National Semiconductor

LH4008/LH4008C Fast Buffer

General Description

The LH4008 is a very high speed, FET input, voltage follower/buffer designed to provide high current drive at frequencies from DC to over 180 MHz. The LH4008/LH4008C will provide ±200 mA into 50Ω loads (±500 mA peak) at slew rates of 10,000 V/µs. In addition, it exhibits excellent phase linearity.

The LH4008 is intended to fulfill a wide range of buffer applications. Due to its high speed it does not degrade the system performance. Its high output current makes it adequate for most loads. Only a single +10V supply is needed for a 5 V_{PP} video signal. In addition, the LH4008 can continuously drive 50Ω coaxial cables.

These devices are constructed using specially selected junction FET's and active laser trimming to achieve guaranteed performance specifications. The LH4008K is specified for operation from −55°C to +125°C; whereas, the LH4008CK and LH4008CT are specified from −25°C to +85°C. LH4008K and LH4008CK are available in an 8-pin TO-3 package. The LH4008CT is available in an 11-pin TO-220 package.

Features

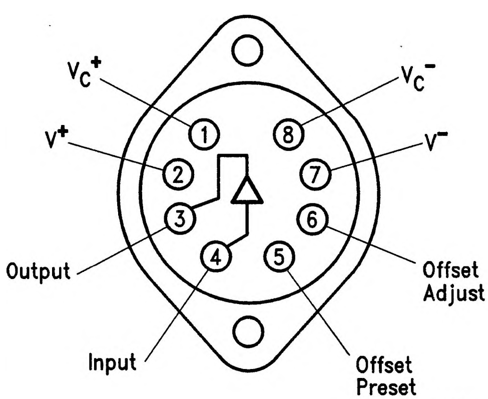
- Fast — 10,000 V/µs
- Wide range single or dual supply operation
- Wide power bandwidth — DC to 130 MHz
- High output drive — ±10V with 50Ω load
- Low phase non-linearity — < 2 degrees
- Fast rise times — < 1.6 ns
- High input resistance — > 10^{10}Ω
- Pin compatible with LH0063

Applications

- High speed line drivers
- Video impedance transformation
- Op amp isolation buffers
- Yoke driver for high resolution CRT
- High impedance input buffer

Connection Diagram

Metal Can Package (TO-3), 8 Pin



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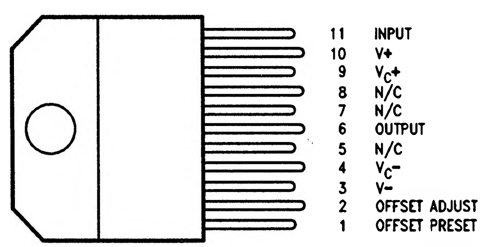
Note: Case is electrically isolated.

Top View

Order Number LH4008K or LH4008CK
See NS Package Number K08A

Plastic Package (TO-220), 11 Leads



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Note: Metal tab is electrically isolated.

Top View

Order Number LH4008CT
See NS Package Number TA11B

Absolute Maximum Ratings

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

Supply Voltage ($V^+ - V^-$)	40V
Maximum Power Dissipation (See Curves)	3.2W
Maximum Junction Temperature	175°C
Input Voltage	Equal to Supplies
Continuous Output Current	±200 mA
Peak Output Current	±500 mA
Operating Temperature Range	
LH4008	−55°C to +125°C
LH4008C	−25°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C
ESD	TBD

DC Electrical Characteristics

$V_S = \pm 15V$, $R_S = R_L = 50\Omega$, $T_A = 25°C$ unless otherwise specified (Note 1)

