LME49871 High Performance, High Fidelity Current Feedback Audio Operational Amplifier

Check for Samples: LME49871

FEATURES

- **Easily drives 150Ω loads**
- **Optimized for superior audio signal fidelity**
- **Output short circuit protection**
- **SOIC package**

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**

KEY SPECIFICATIONS

- **Power Supply Voltage Range ±5V to ±22V**
- **THD+N (AV = 1, RL = 100Ω, VOUT = 2VP-P, f = 1kHz) 0.00021% (typ)**
- **THD+N (AV = 1, RL = 600Ω, VOUT = 1.4VRMS, f = 1kHz) 0.00012% (typ)**
- **Input Noise Density 1.9nV/√Hz (typ)**
- **Slew Rate ±1900V/μs (typ)**
- **Bandwidth (AV = 1, RL= 2kΩ, RF = 800Ω) 213MHz (typ)**
- **Input Bias Current 1.8μA (typ)**
- **Input Offset Voltage 0.05mV (typ)**
- **PSRR 102dB (typ)**
- **CMRR 90dB (typ)**

DESCRIPTION

The LME49871 is an ultra-low distortion, low noise, ultra high slew rate current feedback operational amplifier optimized and fully specified for high performance, high fidelity applications. Combining advanced leading-edge process technology with state-of-the-art circuit design, the LME49871 current feedback operational amplifier delivers superior signal amplification for outstanding performance. Operating on a wide supply range of ±5V to ±22V, the LME49871 combines extremely low voltage noise density (1.9nV/√Hz) with very low THD+N (0.00012%) to easily satisfy the most demanding applications. To ensure that the most challenging loads are driven without compromise, the LME49871 has a high slew rate of ±1900V/μs and an output current capability of ±100mA. Further, dynamic range is maximized by an output stage that drives 150Ω loads to within 2.9V of either power supply voltage.

The LME49871 's outstanding CMRR (88dB), PSRR (102dB), and V_{OS} (0.05mV) give the amplifier excellent operational amplifier DC performance.

The LME49871 is available in an 8–lead narrow body SOIC. Demonstration boards are available.

Connection Diagram

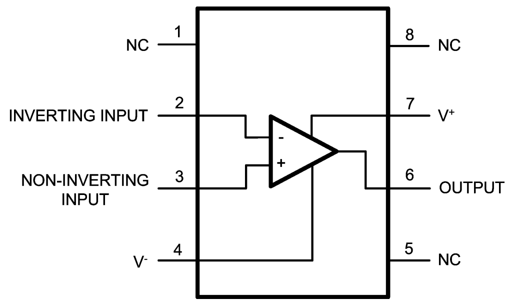

Figure 1. 8-Lead SOIC Package
See D Package

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings (1) (2)(3)

Power Supply Voltage	$V_S = V^+ - V^-$	46V
Storage Temperature		−65°C to 150°C
Input Voltage		(V-) - 0.7V to (V+) + 0.7V
Output Short Circuit (4)		Continuous
Power Dissipation		Internally Limited
ESD Rating (5)		2000V
ESD Rating (6)	Pins 1, 4, 7 and 8	200V
	Pins 2, 3, 5 and 6	100V
Junction Temperature		150°C
Thermal Resistance	θ_{JA} (MA)	145°C/W
Temperature Range	$T_{MIN} \le T_A \le T_{MAX}$	$-40°C \le T_A \le 85°C$
Supply Voltage Range		$\pm5.0V \le V_S \le \pm22V$

(1) *"Absolute Maximum Ratings"* indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The*Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.
(2) The *Electrical Characteristics* tables list ensured specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not ensured
(3) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(4) Amplifier output connected to GND, any number of amplifiers within a package.
(5) Human body model, applicable std. JESD22-A114C.
(6) Machine model, applicable std. JESD22-A115-A.

Electrical Characteristics (1)(2)

The following specifications apply for ±22V, $R_L = 2k\Omega$, $R_{SOURCE} = 10\Omega$, $f_{IN} = 1kHz$, and $T_A = 25°C$, unless otherwise specified.

