National Semiconductor

LH4101/LH4101C Wideband High Current Operational Amplifier

General Description

The LH4101 is a high slew rate, FET input, wideband operational amplifier designed for applications that require an op amp to provide up to 200 mA peak and 100 mA continuous output current. This feature eliminates the need for a buffer to provide the additional current drive not available with most wideband op amps.

Designed for use with minimum external circuitry, the LH4101 provides internal compensation for unity gain stability and all the gain set resistors for most popular gain settings, as well as internal supply bypass capacitors. These features minimize the circuit's sensitivity to external layout conditions. These features are provided in a 24 pin hermetic dual in-line package.

Features

- 45 MHz bandwidth
- $10^{12}\Omega$ input impedance
- Pin strappable gain settings of 1, 2, 3, 4, -1, -2, -3
- Unity gain stable
- Internal supply bypassing
- 100 mA continuous output current
- 24 pin hermetic DIP
- Directly drives 50Ω loads

The LH4101's wide bandwidth, programmable gain settings, and high output current make it an ideal choice for fast buffering applications such as video distribution. It is also appropriate for use in summing amplifiers, sample and hold circuits, and high speed integrators.

Block and Connection Diagrams
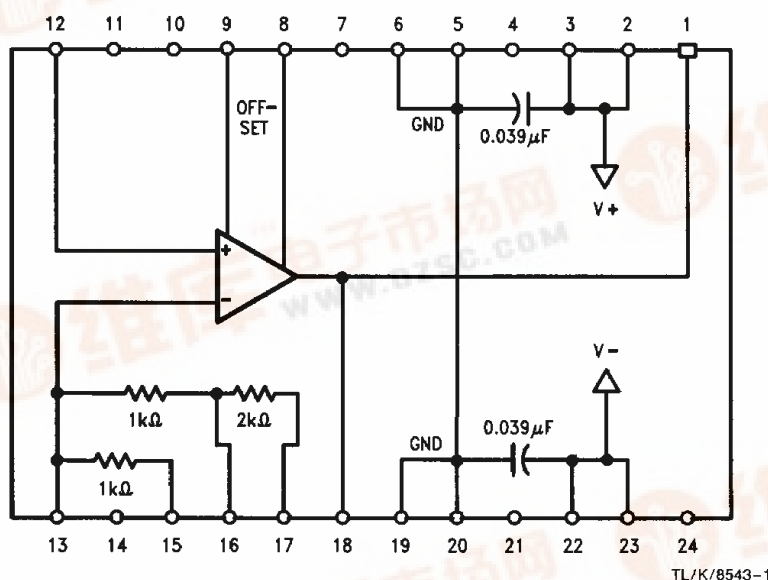
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Dual In-Line Package
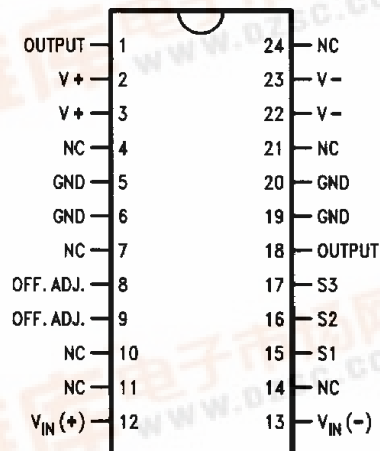
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Order Number LH4101D or LH4101CD
See NS Package Number D24D

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	$\pm 17V$
Power Dissipation, at $T_A = 25°C$, P_D	2W
Input Voltage Range, V_{CM}	$\pm V_S$
Steady State Output Current, I_O	± 100 mA

Operating Temperature Range, T_A	
LH4101CD	$-25°C$ to $+85°C$
LH4101D	$-55°C$ to $+125°C$
Storage Temperature Range, T_{STG}	$-65°C$ to $+150°C$
Maximum Junction Temperature, T_J	175°C
Lead Temperature (Soldering <10 sec.)	300°C
ESD rating to be determined	

