National Semiconductor

# LH4002 Wideband Video Buffer

## General Description

The LH4002 is a high speed voltage follower designed to drive video signals from DC up to 200 MHz. At voltage supplies of ±5V, the LH4002 will provide up to 40 mA into 50Ω at slew rates in excess of 1000 V/μs.

The device is intended to fulfill a wide range of high speed applications including video distribution, impedance transformation, and load isolation. It is also suitable for use in current booster applications within an op amp loop. This allows the output current capability of existing op amps to be increased.

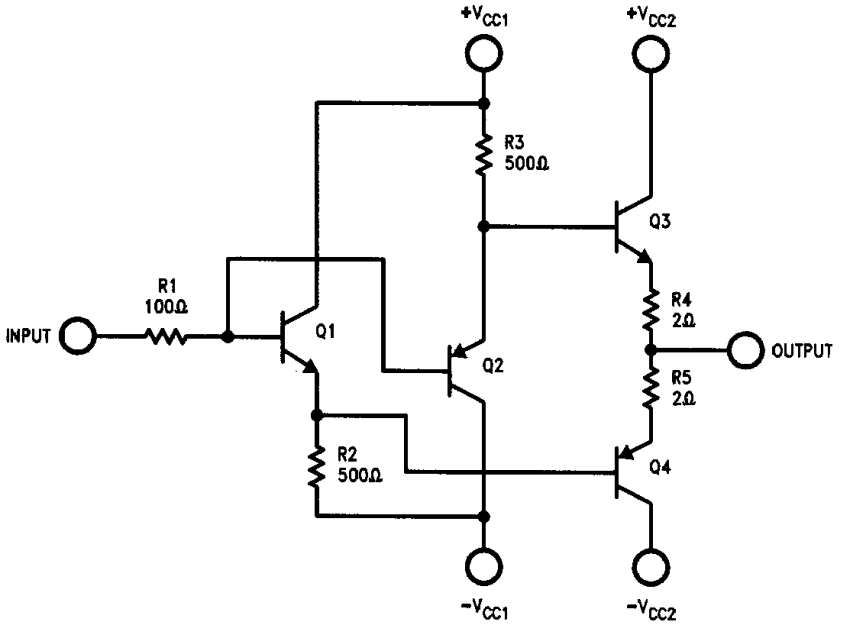
## Features

- DC to 200 MHz Bandwidth with $V_S$ = ±5V
- 1250 V/μs Slew Rate into 50Ω
- 150 MHz Bandwidth with $V_S$ = ±5V, $R_L$ = 50Ω and Voltage Swing = 2 $V_{P-P}$

## Applications

- Wideband Buffer Amplifiers
- Wideband Line Driver

## Schematic and Connection Diagrams

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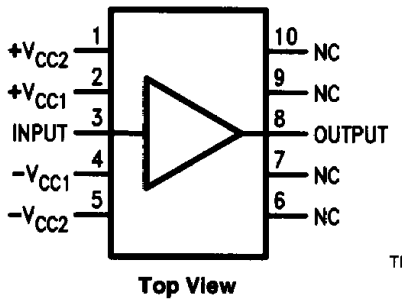
**Dual-In-Line Package**

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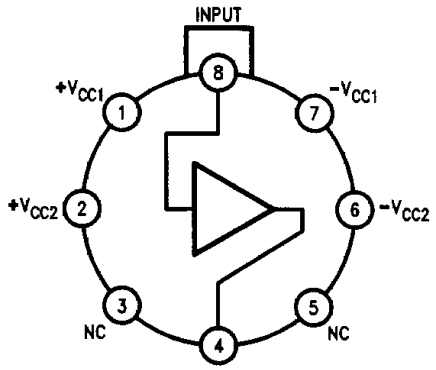
**Top View**

**Order Number LH4002CN**
**See NS Package Number N10A**

**Metal Can Package**

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**Top View**

**Order Number LH4002CH or LH4002H**
**See NS Package Number H08D**

## Absolute Maximum Ratings

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

| | |
|---|---|
| Supply Voltage, $V_S$ | ±6V |
| Input Voltage Range, $V_{IN}$ | ±$V_S$ |
| Continuous Output Current, $I_O$ | ±60 mA |
| Storage Temperature Range, $T_{STG}$ | −65°C to +150°C |
| Operating Temperature Range, $T_A$ | |
| LH4002 | −55°C to +125°C |
| LH4002C | −25°C to +85°C |
| Maximum Junction Temperature, $T_J$ | 150°C |
| Lead Temperature (Soldering, 10 sec) | 300°C |

ESD rating is to be determined.

