

### LME49860

# 44V Dual High Performance, High Fidelity Audio Operational Amplifier

### **General Description**

The LME49860 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 LME49860 audio operational amplifiers deliver superior audio signal amplification for outstanding audio performance. The LME49860 combines extremely low voltage noise density (2.7nV/ $\sqrt{\text{Hz}}$ ) 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 LME49860 has a high slew rate of  $\pm 20\text{V}/\mu\text{s}$  and an output current capability of  $\pm 26\text{mA}$ . Further, dynamic range is maximized by an output stage that drives  $2k\Omega$  loads to within 1V of either power supply voltage and to within 1.4V when driving 600 $\Omega$  loads.

The LME49860's outstanding CMRR (120dB), PSRR (120dB), and  $\rm V_{OS}$  (0.1mV) give the amplifier excellent operational amplifier DC performance.

The LME49860 has a wide supply range of ±2.5V to ±22V. Over this supply range the LME49860 maintains excellent common-mode rejection, power supply rejection, and low input bias current. The LME49860 is unity gain stable. This Audio Operational Amplifier achieves outstanding AC performance while driving complex loads with values as high as 100pF.

The LME49860 is available in 8—lead narrow body SOIC and 8—lead Plastic DIP packages. Demonstration boards are available for each package.

### **Key Specifications**

	Power	Supply	Voltage	Range
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±2.5V to ±22V

■ 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	2.7nV/√Hz (typ)
■ Slew Rate	±20V/μs (typ)
■ Gain Bandwidth Product	55MHz (typ)
■ Open Loop Gain (R <sub>L</sub> = 600Ω)	140dB (typ)
■ Input Bias Current	10nA (typ)
■ Input Offset Voltage	0.1mV (typ)
■ DC Gain Linearity Error	0.000009%

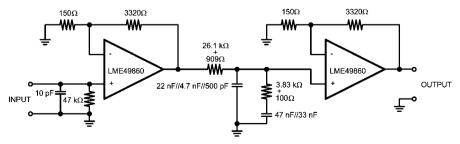
### **Features**

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

### **Applications**

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

### **Typical Application**

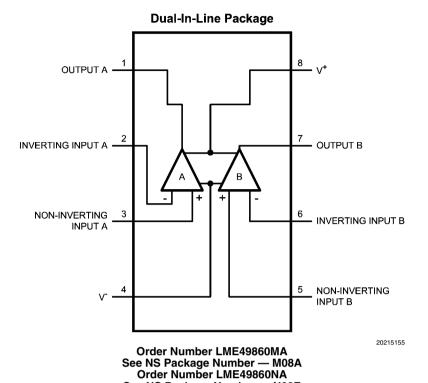


Note: 1% metal film resistors, 5% polypropylene capacitors

**Passively Equalized RIAA Phono Preamplifier** 

202151k5

### **Connection Diagrams**



See NS Package Number — N08E

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LME49860MA Top Mark

**NZXTT** L49860

N — National Logo

Z — Assembly Plant code

X — 1 Digit Date code

TT — Die Traceability

L49860 — LME49860

MA — Package code

LME49860NA Top Mark

**NUZXYTT LME** 49860NA

N — National Logo
U — Fabrication code
Z — Assembly Plant code
XY — 2 Digit Date code
TT — Die Traceability
NA — Package code

20215102

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  $-65^{\circ}$ C to  $150^{\circ}$ C Input Voltage  $(V^-) - 0.7V$  to  $(V^+) + 0.7V$ 

Output Short Circuit (Note 3) Continuous 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  $\theta_{JA} \, (SO) \qquad \qquad 145°C/W \\ \theta_{JA} \, (NA) \qquad \qquad 102°C/W$ 

### **Operating Ratings**

Temperature Range

 $T_{MIN} \le T_A \le T_{MAX}$   $-40^{\circ}C \le T_A \le 85^{\circ}C$ Supply Voltage Range  $\pm 2.5V \le V_S \le \pm 22V$ 

**Electrical Characteristics for the LME49860** (Note 1) The following specifications apply for  $V_S = \pm 18V$  and  $\pm 22V$ ,  $R_L = 2k\Omega$ ,  $R_{SOURCE} = 10\Omega$ ,  $f_{IN} = 1kHz$ ,  $T_A = 25^{\circ}C$ , unless otherwise specified.

	Parameter	Conditions	LME49860		Units
Symbol			Typical	Typical Limit	
			(Note 6)	(Note 7)	(Limits)
		$A_V = 1$ , $V_{OUT} = 3V_{rms}$			
THD+N	Total Harmonic Distortion + Noise	$R_1 = 2k\Omega$	0.00003		% (max)
		$R_L = 600\Omega$	0.00003	0.00009	
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 <sub>OUT</sub> = 1V <sub>P-P</sub> , -3dB referenced to output magnitude at f = 1kHz	10		MHz
t <sub>s</sub>	Settling time	$A_V = -1$ , 10V step, $C_L = 100pF$ 0.1% error range	1.2		μs
	Equivalent Input Noise Voltage	f <sub>BW</sub> = 20Hz to 20kHz	0.34	0.65	μV <sub>RMS</sub> (max)
e <sub>n</sub>	Equivalent Input Noise Density	f = 1kHz	2.7	4.7	nV/√ <del>Hz</del>
		f = 10Hz	6.4		(max)
i <sub>n</sub>	Current Noise Density	f = 1kHz	1.6		A / /I I=
		f = 10Hz	3.1		pAJ√Hz
V	Offset Voltage	V <sub>S</sub> = ±18V	±0.12	±0.7	mV (max)
V <sub>OS</sub>		$V_S = \pm 22V$	±0.14	±0.7	mV (max)
ΔV <sub>OS</sub> /ΔTemp	Average Input Offset Voltage Drift vs Temperature	–40°C ≤ T <sub>A</sub> ≤ 85°C	0.2		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	(Note 8) $V_S = \pm 18V$ , $\Delta V_S = 24V$ $V_S = \pm 22V$ , $\Delta V_S = 30V$	120 120	110	dB dB (min)
ISO <sub>CH-CH</sub>	Channel-to-Channel Isolation	$\begin{split} f_{IN} &= 1 \text{kHz} \\ f_{IN} &= 20 \text{kHz} \end{split}$	118 112		dB
I <sub>B</sub>	Input Bias Current	$V_{CM} = 0V$	10	72	nA (max)
ΔI <sub>OS</sub> /ΔTemp	Input Bias Current Drift vs Temperature	-40°C ≤ T <sub>A</sub> ≤ 85°C	0.1		nA/°C
I <sub>os</sub>	Input Offset Current	$V_{CM} = 0V$	11	65	nA (max)
		V <sub>S</sub> = ±18V	+17.1 -16.9	(V+) - 2.0 (V-) + 2.0	V (min) V (min)
V <sub>IN-CM</sub>	Common-Mode Input Voltage Range	V <sub>S</sub> = ±22V	+21.0 -20.8	(V+) - 2.0 (V-) + 2.0	V (min) V (min)

