

Picoamp Input Current, Microvolt Offset, Low Noise Op Amp

FEATURES

- OP-07 Type Performance:
 - at 1/8th of OP-07's Supply Current
 - at 1/20th of OP-07's Bias and Offset Currents
- *Guaranteed* Offset Voltage: 25 μ V Max
- *Guaranteed* Bias Current: 100pA Max
- *Guaranteed* Drift: 0.6 μ V/ $^{\circ}$ C Max
- Low Noise, 0.1Hz to 10Hz: 0.5 μ V_{P-P}
- *Guaranteed* Low Supply Current: 500 μ A Max
- *Guaranteed* CMRR: 114dB Min
- *Guaranteed* PSRR: 114dB Min
- *Guaranteed* Operation at \pm 1.2V Supplies


APPLICATIONS

- Replaces OP-07 While Saving Power
- Precision Instrumentation
- Charge Integrators
- Wide Dynamic Range Logarithmic Amplifiers
- Light Meters
- Low Frequency Active Filters
- Thermocouple Amplifiers

DESCRIPTION

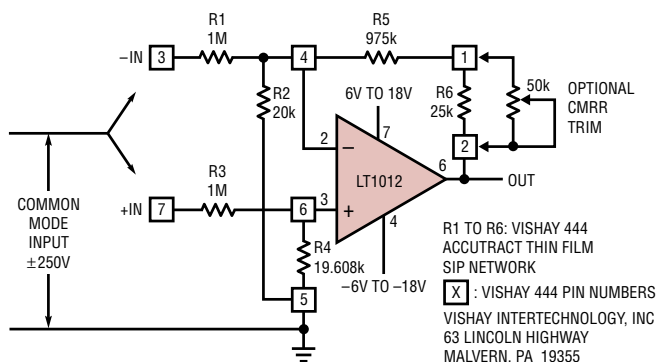
The LT[®]1012 is an internally compensated universal precision operational amplifier which can be used in practically all precision applications. The LT1012 combines picoampere bias currents (which are maintained over the full -55° C to 125° C temperature range), microvolt offset voltage (and low drift with time and temperature), low voltage and current noise, and low power dissipation. The LT1012 achieves precision operation on two Ni-Cad batteries with 1mW of power dissipation. Extremely high common mode and power supply rejection ratios, practically unmeasurable warm-up drift, and the ability to deliver 5mA load current with a voltage gain of one million round out the LT1012's superb precision specifications.

The all around excellence of the LT1012 eliminates the necessity of the time consuming error analysis procedure of precision system design in many applications; the LT1012 can be stocked as the universal internally compensated precision op amp.

 LTC and LT are registered trademarks of Linear Technology Corporation. Protected by U. S. patents 4,575,685 and 4,775,884

TYPICAL APPLICATION

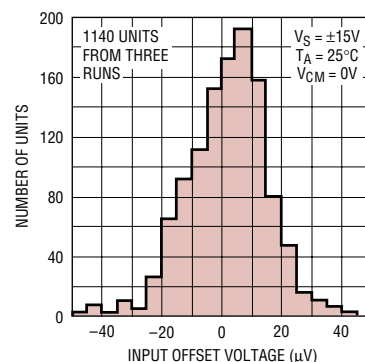
\pm 250V Common Mode Range Instrumentation Amplifier ($A_v = 1$)



COMMON MODE REJECTION RATIO = 74dB (RESISTOR LIMITED)
 WITH OPTIONAL TRIM = 130dB
 OUTPUT OFFSET (TRIMMABLE TO ZERO) = 500 μ V
 OUTPUT OFFSET DRIFT = 10 μ V/ $^{\circ}$ C
 INPUT RESISTANCE = 1M

LT1012A-TA01

Typical Distribution of Input Offset Voltage



LT1012A-TA02

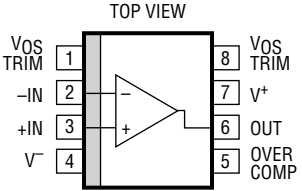
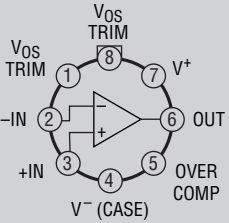
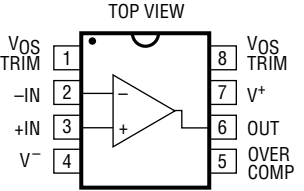
LT1012A/LT1012

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage $\pm 20\text{V}$
 Differential Input Current (Note 1) $\pm 10\text{mA}$
 Input Voltage $\pm 20\text{V}$
 Output Short Circuit Duration Indefinite

Operating Temperature Range
 LT1012AM/LT1012M (**OBSOLETE**).... -55°C to 125°C
 LT1012I/LT1012AI -40°C to 85°C
 LT1012AC/LT1012C
 LT1012D/LT1012S8 0°C to 70°C
 Storage Temperature Range -65°C to 150°C
 Lead Temperature (Soldering, 10 sec)..... 300°C

PACKAGE/ORDER INFORMATION

|  <p>S8 PACKAGE 8-LEAD PLASTIC SO $T_{JMAX} = 100^{\circ}\text{C}$, $\theta_{JA} = 170^{\circ}\text{C/W}$</p> | <p>TOP VIEW</p>  <p>H PACKAGE 8-LEAD TO-5 METAL CAN $T_{JMAX} = 150^{\circ}\text{C}$, $\theta_{JA} = 150^{\circ}\text{C/W}$, $\theta_{JC} = 45^{\circ}\text{C/W}$</p> |  <p>N8 PACKAGE 8-LEAD PDIP $T_{JMAX} = 100^{\circ}\text{C}$, $\theta_{JA} = 130^{\circ}\text{C/W}$</p> |
|---|---|---|
| ORDER PART NUMBER | ORDER PART NUMBER | ORDER PART NUMBER |
| <p>LT1012S8 LT1012IS8 LT1012ACS8 LT1012AIS8</p> | <p>LT1012AMH LT1012MH LT1012ACH LT1012CH LT1012DH</p> | <p>LT1012ACN8 LT1012AIN8 LT1012CN8 LT1012DN8 LT1012IN8</p> |
| S8 PART MARKING | <p>OBSOLETE PACKAGE Consider the S8 or N8 Packages for Alternate Source</p> | |
| <p>1012 1012I 1012A 1012AI</p> | | |

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

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

| SYMBOL | PARAMETER | CONDITIONS | LT1012AM/AC/AI | | | LT1012M/I | | | LT1012C | | | UNITS |
|-----------|--|--|----------------|----------|-----------|------------|----------|-----------|------------|----------|-----------|----------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage | (Note 3) | | 8 | 25 | | 8 | 35 | | 10 | 50 | μV |
| | | | | 20 | 90 | | 20 | 90 | | 25 | 120 | μV |
| | Long Term Input Offset Voltage Stability | | | 0.3 | | | 0.3 | | | 0.3 | | $\mu V/month$ |
| I_{OS} | Input Offset Current | (Note 3) | | 15 | 100 | | 15 | 100 | | 20 | 150 | μA |
| | | | | 25 | 150 | | 25 | 150 | | 30 | 200 | μA |
| I_B | Input Bias Current | (Note 3) | | ± 25 | ± 100 | | ± 25 | ± 100 | | ± 30 | ± 150 | μA |
| | | | | ± 35 | ± 150 | | ± 35 | ± 150 | | ± 40 | ± 200 | μA |
| e_n | Input Noise Voltage | 0.1Hz to 10Hz | | 0.5 | | | 0.5 | | | 0.5 | | μV_{P-P} |
| e_n | Input Noise Voltage Density | $f_0 = 10Hz$ (Note 4) | | 17 | 30 | | 17 | 30 | | 17 | 30 | nV/\sqrt{Hz} |
| | | $f_0 = 1000Hz$ (Note 5) | | 14 | 22 | | 14 | 22 | | 14 | 22 | nV/\sqrt{Hz} |
| i_n | Input Noise Current Density | $f_0 = 10Hz$ | | 20 | | | 20 | | | 20 | | fA/\sqrt{Hz} |
| A_{VOL} | Large Signal Voltage Gain | $V_{OUT} = \pm 12V$, $R_L \geq 10k\Omega$ | 300 | 2000 | | 300 | 2000 | | 200 | 2000 | | V/mV |
| | | $V_{OUT} = \pm 10V$, $R_L \geq 2k\Omega$ | 300 | 1000 | | 200 | 1000 | | 200 | 1000 | | V/mV |
| CMRR | Common Mode Rejection Ratio | $V_{CM} = \pm 13.5V$ | 114 | 132 | | 114 | 132 | | 110 | 132 | | dB |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 1.2V$ to $\pm 20V$ | 114 | 132 | | 114 | 132 | | 110 | 132 | | dB |
| | Input Voltage Range | | ± 13.5 | ± 14 | | ± 13.5 | ± 14 | | ± 13.5 | ± 14 | | V |
| V_{OUT} | Output Voltage Swing | $R_L = 10k\Omega$ | ± 13 | ± 14 | | ± 13 | ± 14 | | ± 13 | ± 14 | | V |
| | Slew Rate | | 0.1 | 0.2 | | 0.1 | 0.2 | | 0.1 | 0.2 | | $V/\mu s$ |
| I_S | Supply Current | (Note 3) | | 370 | 500 | | 380 | | | 380 | | μA |
| | | | | 380 | 600 | | 380 | 600 | | 380 | 600 | μA |

