LM7171

LM7171 Very High Speed, High Output Current, Voltage Feedback Amplifier

Literature Number: SNOS760A

National Semiconductor

May 2006

LM7171
Very High Speed, High Output Current, Voltage Feedback Amplifier

General Description

The LM7171 is a high speed voltage feedback amplifier that has the slewing characteristic of a current feedback amplifier; yet it can be used in all traditional voltage feedback amplifier configurations. The LM7171 is stable for gains as low as +2 or −1. It provides a very high slew rate at 4100V/µs and a wide unity-gain bandwidth of 200 MHz while consuming only 6.5 mA of supply current. It is ideal for video and high speed signal processing applications such as HDSL and pulse amplifiers. With 100 mA output current, the LM7171 can be used for video distribution, as a transformer driver or as a laser diode driver.

Operation on ±15V power supplies allows for large signal swings and provides greater dynamic range and signal-to-noise ratio. The LM7171 offers low SFDR and THD, ideal for ADC/DAC systems. In addition, the LM7171 is specified for ±5V operation for portable applications.

The LM7171 is built on National's advanced VIP™ III (Vertically integrated PNP) complementary bipolar process.

Features

(Typical Unless Otherwise Noted)

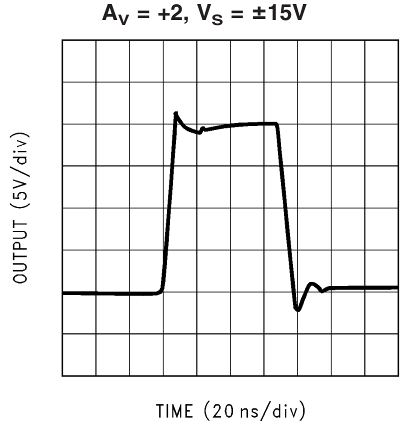
- Easy-to-use voltage feedback topology
- Very high slew rate: 4100 V/µs
- Wide unity-gain bandwidth: 200 MHz
- −3 dB frequency @ A_V = +2: 220 MHz
- Low supply current: 6.5 mA
- High open loop gain: 85 dB
- High output current: 100 mA
- Differential gain and phase: 0.01%, 0.02°
- Specified for ±15V and ±5V operation

Applications

- HDSL and ADSL drivers
- Multimedia broadcast systems
- Professional video cameras
- Video amplifiers
- Copiers/scanners/fax
- HDTV amplifiers
- Pulse amplifiers and peak detectors
- CATV/fiber optics signal processing

Typical Performance

Large Signal Pulse Response
A_V = +2, V_S = ±15V



01238501

VIP™ is a trademark of National Semiconductor Corporation.

 DS012385

Absolute Maximum Ratings (Note 1)

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

ESD Tolerance (Note 2)	2.5 kV
Supply Voltage ($V^+ – V^-$)	36V
Differential Input Voltage (Note 11)	±10V
Output Short Circuit to Ground	
(Note 3)	Continuous
Storage Temperature Range	–65˚C to +150˚C
Maximum Junction Temperature	
(Note 4)	150˚C

Operating Ratings (Note 1)

Supply Voltage	$5.5V \leq V_S \leq 36V$
Junction Temperature Range	
LM7171AI, LM7171BI	$-40˚C \leq T_J \leq +85˚C$
Thermal Resistance (θ_{JA})	
8-Pin MDIP	108˚C/W
8-Pin SOIC	172˚C/W

±15V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, V^+ = +15V, V^- = –15V, V_{CM} = 0V, and R_L = 1 kΩ. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		0.2	1 **4**	3 **7**	mV max
TC V_{OS}	Input Offset Voltage Average Drift		35			μV/˚C
I_B	Input Bias Current		2.7	10 **12**	10 **12**	μA max
I_{OS}	Input Offset Current		0.1	4 **6**	4 **6**	μA max
R_{IN}	Input Resistance	Common Mode	40			MΩ
		Differential Mode	3.3			
R_O	Open Loop Output Resistance		15			Ω
CMRR	Common Mode Rejection Ratio	V_{CM} = ±10V	105	85 **80**	75 **70**	dB min
PSRR	Power Supply Rejection Ratio	V_S = ±15V to ±5V	90	85 **80**	75 **70**	dB min
V_{CM}	Input Common-Mode Voltage Range	CMRR > 60 dB	±13.35			V
A_V	Large Signal Voltage Gain (Note 7)	R_L = 1 kΩ	85	80 **75**	75 **70**	dB min
		R_L = 100Ω	81	75 **70**	70 **66**	dB min
V_O	Output Swing	R_L = 1 kΩ	13.3	13 **12.7**	13 **12.7**	V min
			–13.2	–13 **–12.7**	–13 **–12.7**	V max
		R_L = 100Ω	11.8	10.5 **9.5**	10.5 **9.5**	V min
			–10.5	–9.5 **–9**	–9.5 **–9**	V max
	Output Current (Open Loop) (Note 8)	Sourcing, R_L = 100Ω	118	105 **95**	105 **95**	mA min
		Sinking, R_L = 100Ω	105	95 **90**	95 **90**	mA max

±15V DC Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ C$, $V^+ = +15V$, $V^- = -15V$, $V_{CM} = 0V$, and $R_L = 1\ k\Omega$. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
	Output Current (in Linear Region)	Sourcing, $R_L = 100\Omega$	100			mA
		Sinking, $R_L = 100\Omega$	100			
I_{SC}	Output Short Circuit Current	Sourcing	140			mA
		Sinking	135			
I_S	Supply Current		6.5	8.5 **9.5**	8.5 **9.5**	mA max

±15V AC Electrical Characteristics

Unless otherwise specified, $T_J = 25^\circ C$, $V^+ = +15V$, $V^- = -15V$, $V_{CM} = 0V$, and $R_L = 1\ k\Omega$.

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
SR	Slew Rate (Note 9)	$A_V = +2$, $V_{IN} = 13\ V_{PP}$	4100			V/µs
		$A_V = +2$, $V_{IN} = 10\ V_{PP}$	3100			
	Unity-Gain Bandwidth		200			MHz
	−3 dB Frequency	$A_V = +2$	220			MHz
ϕ_m	Phase Margin		50			Deg
t_s	Settling Time (0.1%)	$A_V = -1$, $V_O = \pm 5V$ $R_L = 500\Omega$	42			ns
t_p	Propagation Delay	$A_V = -2$, $V_{IN} = \pm 5V$, $R_L = 500\Omega$	5			ns
A_D	Differential Gain (Note 10)		0.01			%
ϕ_D	Differential Phase (Note 10)		0.02			Deg
	Second Harmonic (Note 12)	$f_{IN} = 10$ kHz	−110			dBc
		$f_{IN} = 5$ MHz	−75			dBc
	Third Harmonic (Note 12)	$f_{IN} = 10$ kHz	−115			dBc
		$f_{IN} = 5$ MHz	−55			dBc
e_n	Input-Referred Voltage Noise	f = 10 kHz	14			$\frac{nV}{\sqrt{Hz}}$
i_n	Input-Referred Current Noise	f = 10 kHz	1.5			$\frac{pA}{\sqrt{Hz}}$

±5V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ C$, $V^+ = +5V$, $V^- = -5V$, $V_{CM} = 0V$, and $R_L = 1\ k\Omega$. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		0.3	1.5 **4**	3.5 **7**	mV max
TC V_{OS}	Input Offset Voltage Average Drift		35			µV/˚C
I_B	Input Bias Current		3.3	10 **12**	10 **12**	µA max
I_{OS}	Input Offset Current		0.1	4	4	µA

±5V DC Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, V^+ = +5V, V^- = –5V, V_{CM} = 0V, and R_L = 1 kΩ. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
				6	**6**	max
R_{IN}	Input Resistance	Common Mode	40			MΩ
		Differential Mode	3.3			
R_O	Output Resistance		15			Ω
CMRR	Common Mode Rejection Ratio	V_{CM} = ±2.5V	104	80 **75**	70 **65**	dB min
PSRR	Power Supply Rejection Ratio	V_S = ±15V to ±5V	90	85 **80**	75 **70**	dB min
V_{CM}	Input Common-Mode Voltage Range	CMRR > 60 dB	±3.2			V
A_V	Large Signal Voltage Gain (Note 7)	R_L = 1 kΩ	78	75 **70**	70 **65**	dB min
		R_L = 100Ω	76	72 **67**	68 **63**	dB min
V_O	Output Swing	R_L = 1 kΩ	3.4	3.2 **3**	3.2 **3**	V min
			–3.4	–3.2 **–3**	–3.2 **–3**	V max
		R_L = 100Ω	3.1	2.9 **2.8**	2.9 **2.8**	V min
			–3.0	–2.9 **–2.8**	–2.9 **–2.8**	V max
	Output Current (Open Loop) (Note 8)	Sourcing, R_L = 100Ω	31	29 **28**	29 **28**	mA min
		Sinking, R_L = 100Ω	30	29 **28**	29 **28**	mA max
I_{SC}	Output Short Circuit Current	Sourcing	135			mA
		Sinking	100			
I_S	Supply Current		6.2	8 **9**	8 **9**	mA max

±5V AC Electrical Characteristics

Unless otherwise specified, T_J = 25˚C, V^+ = +5V, V^- = –5V, V_{CM} = 0V, and R_L = 1 kΩ.

