March 27, 2008

National Semiconductor

LME49722
Low Noise, High Performance, High Fidelity Dual Audio Operational Amplifier

General Description

The LME49722 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 LME49722 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LME49722 combines extremely low voltage noise density (1.9nV/√Hz) rate with vanishingly low THD+N (0.00002%) to easily satisfy the most demanding audio applications. To ensure that the most challenging loads are driven without compromise, the LME49722 has a high slew rate of ±22V/μs and an output current capability of ±28mA. Further, dynamic range is maximized by an output stage that drives 2kΩ loads to within 1V of either power supply voltage.

The LME49722 has a wide supply range of ±2.5V to ±18V. Over this supply range the LME49722 maintains excellent common-mode and power supply rejection, and low input bias current. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF with gain value greater than 2. Directly interchangeable with LME49720, LM4562 and LME49860 for similar operating voltages.

Key Specifications

■ Wide Operating Voltage Range	±2.5V to ±18V
■ Equivalent Noise (Frequency = 1kHz)	1.9nV/√Hz (typ)
■ Equivalent Noise (Frequency = 10Hz)	2.8nV/√Hz (typ)
■ PSRR	120dB (typ)
■ Slew Rate	±22V/μs (typ)
■ THD+N (A_V = 1, V_{OUT} = $3V_{RMS}$, f_{IN} = 1kHz)	
R_L = 2kΩ	0.00002% (typ)
R_L = 600Ω	0.00002% (typ)
■ Open Loop Gain (R_L = 600Ω)	135dB (typ)
■ Input Bias Current	50nA (typ)
■ Voltage Offset	±0.02mV (typ)

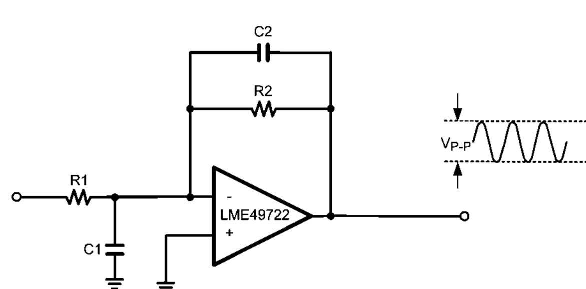
Features

- Easily drives 600Ω loads
- Optimized for superior audio signal fidelity
- Output short circuit protection
- PSRR and CMRR exceed 120dB (typ)

Applications

- Ultra high quality audio amplification
- High fidelity preamplifiers, phono preamps, and multimedia
- High performance professional audio
- High fidelity equalization and crossover networks with active filters
- High performance line drivers and receivers
- Low noise industrial applications including test, measurement, and ultrasound

Typical Application



f_{MAX} = > 300 kHz for V_{P-P} = 20V, R2 C2 ≈ R1 C1

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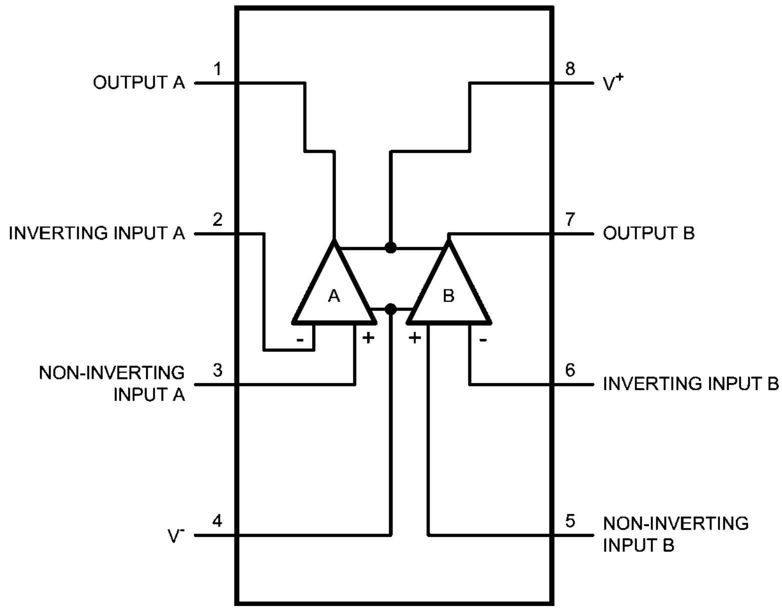
FIGURE 1. Wide Bandwidth Low Noise Low Drift Amplifier

Connection Diagram

Dual-In-Line Package



Order Number LME49722MA
See NS Package Number — M08A

Absolute Maximum Ratings (Notes 1, 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage ($V_S = V_{CC}$-V_{EE})	38V
Storage Temperature	−65°C to 150°C
Input Voltage	(V-) - 0.7V to (V+) + 0.7V
Output Short Circuit (Note 3)	Continuous
ESD Susceptibility (Note 4)	2000V
ESD Susceptibility (Note 5)	200V
Junction Temperature (T_{JMAX})	150°C
Thermal Resistance	
θ_{JA}	154°C/W
θ_{JC}	27°C/W

Operating Ratings

Temperature Range	
$T_{MIN} \leq T_A \leq T_{MAX}$	$-40°C \leq T_A \leq 85°C$
Supply Voltage Range	$\pm 2.5V \leq V_S \leq \pm 18V$

