

# Dual/Quad Micropower, 1MHz C-Load Picoampere Bias Current JFET Input Op Amps

## FEATURES

- **Input Bias Current:**  
     **2pA Max (LT1464A)**  
     **20pA Max (LT1464, LT1465)**
- **Supply Current per Amplifier: 200µA Max**
- **Gain Bandwidth Product: 1MHz Typ**
- **Slew Rate: 0.9V/µs Typ**
- **Input Common Mode Range Includes Positive Rail**
- **Unity-Gain Stable for C-Load™ Up to 10nF**
- **Open-Loop Gain: 1 Million Typ**
- **Guaranteed Specs with ±5V, ±15V Supplies**
- **Guaranteed Matching Specifications**
- **Standard Pinout: SO-8, SO-14 Package**

## APPLICATIONS

- Battery-Powered Systems
- Photocurrent Amplifiers
- Low Frequency, Micropower Active Filters
- Low Droop Track-and-Hold Circuits

## DESCRIPTION

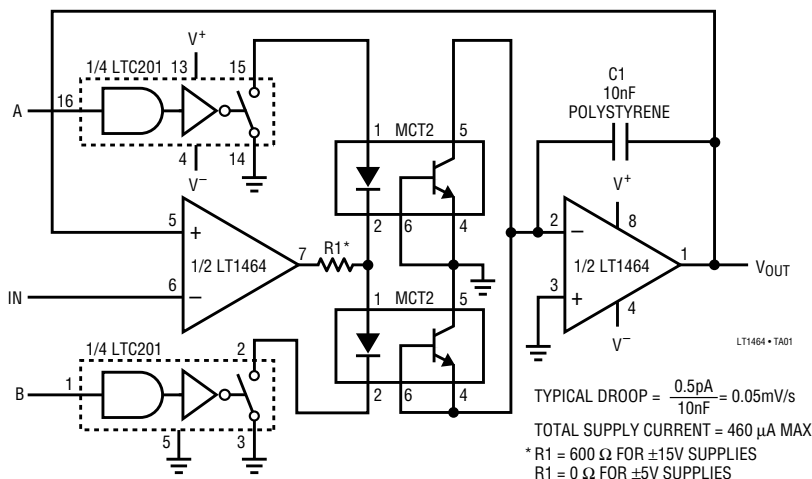
The LT®1464 (dual) and LT1465 (quad) are the first micropower op amps (200µA max per amp) to offer picoampere input bias currents (500fA typ) and unity-gain stability for capacitive loads up to 10nF. The output can swing a 10k load to within 1.5V of either supply, just like op amps that require an order of magnitude more supply current. This unique combination of performance makes the LT1464/LT1465 ideal over a wide range of input and output impedances.

In the design and testing of the LT1464/LT1465, particular emphasis has been placed on optimizing performance in the low cost SO-8 (dual) and 14-lead SO (quad) package for ±15V and ±5V supplies. The input common mode range includes the positive rail. Slew rate (0.5V/µs min) and gain bandwidth product (650kHz min) are 100% tested. A full set of matching specifications is also provided.

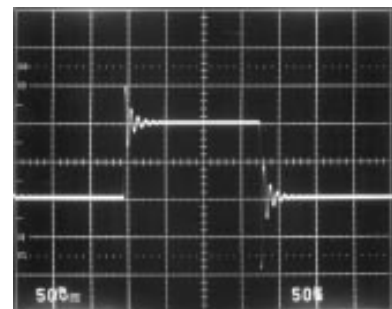
LT, LTC and LT are registered trademarks of Linear Technology Corporation.  
 C-Load is a trademark of Linear Technology Corporation.

## TYPICAL APPLICATION

### Micropower Low Droop Track-and-Hold/Peak Detector



### Small-Signal Response, C<sub>LOAD</sub> = 10nF



A<sub>V</sub> = 1  
 V<sub>S</sub> = ±5V, ±15V  
 C<sub>L</sub> = 10nF

1464 • TA02

| FUNCTION               | MODE  | IN A | IN B | MODE  | IN A | IN B |
|------------------------|-------|------|------|-------|------|------|
| Track-and-Hold         | Track | 0    | 0    | Hold  | 1    | 1    |
| Positive Peak Detector | Reset | 0    | 0    | Store | 0    | 1    |
| Negative Peak Detector | Reset | 0    | 0    | Store | 1    | 0    |

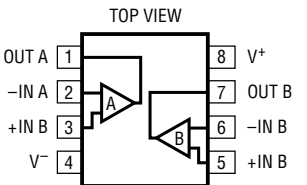
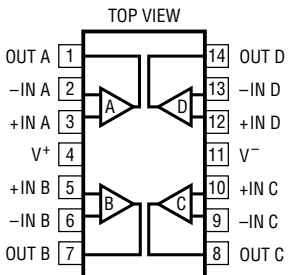
LTC201 switch is open for logic "1".

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage .....  $\pm 20\text{V}$   
 Differential Input Voltage .....  $\pm 40\text{V}$   
 Input Current .....  $20\text{mA}$   
 Output Short-Circuit Duration ..... Indefinite  
 Operating Temperature Range .....  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$

Specified Temperature Range .....  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$   
 Maximum Junction Temperature .....  $150^{\circ}\text{C}$   
 Storage Temperature Range .....  $-65^{\circ}\text{C}$  to  $150^{\circ}\text{C}$   
 Lead Temperature (Soldering, 10 sec) .....  $300^{\circ}\text{C}$

## PACKAGE/ORDER INFORMATION

|                                                                                                                                                                                                                                                                                                                                                                             |                                                    |                                                                                                                                                                                                                                                                                                                                                                              |                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|  <p>N8 PACKAGE<br/>8-LEAD PDIP</p> <p>S8 PACKAGE<br/>8-LEAD PLASTIC SO</p> <p><math>T_{JMAX} = 150^{\circ}\text{C}</math>, <math>\theta_{JA} = 130^{\circ}\text{C/W}</math> (N)<br/> <math>T_{JMAX} = 150^{\circ}\text{C}</math>, <math>\theta_{JA} = 190^{\circ}\text{C/W}</math> (S)</p> | ORDER PART NUMBER                                  |  <p>N PACKAGE<br/>14-LEAD PDIP</p> <p>S PACKAGE<br/>14-LEAD PLASTIC SO</p> <p><math>T_{JMAX} = 150^{\circ}\text{C}</math>, <math>\theta_{JA} = 110^{\circ}\text{C/W}</math> (N)<br/> <math>T_{JMAX} = 150^{\circ}\text{C}</math>, <math>\theta_{JA} = 150^{\circ}\text{C/W}</math> (S)</p> | ORDER PART NUMBER    |
|                                                                                                                                                                                                                                                                                                                                                                             | LT1464ACN8<br>LT1464ACS8<br>LT1464CN8<br>LT1464CS8 |                                                                                                                                                                                                                                                                                                                                                                              | LT1465CN<br>LT1465CS |
|                                                                                                                                                                                                                                                                                                                                                                             | S8 PART MARKING                                    |                                                                                                                                                                                                                                                                                                                                                                              |                      |
|                                                                                                                                                                                                                                                                                                                                                                             | 1464A<br>1464                                      |                                                                                                                                                                                                                                                                                                                                                                              |                      |

Consult factory for Industrial and Military grade parts.

