LME49720 Dual High Performance, High Fidelity Audio Operational Amplifier
Check for Samples: LME49720

FEATURES
- Easily Drives 600Ω Loads
- Optimized for Superior Audio Signal Fidelity
- Output Short Circuit Protection
- PSRR and CMRR Exceed 120dB (typ)
- SOIC, PDIP, TO-99 Metal Can Packages

APPLICATIONS
- Ultra High Quality Audio Amplification
- High Fidelity Preamplifiers
- High Fidelity Multimedia
- State of the Art Phono Pre Amps
- High Performance Professional Audio
- High Fidelity Equalization and Crossover Networks
- High Performance Line Drivers
- High Performance Line Receivers
- High Fidelity Active Filters

KEY SPECIFICATIONS
- Power Supply Voltage Range: ±2.5 to ±17V
- THD+N (A_V = 1, V_OUT = 3V_RMS, f_IN = 1kHz):
  - R_L = 2kΩ: 0.00003% (typ)
  - R_L = 600Ω: 0.00003% (typ)
- Input Noise Density: 2.7nV/√Hz (typ)
- Slew Rate: ±20V/μs (typ)
- Gain Bandwidth Product: 55MHz (typ)
- Open Loop Gain (R_L = 600Ω): 140dB (typ)
- Input Bias Current: 10nA (typ)
- Input Offset Voltage: 0.1mV (typ)
- DC Gain Linearity Error: 0.000009%

DESCRIPTION
The LME49720 is part of the ultra-low distortion, low noise, high slew rate operational amplifier series optimized and fully specified for high performance, high fidelity applications. Combining advanced leading-edge process technology with state-of-the-art circuit design, the LME49720 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LME49720 combines extremely low voltage noise density (2.7nV/√Hz) with vanishingly low THD+N (0.00003%) to easily satisfy the most demanding audio applications.

TYPICAL APPLICATION
Figure 1. Passively Equalized RIAA Phono Preamplifier

Note: 1% metal film resistors, 5% polypropylene capacitors

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DESCRIPTION (CONTINUED)

To ensure that the most challenging loads are driven without compromise, the LME49720 has a high slew rate of ±20V/μs and an output current capability of ±26mA. Further, dynamic range is maximized by an output stage that drives 2kΩ loads to within 1V of either power supply voltage and to within 1.4V when driving 600Ω loads.

The LME49720’s outstanding CMRR (120dB), PSRR (120dB), and $V_{OS} \ (0.1\mV)$ give the amplifier excellent operational amplifier DC performance.

The LME49720 has a wide supply range of ±2.5V to ±17V. Over this supply range the LME49720’s input circuitry maintains excellent common-mode and power supply rejection, as well as maintaining its low input bias current. The LME49720 is unity gain stable. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LME49720 is available in 8–lead narrow body SOIC, 8–lead PDIP, and 8–lead TO-99. Demonstration boards are available for each package.

Connection Diagrams

Figure 2. 8-Pin SOIC or PDIP
See D or P Package

Figure 3. 8-Lead TO-99
See LMC Package

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.
ABSOLUTE MAXIMUM RATINGS (1)(2)(3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage (V&lt;sub&gt;S&lt;/sub&gt; = V&lt;sup&gt;+&lt;/sup&gt; - V&lt;sup&gt;-&lt;/sup&gt;)</td>
<td>36V</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>−65°C to 150°C</td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>(V&lt;sup&gt;-&lt;/sup&gt;) - 0.7V to (V&lt;sup&gt;+&lt;/sup&gt;) + 0.7V</td>
<td></td>
</tr>
<tr>
<td>Output Short Circuit (4)</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>Internally Limited</td>
<td></td>
</tr>
<tr>
<td>ESD Susceptibility (5)</td>
<td>2000V</td>
<td></td>
</tr>
<tr>
<td>ESD Susceptibility (6)</td>
<td>Pins 1, 4, 7 and 8: 200V, Pins 2, 3, 5 and 6: 100V</td>
<td></td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>150°C</td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>θ&lt;sub&gt;JA&lt;/sub&gt; (SOIC): 145°C/W, θ&lt;sub&gt;JA&lt;/sub&gt; (PDIP): 102°C/W, θ&lt;sub&gt;JA&lt;/sub&gt; (TO-99): 150°C/W, θ&lt;sub&gt;JC&lt;/sub&gt; (TO-99): 35°C/W</td>
<td></td>
</tr>
<tr>
<td>Temperature Range</td>
<td>T&lt;sub&gt;MIN&lt;/sub&gt; ≤ T&lt;sub&gt;A&lt;/sub&gt; ≤ T&lt;sub&gt;MAX&lt;/sub&gt;: −40°C ≤ T&lt;sub&gt;A&lt;/sub&gt; ≤ 85°C</td>
<td></td>
</tr>
<tr>
<td>Supply Voltage Range</td>
<td>±2.5V ≤ V&lt;sub&gt;S&lt;/sub&gt; ≤ ±17V</td>
<td></td>
</tr>
</tbody>
</table>