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			LME4	LME49860	
<b>宣词/hbb</b> diE	E49860MA" <b>嫌<u>楍</u>裔<sub>ter</sub></b>	Conditions	Typical	Limit	Units
			(Note 6)	(Note 7)	(Limits)
		V <sub>S</sub> = ±18V	400		
0.455		-12V ≤ V <sub>CM</sub> ≤ 12V	120		dB
CMRR	Common-Mode Rejection	V <sub>S</sub> = ±22V			, .
		-15V ≤ V <sub>CM</sub> ≤ 15V	120	110	dB (min)
_	Differential Input Impedance		30		kΩ
$Z_{IN}$	Common Mode Input Impedance	-10V <vcm<10v< td=""><td>1000</td><td></td><td>ΜΩ</td></vcm<10v<>	1000		ΜΩ
	· ·	V <sub>S</sub> = ±18V			
		_12V≤Vout≤12V			
		$R_L = 600\Omega$	140		ط ا
		$R_1 = 2k\Omega$	140 140		dB dB
		$R_L = 10k\Omega$	140		dB
$A_{VOL}$	Open Loop Voltage Gain	V <sub>S</sub> = ±22V			
		-  -15V≤Vout≤15V			
		$R_1 = 600\Omega$	140	125	alD (main
		$R_L = 2k\Omega$	140 140		dB (min dB
		$R_L = 10k\Omega$	140		dB
		$R_1 = 600\Omega$			
		$V_S = \pm 18V$	±16.7		l v
		V <sub>S</sub> = ±22V	±20.4	±19.0	V (min)
		$R_1 = 2k\Omega$			
V <sub>OUTMAX</sub>	Maximum Output Voltage Swing	$V_S = \pm 18V$	±17.0		V
		$V_S = \pm 22V$	±21.0		V
		$R_L = 10k\Omega$			
		$V_S = \pm 18V$	±17.1		V
		$V_S = \pm 22V$	±21.2		V
	Output Current	$R_L = 600\Omega$			
I <sub>OUT</sub>		$V_S = \pm 20V$	±31		mA
		$V_S = \pm 22V$	±37	±30	mA (min
lour os	Instantaneous Short Circuit Current		+53		mA
I <sub>OUT-CC</sub>	Instantaneous Short Official Gurrent		-42		111/2
_		f <sub>IN</sub> = 10kHz			
R <sub>OUT</sub>	Output Impedance	Closed-Loop	0.01		Ω
	Operation Land Discours	Open-Loop	13		2′
C <sub>LOAD</sub>	Capacitive Load Drive Overshoot	100pF	16		%
	Tatal Ouisesent Ourset	I <sub>OUT</sub> = 0mA			
I <sub>S</sub>	Total Quiescent Current	$V_{S} = \pm 18V$	10.2	10	mA
		$V_S = \pm 22V$	10.5	13	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.

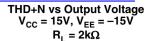
- Note 3: Amplifier output connected to GND, any number of amplifiers within a package.
- Note 4: Human body model, 100pF discharged through a 1.5k $\Omega$  resistor.

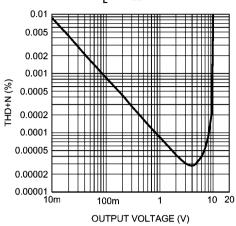
Note 5: Machine Model ESD test is covered by specification EIAJ IC-121-1981. A 200pF cap is charged to the specified voltage and then discharged directly into the IC with no external series resistor (resistance of discharge path must be under  $50\Omega$ ).

- Note 6: Typical specifications are specified at  $+25^{\circ}\text{C}$  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: For  $V_S$  = ±22V,  $V_{OS}$  is measured at two supply voltages, ±7V and ±22V. PSRR = I  $20\log(\Delta V_{OS}/\Delta V_S)$  I.

### **Typical Performance Characteristics**

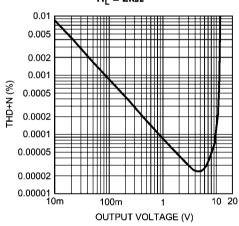
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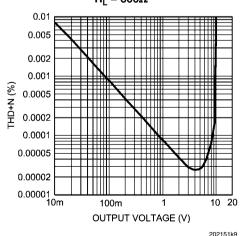
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THD+N vs Output Voltage  $V_{CC}$  = 22V,  $V_{EE}$  = -22V  $R_L$  = 2k $\Omega$ 

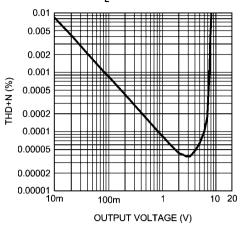


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THD+N vs Output Voltage  $V_{CC} = 15V, \, V_{EE} = -15V \\ R_L = 600\Omega$ 

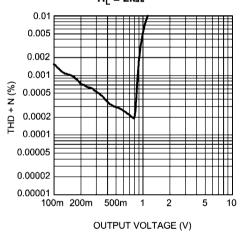


THD+N vs Output Voltage  $V_{CC}$  = 12V,  $V_{EE}$  = -12V  $R_L$  = 2k $\Omega$ 



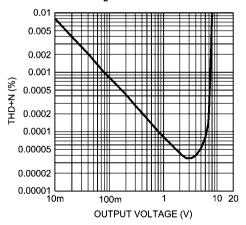
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THD+N vs Output Voltage  $V_{CC}$  = 2.5V,  $V_{EE}$  = -2.5V  $R_L$  = 2k $\Omega$ 



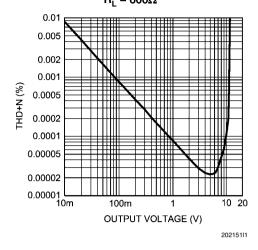
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THD+N vs Output Voltage  $V_{CC} = 12V$ ,  $V_{EE} = -12V$   $R_L = 600\Omega$ 

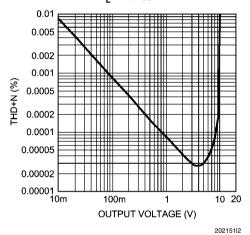


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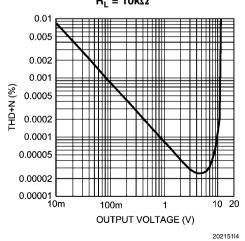
### THD+N vs Output Voltage 查询"LME49860MY c供迎的<sub>EE</sub> = -22V



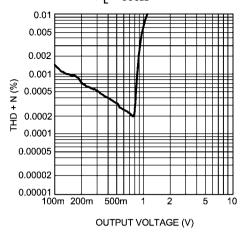
# THD+N vs Output Voltage $V_{CC}$ = 15V, $V_{EE}$ = -15V $R_L$ = 10k $\Omega$



THD+N vs Output Voltage  $V_{CC} = 22V$ ,  $V_{EE} = -22V$   $R_1 = 10k\Omega$ 

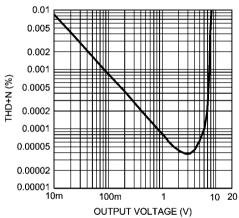


THD+N vs Output Voltage  $V_{CC}$  = 2.5V,  $V_{EE}$  = -2.5V  $R_{L}$  = 600 $\Omega$ 



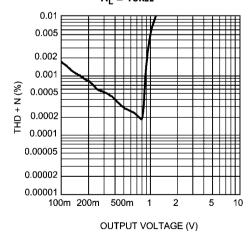
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THD+N vs Output Voltage  $V_{CC} = 12V, \, V_{EE} = -12V \\ R_L = 10k\Omega$ 



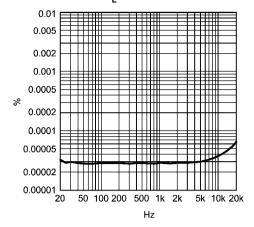
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THD+N vs Output Voltage  $V_{CC} = 2.5V$ ,  $V_{EE} = -2.5V$  $R_{L} = 10k\Omega$ 



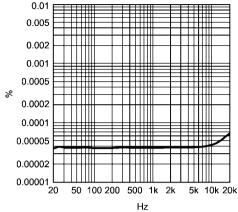
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### THD+N vs Frequency 查询V。从任约必证从A5供收益 R<sub>1</sub> = 2KΩ



