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

Check for Samples: LME49860, LME49860MABD, LME49860NABD

FEATURES

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

APPLICATIONS

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

KEY SPECIFICATIONS

- Power Supply Voltage Range: ±2.5 to ±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: 2.7 nV/$\sqrt{Hz}$ (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%

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.

TYPICAL APPLICATION

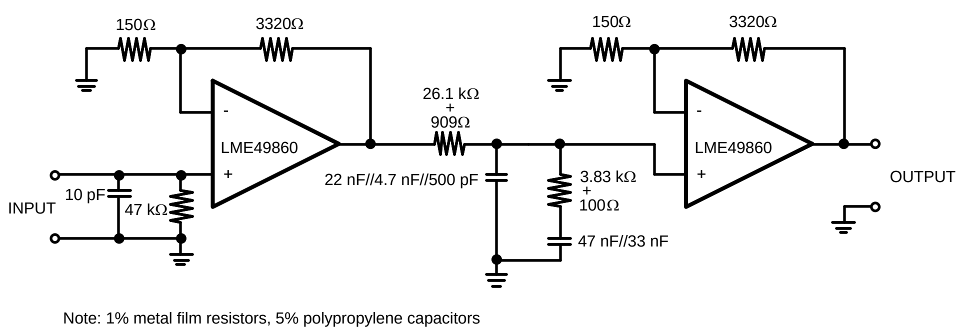


Figure 1. Passively Equalized RIAA Phono Preamplifier

DESCRIPTION (CONTINUED)

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 PDIP packages. Demonstration boards are available for each package.

Connection Diagrams

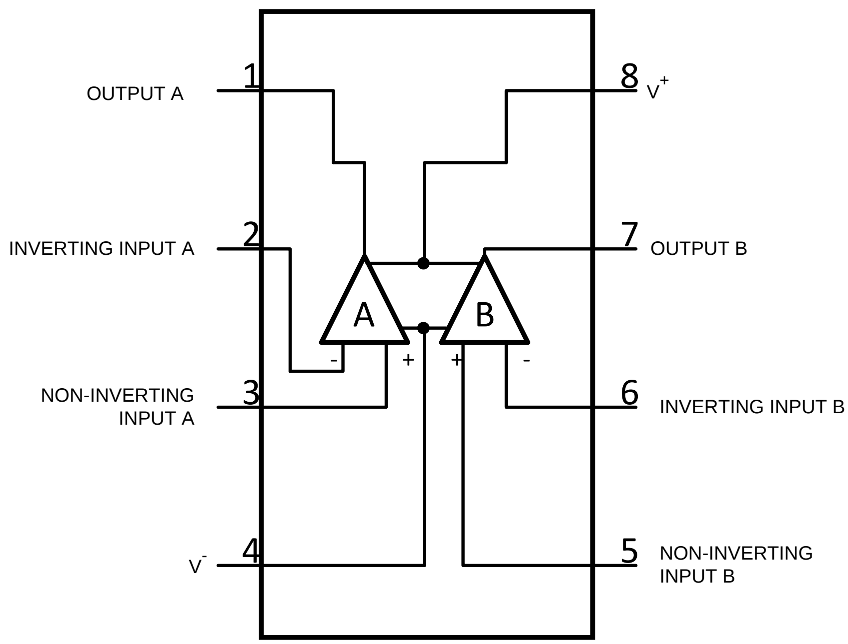


Figure 2. 8-Pin SOIC or PDIP
See D or P Package

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS(1)(2)(3)

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(4)		Continuous
ESD Susceptibility(5)		2000V
ESD Susceptibility(6)	Pins 1, 4, 7 and 8	200V
	Pins 2, 3, 5 and 6	100V
Junction Temperature		150°C
Thermal Resistance	$θ_{JA}$ (SOIC)	145°C/W
	$θ_{JA}$ (PDIP)	102°C/W

(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 Instrument 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).

OPERATING RATINGS

Temperature Range	$T_{MIN} \le T_A \le T_{MAX}$	$-40°C \le T_A \le 85°C$
Supply Voltage Range		$\pm2.5V \le V_S \le \pm22V$

ELECTRICAL CHARACTERISTICS FOR THE LME49860(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		Units (Limits)
				Typical(2)	Limit(3)	
THD+N	Total Harmonic Distortion + Noise	A_V = 1, V_{OUT} = 3V_{rms}	R_L = 2kΩ	0.00003		% (max)
			R_L = 600Ω	0.00003	0.00009	
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/√Hz (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz		1.6 3.1		pA/√Hz
V_{OS}	Offset Voltage	V_S = ±18V		±0.12	±0.7	mV (max)
		V_S = ±22V		±0.14	±0.7	mV (max)
$ΔV_{OS}/ΔTemp$	Average Input Offset Voltage Drift vs Temperature	$-40°C \le T_A \le 85°C$		0.2		μV/°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) Typical specifications are specified at +25ºC and represent the most likely parametric norm.
(3) Tested limits are ensured to AOQL (Average Outgoing Quality Level).

ELECTRICAL CHARACTERISTICS FOR THE LME49860(1) (continued)

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(2)	LME49860 Limit(3)	Units (Limits)
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	See(4) V_S = ±18V, Δ V_S = 24V V_S = ±22V, Δ V_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)
$ΔI_{OS}/ΔTemp$	Input Bias Current Drift vs Temperature	–40°C ≤ T_A ≤ 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)
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)

(4) PSRR is measured as follows: For V_S = ±22V, V_{OS} is measured at two supply voltages, ±7V and ±22V. PSRR = | 20log($ΔV_{OS}/ΔV_S$) |.

TYPICAL PERFORMANCE CHARACTERISTICS

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

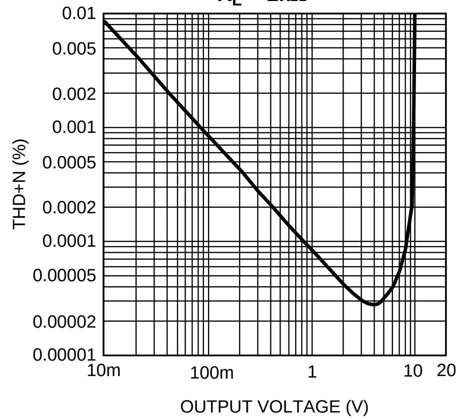


Figure 3.

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

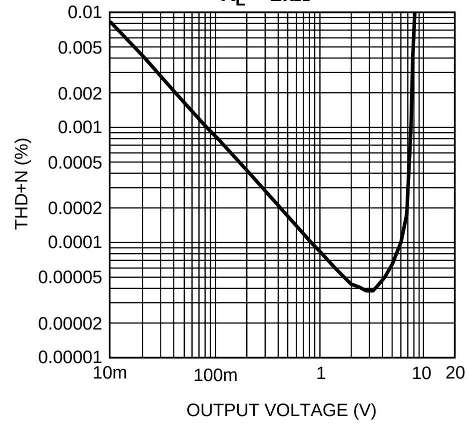


Figure 4.

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

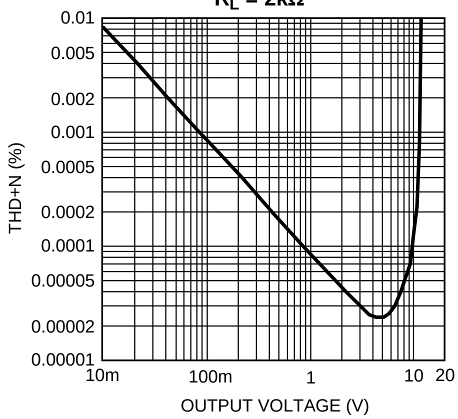


Figure 5.

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

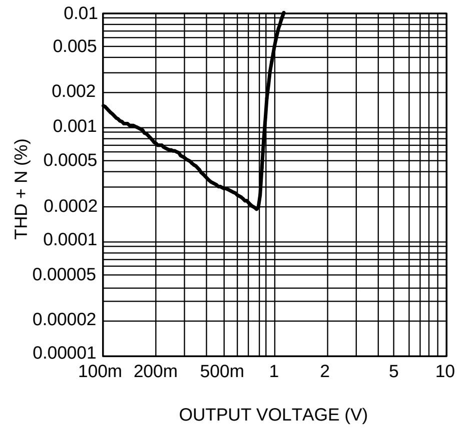


Figure 6.

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

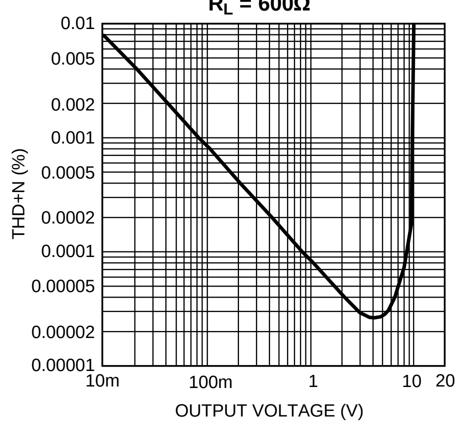


Figure 7.

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

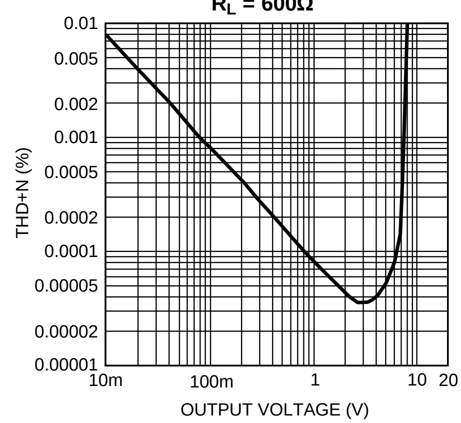


Figure 8.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

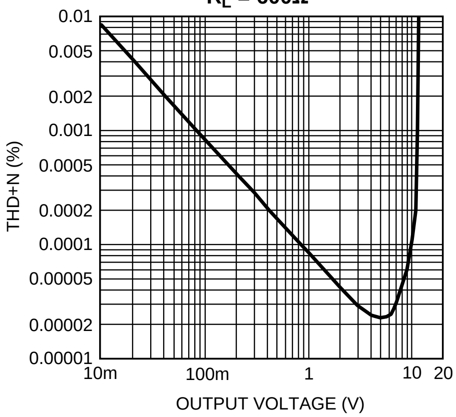


Figure 9.

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

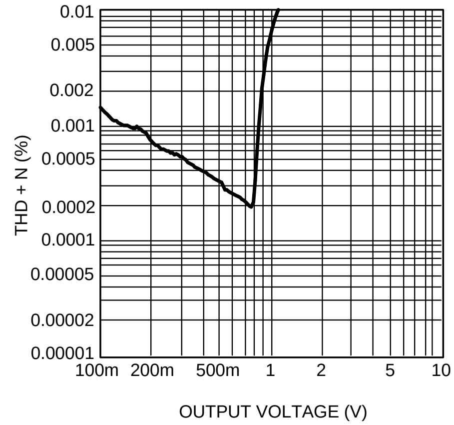


Figure 10.

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

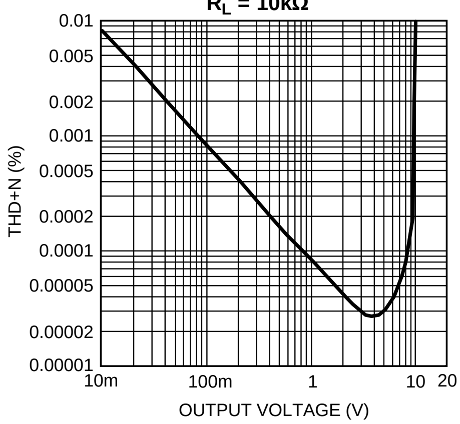


Figure 11.

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

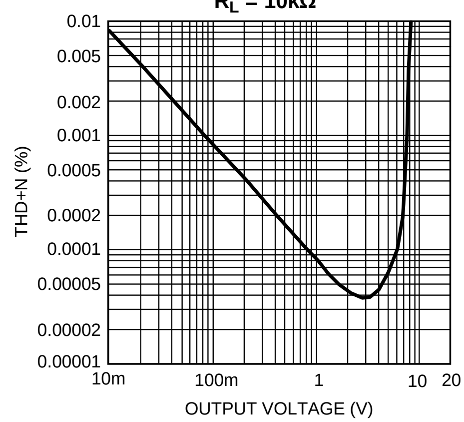


Figure 12.

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

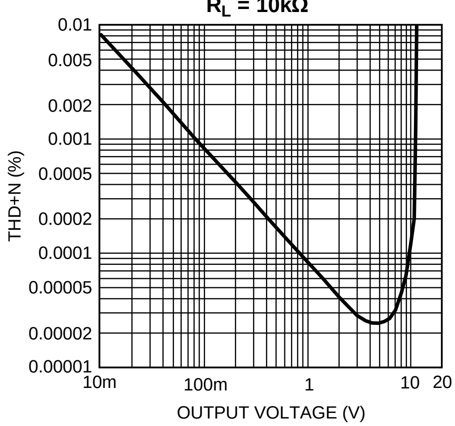


Figure 13.

