elantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

ELH0101/ELH0101A
Power Operational Amplifier T-79-25

Features

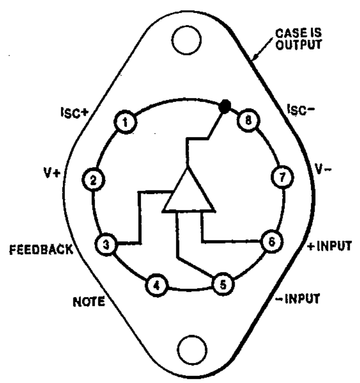
- 5A peak, 2A continuous output current
- 10 V/μs slew rate
- 300 kHz power bandwidth
- 850 mW standby power (±15V supplies)
- 300 pA input bias current
- Virtually no crossover distortion
- 2 μs settling time to 0.01%
- 5 MHz gain bandwidth
- MIL-STD-883 devices 100% manufactured in U.S.A.

Ordering Information

Part No.	Temp. Range	Package	Outline#
ELH0101ACK	−25°C to +85°C	TO-3	MDP0003
ELH0101AK	−55°C to +125°C	TO-3	MDP0003
ELH0101AK/883B	−55°C to +125°C	TO-3	MDP0003
ELH0101CK	−25°C to +85°C	TO-3	MDP0003
ELH0101K	−55°C to +125°C	TO-3	MDP0003
ELH0101K/883B	−55°C to +125°C	TO-3	MDP0003

8508901YX and 8508902YX are the DESC versions of this device.

Connection Diagram



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Top View

Note: Electrically connected internally. No connection should be made to pin.

General Description

The ELH0101 is a wideband power operational amplifier featuring FET inputs, internal compensation, virtually no crossover distortion, and rapid settling time. These features make the ELH0101 an ideal choice for DC or AC servo amplifiers, deflection yoke drivers, programmable power supplies, and disk head positioner amplifiers.

Elantec facilities comply with MIL-I-45208A and other applicable quality specifications. Elantec's Military devices are 100% fabricated and assembled in our rigidly controlled, ultra-clean facilities in Milpitas, California. For additional information on Elantec's Quality and Reliability Assurance policy and procedures request brochure QRA-1.

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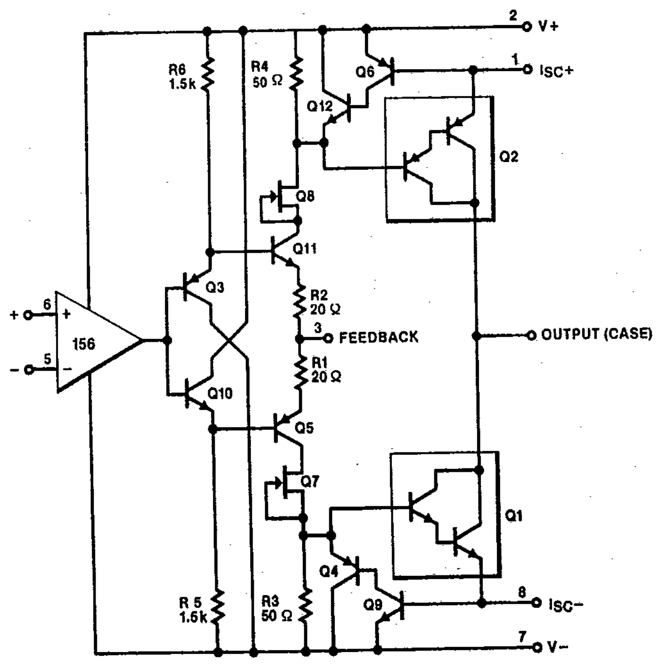
Equivalent Schematic



