LME49722

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

Literature Number: SNAS454

National Semiconductor

March 27, 2008

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

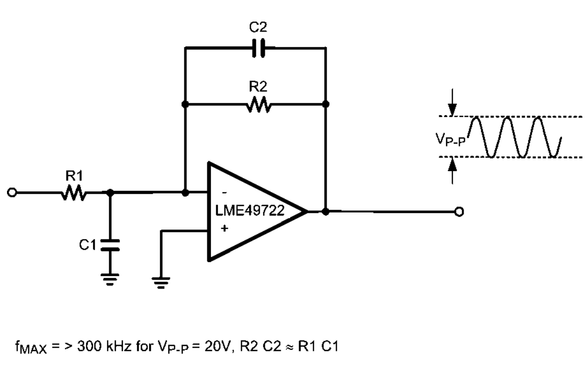
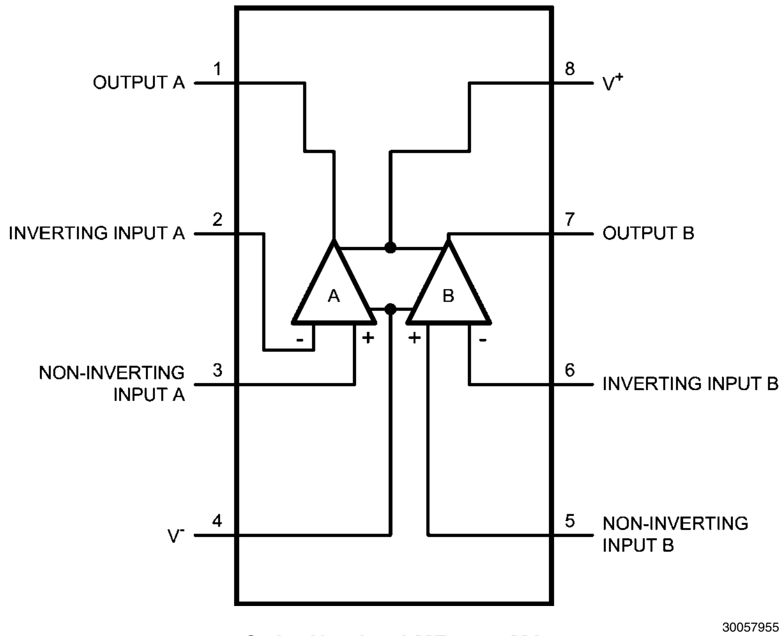


FIGURE 1. Wide Bandwidth Low Noise Low Drift Amplifier

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	
$T_{MIN} \le T_A \le T_{MAX}$	$-40°C \le T_A \le 85°C$
Supply Voltage Range	$\pm2.5V \le V_S \le \pm18V$

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	$-40°C \le T_A \le 85°C$	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		Units (Limits)
			Typical (Note 6)	Limit (Note 7)	
$V_{IN\text{-}CM}$	Common-Mode Input Voltage Range	V_S = ±15V	+14.0 –13.9	(V_{CC}) – 2.0 (V_{EE}) + 2.0	V (min) V (min)
		V_S = ±18V	+17.0 –16.9	(V_{CC}) – 2.0 (V_{EE}) + 2.0	V (min) V (min)
CMRR	Common-Mode Rejection	–10V ≤ V_{CM} ≤ 10V	128	110	dB (min)
Z_{IN}	Differential Input Impedance		30		kΩ
Z_{CM}	Common Mode Input Impedance	–10V ≤ V_{CM} ≤ 10V	1000		MΩ
A_{VOL}	Open Loop Voltage Gain	–12V ≤ V_{OUT} ≤ 12V, R_L = 600Ω –12V ≤ V_{OUT} ≤ 12V, R_L = 2kΩ –12V ≤ V_{OUT} ≤ 12V, R_L = 10kΩ	135 140 140	120	dB dB dB
V_{OM}	Output Voltage Swing	V_S = ±15V R_L = 600Ω R_L = 2kΩ R_L = 10kΩ	 +13.7/–14 ±14.0 ±14.1		 V_{PEAK} V_{PEAK} V_{PEAK}
		V_S = ±18V R_L = 600Ω R_L = 2kΩ R_L = 10kΩ	 +16.6/–16.8 ±17.0 ±17.1	±15.5	 V_{PEAK} (min) V_{PEAK} V_{PEAK}
I_{OUT}	Output Current	R_L = 600Ω V_S = ±15V V_S = ±18V	 ±23 ±27.6/–28	 ±23	 mA mA (min)
$I_{OUT\text{-}CC}$	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 = ±15V V_S = ±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.

