LM4562 Dual High-Performance, High-Fidelity Audio Operational Amplifier

Check for Samples: LM4562

FEATURES

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

APPLICATIONS

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

KEY SPECIFICATIONS

- **Power Supply Voltage Range: ±2.5V to ± 17V**
- **THD+N (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%**

DESCRIPTION

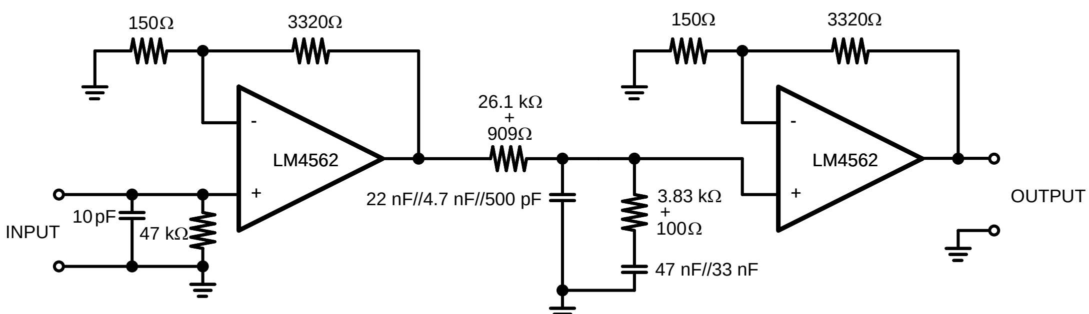
The LM4562 is part of the ultra-low distortion, low-noise, high-slew-rate operational amplifier series optimized and fully specified for high-performance, high-fidelity applications. The LM4562 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LM4562 combines extremely low voltage noise density (2.7nV/$\sqrt{Hz}$) 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 LM4562 has a high slew rate of ±20V/μs and an output current capability of ±26mA. Further, dynamic range is maximized by an output stage that drives 2kΩ loads to within 1V of either power supply voltage and to within 1.4V when driving 600Ω loads.

The LM4562's outstanding CMRR (120dB), PSRR (120dB), and V_{OS} (0.1mV) give the amplifier excellent operational amplifier DC performance.

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

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

TYPICAL APPLICATION



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

Passively Equalized RIAA Phono Preamplifier

CONNECTION DIAGRAMS

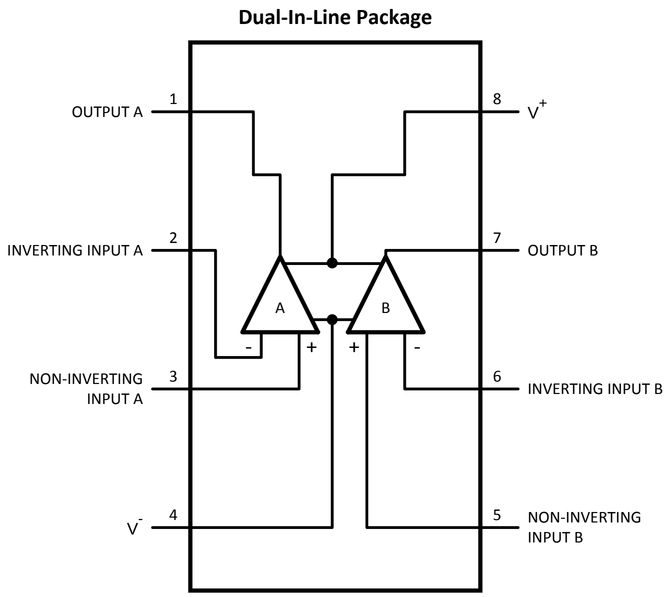


Figure 1. 8-Lead SOIC (D Package)
8-Lead PDIP (P Package)

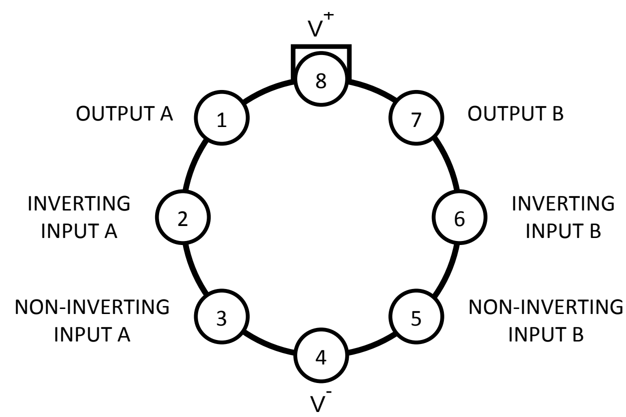


Figure 2. 8-Lead TO-99 (LMC Package)

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 ($V_S = V^+ - V^-$)		36V
Storage Temperature		−65°C to 150°C
Input Voltage		(V-) - 0.7V to (V+) + 0.7V
Output Short Circuit[(4)]		Continuous
Power Dissipation		Internally Limited
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} (D)	145°C/W
	θ_{JA} (P)	102°C/W
	θ_{JA} (LMC)	150°C/W
	θ_{JC} (LMC)	35°C/W
Temperature Range ($T_{MIN} \le T_A \le T_{MAX}$)		$-40°C \le T_A \le 85°C$
Supply Voltage Range		$\pm 2.5V \le V_S \le \pm 17V$

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(3) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
(4) Amplifier output connected to GND, any number of amplifiers within a package.
(5) Human body model, 100pF discharged through a 1.5kΩ resistor.
(6) Machine Model ESD test is covered by specification EIAJ IC-121-1981. A 200pF cap is charged to the specified voltage and then discharged directly into the IC with no external series resistor (resistance of discharge path must be under 50Ω).

ELECTRICAL CHARACTERISTICS FOR THE LM4562 (1) (2)

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

Symbol	Parameter	Conditions	LM4562 Typical (3)	LM4562 Limit (4)	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/√Hz (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		pA/√Hz
V_{OS}	Offset Voltage		±0.1	±0.7	mV (max)
$\Delta V_{OS}/\Delta Temp$	Average Input Offset Voltage Drift vs Temperature	–40°C ≤ T_A ≤ 85°C	0.2		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	ΔV_S = 20V (5)	120	110	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 ≤ 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		+14.1 –13.9	(V+) – 2.0 (V-) + 2.0	V (min)
CMRR	Common-Mode Rejection	–10V<Vcm<10V	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	–10V<Vout<10V, R_L = 600Ω	140	125	dB (min)
		–10V<Vout<10V, R_L = 2kΩ	140		
		–10V<Vout<10V, R_L = 10kΩ	140		
V_{OUTMAX}	Maximum Output Voltage Swing	R_L = 600Ω	±13.6	±12.5	V (min)
		R_L = 2kΩ	±14.0		
		R_L = 10kΩ	±14.1		
I_{OUT}	Output Current	R_L = 600Ω, V_S = ±17V	±26	±23	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

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(3) Typical specifications are specified at +25ºC and represent the most likely parametric norm.
(4) Tested limits are specified to AOQL (Average Outgoing Quality Level).
(5) PSRR is measured as follows: V_{OS} is measured at two supply voltages, ±5V and ±15V. PSRR = | 20log($\Delta V_{OS}/\Delta V_S$) |.

ELECTRICAL CHARACTERISTICS FOR THE LM4562[(1)(2)] (continued)

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

Symbol	Parameter	Conditions	LM4562		Units (Limits)
			Typical[(3)]	Limit[(4)]	
C_{LOAD}	Capacitive Load Drive Overshoot	100pF	16		%
I_S	Total Quiescent Current	I_{OUT} = 0mA	10	12	mA (max)

TYPICAL PERFORMANCE CHARACTERISTICS

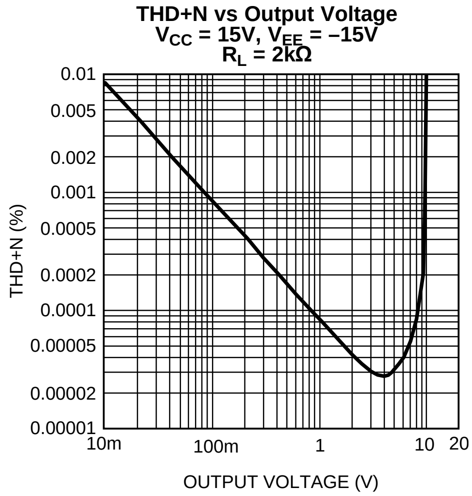


Figure 3.

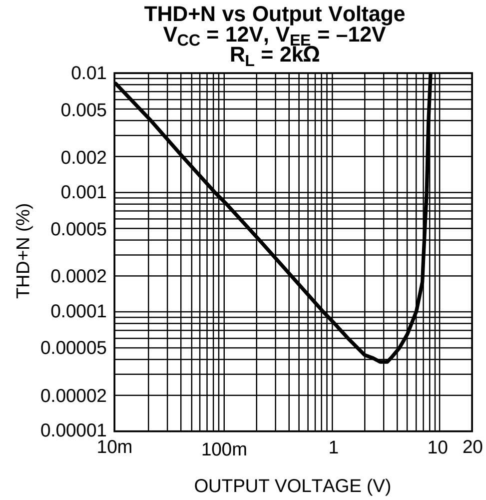


Figure 4.

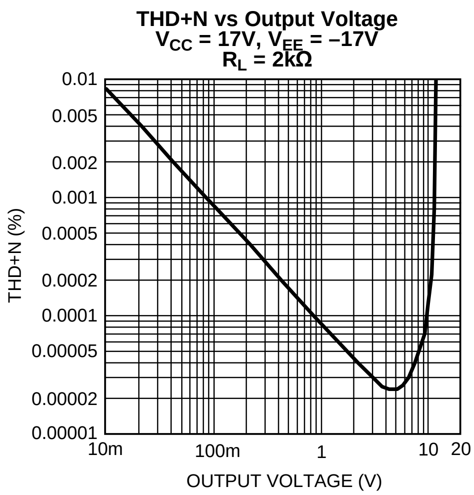


Figure 5.

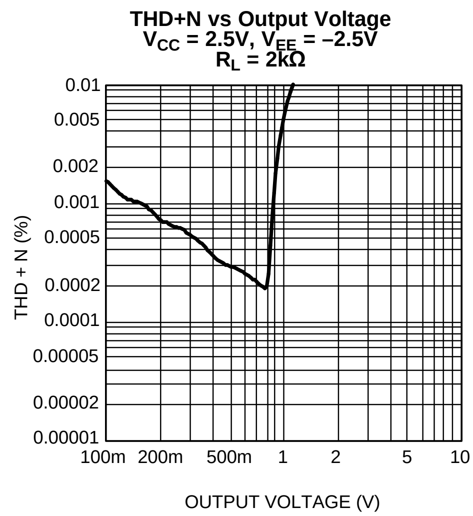


Figure 6.

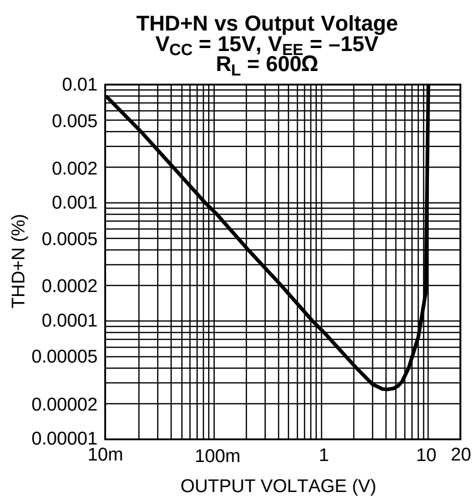


Figure 7.

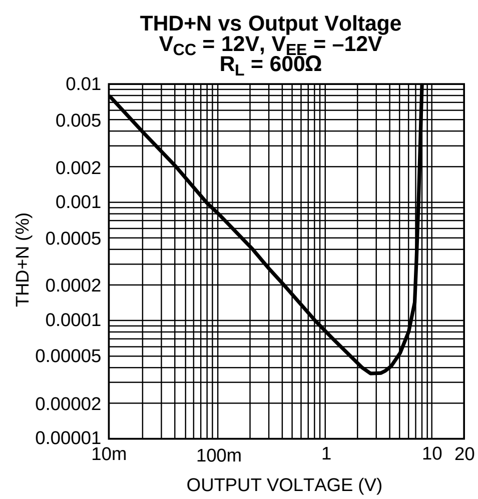


Figure 8.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

THD+N vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 600Ω

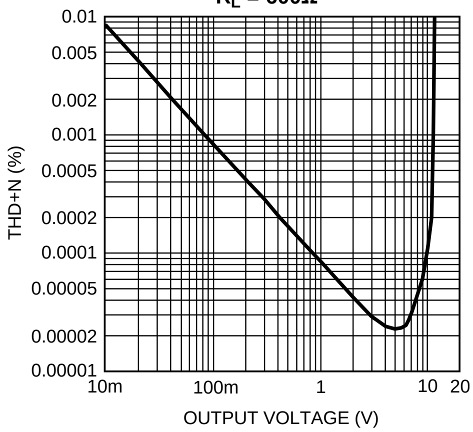


Figure 9.

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

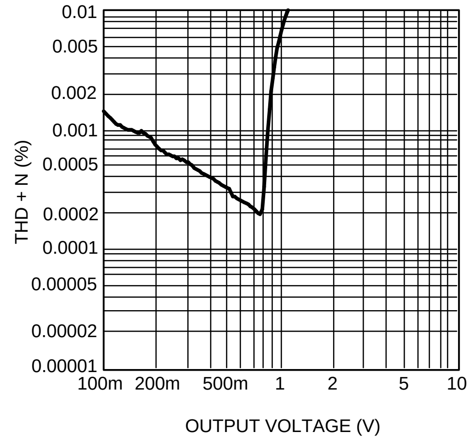


Figure 10.

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

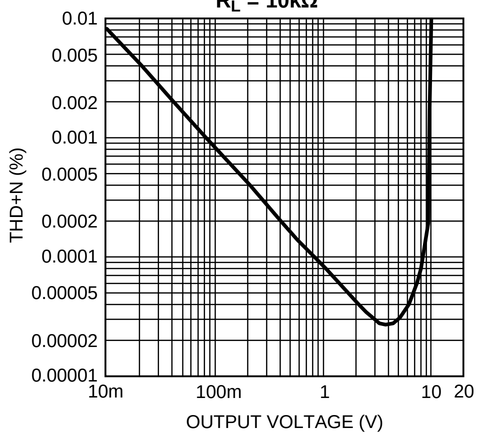


Figure 11.

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

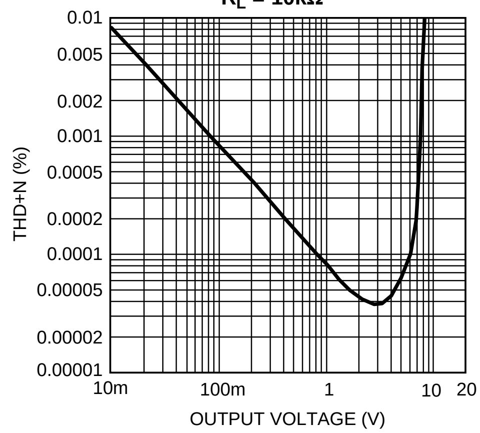


Figure 12.

