National Semiconductor

October 2007

LME49720
Dual High Performance, High Fidelity Audio Operational Amplifier

General Description

The LME49720 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 LME49720 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LME49720 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 LME49720 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 LME49720's outstanding CMRR (120dB), PSRR (120dB), and V_{OS} (0.1mV) give the amplifier excellent operational amplifier DC performance.

The LME49720 has a wide supply range of ±2.5V to ±17V. Over this supply range the LME49720's input circuitry maintains excellent common-mode and power supply rejection, as well as maintaining its low input bias current. The LME49720 is unity gain stable. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LME49720 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%

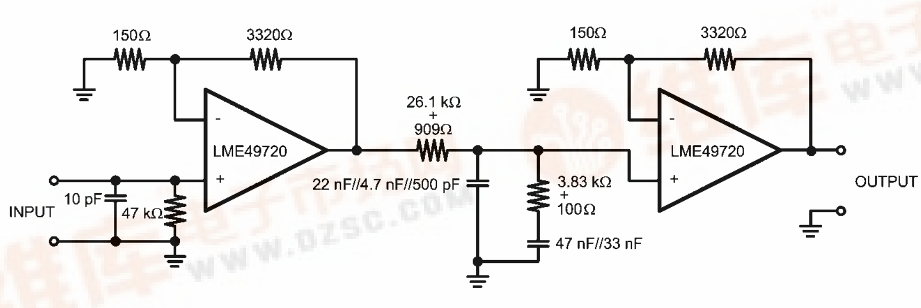
Features

- 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

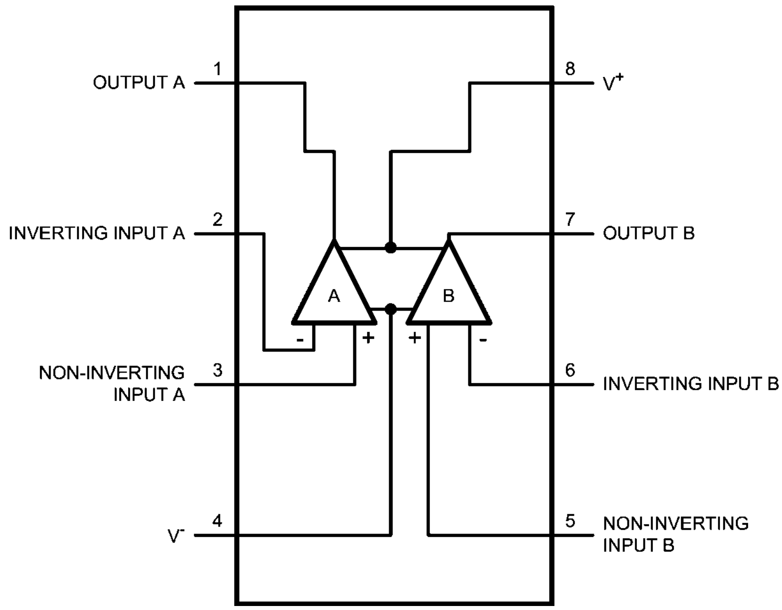
Typical Application



Passively Equalized RIAA Phono Preamplifier

Connection Diagrams

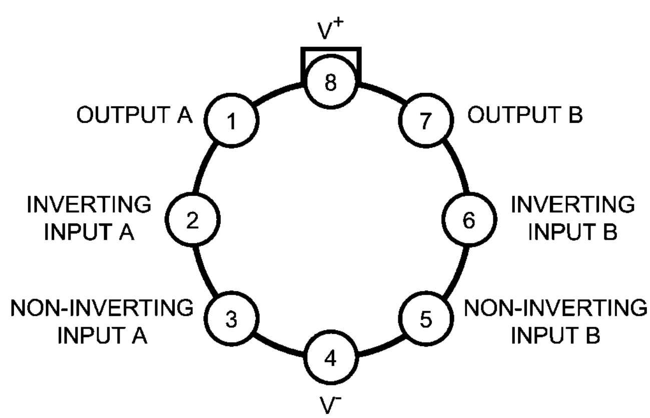
Dual-In-Line Package



30003855

Order Number LME49720MA
See NS Package Number — M08A
Order Number LME49720NA
See NS Package Number — N08E

Metal Can



300038f3

Order Number LME49720HA
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	
$T_{MIN} \le T_A \le T_{MAX}$	$-40°C \le T_A \le 85°C$
Supply Voltage Range	$\pm2.5V \le V_S \le \pm 17V$

Electrical Characteristics for the LME49720 (Notes 1, 2)

The following specifications apply for $V_S = \pm15V$, $R_L = 2k\Omega$, f_{IN} = 1kHz, and T_A = 25°C, unless otherwise specified.

Symbol	Parameter	Conditions	LME49720 Typical (Note 6)	LME49720 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, 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	$-40°C \le T_A \le 85°C$	0.2		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	ΔV_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	$-40°C \le T_A \le 85°C$	0.1		nA/°C
I_{OS}	Input Offset Current	V_{CM} = 0V	11	65	nA (max)
V_{IN-CM}	Common-Mode Input Voltage Range		+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

Symbol	Parameter	Conditions	LME49720		Units (Limits)
			Typical (Note 6)	Limit (Note 7)	
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).

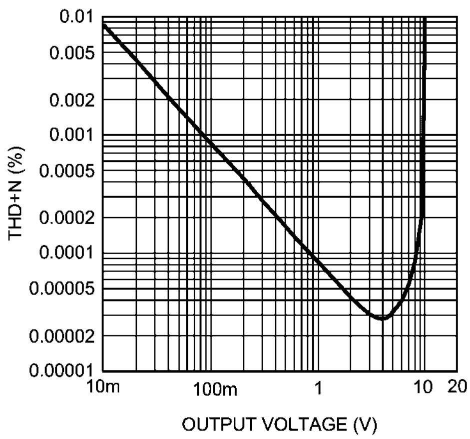
Note 6: Typical specifications are specified at +25ºC and represent the most likely parametric norm.

