ANNEX XIII

TL084
TL081, TL081A, TL081B, TL082, TL082A, TL082B
TL082Y, TL084, TL084A, TL084B, TL084Y
JFET-INPUT OPERATIONAL AMPLIFIERS
SLOS081E – FEBRUARY 1977 – REVISED FEBRUARY 1999

- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Total Harmonic Distortion... 0.003% Typ
- High Input Impedance... JFET-Input Stage
- Latch-Up-Free Operation
- High Slew Rate... 13 V/µs Typ
- Common-Mode Input Voltage Range Includes VCC+

description

The TL08x JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient. Offset adjustment and external compensation options are available within the TL08x family.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The Q-suffix devices are characterized for operation from –40°C to 125°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

symbols

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.
TL081, TL081A, TL081B, TL082, TL082A, TL082B
TL082Y, TL084, TL084A, TL084B, TL084Y
JFET-INPUT OPERATIONAL AMPLIFIERS
SLOS081E – FEBRUARY 1977 – REVISED FEBRUARY 1999

NC – No internal connection
## AVAILABLE OPTIONS

<table>
<thead>
<tr>
<th>TA</th>
<th>$V_{IOMAX}$ AT 25°C</th>
<th>SMALL OUTLINE (D008)</th>
<th>SMALL OUTLINE (D014)</th>
<th>CHIP CARRIER (FK)</th>
<th>CERAMIC DIP (J)</th>
<th>CERAMIC DIP (JG)</th>
<th>PLASTIC DIP (N)</th>
<th>PLASTIC DIP (P)</th>
<th>TSSOP (PW)</th>
<th>FLAT PACK (U)</th>
<th>FLAT PACK (W)</th>
<th>CHIP FORM (Y)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TL081CD</td>
<td>TL081ACD</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL081CP</td>
<td>TL081ACP</td>
<td>TL081BCP</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>0°C to 70°C</td>
<td>15 mV</td>
<td>TL081CD</td>
<td>TL081ACD</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL081CP</td>
<td>TL081ACP</td>
<td>TL081BCP</td>
<td>—</td>
<td>—</td>
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<tr>
<td></td>
<td></td>
<td>TL082CD</td>
<td>TL082ACD</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL082CP</td>
<td>TL082ACP</td>
<td>TL082BCP</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TL084CD</td>
<td>TL084ACD</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL084CN</td>
<td>TL084ACN</td>
<td>TL084BCN</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>−40°C to 85°C</td>
<td>6 mV</td>
<td>TL081ID</td>
<td>TL082ID</td>
<td>TL084ID</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL081IP</td>
<td>TL082IP</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>−40°C to 125°C</td>
<td>9 mV</td>
<td>—</td>
<td>TL084ID</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>−55°C to 125°C</td>
<td>6 mV</td>
<td>—</td>
<td>—</td>
<td>TL081MK</td>
<td>TL082MK</td>
<td>TL084MK</td>
<td>TL081MJK</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL081MU</td>
<td>TL082MU</td>
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<td>—</td>
<td>—</td>
<td>TL081MK</td>
<td>TL082MK</td>
<td>TL084MK</td>
<td>TL081MJK</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>TL081MU</td>
<td>TL082MU</td>
</tr>
</tbody>
</table>

The D package is available taped and reeled. Add R suffix to the device type (e.g., TL081CDR).
schematic (each amplifier)

Component values shown are nominal.
TL082Y chip information

These chips, when properly assembled, display characteristics similar to the TL082. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

**BONDING PAD ASSIGNMENTS**

*CHIP THICKNESS: 15 TYPICAL
  BONDING PADS: 4 × 4 MINIMUM
  $T_{J\text{max}} = 150^\circ\text{C}$
  TOLERANCES ARE ±10%.
  ALL DIMENSIONS ARE IN MILS.
  PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.*
TL084Y chip information

These chips, when properly assembled, display characteristics similar to the TL084. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS

CHIP THICKNESS: 15 TYPICAL
BONDING PADS: 4 × 4 MINIMUM

\[ T_{\text{max}} = 150^\circ C \]

TOLERANCES ARE ±10%.
ALL DIMENSIONS ARE IN MILS.
PIN (11) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.
absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

<table>
<thead>
<tr>
<th></th>
<th>TL081_C</th>
<th>TL081 AC</th>
<th>TL081 BC</th>
<th>TL082</th>
<th>TL082 A</th>
<th>TL082 B</th>
<th>TL084</th>
<th>TL084 A</th>
<th>TL084 B</th>
<th>TL084 Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage, VCC+ (see Note 1)</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage VCC– (see Note 1)</td>
<td>–18</td>
<td>–18</td>
<td>–18</td>
<td>–18</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differential input voltage, VID (see Note 2)</td>
<td>± 30</td>
<td>± 30</td>
<td>± 30</td>
<td>± 30</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input voltage, VI (see Notes 1 and 3)</td>
<td>± 15</td>
<td>± 15</td>
<td>± 15</td>
<td>± 15</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of output short circuit (see Note 4)</td>
<td>unlimited</td>
<td>unlimited</td>
<td>unlimited</td>
<td>unlimited</td>
<td>V</td>
<td></td>
<td></td>
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<tr>
<td>Continuous total power dissipation</td>
<td>See Dissipation Rating Table</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Operating free-air temperature range, TA</td>
<td>0 to 70</td>
<td>– 40 to 85</td>
<td>– 40 to 125</td>
<td>– 55 to 125 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature range, Tstg</td>
<td>– 65 to 150</td>
<td>– 65 to 150</td>
<td>– 65 to 150</td>
<td>– 65 to 150 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case temperature for 60 seconds, TC</td>
<td>FK package</td>
<td>260 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds</td>
<td>J or JG package</td>
<td>300 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds</td>
<td>D, N, P, or PW package</td>
<td>260 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between VCC+ and VCC–.
2. Differential voltages are at IN+ with respect to IN–.
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 to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