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Absolute Maximum Ratings

V_S	Supply Voltage	
	ELH0101C, ELH0101AC	±18V
	ELH0101, ELH0101A	±22V
P_D	Power Dissipation at $T_A = 25°C$	5W
	Derate linearly at 25°C/W to zero at 150°C	
P_D	Power Dissipation at $T_C = 25°C$	62W
	Derate linearly at 2°C/W to zero at 150°C	
	Differential Input Voltage	
	ELH0101C, ELH0101AC	±30V but < $\pm V_S$
	ELH0101, ELH0101A	±40V but < $\pm V_S$
V_{IN}	Input Voltage Range	
	ELH0101C, ELH0101AC	±15V but < $\pm V_S$
	ELH0101, ELH0101A	±20V but < $\pm V_S$
	Peak Output Current (50 ms pulse)	5A
	Output Short Circuit Duration (within rated power dissipation, $R_{SC} = 0.35\Omega$, $T_A = 25°C$)	Continuous
T_A	Operating Temperature Range:	
	ELH0101C, ELH0101AC	−25°C to +85°C
	ELH0101, ELH0101A	−55°C to +125°C
T_J	Maximum Junction Temperature	150°C
T_{ST}	Storage Temperature	−65°C to +150°C
	Lead Temperature (Soldering, 10 seconds)	300°C

Important Note:
All parameters having Min/Max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality inspection. Elantec performs most electrical tests using modern high-speed automatic test equipment, specifically the LTX77 Series system. Unless otherwise noted, all tests are pulsed tests, therefore $T_J = T_C = T_A$.

Test Level	Test Procedure
I	100% production tested and QA sample tested per QA test plan QCX0002.
II	100% production tested at $T_A = 25°C$ and QA sample tested at $T_A = 25°C$, T_{MAX} and T_{MIN} per QA test plan QCX0002.
III	QA sample tested per QA test plan QCX0002.
IV	Parameter is guaranteed (but not tested) by Design and Characterization Data.
V	Parameter is typical value at $T_A = 25°C$ for information purposes only.

DC Electrical Characteristics (Note 1) $V_S = \pm 15V$, $T_A = 25°C$, $V_{CM} = 0V$

Parameter	Description	Test Conditions	ELH0101A, AC				ELH0101, C				Units
			Min	Typ	Max	Test Level	Min	Typ	Max	Test Level	
V_{OS}	Input Offset Voltage			1	3	I		5	10	I	mV
		$T_{MIN} \le T_A \le T_{MAX}$, ELH0101, A			7	I			15	I	mV
		$T_{MIN} \le T_A \le T_{MAX}$, ELH0101C, AC			7	III			15	III	mV
$\Delta V_{OS}/\Delta P_D$	Change in Input Offset Voltage with Dissipated Power	(Note 2)		150		V		300		V	μV/W
$\Delta V_{OS}/\Delta T$	Change in Input Offset Voltage with Temperature			10		V		10		V	μV/°C
I_B	Input Bias Current				300	I			1000	I	pA
		$T_A \le T_{MAX}$, ELH0101C, AC			60	III			60	III	nA
		$T_A \le T_{MAX}$, ELH0101, A			300	I			1000	I	nA

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DC Electrical Characteristics (Note 1) $V_S = \pm15V$, $T_A = 25°C$, $V_{CM} = 0V$ — Contd.

