



## LH4106/LH4106C $\pm 5V$ High Speed Operational Amplifier

### General Description

The LH4106 is a wideband op amp designed to operate with  $\pm 5V$  power supplies. It features a 30 MHz bandwidth and can drive 50 or 75 $\Omega$  loads directly at slew rates in excess of 170 V/ $\mu$ s.

It is intended to fulfill a wide range of applications; such as, precision cable drivers, buffers in high speed data acquisition systems, and high speed peak detectors.

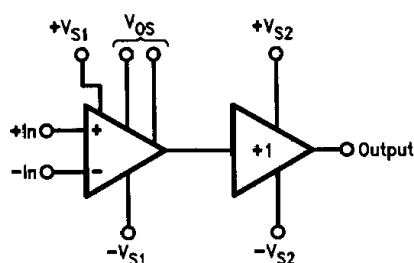
### Features

- Operates from  $V_s$  of  $\pm 5V$
- Unity gain stable
- Very high slew rate—170 V/ $\mu$ s
- Wide small signal bandwidth—32 MHz
- Low supply current—16 mA
- Drives 50 or 75 $\Omega$  directly

### Applications

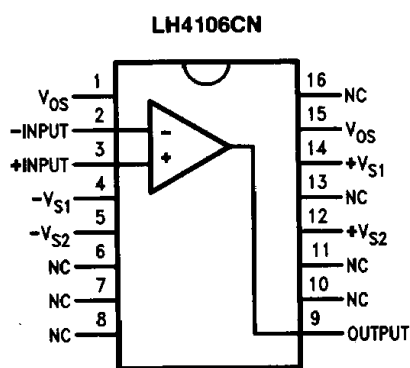
- Flash A/D input buffers
- Video amplifier
- High speed summing amplifiers
- Pulse amplifiers
- Precision cable drivers

### Block Diagram



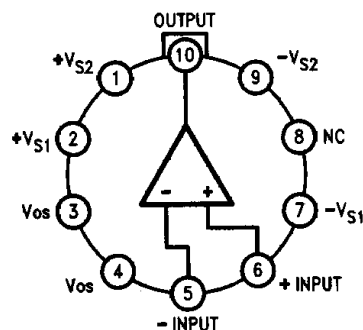
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### Connection Diagrams



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Order Number LH4106CN  
See NS Package Number N16A



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#### Top View

TO-5 Metal Can Package (H)  
Order Number LH4106CH or LH4106H  
See NS Package Number H10F

## Absolute Maximum Ratings

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

|                                         |                                     |
|-----------------------------------------|-------------------------------------|
| Supply Voltage, $V_S$                   | $\pm 7.5V$                          |
| Steady State Output Current, $I_O$      | 40 mA                               |
| Power Dissipation, $P_D$<br>(See Curve) | 600 mW                              |
| Differential Input Voltage, $V_{IN}$    | $\pm V_S$                           |
| Input Voltage Range, $V_{CM}$           | $(V+ - 0.7V) \text{ to } (V- - 7V)$ |

|                                        |                                            |
|----------------------------------------|--------------------------------------------|
| Operating Temperature Range, $T_A$     |                                            |
| LH4106                                 | $-55^\circ\text{C to } +125^\circ\text{C}$ |
| LH4106C                                | $-25^\circ\text{C to } +85^\circ\text{C}$  |
| Storage Temperature Range, $T_{STG}$   | $-65^\circ\text{C to } +150^\circ\text{C}$ |
| Maximum Junction Temperature, $T_j$    | $150^\circ\text{C}$                        |
| Lead Temperature (Soldering < 10 sec.) | $300^\circ\text{C}$                        |
| ESD Rating                             | $\pm 700V$                                 |
| (100 pF in series with 1500 ohms)      |                                            |

