LM4562 Dual High-Performance, High-Fidelity Audio Operational Amplifier
Check for Samples: LM4562

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

APPLICATIONS
- Ultra High-Quality Audio Amplification
- High-Fidelity Preamplifiers
- High-Performance Professional Audio
- High-Fidelity Active Equalization and Crossover Networks
- High-Performance Line Drivers and Receivers

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

DESCRIPTION
The LM4562 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. The LM4562 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LM4562 combines extremely low voltage noise density (2.7nV/√Hz) with vanishingly low THD+N (0.00003%) to easily satisfy the most demanding audio applications. To ensure that the most challenging loads are driven without compromise, the LM4562 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 LM4562’s outstanding CMRR (120dB), PSRR (120dB), and VOS (0.1mV) give the amplifier excellent operational amplifier DC performance.

The LM4562 has a wide supply range of ±2.5V to ±17V. Over this supply range the LM4562’s input circuitry maintains excellent common-mode and power supply rejection, as well as maintaining its low input bias current. The LM4562 is unity gain stable. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LM4562 is available in an 8-lead narrow body SOIC, an 8-lead PDIP, and an 8-lead TO-99.

TYPICAL APPLICATION
A. 1% metal film resistors, 5% polypropylene capacitors

Passively Equalized RIAA Phono Preamplifier

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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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage ($V_S = V^+ - V^-$)</td>
<td>36V</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>−65°C to 150°C</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>($V^-$) - 0.7V to ($V^+$) + 0.7V</td>
</tr>
<tr>
<td>Output Short Circuit(4)</td>
<td>Continuous</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>Internally Limited</td>
</tr>
<tr>
<td>ESD Susceptibility(5)</td>
<td>2000V</td>
</tr>
<tr>
<td>ESD Susceptibility(6)</td>
<td>Pins 1, 4, 7 and 8</td>
</tr>
<tr>
<td></td>
<td>200V</td>
</tr>
<tr>
<td></td>
<td>Pins 2, 3, 5 and 6</td>
</tr>
<tr>
<td></td>
<td>100V</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>150°C</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>$\theta_{JA}$ (D)</td>
</tr>
<tr>
<td></td>
<td>145°C/W</td>
</tr>
<tr>
<td></td>
<td>$\theta_{JA}$ (P)</td>
</tr>
<tr>
<td></td>
<td>102°C/W</td>
</tr>
<tr>
<td></td>
<td>$\theta_{JA}$ (LMC)</td>
</tr>
<tr>
<td></td>
<td>150°C/W</td>
</tr>
<tr>
<td></td>
<td>$\theta_{JC}$ (LMC)</td>
</tr>
<tr>
<td></td>
<td>35°C/W</td>
</tr>
<tr>
<td>Temperature Range ($T_{MIN} \leq T_A \leq T_{MAX}$)</td>
<td>−40°C ≤ $T_A$ ≤ 85°C</td>
</tr>
<tr>
<td>Supply Voltage Range</td>
<td>$\pm 2.5V \leq V_S \leq \pm 17V$</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 the 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 LM4562\(^{(1)(2)}\)