Parameter	Description	Test Conditions	ELH0101A, AC				ELH0101, C				Units
			Min	Typ	Max	Test Level	Min	Typ	Max	Test Level	
I_{OS}	Input Offset Current				75	I			250	I	pA
		$T_A \le T_{MAX}$, ELH0101C, AC			15	III			15	III	nA
		$T_A \le T_{MAX}$, ELH0101, A			75	I			250	I	nA
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm10V$, $R_L = 10\Omega$	50	200		I	50	200		I	V/mV
V_O	Output Voltage Swing	$R_{SC} = 0\Omega$, $A_V = 1$, $R_L = 100\Omega$ (Note 3)	±11.7	±12.5		I	±11.7	±12.5		I	V
		$R_{SC} = 0\Omega$, $A_V = 1$, $R_L = 10\Omega$ (Note 3)	±11	±11.6		I	±11	±11.6		I	V
		$R_{SC} = 0\Omega$, $A_V = 1$, $R_L = 5\Omega$ (Note 3)	±10.5	±11		I	±10.5	±11		I	V
CMRR	Common-Mode Rejection Ratio	$V_{IN} = \pm10V$	85	100		I	85	100		I	dB
PSRR	Power Supply Rejection Ratio	$\pm5V \le V_S \le \pm15V$	85	100		I	85	100		I	dB
		$+5V \le V_S(+) \le +15V$, $V_S(-) = -15V$	80	110		I	80	110		I	dB
		$-5V \ge V_S(-) \ge -15V$, $V_S(+) = +15V$	80	95		I	80	95		I	dB
I_S	Supply Current			28	35	I		28	35	I	mA

AC Electrical Characteristics $V_S = \pm15V$, $T_A = T_C = T_J = 25°C$

Parameter	Description	Test Conditions	ELH0101A, AC				ELH0101, C				Units
			Min	Typ	Max	Test Level	Min	Typ	Max	Test Level	
e_n	Equivalent Input Noise Voltage	f = 1 kHz		25		V		25		V	$nV/\sqrt{Hz}$
C_{IN}	Input Capacitance	f = 1 MHz		3		V		3		V	pF
PBW	Power Bandwidth, −3 dB	$R_L = 10\Omega$, $A_V = 1$		300		V		300		V	kHz
SR	Slew Rate	$R_L = 10\Omega$, $A_V = 1$	7.5	10		I		10		V	V/µs
t_r, t_f	Small Signal Rise or Fall Time	$R_L = 10\Omega$, $A_V = 1$		200		V		200		V	ns
	Small Signal Overshoot	$R_L = 10\Omega$, $A_V = 1$		10		V		10		V	%

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AC Electrical Characteristics $V_S = \pm 15V, T_A = T_C = T_J = 25°C$

Parameter	Description	Test Conditions	ELH0101A, AC				ELH0101, C				Units
			Min	Typ	Max	Test Level	Min	Typ	Max	Test Level	
GBW	Gain-Bandwidth Product	$R_L = \infty, A_V = 1$	4	5		I		5		V	MHz
t_S	Large Signal Settling Time (0.01%)	$R_L = \infty, A_V = 1$		2		V		2		V	μs
THD	Total Harmonic Distortion	$f = 1\ kHz, P_O = 0.5W, R_L = 10\Omega$		0.008		V		0.008		V	%

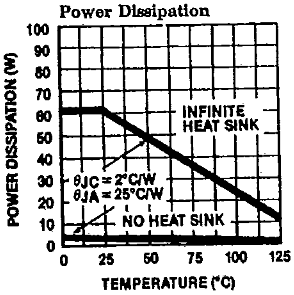
Note 1: Specification is at $T_A = 25°C$. Actual values at operating temperature may differ from the $T_A = 25°C$ value. When supply voltages are ±15V, quiescent operating junction temperature will rise approximately 20°C without heatsinking. Accordingly, V_{OS} may change 0.5 mV and I_B and I_{OS} will change significantly during warm-ups. Refer to I_B vs. temperature and power dissipation graphs for expected values.

Note 2: Change in offset voltage with dissipated power is due entirely to average device temperature rise and not to differential thermal feedback effects. Test is performed without any heatsink.

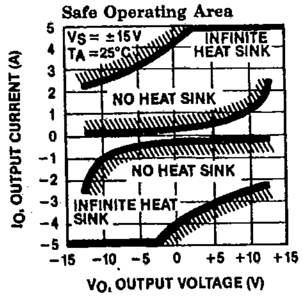
Note 3: At light loads, the output swing may be limited by the second stage rather than the output stage. See the application section under "Output swing enhancement" for hints on how to obtain extended operation. R_{SC} is the current sense resistor.