DISSIPATION RATING TABLE

<table>
<thead>
<tr>
<th>PACKAGE</th>
<th>TA ≤ 25°C POWER RATING</th>
<th>DERATING FACTOR</th>
<th>DERATE ABOVE TA</th>
<th>TA = 70°C POWER RATING</th>
<th>TA = 85°C POWER RATING</th>
<th>TA = 125°C POWER RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>D (8 pin)</td>
<td>680 mW</td>
<td>5.8 mW/°C</td>
<td>32°C</td>
<td>460 mW</td>
<td>373 mW</td>
<td>N/A</td>
</tr>
<tr>
<td>D (14 pin)</td>
<td>680 mW</td>
<td>7.6 mW/°C</td>
<td>60°C</td>
<td>604 mW</td>
<td>490 mW</td>
<td>186 mW</td>
</tr>
<tr>
<td>FK</td>
<td>680 mW</td>
<td>11.0 mW/°C</td>
<td>88°C</td>
<td>680 mW</td>
<td>680 mW</td>
<td>273 mW</td>
</tr>
<tr>
<td>J</td>
<td>680 mW</td>
<td>11.0 mW/°C</td>
<td>88°C</td>
<td>680 mW</td>
<td>680 mW</td>
<td>273 mW</td>
</tr>
<tr>
<td>JG</td>
<td>680 mW</td>
<td>8.4 mW/°C</td>
<td>69°C</td>
<td>672 mW</td>
<td>546 mW</td>
<td>210 mW</td>
</tr>
<tr>
<td>N</td>
<td>680 mW</td>
<td>9.2 mW/°C</td>
<td>76°C</td>
<td>680 mW</td>
<td>597 mW</td>
<td>N/A</td>
</tr>
<tr>
<td>P</td>
<td>680 mW</td>
<td>8.0 mW/°C</td>
<td>65°C</td>
<td>640 mW</td>
<td>520 mW</td>
<td>N/A</td>
</tr>
<tr>
<td>PW (8 pin)</td>
<td>525 mW</td>
<td>4.2 mW/°C</td>
<td>25°C</td>
<td>336 mW</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>PW (14 pin)</td>
<td>700 mW</td>
<td>5.6 mW/°C</td>
<td>25°C</td>
<td>448 mW</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>U</td>
<td>675 mW</td>
<td>5.4 mW/°C</td>
<td>25°C</td>
<td>432 mW</td>
<td>351 mW</td>
<td>135 mW</td>
</tr>
<tr>
<td>W</td>
<td>680 mW</td>
<td>8.0 mW/°C</td>
<td>65°C</td>
<td>640 mW</td>
<td>520 mW</td>
<td>200 mW</td>
</tr>
</tbody>
</table>
### Electrical Characteristics, \( V_{CC\pm} = \pm 15 \text{ V} \) (unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>( T_A )†</th>
<th>TL081C</th>
<th>TL081C</th>
<th>TL081AC</th>
<th>TL081AC</th>
<th>TL081BC</th>
<th>TL081BC</th>
<th>TL081I</th>
<th>TL081I</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IO} ) Input offset voltage</td>
<td>( V_O = 0 ) ( R_S = 50 \Omega )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td></td>
<td>Full range</td>
<td></td>
<td>3</td>
<td>15</td>
<td></td>
<td>3</td>
<td>6</td>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>( \alpha_{VIO} ) Temperature coefficient of input offset voltage</td>
<td>( V_O = 0 ) ( R_S = 50 \Omega )</td>
<td>Full range</td>
<td>18</td>
<td></td>
<td>18</td>
<td></td>
<td>18</td>
<td></td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>( I_{IO} ) Input offset current‡</td>
<td>( V_O = 0 )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td></td>
<td>Full range</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{IB} ) Input bias current‡</td>
<td>( V_O = 0 )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td></td>
<td>Full range</td>
<td></td>
<td>10</td>
<td>7</td>
<td></td>
<td>7</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{ICR} ) Common-mode input voltage range</td>
<td>( R_L = 10 \text{k}\Omega )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td>( V_{OM} ) Maximum peak output voltage swing</td>
<td>( R_L \geq 2 \text{k}\Omega )</td>
<td>Full range</td>
<td>12</td>
<td></td>
<td>12</td>
<td></td>
<td>12</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>( A_{VD} ) Large-signal differential voltage amplification</td>
<td>( V_O = \pm 10 \text{ V} ), ( R_L \geq 2 \text{k}\Omega )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td>( B_1 ) Unity-gain bandwidth</td>
<td>( V_O = \pm 10 \text{ V} ), ( R_L \geq 2 \text{k}\Omega )</td>
<td>Full range</td>
<td>15</td>
<td></td>
<td>25</td>
<td></td>
<td>25</td>
<td></td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>( r_1 ) Input resistance</td>
<td>( V_O = 0 ), ( R_S = 50 \Omega )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td>( CMRR ) Common-mode rejection ratio</td>
<td>( V_{IC} = V_{ICR\min} ), ( V_O = 0 ), ( R_S = 50 \Omega )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td>( k_{SVR} ) Supply voltage rejection ratio ((\Delta V_{CC\pm}/\Delta V_{IO}))</td>
<td>( V_{CC} = \pm 15 \text{ V} ) to ( \pm 9 \text{ V} ), ( V_O = 0 ), ( R_S = 50 \Omega )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td>( I_{CC} ) Supply current (per amplifier)</td>
<td>( V_O = 0 ), No load</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
<tr>
<td>( V_{O1}/V_{O2} ) Crosstalk attenuation</td>
<td>( A_{VD} = 100 )</td>
<td>( 25^\circ \text{C} )</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
<td>Max</td>
<td>Min</td>
<td>TYP</td>
</tr>
</tbody>
</table>