DC Electrical Characteristics $V_S = \pm 15V$, $T_{MIN} \leq T_A \leq T_{MAX}$ unless otherwise specified

Symbol	Parameter	Test Conditions		Min	Typ	Max	Units
V_{OS}	Input Offset Voltage	$V_{IN} = 0V$	$T_A = T_J = 25°C$ (Note 1)			15	mV
						25	mV
$\dfrac{\Delta V_{OS}}{\Delta T}$	Average Offset Voltage Drift				25		$\mu V/°C$
I_B	Input Bias Current		$T_A = T_J = 25°C$ (Note 1)			500	pA
			$T_A = T_J = T_{max}$			500	nA
I_{OS}	Input Offset Current		$T_A = T_J = 25°C$ (Note 1)			200	pA
			$T_A = T_J = T_{max}$			200	nA
CMRR	Common Mode Rejection Ratio	$\Delta V_{IN} = \pm 10V$		50	60		dB
PSRR	Power Supply Rejection Ratio	$\Delta V_S = \pm 10V$		50	60		dB
A_{VOL}	Open-Loop Voltage Gain	$V_O = \pm 10V$, $R_L = 1 k\Omega$, $f = 1$ kHz		60	65		dB
		$V_O = \pm 5V$, $R_L = 50\Omega$, $f = 1$ kHz, $T_A = 25°C$		57	62		dB
V_O	Output Voltage Swing	$V_{IN} = \pm 15V$, $R_L = 1 k\Omega$		± 10	± 13.5		V
		$V_{IN} = \pm 5.5V$, $R_L = 50\Omega$, $T_J = 25°C$ (Note 2)		± 5			V
I_S	Supply Current	$R_L = 1 k\Omega$			25	40	mA
e_{-3}	Gain Error $A_V = -3$	$V_{IN} = \pm 1V$, $R_L = 50\Omega$, $T_J = 25°C$			0.8	2	%
e_{-1}	Gain Error $A_V = -1$				0.8	2	%

Note 1: Specification is at 25°C junction temperature due to requirements of high speed automatic testing. Actual values at operating temperature will exceed the value at $T_J = 25°C$.

Note 2: The output swing is limited by the maximum output current of ± 100 mA when $R_L = 50\Omega$. When the LH4101 is operated at elevated temperature (such as 125°C), some form of heatsinking or forced air cooling is required. The quiescent power with V_S of $\pm 15V$ is 1.2W max, whereas the package can only handle 750 mW without a heatsink at 125°C.

AC Electrical Characteristics $A_V = +1$, $R_L = 50\Omega$, $T_A = 25°C$ unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
S_R	Slew Rate	$V_{IN} = \pm 5V$	200	250		$V/\mu s$
$f_{-3 dB}$	Small Signal Bandwidth	$V_{IN} = 100$ mVrms		45		MHz
t_S	Settling Time to 1%	$\Delta V_{IN} = 10V$		140		ns
	Settling Time to 0.1%			300		ns
t_r	Small Signal Rise Time	$V_{IN} = 0V$ to $+100$ mV		10		ns

Applications Information

Power Supply Bypassing

The LH4101 will perform well in most circuit boards even without external supply bypassing; however, it is recommended that some bulk bypassing be provided. One 10 μF electrolytic on each supply is recommended. Proximity to the device pins is not critical, but the bypass will be most effective if located within an inch of the part.

Input Capacitance

The input capacitance to the LH4101 is typically 5 pF and for source impedances greater than 100Ω, the input time constant should be considered.