The specifications apply for \(V_S = \pm 15V\), \(R_L = 2\,\Omega\), \(f_{IN} = 1kHz\), \(T_A = 25^\circ C\), unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>LM4562</th>
<th>Units (Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Typical(^{(3)})</td>
<td>Limit(^{(4)})</td>
</tr>
<tr>
<td>THD+N</td>
<td>Total Harmonic Distortion - Noise</td>
<td>(A_V = 1), (V_{OUT} = 3V_{rms}) (R_L = 2,\Omega) (R_L = 600,\Omega)</td>
<td>0.00003</td>
<td>0.00009</td>
</tr>
<tr>
<td>IMD</td>
<td>Intermodulation Distortion</td>
<td>(A_V = 1), (V_{OUT} = 3V_{rms}) Two-tone, 60Hz &amp; 7kHz 4:1</td>
<td>0.00005</td>
<td></td>
</tr>
<tr>
<td>GBWP</td>
<td>Gain Bandwidth Product</td>
<td></td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>SR</td>
<td>Slew Rate</td>
<td>(V_{OUT} = 1V_{p-p}, -3dB) referenced to output magnitude at (f = 1kHz)</td>
<td>±20</td>
<td>±15</td>
</tr>
<tr>
<td>FPBW</td>
<td>Full Power Bandwidth</td>
<td>(V_{OUT} = 1V_{p-p}, -3dB) referenced to output magnitude at (f = 1kHz)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>(t_s)</td>
<td>Settling time</td>
<td>(A_V = -1), 10V step, (C_L = 100pF) 0.1% error range</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>(e_n)</td>
<td>Equivalent Input Noise Voltage</td>
<td>(f_{BW} = 20Hz) to 20kHz</td>
<td>0.34</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Equivalent Input Noise Density</td>
<td>(f = 1kHz), (f = 10Hz)</td>
<td>2.7</td>
<td>6.4</td>
</tr>
<tr>
<td>(i_n)</td>
<td>Current Noise Density</td>
<td>(f = 1kHz), (f = 10Hz)</td>
<td>1.6</td>
<td>3.1</td>
</tr>
<tr>
<td>(V_{OS})</td>
<td>Offset Voltage</td>
<td></td>
<td>±0.1</td>
<td>±0.7</td>
</tr>
<tr>
<td>(\Delta V_{OS}/\Delta Temp)</td>
<td>Average Input Offset Voltage Drift vs Temperature</td>
<td>(\Delta V_S = 20V)(^{(5)})</td>
<td>0.2</td>
<td></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</td>
</tr>
<tr>
<td>ISO_{CH-CH}</td>
<td>Channel-to-Channel Isolation</td>
<td>(I_{IN} = 1kHz), (I_{IN} = 20kHz)</td>
<td>118</td>
<td>112</td>
</tr>
<tr>
<td>(I_B)</td>
<td>Input Bias Current</td>
<td>(V_{CM} = 0V)</td>
<td>10</td>
<td>72</td>
</tr>
<tr>
<td>(\Delta I_{OS}/\Delta Temp)</td>
<td>Input Bias Current Drift vs Temperature</td>
<td>(\Delta V_S = 20V)(^{(5)})</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>(I_{OS})</td>
<td>Input Offset Current</td>
<td>(V_{CM} = 0V)</td>
<td>11</td>
<td>65</td>
</tr>
<tr>
<td>(V_{IN-CM})</td>
<td>Common-Mode Input Voltage Range</td>
<td></td>
<td>+14.1</td>
<td>−13.9</td>
</tr>
<tr>
<td>CMRR</td>
<td>Common-Mode Rejection</td>
<td></td>
<td>−10V,(V_{CM})&lt;10V</td>
<td>120</td>
</tr>
<tr>
<td>(Z_{IN})</td>
<td>Differential Input Impedance</td>
<td>(\Delta V_S = 20V)(^{(5)})</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Common Mode Input Impedance</td>
<td>(\Delta V_S = 20V)(^{(5)})</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>(A_{VOL})</td>
<td>Open Loop Voltage Gain</td>
<td>(\Delta V_S = 20V)(^{(5)})</td>
<td>140</td>
<td>125</td>
</tr>
<tr>
<td>(V_{OUTMAX})</td>
<td>Maximum Output Voltage Swing</td>
<td>(R_L = 600,\Omega), (R_L = 2,\Omega), (R_L = 10,\Omega)</td>
<td>±13.6</td>
<td>±125</td>
</tr>
<tr>
<td>(I_{OUT})</td>
<td>Output Current</td>
<td>(R_L = 600,\Omega), (V_S = ±17V)</td>
<td>±26</td>
<td>±23</td>
</tr>
<tr>
<td>(I_{OUT-CC})</td>
<td>Instantaneous Short Circuit Current</td>
<td></td>
<td>+53</td>
<td>−42</td>
</tr>
<tr>
<td>(R_{OUT})</td>
<td>Output Impedance</td>
<td>(I_{IN} = 1kHz) Closed-Loop</td>
<td>0.01</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 the 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 \(+25^\circ C\) and represent the most likely parametric norm.

\(^{(4)}\) Tested limits are specified to AOQL (Average Outgoing Quality Level).

\(^{(5)}\) PSRR is measured as follows: \(V_{OS}\) is measured at two supply voltages, \(\pm 5V\) and \(\pm 15V\). \(PSRR = |20\log(\Delta V_{OS}/\Delta V_S)|\).
# ELECTRICAL CHARACTERISTICS FOR THE LM4562\(^{(1)(2)}\) (continued)

The specifications apply for \(V_S = \pm 15V\), \(R_L = 2k\Omega\), \(f_{IN} = 1kHz\), \(T_A = 25\pm\)C, unless otherwise specified.