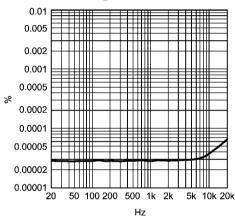
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# THD+N vs Frequency $V_{CC}$ = 12V, $V_{EE}$ = -12V, $V_{OUT}$ = $3V_{RMS}$ $R_L$ = $2k\Omega$



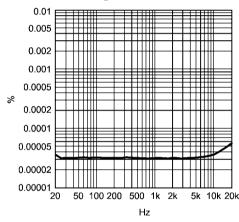
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THD+N vs Frequency 
$$\begin{aligned} \text{V}_{\text{CC}} &= \text{22V}, \, \text{V}_{\text{EE}} = -\text{22V}, \, \text{V}_{\text{OUT}} = \text{3V}_{\text{RMS}} \\ \text{R}_{\text{L}} &= \text{2k}\Omega \end{aligned}$$



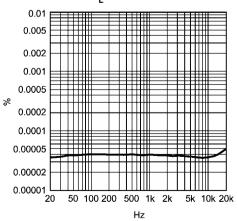
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THD+N vs Frequency 
$$\begin{aligned} V_{CC} = 15V, \, V_{EE} = -15V, \, V_{OUT} = 3V_{RMS} \\ R_L = 600\Omega \end{aligned}$$



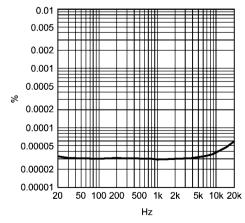
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THD+N vs Frequency 
$$\begin{aligned} V_{CC} &= 12V, \, V_{EE} = -12V, \, V_{OUT} = 3V_{RMS} \\ R_L &= 600\Omega \end{aligned}$$



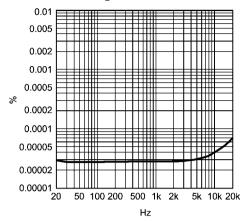
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THD+N vs Frequency 
$$\begin{aligned} V_{CC} = 22V, \, V_{EE} = -22V, \, V_{OUT} = 3V_{RMS} \\ R_L = 600\Omega \end{aligned}$$



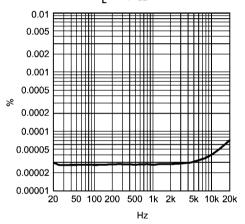
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### THD+N vs Frequency 查询"LME49%60种엦;性应商5V, V<sub>out</sub> = 3V<sub>RMS</sub> R<sub>L</sub> = 10kΩ



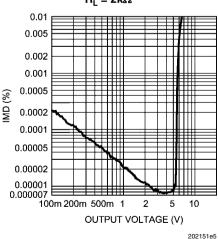
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# THD+N vs Frequency $\begin{aligned} V_{CC} &= 22V, \, V_{EE} = -22V, \, V_{OUT} = 3V_{RMS} \\ R_L &= 10k\Omega \end{aligned}$

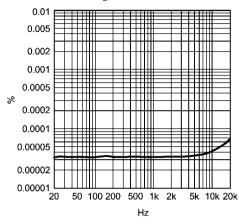


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$$\begin{split} & \text{IMD vs Output Voltage} \\ & \text{V}_{\text{CC}} = 12\text{V}, \, \text{V}_{\text{EE}} = -12\text{V} \\ & \text{R}_{\text{L}} = 2\text{k}\Omega \end{split}$$

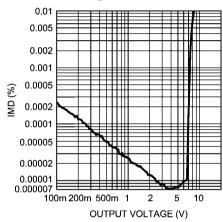


THD+N vs Frequency  $\begin{aligned} V_{CC} &= 12V, \, V_{EE} = -12V, \, V_{OUT} = 3V_{RMS} \\ R_{_{I}} &= 10k\Omega \end{aligned}$ 



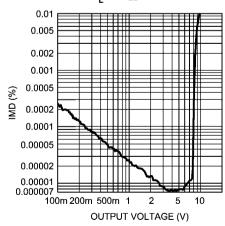
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$$\begin{split} & \text{IMD vs Output Voltage} \\ & \text{V}_{\text{CC}} = 15\text{V}, \, \text{V}_{\text{EE}} = -15\text{V} \\ & \text{R}_{\text{L}} = 2\text{k}\Omega \end{split}$$



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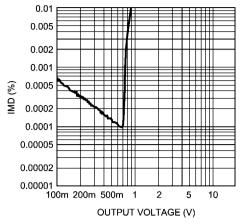
IMD vs Output Voltage  $V_{CC}$  = 22V,  $V_{EE}$  = -22V  $R_L$  = 2k $\Omega$ 



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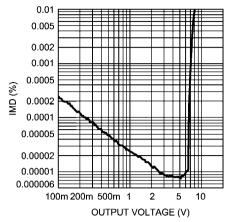
### IMD vs Output Voltage 查询"LME42862\$NA/E共应的



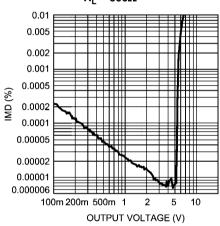


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IMD vs Output Voltage  $V_{CC}$  = 15V,  $V_{EE}$  = -15V  $R_L$  =  $600\Omega$ 

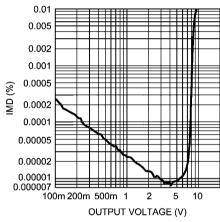


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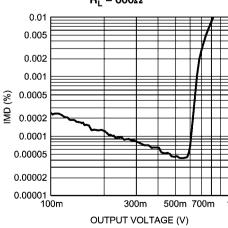
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 $\begin{array}{c} \text{IMD vs Output Voltage} \\ V_{\text{CC}} = 22V, \, V_{\text{EE}} = -22V \\ R_{L} = 600\Omega \end{array}$ 

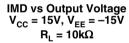


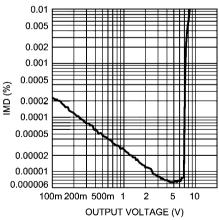
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IMD vs Output Voltage  $V_{CC}$  = 2.5V,  $V_{EE}$  = -2.5V  $R_{L}$  = 600 $\Omega$ 



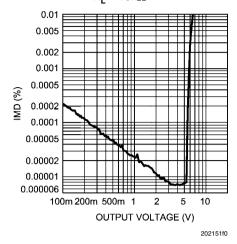
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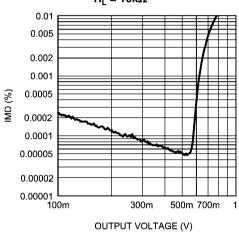


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# IMD vs Output Voltage ≦询"LME49860MAc"供迎哟∈ = −12V