## ELECTRICAL CHARACTERISTICS $V_S = \pm 15\text{V}$ , $V_{CM} = 0\text{V}$ , $T_A = 25^{\circ}\text{C}$ , unless otherwise noted.

| SYMBOL    | PARAMETER                                                   | CONDITIONS (Note 1)                                                             | LT1464AC |                                    |                        | LT1464C/LT1465C |                                     |            | UNITS                                                        |
|-----------|-------------------------------------------------------------|---------------------------------------------------------------------------------|----------|------------------------------------|------------------------|-----------------|-------------------------------------|------------|--------------------------------------------------------------|
|           |                                                             |                                                                                 | MIN      | TYP                                | MAX                    | MIN             | TYP                                 | MAX        |                                                              |
| $V_{OS}$  | Input Offset Voltage                                        | $V_S = \pm 5\text{V}$<br>$V_S = \pm 15\text{V}$                                 |          | 0.4<br>0.6                         | 0.8<br>2.0             |                 | 0.4<br>0.6                          | 0.8<br>2.0 | mV<br>mV                                                     |
| $I_{OS}$  | Input Offset Current                                        | $V_S = \pm 5\text{V}$<br>$V_S = \pm 15\text{V}$                                 |          | 0.2<br>0.5                         | 1.2<br>2.0             |                 | 0.5                                 | 15         | pA<br>pA                                                     |
| $I_B$     | Input Bias Current                                          | $V_S = \pm 5\text{V}$<br>$V_S = \pm 15\text{V}$                                 |          | $\pm 0.4$<br>$\pm 0.5$             | $\pm 2.0$<br>$\pm 3.0$ |                 | $\pm 0.5$                           | $\pm 20$   | pA<br>pA                                                     |
| $e_n$     | Input Noise Voltage                                         | 0.1Hz to 10Hz                                                                   |          | 2                                  |                        |                 | 2                                   |            | $\mu\text{V}_{P-P}$                                          |
|           | Input Noise Voltage Density                                 | $f_0 = 10\text{Hz}$<br>$f_0 = 1000\text{Hz}$                                    |          | 33<br>24                           |                        |                 | 33<br>24                            |            | $\text{nV}/\sqrt{\text{Hz}}$<br>$\text{nV}/\sqrt{\text{Hz}}$ |
|           | Input Noise Current Density                                 | $f_0 = 10\text{Hz}$ , 1kHz (Note 3)                                             |          | 0.4                                |                        |                 | 0.4                                 |            | $\text{fA}/\sqrt{\text{Hz}}$                                 |
| CMRR      | Common Mode Rejection Ratio                                 | $V_{CM} = -12.5\text{V}$ to $15\text{V}$                                        | 76       | 85                                 |                        | 74              | 85                                  |            | dB                                                           |
| PSRR      | Power Supply Rejection Ratio                                | $V_S = \pm 2.5\text{V}$ to $\pm 20\text{V}$                                     | 81       | 90                                 |                        | 78              | 90                                  |            | dB                                                           |
| $R_{IN}$  | Input Resistance—Differential<br>Common Mode<br>Common Mode | $V_{CM} = -12.5\text{V}$ to $8\text{V}$<br>$V_{CM} = 8\text{V}$ to $15\text{V}$ |          | $10^{12}$<br>$10^{12}$<br>$0^{11}$ |                        |                 | $10^{12}$<br>$10^{12}$<br>$10^{11}$ |            | $\Omega$<br>$\Omega$<br>$\Omega$                             |
| $C_{IN}$  | Input Capacitance                                           |                                                                                 |          | 3                                  |                        |                 | 3                                   |            | pF                                                           |
| $A_{VOL}$ | Large-Signal Voltage Gain                                   | $V_O = \pm 10\text{V}$ , $R_L = 10\text{k}$                                     | 350      | 1000                               |                        | 300             | 900                                 |            | V/mV                                                         |
|           |                                                             | $V_O = \pm 10\text{V}$ , $R_L = 2\text{k}$                                      | 150      | 450                                |                        | 150             | 450                                 |            | V/mV                                                         |
|           |                                                             | $V_S = \pm 5\text{V}$ , $V_O = \pm 2\text{V}$ , $R_L = 10\text{k}$              | 100      | 250                                |                        | 100             | 250                                 |            | V/mV                                                         |
|           |                                                             | $V_S = \pm 5\text{V}$ , $V_O = \pm 1\text{V}$ , $R_L = 2\text{k}$               | 50       | 170                                |                        | 50              | 170                                 |            | V/mV                                                         |

# ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$ , $V_{CM} = 0V$ , $T_A = 25^\circ C$ , unless otherwise noted.

| SYMBOL         | PARAMETER                                | CONDITIONS (Note 1)                        | LT1464AC   |            |     | LT1464C/LT1465C |            |     | UNITS      |
|----------------|------------------------------------------|--------------------------------------------|------------|------------|-----|-----------------|------------|-----|------------|
|                |                                          |                                            | MIN        | TYP        | MAX | MIN             | TYP        | MAX |            |
| $V_{OUT}$      | Output Voltage Swing                     | $R_L = 10k$                                | $\pm 13.5$ | $\pm 13.7$ |     | $\pm 13.5$      | $\pm 13.7$ |     | V          |
|                |                                          | $R_L = 2k$                                 | $\pm 13.3$ | $\pm 13.5$ |     | $\pm 13.3$      | $\pm 13.5$ |     | V          |
|                |                                          | $V_S = \pm 5V$ , $R_L = 2k$                | $\pm 3.5$  | $\pm 3.7$  |     | $\pm 3.5$       | $\pm 3.7$  |     | V          |
| SR             | Slew Rate                                | $R_L = 10k$ (Note 4)                       | 0.5        | 0.9        |     | 0.5             | 0.9        |     | V/ $\mu s$ |
| GBW            | Gain Bandwidth Product                   | $f = 10kHz$                                | 650        | 1000       |     | 650             | 1000       |     | kHz        |
| $I_S$          | Supply Current per Amplifier             | $V_S = \pm 5V$                             |            | 145        | 200 |                 | 145        | 200 | $\mu A$    |
|                |                                          |                                            |            | 135        | 200 |                 | 135        | 200 | $\mu A$    |
|                | Channel Separation                       | $f = 10Hz$ , $V_O = \pm 10V$ , $R_L = 10k$ |            | 132        |     |                 | 132        |     | dB         |
| $V_{OS}$       | Offset Voltage Match (Note 7)            | $V_S = \pm 5V$                             |            | 0.5        | 1.3 |                 | 0.5        | 1.3 | mV         |
|                |                                          | $V_S = \pm 15V$                            |            | 0.8        | 3.3 |                 | 0.8        | 3.3 | mV         |
| $\Delta I_B^+$ | Noninverting Bias Current Match (Note 7) | $V_S = \pm 5V$                             |            | 0.4        | 3.0 |                 |            |     | pA         |
|                |                                          | $V_S = \pm 15V$                            |            | 0.5        | 4.0 |                 | 0.5        | 30  | pA         |
| $\Delta CMRR$  | Common Mode Rejection Match              | (Notes 5, 7)                               | 74         | 85         |     | 71              | 85         |     | dB         |
| $\Delta PSRR$  | Power Supply Rejection Match             | (Notes 5, 7)                               | 78         | 88         |     | 74              | 88         |     | dB         |