<table>
<thead>
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<th>Units (Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Typical(^{(3)})</td>
<td>Limit(^{(6)})</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>

\(^{(1)}\) LM4562
\(^{(2)}\) LM4562
\(^{(3)}\) LM4562
\(^{(6)}\) LM4562
TYPICAL PERFORMANCE CHARACTERISTICS

THD+N vs Output Voltage
$V_{CC} = 15V, V_{EE} = -15V$
$R_L = 2k\Omega$

Figure 3.

THD+N vs Output Voltage
$V_{CC} = 12V, V_{EE} = -12V$
$R_L = 2k\Omega$

Figure 4.

THD+N vs Output Voltage
$V_{CC} = 17V, V_{EE} = -17V$
$R_L = 2k\Omega$

Figure 5.

THD+N vs Output Voltage
$V_{CC} = 2.5V, V_{EE} = -2.5V$
$R_L = 2k\Omega$

Figure 6.

THD+N vs Output Voltage
$V_{CC} = 15V, V_{EE} = -15V$
$R_L = 600\Omega$

Figure 7.

THD+N vs Output Voltage
$V_{CC} = 12V, V_{EE} = -12V$
$R_L = 600\Omega$

Figure 8.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

THD+N vs Output Voltage

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

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

Figure 9.

THD+N vs Output Voltage

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

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

Figure 10.

THD+N vs Output Voltage

- $V_{CC} = 17V, V_{EE} = -17V$
- $R_L = 10k\Omega$

- $V_{CC} = 2.5V, V_{EE} = -2.5V$
- $R_L = 10k\Omega$

Figure 11.

THD+N vs Output Voltage

- $V_{CC} = 17V, V_{EE} = -17V$
- $R_L = 10k\Omega$

- $V_{CC} = 2.5V, V_{EE} = -2.5V$
- $R_L = 10k\Omega$

Figure 12.

THD+N vs Output Voltage

- $V_{CC} = 17V, V_{EE} = -17V$
- $R_L = 10k\Omega$

- $V_{CC} = 2.5V, V_{EE} = -2.5V$
- $R_L = 10k\Omega$

Figure 13.

THD+N vs Output Voltage

- $V_{CC} = 17V, V_{EE} = -17V$
- $R_L = 10k\Omega$

- $V_{CC} = 2.5V, V_{EE} = -2.5V$
- $R_L = 10k\Omega$

Figure 14.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

THD+N vs Frequency

Figure 15.

Figure 16.

Figure 17.

Figure 18.

Figure 19.

Figure 20.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

THD+N vs Frequency

V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V, V<sub>OUT</sub> = 3V<sub>RMS</sub>
R<sub>L</sub> = 10kΩ

IMD vs Output Voltage

V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V
R<sub>L</sub> = 10kΩ

Figure 21.

Figure 22.

Figure 23.

Figure 24.

Figure 25.

Figure 26.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

IMD vs Output Voltage

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 2k\Omega$

Figure 27.

IMD vs Output Voltage

$V_{CC} = 15V, V_{EE} = -15V$

$R_L = 600\Omega$

Figure 28.

IMD vs Output Voltage

$V_{CC} = 12V, V_{EE} = -12V$

$R_L = 600\Omega$

Figure 29.

IMD vs Output Voltage

$V_{CC} = 2.5V, V_{EE} = -2.5V$

$R_L = 600\Omega$

Figure 30.

IMD vs Output Voltage

$V_{CC} = 15V, V_{EE} = -15V$

$R_L = 10k\Omega$

Figure 31.

IMD vs Output Voltage

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 2k\Omega$

Figure 32.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

IMD vs Output Voltage
V_{CC} = 12V, V_{EE} = -12V
R_L = 10k\Omega

IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = -17V
R_L = 10k\Omega

Voltage Noise Density vs Frequency
V_S = 30V
V_{CM} = 15V

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = -15V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 2k\Omega
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Crosstalk vs Frequency

Figure 39.

Figure 40.

Figure 41.

Figure 42.

Figure 43.