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

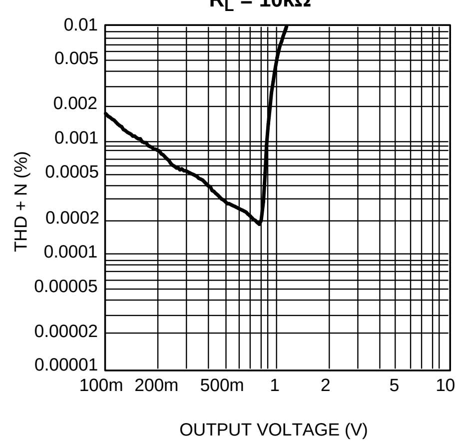


Figure 14.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

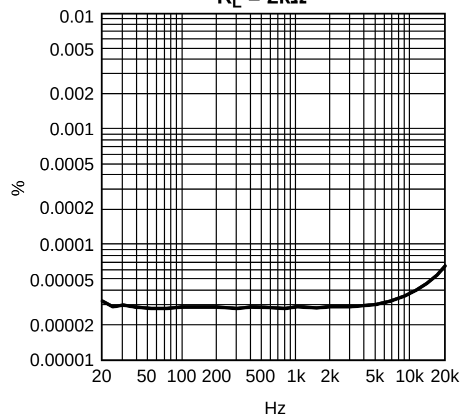


Figure 15.

THD+N vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = $3V_{RMS}$
R_L = 2kΩ

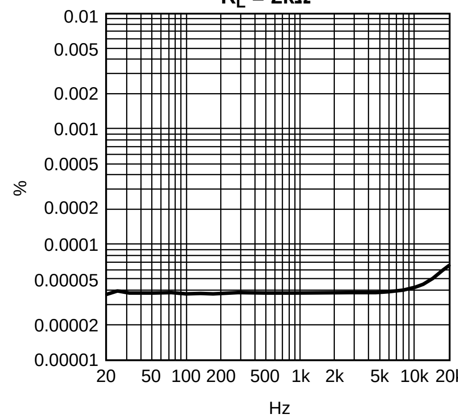


Figure 16.

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

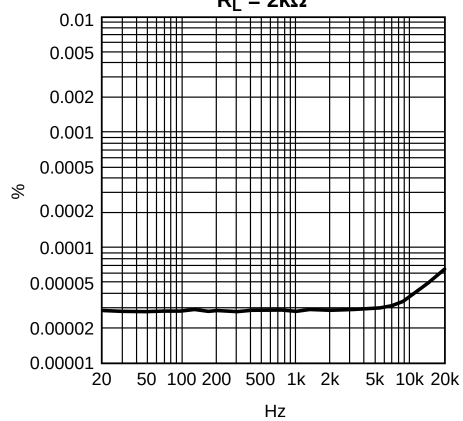


Figure 17.

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

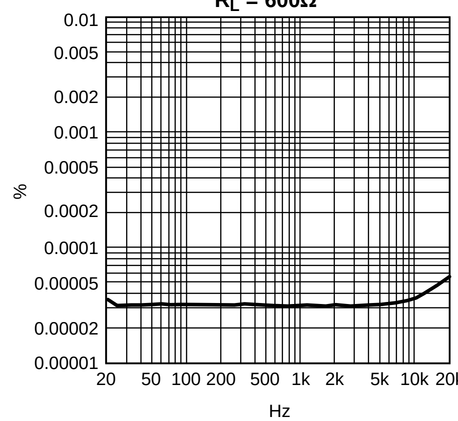


Figure 18.

THD+N vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = $3V_{RMS}$
R_L = 600Ω

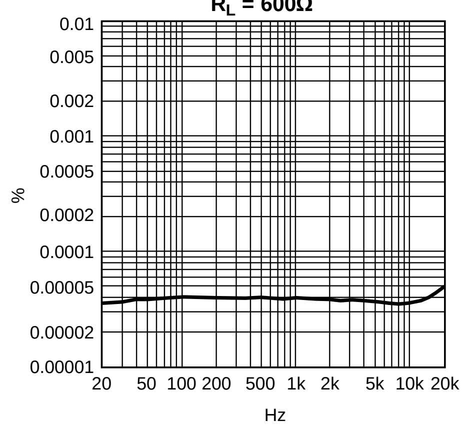


Figure 19.

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

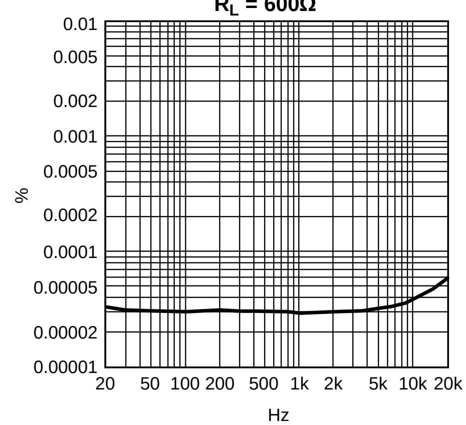


Figure 20.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

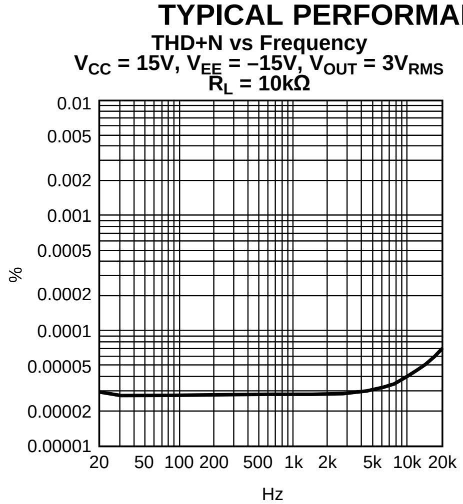
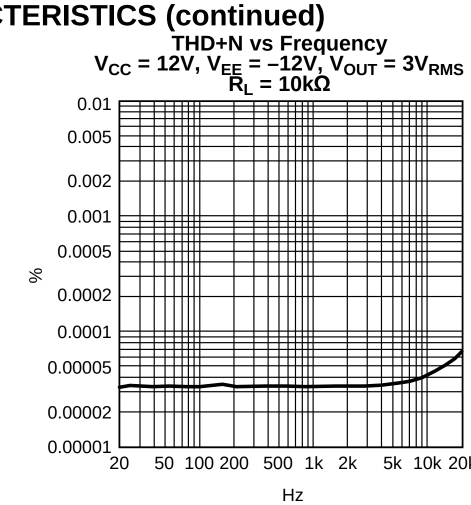


Figure 21.



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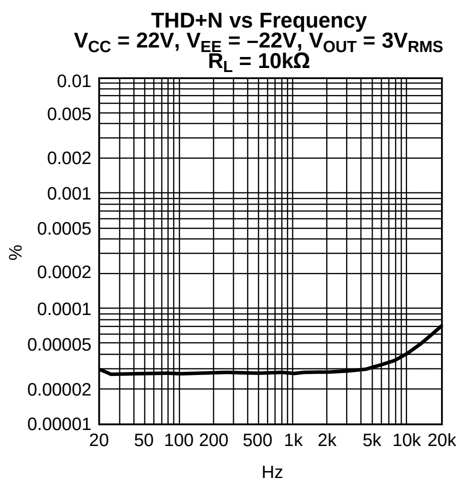

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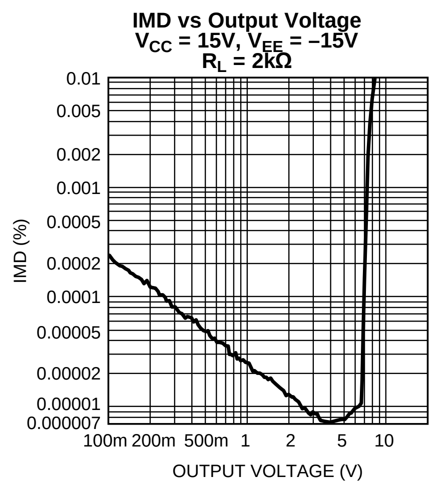

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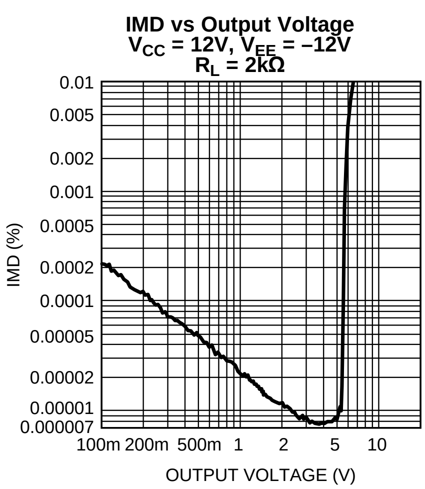

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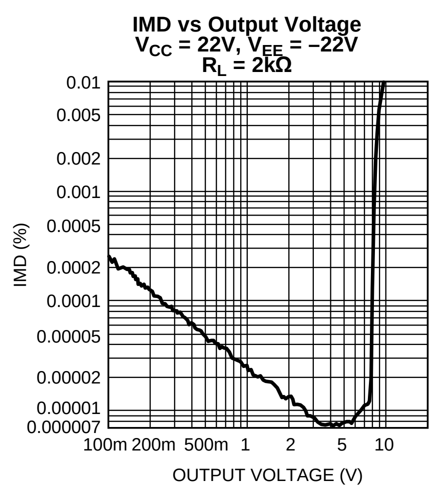


Figure 26.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

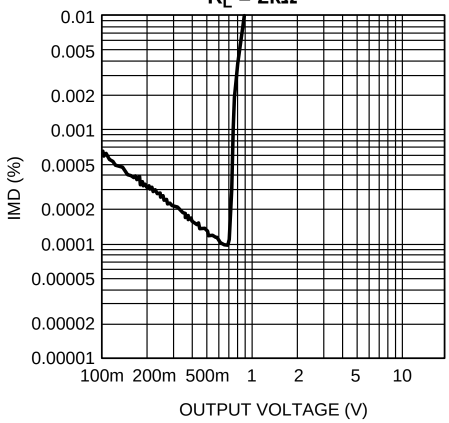


Figure 27.

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

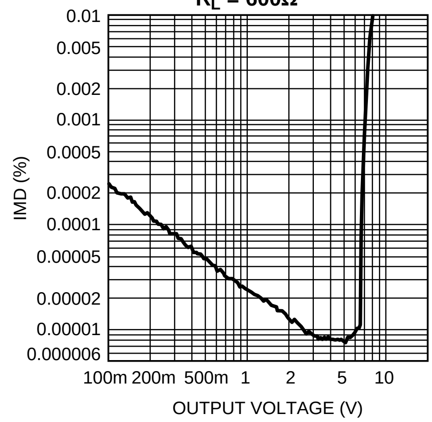


Figure 28.

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

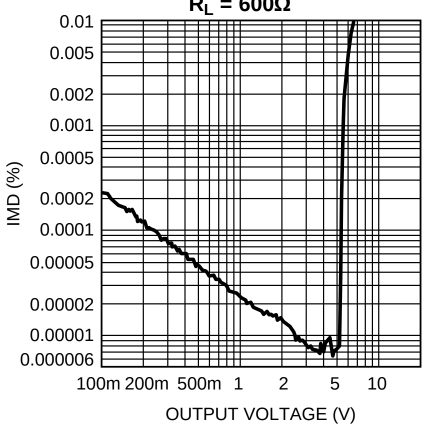


Figure 29.

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

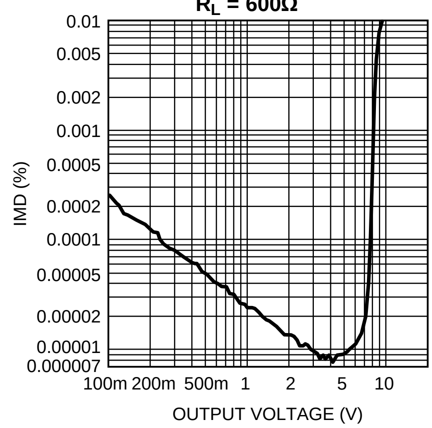


Figure 30.

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

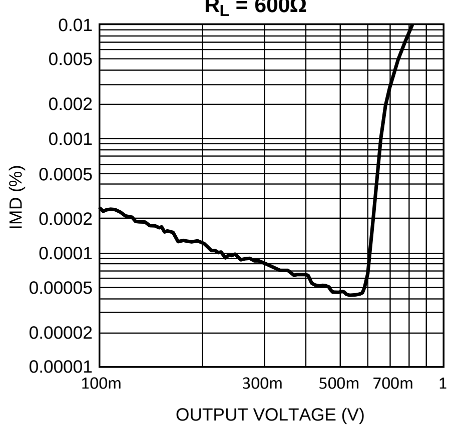


Figure 31.