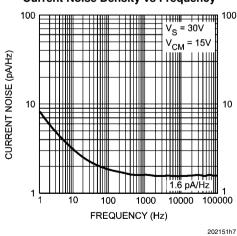


### **IMD vs Output Voltage** $V_{CC} = 2.5V, V_{EE} = -2.5V$ $R_L = 10k\Omega$

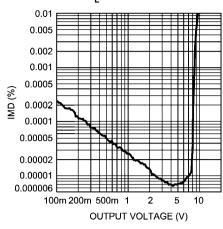


### **Current Noise Density vs Frequency**

20215116

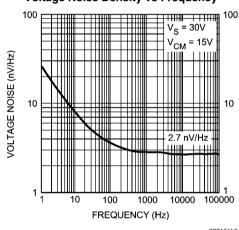


### IMD vs Output Voltage V<sub>CC</sub> = 22V, V<sub>EE</sub> = -22V $R_L = 10k\Omega$



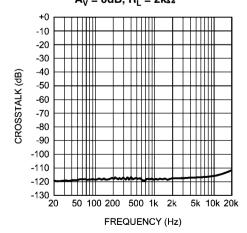
202151f2

### **Voltage Noise Density vs Frequency**



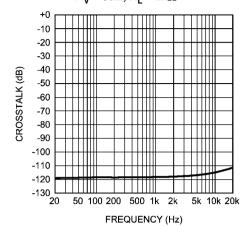
202151h6

### Crosstalk vs Frequency $V_{CC}$ = 15V, $V_{EE}$ = -15V, $V_{OUT}$ = $3V_{RMS}$ $A_V = 0$ dB, $R_L = 2k\Omega$

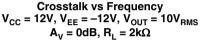


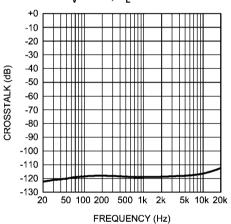
202151c8

### Crosstalk vs Frequency 查询/del 1540%@AASV共物设施 A<sub>V</sub> = 0dB, R<sub>1</sub> = 2kΩ

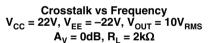


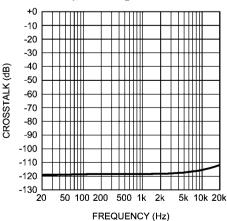
202151c9





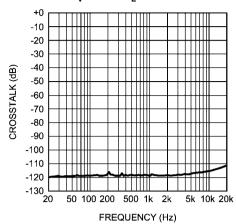
202151c7





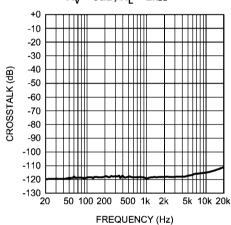
202151d1

 $\begin{array}{c} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = 12\text{V}, \, \text{V}_{\text{EE}} = -12\text{V}, \, \text{V}_{\text{OUT}} = 3\text{V}_{\text{RMS}} \\ \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{I}} = 2\text{k}\Omega \end{array}$ 



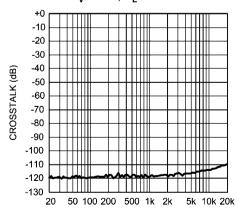
202151c6

 $\begin{aligned} & \text{Crosstalk vs Frequency} \\ V_{\text{CC}} &= 22\text{V}, V_{\text{EE}} = -22\text{V}, V_{\text{OUT}} = 3\text{V}_{\text{RMS}} \\ A_{\text{V}} &= 0\text{dB}, \, R_{\text{L}} = 2\text{k}\Omega \end{aligned}$ 



202151d0

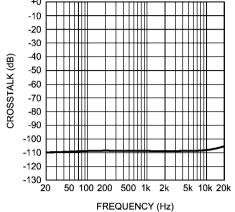
Crosstalk vs Frequency 
$$V_{CC}$$
 = 2.5V,  $V_{EE}$  = -2.5V,  $V_{OUT}$  = 1 $V_{RMS}$   $A_V$  = 0dB,  $R_L$  = 2 $k\Omega$ 



FREQUENCY (Hz)

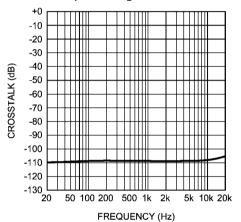
202151n8

# Crosstalk vs Frequency 查询"LME49%60州乡/,怀起南5V, V<sub>OUT</sub> = 3V<sub>RMS</sub> A<sub>V</sub> = 0dB, R<sub>L</sub> = 600Ω



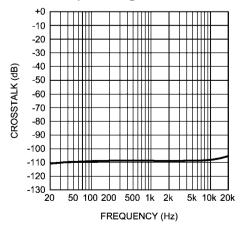
202151d6

 $\begin{array}{c} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = \text{12V}, \text{V}_{\text{EE}} = -\text{12V}, \text{V}_{\text{OUT}} = \text{3V}_{\text{RMS}} \\ \text{A}_{\text{V}} = \text{0dB}, \text{R}_{\text{I}} = 600\Omega \end{array}$ 



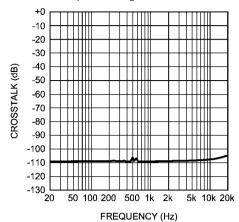
202151d4

 $\begin{array}{c} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = 22\text{V}, \, \text{V}_{\text{EE}} = -22\text{V}, \, \text{V}_{\text{OUT}} = 3\text{V}_{\text{RMS}} \\ \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{I}} = 600\Omega \end{array}$ 



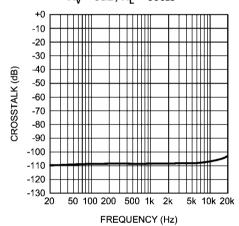
202151d8

 $\begin{array}{l} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = 15\text{V}, \, \text{V}_{\text{EE}} = -15\text{V}, \, \text{V}_{\text{OUT}} = 10\text{V}_{\text{RMS}} \\ \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{I}} = 600\Omega \end{array}$ 



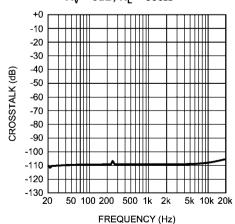
202151d7

 $\begin{array}{l} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = 12\text{V}, \, \text{V}_{\text{EE}} = -12\text{V}, \, \text{V}_{\text{OUT}} = 10\text{V}_{\text{RMS}} \\ \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{L}} = 600\Omega \end{array}$ 



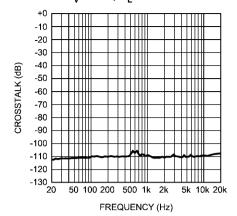
202151d5

Crosstalk vs Frequency  $V_{CC}$  = 22V,  $V_{EE}$  = -22V,  $V_{OUT}$  = 10 $V_{RMS}$   $A_V$  = 0dB,  $R_I$  = 600 $\Omega$ 



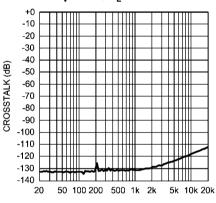
202151d9

### Crosstalk vs Frequency 查询处最初级种类男威爵= 1V<sub>RMS</sub> A<sub>V</sub> = 0dB, R<sub>I</sub> = 600Ω



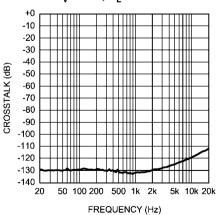
202151d2

# $\begin{array}{l} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = 15\text{V}, \, \text{V}_{\text{EE}} = -15\text{V}, \, \text{V}_{\text{OUT}} = 10\text{V}_{\text{RMS}} \\ \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{L}} = 10\text{k}\Omega \end{array}$



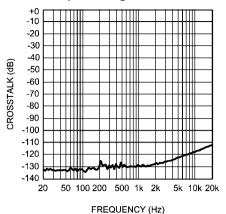
FREQUENCY (Hz) 202151n7

 $\begin{array}{l} \text{Crosstalk vs Frequency} \\ \text{V}_{\text{CC}} = 12\text{V}, \, \text{V}_{\text{EE}} = -12\text{V}, \, \text{V}_{\text{OUT}} = 10\text{V}_{\text{RMS}} \\ \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{L}} = 10\text{k}\Omega \end{array}$ 



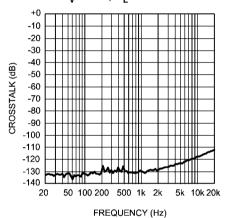
202151n6

 $\begin{aligned} & \text{Crosstalk vs Frequency} \\ V_{\text{CC}} = 15V, \, V_{\text{EE}} = -15V, \, V_{\text{OUT}} = 3V_{\text{RMS}} \\ & A_{\text{V}} = 0\text{dB}, \, R_{\text{I}} = 10\text{k}\Omega \end{aligned}$ 



