Operational Amplifiers

LH0001*/LH0001C low power operational amplifier

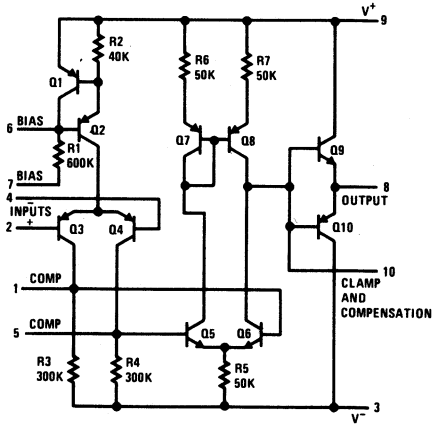
general description

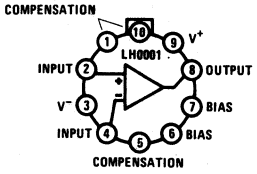
The LH0001/LH0001C is a general purpose operational amplifier designed for extremely low quiescent power. Typical NO-load dissipation at 25°C is 2 milliwatts at V_S = ±15 volts, and 0.5 milliwatts at V_S = ±5 volts. Even with this low power dissipation, the LH0001/LH0001C will deliver ±10 volts into a 2K load with ±15 volt supplies, and typical short circuit currents of 20 to 30 milliamps. Additional features are:

- Operation from ±5V to ±20V
- Very low offset voltage: typically 200 μV at 25°C, 600 μV at −55°C to 125°C
- Very low input offset current: typically 3 nA at 25°C, 6 nA at −55°C
- Low noise: typically 3 μV rms
- Frequency compensation with 2 small capacitors
- Output may be clamped at any desired level
- Output is continuously short circuit proof

The LH0001/LH0001C is ideally suited for space borne applications or where battery operated equipment requires extremely low power dissipation.

schematic and connection diagrams





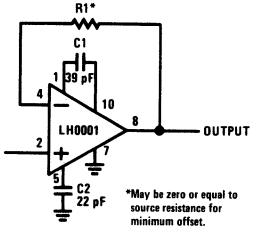
TOP VIEW

Note: Pin 7 must be grounded or connected to a voltage at least 5 volts more negative than the positive supply (Pin 9). Pin 7 may be connected to the negative supply, however the standby current will be increased. A resistor may be inserted in series with Pin 7 up to a maximum of 100 kΩ per volt between Pin 3 and Pin 9.

Order Number LH0001H
See Package 14

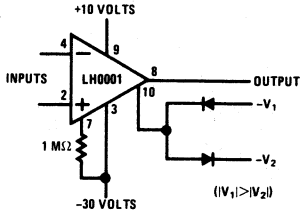
typical applications

Voltage Follower

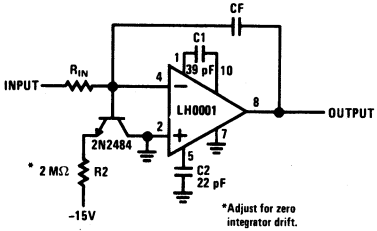


*May be zero or equal to source resistance for minimum offset.

Voltage Comparator for Driving MOS Circuits

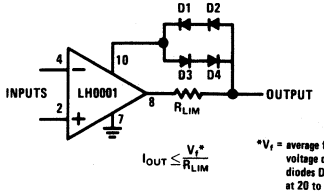


Integrator with Bias Current Compensation



*Adjust for zero integrator drift.

External Current Limiting Method



*Vf = average forward voltage drop of diodes D1 to D4 at 20 to 50 μA.

