LME49710

LME49710 High Performance, High Fidelity Audio Operational Amplifier

Literature Number: SNAS376B

National Semiconductor

March 2007

LME49710
High Performance, High Fidelity Audio Operational Amplifier

General Description

The LME49710 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 LME49710 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LME49710 combines extremely low voltage noise density ($2.5nV/\sqrt{Hz}$) 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 LME49710 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 LME49710's outstanding CMRR(120dB), PSRR(120dB), and V_{OS} (0.05mV) give the amplifier excellent operational amplifier DC performance.

The LME49710 has a wide supply range of ±2.5V to ±17V. Over this supply range the LME49710's input circuitry maintains excellent common-mode and power supply rejection, as well as maintaining its low input bias current. The LME49710 is unity gain stable. The Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LME49710 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 ($A_V = 1$, $V_{OUT} = 3V_{RMS}$, $f_{IN} = 1kHz$)	
$R_L = 2k\Omega$	0.00003% (typ)
$R_L = 600\Omega$	0.00003% (typ)
■ Input Noise Density	$2.5nV/\sqrt{Hz}$ (typ)
■ Slew Rate	±20V/μs (typ)
■ Gain Bandwidth Product	55MHz (typ)
■ Open Loop Gain ($R_L = 600\Omega$)	140dB (typ)
■ Input Bias Current	7nA (typ)
■ Input Offset Voltage	0.05mV (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

 202104

Typical Application

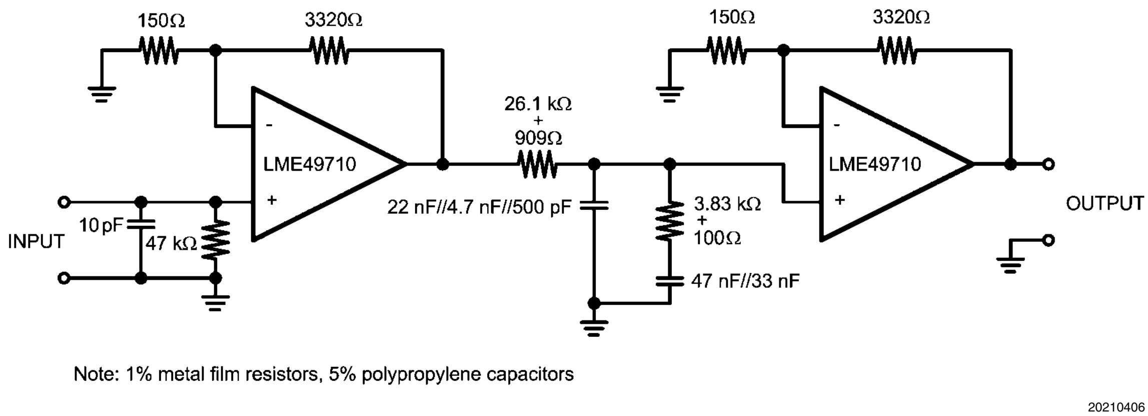
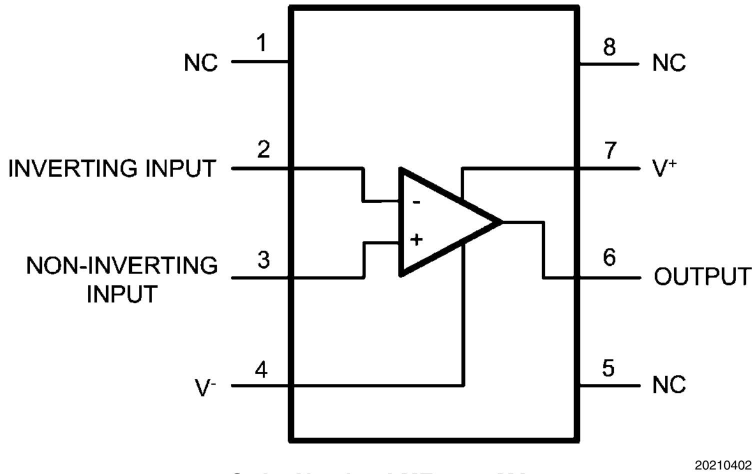


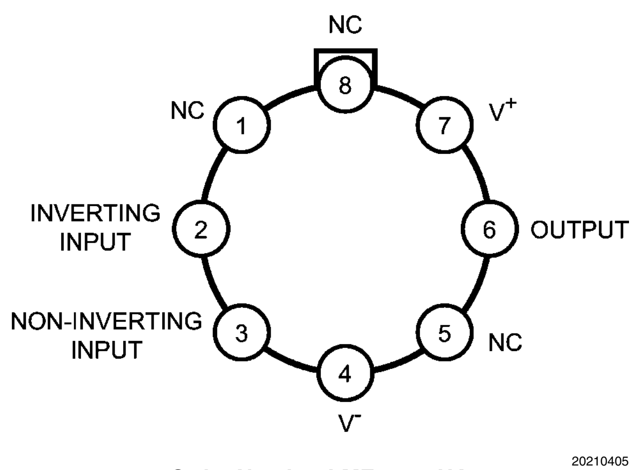
FIGURE 1. Passively Equalized RIAA Phono Preamplifier

Connection Diagrams



Order Number LME49710MA
See NS Package Number — M08A
Order Number LME49710NA
See NS Package Number — N08E

Metal Can



Order Number LME49710HA
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)	200V
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	$\pm 2.5V \le V_S \le \pm 17V$

Electrical Characteristics (Notes 1, 2)

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

Symbol	Parameter	Conditions	LME49710 Typical (Note 6)	LME49710 Limit (Notes 7, 8)	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) % (max)
IMD	Intermodulation Distortion	A_V = 1, V_{OUT} = 3V_{RMS} Two-tone, 60Hz & 7kHz 4:1	0.00005		% (max)
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}
	Equivalent Input Noise Density	f = 1kHz f = 10Hz	2.5 6.4	4.7	$nV/\sqrt{Hz}$ $nV/\sqrt{Hz}$
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		$pA/\sqrt{Hz}$ $pA/\sqrt{Hz}$
V_{OS}	Offset Voltage		±0.05	±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 9)	125	110	dB (min)
I_B	Input Bias Current	V_{CM} = 0V	7	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	5	65	nA (max)
V_{IN-CM}	Common-Mode Input Voltage Range		+14.1 –13.9	(V+) – 2.0 (V-) + 2.0	V (min) V (min)
CMRR	Common-Mode Rejection	$-10V<V_{CM}<10V$	120	110	dB (min)
Z_{IN}	Differential Input Impedance		30		kΩ
	Common Mode Input Impedance	$-10V<V_{CM}<10V$	1000		MΩ
A_{VOL}	Open Loop Voltage Gain	$-10V<V_{OUT}<10V$, R_L = 600Ω	140		dB
		$-10V<V_{OUT}<10V$, R_L = 2kΩ	140	125	dB
		$-10V<V_{OUT}<10V$, R_L = 10kΩ	140		dB

Symbol	Parameter	Conditions	LME49710		Units (Limits)
			Typical	Limit	
			(Note 6)	(Notes 7, 8)	
V_{OUTMAX}	Maximum Output Voltage Swing	R_L = 600Ω	±13.6	±12.5	V
		R_L = 2kΩ	±14.0		V
		R_L = 10kΩ	±14.1		V
I_{OUT}	Output Current	R_L = 600Ω, V_S = ±17V	±26	±23	mA (min)
I_{OUT-CC}	Short Circuit Current		+53 –42		mA mA
R_{OUT}	Output Impedance	f_{IN} = 10kHz Closed-Loop Open-Loop	 0.01 13		 Ω Ω
C_{LOAD}	Capacitive Load Drive Overshoot	100pF	16		%
I_S	Quiescent Current	I_{OUT} = 0mA	4.8	5.5	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.

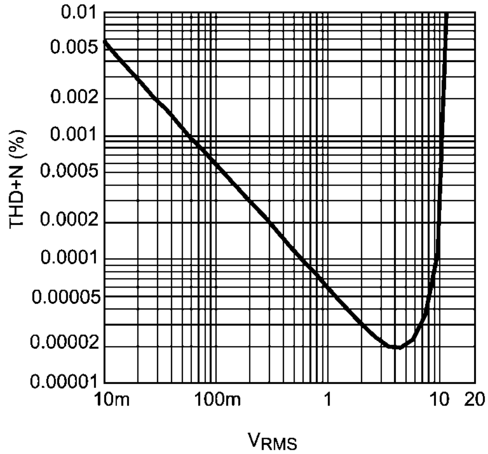
Note 7: Tested limits are guaranteed to National's AOQL (Average Outgoing Quality Level).

Note 8: Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

Note 9: PSRR is measured as follows: V_{OS} is measured at two supply voltages, ±5V and ±15V. PSRR = $|20\log(\Delta V_{OS}/\Delta V_S)|$.

