National Semiconductor

June 2007

LME49860
44V Dual High Performance, High Fidelity Audio Operational Amplifier

General Description

The LME49860 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 LME49860 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LME49860 combines extremely low voltage noise density (2.7nV/$\sqrt{Hz}$) 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 LME49860 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 LME49860's outstanding CMRR (120dB), PSRR (120dB), and V_{OS} (0.1mV) give the amplifier excellent operational amplifier DC performance.

The LME49860 has a wide supply range of ±2.5V to ±22V. Over this supply range the LME49860 maintains excellent common-mode rejection, power supply rejection, and low input bias current. The LME49860 is unity gain stable. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LME49860 is available in 8–lead narrow body SOIC and 8–lead Plastic DIP packages. Demonstration boards are available for each package.

Key Specifications

- Power Supply Voltage Range — ±2.5V to ±22V
- 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/$\sqrt{Hz}$ (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%

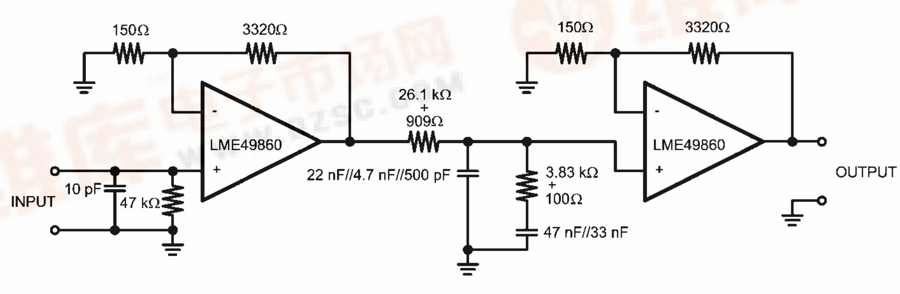
Features

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

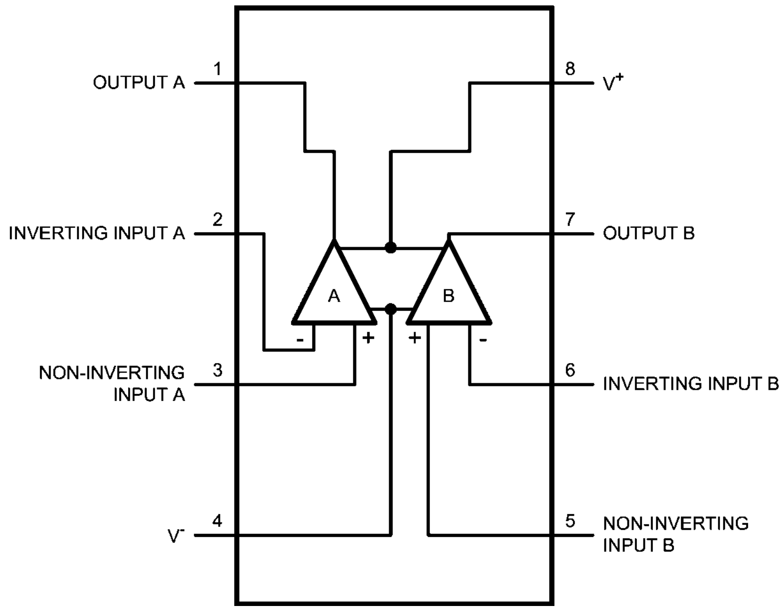
Typical Application



Passively Equalized RIAA Phono Preamplifier

Connection Diagrams

Dual-In-Line Package



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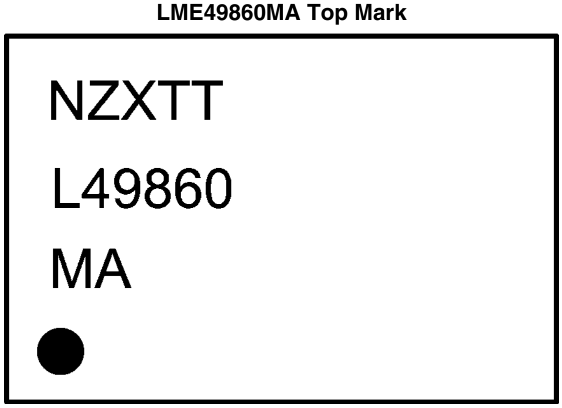
Order Number LME49860MA
See NS Package Number — M08A
Order Number LME49860NA
See NS Package Number — N08E

LME49860MA Top Mark



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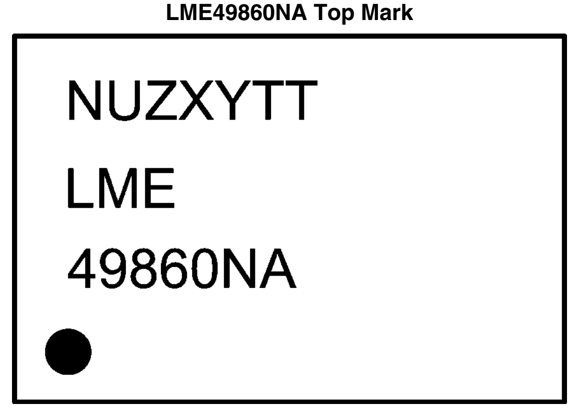
N — National Logo
Z — Assembly Plant code
X — 1 Digit Date code
TT — Die Traceability
L49860 — LME49860
MA — Package code

LME49860NA Top Mark



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N — National Logo
U — Fabrication code
Z — Assembly Plant code
XY — 2 Digit Date code
TT — Die Traceability
NA — Package code

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.

Power Supply Voltage (V_S = V+ - V-)	46V
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)	
Pins 1, 4, 7 and 8	200V
Pins 2, 3, 5 and 6	100V
Junction Temperature	150°C
Thermal Resistance	
θ_{JA} (SO)	145°C/W
θ_{JA} (NA)	102°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	$\pm 2.5V \le V_S \le \pm 22V$

Electrical Characteristics for the LME49860 (Note 1)

The following specifications apply for V_S = ±18V and ±22V, R_L = 2kΩ, R_{SOURCE} = 10Ω, f_{IN} = 1kHz, T_A = 25°C, unless otherwise specified.

Symbol	Parameter	Conditions	LME49860 Typical (Note 6)	LME49860 Limit (Note 7)	Units (Limits)
THD+N	Total Harmonic Distortion + Noise	A_V = 1, V_{OUT} = $3V_{rms}$ R_L = 2kΩ R_L = 600Ω	 0.00003 0.00003	 0.00009	% (max)
IMD	Intermodulation Distortion	A_V = 1, V_{OUT} = $3V_{RMS}$ Two-tone, 60Hz & 7kHz 4:1	0.00005		%
GBWP	Gain Bandwidth Product		55	45	MHz (min)
SR	Slew Rate		±20	±15	V/μs (min)
FPBW	Full Power Bandwidth	V_{OUT} = $1V_{P-P}$, −3dB referenced to output magnitude at f = 1kHz	10		MHz
t_s	Settling time	A_V = −1, 10V step, C_L = 100pF 0.1% error range	1.2		μs
e_n	Equivalent Input Noise Voltage	f_{BW} = 20Hz to 20kHz	0.34	0.65	μV_{RMS} (max)
	Equivalent Input Noise Density	f = 1kHz f = 10Hz	2.7 6.4	4.7	$nV/\sqrt{Hz}$ (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		$pA/\sqrt{Hz}$
V_{OS}	Offset Voltage	V_S = ±18V	±0.12	±0.7	mV (max)
		V_S = ±22V	±0.14	±0.7	mV (max)
$\Delta V_{OS}/\Delta Temp$	Average Input Offset Voltage Drift vs Temperature	$-40°C \le T_A \le 85°C$	0.2		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	(Note 8) V_S = ±18V, ΔV_S = 24V V_S = ±22V, ΔV_S = 30V	 120 120	 110	 dB dB (min)
ISO_{CH-CH}	Channel-to-Channel Isolation	f_{IN} = 1kHz f_{IN} = 20kHz	118 112		dB
I_B	Input Bias Current	V_{CM} = 0V	10	72	nA (max)
$\Delta I_{OS}/\Delta Temp$	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	11	65	nA (max)
V_{IN-CM}	Common-Mode Input Voltage Range	V_S = ±18V	+17.1 −16.9	(V+) − 2.0 (V-) + 2.0	V (min) V (min)
		V_S = ±22V	+21.0 −20.8	(V+) − 2.0 (V-) + 2.0	V (min) V (min)

Symbol	Parameter	Conditions	LME49860		Units (Limits)
			Typical (Note 6)	Limit (Note 7)	
CMRR	Common-Mode Rejection	V_S = ±18V -12V ≤ V_{CM} ≤ 12V	120		dB
		V_S = ±22V -15V ≤ V_{CM} ≤ 15V	120	110	dB (min)
Z_{IN}	Differential Input Impedance		30		kΩ
	Common Mode Input Impedance	–10V<Vcm<10V	1000		MΩ
A_{VOL}	Open Loop Voltage Gain	V_S = ±18V –12V≤Vout≤12V R_L = 600Ω R_L = 2kΩ R_L = 10kΩ	140 140 140		dB dB dB
		V_S = ±22V –15V≤Vout≤15V R_L = 600Ω R_L = 2kΩ R_L = 10kΩ	140 140 140	125	dB (min) dB dB
V_{OUTMAX}	Maximum Output Voltage Swing	R_L = 600Ω V_S = ±18V V_S = ±22V	±16.7 ±20.4	±19.0	V V (min)
		R_L = 2kΩ V_S = ±18V V_S = ±22V	±17.0 ±21.0		V V
		R_L = 10kΩ V_S = ±18V V_S = ±22V	±17.1 ±21.2		V V
I_{OUT}	Output Current	R_L = 600Ω V_S = ±20V V_S = ±22V	±31 ±37	±30	mA mA (min)
I_{OUT-CC}	Instantaneous Short Circuit Current		+53 –42		mA
R_{OUT}	Output Impedance	f_{IN} = 10kHz Closed-Loop Open-Loop	0.01 13		Ω
C_{LOAD}	Capacitive Load Drive Overshoot	100pF	16		%
I_S	Total Quiescent Current	I_{OUT} = 0mA V_S = ±18V V_S = ±22V	10.2 10.5	13	mA mA (max)

Note 1: *Absolute Maximum Ratings* indicate limits beyond which damage to the device may occur.

Note 2: Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 3: Amplifier output connected to GND, any number of amplifiers within a package.

Note 4: Human body model, 100pF discharged through a 1.5kΩ resistor.

Note 5: 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).

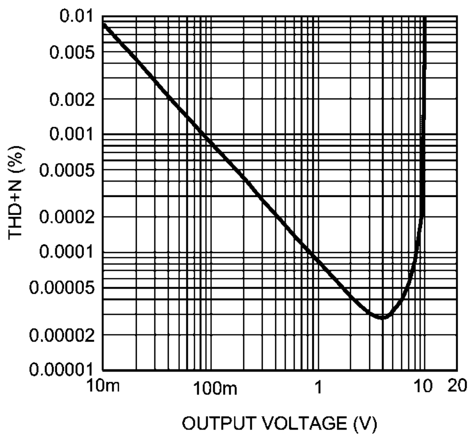
Note 6: Typical specifications are specified at +25ºC and represent the most likely parametric norm.

Note 7: Tested limits are guaranteed to National's AOQL (Average Outgoing Quality Level).

Note 8: PSRR is measured as follows: For V_S = ±22V, V_{OS} is measured at two supply voltages, ±7V and ±22V. PSRR = $\mid 20\log(\Delta V_{OS}/\Delta V_S) \mid$.

Typical Performance Characteristics

THD+N vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 2kΩ



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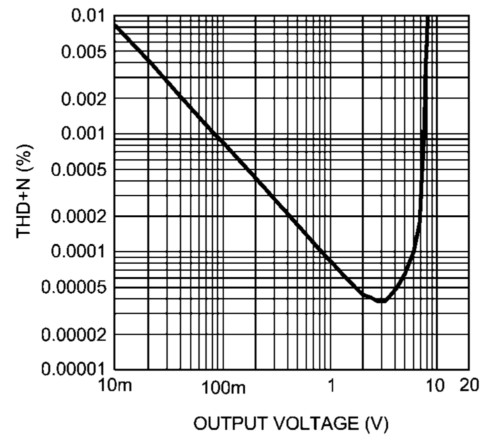
THD+N vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ



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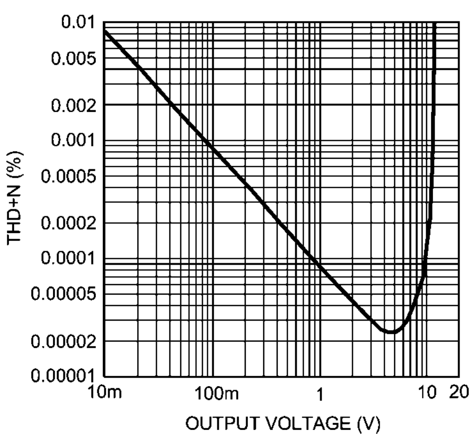
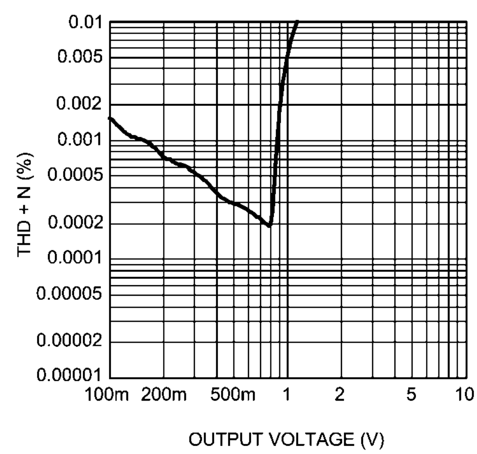
THD+N vs Output Voltage
V_{CC} = 22V, V_{EE} = –22V
R_L = 2kΩ