THD+N vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ

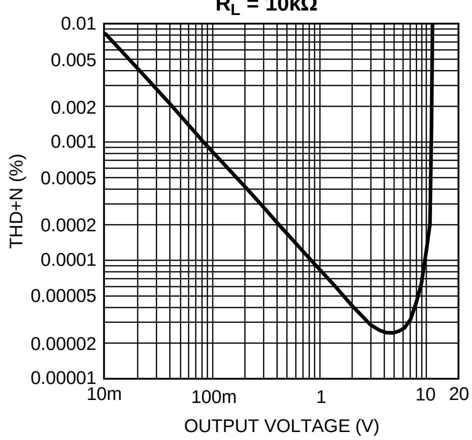


Figure 13.

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

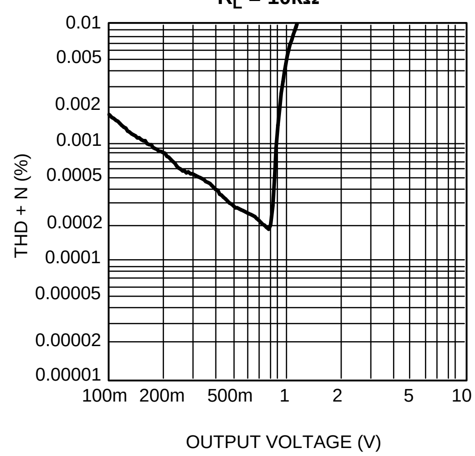


Figure 14.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

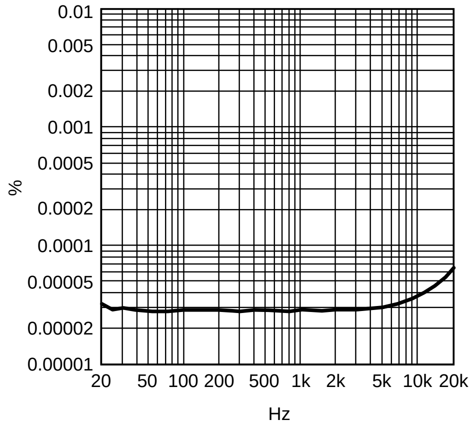


Figure 15.

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

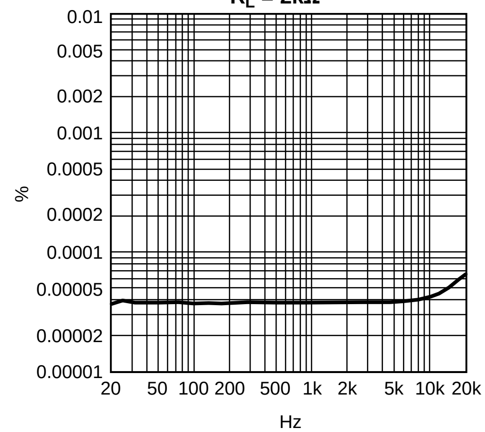


Figure 16.

THD+N vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
R_L = 2kΩ

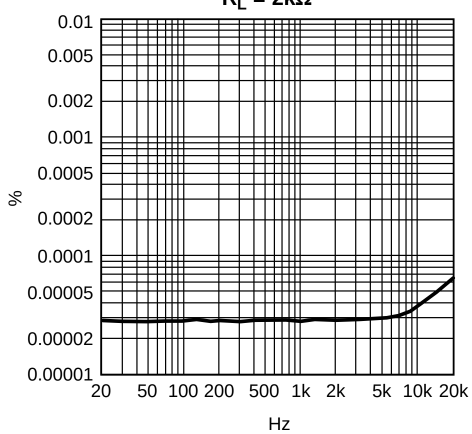


Figure 17.

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

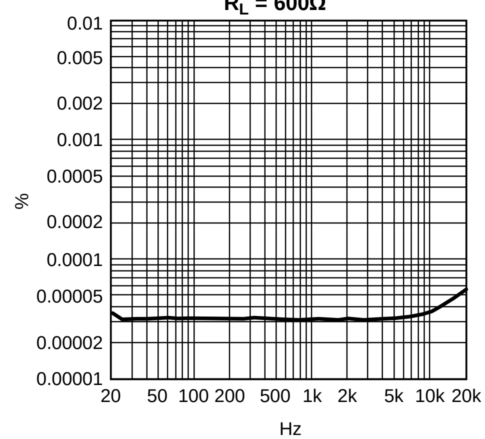


Figure 18.

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

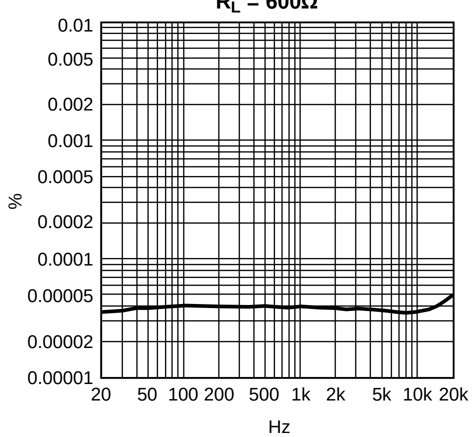


Figure 19.

THD+N vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
R_L = 600Ω

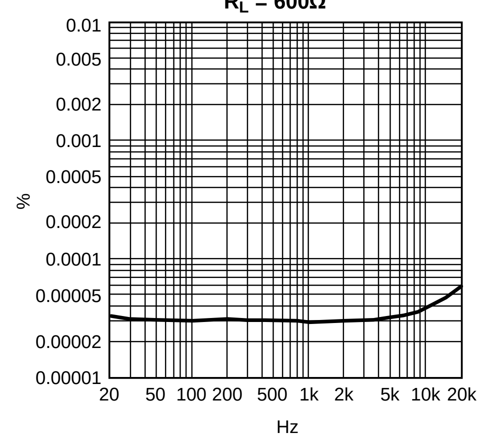


Figure 20.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

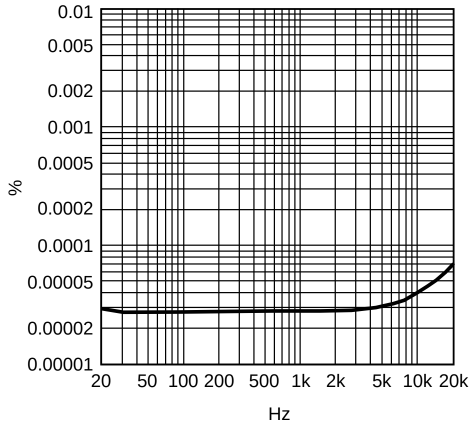


Figure 21.

THD+N vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = 3V_{RMS}
R_L = 10kΩ

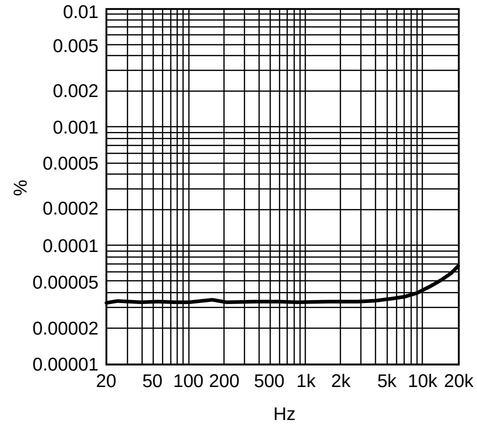


Figure 22.

THD+N vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
R_L = 10kΩ

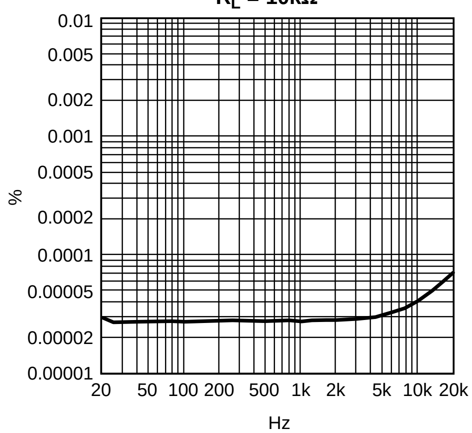


Figure 23.

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

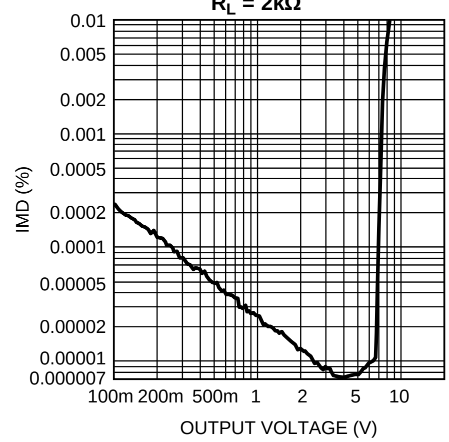


Figure 24.

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

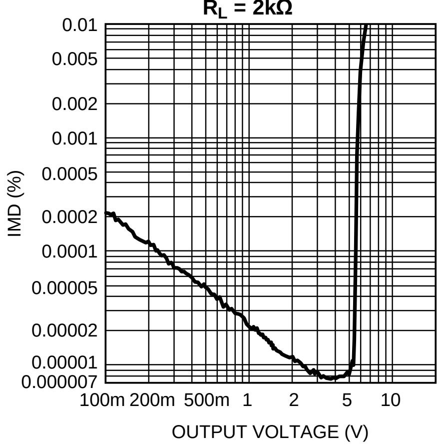


Figure 25.

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

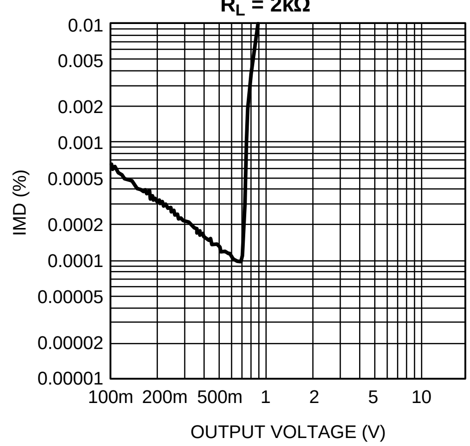


Figure 26.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 2kΩ

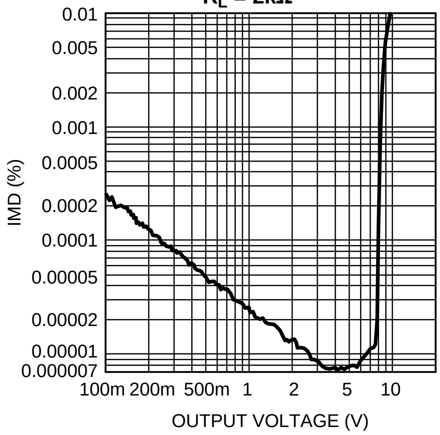


Figure 27.

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

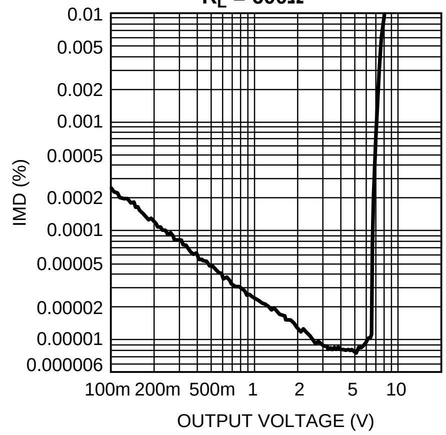


Figure 28.

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

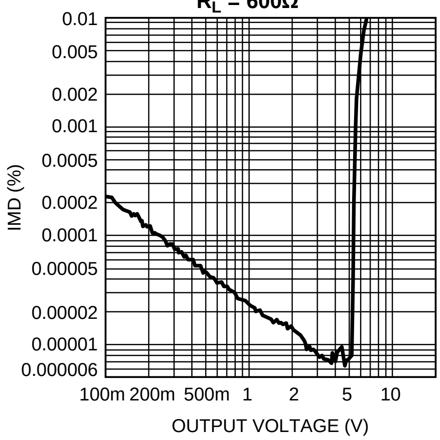


Figure 29.

IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 600Ω

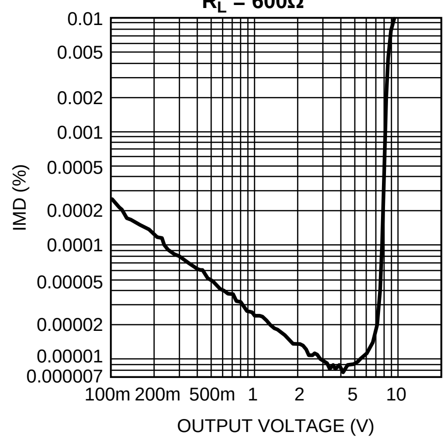


Figure 30.

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

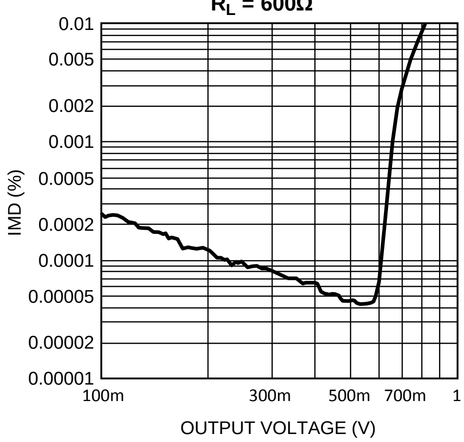


Figure 31.

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

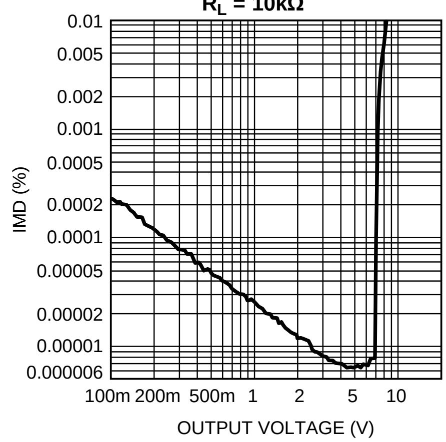


Figure 32.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

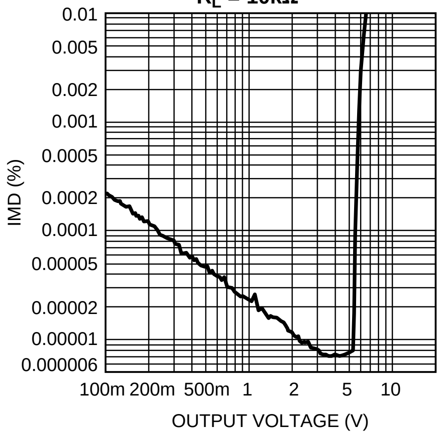


Figure 33.

IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ

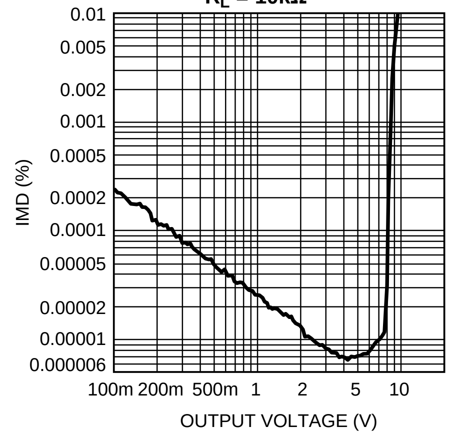


Figure 34.