## DC Electrical Characteristics

$V_S = \pm 5V$ ,  $T_A = 25^\circ\text{C}$ ,  $R_S = 50\Omega$ ,  $R_L = 100\Omega$  unless otherwise noted (Note 1)

| Symbol      | Parameter                    | Conditions                                                          | LH4106C |                              |                             | Units<br>(Max Unless<br>Otherwise<br>Stated) |
|-------------|------------------------------|---------------------------------------------------------------------|---------|------------------------------|-----------------------------|----------------------------------------------|
|             |                              |                                                                     | Typ     | Tested<br>Limit<br>(Note 2)  | Design<br>Limit<br>(Note 3) |                                              |
| $V_{OS}$    | Input Offset Voltage         | $V_{IN} = 0V$                                                       | 5       | 15                           |                             | mV                                           |
| $V_{OS}/AT$ | Offset Voltage Drift         |                                                                     | 10      |                              |                             | $\mu V/^\circ\text{C}$                       |
| $I_B$       | Input Bias Current           | (Note 4)                                                            | 2       | 6                            |                             | $\mu A$                                      |
| $I_{OS}$    | Input Offset Current         | (Note 4)                                                            | 150     | 1200                         |                             | nA                                           |
| $C_{IN}$    | Input Capacitance            | $A_V = +1 @ 10 \text{ MHz}$                                         | 1.5     |                              |                             | pF                                           |
| $R_{IN}$    | Input Resistance             |                                                                     | 325     |                              |                             | k $\Omega$                                   |
| $A_{VOL}$   | Large Signal Voltage Gain    | $R_L = 1 \text{ k}\Omega$ , $V_{OUT} \cong \pm 2V$                  | 65      | 60                           |                             | dB (Min)                                     |
| $V_O$       | Output Voltage Swing         | $R_L = 100\Omega$                                                   |         |                              |                             | V (Min)                                      |
|             |                              | $+V_O$                                                              | +3      | +2                           |                             |                                              |
|             |                              | $-V_O$                                                              | -2.6    | -2                           |                             |                                              |
| $V_{CM}$    | Input Common Mode Range      | See CMRR                                                            |         | $+V_S - 1.5$<br>$-V_S + 2.0$ |                             | V (Min)                                      |
| CMRR        | Common Mode Rejection Ratio  | $V_{IN} = -3V \leq V_{CM} \leq +3.5V$<br>$R_L = 1 \text{ k}\Omega$  | 90      | 70                           |                             | dB (Min)                                     |
| PSRR        | Power Supply Rejection Ratio | $V_{OC} = \pm 3V \text{ to } \pm 6V$ ,<br>$R_L = 1 \text{ k}\Omega$ | 80      | 70                           |                             | dB (Min)                                     |
| $I_S$       | Supply Current               | No Load                                                             | 16      | 20                           |                             | mA                                           |

## DC Electrical Characteristics

$V_S = \pm 5V$ ,  $T_A = 25^\circ\text{C}$ ,  $R_S = 50\Omega$ ,  $R_L = 100\Omega$  unless otherwise noted (Note 1)

| Symbol      | Parameter                 | Conditions                                         | LH4106 |                             |                             | Units<br>(Max Unless<br>Otherwise<br>Stated) |
|-------------|---------------------------|----------------------------------------------------|--------|-----------------------------|-----------------------------|----------------------------------------------|
|             |                           |                                                    | Typ    | Tested<br>Limit<br>(Note 2) | Design<br>Limit<br>(Note 3) |                                              |
| $V_{OS}$    | Input Offset Voltage      | $V_{IN} = 0V$                                      | 5      | <b>20</b>                   |                             | mV                                           |
| $V_{OS}/AT$ | Offset Voltage Drift      |                                                    | 10     |                             |                             | $\mu V/^\circ\text{C}$                       |
| $I_B$       | Input Bias Current        | (Note 4)                                           | 2      | <b>6</b>                    |                             | $\mu A$                                      |
| $I_{OS}$    | Input Offset Current      | (Note 4)                                           | 150    | <b>1500</b>                 |                             | nA                                           |
| $C_{IN}$    | Input Capacitance         | $A_V = +1 @ 10 \text{ MHz}$                        | 1.5    |                             |                             | pF                                           |
| $R_{IN}$    | Input Resistance          |                                                    | 325    |                             |                             | k $\Omega$                                   |
| $A_{VOL}$   | Large Signal Voltage Gain | $R_L = 1 \text{ k}\Omega$ , $V_{OUT} \cong \pm 2V$ | 65     | <b>60</b>                   |                             | dB (Min)                                     |

