

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

Check for Samples: [LM7171](#)

## FEATURES

- (Typical Unless Otherwise Noted)
- Easy-to-use voltage feedback topology
- Very high slew rate: 4100 V/ $\mu$ s
- 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  $\pm 15$ V and  $\pm 5$ V 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

## DESCRIPTION

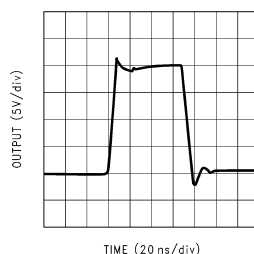
The LM7171 is a high speed voltage feedback amplifier that has the slewing characteristic of a current feedback amplifier; yet it can be used in all traditional voltage feedback amplifier configurations. The LM7171 is stable for gains as low as +2 or -1. It provides a very high slew rate at 4100V/ $\mu$ s 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  $\pm 15$ V 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  $\pm 5$ V operation for portable applications.

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

## Typical Performance

**Figure 1. Large Signal Pulse Response**  
 $A_V = +2$ ,  $V_S = \pm 15$ V



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.



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## Absolute Maximum Ratings <sup>(1)</sup>

ESD Tolerance <sup>(2)</sup>	2.5 kV
Supply Voltage (V <sup>+</sup> –V <sup>–</sup> )	36V
Differential Input Voltage <sup>(3)</sup>	±10V
Output Short Circuit to Ground <sup>(4)</sup>	Continuous
Storage Temperature Range	–65°C to +150°C
Maximum Junction Temperature <sup>(5)</sup>	150°C

- (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.
- (2) Human body model, 1.5 kΩ in series with 100 pF.
- (3) Input differential voltage is applied at V<sub>S</sub> = ±15V.
- (4) 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.
- (5) The maximum power dissipation is a function of T<sub>J(MAX)</sub>, θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any ambient temperature is P<sub>D</sub> = (T<sub>J(MAX)</sub>–T<sub>A</sub>)/θ<sub>JA</sub>. All numbers apply for packages soldered directly into a PC board.

## Operating Ratings <sup>(1)</sup>

Supply Voltage	5.5V ≤ V <sub>S</sub> ≤ 36V
Junction Temperature Range	
LM7171AI, LM7171BI	–40°C ≤ T <sub>J</sub> ≤ +85°C
Thermal Resistance (θ <sub>JA</sub> )	
8-Pin MDIP	108°C/W
8-Pin SOIC	172°C/W

- (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.

## ±15V DC Electrical Characteristics

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

Symbol	Parameter	Conditions	Typ (1)	LM7171AI	LM7171BI	Units
				Limit <sup>(2)</sup>	Limit <sup>(2)</sup>	
$V_{OS}$	Input Offset Voltage		0.2	1	3	mV
				<b>4</b>	<b>7</b>	max
$TC\ V_{OS}$	Input Offset Voltage Average Drift		35			$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current		2.7	10	10	$\mu\text{A}$
				<b>12</b>	<b>12</b>	max
$I_{OS}$	Input Offset Current		0.1	4	4	$\mu\text{A}$
				<b>6</b>	<b>6</b>	max
$R_{IN}$	Input Resistance	Common Mode	40			M $\Omega$
		Differential Mode	3.3			
$R_O$	Open Loop Output Resistance		15			$\Omega$
CMRR	Common Mode Rejection Ratio	$V_{CM} = \pm 10\text{V}$	105	85	75	dB
				<b>80</b>	<b>70</b>	min
PSRR	Power Supply Rejection Ratio	$V_S = \pm 15\text{V}$ to $\pm 5\text{V}$	90	85	75	dB
				<b>80</b>	<b>70</b>	min
$V_{CM}$	Input Common-Mode Voltage Range	CMRR > 60 dB	$\pm 13.35$			V
$A_V$	Large Signal Voltage Gain <sup>(3)</sup>	$R_L = 1\text{ k}\Omega$	85	80	75	dB
				<b>75</b>	<b>70</b>	min
		$R_L = 100\Omega$	81	75	70	dB
				<b>70</b>	<b>66</b>	min
$V_O$	Output Swing	$R_L = 1\text{ k}\Omega$	13.3	13	13	V
				<b>12.7</b>	<b>12.7</b>	min
			-13.2	-13	-13	V
				<b>-12.7</b>	<b>-12.7</b>	max
		$R_L = 100\Omega$	11.8	10.5	10.5	V
				<b>9.5</b>	<b>9.5</b>	min
			-10.5	-9.5	-9.5	V
				<b>-9</b>	<b>-9</b>	max
	Output Current (Open Loop) <sup>(4)</sup>	Sourcing, $R_L = 100\Omega$	118	105	105	mA
				<b>95</b>	<b>95</b>	min
		Sinking, $R_L = 100\Omega$	105	95	95	mA
				<b>90</b>	<b>90</b>	max
	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	8.5	mA
				<b>9.5</b>	<b>9.5</b>	max

(1) Typical values represent the most likely parametric norm.

(2) All limits are guaranteed by testing or statistical analysis.

(3) Large signal voltage gain is the total output swing divided by the input signal required to produce that swing. For  $V_S = \pm 15\text{V}$ ,  $V_{OUT} = \pm 5\text{V}$ . For  $V_S = \pm 5\text{V}$ ,  $V_{OUT} = \pm 1\text{V}$ .

(4) The open loop output current is guaranteed, by the measurement of the open loop output voltage swing, using 100 $\Omega$  output load.

## ±15V AC Electrical Characteristics

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

Symbol	Parameter	Conditions	Typ <sup>(1)</sup>	LM7171AI	LM7171BI	Units
				Limit <sup>(2)</sup>	Limit <sup>(2)</sup>	
SR	Slew Rate <sup>(3)</sup>	$A_V = +2$ , $V_{IN} = 13\text{ V}_{PP}$	4100			V/ $\mu\text{s}$
		$A_V = +2$ , $V_{IN} = 10\text{ V}_{PP}$	3100			
	Unity-Gain Bandwidth		200			MHz
	-3 dB Frequency	$A_V = +2$	220			MHz
$\Phi_m$	Phase Margin		50			Deg
$t_s$	Settling Time (0.1%)	$A_V = -1$ , $V_O = \pm 5\text{V}$ $R_L = 500\Omega$	42			ns
$t_p$	Propagation Delay	$A_V = -2$ , $V_{IN} = \pm 5\text{V}$ , $R_L = 500\Omega$	5			ns
$A_D$	Differential Gain <sup>(4)</sup>		0.01			%
$\Phi_D$	Differential Phase <sup>(4)</sup>		0.02			Deg
	Second Harmonic <sup>(5)</sup>	$f_{IN} = 10\text{ kHz}$	-110			dBc
		$f_{IN} = 5\text{ MHz}$	-75			dBc
	Third Harmonic <sup>(5)</sup>	$f_{IN} = 10\text{ kHz}$	-115			dBc
		$f_{IN} = 5\text{ MHz}$	-55			dBc
$e_n$	Input-Referred Voltage Noise	$f = 10\text{ kHz}$	14			nV/ $\sqrt{\text{Hz}}$
$i_n$	Input-Referred Current Noise	$f = 10\text{ kHz}$	1.5			pA/ $\sqrt{\text{Hz}}$

(1) Typical values represent the most likely parametric norm.

