National Semiconductor

August 2006

LM4562
Dual High Performance, High Fidelity Audio Operational Amplifier

General 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. Combining advanced leading-edge process technology with state-of-the-art circuit design, the LM4562 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LM4562 combines extremely low voltage noise density (2.7nV/√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 8–lead narrow body SOIC, 8–lead Plastic DIP and 8–lead Metal Can TO-99. Demonstration boards are available for each package.

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/√Hz (typ)
■ Slew Rate	±20V/μs (typ)
■ Gain Bandwidth Product	55MHz (typ)
■ Open Loop Gain (R_L = 600Ω)	140dB (typ)
■ Input Bias Current	10nA (typ)
■ Input Offset Voltage	0.1mV (typ)
■ DC Gain Linearity Error	0.000009%

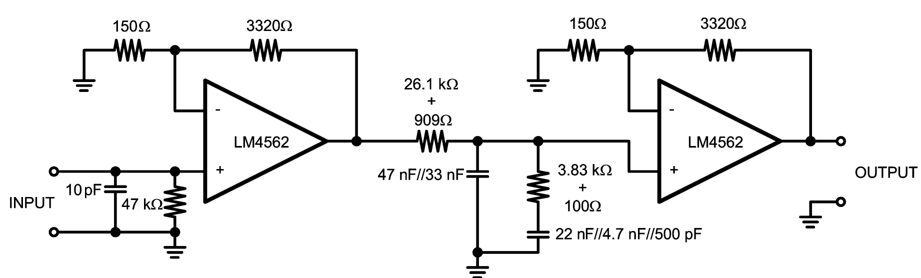
Features

- Easily drives 600Ω loads
- Optimized for superior audio signal fidelity
- Output short circuit protection
- PSRR and CMRR exceed 120dB (typ)
- SOIC, DIP, TO-99 metal can packages

Applications

- Ultra high quality audio amplification
- High fidelity preamplifiers
- High fidelity multimedia
- State of the art phono pre amps
- High performance professional audio
- High fidelity equalization and crossover networks
- High performance line drivers
- High performance line receivers
- High fidelity active filters

Typical Application



Note: 1% metal film resistors, 5% polypropylene capacitors

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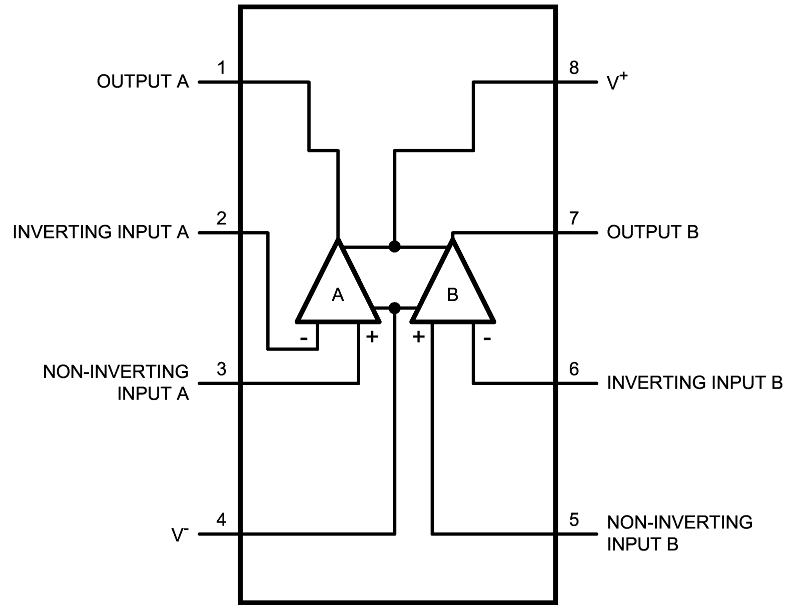
Passively Equalized RIAA Phono Preamplifier

Connection Diagrams

Dual-In-Line Package



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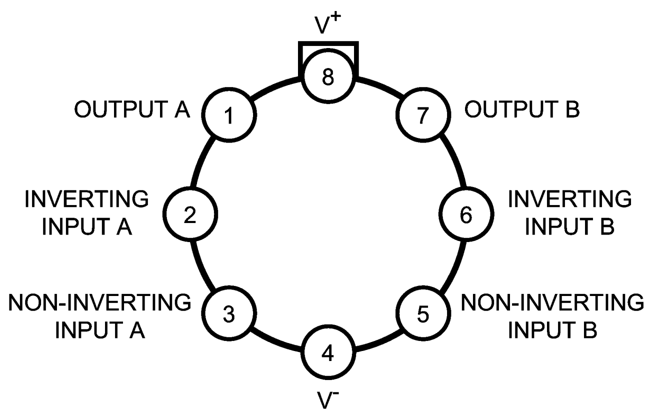
Order Number LM4562MA
See NS Package Number — M08A
Order Number LM4562NA
See NS Package Number — N08E

Metal Can



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Order Number LM4562HA
See NS Package Number — H08C

Absolute Maximum Ratings (Notes 1, 2)

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

Power Supply Voltage	
($V_S = V^+ - V^-$)	36V
Storage Temperature	−65°C to 150°C
Input Voltage	(V-) - 0.7V to (V+) + 0.7V
Output Short Circuit (Note 3)	Continuous
Power Dissipation	Internally Limited
ESD Susceptibility (Note 4)	2000V
ESD Susceptibility (Note 5)	
Pins 1, 4, 7 and 8	200V
Pins 2, 3, 5 and 6	100V
Junction Temperature	150°C
Thermal Resistance	
θ_{JA} (SO)	145°C/W
θ_{JA} (NA)	102°C/W
θ_{JA} (HA)	150°C/W
θ_{JC} (HA)	35°C/W
Temperature Range	
$T_{MIN} \leq T_A \leq T_{MAX}$	$-40°C \leq T_A \leq 85°C$
Supply Voltage Range	$\pm 2.5V \leq V_S \leq \pm 17V$

Electrical Characteristics for the LM4562 (Note 1)

The following specifications apply for the circuit shown in Figure X. $V_S = \pm 15V$, $R_L = 2k\Omega$, $R_{SOURCE} = 10\Omega$, $f_{IN} = 1kHz$, and $T_A = 25°C$, unless otherwise specified.

Symbol	Parameter	Conditions	LM4562 Typical (Note 6)	LM4562 Limit (Note 7)	Units (Limits)
THD+N	Total Harmonic Distortion + Noise	$A_V = 1$, $V_{OUT} = 3V_{rms}$ $R_L = 2k\Omega$ $R_L = 600\Omega$	0.00003 0.00003	 0.00009	% (max)
IMD	Intermodulation Distortion	$A_V = 1$, $V_{OUT} = 3V_{RMS}$ Two-tone, 60kHz & 7kHz 4:1	0.00005		dB
GBWP	Gain Bandwidth Product		55	45	MHz (min)
SR	Slew Rate		±20	±15	V/μs (min)
FPBW	Full Power Bandwidth	$V_{OUT} = 1V_{P-P}$, −3dB referenced to output magnitude at f = 1kHz	10		MHz
t_s	Settling time	$A_V = -1$, 10V step, $C_L = 100pF$ 0.1% error range	1.2		μs
e_n	Equivalent Input Noise Voltage	f_{BW} = 20Hz to 20kHz	0.34	0.65	μV_{RMS} (max)
	Equivalent Input Noise Density	f = 1kHz f = 10Hz	2.7 6.4	4.7	$nV/\sqrt{Hz}$ (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		$pA/\sqrt{Hz}$
V_{OS}	Offset Voltage		±0.1	±0.7	mV (max)
$\Delta V_{OS}/\Delta Temp$	Average Input Offset Voltage Drift vs Temperature	$-40°C \leq T_A \leq 85°C$	0.2		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	$\Delta V_S = 20V$ (Note 8)	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	$-40°C \leq T_A \leq 85°C$	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)

Electrical Characteristics for the LM4562 (Note 1)

The following specifications apply for the circuit shown in Figure X. V_S = ±15V, R_L = 2kΩ, R_{SOURCE} = 10Ω, f_{IN} = 1kHz, and T_A = 25˚C, unless otherwise specified. (Continued)

Symbol	Parameter	Conditions	LM4562 Typical (Note 6)	LM4562 Limit (Note 7)	Units (Limits)
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
C_{LOAD}	Capacitive Load Drive Overshoot	100pF	16		%
I_S	Total Quiescent Current	I_{OUT} = 0mA	10	12	mA (max)

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

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

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

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

Note 5: Machine Model ESD test is covered by specification EIAJ IC-121-1981. A 200pF cap is charged to the specified voltage and then discharged directly into the IC with no external series resistor (resistance of discharge path must be under 50Ω).

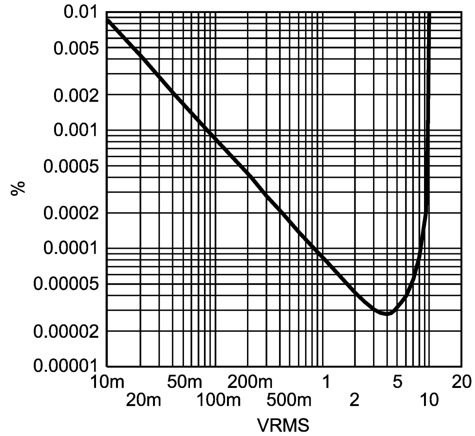
Note 6: Typical specifications are specified at +25ºC and represent the most likely parametric norm.

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

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

Typical Performance Characteristics

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



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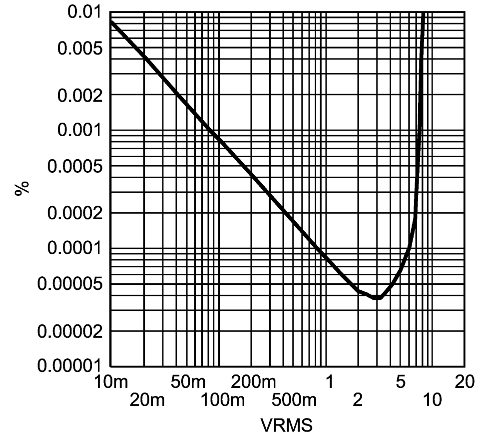
THD+N vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ



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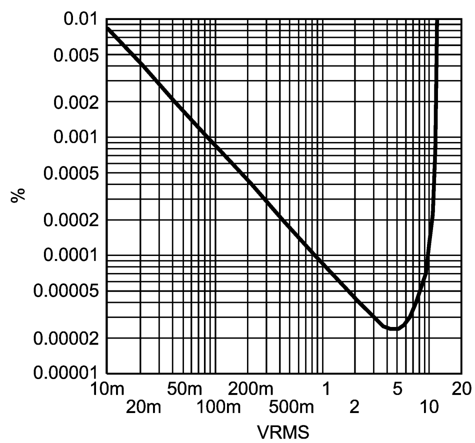
THD+N vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 2kΩ



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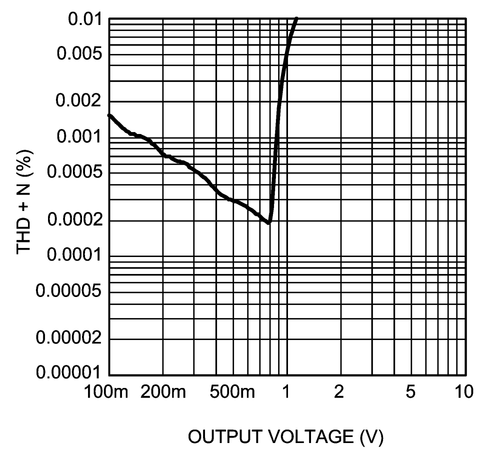
THD+N vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ



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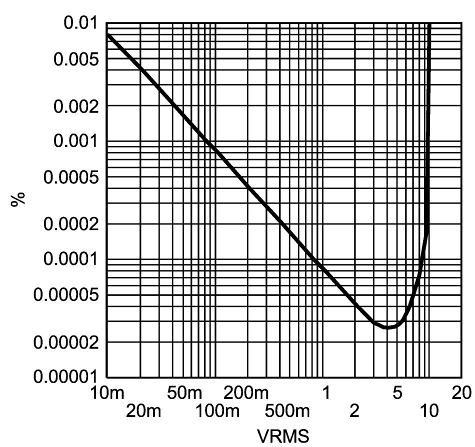
THD+N vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 600Ω



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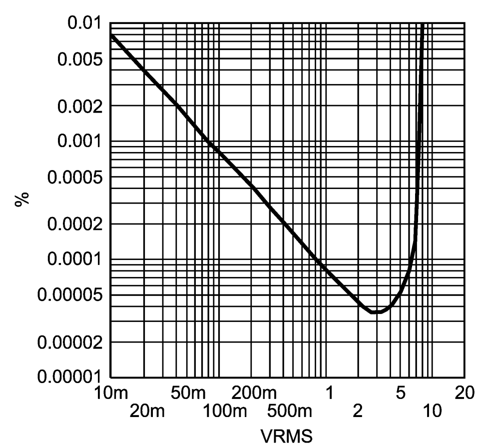
THD+N vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 600Ω



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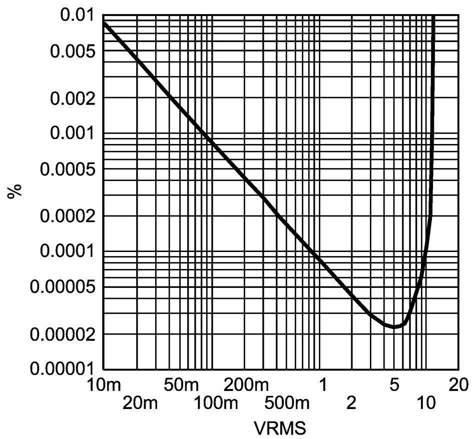
Typical Performance Characteristics (Continued)

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



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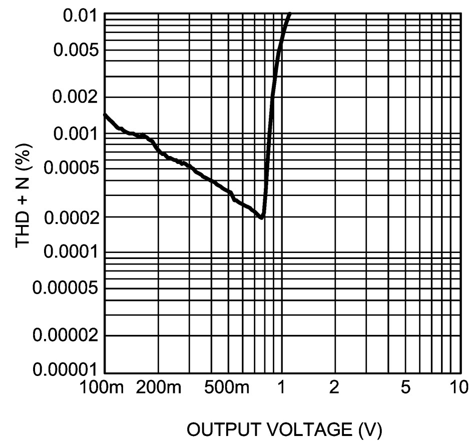
THD+N vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 600Ω