**DC Electrical Characteristics** $V_S = \pm 5V$ ,  $T_A = 25^\circ C$ ,  $R_S = 50\Omega$ ,  $R_L = 100\Omega$  unless otherwise noted (Note 1) (Continued)

| Symbol   | Parameter                    | Conditions                                                        | LH4106 |                              |                             | Units<br>(Max Unless<br>Otherwise<br>Stated) |
|----------|------------------------------|-------------------------------------------------------------------|--------|------------------------------|-----------------------------|----------------------------------------------|
|          |                              |                                                                   | Typ    | Tested<br>Limit<br>(Note 2)  | Design<br>Limit<br>(Note 3) |                                              |
| $V_O$    | Output Voltage Swing         | $R_L = 100\Omega$                                                 | $+V_O$ | +3                           | <b>+2</b>                   | V (Min)                                      |
|          |                              |                                                                   | $-V_O$ | -2.6                         | <b>-2</b>                   |                                              |
| $V_{CM}$ | Input Common Mode Range      | See CMRR                                                          |        | $+V_S - 1.5$<br>$-V_S + 2.0$ |                             |                                              |
| CMRR     | Common Mode Rejection Ratio  | $V_{IN} = -3V \leq V_{CM} \leq +3.5V$<br>$R_L = 1\text{ k}\Omega$ | 90     | <b>70</b>                    |                             | db (Min)                                     |
| PSRR     | Power Supply Rejection Ratio | $V_{OC} = \pm 3V$ to $\pm 6V$ ,<br>$R_L = 1\text{ k}\Omega$       | 80     | <b>70</b>                    |                             |                                              |
| $I_S$    | Supply Current               | No Load                                                           | 16     | 20                           |                             | mA                                           |

**AC Electrical Characteristics**  $V_S = \pm 5V$ ,  $T_A = 25^\circ C$ ,  $R_S = R_L = 50\Omega$  unless otherwise noted (Note 1)

| Symbol | Parameter              | Conditions                   | LH4106/LH4106C |                             |                             | Units<br>(Max Unless<br>Otherwise<br>Stated) |
|--------|------------------------|------------------------------|----------------|-----------------------------|-----------------------------|----------------------------------------------|
|        |                        |                              | Typ            | Tested<br>Limit<br>(Note 2) | Design<br>Limit<br>(Note 3) |                                              |
| $t_s$  | Settling Time to 0.1%  |                              | 120            |                             |                             | ns                                           |
| SR     | Slew Rate              | $V_O = \pm 2V$               | 170            | 120                         |                             | V/ $\mu$ s (Min)                             |
| $t_r$  | Small Signal Rise Time | $A_V = 1$ , $V_O = \pm 0.1V$ | 11             |                             |                             | ns                                           |
|        | Power Bandwidth        | (Note 6)                     | 7              |                             |                             | MHz                                          |
|        | Differential Gain      | NTSC, $A_V = +4$             | <0.1           |                             |                             | %                                            |
|        | Differential Phase     | NTSC, $A_V = +4$             | 0.1            |                             |                             | degrees                                      |
|        | GBWP                   |                              | 34             |                             |                             | MHz                                          |
|        | Phase Margin           |                              | 60             |                             |                             | degrees                                      |
|        | Input Noise Voltage    | $f = 10\text{ kHz}$          | 15             |                             |                             | nV/ $\sqrt{\text{Hz}}$                       |
|        | Input Noise Current    | $f = 10\text{ kHz}$          | 1.5            |                             |                             | pa/ $\sqrt{\text{Hz}}$                       |
| SSBW   | Small Signal Bandwidth | (Note 7)                     | 32             |                             |                             | MHz                                          |

**Note 1:** Boldface limits are guaranteed over full temperature range. Operating ambient temperature range of LH4106C is  $-25^\circ C$  to  $+85^\circ C$ , and LH4106 is  $-55^\circ C$  to  $+125^\circ C$ .