Typical Performance Curves

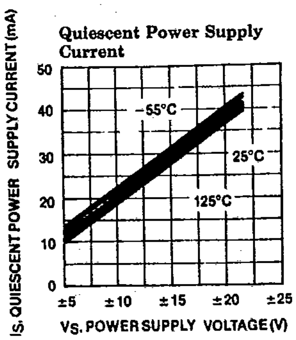
Power Dissipation



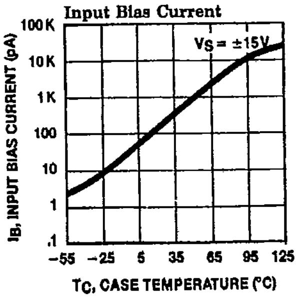
Safe Operating Area



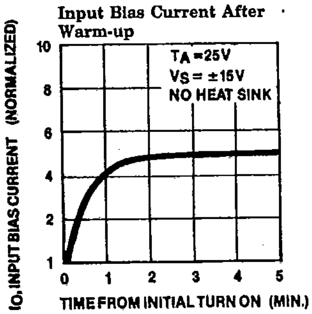
Quiescent Power Supply Current



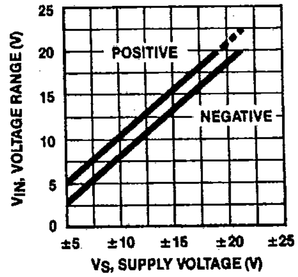
Input Bias Current



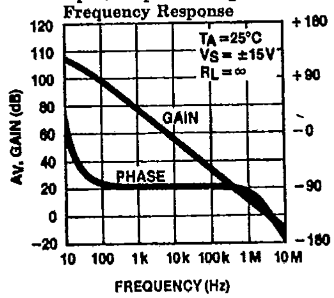
Input Bias Current After Warm-up



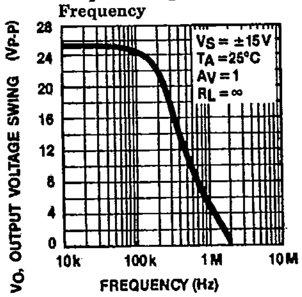
Input Common-Mode Voltage Range



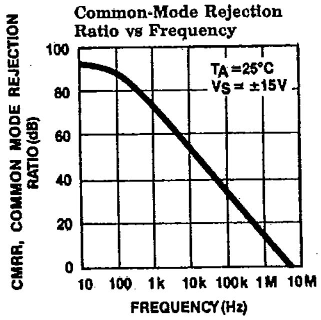
Open-Loop Small Signal Frequency Response



Output Voltage Swing vs Frequency



Common-Mode Rejection Ratio vs Frequency



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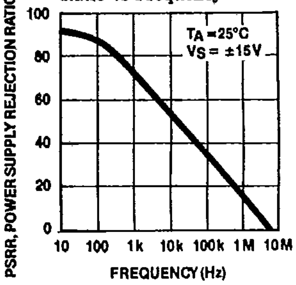
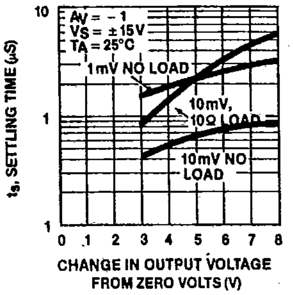
Typical Performance Curves — Contd.