Gain Settings

The LH4101 provides internal gain set resistors for most popular gain settings. A chart is provided to assist in determining the proper pins to connect to achieve these gains. The internal gain resistors are trimmed and matched to insure the gain accuracy to 0.8% typically. The LH4101 can operate at other gain settings, but the user must supply additional gain set resistors external to the part.
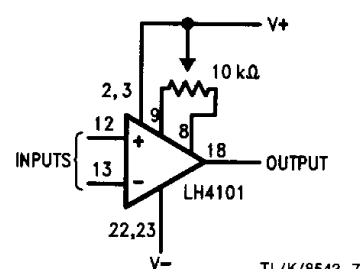
Frequency Response
($A_V = +1$ Closed Loop)
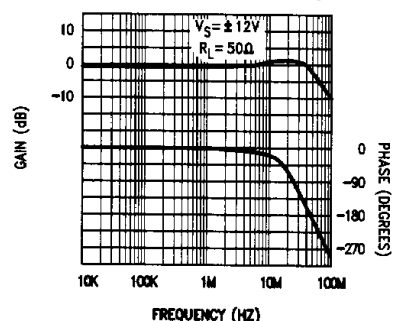
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Frequency Response
(Open Loop)
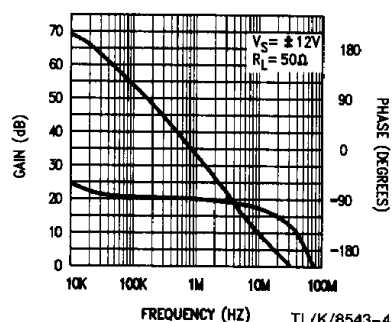
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Offset Null

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Gain	Connect	Pin Number	Comment
+1	V_{out} to S1	18 to 15	For all positive gains, the input is $V_{in(+)}$, pin 12.
	V_{out} to S2	18 to 16	
+2	V_{out} to S2 and	18 to 16	
	S1 to GND	15 to 19	
+3	V_{out} to S3 and	18 to 17	
	S2 to $V_{in(-)}$ and	16 to 13	
	S1 to GND	15 to 19	
+4	V_{out} to S3 and	18 to 17	
	S1 to GND	15 to 19	
−1	S2 to V_{out}	16 to 18	For all negative gains, input is S1, pin 15. Also, $V_{in(+)}$, pin 12, MUST BE CONNECTED TO GROUND.
−2	$V_{in(-)}$ to S2 and	13 to 16	
	S3 to V_{out}	17 to 18	
−3	S3 to V_{out}	17 to 18	