Symbol	Parameter	Conditions	LME49871 Typical See (3)	LME49871 Limit See (4)	Units (Limits)
THD+N	Total Harmonic Distortion + Noise	$A_V = 1$, f = 1kHz, $R_F = 1.2k\Omega$ $R_L = 100\Omega$, $V_{OUT} = 3V_{RMS}$ $R_L = 600\Omega$, $V_{OUT} = 1.4V_{RMS}$	0.00021 0.00012		% %
IMD	Intermodulation Distortion	$A_V = 1$, $V_{IN} = 3V_{RMS}$ Two-tone, 60Hz & 7kHz 4:1	0.00009		%
BW	Bandwidth	$A_V = -1$, $R_F = 800\Omega$	213		MHz
SR	Slew Rate	$V_{OUT} = 20V_{P-P}$, $A_V = -5$	±1900		V/µs
FPBW	Full Power Bandwidth	$V_{OUT} = 20V_{P-P}$, –3dB referenced to output magnitude at f = 1kHz, $A_V = 1$	30		MHz
t_s	Settling Time	$A_V = -1$, 10V step, 0.1% error range	50		ns
e_n	Equivalent Input Noise Voltage	f_{BW} = 20Hz to 20kHz	0.26	0.6	μV_{RMS} (max)
	Equivalent Input Noise Density	f = 1kHz f = 10Hz	1.9 11.5	4.0	$nV/\sqrt{Hz}$ (max)

(1) *"Absolute Maximum Ratings"* indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The*Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.
(2) The *Electrical Characteristics* tables list ensured specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not ensured
(3) Typical values represent most likely parametric norms at T_A = +25ºC, and at the *Recommended Operation Conditions* at the time of product characterization and are not ensured.
(4) Datasheet min/max specification limits are specified by test or statistical analysis.

Electrical Characteristics[1][2] (continued)

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

Symbol	Parameter	Conditions	LME49871 Typical See[3]	LME49871 Limit See[4]	Units (Limits)
i_n	Current Noise Density	f = 1kHz f = 10Hz	16 160		pA/√Hz pA/√Hz
V_{OS}	Input Offset Voltage		±0.05	±1.0	mV (max)
$\Delta V_{OS}/\Delta Temp$	Average Input Offset Voltage Drift vs Temperature	–40°C ≤ T_A ≤ 85°C	0.29		μV/°C
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	V_S = ±22V, ΔV_S = 30V (Note 8)	102	100	dB (min)
I_B	Input Bias Current	V_{CM} = 0V	1.8	6	μA (max)
$\Delta I_{OS}/\Delta Temp$	Input Bias Current Drift vs Temperature	–40°C ≤ T_A ≤ 85°C Inverting input Non-inverting input	 4.5 4.7		 nA/°C nA/°C
I_{OS}	Input Offset Current	V_{CM} = 0V	1.3	5	μA (max)
V_{IN-CM}	Common-Mode Input Voltage Range	V_S = ±22V	±20.5	(V+) – 1.0 (V-) + 1.0	V (min) V (min)
CMRR	Common-Mode Rejection	–10V ≤ V_{CM} ≤ 10V	90	86	dB (min)
Z_{IN}	Non-inverting-input Input Impedance	–10V ≤ V_{CM} ≤ 10V	1.2		MΩ
	Inverting-input Input Impedance	–10V ≤ V_{CM} ≤ 10V	58		Ω
Z_T	Transimpedance	V_{OUT} = ±10V R_L = 200Ω R_L = ∞	 4.2 4.7	 2.0 2.65	 MΩ (min) MΩ (min)
V_{OUTMAX}	Maximum Output Voltage Swing	R_L = 150Ω	±18.6	±17.6	V (min)
		R_L = 600Ω	±19.4	±18.4	V (min)
I_{OUT}	Output Current	R_L = 150Ω, V_S = ±22V	±100	±93	mA (min)
I_{OUT-CC}	Instantaneous Short Circuit Current		±140		mA
R_{OUT}	Output Resistance	f_{IN} = 5MHz Open-Loop	 10		 Ω
I_S	Total Quiescent Current	I_{OUT} = 0mA	8.3	9.5	mA (max)