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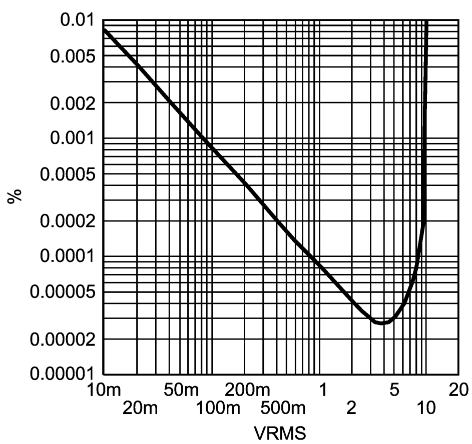
THD+N vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 10kΩ



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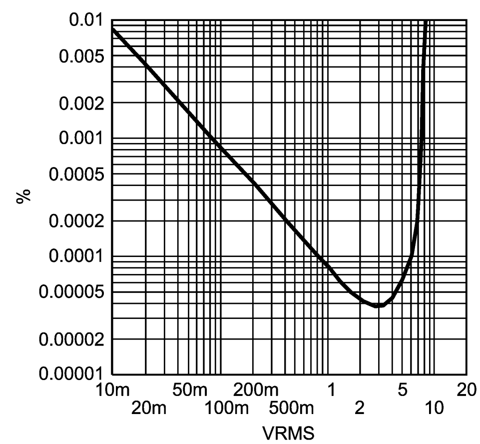
THD+N vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 10kΩ



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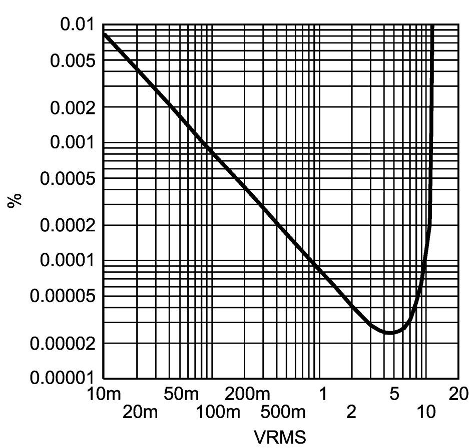
THD+N vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ



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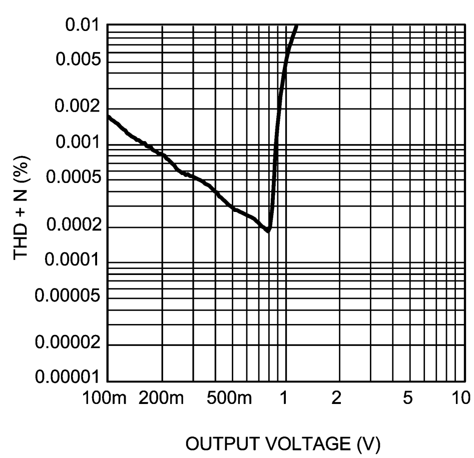
THD+N vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 10kΩ



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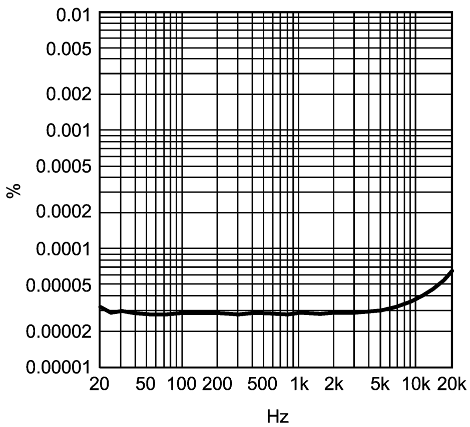
Typical Performance Characteristics (Continued)

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



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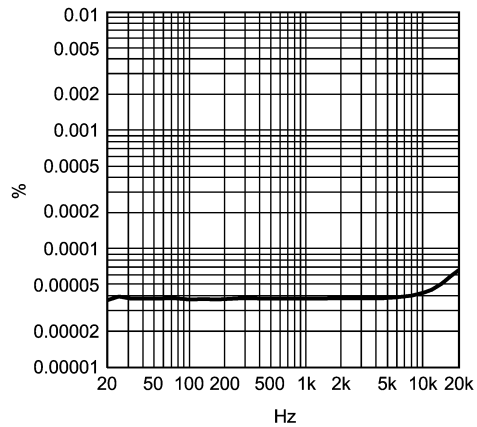
THD+N vs Frequency
V_{CC} = 12V, V_{EE} = −12V, V_{OUT} = $3V_{RMS}$
R_L = 2kΩ



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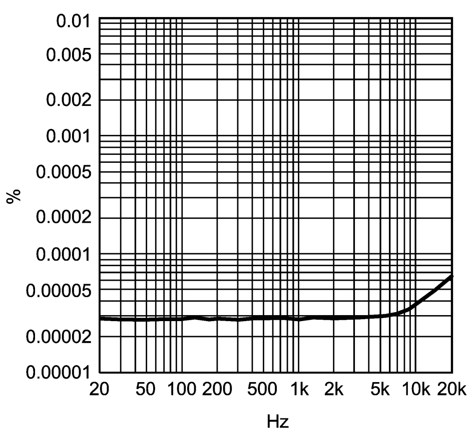
THD+N vs Frequency
V_{CC} = 17V, V_{EE} = −17V, V_{OUT} = $3V_{RMS}$
R_L = 2kΩ



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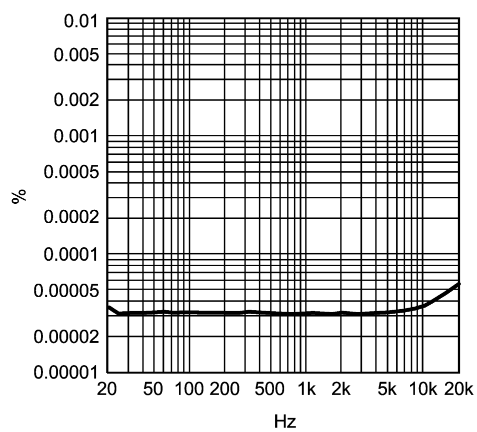
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = −15V, V_{OUT} = $3V_{RMS}$
R_L = 600Ω



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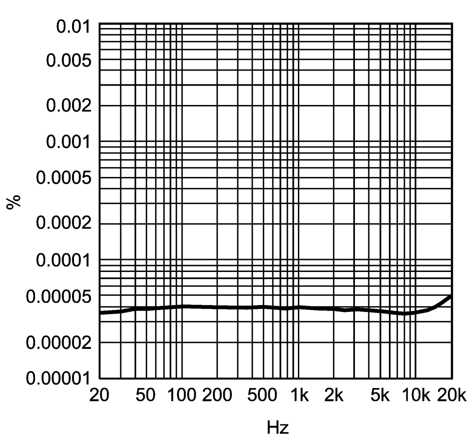
THD+N vs Frequency
V_{CC} = 12V, V_{EE} = −12V, V_{OUT} = $3V_{RMS}$
R_L = 600Ω



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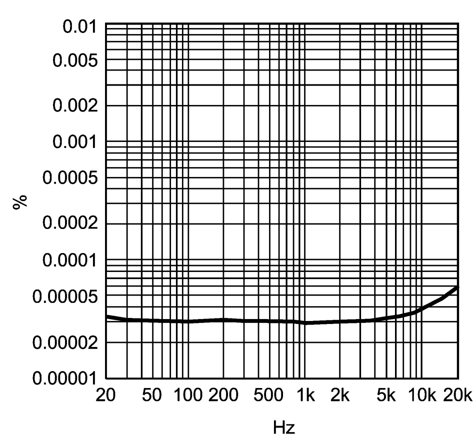
THD+N vs Frequency
V_{CC} = 17V, V_{EE} = −17V, V_{OUT} = $3V_{RMS}$
R_L = 600Ω



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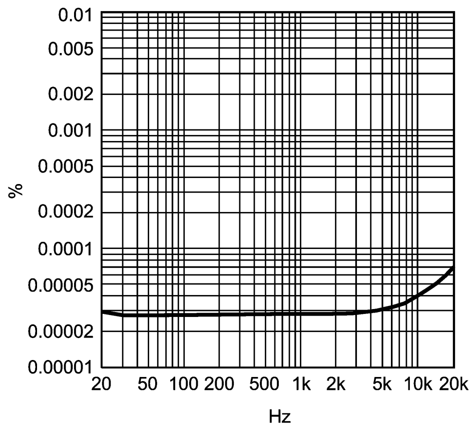
Typical Performance Characteristics (Continued)

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



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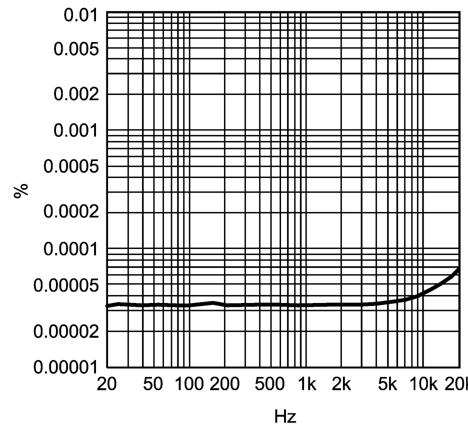
THD+N vs Frequency
V_{CC} = 12V, V_{EE} = –12V, V_{OUT} = 3V_{RMS}
R_L = 10kΩ



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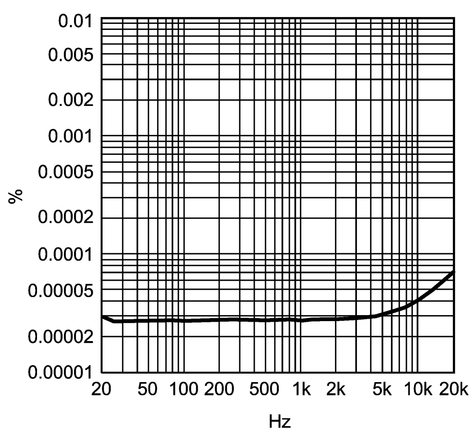
THD+N vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
R_L = 10kΩ



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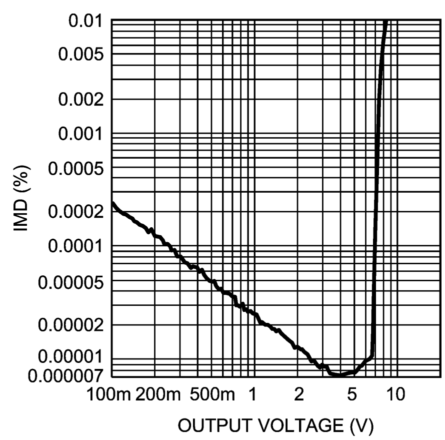
IMD vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V
R_L = 2kΩ



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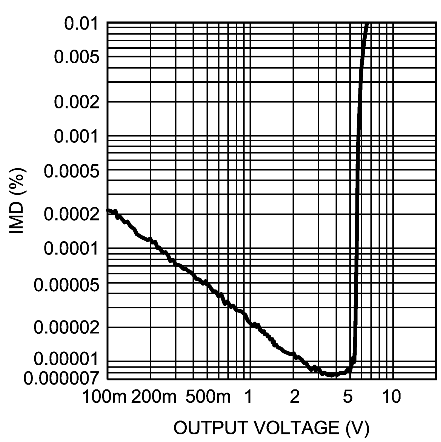
IMD vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ



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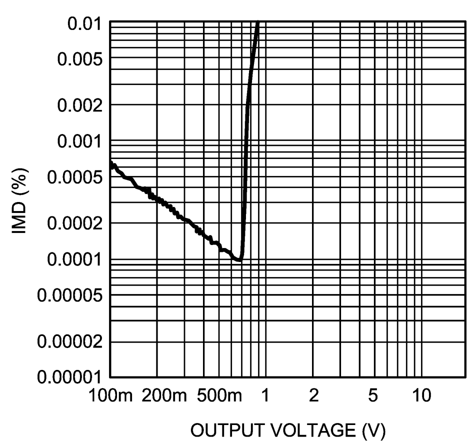
IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 2kΩ



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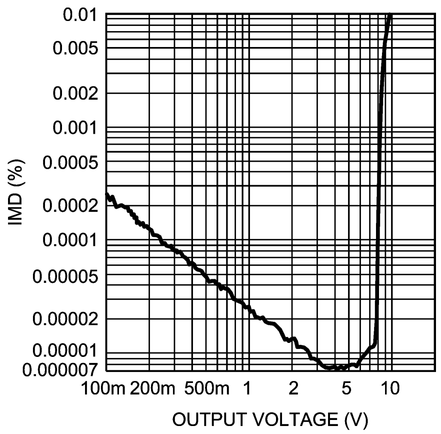
Typical Performance Characteristics (Continued)

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



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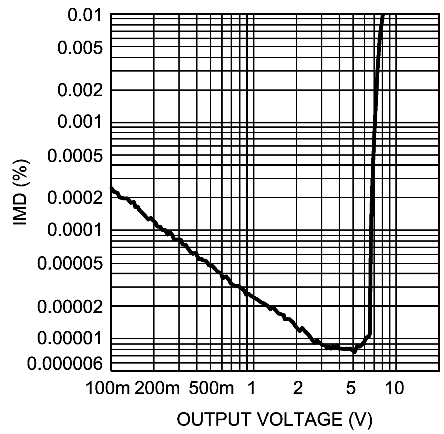
IMD vs Output Voltage
V_{CC} = 15V, V_{EE} = −15V
R_L = 600Ω



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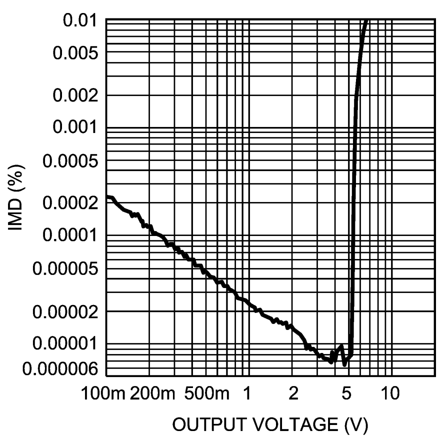
IMD vs Output Voltage
V_{CC} = 12V, V_{EE} = −12V
R_L = 600Ω