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

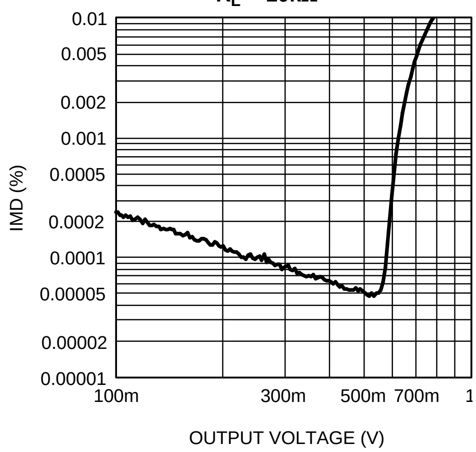


Figure 35.

Voltage Noise Density vs Frequency

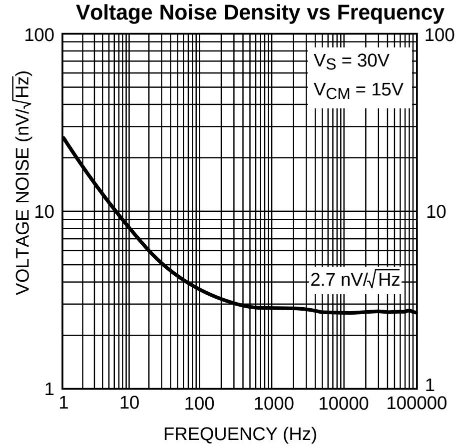


Figure 36.

Current Noise Density vs Frequency

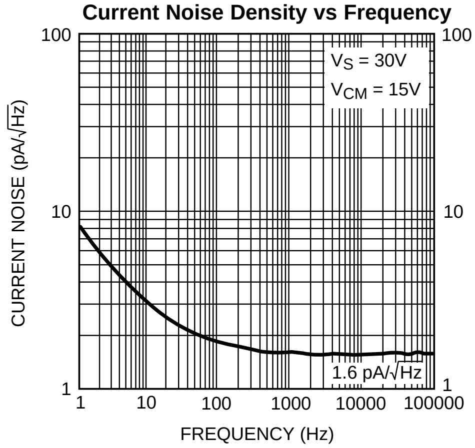


Figure 37.

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

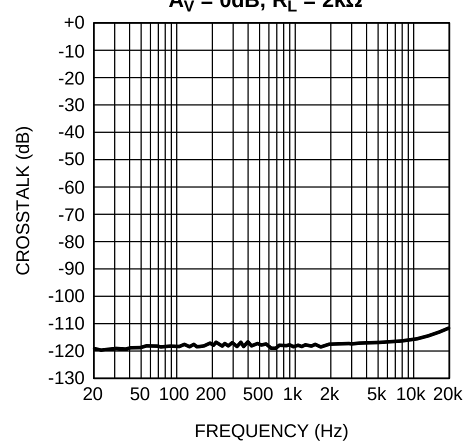


Figure 38.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

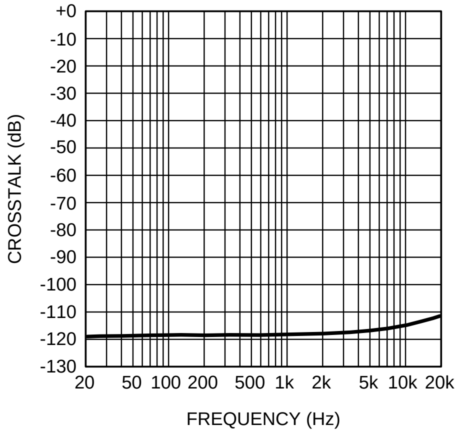


Figure 39.

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

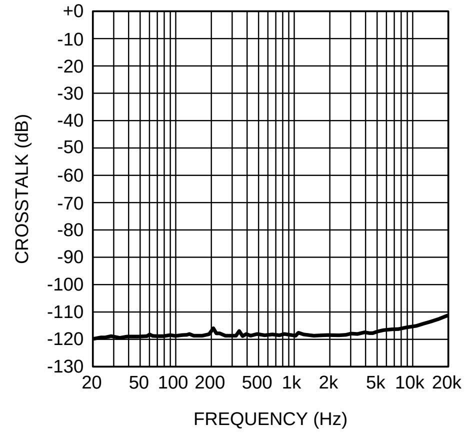


Figure 40.

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

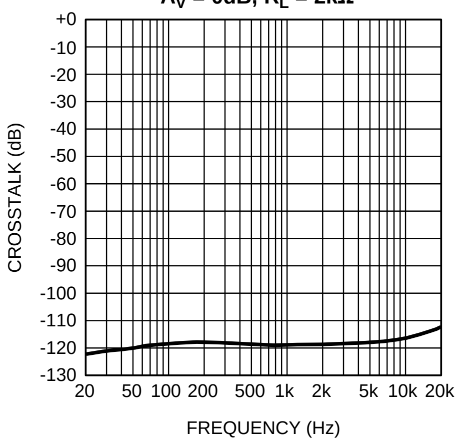


Figure 41.

Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 2kΩ

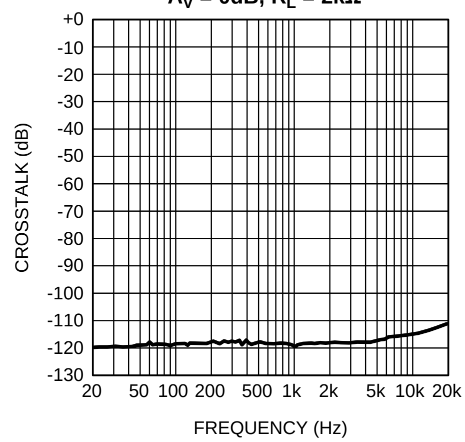


Figure 42.

Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 2kΩ

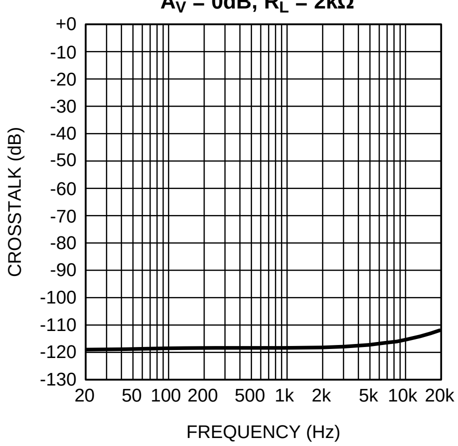


Figure 43.

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

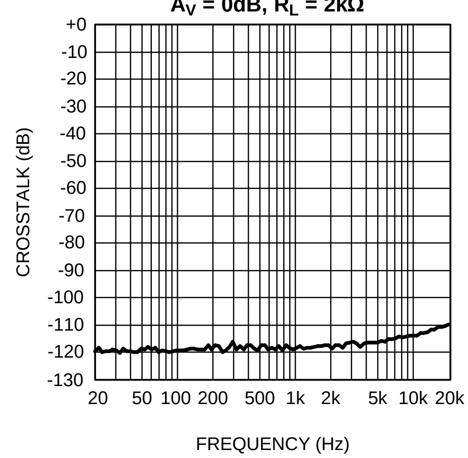


Figure 44.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

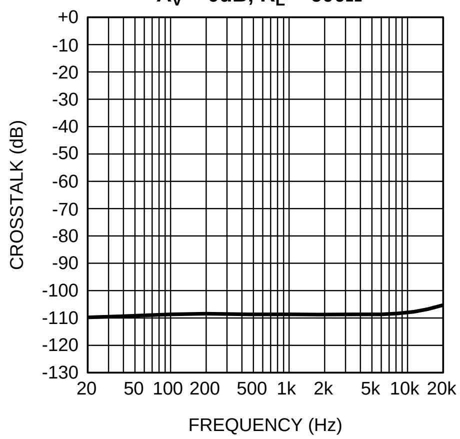


Figure 45.

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

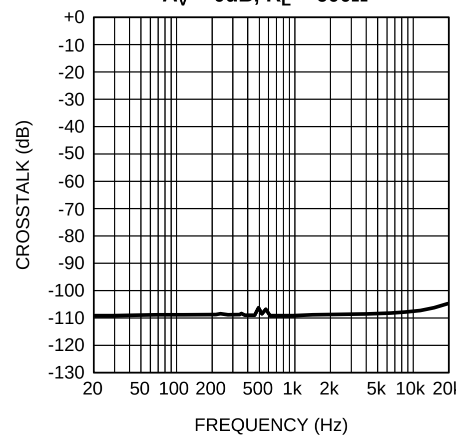


Figure 46.

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

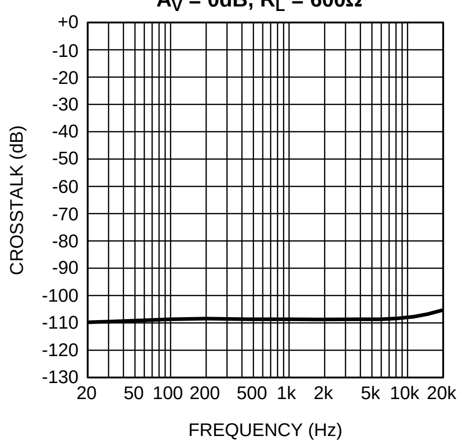


Figure 47.

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

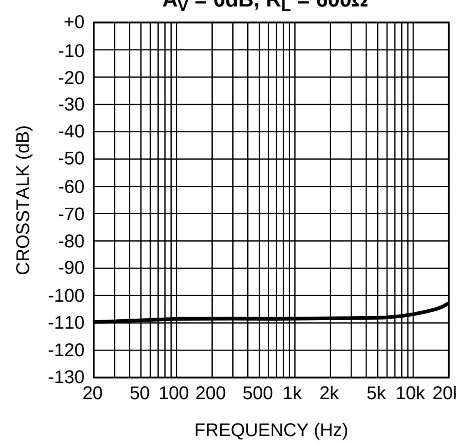


Figure 48.

Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 600Ω

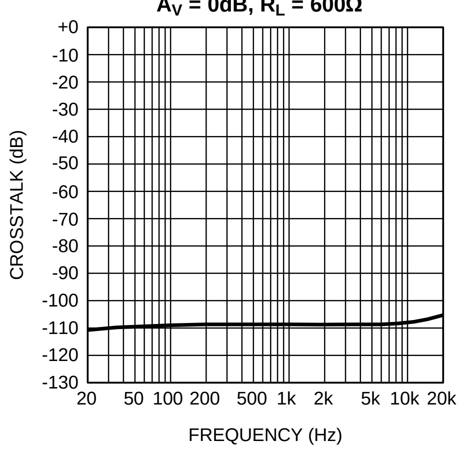


Figure 49.

Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 600Ω

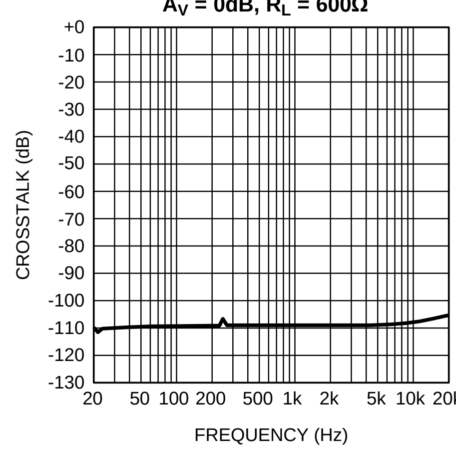


Figure 50.

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

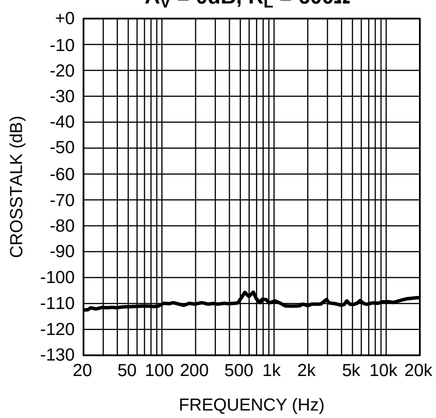


Figure 51.

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

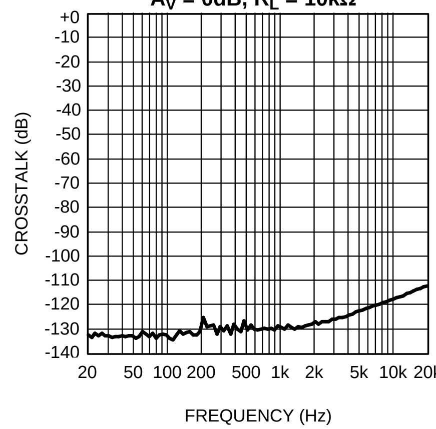


Figure 52.

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

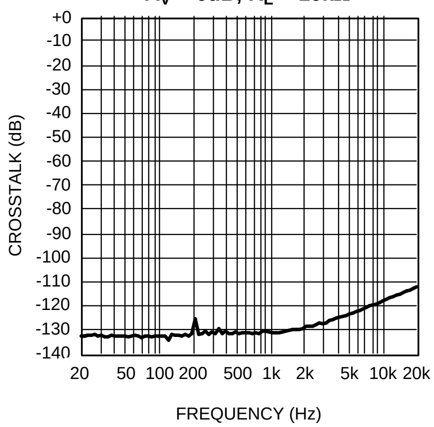


Figure 53.

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

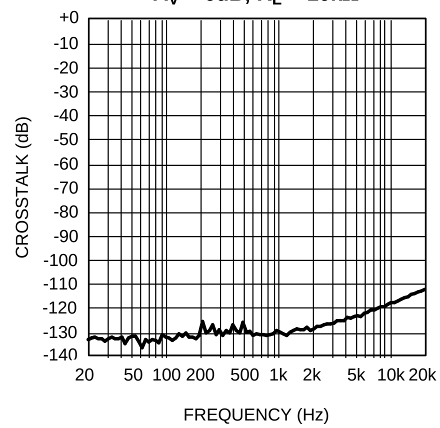


Figure 54.

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

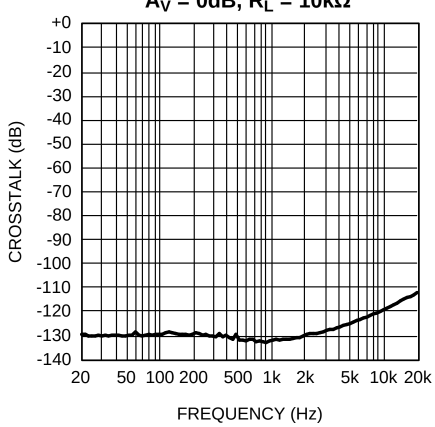


Figure 55.

Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 10kΩ

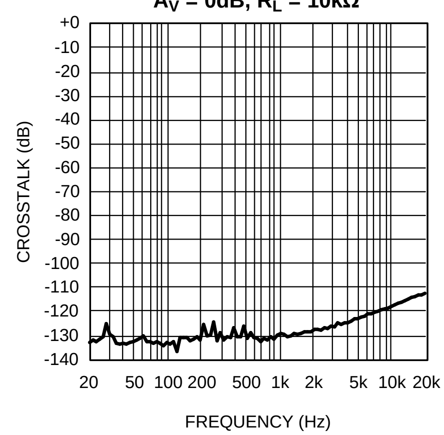


Figure 56.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 10kΩ

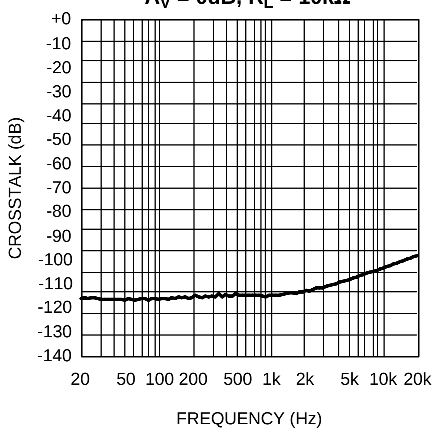


Figure 57.