(2) All limits are guaranteed by testing or statistical analysis.

(3) Slew Rate is the average of the raising and falling slew rates.

(4) Differential gain and phase are measured with  $A_V = +2$ ,  $V_{IN} = 1\text{ V}_{PP}$  at 3.58 MHz and both input and output 75 $\Omega$  terminated.

(5) Harmonics are measured with  $V_{IN} = 1\text{ V}_{PP}$ ,  $A_V = +2$  and  $R_L = 100\Omega$ .

## ±5V DC Electrical Characteristics

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

Symbol	Parameter	Conditions	Typ <sup>(1)</sup>	LM7171AI	LM7171BI	Units
				Limit <sup>(2)</sup>	Limit <sup>(2)</sup>	
V <sub>OS</sub>	Input Offset Voltage		0.3	1.5	3.5	mV
				<b>4</b>	<b>7</b>	max
TC V <sub>OS</sub>	Input Offset Voltage Average Drift		35			μV/°C
I <sub>B</sub>	Input Bias Current		3.3	10	10	μA
				<b>12</b>	<b>12</b>	max
I <sub>OS</sub>	Input Offset Current		0.1	4	4	μA
				<b>6</b>	<b>6</b>	max
R <sub>IN</sub>	Input Resistance	Common Mode	40			MΩ
		Differential Mode	3.3			
R <sub>O</sub>	Output Resistance		15			Ω
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = ±2.5V	104	80	70	dB
				<b>75</b>	<b>65</b>	min
PSRR	Power Supply Rejection Ratio	V <sub>S</sub> = ±15V to ±5V	90	85	75	dB
				<b>80</b>	<b>70</b>	min
V <sub>CM</sub>	Input Common-Mode Voltage Range	CMRR > 60 dB	±3.2			V
A <sub>V</sub>	Large Signal Voltage Gain <sup>(3)</sup>	R <sub>L</sub> = 1 kΩ	78	75	70	dB
				<b>70</b>	<b>65</b>	min
		R <sub>L</sub> = 100Ω	76	72	68	dB
				<b>67</b>	<b>63</b>	min
V <sub>O</sub>	Output Swing	R <sub>L</sub> = 1 kΩ	3.4	3.2	3.2	V
				<b>3</b>	<b>3</b>	min
			-3.4	-3.2	-3.2	V
				<b>-3</b>	<b>-3</b>	max
		R <sub>L</sub> = 100Ω	3.1	2.9	2.9	V
				<b>2.8</b>	<b>2.8</b>	min
			-3.0	-2.9	-2.9	V
				<b>-2.8</b>	<b>-2.8</b>	max
	Output Current (Open Loop) <sup>(4)</sup>	Sourcing, R <sub>L</sub> = 100Ω	31	29	29	mA
				<b>28</b>	<b>28</b>	min
		Sinking, R <sub>L</sub> = 100Ω	30	29	29	mA
				<b>28</b>	<b>28</b>	max
I <sub>SC</sub>	Output Short Circuit Current	Sourcing	135			mA
		Sinking	100			
I <sub>S</sub>	Supply Current		6.2	8	8	mA
				<b>9</b>	<b>9</b>	max

(1) Typical values represent the most likely parametric norm.

(2) All limits are guaranteed by testing or statistical analysis.

(3) Large signal voltage gain is the total output swing divided by the input signal required to produce that swing. For V<sub>S</sub> = ±15V, V<sub>OUT</sub> = ±5V. For V<sub>S</sub> = ±5V, V<sub>OUT</sub> = ±1V.

(4) The open loop output current is guaranteed, by the measurement of the open loop output voltage swing, using 100Ω output load.

## ±5V AC Electrical Characteristics

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

Symbol	Parameter	Conditions	Typ <sup>(1)</sup>	LM7171AI	LM7171BI	Units
				Limit <sup>(2)</sup>	Limit <sup>(2)</sup>	
SR	Slew Rate <sup>(3)</sup>	$A_V = +2$ , $V_{\text{IN}} = 3.5\text{ V}_{\text{PP}}$	950			V/ $\mu\text{s}$
	Unity-Gain Bandwidth		125			MHz
	-3 dB Frequency	$A_V = +2$	140			MHz
$\phi_m$	Phase Margin		57			Deg
$t_s$	Settling Time (0.1%)	$A_V = -1$ , $V_O = \pm 1\text{V}$ , $R_L = 500\Omega$	56			ns
$t_p$	Propagation Delay	$A_V = -2$ , $V_{\text{IN}} = \pm 1\text{V}$ , $R_L = 500\Omega$	6			ns
$A_D$	Differential Gain <sup>(4)</sup>		0.02			%
$\phi_D$	Differential Phase <sup>(5)</sup>		0.03			Deg
	Second Harmonic <sup>(6)</sup>	$f_{\text{IN}} = 10\text{ kHz}$	-102			dBc
		$f_{\text{IN}} = 5\text{ MHz}$	-70			dBc
	Third Harmonic <sup>(6)</sup>	$f_{\text{IN}} = 10\text{ kHz}$	-110			dBc
		$f_{\text{IN}} = 5\text{ MHz}$	-51			dBc
$e_n$	Input-Referred Voltage Noise	$f = 10\text{ kHz}$	14			nV/ $\sqrt{\text{Hz}}$
$i_n$	Input-Referred Current Noise	$f = 10\text{ kHz}$	1.8			pA/ $\sqrt{\text{Hz}}$

(1) Typical values represent the most likely parametric norm.

(2) All limits are guaranteed by testing or statistical analysis.

(3) Slew Rate is the average of the raising and falling slew rates.

