Picoamp Input Current, Microvolt Offset, Low Noise Op Amp

FEATURES

- Internally Compensated
- *Guaranteed* Offset Voltage — 35μV max.
- *Guaranteed* Bias Current
  - 25°C — 100pA max.
  - −55°C to 125°C — 250pA max.
- *Guaranteed* Drift — 1.5μV/°C max.
- Low Noise, 0.1Hz to 10Hz — 0.5μVp-p
- *Guaranteed* Low Supply Current — 600μA max.
- *Guaranteed* CMRR — 114 dB min.
- *Guaranteed* PSRR — 114 db min.
- *Guaranteed* Voltage Gain with 5mA load current

APPLICATIONS

- Precision instrumentation
- Charge integrators
- Wide dynamic range logarithmic amplifiers
- Light meters
- Low frequency active filters
- Standard cell buffers
- Thermocouple amplifiers

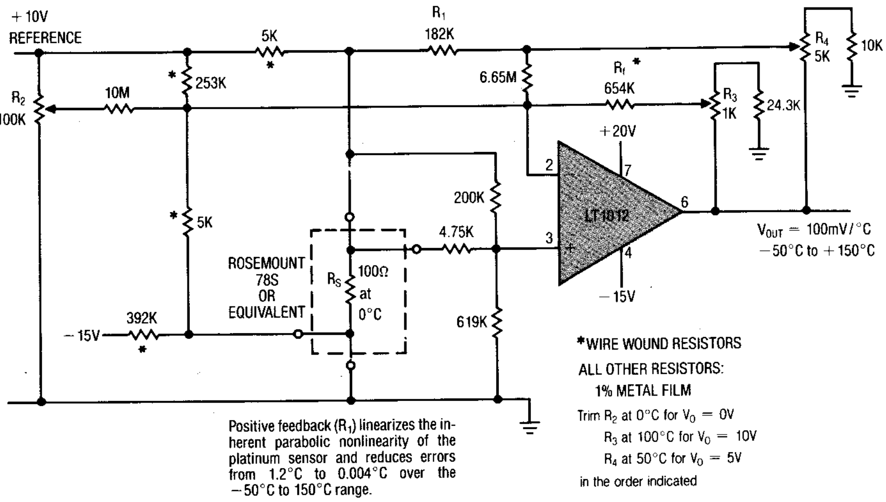
DESCRIPTION

The LT1012 is an internally compensated universal precision operational amplifier which can be used in practically all precision applications. The LT1012 combines picoampere bias currents (which are maintained over the full −55°C to 125°C temperature range), microvolt offset voltage (and low drift with time and temperature), low voltage and current noise, and low power dissipation. Extremely high common-mode and power supply rejection ratios, practically unmeasurable warm-up drift, and the ability to deliver 5mA load current with a voltage gain of a million round out the LT1012's superb precision specifications.

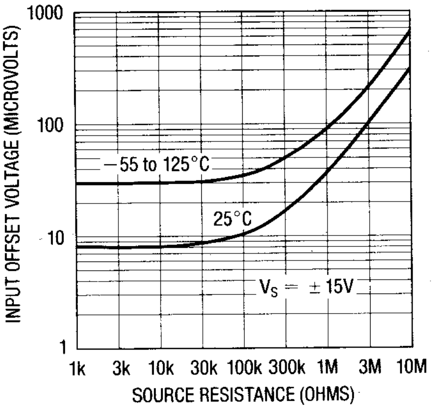
The all around excellence of the LT1012 eliminates the necessity of the time consuming error analysis procedure of precision system design in many applications; the LT1012 can be stocked as the universal internally compensated precision op amp.

For an externally compensated version with additional flexibility in shaping the frequency response of the amplifier, but otherwise similar performance, see the LT1008.

