National Semiconductor

January 14, 2008

LME49870 44V Single High Performance, High Fidelity Audio Operational Amplifier

General Description

The LME49870 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 LME49870 audio operational amplifier delivers superior audio signal amplification for outstanding audio performance. The LME49870 combines extremely low voltage noise density (2.7nV/$\sqrt{Hz}$) with vanishingly low THD+N (0.00003%) to easily satisfy the most demanding audio applications. To ensure that the most challenging loads are driven without compromise, the LME49870 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 LME49870's outstanding CMRR (120dB), PSRR (120dB), and V_{OS} (0.1mV) give the amplifier excellent operational amplifier DC performance.

The LME49870 has a wide supply range of ±2.5V to ±22V. Over this supply range the LME49870 maintains excellent common-mode rejection, power supply rejection, and low input bias current. The LME49870 is unity gain stable. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LME49870 is available in 8–lead narrow body SOIC. Demonstration boards are available for each package.

Key Specifications

- Power Supply Voltage Range: ±2.5V to ±22V
- THD+N (A_V = 1, V_{OUT} = $3V_{RMS}$, f_{IN} = 1kHz)
  - R_L = 2kΩ: 0.00003% (typ)
  - R_L = 600Ω: 0.00003% (typ)
- Input Noise Density: 2.7nV/$\sqrt{Hz}$ (typ)
- Slew Rate: ±20V/μs (typ)
- Gain Bandwidth Product: 55MHz (typ)
- Open Loop Gain (R_L = 600Ω): 140dB (typ)
- Input Bias Current: 10nA (typ)
- Input Offset Voltage: 0.1mV (typ)
- DC Gain Linearity Error: 0.000009%

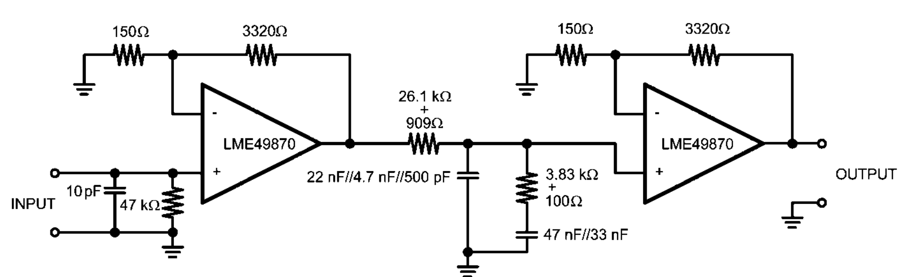
Features

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

Applications

- High quality audio amplification
- High fidelity preamplifiers, phono preamps, and multimedia
- High performance professional audio
- High fidelity equalization and crossover networks with active filters
- High performance line drivers and receivers
- Low noise industrial applications including test, measurement, and ultrasound

Typical Application

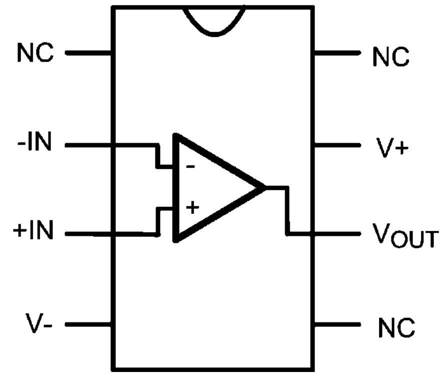


Note: 1% metal film resistors, 5% polypropylene capacitors

300194k5

Passively Equalized RIAA Phono Preamplifier

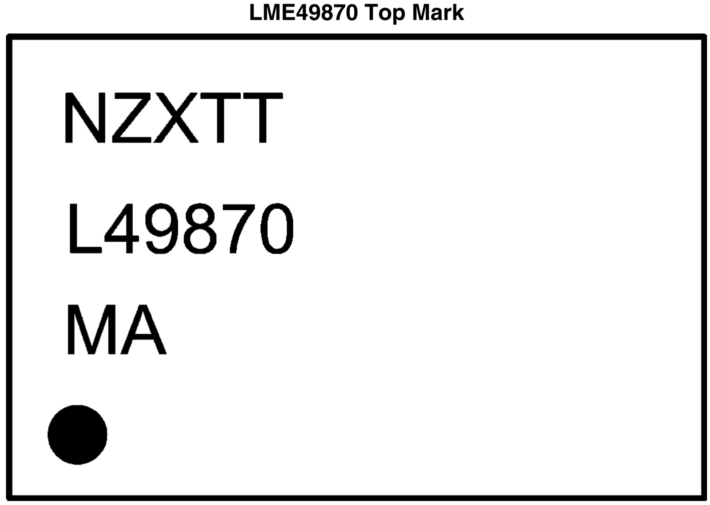
Connection Diagrams



30019401

Order Number LME49870MA
See NS Package Number — M08A

LME49870 Top Mark



30019402

N — National Logo
Z — Assembly Plant code
X — 1 Digit Date code
TT — Die Traceability
L49870 — LME49870
MA — Package code

Absolute Maximum Ratings (Notes 1, 2)

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

Power Supply Voltage ($V_S = V^+ - V^-$)	46V
Storage Temperature	–65°C to 150°C
Input Voltage	(V-) - 0.7V to (V+) + 0.7V
Output Short Circuit (Note 3)	Continuous
Power Dissipation	Internally Limited
ESD Rating (Note 4)	2000V
ESD Rating (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

Operating Ratings

Temperature Range	
$T_{MIN} \leq T_A \leq T_{MAX}$	$-40°C \leq T_A \leq 85°C$
Supply Voltage Range	$\pm 2.5V \leq V_S \leq \pm 22V$

Electrical Characteristics for the LME49870 (Note 1)

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

Symbol	Parameter	Conditions	LME49870 Typical (Note 6)	LME49870 Limit (Note 7)	Units (Limits)
THD+N	Total Harmonic Distortion + Noise	A_V = 1, V_{OUT} = $3V_{rms}$ R_L = 2kΩ R_L = 600Ω	 0.00003 0.00003	 0.00009	% (max)
IMD	Intermodulation Distortion	A_V = 1, V_{OUT} = $3V_{RMS}$ Two-tone, 60Hz & 7kHz 4:1	0.00005		%
GBWP	Gain Bandwidth Product		55	45	MHz (min)
SR	Slew Rate		±20	±15	V/μs (min)
FPBW	Full Power Bandwidth	V_{OUT} = $1V_{P-P}$, –3dB referenced to output magnitude at f = 1kHz	10		MHz
t_s	Settling time	A_V = –1, 10V step, C_L = 100pF 0.1% error range	1.2		μs
e_n	Equivalent Input Noise Voltage	f_{BW} = 20Hz to 20kHz	0.34	0.65	μV_{RMS} (max)
	Equivalent Input Noise Density	f = 1kHz f = 10Hz	2.5 6.4	4.7	$nV/\sqrt{Hz}$ (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		$pA/\sqrt{Hz}$
V_{OS}	Offset Voltage	V_S = ±18V	±0.12		mV (max)
		V_S = ±22V	±0.14	±0.7	mV (max)
$\Delta V_{OS}/\Delta Temp$	Average Input Offset Voltage Drift vs Temperature	$-40°C \leq T_A \leq 85°C$	0.1		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	V_S = ±18V, ΔV_S = 24V (Note 8) V_S = ±22V, ΔV_S = 30V	120 120	 110	dB (min)
I_B	Input Bias Current	V_{CM} = 0V	10	72	nA (max)
$\Delta I_{OS}/\Delta Temp$	Input Bias Current Drift vs Temperature	$-40°C \leq T_A \leq 85°C$	0.2		nA/°C
I_{OS}	Input Offset Current	V_{CM} = 0V	11	65	nA (max)
V_{IN-CM}	Common-Mode Input Voltage Range	V_S = ±18V	+17.1 –16.9		V (min) V (min)
		V_S = ±22V	+21.0 –20.8	(V+) – 2.0 (V-) + 2.0	V (min) V (min)

Symbol	Parameter	Conditions	LME49870 Typical (Note 6)	LME49870 Limit (Note 7)	Units (Limits)
CMRR	Common-Mode Rejection	V_S = ±18V –12V≤Vcm≤12V	120		dB (min)
		V_S = ±22V –15V≤Vcm≤15V	120	110	dB (min)
Z_{IN}	Differential Input Impedance		30		kΩ
	Common Mode Input Impedance	–10V<Vcm<10V	1000		MΩ
A_{VOL}	Open Loop Voltage Gain	V_S = ±18V –12V≤Vout≤12V R_L = 600Ω R_L = 2kΩ R_L = 10Ω	140 140 140		dB dB dB
		V_S = ±22V –15V≤Vout≤15V R_L = 600Ω R_L = 2kΩ R_L = 10Ω	140 140 140	125	dB dB dB
V_{OUTMAX}	Maximum Output Voltage Swing	R_L = 600Ω V_S = ±18V V_S = ±22V	±16.7 ±20.4	±19.0	V (min) V (min)
		R_L = 2kΩ V_S = ±18V V_S = ±22V	±17.0 ±21.0		V (min) V (min)
		R_L = 10kΩ V_S = ±18V V_S = ±22V	±17.1 ±21.0		V (min) V (min)
I_{OUT}	Output Current	R_L = 600Ω V_S = ±20V V_S = ±22V	±31 ±37	±30	mA (min) 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	5	6.5	mA (max)

Note 1: "*Absolute Maximum Ratings*" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The *Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: The *Electrical Characteristics* tables list guaranteed specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not guaranteed.

Note 3: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{JA}, and the ambient temperature, T_A. The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ or the number given in *Absolute Maximum Ratings*, whichever is lower.

Note 4: Human body model, applicable std. JESD22-A114C.

Note 5: Machine model, applicable std. JESD22-A115-A.

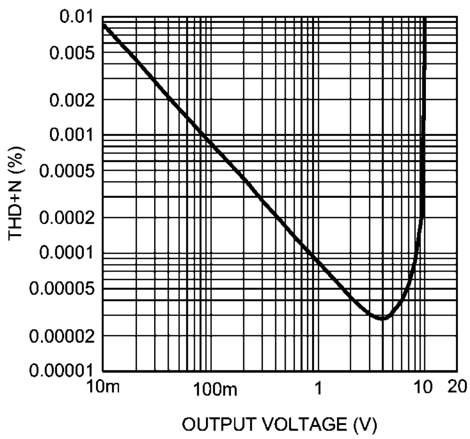
Note 6: Typical values represent most likely parametric norms at T_A = +25ºC, and at the *Recommended Operation Conditions* at the time of product characterization and are not guaranteed.

Note 7: Datasheet min/max specification limits are guaranteed by test or statistical analysis.