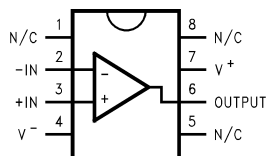
(4) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

(5) Differential gain and phase are measured with  $A_V = +2$ ,  $V_{\text{IN}} = 1\text{ V}_{\text{PP}}$  at 3.58 MHz and both input and output 75 $\Omega$  terminated.

(6) Harmonics are measured with  $V_{\text{IN}} = 1\text{ V}_{\text{PP}}$ ,  $A_V = +2$  and  $R_L = 100\Omega$ .

## Connection Diagram

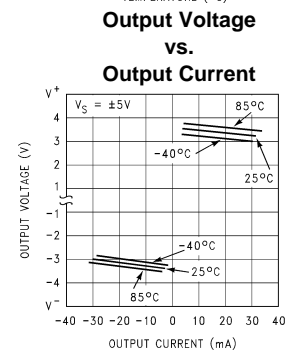
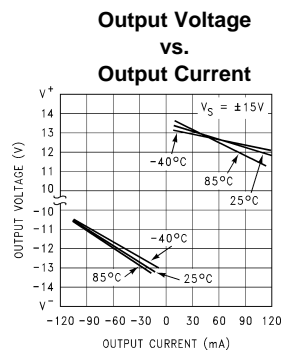
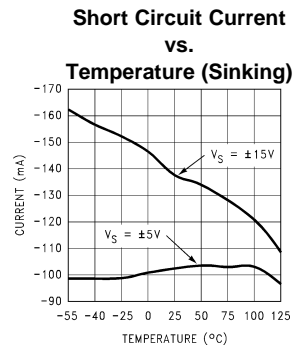
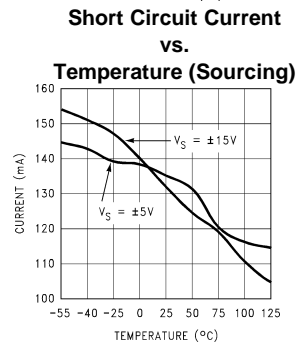
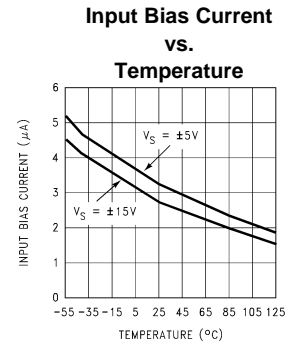
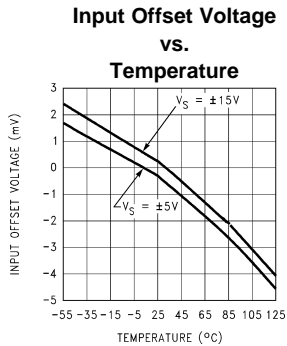
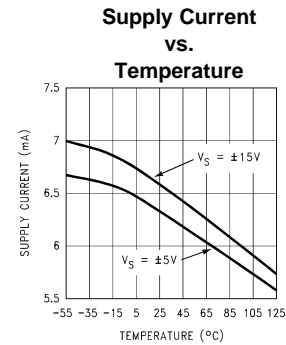
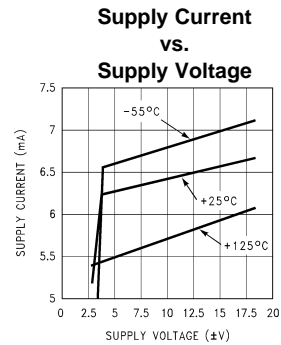
**Figure 2. 8-Pin DIP/SO**



**Figure 3. Top View**

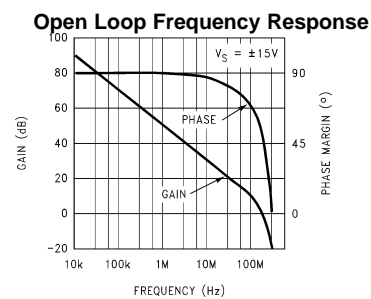
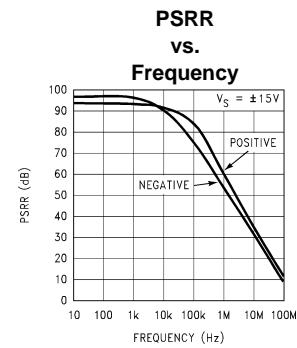
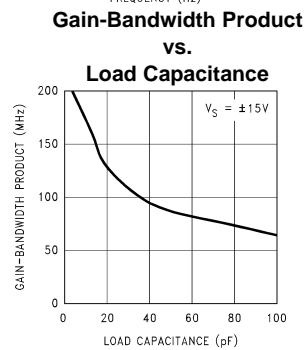
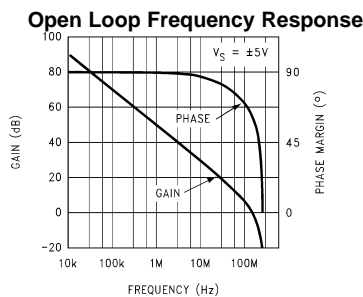
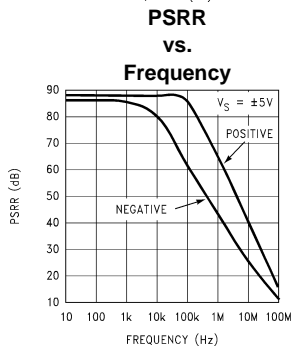
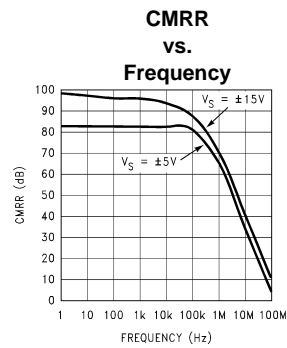
## Typical Performance Characteristics

unless otherwise noted,  $T_A = 25^\circ\text{C}$

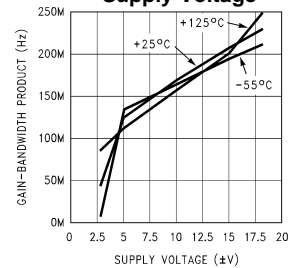


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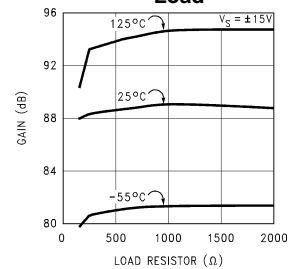
unless otherwise noted,  $T_A = 25^\circ\text{C}$