Electrical Characteristics for the LME49722 (Notes 1, 2)

The following specifications apply for V_S = ±15V and ±18V, R_L = 2kΩ, f_{IN} = 1kHz unless otherwise specified. Limits apply for T_A = 25°C,

Symbol	Parameter	Conditions	LME49722 Typical (Note 6)	LME49722 Limit (Note 7)	Units (Limits)
THD+N	Total Harmonic Distortion + Noise	A_V = 1, V_{OUT} = 3V_{rms} R_L = 2kΩ R_L = 600Ω	 0.00002 0.00002	 0.00009	 % % (max)
IMD	Intermodulation Distortion	A_V = 1, V_{OUT} = 3V_{RMS} Two-tone, 60Hz & 7kHz 4:1	0.00002		%
GBWP	Gain Bandwidth Product	f_{IN} = 100kHz	55	45	MHz (min)
SR	Slew Rate	A_V = 1, V_{OUT} = 10V_{P-P}	±22	±15	V/μs (min)
FPBW	Full Power Bandwidth	V_{OUT} = 1V_{P-P}, –3dB referenced to output magnitude at f = 1kHz	12		MHz
t_s	Settling time	A_V = –1, 10V step, C_L = 100pF 0.1% error range	1.2		μs
e_{INV}	Equivalent Input Voltage Noise	f_{BW} = 20Hz to 20kHz	0.25	0.35	μV_{RMS} (max)
e_N	Equivalent Input Voltage Density	f= 1kHz V_S = ±15V V_S = ±18V	 1.9 1.9	 2.5	 $nV\sqrt{Hz}$ $nV\sqrt{Hz}$ (max)
		f = 10Hz V_S = ±15V V_S = ±18V	 2.8 3.2		 $nV\sqrt{Hz}$ $nV\sqrt{Hz}$
I_n	Current Noise Density	f = 1kHz f = 10Hz	2.6 6		$pA/\sqrt{Hz}$ $pA/\sqrt{Hz}$
V_{OS}	Offset Voltage	V_{CM} = 0V	±0.02	±0.7	mV (max)
PSRR	Power Supply Rejection Ratio	ΔV_S = 20V (Note 8)	120	110	dB (min)
ISO_{CH-CH}	Channel-to-Channel Isolation	f_{IN} = 1kHz f_{IN} = 20kHz	136 135		dB dB
I_B	Input Bias Current	V_{CM} = 0V V_S = ±15V V_S = ±18V	 50 53	 200	 nA nA (max)
ΔI_{OS}/ ΔTemp	Input Bias Current Drift vs Temperature	$-40°C \leq T_A \leq 85°C$	0.1		nA/°C
I_{OS}	Input Offset Current	V_{CM} = 0V V_S = ±15V V_S = ±18V	 25 32	 100	 nA nA (max)

Symbol	Parameter	Conditions	LME49722 Typical (Note 6)	LME49722 Limit (Note 7)	Units (Limits)
V_{IN-CM}	Common-Mode Input Voltage Range	$V_S = \pm 15V$	+14.0 –13.9	$(V_{CC}) - 2.0$ $(V_{EE}) + 2.0$	V (min) V (min)
		$V_S = \pm 18V$	+17.0 –16.9	$(V_{CC}) - 2.0$ $(V_{EE}) + 2.0$	V (min) V (min)
CMRR	Common-Mode Rejection	$-10V \le V_{CM} \le 10V$	128	110	dB (min)
Z_{IN}	Differential Input Impedance		30		kΩ
Z_{CM}	Common Mode Input Impedance	$-10V \le V_{CM} \le 10V$	1000		MΩ
A_{VOL}	Open Loop Voltage Gain	$-12V \le V_{OUT} \le 12V$, $R_L = 600\Omega$ $-12V \le V_{OUT} \le 12V$, $R_L = 2k\Omega$ $-12V \le V_{OUT} \le 12V$, $R_L = 10k\Omega$	135 140 140	120	dB dB dB
V_{OM}	Output Voltage Swing	$V_S = \pm 15V$ $R_L = 600\Omega$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	+13.7/–14 ±14.0 ±14.1		V_{PEAK} V_{PEAK} V_{PEAK}
		$V_S = \pm 18V$ $R_L = 600\Omega$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	+16.6/–16.8 ±17.0 ±17.1	±15.5	V_{PEAK} (min) V_{PEAK} V_{PEAK}
I_{OUT}	Output Current	$R_L = 600\Omega$ $V_S = \pm 15V$ $V_S = \pm 18V$	±23 ±27.6/–28	±23	mA mA (min)
I_{OUT-CC}	Short Circuit Current	Sink to Source	+43 –40		mA mA
Z_{OUT}	Output Impedance	$f_{IN} = 10kHz$ Closed-Loop Open-Loop	0.01 13		Ω Ω
I_S	Total Quiescent Power Supply Current	$I_{OUT} = 0mA$ $V_S = \pm 15V$ $V_S = \pm 18V$	12.1 12.3	16	mA mA (max)

Note 1: "*Absolute Maximum Ratings*" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The *Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: The *Electrical Characteristics* tables list guaranteed specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not guaranteed.

Note 3: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{JA}, and the ambient temperature, T_A. The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ or the number given in*Absolute Maximum Ratings*, whichever is lower. For the LME49722, T_{JMAX} = 150°C and the typical θ_{JC} is 27°C/W.