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

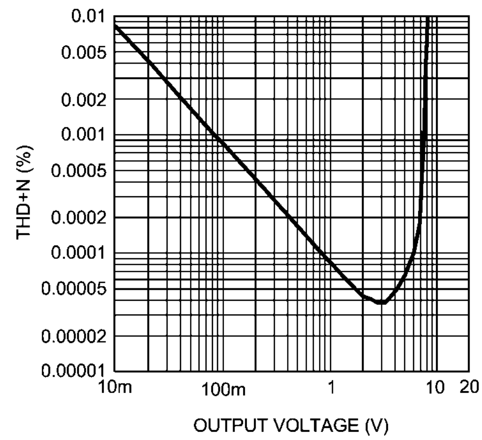
Typical Performance Characteristics

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



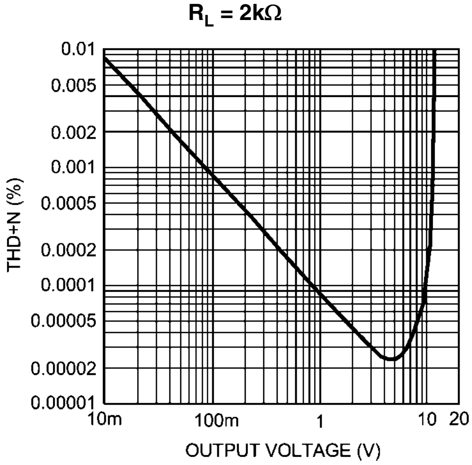
300194k6

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



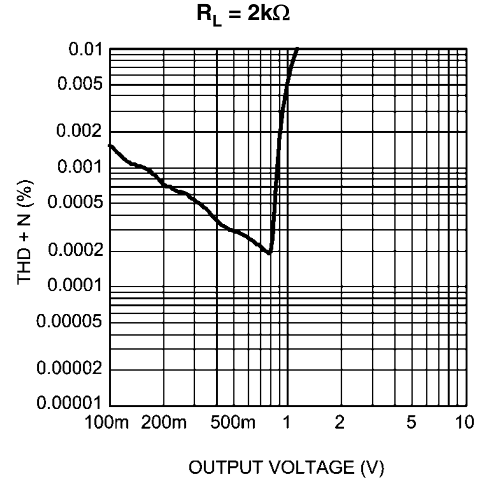
300194k7

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



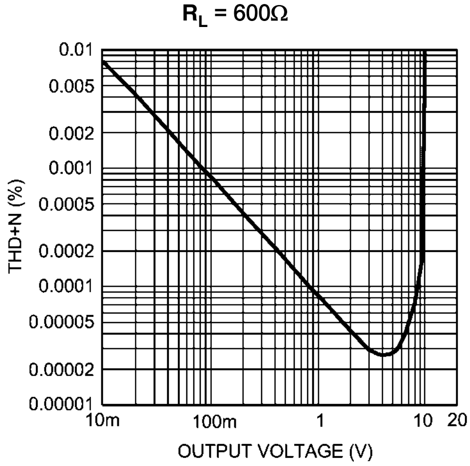
300194k8

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



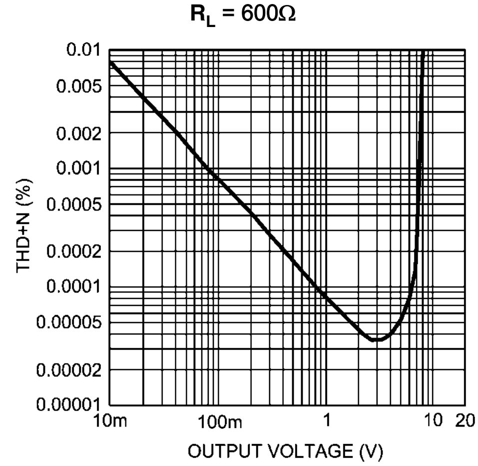
300194i4

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



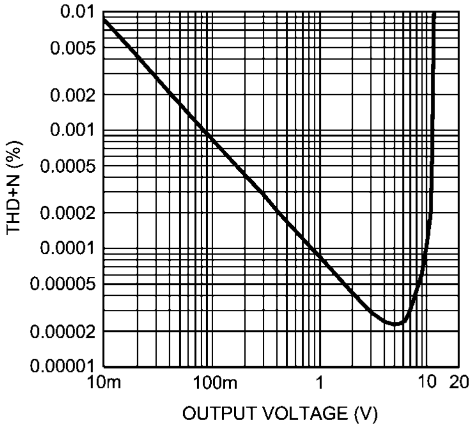
300194k9

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



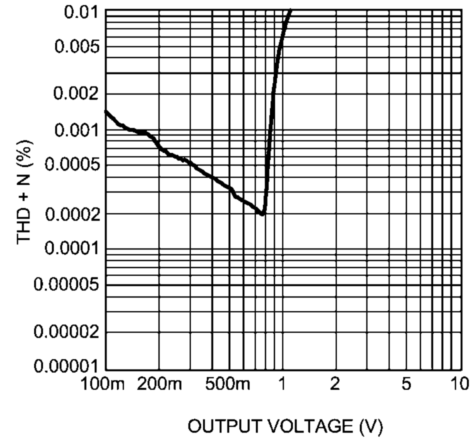
300194l0

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



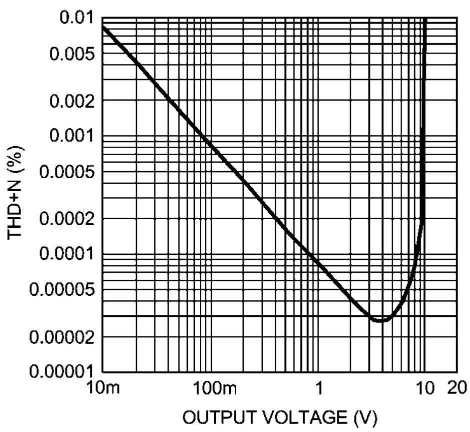
300194l1

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



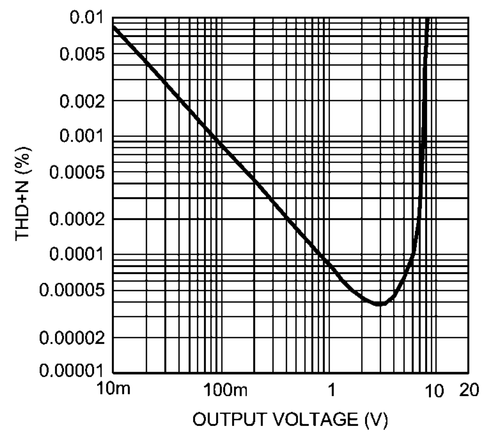
300194i6

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



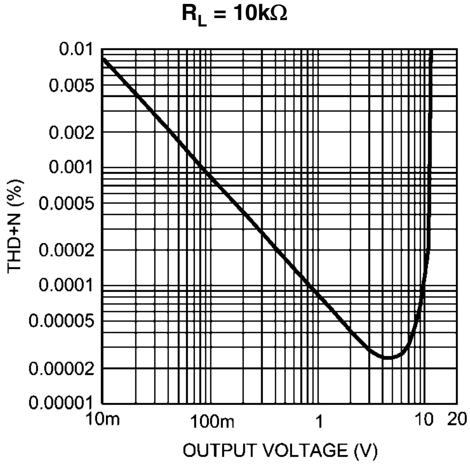
300194l2

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



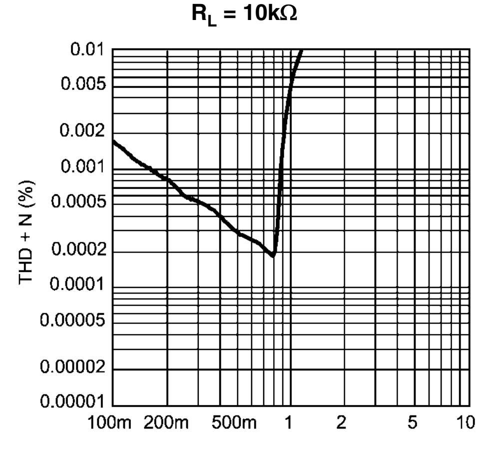
300194l3

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



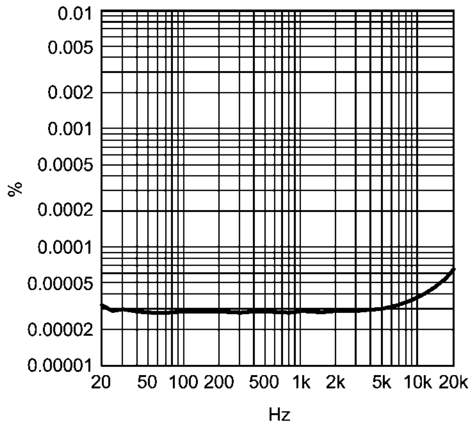
300194l4

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



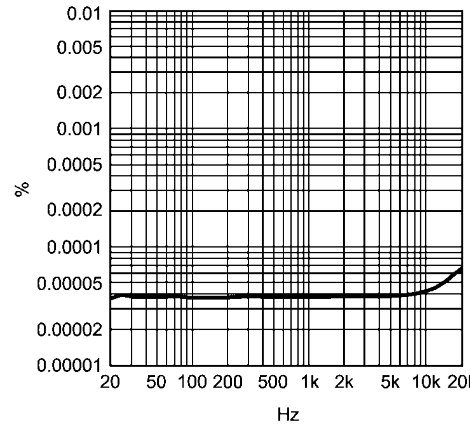
300194i5

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



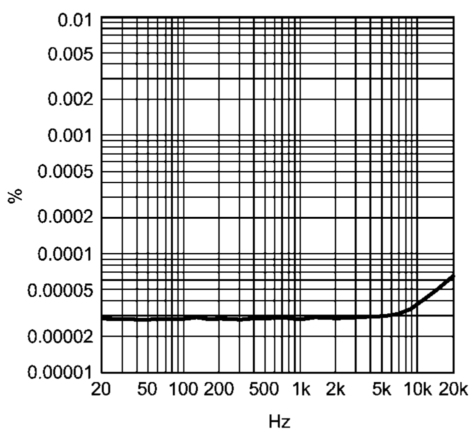
30019463

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



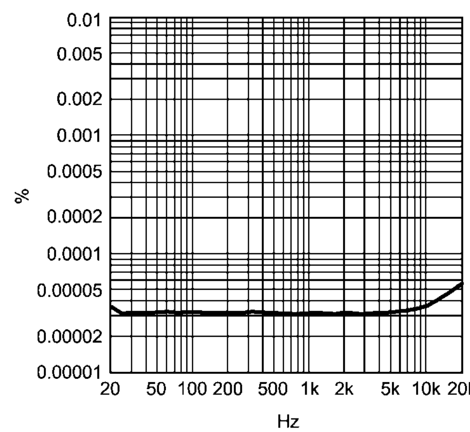
30019462

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



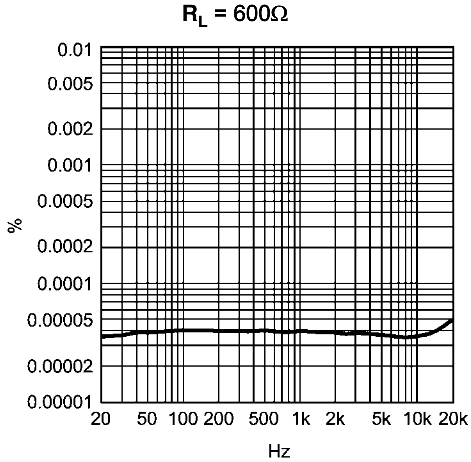
30019464

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



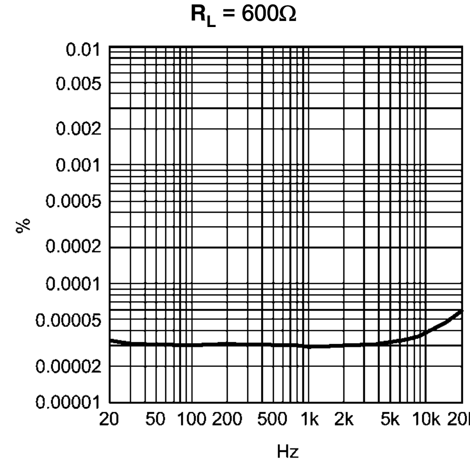
30019459

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



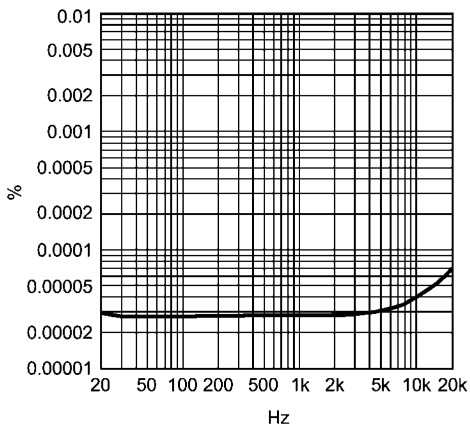
300194k3

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



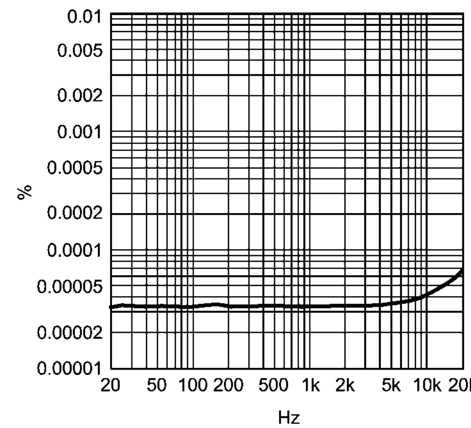
30019460

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



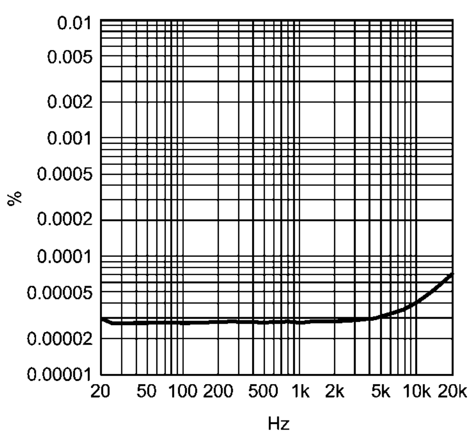