LT1012A/LT1012

ELECTRICAL CHARACTERISTICS

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

| SYMBOL | PARAMETER | CONDITIONS | LT1012D | | | LT1012S8 | | | UNITS |
|-----------|--|---|------------|----------------------|-----------|------------|-----------------------|------------------------|----------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage | (Note 3) | | 12 25 | 60 | | 15 25 | 120 180 | μV μV |
| | Long Term Input Offset Voltage Stability | | | 0.3 | | | 0.4 | | $\mu V/month$ |
| I_{OS} | Input Offset Current | (Note 3) | | 20 30 | 150 | | 50 60 | 280 380 | ρA ρA |
| | Input Bias Current | (Note 3) | | ± 30 ± 40 | ± 150 | | ± 80 ± 120 | ± 300 ± 400 | ρA ρA |
| e_n | Input Noise Voltage | 0.1Hz to 10Hz | | 0.5 | | | 0.5 | | μV_{p-p} |
| e_n | Input Noise Voltage Density | $f_0 = 10Hz$ (Note 5) | | 17 | 30 | | 17 | 30 | nV/\sqrt{Hz} |
| | | $f_0 = 1000Hz$ (Note 5) | | 14 | 22 | | 14 | 22 | nV/\sqrt{Hz} |
| i_n | Input Noise Current Density | $f_0 = 10Hz$ | | 20 | | | 20 | | fA/\sqrt{Hz} |
| A_{VOL} | Large-Signal Voltage Gain | $V_{OUT} = \pm 12V, R_L \geq 10k\Omega$ | 200 | 2000 | | 200 | 2000 | | V/mV |
| | | $V_{OUT} = \pm 10V, R_L \geq 2k\Omega$ | 200 | 1000 | | 120 | 1000 | | V/mV |
| CMRR | Common Mode Rejection Ratio | $V_{CM} = \pm 13.5V$ | 110 | 132 | | 110 | 132 | | dB |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 1.2V$ to $\pm 20V$ | 110 | 132 | | 110 | 132 | | dB |
| | Input Voltage Range | | ± 13.5 | ± 14.0 | | ± 13.5 | ± 14.0 | | V |
| V_{OUT} | Output Voltage Swing | $R_L = 10k\Omega$ | ± 13 | ± 14 | | ± 13 | ± 14 | | V |
| | Slew Rate | | 0.1 | 0.2 | | 0.1 | 0.2 | | $V/\mu s$ |
| I_S | Supply Current | (Note 3) | | 380 | 600 | | 380 | 600 | μA |

ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range of $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ for LT1012AM and LT1012M, and $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ for LT1012AI and LT1012I. $V_S = \pm 15\text{V}$, $V_{CM} = 0\text{V}$, unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | LT1012AM/AI | | | LT1012M/I | | | UNITS |
|-----------|---|--|-------------|------------|-----------|------------|-----------|--------------------------------|-------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage | (Note 3) | ● | 30 | 60 | 30 | 180 | μV | |
| | | | ● | 40 | 180 | 40 | 250 | μV | |
| | Average Temperature Coefficient of Input Offset Voltage | | ● | 0.2 | 0.6 | 0.2 | 1.5 | $\mu\text{V}/^{\circ}\text{C}$ | |
| I_{OS} | Input Offset Current | (Note 3) | ● | 30 | 250 | 30 | 250 | μA | |
| | | | ● | 70 | 350 | 70 | 350 | μA | |
| | Average Temperature Coefficient of Input Offset Current | | ● | 0.3 | 2.5 | 0.3 | 2.5 | $\mu\text{A}/^{\circ}\text{C}$ | |
| I_B | Input Bias Current | (Note 3) | ● | ± 80 | ± 600 | ± 80 | ± 600 | μA | |
| | | | ● | ± 150 | ± 800 | ± 150 | ± 800 | μA | |
| | Average Temperature Coefficient of Input Bias Current | | ● | 0.6 | 6.0 | 0.6 | 6.0 | $\mu\text{A}/^{\circ}\text{C}$ | |
| A_{VOL} | Large-Signal Voltage Gain | $V_{OUT} = \pm 12\text{V}$, $R_L \geq 10\text{k}\Omega$ | ● | 200 | 1000 | 150 | 1000 | V/mV | |
| | | $V_{OUT} = \pm 10\text{V}$, $R_L \geq 2\text{k}\Omega$ | ● | 200 | 600 | 100 | 600 | V/mV | |
| CMRR | Common Mode Rejection Ratio | $V_{CM} = \pm 13.5\text{V}$ | ● | 110 | 128 | 108 | 128 | dB | |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 1.5\text{V}$ to $\pm 20\text{V}$ | ● | 110 | 126 | 108 | 126 | dB | |
| | Input Voltage Range | | ● | ± 13.5 | | ± 13.5 | | V | |
| V_{OUT} | Output Voltage Swing | $R_L = 10\text{k}\Omega$ | ● | ± 13 | ± 14 | ± 13 | ± 14 | V | |
| I_S | Supply Current | | ● | 400 | 650 | 400 | 800 | μA | |

LT1012A/LT1012

ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range of $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$. $V_S = \pm 15\text{V}$, $V_{CM} = 0\text{V}$, unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | LT1012AC | | | LT1012C | | | UNITS |
|-----------|---|--|----------|------------|-----------|------------|-----------|--------------------------------|-------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage | (Note 3) | ● | 20 | 60 | 20 | 100 | μV | |
| | | | ● | 30 | 160 | 30 | 200 | μV | |
| | Average Temperature Coefficient of Input Offset Voltage | | ● | 0.2 | 0.6 | 0.2 | 1.0 | $\mu\text{V}/^{\circ}\text{C}$ | |
| I_{OS} | Input Offset Current | (Note 3) | ● | 25 | 230 | 35 | 230 | μA | |
| | | | ● | 40 | 300 | 45 | 300 | μA | |
| | Average Temperature Coefficient of Input Offset Current | | ● | 0.3 | 2.5 | 0.3 | 2.5 | $\mu\text{A}/^{\circ}\text{C}$ | |
| I_B | Input Bias Current | (Note 3) | ● | ± 35 | ± 230 | ± 35 | ± 230 | μA | |
| | | | ● | ± 50 | ± 300 | ± 50 | ± 300 | μA | |
| | Average Temperature Coefficient of Input Bias Current | | ● | 0.3 | 2.5 | 0.3 | 2.5 | $\mu\text{A}/^{\circ}\text{C}$ | |
| A_{VOL} | Large-Signal Voltage Gain | $V_{OUT} = \pm 12\text{V}$, $R_L \geq 10\text{k}\Omega$ | ● | 200 | 1500 | 150 | 1500 | V/mV | |
| | | $V_{OUT} = \pm 10\text{V}$, $R_L \geq 2\text{k}\Omega$ | ● | 200 | 1000 | 150 | 800 | V/mV | |
| CMRR | Common Mode Rejection Ratio | $V_{CM} = 13.5\text{V}$ | ● | 110 | 130 | 108 | 130 | dB | |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 1.3\text{V}$ to $\pm 20\text{V}$ | ● | 110 | 128 | 108 | 128 | dB | |
| | Input Voltage Range | | ● | ± 13.5 | | ± 13.5 | | V | |
| V_{OUT} | Output Voltage Swing | $R_L = 10\text{k}\Omega$ | ● | ± 13 | ± 14 | ± 13 | ± 14 | V | |
| I_S | Supply Current | | ● | 400 | 600 | 400 | 800 | μA | |

ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range of $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$. $V_S = \pm 15\text{V}$, $V_{CM} = 0\text{V}$, unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | LT1012D | | | LT1012S8 | | | UNITS |
|-----------|---|--|---------|------------|-----------|----------|------------|-----------|--------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage | (Note 3) | ● | 25 | 140 | ● | 30 | 200 | μV |
| | | | ● | 40 | | ● | 45 | 270 | μV |
| | Average Temperature Coefficient of Input Offset Voltage | | ● | 0.3 | 1.7 | ● | 0.3 | 1.8 | $\mu\text{V}/^{\circ}\text{C}$ |
| I_{OS} | Input Offset Current | (Note 3) | ● | 35 | 380 | ● | 60 | 380 | pA |
| | | | ● | 45 | | ● | 80 | 500 | pA |
| | Average Temperature Coefficient of Input Offset Current | | ● | 0.35 | 4.0 | ● | 0.4 | 4.0 | $\text{pA}/^{\circ}\text{C}$ |
| I_B | Input Bias Current | (Note 3) | ● | ± 50 | ± 420 | ● | ± 100 | ± 420 | pA |
| | | | ● | ± 65 | | ● | ± 150 | ± 550 | pA |
| | Average Temperature Coefficient of Input Bias Current | | ● | 0.4 | 5.0 | ● | 0.5 | 5.0 | $\text{pA}/^{\circ}\text{C}$ |
| A_{VOL} | Large-Signal Voltage Gain | $V_{OUT} = \pm 12\text{V}$, $R_L \geq 10\text{k}\Omega$ | ● | 150 | 1500 | ● | 150 | 1500 | V/mV |
| | | $V_{OUT} = \pm 10\text{V}$, $R_L \geq 2\text{k}\Omega$ | ● | 150 | 800 | ● | 100 | 800 | V/mV |
| CMRR | Common Mode Rejection Ratio | $V_{CM} = \pm 13.5\text{V}$ | ● | 108 | 130 | ● | 108 | 130 | dB |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 1.3\text{V}$ to $\pm 20\text{V}$ | ● | 108 | 128 | ● | 108 | 128 | dB |
| | | | ● | ± 13.5 | | ● | ± 13.5 | | V |
| V_{OUT} | Output Voltage Swing | $R_L = 10\text{k}\Omega$ | ● | ± 13 | ± 14 | ● | ± 13 | ± 14 | V |
| I_S | Supply Current | | ● | 400 | 800 | ● | 400 | 800 | μA |

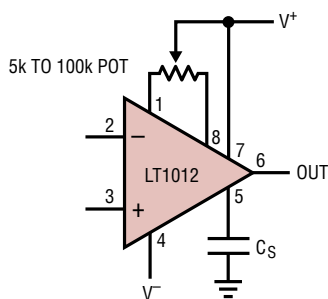
Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: Differential input voltages greater than 1V will cause excessive current to flow through the input protection diodes unless limiting resistance is used.

Note 3: These specifications apply for $V_{MIN} \leq V_S \leq \pm 20\text{V}$ and $-13.5\text{V} \leq V_{CM} \leq 13.5\text{V}$ (for $V_S = \pm 15\text{V}$). $V_{MIN} = \pm 1.2\text{V}$ at 25°C , $\pm 1.3\text{V}$ from 0°C to 70°C , $\pm 1.5\text{V}$ from -55°C to 125°C .

Note 4: 10Hz noise voltage density is sample tested on every lot. Devices 100% tested at 10Hz are available on request.

Note 5: This parameter is tested on a sample basis only.



LT1012A • EC01

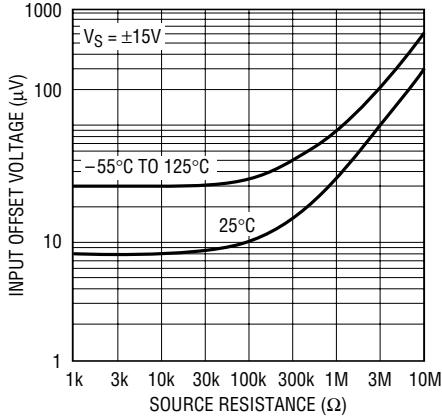
Optional Offset Nulling and Overcompensation Circuits

Input offset voltage can be adjusted over a $\pm 800\mu\text{V}$ range with a 5k to 100k potentiometer.

The LT1012 is internally compensated for unity gain stability. The overcompensation capacitor, C_S , can be used to improve capacitive load handling capability, to narrow noise bandwidth, or to stabilize circuits with gain in the feedback loop.

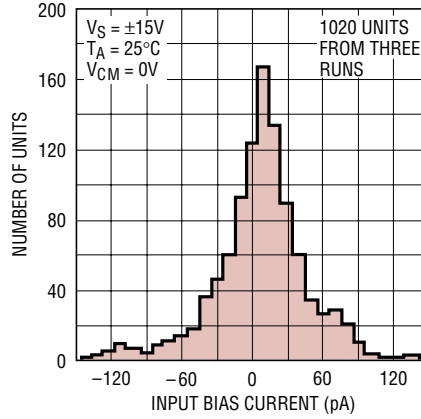
TYPICAL PERFORMANCE CHARACTERISTICS

Offset Voltage vs Source Resistance (Balanced or Unbalanced)