Symbol	Parameter	Conditions	LH4008 Typical	LH4008 Tested Limit (Note 2)	LH4008 Design Limit (Note 3)	Units (Max Unless Otherwise Noted)
V_{OS}	Output Offset	(Note 4)	10	25 **100**		mV
$\Delta V_{OS}/\Delta T$	Average Temperature Coefficient of Output Offset Voltage	$R_S < 100\ k\Omega$	200			$\mu V/°C$
I_B	Input Bias Current	$T_{MIN} < T_A < T_{MAX}$ (Note 4)	10	30 **100**		nA
A_V	Voltage Gain	$V_{IN} = \pm 10V$, $R_L = 1\ k\Omega$	0.95	0.94 **0.92**		V/V (Min)
A_V	Voltage Gain	$V_{IN} = \pm 10V$	0.94	0.90 **0.88**		V/V (Min)
C_{IN}	Input Capacitance	Case Shorted to Output	8			pF
R_{OUT}	Output Impedance	$V_{OUT} = \pm 10V$	1.8	**4**		Ω
V_O	Output Current Swing	$V_{IN} = \pm 10V$, $R_S < 100\ k\Omega$	0.25	**0.2**		Amps (Min)
V_O	Output Voltage Swing		11.9 **11.1**	±10.5 **10.0**		V (Min)
LSV_O	Low Supply Output Voltage Swing	$V_S = \pm 5.0V$	±3.2	±2.5		V (Min)
I_S	Supply Current	$R_L = \infty$, $V_S = \pm 15V$	60	70		mA
I_S	Supply Current	$R_L = \infty$, $V_S = \pm 15V$, $T_A = +125°C$	52	70		mA
I_S	Supply Current	$R_L = \infty$, $V_S = \pm 15V$, $T_A = -55°C$	88	135		mA
I_S	Supply Current	$V_S = \pm 5.0V$	45			mA
P_D	Power Consumption	$R_L = \infty$, $V_S = \pm 15V$	1.8	2.1		W
P_D	Power Consumption	$V_S = \pm 5.0V$	450			mW

Note 1: Boldface limits are guaranteed over full temperature range. Operating ambient temperature range of LH4008C is −25°C to +85°C, and LH4008 is −55°C to +125°C.

Note 2: Tested limits are guaranteed and 100% production tested.

Note 3: Design limits are guaranteed (but not production tested) over the indicated temperature range. These limits are not used to calculate outgoing quality level.

Note 4: Specification is at 25°C junction temperature due to requirements of high speed automatic testing. Actual values at operating temperature will exceed value at $T_J = 25°C$.

DC Electrical Characteristics

$V_S = \pm 15V$, $R_S = R_L = 50\Omega$, $T_A = 25°C$ unless otherwise specified (Note 1) (Continued)

Symbol	Parameter	Conditions	LH4008C Typical	LH4008C Tested Limit (Note 2)	LH4008C Design Limit (Note 3)	Units (Max Unless Otherwise Noted)
V_{OS}	Output Offset	(Note 4)	10	50		mV
$\Delta V_{OS}/\Delta T$	Avererage Temperature Coefficient of Output Offset Voltage	$R_S < 100\ k\Omega$	200			$\mu V/°C$
I_B	Input Bias Current	$T_{MIN} < T_A < T_{MAX}$ (Note 4)	10	30		nA
A_V	Voltage Gain	$V_{IN} = \pm 10V$, $R_L = 1\ k\Omega$	0.95	0.92		V/V
A_V	Voltage Gain	$V_{IN} = \pm 10V$	0.94	0.9		V/V
C_{IN}	Input Capacitance	Case Shorted to Output	8			pF
R_{OUT}	Output Impedance	$V_{OUT} = \pm 10V$	1.8	4		Ω
V_O	Output Current Swing	$V_{IN} = \pm 10V$, $R_S < 100\ k\Omega$	0.25	0.2		Amps
V_O	Output Voltage Swing		11.9	±10.5		V
LSV_O	Low Supply Output Voltage Swing	$V_S = \pm 5.0V$	±3.2	±2.5		V (Min)
I_S	Supply Current	$R_L = \infty$, $V_S = \pm 15V$	60	70		mA
I_S	Supply Current	$V_S = \pm 5.0V$	45			mA
P_D	Power Consumption	$R_L = \infty$, $V_S = \pm 15V$	1.8	2.1		W
P_D	Power Consumption	$V_S = \pm 5.0V$	450			mW

AC Electrical Characteristics

LH4008 ($T_J = 25°C$, $V_S = \pm 15V$, $R_S = 50\Omega$, $R_L = 50\Omega$)

Symbol	Parameter	Conditions	LH4008C/LH4008 Typical	LH4008C/LH4008 Tested Limit (Note 2)	LH4008C/LH4008 Design Limit (Note 3)	Units (Max Unless Otherwise Noted)
S_R	Slew Rate Rising Edge	$V_{IN} = 20\ V_{P-P}$ 20%–80%	10000			V/µs
S_R	Slew Rate Falling Edge	$V_{IN} = 20\ V_{P-P}$ 20%–80%	7000			V/µs
BW	Bandwidth	$V_{IN} = 1.0$ Vrms	180	160		MHz
PBW	Power Bandwidth	$V_{IN} = 20\ V_{P-P}$	130	110		MHz
	Phase Non-Linearity	BW = 1.0 to 50 MHz	2			degrees
t_r	Rise Time	$\Delta V_{IN} = 20\ V_{P-P}$	1.6			ns
t_p	Propagation Delay	$\Delta V_{IN} = 20\ V_{P-P}$	1.2			ns
	Harmonic Distortion		< 0.1			%

Note 1: Boldface limits are guaranteed over full temperature range. Operating ambient temperature range of LH4008C is −25°C to +85°C, and LH4008 is −55°C to +125°C.