Figure 44.
Typical Performance Characteristics (continued)

**Crosstalk vs Frequency**

- **Figure 45.**
  - $V_{CC} = 15V$, $V_{EE} = -15V$, $V_{OUT} = 3V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\Omega$

- **Figure 46.**
  - $V_{CC} = 15V$, $V_{EE} = -15V$, $V_{OUT} = 10V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\Omega$

- **Figure 47.**
  - $V_{CC} = 12V$, $V_{EE} = -12V$, $V_{OUT} = 3V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\Omega$

- **Figure 48.**
  - $V_{CC} = 12V$, $V_{EE} = -12V$, $V_{OUT} = 10V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\Omega$

- **Figure 49.**
  - $V_{CC} = 17V$, $V_{EE} = -17V$, $V_{OUT} = 3V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\Omega$

- **Figure 50.**
  - $V_{CC} = 17V$, $V_{EE} = -17V$, $V_{OUT} = 10V_{RMS}$
  - $A_V = 0dB$, $R_L = 600\Omega$
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Crosstalk vs Frequency

- \( V_{CC} = 2.5 \text{V}, V_{EE} = -2.5 \text{V}, V_{OUT} = 1V_{RMS} \)
- \( A_{V} = 0 \text{dB}, R_{L} = 60k \Omega \)

Figure 51.

- \( V_{CC} = 15V, V_{EE} = -15V, V_{OUT} = 3V_{RMS} \)
- \( A_{V} = 0 \text{dB}, R_{L} = 10k \Omega \)

Figure 52.

- \( V_{CC} = 15V, V_{EE} = -15V, V_{OUT} = 10V_{RMS} \)
- \( A_{V} = 0 \text{dB}, R_{L} = 60k \Omega \)

Figure 53.

- \( V_{CC} = 15V, V_{EE} = -15V, V_{OUT} = 3V_{RMS} \)
- \( A_{V} = 0 \text{dB}, R_{L} = 10k \Omega \)

Figure 54.

- \( V_{CC} = 12V, V_{EE} = -12V, V_{OUT} = 10V_{RMS} \)
- \( A_{V} = 0 \text{dB}, R_{L} = 60k \Omega \)

Figure 55.

- \( V_{CC} = 12V, V_{EE} = -12V, V_{OUT} = 3V_{RMS} \)
- \( A_{V} = 0 \text{dB}, R_{L} = 10k \Omega \)

Figure 56.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Figure 57. Crosstalk vs Frequency

Figure 58. Crosstalk vs Frequency

Figure 59. PSRR+ vs Frequency

Figure 60. PSRR+ vs Frequency

Figure 61. PSRR+ vs Frequency

Figure 62. PSRR+ vs Frequency
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

PSRR+ vs Frequency

$V_{CC} = 15V, V_{EE} = -15V$

$R_L = 600\Omega, f = 200kHz, V_{ripples} = 200mVpp$

Figure 63.

PSRR- vs Frequency

$V_{CC} = 15V, V_{EE} = -15V$

$R_L = 600\Omega, f = 200kHz, V_{ripples} = 200mVpp$

Figure 64.

PSRR+ vs Frequency

$V_{CC} = 12V, V_{EE} = -12V$

$R_L = 10k\Omega, f = 200kHz, V_{ripples} = 200mVpp$

Figure 65.

PSRR- vs Frequency

$V_{CC} = 12V, V_{EE} = -12V$

$R_L = 10k\Omega, f = 200kHz, V_{ripples} = 200mVpp$

Figure 66.

PSRR+ vs Frequency

$V_{CC} = 12V, V_{EE} = -12V$

$R_L = 2k\Omega, f = 200kHz, V_{ripples} = 200mVpp$

Figure 67.

PSRR- vs Frequency

$V_{CC} = 12V, V_{EE} = -12V$

$R_L = 2k\Omega, f = 200kHz, V_{ripples} = 200mVpp$

Figure 68.
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**

$V_{CC} = 12V, V_{EE} = -12V$

$R_L = 600\, \Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 69.**

**Figure 70.**

**PSRR+ vs Frequency**

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 10k\, \Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**PSRR– vs Frequency**

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 10k\, \Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 71.**

**Figure 72.**

**PSRR+ vs Frequency**

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 2k\, \Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**PSRR– vs Frequency**

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 2k\, \Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

**Figure 73.**

**Figure 74.**
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

PSRR+ vs Frequency

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 75.