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

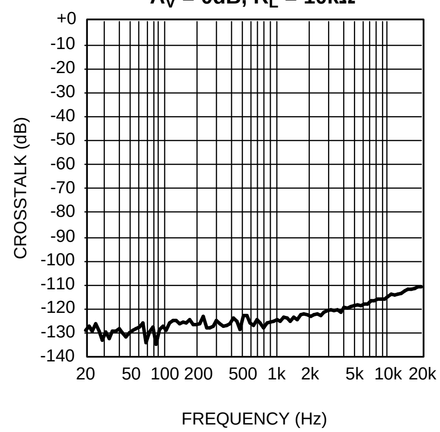


Figure 58.

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

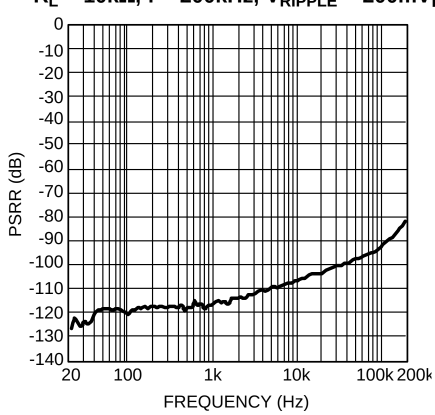


Figure 59.

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

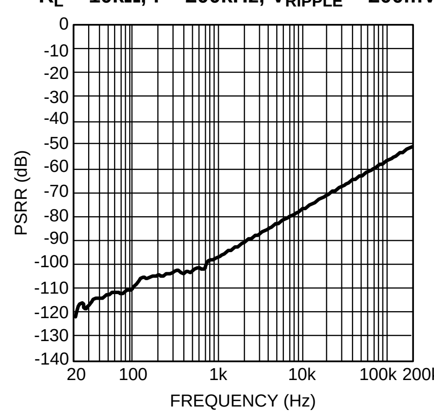


Figure 60.

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

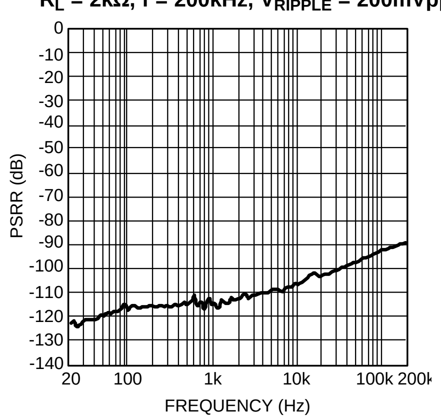


Figure 61.

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

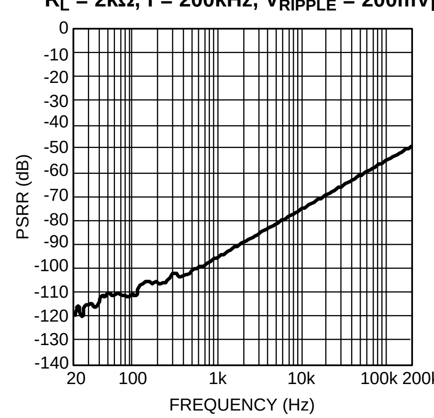


Figure 62.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

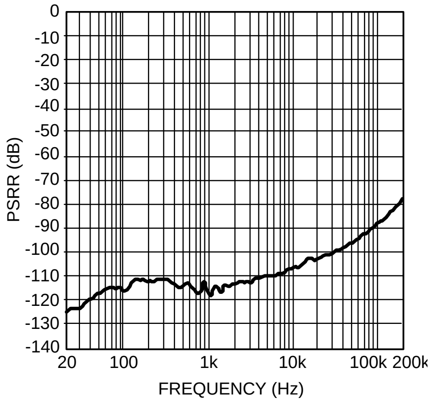


Figure 63.

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

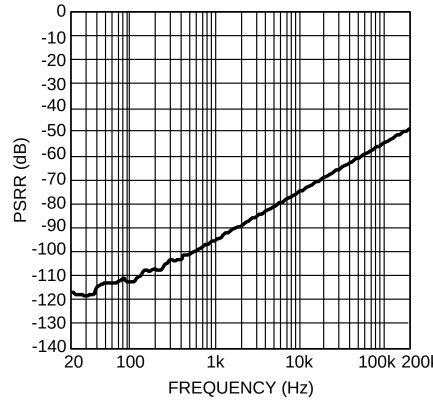


Figure 64.

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

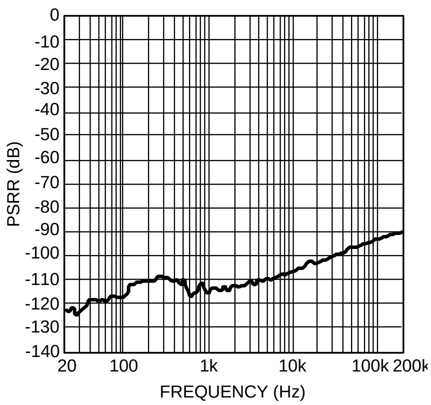


Figure 65.

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

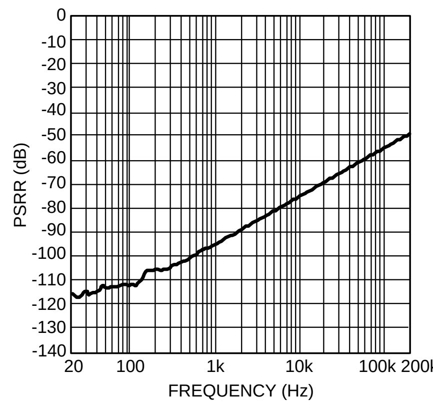


Figure 66.

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

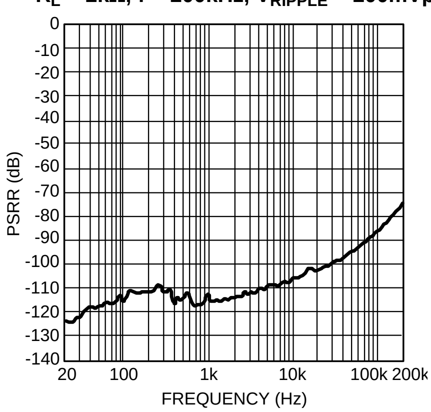


Figure 67.

PSRR– vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ, f = 200kHz, V_{RIPPLE} = 200mVpp

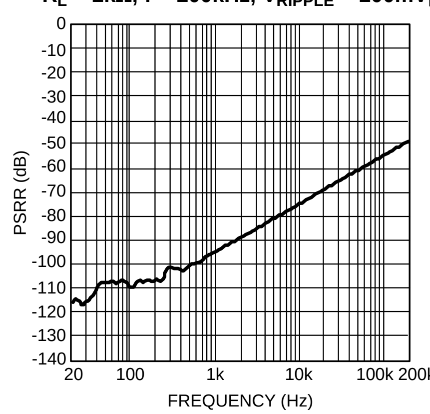


Figure 68.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

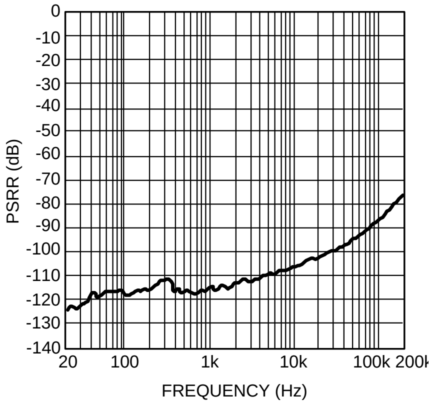


Figure 69.

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

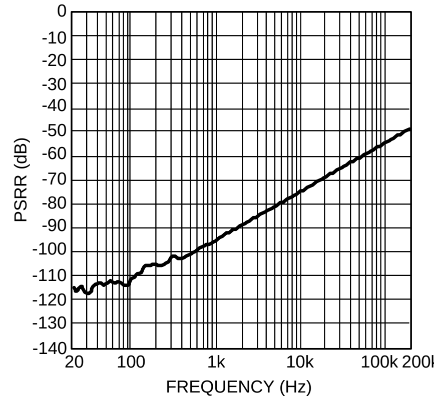


Figure 70.

PSRR+ vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ, f = 200kHz, V_{RIPPLE} = 200mVpp

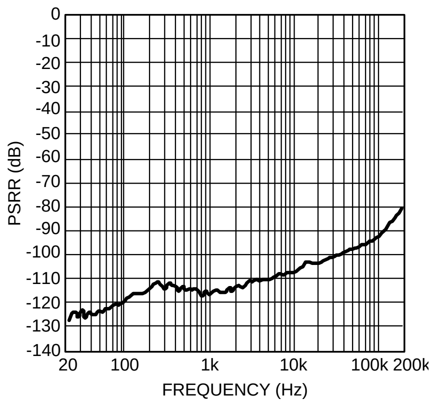


Figure 71.

PSRR– vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ, f = 200kHz, V_{RIPPLE} = 200mVpp

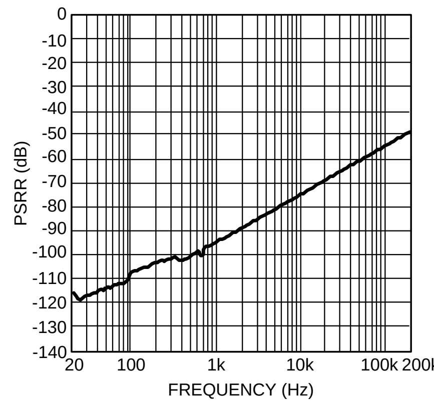


Figure 72.

PSRR+ vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 2kΩ, f = 200kHz, V_{RIPPLE} = 200mVpp

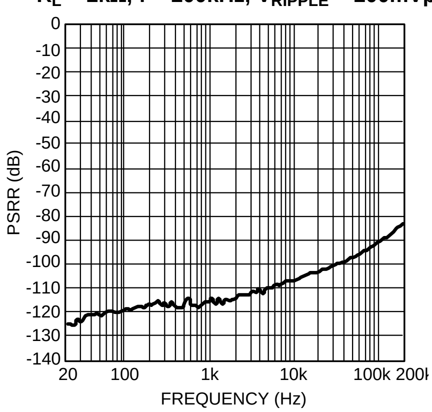


Figure 73.

PSRR– vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 2kΩ, f = 200kHz, V_{RIPPLE} = 200mVpp

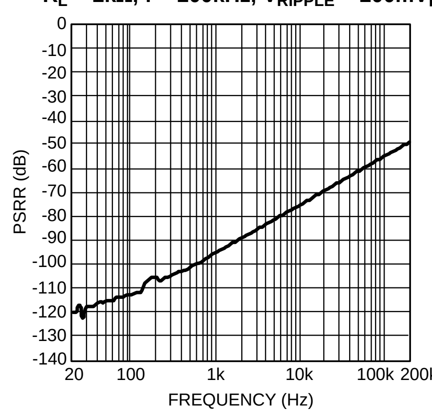


Figure 74.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

PSRR+ vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 600Ω, f = 200kHz, V_{RIPPLE} = 200mVpp

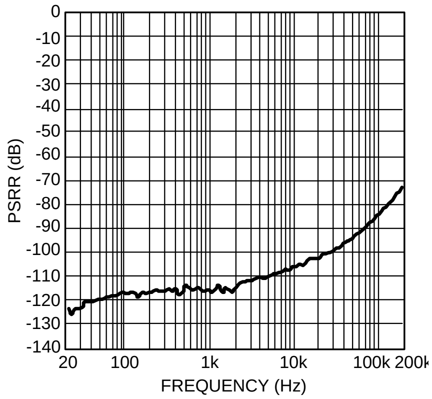


Figure 75.

PSRR– vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 600Ω, f = 200kHz, V_{RIPPLE} = 200mVpp

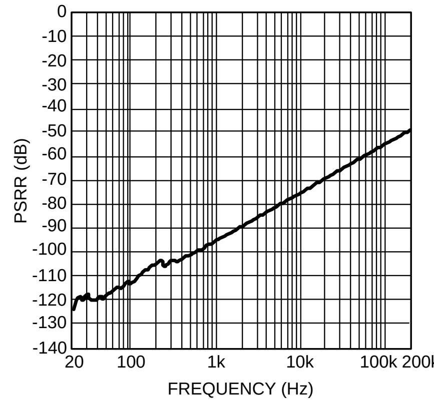


Figure 76.

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

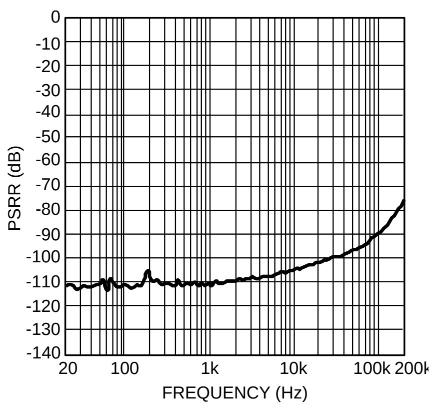


Figure 77.

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

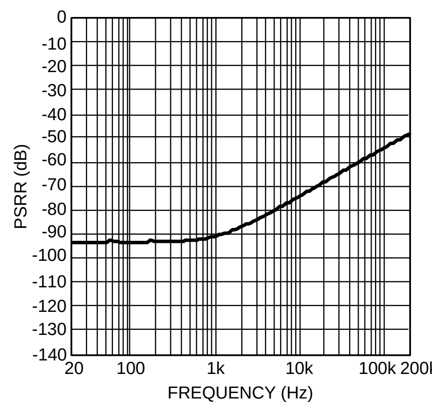


Figure 78.

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

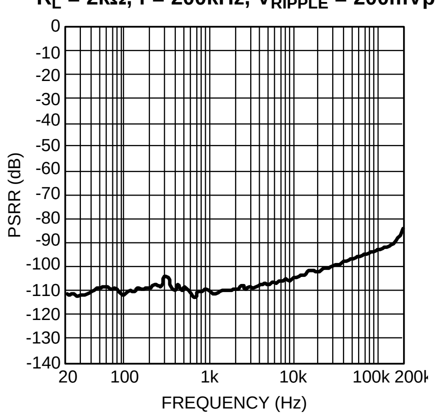


Figure 79.

