**FEATURES**

- **Guaranteed Low Offset Voltage**
  - LT1001AM: 15μV max
  - LT1001C: 60μV max
- **Guaranteed Low Drift**
  - LT1001AM: 0.6μV/°C max
  - LT1001C: 1.0μV/°C max
- **Guaranteed Low Bias Current**
  - LT1001AM: 2nA max
  - LT1001C: 4nA max
- **Guaranteed CMRR**
  - LT1001AM: 114dB min
  - LT1001C: 110dB min
- **Guaranteed PSRR**
  - LT1001AM: 110dB min
  - LT1001C: 106dB min
- **Low Power Dissipation**
  - LT1001AM: 75mW max
  - LT1001C: 80mW max
- **Low Noise** 0.3μVp-p

**APPLICATIONS**

- Thermocouple amplifiers
- Strain gauge amplifiers
- Low level signal processing
- High accuracy data acquisition

**DESCRIPTION**

The LT®1001 significantly advances the state-of-the-art of precision operational amplifiers. In the design, processing, and testing of the device, particular attention has been paid to the optimization of the entire distribution of several key parameters. Consequently, the specifications of the lowest cost, commercial temperature device, the LT1001C, have been dramatically improved when compared to equivalent grades of competing precision amplifiers.

Essentially, the input offset voltage of all units is less than 50μV (see distribution plot below). This allows the LT1001AM/883 to be specified at 15μV. Input bias and offset currents, common-mode and power supply rejection of the LT1001C offer guaranteed performance which were previously attainable only with expensive, selected grades of other devices. Power dissipation is nearly halved compared to the most popular precision op amps, without adversely affecting noise or speed performance. A beneficial by-product of lower dissipation is decreased warm-up drift. Output drive capability of the LT1001 is also enhanced with voltage gain guaranteed at 10mA of load current. For similar performance in a dual precision op amp, with guaranteed matching specifications, see the LT1002. Shown below is a platinum resistance thermometer application.

**TYPICAL APPLICATION**

Linearized Platinum Resistance Thermometer with ±0.025°C Accuracy Over 0 to 100°C

![Circuit Diagram]

**Typical Distribution of Offset Voltage**

\[ V_S = \pm 15V, \, T_A = 25°C \]

![Histogram]

---

ULTRONIX 105A WIREWOUND
1% FILM
PLATINUM RTD
18MΩ (ROSEMOUNT, INC.)

† Trim sequence: trim offset (0°C = 1000.0Ω), trim linearity (30°C = 1138.7Ω), trim gain (100°C = 1392.6Ω). Repeat until all three points are fixed with ±0.025°C.
## LT1001

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Condition</th>
<th>LT1001AM/LT1001M (Obsolete)</th>
<th>LT1001AC/LT1001C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>±22V</td>
<td>±30V</td>
<td></td>
</tr>
<tr>
<td>Differential Input Voltage</td>
<td>±30V</td>
<td>±12V</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>±22V</td>
<td>±12V</td>
</tr>
<tr>
<td>Output Short Circuit Duration</td>
<td>Indefinite</td>
<td>Indefinite</td>
</tr>
</tbody>
</table>

### Operating Temperature Range
- LT1001AM/LT1001M (Obsolete): −55°C to 150°C
- LT1001AC/LT1001C: 0°C to 125°C
- Storage: All Devices: −65°C to 150°C
- Lead Temperature (Soldering, 10 sec.): 300°C

### Package/Order Information

<table>
<thead>
<tr>
<th>Package</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>H Package Metal Can</td>
<td>LT1001AMH/883, LT1001MH, LT1001ACH, LT1001CH</td>
</tr>
<tr>
<td>N8 Package</td>
<td>LT1001ACN8, LT1001CN8, LT1001CS8</td>
</tr>
<tr>
<td>S8 Package</td>
<td>LT1001ACH, LT1001CCH</td>
</tr>
<tr>
<td>J8 Package</td>
<td>LT1001AMJ8/883, LT1001MJ8, LT1001ACJ8, LT1001CJ8</td>
</tr>
</tbody>
</table>