PSRR– vs Frequency

$V_{CC} = 17V, V_{EE} = -17V$

$R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 76.

PSRR+ vs Frequency

$V_{CC} = 2.5V, V_{EE} = -2.5V$

$R_L = 10k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 77.

PSRR– vs Frequency

$V_{CC} = 2.5V, V_{EE} = -2.5V$

$R_L = 10k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 78.

PSRR+ vs Frequency

$V_{CC} = 2.5V, V_{EE} = -2.5V$

$R_L = 2k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 79.

PSRR– vs Frequency

$V_{CC} = 2.5V, V_{EE} = -2.5V$

$R_L = 2k\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp$

Figure 80.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Figure 81. PSRR+ vs Frequency

\[ V_{CC} = 2.5V, V_{EE} = -2.5V \]
\[ R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp \]

Figure 82. PSRR– vs Frequency

\[ V_{CC} = 2.5V, V_{EE} = -2.5V \]
\[ R_L = 600\Omega, f = 200kHz, V_{RIPPLE} = 200mVpp \]

Figure 83. CMRR vs Frequency

\[ V_{CC} = 15V, V_{EE} = -15V \]
\[ R_L = 2k\Omega \]

Figure 84. CMRR vs Frequency

\[ V_{CC} = 12V, V_{EE} = -12V \]
\[ R_L = 2k\Omega \]

Figure 85. CMRR vs Frequency

\[ V_{CC} = 17V, V_{EE} = -17V \]
\[ R_L = 2k\Omega \]

Figure 86. CMRR vs Frequency

\[ V_{CC} = 2.5V, V_{EE} = -2.5V \]
\[ R_L = 2k\Omega \]
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

Figure 87.

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

Figure 88.

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

Figure 89.

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

Figure 90.

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

Figure 91.

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

Figure 92.
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

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

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

**CMRR vs Frequency**
- $V_{CC} = 2.5V, V_{EE} = -2.5V$
- $R_L = 10k\Omega$

**Output Voltage vs Load Resistance**
- $V_{DD} = 2.5V, V_{EE} = -2.5V$
- THD+N ≤ 1%

---

**Figure 93.**

**Figure 94.**

**Figure 95.**

**Figure 96.**

**Figure 97.**

**Figure 98.**
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

Figure 99.

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

Figure 100.

Output Voltage vs Supply Voltage
$R_L = 10k\Omega$, THD+N = 1%  

Figure 101.

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

Figure 102.

Supply Current vs Supply Voltage
$R_L = 600\Omega$  

Figure 103.

Supply Current vs Supply Voltage
$R_L = 10k\Omega$  

Figure 104.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Figure 105.

Figure 106.

Figure 107.

Figure 108.
APPLICATION INFORMATION

DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LM4562 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 LM4562's low residual distortion is an input referred internal error. As shown in Figure 109, 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 $R_1$ low as shown in Figure 109.

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.

![Distortion Signal Gain](image)

**Figure 109. THD+N and IMD Distortion Test Circuit**

The LM4562 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.
A. Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

**Figure 110. Noise Measurement Circuit**
Total Gain: 115 dB @ f = 1 kHz
Input Referred Noise Voltage: $e_n = V_0/560,000$ (V)

**Figure 111. RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency**

**Figure 112. Flat Amp Voltage Gain vs Frequency**
Evaluation Module Schematic

Figure 113. Inverting Amplifiers

Typical Applications

Figure 114. NAB Preamp

\[ A_V = 34.5 \]
\[ F = 1 \text{ kHz} \]
\[ E_{in} = 0.38 \mu \text{V} \]
\[ A \text{ Weighted} \]
Figure 115. NAB Preamp Voltage Gain vs Frequency

\[ V_O = V_1 - V_2 \]

Figure 116. Balanced to Single-Ended Converter

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

Figure 117. Adder/Subtracter

\[ f_0 = \frac{1}{2\pi RC} \]

