

# LM101A, LM201A, LM301A HIGH-PERFORMANCE OPERATIONAL AMPLIFIERS

D961, OCTOBER 1979 – REVISED SEPTEMBER 1990

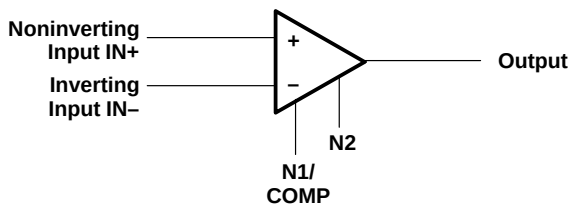
- Low Input Currents
- Low Input Offset Parameters
- Frequency and Transient Response Characteristics Adjustable
- Short-Circuit Protection
- Offset-Voltage Null Capability
- No Latch-Up
- Wide Common-Mode and Differential Voltage Ranges
- Same Pin Assignments as uA709
- Designed to be Interchangeable with National Semiconductor LM101A and LM301A

## description

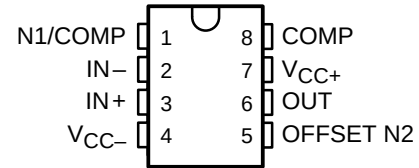
The LM101A, LM201A, and LM301A are high-performance operational amplifiers featuring very low input bias current and input offset voltage and current to improve the accuracy of high-impedance circuits using these devices. The high common-mode input voltage range and the absence of latch-up make these amplifiers ideal for voltage-follower applications. The devices are protected to withstand short circuits at the output. The external compensation of these amplifiers allows the changing of the frequency response (when the closed-loop gain is greater than unity) for applications requiring wider bandwidth or higher slew rate. A potentiometer may be connected between the offset-null inputs (N1 and N2), as shown in Figure 7, to null out the offset voltage.

The LM101A is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , the LM201A is characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , and the LM301A is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

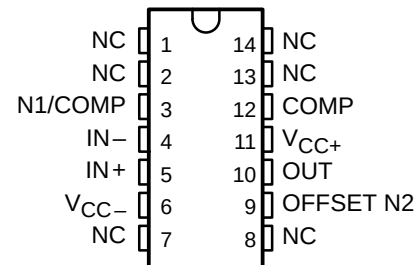
## symbol



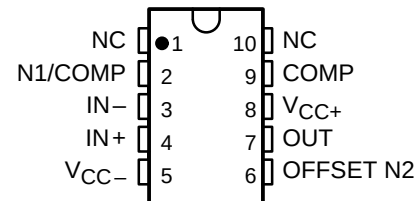
**D, JG, OR P PACKAGE  
(TOP VIEW)**



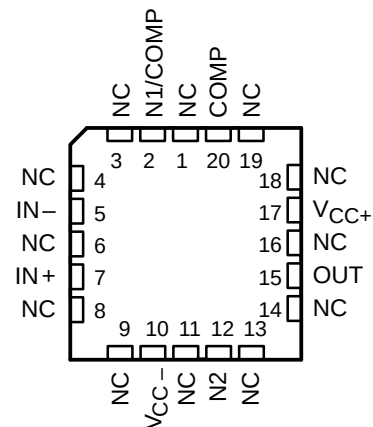
**LM101A  
W FLAT PACKAGE  
(TOP VIEW)**



**LM101A  
U FLAT PACKAGE  
(TOP VIEW)**



**LM101A  
FK CHIP-CARRIER PACKAGE  
(TOP VIEW)**



NC – No internal connection

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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# LM101A, LM201A, LM301A

## HIGH-PERFORMANCE OPERATIONAL AMPLIFIERS

### AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> MAX<br>at 25°C | PACKAGE              |                      |                     |                    |                     |                  |
|----------------|--------------------------------|----------------------|----------------------|---------------------|--------------------|---------------------|------------------|
|                |                                | SMALL OUTLINE<br>(D) | CHIP CARRIER<br>(FK) | CERAMIC DIP<br>(JG) | PLASTIC DIP<br>(P) | FLAT<br>PACK<br>(U) | FLAT PACK<br>(W) |
| 0°C to 70°C    | 7.5 mV                         | LM301AD              | –                    | –                   | LM301AP            | –                   | –                |
| –25°C to 85°C  | 2 mV                           | LM201AD              | –                    | –                   | LM201AP            | –                   | –                |
| –55°C to 125°C | 2 mV                           | LM101AD              | LM101AFK             | LM101AJG            | LM101AP            | LM101AU             | LM101AW          |

The D package is available taped and reeled. Add the suffix R to the device type, (i.e., LM301ADR).