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
SR	Slew Rate (Note 9)	A_V = +2, V_{IN} = 3.5 V_{PP}	950			V/µs
	Unity-Gain Bandwidth		125			MHz
	–3 dB Frequency	A_V = +2	140			MHz
ϕ_m	Phase Margin		57			Deg
t_s	Settling Time (0.1%)	A_V = –1, V_O = ±1V, R_L = 500Ω	56			ns
t_p	Propagation Delay	A_V = –2, V_{IN} = ±1V, R_L = 500Ω	6			ns
A_D	Differential Gain (Note 1)		0.02			%
ϕ_D	Differential Phase (Note 10)		0.03			Deg

±5V AC Electrical Characteristics (Continued)

Unless otherwise specified, $T_J = 25^\circ C$, $V^+ = +5V$, $V^- = -5V$, $V_{CM} = 0V$, and $R_L = 1\ k\Omega$.

Symbol	Parameter	Conditions	Typ (Note 5)	LM7171AI Limit (Note 6)	LM7171BI Limit (Note 6)	Units
	Second Harmonic (Note 12)	f_{IN} = 10 kHz	−102			dBc
		f_{IN} = 5 MHz	−70			dBc
	Third Harmonic (Note 12)	f_{IN} = 10 kHz	−110			dBc
		f_{IN} = 5 MHz	−51			dBc
e_n	Input-Referred Voltage Noise	f = 10 kHz	14			$\frac{nV}{\sqrt{Hz}}$
i_n	Input-Referred Current Noise	f = 10 kHz	1.8			$\frac{pA}{\sqrt{Hz}}$

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: Human body model, 1.5 kΩ in series with 100 pF.

Note 3: Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150˚C.

Note 4: The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

Note 5: Typical values represent the most likely parametric norm.

Note 6: All limits are guaranteed by testing or statistical analysis.

Note 7: Large signal voltage gain is the total output swing divided by the input signal required to produce that swing. For $V_S = \pm15V$, $V_{OUT} = \pm5V$. For $V_S = \pm5V$, $V_{OUT} = \pm1V$.

Note 8: The open loop output current is guaranteed, by the measurement of the open loop output voltage swing, using 100Ω output load.

Note 9: Slew Rate is the average of the raising and falling slew rates.

Note 10: Differential gain and phase are measured with $A_V = +2$, $V_{IN} = 1\ V_{PP}$ at 3.58 MHz and both input and output 75Ω terminated.

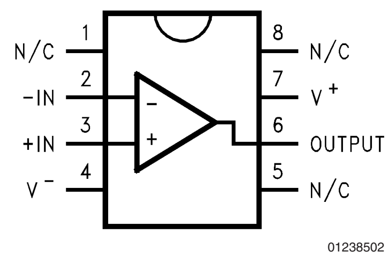
Note 11: Input differential voltage is applied at $V_S = \pm15V$.

Note 12: Harmonics are measured with $V_{IN} = 1\ V_{PP}$, $A_V = +2$ and $R_L = 100\Omega$.

Note 13: The THD measurement at low frequency is limited by the test instrument.

Connection Diagram

8-Pin DIP/SO



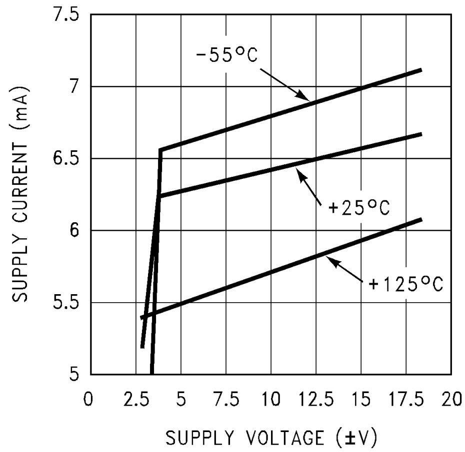
Top View

Ordering Information

Package	Temperature Range		Transport Media	NSC Drawing
	Industrial −40˚C to +85˚C	Military −55˚C to +125˚C		
8-Pin SOIC	LM7171AIM		Rails	M08A
	LM7171AIMX		Tape and Reel	
	LM7171BIM		Rails	
	LM7171BIMX		Tape and Reel	
8-Pin MDIP	LM7171AIN		Rails	N08E
	LM7171BIN		Rails	

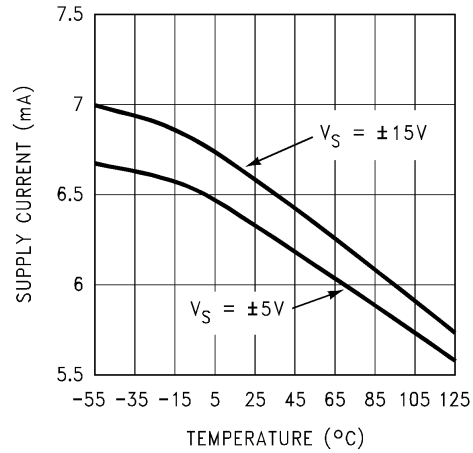
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C

Supply Current vs. Supply Voltage



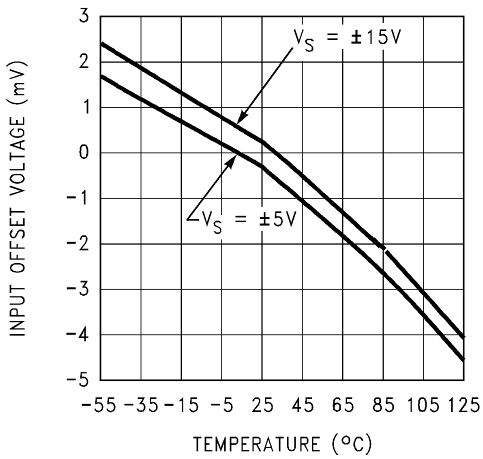
01238563

Supply Current vs. Temperature



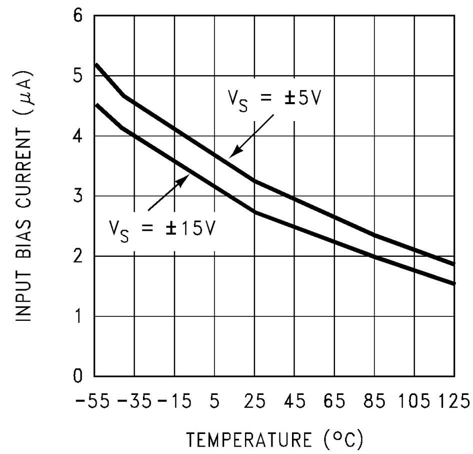
01238564

Input Offset Voltage vs. Temperature



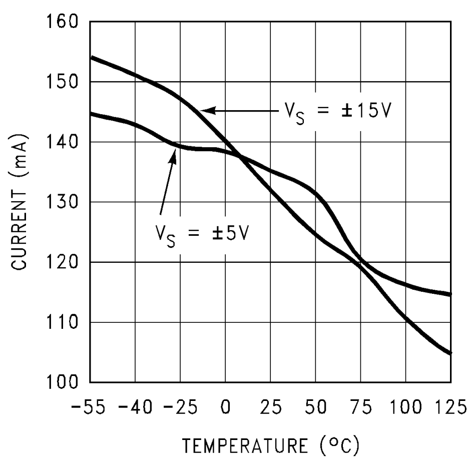
01238565

Input Bias Current vs. Temperature



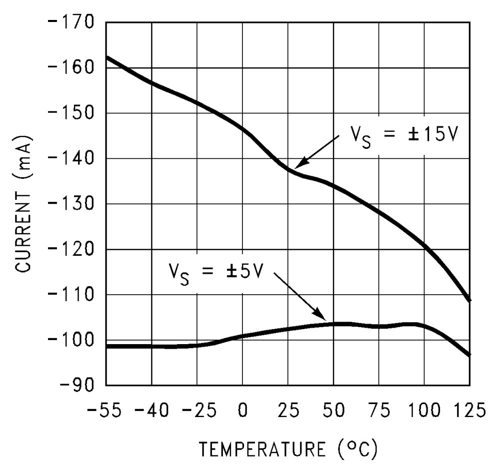
01238566

Short Circuit Current vs. Temperature (Sourcing)



01238567

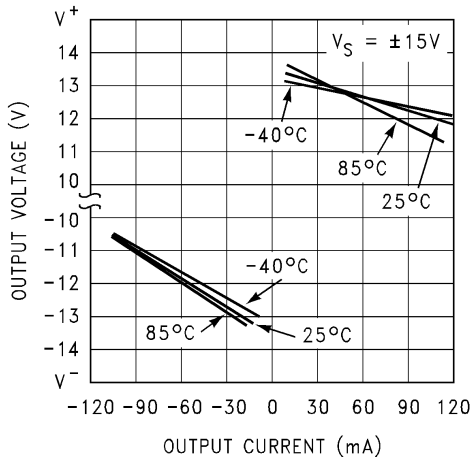
Short Circuit Current vs. Temperature (Sinking)



01238568

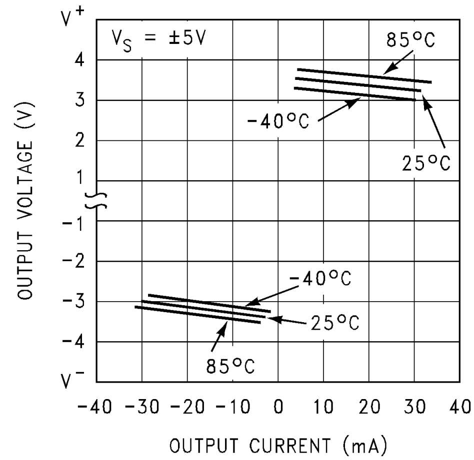
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Output Voltage vs. Output Current