Figure 118. Sine Wave Oscillator
if $C_1 = C_2 = C$

$$R_1 = \frac{\sqrt{2}}{2\omega_0 C}$$

$$R_2 = 2R_1$$

Illustration is $f_0 = 1$ kHz

Figure 119. Second-Order High-Pass Filter (Butterworth)

if $R_1 = R_2 = R$

$$C_1 = \frac{\sqrt{2}}{\omega_0 R}$$

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

Illustration is $f_0 = 1$ kHz

Figure 120. Second-Order Low-Pass Filter (Butterworth)
\[ f_0 = \frac{1}{2\pi C1R1} \quad Q = \frac{1}{2} \left( 1 + \frac{R2}{R0} + \frac{R2}{RG} \right), \quad A_{BP} = QA_{LP} = QA_{LH} = \frac{R2}{RG} \]

Illustration is \( f_0 = 1 \text{ kHz}, \ Q = 10, \ A_{BP} = 1 \)

**Figure 121. State Variable Filter**

**Figure 122. AC/DC Converter**

**Figure 123. 2-Channel Panning Circuit (Pan Pot)**
Figure 124. Line Driver

The equations started above are simplifications, providing guidance of general –3dB point values, when the potentiometers are at their null position.

Illustration is:

\[ f_L = \frac{1}{2\pi R2C1} \]
\[ f_{LB} = \frac{1}{2\pi R1C1} \]
\[ f_H = \frac{1}{2\pi R5C2} \]
\[ f_{HB} = \frac{1}{2\pi (R1 + R5 + 2R3)C2} \]

The equations started above are simplifications, providing guidance of general –3dB point values, when the potentiometers are at their null position.

Illustration is:

\[ f_L \approx 32 \text{ Hz}, \ f_{LB} \approx 320 \text{ Hz} \]
\[ f_H \approx 11 \text{ kHz}, \ f_{HB} \approx 1.1 \text{ kHz} \]

Figure 125. Tone Control
$A_v = 35 \text{ dB}$

$E_n = 0.33 \ \mu V \ S/N = 90 \text{ dB}$

$f = 1 \text{ kHz}$

A Weighted

A Weighted, $V_{IN} = 10 \text{ mV}$

@ $f = 1 \text{ kHz}$

---

**Figure 126. RIAA Preamp**

If $R2 = R5$, $R3 = R6$, $R4 = R7$

$V_0 = \left( 1 + \frac{2R2}{R1} \right) \frac{R4}{R3} (V_2 - V_1)$

Illustration is:

$V_0 = 101(V_2 - V_1)$

**Figure 127. Balanced Input Mic Amp**
A. See Table 1.

Figure 128. 10-Band Graphic Equalizer

Table 1. \( C_1 \), \( C_2 \), \( R_1 \), and \( R_2 \) Values for Figure 128\(^{(1)}\)

<table>
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<th>( f_0 ) (Hz)</th>
<th>( C_1 )</th>
<th>( C_2 )</th>
<th>( R_1 )</th>
<th>( R_2 )</th>
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<td>250</td>
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\(^{(1)}\) At volume of change = ±12 dB  \( Q = 1.7 \)
## REVISION HISTORY

### Changes from Revision J (April 2013) to Revision K

| Page |
|------|---|
| Added EVM schematic | 25 |

Product Folder Links: **LM4562**

Submit Documentation Feedback

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## REVISION HISTORY

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<th>Rev</th>
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<th>Description</th>
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<tr>
<td>1.1</td>
<td>08/22/06</td>
<td>Updated the Instantaneous Short Circuit Current specification.</td>
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<tr>
<td>1.2</td>
<td>09/12/06</td>
<td>Updated the three ±15V CMRR Typical Performance Curves.</td>
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<tr>
<td>1.3</td>
<td>09/26/06</td>
<td>Updated interstage filter capacitor values on page 1 Typical Application schematic.</td>
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<tr>
<td>1.4</td>
<td>05/03/07</td>
<td>Added the &quot;general note&quot; under the EC table.</td>
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<tr>
<td>1.5</td>
<td>10/17/07</td>
<td>Replaced all the PSRR curves.</td>
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<tr>
<td>1.6</td>
<td>01/26/10</td>
<td>Edited the equations on page 28 (under Tone Control).</td>
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<tr>
<td>J</td>
<td>04/04/13</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>
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<th>Package Qty</th>
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<th>Lead/Ball Finish</th>
<th>MSL Peak Temp</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</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.
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(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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*All dimensions are nominal*

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**TAPE AND REEL BOX DIMENSIONS**

*All dimensions are nominal*

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1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.
NOTE: All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001 variation BA.
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