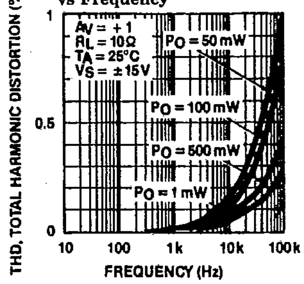
Power Supply Rejection Ratio vs Frequency



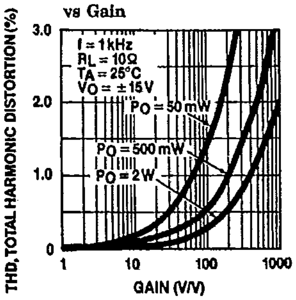
Settling Time



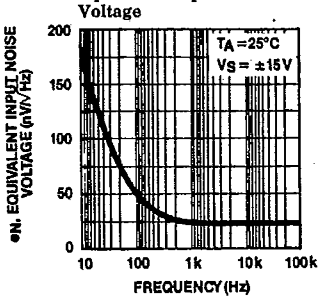
Total Harmonic Distortion vs Frequency



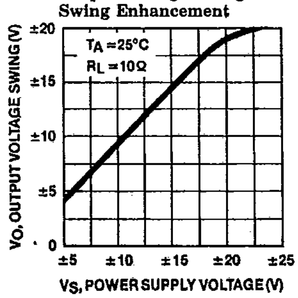
Total Harmonic Distortion vs Gain



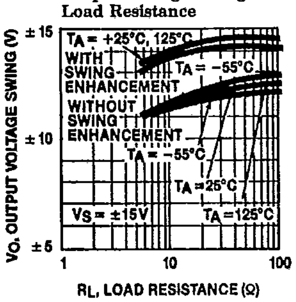
Equivalent Input Noise Voltage



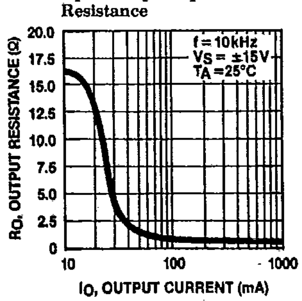
Output Voltage Swing with Swing Enhancement



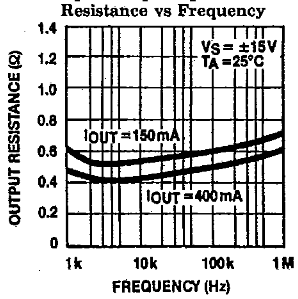
Output Voltage Swing vs Load Resistance



Open-Loop Output Resistance



Open-Loop Output Resistance vs Frequency



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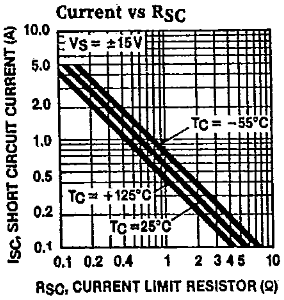
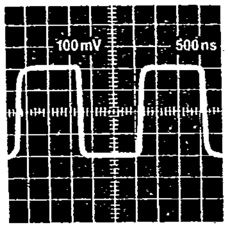
Typical Performance Curves — Contd.

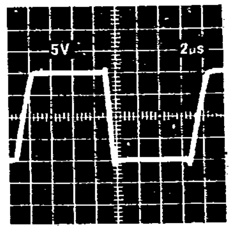
Short Circuit Current vs R_{SC}



Small Signal Pulse Response



Large Signal Pulse Response



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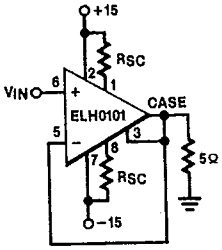
Typical Applications

High Power Voltage Follower



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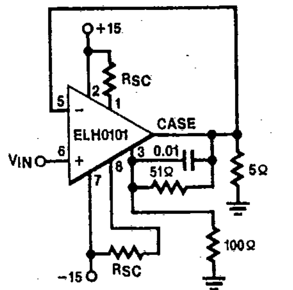
High Power Voltage Follower with Swing Enhancement



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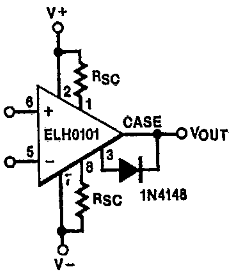
Restricting Outputs to Positive Voltage Only