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

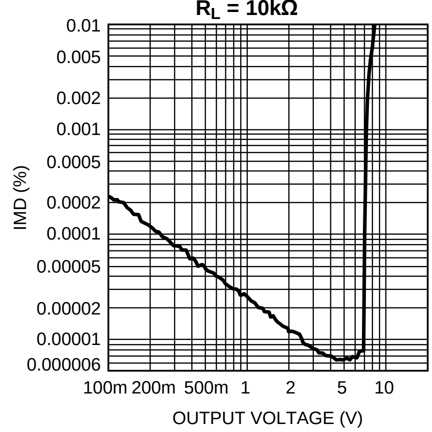


Figure 32.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

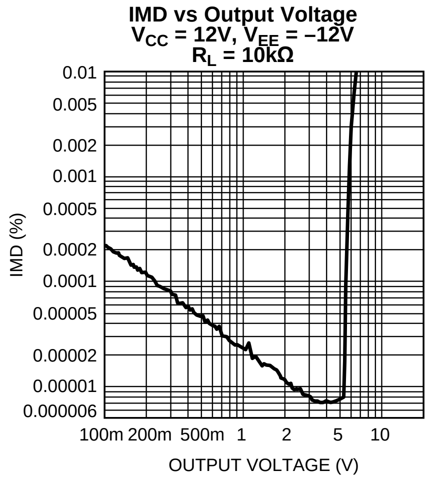


Figure 33.

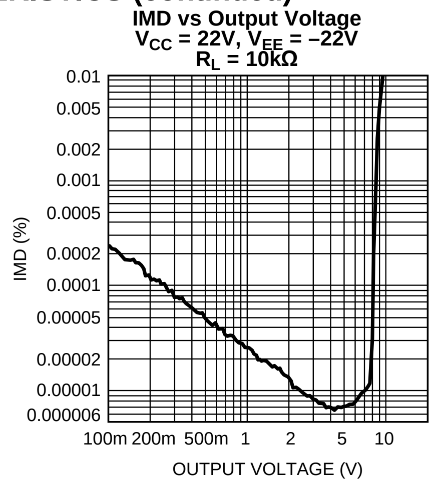
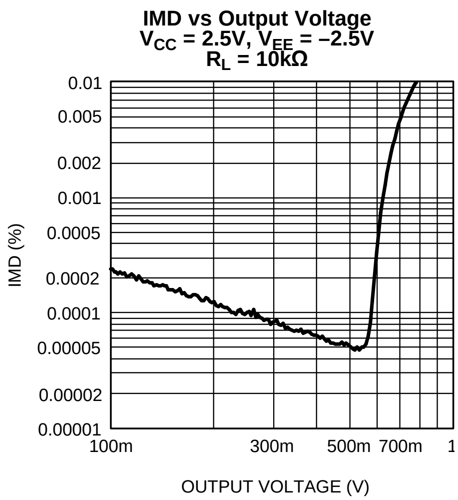


Figure 34.



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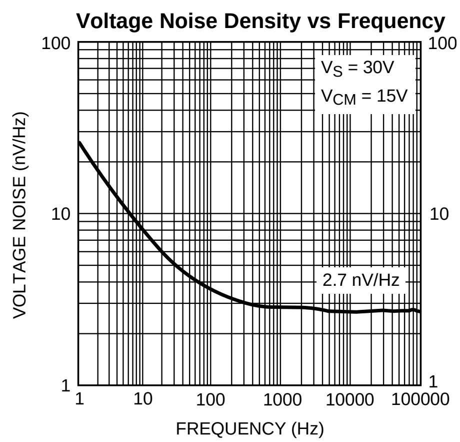

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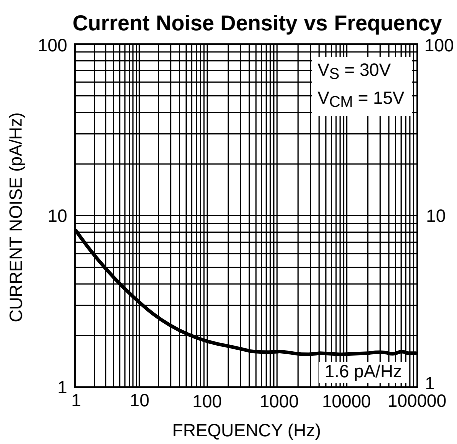


Figure 37.

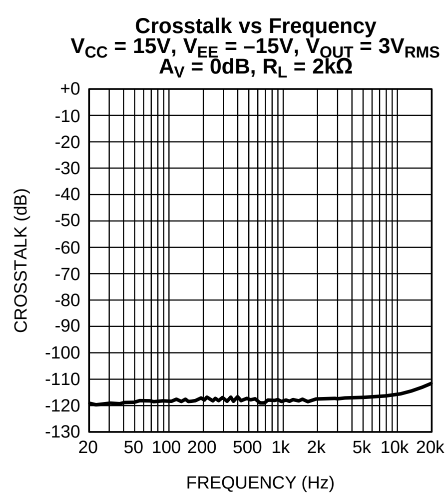


Figure 38.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

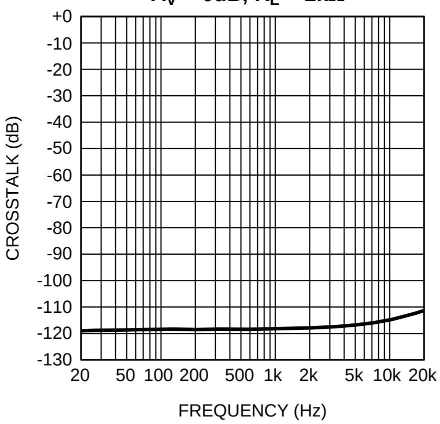


Figure 39.

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

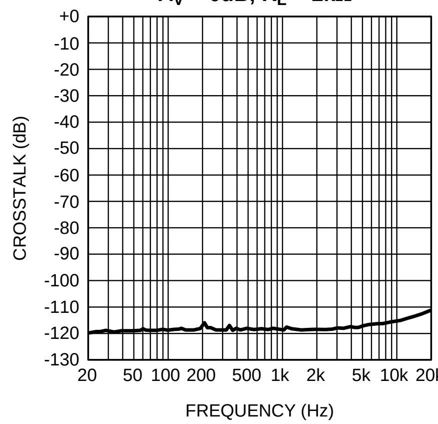


Figure 40.

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

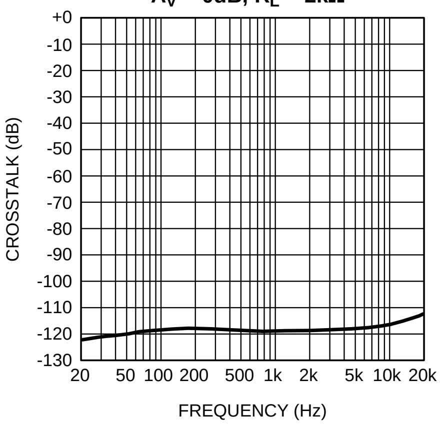


Figure 41.

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

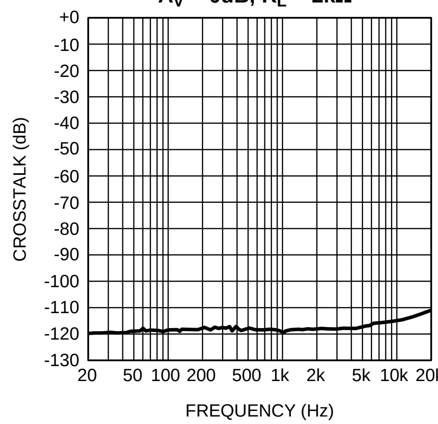


Figure 42.

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

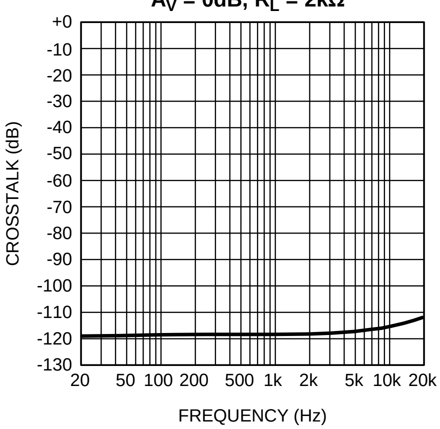


Figure 43.

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

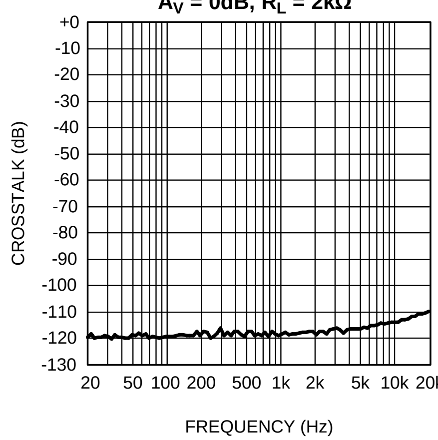


Figure 44.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

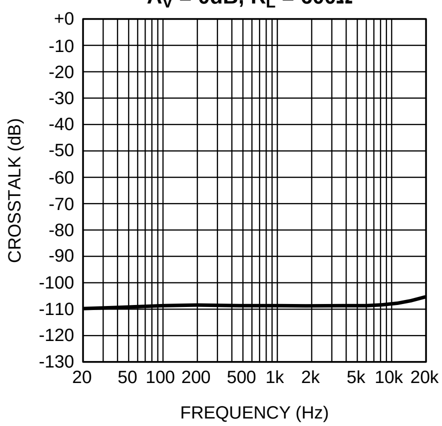


Figure 45.

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

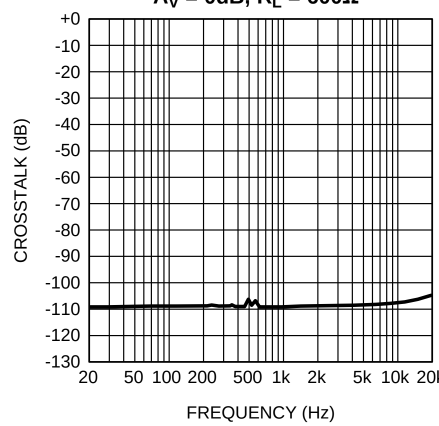


Figure 46.

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

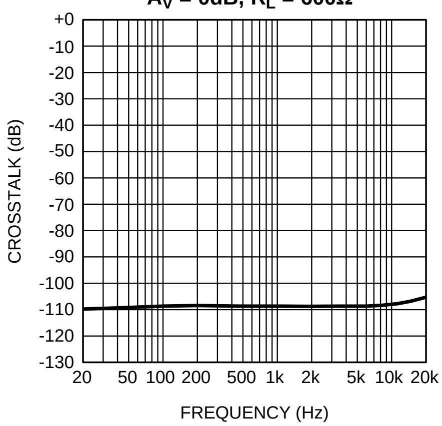


Figure 47.

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

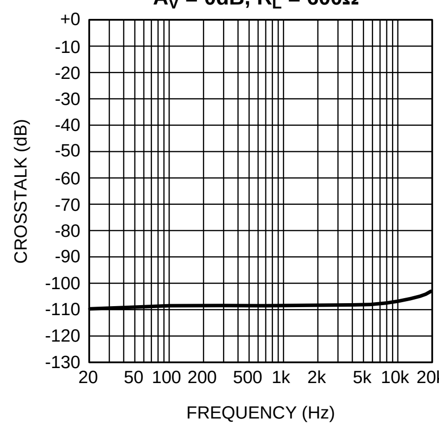


Figure 48.

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

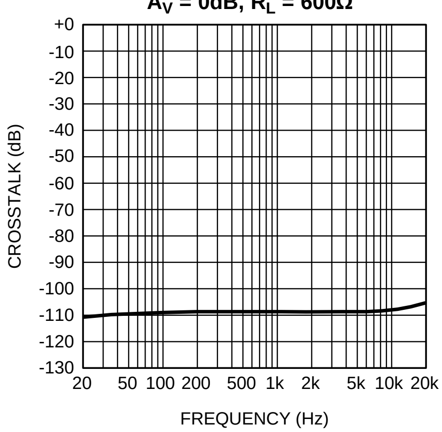


Figure 49.

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

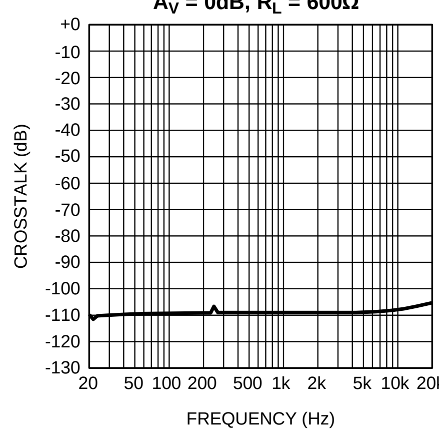


Figure 50.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

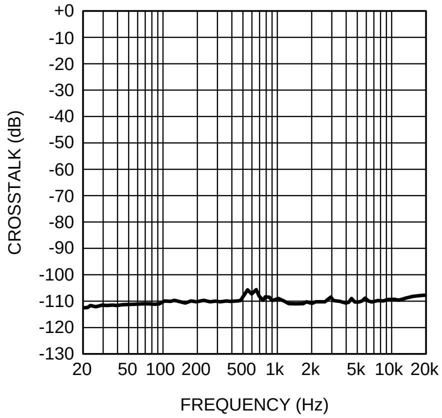


Figure 51.