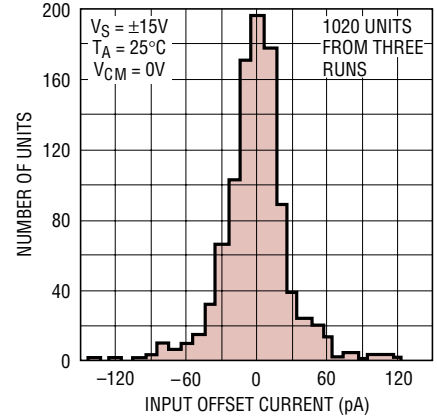
LT1012A • TPC01

Typical Distribution of Input Bias Current



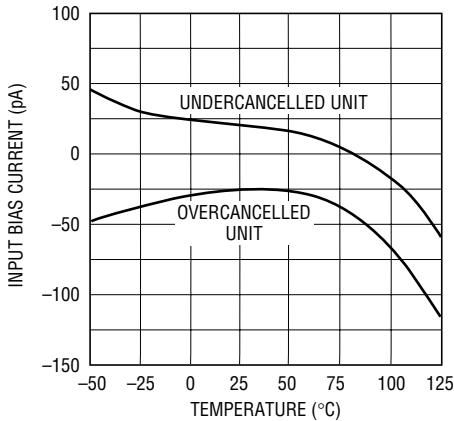
LT1012A • TPC02

Typical Distribution of Input Offset Current



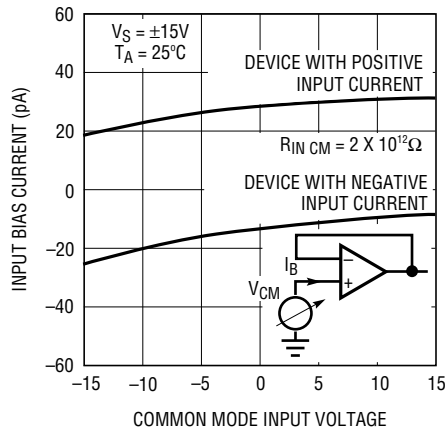
LT1012A • TPC03

Input Bias Current vs Temperature



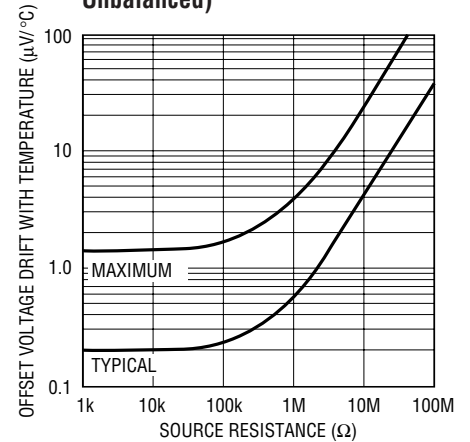
LT1012A • TPC04

Input Bias Current Over Common Mode Range



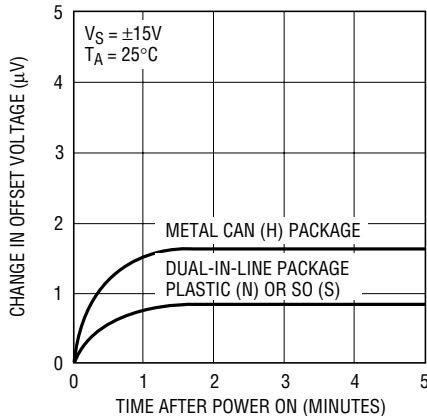
LT1012A • TPC5

Offset Voltage Drift vs Source Resistance (Balanced or Unbalanced)



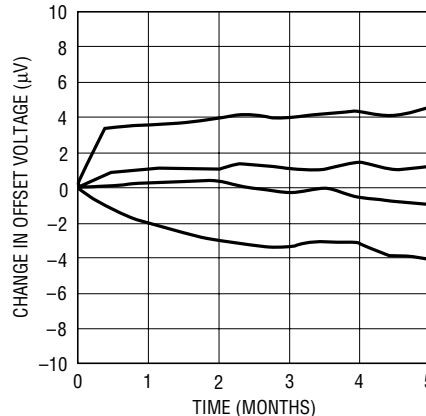
LT1012 • TPC06

Warm-Up Drift



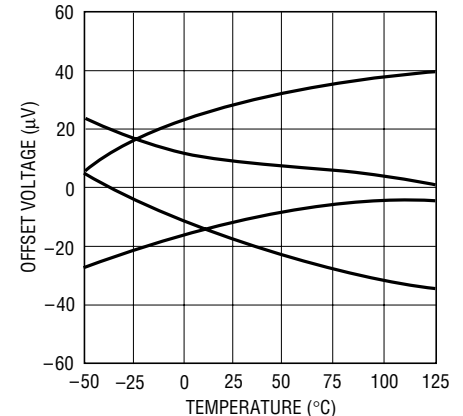
LT1012A • TPC07

Long Term Stability of Four Representative Units



LT1012A • TPC08

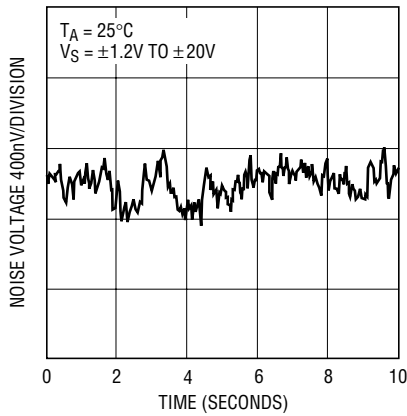
Offset Voltage Drift with Temperature of Four Representative Units