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

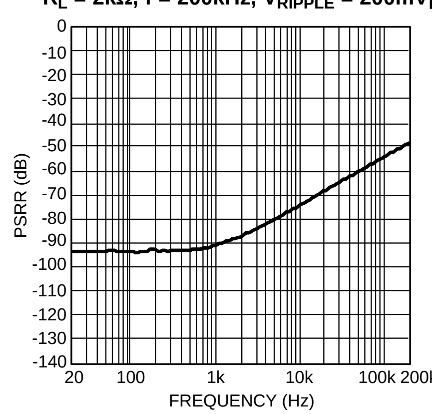


Figure 80.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

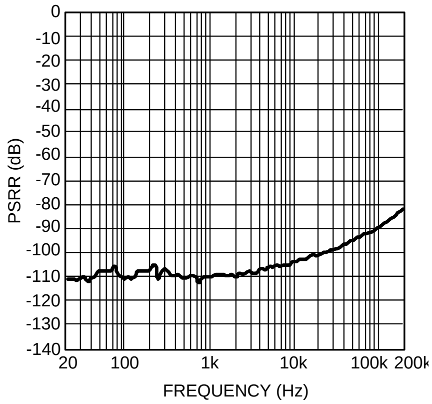


Figure 81.

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

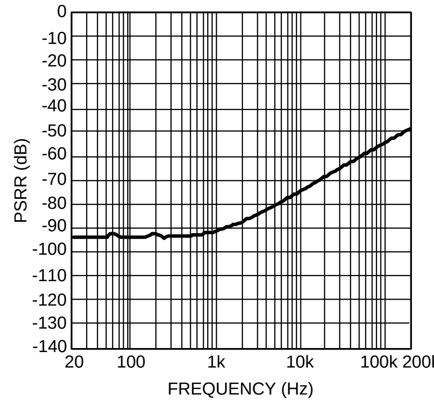


Figure 82.

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

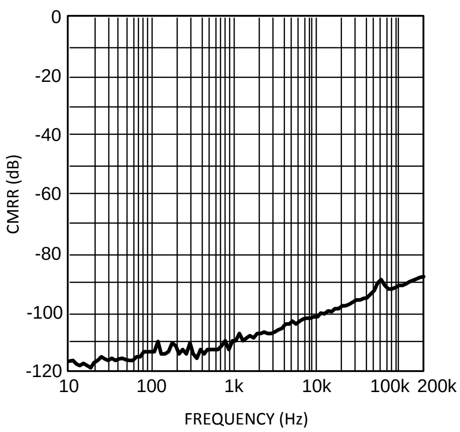


Figure 83.

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

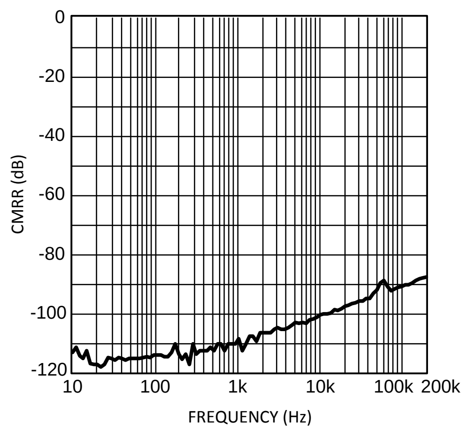


Figure 84.

CMRR vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 2kΩ

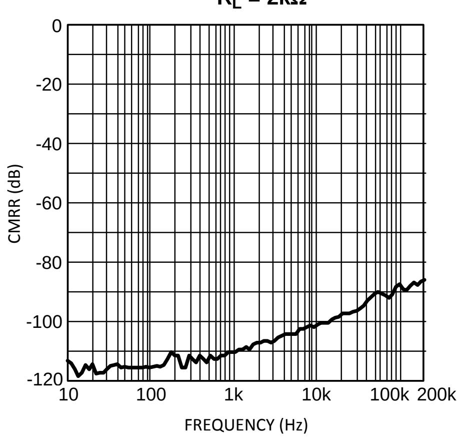


Figure 85.

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

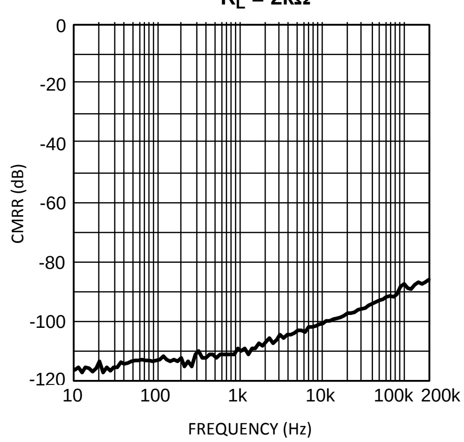


Figure 86.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

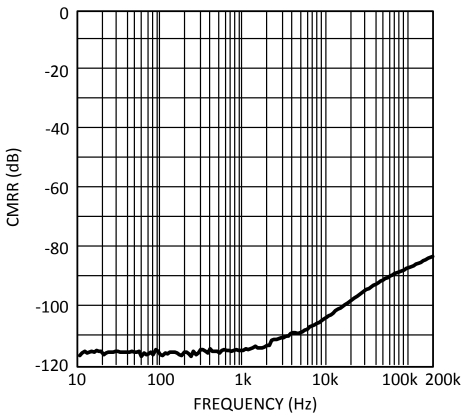


Figure 87.

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

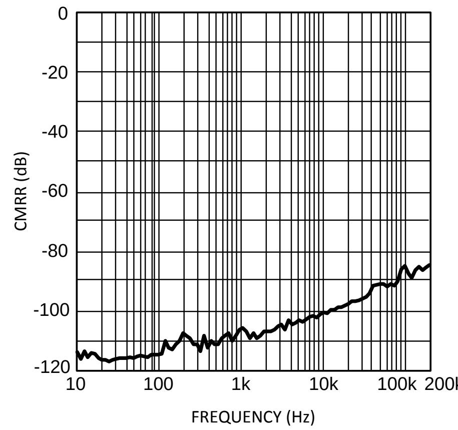


Figure 88.

CMRR vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 600Ω

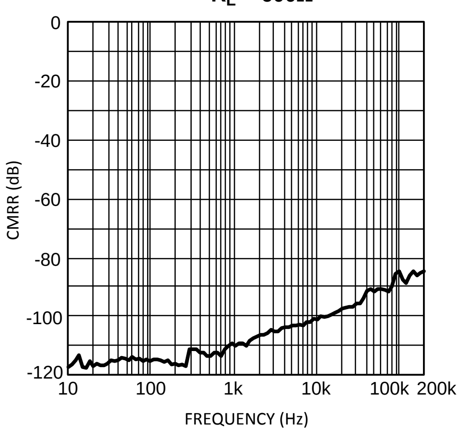


Figure 89.

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

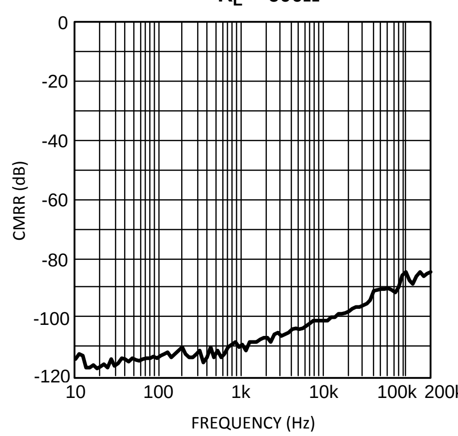


Figure 90.

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

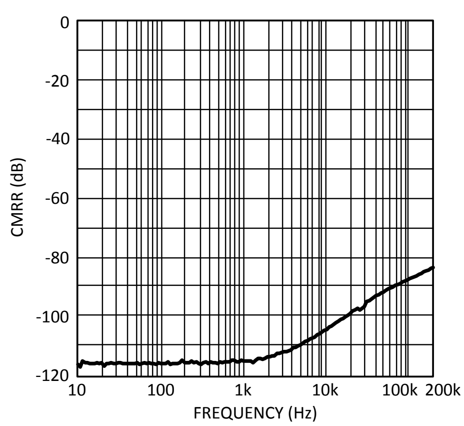


Figure 91.

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

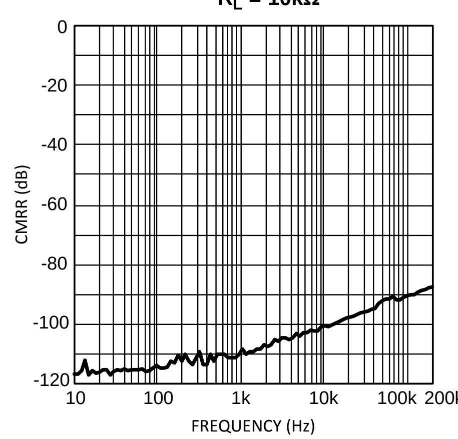


Figure 92.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

CMRR vs Frequency
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ

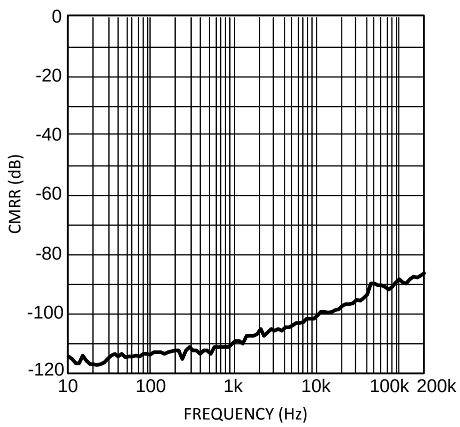


Figure 93.

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

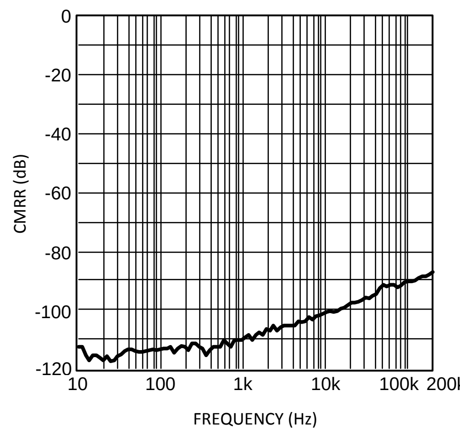


Figure 94.

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

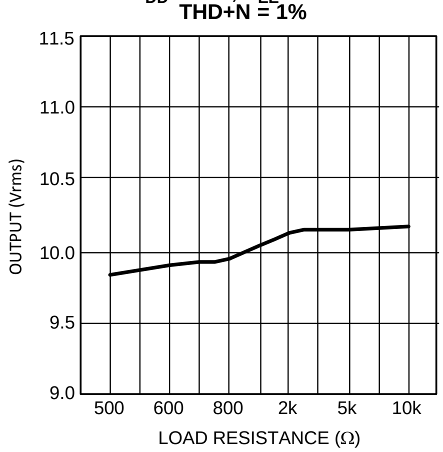


Figure 95.

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

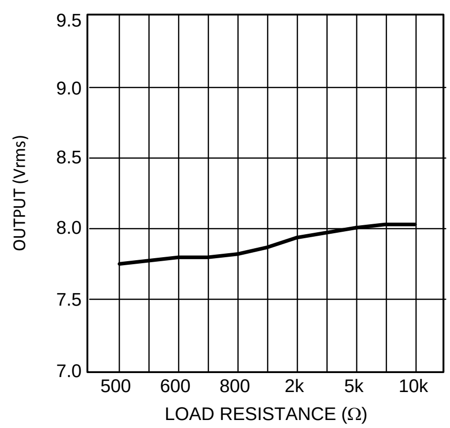


Figure 96.

Output Voltage vs Load Resistance
V_{DD} = 17V, V_{EE} = –17V
THD+N = 1%

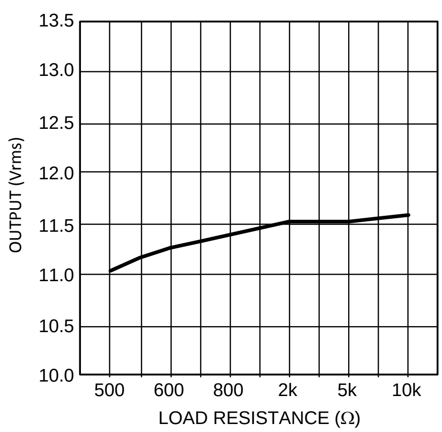


Figure 97.

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

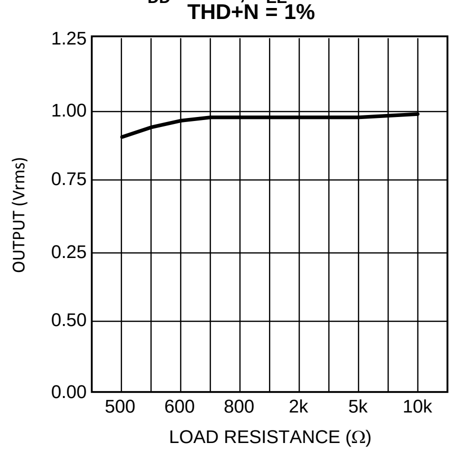


Figure 98.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

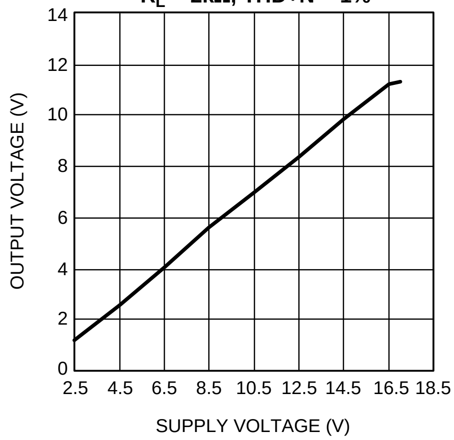


Figure 99.

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

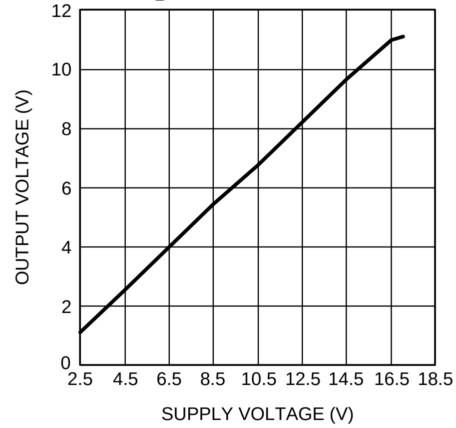


Figure 100.

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

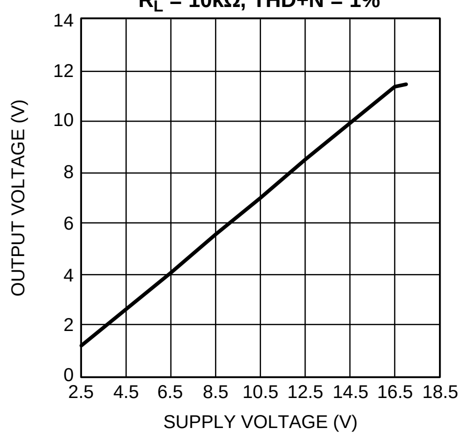


Figure 101.

Supply Current vs Supply Voltage
R_L = 2kΩ

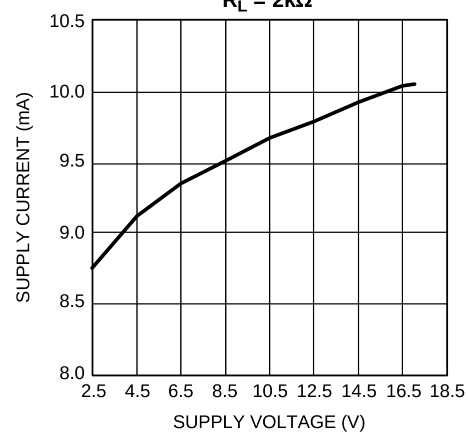


Figure 102.