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

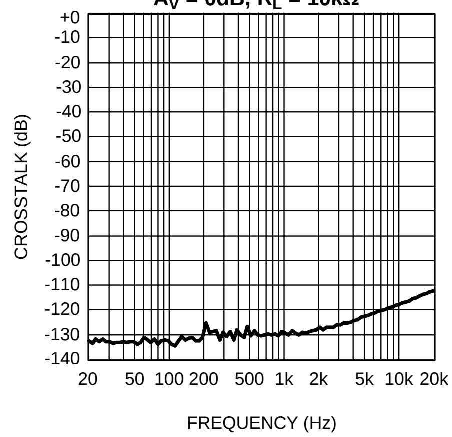


Figure 52.

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

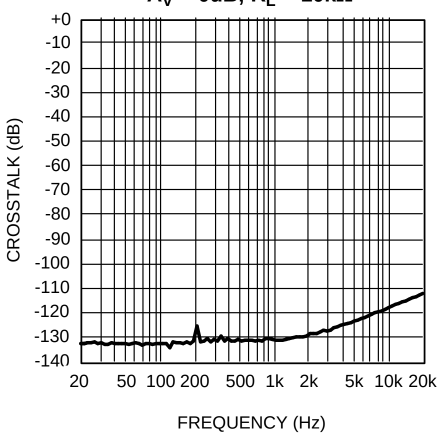


Figure 53.

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

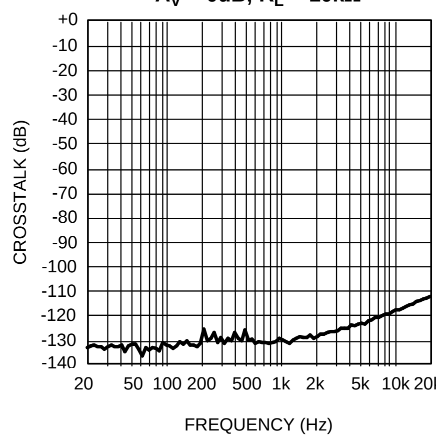


Figure 54.

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

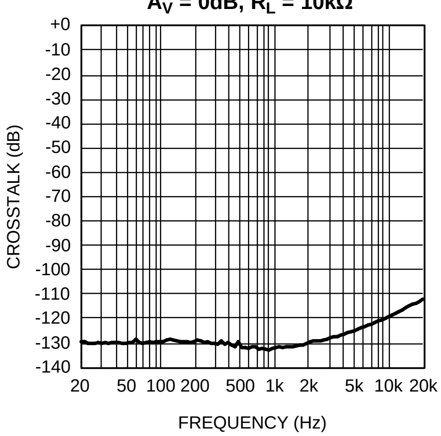


Figure 55.

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

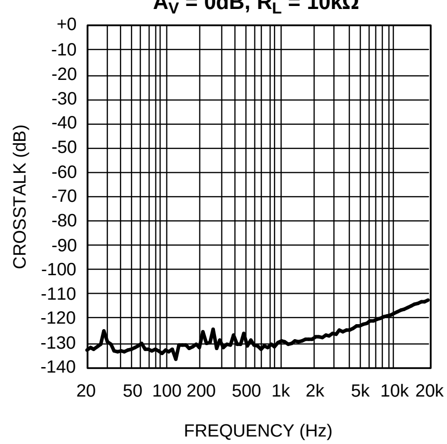


Figure 56.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

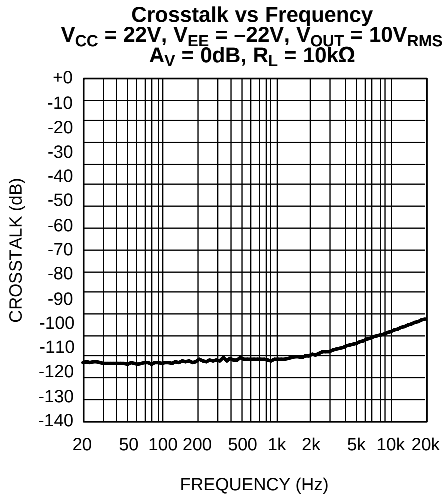


Figure 57.

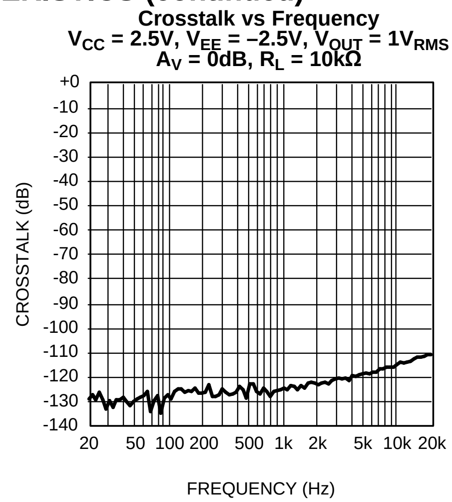


Figure 58.

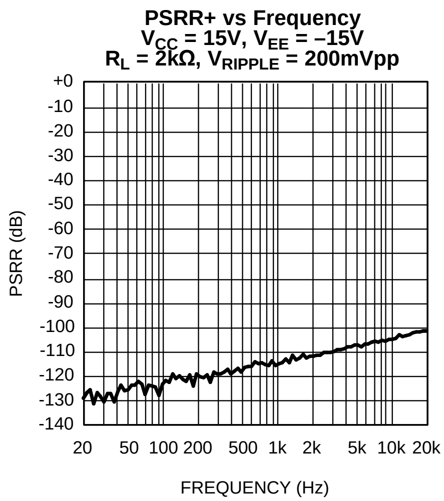


Figure 59.

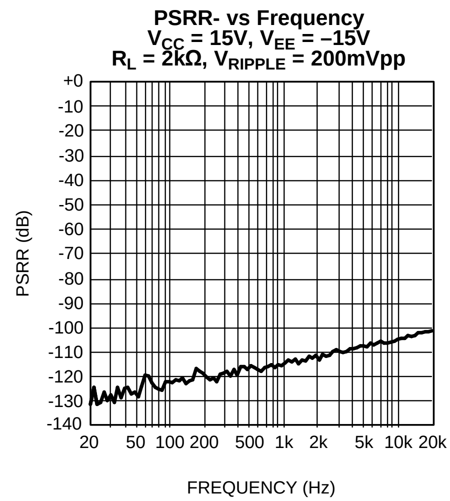


Figure 60.

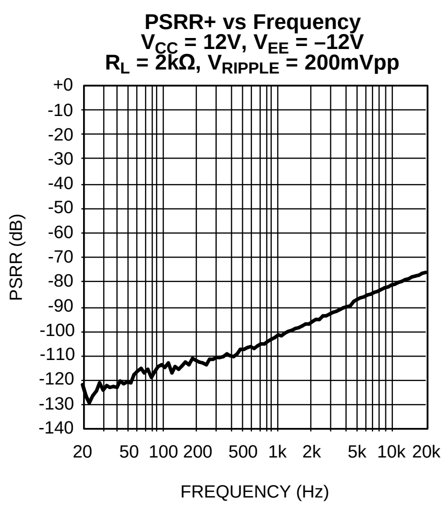


Figure 61.

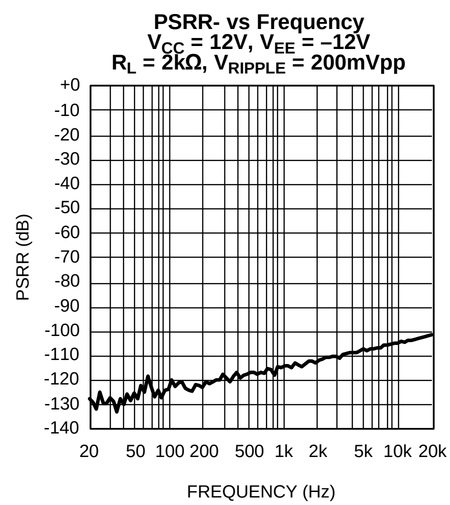


Figure 62.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

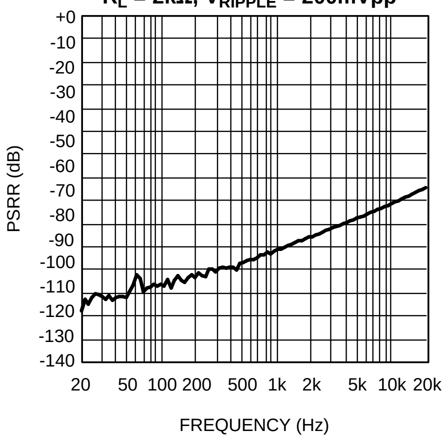


Figure 63.

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

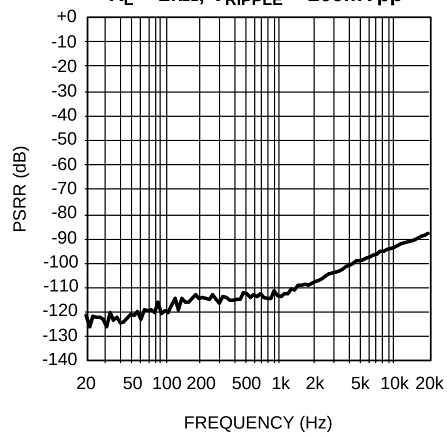


Figure 64.

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

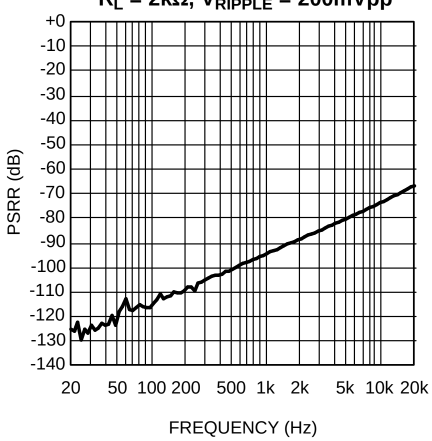


Figure 65.

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

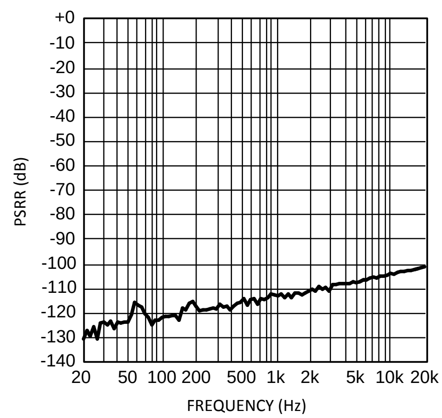


Figure 66.

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

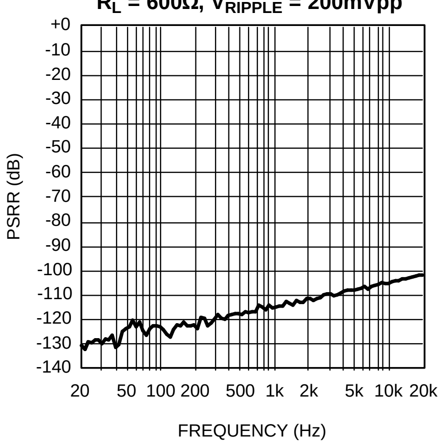


Figure 67.

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

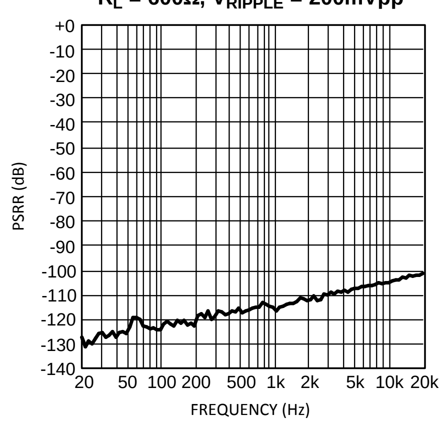


Figure 68.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

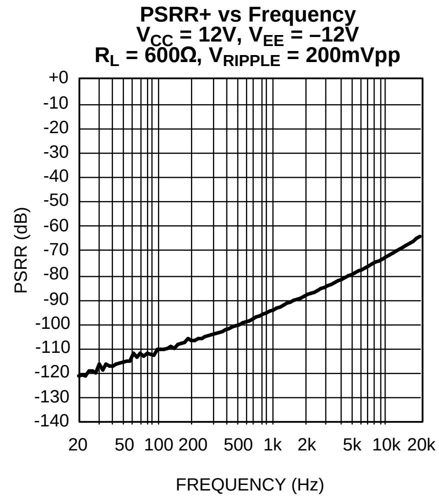


Figure 69.

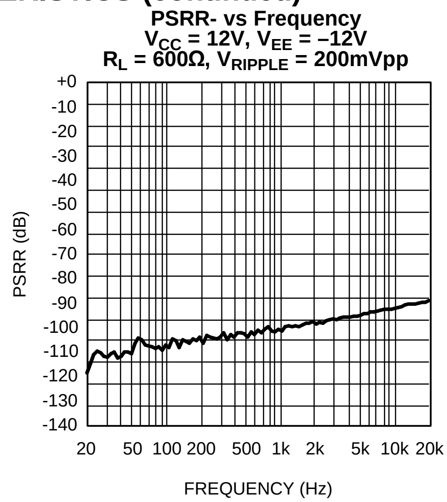


Figure 70.