30019467

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



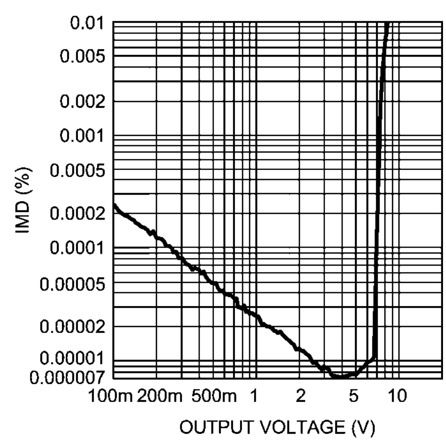
30019466

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



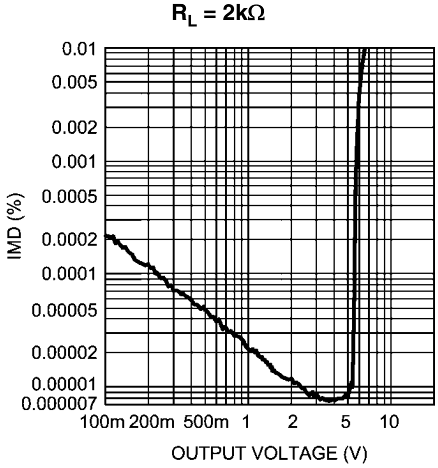
30019468

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



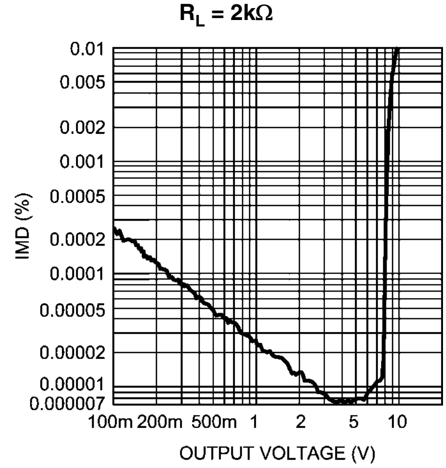
300194e6

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



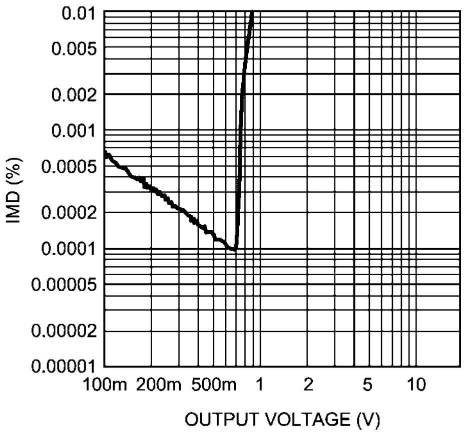
300194e5

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



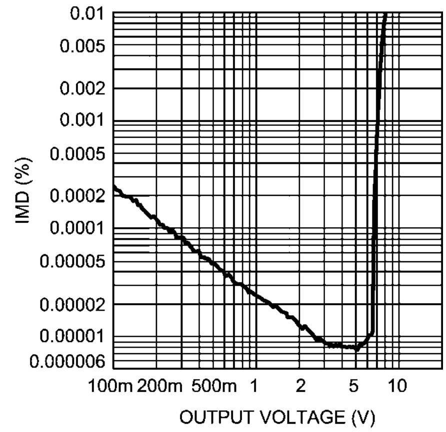
300194e7

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



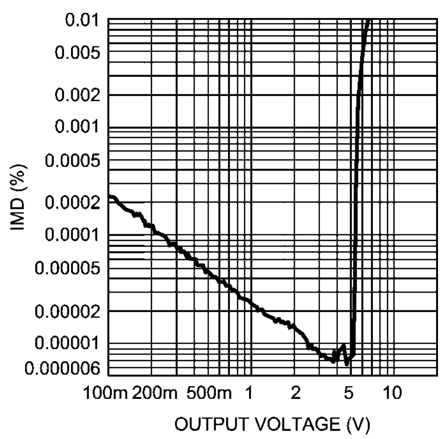
300194e4

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



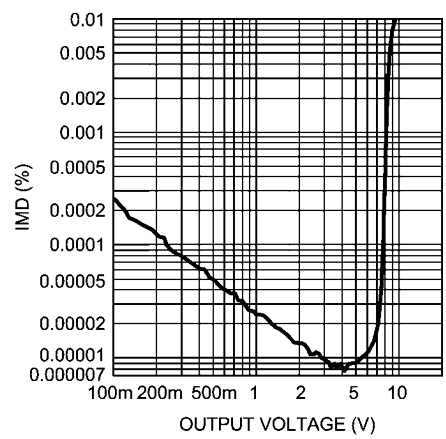
300194e2

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



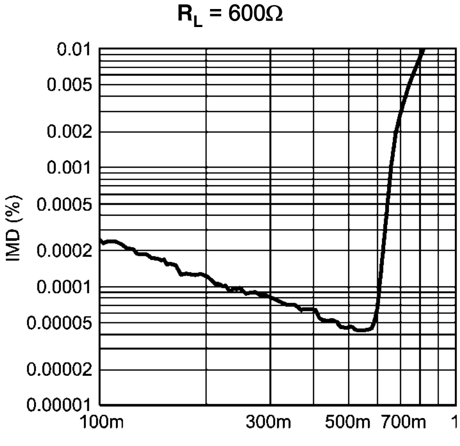
300194e0

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



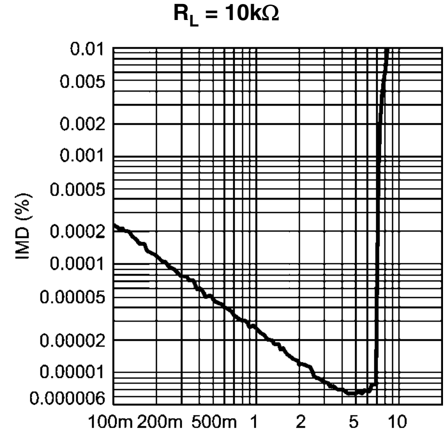
300194e3

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



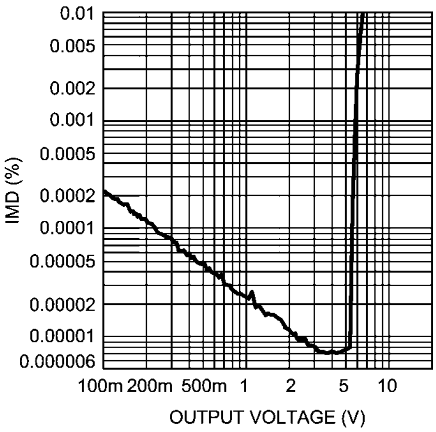
300194e1

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



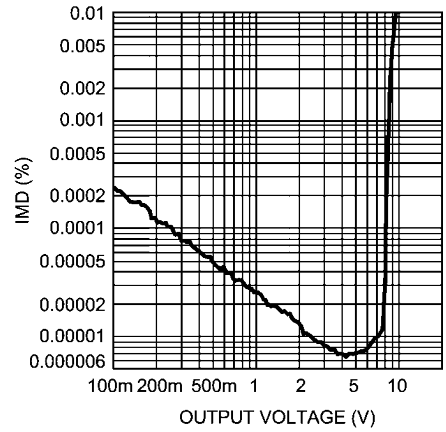
300194f1

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



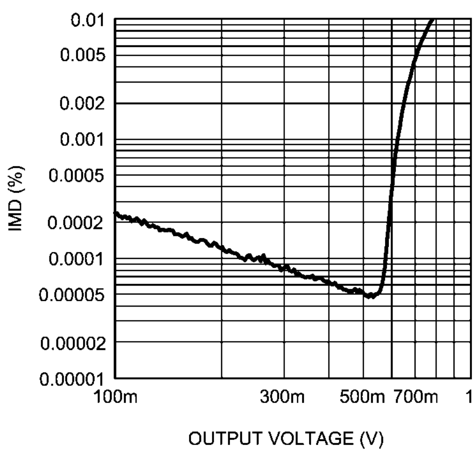
300194f0

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



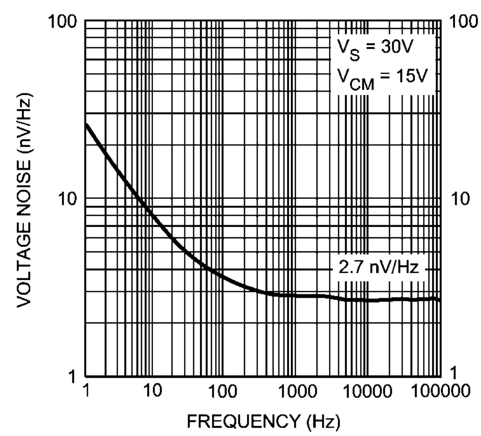
300194f2

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



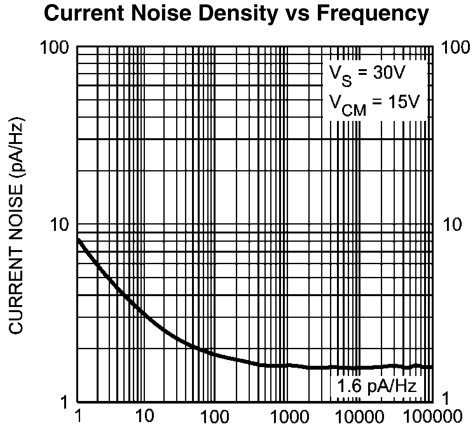
300194l6

Voltage Noise Density vs Frequency



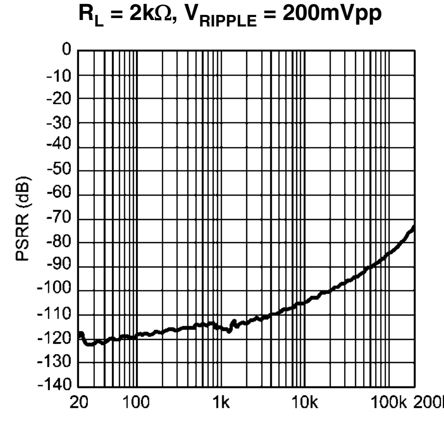
300194h6

Current Noise Density vs Frequency



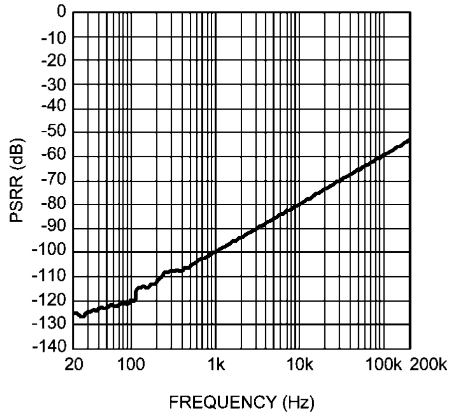
300194h7

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



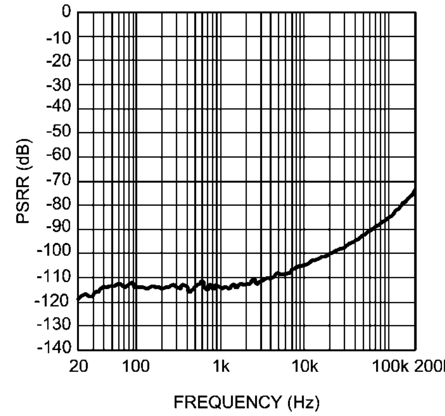
300194p7

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



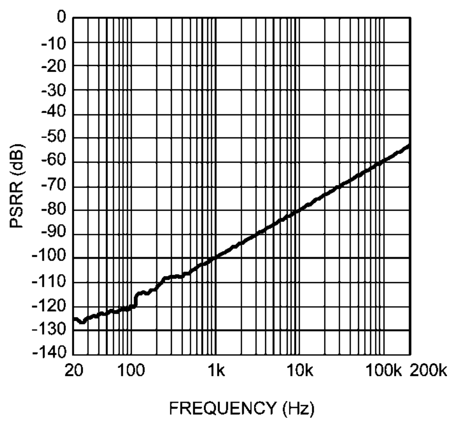
300194r2

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



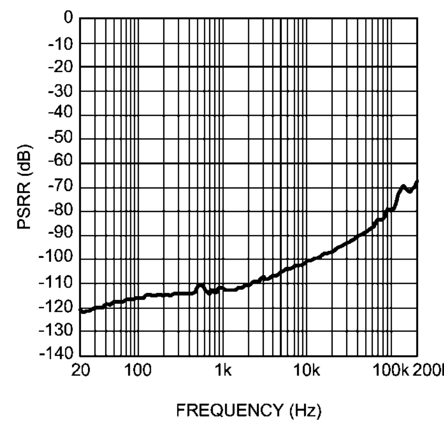
300194q0

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



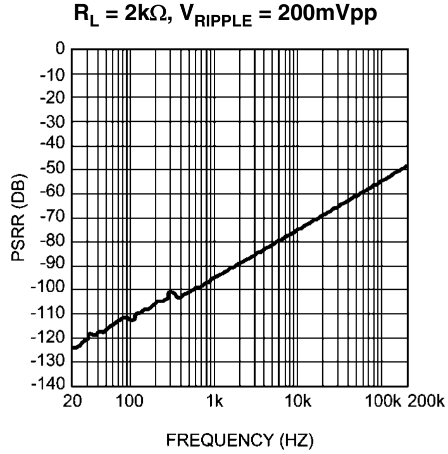
300194r2

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