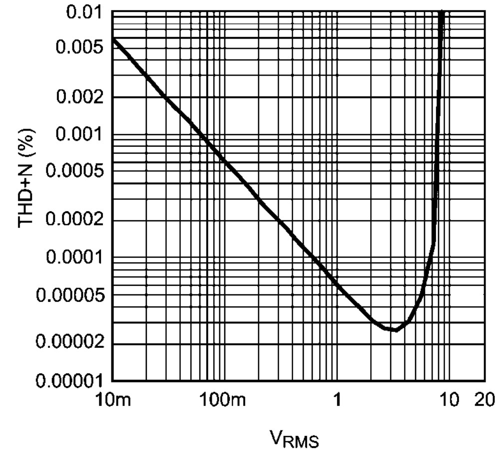
Typical Performance Characteristics

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



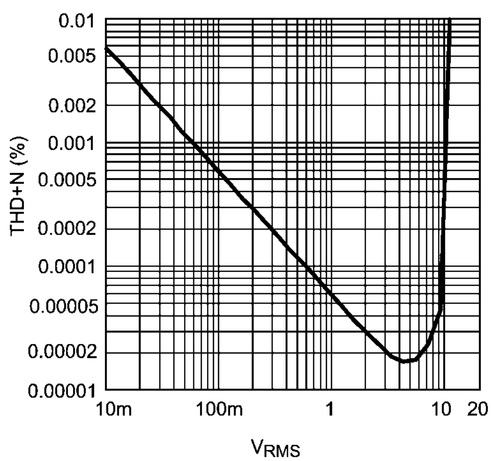
20210476

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



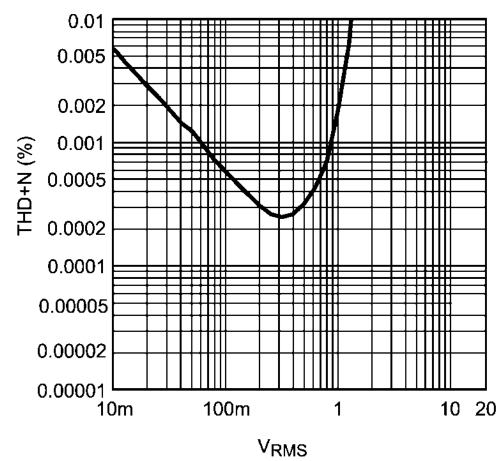
20210473

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



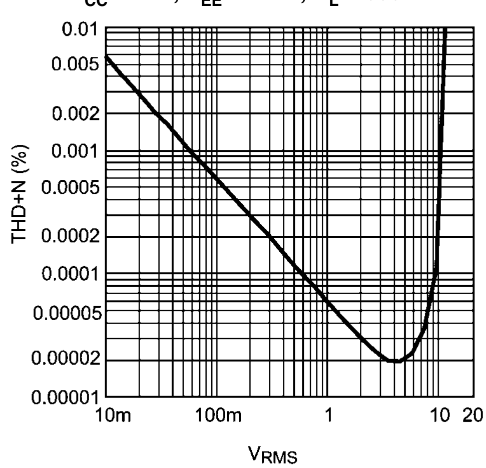
20210479

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



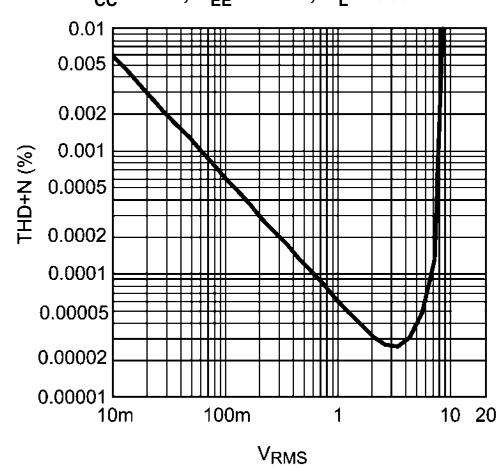
20210470

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



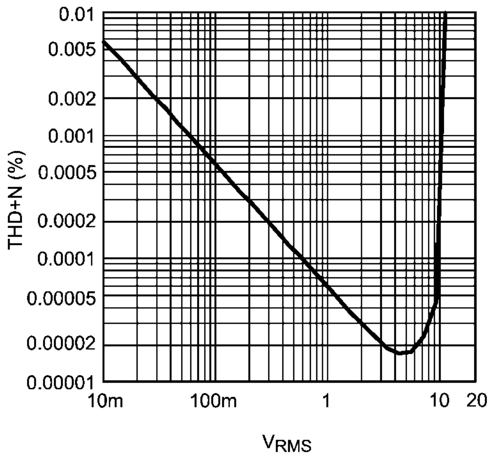
20210478

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



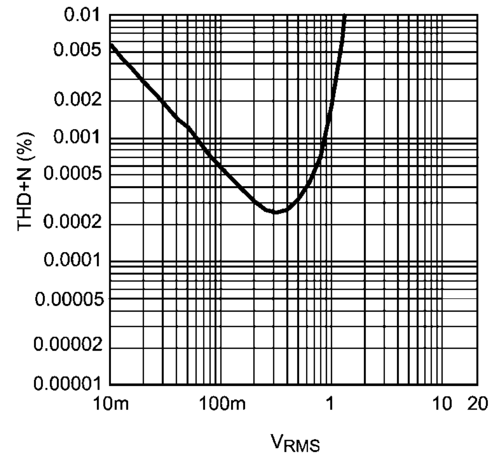
20210475

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



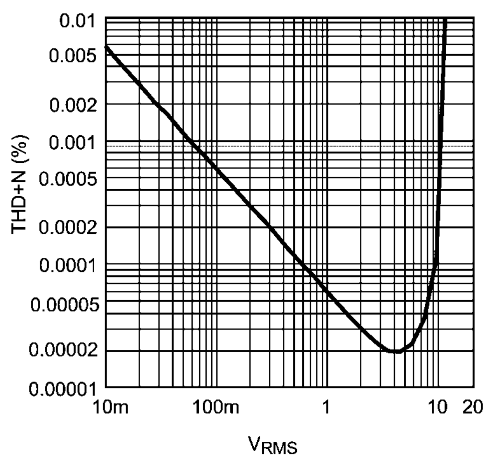
20210481

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



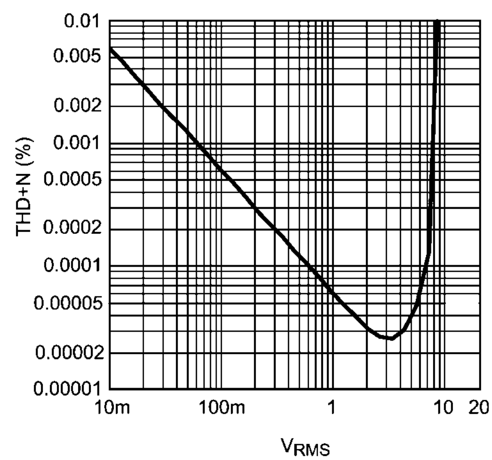
20210472

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



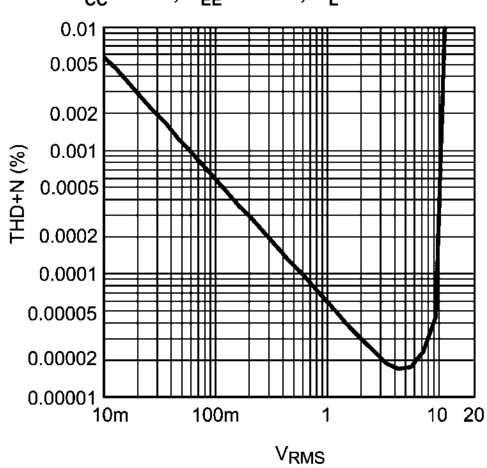
20210477

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



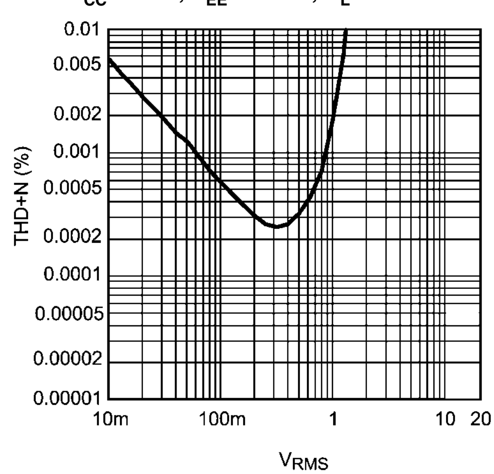
20210474

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



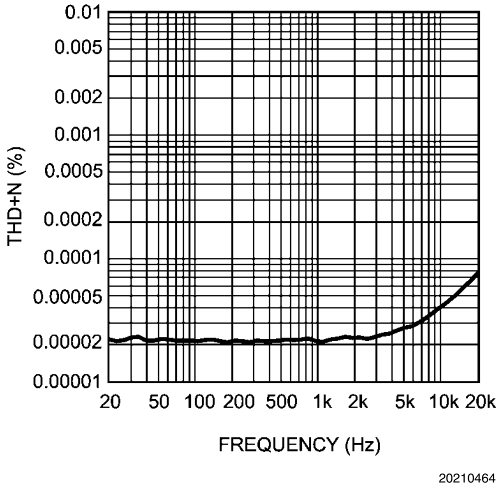
20210480

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

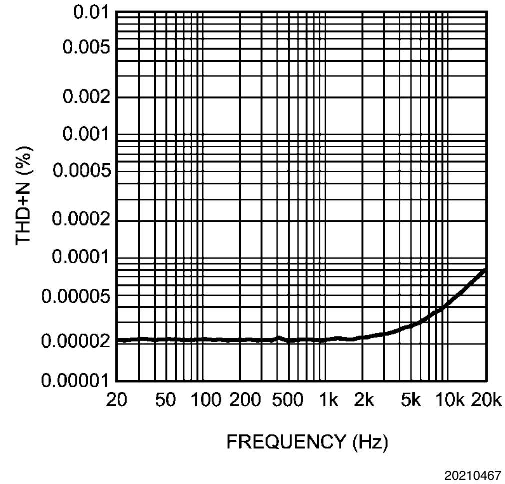


20210471

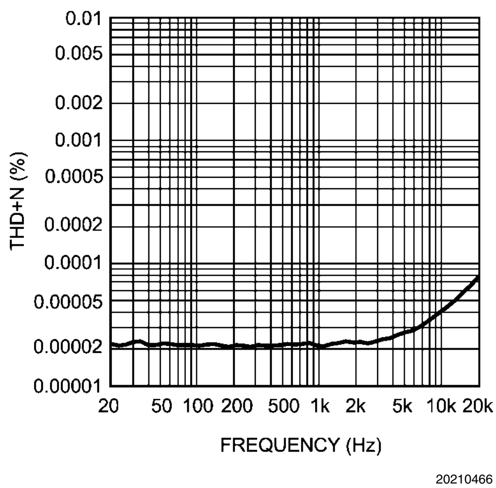
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 2kΩ, V_{OUT} = $3V_{RMS}$



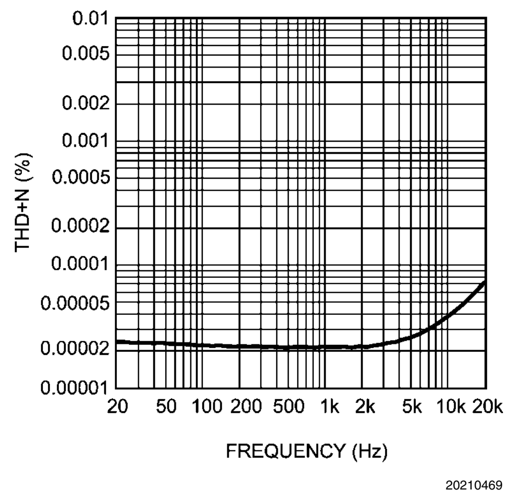
THD+N vs Frequency
V_{CC} = 17V, V_{EE} = –17V,
R_L = 2kΩ, V_{OUT} = $3V_{RMS}$



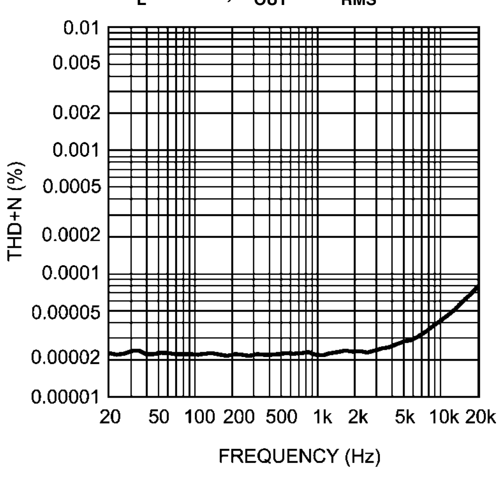
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 600Ω, V_{OUT} = $3V_{RMS}$



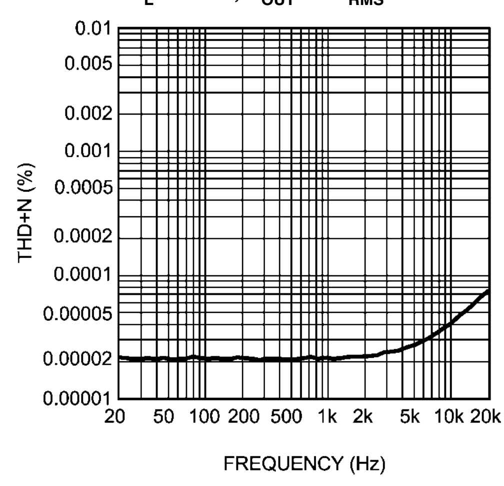
THD+N vs Frequency
V_{CC} = 17V, V_{EE} = –17V,
R_L = 600Ω, V_{OUT} = $3V_{RMS}$



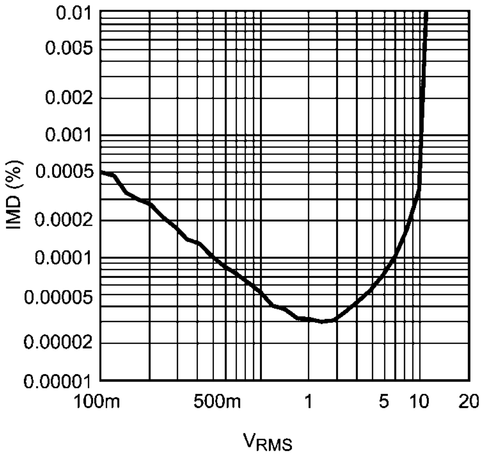
THD+N vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 10kΩ, V_{OUT} = $3V_{RMS}$