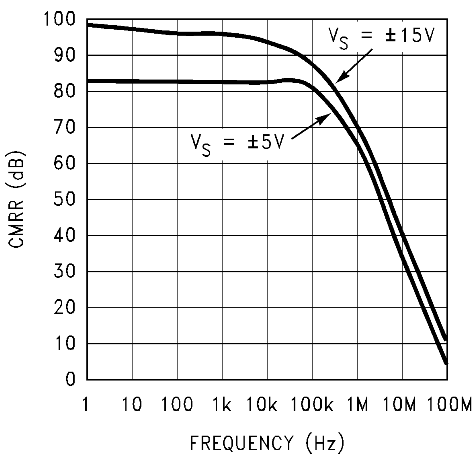
01238569

Output Voltage vs. Output Current



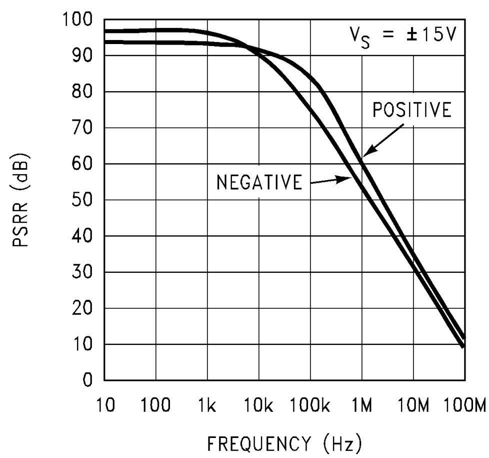
01238570

CMRR vs. Frequency



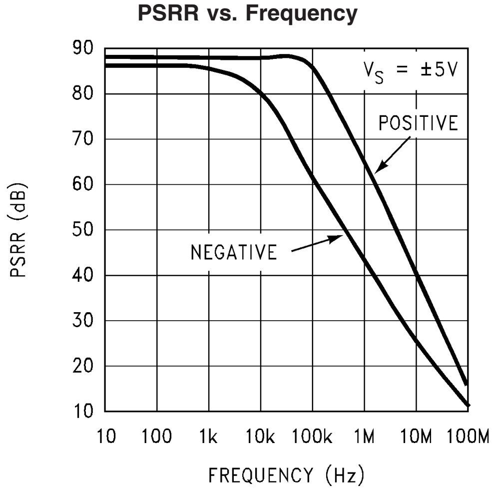
01238571

PSRR vs. Frequency



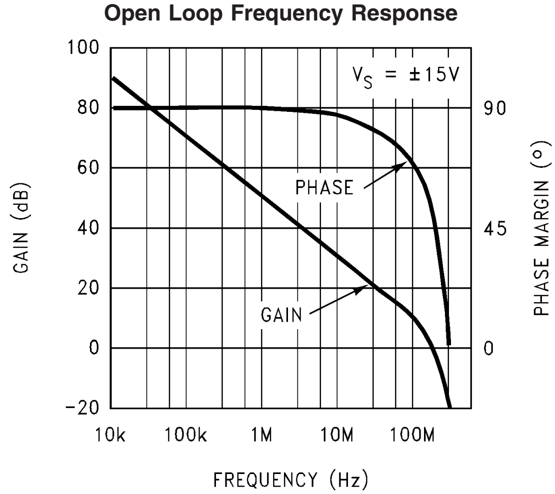
01238572

PSRR vs. Frequency



01238573

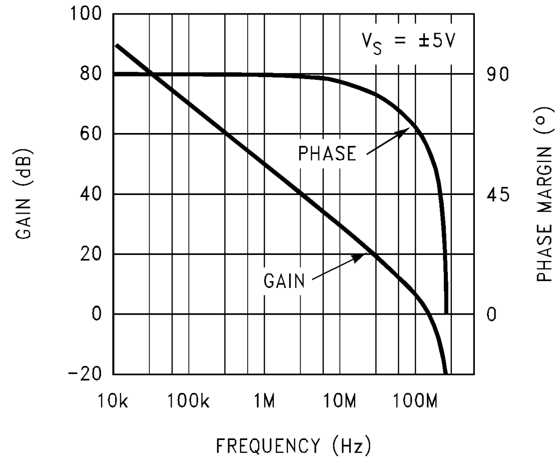
Open Loop Frequency Response



01238551

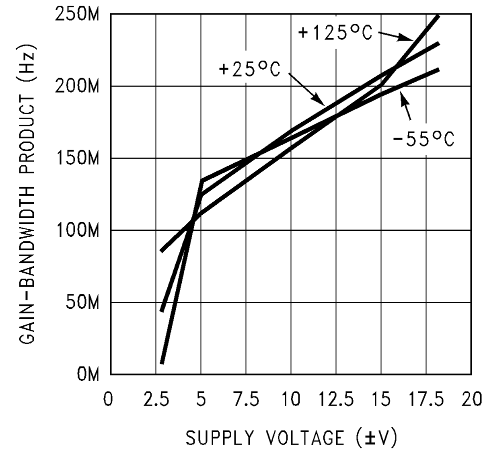
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Open Loop Frequency Response