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(3) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(4) Amplifier output connected to GND, any number of amplifiers within a package.
(5) Human body model, 100pF discharged through a 1.5kΩ resistor.
(6) Machine Model ESD test is covered by specification EIAJ IC-121-1981. A 200pF cap is charged to the specified voltage and then discharged directly into the IC with no external series resistor (resistance of discharge path must be under 50Ω).

ELECTRICAL CHARACTERISTICS FOR THE LME49720 (1)(2)
The following specifications apply for V<sub>S</sub> = ±15V, R<sub>L</sub> = 2kΩ, f<sub>N</sub> = 1kHz, and T<sub>A</sub> = 25°C, unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>LME49720</th>
<th>Units (Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>THD+N</td>
<td>Total Harmonic Distortion + Noise A&lt;sub&gt;V&lt;/sub&gt; = 1, V&lt;sub&gt;OUT&lt;/sub&gt; = 3V&lt;sub&gt;rms&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 2kΩ</td>
<td>0.00003</td>
<td>% (max)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 600Ω</td>
<td>0.00003</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IMD</td>
<td>Intermodulation Distortion A&lt;sub&gt;V&lt;/sub&gt; = 1, V&lt;sub&gt;OUT&lt;/sub&gt; = 3V&lt;sub&gt;RMS&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two-tone, 60Hz &amp; 7kHz 4:1</td>
<td>0.00005</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>GBWP</td>
<td>Gain Bandwidth Product</td>
<td>55</td>
<td>45 MHz (min)</td>
</tr>
<tr>
<td></td>
<td>SR</td>
<td>Slew Rate</td>
<td>±20</td>
<td>±15 V/μs (min)</td>
</tr>
<tr>
<td></td>
<td>FPBW</td>
<td>Full Power Bandwidth V&lt;sub&gt;OUT&lt;/sub&gt; = 1V&lt;sub&gt;P-P&lt;/sub&gt; −3dB referenced to output magnitude at f = 1kHz</td>
<td>10</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t&lt;sub&gt;s&lt;/sub&gt; = 0.1% error range</td>
<td>1.2</td>
<td>μs</td>
</tr>
<tr>
<td></td>
<td>e&lt;sub&gt;n&lt;/sub&gt;</td>
<td>Equivalent Input Noise Voltage f&lt;sub&gt;BW&lt;/sub&gt; = 20Hz to 20kHz</td>
<td>0.34</td>
<td>0.65 μV&lt;sub&gt;RMS&lt;/sub&gt; (max)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equivalent Input Noise Density</td>
<td>2.7</td>
<td>4.7 nV/√Hz (max)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1kHz</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 10Hz</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;n&lt;/sub&gt;</td>
<td>1.6</td>
<td>3.1 pA/√Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current Noise Density</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;DS&lt;/sub&gt;</td>
<td>±0.1</td>
<td>±0.7 mV (max)</td>
</tr>
</tbody>
</table>