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

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

**Note 4:** Specification is at  $25^\circ C$  junction temperature due to requirements of high speed automatic testing. Actual values at operating temperature may exceed value at  $T_j = 25^\circ C$ .

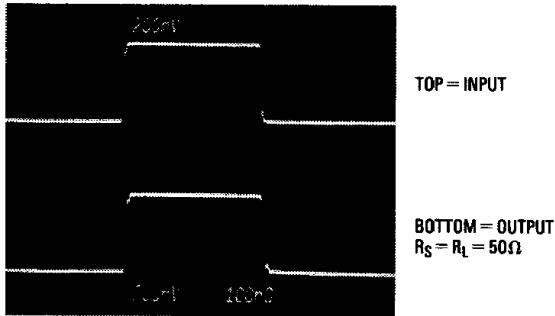
**Note 5:** When the LH4106 is operated at elevated temperature (such as  $125^\circ$ ), some form of heatsinking or forced air cooling is required. The quiescent power with  $V_S = \pm 5V$  is 160 mW, whereas, the package is only rated to 170 mW without a heatsink at  $125^\circ C$ .

**Note 6:** Power bandwidth is calculated from slew rate measurement using  $BW = \text{Slew Rate}/2\pi V_{\text{Peak}}$ .

**Note 7:** Calculated from  $t_r$  using  $SSBW = 0.35/t_r$ .

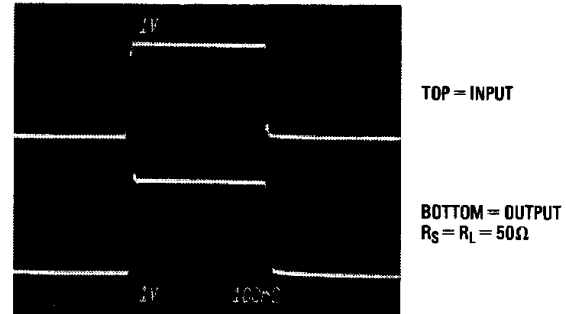
## Typical Performance Characteristics

Small Signal Pulse Response



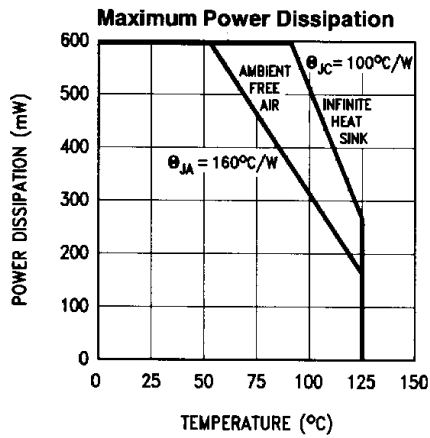
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Large Signal Pulse Response