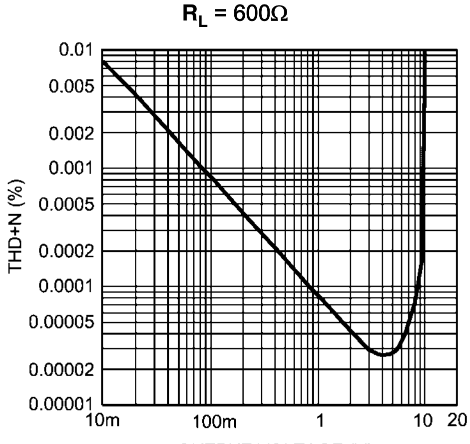
202151k8

THD+N vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ



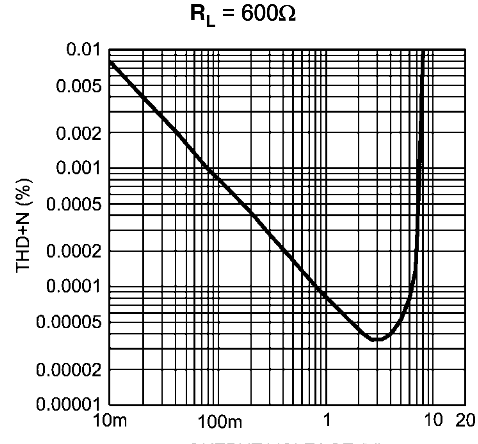
202151i4

THD+N vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 600Ω



202151k9

THD+N vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 600Ω



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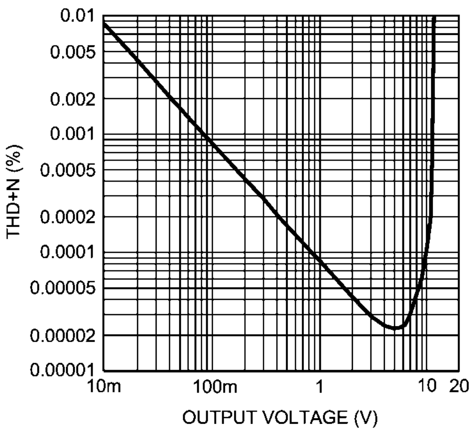
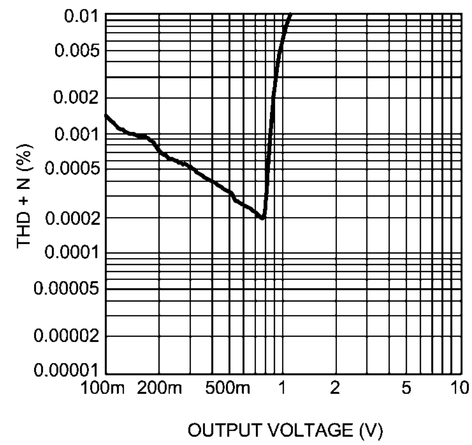
THD+N vs Output Voltage
V_{CC} = 22V, V_{EE} = –22V
R_L = 600Ω



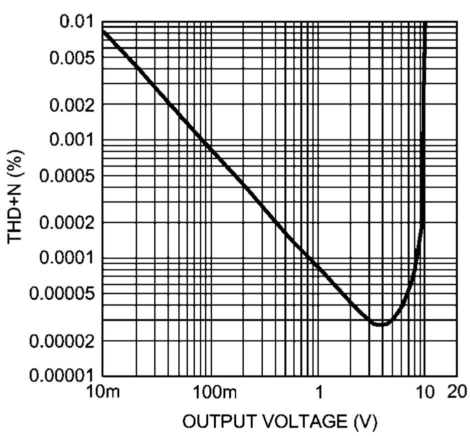
202151I1

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



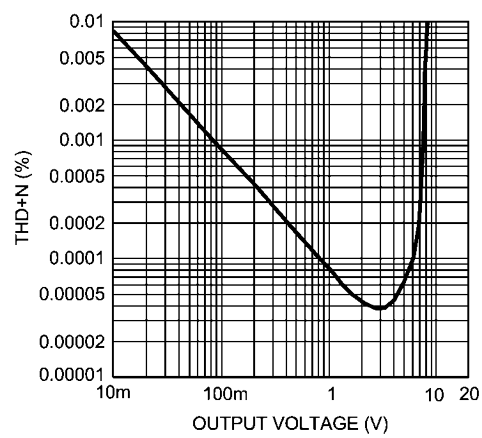
202151i6

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



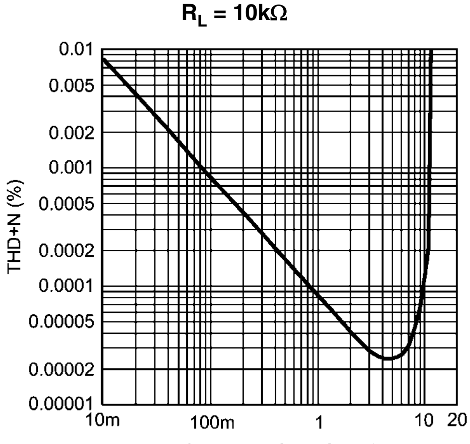
202151I2

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



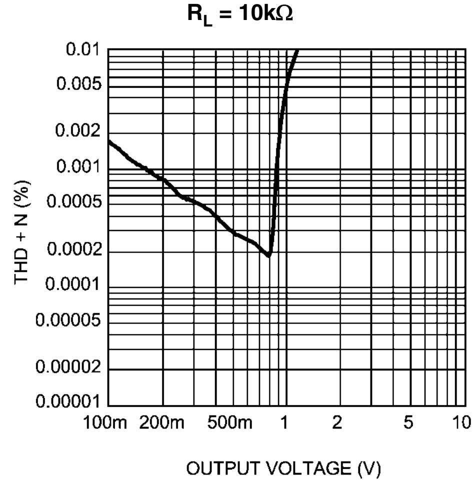
202151I3

THD+N vs Output Voltage
V_{CC} = 22V, V_{EE} = –22V
R_L = 10kΩ



202151I4

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



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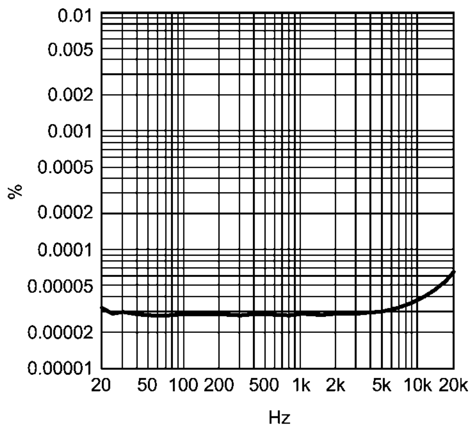
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 3V_{RMS}
R_L = 2kΩ



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THD+N vs Frequency
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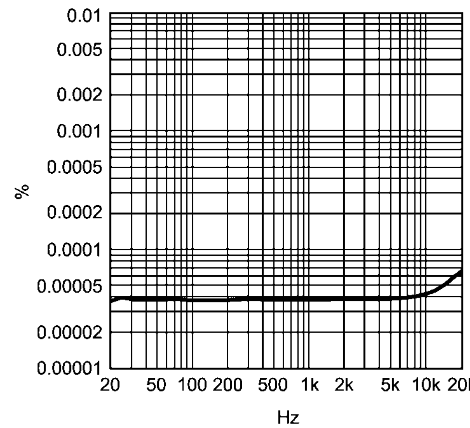
R_L = 2kΩ



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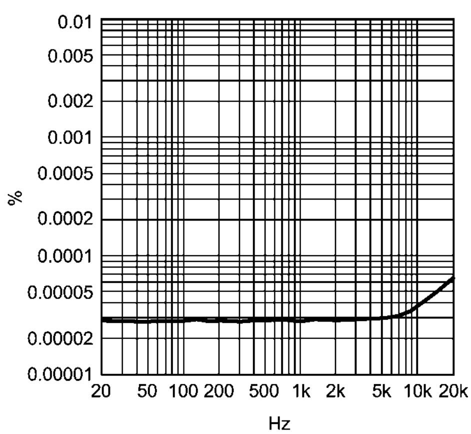
THD+N vs Frequency
V_{CC} = 22V, V_{EE} = –22V, V_{OUT} = 3V_{RMS}
R_L = 2kΩ



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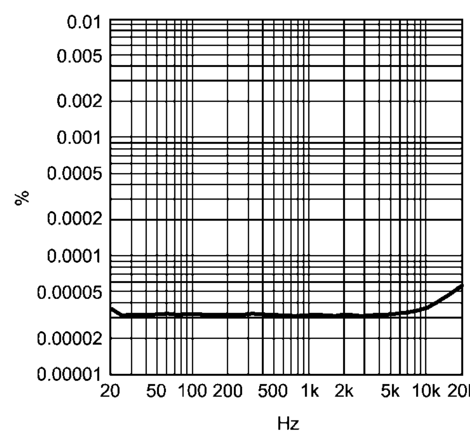
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 3V_{RMS}
R_L = 600Ω



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THD+N vs Frequency
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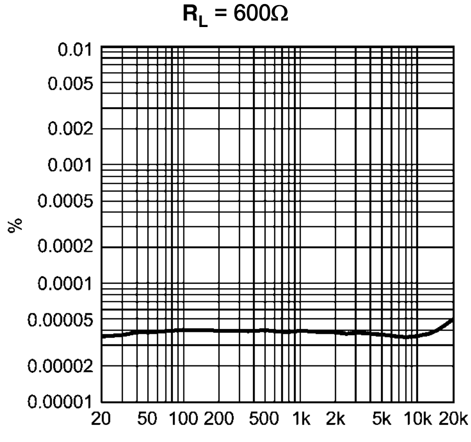
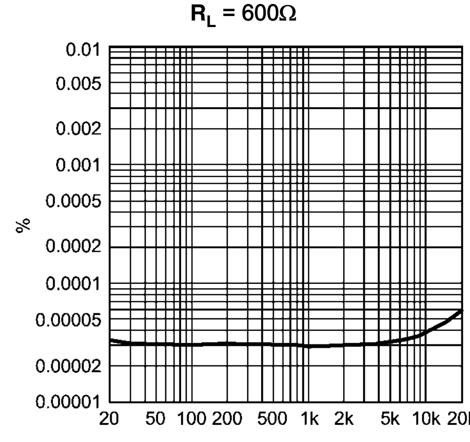
R_L = 600Ω



202151k3

THD+N vs Frequency
V_{CC} = 22V, V_{EE} = –22V, V_{OUT} = 3V_{RMS}
R_L = 600Ω



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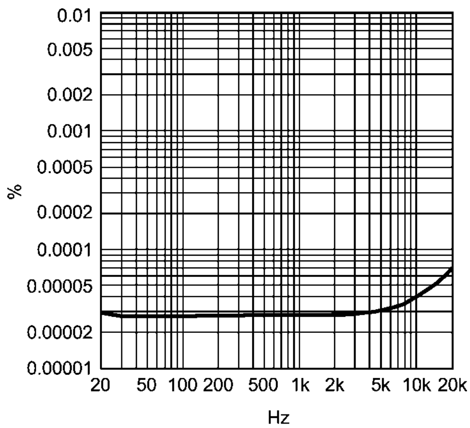
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 3V_{RMS}
R_L = 10kΩ



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THD+N vs Frequency
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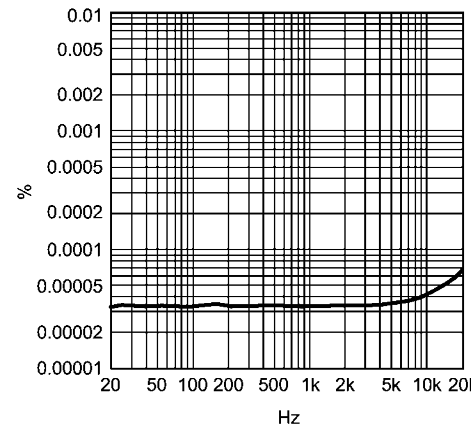
R_L = 10kΩ



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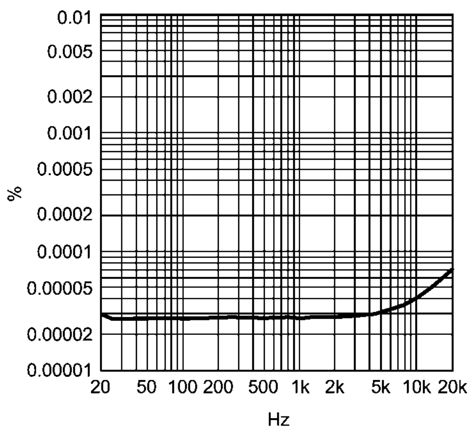
THD+N vs Frequency
V_{CC} = 22V, V_{EE} = –22V, V_{OUT} = 3V_{RMS}
R_L = 10kΩ



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IMD vs Output Voltage
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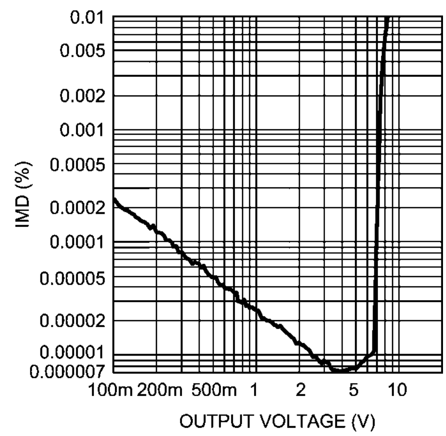
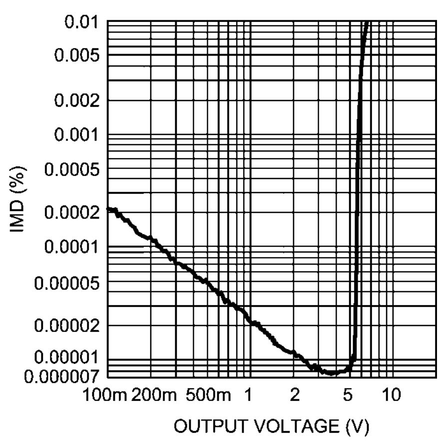
R_L = 2kΩ



202151e6

IMD vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ



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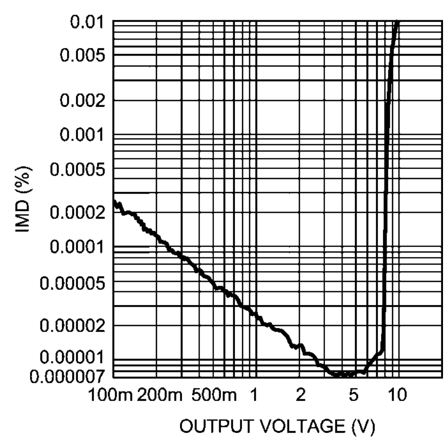
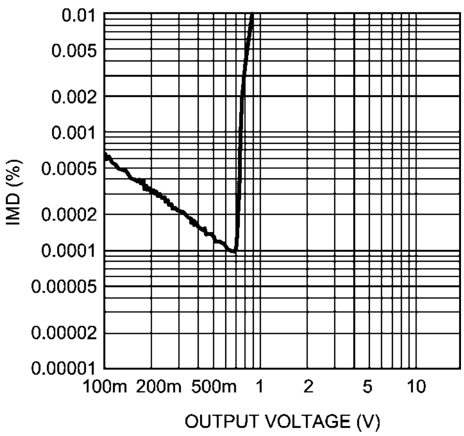
IMD vs Output Voltage
V_{CC} = 22V, V_{EE} = –22V
R_L = 2kΩ