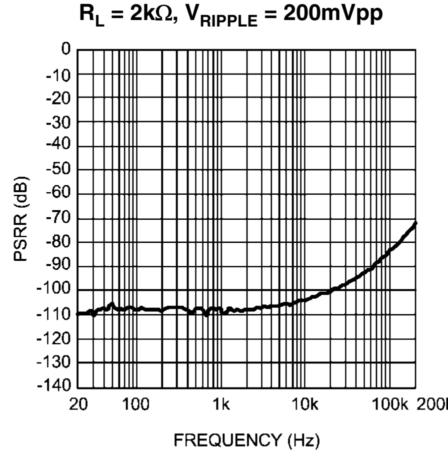
300194p4

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



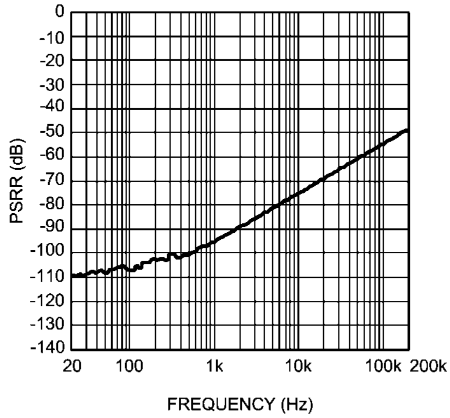
300194q9

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



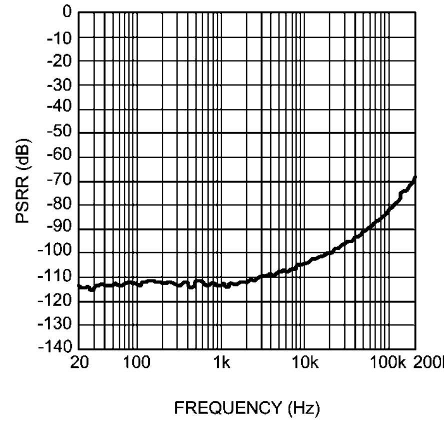
300194q3

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



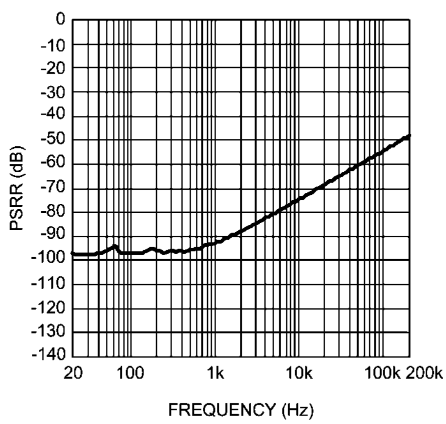
300194r8

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



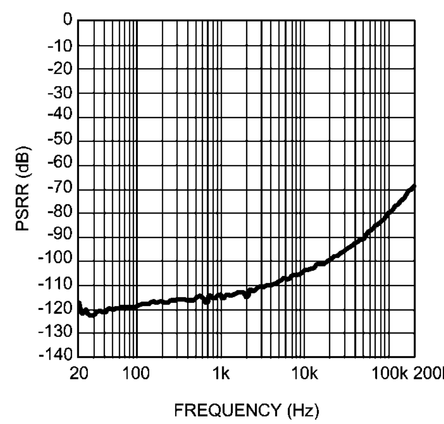
300194p1

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



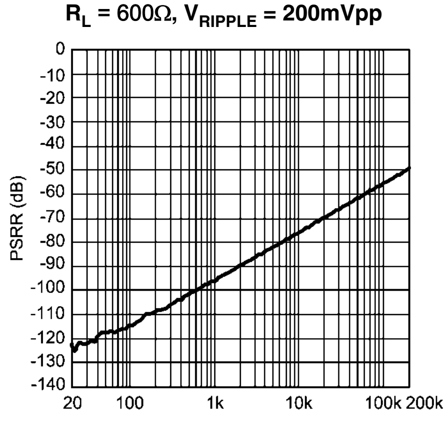
300194q6

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



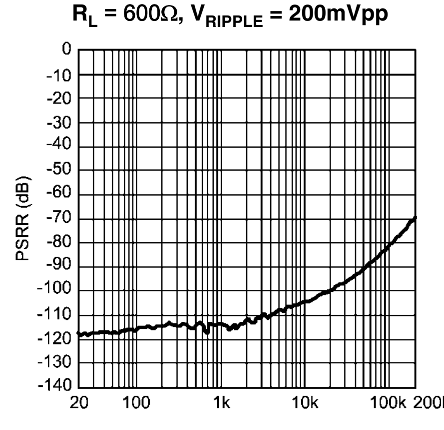
300194p9

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



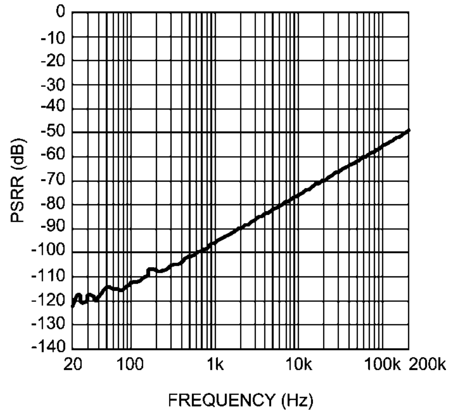
300194r4

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



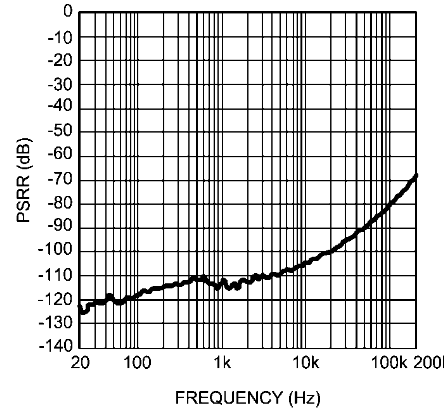
300194q2

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



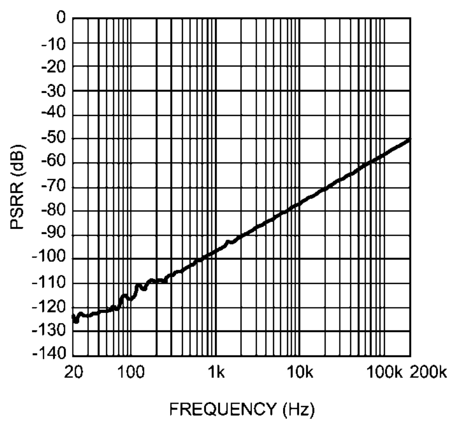
300194r7

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



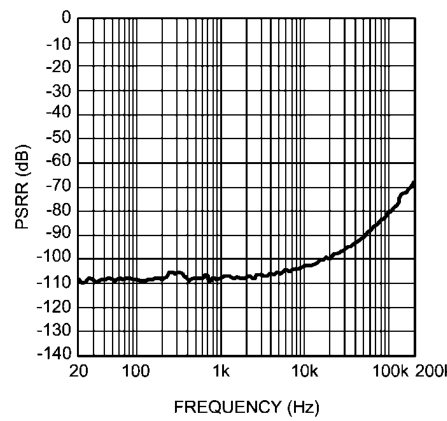
300194p6

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



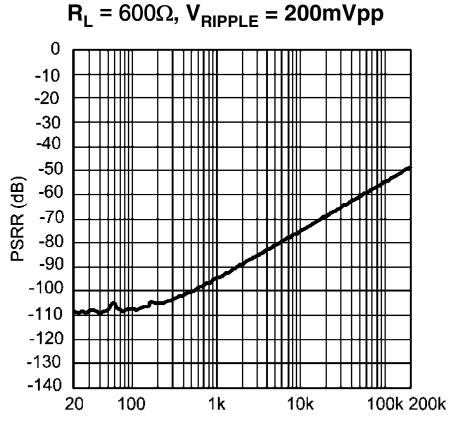
300194r1

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



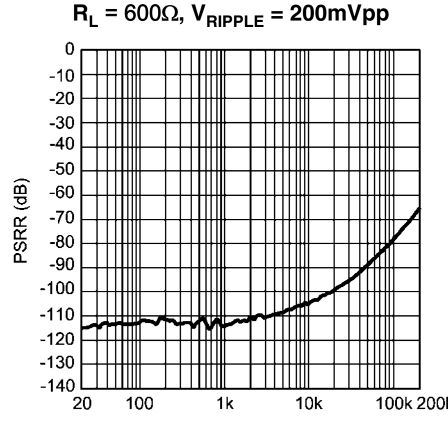
300194q5

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



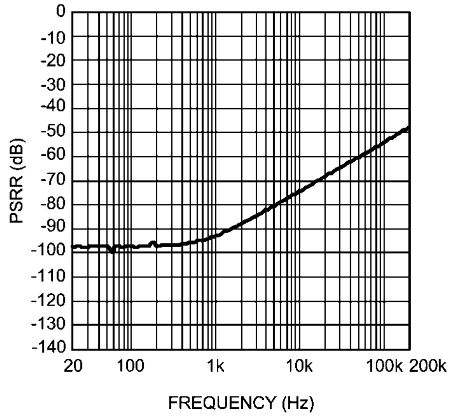
300194s0

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



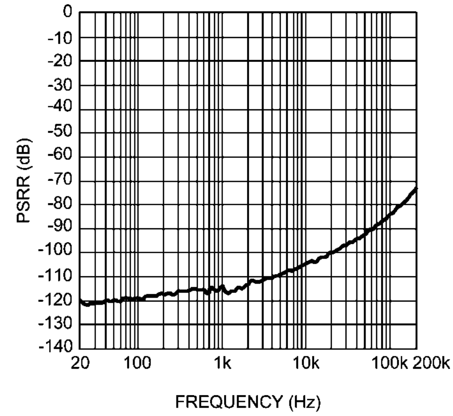
300194p3

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



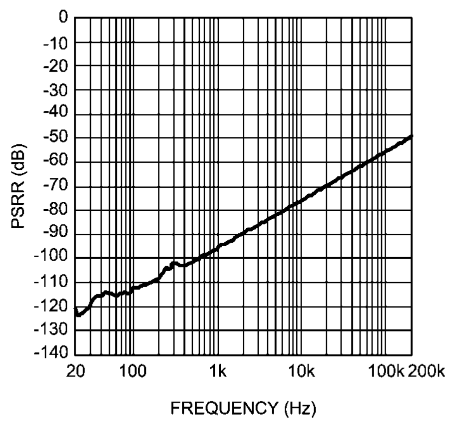
300194q8

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



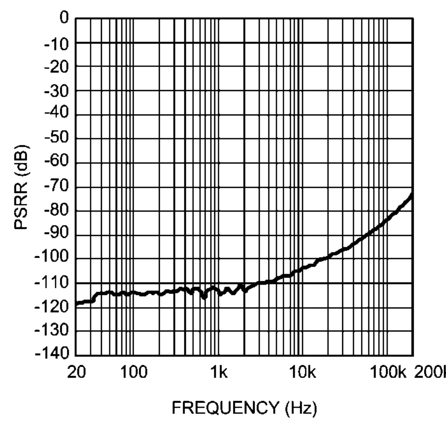
300194p8

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



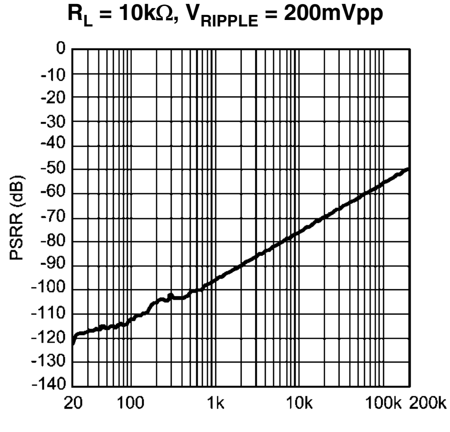
300194r3

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



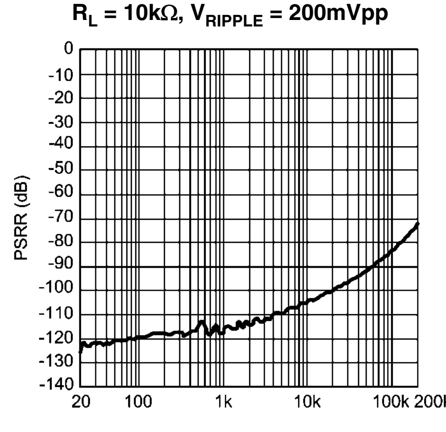
300194q1

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



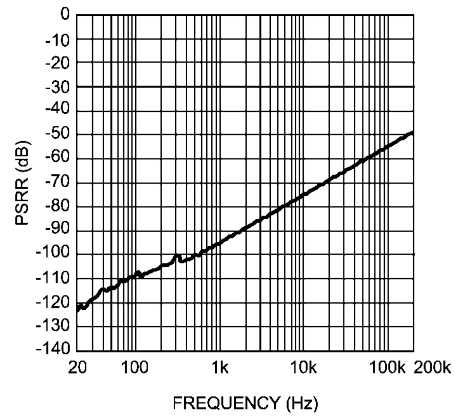
300194r6

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