Supply Current vs Supply Voltage
R_L = 600Ω

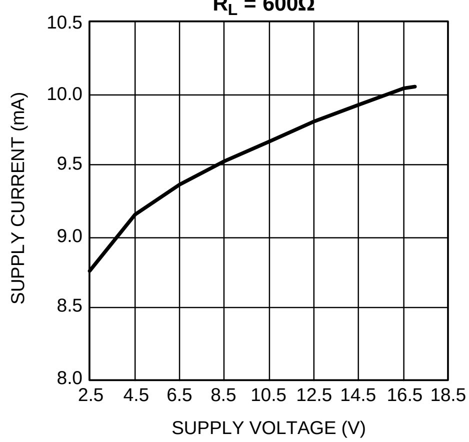


Figure 103.

Supply Current vs Supply Voltage
R_L = 10kΩ

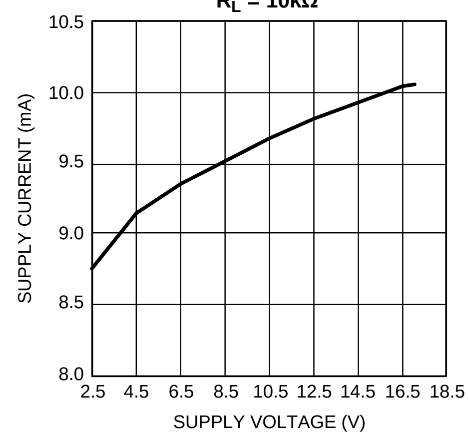


Figure 104.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Full Power Bandwidth vs Frequency

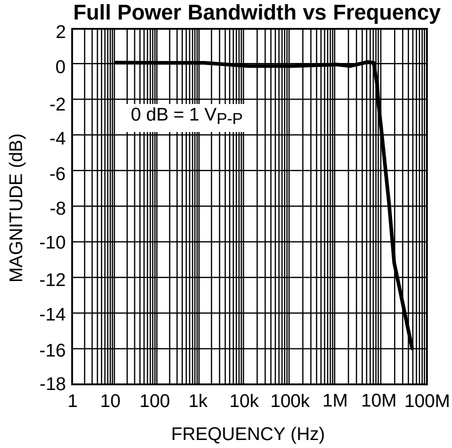


Figure 105.

Gain Phase vs Frequency

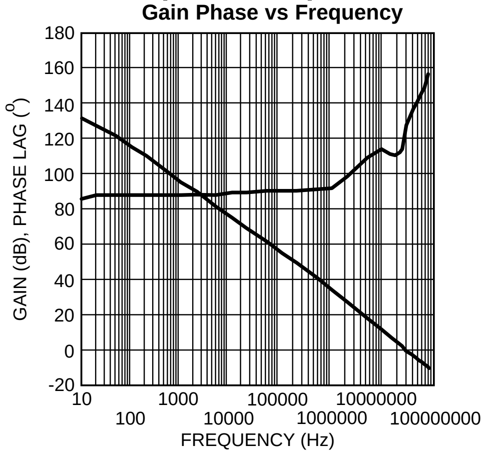


Figure 106.

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

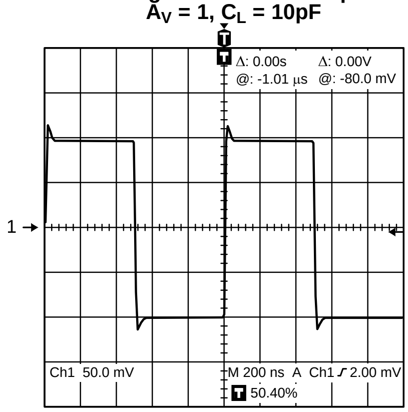


Figure 107.

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

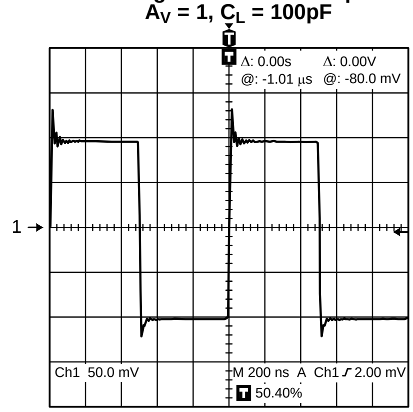


Figure 108.

APPLICATION INFORMATION

DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LM4562 is below the capabilities of all commercially available equipment. This makes distortion measurements just slightly more difficult than simply connecting a distortion meter to the amplifier's inputs and outputs. The solution, however, is quite simple: an additional resistor. Adding this resistor extends the resolution of the distortion measurement equipment.

The LM4562's low residual distortion is an input referred internal error. As shown in Figure 109, adding the 10Ω resistor connected between the amplifier's inverting and non-inverting inputs changes the amplifier's noise gain. The result is that the error signal (distortion) is amplified by a factor of 101. Although the amplifier's closed-loop gain is unaltered, the feedback available to correct distortion errors is reduced by 101, which means that measurement resolution increases by 101. To ensure minimum effects on distortion measurements, keep the value of 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.

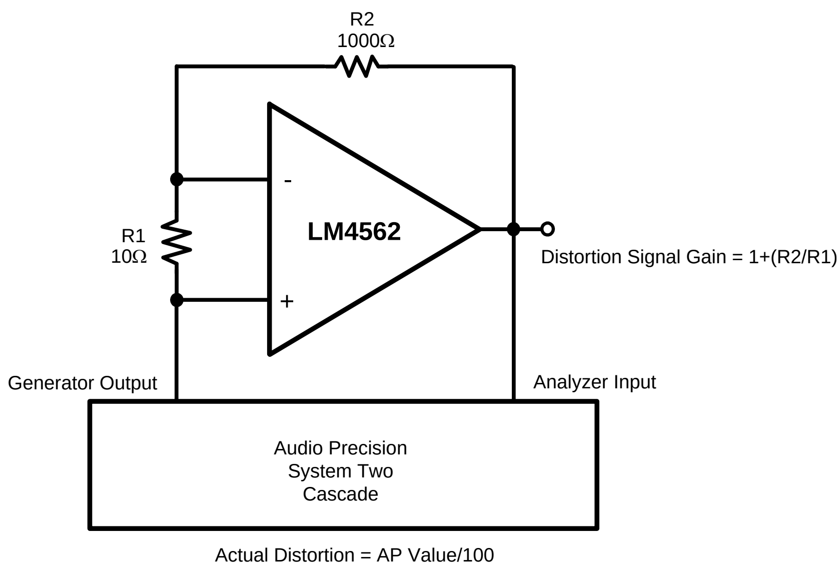
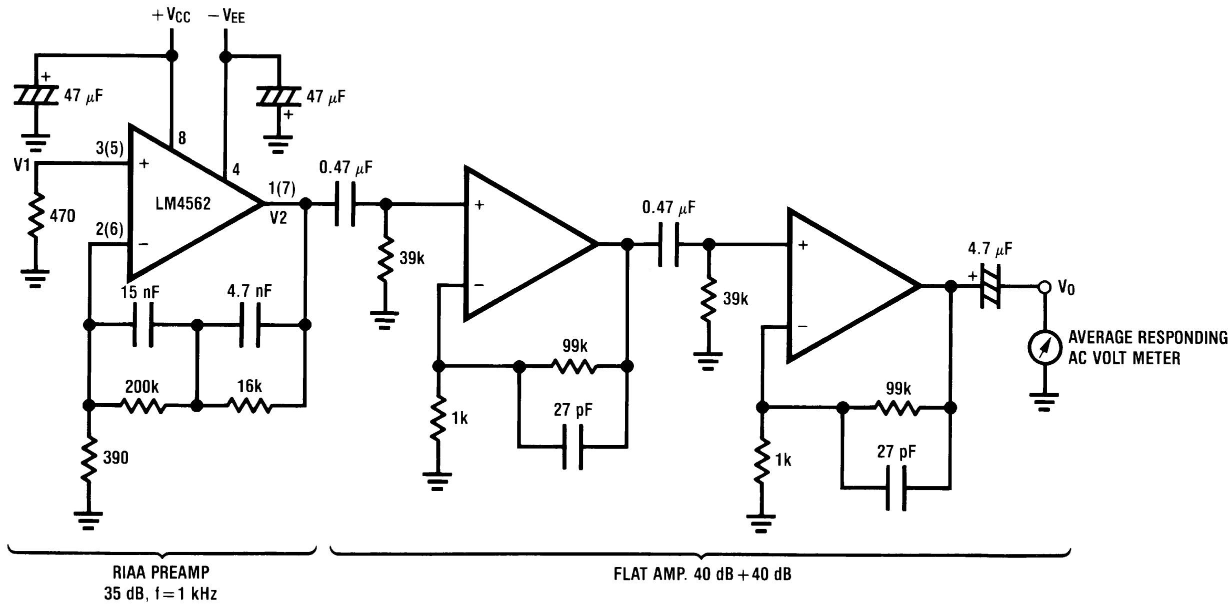


Figure 109. THD+N and IMD Distortion Test Circuit

The LM4562 is a high-speed op amp with excellent phase margin and stability. Capacitive loads up to 100pF will cause little change in the phase characteristics of the amplifiers and are therefore allowable.

Capacitive loads greater than 100pF must be isolated from the output. The most straightforward way to do this is to put a resistor in series with the output. This resistor will also prevent excess power dissipation if the output is accidentally shorted.



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

Figure 110. Noise Measurement Circuit
Total Gain: 115 dB @f = 1 kHz
Input Referred Noise Voltage: e_n = V0/560,000 (V)

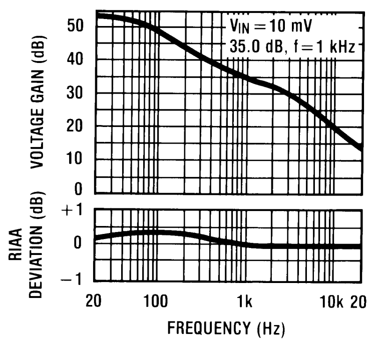


Figure 111. RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency

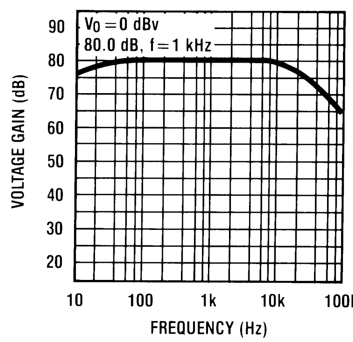


Figure 112. Flat Amp Voltage Gain vs Frequency

Evaluation Module Schematic

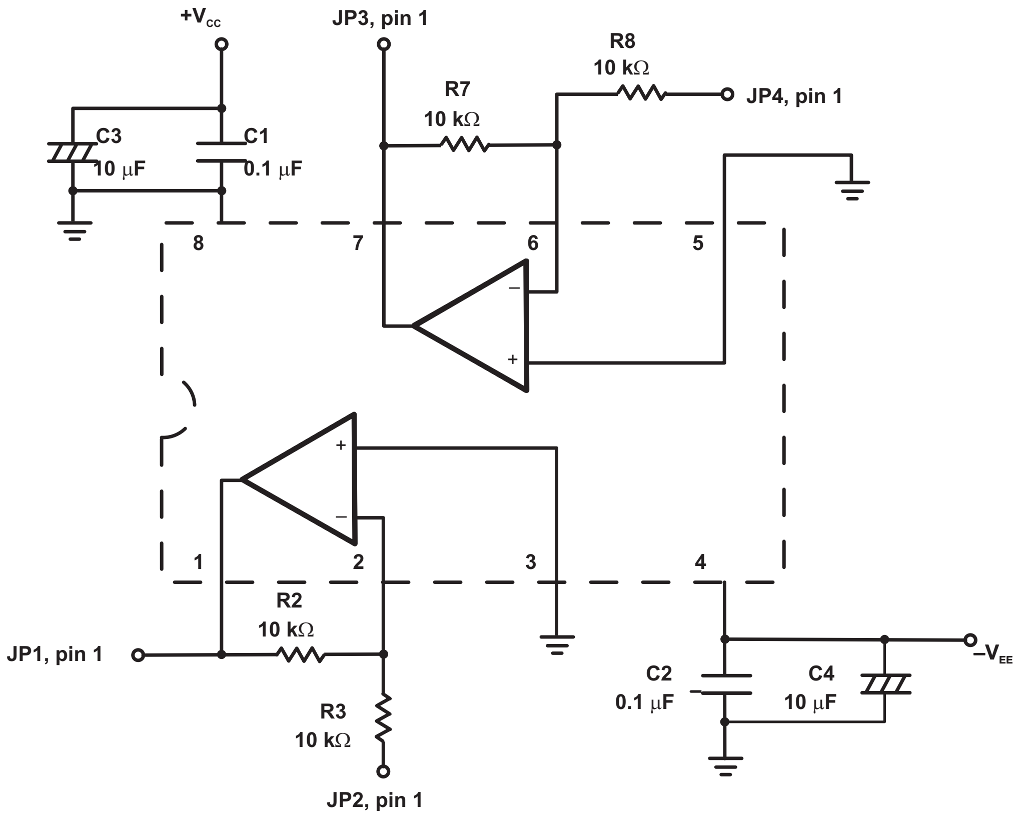
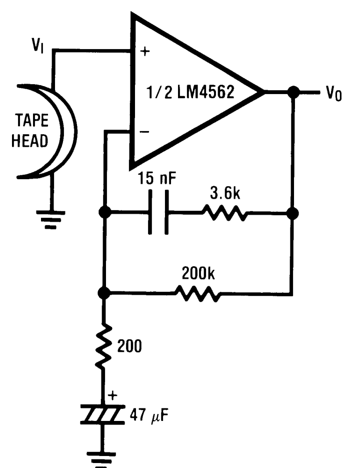


Figure 113. Inverting Amplifiers

Typical Applications



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

Figure 114. NAB Preamp

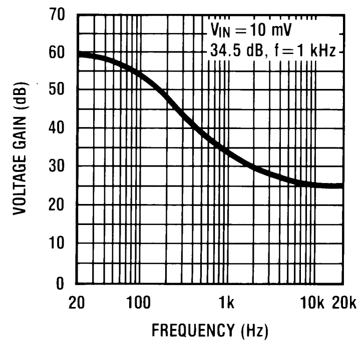
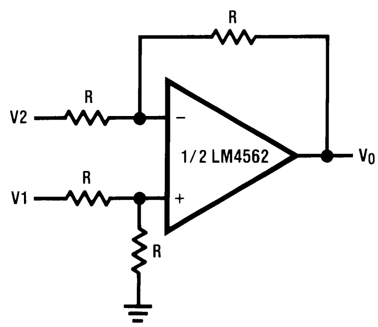
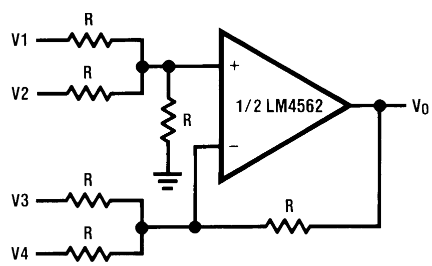