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

|                                                                   |                     | LM101A                       | LM201A     | LM301A     | UNIT |
|-------------------------------------------------------------------|---------------------|------------------------------|------------|------------|------|
| Supply voltage $V_{CC+}$ (see Note 1)                             |                     | 22                           | 22         | 18         | V    |
| Supply voltage $V_{CC-}$ (see Note 1)                             |                     | −22                          | −22        | −18        | V    |
| Differential input voltage (see Note 2)                           |                     | ±30                          | ±30        | ±30        | V    |
| Input voltage (either input, see Notes 1 and 3)                   |                     | ±15                          | ±15        | ±15        | V    |
| Voltage between either offset null terminal (N1/N2) and $V_{CC-}$ |                     | −0.5 to 2                    | −0.5 to 2  | −0.5 to 2  | V    |
| Duration of output short-circuit (see Note 4)                     |                     | unlimited                    | unlimited  | unlimited  |      |
| Continuous total power dissipation                                |                     | See Dissipation Rating Table |            |            |      |
| Operating free-air temperature range                              |                     | −55 to 125                   | −25 to 85  | 0 to 70    | °C   |
| Storage temperature range                                         |                     | −65 to 150                   | −65 to 150 | −65 to 150 | °C   |
| Case temperature for 60 seconds: FK package                       |                     | 260                          |            |            | °C   |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds      | JG, U, or W package | 300                          |            |            | °C   |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds      | D or P package      | 260                          | 260        | 260        | °C   |

- NOTES: 1. All voltage values, unless otherwise noted, are with respect to the midpoint between V<sub>CC+</sub> and V<sub>CC–</sub>.  
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.  
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.  
4. The output may be shorted to ground or either power supply. For the LM101A only, the unlimited duration of the short-circuit applies at (or above) 125°C case temperature or 75°C free-air temperature. For the LM201A only, the unlimited duration of the short-circuit applies at (or below) 85°C case temperature or 75°C free-air temperature.

### DISSIPATION RATING TABLE

| PACKAGE | T <sub>A</sub> ≤ 25°C<br>POWER RATING | DERATING<br>FACTOR | DERATE<br>ABOVE T <sub>A</sub> | T <sub>A</sub> = 70°C<br>POWER RATING | T <sub>A</sub> = 85°C<br>POWER RATING | T <sub>A</sub> = 125°C<br>POWER RATING |
|---------|---------------------------------------|--------------------|--------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| D       | 500 mW                                | 5.8 mW/°C          | 64°C                           | 464 mW                                | 377 mW                                | 145 mW                                 |
| FK      | 500 mW                                | 11.0 mW/°C         | 105°C                          | 500 mW                                | 500 mW                                | 275 mW                                 |
| JG      | 500 mW                                | 8.4 mW/°C          | 90°C                           | 500 mW                                | 500 mW                                | 210 mW                                 |
| P       | 500 mW                                | 8.0 mW/°C          | 87°C                           | 500 mW                                | 500 mW                                | 200 mW                                 |
| U       | 500 mW                                | 5.4 mW/°C          | 57°C                           | 432 mW                                | 351 mW                                | 135 mW                                 |
| W       | 500 mW                                | 8.0 mW/°C          | 87°C                           | 500 mW                                | 500 mW                                | 200 mW                                 |

### recommended operating conditions

|                                  | MIN | MAX | UNIT |
|----------------------------------|-----|-----|------|
| Supply voltage, V <sub>CC+</sub> | 5   | 18  | V    |
| Supply voltage, V <sub>CC–</sub> | –5  | –18 | V    |