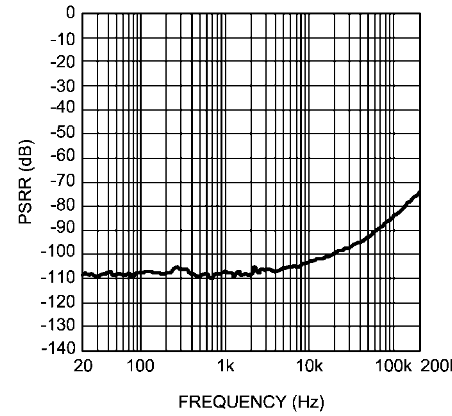
300194p5

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



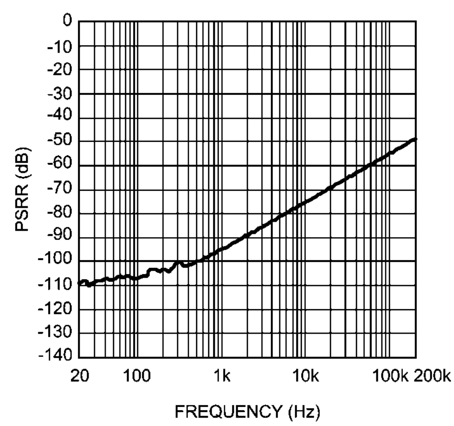
300194r0

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



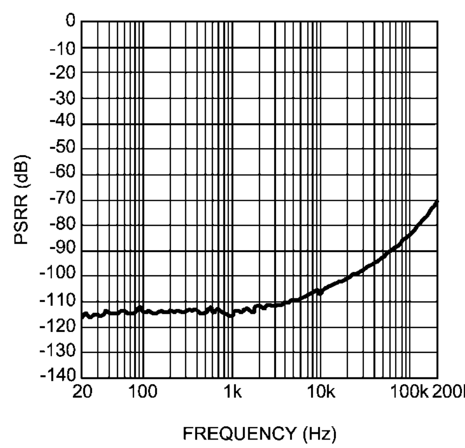
300194q4

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



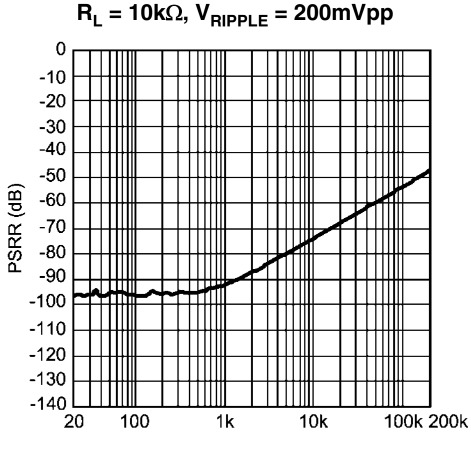
300194r9

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



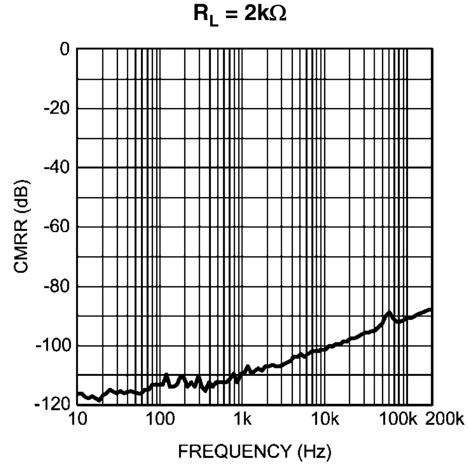
300194p2

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



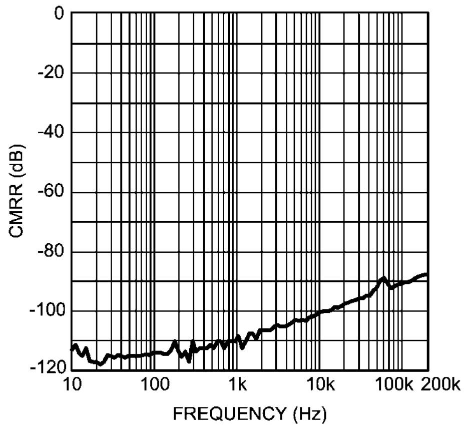
300194q7

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



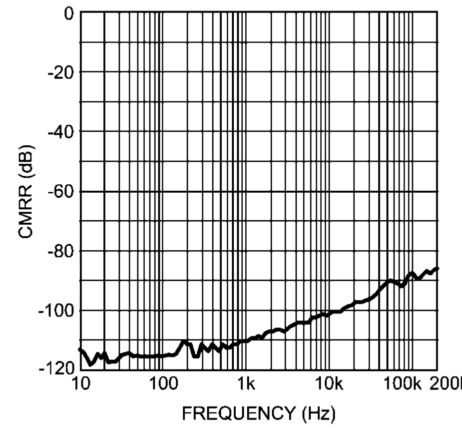
300194g0

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



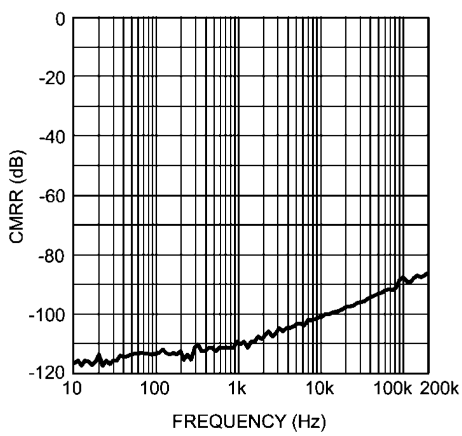
300194f7

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



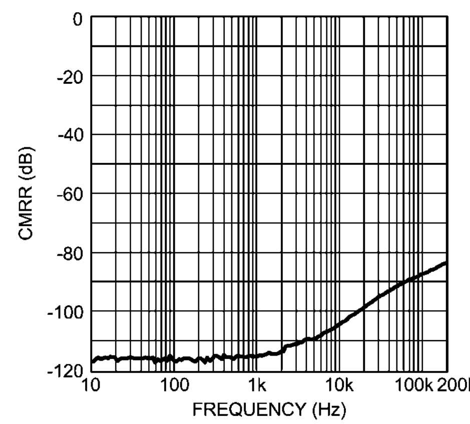
300194g3

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



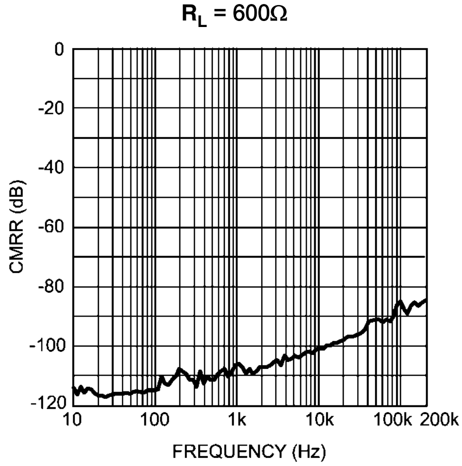
300194f4

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



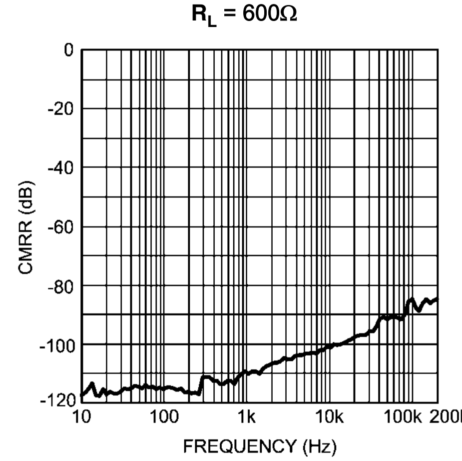
300194o9

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



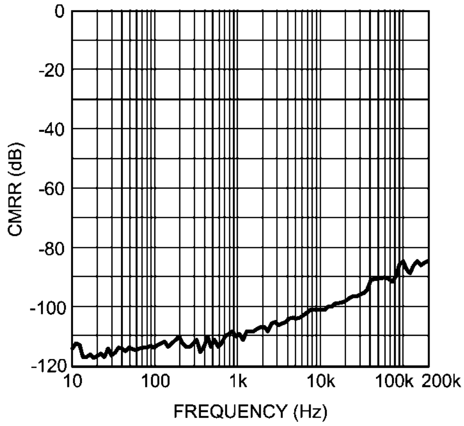
300194f9

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



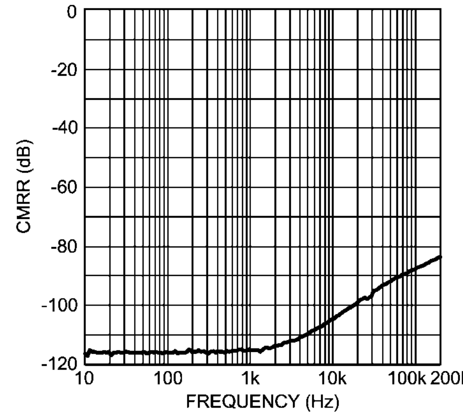
300194g5

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



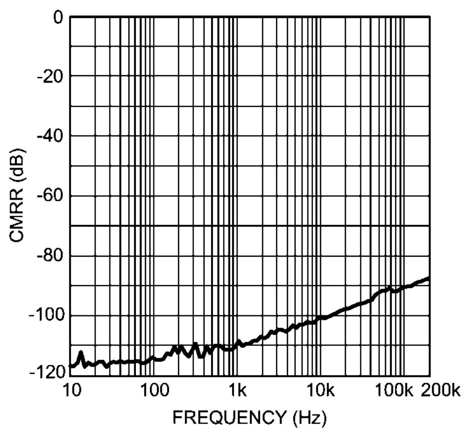
300194f6

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



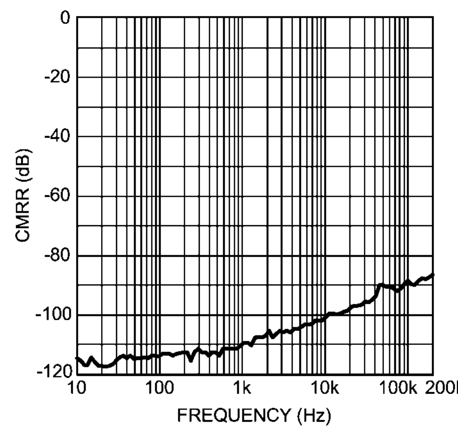
300194o8

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



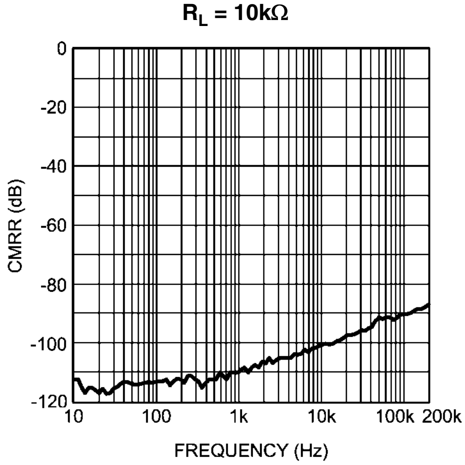
300194f8

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



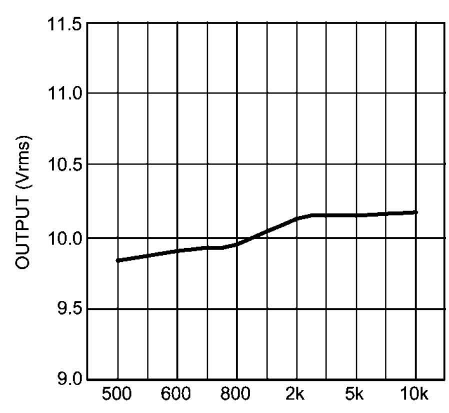
300194g4

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



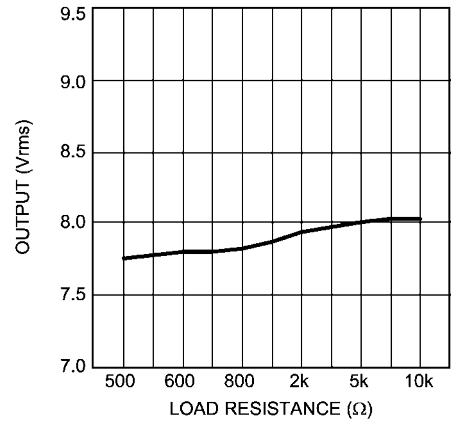
300194f5

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



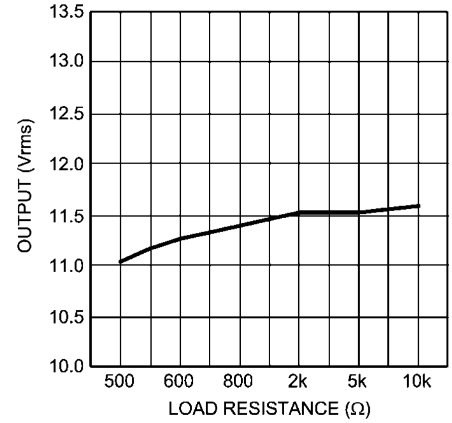
300194h1

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



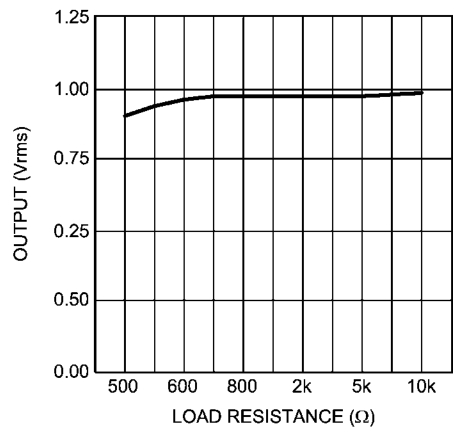
300194h0

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