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

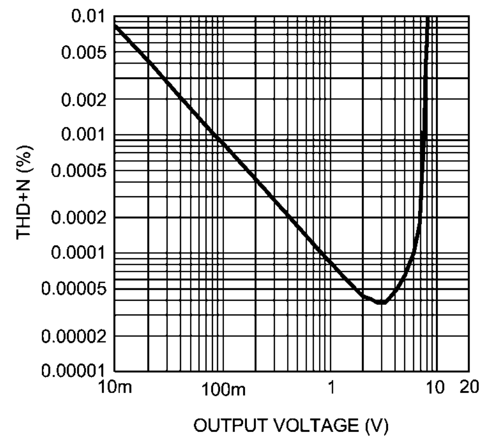
Typical Performance Characteristics

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



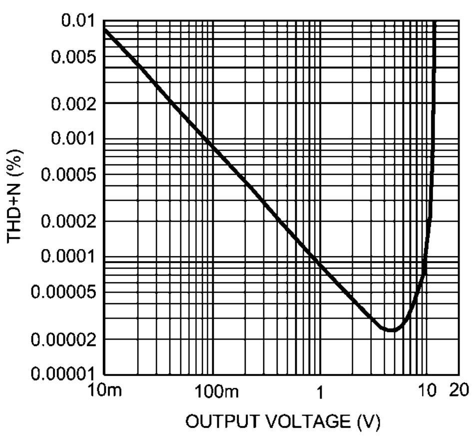
300038k6

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



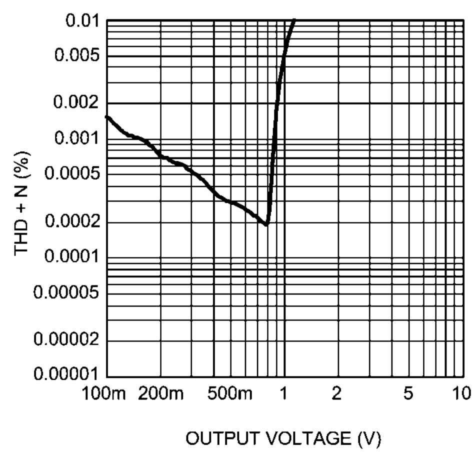
300038k7

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



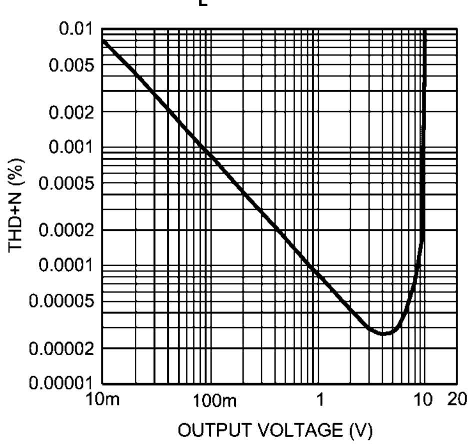
300038k8

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



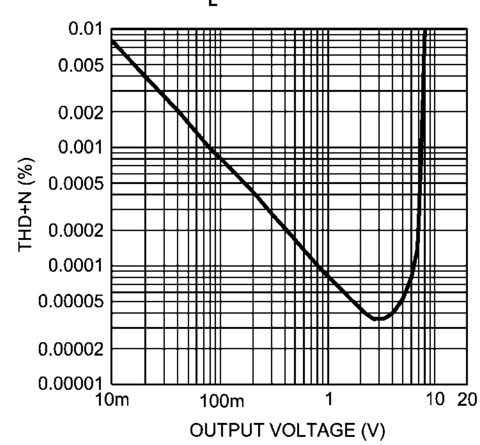
300038i4

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



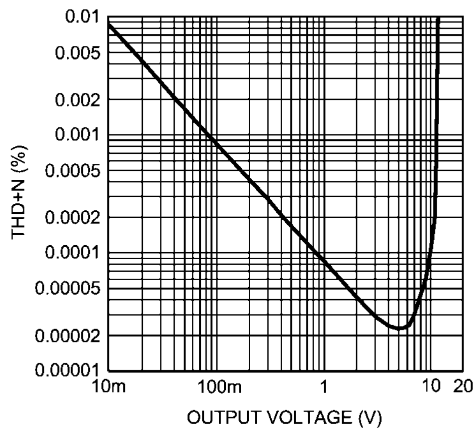
300038k9

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



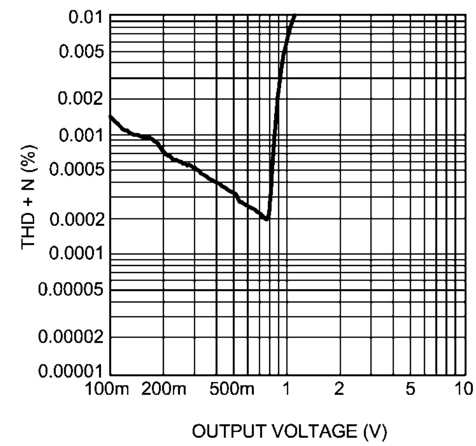
300038l0

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



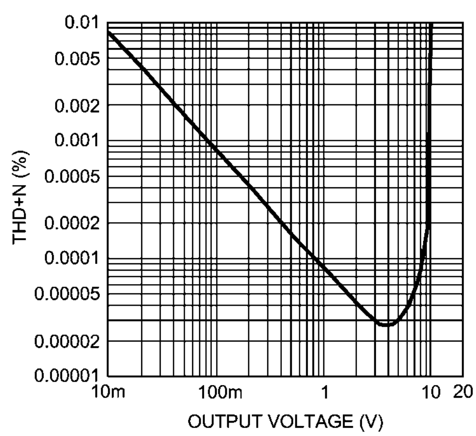
300038I1

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



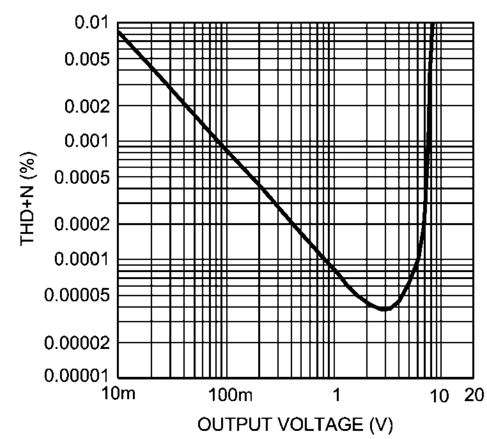
300038I6

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



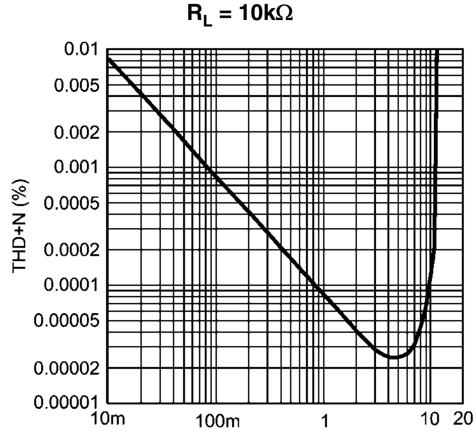
300038I2

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



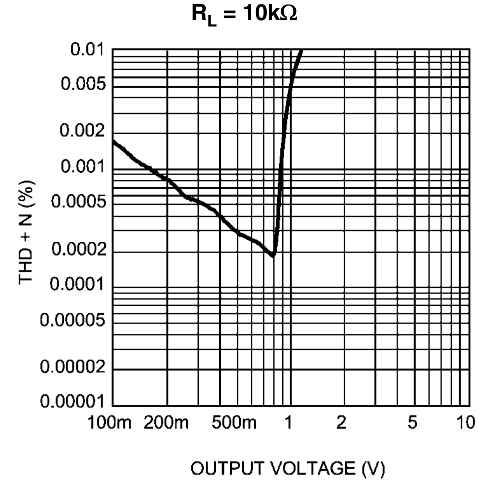
300038I3

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



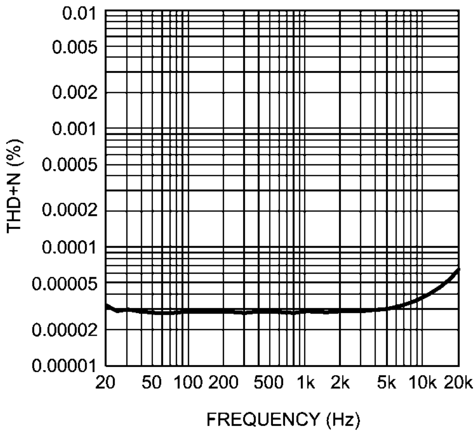
300038I4

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



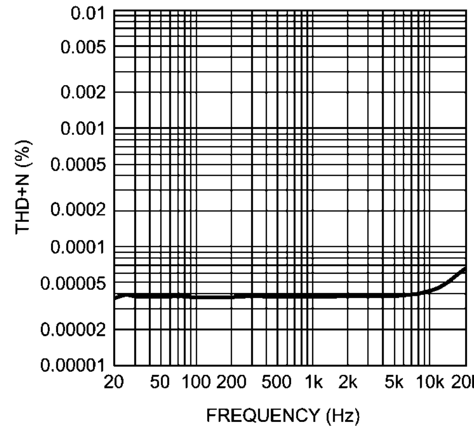
300038I5

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



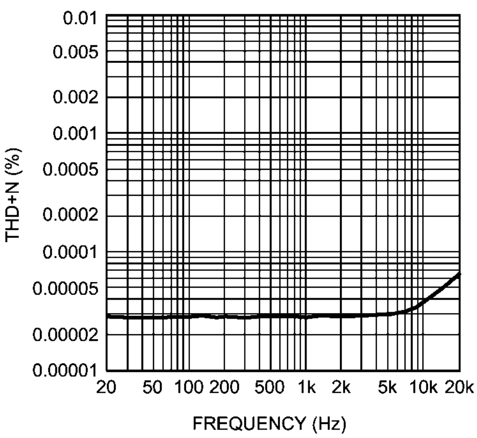
30003863

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



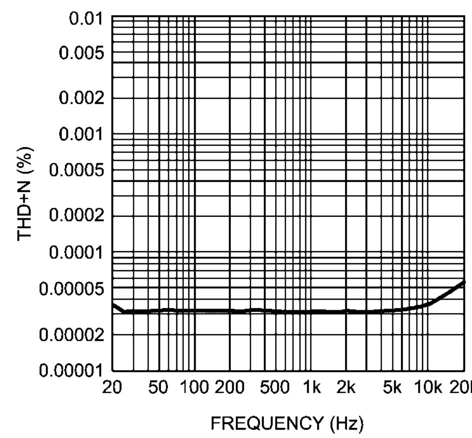
30003862

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



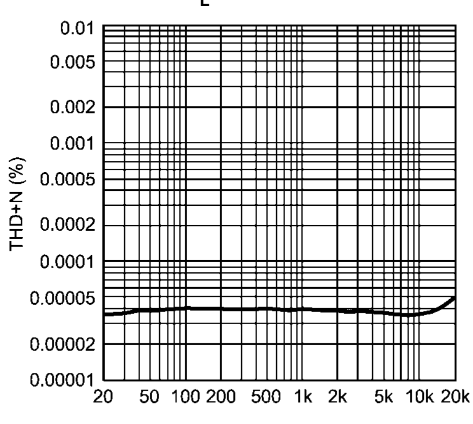
30003864

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



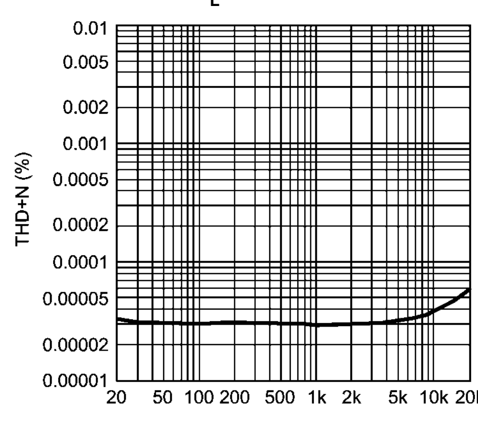
30003859

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



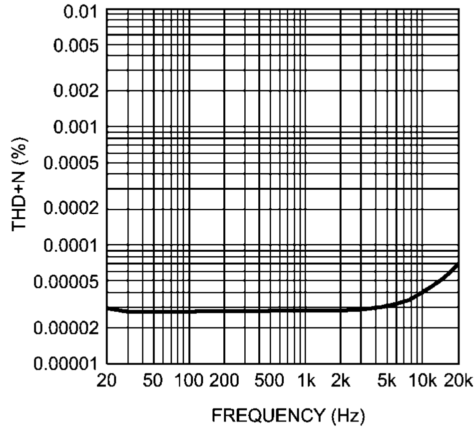
300038k3

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