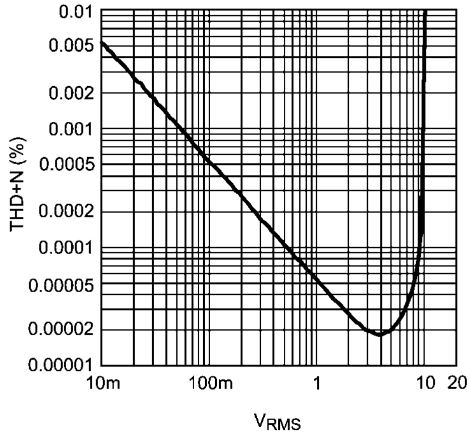
Note 6: Typical values represent most likely parametric norms at T_A = +25°C, and at the *Recommended Operation Conditions* at the time of product characterization and are not guaranteed.

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 = $| 20\log(\Delta V_{OS}/\Delta V_S) |$.

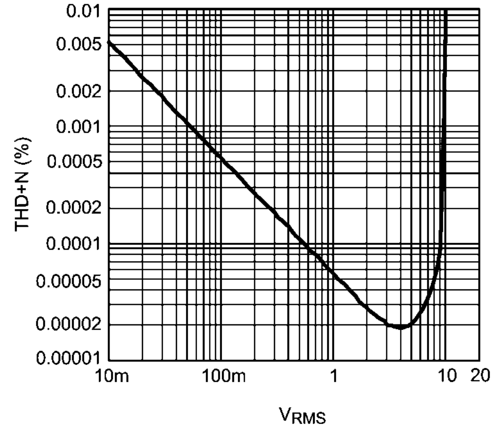
Typical Performance Characteristics

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



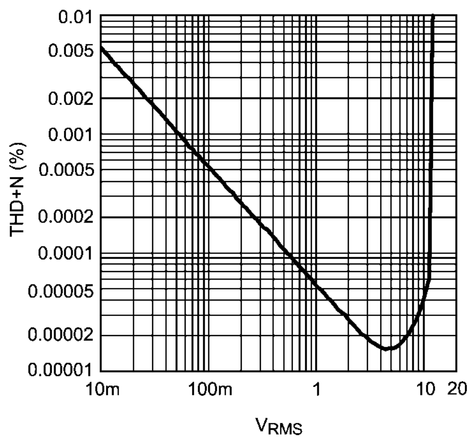
300579p5

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



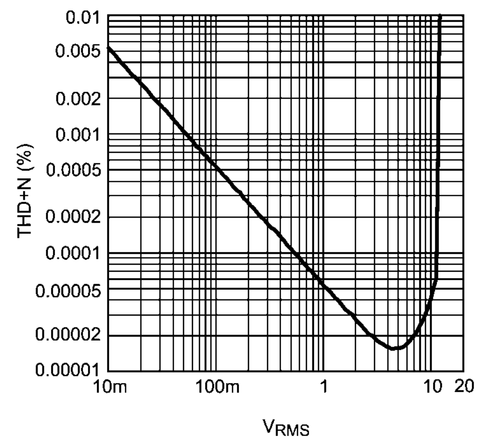
300579p6