202151e7

IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ



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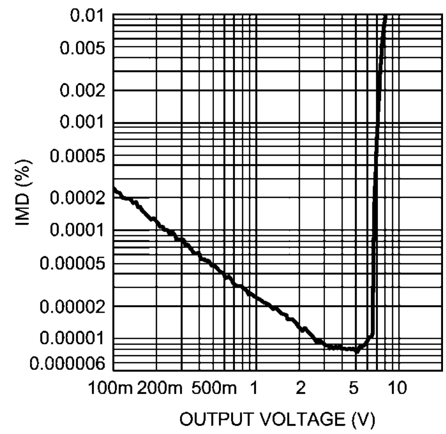
IMD vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 600Ω



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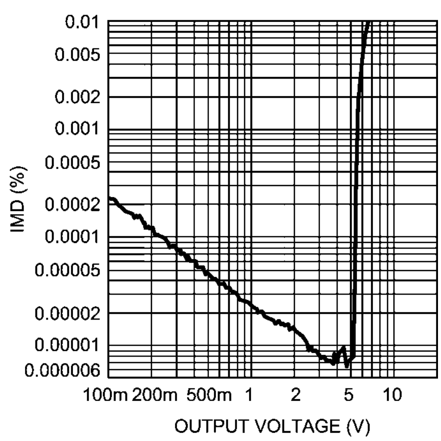
IMD vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 600Ω



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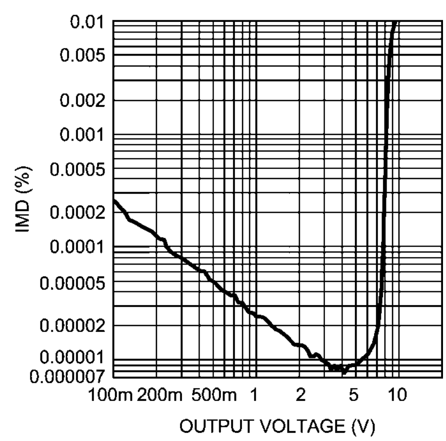
IMD vs Output Voltage
V_{CC} = 22V, V_{EE} = –22V
R_L = 600Ω



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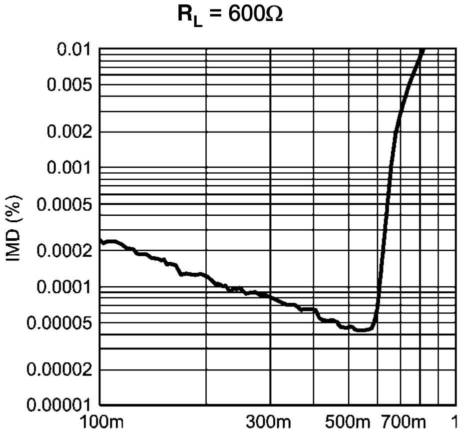
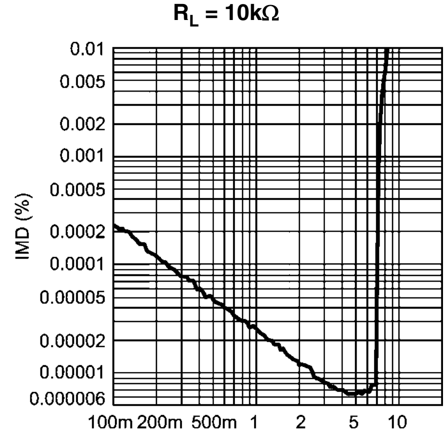
IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 600Ω



202151e1

IMD vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 10kΩ



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IMD vs Output Voltage
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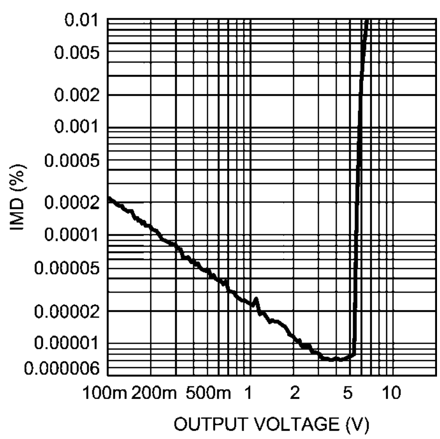
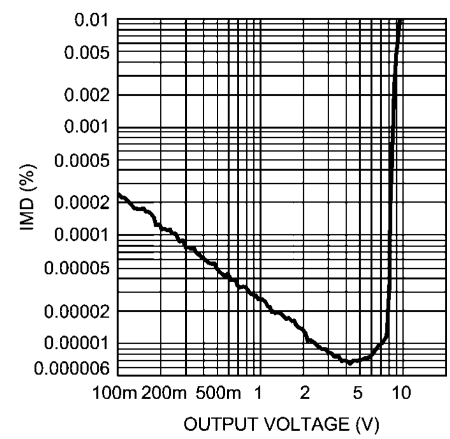
R_L = 10kΩ



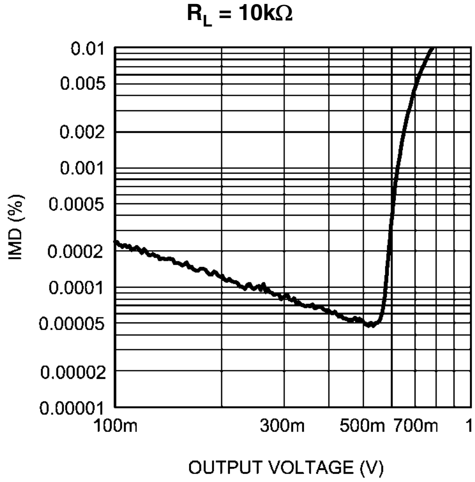
202151f0

IMD vs Output Voltage
V_{CC} = 22V, V_{EE} = –22V
R_L = 10kΩ



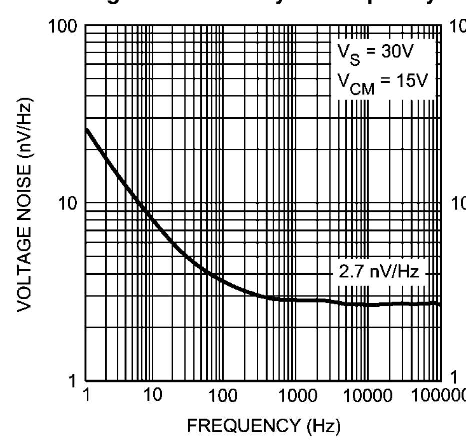
202151f2

IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 10kΩ



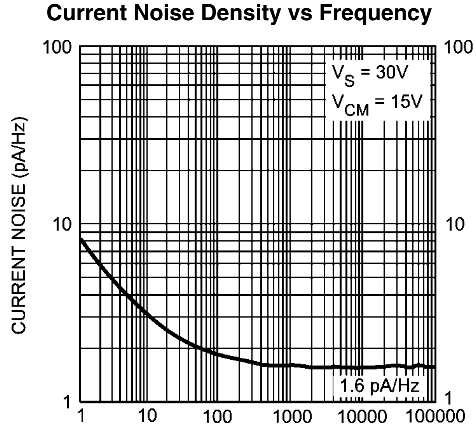
202151l6

Voltage Noise Density vs Frequency



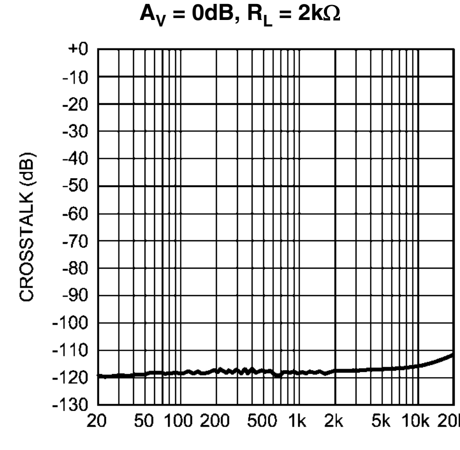
202151h6

Current Noise Density vs Frequency



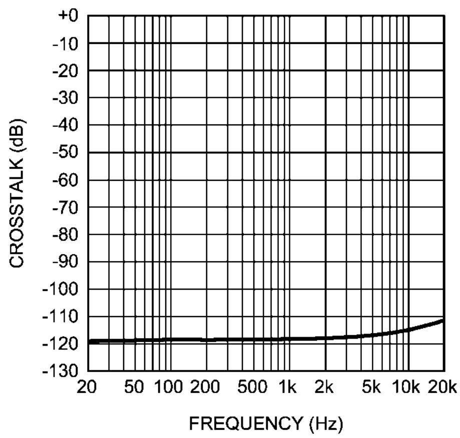
202151h7

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = $3V_{RMS}$
A_V = 0dB, R_L = 2kΩ



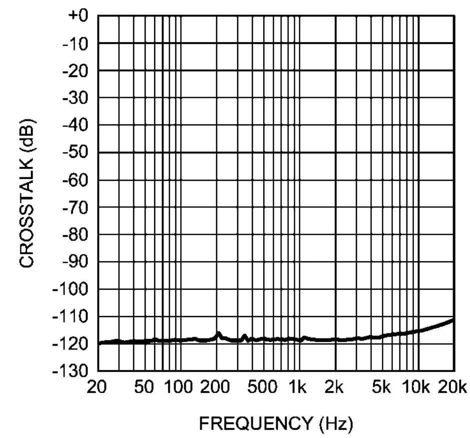
202151c8

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 2kΩ



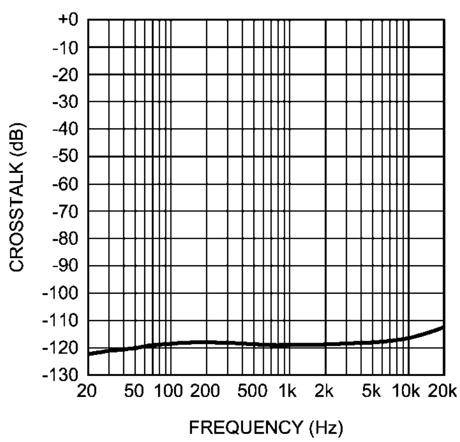
202151c9

Crosstalk vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 2kΩ



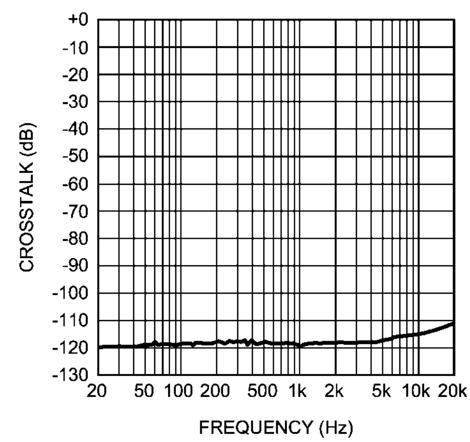
202151c6

Crosstalk vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 2kΩ



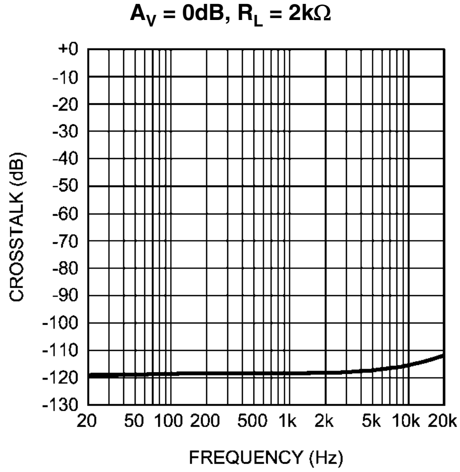
202151c7

Crosstalk vs Frequency
V_{CC} = 22V, V_{EE} = –22V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 2kΩ



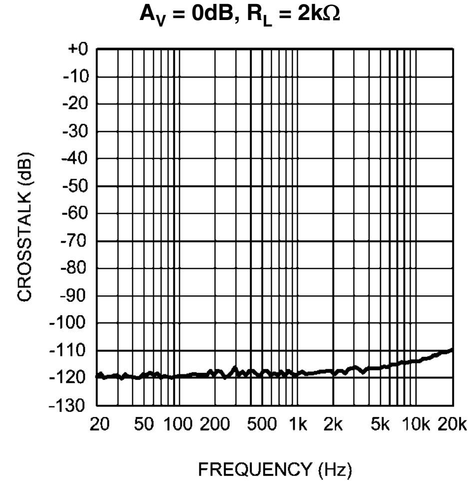
202151d0

Crosstalk vs Frequency
V_{CC} = 22V, V_{EE} = –22V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 2kΩ



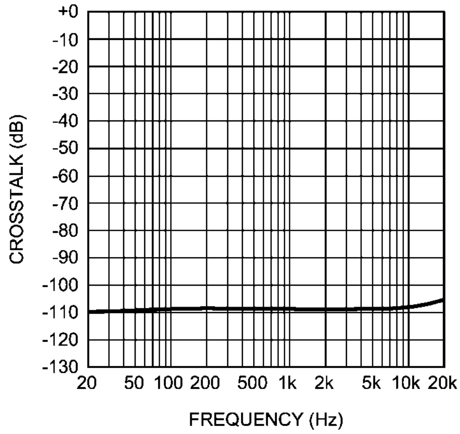
202151d1

Crosstalk vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, V_{OUT} = 1V_{RMS}
A_V = 0dB, R_L = 2kΩ



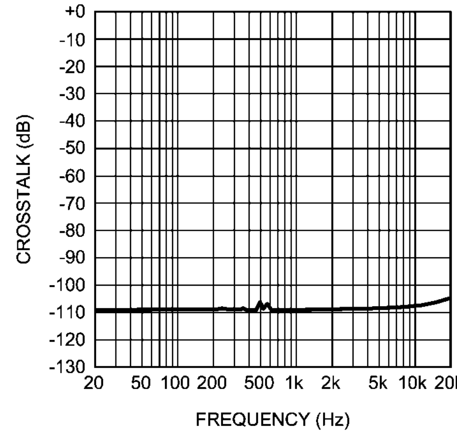
202151n8

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = −15V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 600Ω