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for \( T_A \) is \( 0^\circ \text{C} \) to \( 70^\circ \text{C} \) for TL081C, TL081AC, TL081BC, and \( -40^\circ \text{C} \) to \( 85^\circ \text{C} \) for TL081I.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 17. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.
### Electrical Characteristics, $V_{CC} = \pm 15$ V (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS†</th>
<th>$T_A$</th>
<th>TL081M, TL082M</th>
<th>TL084Q, TL084M</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IO}$ Input offset voltage</td>
<td>$V_O = 0$, $R_S = 50 \Omega$</td>
<td>25°C</td>
<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
</tr>
<tr>
<td>$\alpha_{VIO}$ Temperature</td>
<td>$V_O = 0$, $R_S = 50 \Omega$</td>
<td>Full range</td>
<td></td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>coefficient of input</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>offset voltage</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{IO}$ Input offset current‡</td>
<td>$V_O = 0$</td>
<td>25°C</td>
<td>5</td>
<td>100</td>
<td>5 100</td>
</tr>
<tr>
<td>$I_{IB}$ Input bias current‡</td>
<td>$V_O = 0$</td>
<td>25°C</td>
<td>30</td>
<td>200</td>
<td>30 200</td>
</tr>
<tr>
<td>$V_{ICR}$ Common-mode input</td>
<td>$V_O = 0$, $R_S = 50 \Omega$</td>
<td>Full range</td>
<td>±12</td>
<td>15</td>
<td>±12</td>
</tr>
<tr>
<td>voltage range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OM}$ Maximum peak output</td>
<td>$R_L = 10 \Omega$</td>
<td>25°C</td>
<td>±12</td>
<td>±13.5</td>
<td>±12</td>
</tr>
<tr>
<td>voltage swing</td>
<td>$R_L \geq 10 \Omega$</td>
<td>Full range</td>
<td>±12</td>
<td></td>
<td>±12</td>
</tr>
</tbody>
</table>
| $A_{VD}$ Large-signal           | $V_O = \pm 10 \text{ V}$, $R_L \geq 2 \text{ k}\Omega$ | 25°C  | 25   | 200 | 25 200 |    |    |    | V/mV |}

- All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified.
- Input bias currents of a JFET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 17. Pulse techniques must be used that maintain the junction temperatures as close to the ambient temperature as is possible.