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

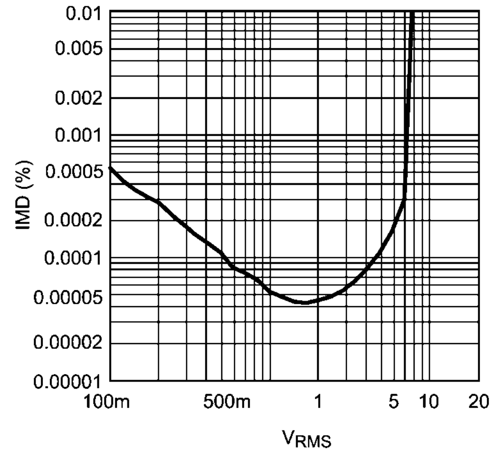


IMD vs Output Voltage
V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ



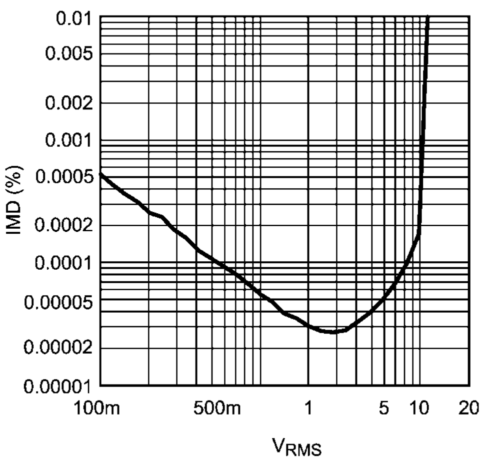
20210414

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



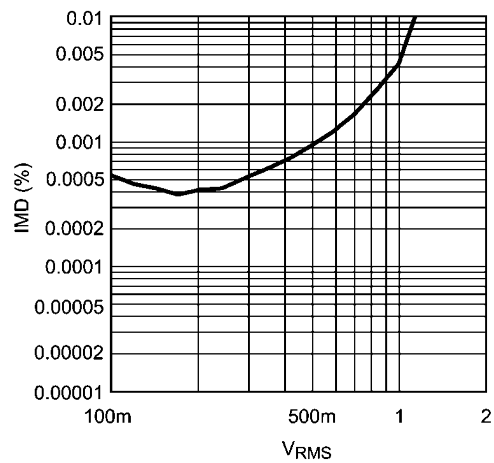
20210411

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



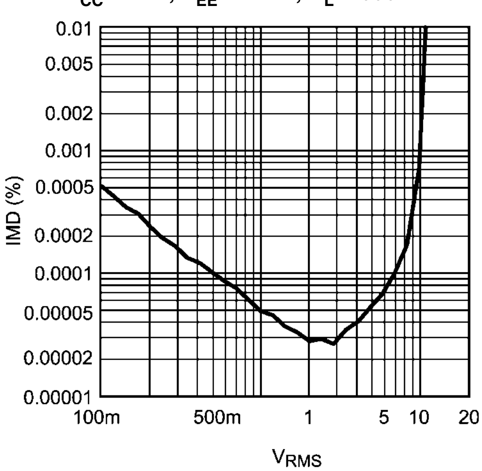
20210417

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



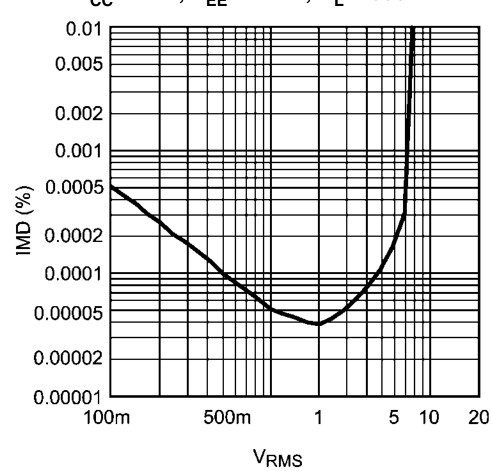
20210408

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



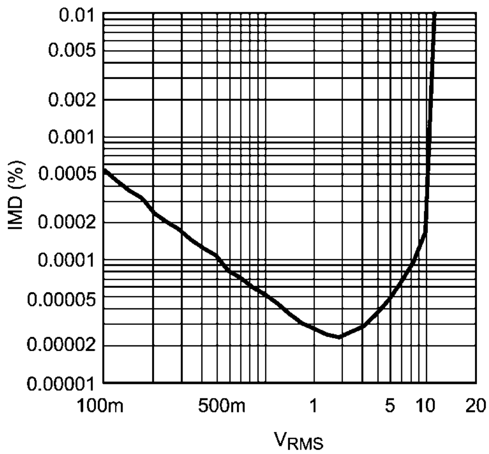
20210416

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



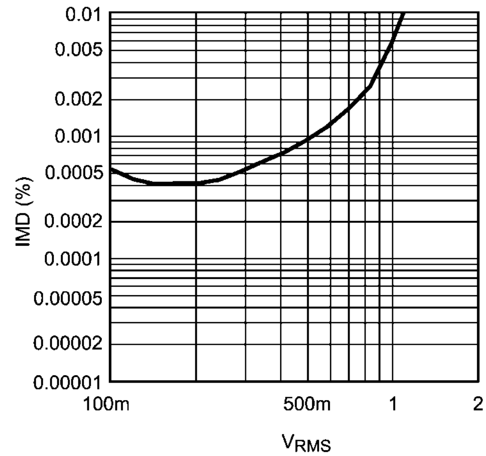
20210413

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



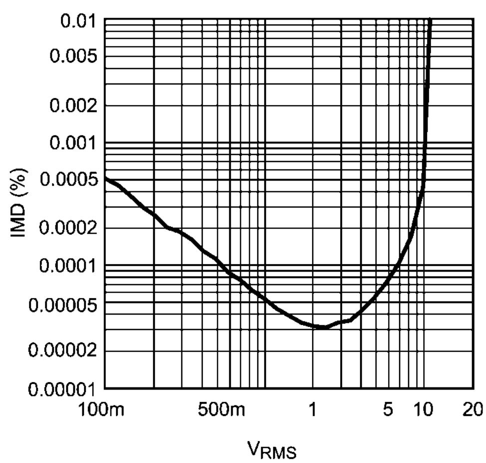
20210419

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



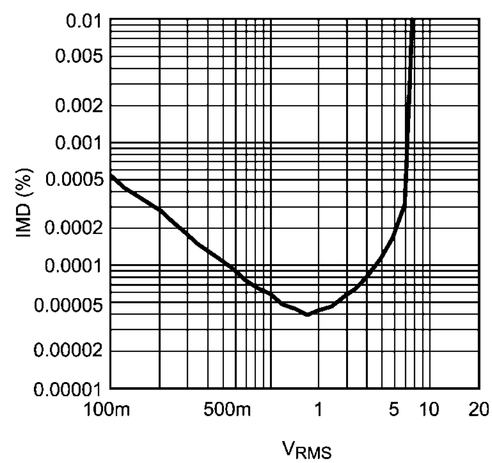
20210410

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



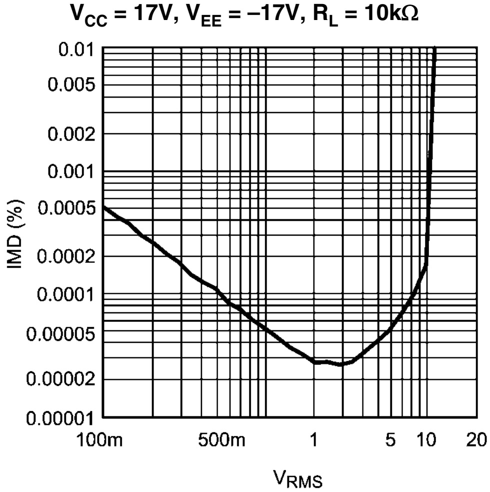
20210415

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



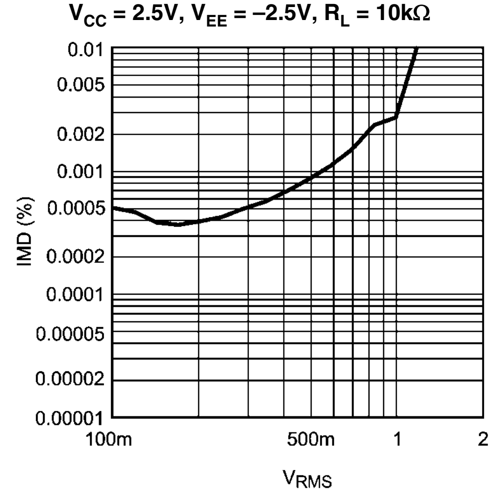
20210412

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



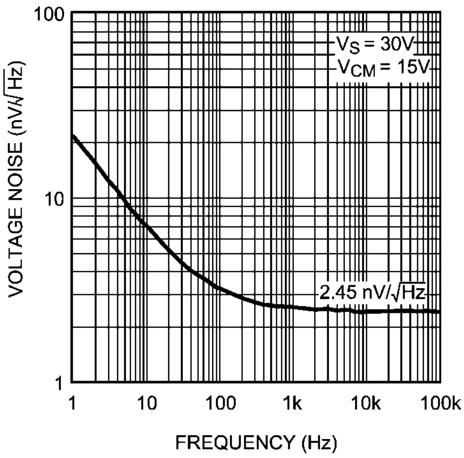
20210418