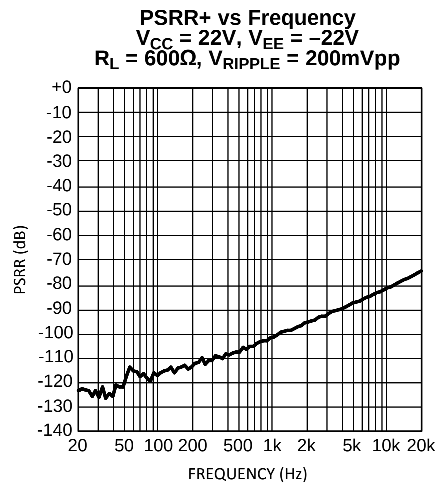


Figure 71.

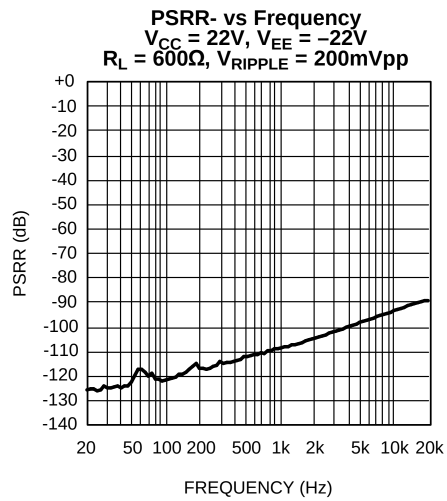


Figure 72.

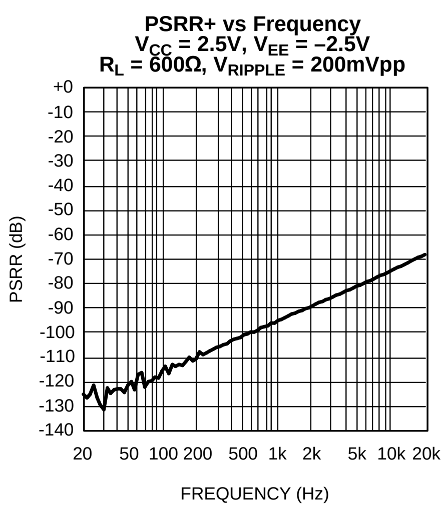


Figure 73.

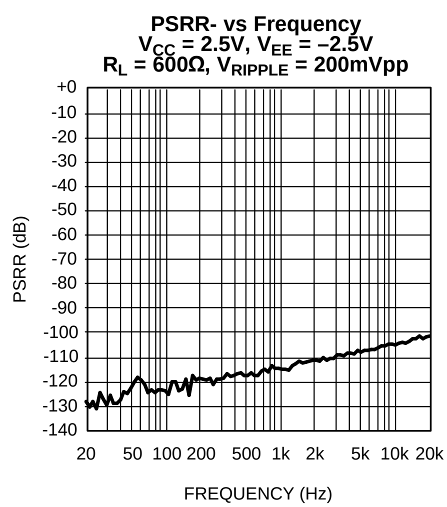


Figure 74.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

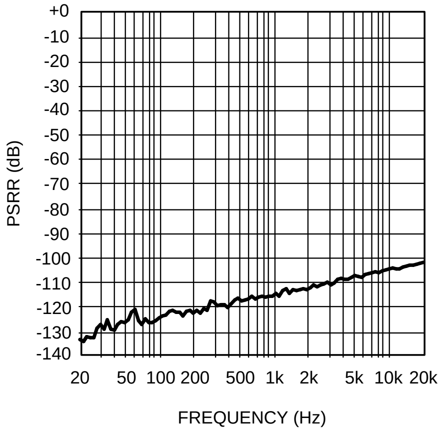


Figure 75.

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

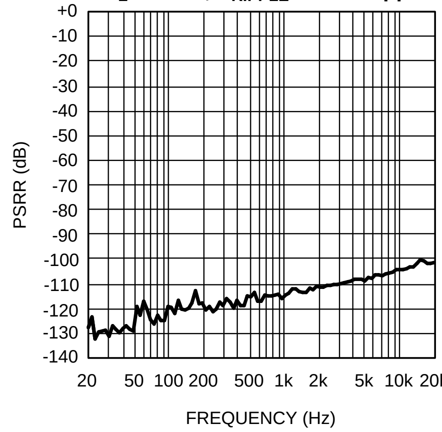


Figure 76.

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

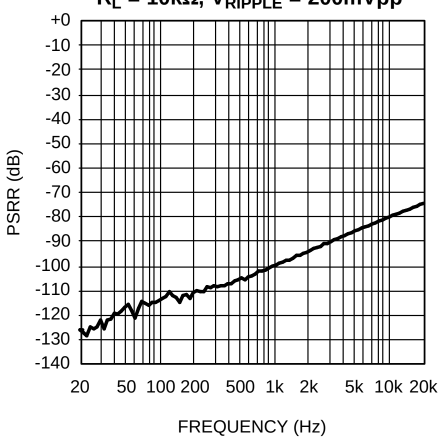


Figure 77.

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

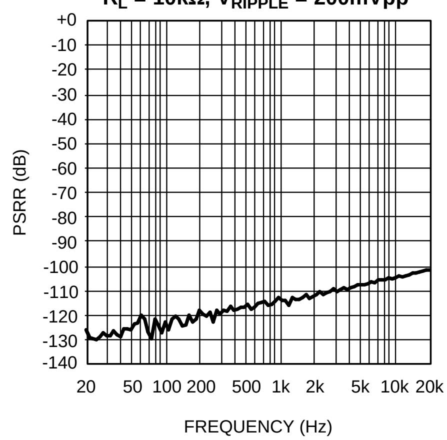


Figure 78.

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

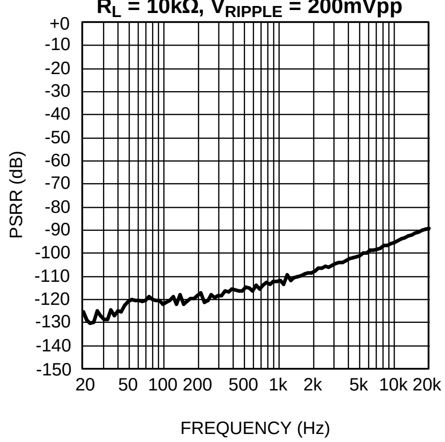


Figure 79.

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

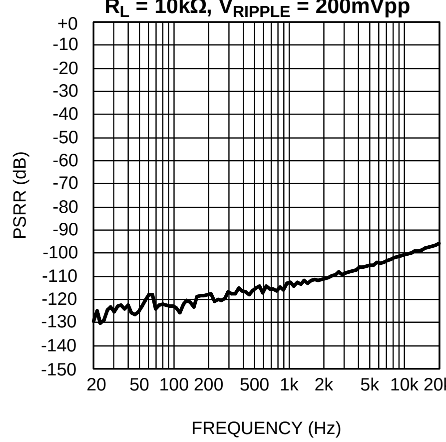


Figure 80.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

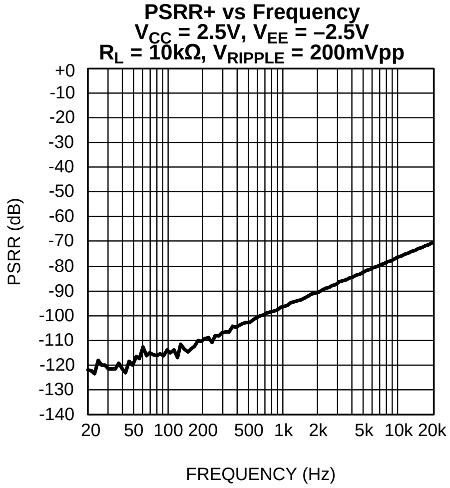


Figure 81.

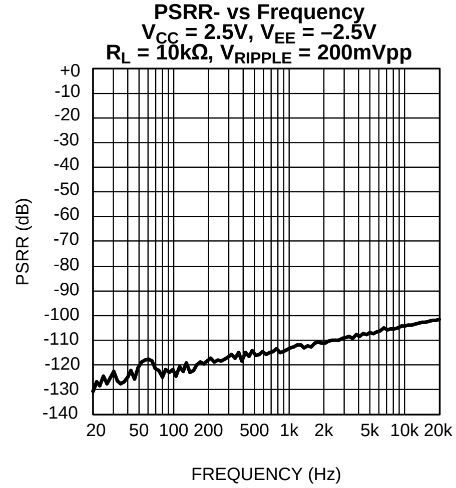


Figure 82.

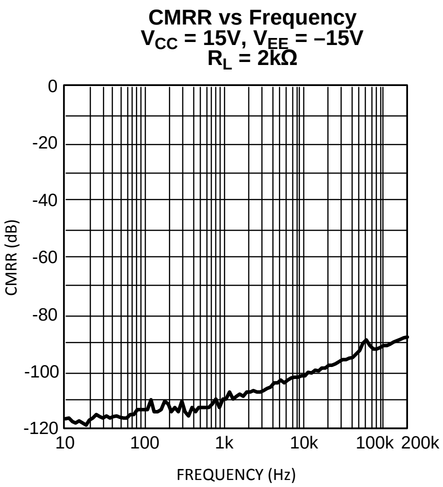


Figure 83.

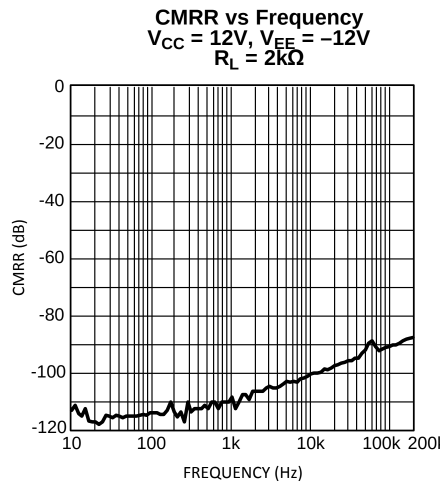


Figure 84.

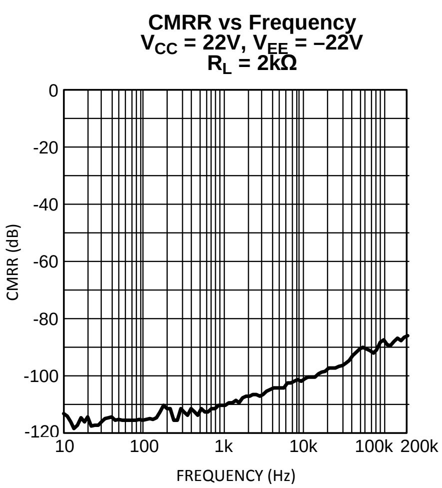


Figure 85.

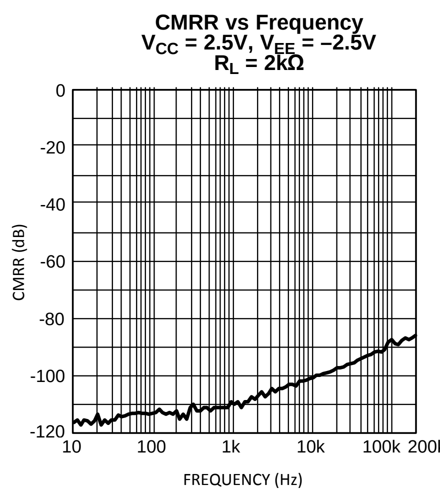


Figure 86.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

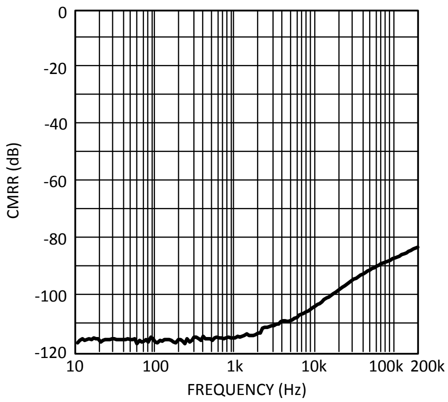


Figure 87.

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

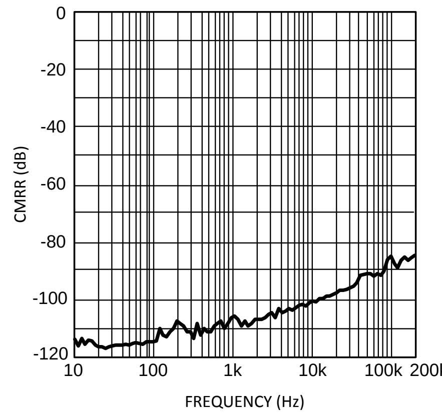


Figure 88.

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

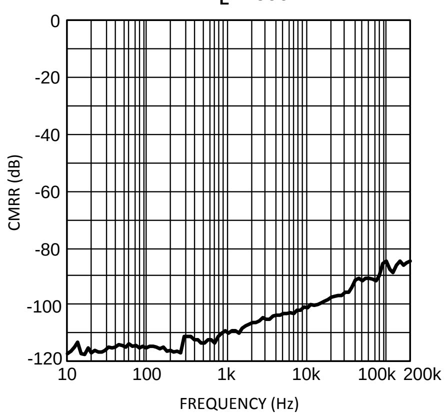


Figure 89.