## DC Electrical Characteristics $V_{CC}$ = ±5V, $T_{min} \le T_A \le T_{max}$ unless otherwise stated.

| Symbol | Parameter | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | $T_A = T_J = 25°C$<br>$R_S = 150\Omega$, $R_L = 50\Omega$ | | | 20 | 50 | mV |
| $I_B$ | Input Bias Current | $R_S = 1\ k\Omega$, $R_L = 50\Omega$ | | | 100 | 200 | μA |
| $A_V$ | DC Voltage Gain | $R_S = 10\ k\Omega$, $R_L = 1.0\ k\Omega$, $V_{IN} = \pm 2V$ | | 0.95 | 0.97 | | V/V |
| $V_O$ | Output Voltage Swing | $R_S = 150\Omega$, $V_{IN} = \pm 2.5V$ | $R_L = 1\ k\Omega$ | ±2.2 | ±2.4 | | V |
| | | | $T_A = 25°C$, $R_L = 50\Omega$ | ±2.0 | ±2.2 | | V |
| $I_S$ | Supply Current | $R_S = 10\ k\Omega$, $V_{IN} = 0V$, $R_L = 1\ k\Omega$, $T_A = T_J = 25°C$ | | | 20 | 35 | mA |
| $R_{OUT}$ | Output Resistance | $R_S = 10\ k\Omega$, $R_L = 50\Omega$ | | | 6 | 10 | Ω |
| $R_{IN}$ | Input Resistance | $R_S = 10\ k\Omega$, $R_L = 50\Omega$ | | 10 | 18 | | kΩ |

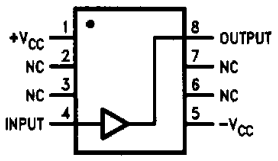
## AC Electrical Characteristics $V_{CC}$ = ±5V, $T_A$ = 25°C.

| Symbol | Parameter | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| $S_R$ | Slew Rate | $R_L = 50\Omega$, $R_S = 50\Omega$<br>$V_{IN} = \pm 2V$ | | 1000 | 1250 | | V/μs |
| $f_{3dB}$ | Bandwidth, −3 dB | $R_S = 50\Omega$<br>$R_L = 50\Omega$ | $V_{OUT} = 4V_{P-P}$ | | 125 | | MHz |
| | | | $V_{OUT} = 2V_{P-P}$ | 100 | 150 | | MHz |
| | | (Note 2) | $V_{OUT} = 100\ mV_{P-P}$ | | 200 | | MHz |
| | Phase Non-Linearity | BW = 1.0–20 MHz | | | 2.0 | | degrees |
| $t_r$ | Rise Time | $\Delta V_{IN} = 0.5V$ | | | 3 | | ns |
| $t_d$ | Propagation Delay | $\Delta V_{IN} = 0.5V$ | | | 1.2 | | ns |
| THD | Harmonic Distortion | f = 1 kHz | | | 0.1 | | % |

**Note 1:** Under normal operating conditions $+V_{CC1}$ and $+V_{CC2}$ should be connected together, and $-V_{CC1}$ and $-V_{CC2}$ should be connected together.

**Note 2:** Guaranteed by design. This parameter is sample tested.

## Connection Diagrams (Continued)

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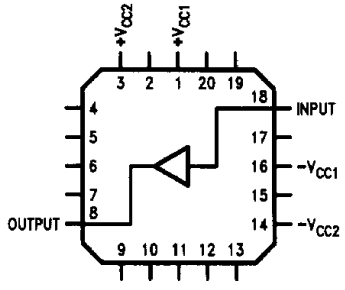
**Top View**

**Order Number LH4002CN-8**
**See NS Package Number N08E**

**Note:** $+V_{CC1}$ and $+V_{CC2}$ pins and $-V_{CC1}$ and $-V_{CC2}$ pins are internally connected.

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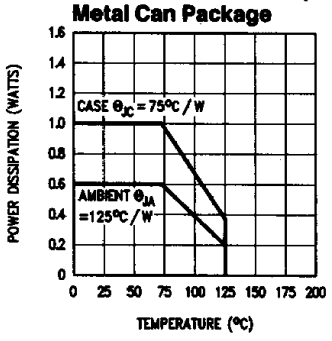
**Top View**