Figure 115. NAB Preamp Voltage Gain vs Frequency



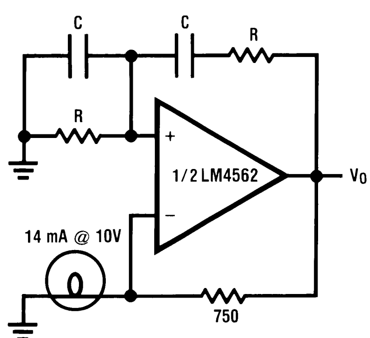
$V_O = V1–V2$

Figure 116. Balanced to Single-Ended Converter



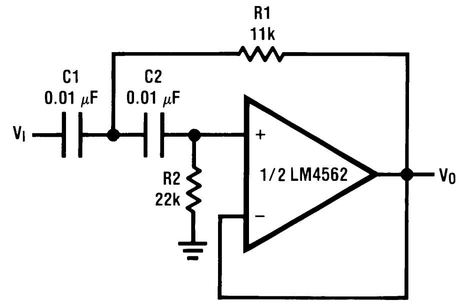
$V_O = V1 + V2 − V3 − V4$

Figure 117. Adder/Subtracter



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

Figure 118. Sine Wave Oscillator



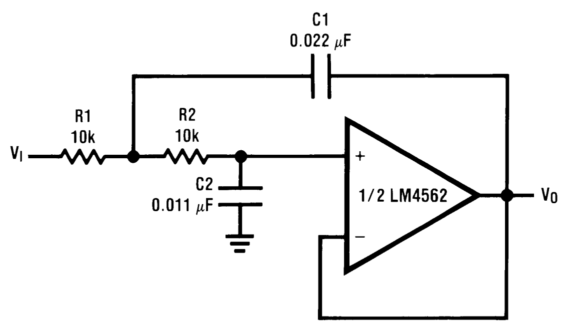
if $C1 = C2 = C$

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

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

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



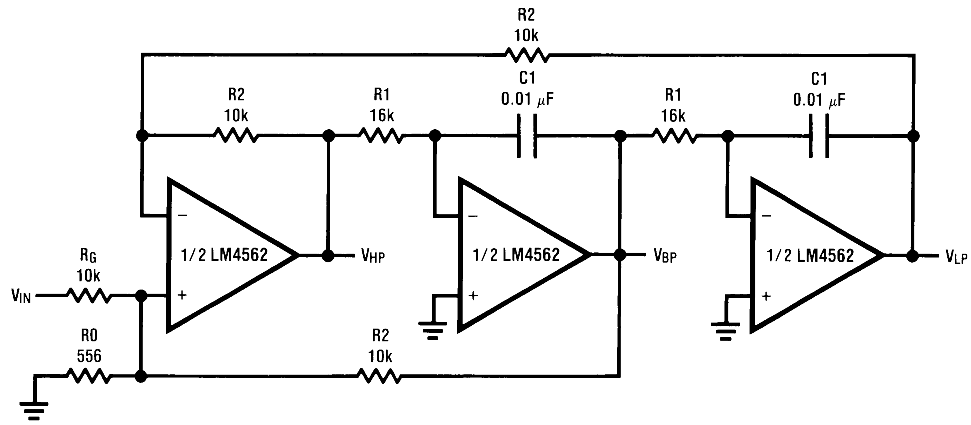
if $R1 = R2 = R$

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

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

Illustration is f_0 = 1 kHz

Figure 120. 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 121. State Variable Filter

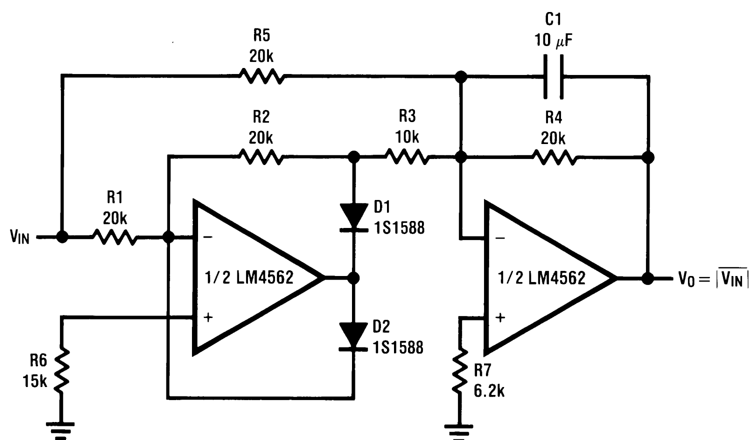


Figure 122. AC/DC Converter

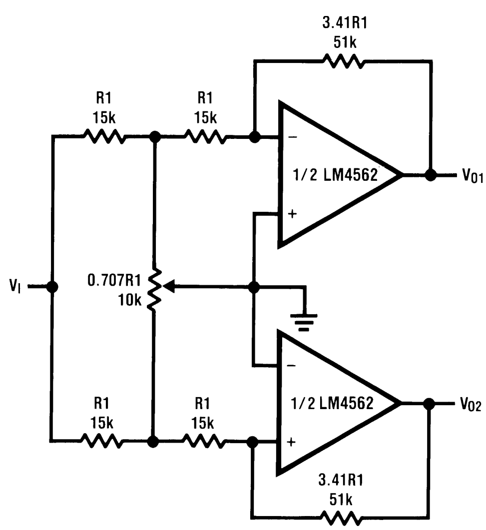


Figure 123. 2-Channel Panning Circuit (Pan Pot)

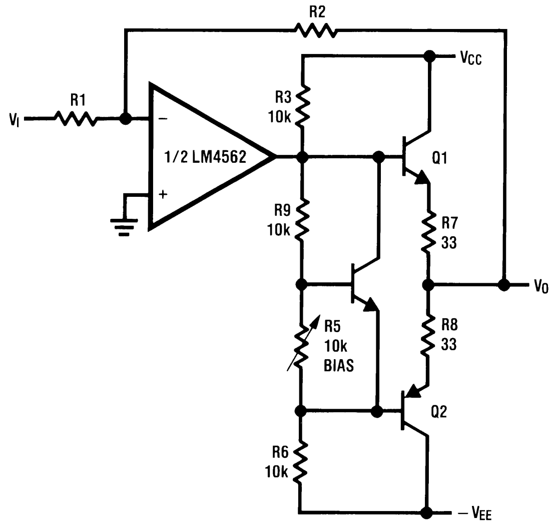
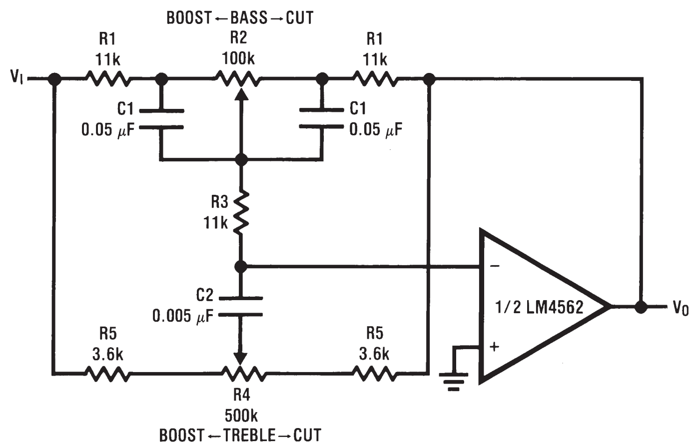


Figure 124. Line Driver



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

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

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

Illustration is:

$f_L \approx 32$ Hz, $f_{LB} \approx 320$ Hz

$f_H \approx 11$ kHz, $f_{HB} \approx 1.1$ kHz

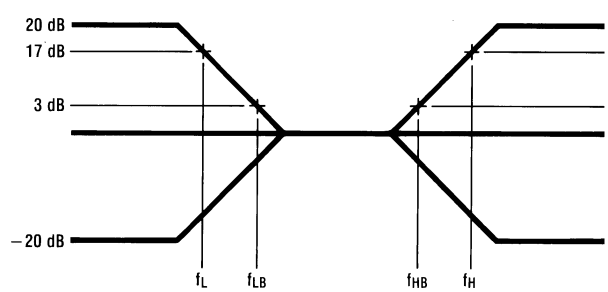
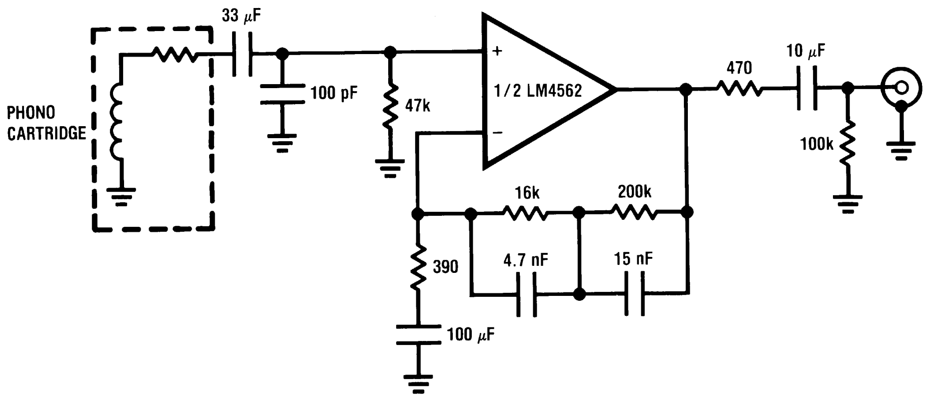
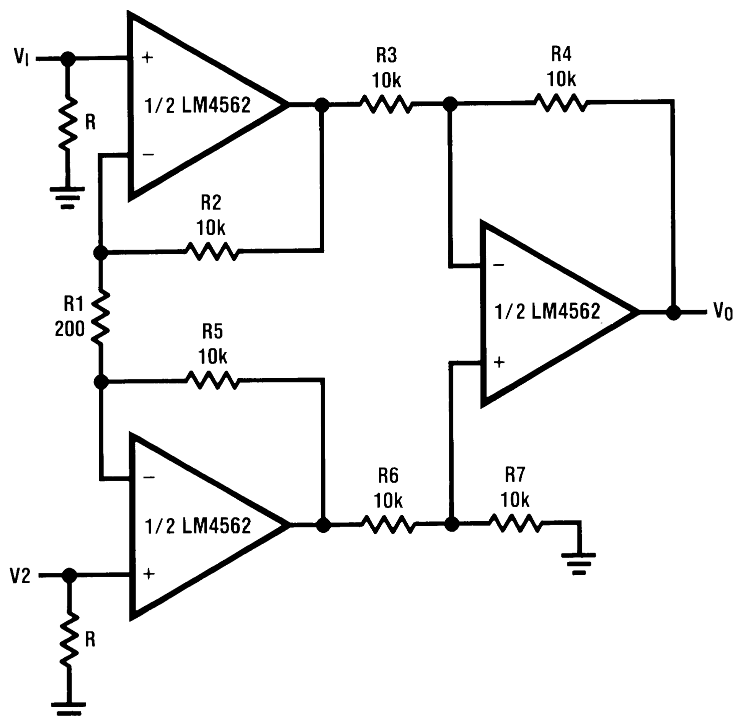


Figure 125. Tone Control



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 126. RIAA Preamp

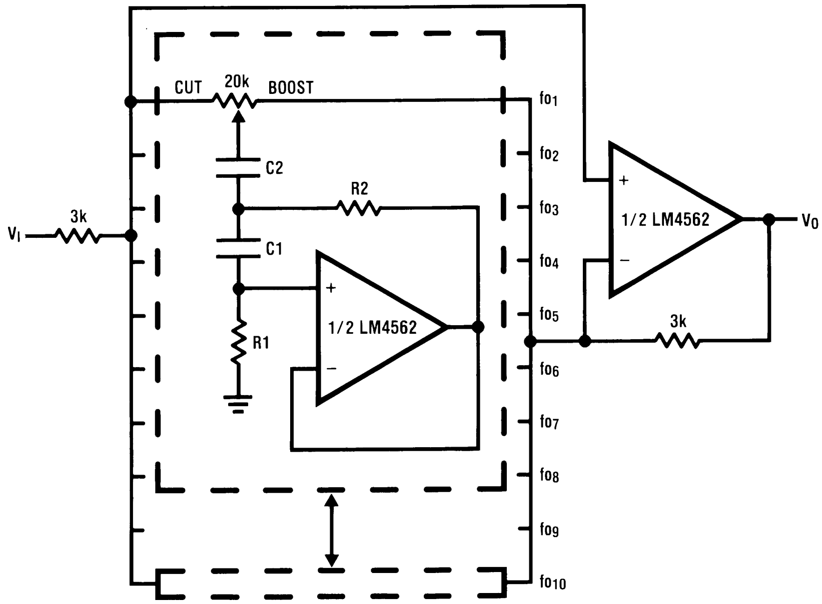


If R2 = R5, R3 = R6, R4 = R7

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

Illustration is:
V0 = 101(V2 − V1)

Figure 127. Balanced Input Mic Amp



A. See Table 1.

Figure 128. 10-Band Graphic Equalizer

Table 1. C_1, C_2, R_1, and R_2 Values for Figure 128(1)

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

(1) At volume of change = ±12 dB Q = 1.7

REVISION HISTORY

Changes from Revision J (April 2013) to Revision K	Page
• Added EVM schematic	25

REVISION HISTORY

Rev	Date	Description
1.0	08/16/06	Initial release.
1.1	08/22/06	Updated the Instantaneous Short Circuit Current specification.
1.2	09/12/06	Updated the three ±15V CMRR Typical Performance Curves.
1.3	09/26/06	Updated interstage filter capacitor values on page 1 Typical Application schematic.
1.4	05/03/07	Added the “general note” under the EC table.
1.5	10/17/07	Replaced all the PSRR curves.
1.6	01/26/10	Edited the equations on page 28 (under Tone Control).
J	04/04/13	Changed layout of National Data Sheet to TI format

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM4562MA/NOPB	ACTIVE	SOIC	D	8	95	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	L4562 MA	Samples
LM4562MAX/NOPB	ACTIVE	SOIC	D	8	2500	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	L4562 MA	Samples
LM4562NA/NOPB	ACTIVE	PDIP	P	8	40	RoHS & Green	NIPDAU	Level-1-NA-UNLIM	-40 to 85	LM 4562NA	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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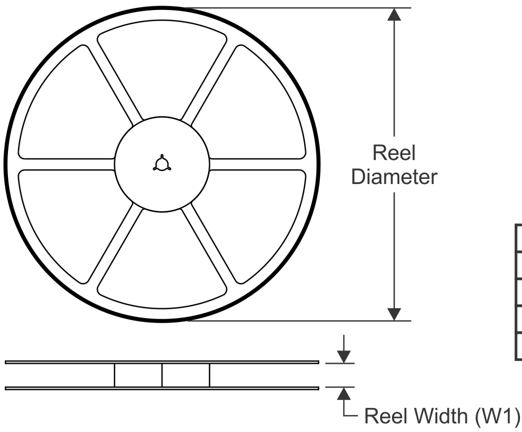
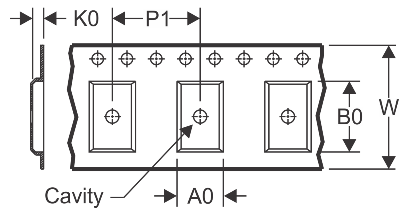
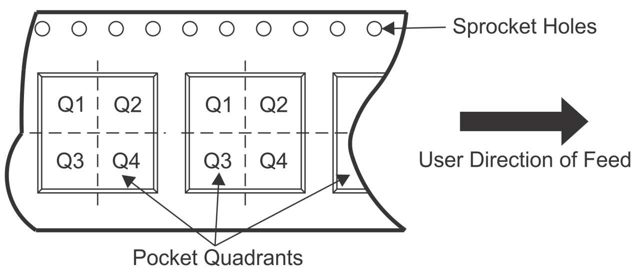