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(3) Typical specifications are specified at +25°C and represent the most likely parametric norm.
(4) Tested limits are ensured at AOQL (Average Outgoing Quality Level).
ELECTRICAL CHARACTERISTICS FOR THE LME49720 (1)(2) (continued)
The following specifications apply for $V_S = \pm 15V$, $R_L = 2k\Omega$, $f_{IN} = 1kHz$, and $T_A = 25^\circ C$, unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>LME49720</th>
<th>Units (Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta V_{OS}/\Delta Temp$</td>
<td>Average Input Offset Voltage Drift vs Temperature</td>
<td>$-40^\circ C \leq T_A \leq 85^\circ C$</td>
<td>0.2</td>
<td>$\mu V/^\circ C$</td>
</tr>
<tr>
<td>PSRR</td>
<td>Average Input Offset Voltage Shift vs Power Supply Voltage</td>
<td>$\Delta V_S = 20V$ (5)</td>
<td>120</td>
<td>110 dB (min)</td>
</tr>
<tr>
<td>ISO&lt;sub&gt;CH-CH&lt;/sub&gt;</td>
<td>Channel-to-Channel Isolation</td>
<td>$f_{IN} = 1kHz$ &lt;br&gt; $f_{IN} = 20kHz$</td>
<td>118</td>
<td>112 dB</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Input Bias Current</td>
<td>$V_{CM} = 0V$</td>
<td>10</td>
<td>72 nA (max)</td>
</tr>
<tr>
<td>$\Delta I_{OS}/\Delta Temp$</td>
<td>Input Bias Current Drift vs Temperature</td>
<td>$-40^\circ C \leq T_A \leq 85^\circ C$</td>
<td>0.1</td>
<td>nA/^\circ C</td>
</tr>
<tr>
<td>$I_{OS}$</td>
<td>Input Offset Current</td>
<td>$V_{CM} = 0V$</td>
<td>+14.1</td>
<td>(V+) – 2.0 V (min)</td>
</tr>
<tr>
<td>$V_{IN-CM}$</td>
<td>Common-Mode Input Voltage Range</td>
<td>–10V $&lt; V_{CM} &lt; 10V$</td>
<td>120</td>
<td>110 dB (min)</td>
</tr>
<tr>
<td>CMRR</td>
<td>Common-Mode Rejection</td>
<td>–10V $&lt; V_{CM} &lt; 10V$</td>
<td>30</td>
<td>kΩ</td>
</tr>
<tr>
<td>$Z_{IN}$</td>
<td>Differential Input Impedance</td>
<td>–10V $&lt; V_{CM} &lt; 10V$</td>
<td>1000</td>
<td>MΩ</td>
</tr>
<tr>
<td>$A_{VOL}$</td>
<td>Open Loop Voltage Gain</td>
<td>–10V $&lt; V_{OUT} &lt; 10V$, $R_L = 600\Omega$</td>
<td>140</td>
<td>125 dB (min)</td>
</tr>
<tr>
<td>$V_{OUTMAX}$</td>
<td>Maximum Output Voltage Swing</td>
<td>$R_L = 600\Omega$</td>
<td>±13.6</td>
<td>±12.5 V (min)</td>
</tr>
<tr>
<td>$R_{OUT}$</td>
<td>Output Impedance</td>
<td>$f_{IN} = 1kHz$ &lt;br&gt; Closed-Loop &lt;br&gt; Open-Loop</td>
<td>0.01</td>
<td>13 Ω</td>
</tr>
<tr>
<td>$C_{LOAD}$</td>
<td>Capacitive Load Drive Overshoot</td>
<td>100pF</td>
<td>16</td>
<td>%</td>
</tr>
<tr>
<td>$I_S$</td>
<td>Total Quiescent Current</td>
<td>$I_{OUT} = 0mA$</td>
<td>10</td>
<td>12 mA (max)</td>
</tr>
</tbody>
</table>

(5) PSRR is measured as follows: $V_{OS}$ is measured at two supply voltages, ±5V and ±15V. $PSRR = |20\log(\Delta V_{OS}/\Delta V_S)|$. 

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(1) (2)
## TYPICAL PERFORMANCE CHARACTERISTICS

### THD+N vs Output Voltage

**Figure 4.**

<table>
<thead>
<tr>
<th>CC Voltage</th>
<th>EE Voltage</th>
<th>RL Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15V</td>
<td>-15V</td>
<td>2kΩ</td>
</tr>
<tr>
<td>12V</td>
<td>-12V</td>
<td>2kΩ</td>
</tr>
</tbody>
</table>

**Figure 5.**

<table>
<thead>
<tr>
<th>CC Voltage</th>
<th>EE Voltage</th>
<th>RL Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>17V</td>
<td>-17V</td>
<td>2kΩ</td>
</tr>
<tr>
<td>2.5V</td>
<td>-2.5V</td>
<td>2kΩ</td>
</tr>
</tbody>
</table>