Note 4: Human body model, applicable std. JESD22-A114C.

Note 5: Machine model, applicable std. JESD22-A115-A.

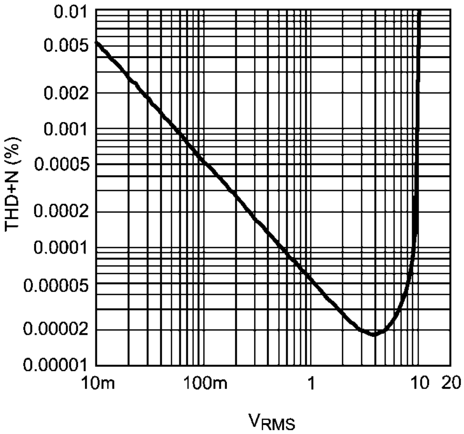
Note 6: Typical values represent most likely parametric norms at T_A = +25°C, and at the *Recommended Operation Conditions* at the time of product characterization and are not guaranteed.

Note 7: Datasheet min/max specification limits are guaranteed by test or statistical analysis.

Note 8: PSRR is measured as follow: V_{OS} is measured at two supply voltages, ±5V and ±15V. PSRR = $| 20\log(\Delta V_{OS}/\Delta V_S) |$.

Typical Performance Characteristics

THD+N vs Output Voltage
$+V_{CC} = -V_{EE} = 15V$, $f_{IN} = 1kHz$, $R_L = 2k\Omega$



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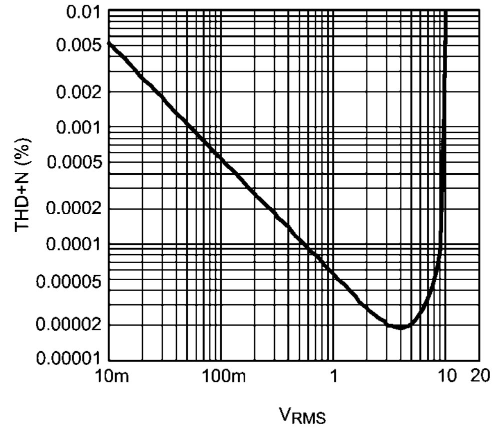
THD+N vs Output Voltage
$+V_{CC} = -V_{EE} = 15V$, $f_{IN} = 1kHz$, $R_L = 600\Omega$



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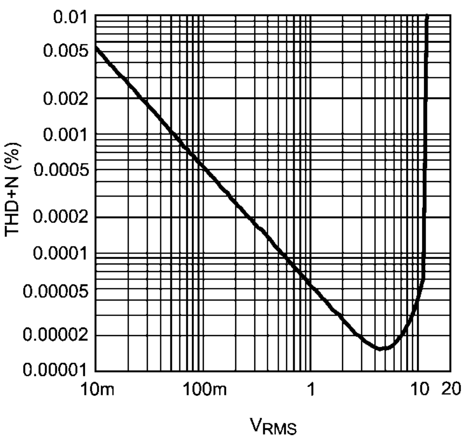
THD+N vs Output Voltage
$+V_{CC} = -V_{EE} = 18V$, $f_{IN} = 1kHz$, $R_L = 2k\Omega$



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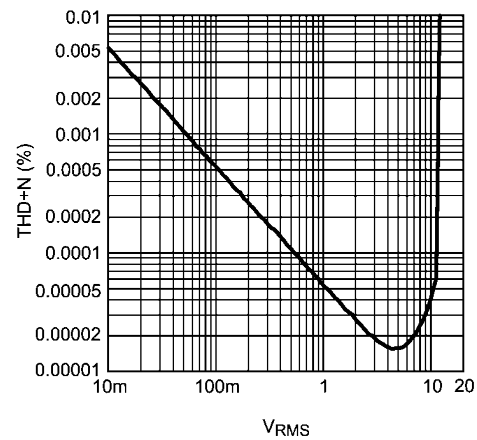
THD+N vs Output Voltage
$+V_{CC} = -V_{EE} = 18V$, $f_{IN} = 1kHz$, $R_L = 600\Omega$



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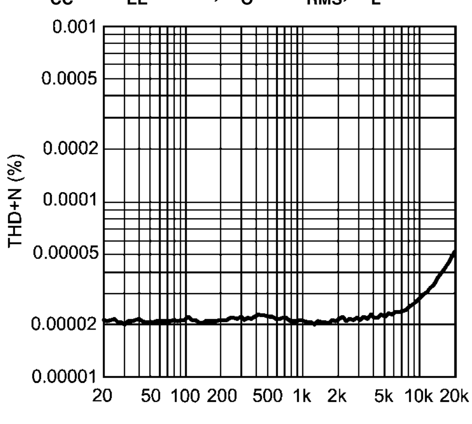
THD+N vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $V_O = 3V_{RMS}$, $R_L = 2k\Omega$



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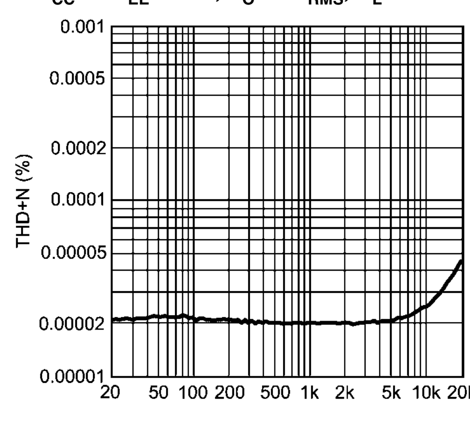
THD+N vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $V_O = 3V_{RMS}$, $R_L = 600\Omega$