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



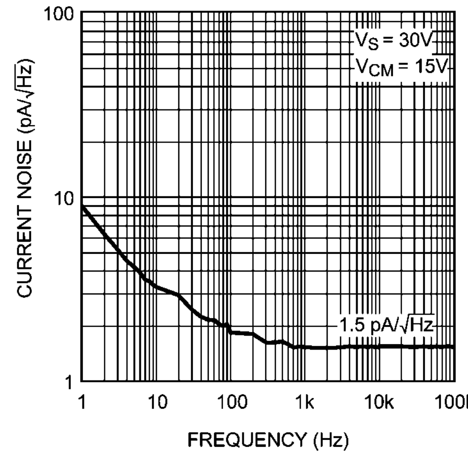
20210409

Voltage Noise Density vs Frequency



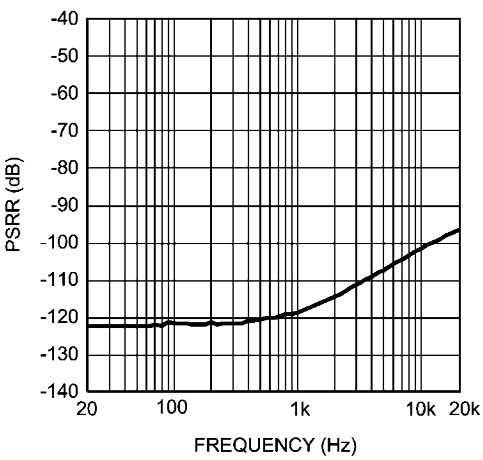
20210490

Current Noise Density vs Frequency



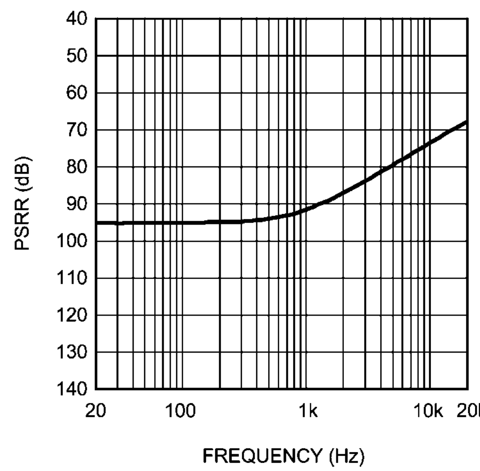
20210489

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



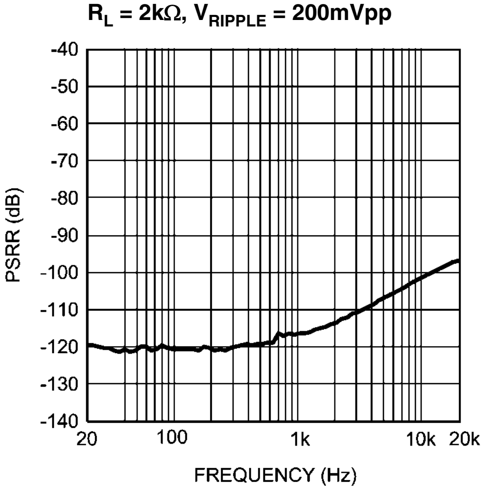
20210491

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



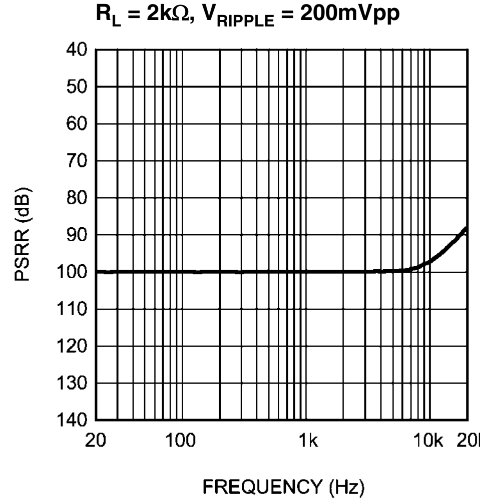
20210420

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



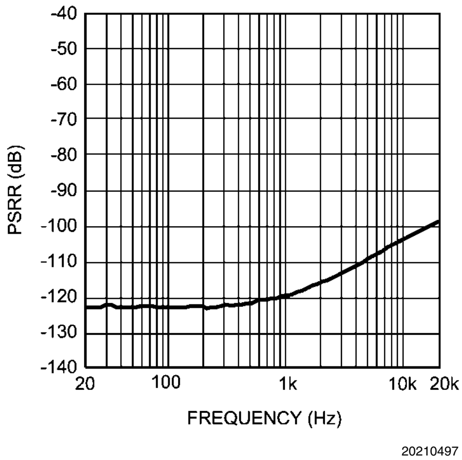
20210494

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

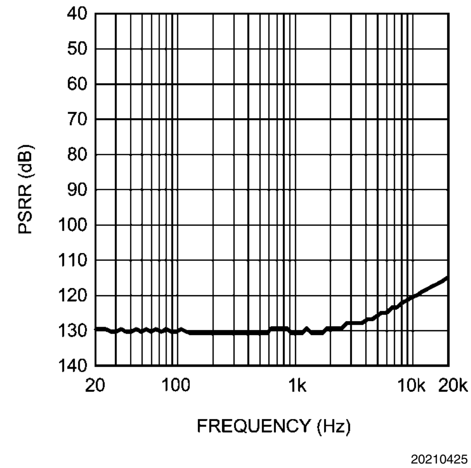


20210455

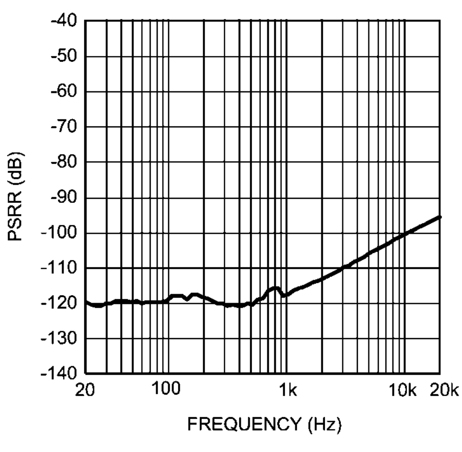
PSRR+ vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ, V_{RIPPLE} = 200mVpp



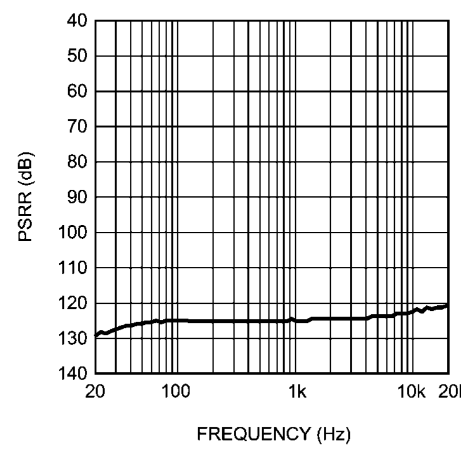
PSRR- vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ, V_{RIPPLE} = 200mVpp



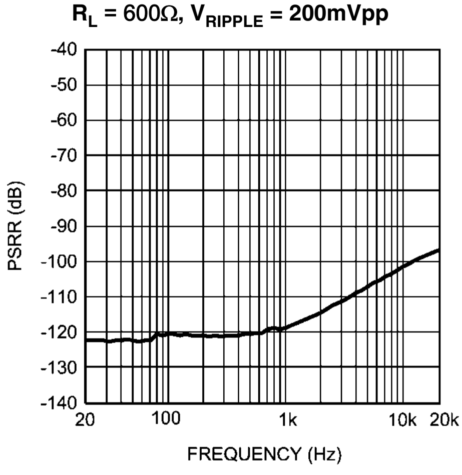
PSRR+ vs Frequency
V_{CC} = 17V, V_{EE} = –17V, R_L = 2kΩ, V_{RIPPLE} = 200mVpp



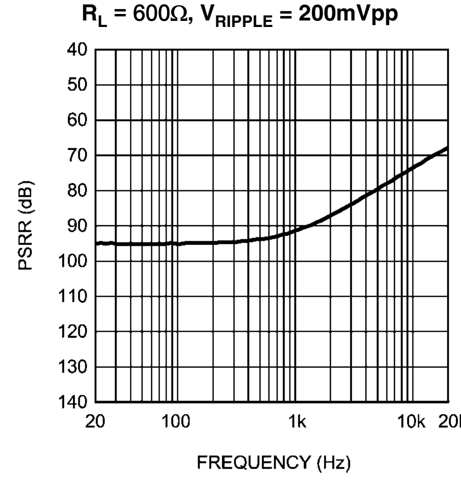
PSRR- vs Frequency
V_{CC} = 17V, V_{EE} = –17V, R_L = 2kΩ, V_{RIPPLE} = 200mVpp



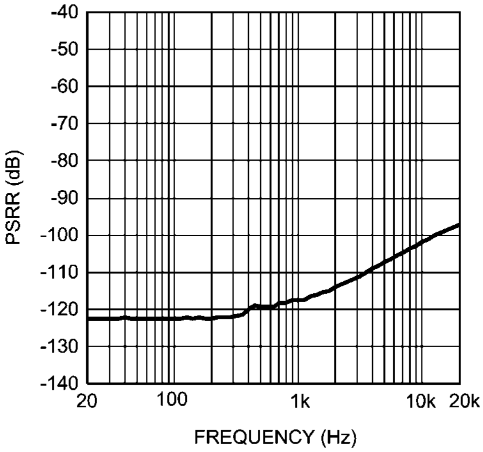
PSRR+ vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, R_L = 600Ω, V_{RIPPLE} = 200mVpp