**Figure 6.**

<table>
<thead>
<tr>
<th>CC Voltage</th>
<th>EE Voltage</th>
<th>RL Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15V</td>
<td>-15V</td>
<td>600Ω</td>
</tr>
</tbody>
</table>

**Figure 7.**

<table>
<thead>
<tr>
<th>CC Voltage</th>
<th>EE Voltage</th>
<th>RL Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V</td>
<td>-12V</td>
<td>600Ω</td>
</tr>
</tbody>
</table>
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

THD+N vs Output Voltage
V_{CC} = 17V, V_{EE} = -17V
R_L = 600Ω

Figure 10.

THD+N vs Output Voltage
V_{CC} = 2.5V, V_{EE} = -2.5V
R_L = 600Ω

Figure 11.

THD+N vs Output Voltage
V_{CC} = 15V, V_{EE} = -15V
R_L = 10kΩ

Figure 12.

THD+N vs Output Voltage
V_{CC} = 12V, V_{EE} = -12V
R_L = 10kΩ

Figure 13.

THD+N vs Output Voltage
V_{CC} = 17V, V_{EE} = -17V
R_L = 10kΩ

Figure 14.

THD+N vs Output Voltage
V_{CC} = 2.5V, V_{EE} = -2.5V
R_L = 10kΩ

Figure 15.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

**Figure 16.** THD+N vs Frequency

- $V_{CC} = 15V$, $V_{EE} = -15V$, $V_{OUT} = 3V_{RMS}$
- $R_L = 2k\Omega$

**Figure 17.** THD+N vs Frequency

- $V_{CC} = 12V$, $V_{EE} = -12V$, $V_{OUT} = 3V_{RMS}$
- $R_L = 2k\Omega$

**Figure 18.** THD+N vs Frequency

- $V_{CC} = 17V$, $V_{EE} = -17V$, $V_{OUT} = 3V_{RMS}$
- $R_L = 2k\Omega$

**Figure 19.** THD+N vs Frequency

- $V_{CC} = 15V$, $V_{EE} = -15V$, $V_{OUT} = 3V_{RMS}$
- $R_L = 600\Omega$

**Figure 20.** THD+N vs Frequency

- $V_{CC} = 12V$, $V_{EE} = -12V$, $V_{OUT} = 3V_{RMS}$
- $R_L = 600\Omega$

**Figure 21.** THD+N vs Frequency

- $V_{CC} = 17V$, $V_{EE} = -17V$, $V_{OUT} = 3V_{RMS}$
- $R_L = 600\Omega$
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

THD+N vs Frequency
$V_{CC} = 15\, \text{V}, \ V_{EE} = -15\, \text{V}, \ V_{OUT} = 3\, \text{V}_{\text{RMS}}$
$R_L = 10\, \Omega$

Figure 22.

THD+N vs Frequency
$V_{CC} = 12\, \text{V}, \ V_{EE} = -12\, \text{V}, \ V_{OUT} = 3\, \text{V}_{\text{RMS}}$
$R_L = 10\, \Omega$

Figure 23.

THD+N vs Frequency
$V_{CC} = 17\, \text{V}, \ V_{EE} = -17\, \text{V}, \ V_{OUT} = 3\, \text{V}_{\text{RMS}}$
$R_L = 10\, \Omega$

Figure 24.

IMD vs Output Voltage
$V_{CC} = 15\, \text{V}, \ V_{EE} = -15\, \text{V}$
$R_L = 2\, \Omega$

Figure 25.

IMD vs Output Voltage
$V_{CC} = 12\, \text{V}, \ V_{EE} = -12\, \text{V}$
$R_L = 2\, \Omega$

Figure 26.

IMD vs Output Voltage
$V_{CC} = 2.5\, \text{V}, \ V_{EE} = -2.5\, \text{V}$
$R_L = 2\, \Omega$

Figure 27.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

IMD vs Output Voltage

$V_{CC} = 17\,V, \quad V_{EE} = -17\,V$
$R_L = 2\,k\Omega$

Figure 28.

IMD vs Output Voltage

$V_{CC} = 15\,V, \quad V_{EE} = -15\,V$
$R_L = 600\,\Omega$

Figure 29.