### Operating Characteristics, $V_{CC} = \pm 15$ V, $T_A = 25^\circ$C (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{I}$ Slew rate at unity gain</td>
<td>$V_L = 10 \text{ V}$, $R_L = 2 \text{ k}\Omega$, $C_L = 100 \text{ pF}$, See Figure 1</td>
<td>8*</td>
<td>13</td>
<td></td>
<td>V/µs</td>
</tr>
<tr>
<td>$t_r$ Rise time</td>
<td>$V_L = 10 \text{ V}$, $T_A = -55^\circ$ to 125°C, See Figure 1</td>
<td>5*</td>
<td></td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>$V_{n}$ Equivalent input noise</td>
<td>$R_S = 20 \Omega$, $f = 1 \text{ kHz}$</td>
<td>18</td>
<td></td>
<td></td>
<td>nV/√Hz</td>
</tr>
<tr>
<td>voltage</td>
<td>$R_S = 20 \Omega$, $f = 10 \text{ Hz}$ to 10 kHz</td>
<td>4</td>
<td></td>
<td></td>
<td>µV</td>
</tr>
<tr>
<td>$I_{n}$ Equivalent input noise</td>
<td>$R_S = 20 \Omega$, $f = 1 \text{ kHz}$</td>
<td>0.01</td>
<td></td>
<td></td>
<td>pA/√Hz</td>
</tr>
<tr>
<td>current</td>
<td>$R_S = 1 \text{ k}\Omega$, $R_L \geq 2 \text{ k}\Omega$</td>
<td>0.003%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- On products compliant to MIL-PRF-38535, this parameter is not production tested.
### Electrical Characteristics, $V_{CC} = \pm 15\ V, T_A = 25^\circ C$ (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS†</th>
<th>TL082Y, TL084Y</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IO}$ Input offset voltage</td>
<td>$V_O = 0, R_S = 50\ \Omega$</td>
<td>3 15</td>
<td>mV</td>
</tr>
<tr>
<td>$\alpha_{VIO}$ Temperature coefficient of input offset voltage</td>
<td>$V_O = 0, R_S = 50\ \Omega$</td>
<td>18</td>
<td>$\mu V/^\circ C$</td>
</tr>
<tr>
<td>$I_{IO}$ Input offset current‡</td>
<td>$V_O = 0, R_S = 50\ \Omega$</td>
<td>5 200</td>
<td>pA</td>
</tr>
<tr>
<td>$I_{IB}$ Input bias current‡</td>
<td>$V_O = 0$</td>
<td>30 400</td>
<td>pA</td>
</tr>
<tr>
<td>$V_{ICR}$ Common-mode input voltage range</td>
<td></td>
<td>±12 to 15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OM}$ Maximum peak output voltage swing</td>
<td>$R_L = 10\ k\Omega$</td>
<td>±12 ±13.5</td>
<td>V</td>
</tr>
<tr>
<td>$A_{VD}$ Large-signal differential voltage amplification</td>
<td>$V_O = \pm 10\ V, R_L \geq 2\ k\Omega$</td>
<td>25 200</td>
<td>V/mV</td>
</tr>
<tr>
<td>$B_1$ Unity-gain bandwidth</td>
<td></td>
<td>3</td>
<td>MHz</td>
</tr>
<tr>
<td>$r_i$ Input resistance</td>
<td></td>
<td>10$^{12}$</td>
<td>$\Omega$</td>
</tr>
<tr>
<td>$CMRR$ Common-mode rejection ratio</td>
<td>$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$</td>
<td>70 86</td>
<td>dB</td>
</tr>
<tr>
<td>$k_{SVR}$ Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)</td>
<td>$V_{CC} = \pm 15\ V\ to\ \pm 9\ V, V_O = 0, R_S = 50\ \Omega$</td>
<td>70 86</td>
<td>dB</td>
</tr>
<tr>
<td>$I_{CC}$ Supply current (per amplifier)</td>
<td>$V_O = 0, No\ load$</td>
<td>1.4 2.8</td>
<td>mA</td>
</tr>
<tr>
<td>$V_{O1}/V_{O2}$ Crosstalk attenuation</td>
<td>$A_{VD} = 100$</td>
<td>120</td>
<td>dB</td>
</tr>
</tbody>
</table>

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.
‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 17. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

### Operating Characteristics, $V_{CC} = \pm 15\ V, T_A = 25^\circ C$

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$SR$ Slew rate at unity gain</td>
<td>$V_I = 10\ V, R_L = 2\ k\Omega, C_L = 100\ pF, See\ Figure 1$</td>
<td>8</td>
<td>13</td>
<td></td>
<td>V/\mu s</td>
</tr>
<tr>
<td>$T_r$ Rise time</td>
<td>$V_I = 20\ mV, R_L = 2\ k\Omega, C_L = 100\ pF, See\ Figure 1$</td>
<td>0.05</td>
<td></td>
<td></td>
<td>\mu s</td>
</tr>
<tr>
<td></td>
<td>Overshoot factor</td>
<td></td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_n$ Equivalent input noise voltage</td>
<td>$R_S = 20\ \Omega, f = 1\ kHz$</td>
<td>18</td>
<td></td>
<td></td>
<td>nV/$\sqrt{Hz}$</td>
</tr>
<tr>
<td></td>
<td>$f = 10\ Hz\ to\ 10\ kHz$</td>
<td>4</td>
<td></td>
<td></td>
<td>$\mu V$</td>
</tr>
<tr>
<td>$I_{n}$ Equivalent input noise current</td>
<td>$R_S = 20\ \Omega, f = 1\ kHz$</td>
<td>0.01</td>
<td></td>
<td></td>
<td>pA/$\sqrt{Hz}$</td>
</tr>
<tr>
<td>THD Total harmonic distortion</td>
<td>$V_{rms} = 6\ V, A_{VD} = 1, R_S \leq 1\ k\Omega, R_L \geq 2\ k\Omega$</td>
<td>0.003%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PARAMETER MEASUREMENT INFORMATION