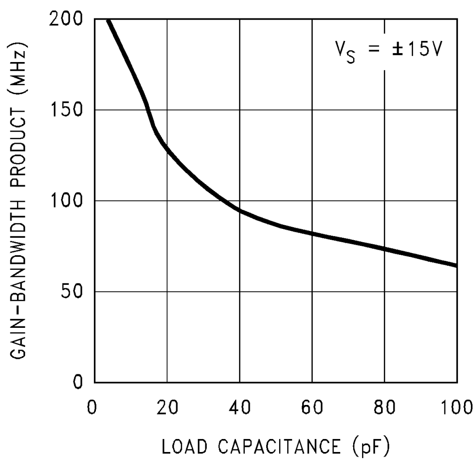
01238552

Gain-Bandwidth Product vs. Supply Voltage



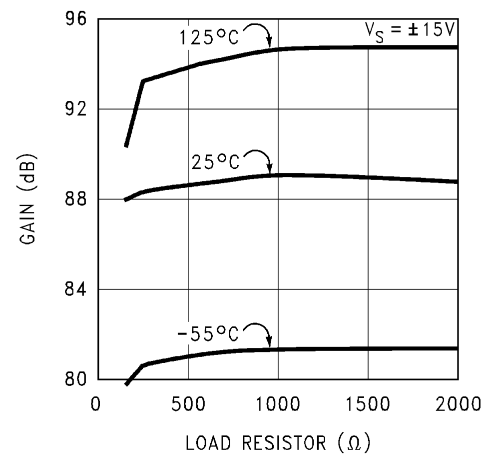
01238553

Gain-Bandwidth Product vs. Load Capacitance



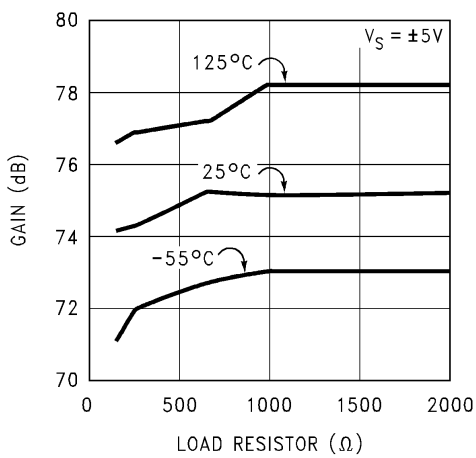
01238554

Large Signal Voltage Gain vs. Load



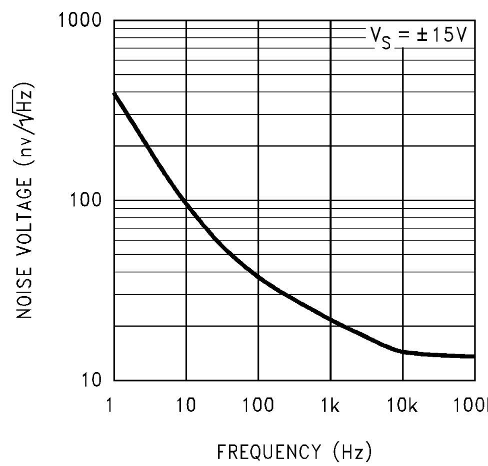
01238555

Large Signal Voltage Gain vs. Load



01238556

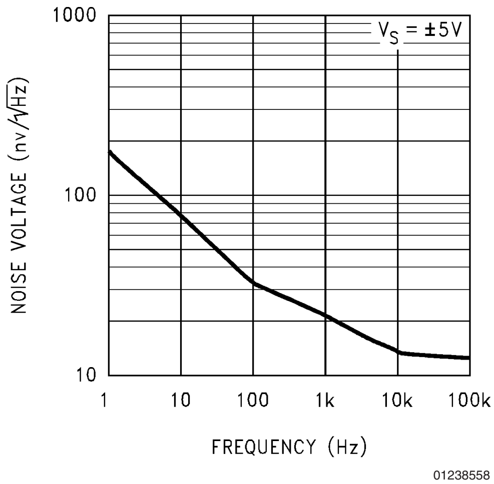
Input Voltage Noise vs. Frequency



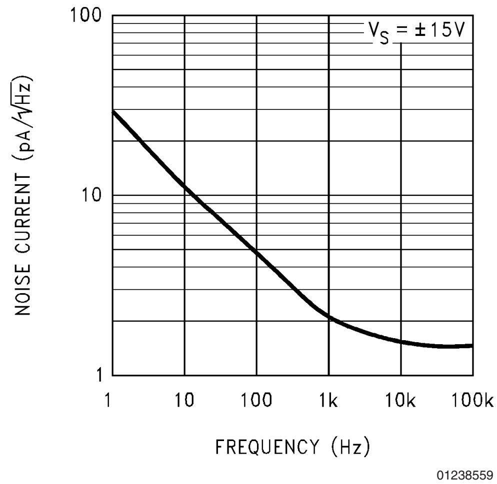
01238557

Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

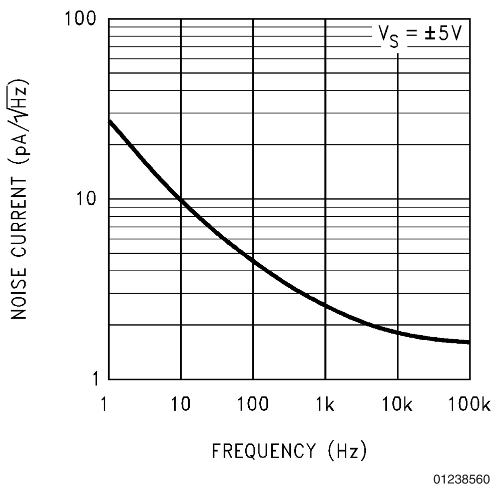
Input Voltage Noise vs. Frequency



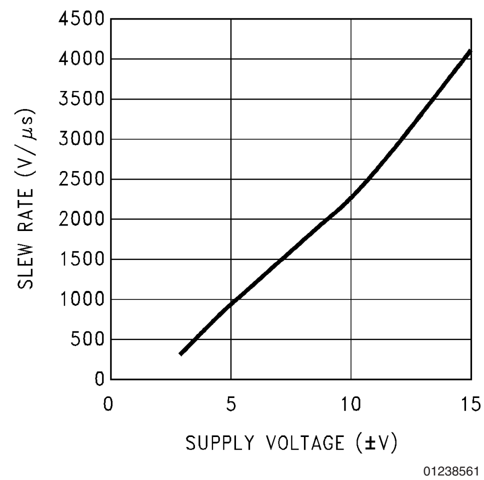
Input Current Noise vs. Frequency



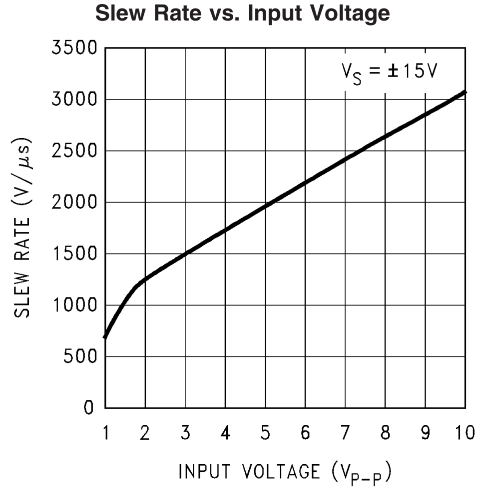
Input Current Noise vs. Frequency



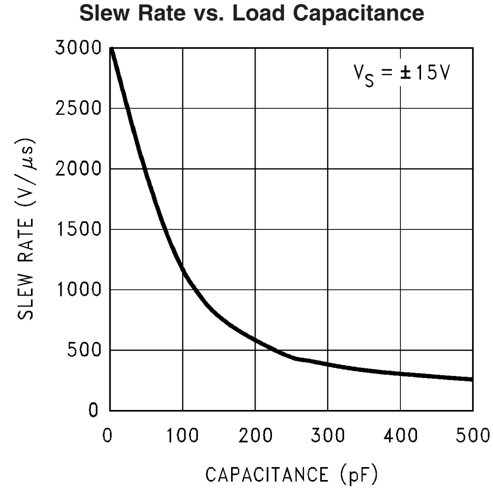
Slew Rate vs. Supply Voltage



Slew Rate vs. Input Voltage

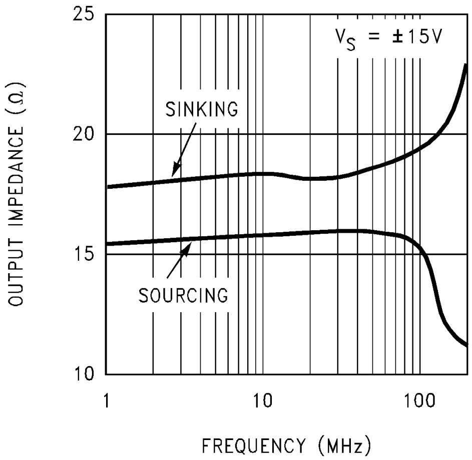


Slew Rate vs. Load Capacitance



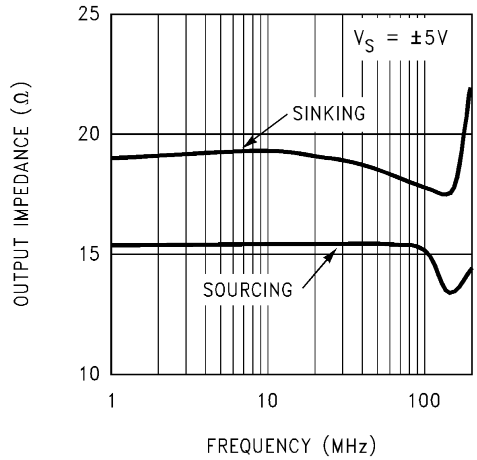
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Open Loop Output Impedance vs. Frequency



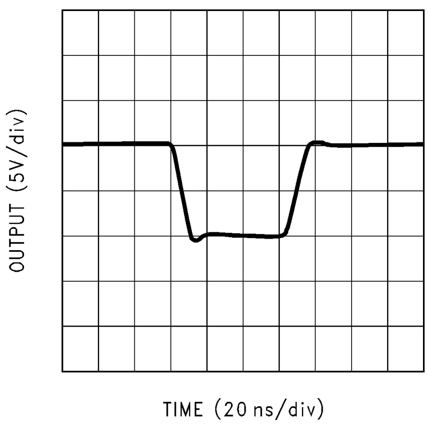
01238525

Open Loop Output Impedance vs Frequency



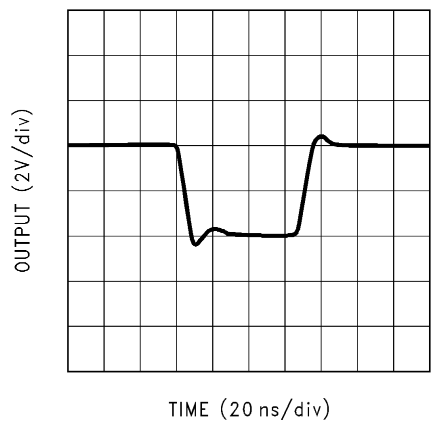
01238526

Large Signal Pulse Response
A_V = −1, V_S = ±15V



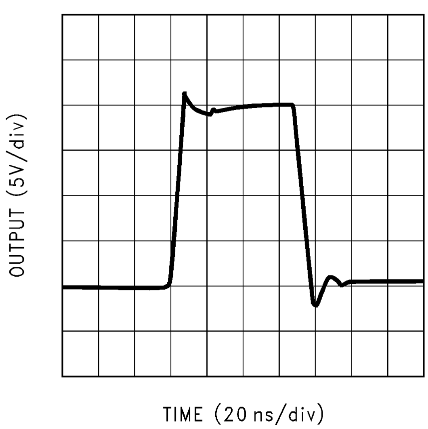
01238527

Large Signal Pulse Response
A_V = −1, V_S = ±5V



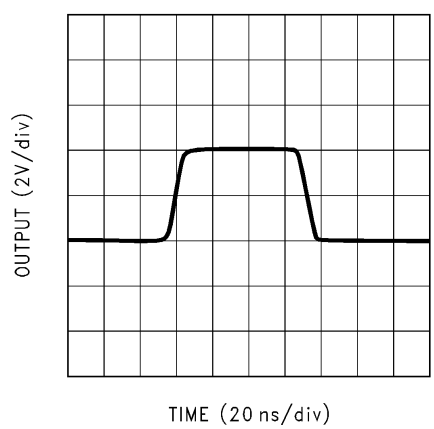
01238528

Large Signal Pulse Response
A_V = +2, V_S = ±15V



01238529

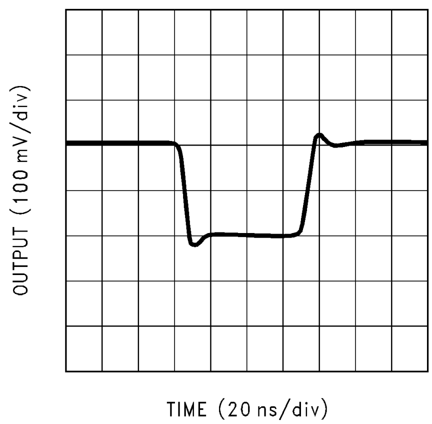
Large Signal Pulse Response
A_V = +2, V_S = ±5V



01238530

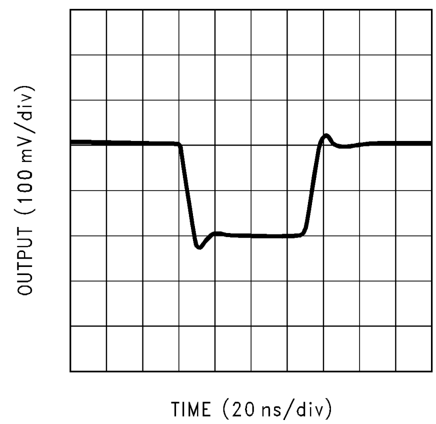
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Small Signal Pulse Response
A_V = −1, V_S = ±15V