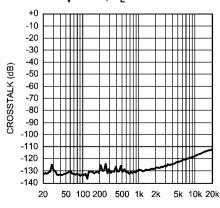
20215100

 $\begin{aligned} & \text{Crosstalk vs Frequency} \\ V_{\text{CC}} &= 12V, \, V_{\text{EE}} = -12V, \, V_{\text{OUT}} = 3V_{\text{RMS}} \\ & A_{_{V}} = 0 dB, \, R_{_{L}} = 10 k\Omega \end{aligned}$ 



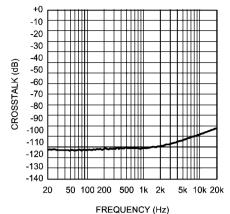
202151n9

 $\begin{aligned} & \text{Crosstalk vs Frequency} \\ & \text{V}_{\text{CC}} = 22\text{V}, \, \text{V}_{\text{EE}} = -22\text{V}, \, \text{V}_{\text{OUT}} = 3\text{V}_{\text{RMS}} \\ & \text{A}_{\text{V}} = 0\text{dB}, \, \text{R}_{\text{L}} = 10\text{k}\Omega \end{aligned}$ 



FREQUENCY (Hz)

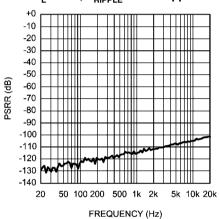
### Crosstalk vs Frequency 查询"LME4%6θΨΑΝ,"烷型磁火, V<sub>OUT</sub> = 10V<sub>RMS</sub> A<sub>V</sub> = 0dB, R<sub>L</sub> = 10kΩ



202151n3

202151

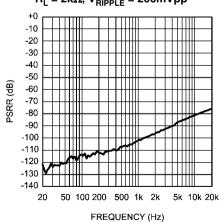
# PSRR+ vs Frequency $V_{CC}$ = 15V, $V_{EE}$ = -15V $R_L$ = 2k $\Omega$ , $V_{RIPPLE}$ = 200mVpp



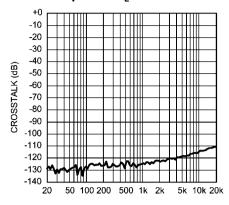
0ENC1 (HZ) 20215101

202151n1

PSRR+ vs Frequency  $V_{CC}$  = 12V,  $V_{EE}$  = -12V  $R_L$  = 2k $\Omega$ ,  $V_{RIPPLE}$  = 200mVpp



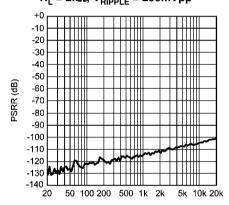
Crosstalk vs Frequency  $V_{CC}$  = 2.5V,  $V_{EE}$  = -2.5V,  $V_{OUT}$  = 1 $V_{RMS}$   $A_V$  = 0dB,  $R_I$  = 10k $\Omega$ 



FREQUENCY (Hz)

202151n4

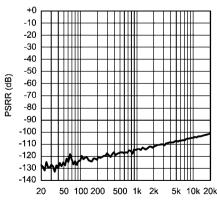
 $\begin{aligned} & \text{PSRR- vs Frequency} \\ & \text{V}_{\text{CC}} = 15\text{V}, \, \text{V}_{\text{EE}} = -15\text{V} \\ & \text{R}_{\text{L}} = 2k\Omega, \, \text{V}_{\text{RIPPLE}} = 200\text{mVpp} \end{aligned}$ 



FREQUENCY (Hz)

202151n2

PSRR- vs Frequency  $V_{CC}$  = 12V,  $V_{EE}$  = -12V  $R_L$  = 2k $\Omega$ ,  $V_{RIPPLE}$  = 200mVpp

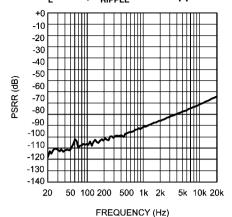


FREQUENCY (Hz)

202151n0

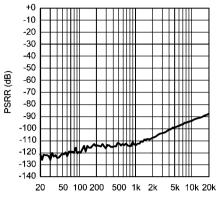
### PSRR+ vs Frequency 查询"LME¥886241.A/最短期

### $R_L = 2k\Omega$ , $V_{RIPPLE} = 200mVpp$



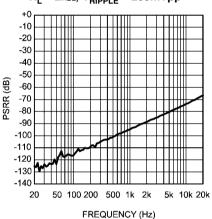
202151m9

# $\begin{aligned} & \text{PSRR- vs Frequency} \\ & \text{V}_{\text{CC}} = 22\text{V}, \, \text{V}_{\text{EE}} = -22\text{V} \\ & \text{R}_{\text{L}} = 2\text{k}\Omega, \, \text{V}_{\text{RIPPLE}} = 200\text{mVpp} \end{aligned}$



20215103

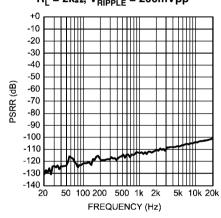
# $\begin{aligned} & \text{PSRR+ vs Frequency} \\ & \text{V}_{\text{CC}} = 2.5\text{V}, \, \text{V}_{\text{EE}} = -2.5\text{V} \\ & \text{R}_{\text{L}} = 2\text{k}\Omega, \, \text{V}_{\text{RIPPLE}} = 200\text{mVpp} \end{aligned}$



202151m8

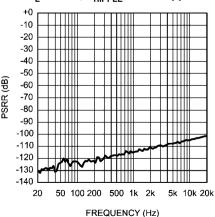
# PSRR- vs Frequency $V_{CC}$ = 2.5V, $V_{EE}$ = -2.5V $R_L$ = 2k $\Omega$ , $V_{RIPPLE}$ = 200mVpp

FREQUENCY (Hz)



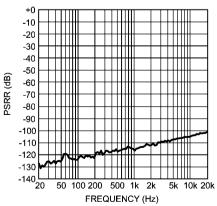
20215106

# $\begin{aligned} & \text{PSRR+ vs Frequency} \\ & \text{V}_{\text{CC}} = 15\text{V}, \, \text{V}_{\text{EE}} = -15\text{V} \\ & \text{R}_{\text{L}} = 600\Omega, \, \text{V}_{\text{RIPPLE}} = 200\text{mVpp} \end{aligned}$



20215102

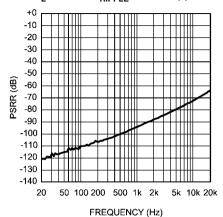
# $\begin{aligned} & \text{PSRR- vs Frequency} \\ & \text{V}_{\text{CC}} = 15\text{V}, \, \text{V}_{\text{EE}} = -15\text{V} \\ & \text{R}_{\text{L}} = 600\Omega, \, \text{V}_{\text{RIPPLE}} = 200\text{mVpp} \end{aligned}$



20215107

# 

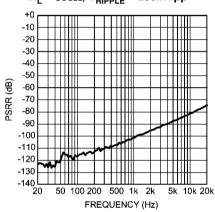
### $R_L = 600\Omega$ , $V_{RIPPLE} = 200 \text{mVpp}$



202151m7

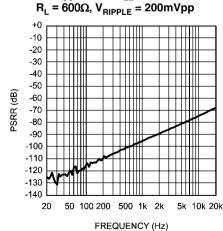
# PSRR+ vs Frequency $V_{CC}$ = 22V, $V_{EE}$ = -22V $R_L$ = 600 $\Omega$ , $V_{RIPPLE}$ = 200mVpp