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



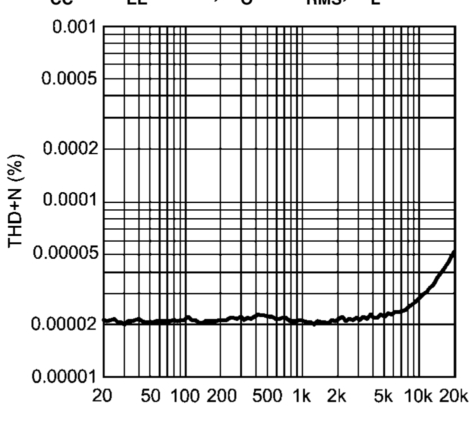
300579p7

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



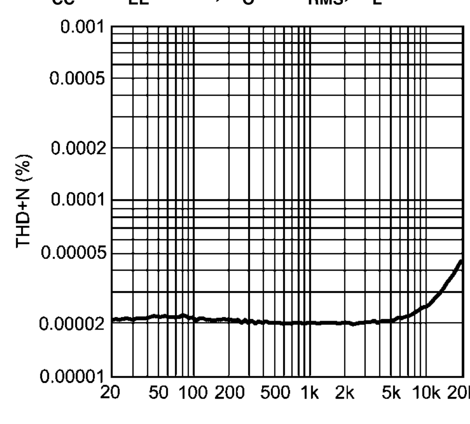
300579p8

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



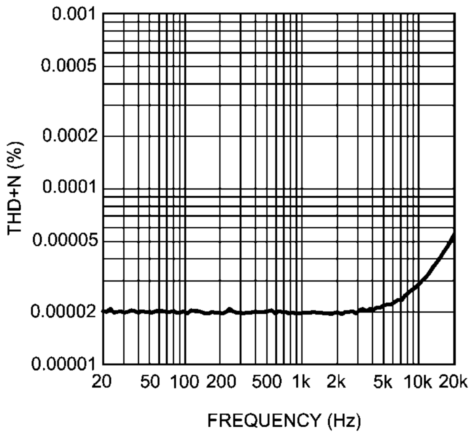
300579p1

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



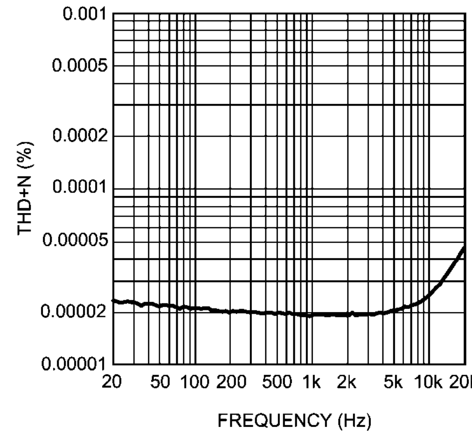
300579p2

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



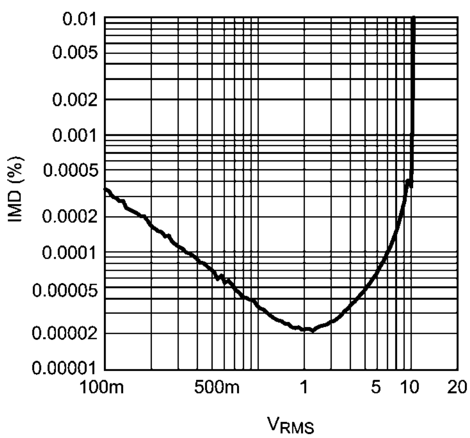
300579p3

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



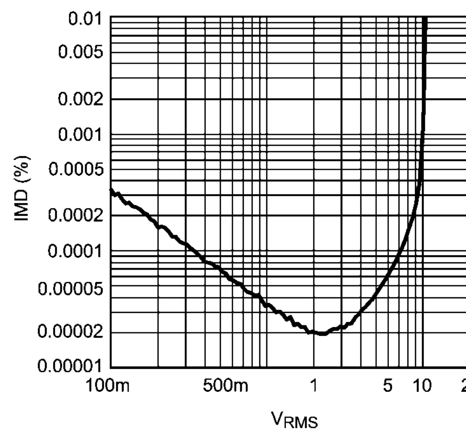
300579p4