$V_S = \pm 15V$ ,  $V_{CM} = 0V$ ,  $0^\circ C \leq T_A \leq 70^\circ C$ , unless otherwise noted.

| SYMBOL                              | PARAMETER                                | CONDITIONS (Note 1)                           |   | LT1464AC   |            |     | LT1464C/LT1465C |            |     | UNITS            |
|-------------------------------------|------------------------------------------|-----------------------------------------------|---|------------|------------|-----|-----------------|------------|-----|------------------|
|                                     |                                          |                                               |   | MIN        | TYP        | MAX | MIN             | TYP        | MAX |                  |
| $V_{OS}$                            | Input Offset Voltage                     | $V_S = \pm 5V$                                | ● |            | 0.5        | 1.4 |                 | 0.5        | 1.4 | mV               |
|                                     |                                          | $V_S = \pm 15V$                               | ● |            | 0.9        | 2.8 |                 | 0.9        | 2.8 | mV               |
| $\frac{\Delta V_{OS}}{\Delta Temp}$ | Average Input Offset Voltage Drift       | (Note 6)                                      | ● |            | 7          | 20  |                 | 7          | 20  | $\mu V/^\circ C$ |
| $I_{OS}$                            | Input Offset Current                     |                                               | ● |            | 10         | 50  |                 | 25         | 450 | pA               |
| $I_B$                               | Input Bias Current                       |                                               | ● |            | 60         | 150 |                 | 150        | 750 | pA               |
| CMRR                                | Common Mode Rejection Ratio              | $V_{CM} = -12V$ to $15V$                      | ● | 75         | 85         |     | 73              | 85         |     | dB               |
| PSRR                                | Power Supply Rejection Ratio             | $V_S = \pm 3V$ to $\pm 20V$                   | ● | 80         | 89         |     | 77              | 89         |     | dB               |
| $A_{VOL}$                           | Large-Signal Voltage Gain                | $V_O = \pm 10V$ , $R_L = 10k$                 | ● | 200        | 600        |     | 200             | 600        |     | V/mV             |
|                                     |                                          | $V_O = \pm 10V$ , $R_L = 2k$                  | ● | 100        | 350        |     | 100             | 350        |     | V/mV             |
|                                     |                                          | $V_S = \pm 5V$ , $V_O = \pm 2V$ , $R_L = 10k$ | ● | 80         | 200        |     | 80              | 200        |     | V/mV             |
|                                     |                                          | $V_S = \pm 5V$ , $V_O = \pm 1V$ , $R_L = 2k$  | ● | 45         | 150        |     | 45              | 150        |     | V/mV             |
| $V_{OUT}$                           | Output Voltage Swing                     | $R_L = 10k$                                   | ● | $\pm 13.4$ | $\pm 13.6$ |     | $\pm 13.4$      | $\pm 13.6$ |     | V                |
|                                     |                                          | $R_L = 2k$                                    | ● | $\pm 13.2$ | $\pm 13.4$ |     | $\pm 13.2$      | $\pm 13.4$ |     | V                |
|                                     |                                          | $V_S = \pm 5V$ , $R_L = 2k$                   | ● | $\pm 3.4$  | $\pm 3.6$  |     | $\pm 3.4$       | $\pm 3.6$  |     | V                |
| SR                                  | Slew Rate                                | $R_L = 10k$ (Note 4)                          | ● | 0.4        | 0.8        |     | 0.4             | 0.8        |     | V/ $\mu s$       |
| GBW                                 | Gain Bandwidth Product                   | $f = 10kHz$                                   | ● | 540        | 870        |     | 540             | 870        |     | kHz              |
| $I_S$                               | Supply Current per Amplifier             | $V_S = \pm 5V$                                | ● |            | 160        | 220 |                 | 160        | 220 | $\mu A$          |
|                                     |                                          |                                               | ● |            | 150        | 220 |                 | 150        | 220 | $\mu A$          |
| $V_{OS}$                            | Offset Voltage Match (Note 7)            | $V_S = \pm 5V$                                | ● |            | 0.7        | 2.0 |                 | 0.7        | 2.0 | mV               |
|                                     |                                          | $V_S = \pm 15V$                               | ● |            | 0.9        | 3.5 |                 | 0.9        | 3.5 | mV               |
| $\Delta I_B^+$                      | Noninverting Bias Current Match (Note 7) |                                               | ● |            | 5          | 40  |                 | 35         | 500 | pA               |

## ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$ , $V_{CM} = 0V$ , $0^\circ C \leq T_A \leq 70^\circ C$ , unless otherwise noted.

| SYMBOL        | PARAMETER                    | CONDITIONS (Note 1) |   | LT1464AC |     |     | LT1464C/LT1465C |     |     | UNITS |
|---------------|------------------------------|---------------------|---|----------|-----|-----|-----------------|-----|-----|-------|
|               |                              |                     |   | MIN      | TYP | MAX | MIN             | TYP | MAX |       |
| $\Delta CMRR$ | Common Mode Rejection Match  | (Notes 5, 7)        | ● | 73       | 84  |     | 70              | 84  |     | dB    |
| $\Delta PSRR$ | Power Supply Rejection Match | (Notes 5, 7)        | ● | 77       | 85  |     | 73              | 85  |     | dB    |

$V_S = \pm 15V$ ,  $V_{CM} = 0V$ ,  $-40^\circ C \leq T_A \leq 85^\circ C$  (Note 2), unless otherwise noted.