Typical Performance Characteristics

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 3V_{RMS}, R_L = 1kΩ, V_S = ±15V, A_V = 1

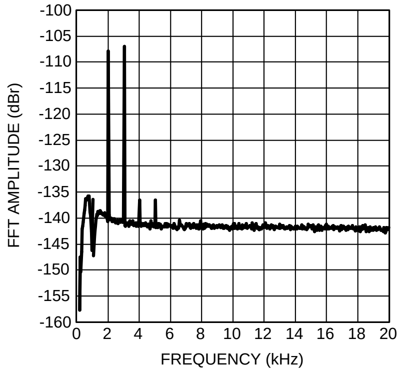

Figure 2.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 3V_{RMS}, R_L = 100Ω, V_S = ±15V, A_V = 1

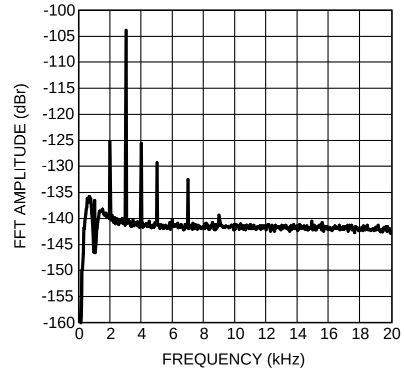

Figure 3.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 3V_{RMS}, R_L = 600Ω, V_S = ±15V, A_V = 1

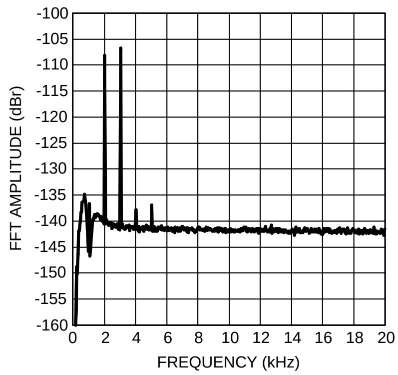

Figure 4.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 1.4V_{RMS}, R_L = 1kΩ, V_S = ±15V, A_V = 1

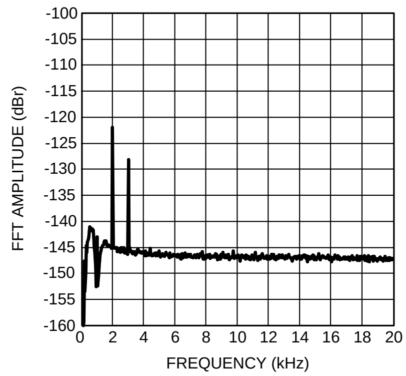

Figure 5.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 1.4V_{RMS}, R_L = 100Ω, V_S = ±15V, A_V = 1

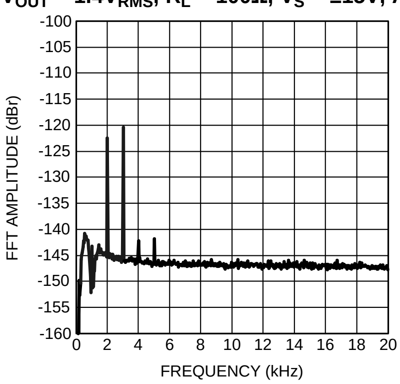

Figure 6.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 1.4V_{RMS}, R_L = 600Ω, V_S = ±15V, A_V = 1

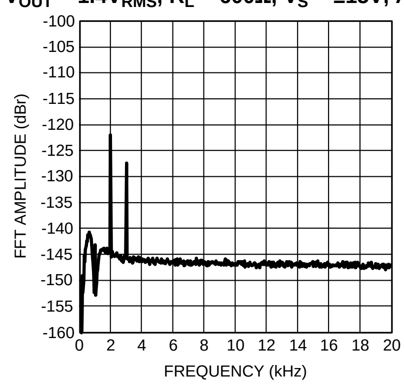

Figure 7.