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



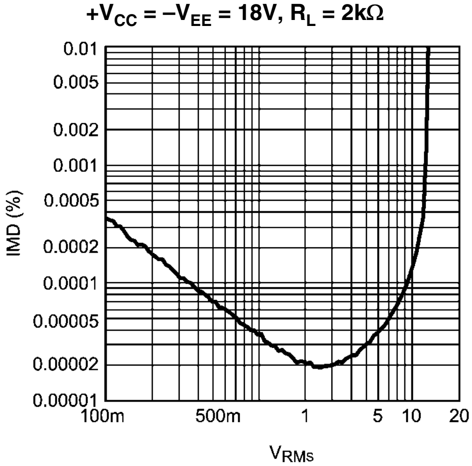
30057922

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



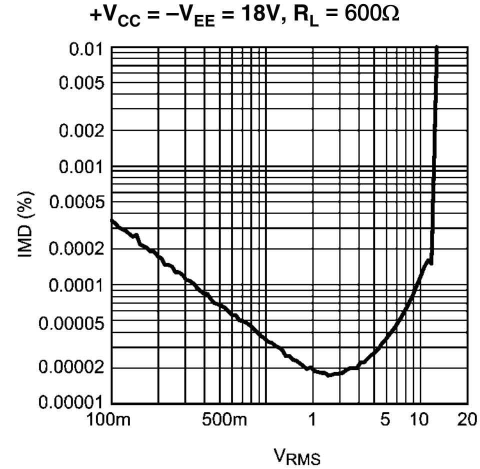
30057923

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



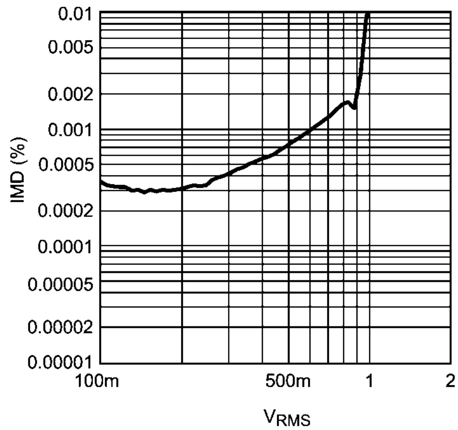
30057924

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



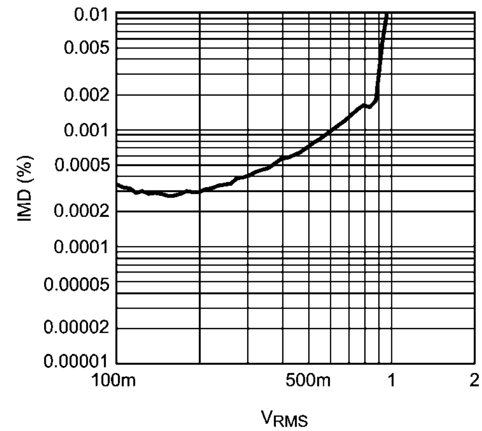
30057925

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



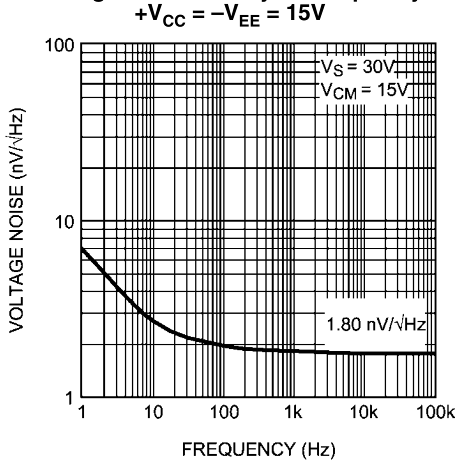
30057920

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



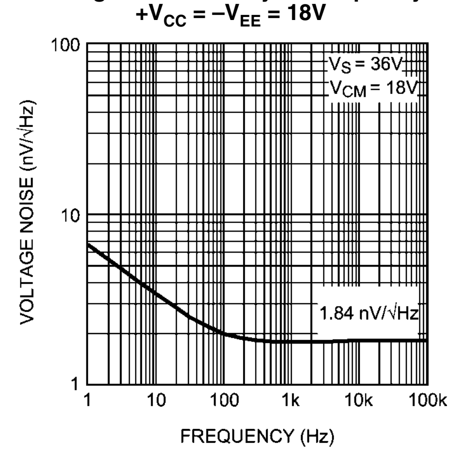
30057921