# LM101A, LM201A, LM301A

## HIGH-PERFORMANCE OPERATIONAL AMPLIFIERS

electrical characteristics at specified free-air temperature,  $C_C = 30$  pF (see Note 5)

| PARAMETER      |                                                                     | TEST CONDITIONS†                                                        |            | LM101A, LM201A |     |     | LM301A   |     |     | UNIT                         |
|----------------|---------------------------------------------------------------------|-------------------------------------------------------------------------|------------|----------------|-----|-----|----------|-----|-----|------------------------------|
|                |                                                                     |                                                                         |            | MIN            | TYP | MAX | MIN      | TYP | MAX |                              |
| $V_{IO}$       | Input offset voltage                                                | $V_O = 0$                                                               | 25°C       | 0.6            | 2   |     | 2        | 7.5 |     | mV                           |
|                |                                                                     |                                                                         | Full range |                |     | 3   |          |     | 10  |                              |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage             | $V_O = 0$                                                               | Full range | 3              | 15  |     | 6        | 30  |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$       | Input offset current                                                |                                                                         | 25°C       | 1.5            | 10  |     | 3        | 50  |     | nA                           |
|                |                                                                     |                                                                         | Full range |                |     | 20  |          |     | 70  |                              |
| $\alpha_{IIO}$ | Average temperature coefficient of input offset current             | $T_A = -55^\circ\text{C}$ to $25^\circ\text{C}$                         |            | 0.02           | 0.2 |     |          |     |     | nA/ $^\circ\text{C}$         |
|                |                                                                     | $T_A = 25^\circ\text{C}$ to MAX                                         |            | 0.01           | 0.1 |     |          |     |     |                              |
|                |                                                                     | $T_A = 0^\circ\text{C}$ to $25^\circ\text{C}$                           |            |                |     |     | 0.02     | 0.6 |     |                              |
|                |                                                                     | $T_A = 25^\circ\text{C}$ to $70^\circ\text{C}$                          |            |                |     |     | 0.01     | 0.3 |     |                              |
| $I_{IB}$       | Input bias current                                                  |                                                                         | 25°C       | 30             | 75  |     | 70       | 250 |     | nA                           |
|                |                                                                     |                                                                         | Full range |                |     | 100 |          |     | 300 |                              |
| $V_{ICR}$      | Common-mode input voltage range                                     | See Note 6                                                              | Full range | $\pm 15$       |     |     | $\pm 12$ |     |     | V                            |
| $V_{OPP}$      | Maximum peak-to-peak output voltage swing                           | $V_{CC\pm} = \pm 15$ V,<br>$R_L = 10$ k $\Omega$                        | 25°C       | 24             | 28  |     | 24       | 28  |     | V                            |
|                |                                                                     |                                                                         | Full range | 24             |     |     | 24       |     |     |                              |
|                |                                                                     | $V_{CC\pm} = \pm 15$ V,<br>$R_L = 2$ k $\Omega$                         | 25°C       | 20             | 26  |     | 20       | 26  |     |                              |
|                |                                                                     |                                                                         | Full range | 20             |     |     | 20       |     |     |                              |
| $A_{VD}$       | Large-signal differential voltage amplification                     | $V_{CC\pm} = \pm 15$ V,<br>$V_O = \pm 10$ V,<br>$R_L \geq 2$ k $\Omega$ | 25°C       | 50             | 200 |     | 25       | 200 |     | V/mV                         |
|                |                                                                     |                                                                         | Full range | 25             |     |     | 15       |     |     |                              |
| $r_i$          | Input resistance                                                    |                                                                         | 25°C       | 1.5            | 4   |     | 0.5      | 2   |     | M $\Omega$                   |
| CMRR           | Common-mode rejection ratio                                         | $V_{IC} = V_{ICR \text{ min}}$                                          | 25°C       | 80             | 98  |     | 70       | 90  |     | dB                           |
|                |                                                                     |                                                                         | Full range | 80             |     |     | 70       |     |     |                              |
| $k_{SVR}$      | Supply voltage rejection ratio<br>( $\Delta V_{CC}/\Delta V_{IO}$ ) |                                                                         | 25°C       | 80             | 98  |     | 70       | 96  |     | dB                           |
|                |                                                                     |                                                                         | Full range | 80             |     |     | 70       |     |     |                              |
| $I_{CC}$       | Supply current                                                      | No load, $V_O = 0$ ,<br>See Note 6                                      | 25°C       | 1.8            | 3   |     | 1.8      | 3   |     | mA                           |
|                |                                                                     |                                                                         | MAX        | 1.2            | 2.5 |     |          |     |     |                              |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for LM101A is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ , for LM201A is  $-25^\circ\text{C}$  to  $85^\circ\text{C}$ , and for LM301A is  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