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

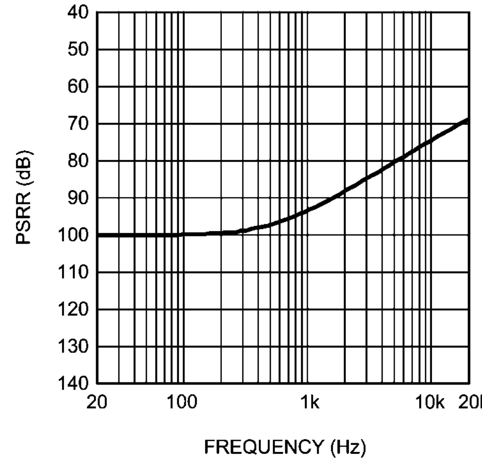


PSRR+ vs Frequency
V_{CC} = 12V, V_{EE} = –12V,
R_L = 600Ω, V_{RIPPLE} = 200mVpp



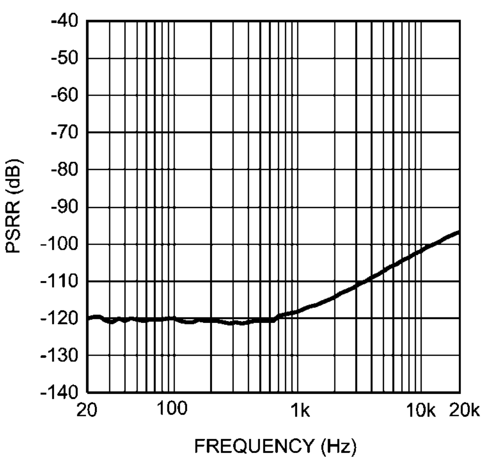
20210496

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



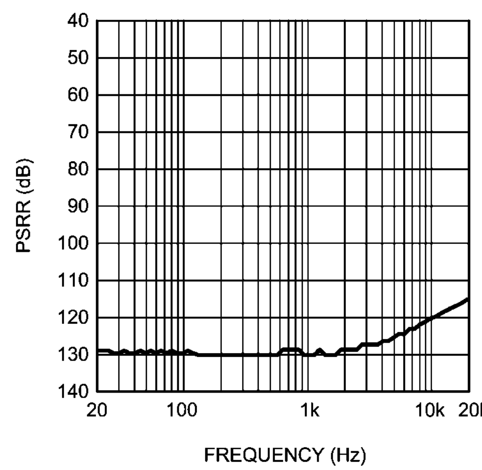
20210424

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



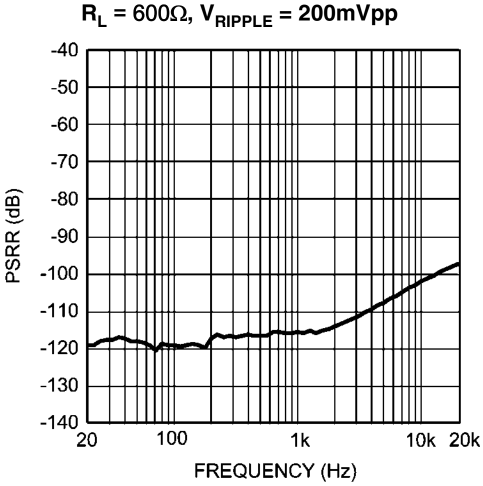
20210499

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



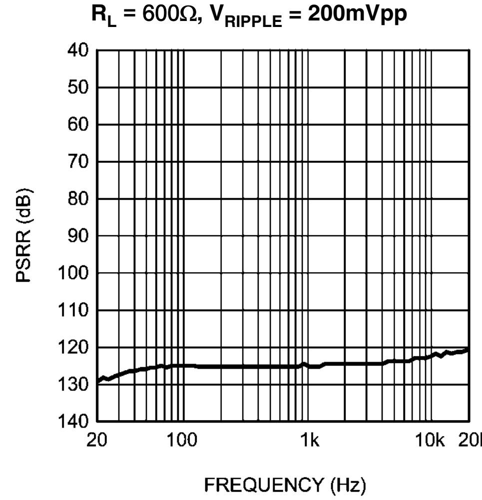
20210451

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



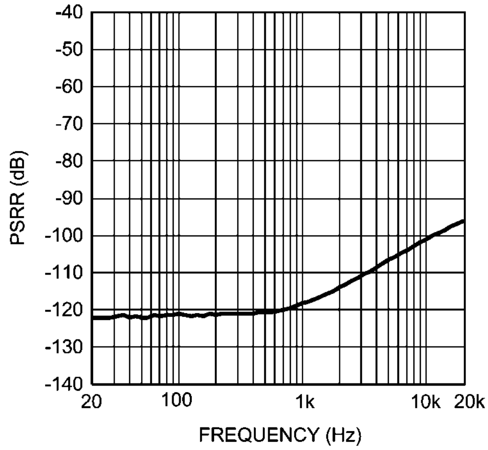
202104a2

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



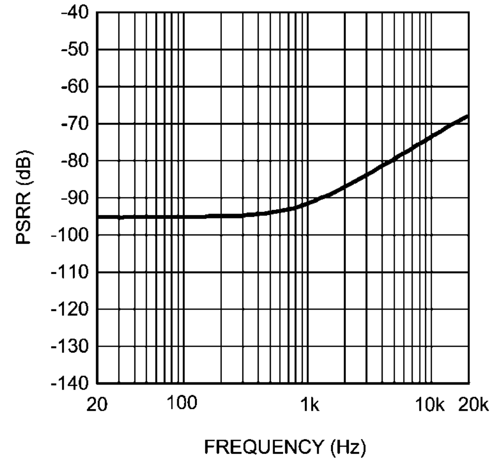
20210444

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



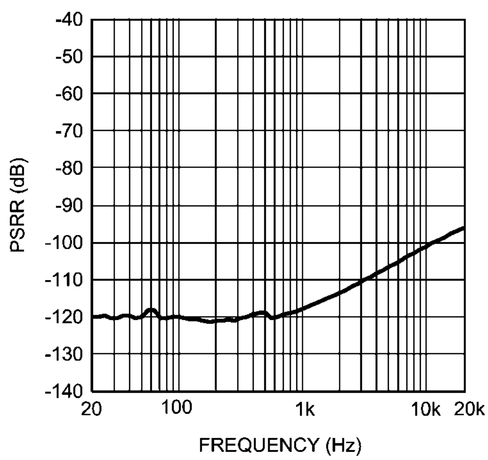
20210492

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



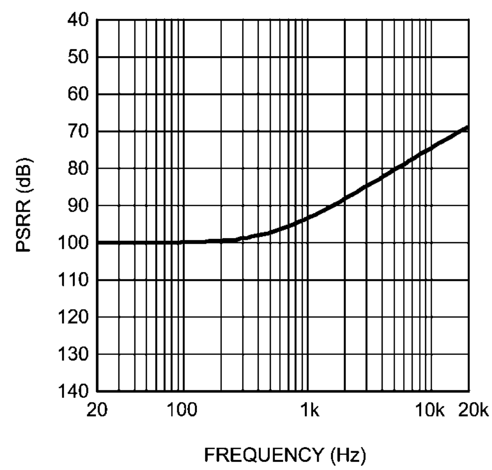
20210488

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



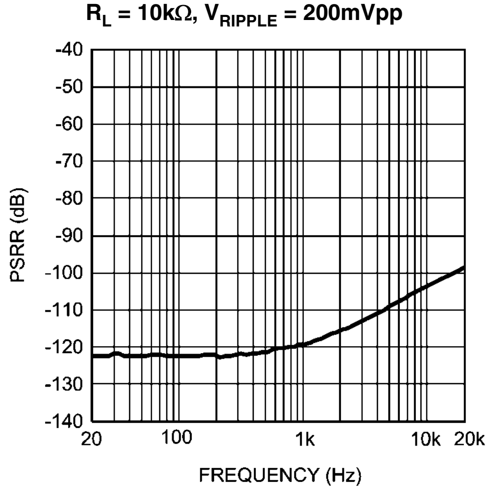
20210495

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



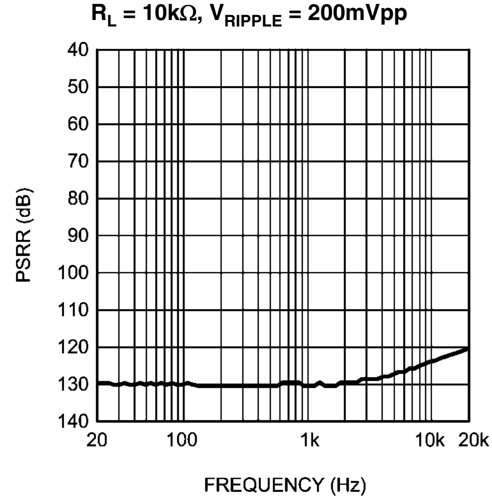
20210423

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



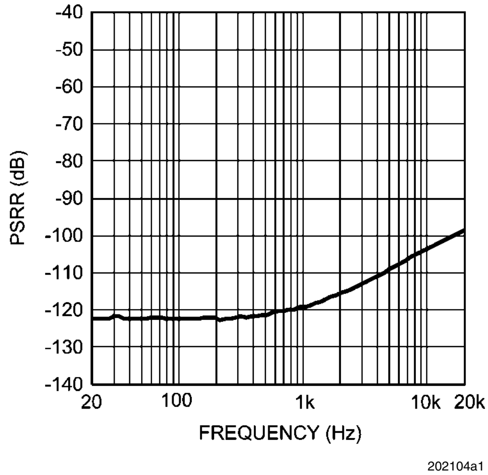
20210498

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

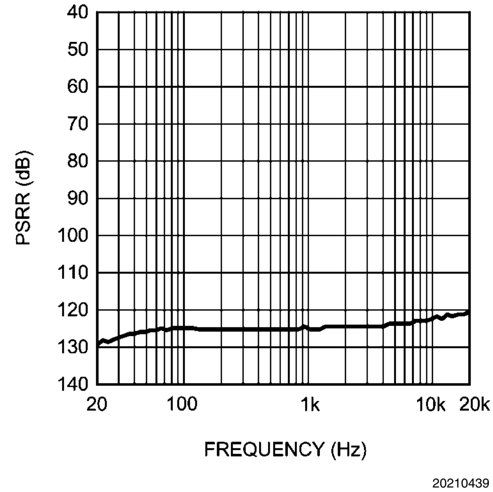


20210426

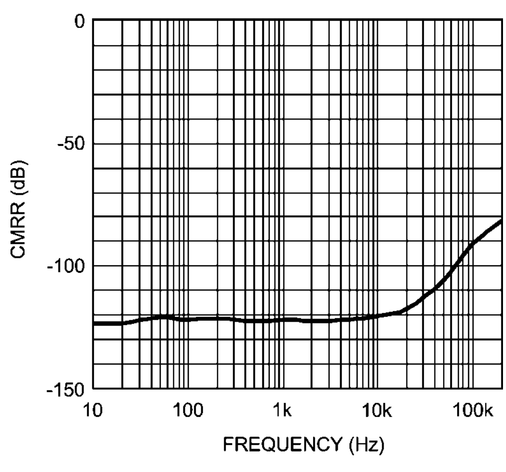
PSRR+ vs Frequency
V_{CC} = 17V, V_{EE} = –17V,
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



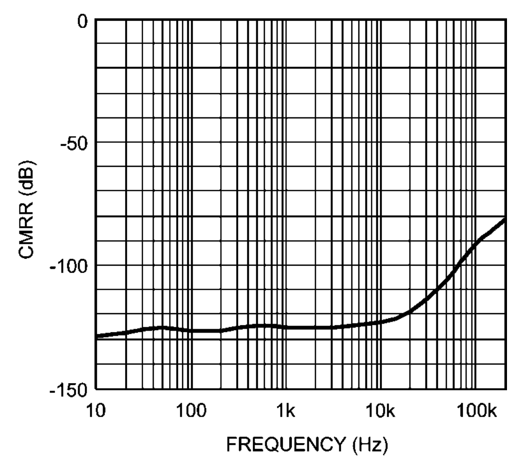
PSRR- vs Frequency
V_{CC} = 17V, V_{EE} = –17V,
R_L = 10kΩ, V_{RIPPLE} = 200mVpp



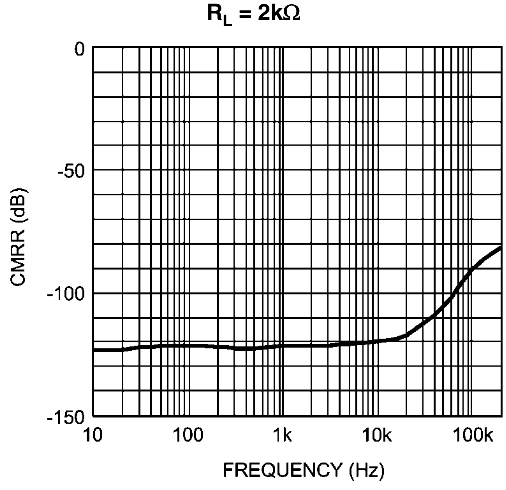
CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 2kΩ



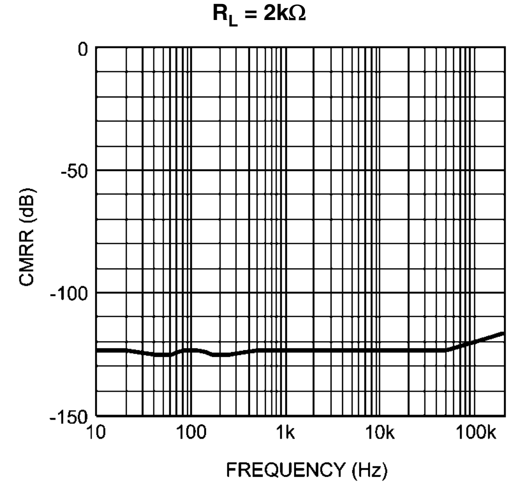
CMRR vs Frequency
V_{CC} = 12V, V_{EE} = –12V,
R_L = 2kΩ



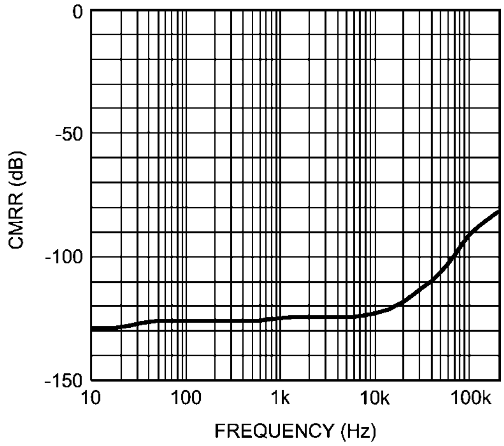
CMRR vs Frequency
V_{CC} = 17V, V_{EE} = –17V,
R_L = 2kΩ