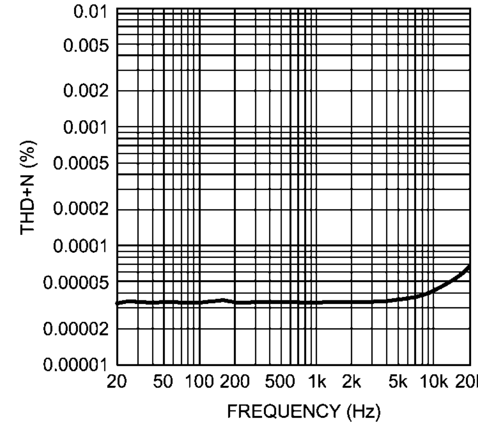
30003860

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



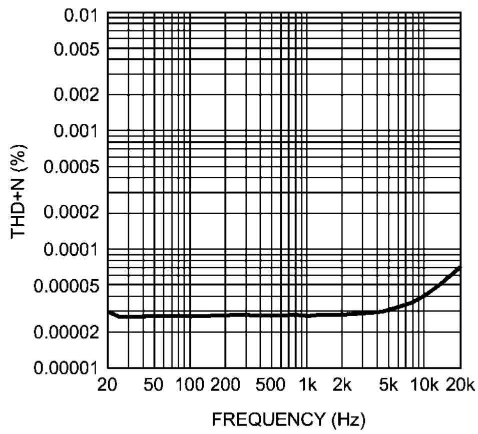
30003867

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



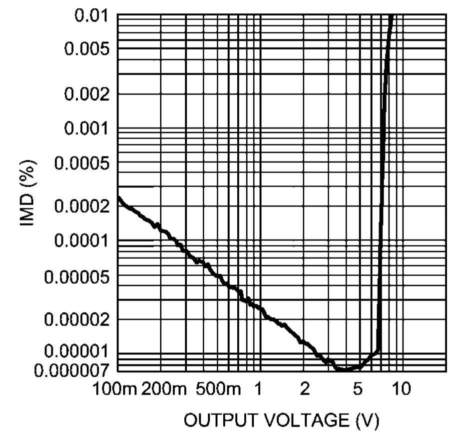
30003866

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



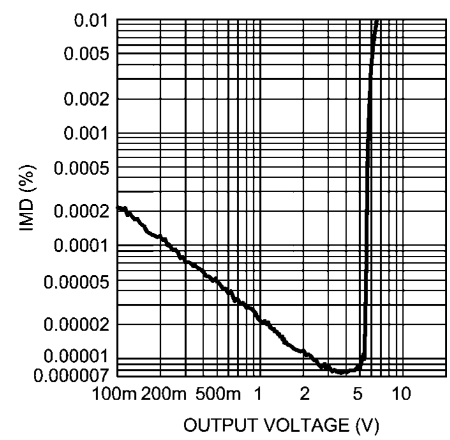
30003868

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



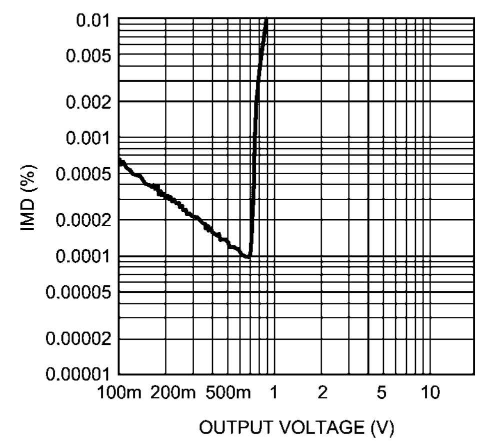
300038e6

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



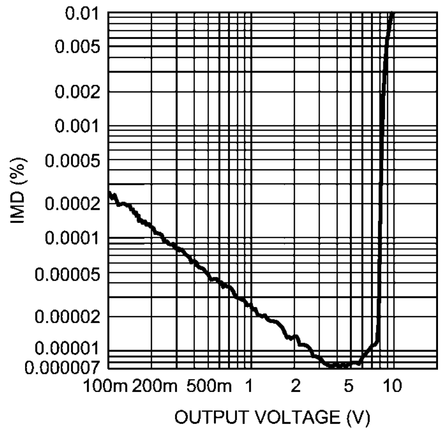
300038e5

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



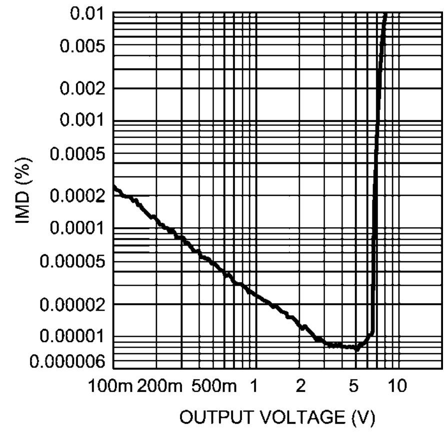
300038e4

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



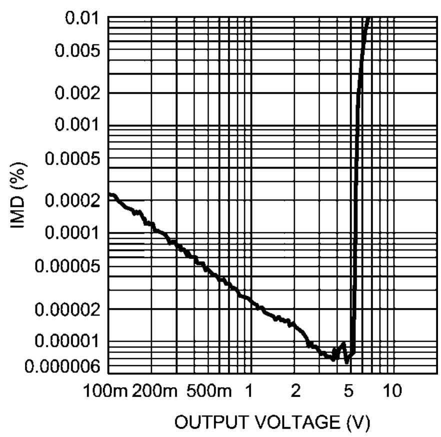
300038e7

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



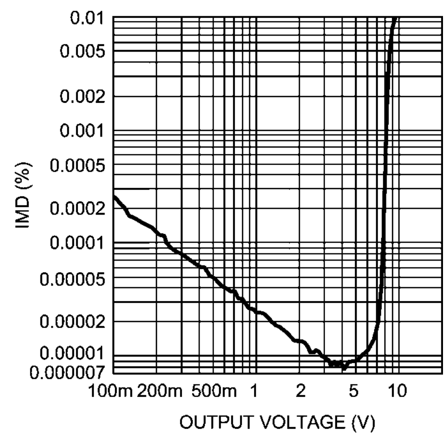
300038e2

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



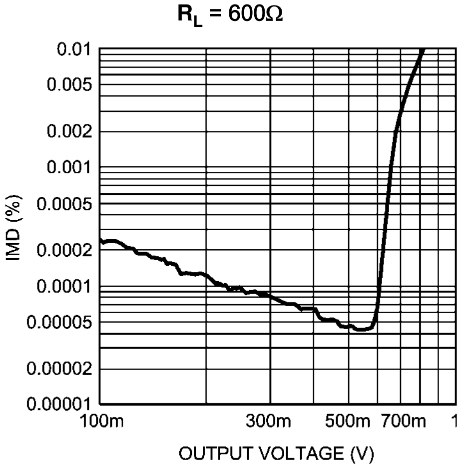
300038e0

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



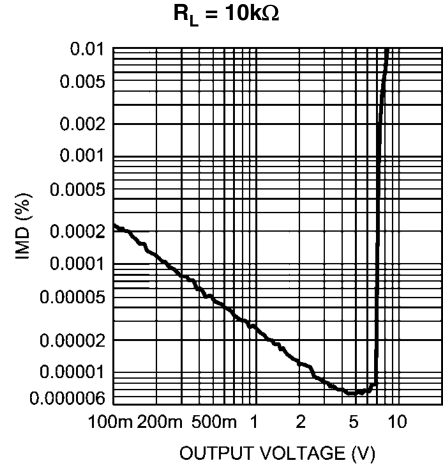
300038e3

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



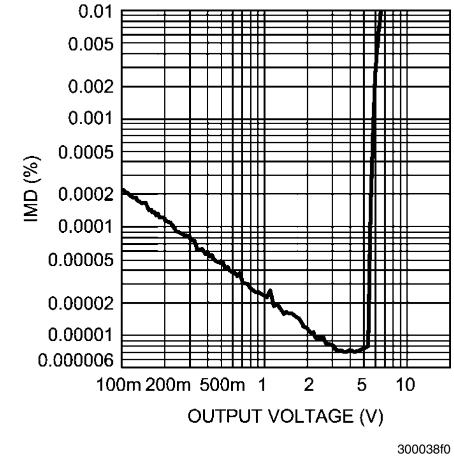
300038e1

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

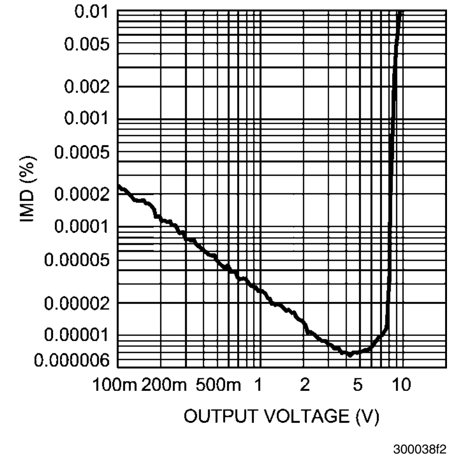


300038f1

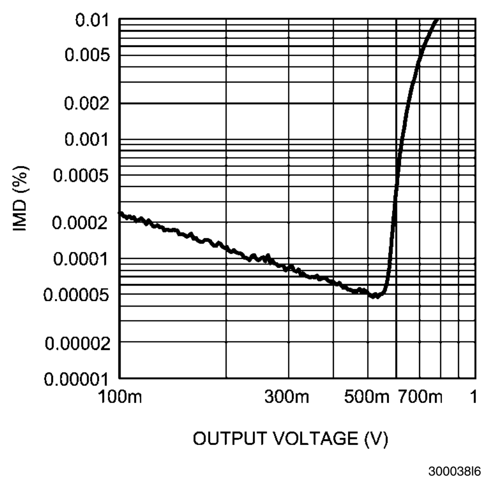
IMD vs Output Voltage
V_{CC} = 12V, V_{EE} = –12V
R_L = 10kΩ



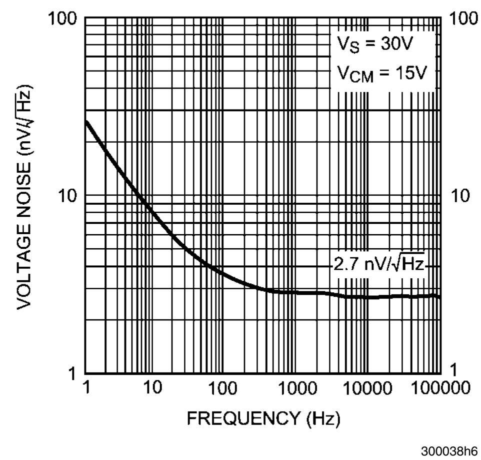
IMD vs Output Voltage
V_{CC} = 17V, V_{EE} = –17V
R_L = 10kΩ



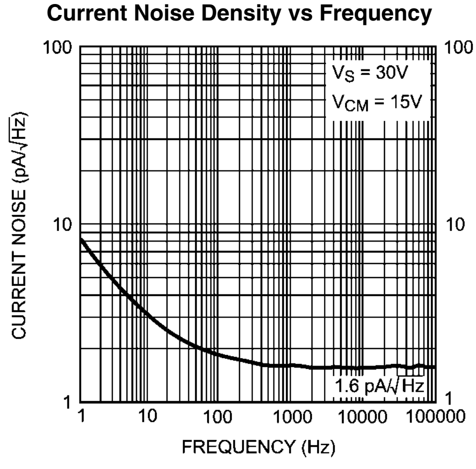
IMD vs Output Voltage
V_{CC} = 2.5V, V_{EE} = –2.5V
R_L = 10kΩ



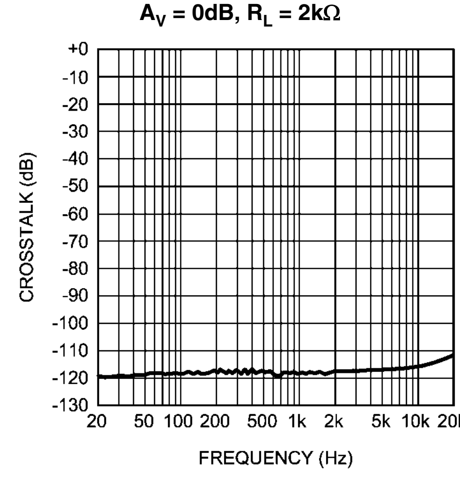
Voltage Noise Density vs Frequency



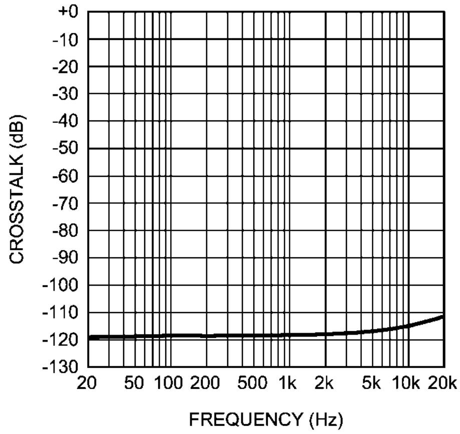
Current Noise Density vs Frequency



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

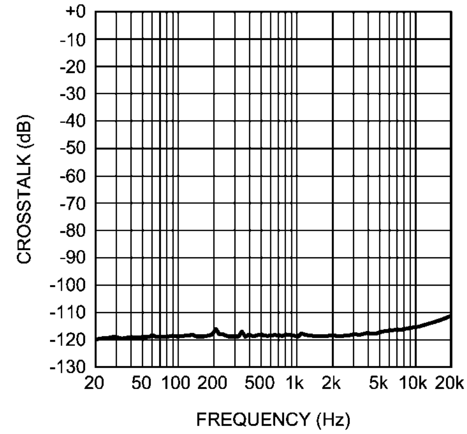


Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = –15V, V_{OUT} = 10V_{RMS}
A_V = 0dB, R_L = 2kΩ



