ to $5k\Omega$              | 12                       | 18                       | —    | 12                       | 18                       | —    | V/ $\mu s$ |
| Large-Signal Bandwidth (Notes 3, 4)        |          |  | 150                      | 250                      | —    | 150                      | 250                      | —    | kHz        |
| Small-Signal Bandwidth (Notes 3, 4)        |          |  | 1.5                      | 2.5                      | —    | 1.5                      | 2.5                      | —    | MHz        |
| Risetime                                   | $t_r$    | $A_V = -1$ , $V_{IN} = 50mV$                       | —                        | 150                      | —    | —                        | 150                      | —    | ns         |
| Overshoot                                  | OS       |  | —                        | 2                        | —    | —                        | 2                        | —    | %          |

- NOTES:**
1.  $R_L = 25k\Omega$ ;  $C_L = 50pF$ . See Settling Time Test Circuit
  2. Sample Tested.
  3. See applications information.
  4. Guaranteed by design.

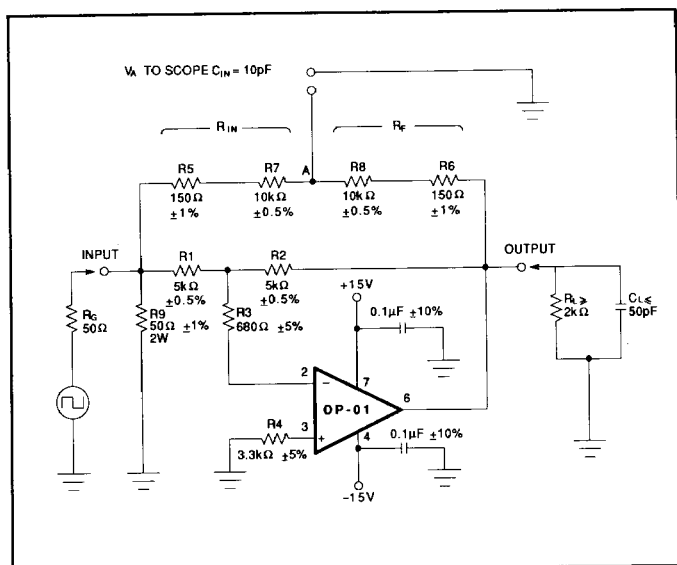
**ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 15V$ ,  $-55^\circ C \leq T_A \leq +125^\circ C$  for OP-01, OP-01G and  $0^\circ C \leq T_A \leq +70^\circ C$  for OP-01H, OP-01C, unless otherwise noted.

| PARAMETER                     | SYMBOL     | CONDITIONS   | OP-01, OP-01H            |                          |      | OP-01G, OP-01C           |                          |      | UNITS            |
|-------------------------------|------------|--|--------------------------|--------------------------|------|--------------------------|--------------------------|------|------------------|
|                               |            |  | MIN.                     | TYP.                     | MAX. | MIN.                     | TYP.                     | MAX. |                  |
| Input Offset Voltage          | $V_{OS}$   | $R_S \leq 20k\Omega$                               | —                        | 0.4                      | 1.0  | —                        | 3.0                      | 6.0  | mV               |
| Input Offset Current          | $I_{OS}$   |  | —                        | 1                        | 4    | —                        | 4                        | 40   | nA               |
| Input Bias Current            | $I_B$      |  | —                        | 30                       | 50   | —                        | 50                       | 200  | nA               |
| Input Voltage Range           | IVR        |  | $\pm 10$                 | $\pm 13$                 | —    | $\pm 10$                 | $\pm 13$                 | —    | dB               |
| Common-Mode Rejection Ratio   | CMRR       | $V_{CM} = \pm 10V$ , $R_S \leq 20k\Omega$          | 85                       | 110                      | —    | 80                       | 100                      | —    | V                |
| Power Supply Rejection Ratio  | PSRR       | $V_S = \pm 5V$ to $\pm 20V$ , $R_S \leq 20k\Omega$ | —                        | 10                       | 60   | —                        | 100                      | 150  | $\mu V/V$        |
| Large-Signal Voltage Gain     | $A_{VO}$   | $R_L \geq 2k\Omega$ , $V_O = \pm 10V$              | 30                       | 60                       | —    | 15                       | 50                       | —    | V/mV             |
| Output Voltage Swing          | $V_O$      | $R_L \geq 5k\Omega$<br>$R_L \geq 2k\Omega$         | $\pm 12.5$<br>$\pm 12.0$ | $\pm 13.5$<br>$\pm 13.0$ | —    | $\pm 12.5$<br>$\pm 12.0$ | $\pm 13.5$<br>$\pm 13.0$ | —    | V                |
| Offset Voltage Drift (Note 1) | $TCV_{OS}$ | $R_S \leq 5k\Omega$                                | —                        | 2                        | 8    | —                        | 5                        | 20   | $\mu V/^\circ C$ |