| SYMBOL                              | PARAMETER                                | CONDITIONS (Note 1)                           |   | LT1464AC   |            |     | LT1464C/LT1465C |            |      | UNITS            |
|-------------------------------------|------------------------------------------|-----------------------------------------------|---|------------|------------|-----|-----------------|------------|------|------------------|
|                                     |                                          |                                               |   | MIN        | TYP        | MAX | MIN             | TYP        | MAX  |                  |
| $V_{OS}$                            | Input Offset Voltage                     | $V_S = \pm 5V$                                | ● |            | 0.6        | 1.5 |                 | 0.6        | 1.5  | mV               |
|                                     |                                          | $V_S = \pm 15V$                               | ● |            | 1.0        | 3.0 |                 | 1.0        | 3.0  | mV               |
| $\frac{\Delta V_{OS}}{\Delta Temp}$ | Average Input Offset Voltage Drift       | (Note 6)                                      | ● |            | 7          | 20  |                 | 7          | 20   | $\mu V/^\circ C$ |
| $I_{OS}$                            | Input Offset Current                     |                                               | ● |            | 40         | 150 |                 | 60         | 700  | pA               |
| $I_B$                               | Input Bias Current                       |                                               | ● |            | 200        | 500 |                 | 300        | 2500 | pA               |
| CMRR                                | Common Mode Rejection Ratio              | $V_{CM} = -12V$ to $15V$                      | ● | 74         | 84         |     | 72              | 84         |      | dB               |
| PSRR                                | Power Supply Rejection Ratio             | $V_S = \pm 3V$ to $\pm 20V$                   | ● | 79         | 88         |     | 76              | 88         |      | dB               |
| $A_{VOL}$                           | Large-Signal Voltage Gain                | $V_O = \pm 10V$ , $R_L = 10k$                 | ● | 175        | 400        |     | 175             | 400        |      | V/mV             |
|                                     |                                          | $V_O = \pm 10V$ , $R_L = 2k$                  | ● | 80         | 250        |     | 80              | 250        |      | V/mV             |
|                                     |                                          | $V_S = \pm 5V$ , $V_O = \pm 2V$ , $R_L = 10k$ | ● | 70         | 180        |     | 70              | 180        |      | V/mV             |
|                                     |                                          | $V_S = \pm 5V$ , $V_O = \pm 1V$ , $R_L = 2k$  | ● | 45         | 140        |     | 45              | 140        |      | V/mV             |
| $V_{OUT}$                           | Output Voltage Swing                     | $R_L = 10k$                                   | ● | $\pm 13.2$ | $\pm 13.4$ |     | $\pm 13.2$      | $\pm 13.4$ |      | V                |
|                                     |                                          | $R_L = 2k$                                    | ● | $\pm 13.0$ | $\pm 13.2$ |     | $\pm 13.0$      | $\pm 13.2$ |      | V                |
|                                     |                                          | $V_S = \pm 5V$ , $R_L = 2k$                   | ● | $\pm 3.2$  | $\pm 3.4$  |     | $\pm 3.2$       | $\pm 3.4$  |      | V                |
| SR                                  | Slew Rate                                | $R_L = 10k$ (Note 4)                          | ● | 0.35       | 0.7        |     | 0.35            | 0.7        |      | V/ $\mu s$       |
| GBW                                 | Gain Bandwidth Product                   | $f = 10kHz$                                   | ● | 510        | 850        |     | 510             | 850        |      | kHz              |
| $I_S$                               | Supply Current per Amplifier             |                                               | ● |            | 165        | 230 |                 | 165        | 230  | $\mu A$          |
|                                     |                                          | $V_S = \pm 5V$                                | ● |            | 160        | 230 |                 | 160        | 230  | $\mu A$          |
| $V_{OS}$                            | Offset Voltage Match (Note 7)            | $V_S = \pm 5V$                                | ● |            | 0.8        | 2.5 |                 | 0.8        | 2.5  | mV               |
|                                     |                                          | $V_S = \pm 15V$                               | ● |            | 1.0        | 4.0 |                 | 1.0        | 4.0  | mV               |
| $\Delta I_B^+$                      | Noninverting Bias Current Match (Note 7) |                                               | ● |            | 20         | 100 |                 | 70         | 800  | pA               |
| $\Delta CMRR$                       | Common Mode Rejection Match              | (Notes 5, 7)                                  | ● | 72         | 83         |     | 69              | 83         |      | dB               |
| $\Delta PSRR$                       | Power Supply Rejection Match             | (Notes 5, 7)                                  | ● | 76         | 81         |     | 73              | 81         |      | dB               |

The ● denotes specifications which apply over the full operating temperature range.

**Note 1:** Typical parameters are defined as 60% yield of parameter distributions of individual amplifiers, i.e., out of 100 LT1465s (or 100 LT1464s) typically 240 op amps (or 120) will be better than the indicated specification.

**Note 2:** The LT1464 and LT1465 are designed, characterized and expected to meet these extended temperature limits, but are not tested at  $-40^\circ C$  and  $85^\circ C$ . Guaranteed I grade parts are available, consult factory.

**Note 3:** Current noise is calculated from the formula:  $i_n = (2qI_b)^{1/2}$  where  $q = (1.6)(10)^{-19}$  coulomb. The noise of source resistors up to  $1G\Omega$  swamps the contribution of current noise.

**Note 4:** Slew rate is measured in  $A_V = -1$ ; input signal is  $\pm 7.5V$ , output is measured at  $\pm 2.5V$ .

**Note 5:**  $\Delta CMRR$  and  $\Delta PSRR$  are defined as follows:

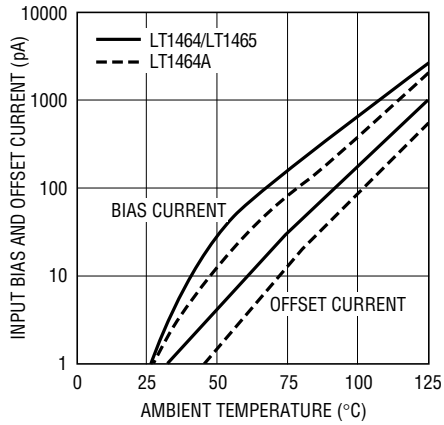
1. CMRR and PSRR are measured in  $\mu V/V$  on the individual amplifiers.
2. The difference is calculated between the matching sides in  $\mu V/V$ .
3. The result is converted to dB.

**Note 6:** This parameter is not 100% tested.

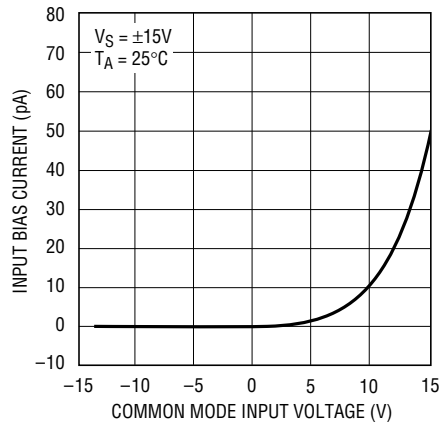
**Note 7:** Matching parameters are the difference between amplifiers A and D and between B and C on the LT1465; between the two amplifiers on the LT1464.

# TYPICAL PERFORMANCE CHARACTERISTICS

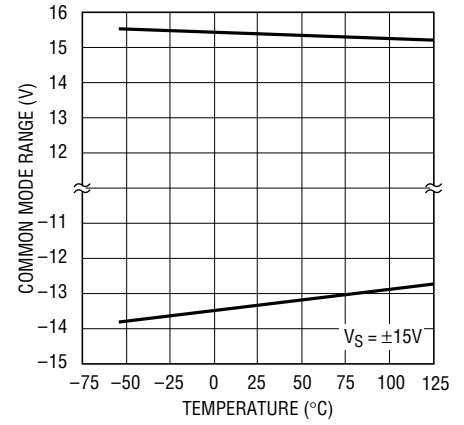
**Input Bias and Offset Current vs Temperature**



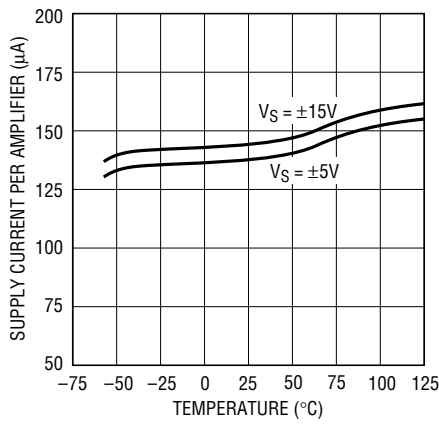
**Input Bias Current Over the Common Mode Range**