LT1012A • TPC09

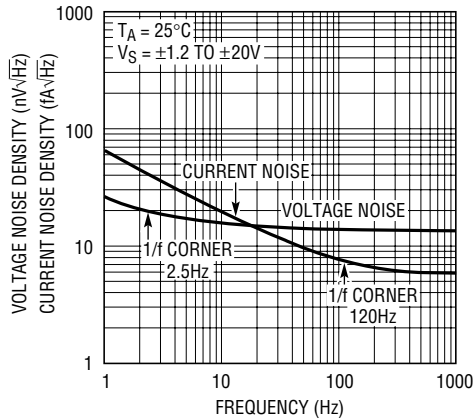
TYPICAL PERFORMANCE CHARACTERISTICS

0.1Hz to 10Hz Noise



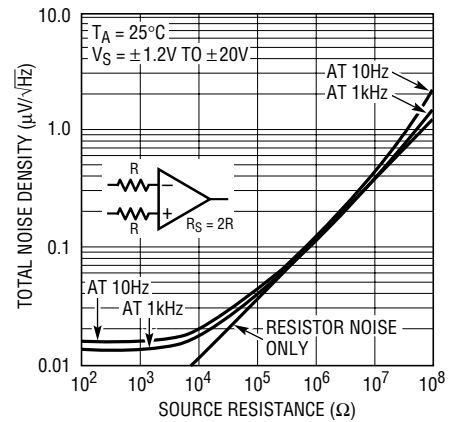
LT1012A • TPC10

Noise Spectrum



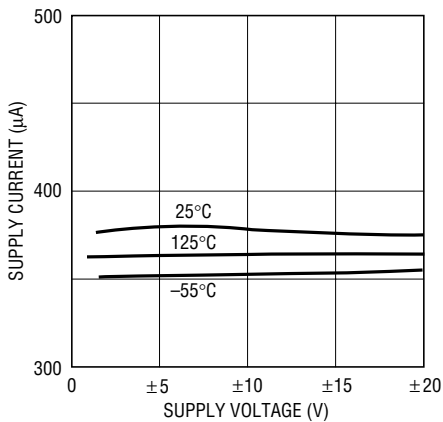
LT1012A • TPC11

Total Noise vs Source Resistance



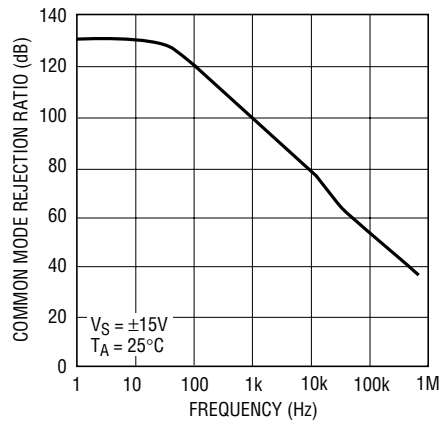
LT1012A • TPC12

Supply Current vs Supply Voltage



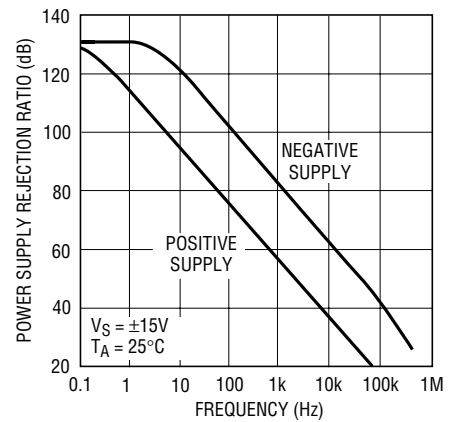
LT1012A • TPC13

Common Mode Rejection vs Frequency



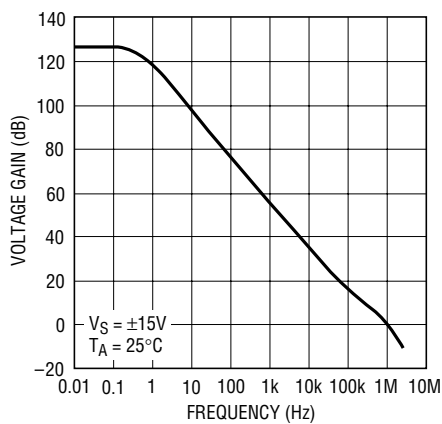
LT1012A • TPC14

Power Supply Rejection vs Frequency



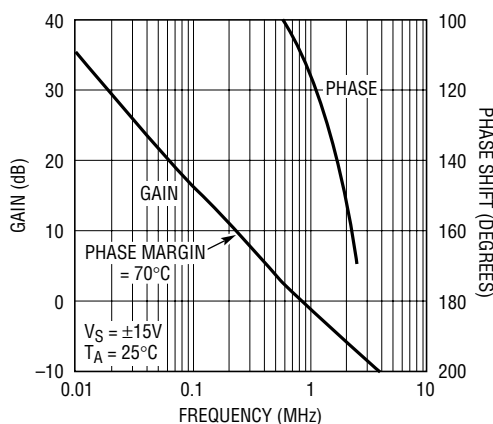
LT1012A • TPC15

Voltage Gain vs Frequency



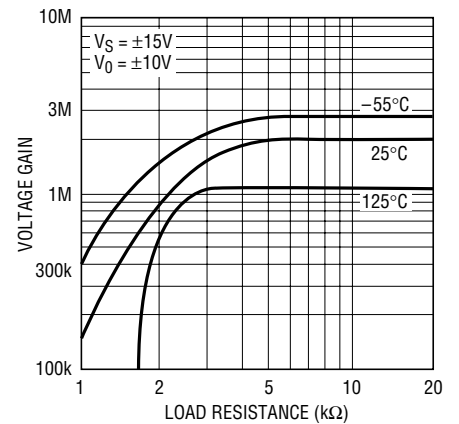
LT1012A • TPC16

Gain, Phase Shift vs Frequency



LT1012A • TPC17

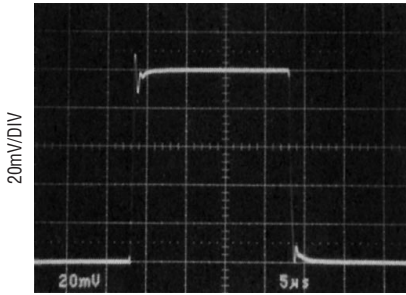
Voltage Gain vs Load Resistance



LT1012A • TPC18

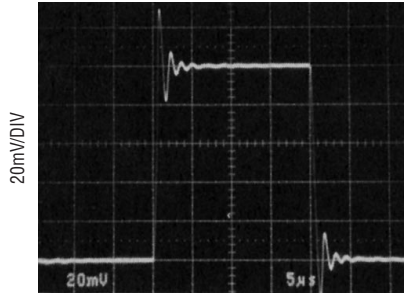
TYPICAL PERFORMANCE CHARACTERISTICS

Small-Signal Transient Response



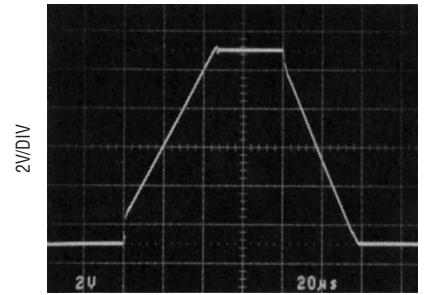
$A_V = +1$
 $C_{LOAD} = 100pF$

Small-Signal Transient Response



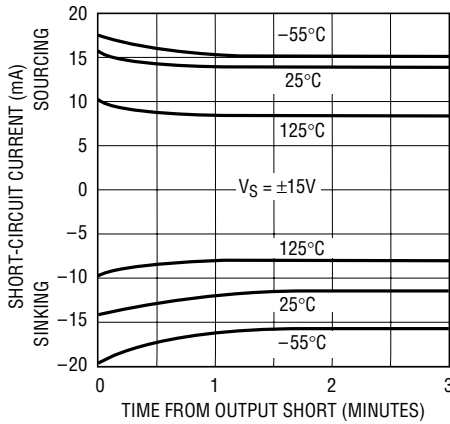
$A_V = +1$
 $C_{LOAD} = 1000pF$

Large-Signal Transient Response



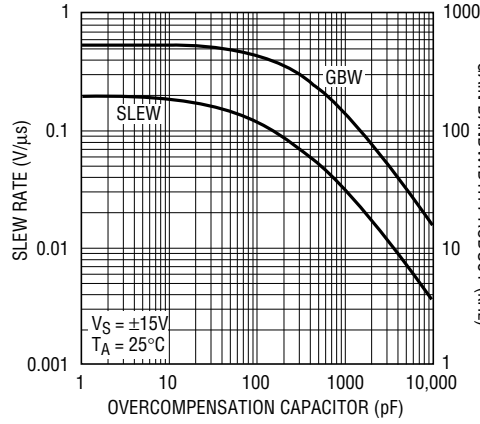
$A_V = +1$
20µs/DIV

Output Short-Circuit Current vs Time



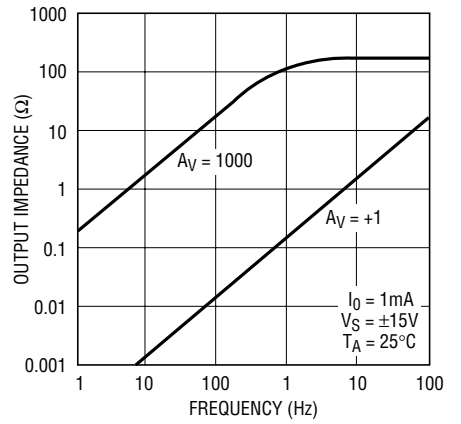
LT1012A • TPC19

Slew Rate, Gain Bandwidth Product vs Overcompensation Capacitor



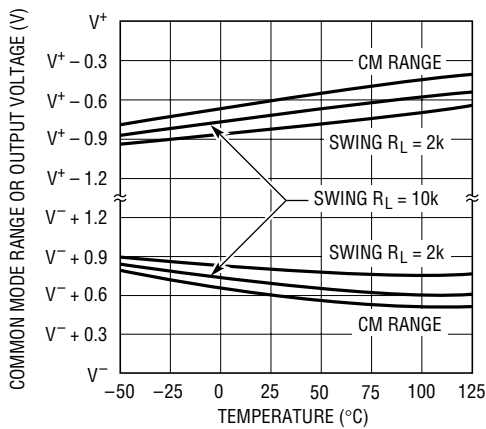
LT1012A • TPC20

Closed-Loop Output Impedance



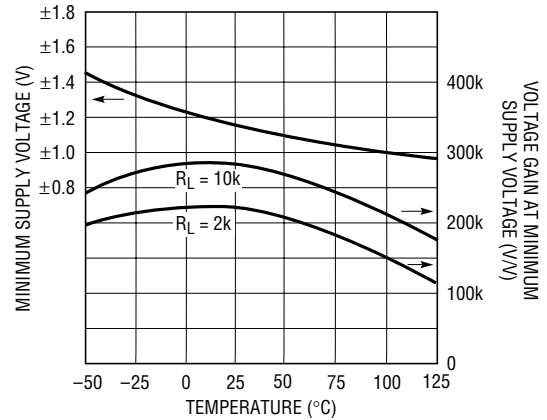
LT1012A • TPC21

Common Mode Range and Voltage Swing at Minimum Supply Voltage



LT1012A • TPC22

Minimum Supply Voltage, Voltage Gain at V_{MIN}



LT1012A • TPC23

APPLICATIONS INFORMATION

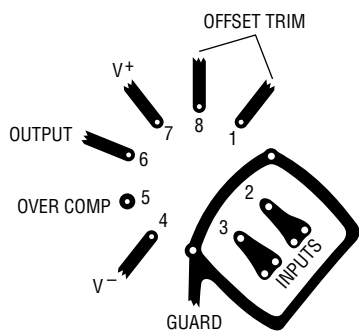
The LT1012 may be inserted directly into OP-07, LM11, 108A or 101A sockets with or without removal of external frequency compensation or nulling components. The LT1012 can also be used in 741, LF411, LF156 or OP-15 applications provided that the nulling circuitry is removed.

Although the OP-97 is a copy of the LT1012, the LT1012 directly replaces and upgrades OP-97 applications. The LT1012C and D have lower offset voltage and drift than the OP-97F. The LT1012A has lower supply current than the OP-97A/E. In addition, all LT1012 grades guarantee operation at $\pm 1.2V$ supplies.