TAPE DIMENSIONS



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

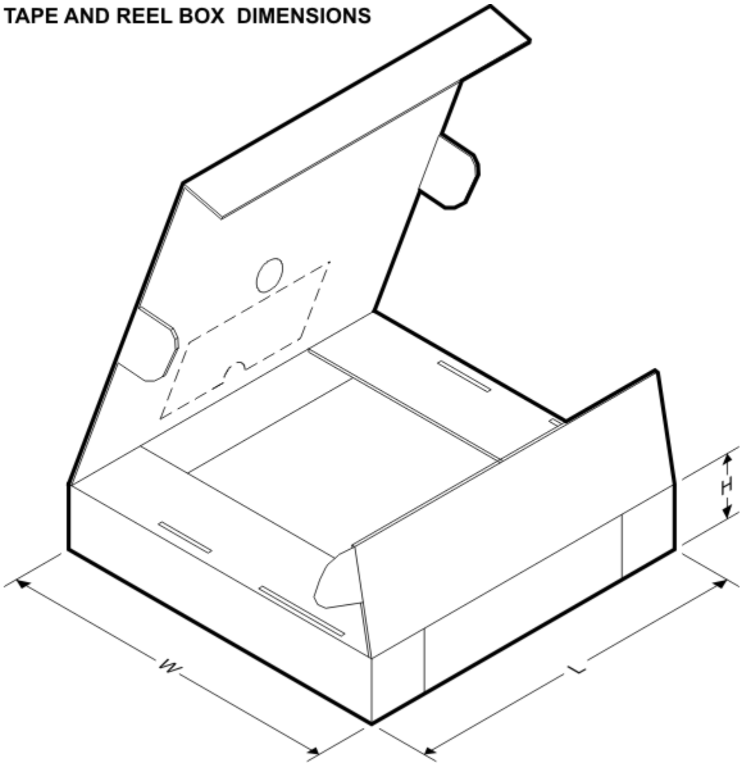
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM4562MAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

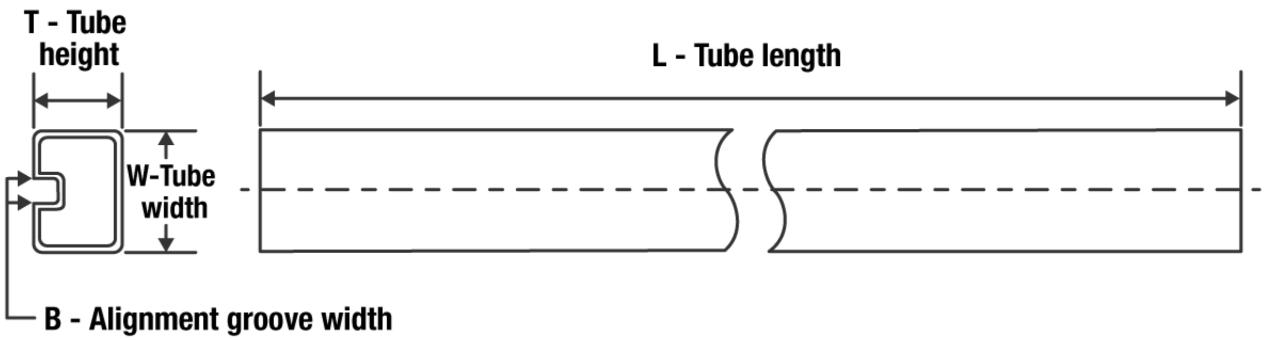
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

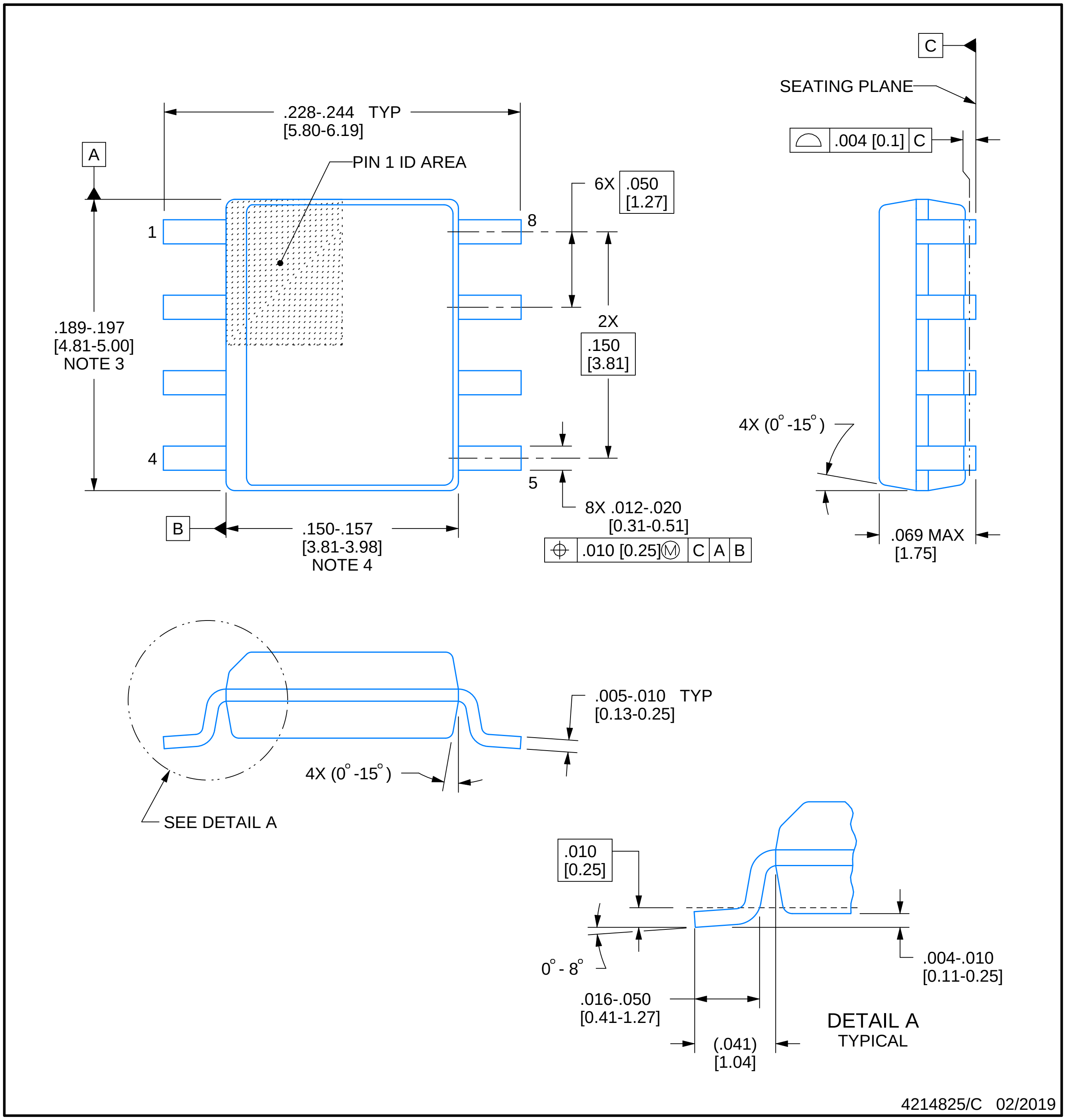
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM4562MAX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

TUBE



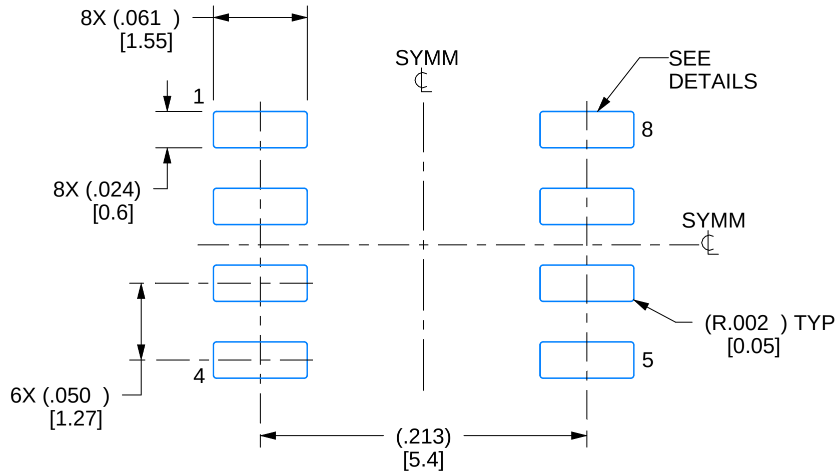
*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM4562MA/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM4562NA/NOPB	P	PDIP	8	40	502	14	11938	4.32

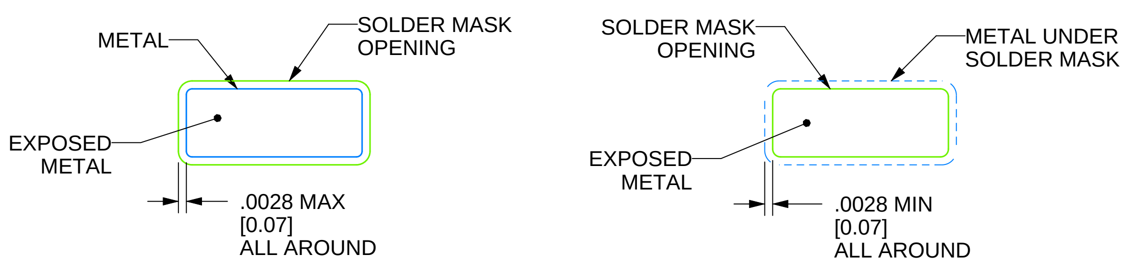


NOTES:

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



NON SOLDER MASK DEFINED

SOLDER MASK DEFINED

SOLDER MASK DETAILS

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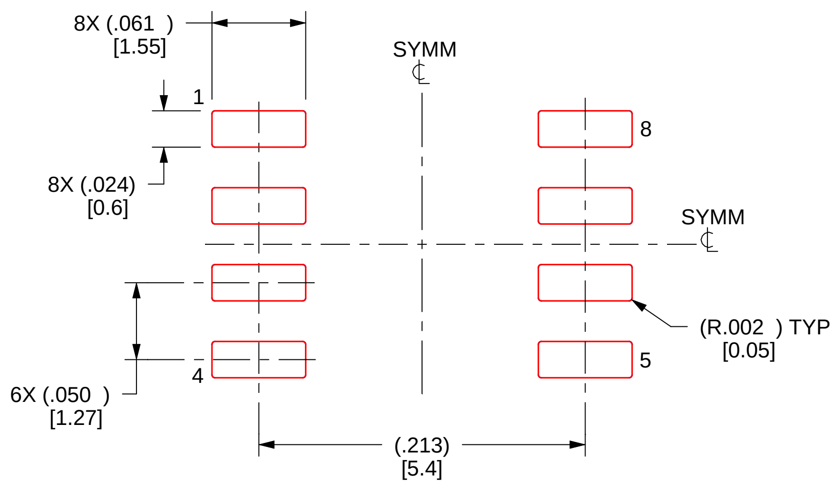
NOTES: (continued)

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

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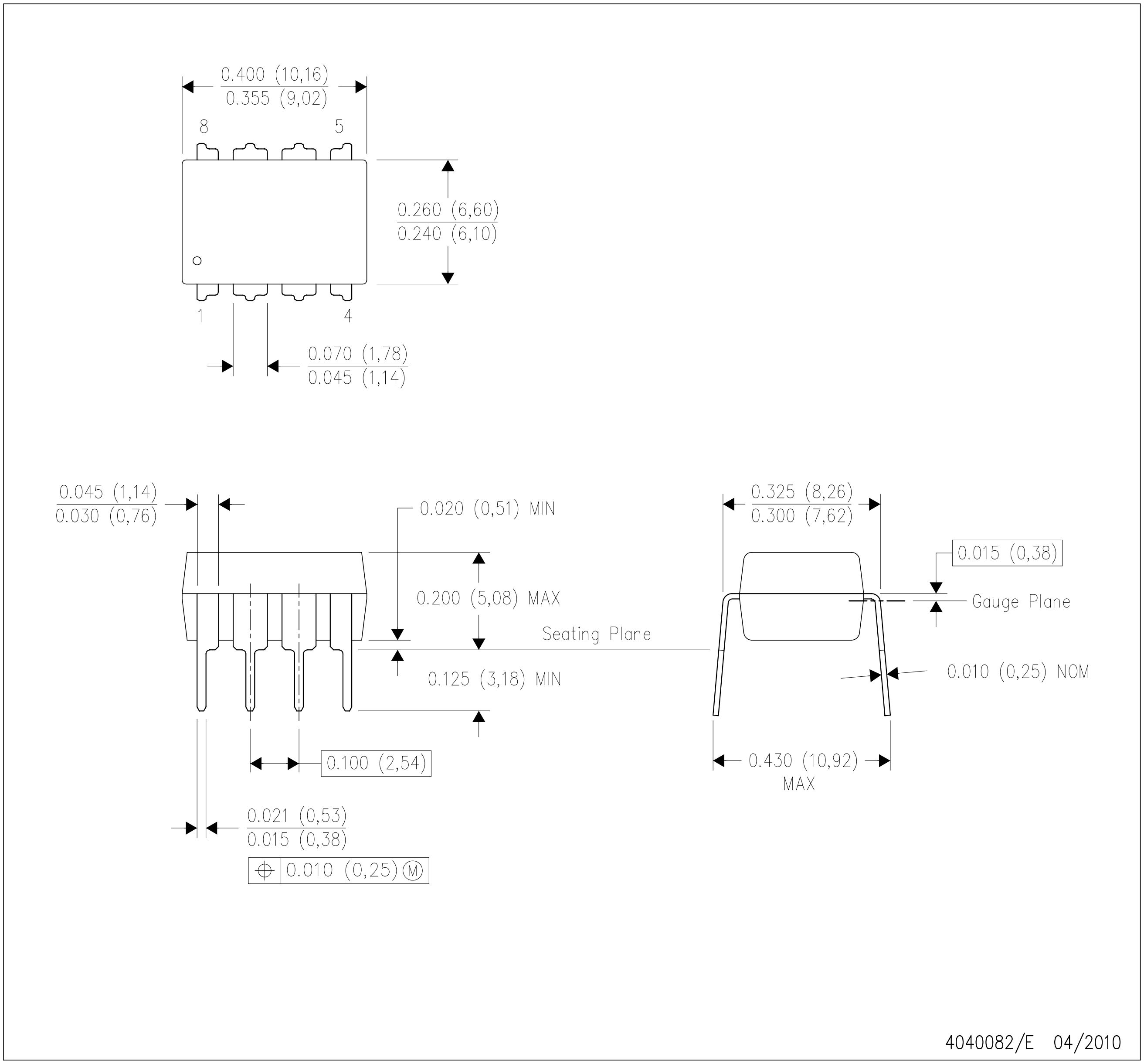
NOTES: (continued)

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.

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

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