**Order Number LH4002E**
**See NS Package Number E20A**

# Typical Performance Characteristics

**Maximum Power Dissipation Metal Can Package**

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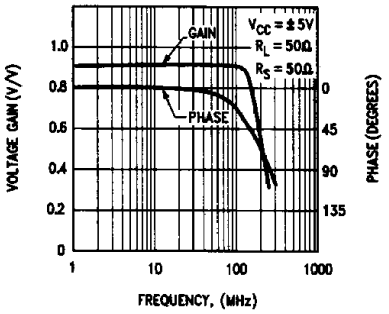
**Frequency Response**

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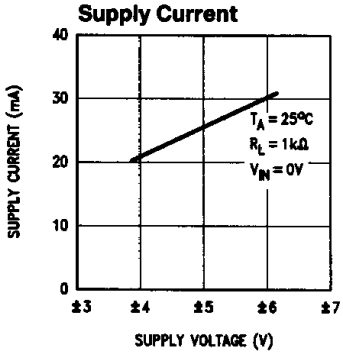
**Supply Current**

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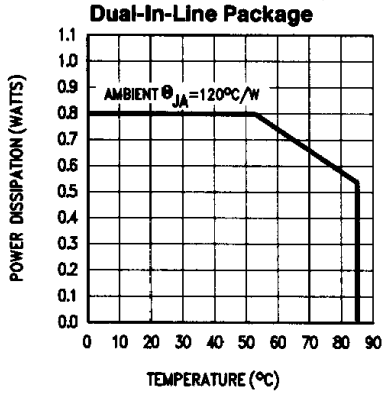
**Maximum Power Dissipation Dual-In-Line Package**

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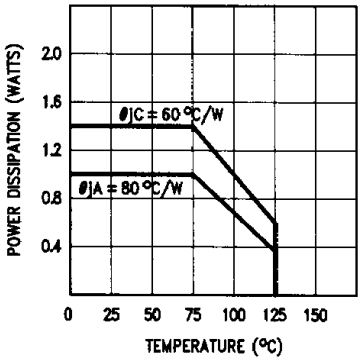
**Maximum Power Dissipation E20A Package**

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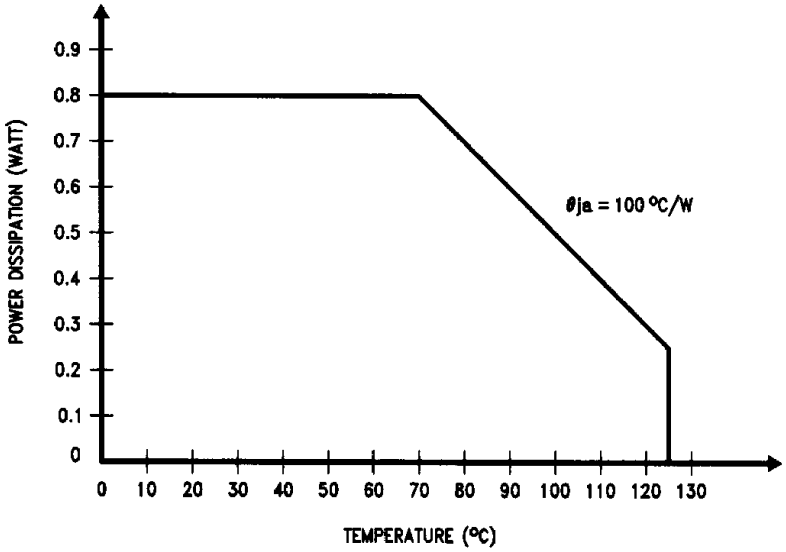
**Maximum Power Dissipation For N08E Package**

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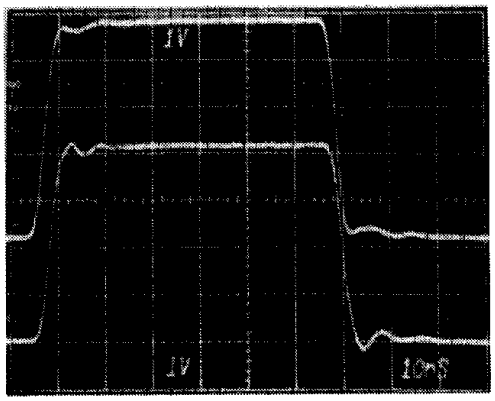
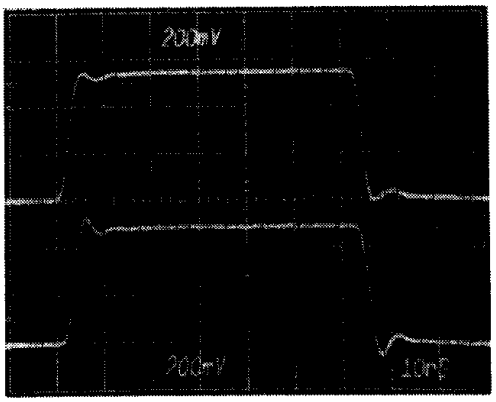
## Pulse Response