Achieving Picoampere/Microvolt Performance

In order to realize the picoampere/microvolt level accuracy of the LT1012, proper care must be exercised. For example, leakage currents in circuitry external to the op amp can significantly degrade performance. High quality insulation should be used (e.g. Teflon, Kel-F); cleaning of all insulating surfaces to remove fluxes and other residues will probably be required. Surface coating may be necessary to provide a moisture barrier in high humidity environments.

Board leakage can be minimized by encircling the input circuitry with a guard ring operated at a potential close to that of the inputs: in inverting configurations the guard ring should be tied to ground, in non-inverting connections to the inverting input at Pin 2. Guarding both sides of the printed circuit board is required. Bulk leakage reduction depends on the guard ring width. Nanoampere level leakage into the offset trim terminals can affect offset voltage and drift with temperature.



LT1012A • A101

Microvolt level error voltages can also be generated in the external circuitry. Thermocouple effects caused by temperature gradients across dissimilar metals at the contacts to the input terminals can exceed the inherent drift of the amplifier. Air currents over device leads should be minimized, package leads should be short, and the two input leads should be as close together as possible and maintained at the same temperature.

Noise Testing

For application information on noise testing and calculations, please see the LT1008 data sheet.

Frequency Compensation

The LT1012 can be overcompensated to improve capacitive load handling capability or to narrow noise bandwidth. In many applications, the feedback loop around the amplifier has gain (e.g. logarithmic amplifiers); overcompensation can stabilize these circuits with a single capacitor.

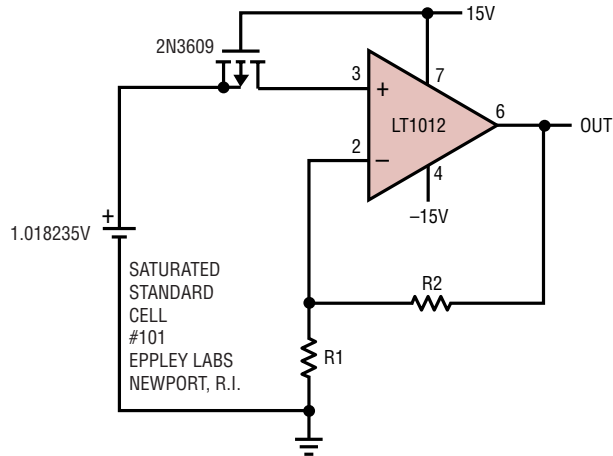
The availability of the compensation terminal permits the use of feedforward frequency compensation to enhance slew rate. The voltage follower feedforward scheme bypasses the amplifier's gain stages and slews at nearly $10V/\mu s$.

The inputs of the LT1012 are protected with back-to-back diodes. Current limiting resistors are not used, because the leakage of these resistors would prevent the realization of picoampere level bias currents at elevated temperatures. In the voltage follower configuration, when the input is driven by a fast, large signal pulse ($>1V$), the input protection diodes effectively short the output to the input during slewing, and a current, limited only by the output short-circuit protection will flow through the diodes.

The use of a feedback resistor, as shown in the voltage follower feedforward diagram, is recommended because this resistor keeps the current below the short-circuit limit, resulting in faster recovery and settling of the output.

TYPICAL APPLICATIONS

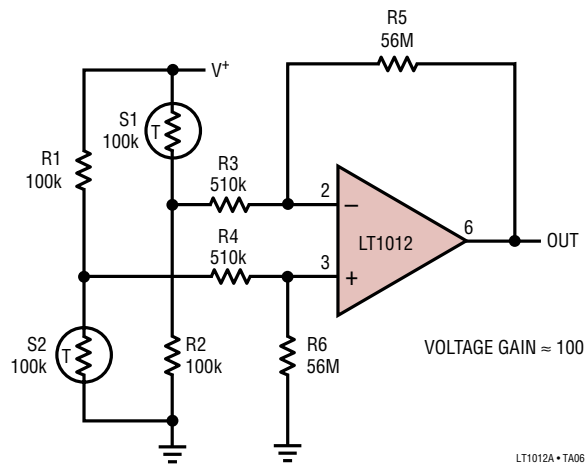
Saturated Standard Cell Amplifier



THE TYPICAL 30pA BIAS CURRENT OF THE LT1012 WILL DEGRADE THE STANDARD CELL BY ONLY 1ppm/YEAR. NOISE IS A FRACTION OF A ppm. UNPROTECTED GATE MOSFET ISOLATES STANDARD CELL ON POWER DOWN

LT1012A • TA05

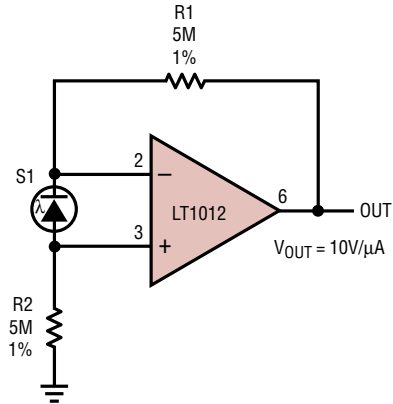
Amplifier for Bridge Transducers



LT1012A • TA06

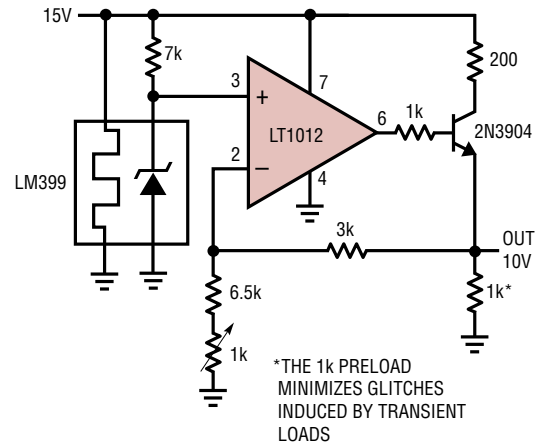
TYPICAL APPLICATIONS

Amplifier for Photodiode Sensor



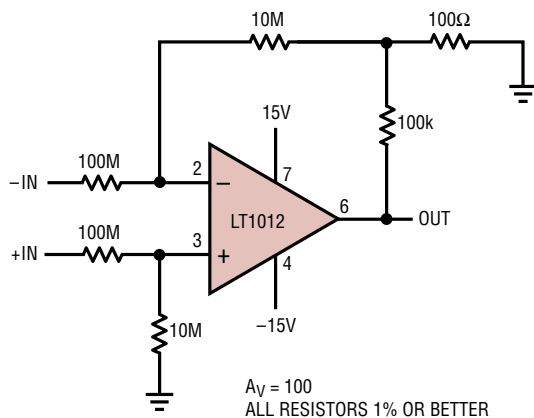
LT1012A • TA07

Buffered Reference for A-to-D Converters



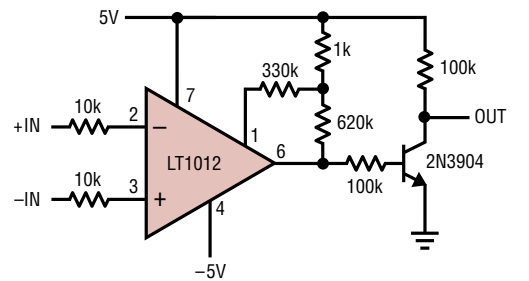
LT1012A • TA08

Instrumentation Amplifier with ±100V Common Mode Range



LT1012A • TA09

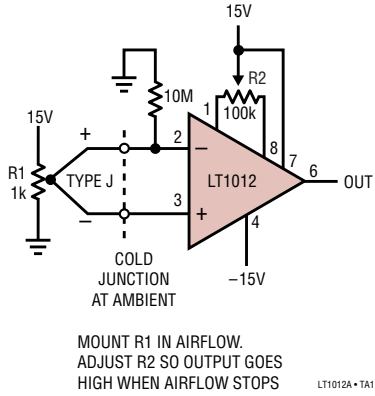
Low Power Comparator with <math><10\mu\text{V}</math> Hysteresis