Kelvin-Sensed Platinum Temperature Sensor Amplifier



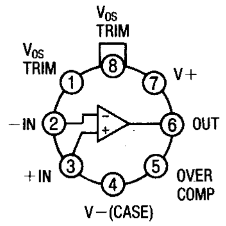
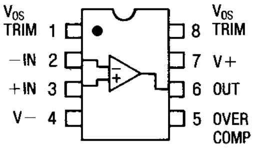
Offset Voltage vs Source Resistance (Balanced or Unbalanced)



ABSOLUTE MAXIMUM RATING

Supply Voltage .... ±20V
Differential Input Current (Note 1) .... ±10mA
Input Voltage .... ±20V
Output Short Circuit Duration .... Indefinite
Operating Temperature Range
  LT1012M .... −55°C to 125°C
  LT1012C .... 0°C to 70°C
Storage Temperature Range
  All Devices .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec.) ...... 300°C

PACKAGE/ORDER INFORMATIO

	ORDER PART NO.
TOP VIEW  METAL CAN H PACKAGE	LT1012MH LT1012CH
TOP VIEW  HERMETIC DIP J8 PACKAGE PLASTIC DIP N8 PACKAGE	LT1012MJ8 LT1012CJ8 LT1012CN8

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$, $V_{CM} = 0V$, $T_A = 25°C$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1012M MIN	LT1012M TYP	LT1012M MAX	LT1012C MIN	LT1012C TYP	LT1012C MAX	UNIT
V_{OS}	Input Offset Voltage	 Note 2		8 20	35 90		10 25	50 120	μ μ
	Long Term Input Offset Voltage Stability			0.3			0.3		$\mu V/mon$
I_{OS}	Input Offset Current	 Note 2		15 25	100 150		20 30	150 200	p p
I_B	Input Bias Current	 Note 2		±25 ±35	±100 ±150		±30 ±40	±150 ±200	
e_n	Input Noise Voltage	0.1Hz to 10Hz		0.5			0.5		μVp
e_n	Input Noise Voltage Density	f_0 = 10Hz (Note 3) f_0 = 1000Hz (Note 4)		17 14	30 22		17 14	30 22	$nV\sqrt{}$ $nV\sqrt{}$
i_n	Input Noise Current Density	f_0 = 10Hz		20			20		$fA/\sqrt{}$
A_{VOL}	Large Signal Voltage Gain	$V_{OUT} = \pm 12V$, $R_L \geq 10k\Omega$ $V_{OUT} = \pm 10V$, $R_L \geq 2k\Omega$	300 200	2000 1000		200 120	2000 1000		V/m V/m
CMRR	Common Mode Rejection Ratio	$V_{CM} = \pm 13.5V$	114	132		110	132		
PSRR	Power Supply Rejection Ratio	$V_S = \pm 2V$ to $\pm 20V$	114	132		110	132		
	Input Voltage Range		±13.5	±14.0		±13.5	±14.0		
V_{OUT}	Output Voltage Swing	$R_L = 10k\Omega$	±13	±14		±13	±14		
	Slew Rate		0.1	0.2		0.1	0.2		$V/\mu s$
I_S	Supply Current	Note 2		380	600		380	600	

ELECTRICAL CHARACTERISTICS

$V_S = \pm15V$, $V_{CM} = 0V$, $0°C \leq T_A \leq 70°C$ for the LT1012C and $-55°C \leq T_A \leq 125°C$ for the LT1012M, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT1012M MIN	LT1012M TYP	LT1012M MAX	LT1012C MIN	LT1012C TYP	LT1012C MAX	UNITS
V_{OS}	Input Offset Voltage		●		30	180		20	120	μV
		Note 2	●		40	250		30	200	μV
	Average Temperature Coefficient of Input Offset Voltage		●		0.2	1.5		0.2	1.5	μV/°C
I_{OS}	Input Offset Current		●		30	250		20	230	pA
		Note 2	●		70	350		40	300	pA
	Average Temperature Coefficient of Input Offset Current		●		0.3	2.5		0.3	2.5	pA/°C
I_B	Input Bias Current		●		±50	±250		±35	±230	pA
		Note 2	●		±80	±350		±50	±300	pA
	Average Temperature Coefficient of Input Bias Current		●		0.3	2.5		0.3	2.5	pA/°C
A_{VOL}	Large Signal Voltage Gain	$V_{OUT} = \pm 12V$, $R_L \geq 10k\Omega$	●	150	1000		150	1500		V/mV
		$V_{OUT} = \pm 10V$, $R_L \geq 2k\Omega$	●	100	600		100	800		V/mV
CMRR	Common Mode Rejection Ratio	$V_{CM} = \pm 13.5V$	●	108	128		108	130		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 2.5V$ to $\pm 20V$	●	108	126		108	128		dB
	Input Voltage Range		●	±13.5			±13.5			V
V_{OUT}	Output Voltage Swing	$R_L = 10k\Omega$	●	±13	±14		±13	±14		V
I_S	Supply Current		●		400	800		400	800	μA