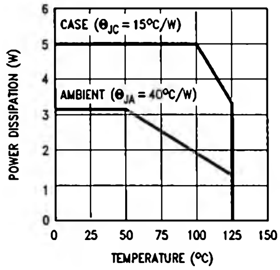
Note 2: Tested limits are guaranteed and 100% production tested.

Note 3: Design limits are guaranteed (but not production tested) over the indicated temperature range. These limits are not used to calculate outgoing quality level.

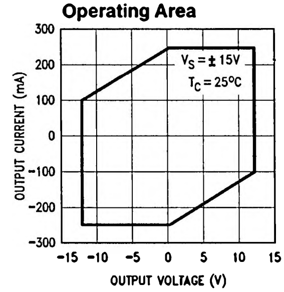
Note 4: Specification is at 25°C junction temperature due to requirements of high speed automatic testing. Actual values at operating temperature will exceed value at $T_J = 25°C$.

Typical Performance Characteristics

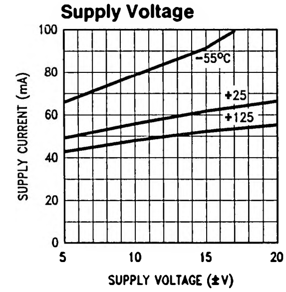
Maximum Power Dissipation vs Temperature



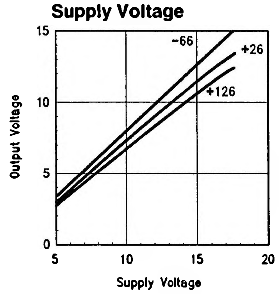
DC Safe Operating Area



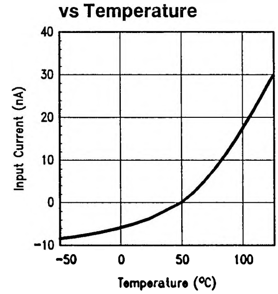
Supply Current vs Supply Voltage



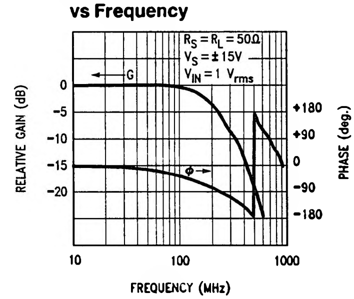
Output Swing vs Supply Voltage



Input Bias Current vs Temperature



Gain Phase vs Frequency



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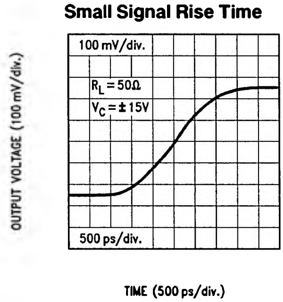
Small Signal Rise Time



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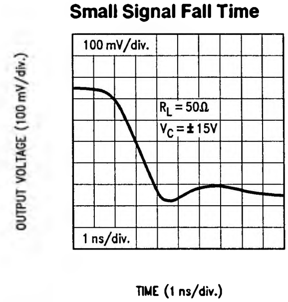
Small Signal Fall Time



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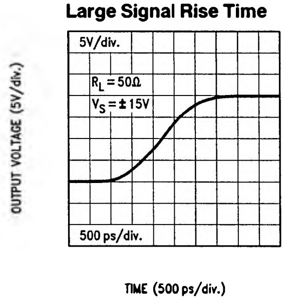
Large Signal Rise Time



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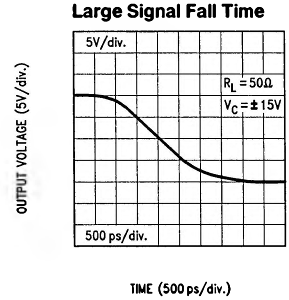
Large Signal Fall Time



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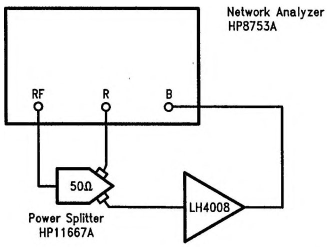
Bandwidth Test Circuit