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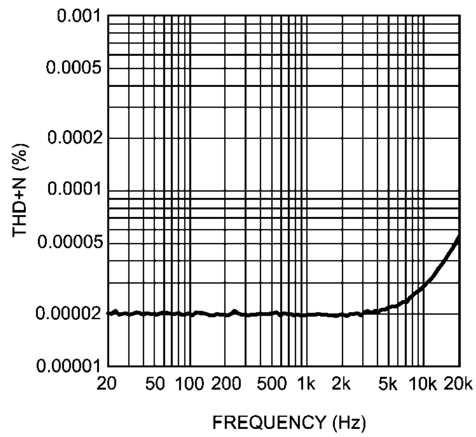
THD+N vs Frequency
$+V_{CC} = -V_{EE} = 18V$, $V_O = 3V_{RMS}$, $R_L = 2k\Omega$



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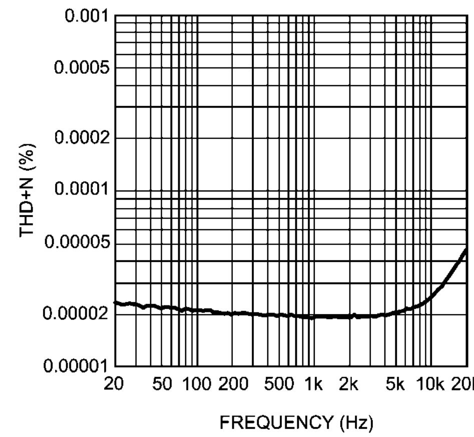
THD+N vs Frequency
$+V_{CC} = -V_{EE} = 18V$, $V_O = 3V_{RMS}$, $R_L = 600\Omega$



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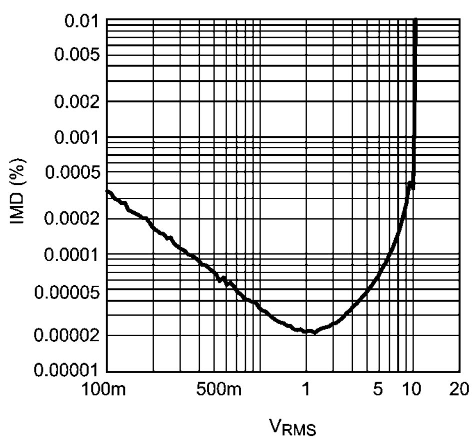
IMD vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $R_L = 2k\Omega$



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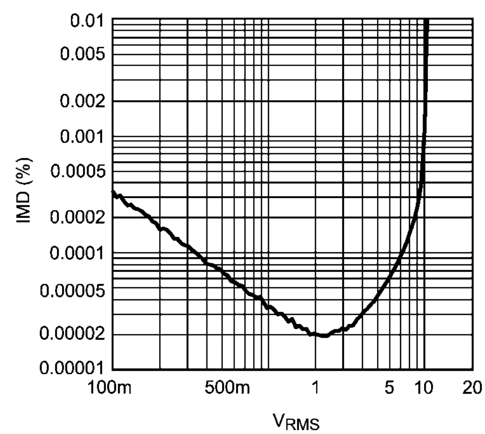
IMD vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $R_L = 600\Omega$



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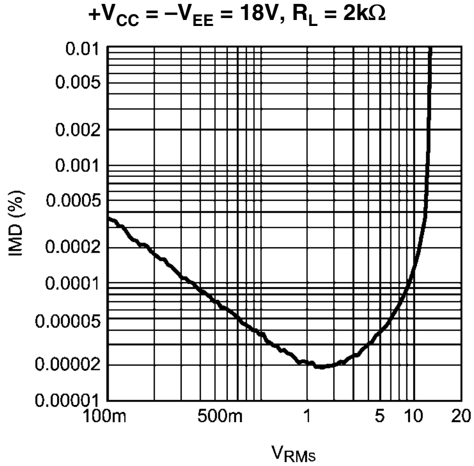
IMD vs Frequency
$+V_{CC} = -V_{EE} = 18V$, $R_L = 2k\Omega$



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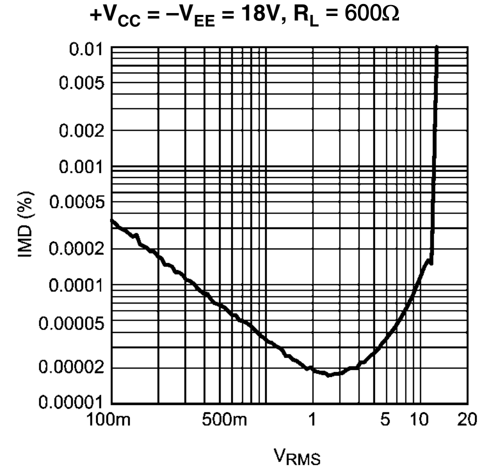
IMD vs Frequency
$+V_{CC} = -V_{EE} = 18V$, $R_L = 600\Omega$