Figure 1

\[ V_{I} \]

\[ C_{L} = 100 \text{ pF} \]

\[ R_{L} = 2 \text{ k}\Omega \]

\[ \text{OUT} \]

\[ V_{O} \]

Figure 2

\[ V_{I} \]

\[ 1 \text{ k}\Omega \]

\[ R_{L} \]

\[ C_{L} = 100 \text{ pF} \]

\[ \text{OUT} \]

\[ V_{O} \]

Figure 3

\[ 100 \text{ k}\Omega \]

\[ C_{2} \]

\[ C_{1} = 500 \text{ pF} \]

\[ \text{IN}^{-} \]

\[ \text{IN}^{+} \]

\[ \text{N1} \]

\[ \text{OUT} \]

\[ V_{O} \]

Figure 4

\[ \text{IN}^{-} \]

\[ \text{IN}^{+} \]

\[ \text{N1} \]

\[ \text{N2} \]

\[ \text{TL081} \]

\[ 100 \text{ k}\Omega \]

\[ 1.5 \text{ k}\Omega \]

\[ V_{CC}^{-} \]

\[ V_{O} \]
## TYPICAL CHARACTERISTICS

### Table of Graphs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>vs</th>
<th>FIGURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{OM} ) Maximum peak output voltage</td>
<td>Frequency</td>
<td>5, 6, 7</td>
</tr>
<tr>
<td>( V_{OM} ) Maximum peak output voltage</td>
<td>Free-air temperature</td>
<td>8</td>
</tr>
<tr>
<td>( V_{OM} ) Maximum peak output voltage</td>
<td>Load resistance</td>
<td>9</td>
</tr>
<tr>
<td>( V_{OM} ) Maximum peak output voltage</td>
<td>Supply voltage</td>
<td>10</td>
</tr>
<tr>
<td>( A_{VD} ) Large-signal differential voltage amplification</td>
<td>Free-air temperature</td>
<td>11</td>
</tr>
<tr>
<td>( A_{VD} ) Large-signal differential voltage amplification</td>
<td>Frequency</td>
<td>12</td>
</tr>
<tr>
<td>( A_{VD} ) Differential voltage amplification</td>
<td>Frequency with feed-forward compensation</td>
<td>13</td>
</tr>
<tr>
<td>( P_{D} ) Total power dissipation</td>
<td>Free-air temperature</td>
<td>14</td>
</tr>
<tr>
<td>( I_{CC} ) Supply current</td>
<td>Free-air temperature</td>
<td>15</td>
</tr>
<tr>
<td>( I_{CC} ) Supply current</td>
<td>Supply voltage</td>
<td>16</td>
</tr>
<tr>
<td>( I_{IB} ) Input bias current</td>
<td>Free-air temperature</td>
<td>17</td>
</tr>
<tr>
<td>( V_{O} ) Output voltage</td>
<td>Frequency</td>
<td>18</td>
</tr>
<tr>
<td>( V_{O} ) Output voltage</td>
<td>Time</td>
<td>19</td>
</tr>
<tr>
<td>( CMRR ) Common-mode rejection ratio</td>
<td>Free-air temperature</td>
<td>20</td>
</tr>
<tr>
<td>( V_{n} ) Equivalent input noise voltage</td>
<td>Frequency</td>
<td>21</td>
</tr>
<tr>
<td>( THD ) Total harmonic distortion</td>
<td>Frequency</td>
<td>22</td>
</tr>
</tbody>
</table>