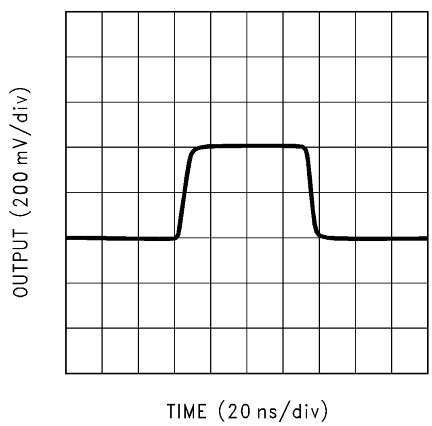
01238531

Small Signal Pulse Response
A_V = −1, V_S = ±5V



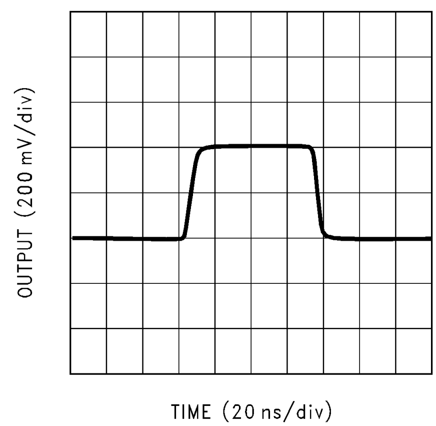
01238532

Small Signal Pulse Response
A_V = +2, V_S = ±15V



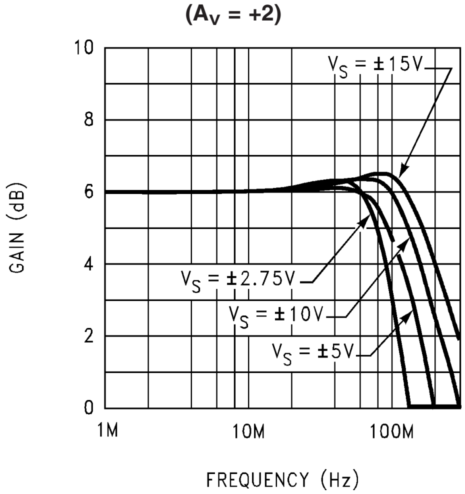
01238533

Small Signal Pulse Response
A_V = +2, V_S = ±5V



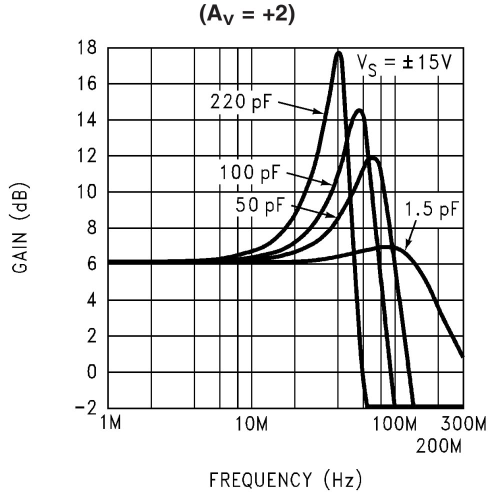
01238534

Closed Loop Frequency Response vs. Supply Voltage
(A_V = +2)



01238535

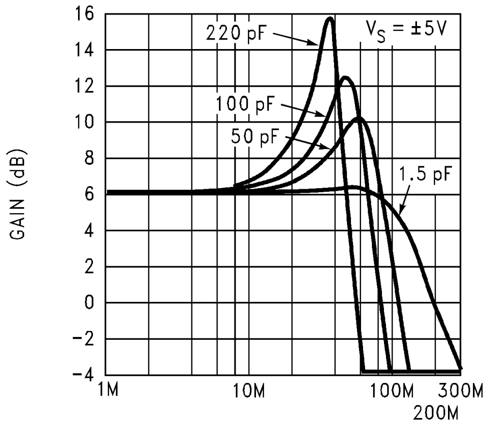
Closed Loop Frequency Response vs. Capacitive Load
(A_V = +2)



01238536

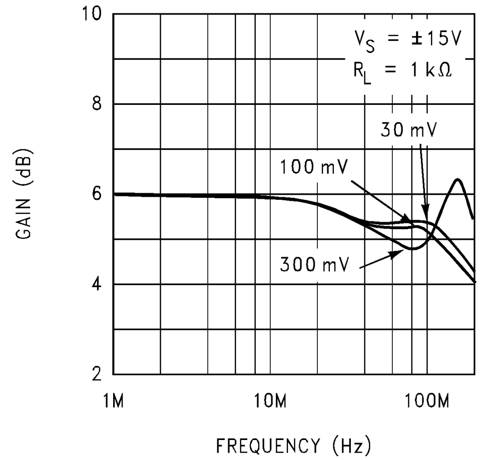
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Closed Loop Frequency Response vs. Capacitive Load (A_V = +2)



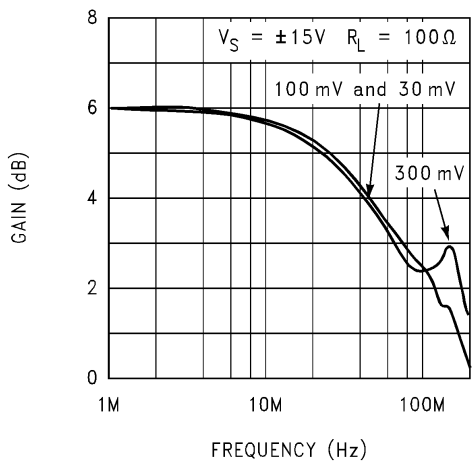
01238537

Closed Loop Frequency Response vs. Input Signal Level (A_V = +2)



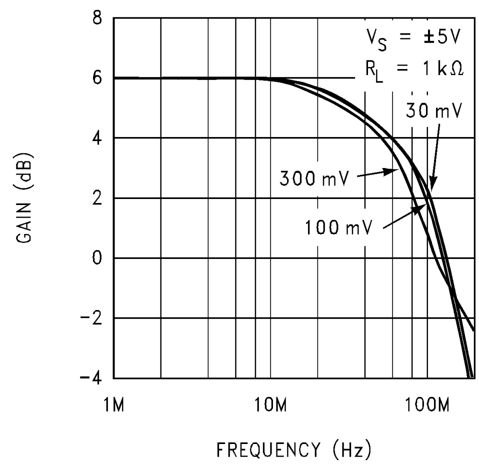
01238538

Closed Loop Frequency Response vs. Input Signal Level (A_V = +2)



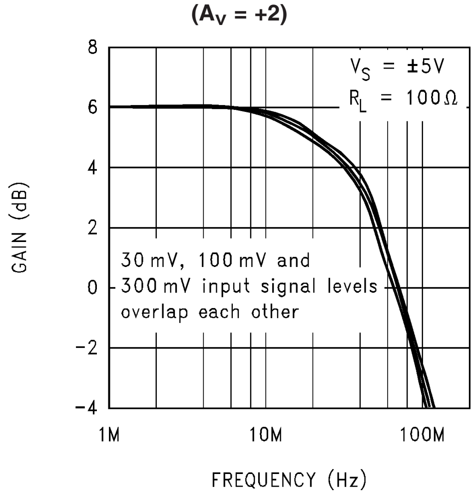
01238543

Closed Loop Frequency Response vs. Input Signal Level (A_V = +2)



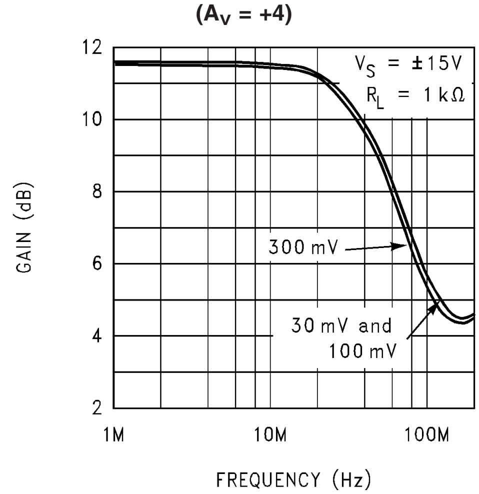
01238539

Closed Loop Frequency Response vs. Input Signal Level (A_V = +2)



01238540

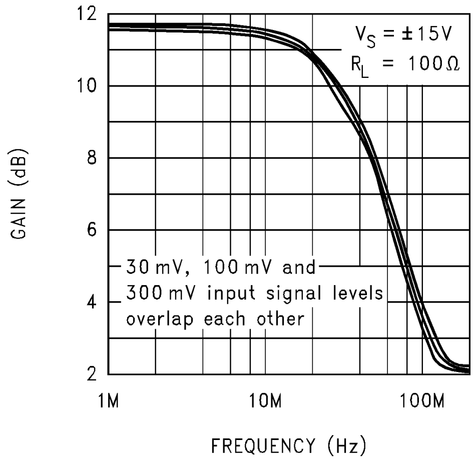
Closed Loop Frequency Response vs. Input Signal Level (A_V = +4)



01238544

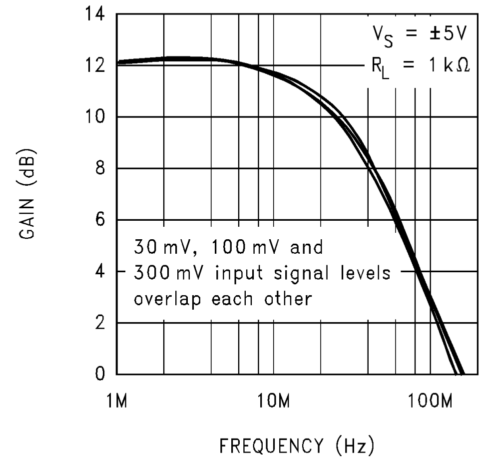
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Closed Loop Frequency Response vs. Input Signal Level (A_V = +4)



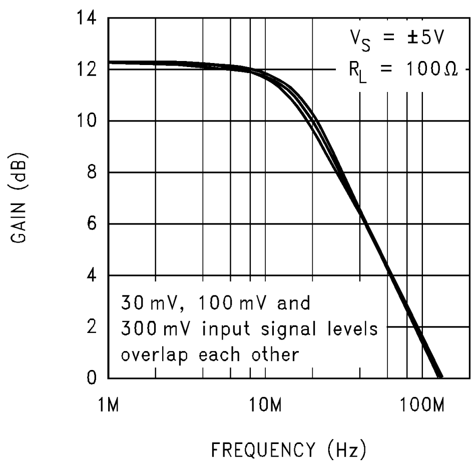
01238545

Closed Loop Frequency Response vs. Input Signal Level (A_V = +4)