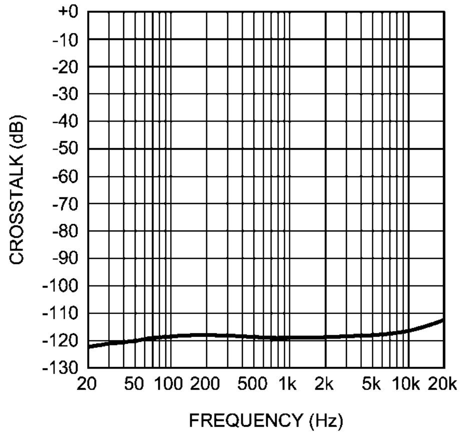
300038c9

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



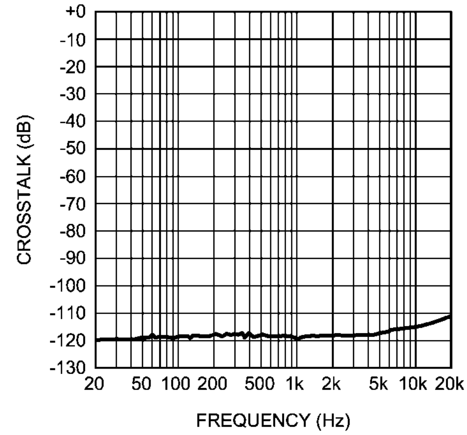
300038c6

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



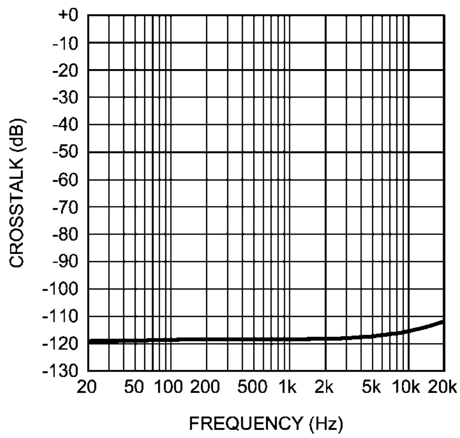
300038c7

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



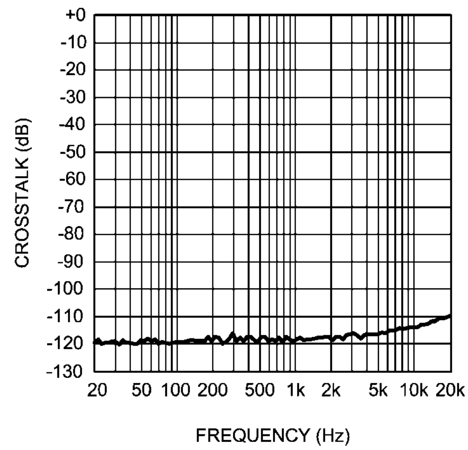
300038d0

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



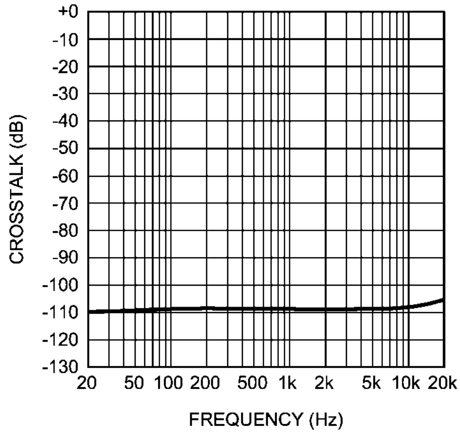
300038d1

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



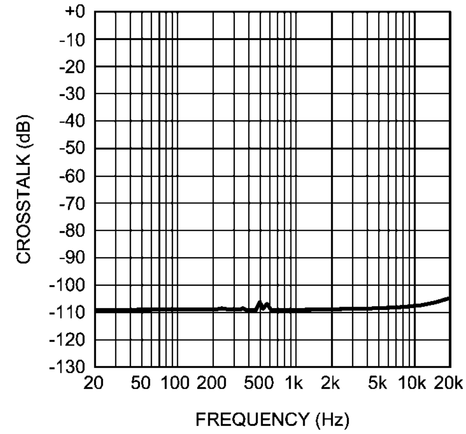
300038n8

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



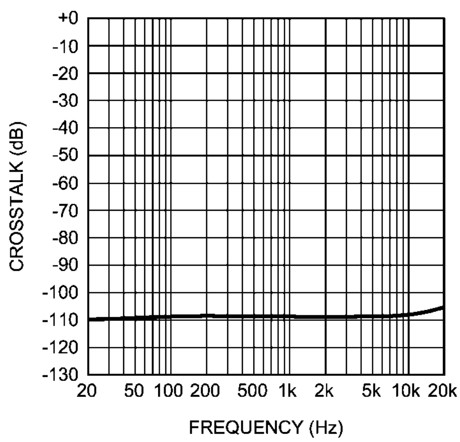
300038d6

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



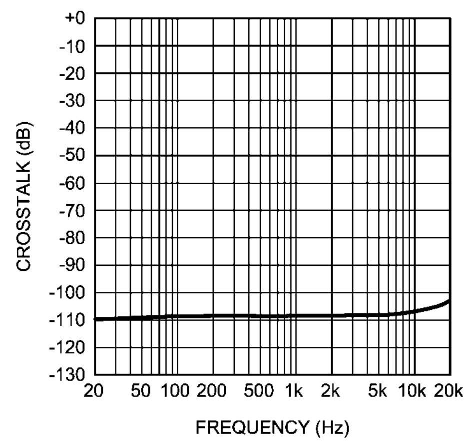
300038d7

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



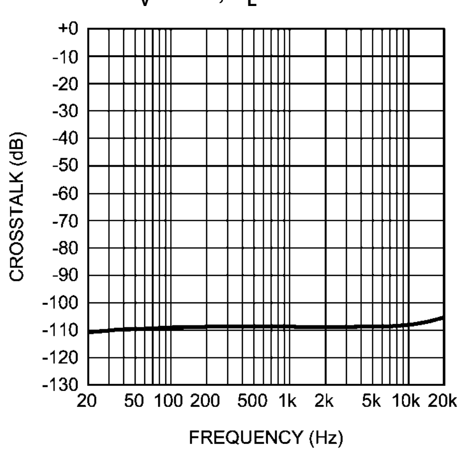
300038d4

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



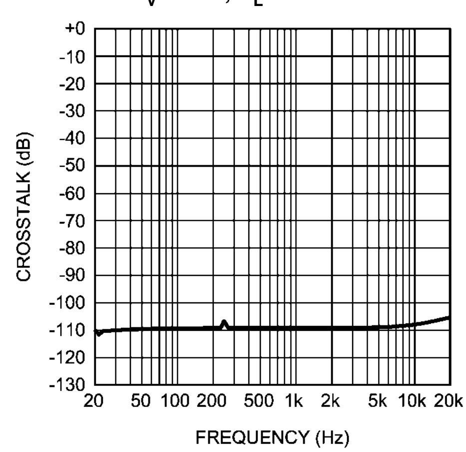
300038d5

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



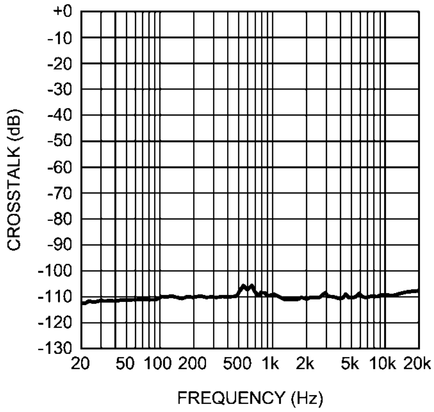
300038d8

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



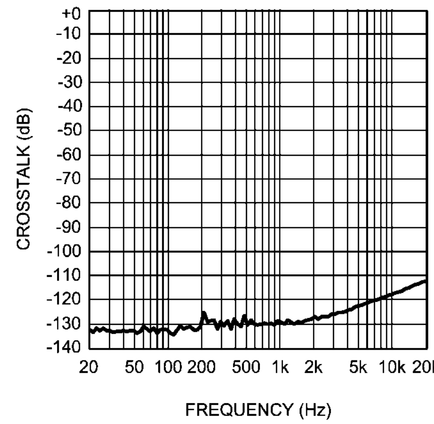
300038d9

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



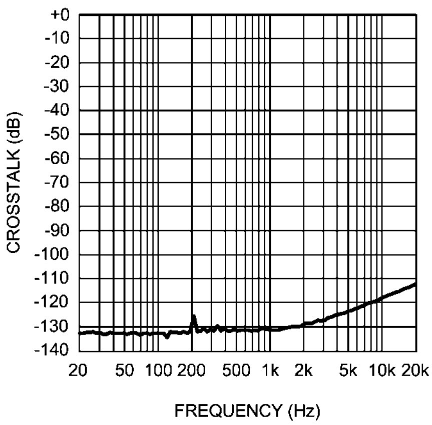
300038d2

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



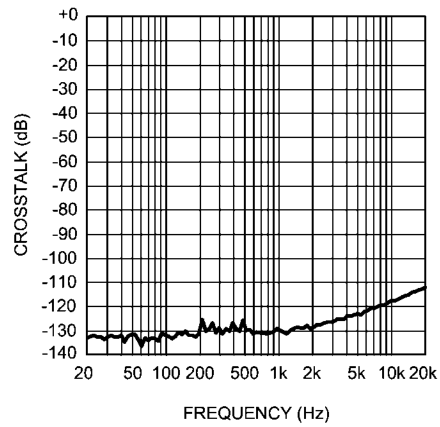
300038o0

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



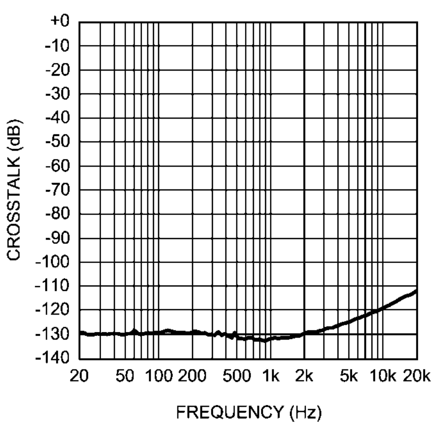
300038n7

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



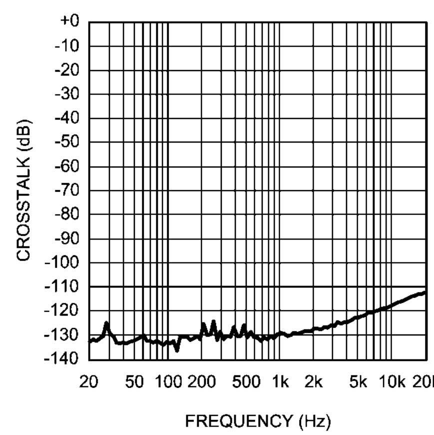
300038n9

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



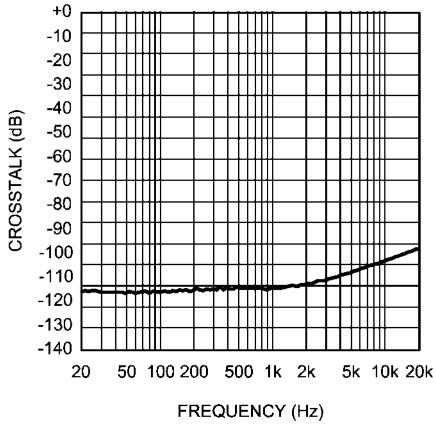
300038n6

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



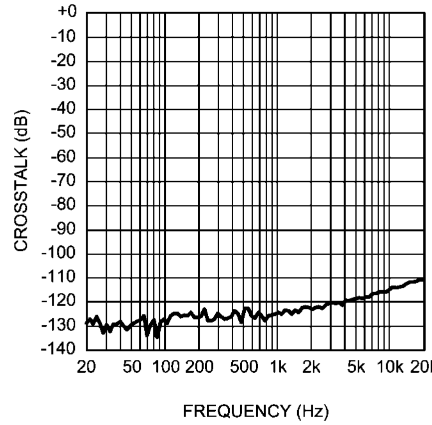
300038n5

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



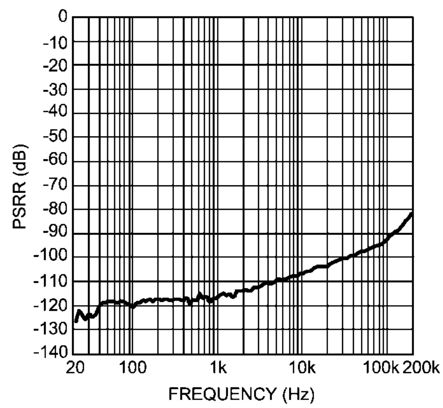
300038n3

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



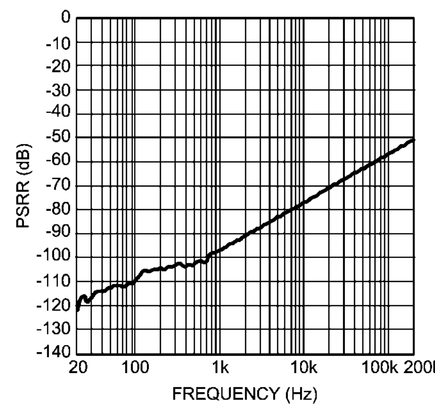
300038n4

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



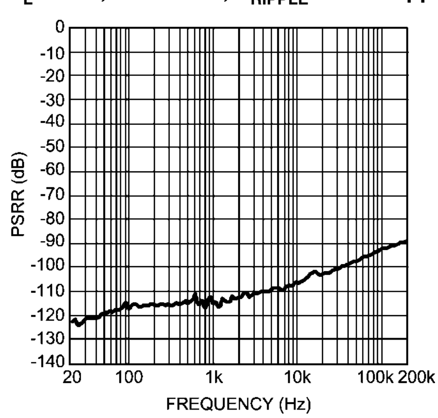
300038p2

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



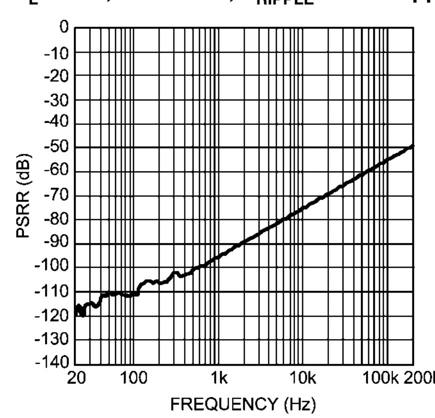
300038p5

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



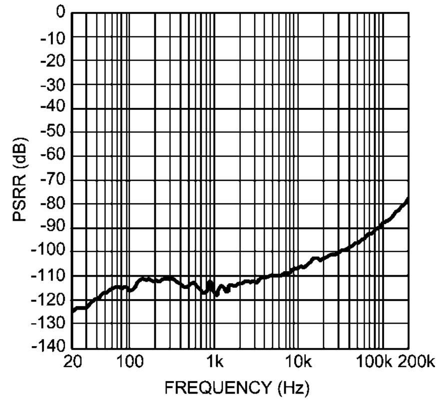
300038p3

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



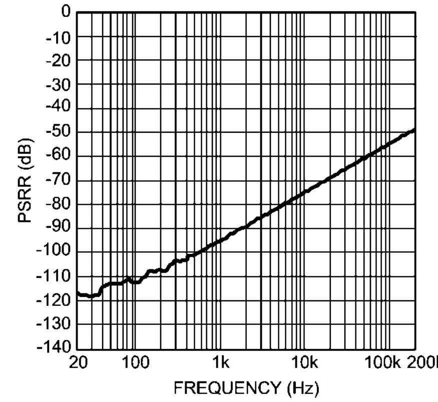
300038p6

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



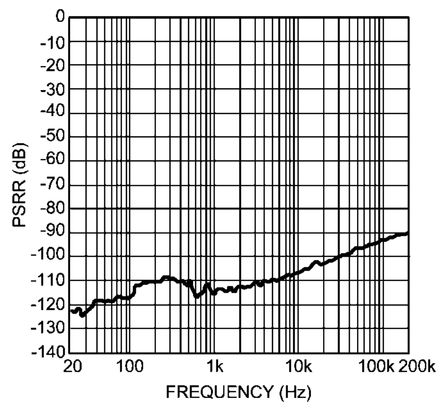
300038p1

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