*Previously called NH0001

absolute maximum ratings

Supply Voltage	±20V
Power Dissipation (see Curve)	400 mW
Differential Input Voltage	±7V
Input Voltage	Equal to supply
Short Circuit Duration (Note 1)	Continuous
Operating Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering 10 sec.)	300°C

electrical characteristics (Note 2)

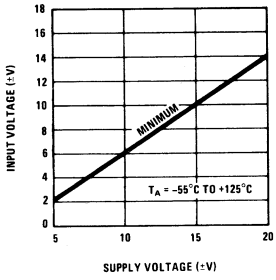
PARAMETER	TEMP (°C)	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	25	$R_S \leq 5K$		0.2	1.0	mV
	−55 to 125	$R_S \leq 5K$		0.6	2.0	mV
Input Offset Current	25 to 125				20	nA
	−55				100	nA
Input Bias Current	25 to 125				100	nA
	−55				300	nA
Supply Current (+)	25	$V_S = \pm 20V$		90	125	μA
	125	$V_S = \pm 20V$		70	100	μA
	−55	$V_S = \pm 20V$		100	150	μA
Supply Current (−)	25	$V_S = \pm 20V$		60	90	μA
	125	$V_S = \pm 20V$		45	75	μA
	−55	$V_S = \pm 20V$		75	125	μA
Voltage Gain	−55 to 25	$R_L = 100\ K\Omega$, $V_S = \pm 15V$, $V_{OUT} = \pm 10V$	25	60		V/mV
	125	$R_L = 100\ K\Omega$, $V_S = \pm 15V$, $V_{OUT} = \pm 10V$	10	30		V/mV
V_{OUT}	25	$V_S = \pm 15V$, $R_L = 2K$	10	11.5		V
	−55	$V_S = \pm 15V$, $R_L = 2K$	9	10.5		V
	125	$V_S = \pm 15V$, $R_L = 2K$	11	12.5		V
Common Mode Rejection Ratio	−55 to 125	$V_S = \pm 15V$, $V_{IN} = \pm 10V$, $R_S \leq 5K$	70	90		dB
Power Supply Rejection Ratio	−55 to 125	$V_S = \pm 15V$, $\Delta V = 5V$ to 20V, $R_S = \leq 5K$	70	90		dB
Input Resistance	25		0.5	1.5		MΩ
Average Temperature Coefficient of Offset Voltage	−55 to 125	$R_S \leq 5K$		4		μA/°C
Average Temperature Coefficient of Bias Current	−55 to 125			0.4		nA/°C
Equivalent Input Noise Voltage	25	$R_S = 1K$, f = 5 Hz to 1000 Hz, $V_S = \pm 15V$		3.0		μV rms

Note 1: Based on maximum short circuit current of 50 mA, device may be operated at any combination of supply voltages, and temperature to be within rated power dissipation (see Curve).

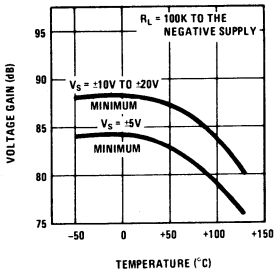
Note 2: These specifications apply for Pin 7 grounded, for $\pm 5V \leq V_S \leq \pm 20V$, with Capacitor C1 = 39 pF from Pin 1 to Pin 10, and C2 = 22 pF from Pin 5 to ground, unless otherwise specified.