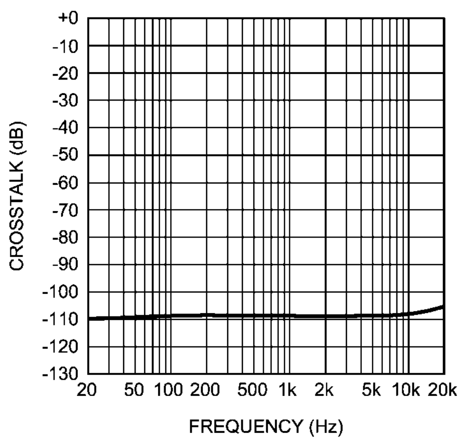
202151d6

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = −15V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 600Ω



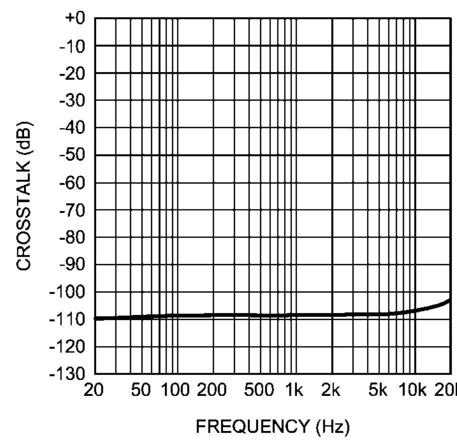
202151d7

Crosstalk vs Frequency
V_{CC} = 12V, V_{EE} = −12V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 600Ω



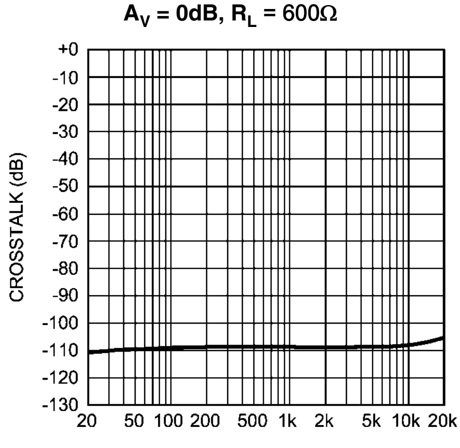
202151d4

Crosstalk vs Frequency
V_{CC} = 12V, V_{EE} = −12V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 600Ω



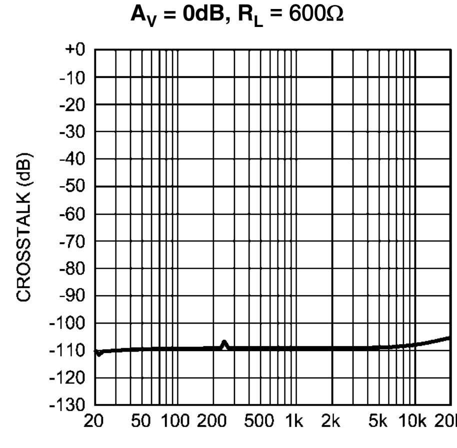
202151d5

Crosstalk vs Frequency
V_{CC} = 22V, V_{EE} = −22V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 600Ω



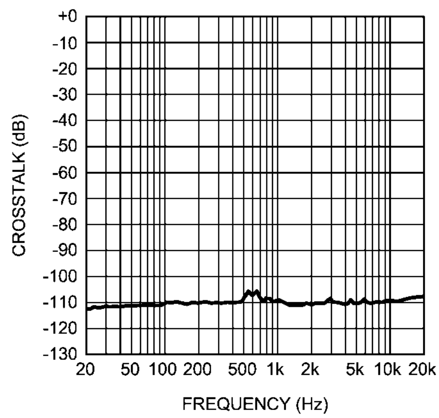
202151d8

Crosstalk vs Frequency
V_{CC} = 22V, V_{EE} = −22V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 600Ω



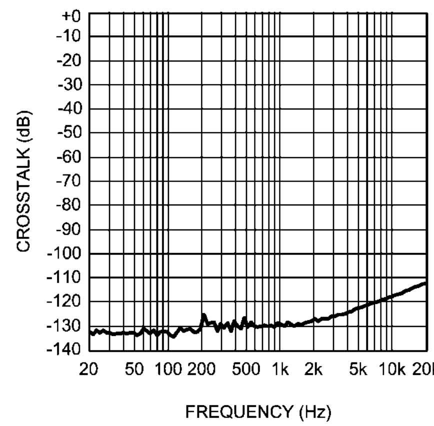
202151d9

Crosstalk vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, V_{OUT} = 1V_{RMS}
A_V = 0dB, R_L = 600Ω



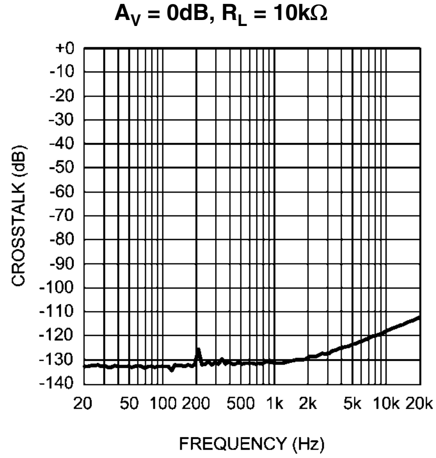
202151d2

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 10kΩ



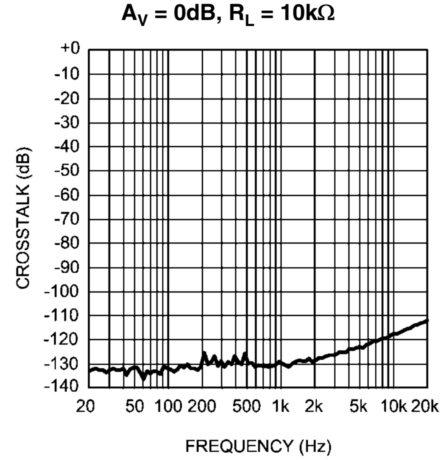
202151o0

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 10kΩ



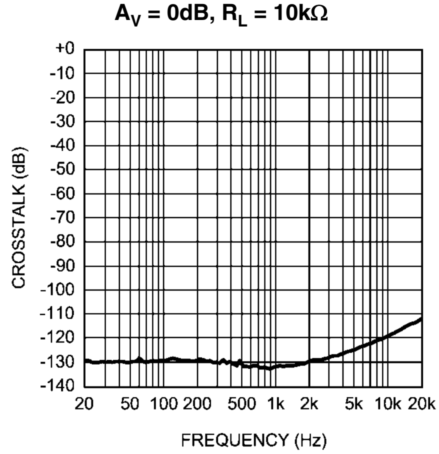
202151n7

Crosstalk vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 10kΩ



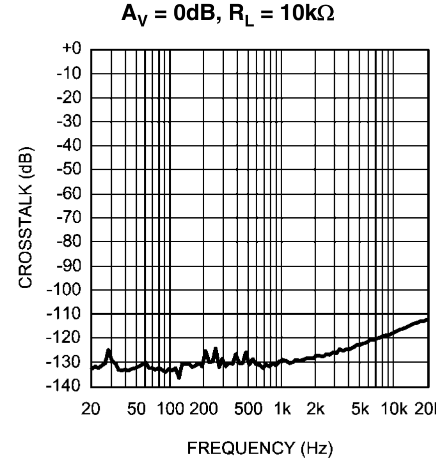
202151n9

Crosstalk vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 10kΩ



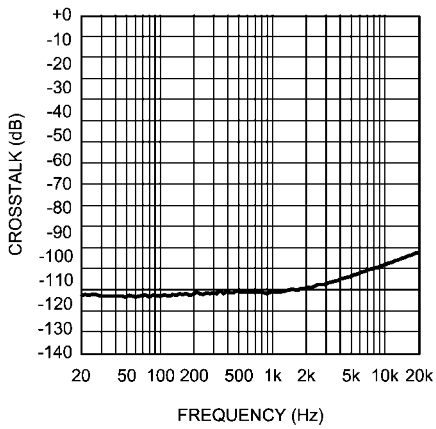
202151n6

Crosstalk vs Frequency
V_{CC} = 22V, V_{EE} = –22V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 10kΩ



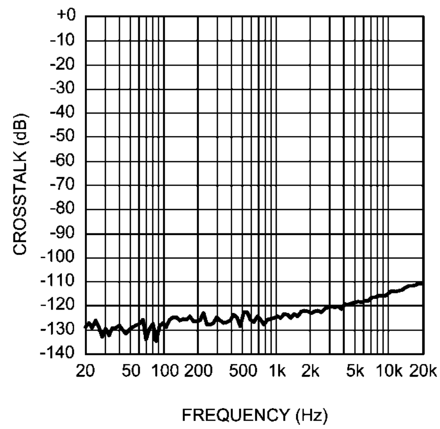
202151n5

Crosstalk vs Frequency
V_{CC} = 22V, V_{EE} = −22V, V_{OUT} = $10V_{RMS}$
A_V = 0dB, R_L = 10kΩ



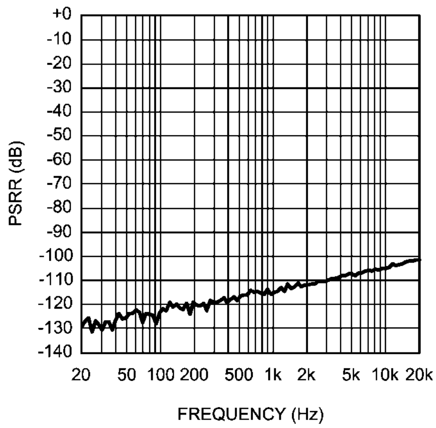
202151n3

Crosstalk vs Frequency
V_{CC} = 2.5V, V_{EE} = −2.5V, V_{OUT} = $1V_{RMS}$
A_V = 0dB, R_L = 10kΩ



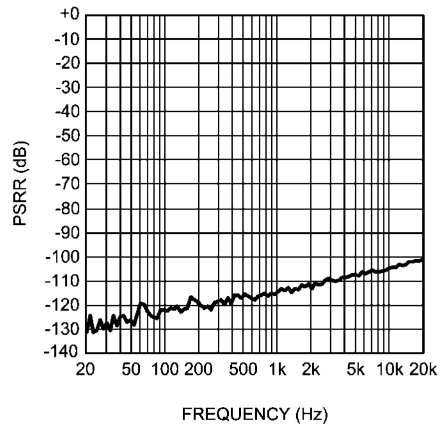
202151n4

PSRR+ vs Frequency
V_{CC} = 15V, V_{EE} = −15V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



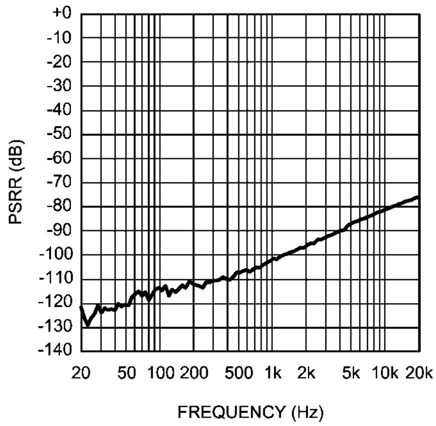
202151o1

PSRR- vs Frequency
V_{CC} = 15V, V_{EE} = −15V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



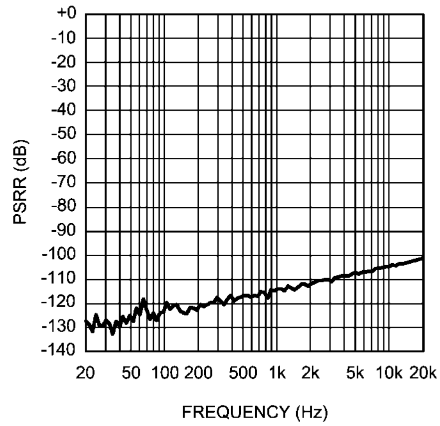
202151n2

PSRR+ vs Frequency
V_{CC} = 12V, V_{EE} = −12V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



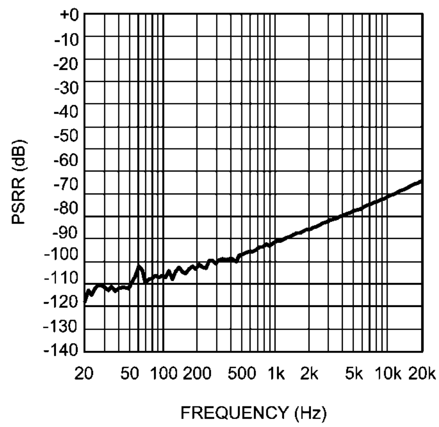
202151n1

PSRR- vs Frequency
V_{CC} = 12V, V_{EE} = −12V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