The ● denotes the specifications which apply over the full operating temperature range.

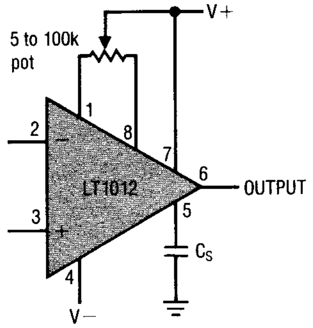
Note 1: Differential input voltages greater than 1V will cause excessive current to flow through the input protection diodes unless limiting resistance is used.

Note 2: These specifications apply for $\pm 2V \leq V_S \leq \pm 20V$ ($\pm 2.5V \leq V_S \leq \pm 20V$ over the temperature range) and $-13.5V \leq V_{CM} \leq 13.5V$ (for $V_S = \pm 15V$).

Note 3: 10Hz noise voltage density is sample tested on every lot. Devices 100% tested at 10Hz are available on request.

Note 4: This parameter is tested on a sample basis only.

Optional Offset Nulling and Over-Compensation Circuits

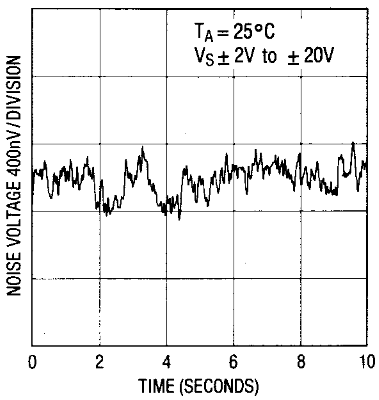


Input offset voltage can be adjusted over a $\pm 800\mu V$ range with a 5k to 100k potentiometer.

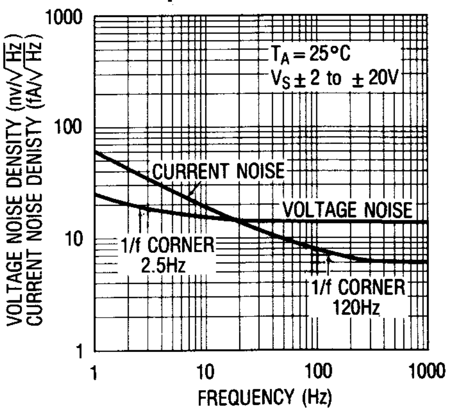
The LT1012 is internally compensated for unity gain stability. The over-compensation capacitor, C_S, can be used to improve capacitive load handling capability, to narrow noise bandwidth, or to stabilize circuits with gain in the feedback loop.