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Typical Applications

Unity Gain Follower

The LH4101 can be used as a unity gain follower to provide output current to drive 50Ω or 75Ω coax cable directly. By shorting pins 15, 16 and 18, a follower circuit is configured as seen in *Figure 1a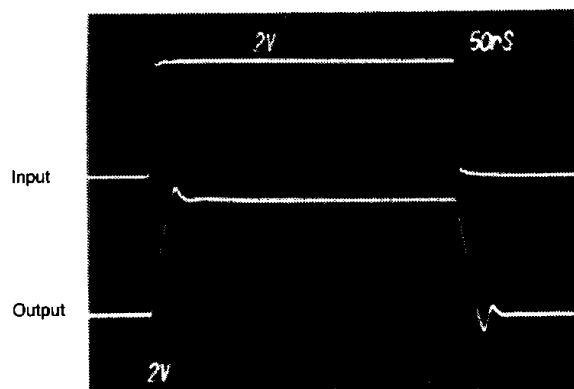*. This configuration features a band-width greater than 40 MHz with an input signal of 1.0 V_{p-p} and greater than 16 MHz with a 5 V_{p-p} input signal. This is all achieved without any external components. *Figures 1b* and *1c* show the small and large signal pulse responses, respectively.
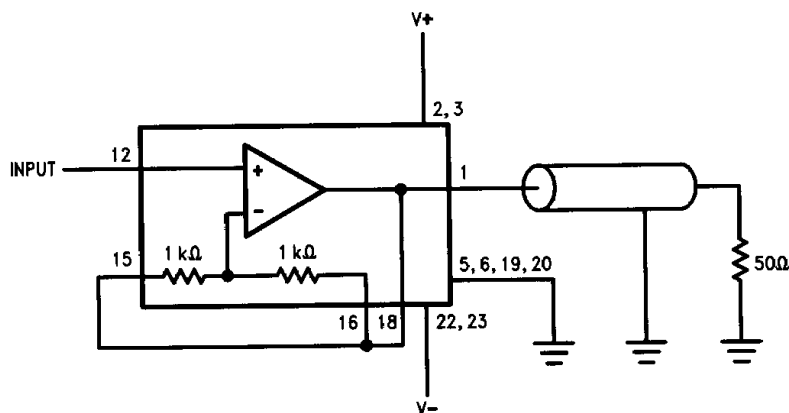
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FIGURE 1a. Unity Gain Follower
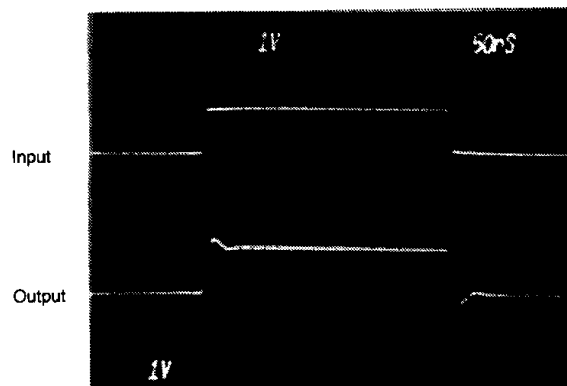
Large Signal Pulse Response

$V_S = \pm 15V$
$A_V = 1$
$R_L = 50\Omega$

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FIGURE 1b

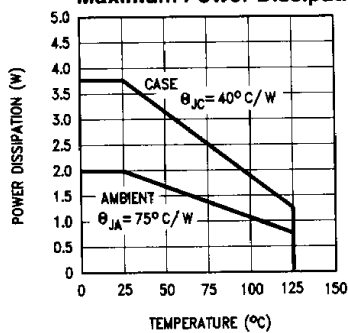**Small Signal Pulse Response**

$V_S = \pm 15V$
$A_V = 1$
$R_L = 50\Omega$

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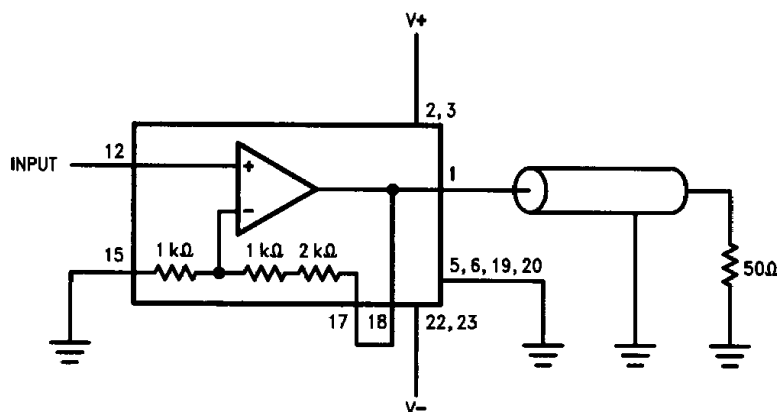**FIGURE 1c**

Maximum Power Dissipation

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Non-Inverting Amplifier

To configure the LH4101 as a non-inverting amplifier with a gain of 4, short pins 17 to 18 and 15 to 19, as shown in *Figure 2a*. Again, no external components are necessary. This configuration provides a bandwidth of 25 MHz with an input sine wave of 1.0 V_{p-p} and a bandwidth of 10 MHz with an input of 5 V_{p-p} while providing 100 mA of output current. This eliminates the need of an additional buffer in the circuit to provide the output current to drive large loads. *Figures 2b* and *2c* show the small and large signal pulse responses, respectively.