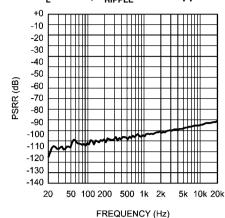
20215105

# PSRR+ vs Frequency $V_{CC} = 2.5V$ , $V_{EE} = -2.5V$



202151m5

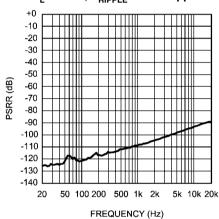
# $\begin{array}{c} \text{PSRR- vs Frequency} \\ \text{V}_{\text{CC}} = 12\text{V}, \, \text{V}_{\text{EE}} = -12\text{V} \\ \text{R}_{\text{L}} = 600\Omega, \, \text{V}_{\text{RIPPLE}} = 200\text{mVpp} \end{array}$



20215104

# PSRR- vs Frequency $V_{CC} = 22V$ , $V_{EE} = -22V$

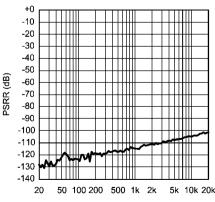
### $R_L = 600\Omega$ , $V_{RIPPLE} = 200 \text{mVpp}$



202151m6

### **PSRR- vs Frequency** $V_{CC} = 2.5V, V_{EE} = -2.5V$

 $R_L = 600\Omega$ ,  $V_{RIPPLE} = 200 \text{mVpp}$ 

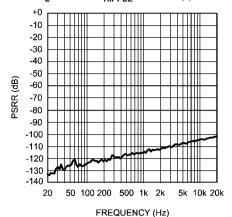


FREQUENCY (Hz)

202151m4

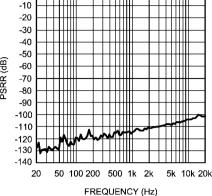
# PSRR+ vs Frequency 宣询"LME48860\$A/A/提供函额





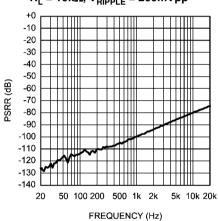
202151m3

### PSRR- vs Frequency $V_{CC} = 15V$ , $V_{EE} = -15V$ $R_L = 10k\Omega$ , $V_{RIPPLE} = 200mVpp$ +0 -10 -20 -30 -40 -50 -60



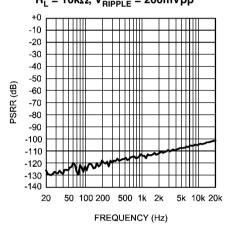
202151m2

### **PSRR+ vs Frequency** $V_{CC} = 12V, V_{EE} = -12V$ $R_L = 10k\Omega$ , $V_{RIPPLE} = 200mVpp$



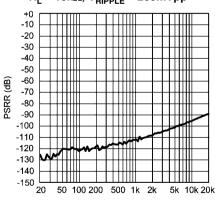
202151m1

PSRR- vs Frequency  $V_{CC} = 12V$ ,  $V_{EE} = -12V$  $R_L = 10k\Omega$ ,  $V_{RIPPLE} = 200mVpp$ 



202151m0

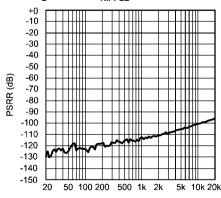
### **PSRR+ vs Frequency** $V_{CC} = 22V, V_{EE} = -22V$ $R_L = 10k\Omega$ , $V_{RIPPLE} = 200mVpp$



FREQUENCY (Hz)

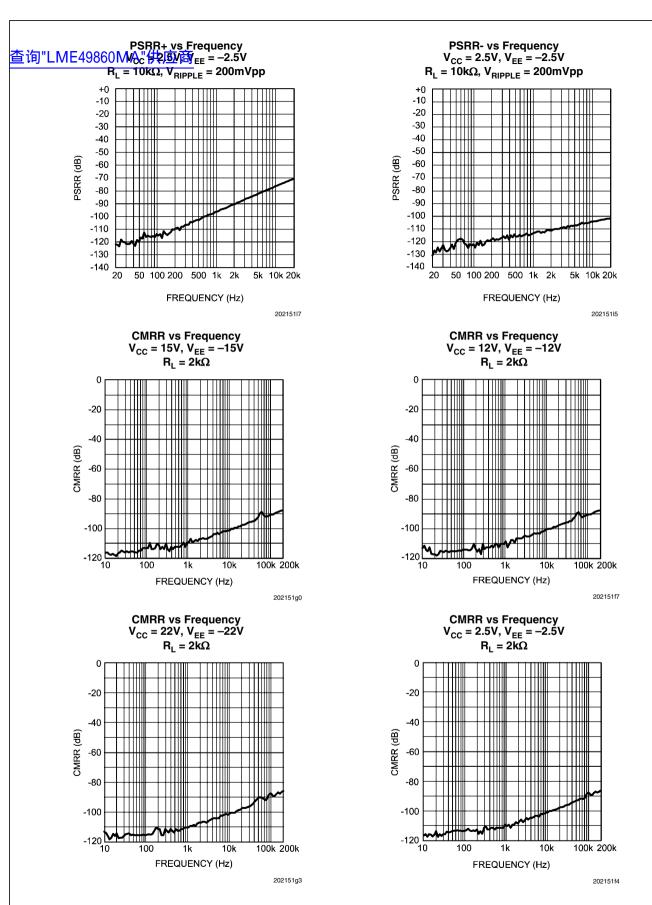
20215119

### **PSRR- vs Frequency** $V_{CC} = 22V, V_{EE} = -22V$ $R_L = 10k\Omega$ , $V_{RIPPLE} = 200mVpp$



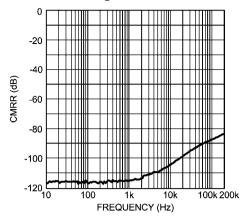
FREQUENCY (Hz)

20215118

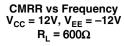


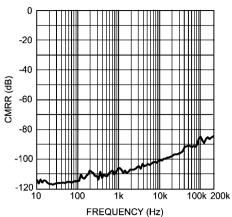
### CMRR vs Frequency 查询"LME48860\$MA/L共应的

 $R_L = 600\Omega$ 

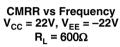


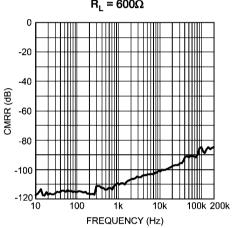
20215109



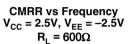


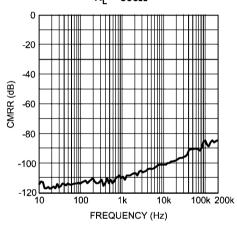
202151f9





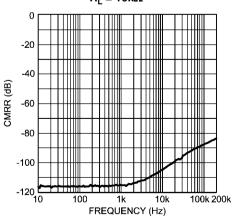
202151g5





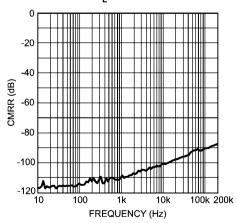
202151f6

# CMRR vs Frequency $V_{CC}$ = 15V, $V_{EE}$ = -15V $R_L$ = 10k $\Omega$



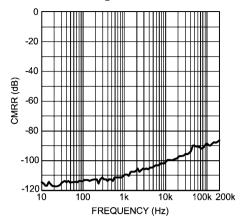
20215108

# CMRR vs Frequency $V_{CC}$ = 12V, $V_{EE}$ = -12V $R_L$ = 10k $\Omega$



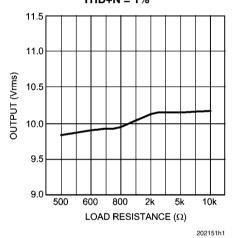
202151f8

### CMRR vs Frequency 查询"LME49860M%;"供视的<sub>EE</sub> = -22V R<sub>1</sub> = 10kΩ

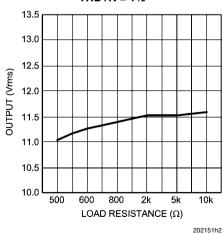


202151g4

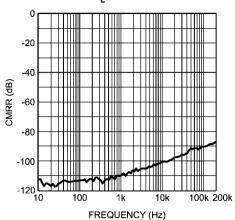
# Output Voltage vs Load Resistance $V_{CC}$ = 15V, $V_{EE}$ = -15V THD+N = 1%