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

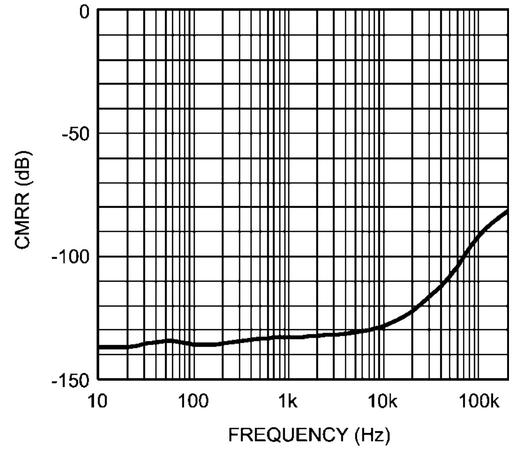


CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 600Ω



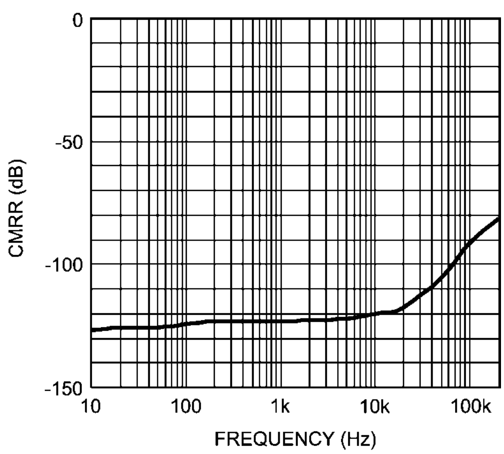
202104b3

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



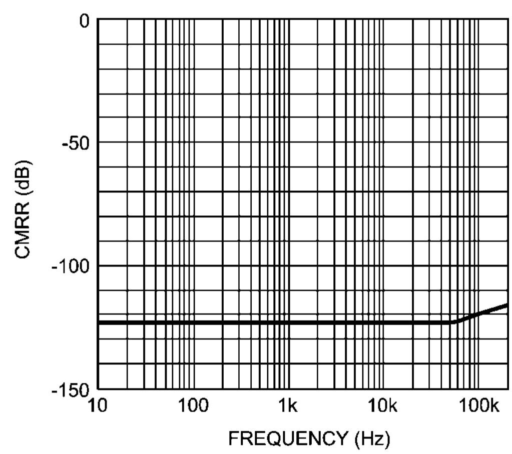
202104b0

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



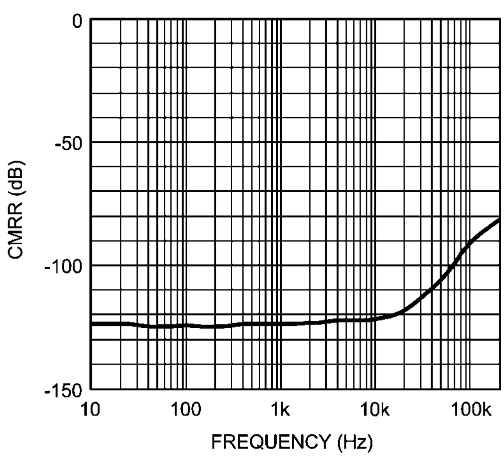
202104b6

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



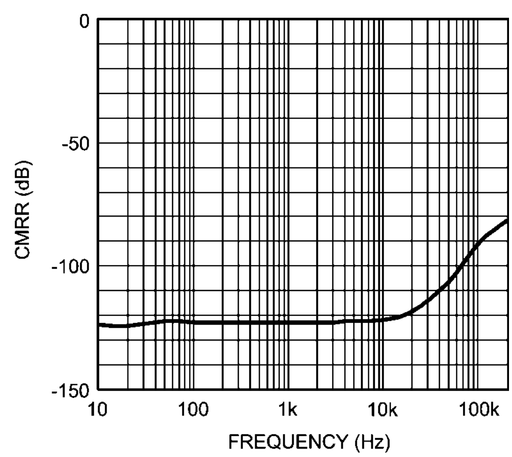
202104a7

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



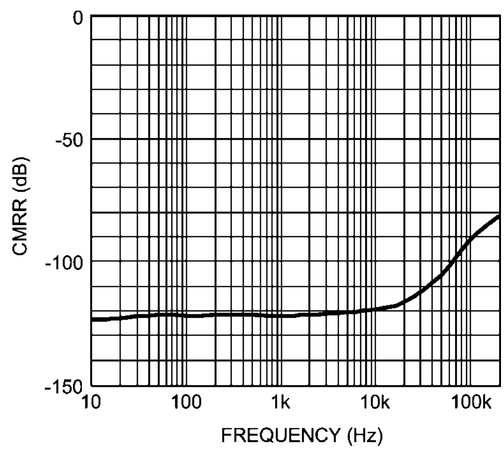
202104b2

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



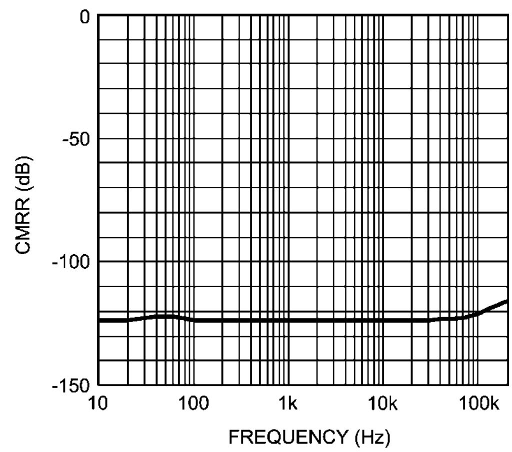
202104a9

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



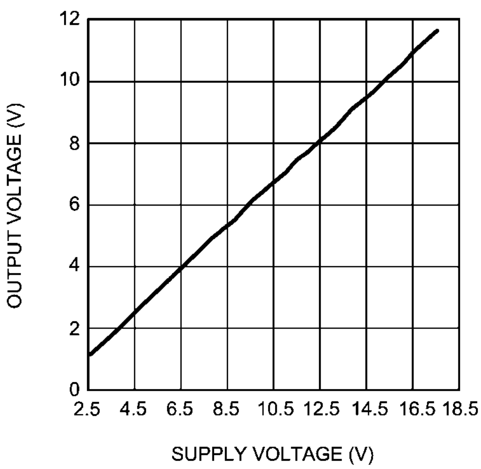
202104b5

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



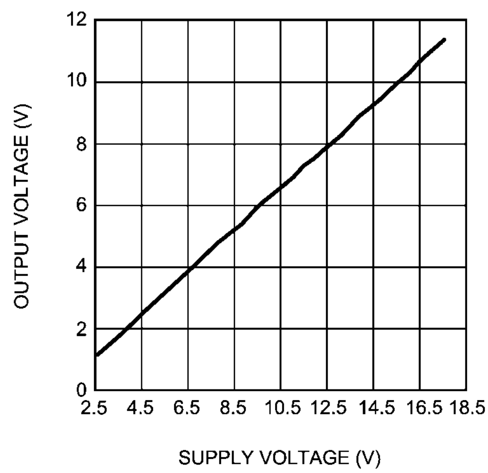
202104a6

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



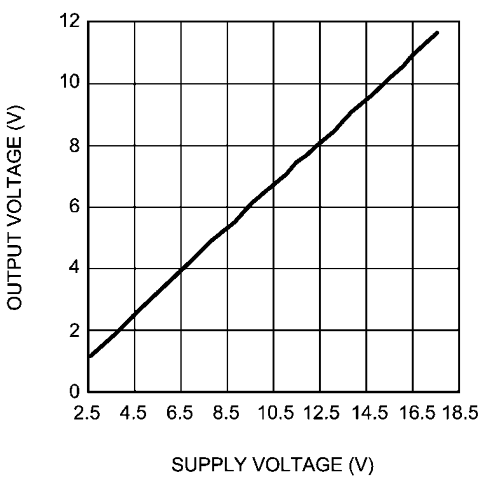
20210485

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



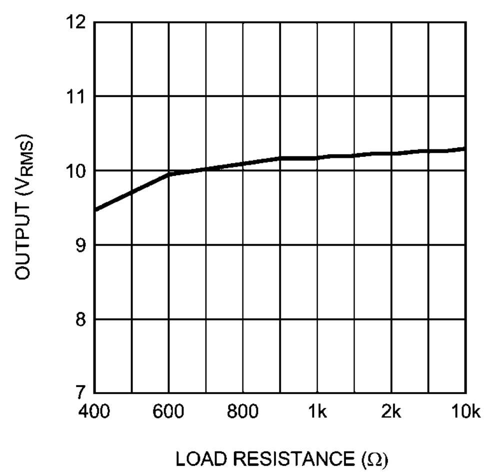
20210487

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



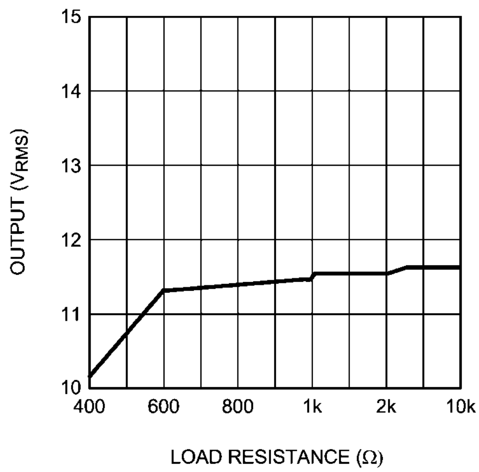
20210486

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



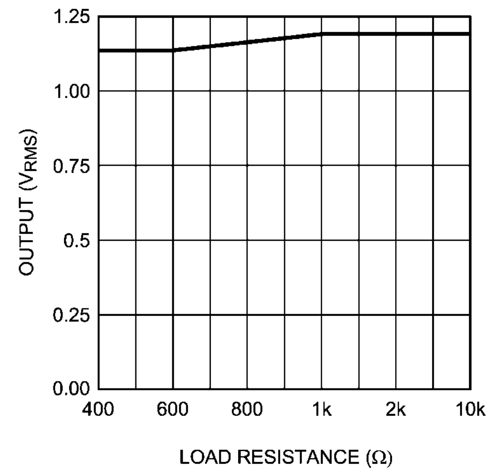
20210483

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



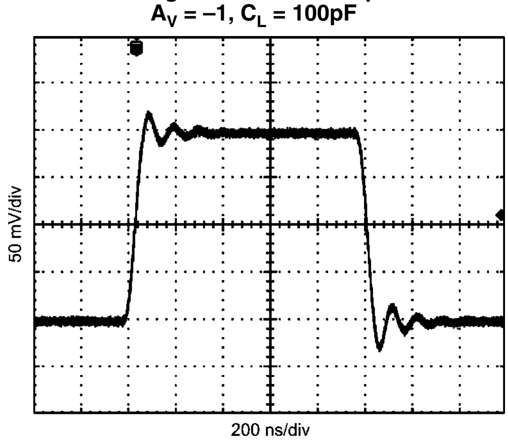
20210484

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



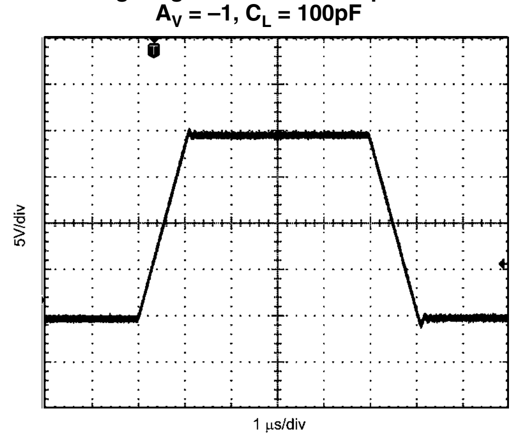
20210482

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



202104a4

Large-Signal Transient Response
A_V = –1, C_L = 100pF



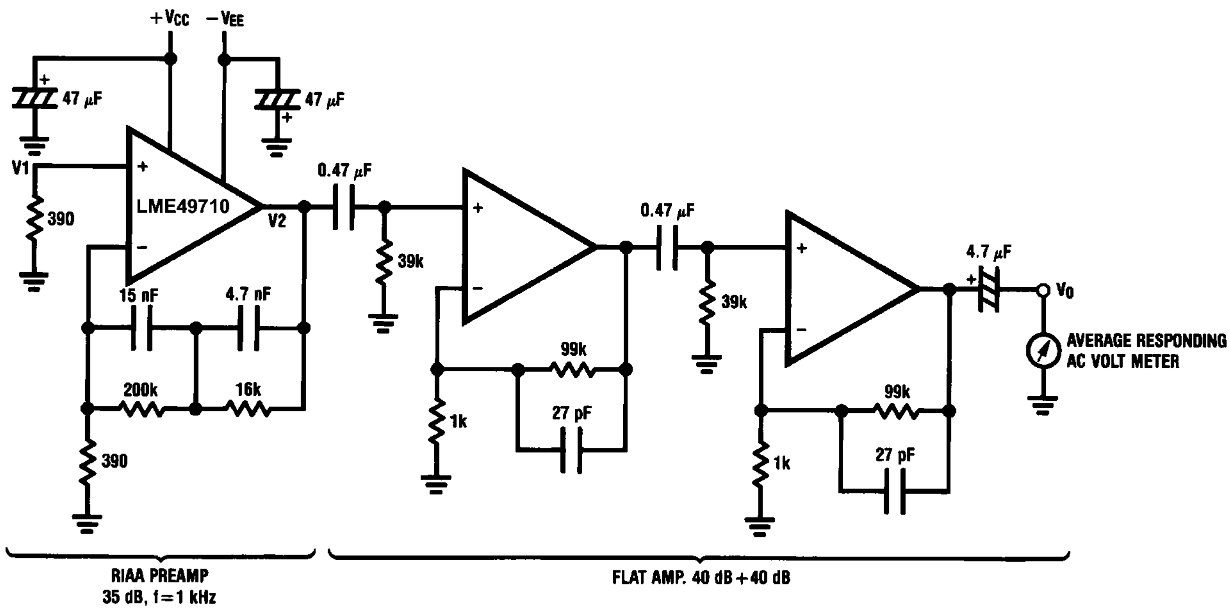
202104a3

Application Hints

The LME49710 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 straight forward 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.