### Electrical Characteristics

#### Symbol | Parameter | Conditions | LT1001AM/883 | LT1001AC | LT1001M/LT1001C | Units
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{OS} )</td>
<td>Input Offset Voltage</td>
<td>Note 2</td>
<td>LT1001AM/883</td>
<td>7</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>( V_{OS} )</td>
<td>Input Offset Voltage</td>
<td>LT1001AC</td>
<td>10</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta V_{OS} )</td>
<td>Long Term Input Offset Voltage Stability</td>
<td>Notes 3 and 4</td>
<td>0.2</td>
<td>1.0</td>
<td>0.3</td>
<td>1.5</td>
</tr>
<tr>
<td>( I_{OS} )</td>
<td>Input Offset Current</td>
<td></td>
<td>0.3</td>
<td>2.0</td>
<td>0.4</td>
<td>3.8</td>
</tr>
<tr>
<td>( I_{b} )</td>
<td>Input Bias Current</td>
<td></td>
<td>±0.5</td>
<td>±2.0</td>
<td>±0.7</td>
<td>±4.0</td>
</tr>
<tr>
<td>( e_{n} )</td>
<td>Input Noise Voltage</td>
<td>0.1Hz to 10Hz (Note 3)</td>
<td>0.3</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>( e_{n} )</td>
<td>Input Noise Voltage Density</td>
<td>( f_0 = 10Hz ) (Note 6)</td>
<td>10.3</td>
<td>18.0</td>
<td>10.5</td>
<td>18.0</td>
</tr>
<tr>
<td>( e_{n} )</td>
<td>Input Noise Voltage Density</td>
<td>( f_0 = 1000Hz ) (Note 3)</td>
<td>9.6</td>
<td>11.0</td>
<td>9.8</td>
<td>11.0</td>
</tr>
<tr>
<td>( A_{VOL} )</td>
<td>Large Signal Voltage Gain</td>
<td>( R_L \geq 2k\Omega, , V_O = \pm 12V )</td>
<td>450</td>
<td>800</td>
<td>400</td>
<td>800</td>
</tr>
<tr>
<td>( A_{VOL} )</td>
<td>Large Signal Voltage Gain</td>
<td>( R_L \geq 1k\Omega, , V_O = \pm 10V )</td>
<td>300</td>
<td>500</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>CMRR</td>
<td>Common Mode Rejection Ratio</td>
<td>( V_{CM} = \pm 13V )</td>
<td>114</td>
<td>126</td>
<td>110</td>
<td>126</td>
</tr>
<tr>
<td>PSRR</td>
<td>Power Supply Rejection Ratio</td>
<td>( V_S = \pm 3V ) to ( \pm 18V )</td>
<td>110</td>
<td>123</td>
<td>106</td>
<td>123</td>
</tr>
<tr>
<td>( R_{in} )</td>
<td>Input Resistance Differential Mode</td>
<td></td>
<td>30</td>
<td>100</td>
<td>15</td>
<td>80</td>
</tr>
</tbody>
</table>

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

The ★ denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ C$. $V_S = \pm 15V$, $T_A = 25^\circ C$, unless otherwise noted.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>LT1001AM/883</th>
<th>LT1001C/LT1001C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
</tr>
<tr>
<td>$V_{OS}$</td>
<td>Input Offset Voltage</td>
<td>★</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>$\Delta V_{OS}$</td>
<td>Average Offset Voltage Drift</td>
<td>★</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>$I_{OS}$</td>
<td>Input Offset Current</td>
<td>★</td>
<td>0.8</td>
<td>4.0</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Input Bias Current</td>
<td>★</td>
<td>±1.0</td>
<td>±4.0</td>
</tr>
<tr>
<td>$A_{VOL}$</td>
<td>Large Signal Voltage Gain</td>
<td>★</td>
<td>300</td>
<td>700</td>
</tr>
<tr>
<td>$CMRR$</td>
<td>Common Mode Rejection Ratio</td>
<td>★</td>
<td>110</td>
<td>122</td>
</tr>
<tr>
<td>$PSRR$</td>
<td>Power Supply Rejection Ratio</td>
<td>★</td>
<td>104</td>
<td>117</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage Swing</td>
<td>★</td>
<td>±12.5</td>
<td>±13.5</td>
</tr>
<tr>
<td>$P_d$</td>
<td>Power Dissipation</td>
<td>★</td>
<td>55</td>
<td>90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>LT1001AM/883</th>
<th>LT1001C/LT1001C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
</tr>
<tr>
<td>$V_{DS}$</td>
<td>Input Offset Voltage</td>
<td>★</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>$\Delta V_{DS}$</td>
<td>Average Offset Voltage Drift</td>
<td>★</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>$I_{DS}$</td>
<td>Input Offset Current</td>
<td>★</td>
<td>0.5</td>
<td>3.5</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Input Bias Current</td>
<td>★</td>
<td>±0.7</td>
<td>±3.5</td>
</tr>
<tr>
<td>$A_{VOL}$</td>
<td>Large Signal Voltage Gain</td>
<td>★</td>
<td>350</td>
<td>750</td>
</tr>
<tr>
<td>$CMRR$</td>
<td>Common Mode Rejection Ratio</td>
<td>★</td>
<td>110</td>
<td>124</td>
</tr>
<tr>
<td>$PSRR$</td>
<td>Power Supply Rejection Ratio</td>
<td>★</td>
<td>106</td>
<td>120</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage Swing</td>
<td>★</td>
<td>±12.5</td>
<td>±13.8</td>
</tr>
<tr>
<td>$P_d$</td>
<td>Power Dissipation</td>
<td>★</td>
<td>50</td>
<td>85</td>
</tr>
</tbody>
</table>