Typical Performance Characteristics (continued)

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 3V_{RMS}, R_L = 1kΩ, V_S = ±22V, A_V = 1

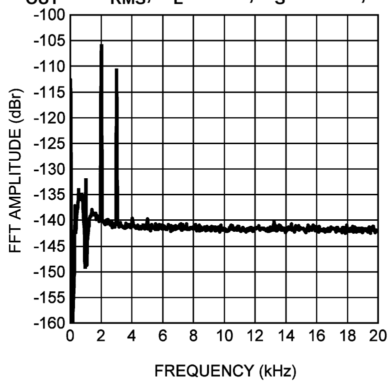

Figure 8.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 3V_{RMS}, R_L = 100Ω, V_S = ±22V, A_V = 1

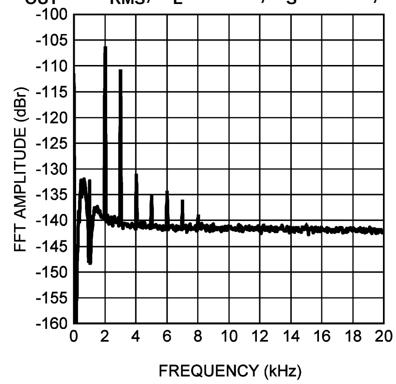

Figure 9.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 3V_{RMS}, R_L = 600Ω, V_S = ±22V, A_V = 1

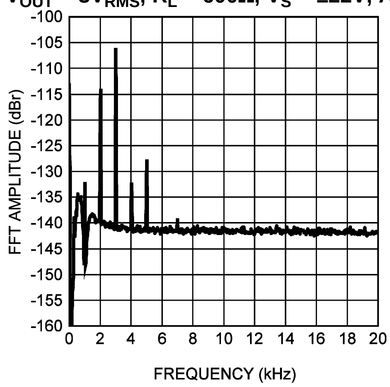

Figure 10.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 1.4V_{RMS}, R_L = 1kΩ, V_S = ±22V, A_V = 1

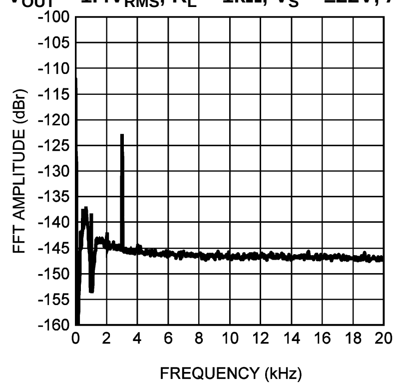

Figure 11.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 1.4V_{RMS}, R_L = 100Ω, V_S = ±22V, A_V = 1

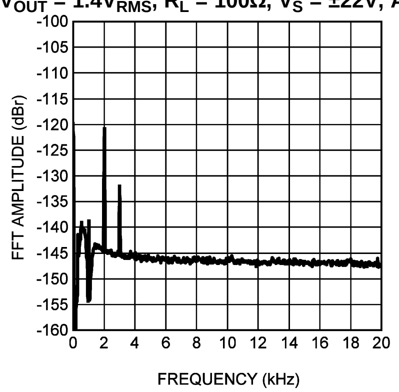

Figure 12.

FFT of 1kHz Sinewave, 0dBr Input Magnitude
V_{OUT} = 1.4V_{RMS}, R_L = 600Ω, V_S = ±22V, A_V = 1

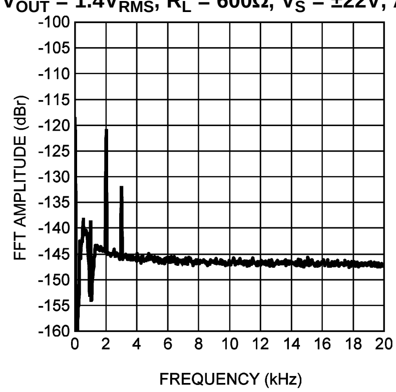

Figure 13.