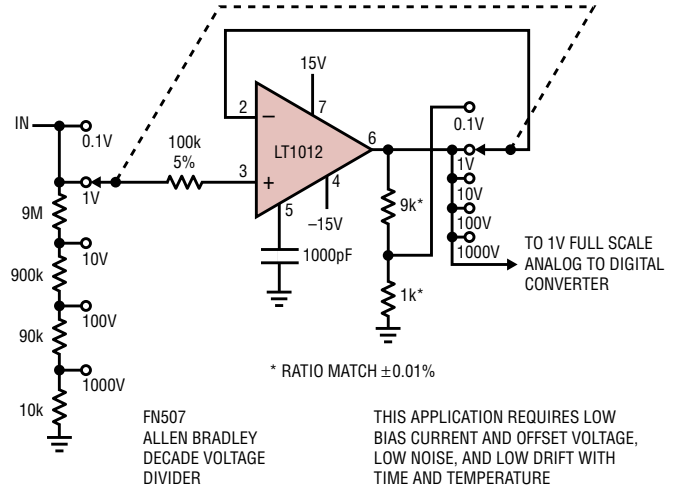
LT1012A • TA10

TYPICAL APPLICATIONS

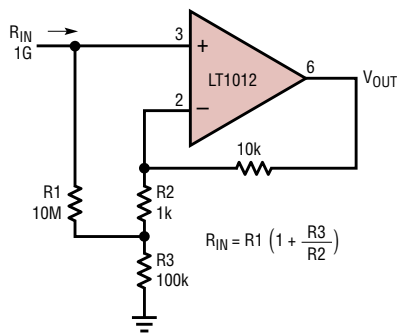
Air Flow Detector



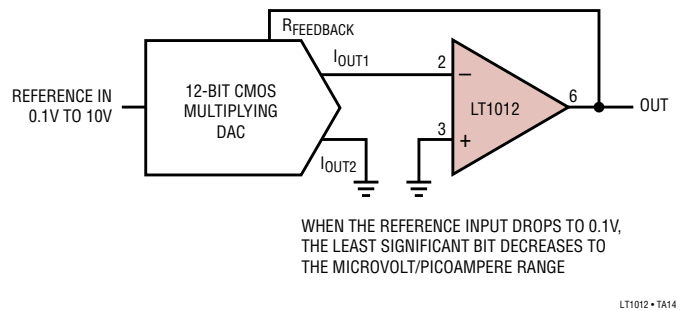
Input Amplifier for 4.5 Digit Voltmeter



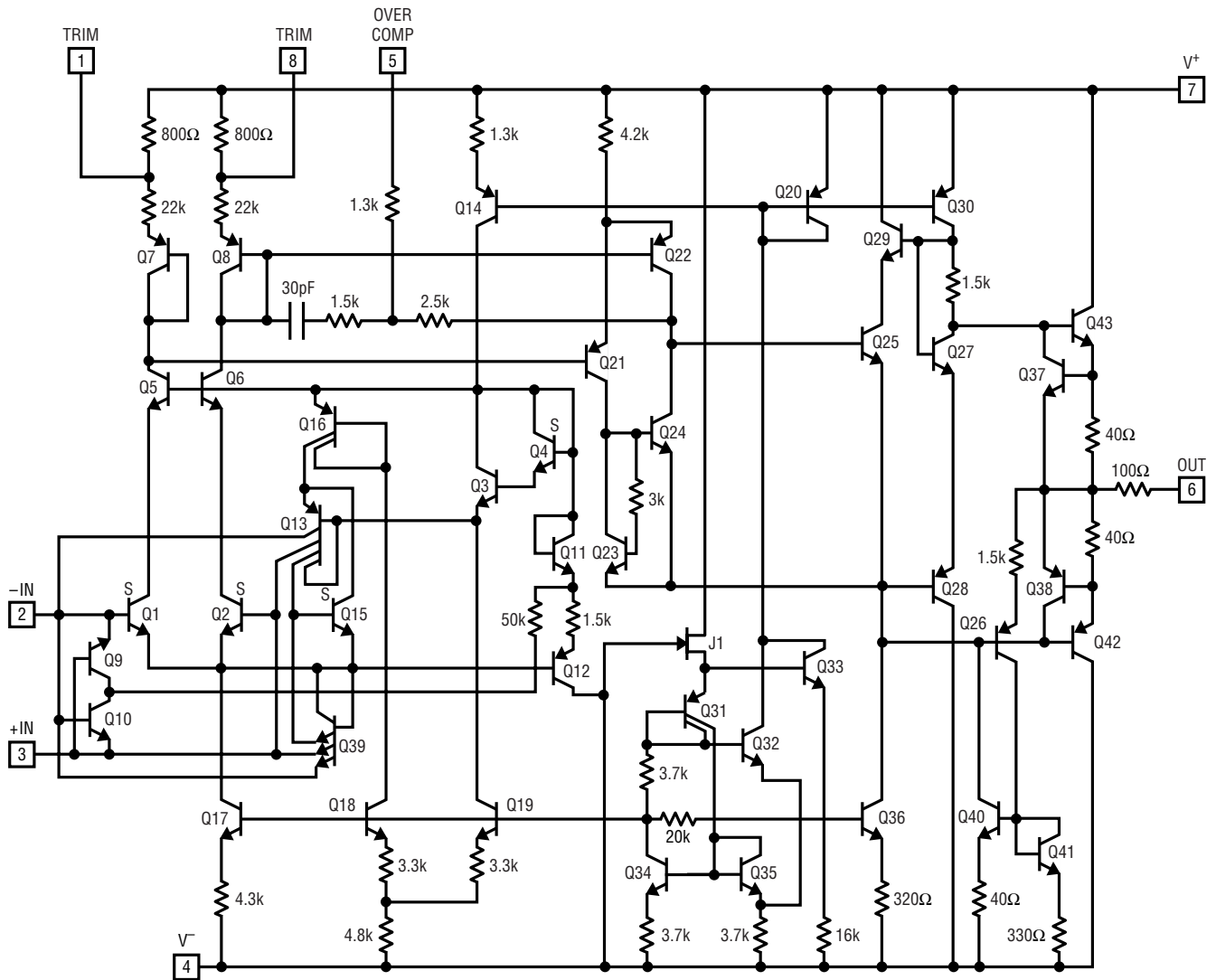
Resistor Multiplier



“No Trims” 12-Bit Multiplying DAC Output Amplifier



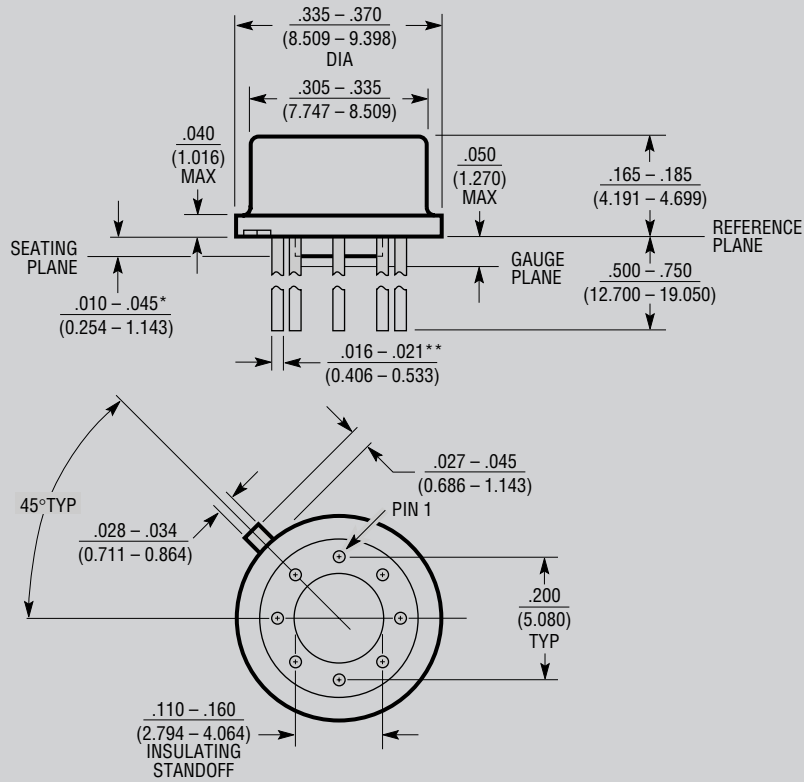
SCHEMATIC DIAGRAM



LT1012A • SD01

PACKAGE DESCRIPTION

H Package
8-Lead TO-5 Metal Can (.200 Inch PCD)
 (Reference LTC DWG # 05-08-1320)