Noise Measurement Circuit



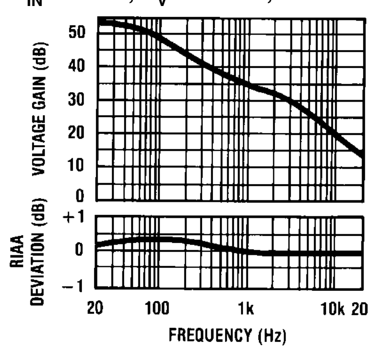
20210427

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

Total Gain: 115 dB at f = 1 kHz

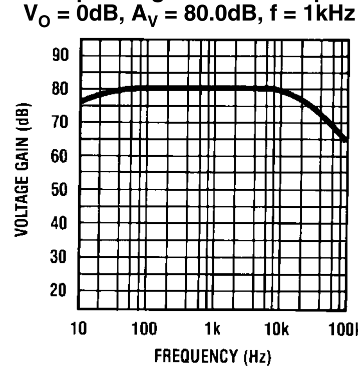
Input Referred Noise Voltage: $e_n = V_O/560{,}000$ (V)

RIAA Preamp Voltage Gain
RIAA Deviation vs Frequency
V_{IN} = 10mV, A_V = 35.0dB, f = 1kHz



20210428

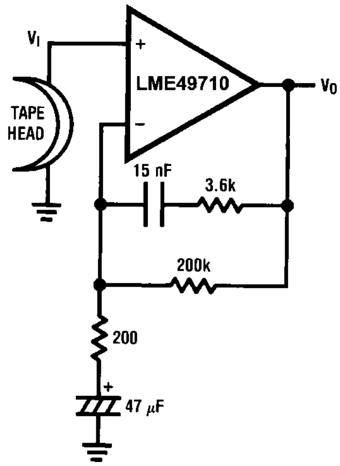
Flat Amp Voltage Gain vs Frequency
V_O = 0dB, A_V = 80.0dB, f = 1kHz



20210429

Typical Applications

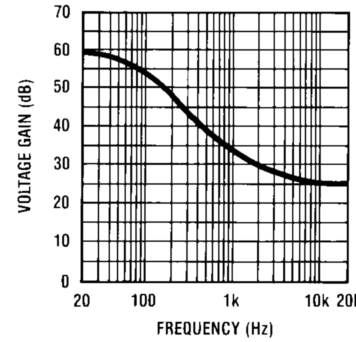
NAB Preamp



20210430

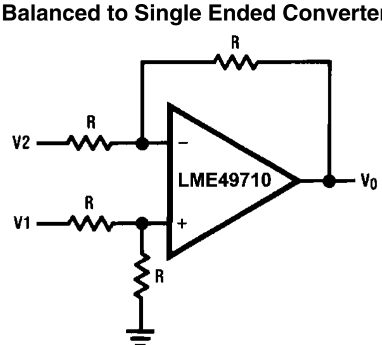
$A_V = 34.5$
F = 1 kHz
$E_n = 0.38\ \mu V$
A Weighted

NAB Preamp Voltage Gain vs Frequency
V_{IN} = 10mV, 34.5dB, f = 1kHz



20210431

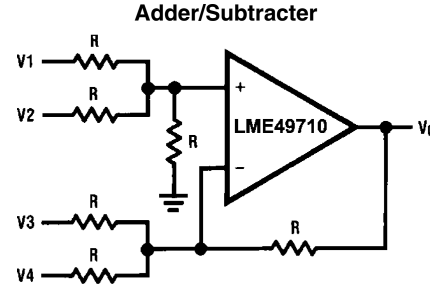
Balanced to Single Ended Converter



20210432

V_O = V1–V2

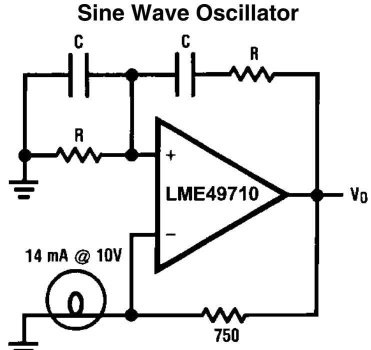
Adder/Subtracter



20210433

V_O = V1 + V2 – V3 – V4

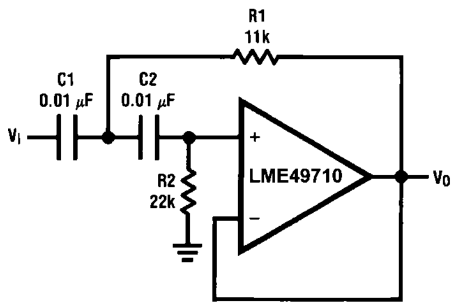
Sine Wave Oscillator



20210434

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

Second Order High Pass Filter (Butterworth)



20210435

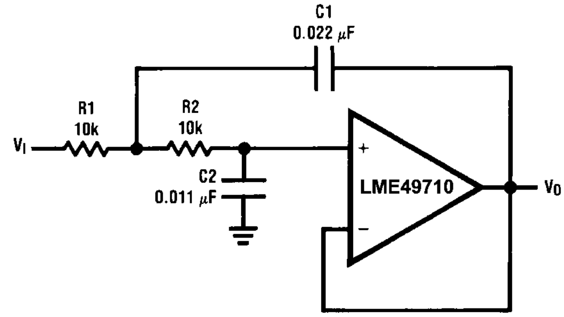
if $C1 = C2 = C$

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

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



20210436

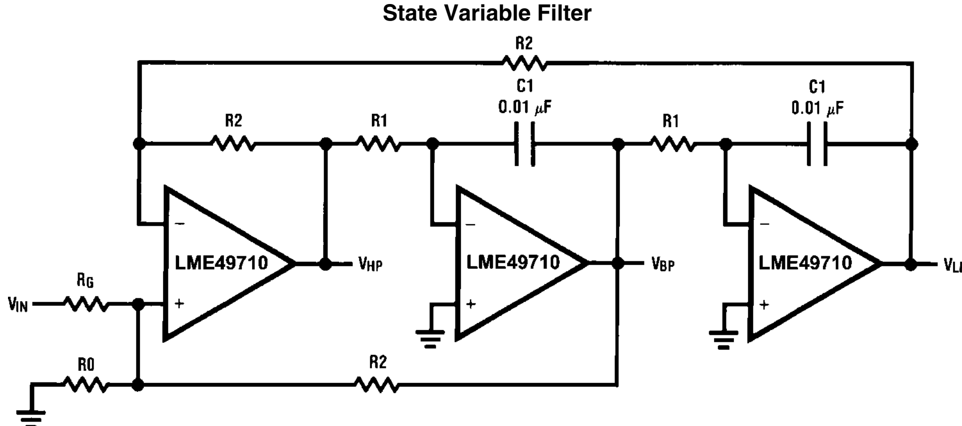
if $R1 = R2 = R$

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

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

Illustration is f_0 = 1 kHz

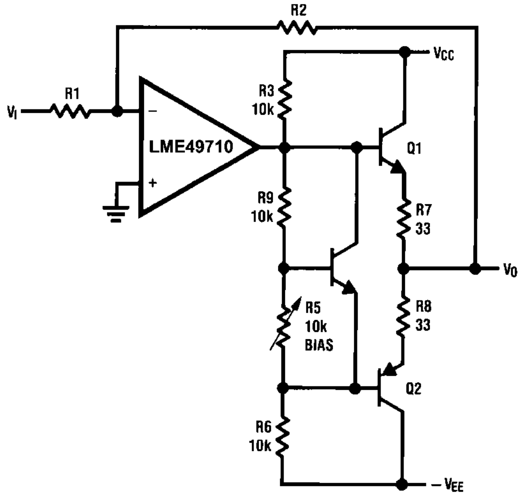
State Variable Filter



20210437

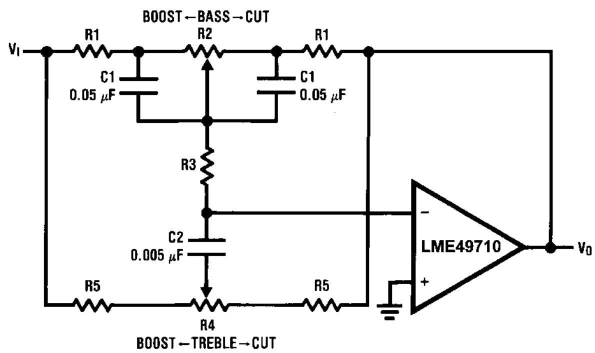
$$f_0 = \frac{1}{2\pi C1R1},\ Q = \frac{1}{2}\left(1 + \frac{R2}{R0} + \frac{R2}{RG}\right),\ A_{BP} = QA_{LP} = QA_{LH} = \frac{R2}{RG}$$

Line Driver



20210440

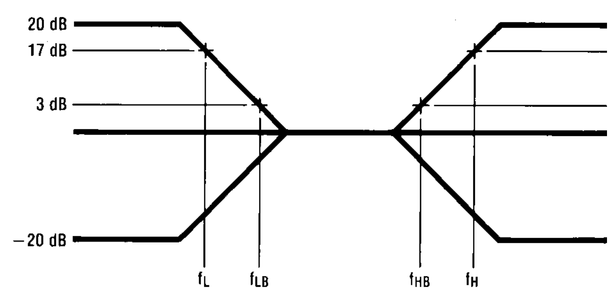
Tone Control



20210441

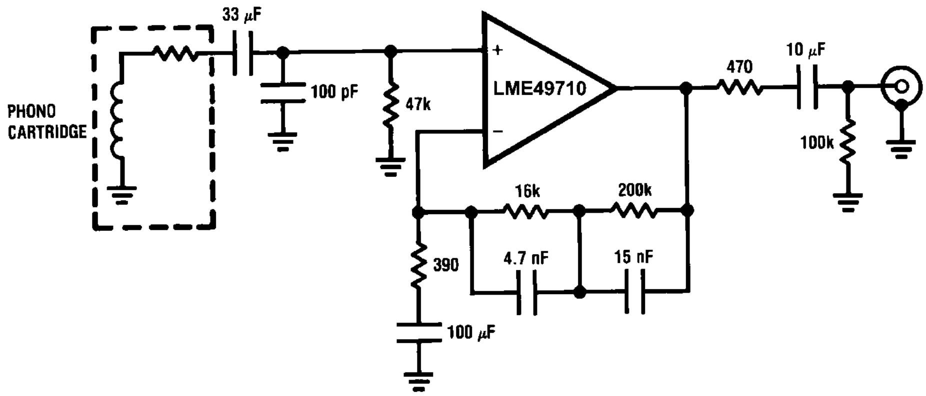
$$f_L = \frac{1}{2\pi R2C1},\ f_{LB} = \frac{1}{2\pi R1C1}$$

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



20210442

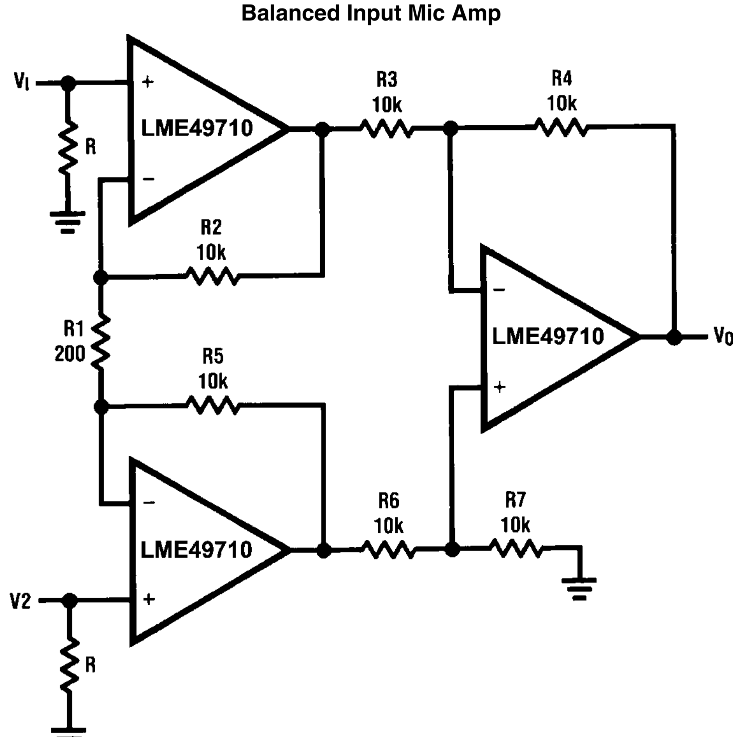
RIAA Preamp



20210403

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



20210443

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

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

Illustration is:

V0 = 101(V2 – V1)

Application Information

DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LME49710 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 LME49710's low residual distortion is an input referred internal error. As shown in Figure 2, 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 2.