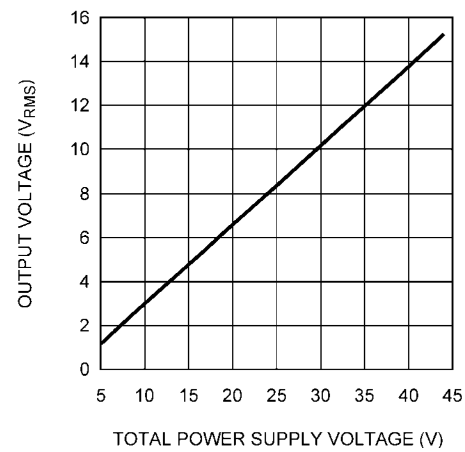
300194h2

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



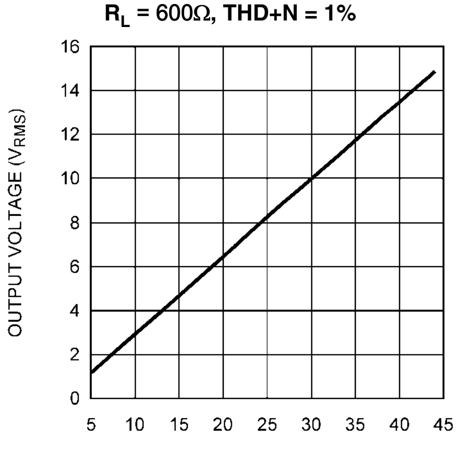
300194g9

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



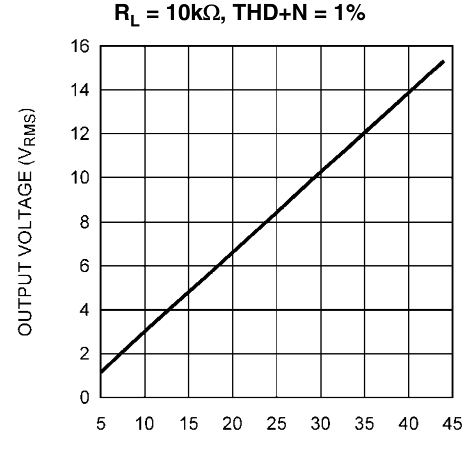
30019407

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



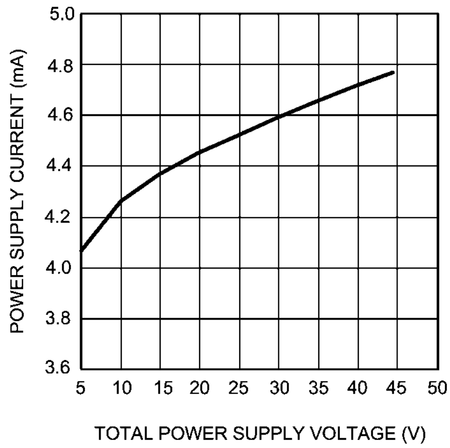
30019409

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



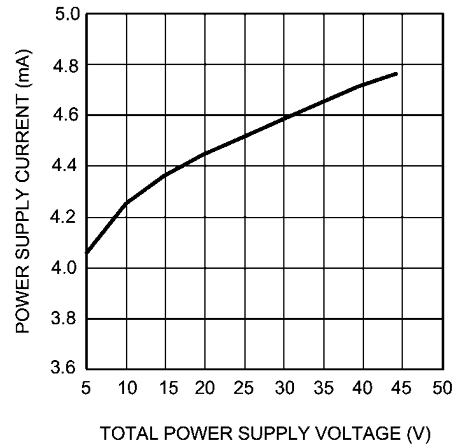
30019408

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



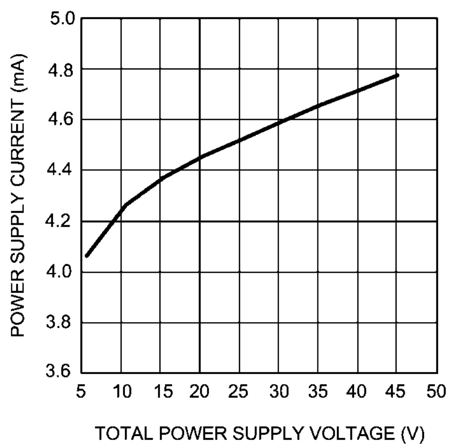
30019413

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



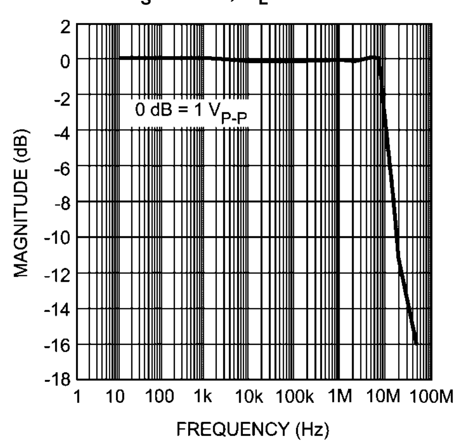
30019415

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



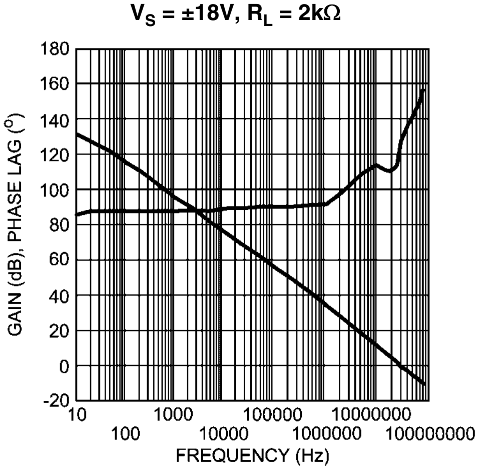
30019414

Full Power Bandwidth vs Frequency
V_S = ±18V, R_L = 2kΩ



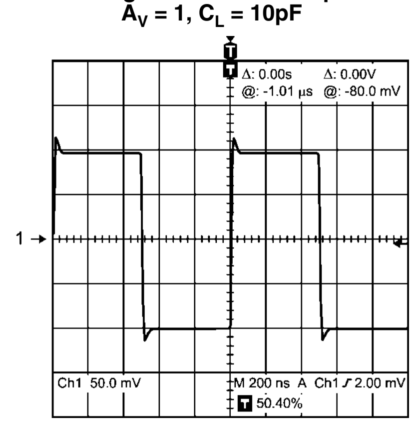
300194j0

Gain Phase vs Frequency
V_S = ±18V, R_L = 2kΩ



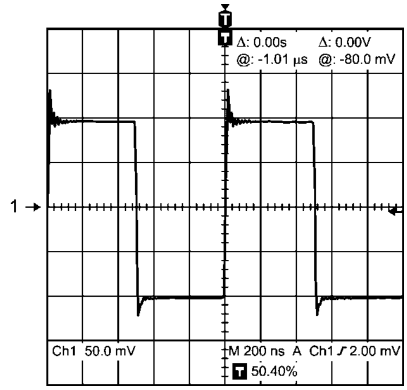
300194j1

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



300194i7

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



300194i8

Application Information

DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LME49870 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 LME49870'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.

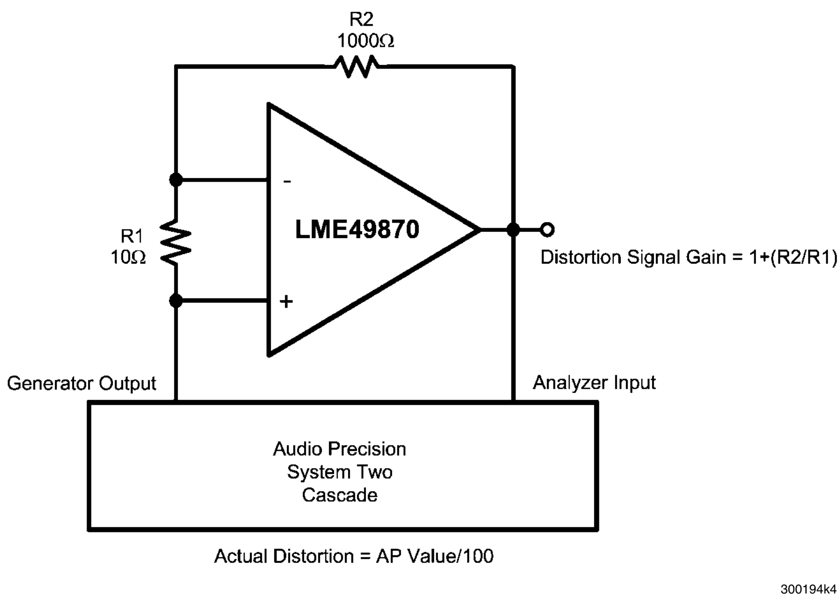
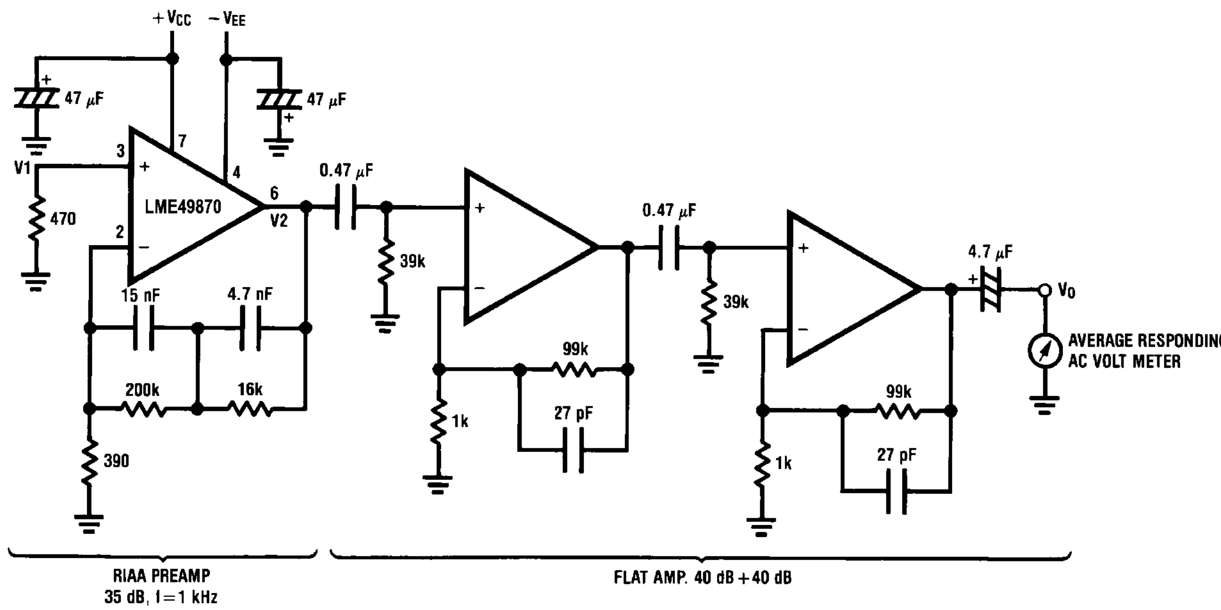


FIGURE 1. THD+N and IMD Distortion Test Circuit

The LME49870 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.

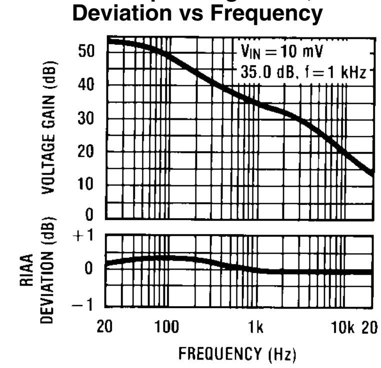


30019427

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

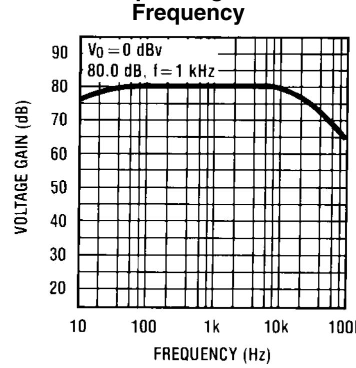
Noise Measurement Circuit
Total Gain: 115 dB @f = 1 kHz
Input Referred Noise Voltage: e_n = V0/560,000 (V)

RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



30019428

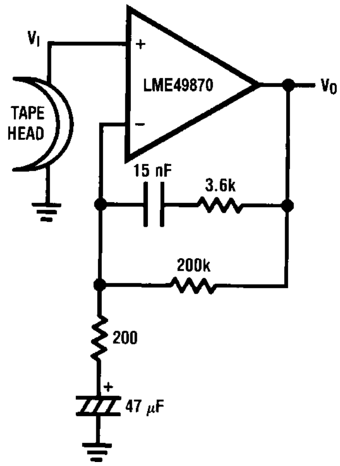
Flat Amp Voltage Gain vs Frequency



30019429

TYPICAL APPLICATIONS

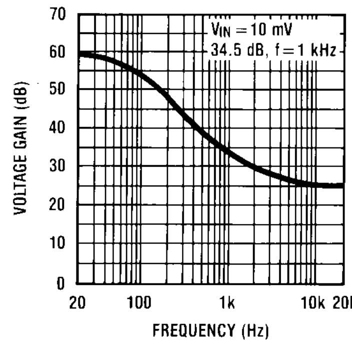
NAB Preamp



30019430

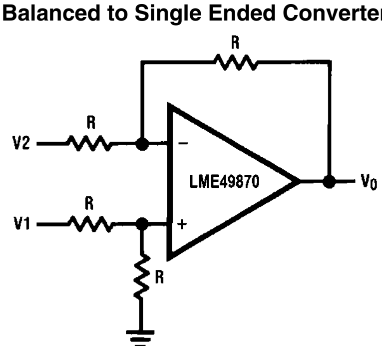
$A_V = 34.5$
F = 1 kHz
$E_n = 0.38\ \mu V$
A Weighted