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

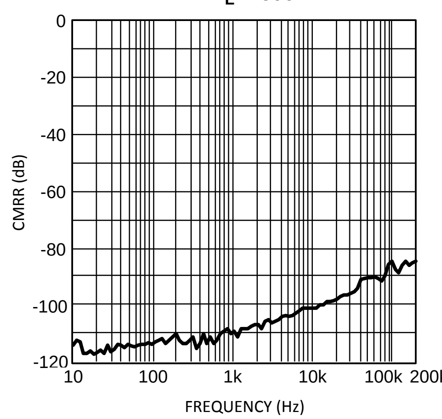


Figure 90.

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

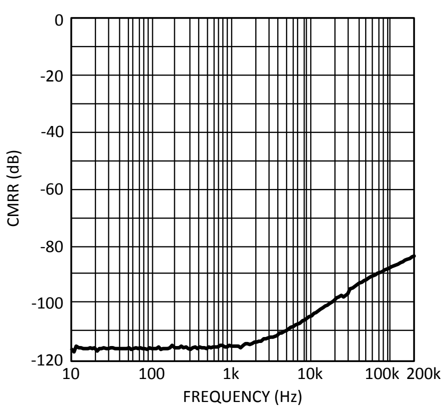


Figure 91.

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

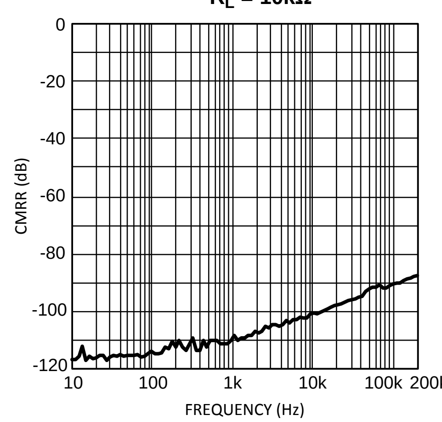


Figure 92.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

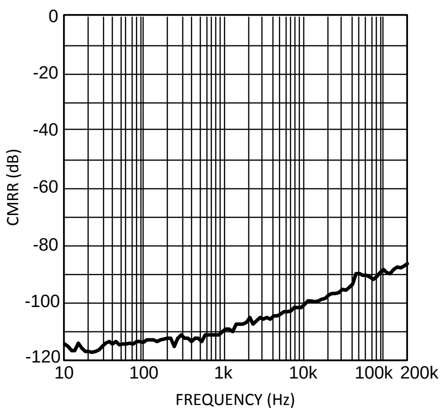


Figure 93.

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

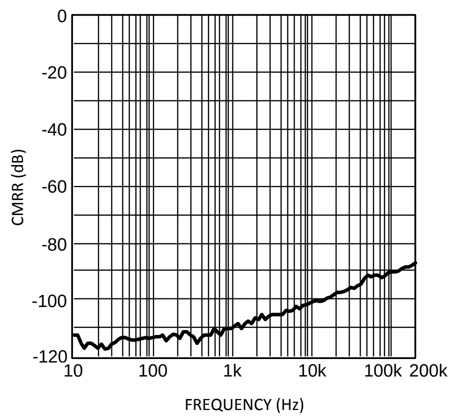


Figure 94.

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

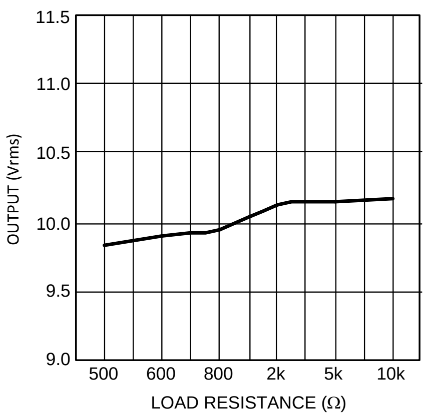


Figure 95.

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

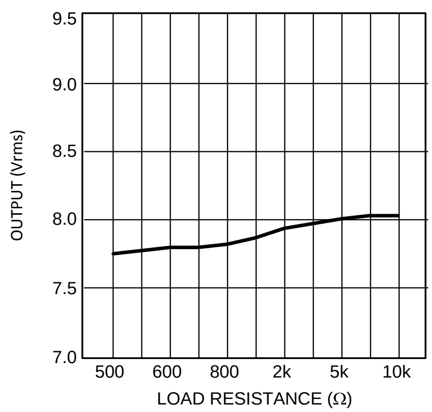


Figure 96.

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

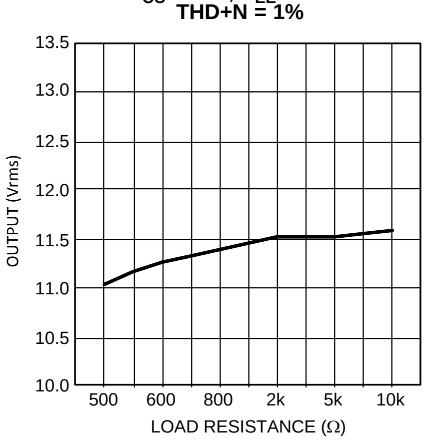


Figure 97.

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

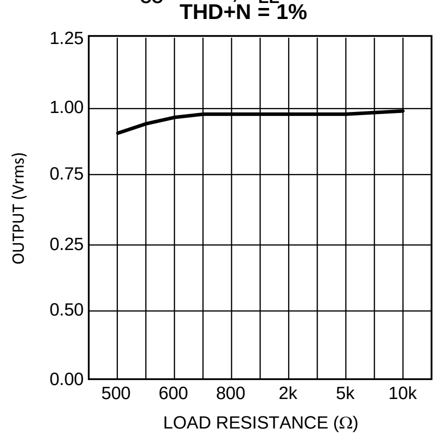


Figure 98.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

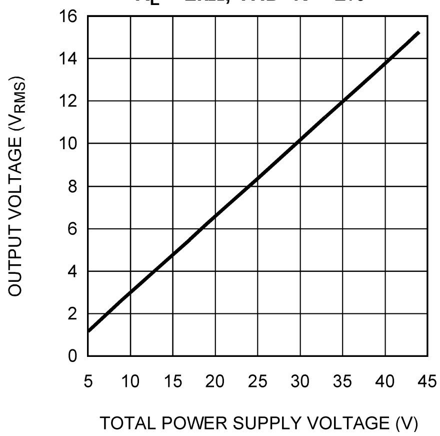


Figure 99.

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

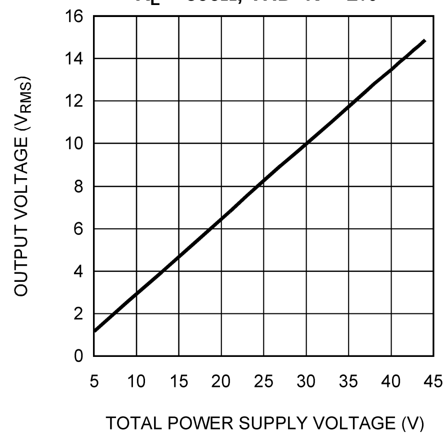


Figure 100.

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

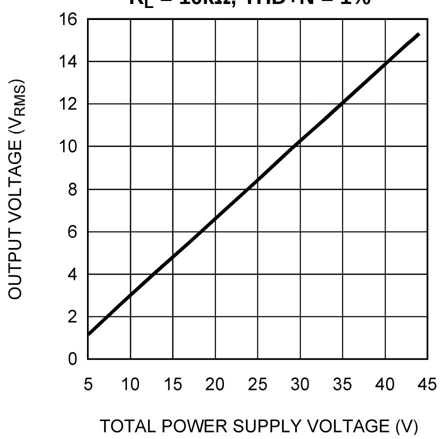


Figure 101.

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

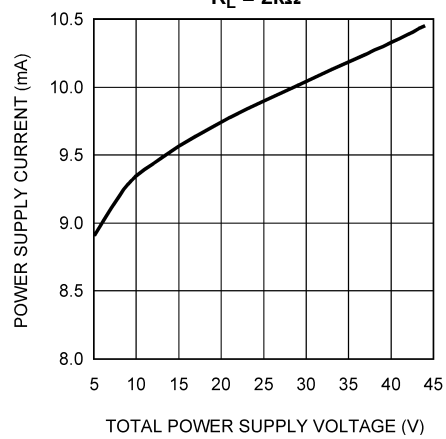


Figure 102.

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

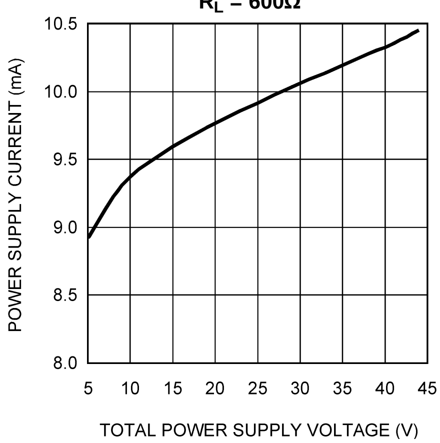


Figure 103.

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

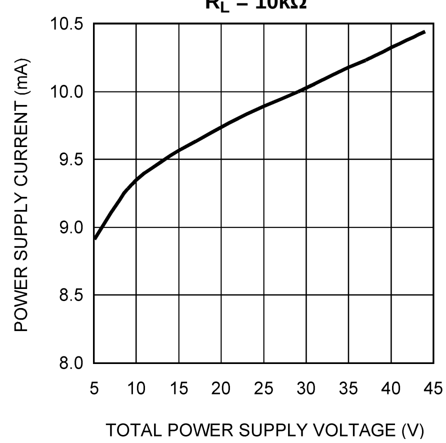


Figure 104.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Full Power Bandwidth vs Frequency

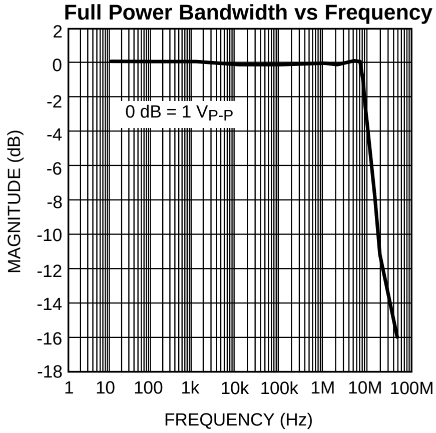


Figure 105.

Gain Phase vs Frequency

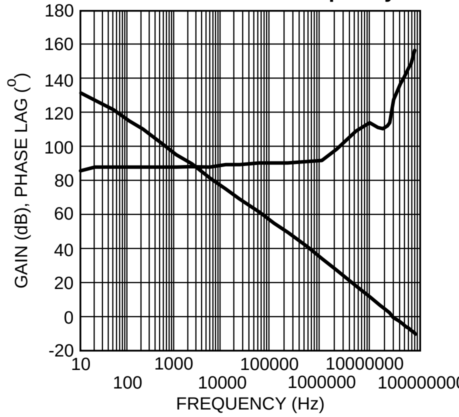


Figure 106.

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

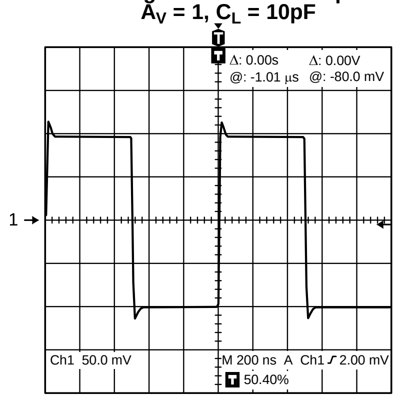


Figure 107.

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

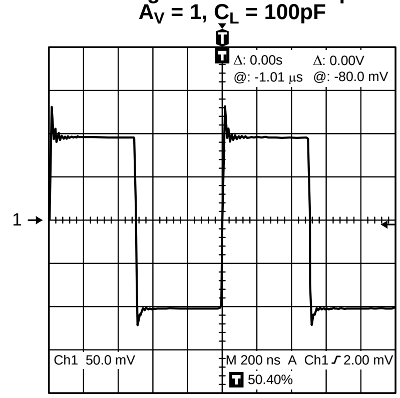


Figure 108.

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 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 R1 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.