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

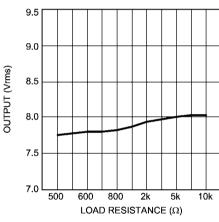


CMRR vs Frequency  $V_{CC}$  = 2.5V,  $V_{EE}$  = -2.5V  $R_L$  = 10k $\Omega$ 



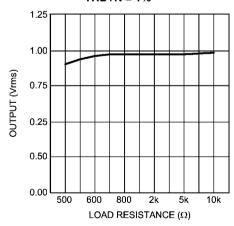
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Output Voltage vs Load Resistance  $V_{CC}$  = 12V,  $V_{EE}$  = -12V THD+N = 1%



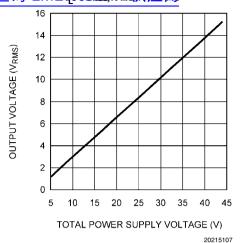
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# Output Voltage vs Load Resistance $V_{CC}$ = 2.5V, $V_{EE}$ = -2.5V THD+N = 1%

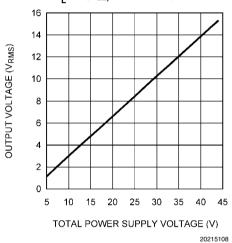


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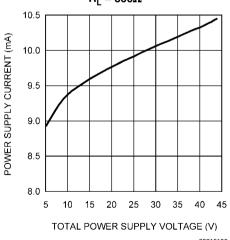
### Output Voltage vs Total Power Supply Voltage 查询"LM En 9820011 An Danie 188



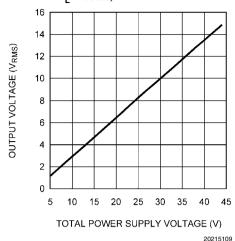
### Output Voltage vs Total Power Supply Voltage $R_1 = 10k\Omega$ , THD+N = 1%



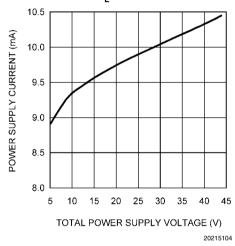
## Power Supply Current vs Total Power Supply Voltage $\rm R_L = 600\Omega$



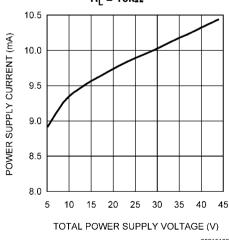
### Output Voltage vs Total Power Supply Voltage $R_1 = 600\Omega$ , THD+N = 1%



### Power Supply Current vs Total Power Supply Voltage $R_1 = 2k\Omega$

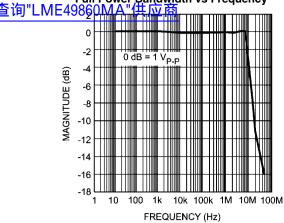


### Power Supply Current vs Total Power Supply Voltage $R_L = 10k\Omega$



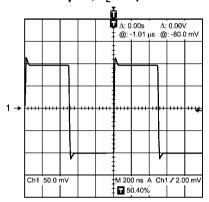
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Full Power Bandwidth vs Frequency



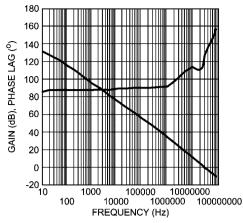
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### **Small-Signal Transient Response** $A_V = 1, C_L = 10pF$



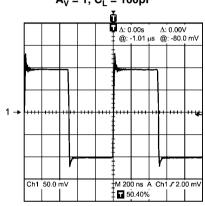
202151i7

### **Gain Phase vs Frequency**



202151j1

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



202151i8

### Application Information 查询"LME49860MA"供应商

### DISTORTION MEASUREMENTS

The vanishingly low residual distortion produced by LME49860 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 LME49860's low residual distortion is an input referred internal error. As shown in Figure 1, adding the  $10\Omega$  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.

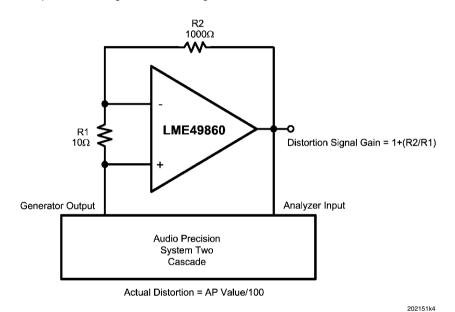
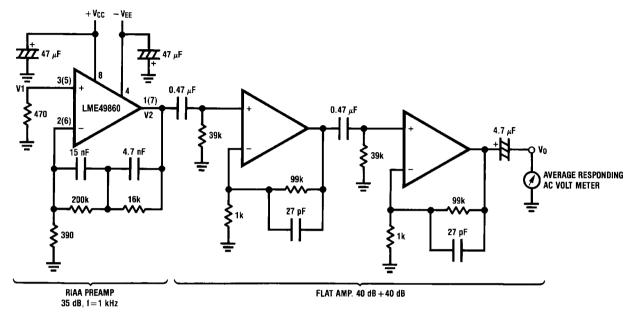


FIGURE 1. THD+N and IMD Distortion Test Circuit

The LME49860 is a high speed op amp with excellent phase harpin and stability Carletings and sup 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.

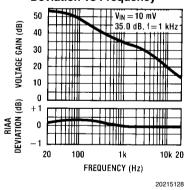


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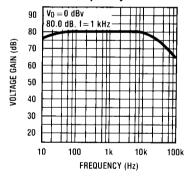
Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

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

### RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



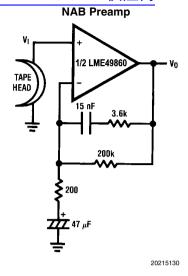
### Flat Amp Voltage Gain vs Frequency



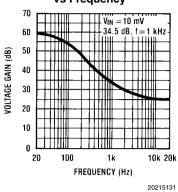
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### **TYPICAL APPLICATIONS**

### 查询"LME49860MA"供应商

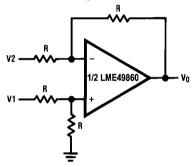


# NAB Preamp Voltage Gain vs Frequency



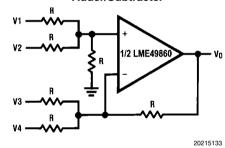
 $A_V = 34.5$  F = 1 kHz  $E_n = 0.38 \mu\text{V}$ A Weighted

### **Balanced to Single Ended Converter**



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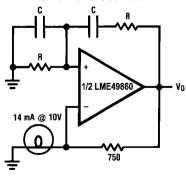
### Adder/Subtracter