NAB Preamp Voltage Gain vs Frequency



30019431

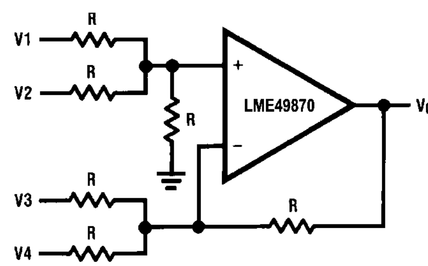
Balanced to Single Ended Converter



30019432

$V_O = V1–V2$

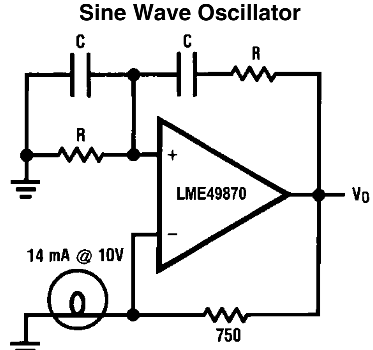
Adder/Subtracter



30019433

$V_O = V1 + V2 – V3 – V4$

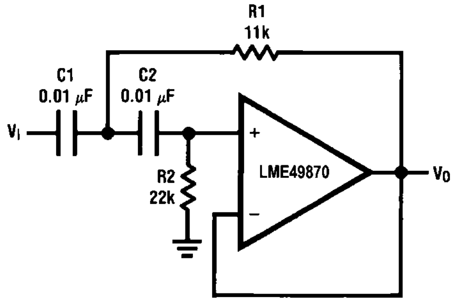
Sine Wave Oscillator



30019434

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

Second Order High Pass Filter (Butterworth)



30019435

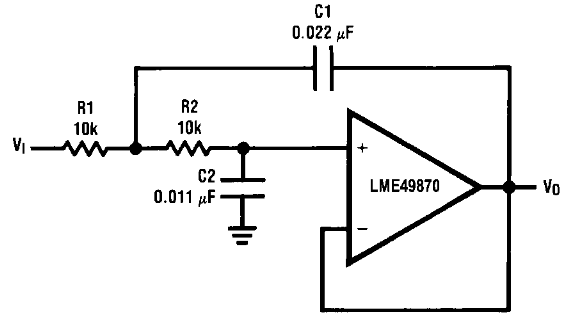
if C1 = C2 = C

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

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



30019436

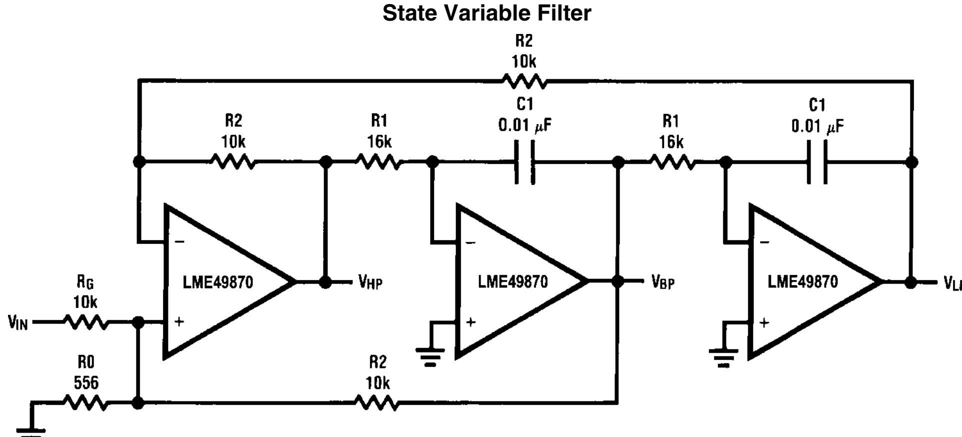
if R1 = R2 = R

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

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

Illustration is f_0 = 1 kHz

State Variable Filter

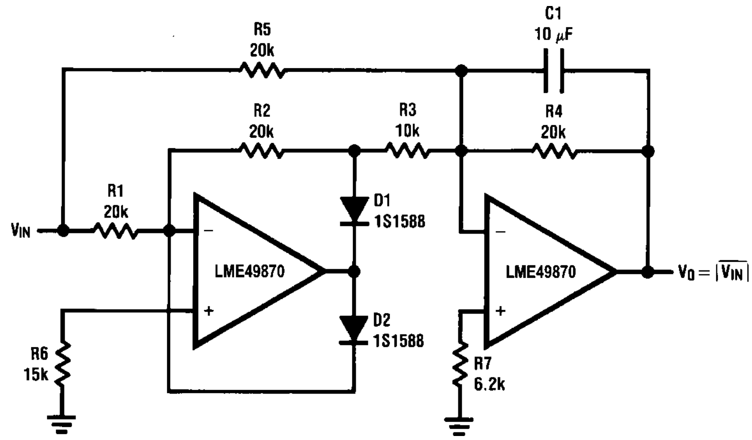


30019437

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

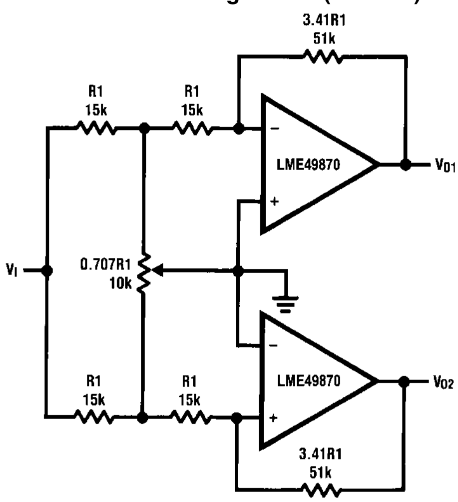
Illustration is f_0 = 1 kHz, Q = 10, A_{BP} = 1

AC/DC Converter



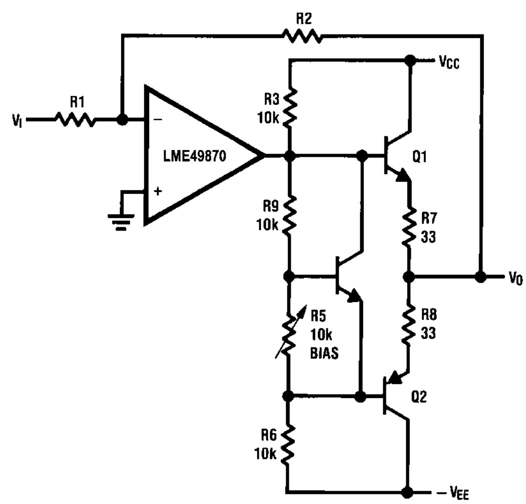
30019438

2 Channel Panning Circuit (Pan Pot)



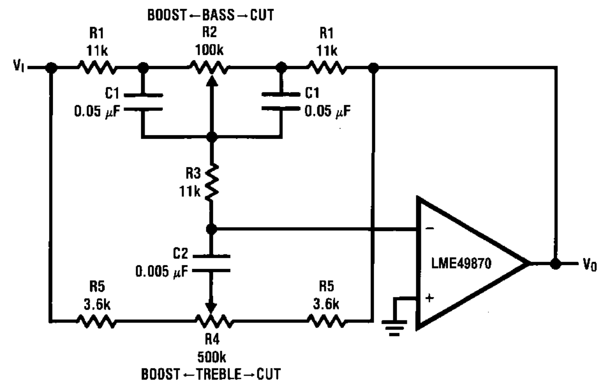
30019439

Line Driver



30019440

Tone Control



30019441

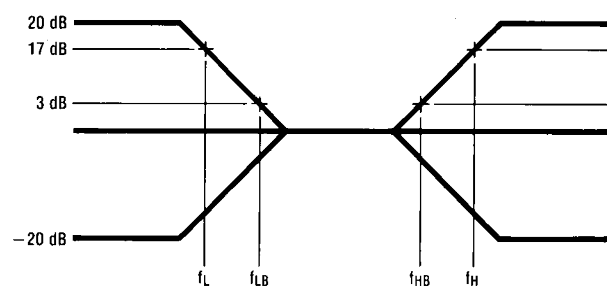
$$f_L = \frac{1}{2\pi R2C1},\ f_{LB} = \frac{1}{2\pi R1C1}$$

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

Illustration is:

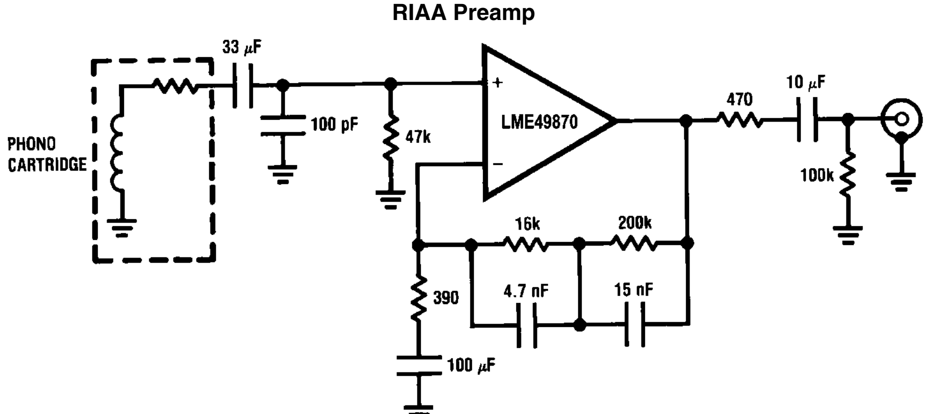
f_L = 32 Hz, f_{LB} = 320 Hz

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



30019442

RIAA Preamp



30019403

A_v = 35 dB

E_n = 0.33 μV

S/N = 90 dB

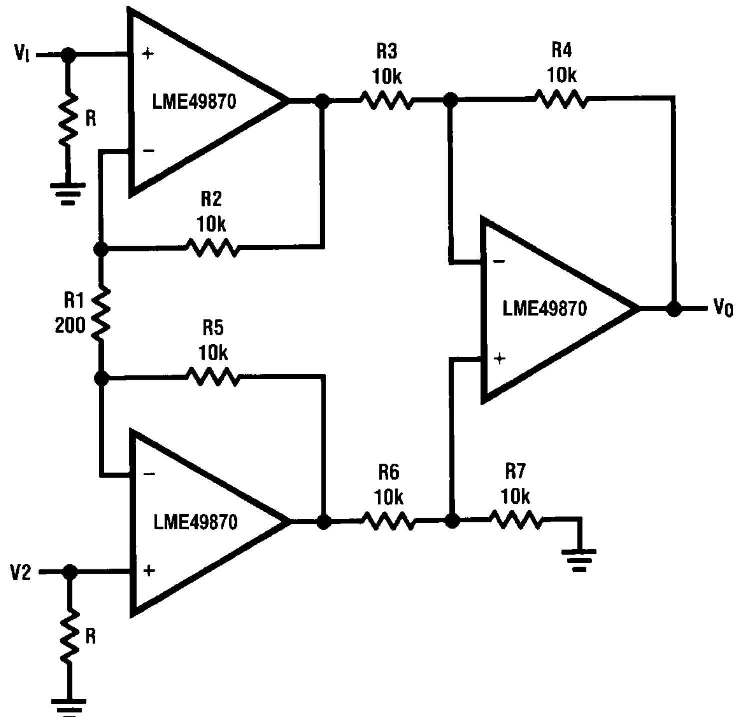
f = 1 kHz

A Weighted

A Weighted, V_{IN} = 10 mV

@f = 1 kHz

Balanced Input Mic Amp



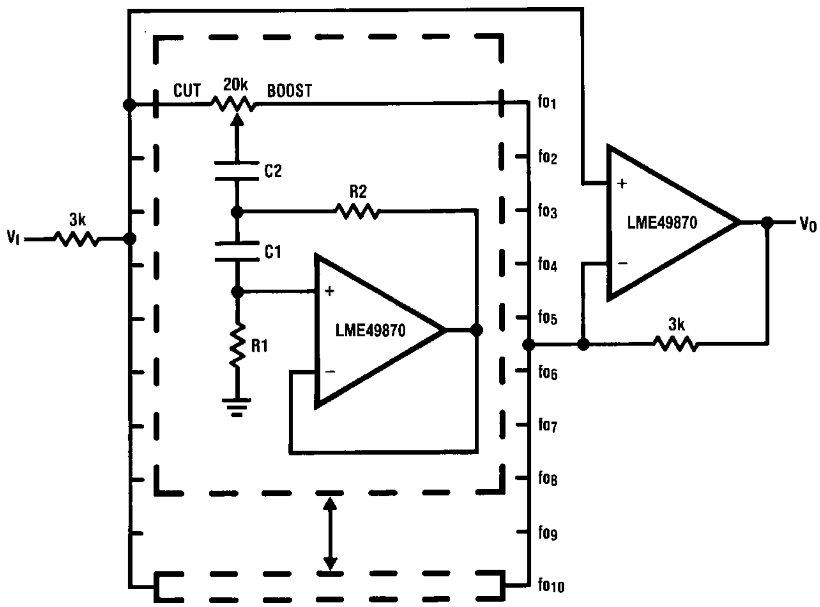
If R2 = R5, R3 = R6, R4 = R7

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

Illustration is:

V0 = 101(V2 – V1)

10 Band Graphic Equalizer



30019444

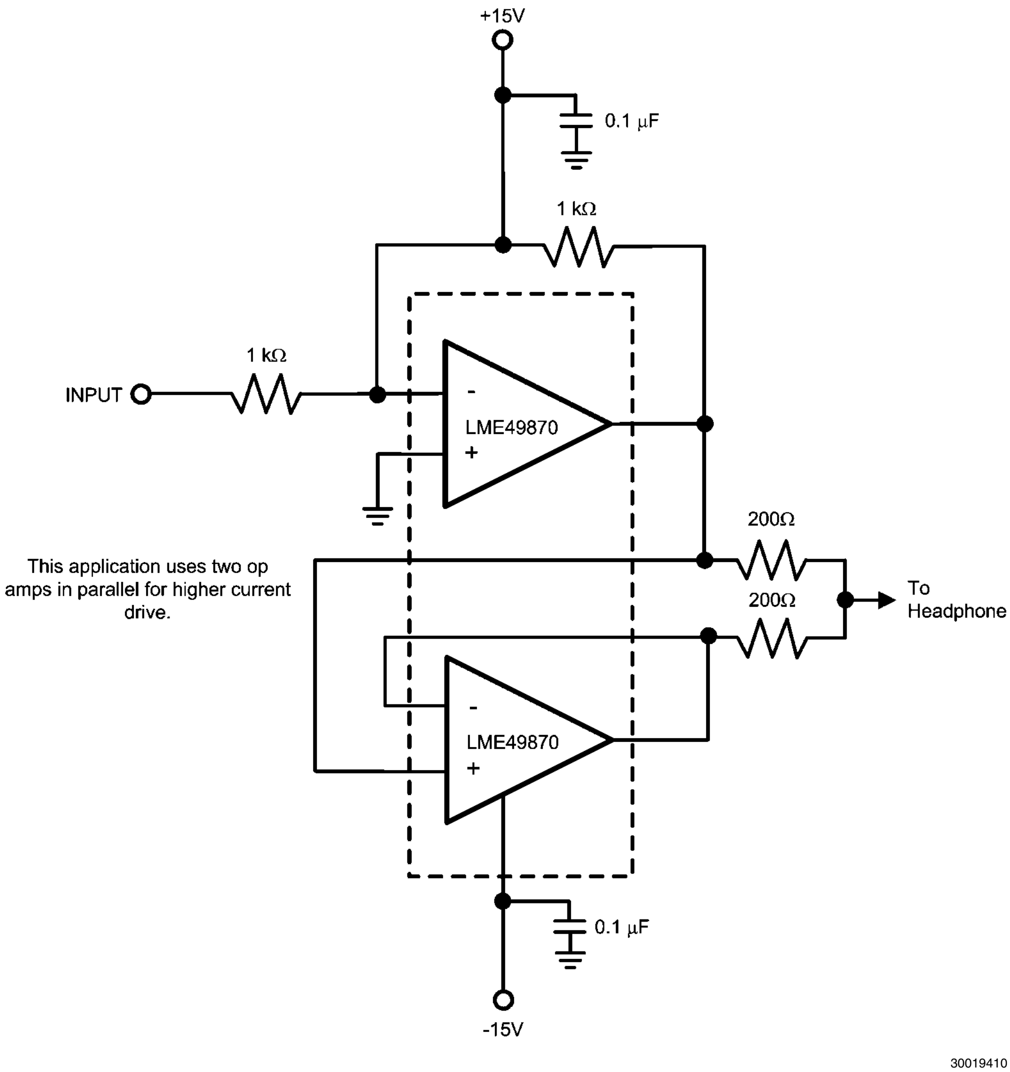
fo (Hz)	C_1	C_2	R_1	R_2
32	0.12μF	4.7μF	75kΩ	500Ω
64	0.056μF	3.3μF	68kΩ	510Ω
125	0.033μF	1.5μF	62kΩ	510Ω
250	0.015μF	0.82μF	68kΩ	470Ω
500	8200pF	0.39μF	62kΩ	470Ω
1k	3900pF	0.22μF	68kΩ	470Ω
2k	2000pF	0.1μF	68kΩ	470Ω
4k	1100pF	0.056μF	62kΩ	470Ω
8k	510pF	0.022μF	68kΩ	510Ω
16k	330pF	0.012μF	51kΩ	510Ω

Note 9: At volume of change = ±12 dB

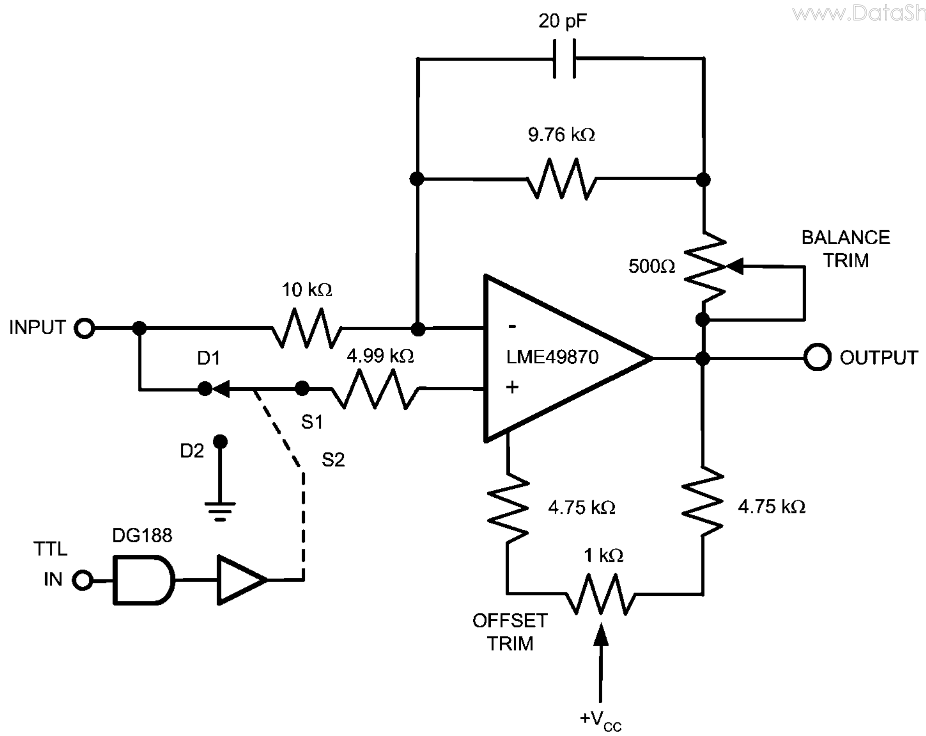
Q = 1.7

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

Headphone Amplifier

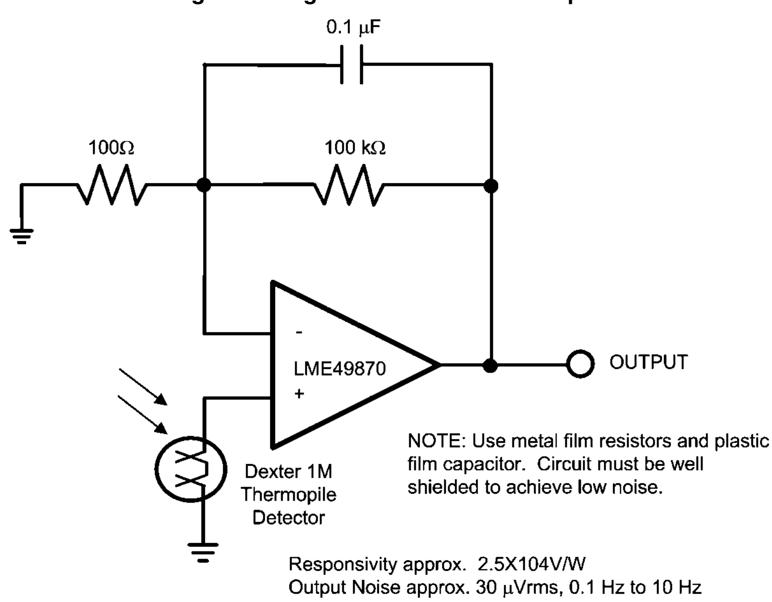


High Performance Synchronous Demodulator



30019411

Long-Wavelength Infrared Detector Amplifier

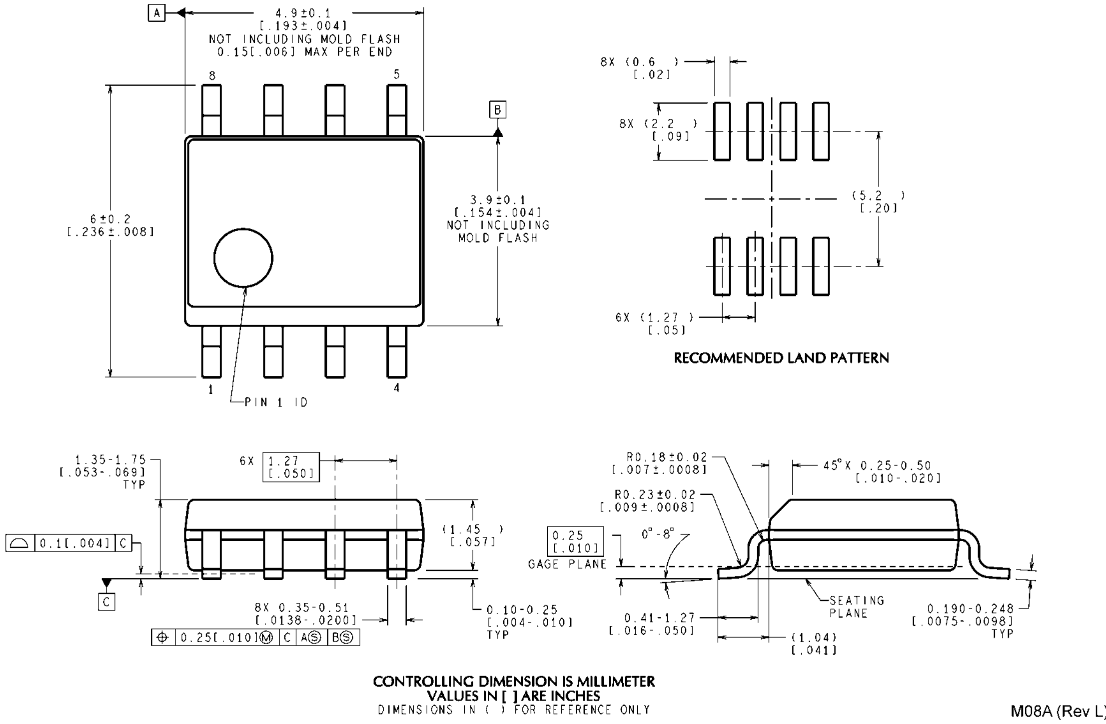


30019412

Revision History

Rev	Date	Description
1.0	09/20/07	Initial release.
1.1	09/27/07	Updated Notes 1–7 (per National standard).
1.2	12/20/07	Deleted all Crosstalk vs Frequency curves.
1.3	01/14/08	Edited some graphics.

Physical Dimensions inches (millimeters) unless otherwise noted



Narrow SOIC Package
Order Number LME49870MA
NS Package Number M08A

Notes

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH	www.national.com/webench
Audio	www.national.com/audio	Analog University	www.national.com/AU
Clock Conditioners	www.national.com/timing	App Notes	www.national.com/appnotes
Data Converters	www.national.com/adc	Distributors	www.national.com/contacts
Displays	www.national.com/displays	Green Compliance	www.national.com/quality/green
Ethernet	www.national.com/ethernet	Packaging	www.national.com/packaging
Interface	www.national.com/interface	Quality and Reliability	www.national.com/quality
LVDS	www.national.com/lvds	Reference Designs	www.national.com/refdesigns
Power Management	www.national.com/power	Feedback	www.national.com/feedback
Switching Regulators	www.national.com/switchers		
LDOs	www.national.com/ldo		
LED Lighting	www.national.com/led		
PowerWise	www.national.com/powerwise		
Serial Digital Interface (SDI)	www.national.com/sdi		
Temperature Sensors	www.national.com/tempsensors		
Wireless (PLL/VCO)	www.national.com/wireless		

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

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

National Semiconductor Europe Technical Support Center
Email: europe.support@nsc.com
German Tel: +49 (0) 180 5010 771
English Tel: +44 (0) 870 850 4288

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

National Semiconductor Japan Technical Support Center
Email: jpn.feedback@nsc.com