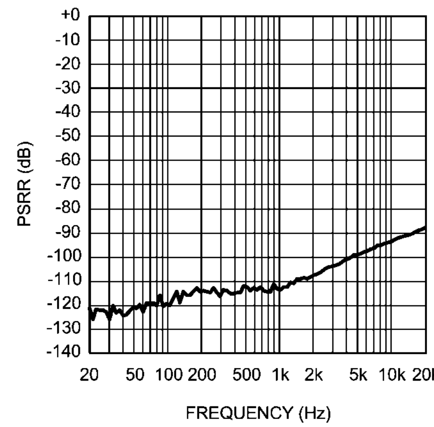
202151n0

PSRR+ vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



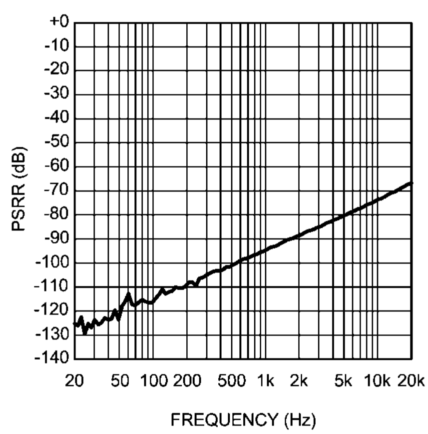
202151m9

PSRR- vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



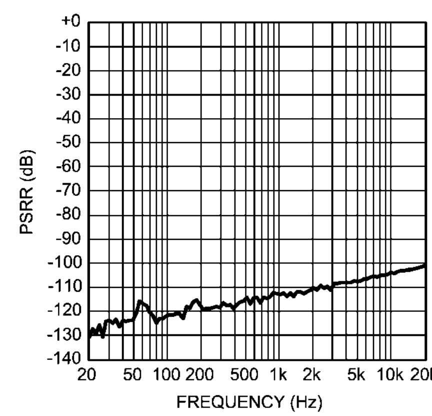
202151o3

PSRR+ vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



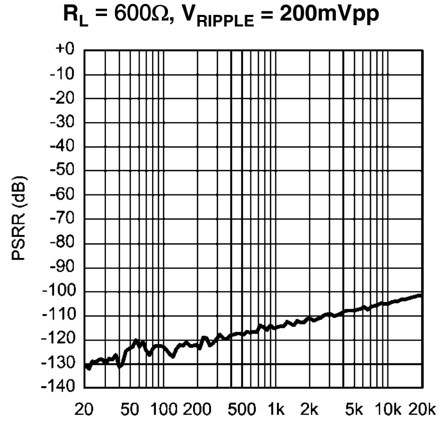
202151m8

PSRR- vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



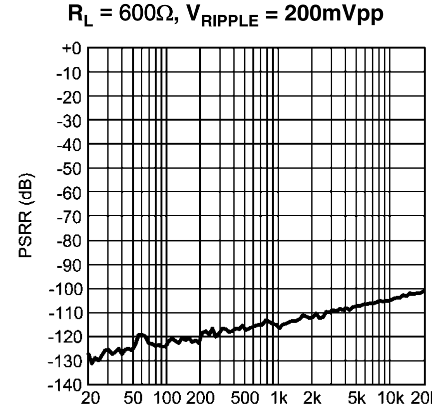
202151o6

PSRR+ vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



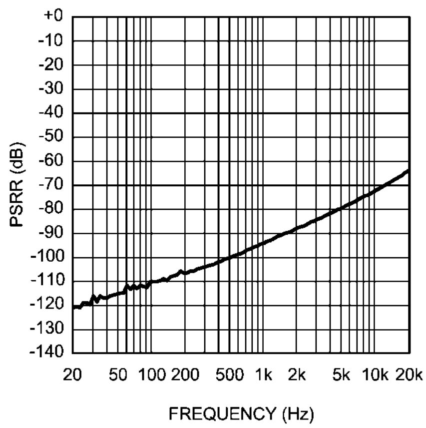
202151o2

PSRR- vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



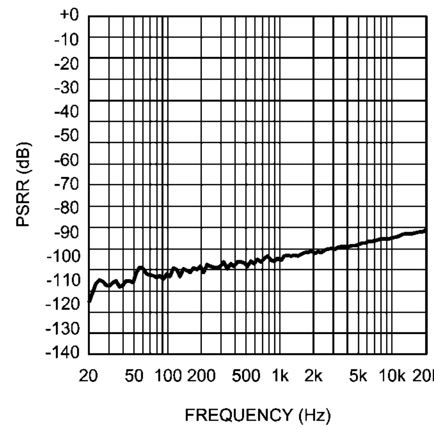
202151o7

PSRR+ vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



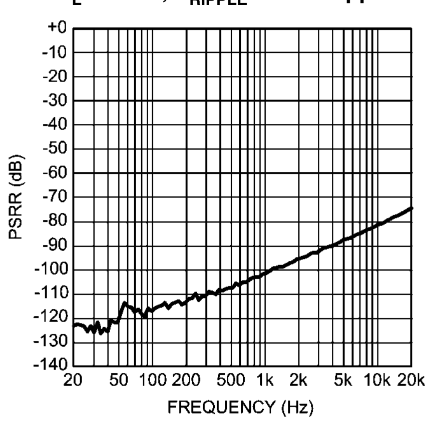
202151m7

PSRR- vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



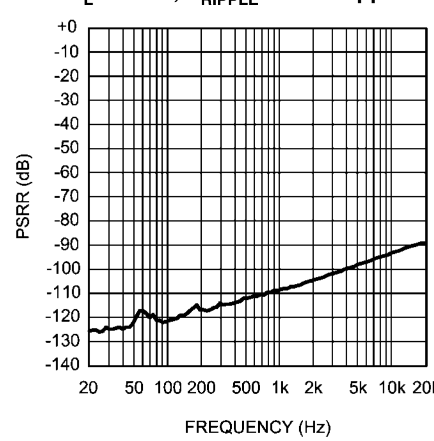
202151o4

PSRR+ vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



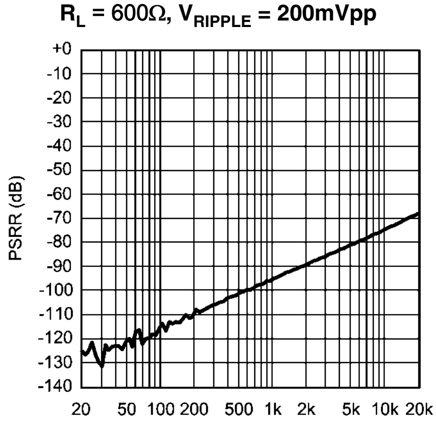
202151o5

PSRR- vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



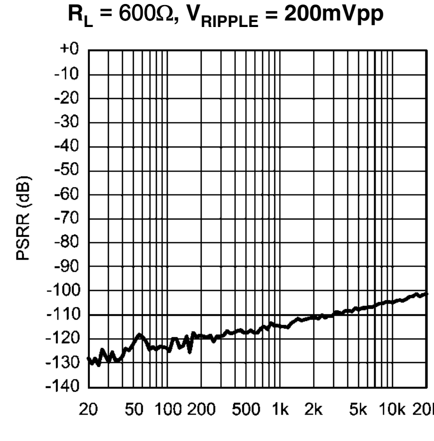
202151m6

PSRR+ vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



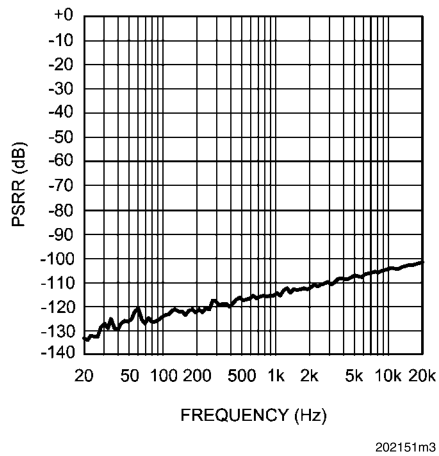
202151m5

PSRR- vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 600Ω, V_{RIPPLE} = 200mVpp

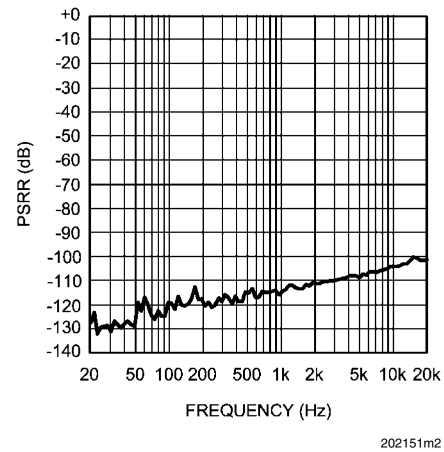


202151m4

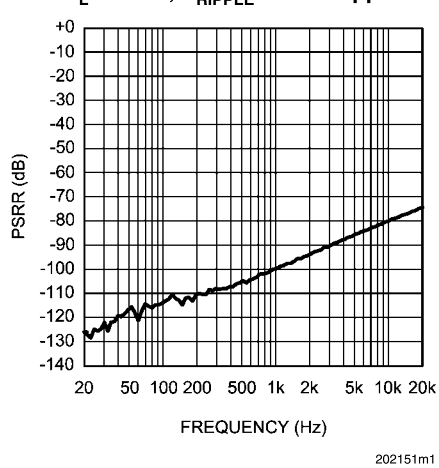
PSRR+ vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



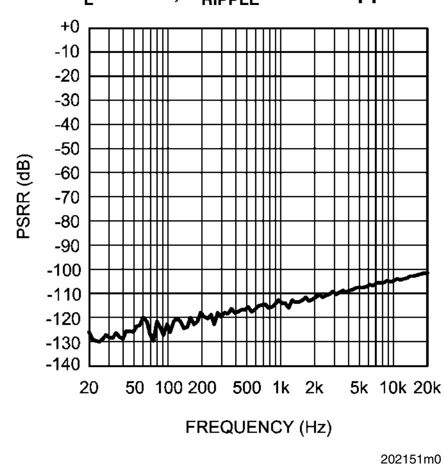
PSRR- vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



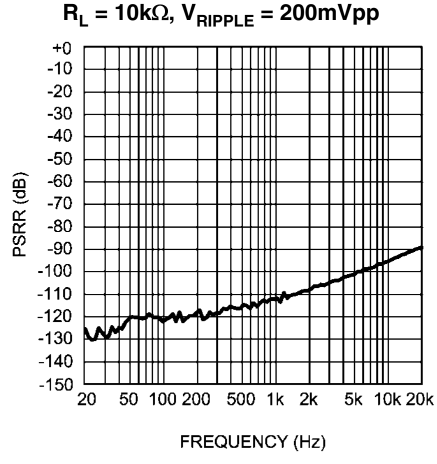
PSRR+ vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



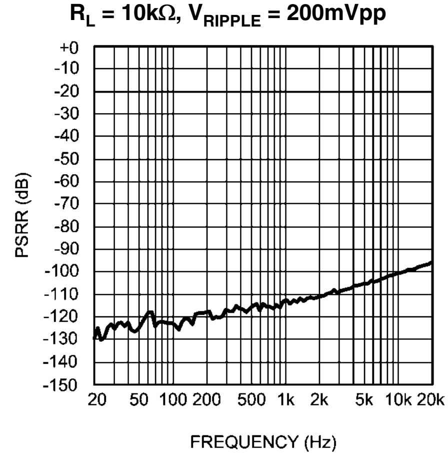
PSRR- vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



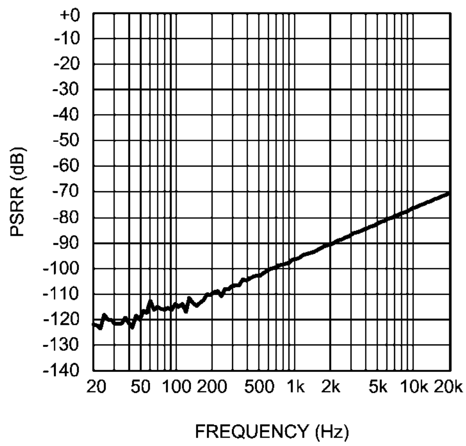
PSRR+ vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



PSRR- vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp

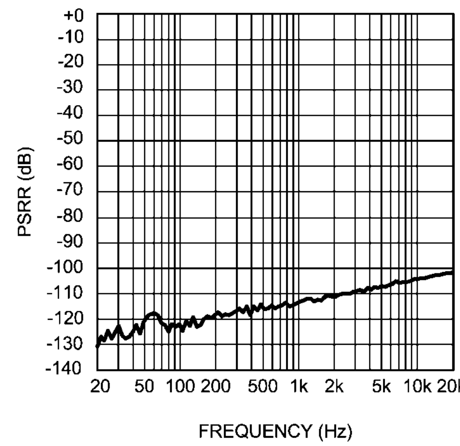


PSRR+ vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



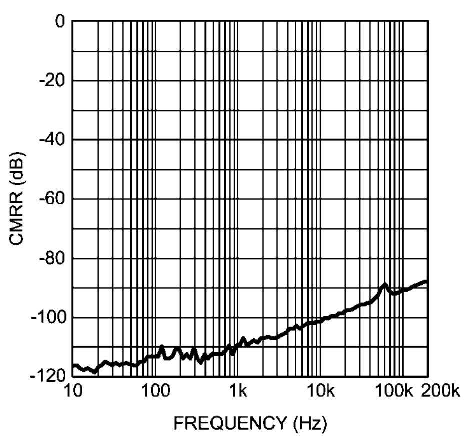
202151l7

PSRR- vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



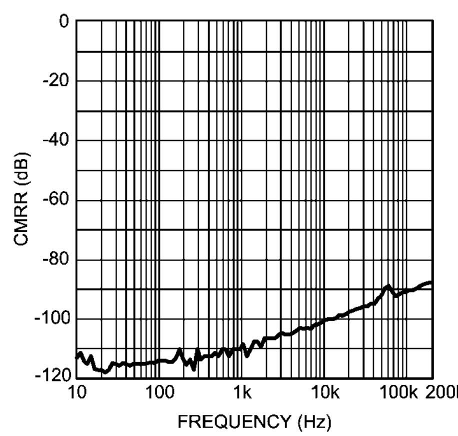
202151l5

CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 2kΩ



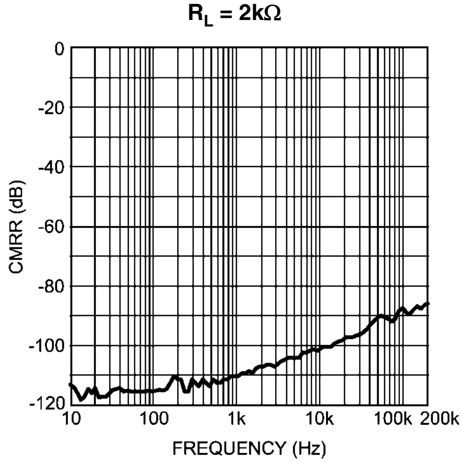
202151g0

CMRR vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ



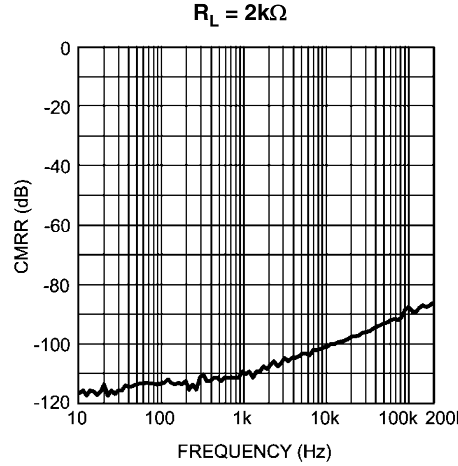
202151f7

CMRR vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 2kΩ



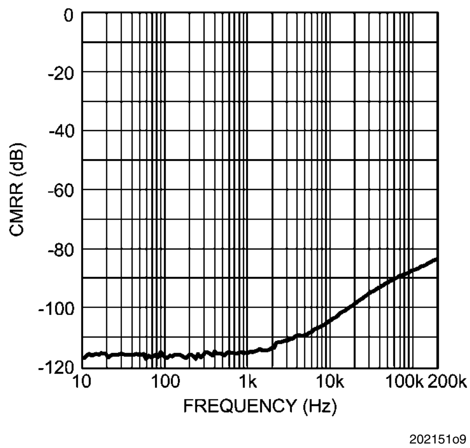
202151g3

CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ

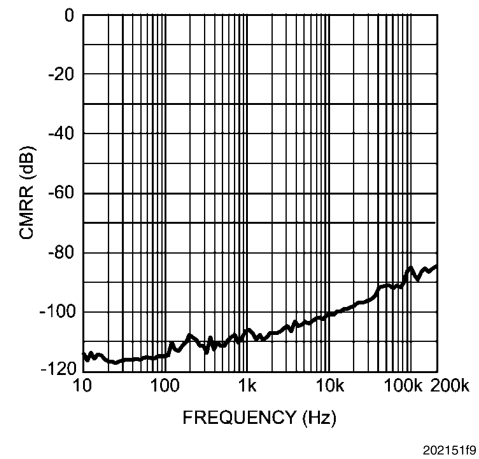


202151f4

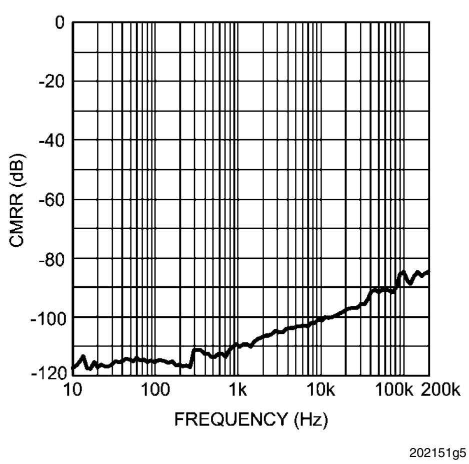
CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 600Ω