**Gain-Bandwidth Product**  
**vs.**  
**Supply Voltage**



**Large Signal Voltage Gain**  
**vs.**  
**Load**

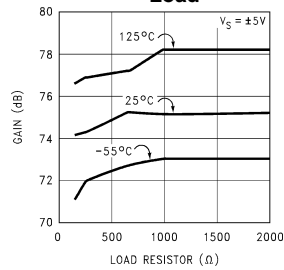




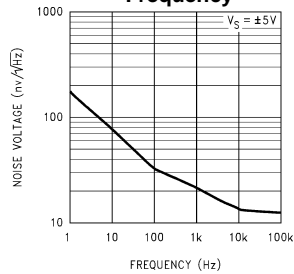
## Typical Performance Characteristics (continued)

unless otherwise noted,  $T_A = 25^\circ\text{C}$

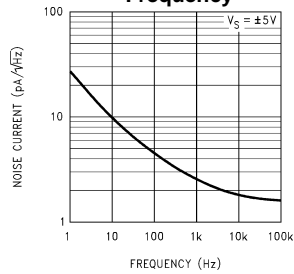
**Large Signal Voltage Gain  
vs.  
Load**



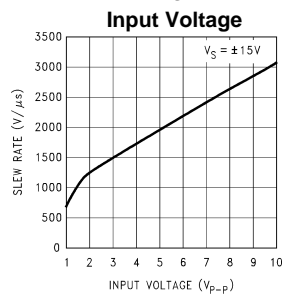
**Input Voltage Noise  
vs.  
Frequency**



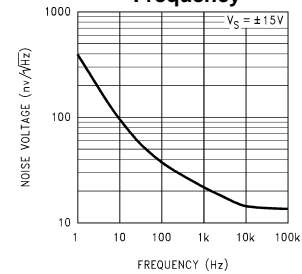
**Input Current Noise  
vs.  
Frequency**



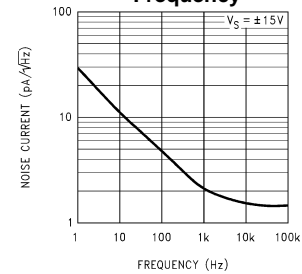
**Slew Rate  
vs.  
Input Voltage**



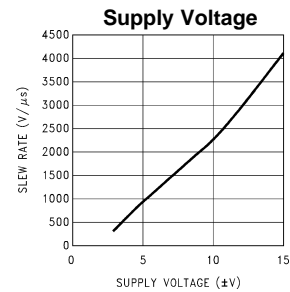
**Input Voltage Noise  
vs.  
Frequency**



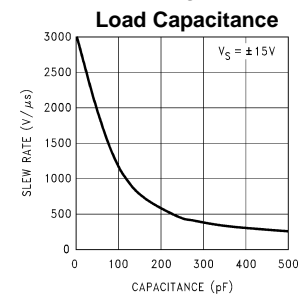
**Input Current Noise  
vs.  
Frequency**



**Slew Rate  
vs.  
Supply Voltage**



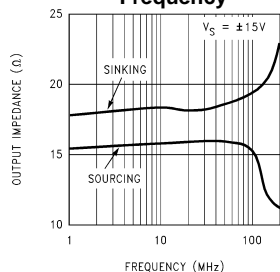
**Slew Rate  
vs.  
Load Capacitance**



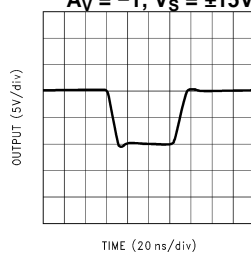
## Typical Performance Characteristics (continued)

unless otherwise noted,  $T_A = 25^\circ\text{C}$

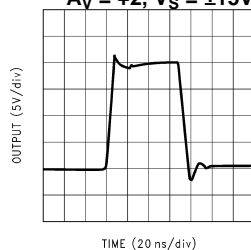
**Open Loop Output Impedance  
vs.  
Frequency**



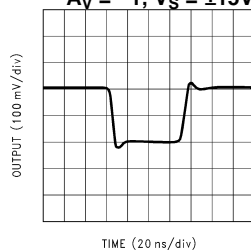
**Large Signal Pulse Response**  
 $A_V = -1, V_S = \pm 15\text{V}$



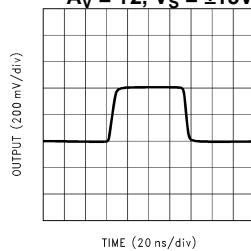
**Large Signal Pulse Response**  
 $A_V = +2, V_S = \pm 15\text{V}$



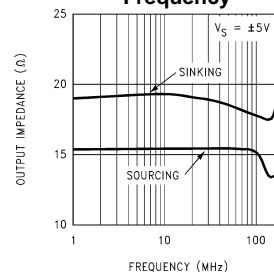
**Small Signal Pulse Response**  
 $A_V = -1, V_S = \pm 15\text{V}$



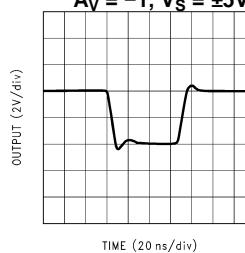
**Small Signal Pulse Response**  
 $A_V = +2, V_S = \pm 15\text{V}$



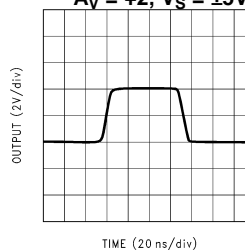
**Open Loop Output Impedance  
vs.  
Frequency**



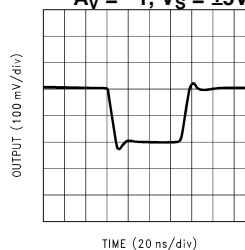
**Large Signal Pulse Response**  
 $A_V = -1, V_S = \pm 5\text{V}$



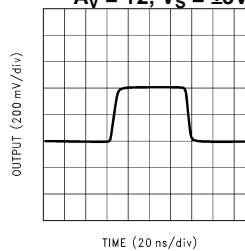
**Large Signal Pulse Response**  
 $A_V = +2, V_S = \pm 5\text{V}$



**Small Signal Pulse Response**  
 $A_V = -1, V_S = \pm 5\text{V}$



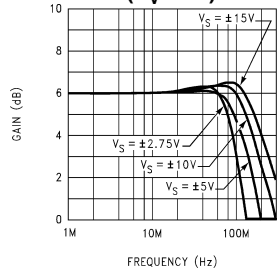
**Small Signal Pulse Response**  
 $A_V = +2, V_S = \pm 5\text{V}$