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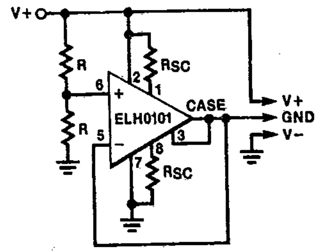
Generating a Split Supply from a Single Voltage Supply



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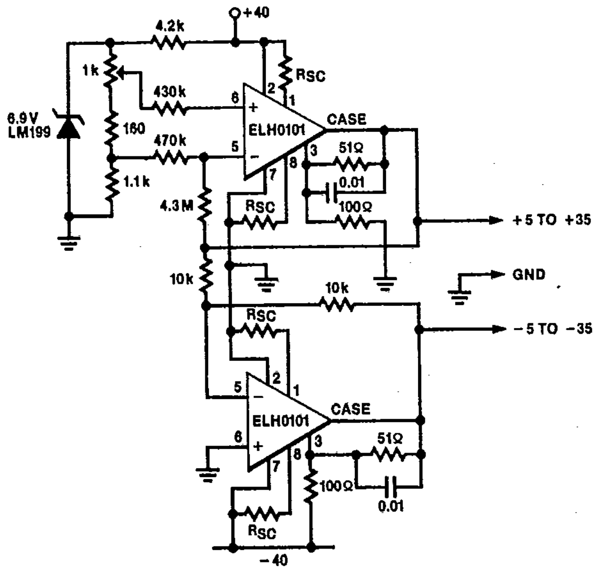
Typical Applications — Contd.

±5 to ±35 Power Source or Sink



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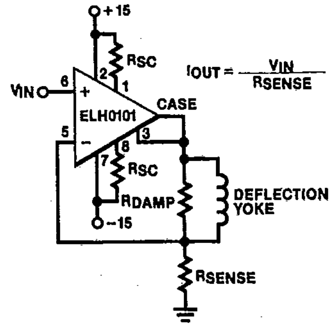
CRT Deflection Yoke Driver



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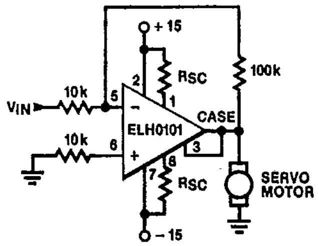
DC Servo Amplifier



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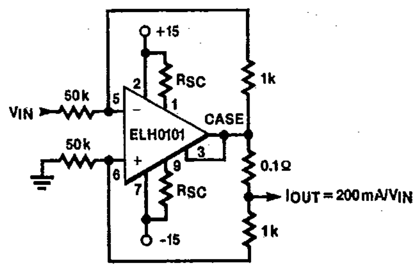
High Current Source/Sink



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ELH0101/ELH0101A
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Applications Information

Input Voltages

The ELH0101 operational amplifier contains JFET input devices which exhibit high reverse breakdown voltages from gate to source or drain. This eliminates the need for input clamp diodes, so that high differential input voltages may be applied without a large increase in input current. However, neither input voltage should be allowed to exceed the negative supply as the resultant high current flow may destroy the unit.

Exceeding the negative common-mode limit on either input will cause a reversal of the phase to the output and force the amplifier output to the corresponding high or low state. Exceeding the negative common-mode limit on both inputs will force the amplifier output to a high state. In neither case does a latch occur since raising the input back within the common-mode range again puts the input stage and thus the amplifier in a normal operating mode.

Exceeding the positive common-mode limit on a single input will not change the phase of the output, however; if both inputs exceed the limit, the output of the amplifier will be forced to a high state.

These amplifiers will operate with the common-mode input voltage equal to the positive supply. In fact, the common-mode voltage may exceed the positive supply by approximately 100 mV, independent of supply voltage and over the full operating temperature range. The positive supply may therefore be used as a reference on an input as, for example, in a supply current monitor and/or limiter.