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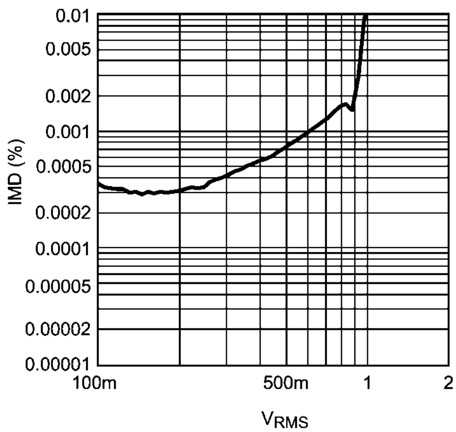
IMD vs Frequency
$+V_{CC} = -V_{EE} = 2.5V$, $R_L = 2k\Omega$



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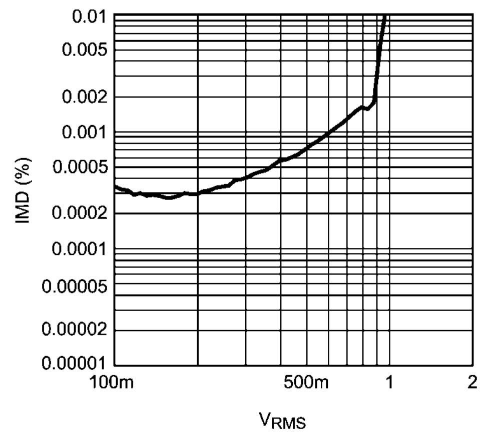
IMD vs Frequency
$+V_{CC} = -V_{EE} = 2.5V$, $R_L = 600\Omega$



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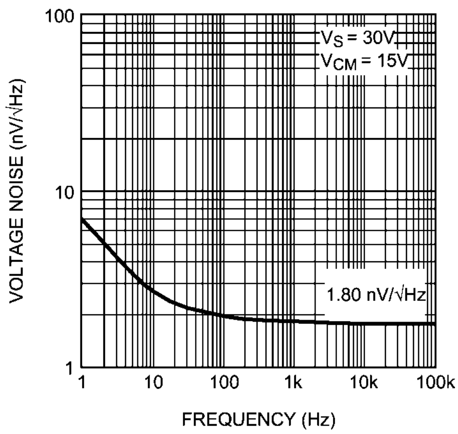
Voltage Noise Density vs Frequency
$+V_{CC} = -V_{EE} = 15V$



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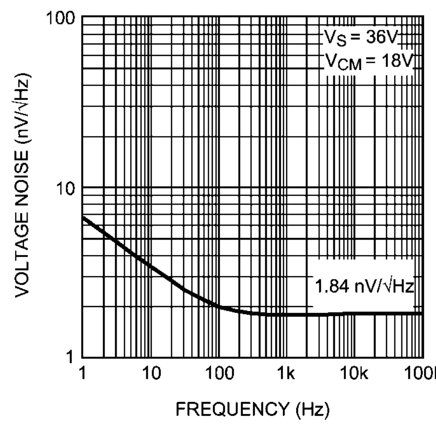
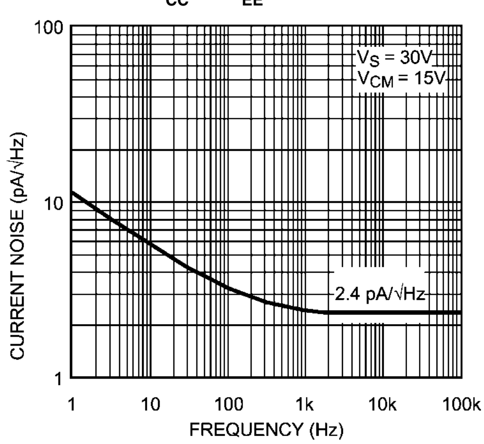
Voltage Noise Density vs Frequency
$+V_{CC} = -V_{EE} = 18V$



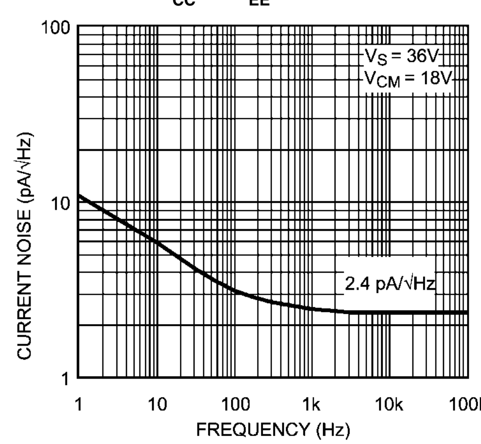
300579q0

Current Noise Density vs Frequency
$+V_{CC} = -V_{EE} = 15V$



30057917

Current Noise Density vs Frequency
$+V_{CC} = -V_{EE} = 18V$



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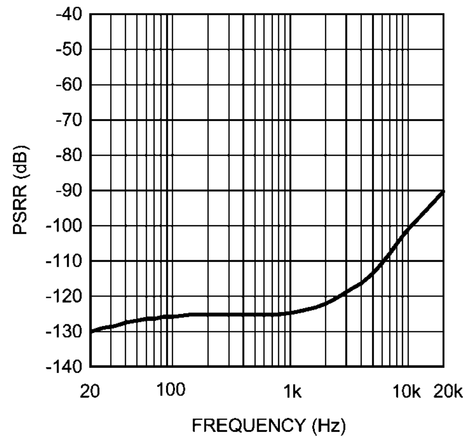
PSRR+ vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $V_{RIPPLE} = 200mV_{PP}$, $R_L = 2k\Omega$