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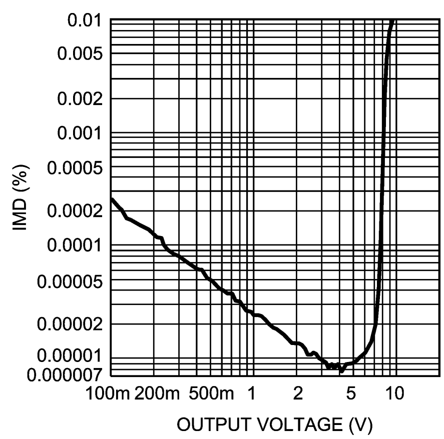
IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = −17V
R_L = 600Ω



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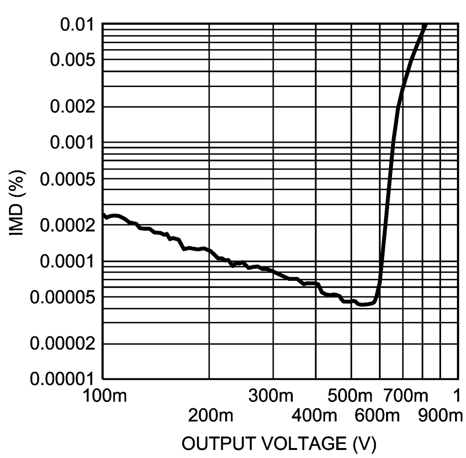
IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = −2.5V
R_L = 600Ω



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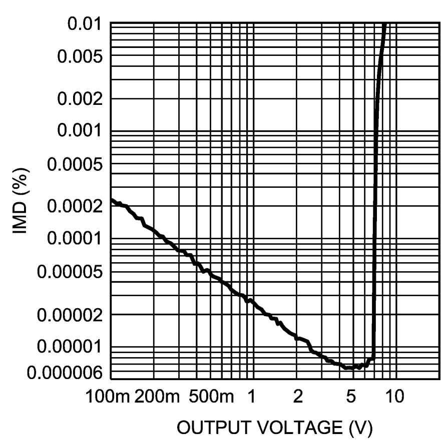
IMD vs Output Voltage
V_{CC} = 15V, V_{EE} = −15V
R_L = 10kΩ



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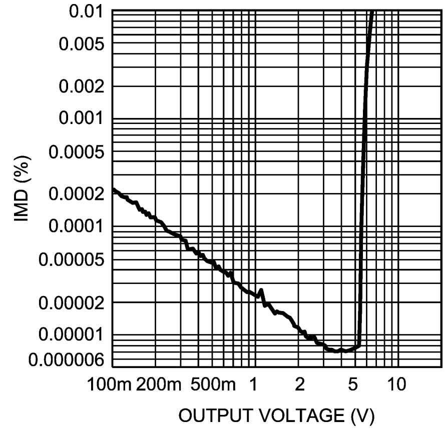
Typical Performance Characteristics (Continued)

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



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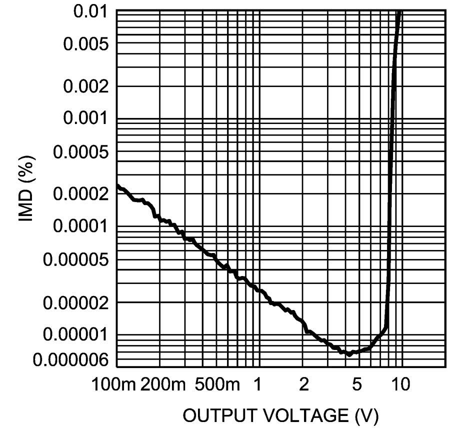
IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = −17V
R_L = 10kΩ



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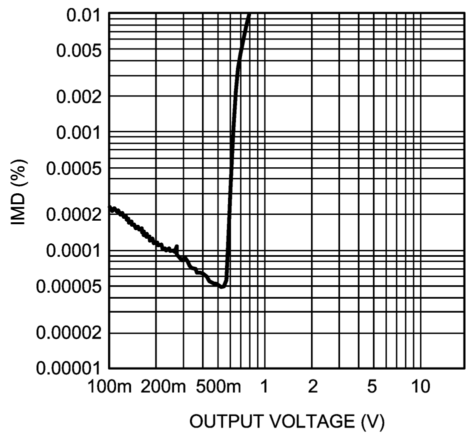
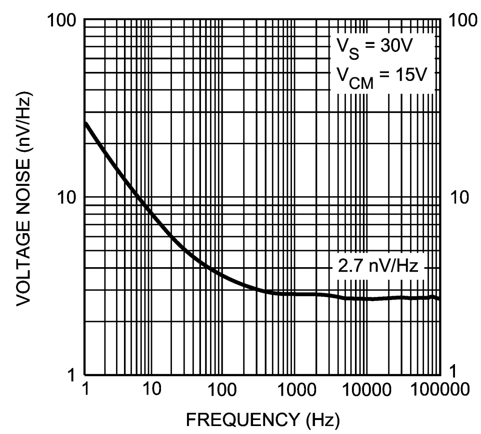
IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = −2.5V
R_L = 10kΩ



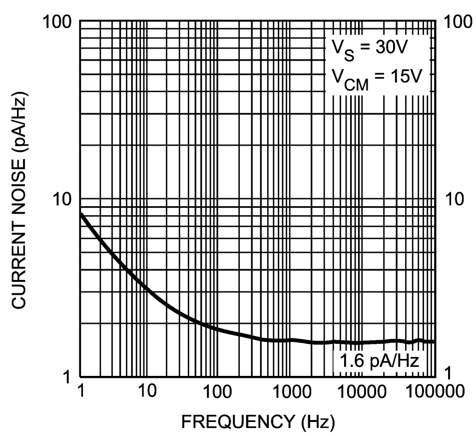
201572E9

Voltage Noise Density vs Frequency



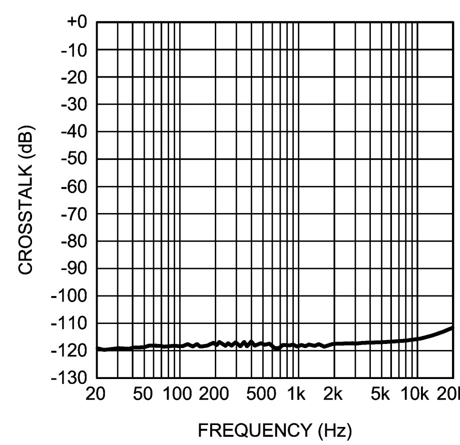
201572H6

Current Noise Density vs Frequency



201572H7

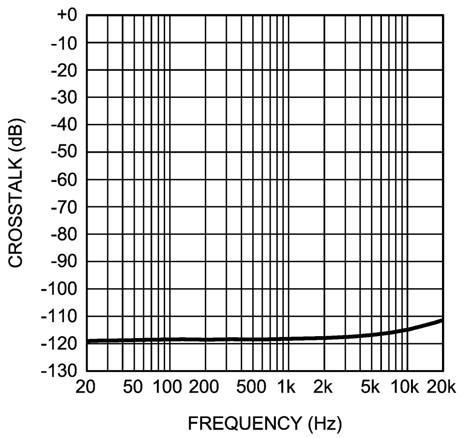
Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = −15V, V_{OUT} = $3V_{RMS}$
A_V = 0dB, R_L = 2kΩ



201572C8

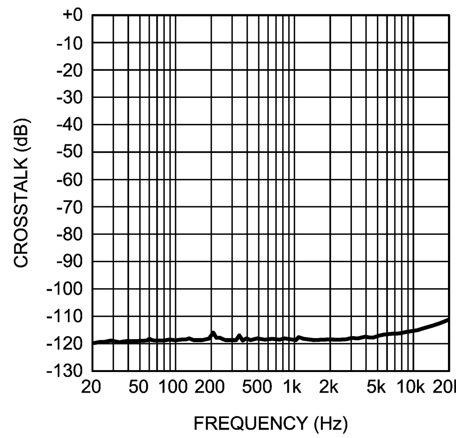
Typical Performance Characteristics (Continued)

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



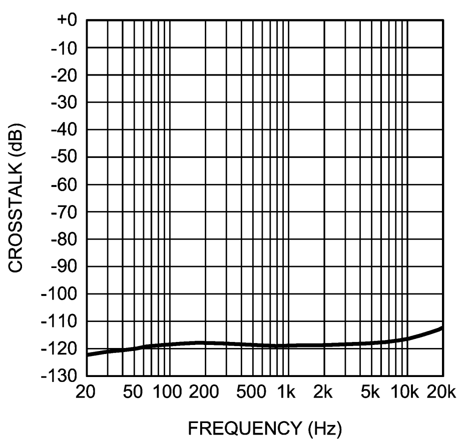
201572C9

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



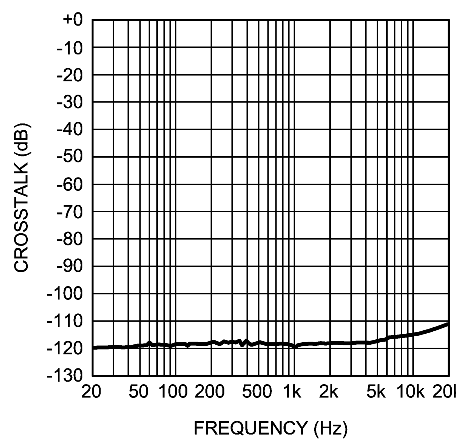
201572C6

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



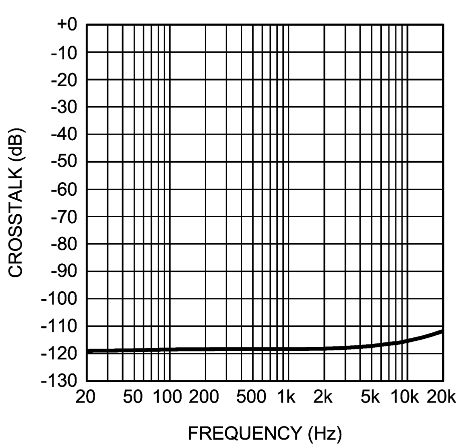
201572C7

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



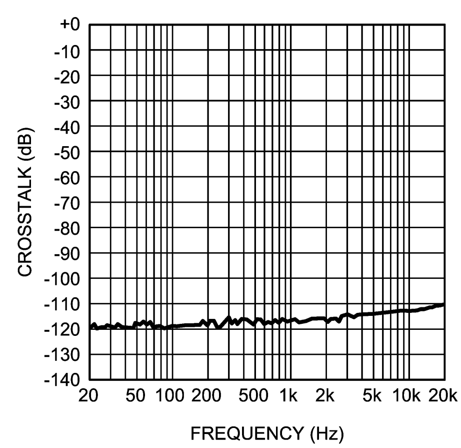
201572D0

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



201572D1

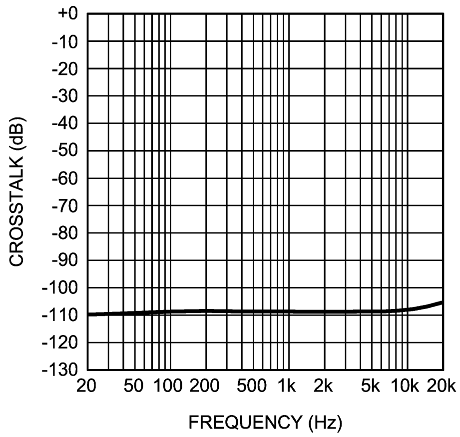
Crosstalk vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, V_{OUT} = 1V_{RMS}
A_V = 0dB, R_L = 2kΩ



201572C4

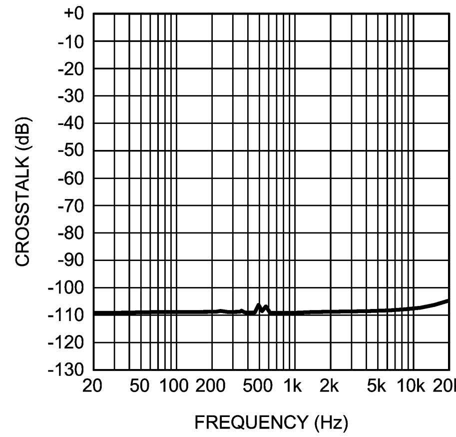
Typical Performance Characteristics (Continued)

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



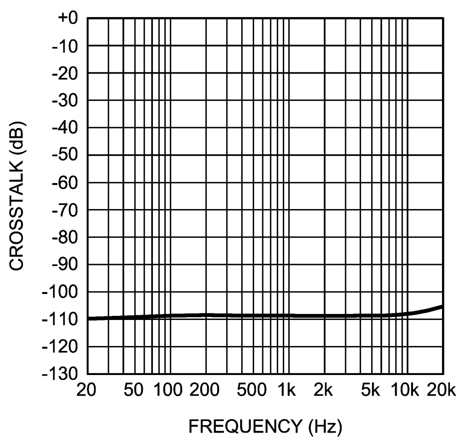
201572D6

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



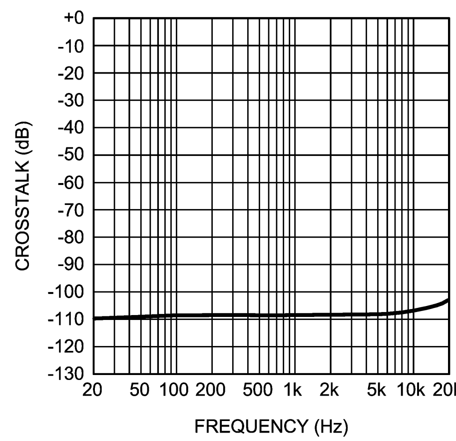
201572D7

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



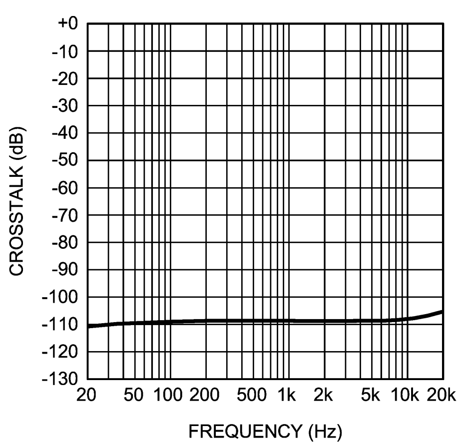
201572D4

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



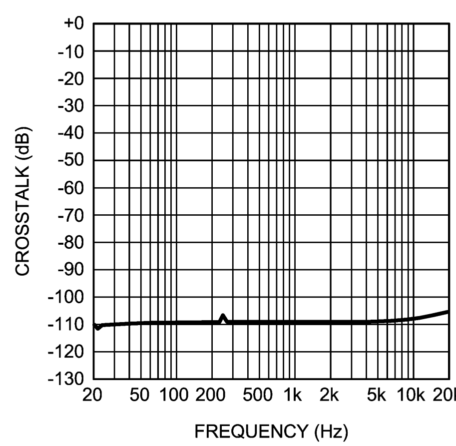
201572D5

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



201572D8

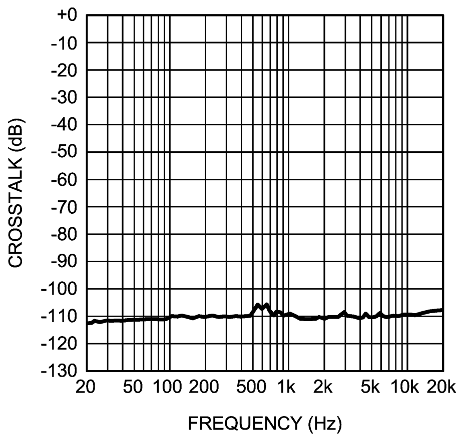
Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 600Ω