TYPICAL PERFORMANCE CHARACTERISTICS

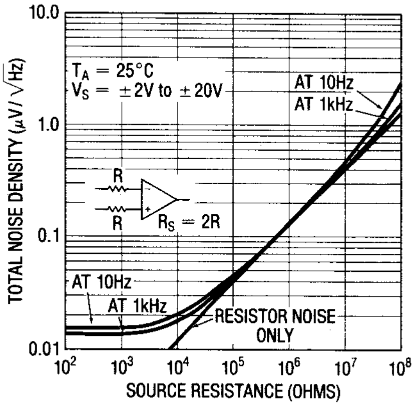
0.1Hz to 10Hz Noise



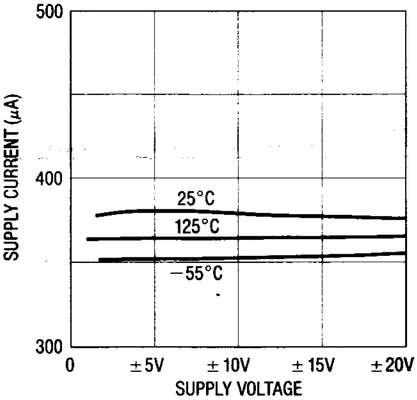
Noise Spectrum



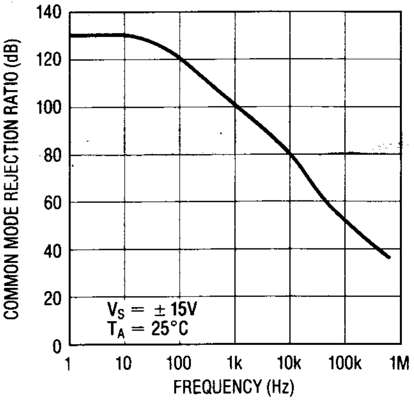
Total Noise vs Source Resistance



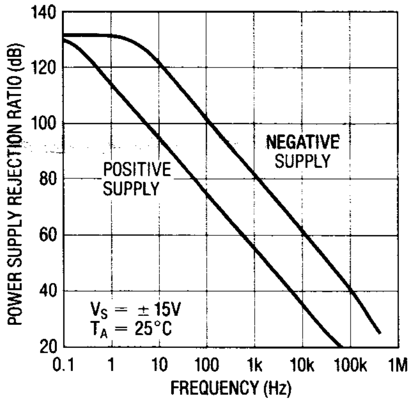
Supply Current vs Supply Voltage



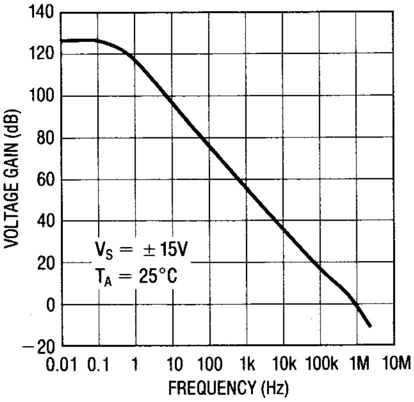
Common Mode Rejection vs Frequency



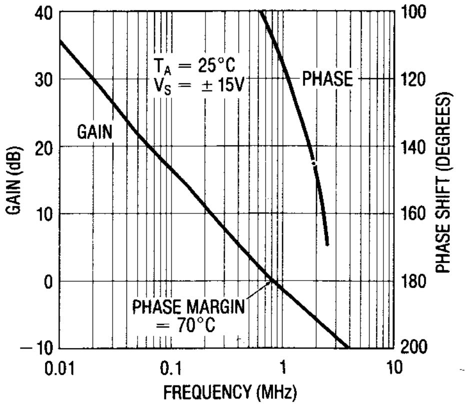
Power Supply Rejection vs Frequency



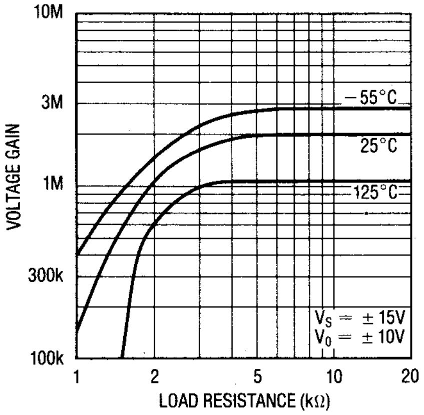
Voltage Gain vs Frequency



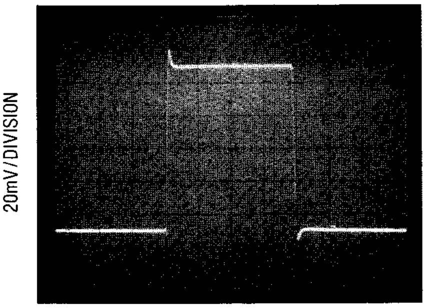
Gain, Phase Shift vs Frequency



Voltage Gain vs Load Resistance

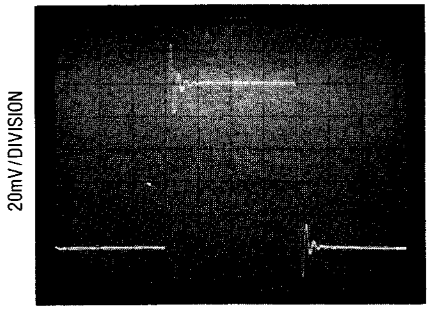


Small Signal Transient Response



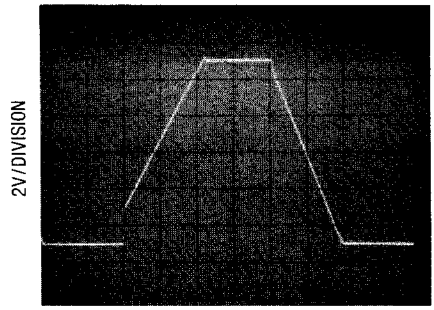