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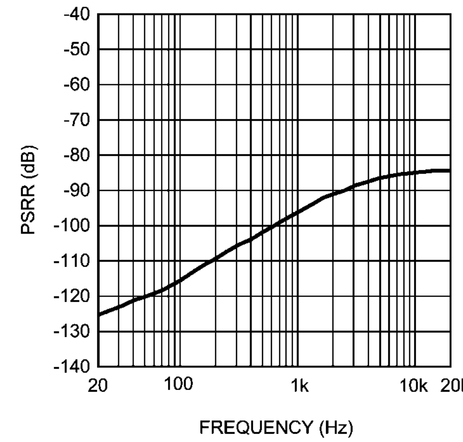
PSRR- vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $V_{RIPPLE} = 200mV_{PP}$, $R_L = 2k\Omega$



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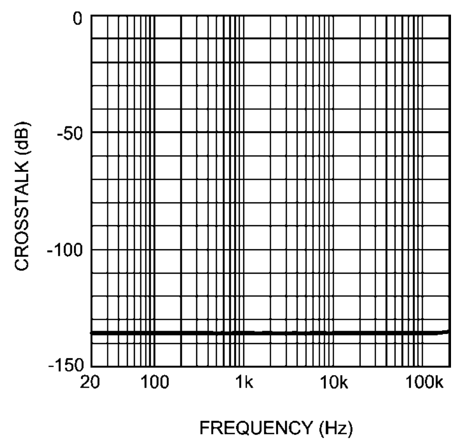
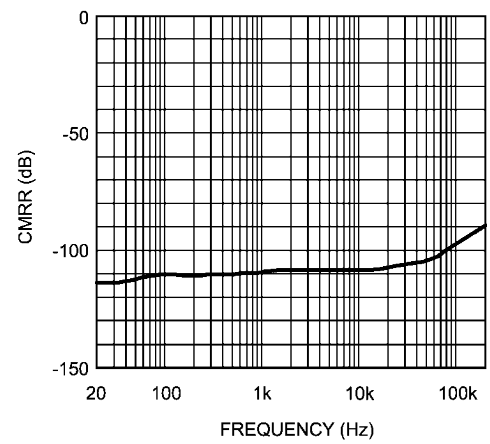
Crosstalk vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $R_L = 2k\Omega$, $V_{OUT} = 3V_{RMS}$



300579p0

CMRR vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $R_L = 2k\Omega$



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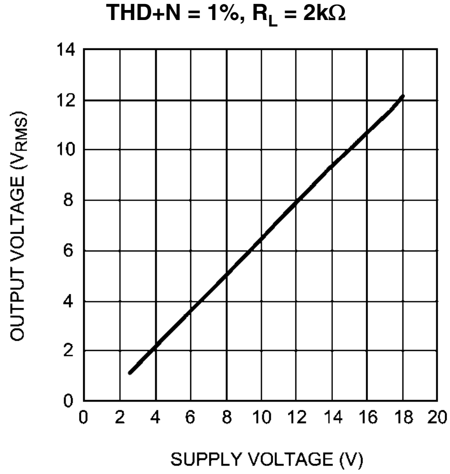
Output Voltage vs Supply Voltage
THD+N = 1%, $R_L = 2k\Omega$



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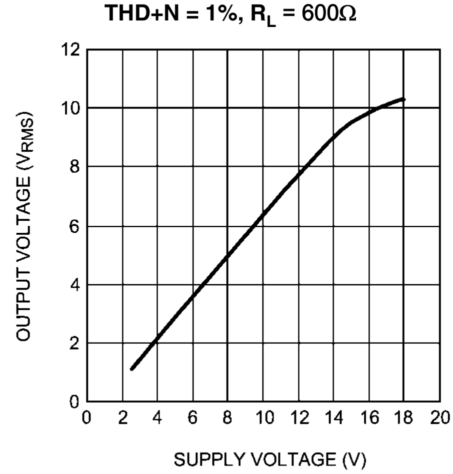
Output Voltage vs Supply Voltage
THD+N = 1%, $R_L = 600\Omega$