Typical Performance Characteristics (continued)

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

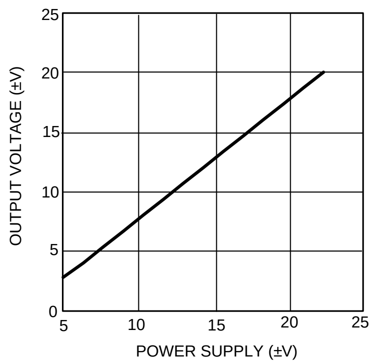

Figure 14.

Output Voltage vs Supply Voltage A_V = 1, R_L = open, 1% THD+N

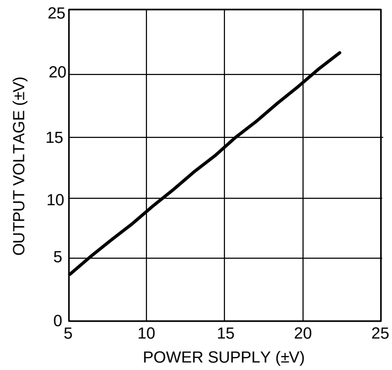

Figure 15.

Supply Current (I_{CC}) vs Power Supply R_L = open

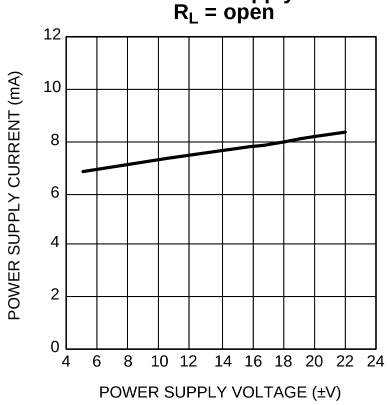

Figure 16.

Gain vs Frequency V_S = ±15V, G = –1

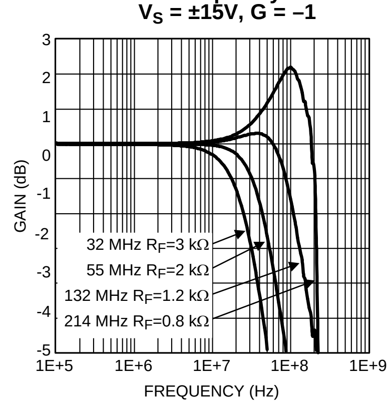

Figure 17.

Gain vs Frequency V_S = ±15V, G = –2

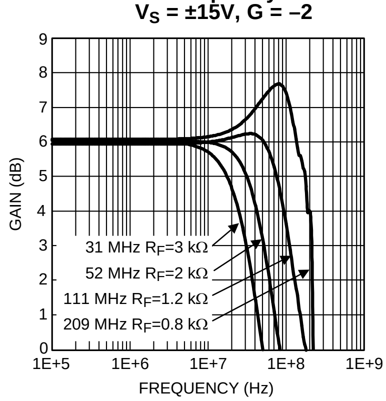

Figure 18.

Gain vs Frequency V_S = ±15V, G = –5

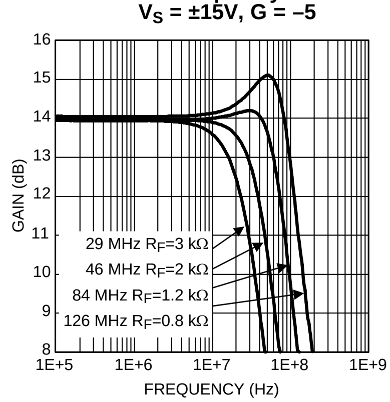

Figure 19.