FIGURE 2a. Non-Inverter with Gain of + 4

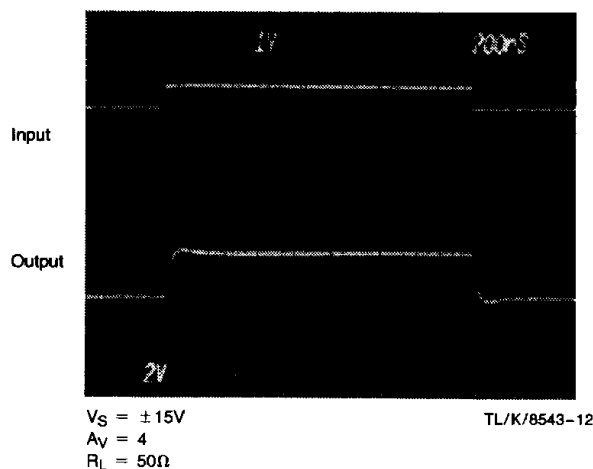TL/K/8543-8

Large Signal Pulse Response

$V_S = \pm15V$
$A_V = 4$
$R_L = 50\Omega$
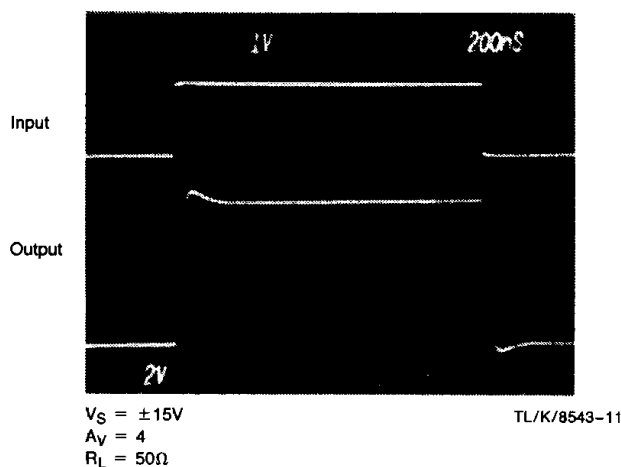
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FIGURE 2b

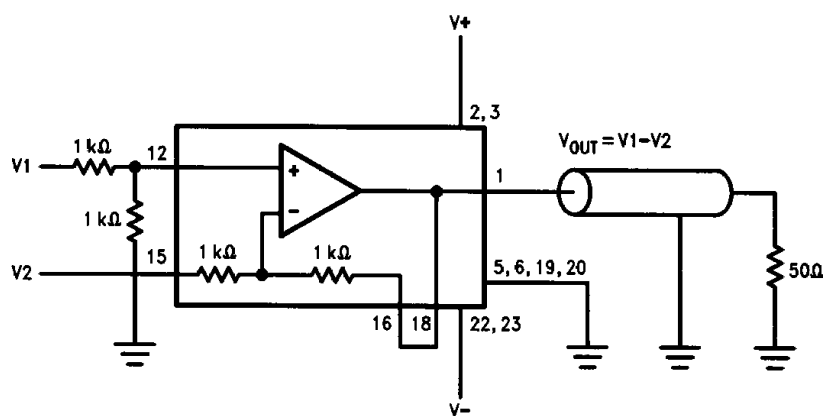**Small Signal Pulse Response**

$V_S = \pm15V$
$A_V = 4$
$R_L = 50\Omega$

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FIGURE 2c

Differential Amplifier

To configure the LH4101 as a differential amplifier, two additional 1 kΩ resistors are required. *Figure 3* shows this configuration, where $V_0 = V_1 - V_2$. The gain accuracy of this circuit is dependent upon the gain accuracy of the additional 1 kΩ resistors.

$V_{OUT} = V1-V2$

FIGURE 3. Wideband Differential Amplifier

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