NOTES: 5. Unless otherwise noted,  $V_{CC\pm} = \pm 5$  V to  $\pm 20$  V for LM101A and LM201A, and  $V_{CC\pm} = \pm 5$  V to  $\pm 15$  V for LM301A. All typical values are at  $V_{CC\pm} = \pm 15$  V.

6. For LM101A and LM201A,  $V_{CC\pm} = \pm 20$  V. For LM301A,  $V_{CC\pm} = \pm 15$  V.

# TYPICAL CHARACTERISTICS

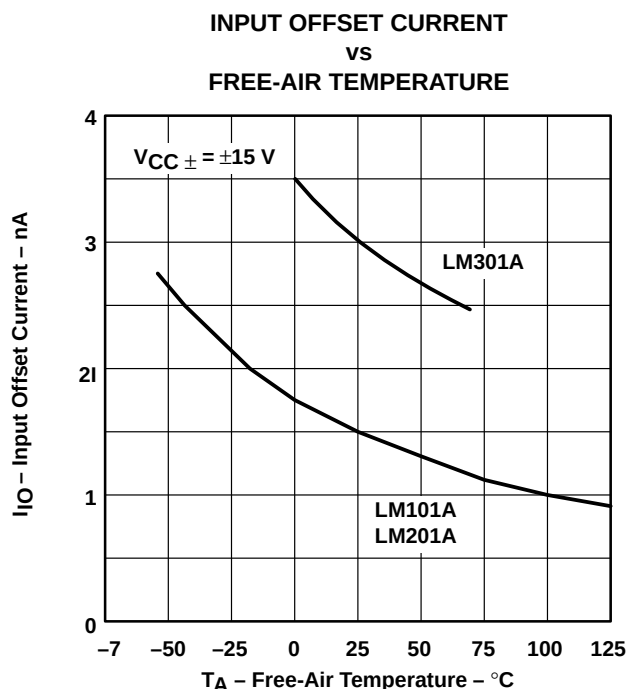


Figure 1