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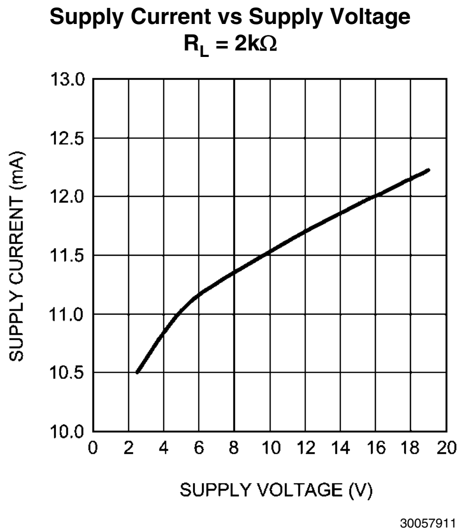
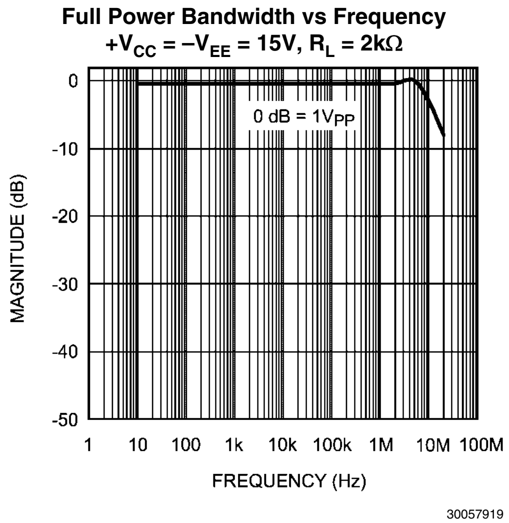
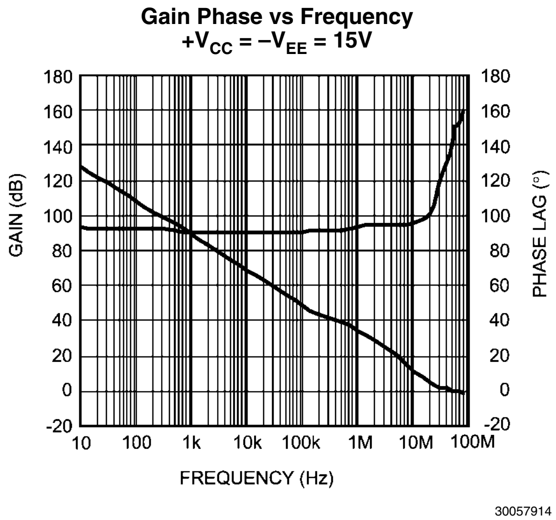

Supply Current vs Supply Voltage
$R_L = 2k\Omega$
13.0
12.5
12.0
11.5
11.0
10.5
10.0
SUPPLY CURRENT (mA)
0 2 4 6 8 10 12 14 16 18 20
SUPPLY VOLTAGE (V)
30057911

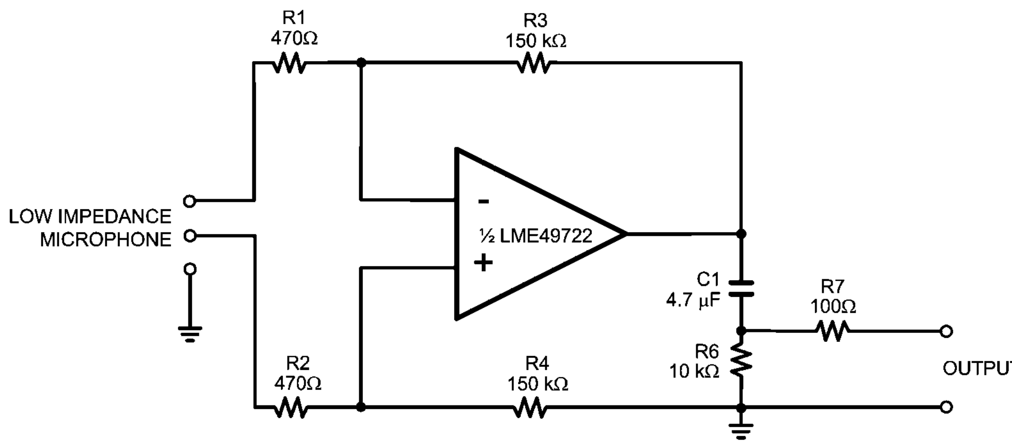

Full Power Bandwidth vs Frequency
$+V_{CC} = -V_{EE} = 15V, R_L = 2k\Omega$
0 dB = $1V_{PP}$
0
-10
-20
-30
-40
-50
MAGNITUDE (dB)
1 10 100 1k 10k 100k 1M 10M 100M
FREQUENCY (Hz)
30057919


Gain Phase vs Frequency
$+V_{CC} = -V_{EE} = 15V$
180
160
140
120
100
80
60
40
20
0
-20
GAIN (dB)
PHASE LAG (°)
10 100 1k 10k 100k 1M 10M 100M
FREQUENCY (Hz)
30057914

Application Information

APPLICATION HINTS

The LME49722 is a high speed operational amplifier which can operate stably in most of the applications. For the application with gain greater than 2, capacitive loads up to 100pF will cause little change in the phase characteristics of the amplifiers and are therefore allowable. Capacitive loads greater than 10pF must be isolated from the output, if the gain value is less than 2. The most straightforward way to do this is to put a resistor (its value ≥ 20Ω) in series with the output. The resistor will also prevent unnecessary power dissipation if the output is accidentally shorted.



- Total voltage noise density: $e_{N\_total}^2 \approx e_N^2 + e_{N\_R1}^2 + e_{N\_R2}^2 = 1.9^2 + 2\,(2.7^2)$, then $e_{N\_total} = 4.3\ nV/\sqrt{Hz}$. For $e_{N\_R1} = e_{N\_R2} \approx 2.7\ nV/\sqrt{Hz}$, if $R1 = R2 \approx 470\Omega$.
- Or total voltage noise = 0.13 µV input referred in a 1 kHz noise bandwidth.