guaranteed performance

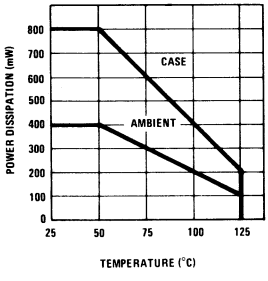
Input Voltage Range



Small Signal Voltage Gain

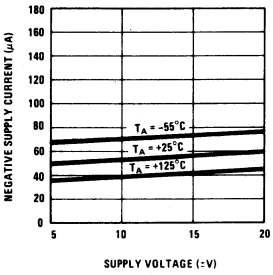


Maximum Power Dissipation

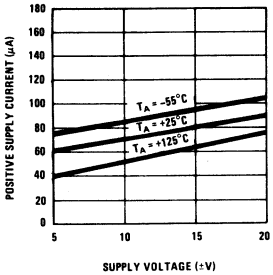


typical performance characteristics

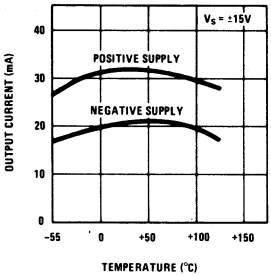
Negative Supply Current



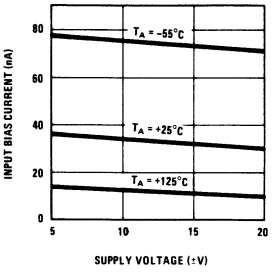
Positive Supply Currents



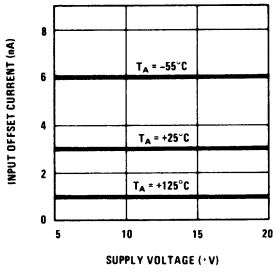
Short Circuit Output Current



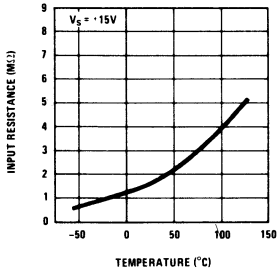
Input Bias Current



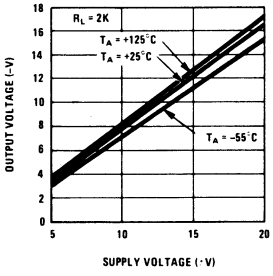
Input Offset Current



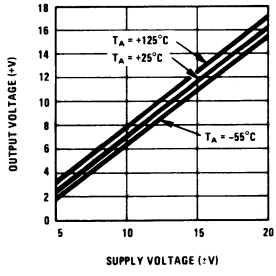
Input Resistance



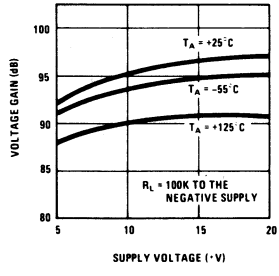
Negative Output Voltage Swing



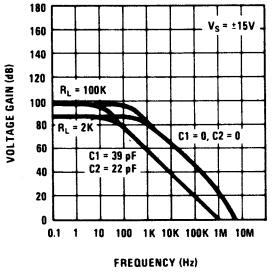
Positive Output Voltage Swing



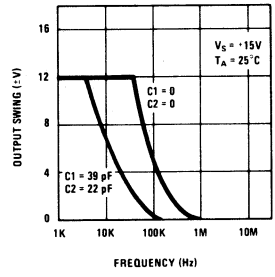
Voltage Gain



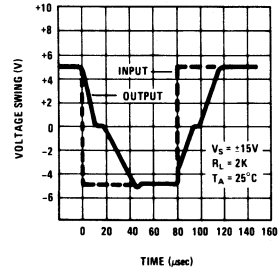
Open Loop Frequency Response



Large Signal Frequency Response



Voltage Follower Pulse Response



Operational Amplifiers

LH0001A/LH0001AC micropower operational amplifier

general description

The LH0001A/LH0001AC is a micropower, high performance integrated circuit operational amplifier designed to have a no load power dissipation of less than 0.5 mW at $V_S = \pm 5V$ and less than 2 mW at $V_S = \pm 20V$. Open loop gain is greater than 50k and input bias current is typically 20 nA.

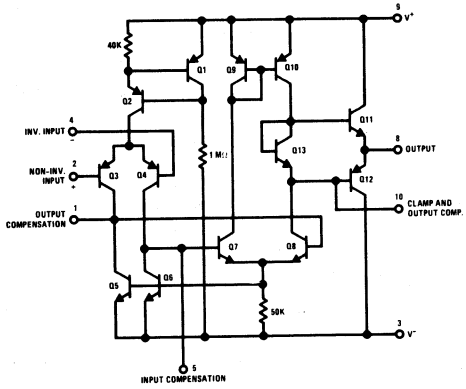
features

- 1.0 mV Typical low offset voltage
- 5 nA Typical low offset current
- 3 μVrms Typical low noise
- Simple frequency compensation
- Moderate bandwidth and slewrate
- Output short circuit proof

The LH0001A/LH0001AC may be substituted directly for the LH0001/LH0001C. Low power consumption, high open loop gain, and excellent input characteristics make the LH0001A an ideal amplifier for many low power applications such as battery powered instrument or transducer amplifiers.