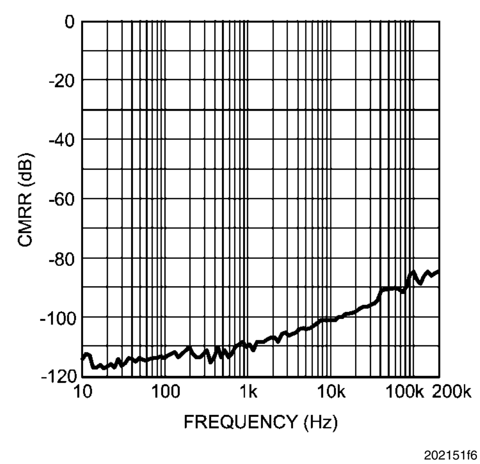
CMRR vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 600Ω



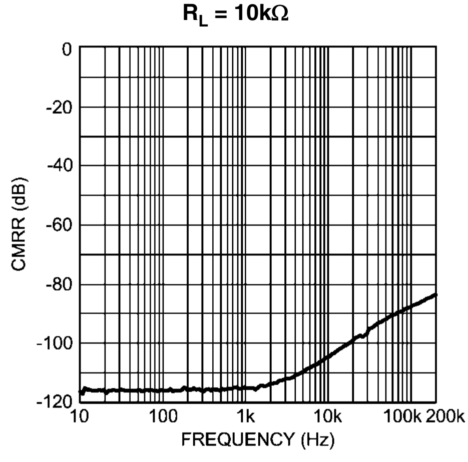
CMRR vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 600Ω



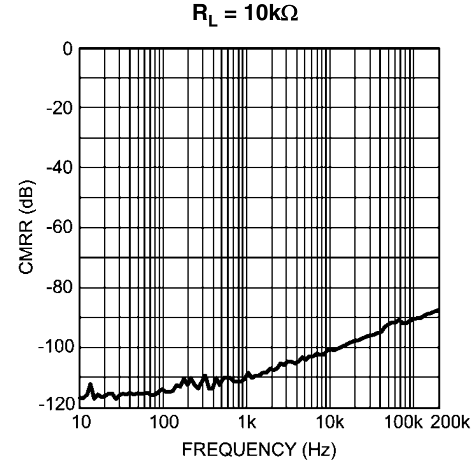
CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 600Ω



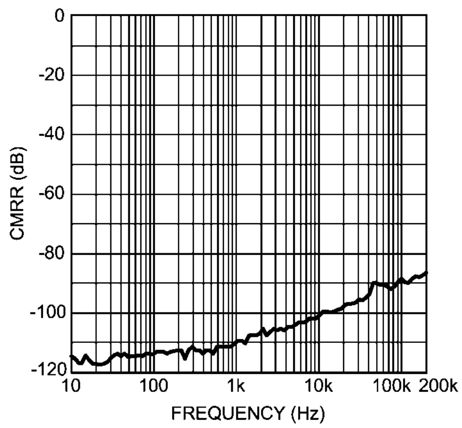
CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V
R_L = 10kΩ



CMRR vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 10kΩ

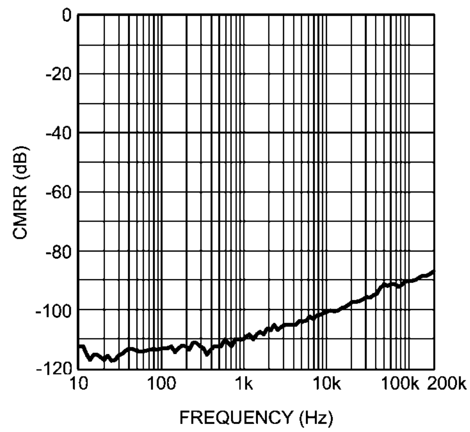


CMRR vs Frequency
V_{CC} = 22V, V_{EE} = –22V
R_L = 10kΩ



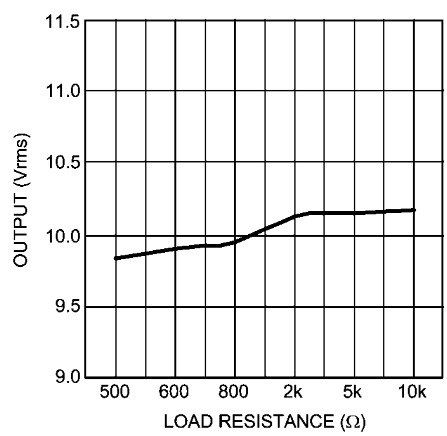
202151g4

CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 10kΩ



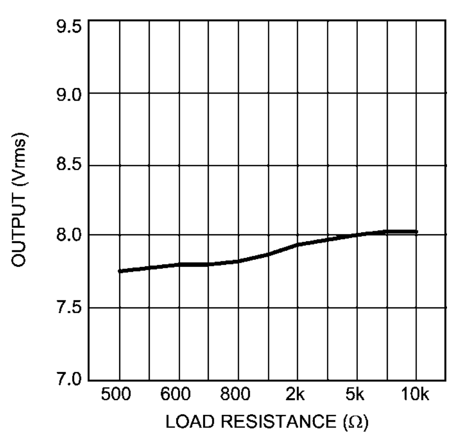
202151f5

Output Voltage vs Load Resistance
V_{CC} = 15V, V_{EE} = –15V
THD+N = 1%



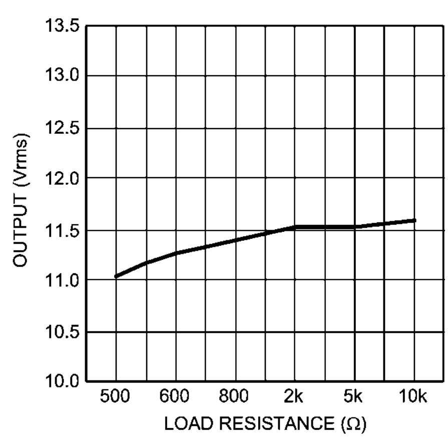
202151h1

Output Voltage vs Load Resistance
V_{CC} = 12V, V_{EE} = –12V
THD+N = 1%



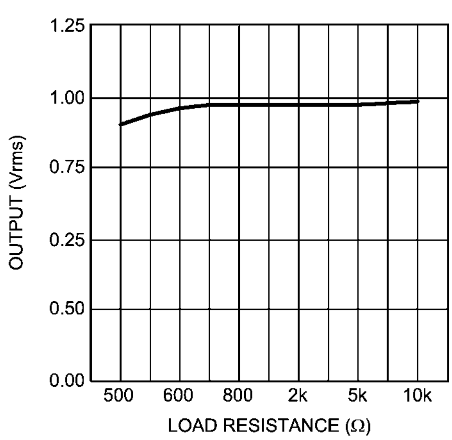
202151h0

Output Voltage vs Load Resistance
V_{CC} = 22V, V_{EE} = –22V
THD+N = 1%



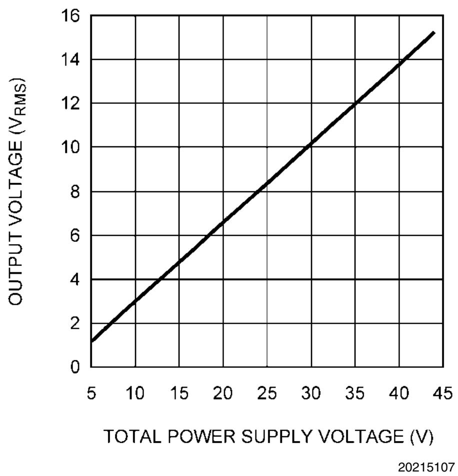
202151h2

Output Voltage vs Load Resistance
V_{CC} = 2.5V, V_{EE} = –2.5V
THD+N = 1%

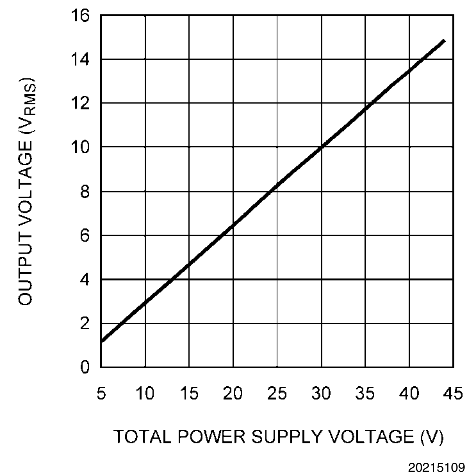


202151g9

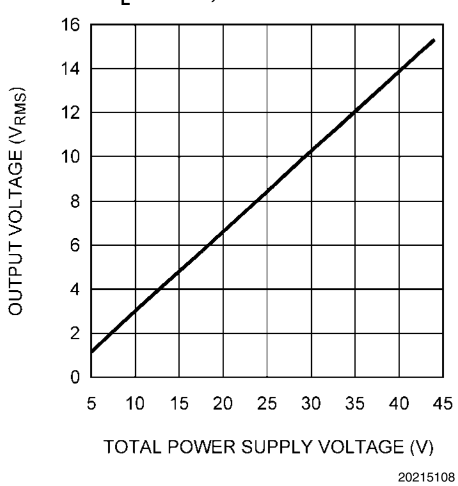
Output Voltage vs Total Power Supply Voltage
R_L = 2kΩ, THD+N = 1%



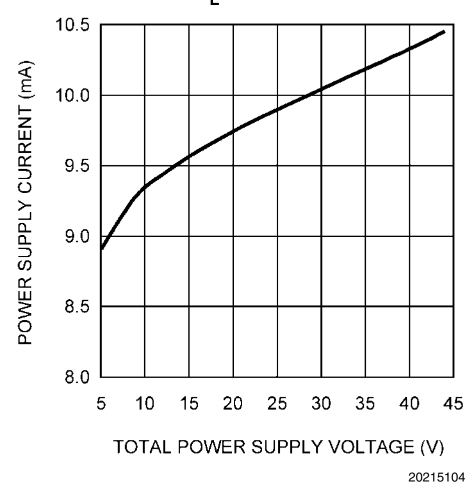
Output Voltage vs Total Power Supply Voltage
R_L = 600Ω, THD+N = 1%



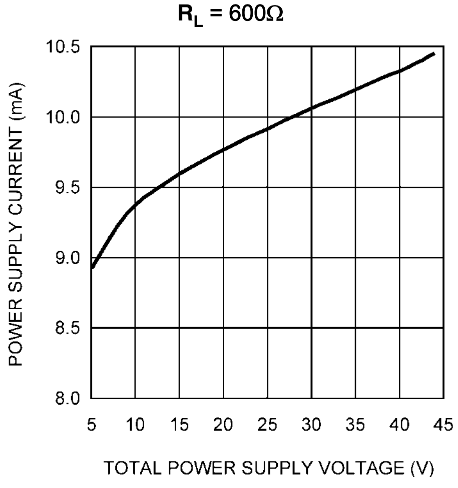
Output Voltage vs Total Power Supply Voltage
R_L = 10kΩ, THD+N = 1%



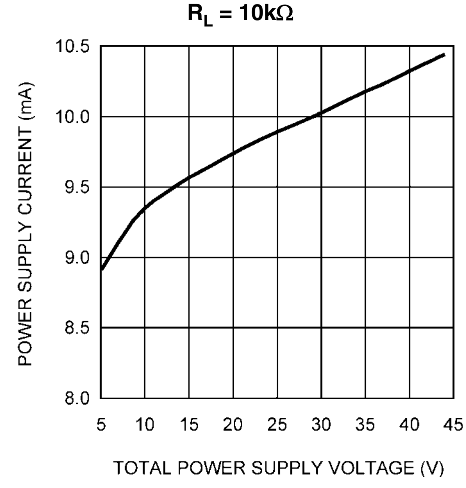
Power Supply Current vs Total Power Supply Voltage
R_L = 2kΩ



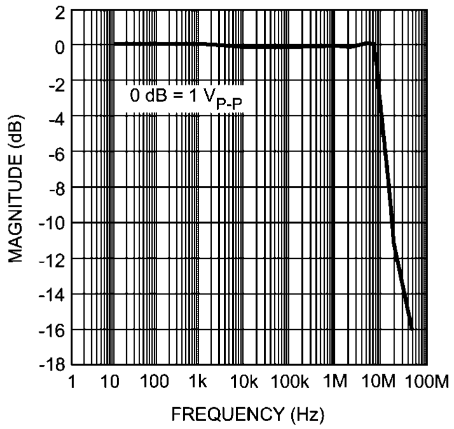
Power Supply Current vs Total Power Supply Voltage
R_L = 600Ω



Power Supply Current vs Total Power Supply Voltage
R_L = 10kΩ

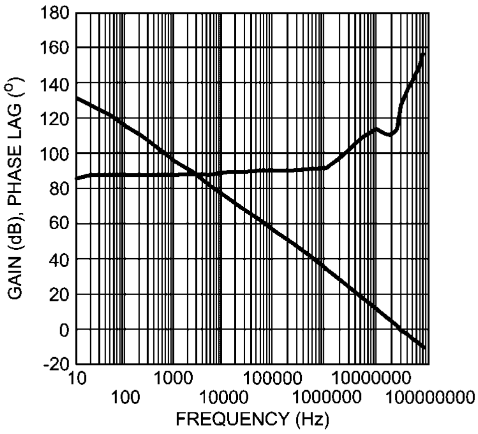


Full Power Bandwidth vs Frequency



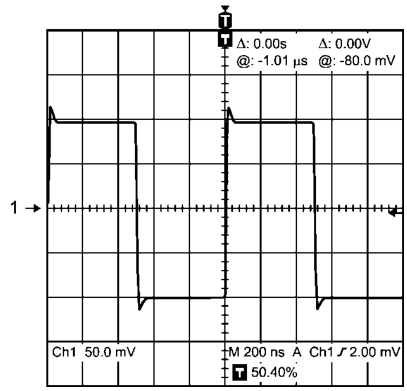
202151j0

Gain Phase vs Frequency



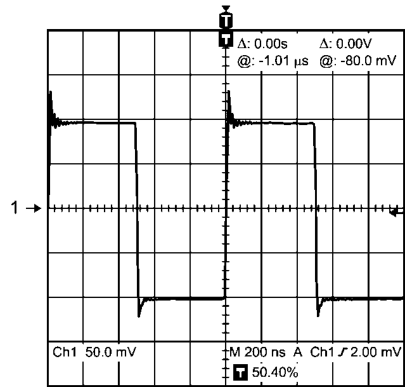
202151j1

Small-Signal Transient Response $A_V = 1$, $C_L = 10pF$



202151i7

Small-Signal Transient Response $A_V = 1$, $C_L = 100pF$



202151i8

Application Information

DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LME49860 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 LME49860's low residual distortion is an input referred internal error. As shown in Figure 1, 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 1.