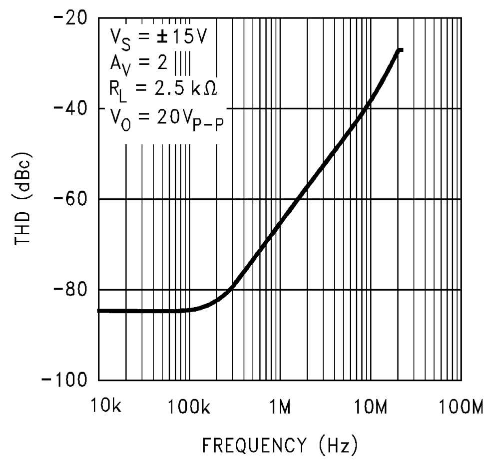
01238541

Closed Loop Frequency Response vs. Input Signal Level (A_V = +4)



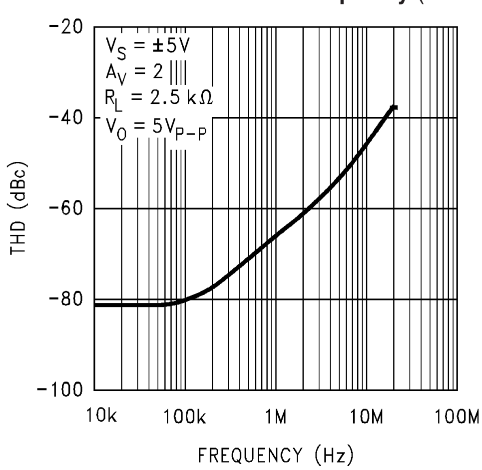
01238542

Total Harmonic Distortion vs. Frequency (Note 13)



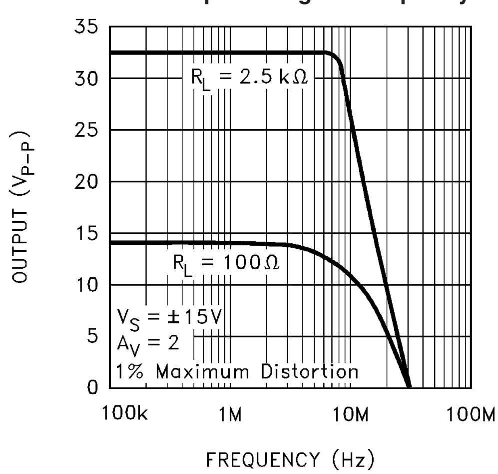
01238546

Total Harmonic Distortion vs. Frequency (Note 13)



01238547

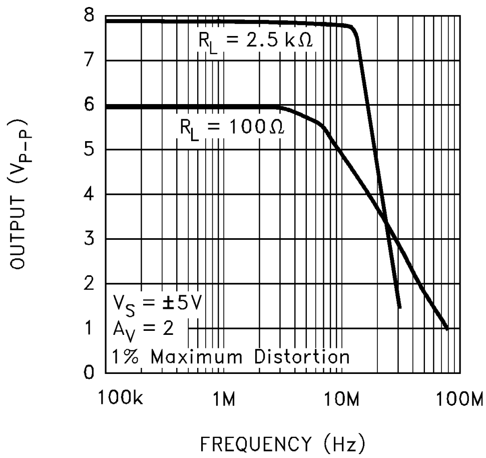
Undistorted Output Swing vs. Frequency



01238549

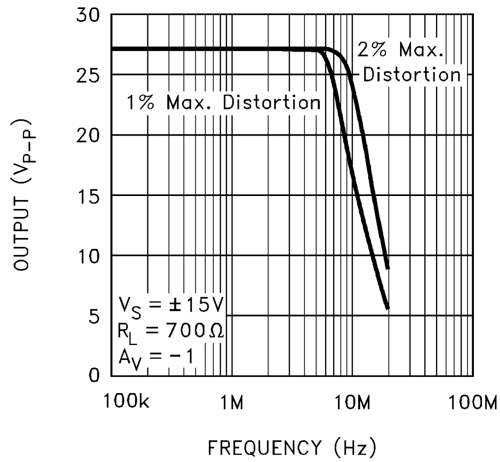
Typical Performance Characteristics unless otherwise noted, T_A= 25˚C (Continued)

Undistorted Output Swing vs. Frequency



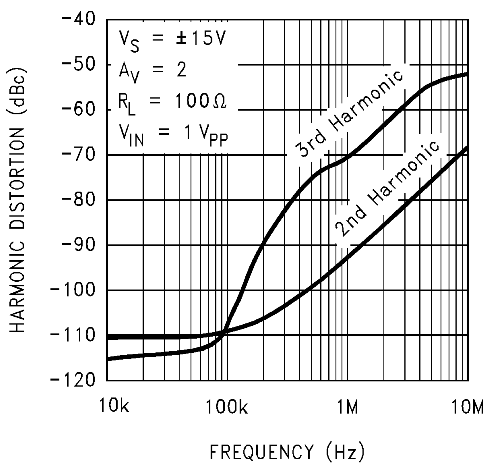
01238548

Undistorted Output Swing vs. Frequency



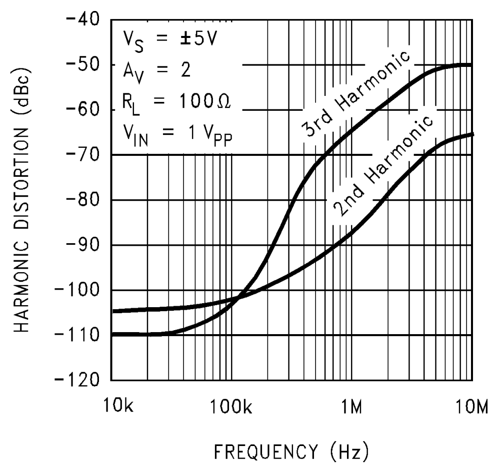
01238550

Harmonic Distortion vs. Frequency (Note 13)



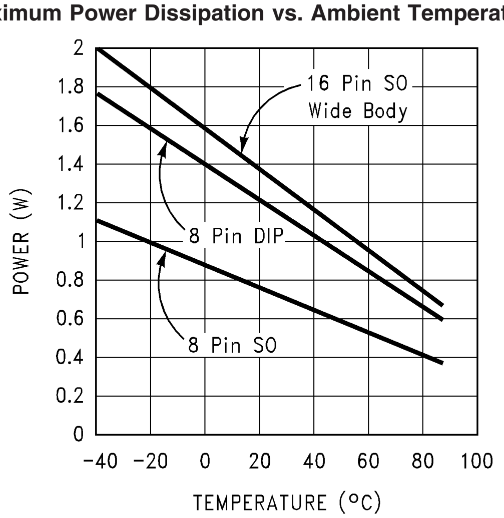
01238574

Harmonic Distortion vs. Frequency (Note 13)



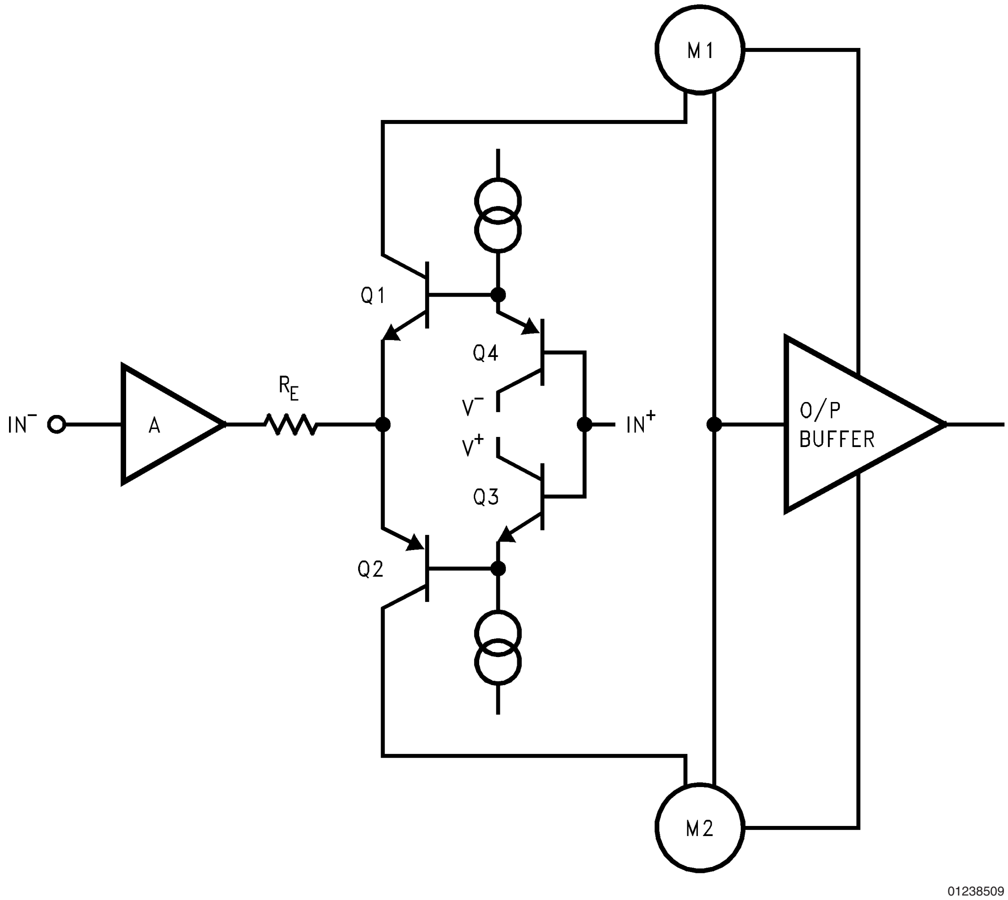
01238575

Maximum Power Dissipation vs. Ambient Temperature



01238520

Simplified Schematic Diagram



Note: M1 and M2 are current mirrors.