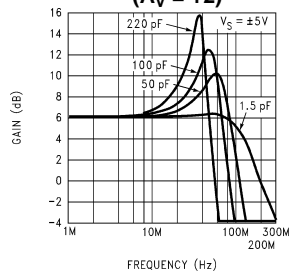
## Typical Performance Characteristics (continued)

unless otherwise noted,  $T_A = 25^\circ\text{C}$

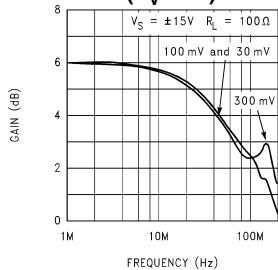
**Closed Loop Frequency Response  
vs.  
Supply Voltage  
( $A_V = +2$ )**



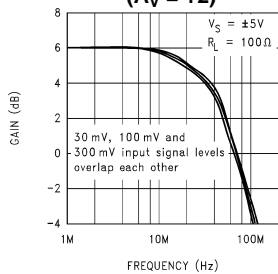
**Closed Loop Frequency Response  
vs.  
Capacitive Load  
( $A_V = +2$ )**



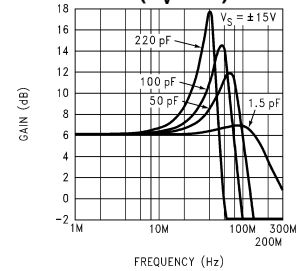
**Closed Loop Frequency Response  
vs.  
Input Signal Level  
( $A_V = +2$ )**



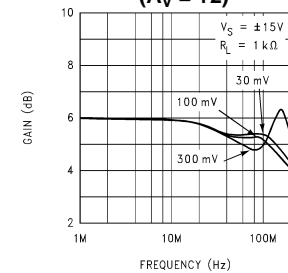
**Closed Loop Frequency Response  
vs.  
Input Signal Level  
( $A_V = +2$ )**



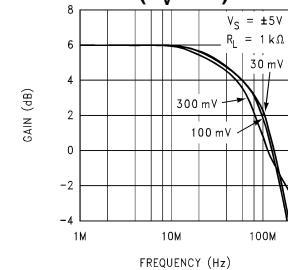
**Closed Loop Frequency Response  
vs.  
Capacitive Load  
( $A_V = +2$ )**



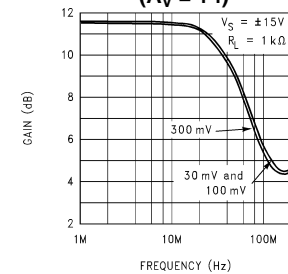
**Closed Loop Frequency Response  
vs.  
Input Signal Level  
( $A_V = +2$ )**



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



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



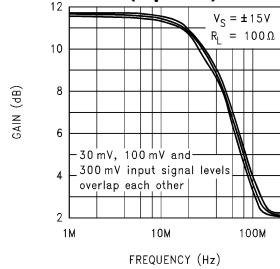
## Typical Performance Characteristics (continued)

unless otherwise noted,  $T_A = 25^\circ\text{C}$

### Closed Loop Frequency Response

vs.

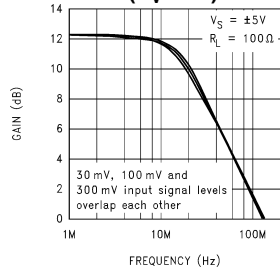
#### Input Signal Level ( $A_V = +4$ )



### Closed Loop Frequency Response

vs.

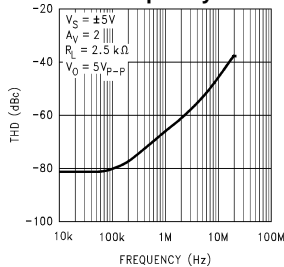
#### Input Signal Level ( $A_V = +4$ )



### Total Harmonic Distortion

vs.

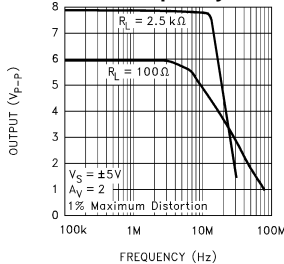
#### Frequency (2)



### Undistorted Output Swing

vs.

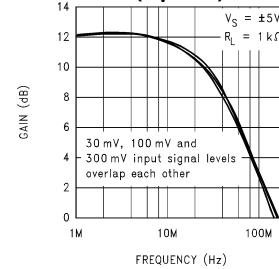
#### Frequency



### Closed Loop Frequency Response

vs.

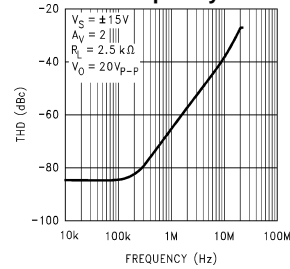
#### Input Signal Level ( $A_V = +4$ )



### Total Harmonic Distortion

vs.

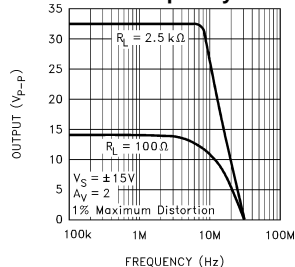
#### Frequency (1)



### Undistorted Output Swing

vs.

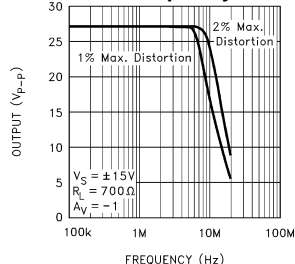
#### Frequency



### Undistorted Output Swing

vs.

#### Frequency

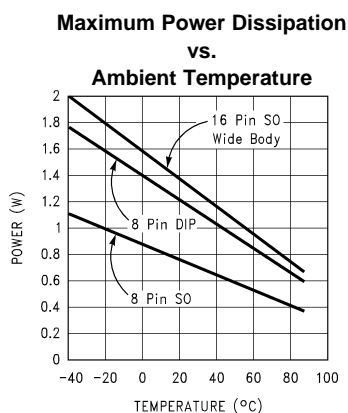
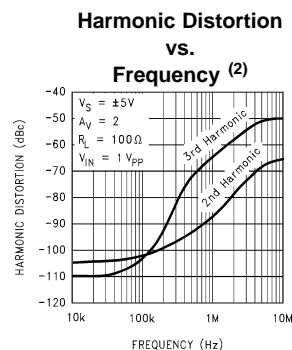
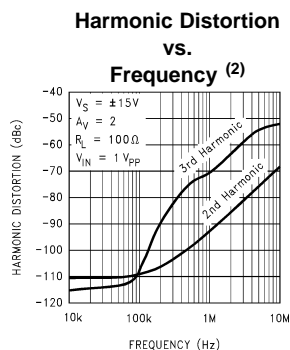


(1) The THD measurement at low frequency is limited by the test instrument.