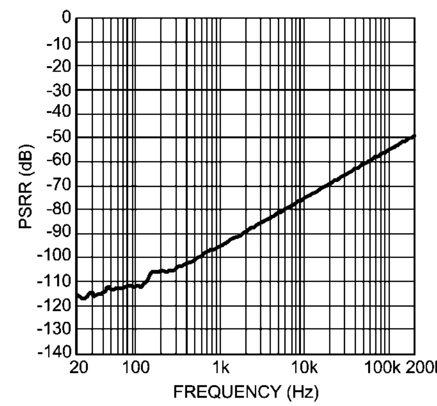
300038p4

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



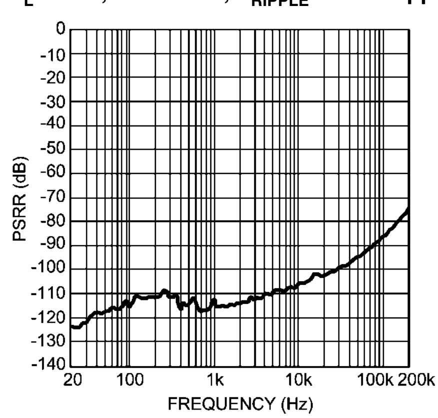
300038p8

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



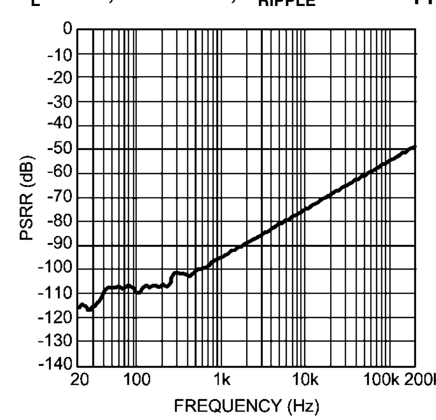
300038q1

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



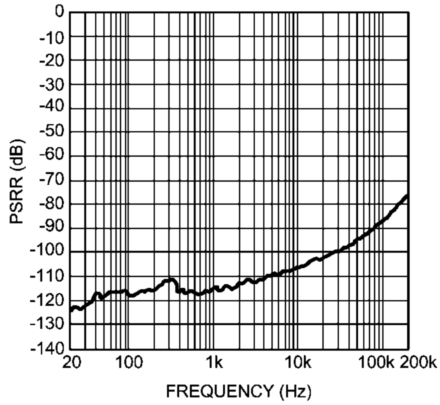
300038p9

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



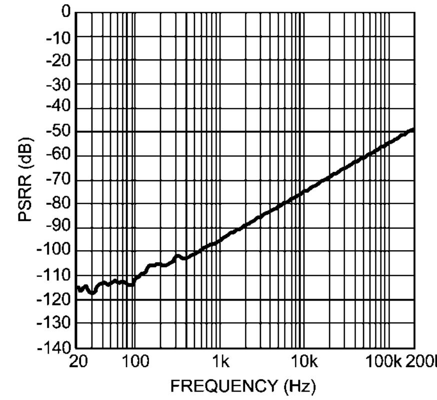
300038q2

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



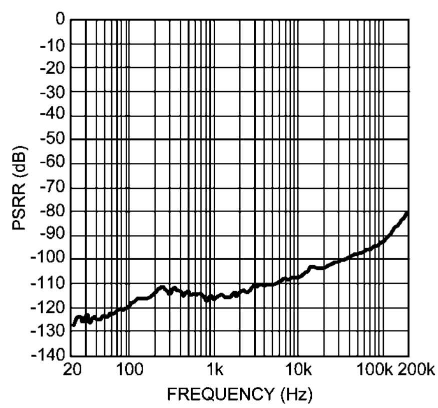
300038p7

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



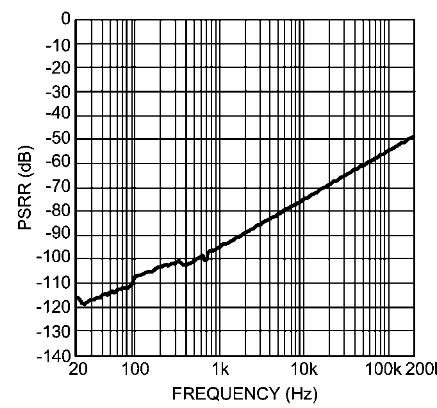
300038q0

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



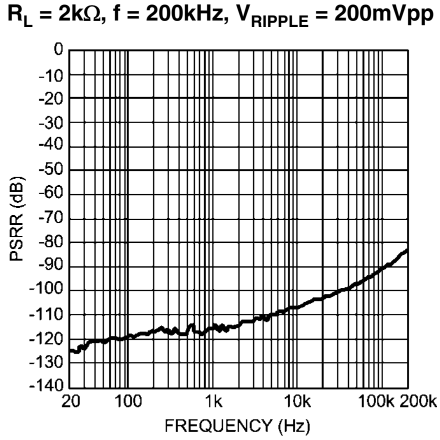
300038r0

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



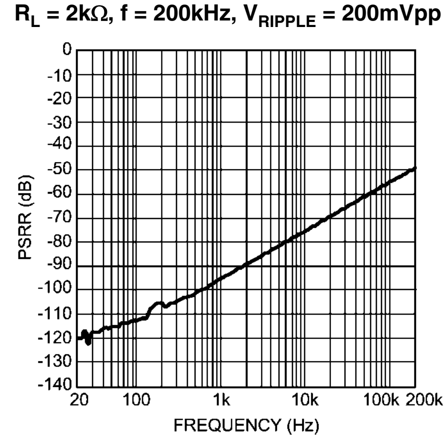
300038r3

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



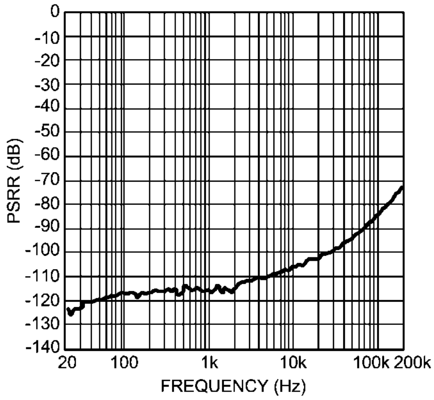
300038r1

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



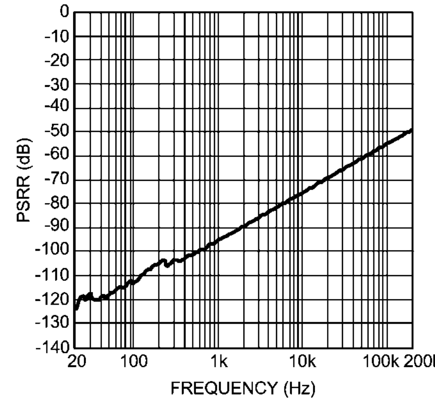
300038r4

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



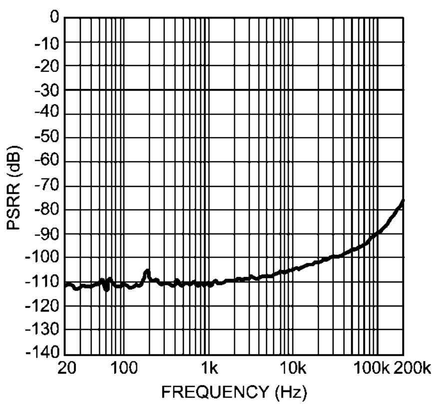
300038q9

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



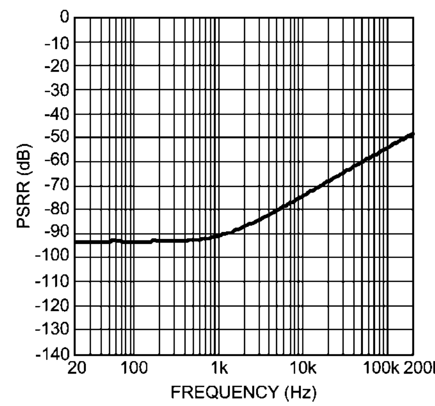
300038r2

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



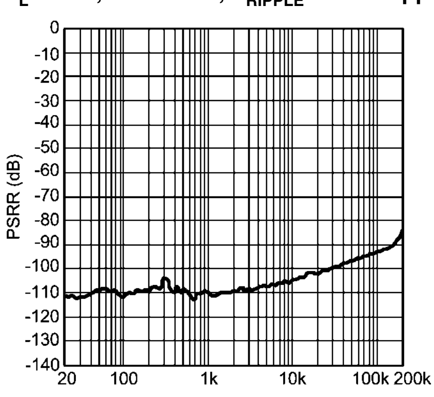
300038q4

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



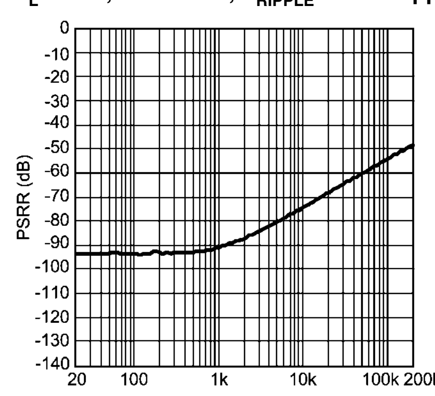
300038q7

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



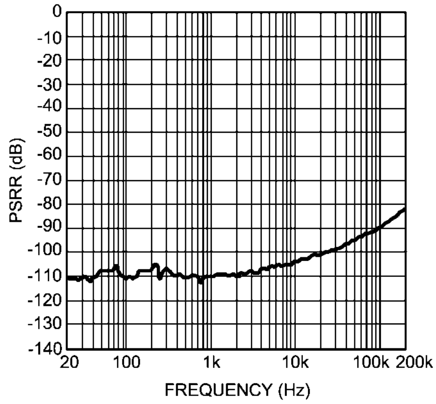
300038q5

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



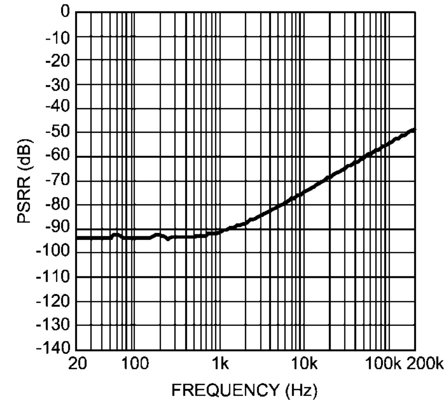
300038q8

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



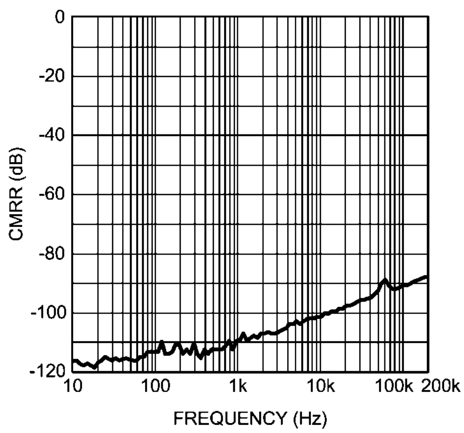
300038q3

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



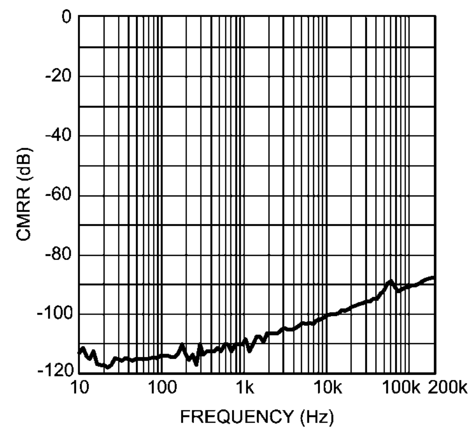
300038q6

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



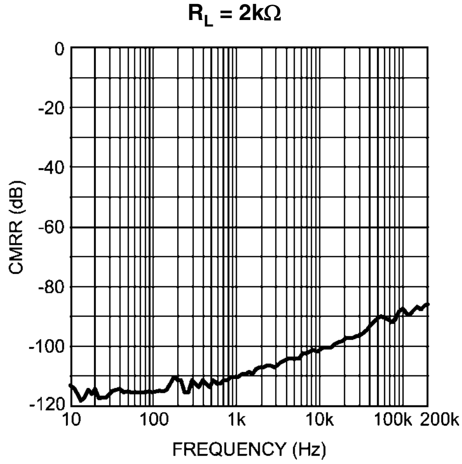
300038g0

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



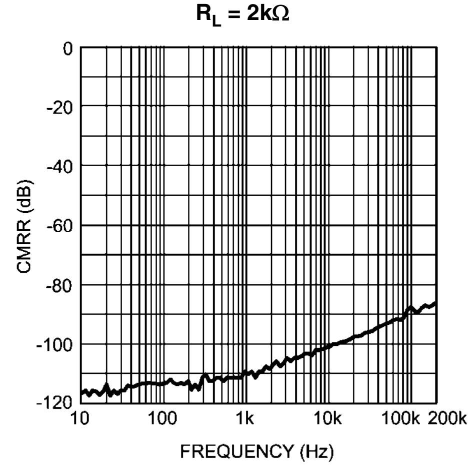
300038f7

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



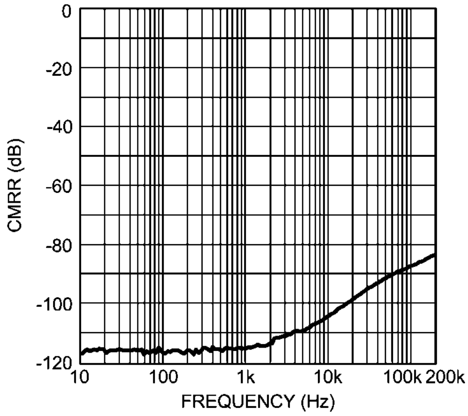
300038g3

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



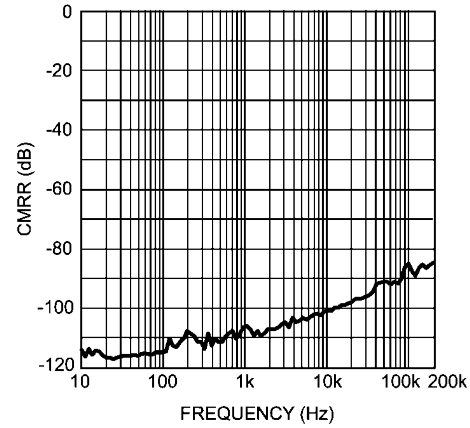
300038f4

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



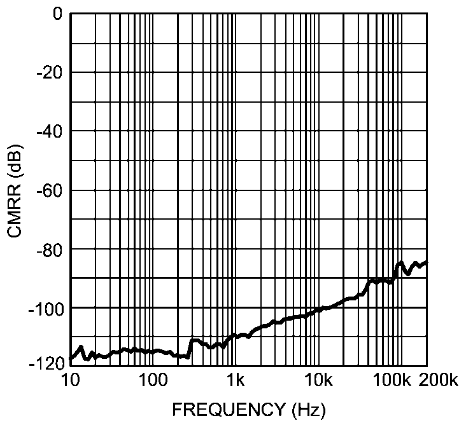
300038o9

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



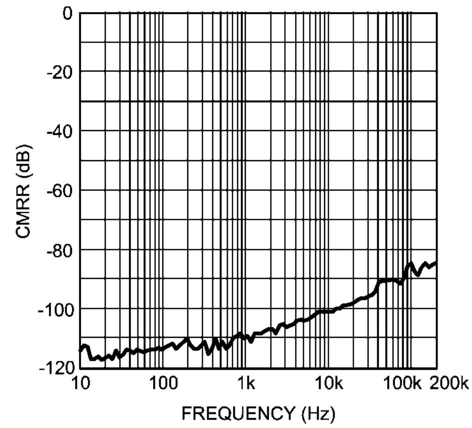
300038f9

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