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FIGURE 2. Low Impedance Microphone Pre-amplifier

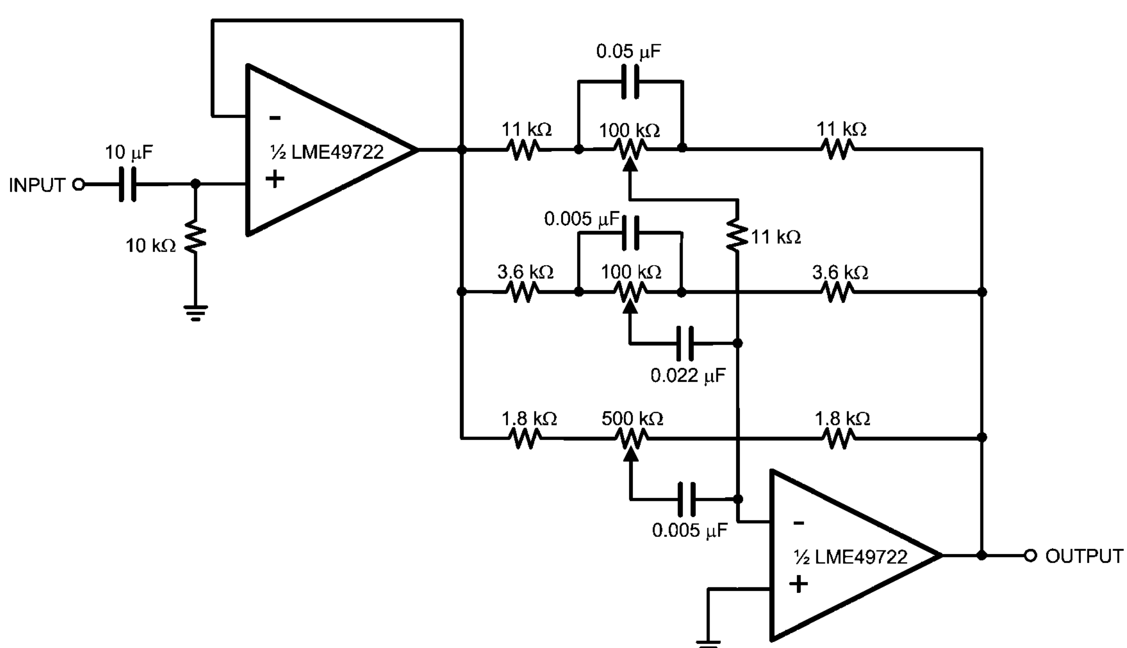

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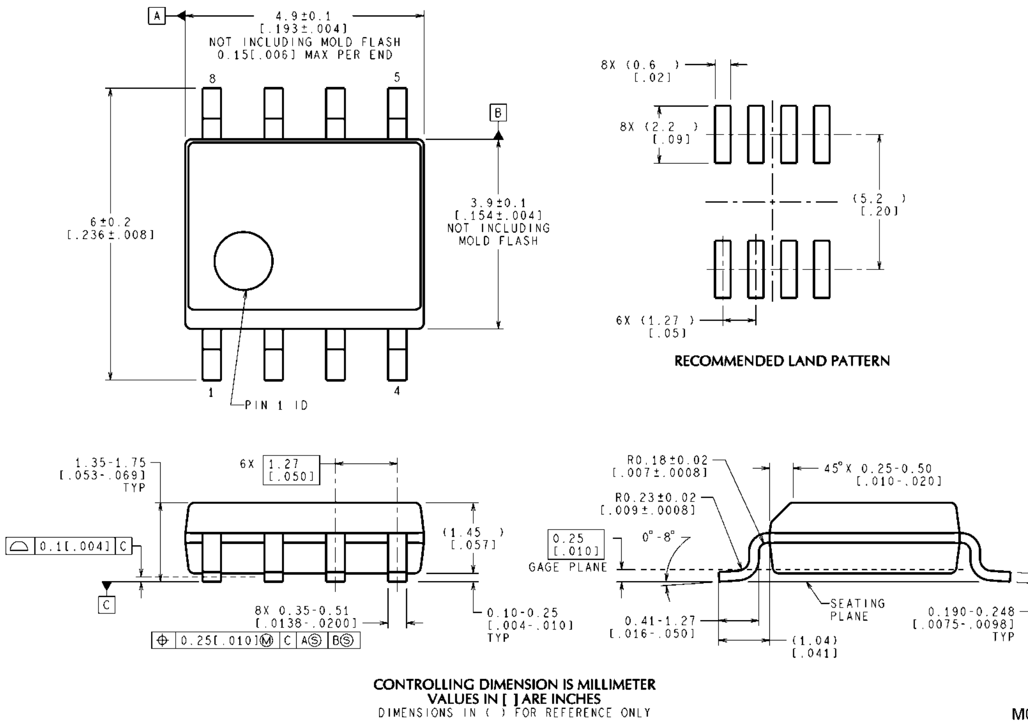
FIGURE 3. Three-Band Active Tone Control

Revision History

Rev	Date	Description
1.0	03/27/08	Initial release.

Physical Dimensions inches (millimeters) unless otherwise noted



M08A (Rev L)

Narrow SOIC Package
Order Number LME49722MA
NS Package Number M08A

Notes

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

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LIFE SUPPORT POLICY

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Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

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