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



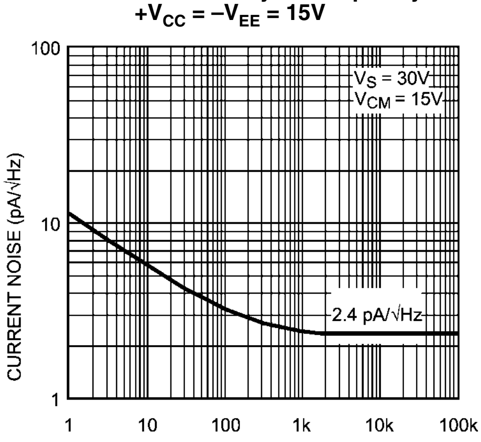
300579p9

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



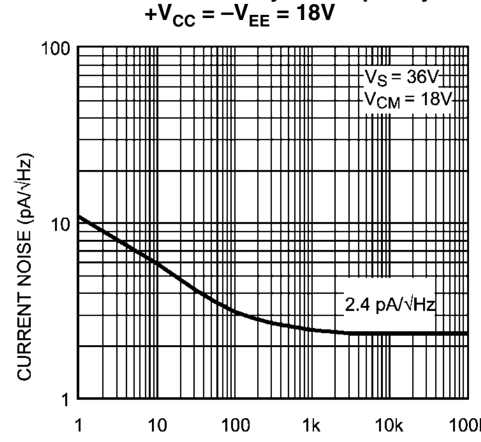
300579q0

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



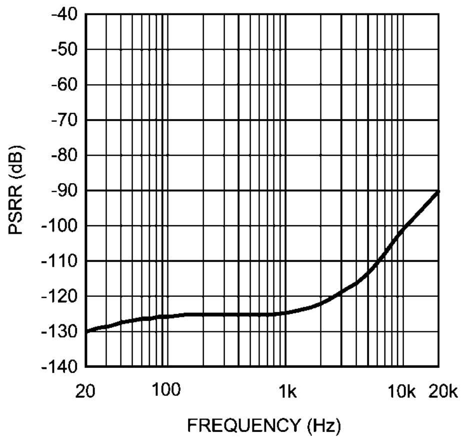
30057917

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



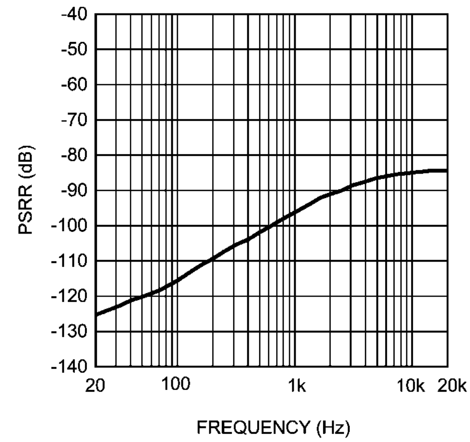
30057918

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



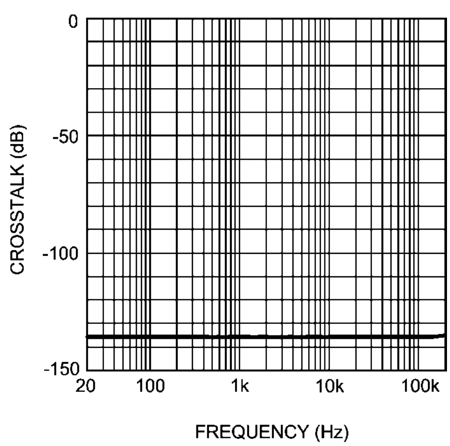
30057915

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



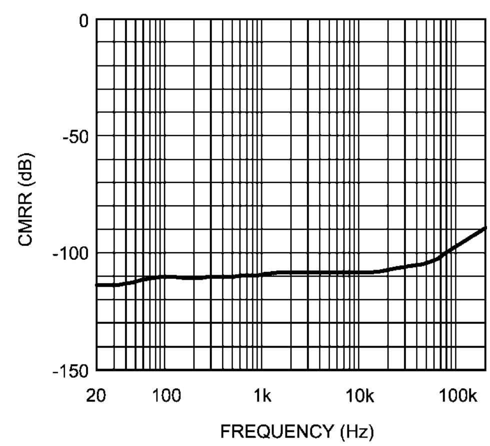
30057926