Application Notes

PERFORMANCE DISCUSSION

The LM7171 is a very high speed, voltage feedback amplifier. It consumes only 6.5 mA supply current while providing a unity-gain bandwidth of 200 MHz and a slew rate of 4100V/μs. It also has other great features such as low differential gain and phase and high output current.

The LM7171 is a true voltage feedback amplifier. Unlike current feedback amplifiers (CFAs) with a low inverting input impedance and a high non-inverting input impedance, both inputs of voltage feedback amplifiers (VFAs) have high impedance nodes. The low impedance inverting input in CFAs and a feedback capacitor create an additional pole that will lead to instability. As a result, CFAs cannot be used in traditional op amp circuits such as photodiode amplifiers, I-to-V converters and integrators where a feedback capacitor is required.

CIRCUIT OPERATION

The class AB input stage in LM7171 is fully symmetrical and has a similar slewing characteristic to the current feedback amplifiers. In the LM7171 Simplified Schematic, Q1 through Q4 form the equivalent of the current feedback input buffer, R_E the equivalent of the feedback resistor, and stage A buffers the inverting input. The triple-buffered output stage isolates the gain stage from the load to provide low output impedance.

SLEW RATE CHARACTERISTIC

The slew rate of LM7171 is determined by the current available to charge and discharge an internal high impedance node capacitor. This current is the differential input voltage divided by the total degeneration resistor R_E. Therefore, the slew rate is proportional to the input voltage level, and the higher slew rates are achievable in the lower gain configurations. A curve of slew rate versus input voltage level is provided in the “Typical Performance Characteristics”.

When a very fast large signal pulse is applied to the input of an amplifier, some overshoot or undershoot occurs. By placing an external resistor such as 1 kΩ in series with the input of LM7171, the bandwidth is reduced to help lower the overshoot.

SLEW RATE LIMITATION

If the amplifier’s input signal has too large of an amplitude at too high of a frequency, the amplifier is said to be slew rate limited; this can cause ringing in time domain and peaking in frequency domain at the output of the amplifier.

In the “Typical Performance Characteristics” section, there are several curves of A_V = +2 and A_V = +4 versus input signal levels. For the A_V = +4 curves, no peaking is present and the LM7171 responds identically to the different input signal levels of 30 mV, 100 mV and 300 mV.

For the A_V = +2 curves, with slight peaking occurs. This peaking at high frequency (>100 MHz) is caused by a large input signal at high enough frequency that exceeds the amplifier’s slew rate. The peaking in frequency response does not limit the pulse response in time domain, and the LM7171 is stable with noise gain of ≥+2.

LAYOUT CONSIDERATION

Printed Circuit Board and High Speed Op Amps

There are many things to consider when designing PC boards for high speed op amps. Without proper caution, it is very easy to have excessive ringing, oscillation and other degraded AC performance in high speed circuits. As a rule, the signal traces should be short and wide to provide low inductance and low impedance paths. Any unused board space needs to be grounded to reduce stray signal pickup. Critical components should also be grounded at a common point to eliminate voltage drop. Sockets add capacitance to the board and can affect high frequency performance. It is better to solder the amplifier directly into the PC board without using any socket.

Using Probes

Active (FET) probes are ideal for taking high frequency measurements because they have wide bandwidth, high input impedance and low input capacitance. However, the probe ground leads provide a long ground loop that will produce errors in measurement. Instead, the probes can be grounded directly by removing the ground leads and probe jackets and using scope probe jacks.

Component Selection and Feedback Resistor

It is important in high speed applications to keep all component leads short. For discrete components, choose carbon composition-type resistors and mica-type capacitors. Surface mount components are preferred over discrete components for minimum inductive effect.

Large values of feedback resistors can couple with parasitic capacitance and cause undesirable effects such as ringing or oscillation in high speed amplifiers. For LM7171, a feedback resistor of 510Ω gives optimal performance.

COMPENSATION FOR INPUT CAPACITANCE

The combination of an amplifier’s input capacitance with the gain setting resistors adds a pole that can cause peaking or oscillation. To solve this problem, a feedback capacitor with a value

$$C_F > (R_G \times C_{IN})/R_F$$

can be used to cancel that pole. For LM7171, a feedback capacitor of 2 pF is recommended. *Figure 1* illustrates the compensation circuit.

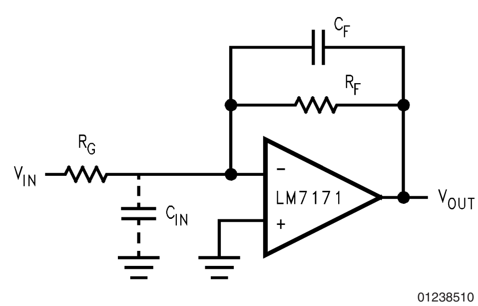


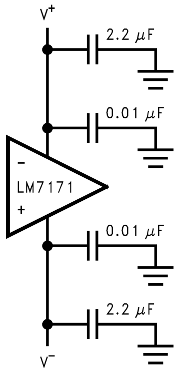
FIGURE 1. Compensating for Input Capacitance

POWER SUPPLY BYPASSING

Bypassing the power supply is necessary to maintain low power supply impedance across frequency. Both positive and negative power supplies should be bypassed individu-

Application Notes (Continued)

ally by placing 0.01 µF ceramic capacitors directly to power supply pins and 2.2 µF tantalum capacitors close to the power supply pins.

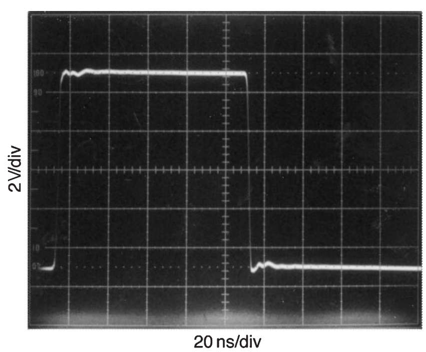


01238511

FIGURE 2. Power Supply Bypassing

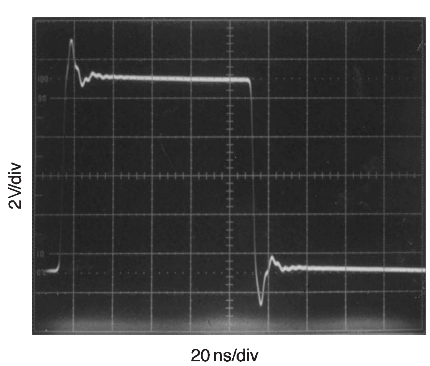
TERMINATION

In high frequency applications, reflections occur if signals are not properly terminated. *Figure 3* shows a properly terminated signal while *Figure 4* shows an improperly terminated signal.



01238517

FIGURE 3. Properly Terminated Signal



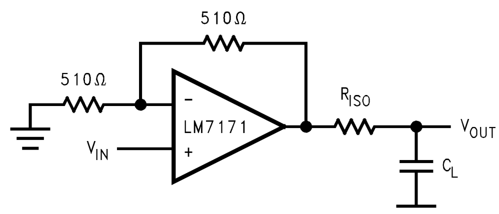
01238518

FIGURE 4. Improperly Terminated Signal

To minimize reflection, coaxial cable with matching characteristic impedance to the signal source should be used. The other end of the cable should be terminated with the same value terminator or resistor. For the commonly used cables, RG59 has 75Ω characteristic impedance, and RG58 has 50Ω characteristic impedance.

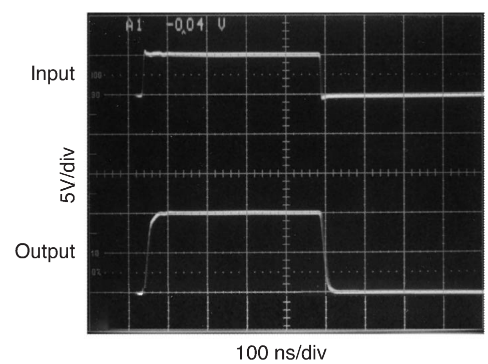
DRIVING CAPACITIVE LOADS

Amplifiers driving capacitive loads can oscillate or have ringing at the output. To eliminate oscillation or reduce ringing, an isolation resistor can be placed as shown below in *Figure 5*. The combination of the isolation resistor and the load capacitor forms a pole to increase stability by adding more phase margin to the overall system. The desired performance depends on the value of the isolation resistor; the bigger the isolation resistor, the more damped the pulse response becomes. For LM7171, a 50Ω isolation resistor is recommended for initial evaluation. *Figure 6* shows the LM7171 driving a 150 pF load with the 50Ω isolation resistor.



01238512

FIGURE 5. Isolation Resistor Used to Drive Capacitive Load



01238513

FIGURE 6. The LM7171 Driving a 150 pF Load with a 50Ω Isolation Resistor

POWER DISSIPATION

The maximum power allowed to dissipate in a device is defined as:

$$P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$$

Where

PD	is the power dissipation in a device
$T_{J(max)}$	is the maximum junction temperature
T_A	is the ambient temperature
θ_{JA}	is the thermal resistance of a particular package

For example, for the LM7171 in a SO-8 package, the maximum power dissipation at 25˚C ambient temperature is 730 mW.