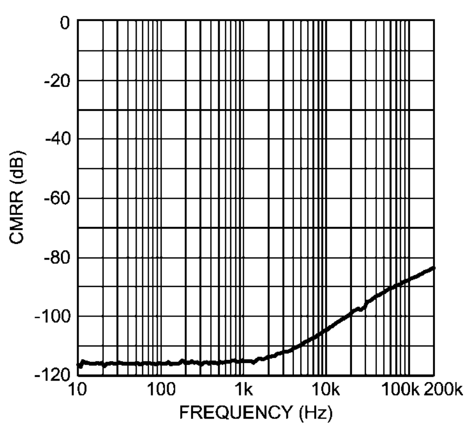
300038g5

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



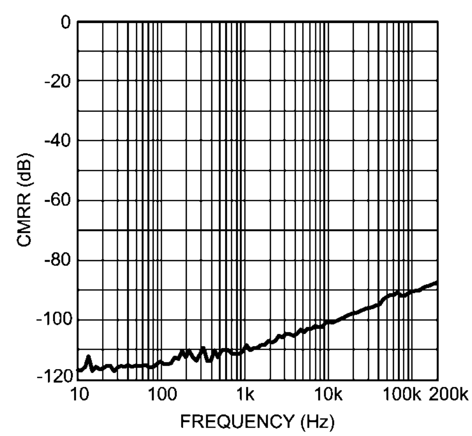
300038f6

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



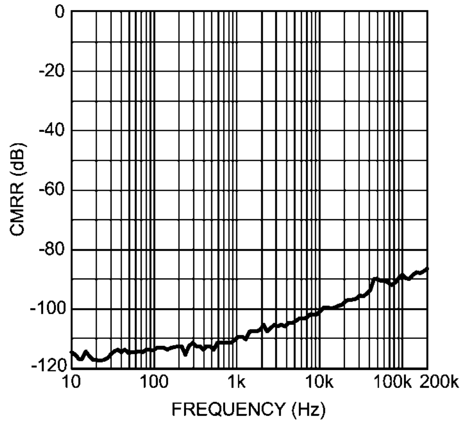
300038o8

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



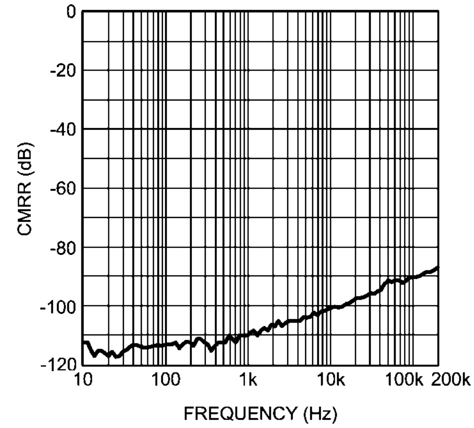
300038f8

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



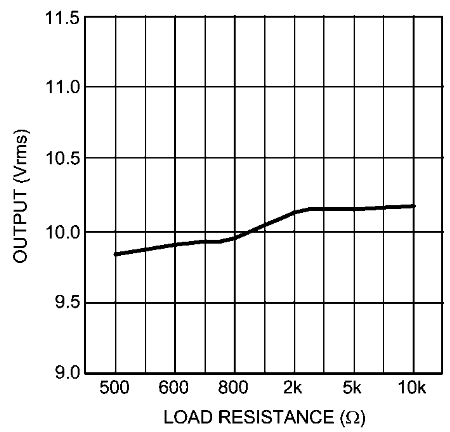
300038g4

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



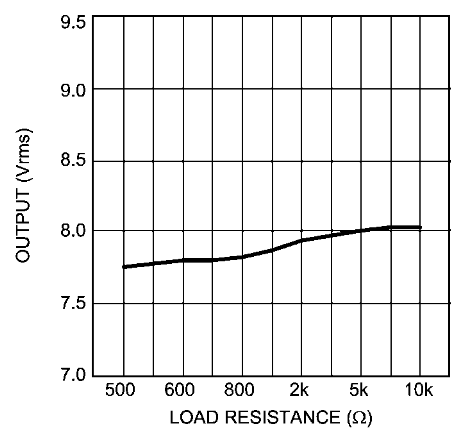
300038f5

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



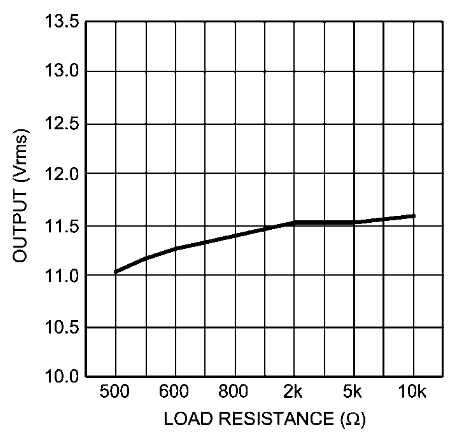
300038h1

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



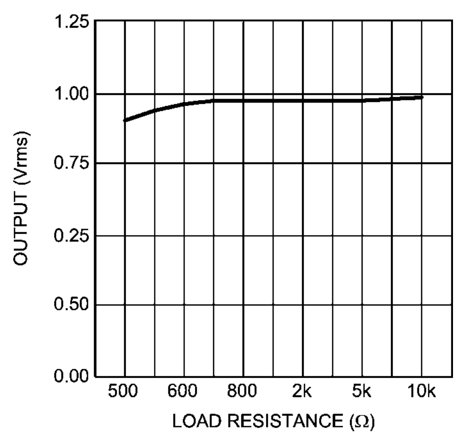
300038h0

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



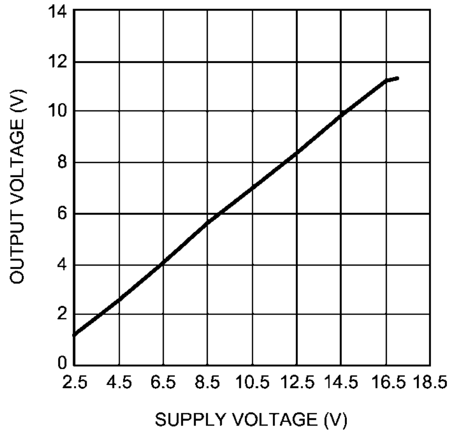
300038h2

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



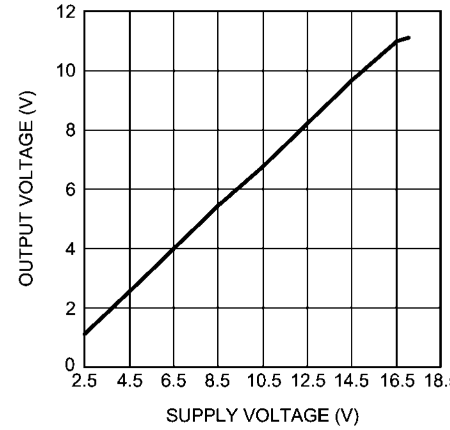
300038g9

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



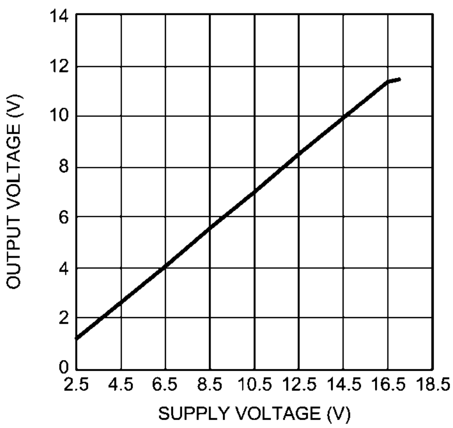
300038j9

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



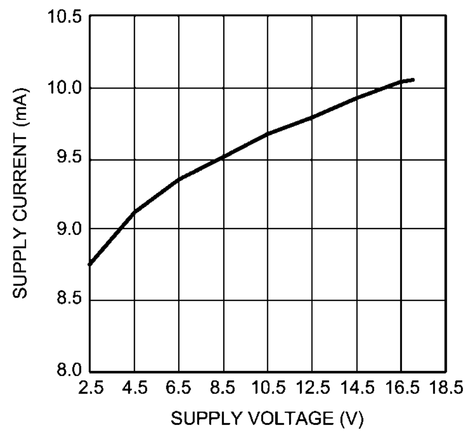
300038j8

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



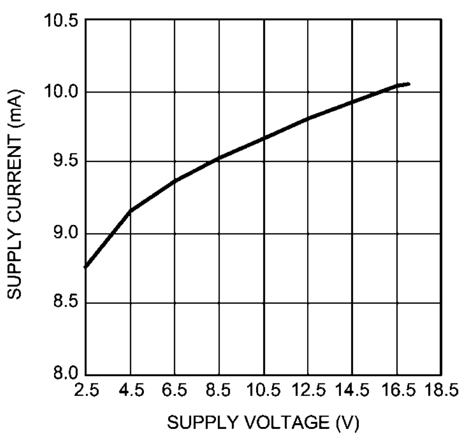
300038k0

Supply Current vs Supply Voltage
R_L = 2kΩ



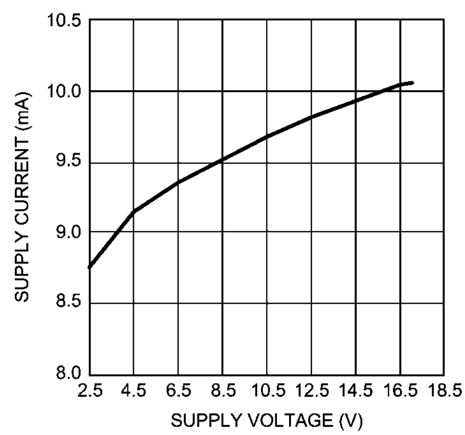
300038j6

Supply Current vs Supply Voltage
R_L = 600Ω



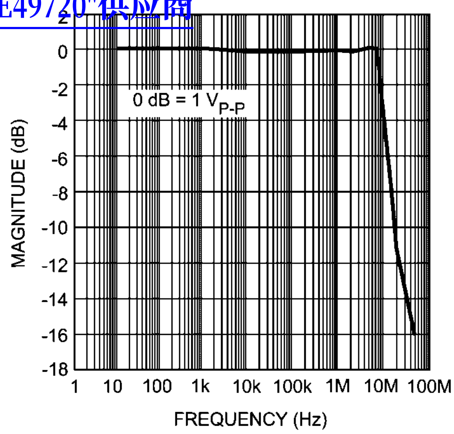
300038j5

Supply Current vs Supply Voltage
R_L = 10kΩ



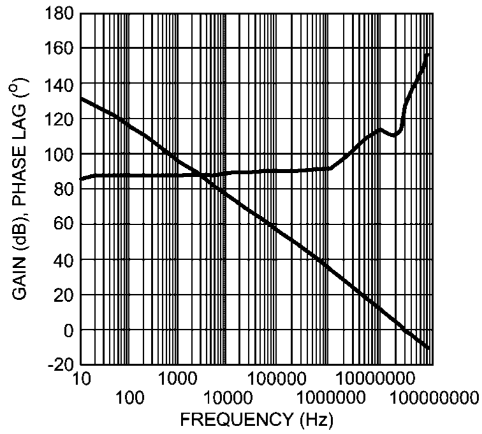
300038j7

Full Power Bandwidth vs Frequency



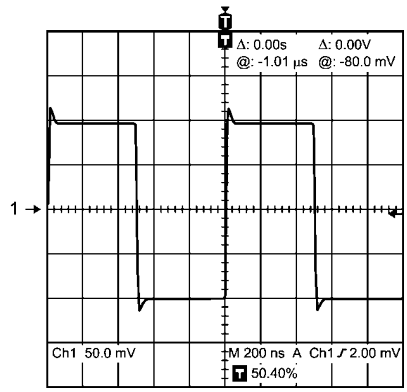
300038j0

Gain Phase vs Frequency



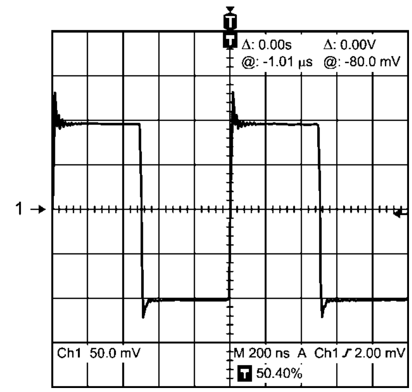
300038j1

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



300038i7

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



300038i8

Application Information

DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LME49720 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 LME49720's low residual distortion is an input referred internal error. As shown in Figure 1, adding the 10Ω resistor connected between the amplifier's inverting and non-inverting inputs changes the amplifier's noise gain. The result is that the error signal (distortion) is amplified by a factor of 101. Although the amplifier's closed-loop gain is unaltered, the feedback available to correct distortion errors is reduced by 101, which means that measurement resolution increases by 101. To ensure minimum effects on distortion measurements, keep the value of R1 low as shown in Figure 1.