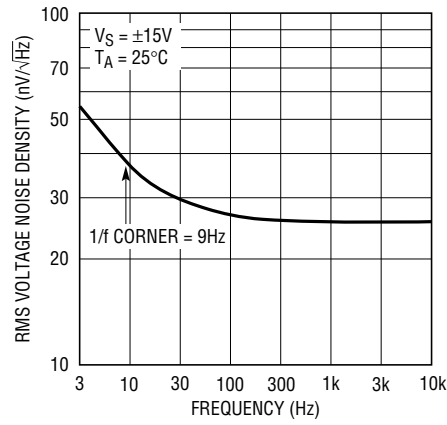
**Common Mode Range vs Temperature**



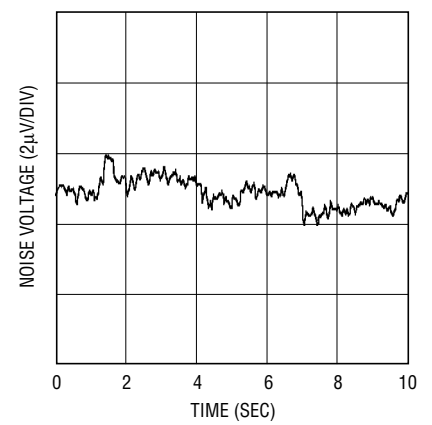
**Supply Current vs Temperature**



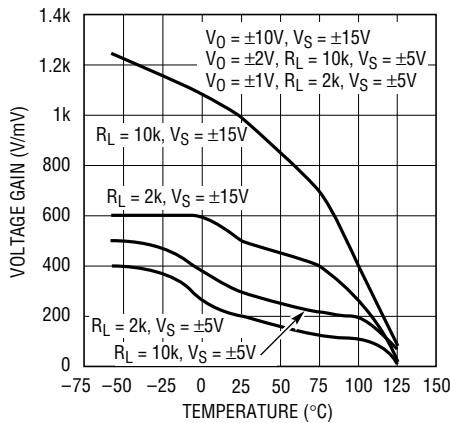
**Voltage Noise vs Frequency**



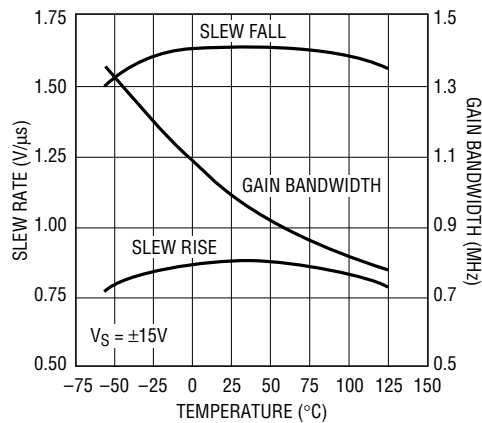
**0.1Hz to 10Hz Noise**



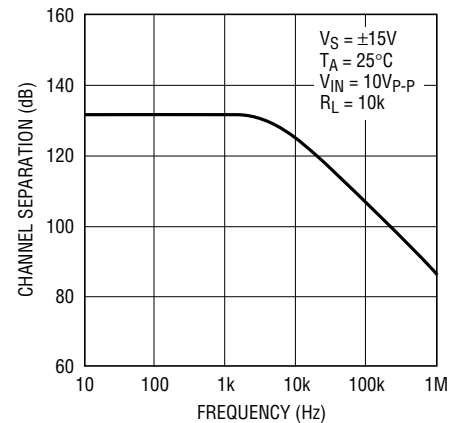
**Voltage Gain vs Temperature**



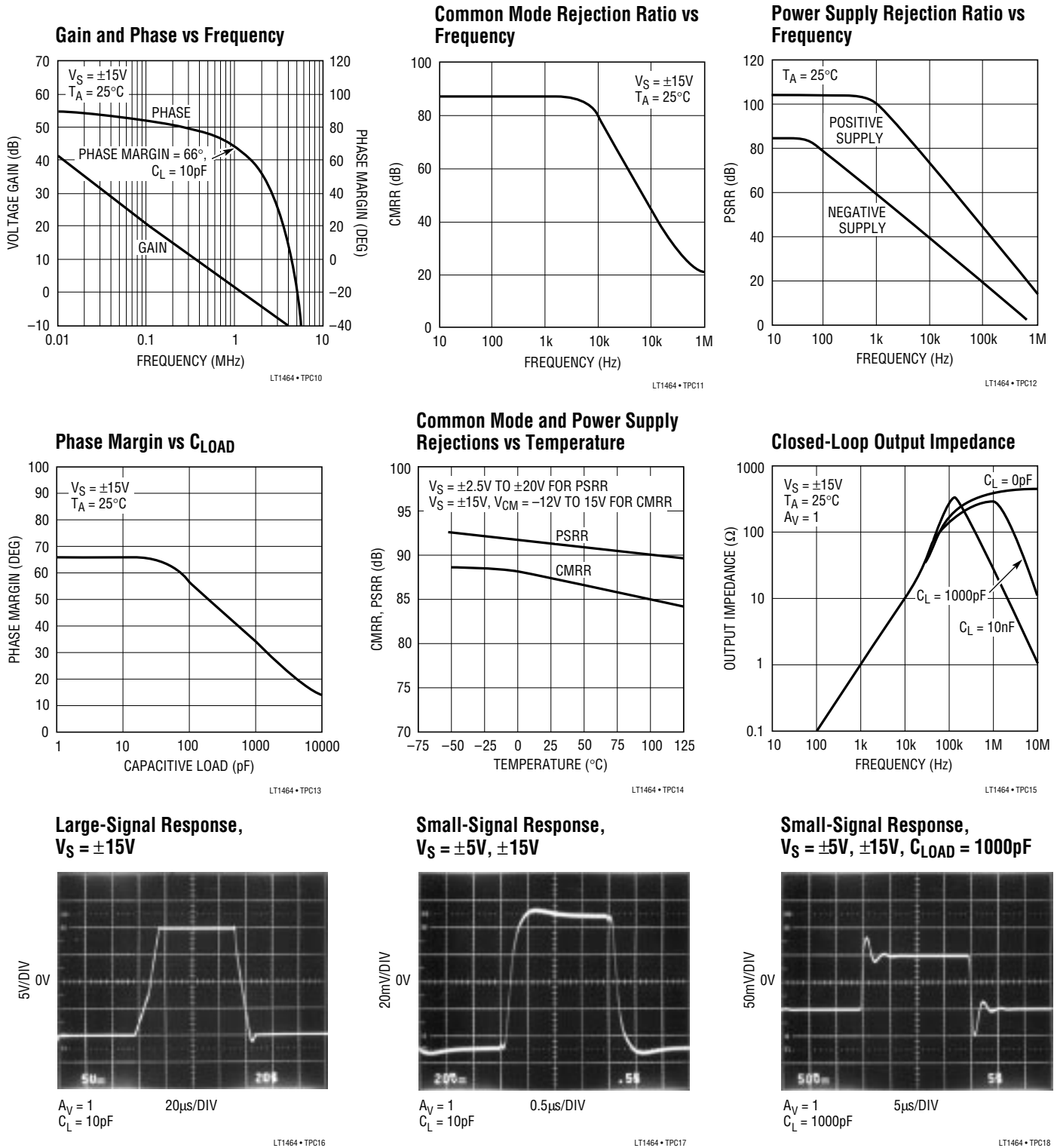
**Slew Rate, Gain Bandwidth Product vs Temperature**