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.

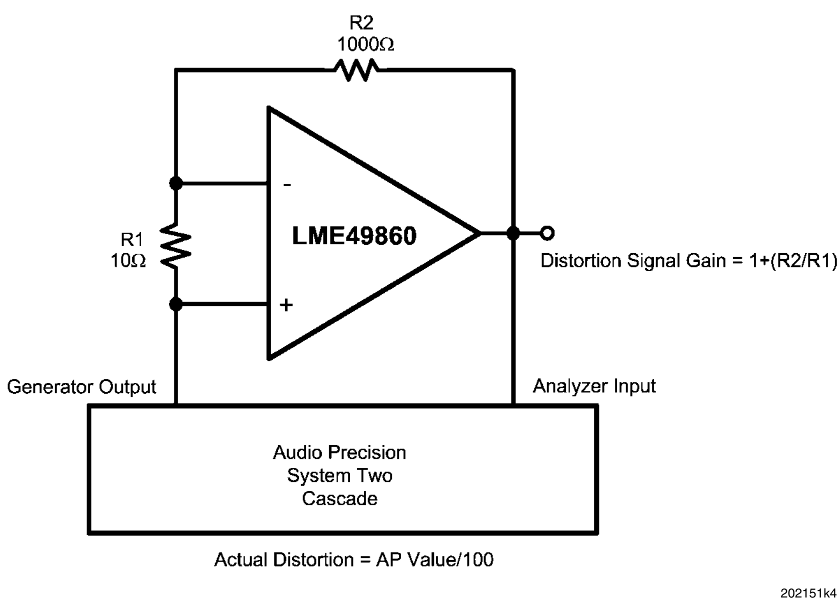
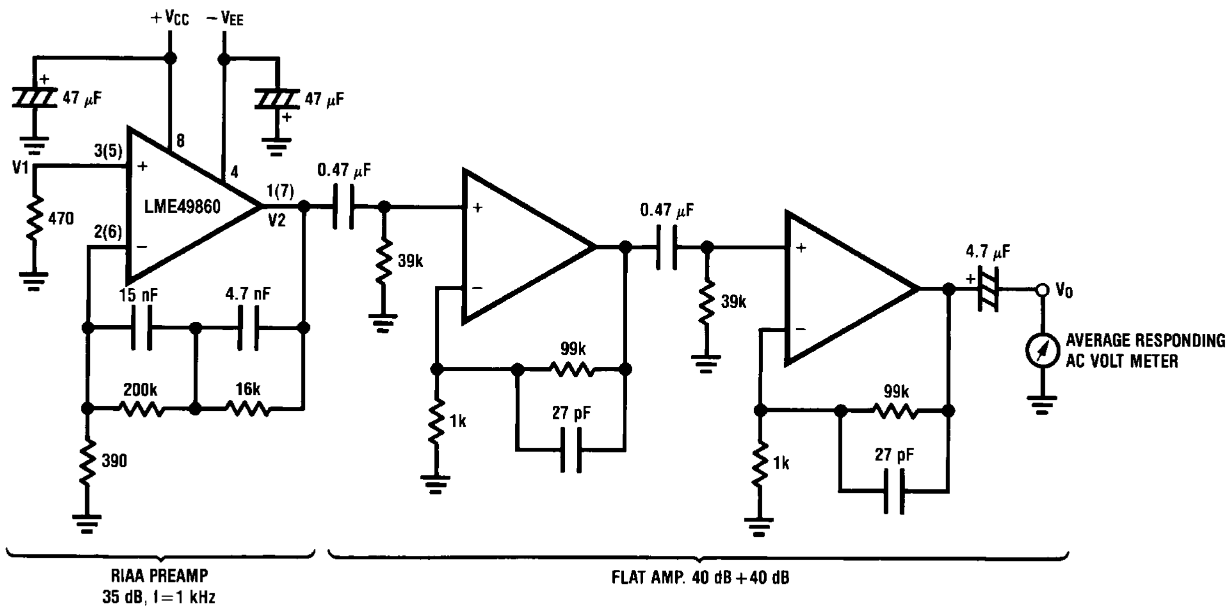


FIGURE 1. THD+N and IMD Distortion Test Circuit

The LME49860 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.

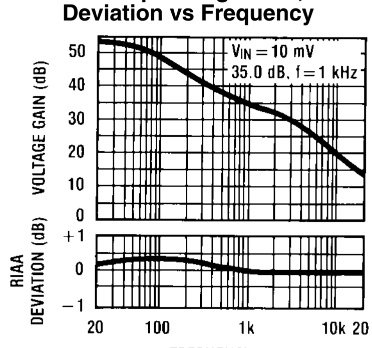


20215127

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

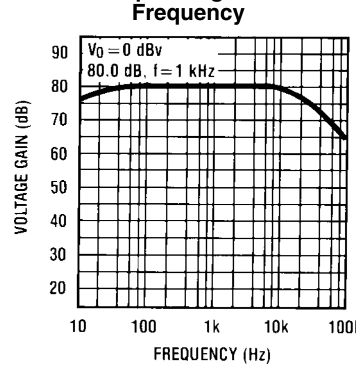
Noise Measurement Circuit
Total Gain: 115 dB @f = 1 kHz
Input Referred Noise Voltage: e_n = V0/560,000 (V)

RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



20215128

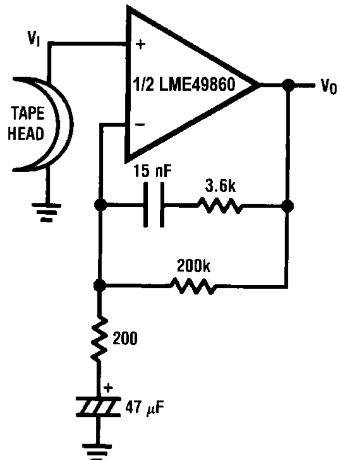
Flat Amp Voltage Gain vs Frequency



20215129

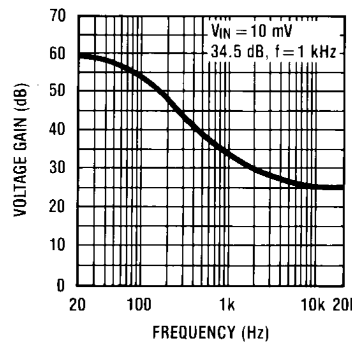
TYPICAL APPLICATIONS

NAB Preamp



20215130

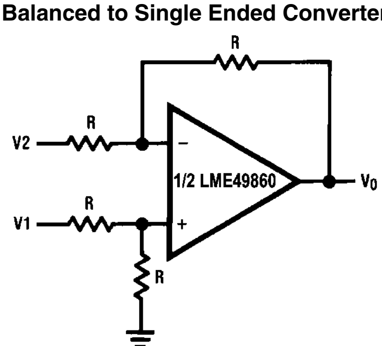
NAB Preamp Voltage Gain vs Frequency



20215131

$A_V = 34.5$
F = 1 kHz
$E_n = 0.38\ \mu V$
A Weighted

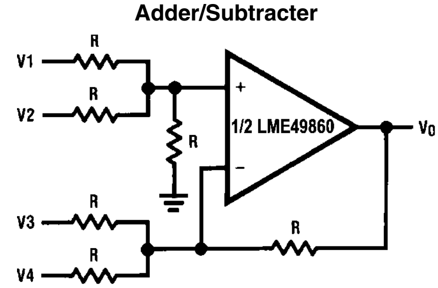
Balanced to Single Ended Converter



20215132

$V_O = V1 - V2$

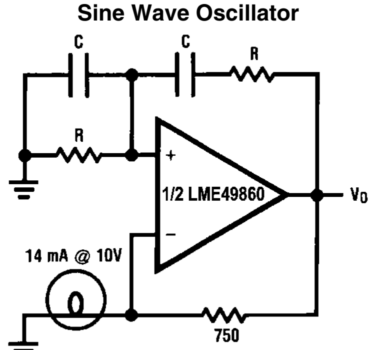
Adder/Subtracter



20215133

$V_O = V1 + V2 - V3 - V4$

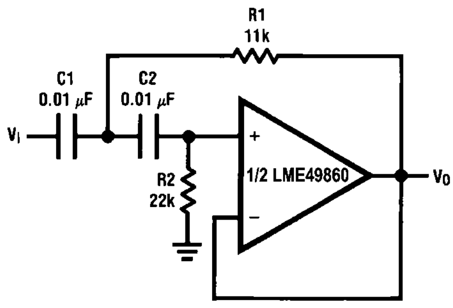
Sine Wave Oscillator



20215134

$$f_O = \frac{1}{2\pi RC}$$

Second Order High Pass Filter (Butterworth)



20215135

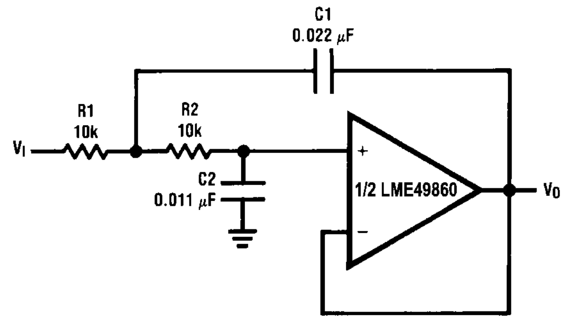
if C1 = C2 = C

$$R1 = \frac{\sqrt{2}}{2\omega_0 C}$$

R2 = 2•R1

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



20215136

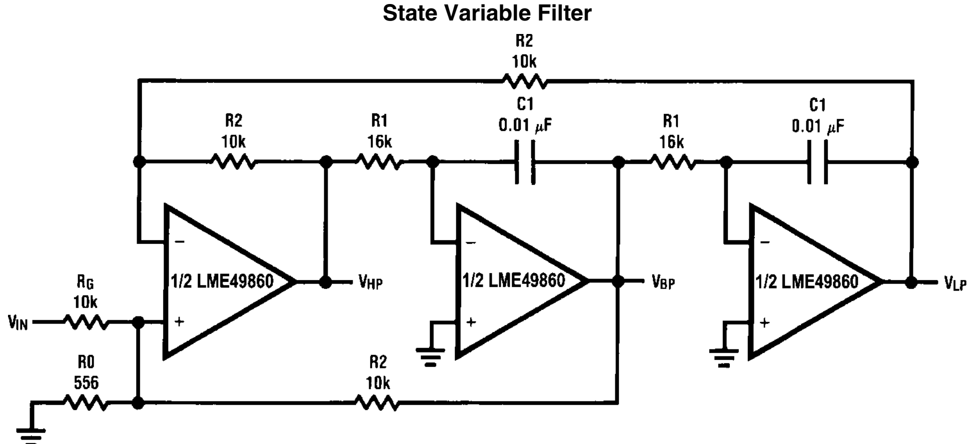
if R1 = R2 = R

$$C1 = \frac{\sqrt{2}}{\omega_0 R}$$

$$C2 = \frac{C1}{2}$$

Illustration is f_0 = 1 kHz

State Variable Filter

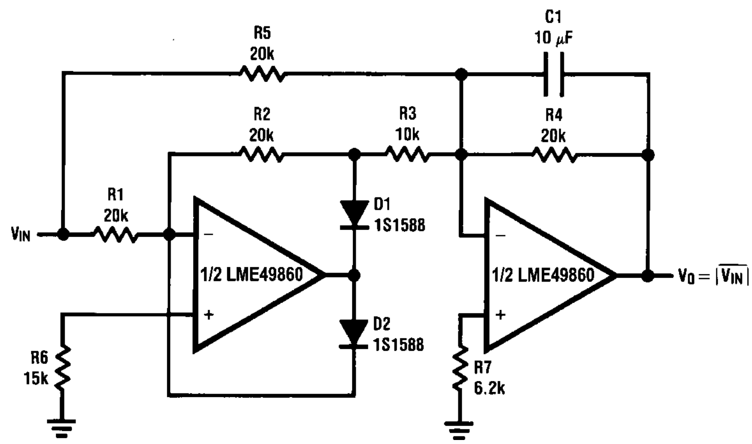


20215137

$$f_0 = \frac{1}{2\pi C1R1}, Q = \frac{1}{2}\left(1 + \frac{R2}{R0} + \frac{R2}{RG}\right), A_{BP} = QA_{LP} = QA_{LH} = \frac{R2}{RG}$$