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

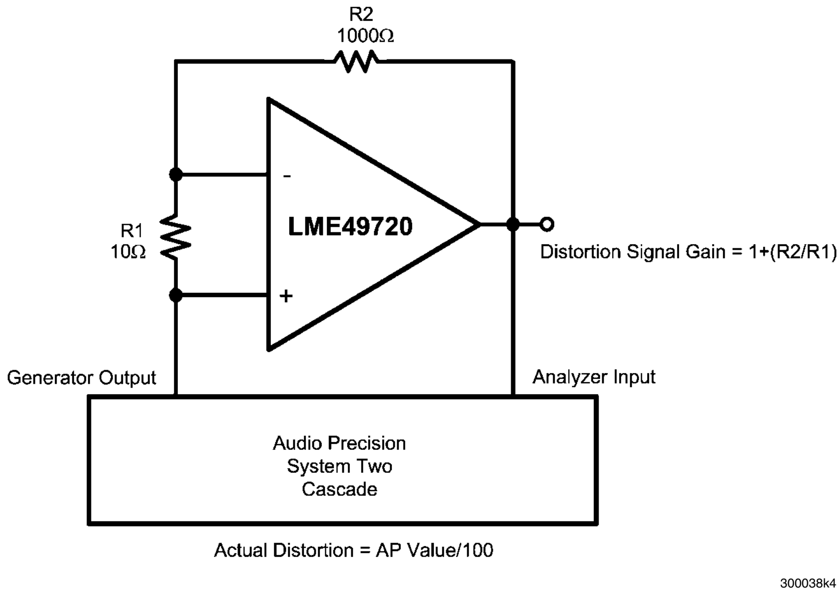
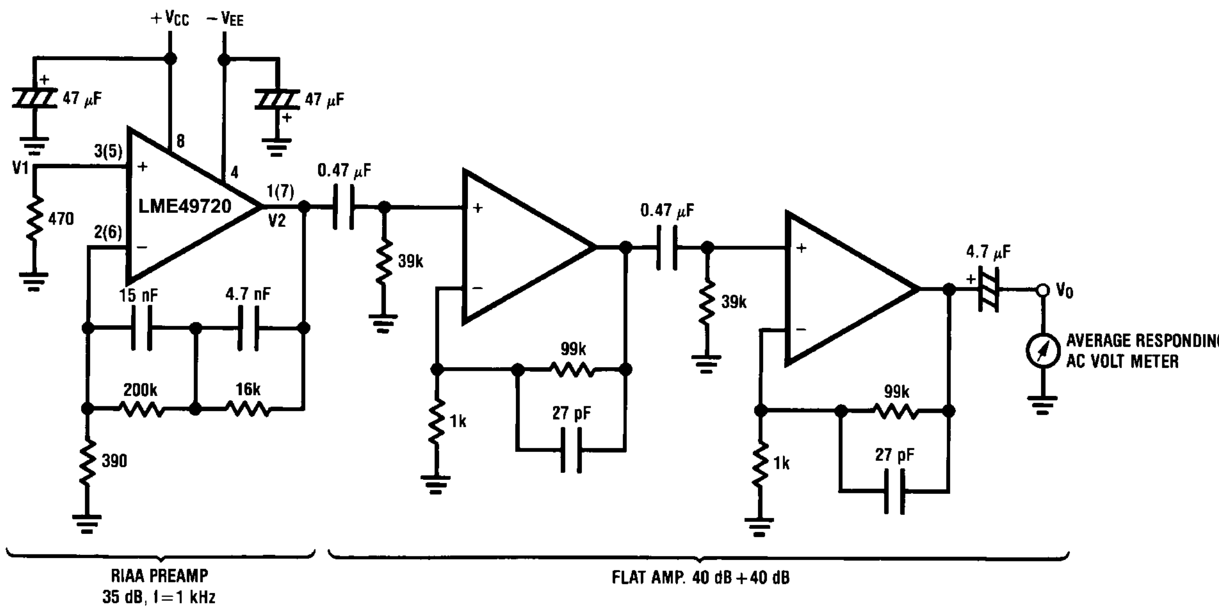


FIGURE 1. THD+N and IMD Distortion Test Circuit

The LME49720 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.

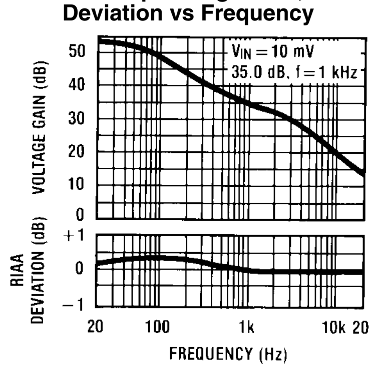


30003827

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

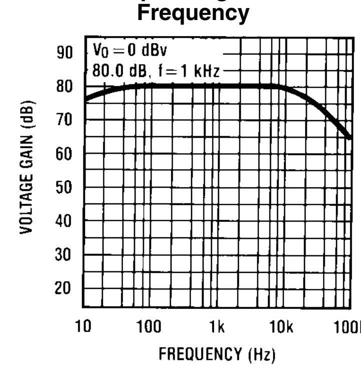
Noise Measurement Circuit
Total Gain: 115 dB @f = 1 kHz
Input Referred Noise Voltage: e_n = V0/560,000 (V)

RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



30003828

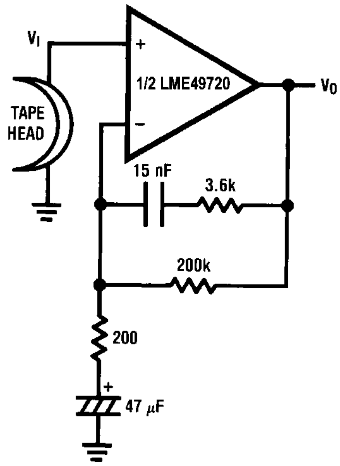
Flat Amp Voltage Gain vs Frequency



30003829

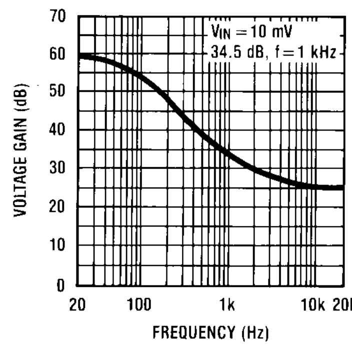
TYPICAL APPLICATIONS

NAB Preamp



30003830

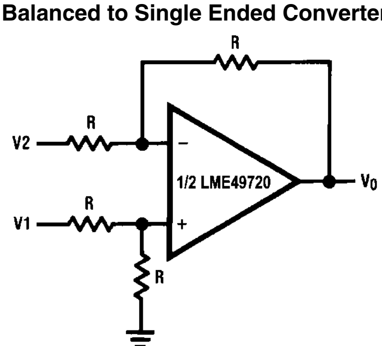
NAB Preamp Voltage Gain vs Frequency



30003831

A_V = 34.5
F = 1 kHz
E_n = 0.38 μV
A Weighted

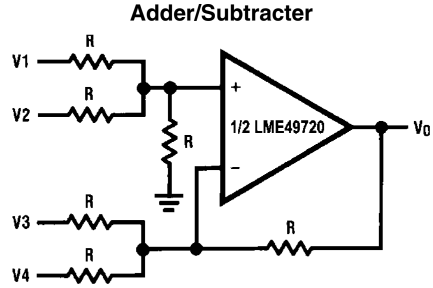
Balanced to Single Ended Converter



30003832

V_O = V1–V2

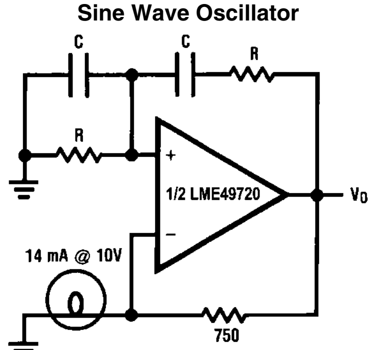
Adder/Subtracter



30003833

V_O = V1 + V2 – V3 – V4

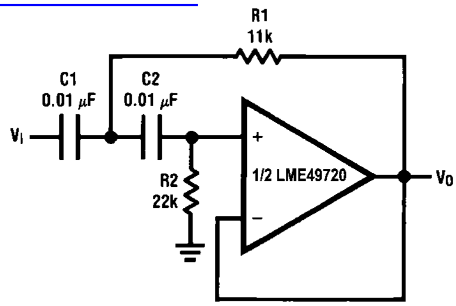
Sine Wave Oscillator



30003834

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

Second Order High Pass Filter (Butterworth)



30003835

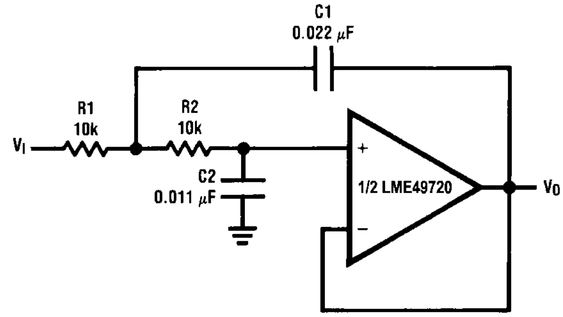
if C1 = C2 = C

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

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



30003836

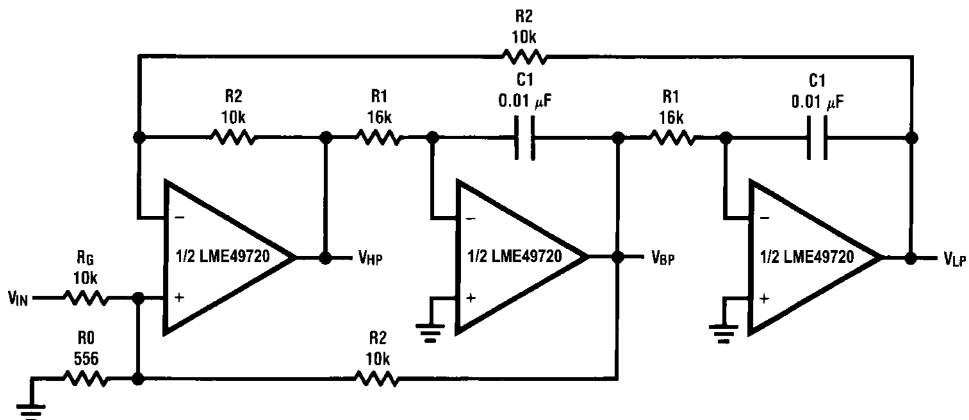
if R1 = R2 = R

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

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

Illustration is f_0 = 1 kHz

State Variable Filter

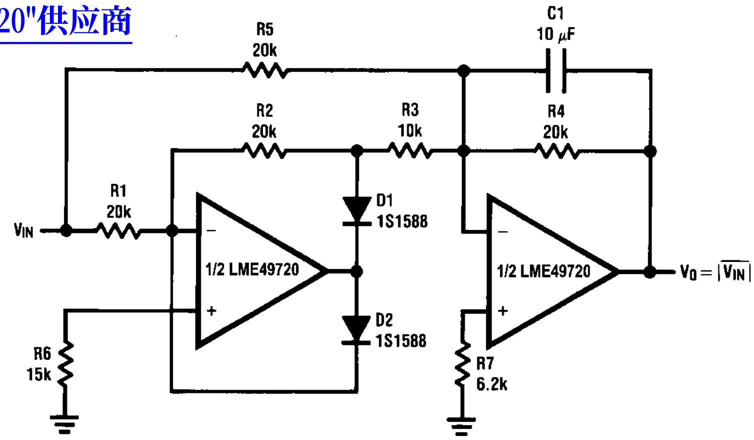


30003837

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

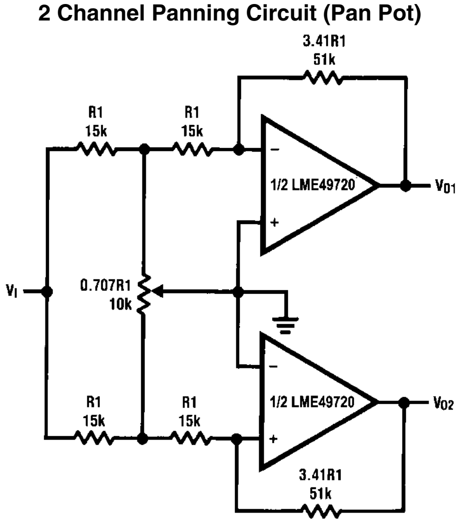
Illustration is f_0 = 1 kHz, Q = 10, A_{BP} = 1

AC/DC Converter



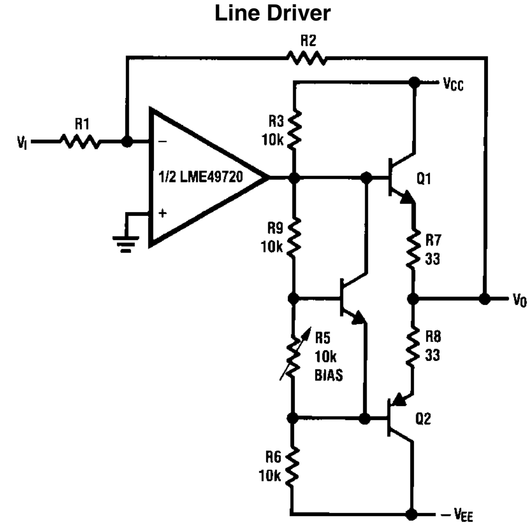
30003838

2 Channel Panning Circuit (Pan Pot)



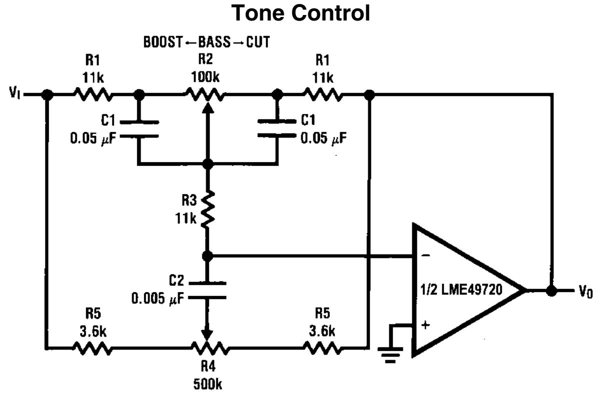
30003839

Line Driver



30003840

Tone Control



300038p0

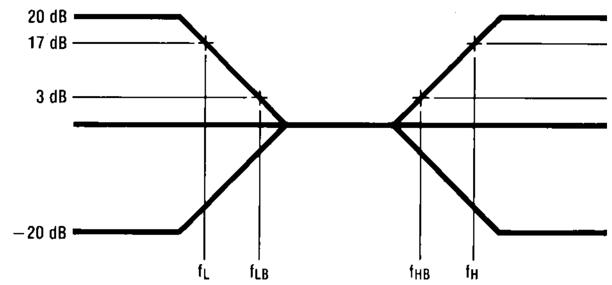
$$f_L = \frac{1}{2\pi R2C1},\ f_{LB} = \frac{1}{2\pi R1C1}$$