### Graphs

**Figure 5**

**Maximum Peak Output Voltage vs Frequency**

- \( V_{CC} \pm = \pm 15 \text{ V} \)
- \( V_{CC} \pm = \pm 10 \text{ V} \)
- \( V_{CC} \pm = \pm 5 \text{ V} \)

- \( R_L = 10 \text{ k} \Omega \)
- \( T_{A} = 25^\circ \text{C} \)
- See Figure 2

**Figure 6**

**Maximum Peak Output Voltage vs Frequency**

- \( V_{CC} \pm = \pm 15 \text{ V} \)
- \( V_{CC} \pm = \pm 10 \text{ V} \)
- \( V_{CC} \pm = \pm 5 \text{ V} \)

- \( R_L = 2 \text{ k} \Omega \)
- \( T_{A} = 25^\circ \text{C} \)
- See Figure 2
TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

![Graph showing maximum peak output voltage vs frequency for different temperatures and supply voltages.]

Figure 7

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

![Graph showing maximum peak output voltage vs free-air temperature for different load resistances and supply voltages.]

Figure 8

MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE

![Graph showing maximum peak output voltage vs load resistance for different supply voltages and temperatures.]

Figure 9

MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE

![Graph showing maximum peak output voltage vs supply voltage for different load resistances and temperatures.]

Figure 10

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
Typical Characteristics†

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION

vs FREE-AIR TEMPERATURE

Figure 11

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION

vs FREQUENCY

Figure 12

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
**TYPICAL CHARACTERISTICS†**

**DIFFERENTIAL VOLTAGE AMPLIFICATION**

**vs**

**FREQUENCY WITH FEED-FORWARD COMPENSATION**

![Graph](attachment:image1)

- $V_{CC} = \pm 15$ V
- $C_2 = 3$ pF
- $T_A = 25°C$
- See Figure 3

**Figure 13**

**TOTAL POWER DISSIPATION**

**vs**

**FREE-AIR TEMPERATURE**

![Graph](attachment:image2)

- $V_{CC} = \pm 15$ V
- No Signal
- No Load

**Figure 14**

**SUPPLY CURRENT PER AMPLIFIER**

**vs**

**FREE-AIR TEMPERATURE**

![Graph](attachment:image3)

- $V_{CC} = \pm 15$ V
- No Signal
- No Load

**Figure 15**

**SUPPLY CURRENT**

**vs**

**SUPPLY VOLTAGE**

![Graph](attachment:image4)

- $T_A = 25°C$
- No Signal
- No Load

**Figure 16**

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
TYPICAL CHARACTERISTICS†

**INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE**

- $V_{CC} = \pm 15 \text{ V}$
- $V_{IB}$ vs $T_A$ for $V_{CC} = \pm 15 \text{ V}$

**VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE**

- $V_{CC} = \pm 15 \text{ V}$
- $R_L = 2 \text{ k}\Omega$
- $C_L = 100 \text{ pF}$
- $T_A = 25^\circ\text{C}$

**OUTPUT VOLTAGE vs ELAPSED TIME**

- $V_{CC} = \pm 15 \text{ V}$
- $R_L = 2 \text{ k}\Omega$
- $C_L = 100 \text{ pF}$
- $T_A = 25^\circ\text{C}$

**COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE**

- $V_{CC} = \pm 15 \text{ V}$
- $R_L = 10 \text{ k}\Omega$

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
Figure 21

Figure 22

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

APPLICATION INFORMATION

Figure 23

Figure 24

\[ f = \frac{1}{2\pi R_F C_F} \]
APPLICATION INFORMATION

![Audio-Distribution Amplifier Diagram](image)

**Figure 25. Audio-Distribution Amplifier**

![100-KHz Quadrature Oscillator Diagram](image)

**Figure 26. 100-KHz Quadrature Oscillator**

**NOTE A:** These resistor values may be adjusted for a symmetrical output.
APPLICATION INFORMATION

2 kHz/div
Second-Order Bandpass Filter
\( f_0 = 100 \text{ kHz}, \ Q = 30, \ \text{GAIN} = 4 \)