- NOTE:**
1. Sample Tested.

### SETTLING-TIME TEST CIRCUIT

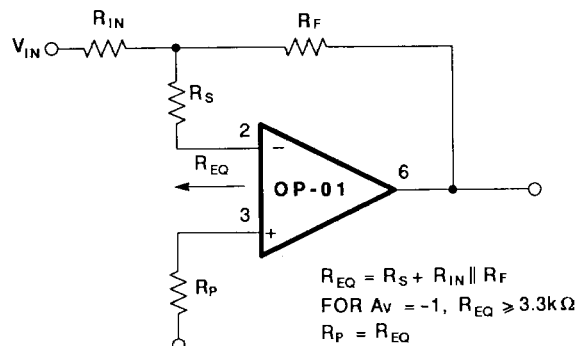
Settling time may be measured using the circuit shown below. This circuit incorporates the “false sum node” technique to produce accurate, repeatable results. For a 5V input step, 0.1% settling will be achieved when the false sum node settles to within  $\pm 2.5\text{mV}$  of its final value. The oscilloscope used for observation of the false sum node should have wide bandwidth, fast overload recovery time, and be used with a low capacity probe ( $\leq 10\text{pF}$ , including strays). A Tektronix 7504 scope with a 7A11 probe or equivalent is suggested. The pulse generator should have a  $50\Omega$  output impedance and be capable of a 5V rise time in  $\leq 20\text{ns}$  with ringing less than  $2.5\text{mV}$  after  $0.5\mu\text{s}$ . Measurements to 0.1% require  $R_{\text{IN}}$  to equal  $R_{\text{F}}$  within 0.01%;  $R_5$  and  $R_6$  are used as trimming resistors to achieve this matching.



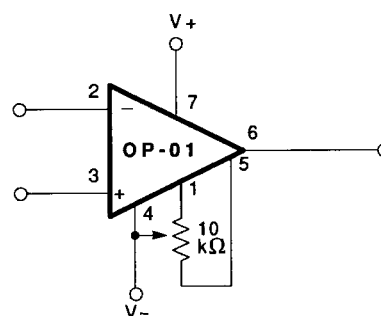
## APPLICATIONS INFORMATION

The OP-01 incorporates an internal feed-forward compensation network to provide fast slewing and settling times in all inverting and moderate-to-high-gain noninverting applications. Unity-gain bandwidth is a function of the total equivalent source resistance seen by the inverting terminal. Proper choice of this resistance will allow the user to maximize bandwidth while assuring proper stability. The equivalent-inverting-terminal-resistance is defined as  $R_{IN} || R_F$ , and it must be greater than

### Fast Inverting Amplifier



### Offset Nulling Circuit



3.3k $\Omega$  to assure stability in all closed-loop gain configurations including unity gain. Should  $R_{IN} || R_F \leq 3.3k\Omega$ , a resistor ( $R_S$ ) may be placed between the inverting input and the sum node to provide the required resistance. (See Fast Inverting Amplifier Diagram.) Lower values to total equivalent resistance may be used to improve bandwidth in higher closed-loop gain configurations.