National Semiconductor

# LH4106/LH4106C ±5V High Speed Operational Amplifier

## General Description

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

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.

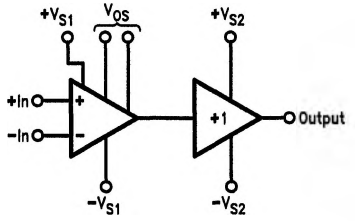
## Features

- Operates from $V_S$ of ±5V
- Unity gain stable
- Very high slew rate—170 V/μs
- Wide small signal bandwidth—32 MHz
- Low supply current—16 mA
- Drives 50 or 75Ω directly

## Applications

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

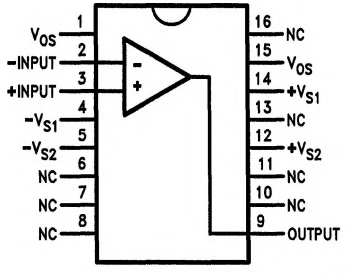
## Block Diagram




TL/K/9317-10

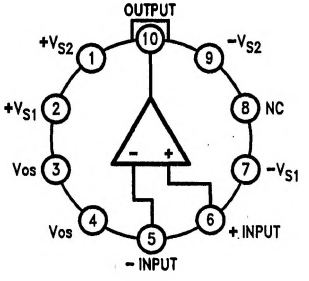
## Connection Diagrams

**LH4106CN**




TL/K/9317-13

**Order Number LH4106CN**
**See NS Package Number N16A**




TL/K/9317-1

**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, $V_S$ | ±7.5V |
| Steady State Output Current, $I_O$ | 40 mA |
| Power Dissipation, $P_D$ (See Curve) | 600 mW |
| Differential Input Voltage, $V_{IN}$ | $\pm V_S$ |
| Input Voltage Range, $V_{CM}$ | (V+ − 0.7V) to (V− − 7V) |
| Operating Temperature Range, $T_A$ | |
| LH4106 | −55°C to +125°C |
| LH4106C | −25°C to +85°C |
| Storage Temperature Range, $T_{STG}$ | −65°C to +150°C |
| Maximum Junction Temperature, $T_j$ | 150°C |
| Lead Temperature (Soldering <10 sec.) | 300°C |
| ESD Rating (100 pF in series with 1500 ohms) | ±700V |

## DC Electrical Characteristics

$V_S$ = ±5V, $T_A$ = 25°C, $R_S$ = 50Ω, $R_L$ = 100Ω unless otherwise noted (Note 1)

| Symbol | Parameter | Conditions | | LH4106C Typ | LH4106C Tested Limit (Note 2) | LH4106C Design Limit (Note 3) | Units (Max Unless Otherwise Stated) |
|---|---|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | $V_{IN}$ = 0V | | 5 | 15 | | mV |
| $V_{OS/AT}$ | Offset Voltage Drift | | | 10 | | | µV/°C |
| $I_B$ | Input Bias Current | (Note 4) | | 2 | 6 | | µA |
| $I_{OS}$ | Input Offset Current | (Note 4) | | 150 | 1200 | | nA |
| $C_{IN}$ | Input Capacitance | $A_V$ = +1 @ 10 MHz | | 1.5 | | | pF |
| $R_{IN}$ | Input Resistance | | | 325 | | | kΩ |
| $A_{VOL}$ | Large Signal Voltage Gain | $R_L$ = 1 kΩ, $V_{OUT} \cong \pm 2V$ | | 65 | 60 | | dB (Min) |
| $V_O$ | Output Voltage Swing | $R_L$ = 100Ω | $+V_o$ | +3 | +2 | | V (Min) |
| | | | $-V_o$ | −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 | $V_{IN} = -3V \le V_{CM} \le +3.5V$<br>$R_L$ = 1 kΩ | | 90 | 70 | | db (Min) |
| PSRR | Power Supply Rejection Ratio | $V_{OC} = \pm 3V$ to ±6V,<br>$R_L$ = 1 kΩ | | 80 | 70 | | dB (Min) |
| $I_S$ | Supply Current | No Load | | 16 | 20 | | mA |

## DC Electrical Characteristics

$V_S$ = ±5V, $T_A$ = 25°C, $R_S$ = 50Ω, $R_L$ = 100Ω unless otherwise noted (Note 1)

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

## DC Electrical Characteristics

$V_S = \pm 5V$, $T_A = 25°C$, $R_S = 50\Omega$, $R_L = 100\Omega$ unless otherwise noted (Note 1) (Continued)

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

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

| Symbol | Parameter | Conditions | LH4106/LH4106C Typ | LH4106/LH4106C Tested Limit (Note 2) | LH4106/LH4106C Design Limit (Note 3) | Units (Max Unless Otherwise Stated) |
|---|---|---|---|---|---|---|
| $t_s$ | Settling Time to 0.1% | | 120 | | | ns |
| SR | Slew Rate | $V_O = \pm 2V$ | 170 | 120 | | V/μs (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 kHz | 15 | | | $nV/\sqrt{Hz}$ |
| | Input Noise Current | f = 10 kHz | 1.5 | | | $pa/\sqrt{Hz}$ |
| 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°C to +85°C, and LH4106 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 or 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 may exceed value at $T_J = 25°C$.