2 kHz/div
Cascaded Bandpass Filter
\( f_0 = 100 \text{ kHz}, \ Q = 69, \ \text{GAIN} = 16 \)

Figure 27. Positive-Feedback Bandpass Filter
MECHANICAL DATA

PLASTIC SMALL-OUTLINE PACKAGE

D (R-PDSO-G**)

14 PIN SHOWN

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012
MECHANICAL DATA

FK (S-CQCC-N**)  LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

NOTES:  A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. The terminals are gold plated.
E. Falls within JEDEC MS-004
MECHANICAL DATA

J (R-GDIP-T**)  
14 PIN SHOWN

### CERAMIC DUAL-IN-LINE PACKAGE

<table>
<thead>
<tr>
<th>DIM</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>A MAX</td>
<td>0.310 (7.87)</td>
<td>0.310 (7.87)</td>
<td>0.310 (7.87)</td>
<td>0.310 (7.87)</td>
</tr>
<tr>
<td>A MIN</td>
<td>0.290 (7.37)</td>
<td>0.290 (7.37)</td>
<td>0.290 (7.37)</td>
<td>0.290 (7.37)</td>
</tr>
<tr>
<td>B MAX</td>
<td>0.785 (19.94)</td>
<td>0.785 (19.94)</td>
<td>0.910 (23.10)</td>
<td>0.975 (24.77)</td>
</tr>
<tr>
<td>B MIN</td>
<td>0.755 (19.18)</td>
<td>0.755 (19.18)</td>
<td>—</td>
<td>0.930 (23.62)</td>
</tr>
<tr>
<td>C MAX</td>
<td>0.300 (7.62)</td>
<td>0.300 (7.62)</td>
<td>0.300 (7.62)</td>
<td>0.300 (7.62)</td>
</tr>
<tr>
<td>C MIN</td>
<td>0.245 (6.22)</td>
<td>0.245 (6.22)</td>
<td>0.245 (6.22)</td>
<td>0.245 (6.22)</td>
</tr>
</tbody>
</table>

NOTES:  
A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. This package can be hermetically sealed with a ceramic lid using glass frit.  
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.  
E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, GDIP1-T20, and GDIP1-T22.
MECHANICAL DATA

CERAMIC DUAL-IN-LINE PACKAGE

JG (R-GDIP-T8)

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL-STD-1835 GDIP1-T8
MECHANICAL DATA

PLASTIC DUAL-IN-LINE PACKAGE

N (R-PDIP-T**)

16 PIN SHOWN

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001 (20 pin package is shorter than MS-001.)
MECHANICAL DATA

P (R-PDIP-T8) PLASTIC DUAL-IN-LINE PACKAGE

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001
MECHANICAL DATA

PW (R-PDSO-G**)  PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN

NOTES:

A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.15.
D. Falls within JEDEC MO-153
MECHANICAL DATA

U (S-GDFP-F10) CERAMIC DUAL FLATPACK

NOTES:  
A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. This package can be hermetically sealed with a ceramic lid using glass frit.  
D. Index point is provided on cap for terminal identification only.  
E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA
MECHANICAL DATA

CERAMIC DUAL FLATPACK

W (R-GDFP-F14)

Base and Seating Plane

0.260 (6.60)
0.235 (5.97)

0.280 (7.11)
0.255 (6.48)

0.360 (9.14)
0.240 (6.10)

0.360 (9.14)
0.240 (6.10)

0.390 (9.91)
0.335 (8.51)

0.045 (1.14)

0.004 (0,10)

0.007 (0,18)

0.026 (0,66)

0.015 (0,38)

0.080 (2,03)
0.045 (1,14)

0.019 (0,48)
0.015 (0,38)

0.045 (1,14)

0.025 (0,64)
0.015 (0,36)

1.000 (25,40)
0.735 (18,67)

0.050 (1,27)

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP1-F14 and JEDEC MO-092AB
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