LM709 Operational Amplifier

General Description

The LM709 series is a monolithic operational amplifier intended for general-purpose applications. Operation is completely specified over the range of voltages commonly used for these devices. The design, in addition to providing high gain, minimizes both offset voltage and bias currents. Further, the class-B output stage gives a large output capability with minimum power drain.

External components are used to frequency compensate the amplifier. Although the unity-gain compensation network specified will make the amplifier unconditionally stable in all feedback configurations, compensation can be tailored to optimize high-frequency performance for any gain setting.

The LM709C is the commercial-industrial version of the LM709. It is identical to the LM709 except that it is specified for operation from 0°C to +70°C.
Absolute Maximum Ratings (Note 3)
If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

- **Supply Voltage**
  - LM709/LM709A/LM709C: ±18V

- **Power Dissipation (Note 1)**
  - LM709/LM709A: 300 mW
  - LM709C: 250 mW

- **Differential Input Voltage**
  - LM709/LM709A/LM709C: ±5V

- **Input Voltage**
  - LM709/LM709A/LM709C: ±10V

- **Output Short-Circuit Duration** (TA = +25°C)
  - LM709/LM709A/LM709C: 5 seconds

Operating Ratings (Note 3)
- **Junction Temperature Range (Note 1)**
  - LM709/LM709A: -55°C to +150°C
  - LM709C: 0°C to +100°C

- **Thermal Resistance (θJA)**
  - H Package: 150°C/W
  - 8-Pin N Package: 134°C/W
  - 14-Pin N Package: 109°C/W

Electrical Characteristics (Note 2)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM709A</th>
<th>LM709</th>
<th>LM709C</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Offset Voltage</td>
<td>TA = 25°C, RS ≤ 10 kΩ</td>
<td>0.6</td>
<td>2.0</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>TA = 25°C</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>TA = 25°C</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Input Resistance</td>
<td>TA = 25°C</td>
<td>350</td>
<td>700</td>
<td>150</td>
<td>400</td>
</tr>
<tr>
<td>Output Resistance</td>
<td>TA = 25°C</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Supply Current</td>
<td>TA = 25°C, VS = ±15V</td>
<td>2.5</td>
<td>3.6</td>
<td>2.6</td>
<td>5.5</td>
</tr>
<tr>
<td>Transient Response</td>
<td>VIN = 20 mV, CL = 100 pF</td>
<td>VTA = 25°C</td>
<td>1.5</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>RiseTime</td>
<td>VTA = 25°C</td>
<td>30</td>
<td>10</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Overshoot</td>
<td>VTA = 25°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slew Rate</td>
<td>VTA = 25°C</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Input Offset Voltage</td>
<td>RS ≤ 10 kΩ</td>
<td>3.0</td>
<td>6.0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Average Temperature of Input Offset Voltage</td>
<td>RS = 50Ω, TA = 25°C to TMAX</td>
<td>1.8</td>
<td>10</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Coefficient of Input Offset Voltage</td>
<td>RS = 10 kΩ, TA = 25°C to TMIN</td>
<td>1.8</td>
<td>10</td>
<td>6.0</td>
<td>12</td>
</tr>
<tr>
<td>Large Signal Voltage Gain</td>
<td>VS = ±15V, RL ≥ 2 kΩ</td>
<td>25</td>
<td>70</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>Output Voltage Swing</td>
<td>VS = ±15V, RL = 10 kΩ</td>
<td>±12</td>
<td>±14</td>
<td>±12</td>
<td>±14</td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td>VS = ±15V</td>
<td>±8</td>
<td>±8</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Common-Mode Rejection Ratio</td>
<td>RS ≤ 10 kΩ</td>
<td>80</td>
<td>110</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Supply Voltage Rejection Ratio</td>
<td>RS ≤ 10 kΩ</td>
<td>40</td>
<td>100</td>
<td>25</td>
<td>150</td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>TA = TMAX</td>
<td>3.5</td>
<td>50</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>TA = TMIN</td>
<td>40</td>
<td>250</td>
<td>100</td>
<td>500</td>
</tr>
<tr>
<td>Input Resistance</td>
<td>TA = TMIN</td>
<td>85</td>
<td>170</td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>

Note 1: For operating at elevated temperatures, the device must be derated based on a 150°C maximum junction temperature for LM709/LM709A and 100°C maximum for LM709C. For operating at elevated temperatures, the device must be derated based on thermal resistance θJA, Tj(MAX) and TA.

Note 2: These specifications apply for −55°C ≤ TA ≤ +125°C for the LM709/LM709A and 0°C ≤ TA ≤ +70°C for the LM709C with the following conditions:
- ±9V ≤ VS ≤ ±15V, C1 = 5000 pF, R1 = 1.5 kΩ, C2 = 200 pF and R2 = 51Ω.

Note 3: Absolute Maximum Ratings indicate limits which if exceeded may result in damage. Operating Ratings are conditions where the device is expected to be functional but not necessarily within the guaranteed performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.
Schematic Diagram

Typical Applications

Unity Gain Inverting Amplifier

FET Operational Amplifier

Voltage Follower

Offset Balancing Circuit

*To be used with any capacitive loading on output.
**Pin connections shown are for metal can package.
¹Should be equal to DC source resistance on input.

TL/H/11477–1
TL/H/11477–2
TL/H/11477–3
TL/H/11477–7
TL/H/11477–8

Obsolescent
Guaranteed Performance Characteristics

Output Voltage Swing

Input Common-Mode Voltage Range

Voltage Gain

Supply Current

TL/H/11477–9
Typical Performance Characteristics

- **Input Offset Current**
- **Input Bias Current**
- **Supply Current**

- **Slew Rate as a Function of Closed-Loop Gain Using Recommended Compensation Networks**
- **Frequency Response for Various Closed-Loop Gains**
- **Output Voltage Swing as a Function of Frequency**

- **Output Voltage Swing as a Function of Supply Voltage**
- **Input Bias Current as a Function of Supply Voltage**
Physical Dimensions inches (millimeters)

Metal Can Package (H)
Order Number LM709AH, LM709H or LM709CH
NS Package Number H08C

8-Lead Molded Dual-In-Line Package (N)
Order Number LM709CN-8
NS Package Number N08E
Physical Dimensions inches (millimeters) (Continued)

14-Lead Molded Dual-In-Line Package (N)
Order Number LM709CN
NS Package Number N14A

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