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

**Note 2:** Offset voltage for the LT1001AM/883 and LT1001C are measured after power is applied and the device is fully warmed up. All other grades are measured with high speed test equipment, approximately 1 second after power is applied. The LT1001AM/883 receives 168 hr. burn-in at 125°C, or equivalent.

**Note 3:** This parameter is tested on a sample basis only.

**Note 4:** Long Term Input Offset Voltage Stability refers to the averaged trendline of $V_{DS}$ versus Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in $V_{DS}$ during the first 30 days are typically 2.5 μV.

**Note 5:** Parameter is guaranteed by design.

**Note 6:** 10Hz noise voltage density is sample tested on every lot. Devices 100% tested at 10Hz are available on request.
**TYPICAL PERFORMANCE CHARACTERISTICS**

**Small Signal Transient Response**

![Small Signal Transient Response Graph](Image)

**Voltage Follower Overshoot vs Capacitive Load**

![Voltage Follower Overshoot Graph](Image)

**Small Signal Transient Response**

![Small Signal Transient Response Graph](Image)

**Large Signal Transient Response**

![Large Signal Transient Response Graph](Image)

**Maximum Undistorted Output vs. Frequency**

![Maximum Undistorted Output Graph](Image)

**Closed Loop Output Impedance**

![Closed Loop Output Impedance Graph](Image)

**APPLICATIONS INFORMATION**

**Application Notes and Test Circuits**

The LT1001 series units may be inserted directly into OP-07, OP-05, 725, 108A or 101A sockets with or without removal of external frequency compensation or nulling components. The LT1001 can also be used in 741, LF156 or OP-15 applications provided that the nulling circuitry is removed.

The LT1001 is specified over a wide range of power supply voltages from $\pm 3$V to $\pm 18$V. Operation with lower supplies is possible down to $\pm 1.2$V (two Ni-Cad batteries). However, with $\pm 1.2$V supplies, the device is stable only in closed loop gains of $+2$ or higher (or inverting gain of one or higher).

Unless proper care is exercised, 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.

**Test Circuit for Offset Voltage and its Drift with Temperature**

![Test Circuit Diagram](Image)

* RESISTORS MUST HAVE LOW THERMOELECTRIC POTENTIAL.

** This Circuit is also used as the burn-in configuration for the LT1001, with supply voltages increased to $\pm 20$V.
OFFSET VOLTAGE ADJUSTMENT

The input offset voltage of the LT1001, and its drift with temperature, are permanently trimmed at wafer test to a low level. However, if further adjustment of Vos is necessary, nulling with a 10k or 20k potentiometer will not degrade drift with temperature. Trimming to a value other than zero creates a drift of (Vos/300)μV/°C, e.g., if Vos is adjusted to 300 μV, the change in drift will be 1 μV/°C. The adjustment range with a 10k or 20k pot is approximately ±2.5mV. If less adjustment range is needed, the sensitivity and resolution of the nulling can be improved by using a smaller pot in conjunction with fixed resistors. The example below has an approximate null range of ±100 μV.