Typical Performance Characteristics (continued)

Gain vs Frequency V_S = ±15V, G = –10

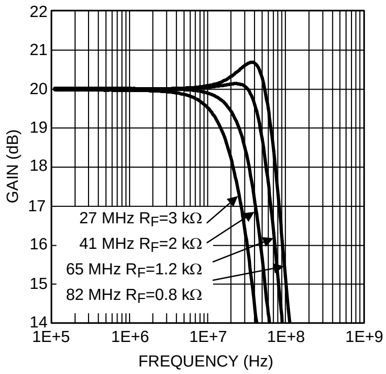

Figure 20.

Gain vs Frequency V_S = ±15V, R_F = 800Ω

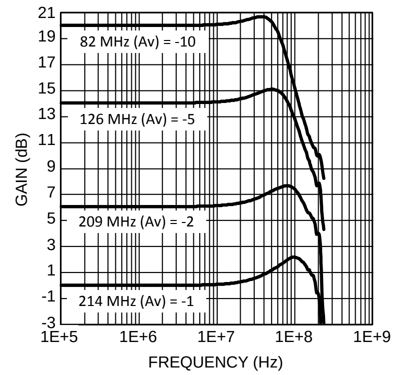

Figure 21.

Gain vs Frequency V_S = ±15V, R_F = 1.2kΩ

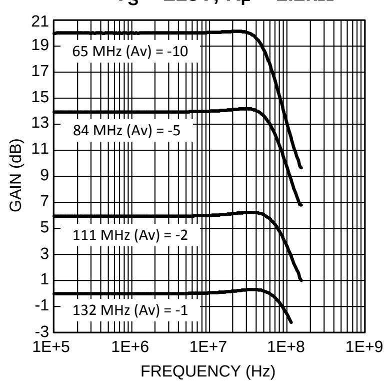

Figure 22.

Gain vs Frequency V_S = ±15V, R_F = 2kΩ

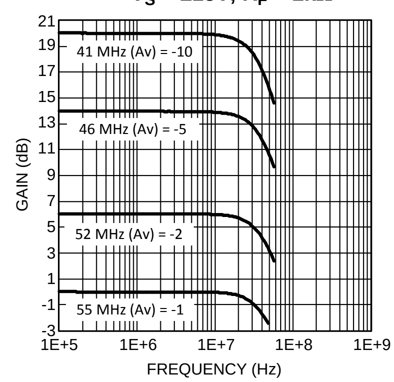

Figure 23.

Gain vs Frequency V_S = ±15V, R_F = 3kΩ

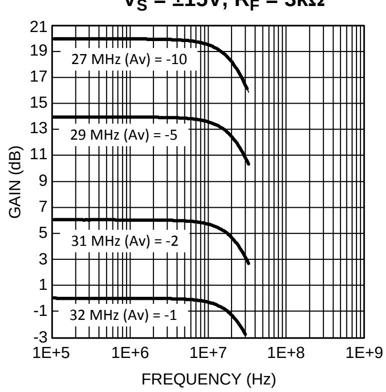

Figure 24.

Gain vs Frequency V_S = ±22V, R_F = 1.2kΩ

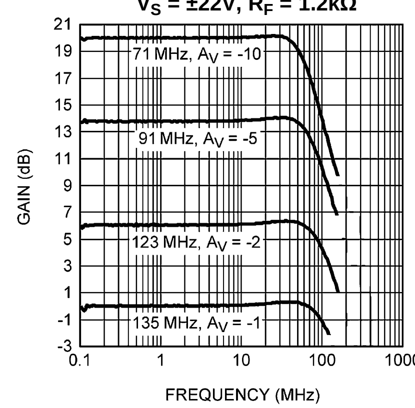

Figure 25.

Typical Performance Characteristics (continued)

Gain vs Frequency V_S = ±22V, R_F = 2kΩ

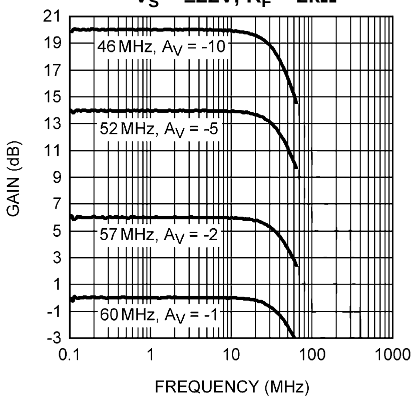

Figure 26.