With the ELH0101 there is a temptation to remove the bias current compensation resistor normally used on the non-inverting input of a summing amplifier. Direct connection of the inputs to ground or a low-impedance voltage source is not recommended with supply voltages greater than 3V. The potential problem involves loss of one supply which can cause excessive current in the second supply. Destruction of the IC could result if the current to the inputs of the device is not limited to less than 100 mA or if there is much more than 1 μF bypass on the supply bus.

Although difficulties can be largely avoided by installing clamp diodes across the supply lines on every PC board, a conservative design would include enough resistance in the input lead to limit current to 10 mA if the input lead is pulled to either supply by internal currents. This precaution is by no means limited to the ELH0101.

Layout Considerations

When working with circuitry capable of resolving picoampere level signals, leakage currents in circuitry external to the op amp can significantly degrade performance. High quality insulation is a must (Kel-F and Teflon rate high). Proper cleaning of all insulating surfaces to remove fluxes and other residues is also required. This includes the IC package as well as sockets and printed circuit boards. When operating in high humidity environments or near 0°C, some form of surface coating may be necessary to provide a moisture barrier.

The effects of board leakage can be minimized by encircling the input circuitry with a conductive guard ring operated at a potential close to that of the inputs.

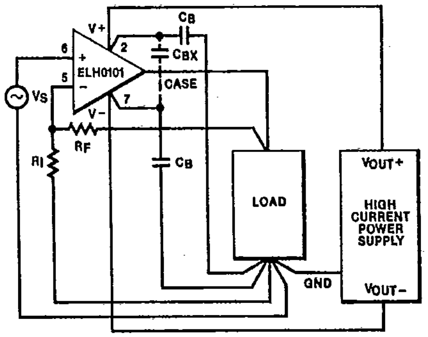
Electrostatic shielding of high impedance circuitry is advisable.

Error voltages can also be generated in the external circuitry. Thermocouples formed between dissimilar metals can cause hundreds of microvolts of error in the presence of temperature gradients.

Since the ELH0101 can deliver large output currents, careful attention should be paid to power supply, power supply bypassing and load currents. Incorrect grounding of signal inputs and load can cause significant errors.

Applications Information — Contd.

Every attempt should be made to achieve a single point ground system as shown in the figure below.



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Bypass capacitor C_{BX} should be used if the lead lengths of bypass capacitors C_B are long. If a single point ground system is not possible, keep signal, load, and power supply from intermingling as much as possible. For further information on proper grounding techniques refer to "Grounding and Shielding Techniques in Instrumentation" by Morrison, and "Noise Reduction Techniques in Electronic Systems" by Ott (both published by John Wiley and Sons).

Leads or PC board traces to the supply pins, short circuit current limit pins, and the output pin must be substantial enough to handle the high currents that the ELH0101 is capable of producing.

Short Circuit Current Limiting

Should current limiting of the output not be necessary, SC+ should be shorted to V+ and SC− should be shorted to V−. Remember that the short circuit current limit is dependent upon the total resistance seen between the supply and current limit pins. This total resistance includes the desired resistor plus leads, PC Board traces, and solder joints.* Assuming a zero TCR current limit resistor, typical temperature coefficient of the short circuit will be approximately 0.3%.

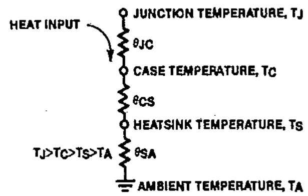
Thermal Resistance

The thermal resistance between two points of a conductive system is expressed as:

$$\theta_{12} = \frac{T_1 - T_2}{P_D}\ {}^\circ C/W \qquad (1)$$

where subscript order indicates the direction of heat flow. A simplified heat transfer circuit for a cased semiconductor and heatsink system is shown in the figure below.