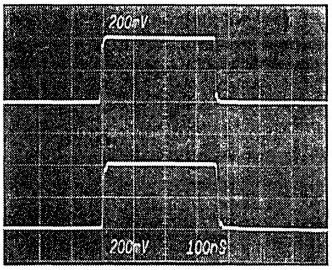
**Note 5:** When the LH4106 is operated at elevated temperature (such as 125°), some form of heatsinking or forced air cooling is required. The quiescent power with $V_S = \pm 5V$ is 160 mW, whereas, the package is only rated to 170 mW without a heatsink at 125°C.

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

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

## Typical Performance Characteristics

**Small Signal Pulse Response**

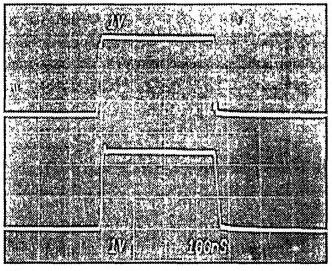



TOP = INPUT

BOTTOM = OUTPUT
$R_S = R_L = 50\Omega$

TL/K/9317–3

**Large Signal Pulse Response**



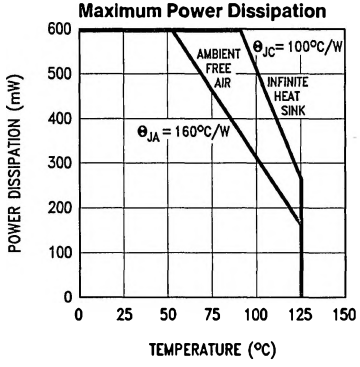

TOP = INPUT

BOTTOM = OUTPUT
$R_S = R_L = 50\Omega$

TL/K/9317–4

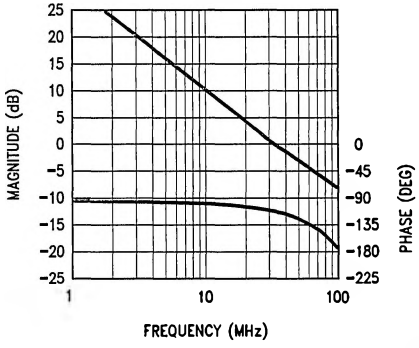
## Typical Applications

**Maximum Power Dissipation**



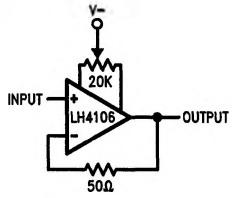

TL/K/9317–5

**Bode Plot LH4106**



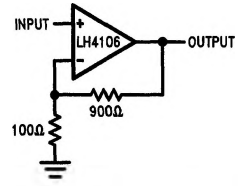

TL/K/9317–6

## Typical Applications (Continued)



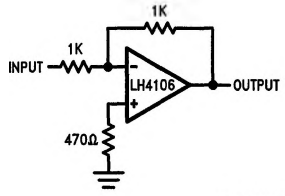

TL/K/9317-7

**FIGURE 1. Unity Gain Follower with Offset Adjust**



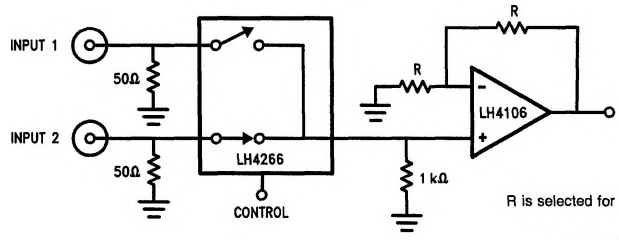

TL/K/9317-8

**FIGURE 2. 10X Buffer Amplifier**




TL/K/9317-9

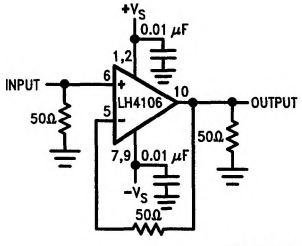
**FIGURE 3. Unity Gain Inverter**




TL/K/9317-15

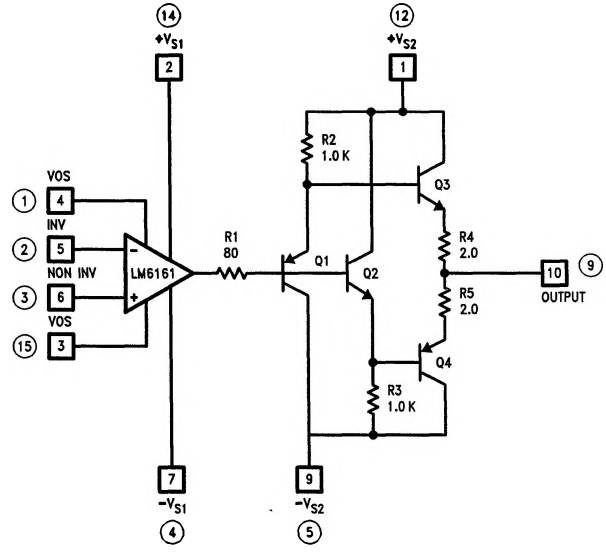
**FIGURE 4. Switched Video Amplifier**

## AC Test Circuit




TL/K/9317-2

## Circuit Schematic




TL/K/9317-14

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