0.1Hz to 10Hz Noise Test Circuit

The device under test should be warmed up for three minutes and shielded from air currents.
**LT1001**

**TYPICAL APPLICATIONS**

**Microvolt Comparator with TTL Output**

**Photodiode Amplifier**

Positive feedback to one of the nulling terminals creates 5µV to 20µV of hysteresis. Input offset voltage is typically changed by less than 5µV due to the feedback.

**Precision Current Source**

**Precision Current Sink**

**Strain Gauge Signal Conditioner with Bridge Excitation**

REFERENCE OUT TO MONITORING A/D CONVERTER

*RN60C FILM RESISTORS*
The voltage follower is an ideal example illustrating the overall excellence of the LT1001. The contributing error terms are due to offset voltage, input bias current, voltage gain, common mode and power-supply rejections. Worst-case summation of guaranteed specifications is tabulated below.

<table>
<thead>
<tr>
<th>Error</th>
<th>LT1001AM /833</th>
<th>LT1001C</th>
<th>LT1001AM /833</th>
<th>LT1001C</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C Max.</td>
<td>15μV</td>
<td>60μV</td>
<td>60μV</td>
<td>110μV</td>
</tr>
<tr>
<td>25°C Max. –55 to 125°C Max.</td>
<td>20μV</td>
<td>30μV</td>
<td>30μV</td>
<td>50μV</td>
</tr>
<tr>
<td>Power Supply Rejection</td>
<td>18μV</td>
<td>30μV</td>
<td>36μV</td>
<td>42μV</td>
</tr>
<tr>
<td>Voltage Gain</td>
<td>22μV</td>
<td>25μV</td>
<td>33μV</td>
<td>40μV</td>
</tr>
<tr>
<td>Worst-case Sum</td>
<td>95μV</td>
<td>185μV</td>
<td>199μV</td>
<td>297μV</td>
</tr>
<tr>
<td>Percent of Full Scale</td>
<td>0.0005%</td>
<td>0.0009%</td>
<td>0.0010%</td>
<td>0.0015%</td>
</tr>
</tbody>
</table>

Circuit uses temperature difference between battery pack mounted thermocouple and ambient thermocouple to set battery charge current. Peak charging current is 1 AMP.

* SINGLE POINT GROUND THERMOCOUPLES ARE 40μV/°C CHROMEL-ALUMEL (TYPE K)
**TYPICAL APPLICATIONS**

**Precision Power Supply with Two Outputs**

1. 0V to 10V in 100µV STEPS
2. 0V to 100V in 1mV STEPS

**Dead Zone Generator**

Bipolar symmetry is excellent because one device, Q2, sets both limits.
Instrumentation Amplifier with ±300V
Common Mode Range and CMRR > 150dB

A flying capacitor charged by clocked photo driven FET switches converts a differential signal at a high common mode voltage to a single ended signal at the LT1001 output.

1) ALL DIODES IN4148
2) S1–S4 OPTO MOS SWITCH OFM-1A, THETA-J CORP.
3) **FILM RESISTOR
4) **POLYPROPYLENE CAPACITORS
5) ADJUST R1 for 93 Hz AT TEST POINT  A
PACKAGE DESCRIPTION

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

SEATING PLANE
0.010 – 0.045* (0.254 – 1.143)
0.016 – 0.021** (0.406 – 0.533)

GAUGE PLANE
0.027 – 0.045 (0.686 – 1.143)

REFERENCE PLANE
0.050 (1.270)
0.165 – 0.185 (4.191 – 4.699)

0.500 – 0.750 (12.700 – 19.050)

0.200 (5.080) TYP

0.335 – 0.370 (8.509 – 9.398)

0.305 – 0.335 (7.747 – 8.350)

DIA

0.110 – 0.160 (2.794 – 4.064)

INSULATING STANDOFF

45° TYP

* LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE
AND 0.045" BELOW THE REFERENCE PLANE

** FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS
0.016 – 0.024 (0.406 – 0.610)

OBSOLETE PACKAGE
J8 Package
8-Lead CERDIP (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)

NOTE: LEAD DIMENSIONS APPLY TO SOLDER DIP/PLATE OR TIN PLATE LEADS

PACKAGE DESCRIPTION

OBSOLETE PACKAGE
N8 Package
8-Lead PDIP (Narrow .300 Inch)
(Reference 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 .150 Inch)
(Reference 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