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



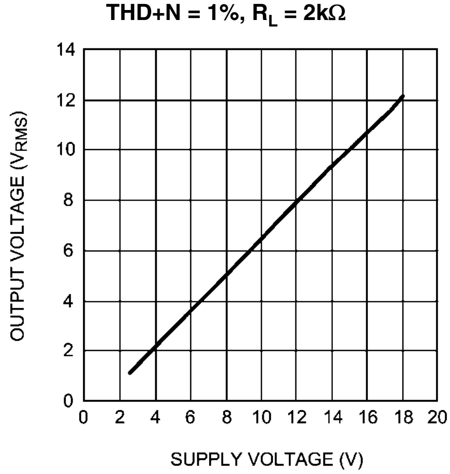
300579p0

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



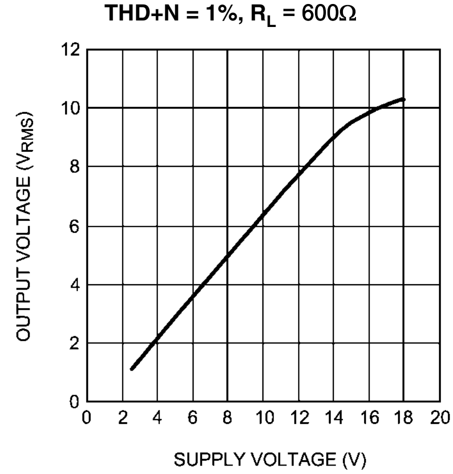
30057916

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



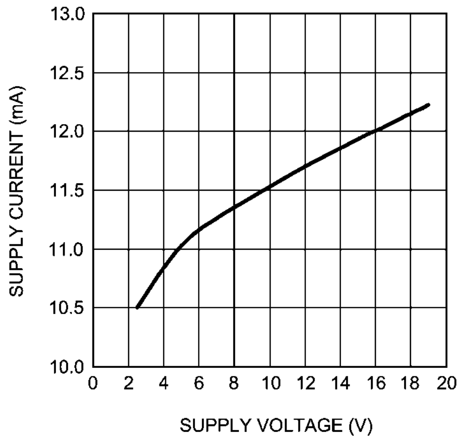
300579q1

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



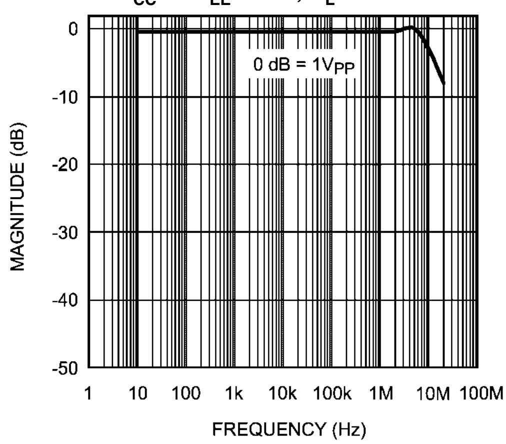
300579q2

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



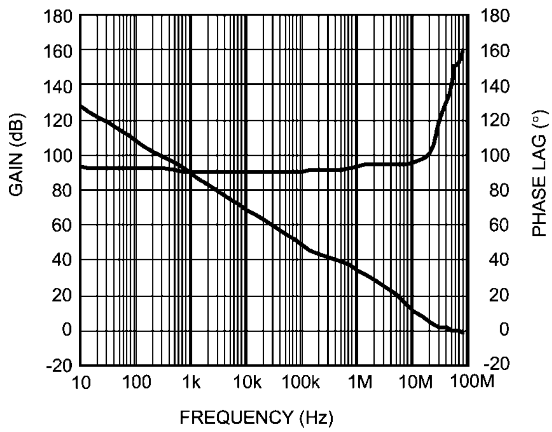
30057911

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



30057919

Gain Phase vs Frequency
$+V_{CC} = -V_{EE} = 15V$