**Channel Separation vs Frequency**



# TYPICAL PERFORMANCE CHARACTERISTICS



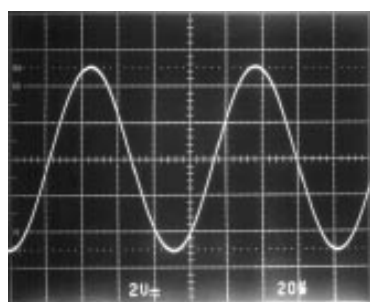
## APPLICATIONS INFORMATION

### Phase Reversal Protection

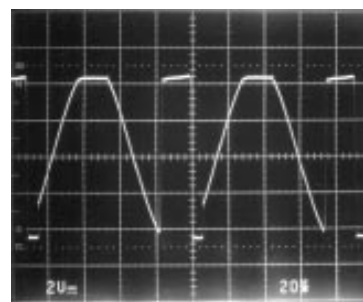
Most industry standard JFET input single, dual and quad op amps exhibit phase reversal at the output when the negative common mode limit at the input is exceeded. Common mode range is at a premium at  $\pm 5V$  supplies. The Figures show a  $\pm 5.2V$  sine wave input (Figure 1a), the response of a competing JFET input op amp in the unity-

gain follower mode (Figure 1b) and the response of the LT1464/LT1465 (Figure 1c).

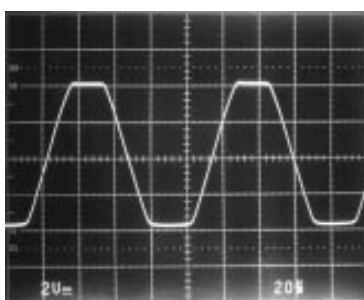
The phase reversal of Figure 1b can cause lock-up in servo systems. The LT1464/LT1465 does not phase-reverse when the common mode input is anywhere within the supplies.



(1a)  $\pm 5.2V$  Sine Wave



(1b) Typical JFET Input Op Amp  
with  $\pm 5V$  Supplies

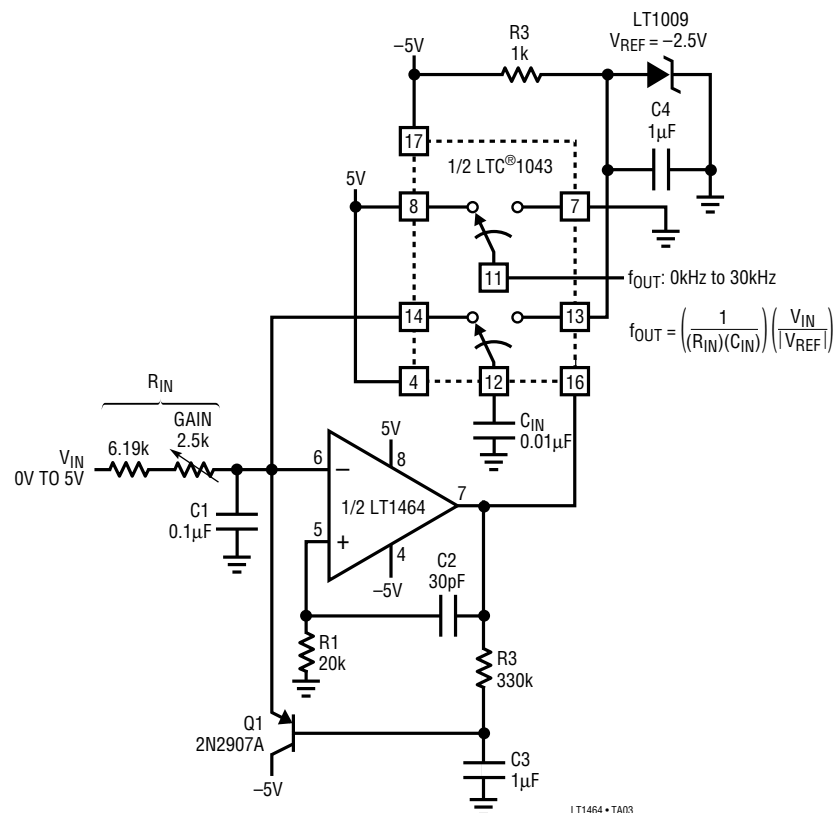


(1c) LT1464/LT1465 Output  
with  $\pm 5V$  Supplies

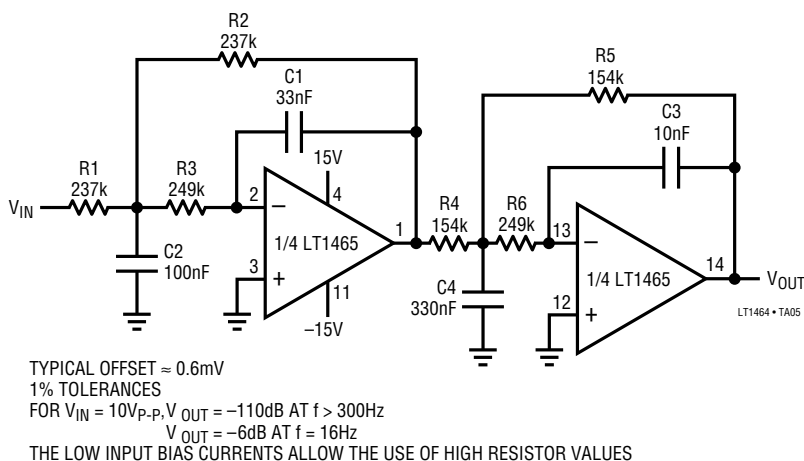
Figure 1. Voltage Follower with Input Exceeding the Common Mode Range ( $V_S = \pm 5V$ )