Gain vs Frequency V_S = ±22V, R_F = 3kΩ

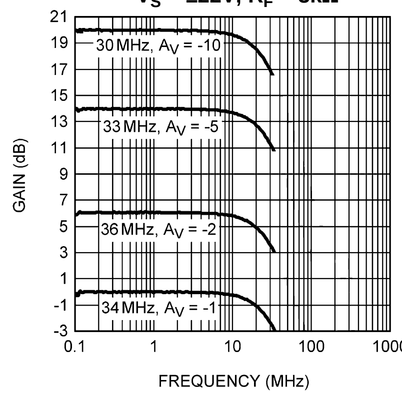

Figure 27.

Gain vs Frequency V_S = ±22V, R_F = 800Ω

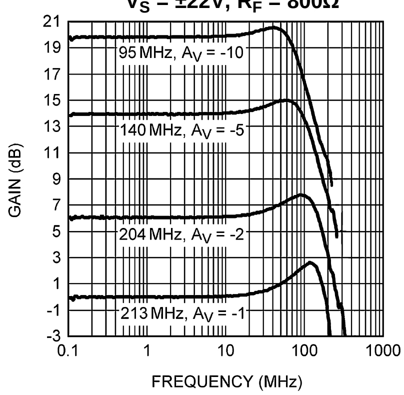

Figure 28.

Gain vs Frequency V_S = ±22V, A_V = –1

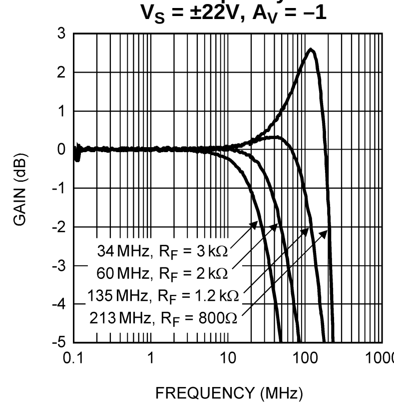

Figure 29.

Gain vs Frequency V_S = ±22V, A_V = –2

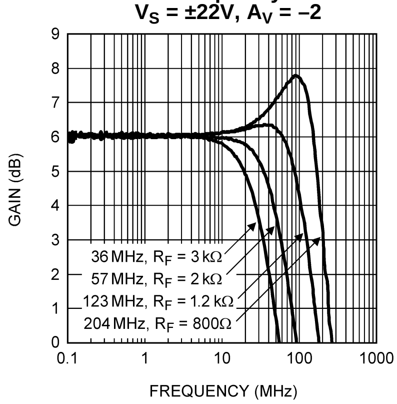

Figure 30.

Gain vs Frequency V_S = ±22V, A_V = –5

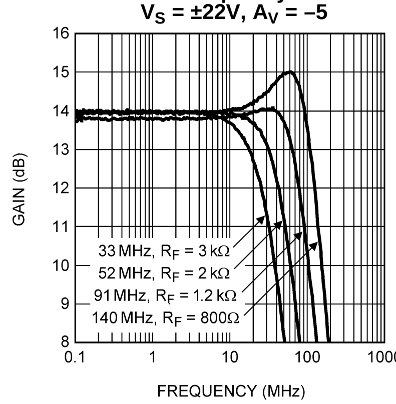

Figure 31.

Typical Performance Characteristics (continued)

Gain vs Frequency
V_S = ±22V, A_V = –10

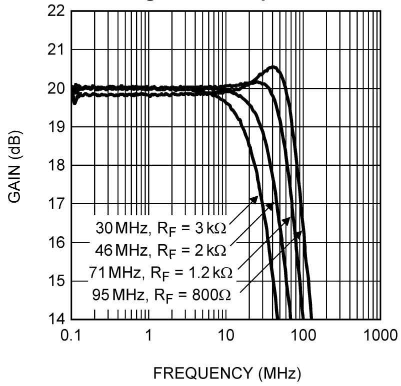

Figure 32.