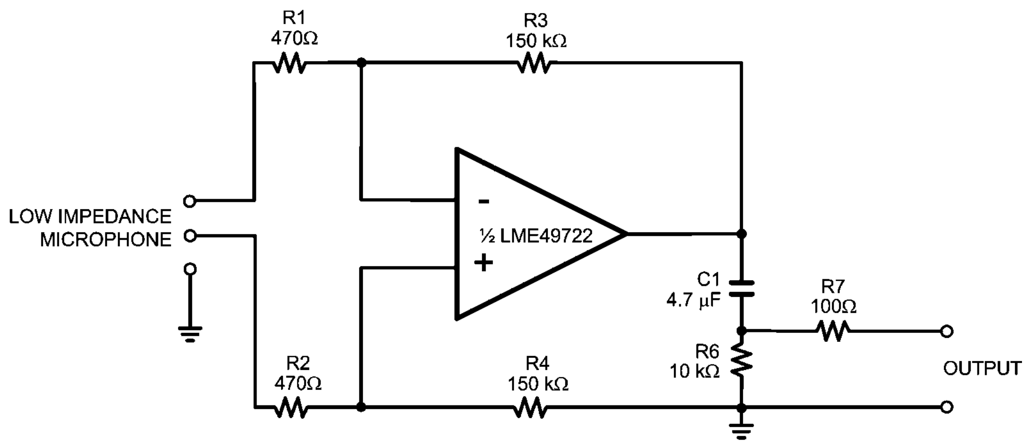


30057914

Application Information

APPLICATION HINTS

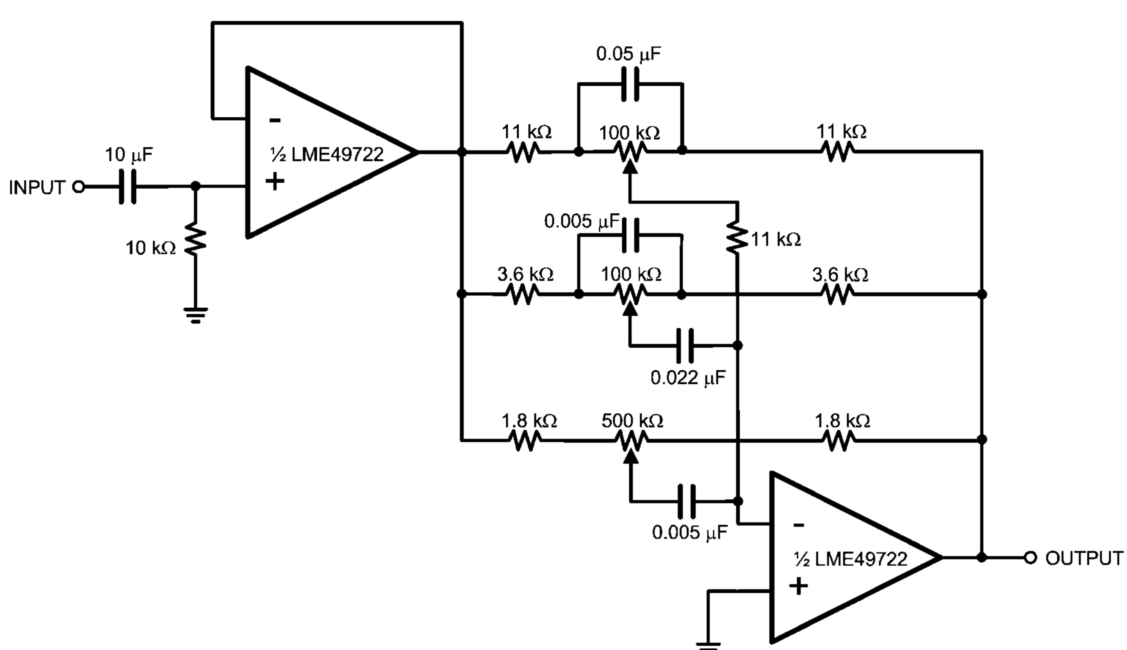
The LME49722 is a high speed operational amplifier which can operate stably in most of the applications. For the application with gain greater than 2, capacitive loads up to 100pF will cause little change in the phase characteristics of the amplifiers and are therefore allowable. Capacitive loads greater 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/√Hz. For $e_{N\_R1} = e_{N\_R2} \approx 2.7$ nV/√Hz, if R1 = R2 ≈ 470Ω.
- Or total voltage noise = 0.13 μV input referred in a 1 kHz noise bandwidth.