IMD vs Output Voltage

$V_{CC} = 12\,V, \quad V_{EE} = -12\,V$
$R_L = 600\,\Omega$

Figure 30.

IMD vs Output Voltage

$V_{CC} = 2.5\,V, \quad V_{EE} = -2.5\,V$
$R_L = 600\,\Omega$

Figure 31.

IMD vs Output Voltage

$V_{CC} = 15\,V, \quad V_{EE} = -15\,V$
$R_L = 10\,k\Omega$

Figure 32.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

IMD vs Output Voltage

V_{CC} = 12V, V_{EE} = −12V
R_L = 10kΩ

Figure 34.

IMD vs Output Voltage

V_{CC} = 17V, V_{EE} = −17V
R_L = 10kΩ

Figure 35.

IMD vs Output Voltage

V_{CC} = 2.5V, V_{EE} = −2.5V
R_L = 10kΩ

Figure 36.

Voltage Noise Density vs Frequency

V_S = 30V
V_{CM} = 15V

Figure 37.

Current Noise Density vs Frequency

V_S = 30V
V_{CM} = 15V

Figure 38.

Crosstalk vs Frequency

V_{CC} = 15V, V_{EE} = −15V, V_{OUT} = 3V_{RMS}
A_V = 6dB, R_L = 2kΩ

Figure 39.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Crosstalk vs Frequency
$V_{CC} = 15V, V_{EE} = -15V, V_{OUT} = 10V_{RMS}$
$A_V = 0dB, R_L = 2\Omega$

Crosstalk vs Frequency
$V_{CC} = 12V, V_{EE} = -12V, V_{OUT} = 3V_{RMS}$
$A_V = 0dB, R_L = 2\Omega$

Crosstalk vs Frequency
$V_{CC} = 17V, V_{EE} = -17V, V_{OUT} = 10V_{RMS}$
$A_V = 0dB, R_L = 2\Omega$

Crosstalk vs Frequency
$V_{CC} = 2.5V, V_{EE} = -2.5V, V_{OUT} = 1V_{RMS}$
$A_V = 0dB, R_L = 2\Omega$
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

**Crosstalk vs Frequency**

- **Figure 46.**
  - $V_{CC} = 15V$, $V_{EE} = -15V$, $V_{OUT} = 3V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\, \Omega$

- **Figure 47.**
  - $V_{CC} = 15V$, $V_{EE} = -15V$, $V_{OUT} = 10V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\, \Omega$

- **Figure 48.**
  - $V_{CC} = 12V$, $V_{EE} = -12V$, $V_{OUT} = 3V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\, \Omega$

- **Figure 49.**
  - $V_{CC} = 12V$, $V_{EE} = -12V$, $V_{OUT} = 10V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\, \Omega$

- **Figure 50.**
  - $V_{CC} = 17V$, $V_{EE} = -17V$, $V_{OUT} = 3V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\, \Omega$

- **Figure 51.**
  - $V_{CC} = 17V$, $V_{EE} = -17V$, $V_{OUT} = 10V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\, \Omega$
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Crosstalk vs Frequency

\[ V_{CC} = 2.5V, \quad V_{EE} = -2.5V, \quad V_{OUT} = 1V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 600\Omega \]

FREQUENCY (Hz)
CROSSTALK (dB)

\[ V_{CC} = 15V, \quad V_{EE} = -15V, \quad V_{OUT} = 3V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 10k\Omega \]

**Figure 52.**

Crosstalk vs Frequency

\[ V_{CC} = 15V, \quad V_{EE} = -15V, \quad V_{OUT} = 10V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 10k\Omega \]

FREQUENCY (Hz)
CROSSTALK (dB)

**Figure 53.**

Crosstalk vs Frequency

\[ V_{CC} = 12V, \quad V_{EE} = -12V, \quad V_{OUT} = 3V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 10k\Omega \]

FREQUENCY (Hz)
CROSSTALK (dB)

**Figure 54.**

Crosstalk vs Frequency

\[ V_{CC} = 12V, \quad V_{EE} = -12V, \quad V_{OUT} = 10V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 10k\Omega \]

FREQUENCY (Hz)
CROSSTALK (dB)

**Figure 55.**

Crosstalk vs Frequency

\[ V_{CC} = 17V, \quad V_{EE} = -17V, \quad V_{OUT} = 3V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 10k\Omega \]