TOP TRACE
= INPUT

BOTTOM TRACE
= OUTPUT

$V_S = \pm 5V$
$R_L = 50\Omega$



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## Typical Applications

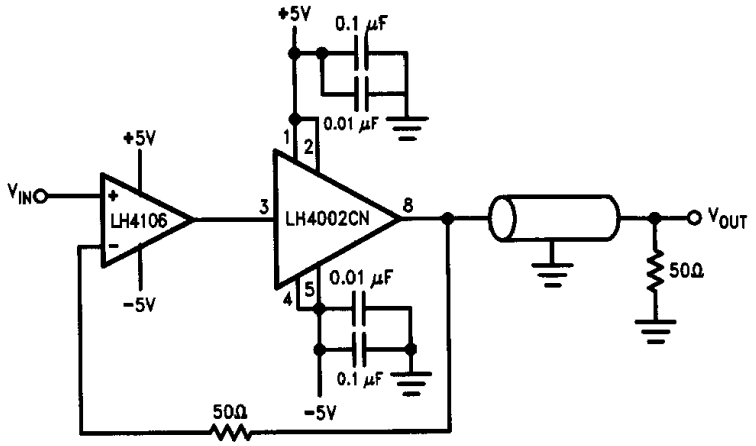


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**FIGURE 1. Wideband Unity Gain Amplifier Using LH4002CN**

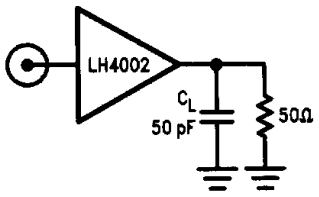


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**FIGURE 2. Compensation for Capacitive Loads**

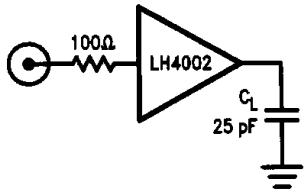


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**FIGURE 3. Compensation for Capacitive Loads**

## Applications Information

The high speed performance of the LH4002 can only be realized by taking certain precautions in circuit layout and power supply decoupling. Low inductance ceramic chip or disc power supply decoupling capacitors of 0.01 μF in parallel with 0.1 μF should be connected with the shortest practical lead length between device supply leads and a ground plane. Failure to follow these rules can result in oscillations. When driving a capacitive load such as inputs to flash converters, the circuits in *Figure 2* and *3* can be used to minimize the amount of overshoot and ringing at the outputs. *Figure 2* indicates that a 50Ω should be placed in parallel with the load and *Figure 3* recommends that a 100Ω resistor be placed in series with the input to the LH4002.

## Short Circuit Protection

In order to optimize transient response and output swing, output current limits have been omitted from the LH4002. Short circuit protection may be added by inserting appropriate value resistors between $+V_{CC1}$ and $+V_{CC2}$ pins and between $-V_{CC1}$ and $-V_{CC2}$ pins as illustrated in *Figure 4*. Resistor values may be predicted by:

$$R_{LIM} = \frac{+V_{CC1}}{I_{SC}} = \frac{-V_{CC1}}{I_{SC}}$$

where $I_{SC} \leq 100$ mA. The inclusion of 50Ω limiting resistors in the collectors of the output transistors limits the short circuit current to approximately 100 mA without reducing the output voltage swing.

## Short Circuit Protection (Continued)

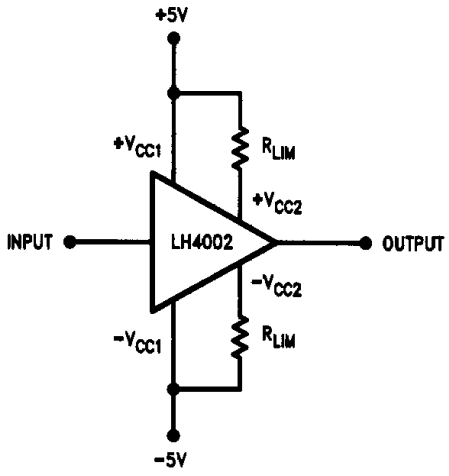


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**FIGURE 4. LH4002 Using Resistor Current Limiting**