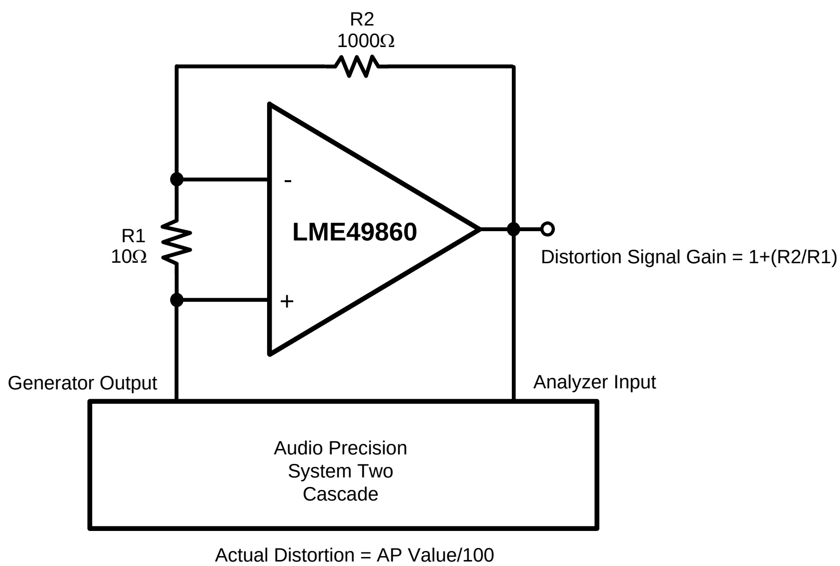
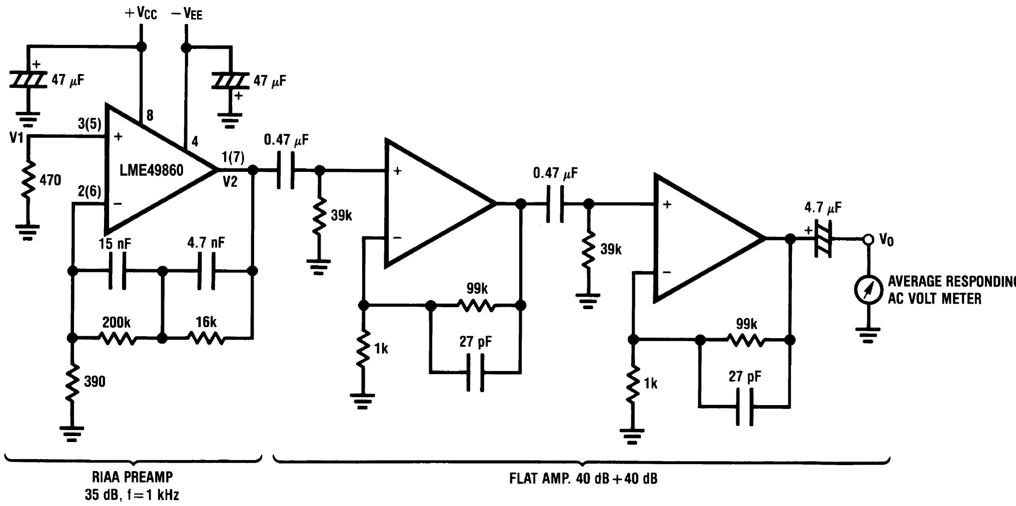


Figure 109. THD+N and IMD Distortion Test Circuit

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.



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 = V0/560,000 (V)

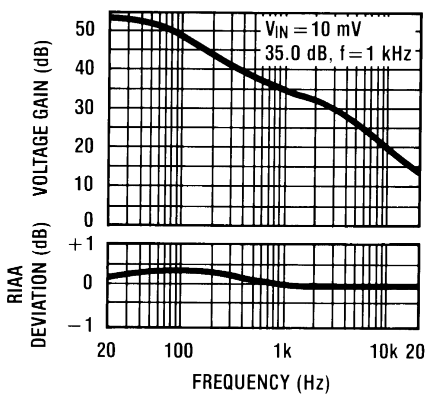


Figure 111. RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency

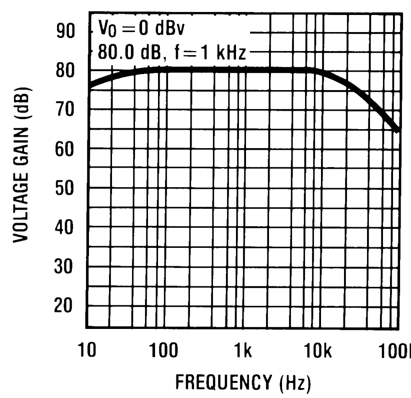
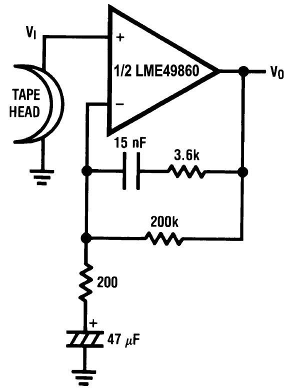


Figure 112. Flat Amp Voltage Gain vs Frequency

TYPICAL APPLICATIONS



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

Figure 113. NAB Preamp

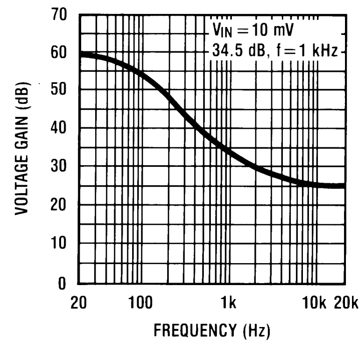
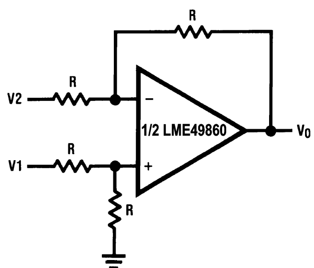
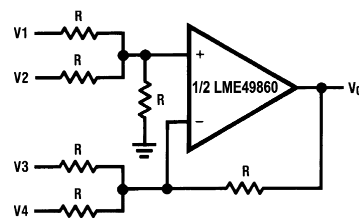


Figure 114. NAB Preamp Voltage Gain vs Frequency



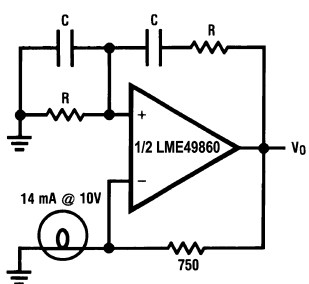
$V_O = V1–V2$

Figure 115. Balanced to Single Ended Converter



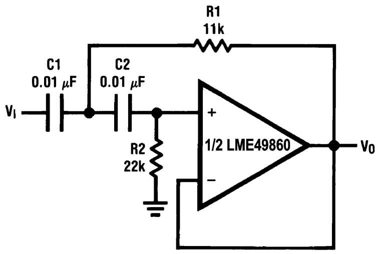
$V_O = V1 + V2 − V3 − V4$

Figure 116. Adder/Subtracter



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

Figure 117. Sine Wave Oscillator



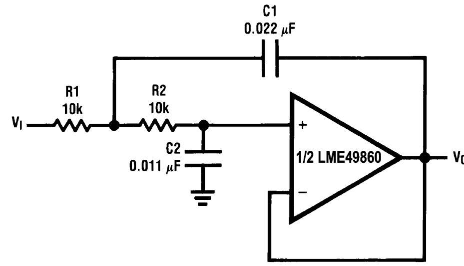
if $C1 = C2 = C$

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

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

Figure 118. Second Order High Pass Filter (Butterworth)



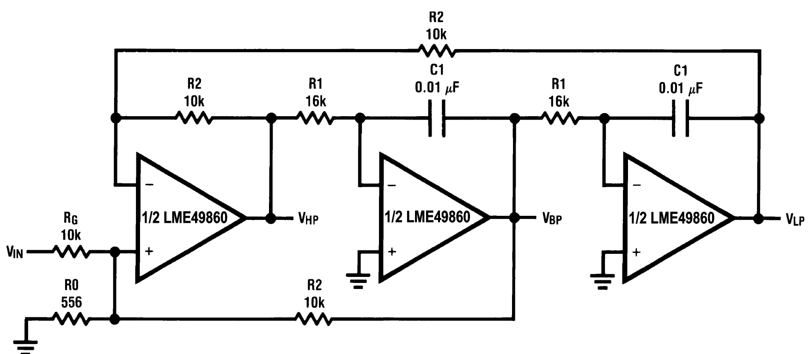
if $R1 = R2 = R$

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

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

Illustration is f_0 = 1 kHz

Figure 119. Second Order Low Pass Filter (Butterworth)



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

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

Figure 120. State Variable Filter

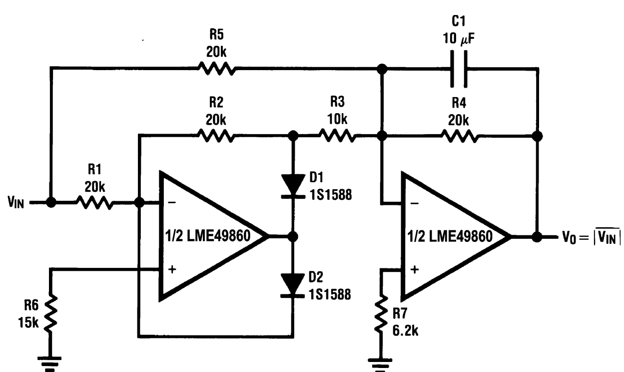


Figure 121. AC/DC Converter

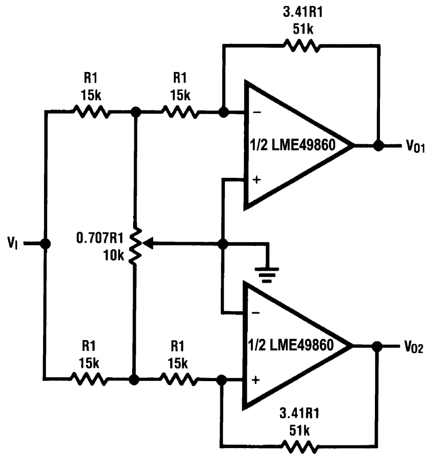


Figure 122. 2 Channel Panning Circuit (Pan Pot)

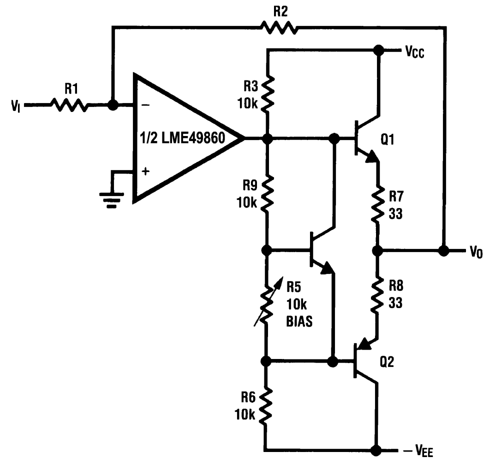
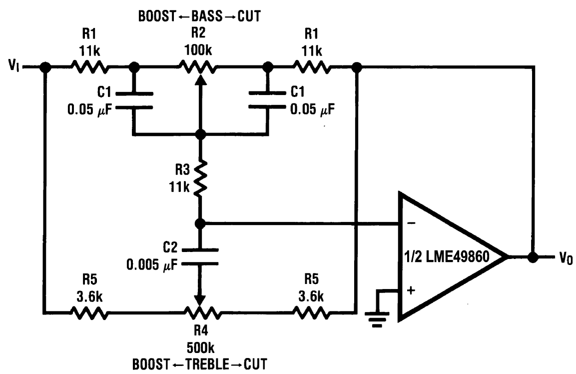


Figure 123. Line Driver



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

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

Illustration is:

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

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

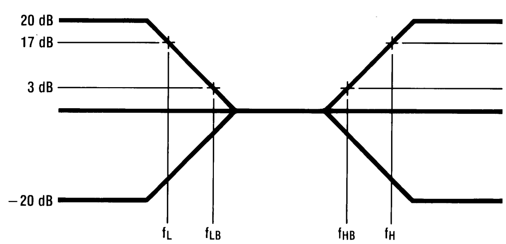
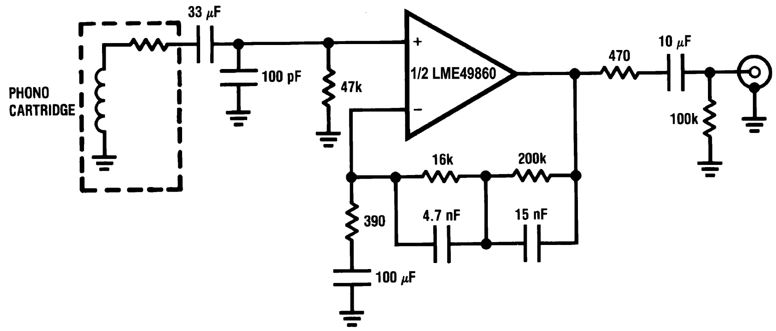
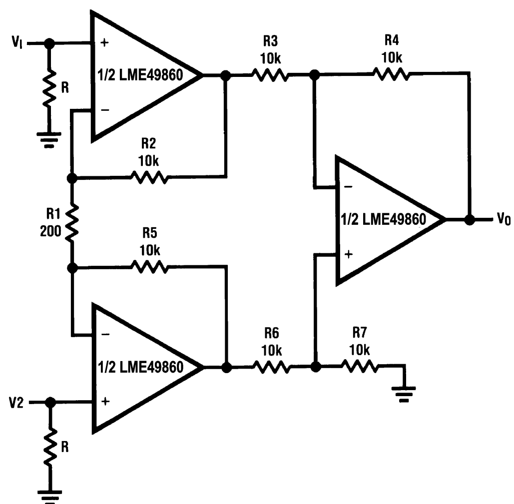