 $V_0 = V1 + V2 - V3 - V4$ 

 $V_O = V1-V2$ 

### Sine Wave Oscillator



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$$f_0 = \frac{1}{2\pi BC}$$

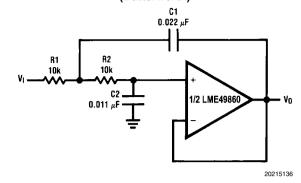
### Second Order High Pass Filter 查询"LME49860MA"(<mark>碘吨钝</mark>vorth)

# C1 0.01 μF 0.01 μF 1/2 LME49860 V<sub>0</sub>

$$R1 = \frac{\sqrt{2}}{2w-C}$$

Illustration is  $f_0 = 1 \text{ kHz}$ 

### Second Order Low Pass Filter (Butterworth)

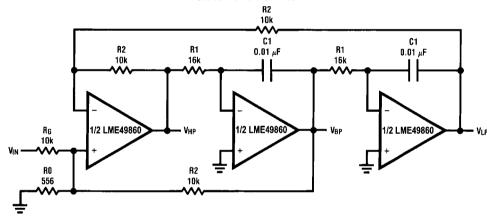


$$C1 = \frac{\sqrt{2}}{\omega_0 R}$$

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

Illustration is  $f_0 = 1 \text{ kHz}$ 

### State Variable Filter



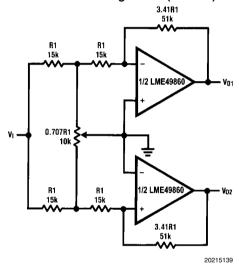
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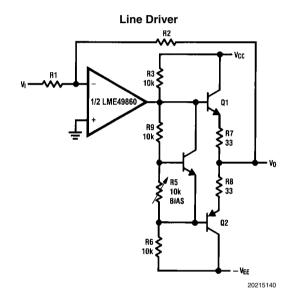
$$f_0 = \frac{1}{2\pi C1 R1}, Q = \frac{1}{2} \left( 1 + \frac{R2}{R0} + \frac{R2}{RG} \right), A_{BP} = QA_{LP} = QA_{LH} = \frac{R2}{RG}$$

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

# 本C/DC Converter \*\*E询"LME49860MA"供应商 \*\*R5 20k 10k 20k 10k 20k 10k 1/2 LME49860 1/2 LME49860 1/2 LME49860 \*\*PRODUCTION TO THE TO THE

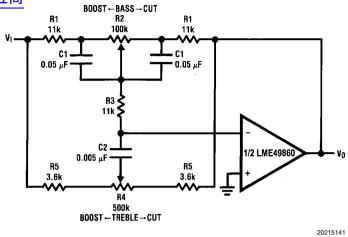
### 2 Channel Panning Circuit (Pan Pot)





### 查询"LME49860MA"供应商

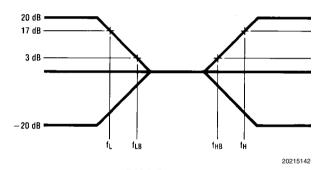
### **Tone Control**

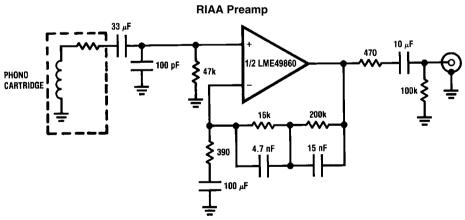


$$\begin{split} f_L &= \frac{1}{2\pi R2C1}, f_{LB} = \frac{1}{2\pi R1C1} \\ f_H &= \frac{1}{2\pi R5C2}, f_{HB} = \frac{1}{2\pi (R1 + R5 + 2R3)C2} \end{split}$$

Illustration is:

$$f_L = 32 \text{ Hz}, f_{LB} = 320 \text{ Hz}$$
  
 $f_H = 11 \text{ kHz}, f_{HB} = 1.1 \text{ kHz}$ 





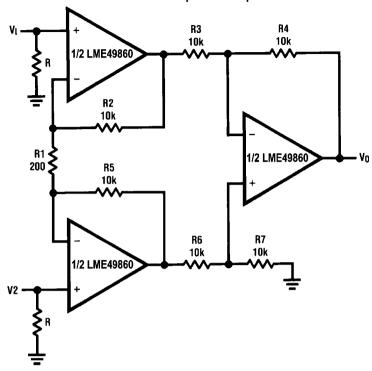
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 $\begin{array}{l} A_v = 35 \text{ dB} \\ E_n = 0.33 \text{ µV} \\ \text{S/N} = 90 \text{ dB} \\ \text{f} = 1 \text{ kHz} \\ \text{A Weighted} \\ \text{A Weighted}, V_{\text{IN}} = 10 \text{ mV} \end{array}$ 

@f = 1 kHz

### 查询"LME49860MA"供应商

### **Balanced Input Mic Amp**



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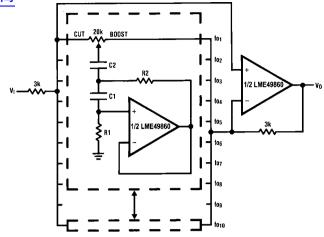
If R2 = R5, R3 = R6, R4 = R7  

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

Illustration is: V0 = 101(V2 - V1)

### 查询"LME49860MA"供应商

### 10 Band Graphic Equalizer



20215144

fo (Hz)	C <sub>1</sub>	C <sub>2</sub>	R <sub>1</sub>	R <sub>2</sub>
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 =  $\pm 12 \text{ dB}$ 

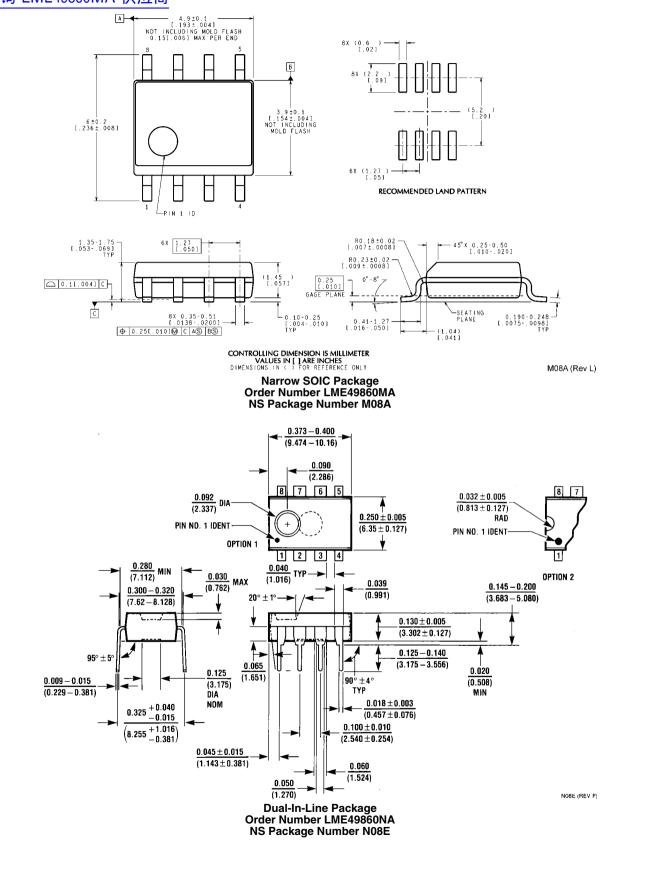
Q = 1.7

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

Revision History 查询"LME49860MA"供应商

Rev	Date	Description
1.0	06/01/07	Initial release.
1.1	06/11/07	Added the LME49860MA and LME49860NA Top Mark Information.

### Physical Dimensions inches (millimeters) unless otherwise noted 查询"LME49860MA"供应商



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Performance, High Fidelity Audio Operational Amplifier

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