201572D9

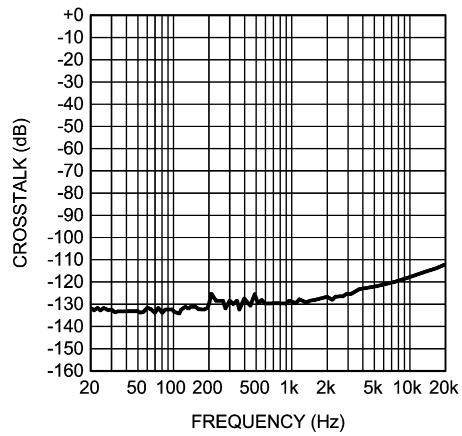
Typical Performance Characteristics (Continued)

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



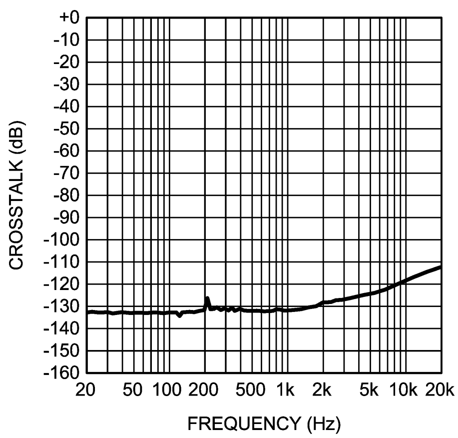
201572D2

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



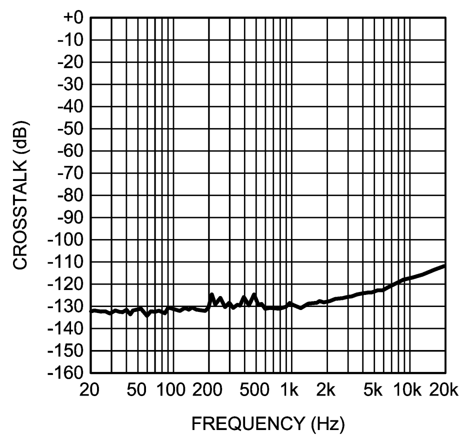
201572C0

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



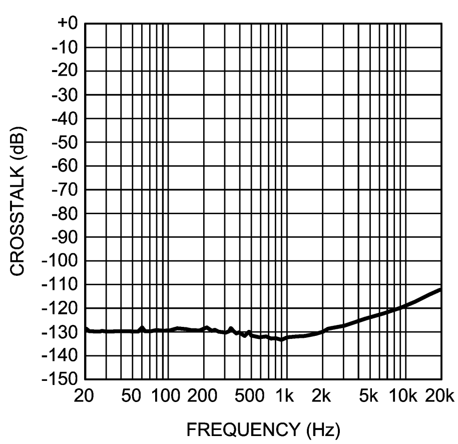
201572C1

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



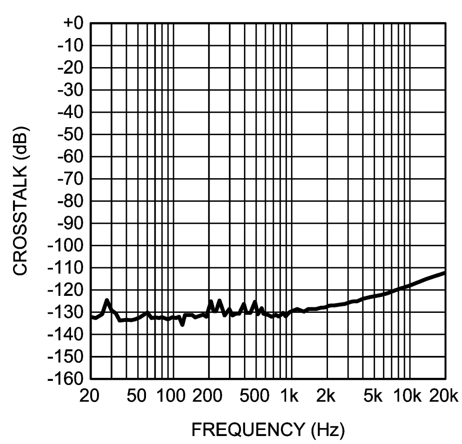
201572B8

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



201572B9

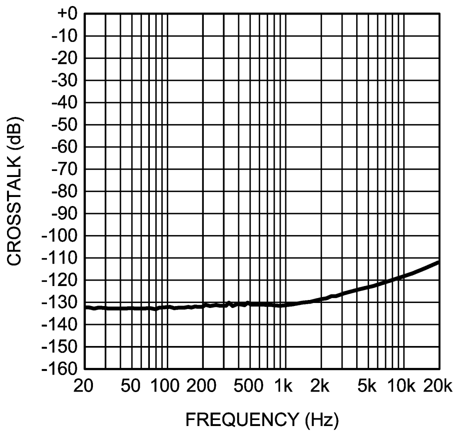
Crosstalk vs Frequency
V_{CC} = 17V, V_{EE} = –17V, V_{OUT} = 3V_{RMS}
A_V = 0dB, R_L = 10kΩ



201572C2

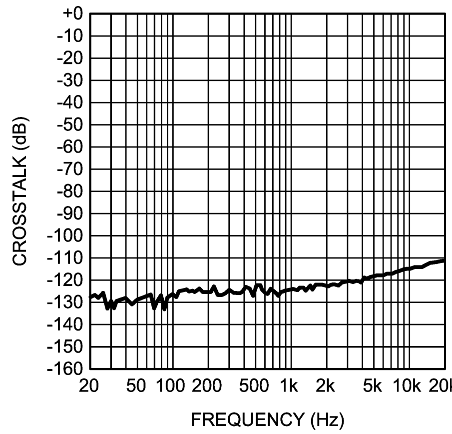
Typical Performance Characteristics (Continued)

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



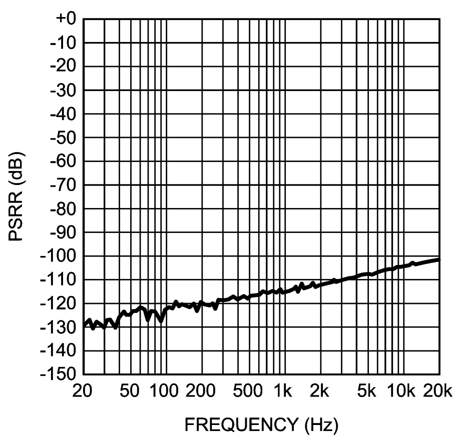
201572C3

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



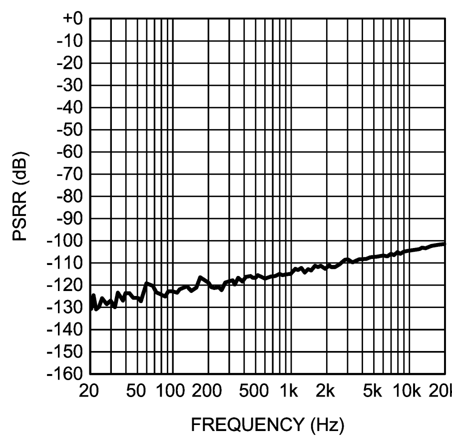
201572B6

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



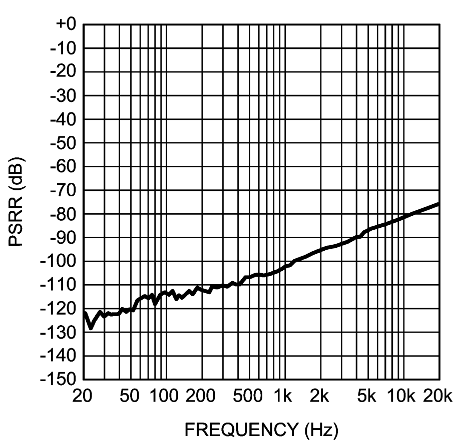
201572B0

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



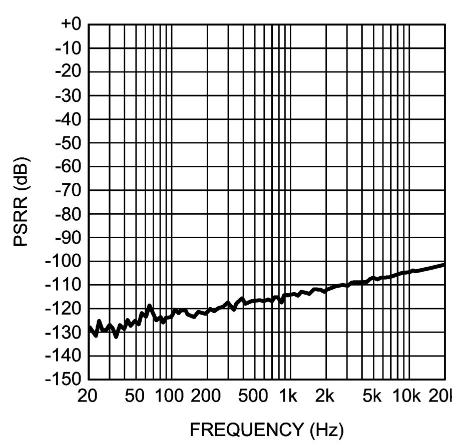
201572B4

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



201572A9

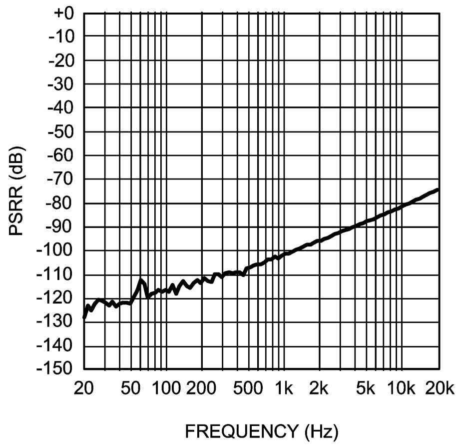
PSRR- vs Frequency
V_{CC} = 12V, V_{EE} = –12V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



201572B3

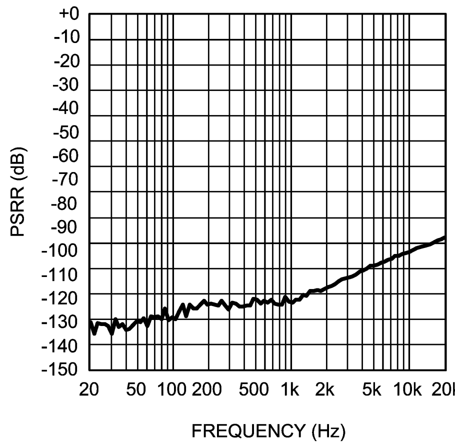
Typical Performance Characteristics (Continued)

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



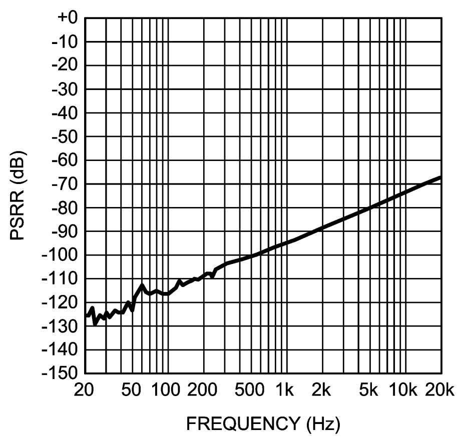
201572J3

PSRR- vs Frequency
V_{CC} = 17V, V_{EE} = −17V
R_L = 2kΩ, V_{RIPPLE} = 200mVpp



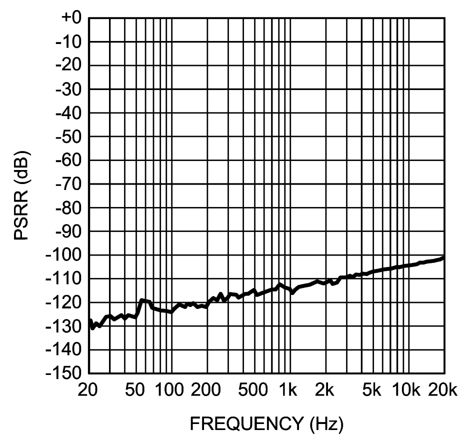
201572J2

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



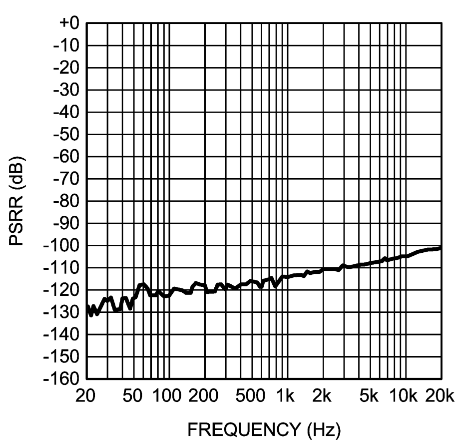
201572A8

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



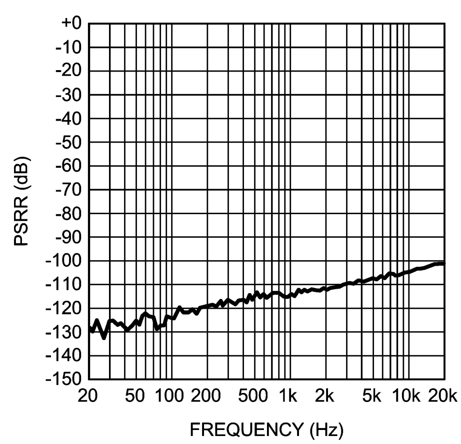
201572B2

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



201572A1

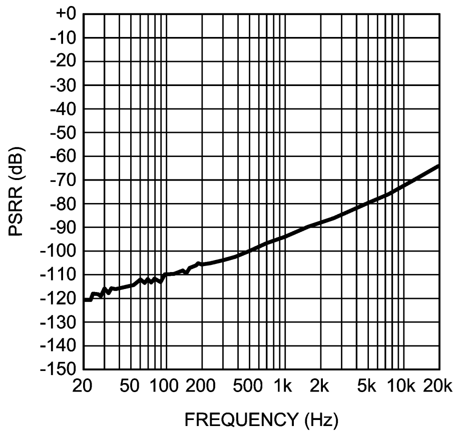
PSRR- vs Frequency
V_{CC} = 15V, V_{EE} = −15V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