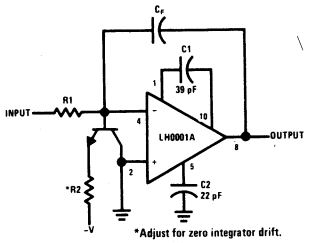
The LH0001A is specified for operation over the −55°C to +125°C military temperature range. The LH0001AC is specified for operation over the 0°C to +85°C temperature range.

schematic diagram*



*Pin shown for TO-5 package

typical application*

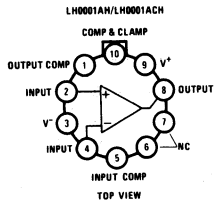


*Adjust for zero integrator drift.

Integrator with Bias Compensation

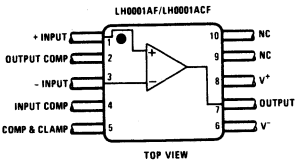
connection diagrams

Metal Can Package



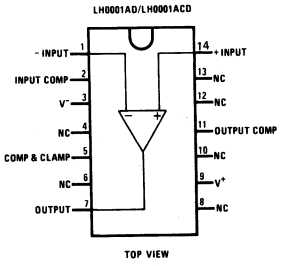
Order Number
LH0001AH or LH0001ACH
See Package 14

Flat Package



Order Number
LH0001AF or LH0001ACF
See Package 3

Cavity Dual-In-Line Package



Order Number
LH0001AD or LH0001ACD
See Package 1

absolute maximum ratings

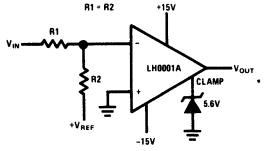
Supply Voltage		±20V
Power Dissipation (See curve)		400 mW
Differential Input Voltage		±7V
Input Voltage		$\pm V_S$
Short Circuit Duration		Continuous
Operating Temperature Range	LH0001A	-55°C to 125°C
	LH0001AC	-25°C to 85°C
Storage Temperature Range		-65°C to 150°C
Lead Temperature (Soldering, 10 sec)		300°C

electrical characteristics (Note 1)

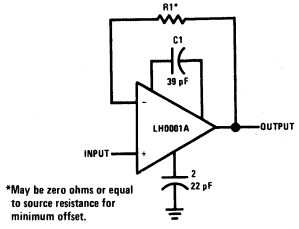
PARAMETERS	CONDITIONS	LH0001A			LH0001AC			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$R_S \leq 1k$, $T_A = 25°C$		1.0	2.5 4.0		2.0	5.0 7.0	mV mV
Input Bias Current	$T_A = 25°C$		20	100 300		20	200 300	nA nA
Input Offset Current	$T_A = 25°C$		5	20 100		20	60 100	nA nA
Supply Current	$V_S = \pm 20V$, $T_A = 25°C$ $V_S = \pm 20V$		80	125 150		80	125 150	μA nA
Voltage Gain	$V_S = \pm 15V$, $V_{OUT} = 10V$, $R_L = 100k$, $T_A = 25°C$ $V_S = \pm 15V$, $V_{OUT} = 10V$, $R_L = 100k$	25 25 10	60 60 30		25 25 10	60 60		V/mV V/mV
Output Voltage	$V_S = \pm 15V$, $R_L = 2k$, $T_A = 25°C$ $V_S = \pm 15V$, $R_L = 2k$	10 9	11.5		10 9	11.5		V V
Common Mode Rejection Ratio	$V_S = \pm 15V$, $V_{IN} = 10V$, $R_S = 1k$	70	90		70	90		db
Power Supply Rejection Ratio	$V_S = \pm 15V$, $R_S = 1k$, $V_S = \pm 5V$ to $\pm 20V$	70	90		70	90		db
Equivalent Input Noise Voltage	$V_S = \pm 15V$, $R_S = 1k$, $T_A = 25°C$ f = 500 Hz to 5 kHz		3.0			3.0		μVrms
Average Temperature Coefficient of Offset Voltage	$R_S \leq 1k$		3.0			3.0		μV/°C
Average Temperature Coefficient of Bias Current			0.3			0.3		nA/°C