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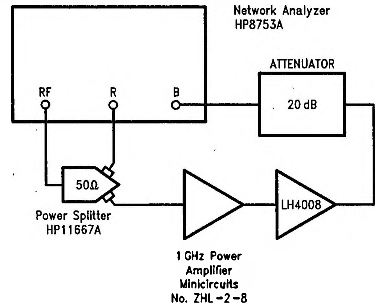
Power Bandwidth Test Circuit



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Application Hints

Recommended Layout Precautions: RF/video printed circuit board layout rules should be followed when using the LH4008 since it will provide power gain to frequencies over 180 MHz. Ground planes are recommended and power supplies should be decoupled at each device with low inductance capacitors. In addition, ground plane shielding may be extended to the metal case of the device since it is electrically isolated from internal circuitry. Alternatively, the case should be connected to the output to minimize input capacitance.

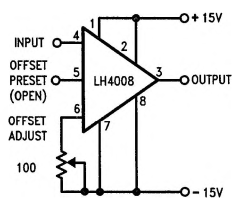

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FIGURE 2. Offset Zero Adjust

Short Circuit Protection: Short circuit protection may be added by inserting appropriate value resistors between V^+ and V_C^+ pins and V^- and V_C^- pins as illustrated in *Figures 2* and *3*. Resistor values may be predicted by:

$$R_{LIM} = \frac{V^+}{I_{SC}} = \frac{V^-}{I_{SC}}$$

The inclusion of limiting resistors in the collectors of the output transistors reduces output voltage swing. Decoupling V_C^+ and V_C^- pins with capacitors to ground will retain full output swing for transient pulses.

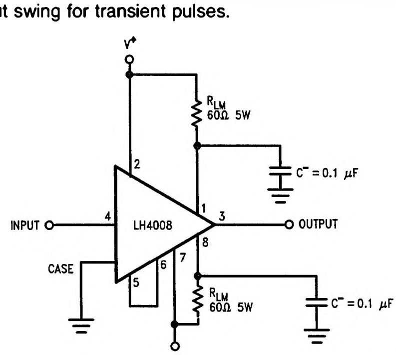

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FIGURE 3. Using Resistor Current Limiting

Capacitive Loading: The LH4008 is designed to drive capacitive loads such as coaxial cables in excess of several thousand picofarads without susceptibility to oscillation. However, peak current resulting from ($C \times dV/dt$), should be limited below absolute maximum peak current ratings for the devices.

$$\left(\frac{\Delta V_{IN}}{\Delta t}\right) \times C_L \leq I_{OUT} \leq \pm 500 \text{ mA}$$

In addition, power dissipation resulting from driving capacitive loads plus standby power should be kept below package power rating:

$$P_{\substack{diss\\pkg.}} \geq P_{DC} + P_{AC}$$

$$P_{\substack{diss\\pkg.}} \geq (V^+ - V^-) \times I_S + P_{AC}$$

$$P_{AC} = (V_{p\text{-}p})^2 \times f \times C_L$$

where

$V_{p\text{-}p}$ = Peak-to-peak output voltage swing

f = frequency

C_L = Load Capacitance

Operation within an Op Amp Loop: The device may be used as a current booster or isolation buffer within a closed loop with op amps such as LH0032, LM6161, or LM118. An isolation resistor of 47Ω should be used between the op amp output and the input of LH4008. The wide bandwidth and high slew rate of the LH4008 assures that the loop has the characteristics of the op amp and that additional rolloff is not required.

Hardware: In order to utilize the full drive capabilities of both devices, each should be mounted with a heat sink particularly for extended temperature operation. The cases of both are isolated from the circuit and may be connected to system chassis.

ATTENTION!

Power supply bypassing is necessary to prevent oscillation in all circuits. Low inductance ceramic disc capacitance with the shortest practical lead lengths must be connected from each supply lead (within < ¼ to ½″ of the device package) to a ground plane. Capacitors should be two 0.1 μF ceramic and one 4.7 μF solid tantalum capacitors in parallel on each supply lead.