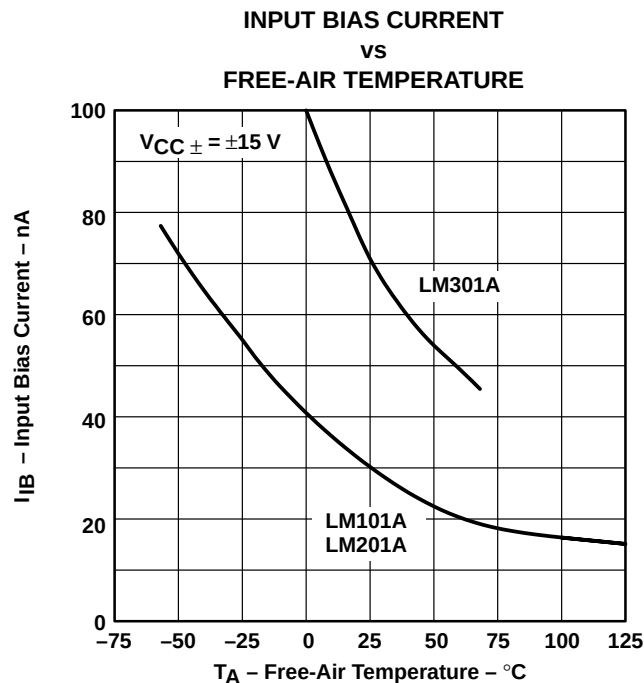


Figure 2

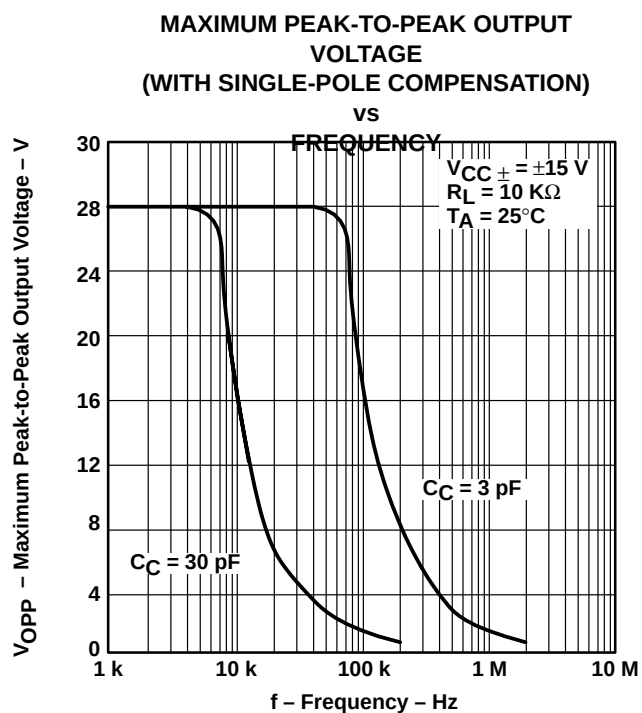


Figure 3

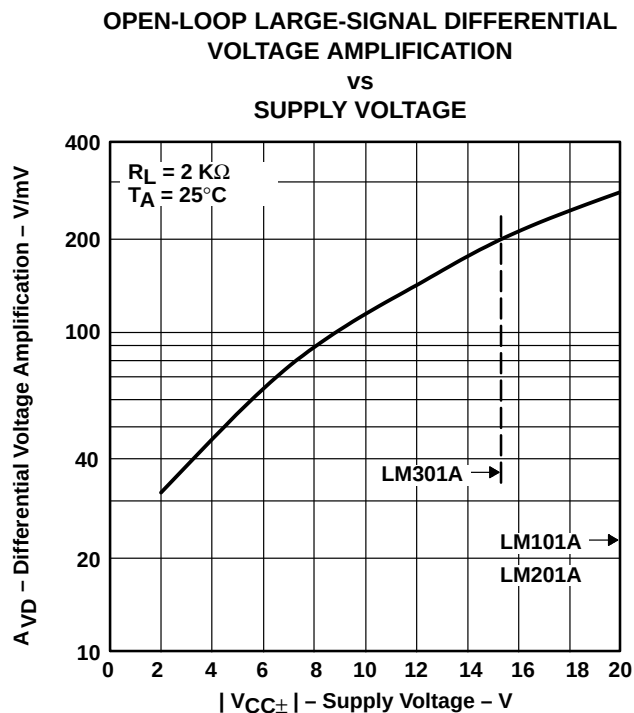


Figure 4

## TYPICAL CHARACTERISTICS

### OPEN-LOOP LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION

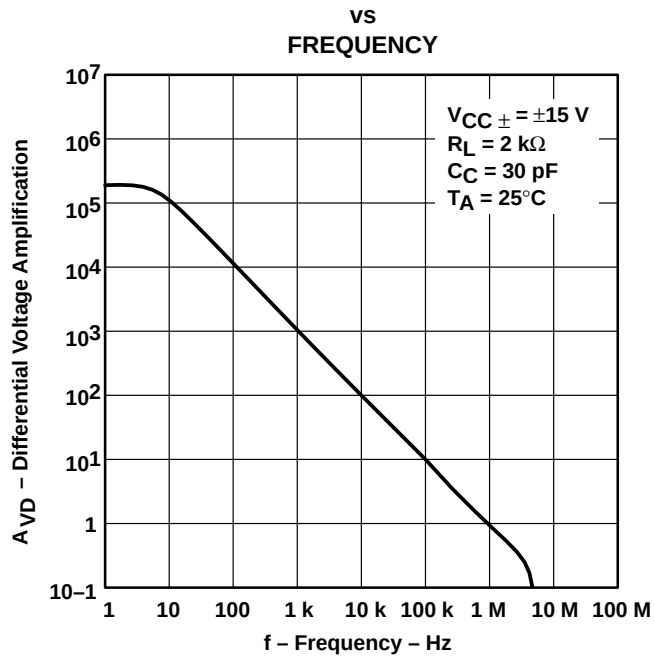


Figure 5

### VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

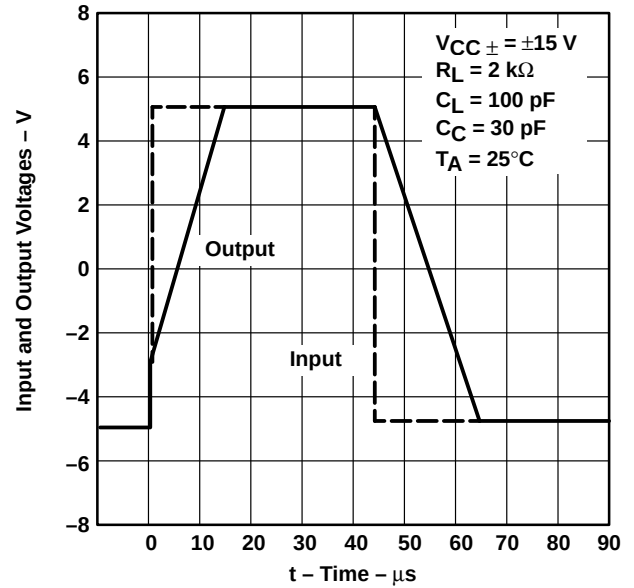