201572A6

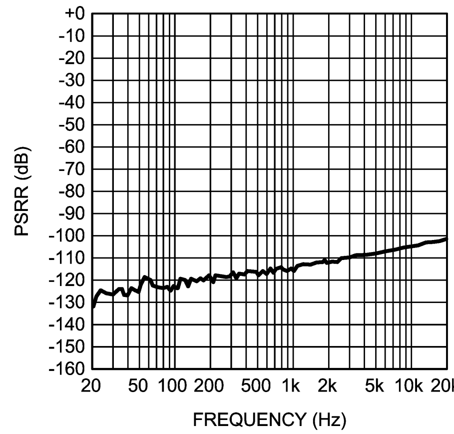
Typical Performance Characteristics (Continued)

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



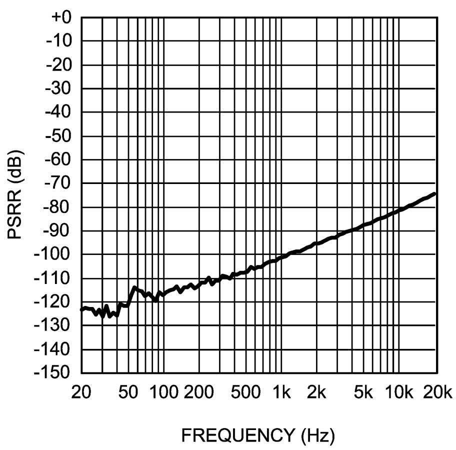
201572A0

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



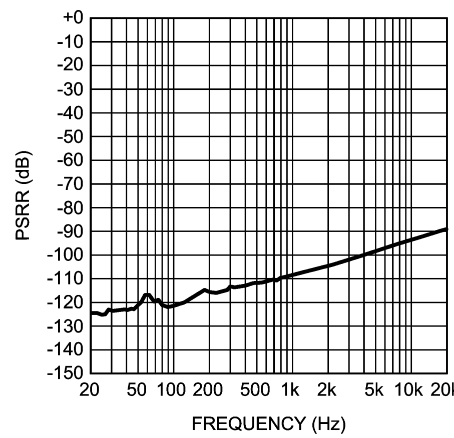
201572A5

PSRR+ vs Frequency
V_{CC} = 17V, V_{CC} = −17V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



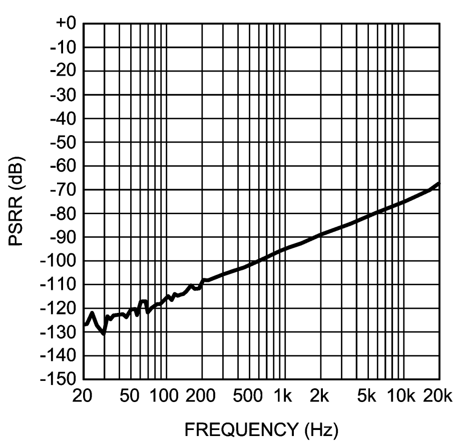
201572J4

PSRR- vs Frequency
V_{CC} = 17V, V_{CC} = −17V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



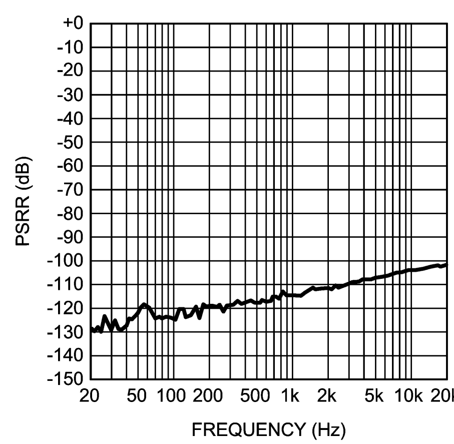
201572A3

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



20157299

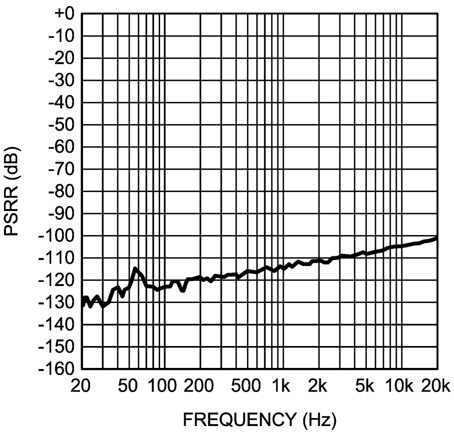
PSRR- vs Frequency
V_{CC} = 2.5V, V_{EE} = −2.5V
R_L = 600Ω, V_{RIPPLE} = 200mVpp



201572A4

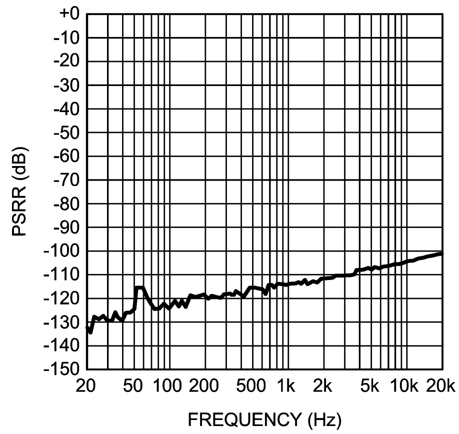
Typical Performance Characteristics (Continued)

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



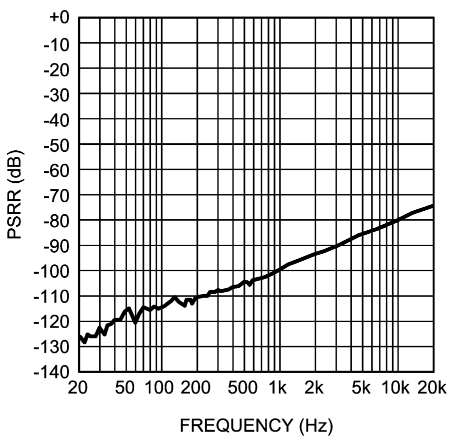
20157293

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



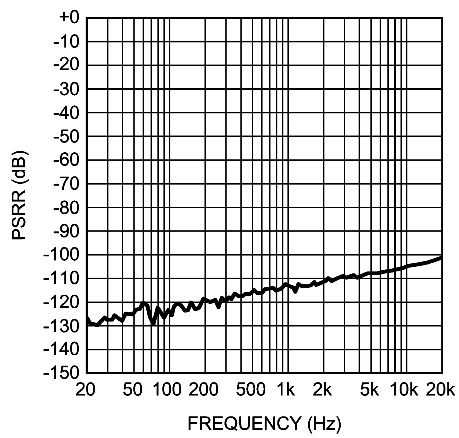
20157297

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



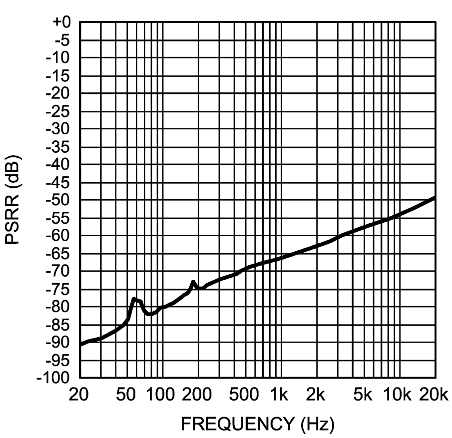
20157292

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



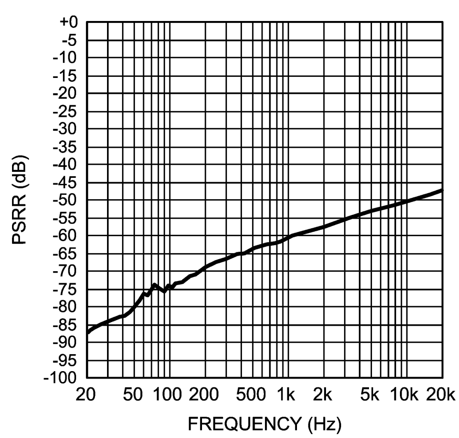
20157296

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



20157294

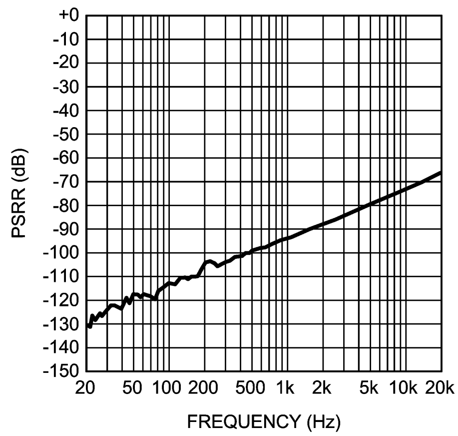
PSRR- vs Frequency
V_{CC} = 17V, V_{EE} = −17V
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



20157298

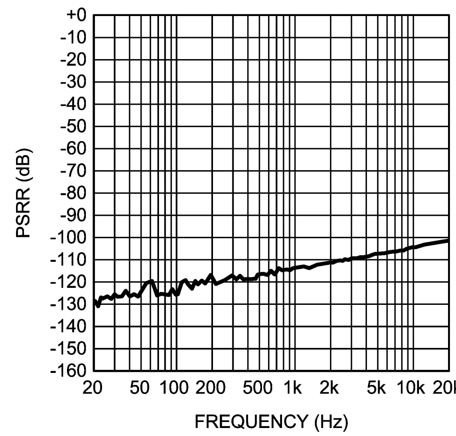
Typical Performance Characteristics (Continued)

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



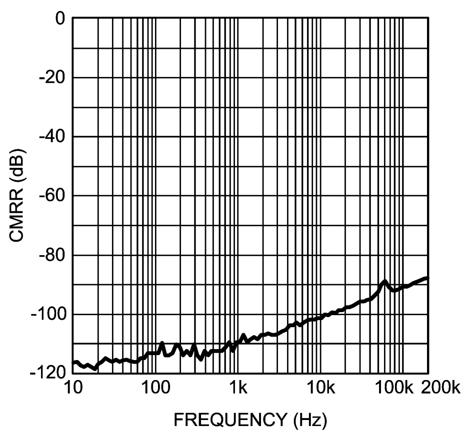
20157291

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



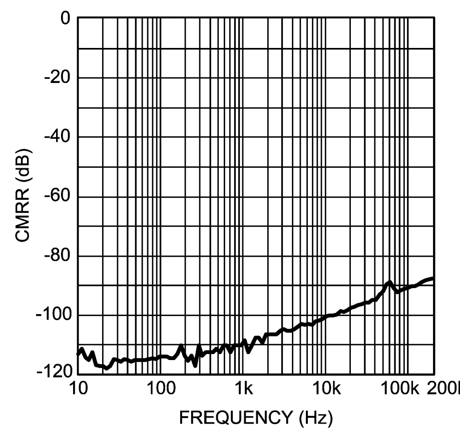
20157295

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



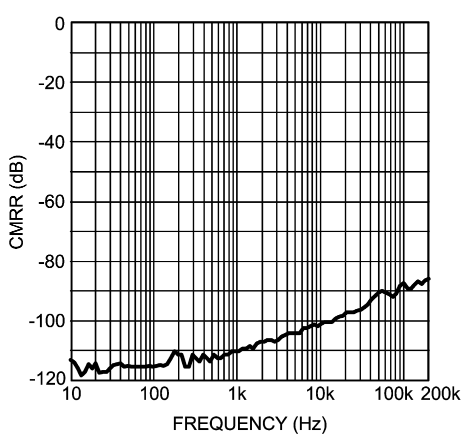
201572G0

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



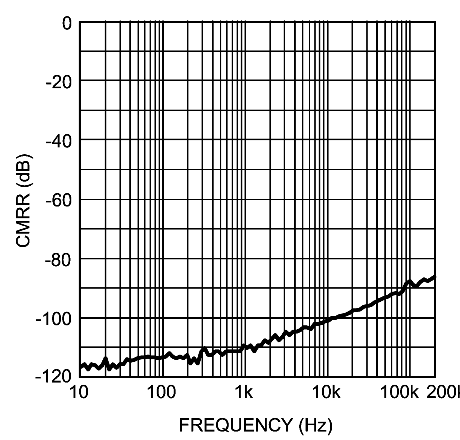
201572F7

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



201572G3

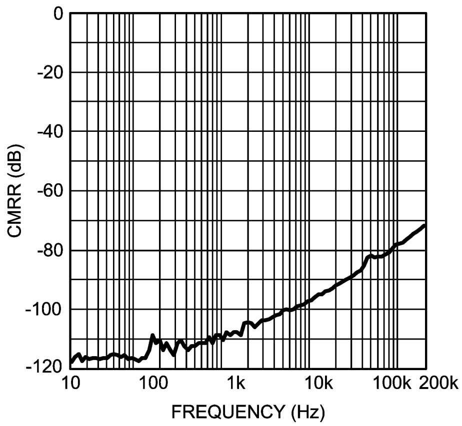
CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = −2.5V
R_L = 2kΩ



201572F4

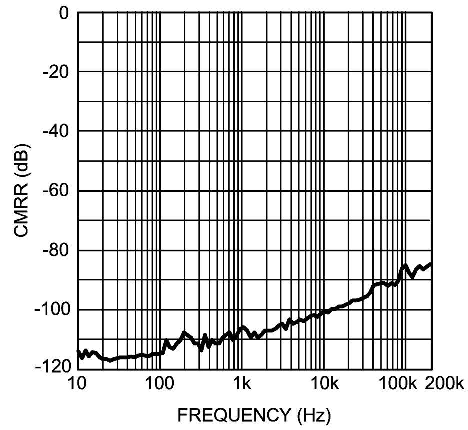
Typical Performance Characteristics (Continued)