# TYPICAL APPLICATIONS

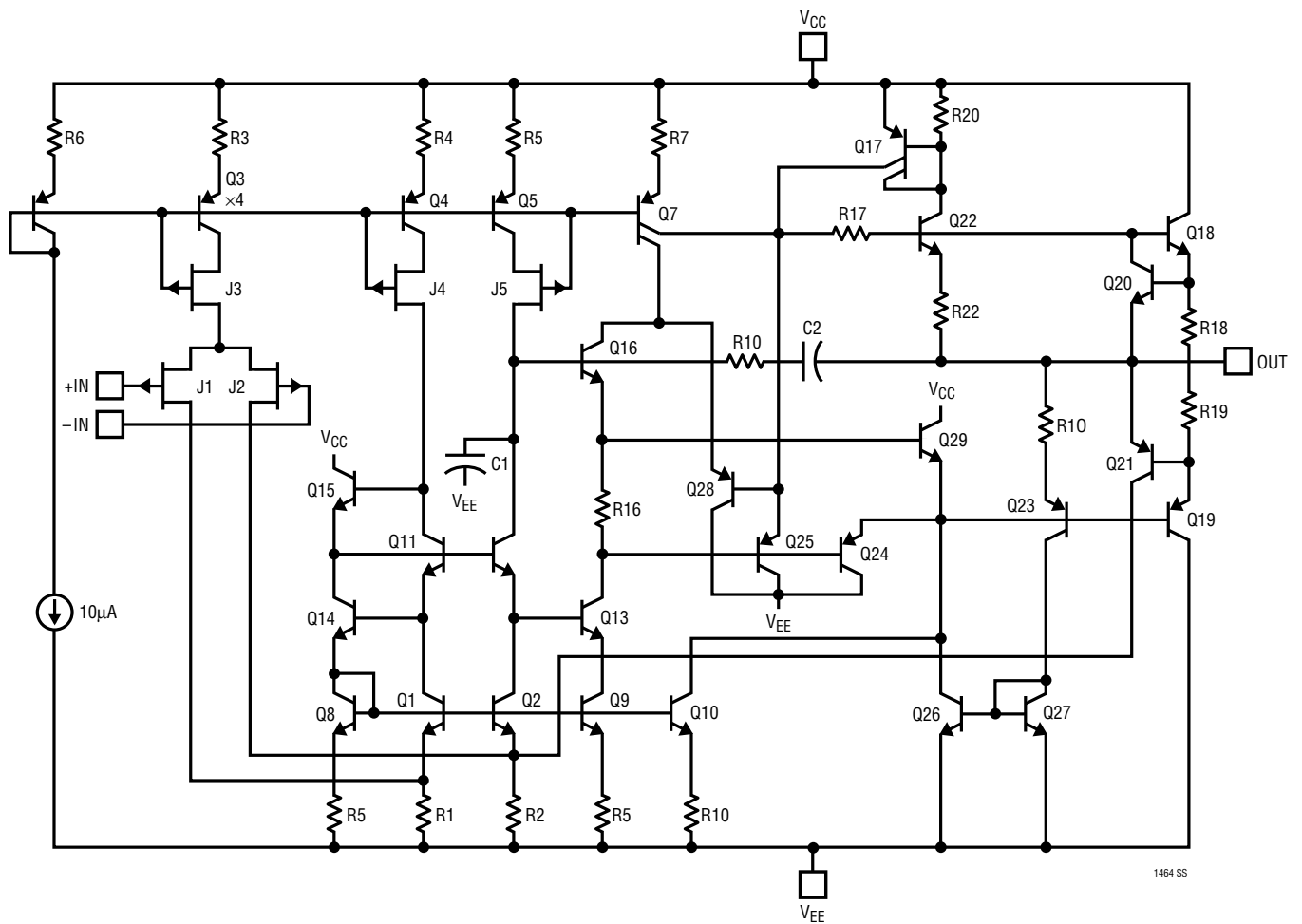
## Low Voltage 0.016% Voltage to Frequency Converter



## 10Hz 4th Order Chebyshev Lowpass Filter (0.01dB Ripple)



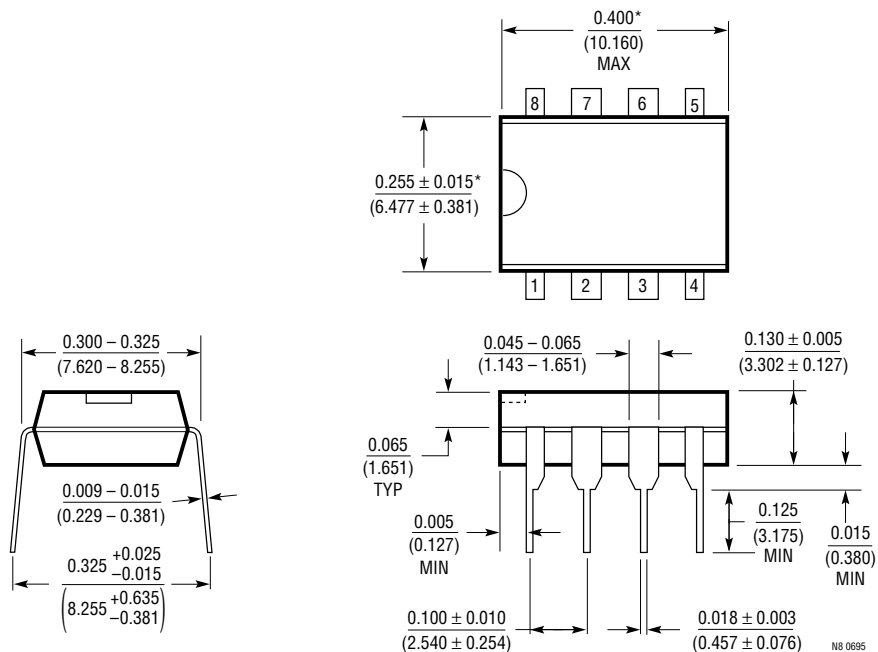
# SIMPLIFIED SCHEMATIC



# PACKAGE DESCRIPTION

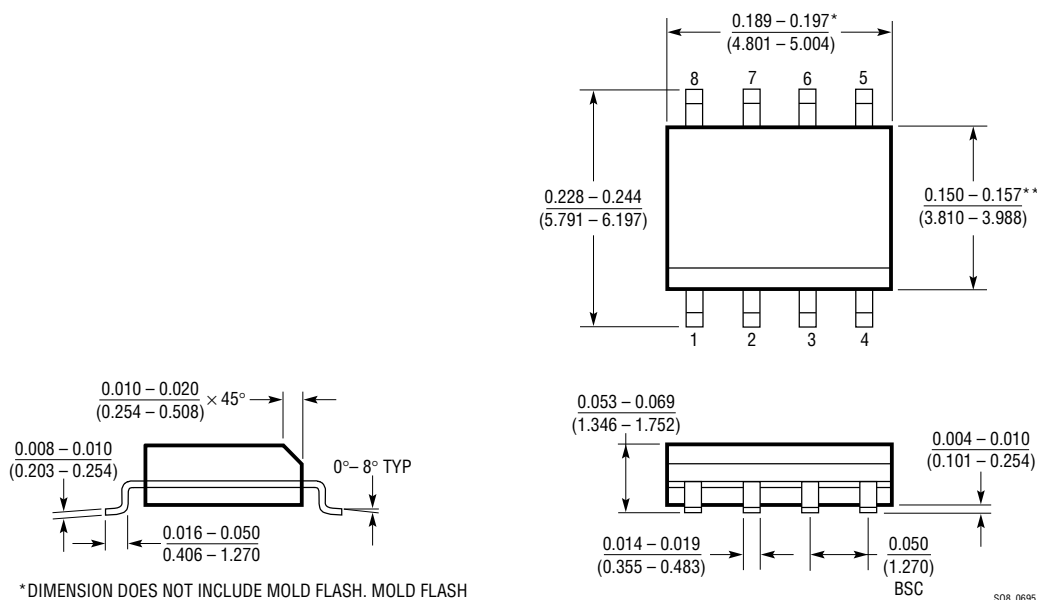
Dimensions in inches (millimeters) unless otherwise noted.