Application Notes (Continued)

Thermal resistance, θ_{JA}, depends on parameters such as die size, package size and package material. The smaller the die size and package, the higher θ_{JA} becomes. The 8-pin DIP package has a lower thermal resistance (108˚C/W) than that of 8-pin SO (172˚C/W). Therefore, for higher dissipation capability, use an 8-pin DIP package.

The total power dissipated in a device can be calculated as:

$$P_D = P_Q + P_L$$

P_Q is the quiescent power dissipated in a device with no load connected at the output. P_L is the power dissipated in the device with a load connected at the output; it is not the power dissipated by the load.

Furthermore,

P_Q: = supply current x total supply voltage with no load

P_L: = output current x (voltage difference between supply voltage and output voltage of the same side of supply voltage)

For example, the total power dissipated by the LM7171 with $V_S = \pm 15V$ and output voltage of 10V into 1 kΩ is

$P_D = P_Q + P_L$

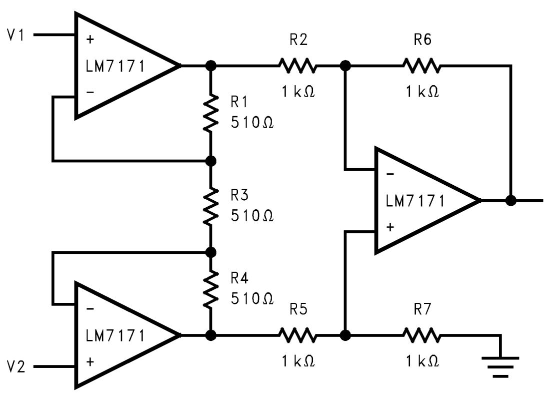
$= (6.5\ mA) \times (30V) + (10\ mA) \times (15V - 10V)$

$= 195\ mW + 50\ mW$

$= 245\ mW$

Application Circuit

Fast Instrumentation Amplifier



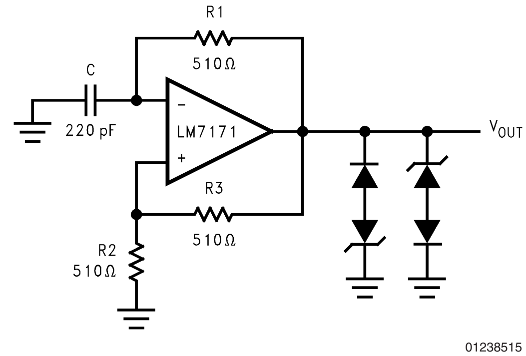
$$V_{IN} = V_2 - V_1$$

if R6 = R2, R7 = R5, and R1 = R4

$$\frac{V_{OUT}}{V_{IN}} = \frac{R6}{R2}\left(1 + 2\frac{R1}{R3}\right) = 3$$

01238580

Multivibrator

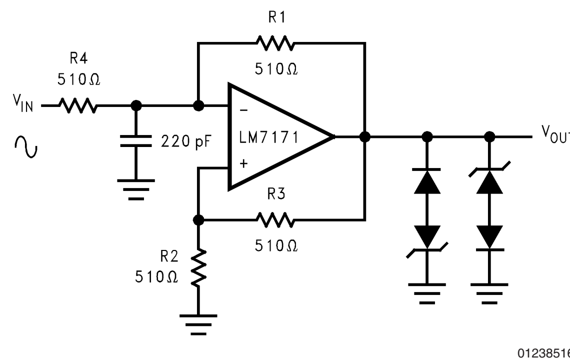


$$f = \frac{1}{2\left(R1\,C\,\ln\left(1 + 2\frac{R2}{R3}\right)\right)}$$

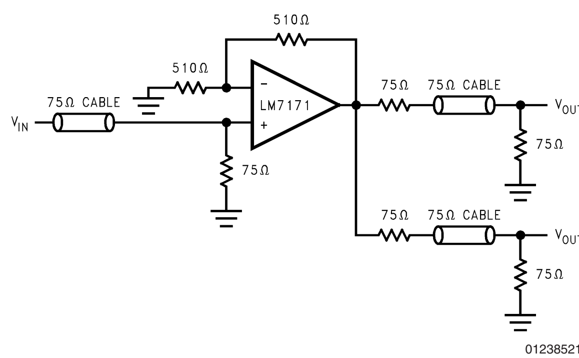
f = 4 MHz

01238581

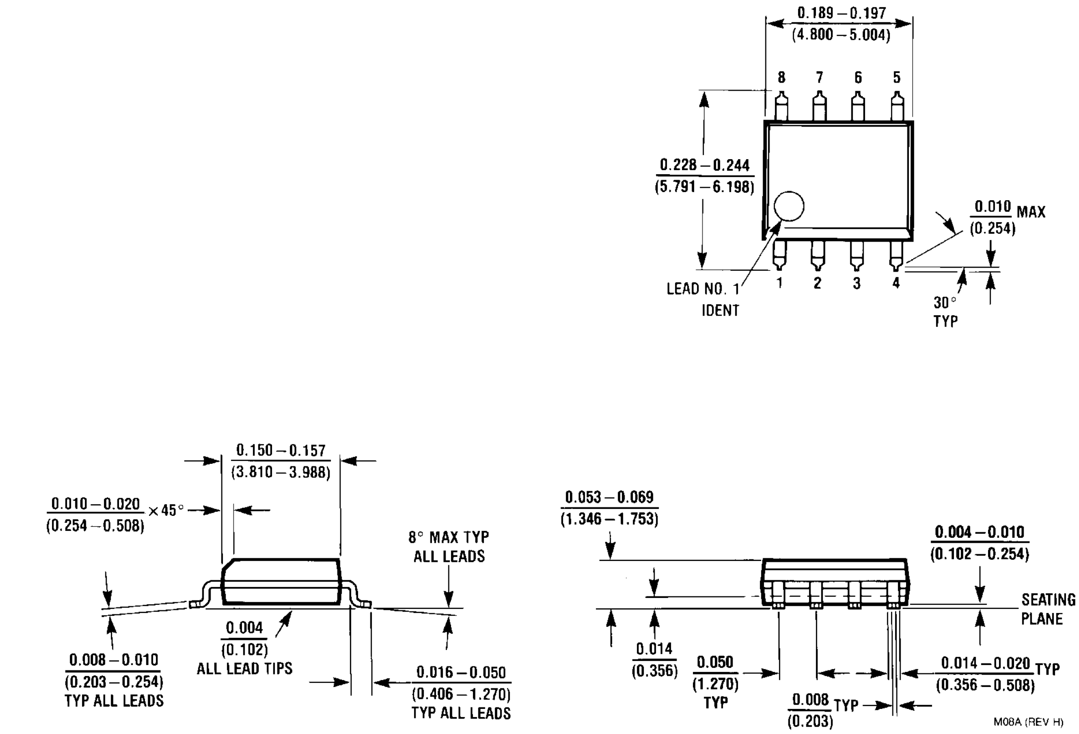
Pulse Width Modulator



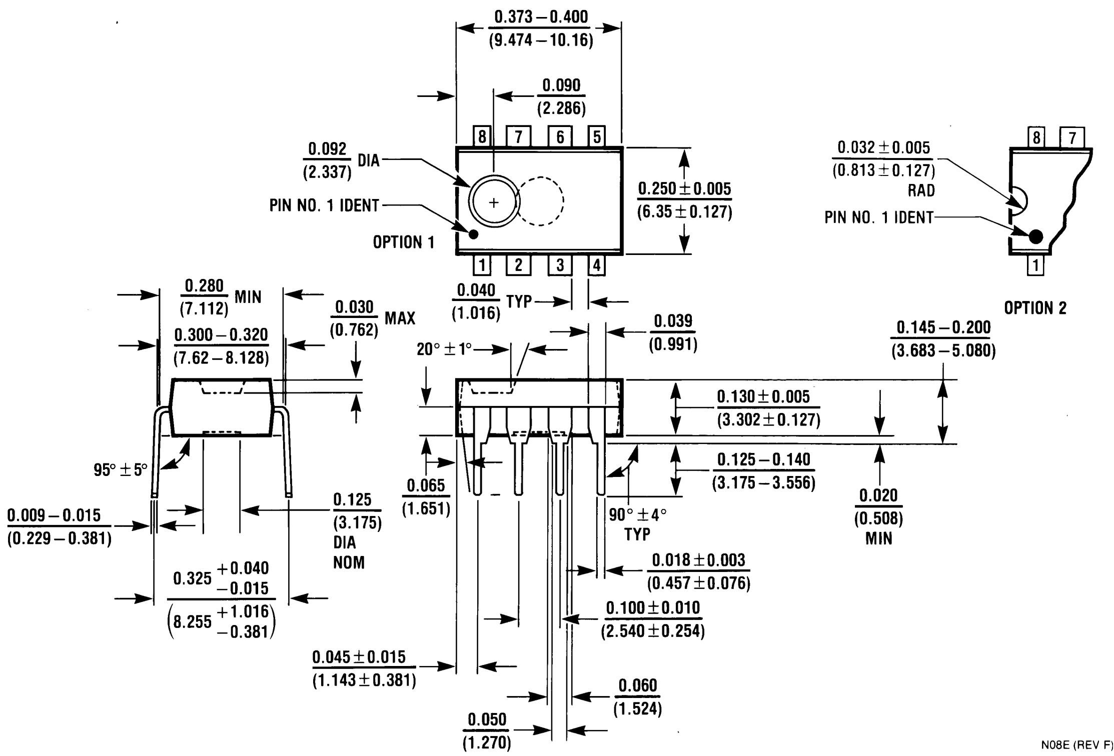
Video Line Driver



Physical Dimensions inches (millimeters) unless otherwise noted



8-Pin SOIC
NS Package Number M08A



8-Pin MDIP
NS Package Number N08E

Notes

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: +44 (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

www.national.com