FREQUENCY (Hz)
CROSSTALK (dB)

**Figure 56.**

Crosstalk vs Frequency

\[ V_{CC} = 17V, \quad V_{EE} = -17V, \quad V_{OUT} = 10V_{RMS} \]
\[ A_V = 0dB, \quad R_L = 10k\Omega \]

FREQUENCY (Hz)
CROSSTALK (dB)

**Figure 57.**
LME49720

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Crosstalk vs Frequency

V<sub>CC</sub> = 17V, V<sub>EE</sub> = -17V, V<sub>OUT</sub> = 10V<sub>RMS</sub>
A<sub>V</sub> = 0dB, R<sub>L</sub> = 10kΩ

Figure 58.

PSRR+ vs Frequency

V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V
R<sub>L</sub> = 10kΩ, f = 200kHz, V<sub>RIPPLE</sub> = 200mVpp

Figure 60.

PSRR+ vs Frequency

V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V
R<sub>L</sub> = 2kΩ, f = 200kHz, V<sub>RIPPLE</sub> = 200mVpp

Figure 62.

Crosstalk vs Frequency

V<sub>CC</sub> = 2.5V, V<sub>EE</sub> = -2.5V, V<sub>OUT</sub> = 1V<sub>RMS</sub>
A<sub>V</sub> = 0dB, R<sub>L</sub> = 10kΩ

Figure 59.

PSRR- vs Frequency

V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V
R<sub>L</sub> = 10kΩ, f = 200kHz, V<sub>RIPPLE</sub> = 200mVpp

Figure 61.

PSRR- vs Frequency

V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V
R<sub>L</sub> = 2kΩ, f = 200kHz, V<sub>RIPPLE</sub> = 200mVpp

Figure 63.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

**PSRR+ vs Frequency**

- $V_{CC} = 15V, V_{EE} = -15V$
- $R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 64.**

**PSRR- vs Frequency**

- $V_{CC} = 15V, V_{EE} = -15V$
- $R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 65.**

**PSRR+ vs Frequency**

- $V_{CC} = 12V, V_{EE} = -12V$
- $R_L = 10k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 66.**

**PSRR- vs Frequency**

- $V_{CC} = 12V, V_{EE} = -12V$
- $R_L = 10k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 67.**

**PSRR+ vs Frequency**

- $V_{CC} = 12V, V_{EE} = -12V$
- $R_L = 2k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 68.**

**PSRR- vs Frequency**

- $V_{CC} = 12V, V_{EE} = -12V$
- $R_L = 2k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 69.**
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

**PSRR+ vs Frequency**  
\[ V_{CC} = 12V, V_{EE} = -12V \]  
\[ R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp \]

**PSRR- vs Frequency**  
\[ V_{CC} = 12V, V_{EE} = -12V \]  
\[ R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp \]

**VCC = 17V, VEE = -17V**  
\[ R_L = 10k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp \]

**VCC = 17V, VEE = -17V**  
\[ R_L = 2k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp \]
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

**PSRR+ vs Frequency**
$V_{CC} = 17V, V_{EE} = -17V$
$R_L = 600\,\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**PSRR– vs Frequency**
$V_{CC} = 17V, V_{EE} = -17V$
$R_L = 600\,\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**V_{CC} = 2.5V, V_{EE} = -2.5V**
$R_L = 10k\,\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**V_{CC} = 2.5V, V_{EE} = -2.5V**
$R_L = 2k\,\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 76.
Figure 77.
Figure 78.
Figure 79.
Figure 80.
Figure 81.
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

**PSRR+ vs Frequency**  
$V_{CC} = 2.5V$, $V_{EE} = -2.5V$  
$R_L = 600\, \Omega$, $f = 200kHz$, $V_{RIPPLE} = 200mVpp$

**PSRR- vs Frequency**  
$V_{CC} = 2.5V$, $V_{EE} = -2.5V$  
$R_L = 600\, \Omega$, $f = 200kHz$, $V_{RIPPLE} = 200mVpp$

**CMRR vs Frequency**  
$V_{CC} = 15V$, $V_{EE} = -15V$

$R_L = 2k\Omega$

**CMRR vs Frequency**  
$V_{CC} = 12V$, $V_{EE} = -12V$

$R_L = 2k\Omega$

**CMRR vs Frequency**  
$V_{CC} = 17V$, $V_{EE} = -17V$

$R_L = 2k\Omega$

**CMRR vs Frequency**  
$V_{CC} = 2.5V$, $V_{EE} = -2.5V$

$R_L = 2k\Omega$

---

**Figure 82.**  
**Figure 83.**  
**Figure 84.**  
**Figure 85.**  
**Figure 86.**  
**Figure 87.**
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