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



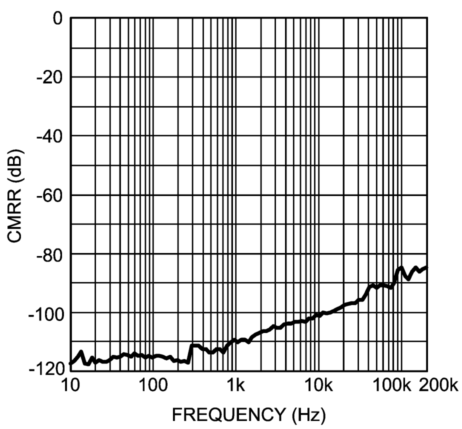
201572G2

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



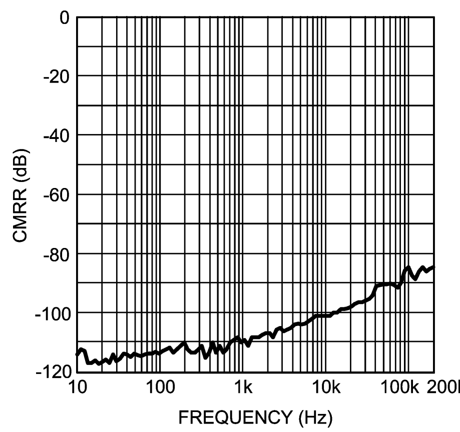
201572F9

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



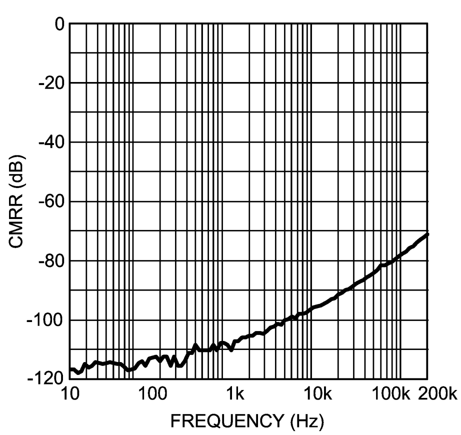
201572G5

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



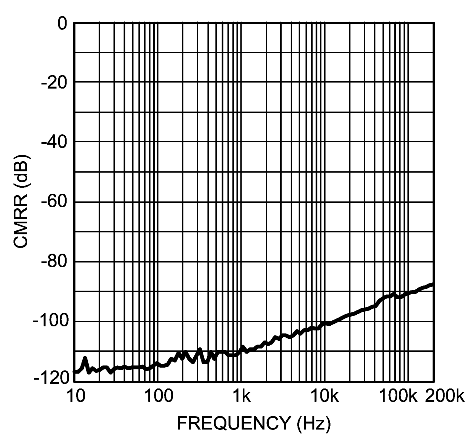
201572F6

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



201572G1

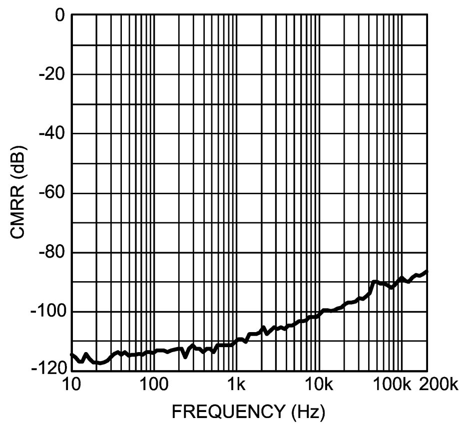
CMRR vs Frequency
V_{CC} = 12V, V_{EE} = −12V
R_L = 10kΩ



201572F8

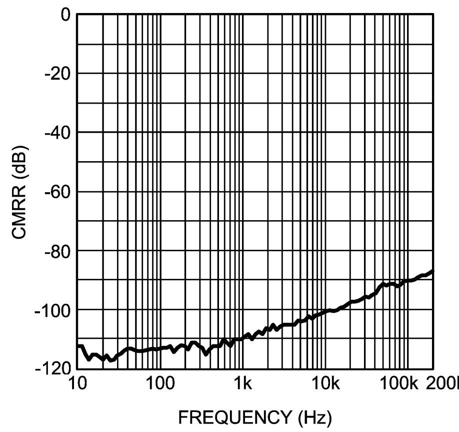
Typical Performance Characteristics (Continued)

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



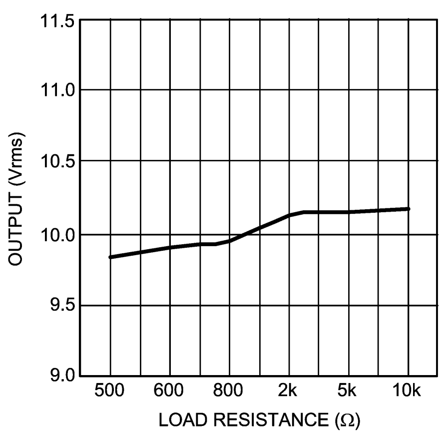
201572G4

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



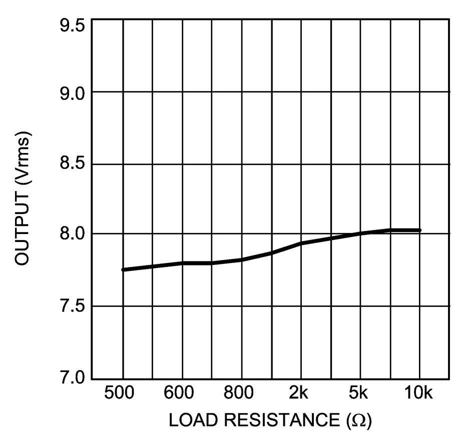
201572F5

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



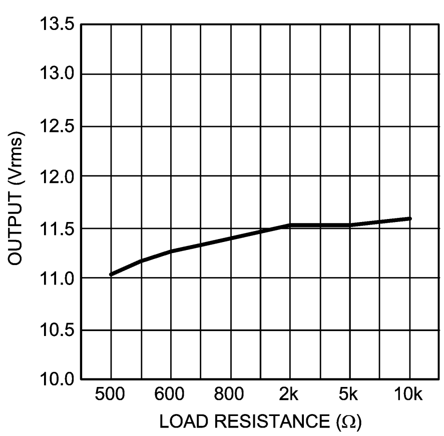
201572H1

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



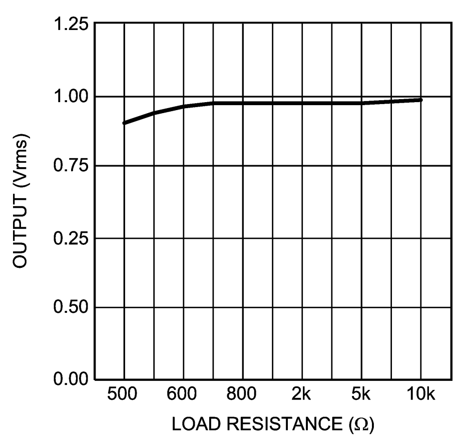
201572H0

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



201572H2

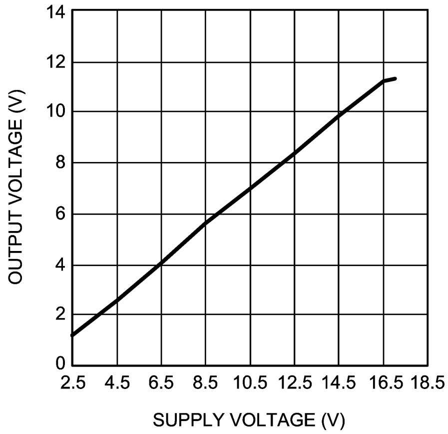
Output Voltage vs Load Resistance
V_{DD} = 2.5V, V_{EE} = –2.5V
THD+N = 1%



201572G9

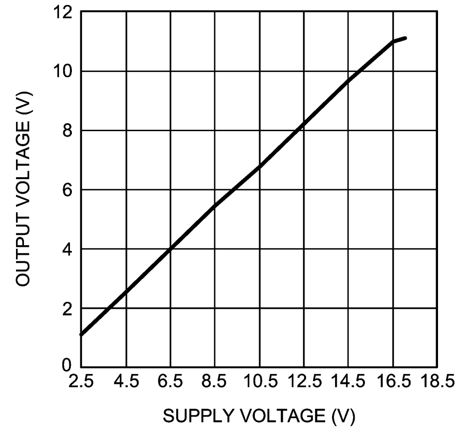
Typical Performance Characteristics (Continued)

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



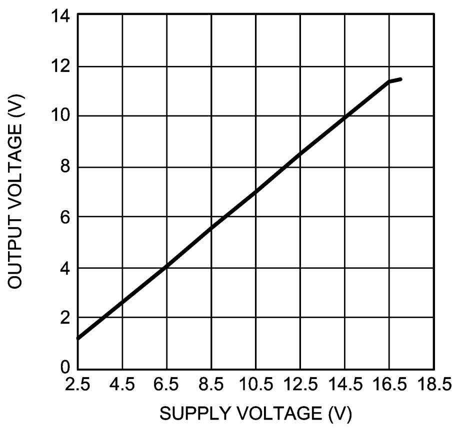
201572J9

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



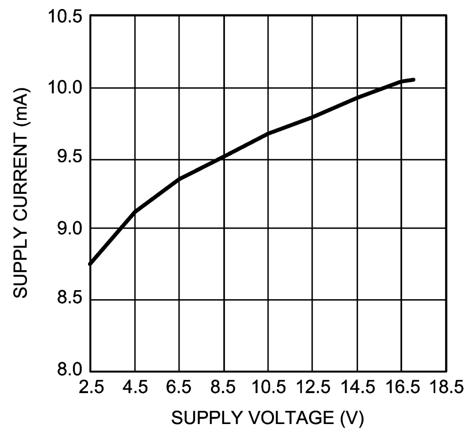
201572J8

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



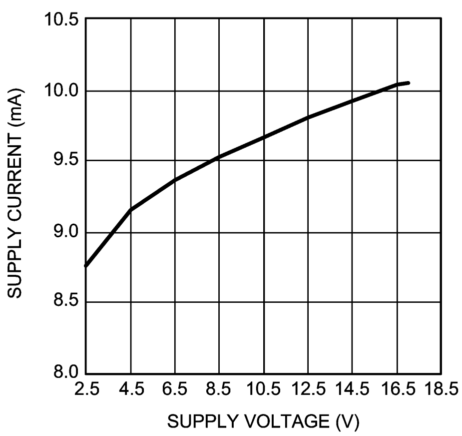
201572K0

Supply Current vs Supply Voltage
R_L = 2kΩ



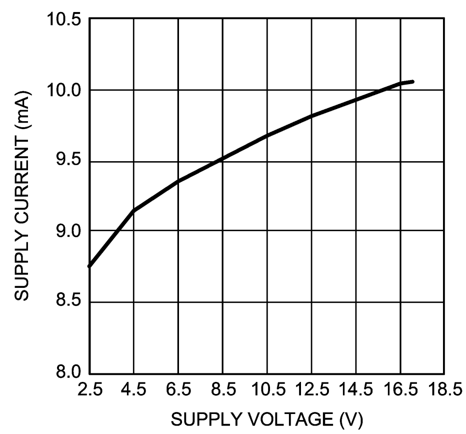
201572J6

Supply Current vs Supply Voltage
R_L = 600Ω



201572J5

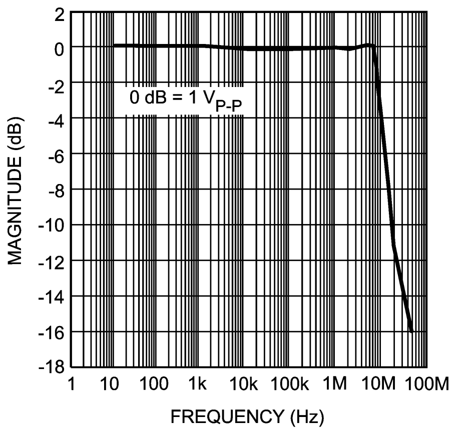
Supply Current vs Supply Voltage
R_L = 10kΩ



201572J7

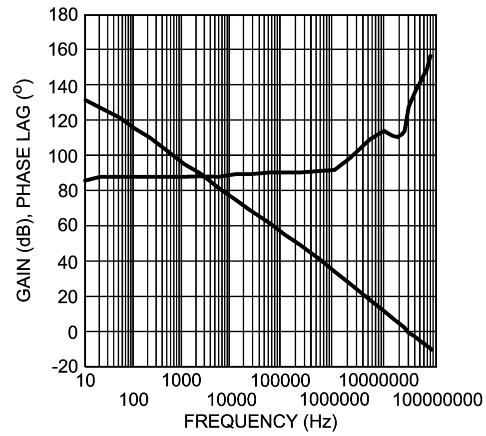
Typical Performance Characteristics (Continued)

Full Power Bandwidth vs Frequency



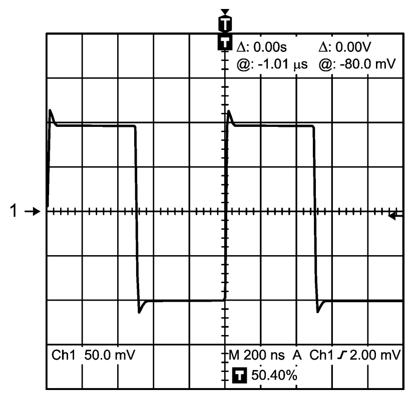
201572J0

Gain Phase vs Frequency



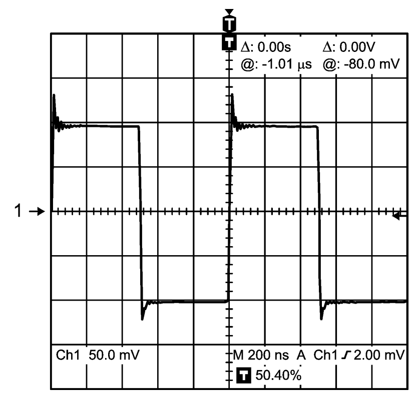
201572J1

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



201572I7

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



201572I8

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 1, adding the 10Ω resistor connected between the amplifier's inverting and non-inverting inputs changes the amplifier's noise gain. The result is that the error signal (distortion) is amplified by a factor of 101. Although the amplifier's closed-loop gain is unaltered, the feedback available to correct distortion errors is reduced by 101, which means that measurement resolution increases by 101. To ensure minimum effects on distortion measurements, keep the value of R1 low as shown in Figure 1.