APPLICATION INFORMATION

GENERAL AMPLIFIER FUNCTION

oltage feedback amplifiers have a small-signal bandwidth that is a function of the closed-loop gain. Conversely, the LME49871 current feedback amplifier features a small-signal bandwidth that is relatively independent of the closed-loop gain. This is shown in Figure 33 where the LME49871's gain is –1,–2, –5 and –10. Like all current feedback amplifiers, the LME49871's closed-loop bandwidth is a function of the feedback resistance value. Therefore, R_S must be varied to select the desired closed-loop gain.

POWER SUPPLY BYPASSING AND LAYOUT CONSIDERATIONS

Properly placed and correctly valued supply bypassing is essential for optimized high-speed amplifier operation. The supply bypassing must maintain a wideband, low-impedance capacitive connection between the amplifier's supply pin and ground. This helps preserve high speed signal and fast transient fidelity. The bypassing is easily accomplished using a parallel combination of a 10μF tantalum and a 0.1μF ceramic capacitors for each power supply pin. The bypass capacitors should be placed as close to the amplifier power supply pins as possible.

FEEDBACK RESISTOR SELECTION (R_f)

The value of the R_f, is also a dominant factor in compensating the LME49871. For general applications, the LME49871 will maintain specified performance with an 1.2kΩ feedback resistor. Although this value will provide good results for most applications, it may be advantageous to adjust this value slightly for best pulse response optimized for the desired bandwidth. In addition to reducing bandwidth, increasing the feedback resistor value also reduces overshoot in the time domain response.

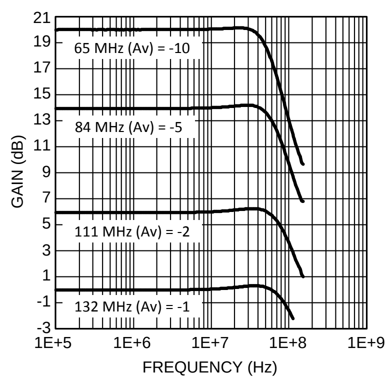

Figure 33. Bandwidth as a function of gain

SLEW RATE CONSIDERATIONS

A current feedback amplifier's slew rate characteristics are different than that of voltage feedback amplifiers. A voltage feedback amplifier's slew rate limiting or non-linear amplifier behavior is dominated by the finite availability of the first stage tail current charging the second stage voltage amplifier's compensation capacitor. Conversely, a current feedback amplifier's slew rate is not constant. Transient current at the inverting input determines slew rate for both inverting and non-inverting gains. The non-inverting configuration slew rate is also determined by input stage limitations. Accordingly, variations of slew rates occur for different circuit topologies.

DRIVING CAPACITIVE LOADS

The LME49871 can drive significantly higher capacitive loads than many current feedback amplifiers. Although the LME49871 can directly drive as much as 100pF without oscillating, the resulting response will be a function of the feedback resistor value.

CAPACITIVE FEEDBACK

It is quite common to place a small lead-compensation capacitor in parallel with a voltage feedback amplifier's feedback resistance, R_f. This compensation reduces the amplifier's peaking in the frequency domain and damps the transient response. Whereas this yields the expected results when used with voltage feedback amplifiers, this technique must not be used with current feedback amplifiers. The dynamic impedance of capacitors in the feedback loop reduces the amplifier's stability. Instead, reduced peaking in the frequency response and bandwidth limiting can be accomplished by adding an RC circuit to the amplifier's input.

Revision History

Rev	Date	Description
1.0	04/24/08	Initial release.
1.01	04/28/08	Changed the Limit values on V_{IN-CM} from –2.0 and +2.0 to –1.0 and +1.0.
C	04/10/13	Changed layout of National Data Sheet to TI format.

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