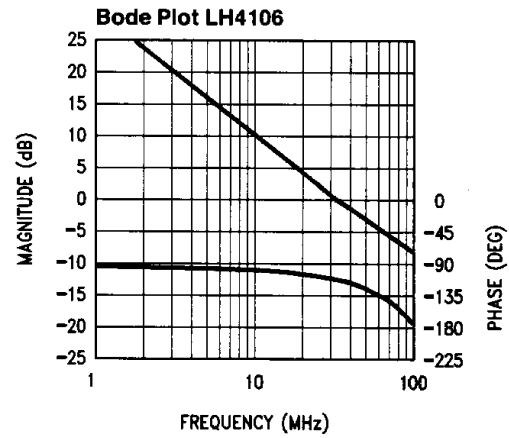


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## Typical Applications

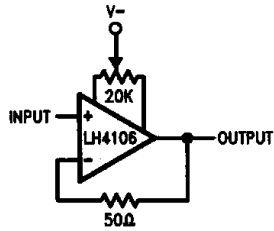


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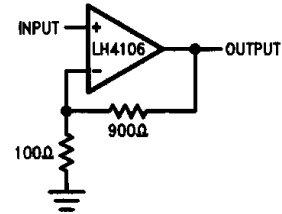
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## Typical Applications (Continued)



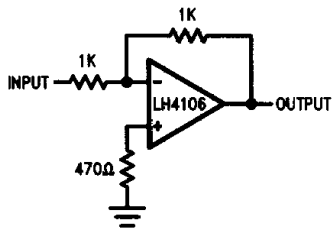
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FIGURE 1. Unity Gain Follower with Offset Adjust



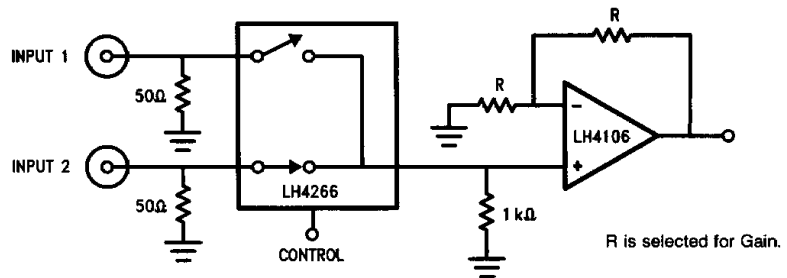
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FIGURE 2. 10X Buffer Amplifier



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FIGURE 3. Unity Gain Inverter

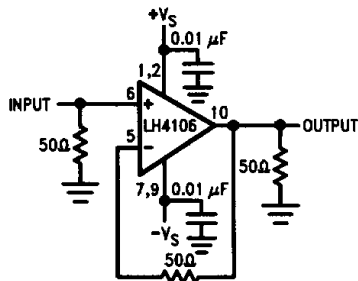


R is selected for Gain.

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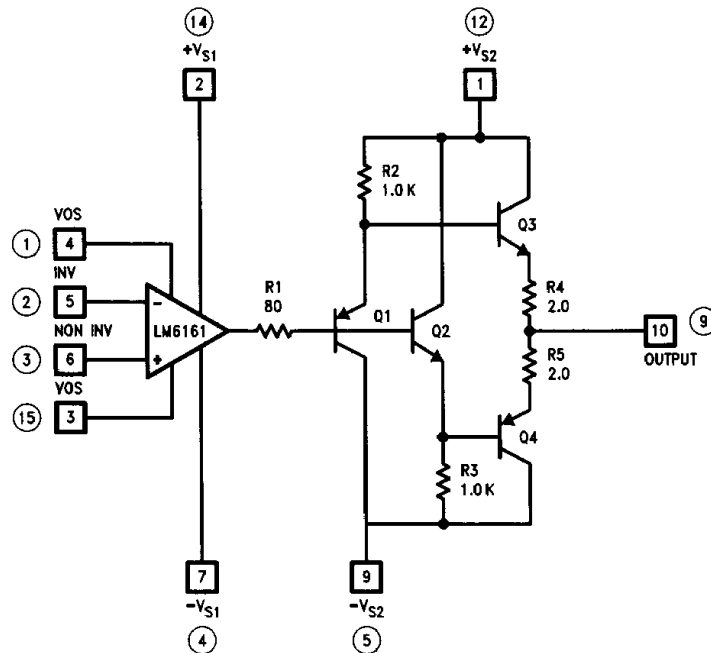
FIGURE 4. Switched Video Amplifier

## AC Test Circuit



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## Circuit Schematic



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Pin numbers in circle denote pin connections for the dual-in-line package.