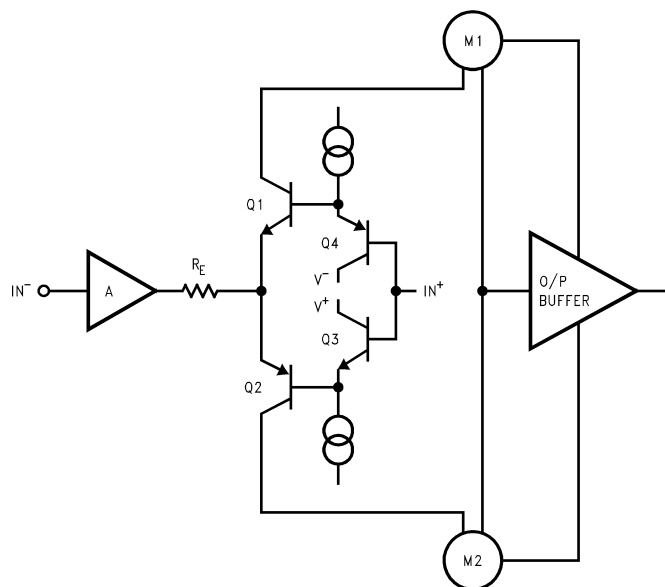
(2) The THD measurement at low frequency is limited by the test instrument.

## Typical Performance Characteristics (continued)

unless otherwise noted,  $T_A = 25^\circ\text{C}$



## 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/ $\mu$ s. 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 k $\Omega$  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  $\geq 2$ .

### 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

$$C_F > (R_G \times C_{IN})/R_F \quad (1)$$

can be used to cancel that pole. For LM7171, a feedback capacitor of 2 pF is recommended. Figure 4 illustrates the compensation circuit.

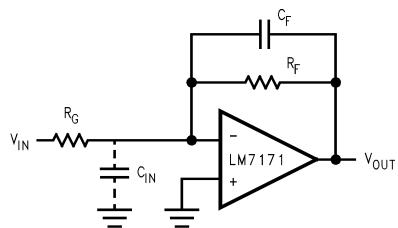


Figure 4. Compensating for Input Capacitance

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

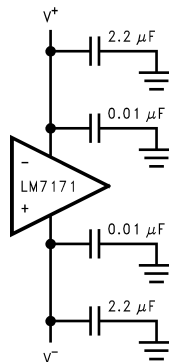
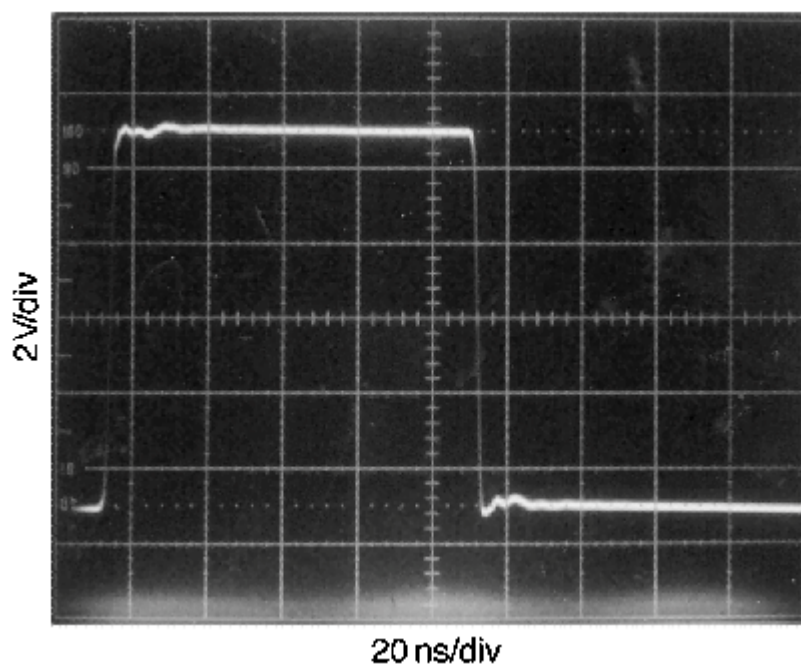
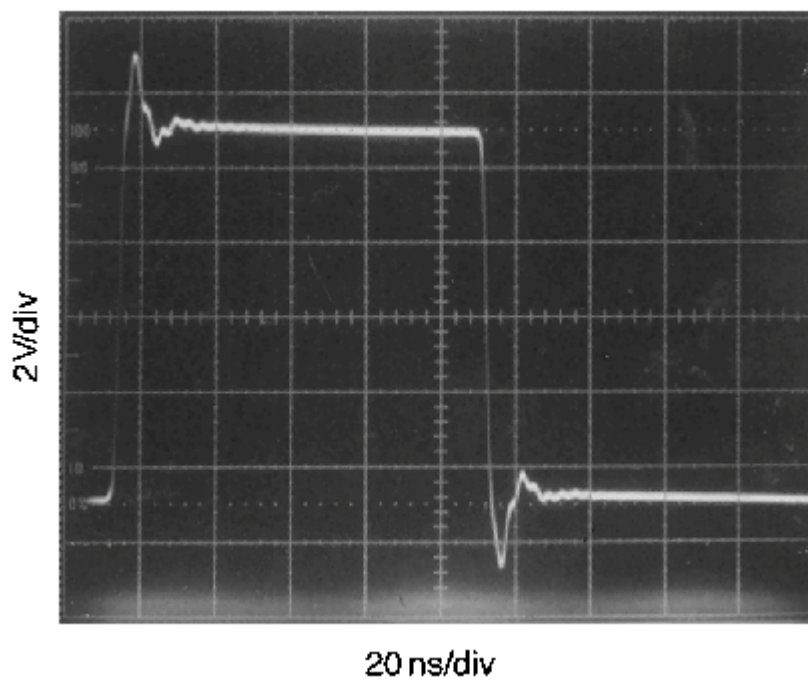


Figure 5. Power Supply Bypassing

### TERMINATION

In high frequency applications, reflections occur if signals are not properly terminated. Figure 6 shows a properly terminated signal while Figure 7 shows an improperly terminated signal.