CMRR vs Frequency
$V_{CC} = 15V, V_{EE} = -15V$
$R_L = 600\,\Omega$

Figure 88.

CMRR vs Frequency
$V_{CC} = 12V, V_{EE} = -12V$
$R_L = 600\,\Omega$

Figure 89.

CMRR vs Frequency
$V_{CC} = 17V, V_{EE} = -17V$
$R_L = 600\,\Omega$

Figure 90.

CMRR vs Frequency
$V_{CC} = 2.5V, V_{EE} = -2.5V$
$R_L = 600\,\Omega$

Figure 91.

CMRR vs Frequency
$V_{CC} = 15V, V_{EE} = -15V$
$R_L = 10\,k\Omega$

Figure 92.

CMRR vs Frequency
$V_{CC} = 12V, V_{EE} = -12V$
$R_L = 10\,k\Omega$

Figure 93.
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

**CMRR vs Frequency**
- $V_{CC} = 17V$, $V_{EE} = -17V$
- $R_L = 10\, \Omega$

**Output Voltage vs Load Resistance**
- $V_{DD} = 15V$, $V_{EE} = -15V$
- $V_{DD} = 12V$, $V_{EE} = -12V$
- THD+N = 1%

Figure 94.

Figure 96.

Figure 98.

Figure 99.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Output Voltage vs Supply Voltage
- $R_L = 2k\Omega$, THD+N = 1%
- $R_L = 600\Omega$, THD+N = 1%

Supply Current vs Supply Voltage
- $R_L = 2k\Omega$
- $R_L = 600\Omega$

Figure 100.

Figure 101.

Figure 102.

Figure 103.

Figure 104.

Figure 105.

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TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Figure 106. Full Power Bandwidth vs Frequency

Figure 107. Gain Phase vs Frequency

Figure 108. Small-Signal Transient Response
\[ A_V = 1, C_L = 10pF \]

Figure 109. Small-Signal Transient Response
\[ A_V = 1, C_L = 100pF \]
DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LME49720 is below the capabilities of all commercially available equipment. This makes distortion measurements just slightly more difficult than simply connecting a distortion meter to the amplifier’s inputs and outputs. The solution, however, is quite simple: an additional resistor. Adding this resistor extends the resolution of the distortion measurement equipment.

The LME49720’s low residual distortion is an input referred internal error. As shown in Figure 110, adding the 10Ω resistor connected between the amplifier’s inverting and non-inverting inputs changes the amplifier’s noise gain. The result is that the error signal (distortion) is amplified by a factor of 101. Although the amplifier’s closed-loop gain is unaltered, the feedback available to correct distortion errors is reduced by 101, which means that measurement resolution increases by 101. To ensure minimum effects on distortion measurements, keep the value of R1 low as shown in Figure 110.

This technique is verified by duplicating the measurements with high closed loop gain and/or making the measurements at high frequencies. Doing so produces distortion components that are within the measurement equipment’s capabilities. This datasheet’s THD+N and IMD values were generated using the above described circuit connected to an Audio Precision System Two Cascade.

The LME49720 is a high speed op amp with excellent phase margin and stability. Capacitive loads up to 100pF will cause little change in the phase characteristics of the amplifiers and are therefore allowable.