Figure 124. Tone Control



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

Figure 125. RIAA Preamp



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)

Figure 126. Balanced Input Mic Amp

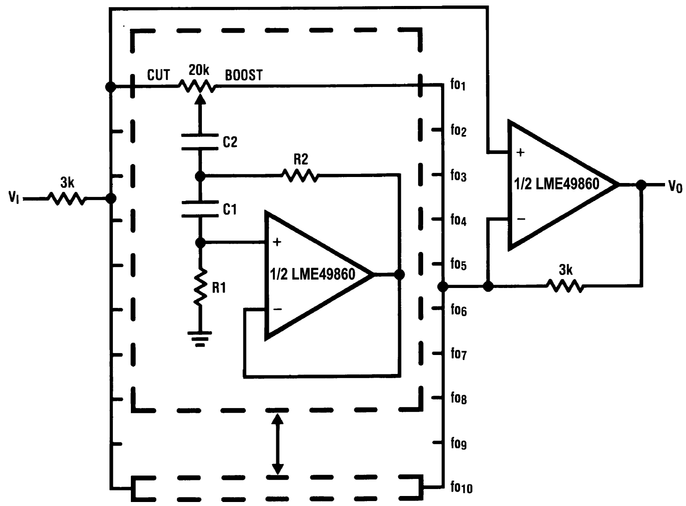


Figure 127. 10 Band Graphic Equalizer

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

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.
C	04/05/13	Changed layout of National Data Sheet to TI format.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LME49860MAX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	L49860 MA
LME49860MAX/NOPB.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	L49860 MA
LME49860MAX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	L49860 MA

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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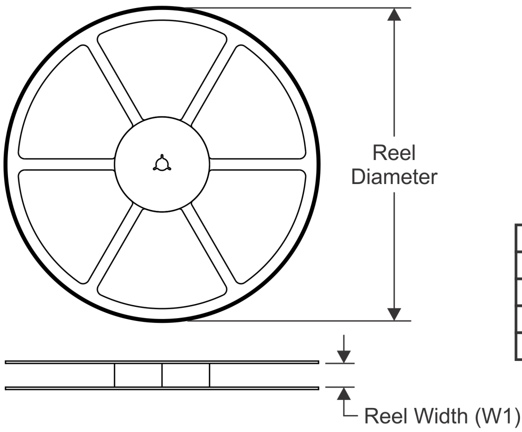
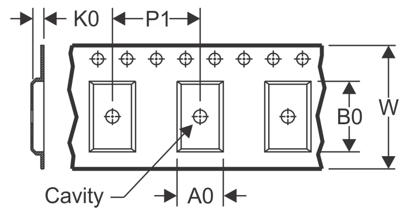
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

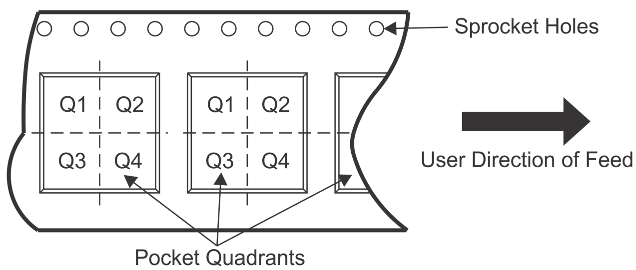


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

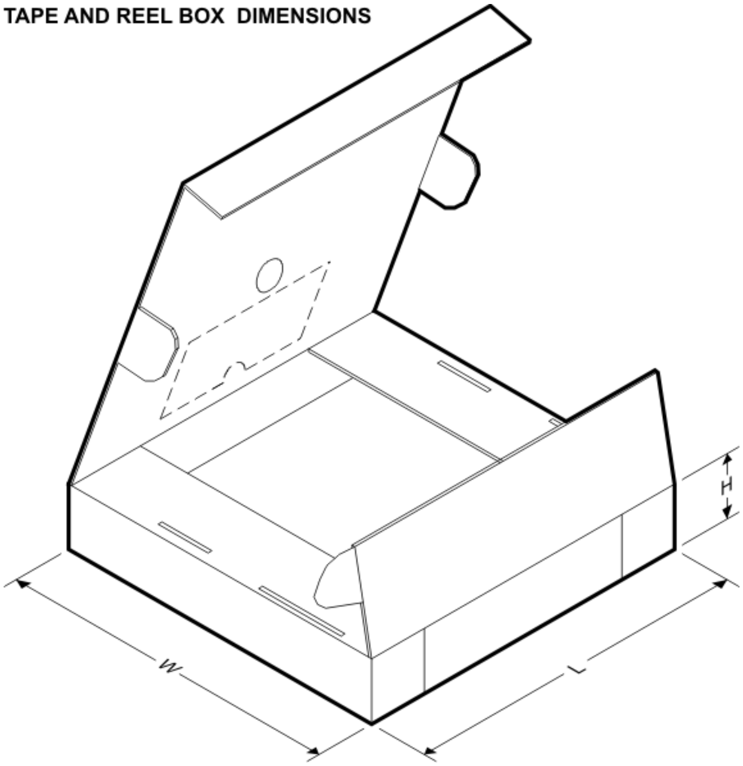
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

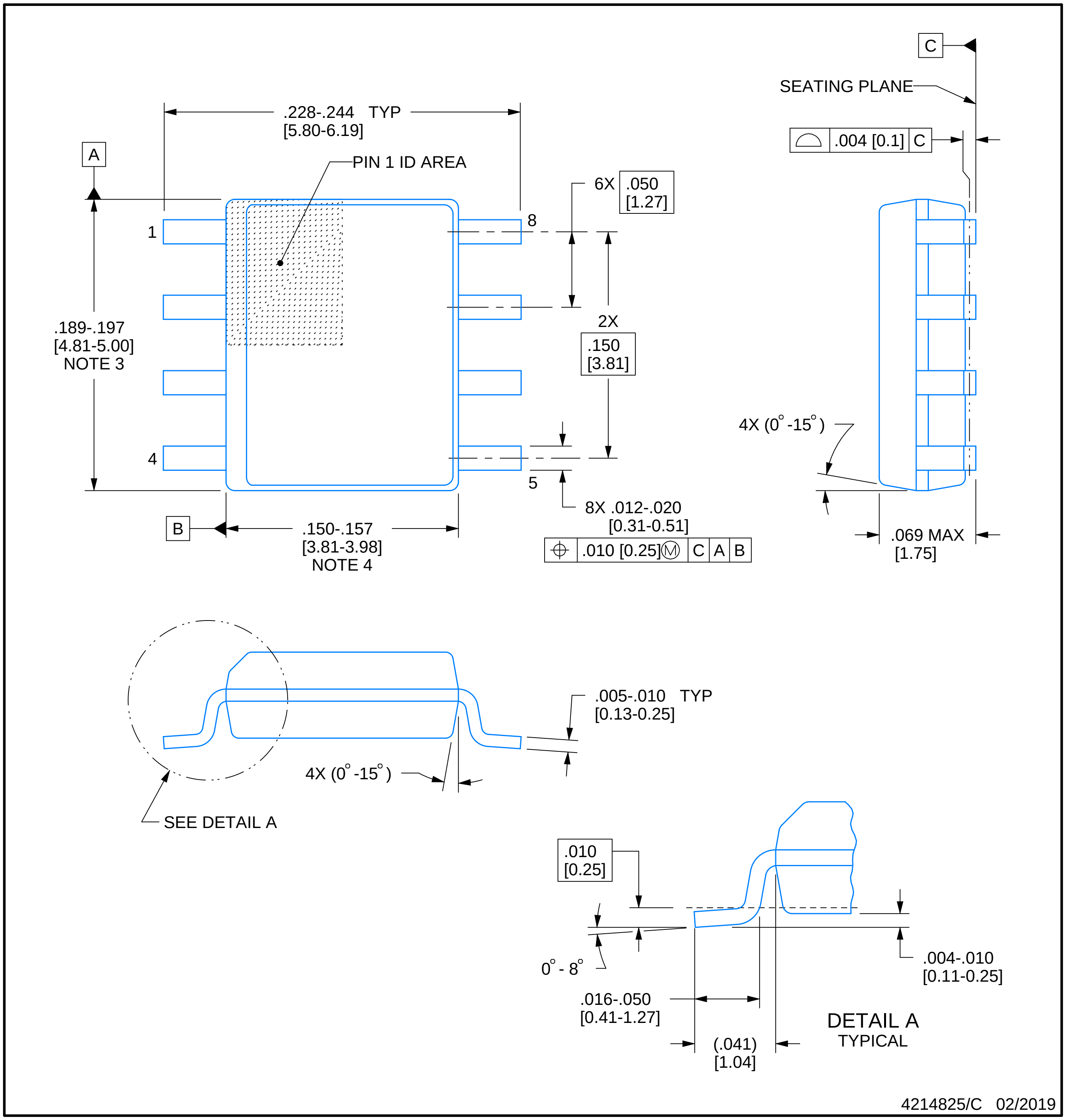
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LME49860MAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



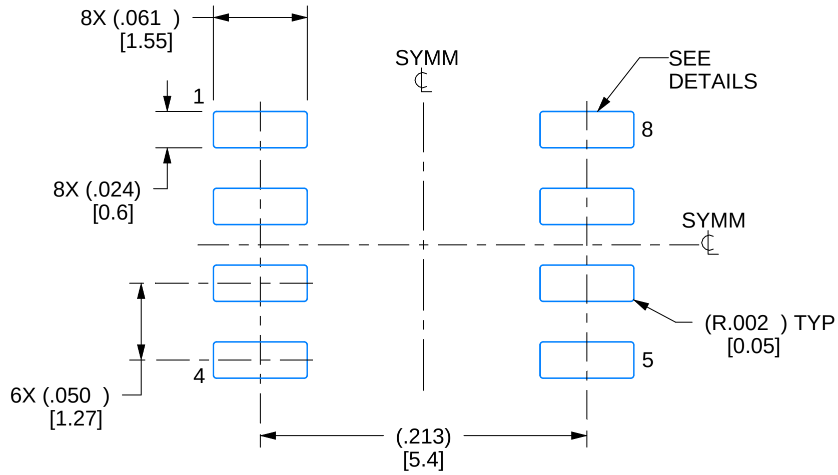
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LME49860MAX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

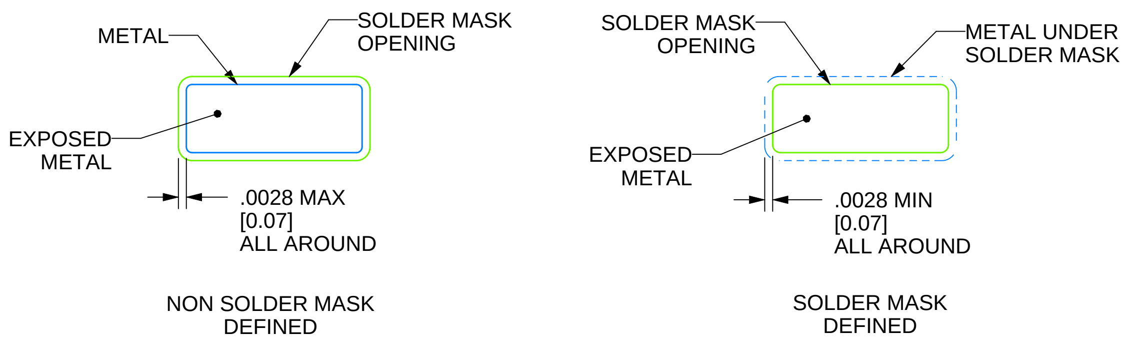


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X

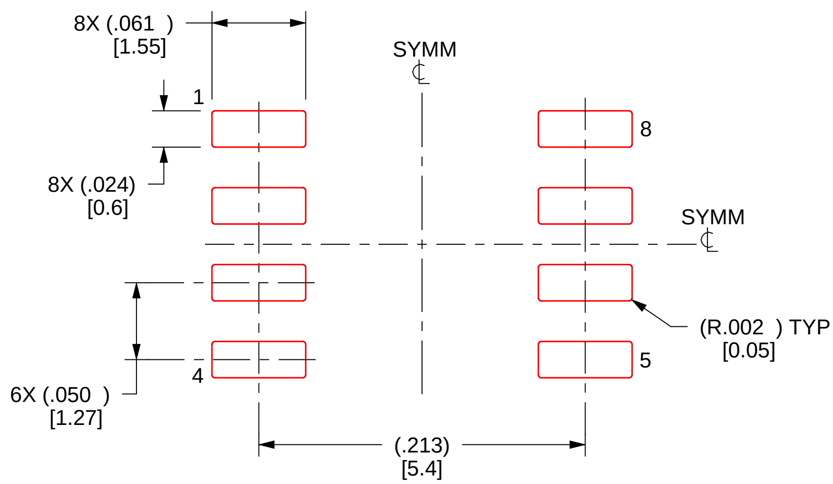


SOLDER MASK DETAILS

4214825/C 02/2019

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.



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

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.