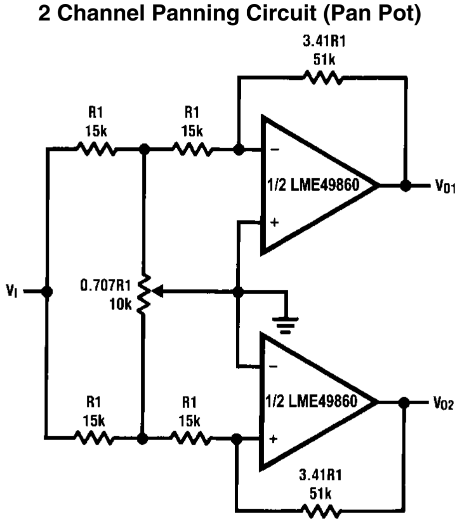
Illustration is f_0 = 1 kHz, Q = 10, A_{BP} = 1

AC/DC Converter



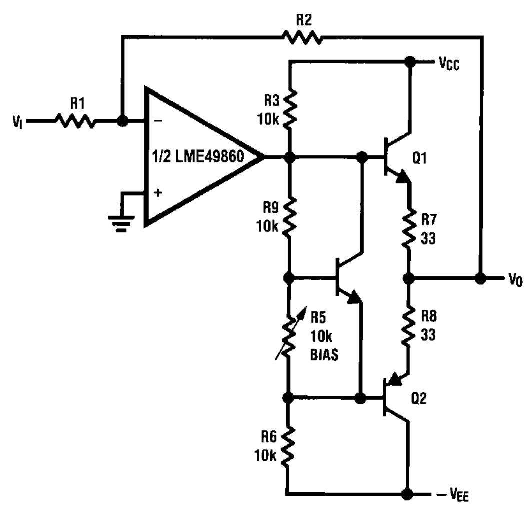
20215138

2 Channel Panning Circuit (Pan Pot)



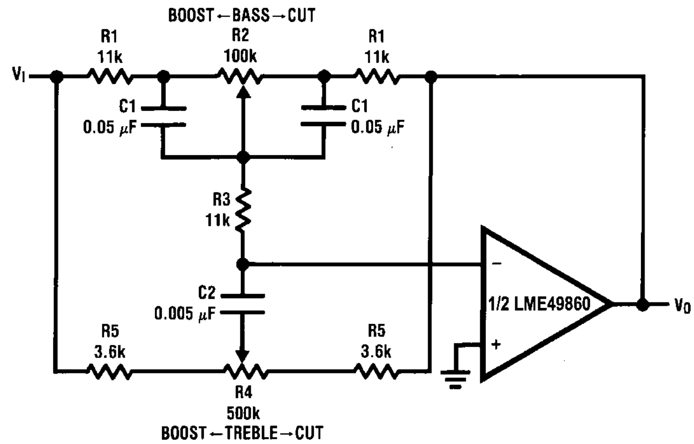
20215139

Line Driver



20215140

Tone Control



20215141

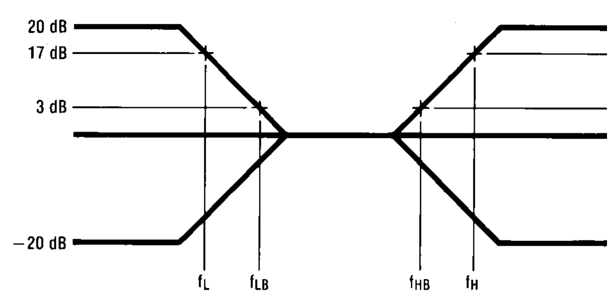
$$f_L = \frac{1}{2\pi R2C1},\ f_{LB} = \frac{1}{2\pi R1C1}$$

$$f_H = \frac{1}{2\pi R5C2},\ f_{HB} = \frac{1}{2\pi(R1 + R5 + 2R3)C2}$$

Illustration is:

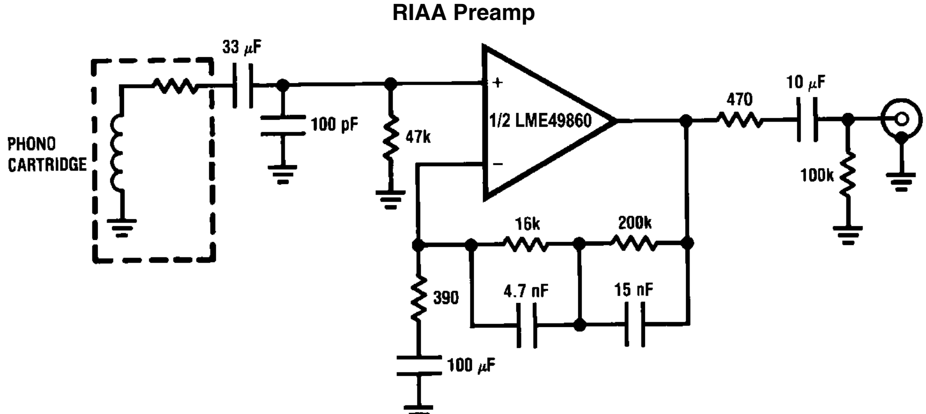
f_L = 32 Hz, f_{LB} = 320 Hz

f_H =11 kHz, f_{HB} = 1.1 kHz



20215142

RIAA Preamp



20215103

A_v = 35 dB

E_n = 0.33 µV

S/N = 90 dB

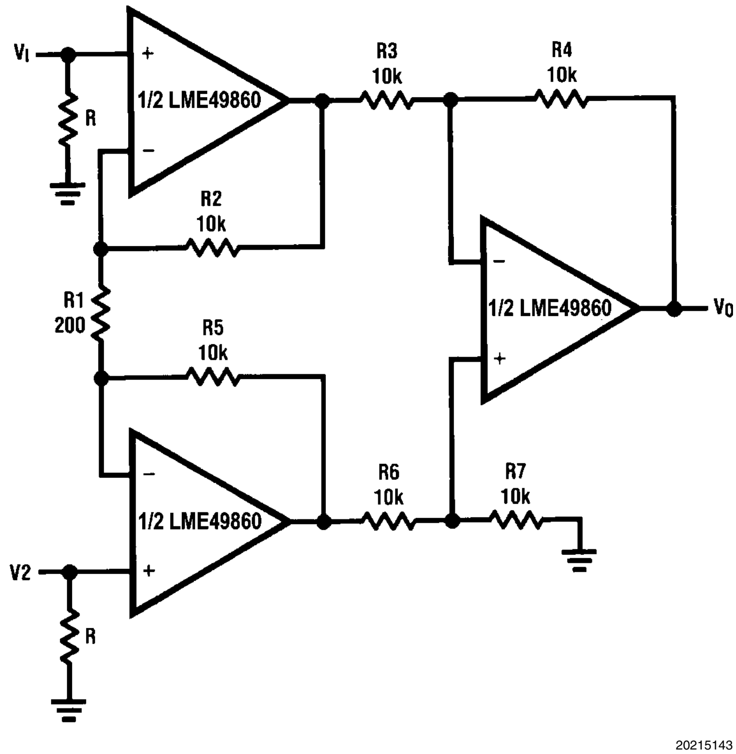
f = 1 kHz

A Weighted

A Weighted, V_{IN} = 10 mV

@f = 1 kHz

Balanced Input Mic Amp



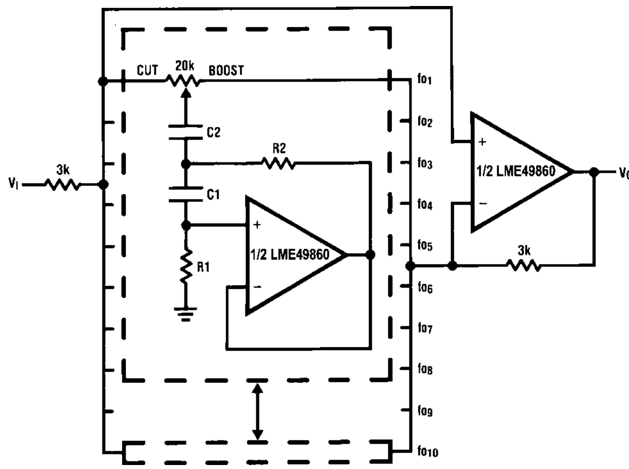
If R2 = R5, R3 = R6, R4 = R7

$$V0 = \left(1 + \frac{2R2}{R1}\right)\frac{R4}{R3}(V2 - V1)$$

Illustration is:

V0 = 101(V2 – V1)

10 Band Graphic Equalizer



20215144

fo (Hz)	C_1	C_2	R_1	R_2
32	0.12µF	4.7µF	75kΩ	500Ω
64	0.056µF	3.3µF	68kΩ	510Ω
125	0.033µF	1.5µF	62kΩ	510Ω
250	0.015µF	0.82µF	68kΩ	470Ω
500	8200pF	0.39µF	62kΩ	470Ω
1k	3900pF	0.22µF	68kΩ	470Ω
2k	2000pF	0.1µF	68kΩ	470Ω
4k	1100pF	0.056µF	62kΩ	470Ω
8k	510pF	0.022µF	68kΩ	510Ω
16k	330pF	0.012µF	51kΩ	510Ω

Note 9: At volume of change = ±12 dB

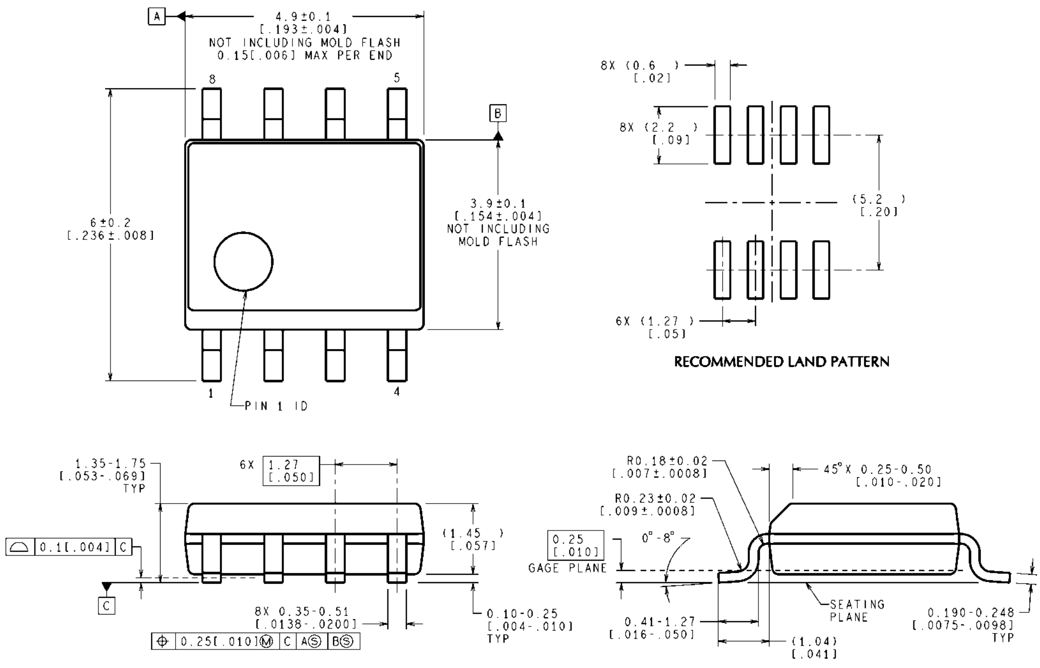
Q = 1.7

Reference: “AUDIO/RADIO HANDBOOK”, National Semiconductor, 1980, Page 2–61

Revision History

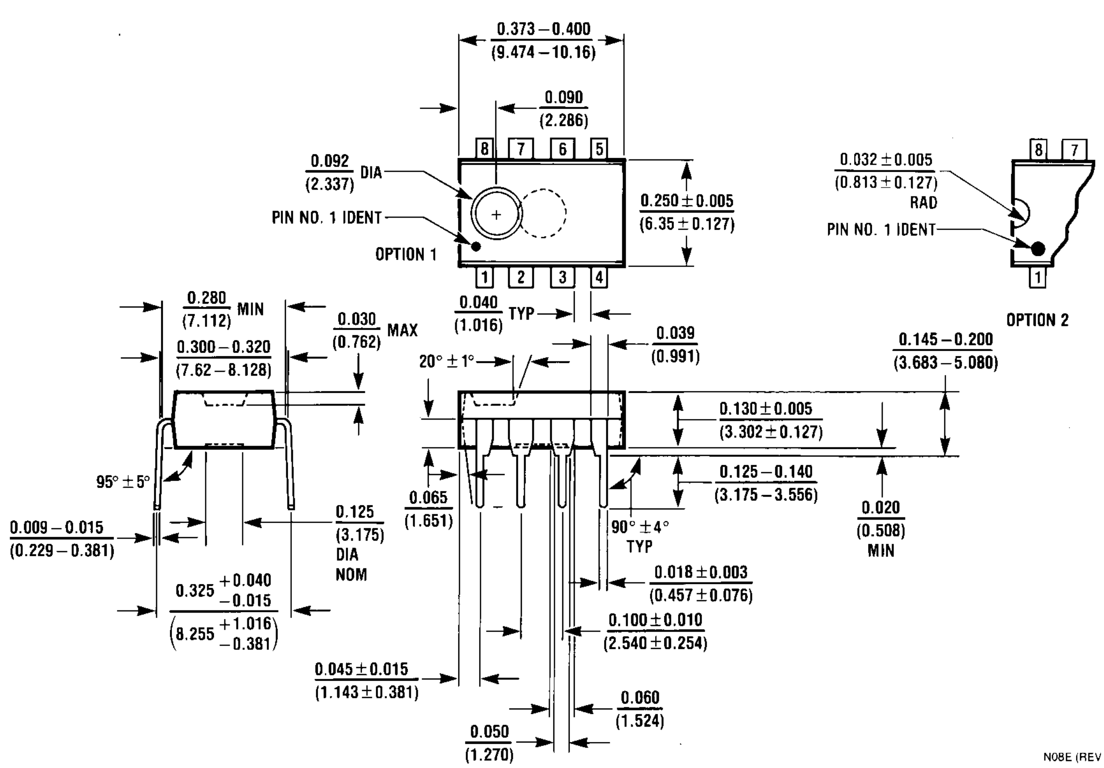
Rev	Date	Description
1.0	06/01/07	Initial release.
1.1	06/11/07	Added the LME49860MA and LME49860NA Top Mark Information.

Physical Dimensions inches (millimeters) unless otherwise noted



M08A (Rev L)

Narrow SOIC Package
Order Number LME49860MA
NS Package Number M08A



N08E (REV F)

Dual-In-Line Package
Order Number LME49860NA
NS Package Number N08E

Notes

Notes

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

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Email: jpn.feedback@nsc.com
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