This technique is verified by duplicating the measurements with high closed loop gain and/or making the measurements at high frequencies. Doing so produces distortion components that are within the measurement equipment's capabilities. This datasheet's THD+N and IMD values were generated using the above described circuit connected to an Audio Precision System Two Cascade.

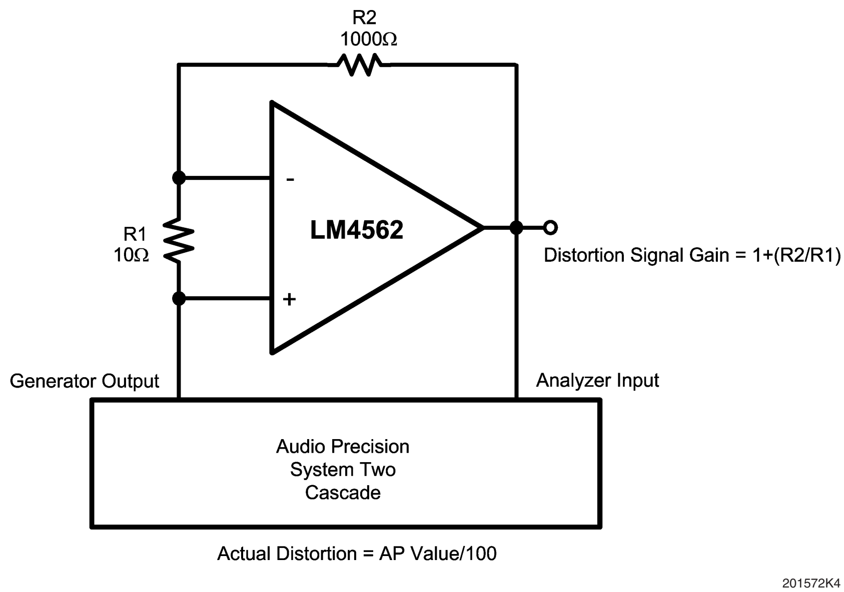


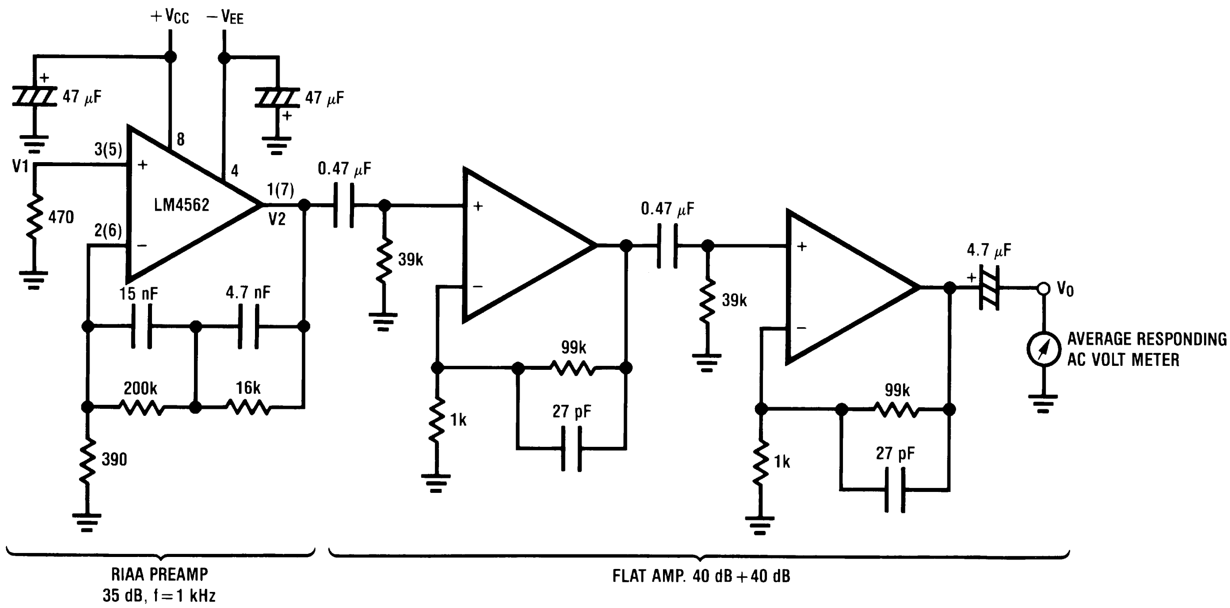
FIGURE 1. THD+N and IMD Distortion Test Circuit

Application Information (Continued)

NOISE MEASUREMENT 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.



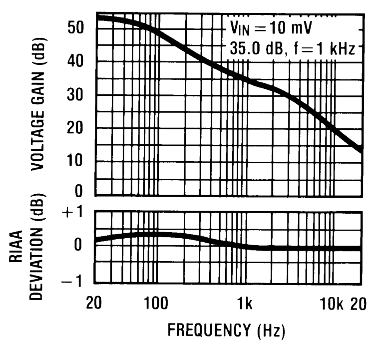
20157227

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

Total Gain: 115 dB @f = 1 kHz

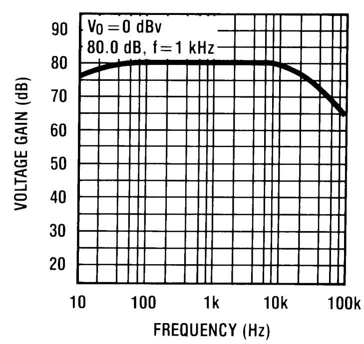
Input Referred Noise Voltage: e_n = V0/560,000 (V)

RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



20157228

Flat Amp Voltage Gain vs Frequency

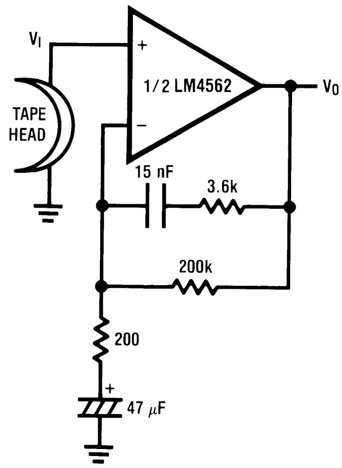


20157229

Application Information (Continued)

TYPICAL APPLICATIONS

NAB Preamp



20157230

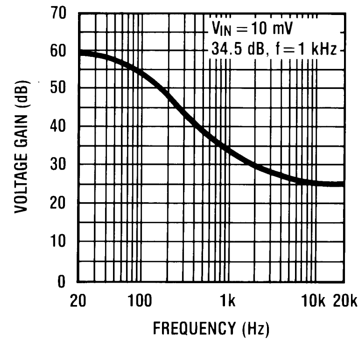
$A_V = 34.5$

F = 1 kHz

$E_n = 0.38\ \mu V$

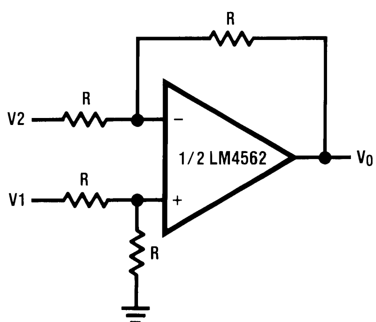
A Weighted

NAB Preamp Voltage Gain vs Frequency



20157231

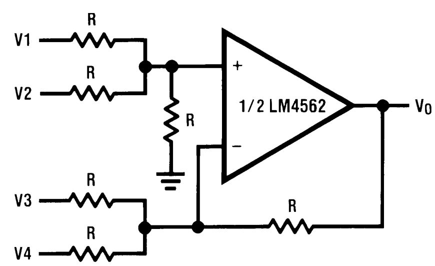
Balanced to Single Ended Converter



20157232

$V_O = V1 - V2$

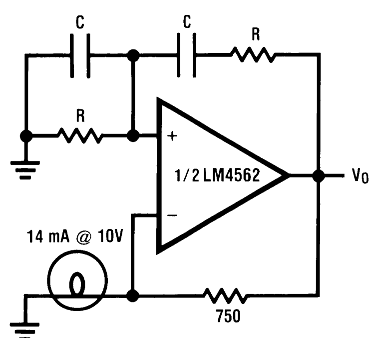
Adder/Subtracter



20157233

$V_O = V1 + V2 - V3 - V4$

Sine Wave Oscillator

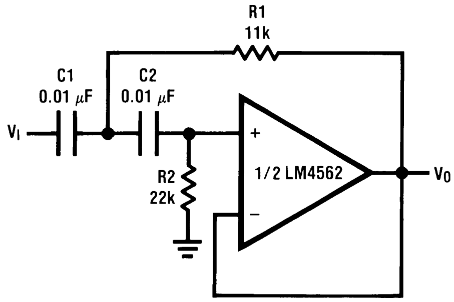


20157234

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

Application Information (Continued)

Second Order High Pass Filter (Butterworth)



20157235

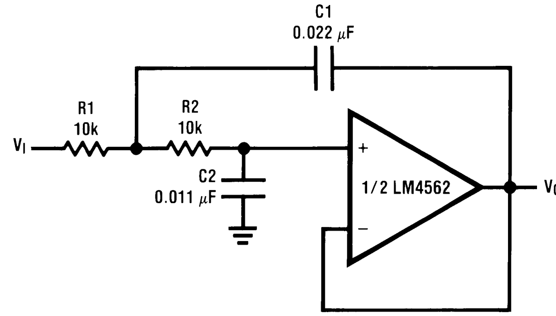
if C1 = C2 = C

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

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



20157236

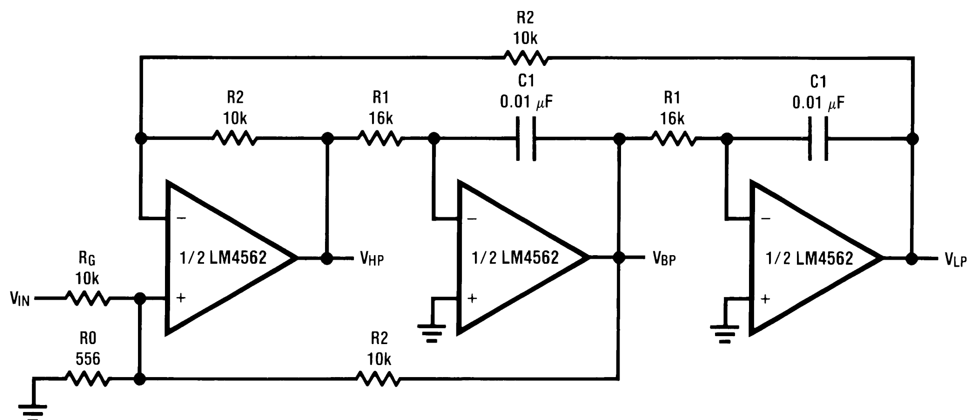
if R1 = R2 = R

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

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

Illustration is f_0 = 1 kHz

State Variable Filter



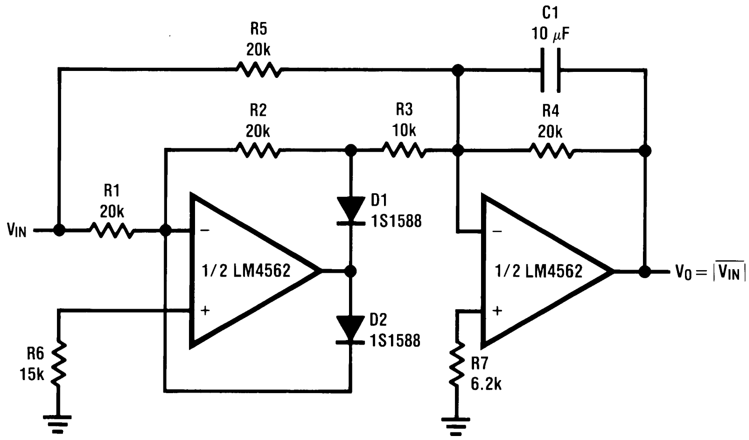
20157237

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

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

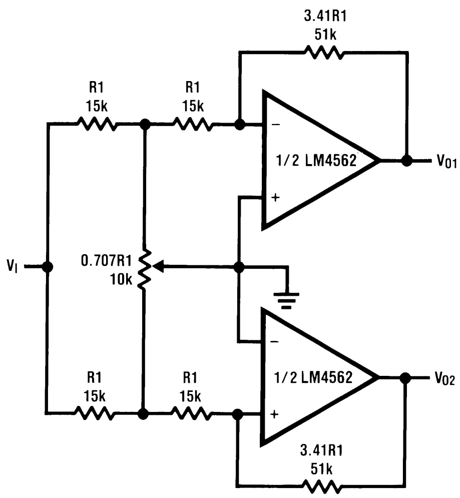
Application Information (Continued)

AC/DC Converter



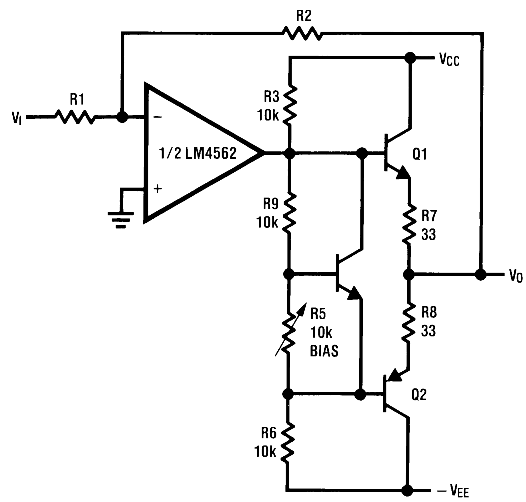
20157238

2 Channel Panning Circuit (Pan Pot)



20157239

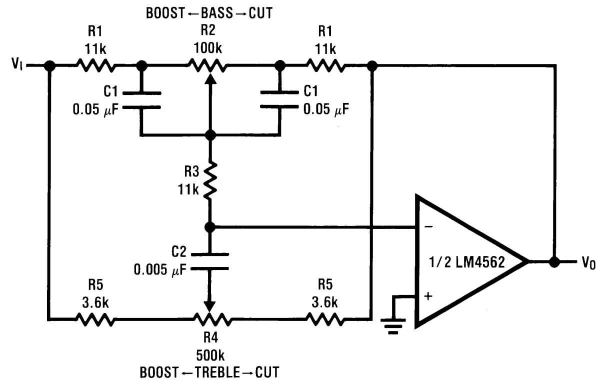
Line Driver



20157240

Application Information (Continued)