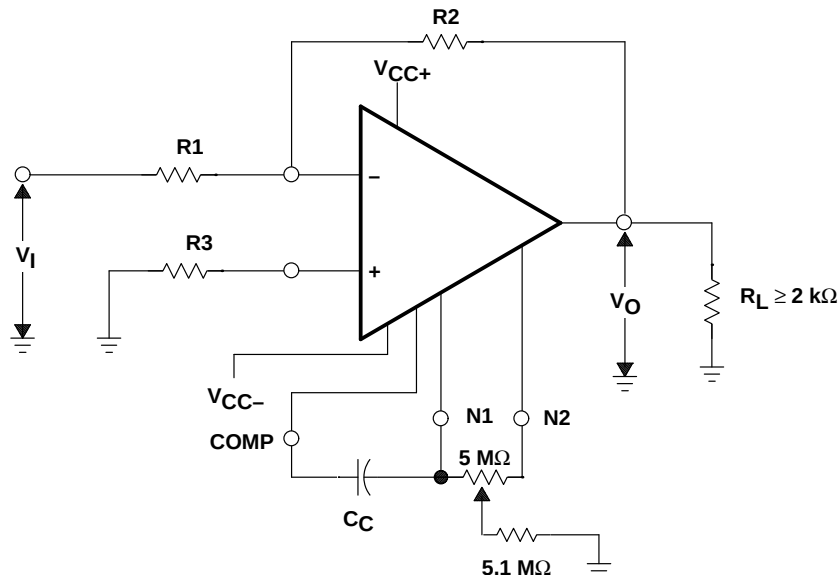


Figure 6

## TYPICAL APPLICATION DATA



$$\frac{V_O}{V_I} = - \frac{R_2}{R_1}$$

$$C_C \geq \frac{R_1 \cdot 30 \text{ pF}}{R_1 + R_2}$$

$$R_3 = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Figure 7. Inverting Circuit with Adjustable Gain, Single-Pole Compensation, and Offset Adjustment



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