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

Illustration is:

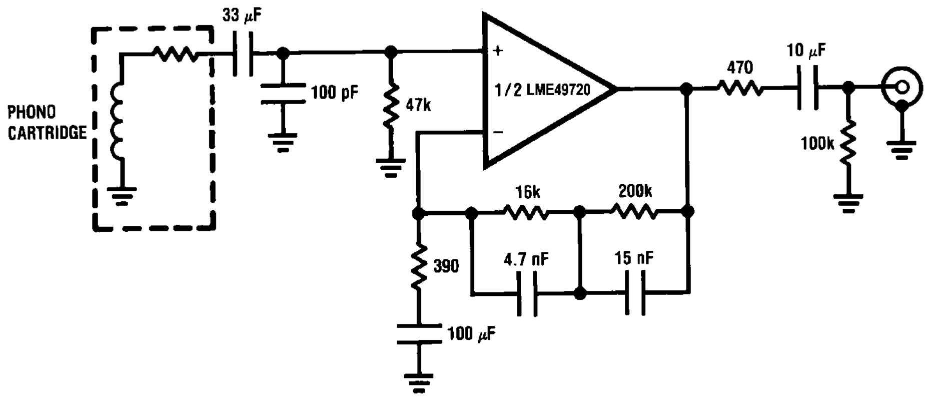
f_L = 32 Hz, f_{LB} = 320 Hz

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



30003842

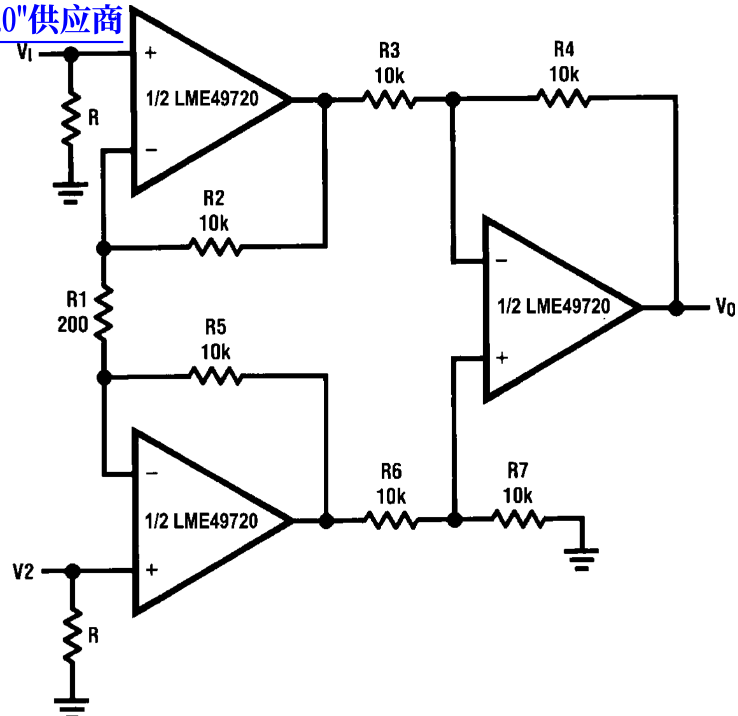
RIAA Preamp



30003803

A_v = 35 dB
E_n = 0.33 µV
S/N = 90 dB
f = 1 kHz
A Weighted
A Weighted, V_{IN} = 10 mV
@f = 1 kHz

Balanced Input Mic Amp



30003843

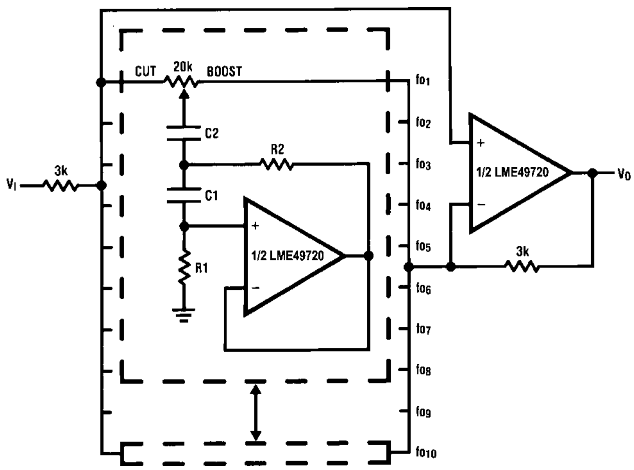
If R2 = R5, R3 = R6, R4 = R7

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

Illustration is:

V0 = 101(V2 – V1)

10 Band Graphic Equalizer



30003844

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

Note 9: At volume of change = ±12 dB

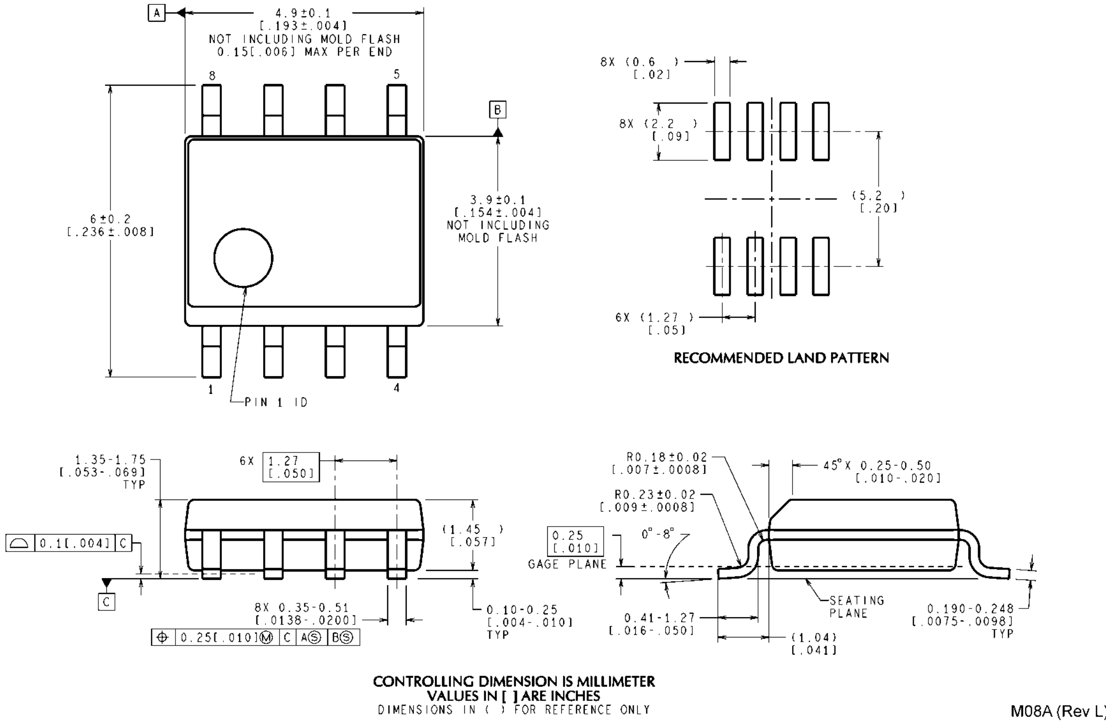
Q = 1.7

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

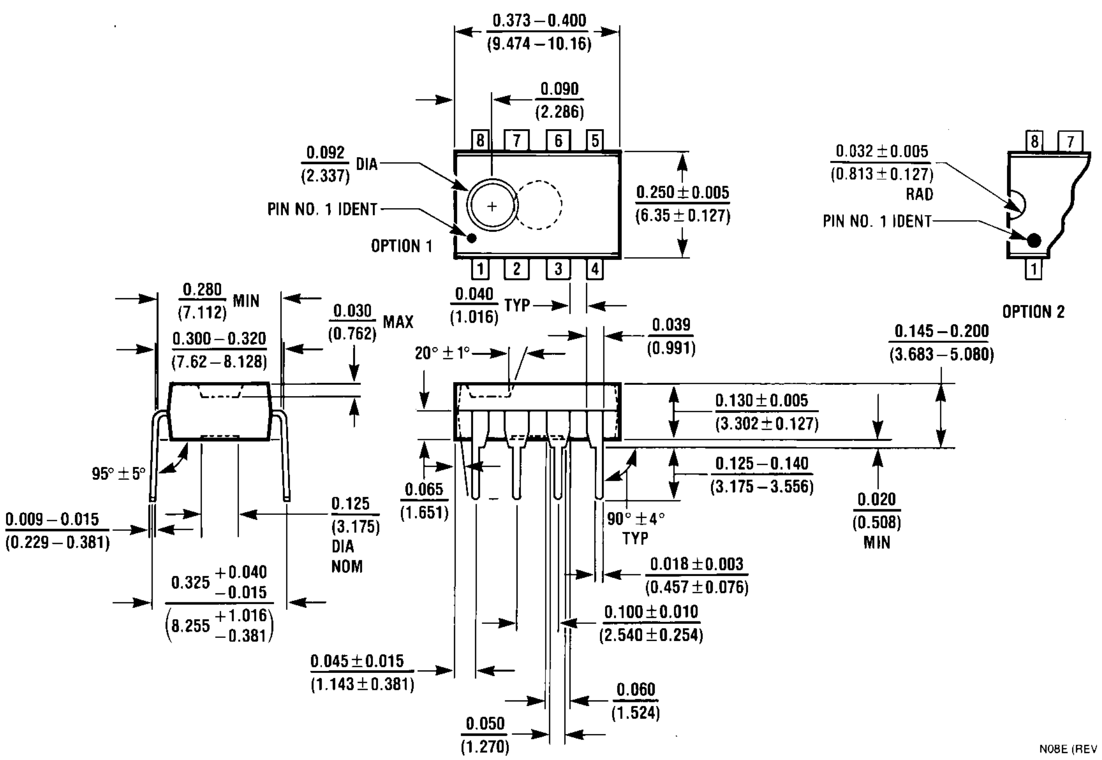
Revision History

Rev	Date	Description
1.0	03/30/07	Initial release.
1.1	05/03/07	Put the “general note” under the EC table.
1.2	10/22/07	Replaced all the PSRR curves.

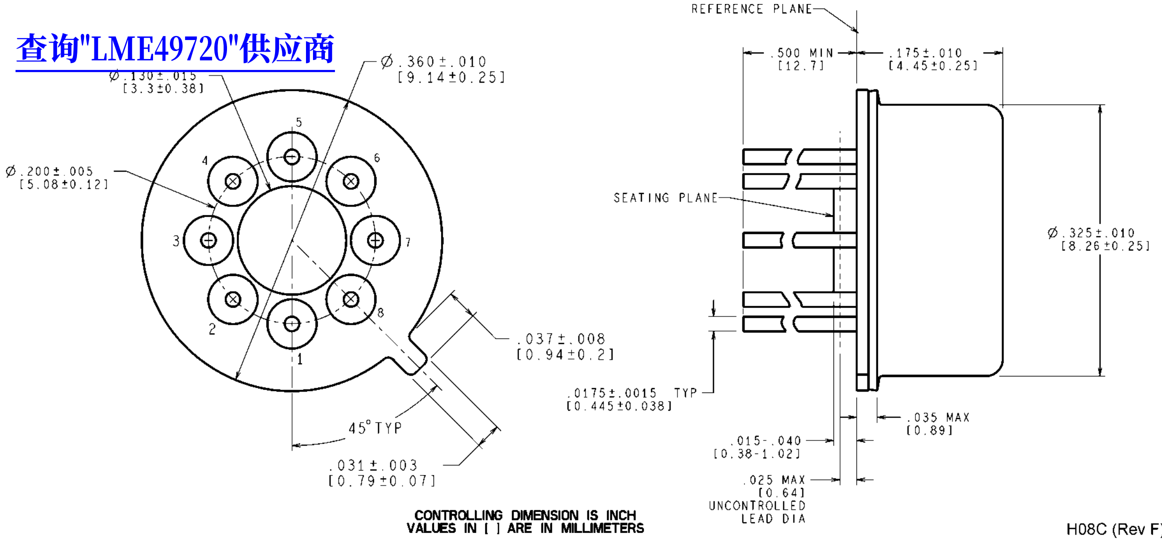
Physical Dimensions inches (millimeters) unless otherwise noted



Narrow SOIC Package
Order Number LME49720MA
NS Package Number M08A



Dual-In-Line Package
Order Number LME49720NA
NS Package Number N08E



TO-99 Metal Can Package
Order Number LME49720HA
NS Package Number H08C

Notes

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

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

National Semiconductor Europe Customer Support Center
Fax: +49 (0) 180-530-85-86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +49 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

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

National Semiconductor Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560