## N8 Package 8-Lead PDIP (Narrow 0.300) (LTC DWG # 05-08-1510)



\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)

## S8 Package 8-Lead Plastic Small Outline (Narrow 0.150) (LTC DWG # 05-08-1610)

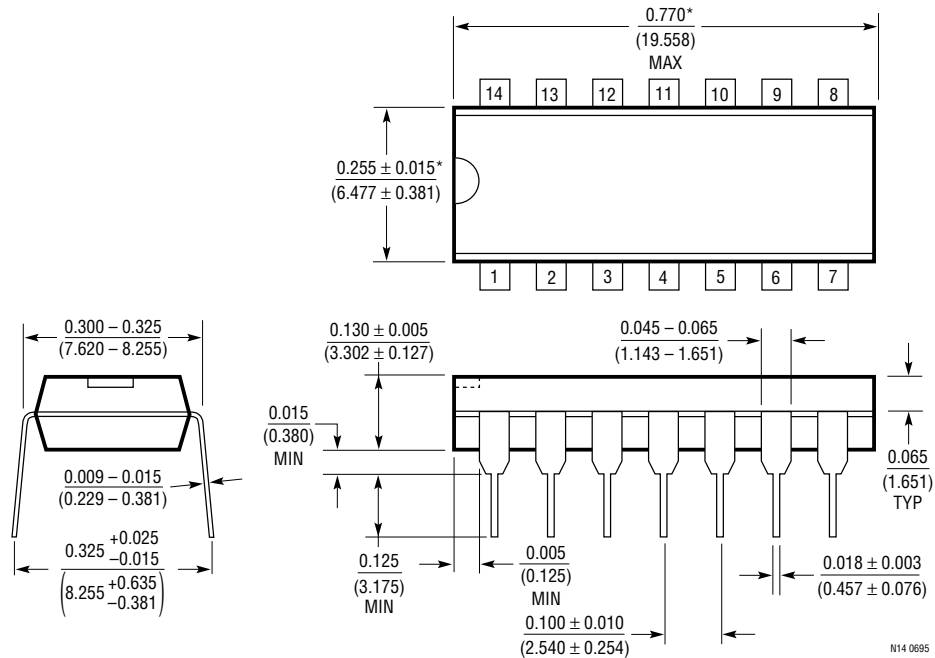


\*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH  
SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

\*\*DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD  
FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

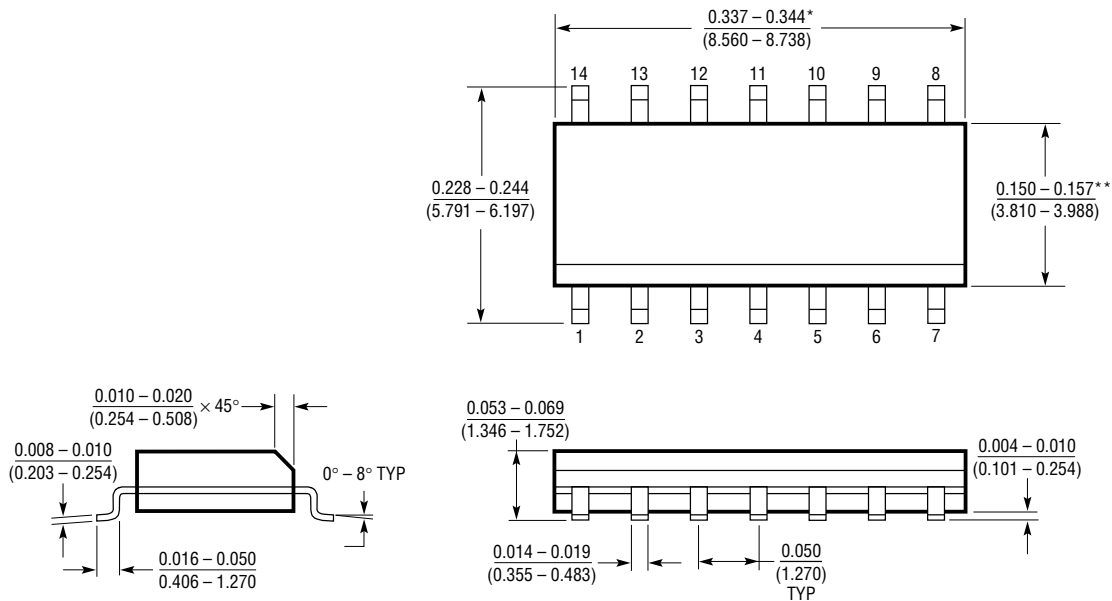
# PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise noted.

## N Package 14-Lead PDIP (Narrow 0.300) (LTC DWG # 05-08-1510)



\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)

## S Package 14-Lead Plastic Small Outline (Narrow 0.150) (LTC DWG # 05-08-1610)

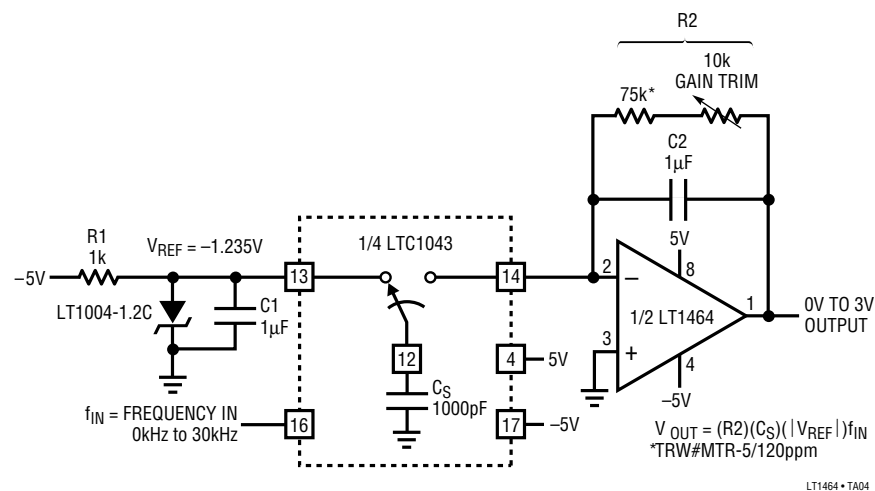


\*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH  
SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

\*\*DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD  
FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

TYPICAL APPLICATION

Low Voltage 0.027% Frequency to Voltage Converter



RELATED PARTS

| PART NUMBER   | DESCRIPTION                                                             | COMMENTS                                                                                  |
|---------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| LT1057        | Dual JFET Input Precision, High Speed Op Amp                            | Fast Settling Time, 14V/μs Slew Rate, 5Mhz GBW, 450μV $V_{OS}$ (Max), 50pA $I_{OS}$ (Max) |
| LT1113        | Dual Low Noise, Precision, JFET Input Op Amp                            | 6nV/√Hz Input Noise Voltage Density, 480pA $I_B$ , 6.3MHz GBW                             |
| LT1169        | Dual Low Noise, Picoampere Bias Current, JFET Input Op Amp              | 20pA $I_B$ , 8nV/√Hz $e_n$ , 5.3MHz GBW, 1.5pF Input Capacitance                          |
| LT1457        | Dual Precision JFET Input Op Amp C-Load                                 | Drives 10,000pF Capacitive Load, 450μV $V_{OS}$ (Max), 4μV/°C Drift                       |
| LT1462/LT1463 | Dual/Quad Micropower, C-Load Picoampere Bias Current JFET Input Op Amps | 28μA Supply Current Per Amplifiers Drives 10μF Capacitive Load, 175kHz GBW                |