Tone Control



20157241

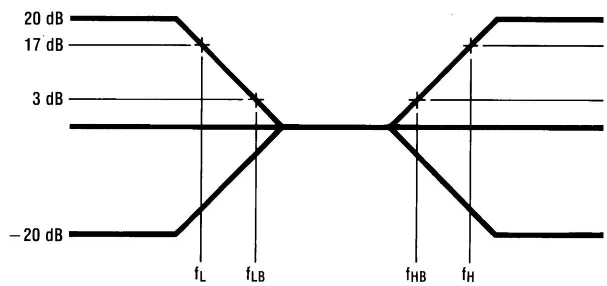
$$f_L = \frac{1}{2\pi R2C1},\ f_{LB} = \frac{1}{2\pi R1C1}$$

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

Illustration is:

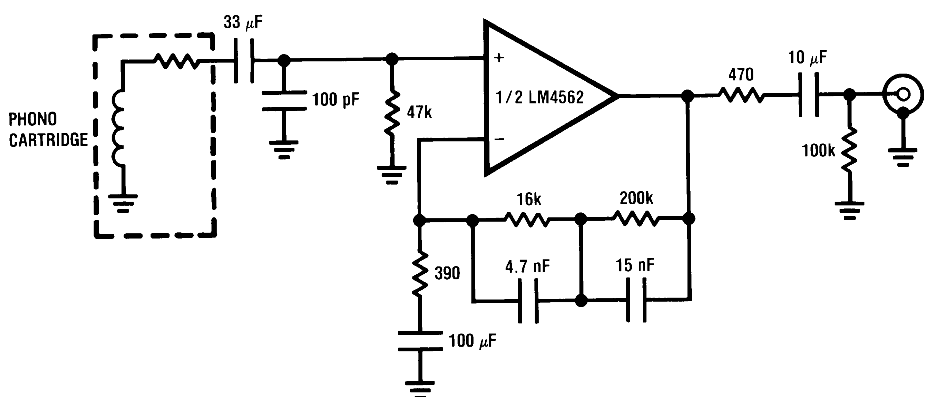
f_L = 32 Hz, f_{LB} = 320 Hz

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



20157242

RIAA Preamp



20157203

A_v = 35 dB

E_n = 0.33 μV

S/N = 90 dB

f = 1 kHz

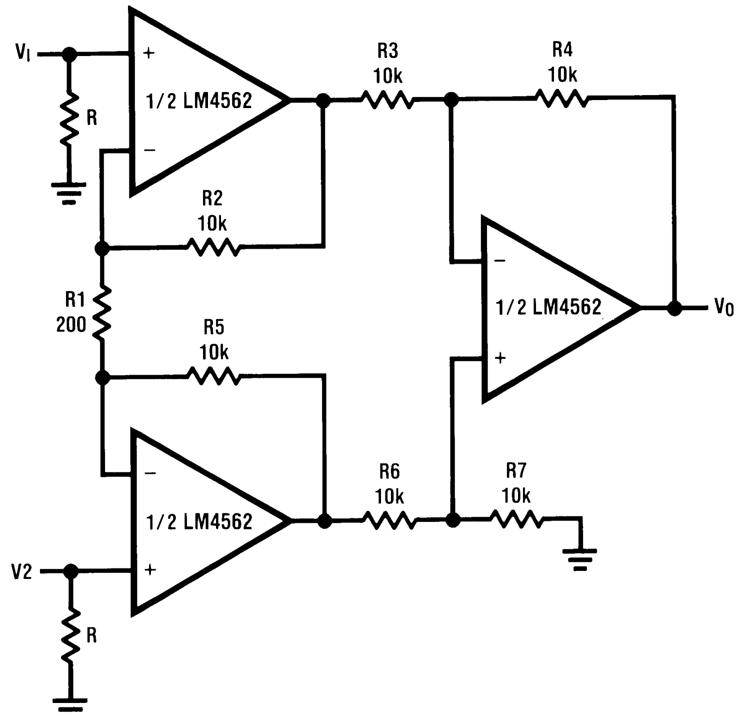
A Weighted

A Weighted, V_{IN} = 10 mV

@f = 1 kHz

Application Information (Continued)

Balanced Input Mic Amp



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

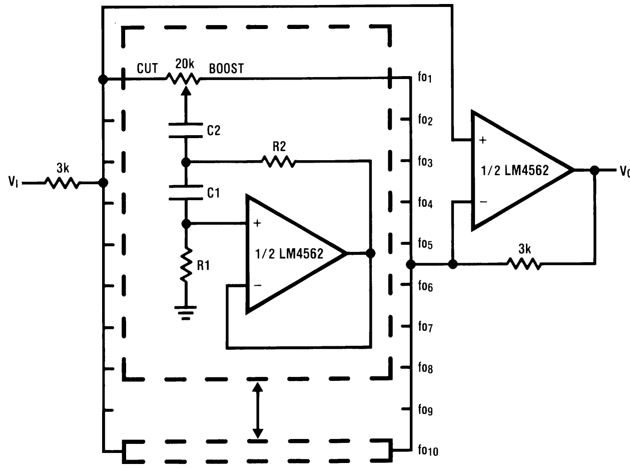
$$V0 = \left(1 + \frac{2R2}{R1}\right)\frac{R4}{R3}(V2 - V1)$$

Illustration is:

V0 = 101(V2 − V1)

Application Information (Continued)

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

Note 9: At volume of change = ±12 dB

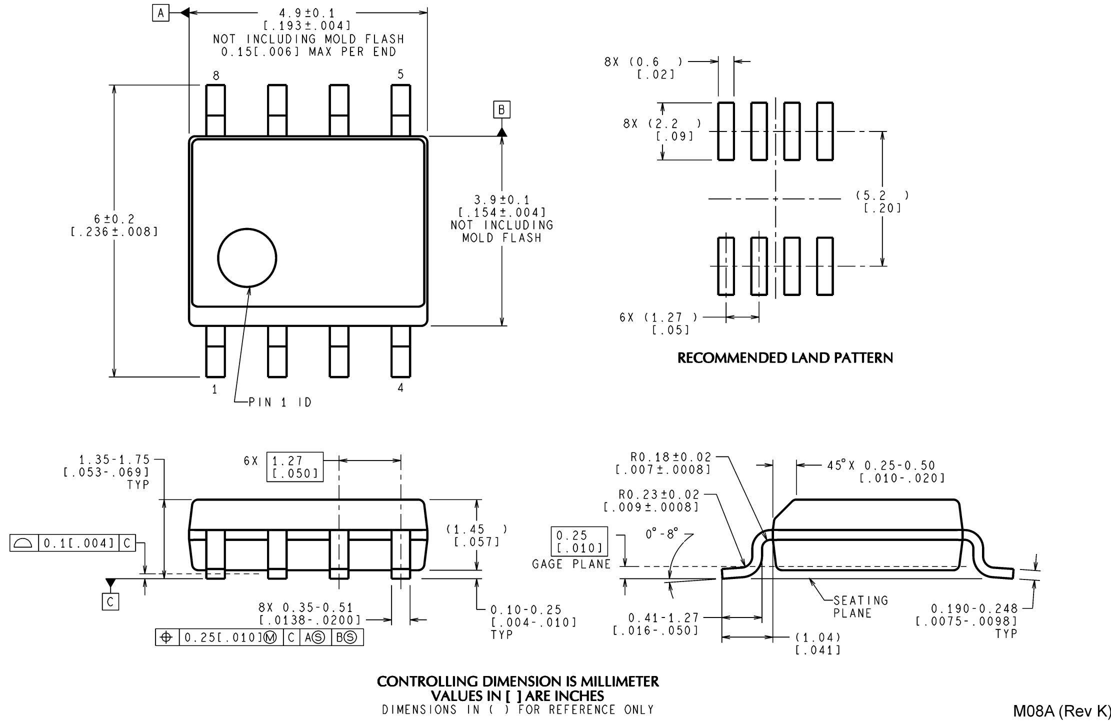
Q = 1.7

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

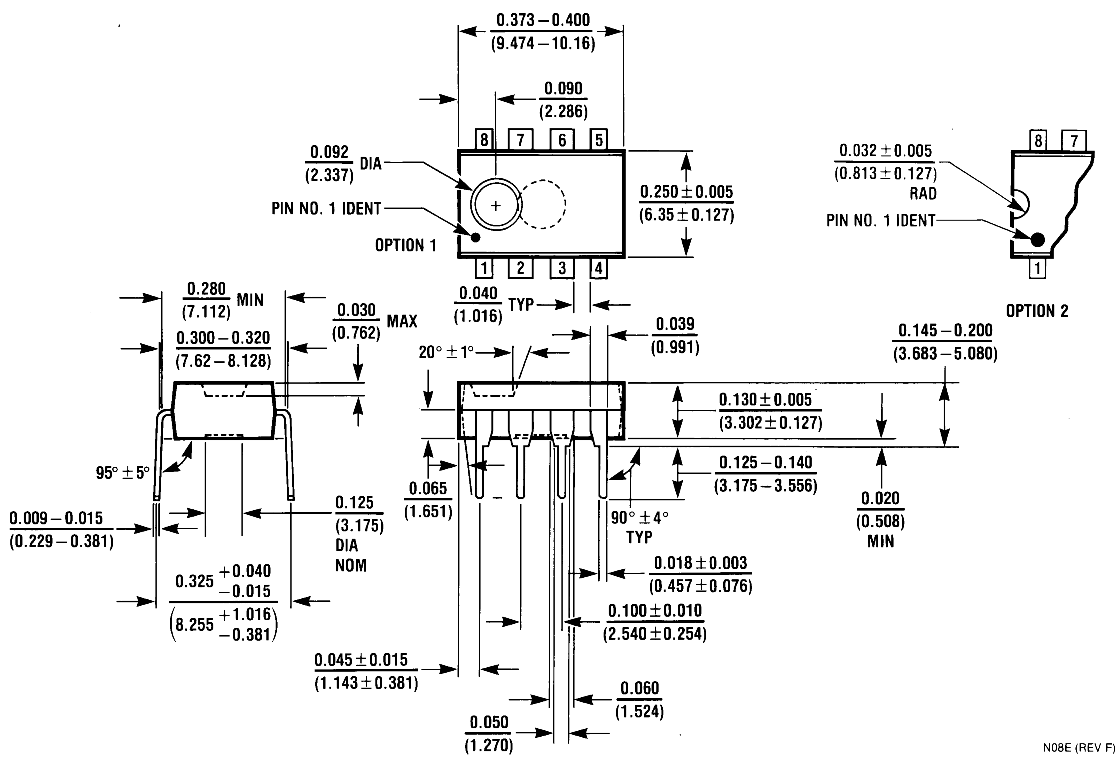
Revision History

Rev	Date	Description
0.05	5/24/05	Added edits and changes per TW Chan's and M Koterasawa-san's inputs and conference call (5/20/05). Changed part number to LM4562.
0.10	5/25/05	Updates based on inputs from design after KPC review.
0.15	10/5/05	Edited 201572 55 (pkg drwg) and added the M08A mktg outline.
0.20	11/01/05	Mjor edits on the EC table (by Heather).
0.25	02/02/06	Input major text (Typical limits) edits.
0.30	05/31/06	Some text edits.
0.35	06/07/06	Edited Typical values on Zin.
0.40	08/02/06	Added the Typ. Perf. Curves and some text edits.
0.45	08/07/06	Added the 2 curves (Voltage/Current Noise Density vs Freq.)
0.50	08/08/06	Replaced some of the curves.
0.55	08/10/06	Added more curves.
0.56	08/16/06	Initial WEB.
0.57	08/22/06	Changed the Typical values on Instantaneous Short Circuit Current from +30/-38 into +53/-42 (per Robin S.), then re-released the D/S to the WEB.

Physical Dimensions inches (millimeters) unless otherwise noted

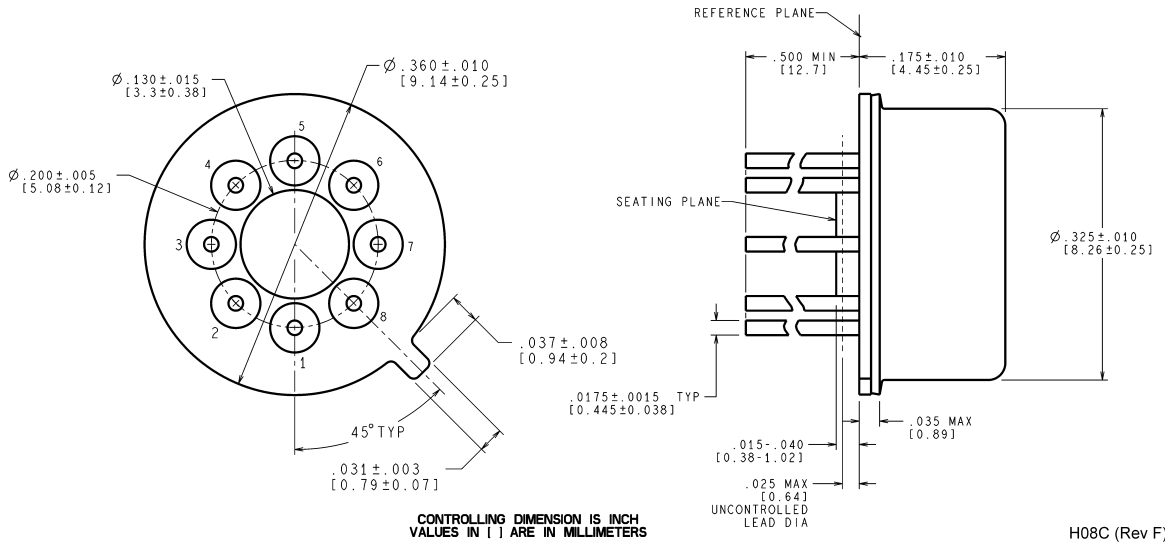


Narrow SOIC Package
Order Number LM4562MA
NS Package Number M08A



Dual-In-Line Package
Order Number LM4562NA
NS Package Number N08E

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



TO-99 Metal Can Package
Order Number LM4562HA
NS Package Number H08C

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