Note 1: The specifications apply for $\pm 5V \leq V_S \leq 20V$, with output compensation capacitor, C_1 = 39 pF, input compensation capacitor, C_2 = 22 pF, -55°C to 125°C for the LH0001A and -25°C to +85°C for the LH0001AC unless otherwise specified.

typical applications

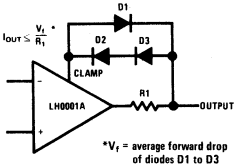


TTL/DTL Compatible Comparator



*May be zero ohms or equal to source resistance for minimum offset.

Voltage Follower

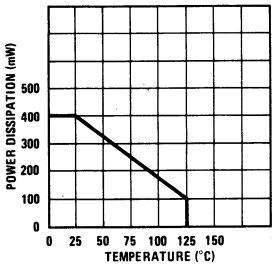


*V_f = average forward drop of diodes D1 to D3 at 20 to 50 μA.

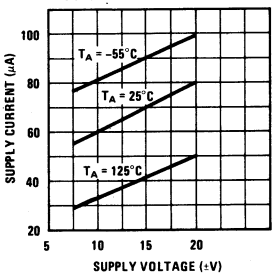
External Output Current Limiting

typical performance characteristics

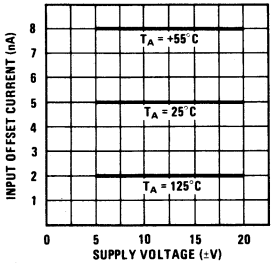
Maximum Power Dissipation



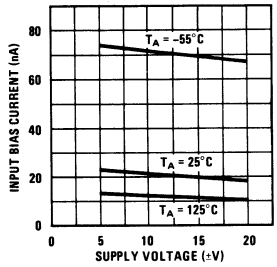
Supply Current



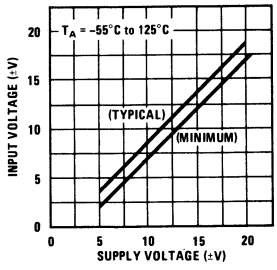
Input Offset Current



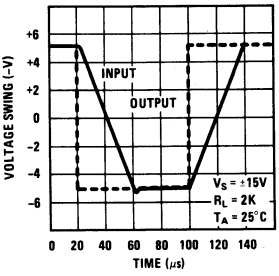
Input Bias Current



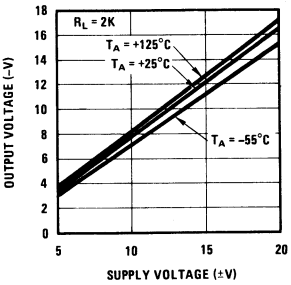
Input Voltage Range



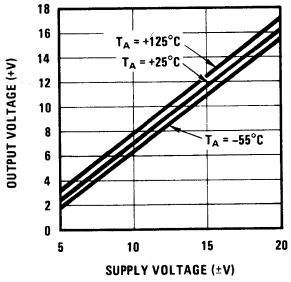
Voltage Follower Pulse Response



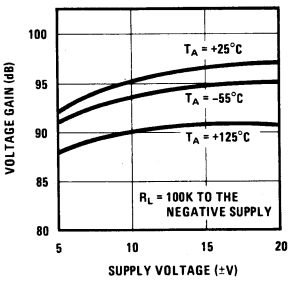
Negative Output Voltage Swing



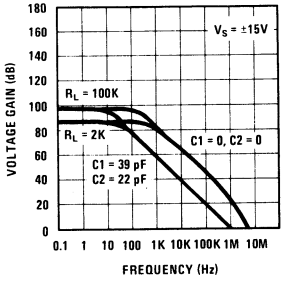
Positive Output Voltage Swing



Voltage Gain



Open Loop Frequency Response



Large Signal Frequency Response