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.

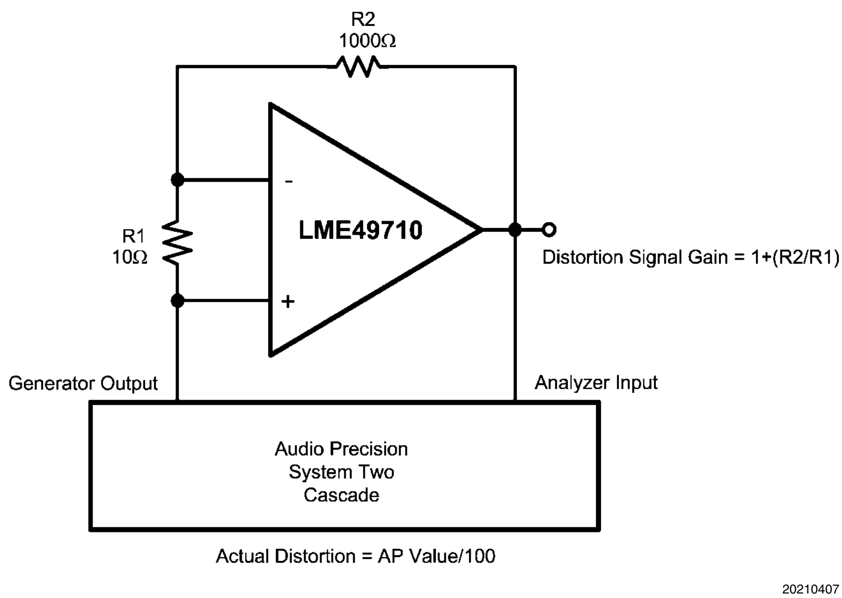
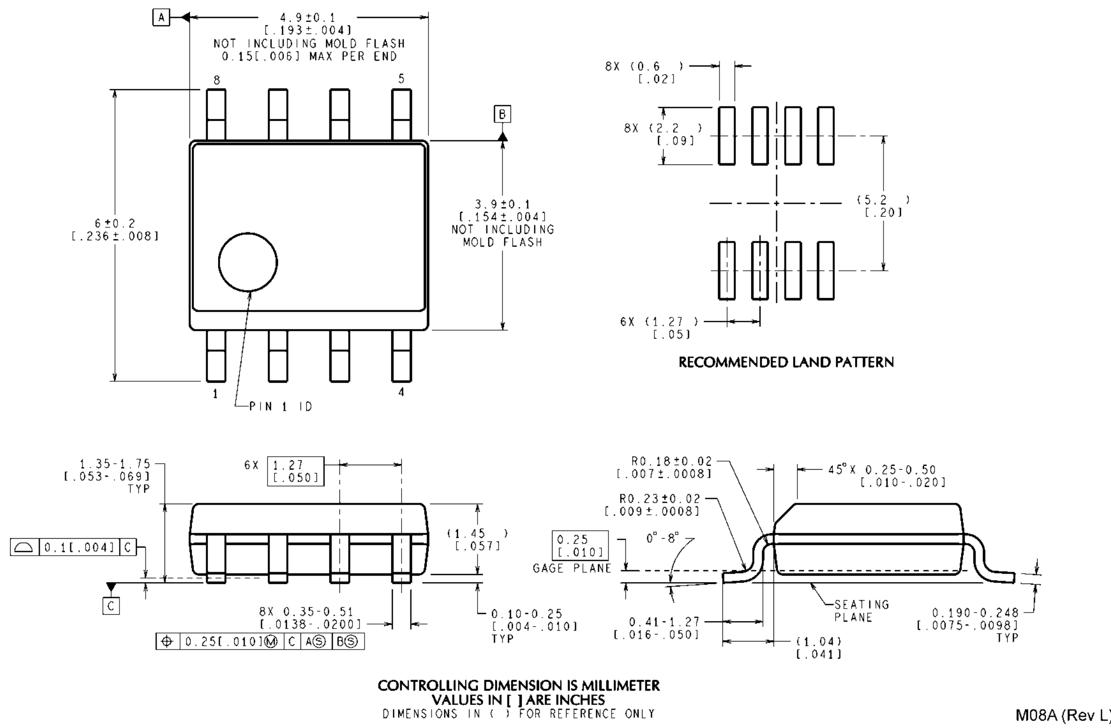


FIGURE 2. THD+N and IMD Distortion Test Circuit

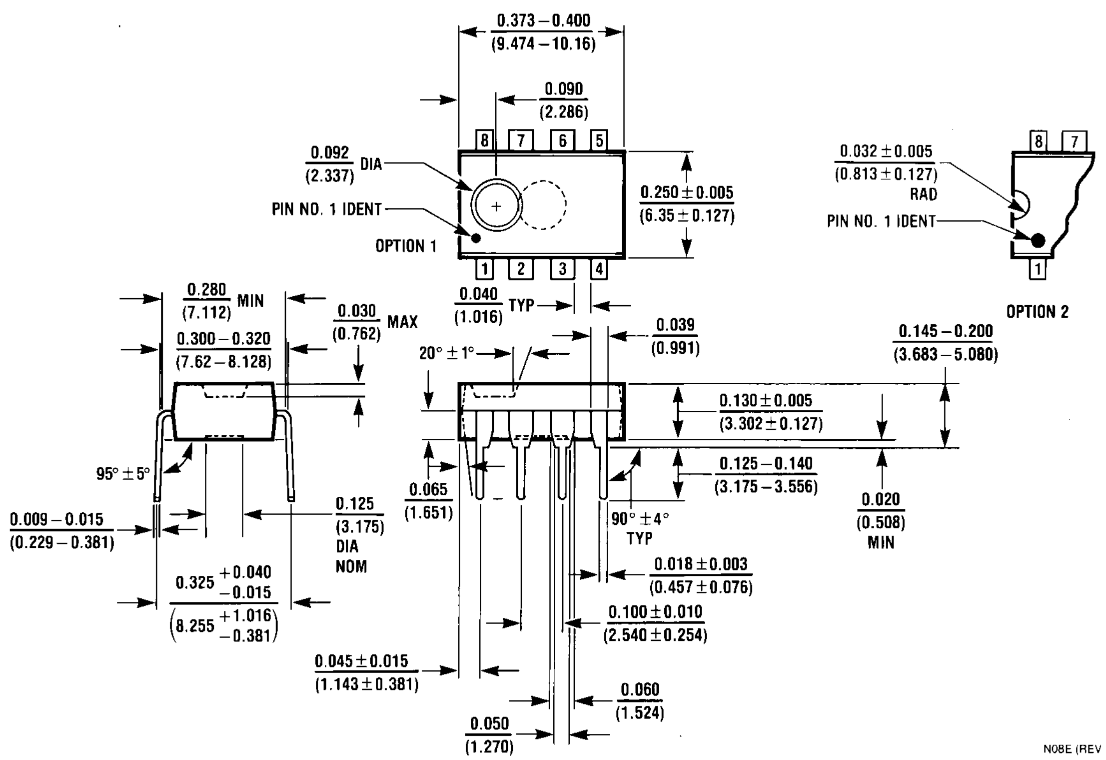
Revision History

Rev	Date	Description
1.0	11/16/07	Initial release.
1.1	12/12/06	Added the Typical Performance curves.
1.2	01/15/07	Added more curves and input some text edits.
1.3	03/09/07	Fixed graphics 20210489 and 90.

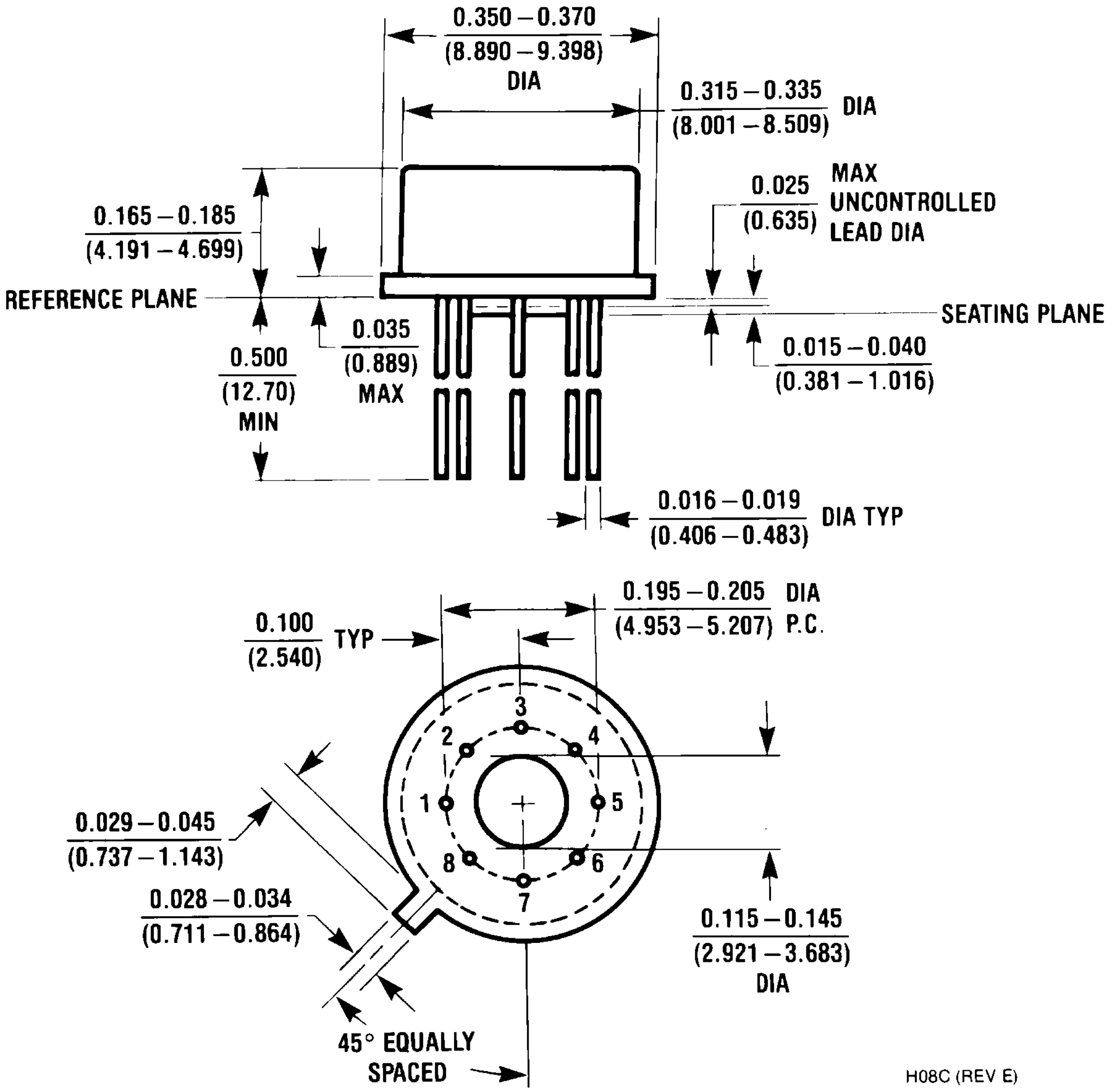
Physical Dimensions inches (millimeters) unless otherwise noted



Dual-In-Line Package
Order Number LME49710MA
NS Package Number M08A



Dual-In-Line Package
Order Number LME49710NA
NS Package Number N08E



TO-99 Metal Can
Order Number LME49710HA
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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
		TI E2E Community Home Page	e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265