30057913

FIGURE 2. Low Impedance Microphone Pre-amplifier



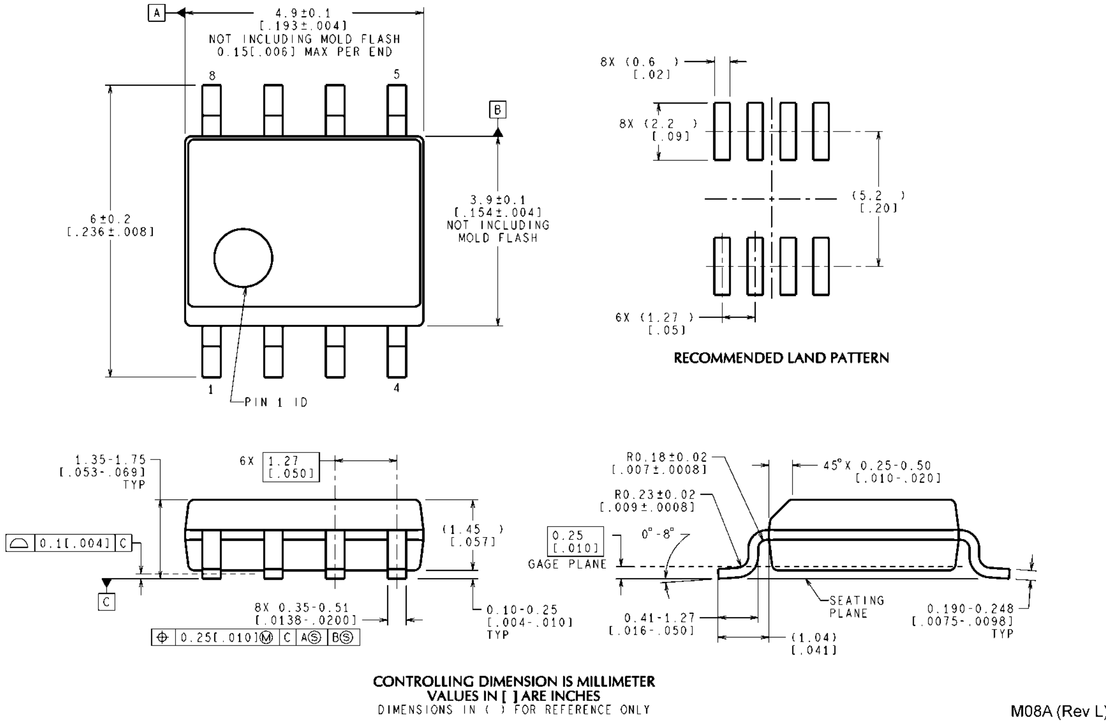
30057912

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



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:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH	www.national.com/webench
Audio	www.national.com/audio	Analog University	www.national.com/AU
Clock Conditioners	www.national.com/timing	App Notes	www.national.com/appnotes
Data Converters	www.national.com/adc	Distributors	www.national.com/contacts
Displays	www.national.com/displays	Green Compliance	www.national.com/quality/green
Ethernet	www.national.com/ethernet	Packaging	www.national.com/packaging
Interface	www.national.com/interface	Quality and Reliability	www.national.com/quality
LVDS	www.national.com/lvds	Reference Designs	www.national.com/refdesigns
Power Management	www.national.com/power	Feedback	www.national.com/feedback
Switching Regulators	www.national.com/switchers		
LDOs	www.national.com/ldo		
LED Lighting	www.national.com/led		
PowerWise	www.national.com/powerwise		
Serial Digital Interface (SDI)	www.national.com/sdi		
Temperature Sensors	www.national.com/tempsensors		
Wireless (PLL/VCO)	www.national.com/wireless		

For the most current product information visit us at www.national.com

National Semiconductor Americas Technical Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

National Semiconductor Europe Technical Support Center
Email: europe.support@nsc.com
German Tel: +49 (0) 180 5010 771
English Tel: +44 (0) 870 850 4288

National Semiconductor Asia Pacific Technical Support Center
Email: ap.support@nsc.com

National Semiconductor Japan Technical Support Center
Email: jpn.feedback@nsc.com