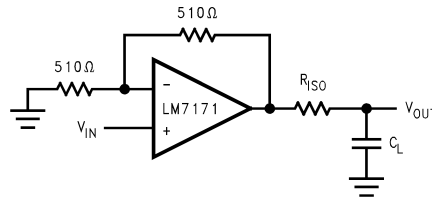
**Figure 6. Properly Terminated Signal****Figure 7. Improperly Terminated Signal**

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 75 $\Omega$  characteristic impedance, and RG58 has 50 $\Omega$  characteristic impedance.

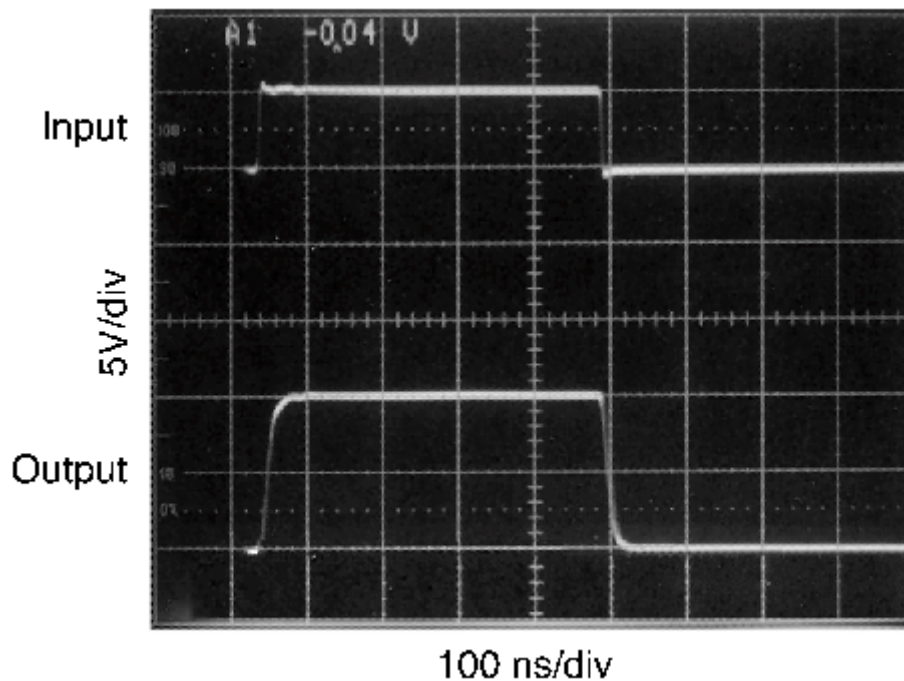


## DRIVING CAPACITIVE LOADS

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 8](#). 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 9](#) shows the LM7171 driving a 150 pF load with the 50Ω isolation resistor.



**Figure 8. Isolation Resistor Used to Drive Capacitive Load**



**Figure 9. 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:

$$P_D = (T_{J(MAX)} - T_A) / \theta_{JA} \quad (2)$$

### Where

- P<sub>D</sub>** is the power dissipation in a device
- T<sub>J(max)</sub>** is the maximum junction temperature
- T<sub>A</sub>** is the ambient temperature
- θ<sub>JA</sub>** 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.

Thermal resistance,  $\theta_{JA}$ , depends on parameters such as die size, package size and package material. The smaller the die size and package, the higher  $\theta_{JA}$  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:

$$P_D = P_Q + P_L \quad (3)$$

$P_Q$  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  $\times$  total supply voltage with no load

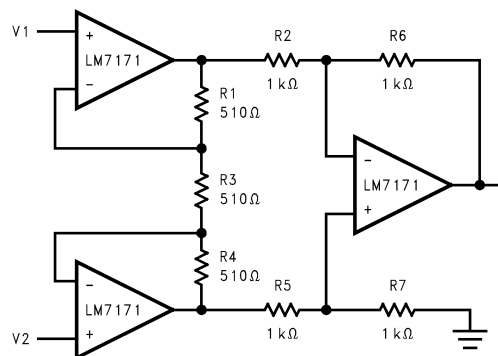
**$P_L$ :** = output current  $\times$  (voltage difference between supply voltage and output voltage of the same side of supply voltage)

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

$$\begin{aligned} P_D &= P_Q + P_L \\ &= (6.5 \text{ mA}) \times (30V) + (10 \text{ mA}) \times (15V - 10V) \\ &= 195 \text{ mW} + 50 \text{ mW} \\ &= 245 \text{ mW} \end{aligned}$$

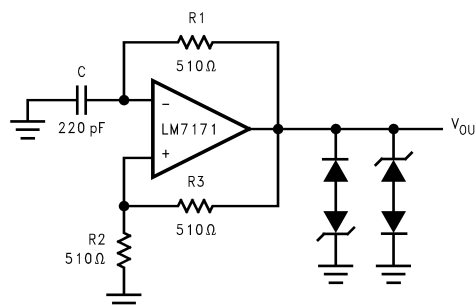
## Application Circuit

**Figure 10. Fast Instrumentation Amplifier**



$$\begin{aligned} V_{IN} &= V_2 - V_1 \\ \text{if } R_6 &= R_2, R_7 = R_5, \text{ and } R_1 = R_4 \\ \frac{V_{OUT}}{V_{IN}} &= \frac{R_6}{R_2} \left( 1 + 2 \frac{R_1}{R_3} \right) = 3 \end{aligned}$$

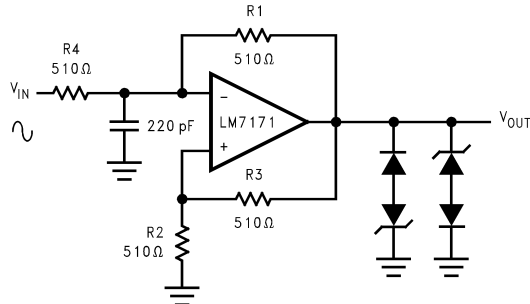
**Figure 11. Multivibrator**



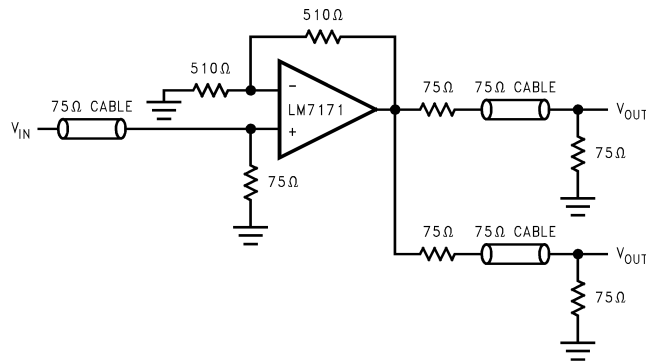
$$f = \frac{1}{2 \left( R1 C \ln \left( 1 + 2 \frac{R2}{R3} \right) \right)}$$