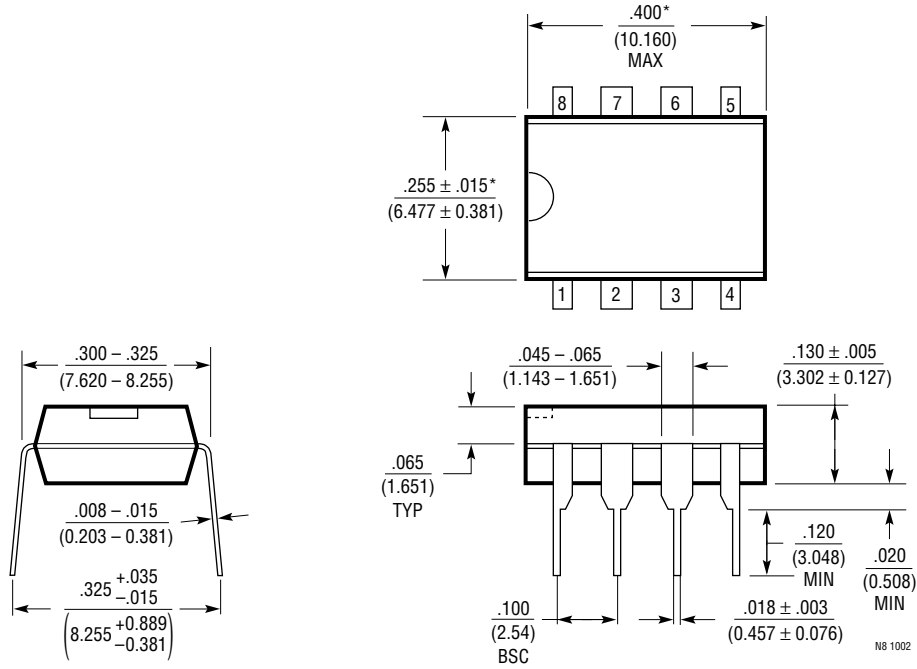
* LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND THE SEATING PLANE

** FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS $.016 - .024$ (0.406 - 0.610) H8(TO-5) 0.200 PCD 0801

OBSOLETE PACKAGE

PACKAGE DESCRIPTION

N8 Package
8-Lead PDIP (Narrow .300 Inch)
 (Reference LTC DWG # 05-08-1510)

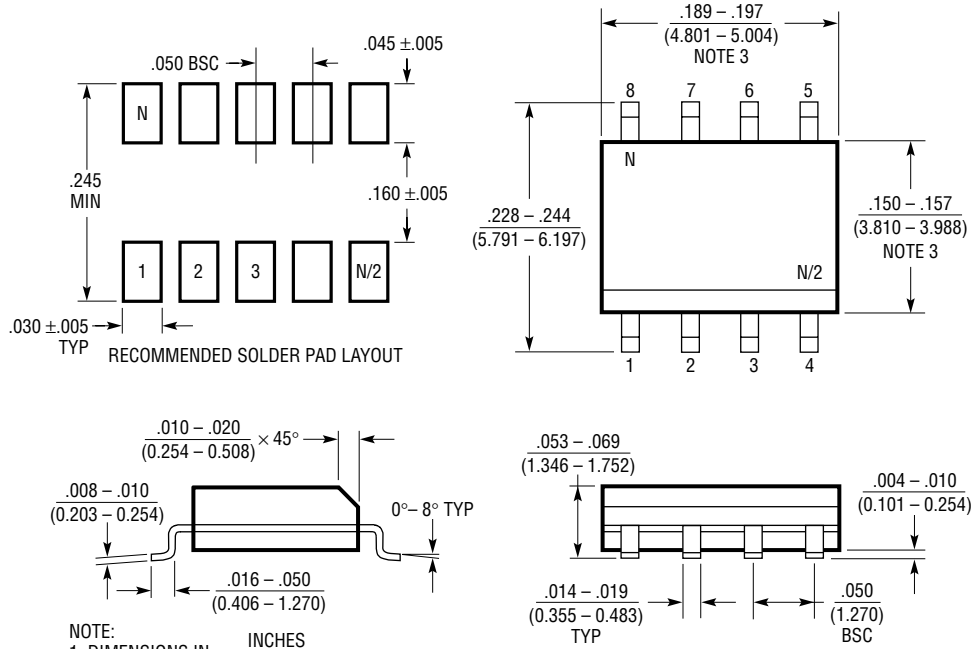


NOTE:
 1. DIMENSIONS ARE $\frac{\text{INCHES}}{\text{MILLIMETERS}}$
 *THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
 MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

N8 1002

PACKAGE DESCRIPTION

S8 Package
8-Lead Plastic Small Outline (Narrow .150 Inch)
 (Reference LTC DWG # 05-08-1610)

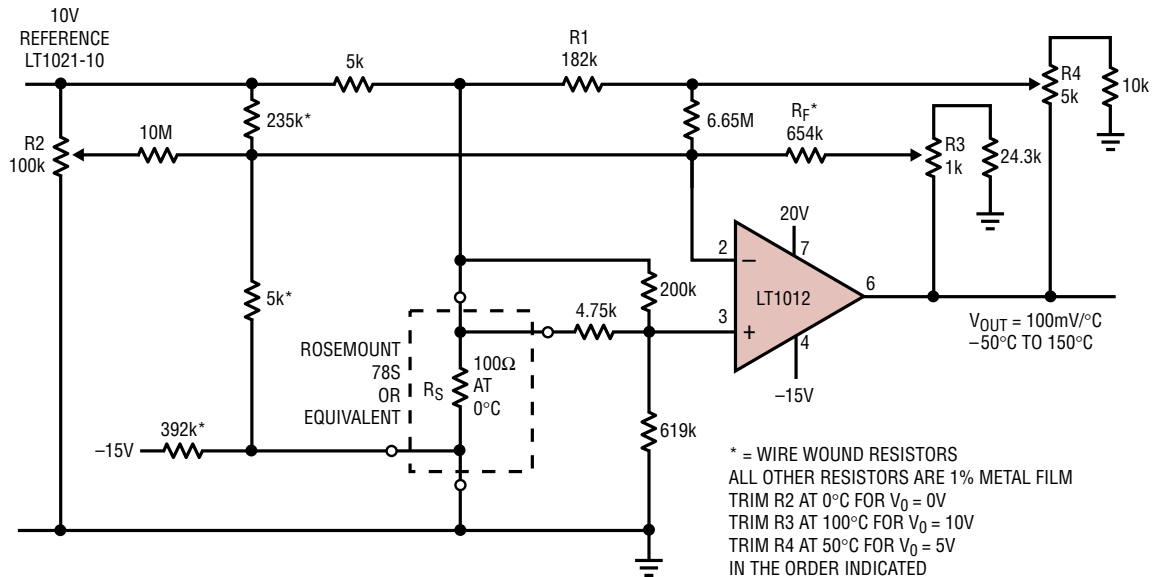


- NOTE:
 1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{MILLIMETERS}}$
 2. DRAWING NOT TO SCALE
 3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
 MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED $.006''$ (0.15mm)

S08 0502

TYPICAL APPLICATION

Kelvin-Sensed Platinum Temperature Sensor Amplifier



POSITIVE FEEDBACK (R1) LINEARIZES THE
 INHERENT PARABOLIC NONLINEARITY OF
 THE PLATINUM SENSOR AND REDUCES
 ERRORS FROM 1.2°C TO 0.004°C OVER
 THE -50°C TO 150°C RANGE

LT1012A • TA04