Schematic Diagram

LH4008/LH4008C

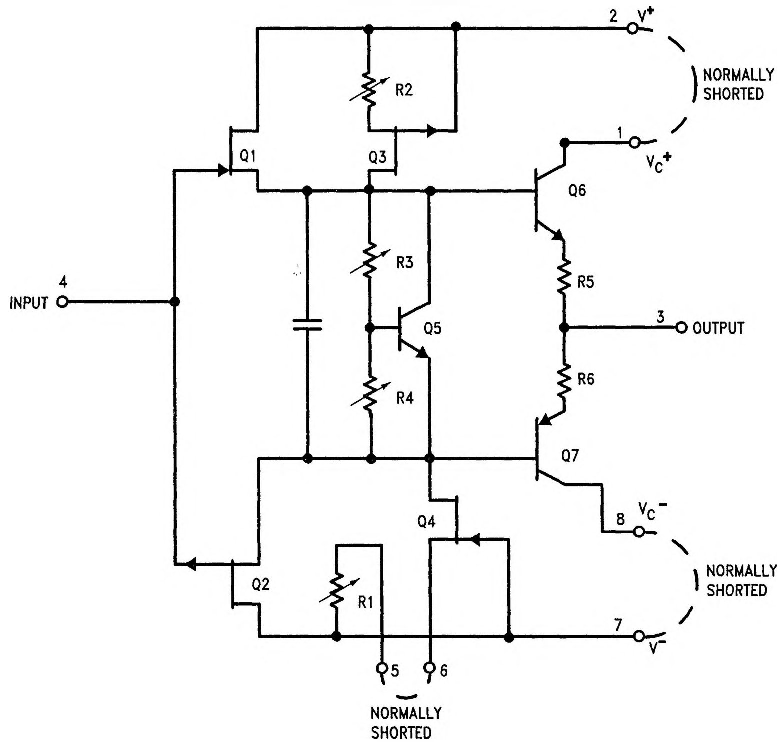

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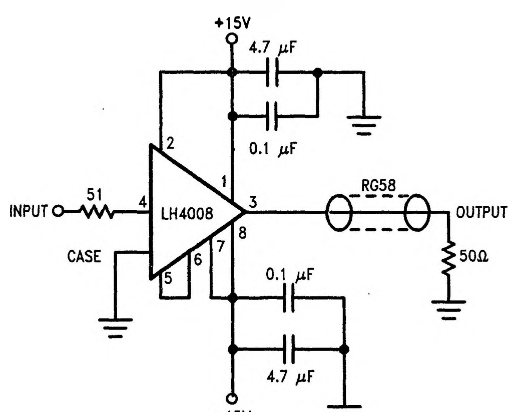
FIGURE 1

Typical Applications

Coaxial Cable Driver



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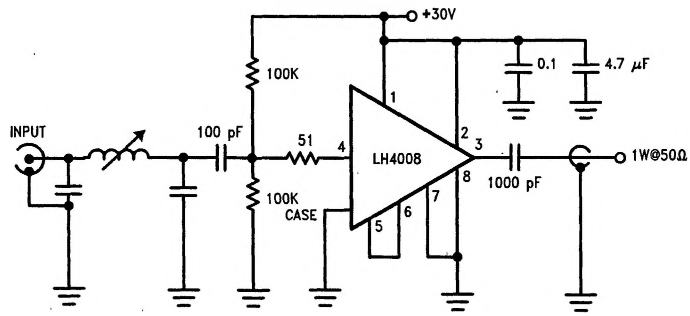
Typical Applications (Continued)

1W CW Final Amplifier



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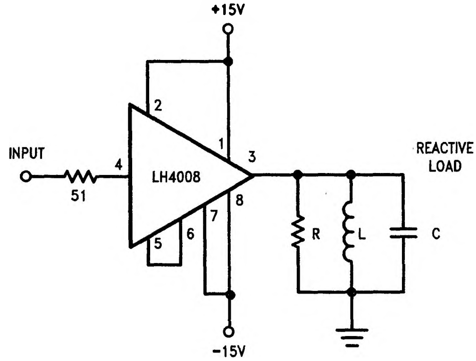
Isolation Buffer



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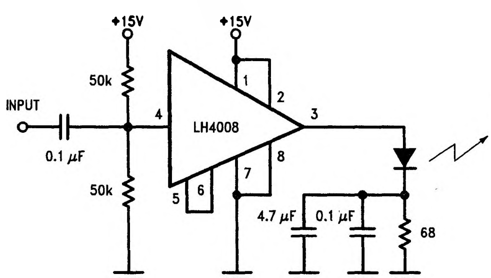
Laser Diode Transmitter



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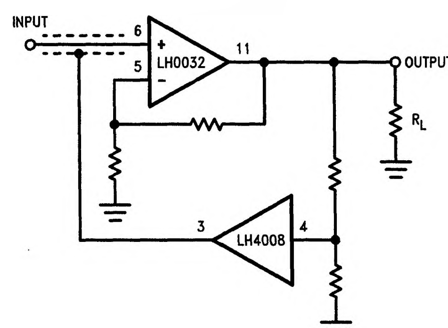
Guard Driver



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