Capacitive loads greater than 100pF must be isolated from the output. The most straightforward way to do this is to put a resistor in series with the output. This resistor will also prevent excess power dissipation if the output is accidentally shorted.
Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

Figure 111. Noise Measurement Circuit
Total Gain: 115 dB @f = 1 kHz
Input Referred Noise Voltage: $e_n = V_0/560,000$ (V)

Figure 112. RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency

Figure 113. Flat Amp Voltage Gain vs Frequency
TYPICAL APPLICATIONS

AV = 34.5
F = 1 kHz
EN = 0.38 μV
A Weighted

Figure 114. NAB Preamp

\[ V_O = V_1 - V_2 \]

Figure 115. NAB Preamp Voltage Gain vs Frequency

\[ V_O = V_1 + V_2 - V_3 - V_4 \]

Figure 116. Balanced to Single Ended Converter

Figure 117. Adder/Subtractor

f0 = \frac{1}{2\pi RC}

Figure 118. Sine Wave Oscillator

\begin{align*}
C_1 & = \frac{3}{2\pi f_0 C} \\
R_1 & = \frac{2}{2\pi f_0 C} \\
R_2 &= 2R_1
\end{align*}

Illustration is f0 = 1 kHz

Figure 119. Second Order High Pass Filter (Butterworth)
If $R_1 = R_2 = R$

$$C_1 = \frac{1}{2\pi f_0 R}$$

$$C_2 = \frac{C_1}{2}$$

Illustration is $f_0 = 1$ kHz

**Figure 120. Second Order Low Pass Filter (Butterworth)**

**Figure 121. State Variable Filter**

Illustration is $f_0 = 1$ kHz, $Q = 10$, $A_{BP} = 1$

$$f_L = 32 \text{ Hz}, f_{LB} = 320 \text{ Hz}$$

$$f_H = 11 \text{ kHz}, f_{HB} = 1.1 \text{ kHz}$$

**Figure 122. AC/DC Converter**

**Figure 123. 2 Channel Panning Circuit (Pan Pot)**

Illustration is:

$$I_L = \frac{1}{2\pi R_2C_1}$$

$$I_{HB} = \frac{1}{2\pi R_5C_2}$$

**Figure 124. Line Driver**

**Figure 125. Tone Control**
$A_v = 35 \text{ dB}$  
$E_n = 0.33 \mu \text{V}$  
$S/N = 90 \text{ dB}$  
$f = 1 \text{ kHz}$  
A Weighted  
A Weighted, $V_{IN} = 10 \text{ mV}$  
@$f = 1 \text{ kHz}$

Figure 126. Balanced Input Mic Amp

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<th>fo (Hz)</th>
<th>$C_1$</th>
<th>$C_2$</th>
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## REVISION HISTORY

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<td>Initial release.</td>
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<td>1.1</td>
<td>05/03/07</td>
<td>Put the “general note” under the EC table.</td>
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<td>1.2</td>
<td>10/22/07</td>
<td>Replaced all the PSRR curves.</td>
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<td>C</td>
<td>04/05/13</td>
<td>Changed layout of National Data Sheet to TI format.</td>
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## PACKAGING INFORMATION

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<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp</th>
<th>Op Temp (°C)</th>
<th>Device Marking</th>
<th>Samples</th>
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(1) The marketing status values are defined as follows:
- **ACTIVE**: Product device recommended for new designs.
- **LIFEBUY**: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
- **NRND**: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
- **PREVIEW**: Device has been announced but is not in production. Samples may or may not be available.
- ** OBSOLETE**: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check [http://www.ti.com/productcontent](http://www.ti.com/productcontent) for the latest availability information and additional product content details.

- **TBD**: The Pb-Free/Green conversion plan has not been defined.
- **Pb-Free (RoHS)**: TI’s terms “Lead-Free” or “Pb-Free” mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
- **Pb-Free (RoHS Exempt)**: This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
- **Green (RoHS & no Sb/Br)**: TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a “~” will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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TAPE AND REEL INFORMATION

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*All dimensions are nominal.

A0: Dimension designed to accommodate the component width
B0: Dimension designed to accommodate the component length
K0: Dimension designed to accommodate the component thickness
W: Overall width of the carrier tape
P1: Pitch between successive cavity centers
**TAPE AND REEL BOX DIMENSIONS**

*All dimensions are nominal*

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NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Leads in true position within 0.010 (0.25) R © MMC at seating plane.
D. Pin numbers shown for reference only. Numbers may not be marked on package.
E. Falls within JEDEC MO-002/10-99.
NOTES:  
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001 variation BA.
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.

⚠️ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0.15) each side.

⚠️ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0.43) each side.

E. Reference JEDEC MS-012 variation AA.
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No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have not been so designated is solely at the Buyer’s risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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