The circuit is valid only if the system is in thermal equilibrium (constant heat flow) and there are, indeed, single specific temperatures, T_J, T_C, and T_S, (no temperature distribution in junction, case, or heatsink). Nevertheless, this is a reasonable approximation of actual performance.



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*Short circuit current will be limited to approximately $\frac{0.6}{RSC}$.

The junction-to-case thermal resistance, θ_{JC}, specified in the data sheet depends upon the material and size of the package, die size and thickness, and quality of the die bond to the case or lead frame. The case-to-heatsink thermal resistance, θ_{CS}, depends on the mounting of the device to the heatsink and upon the area and quality of the contact surface. Typical θ_{CS} for a TO-3 package is 0.5°C/W to 0.7°C/W, and 0.3°C/W to 0.5°C/W using silicone grease.

The heatsink to ambient thermal resistance, θ_{SA}, depends on the quality of the heatsink and the ambient conditions.

ELH0101/ELH0101A
Power Operational Amplifier

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Application Information — Contd.

Cooling is normally required to maintain the worst case operating junction temperature, T_J, of the device below the specified maximum value, $T_{J(MAX)}$. T_J can be calculated from known operating conditions. Rewriting equation (1), we find:

$$\theta_{JA} = \frac{T_J - T_A}{P_D} \, ^\circ C/W$$

$$T_J = T_A + P_D \theta_{JA} \, ^\circ C$$

Where: $P_D = (V_S - V_{OUT}) I_{OUT} + |V\pm (V-)| I_Q$

$\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$ and

V_S = Supply Voltage

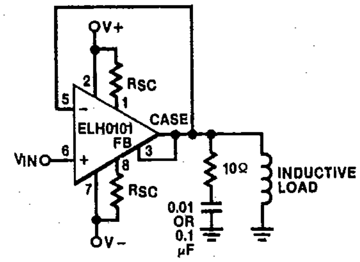
θ_{JC} for the ELH0101 is typically 2°C/W.

Stability and Compensation

As with most amplifiers, care should be taken with lead dress, component placement and supply decoupling in order to ensure stability. For example, resistors from the output to an input should be placed with the body close to the input to minimize "pickup" and maximize the frequency of the feedback pole by minimizing the capacitance from the input to ground.

A feedback pole is created when the feedback around any amplifier is resistive. The parallel resistance and capacitance from the input of the device (usually the inverting input) to AC ground set the frequency of the pole. In many instances the frequency of this pole is much greater than the expected 3 dB frequency of the closed loop gain and consequently there is negligible effect on stability margin. However, if the feedback pole is less than approximately six times the expected 3 dB frequency, a lead capacitor should be placed from the output to the input of the op amp. The value of the added capacitor should be such that the RC time constant of this capacitor and the resistance it parallels is greater than or equal to the original feedback pole time constant.

Some inductive loads may cause output stage oscillation. A 0.01 μF ceramic capacitor in series with a 10Ω resistor from the output to ground will usually remedy this situation.



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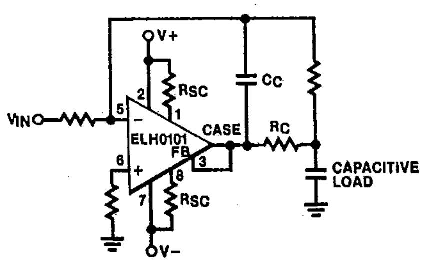
Capacitive loads may be compensated for by traditional techniques. (See "Operational Amplifiers: Theory and Practice" by Roberge, published by Wiley.)



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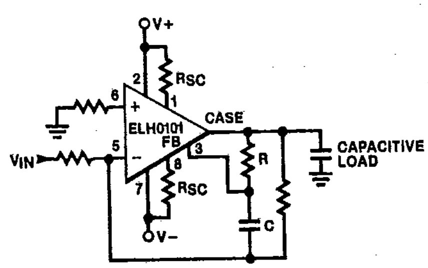
A similar but alternative technique may be used for the ELH0101.



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