$f = 4 \text{ MHz}$

**Figure 12. Pulse Width Modulator**



**Figure 13. Video Line Driver**



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM7171AIM	ACTIVE	SOIC	D	8	95	TBD	CU SNPB	Level-1-235C-UNLIM	-40 to 85	LM71 71AIM	<a href="#">Samples</a>
LM7171AIM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM71 71AIM	<a href="#">Samples</a>
LM7171AIMX	ACTIVE	SOIC	D	8	2500	TBD	CU SNPB	Level-1-235C-UNLIM	-40 to 85	LM71 71AIM	<a href="#">Samples</a>
LM7171AIMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM71 71AIM	<a href="#">Samples</a>
LM7171AMWG-QML/NOPB	ACTIVE	CLGA	NAC	10	1	Green (RoHS & no Sb/Br)	A42 SNAGCU	Level-1-NA-UNLIM		LM7171AM WG Q 5962-95536 01QXA ACO 01QXA >T	<a href="#">Samples</a>
LM7171BIM	ACTIVE	SOIC	D	8	95	TBD	CU SNPB	Level-1-235C-UNLIM	-40 to 85	LM71 71BIM	<a href="#">Samples</a>
LM7171BIM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM71 71BIM	<a href="#">Samples</a>
LM7171BIMX	ACTIVE	SOIC	D	8	2500	TBD	CU SNPB	Level-1-235C-UNLIM	-40 to 85	LM71 71BIM	<a href="#">Samples</a>
LM7171BIMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM71 71BIM	<a href="#">Samples</a>
LM7171BIN	ACTIVE	PDIP	P	8	40	TBD	SNPB	Level-1-NA-UNLIM	-40 to 85	LM7171 BIN	<a href="#">Samples</a>
LM7171BIN/NOPB	ACTIVE	PDIP	P	8	40	Green (RoHS & no Sb/Br)	SN	Level-1-NA-UNLIM	-40 to 85	LM7171 BIN	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

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**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> Only one of markings shown within the brackets will appear on the physical device.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM7171AIMX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM7171AIMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM7171BIMX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM7171BIMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

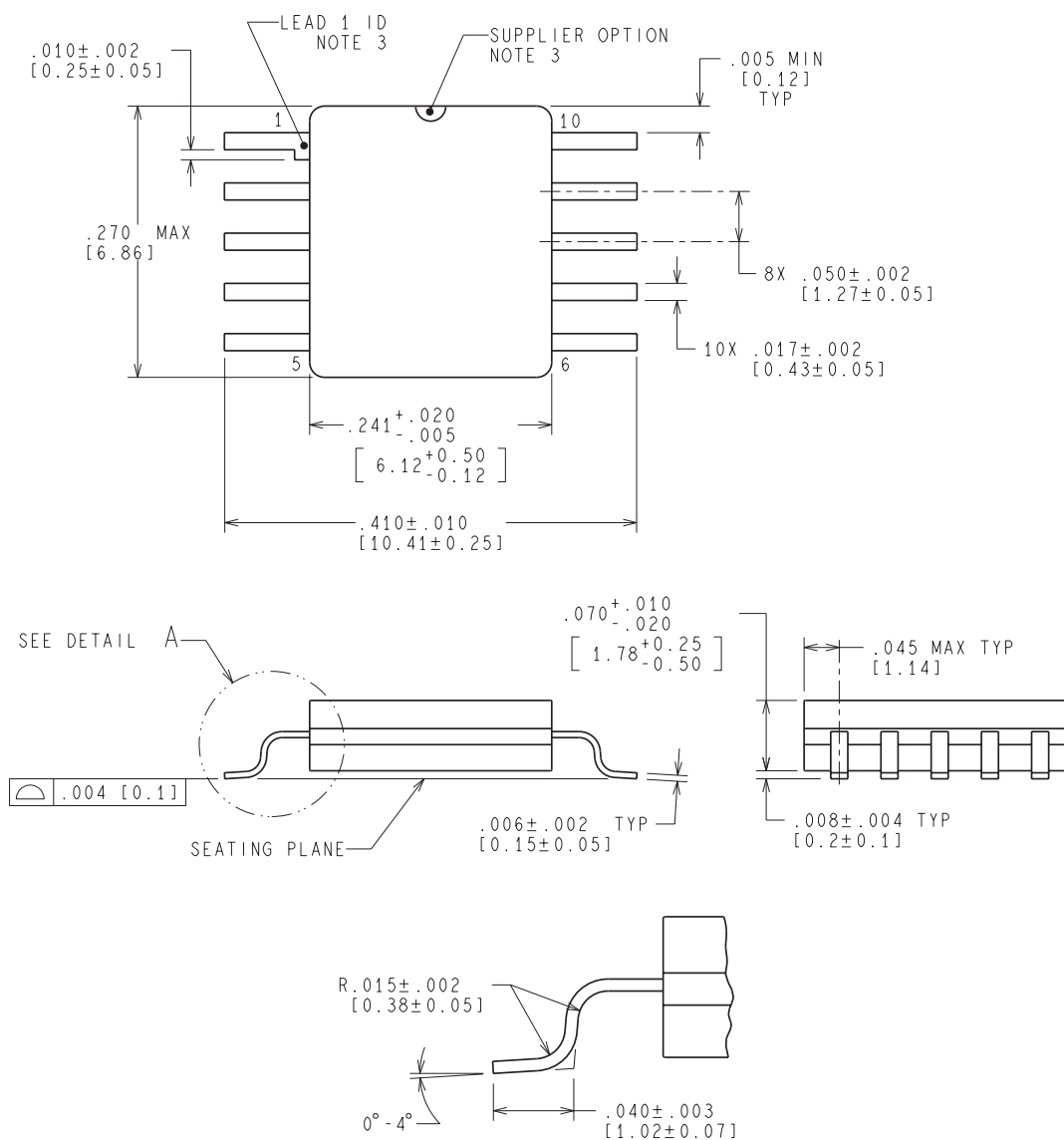
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM7171AIMX	SOIC	D	8	2500	349.0	337.0	45.0
LM7171AIMX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM7171BIMX	SOIC	D	8	2500	349.0	337.0	45.0
LM7171BIMX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0

NAC0010A



MIL-PRF-38535  
CONFIGURATION CONTROL

DETAIL A  
TYPICAL

WG10A (Rev H)



P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



## NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AA.

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