$A_V = +1$, $C_{LOAD} = 100pF$, 5μsec/DIV

Small Signal Transient Response



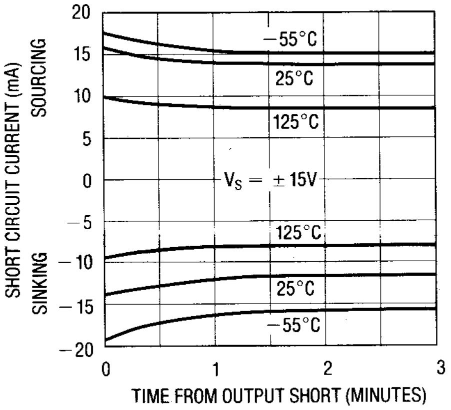
$A_V = +1$, $C_{LOAD} = 1000pF$, 5μsec/DIV

Large Signal Transient Response

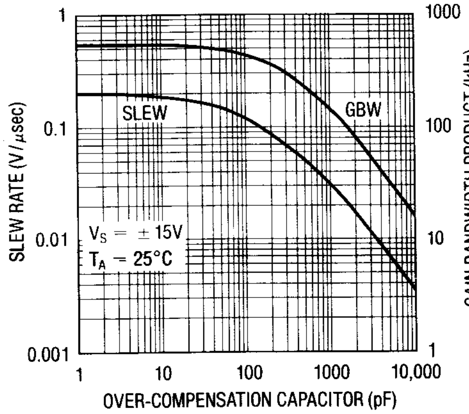


$A_V = +1$, 20μsec/DIV

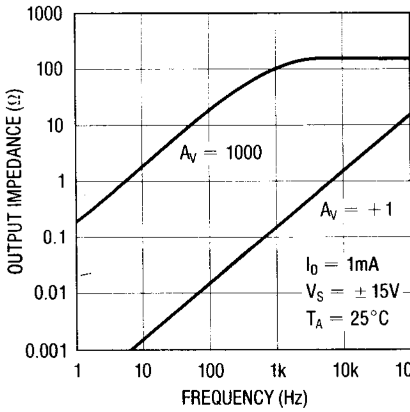
Output Short Circuit Current vs Time



Slew Rate, Gain Bandwidth Product vs Over-Compensation Capacitor



Closed Loop Output Impedance



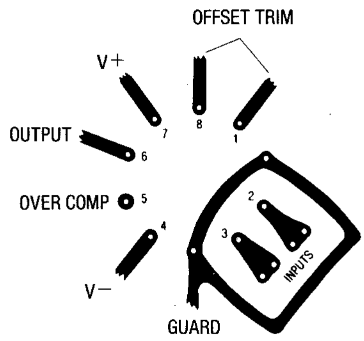
APPLICATIONS INFORMATION

The LT1012 may be inserted directly into OP-07, LM11, 108A or 101A sockets with or without removal of external frequency compensation or nulling components. The LT1012 can also be used in 741, LF411, LF156 or OP-15 applications provided that the nulling circuitry is removed.

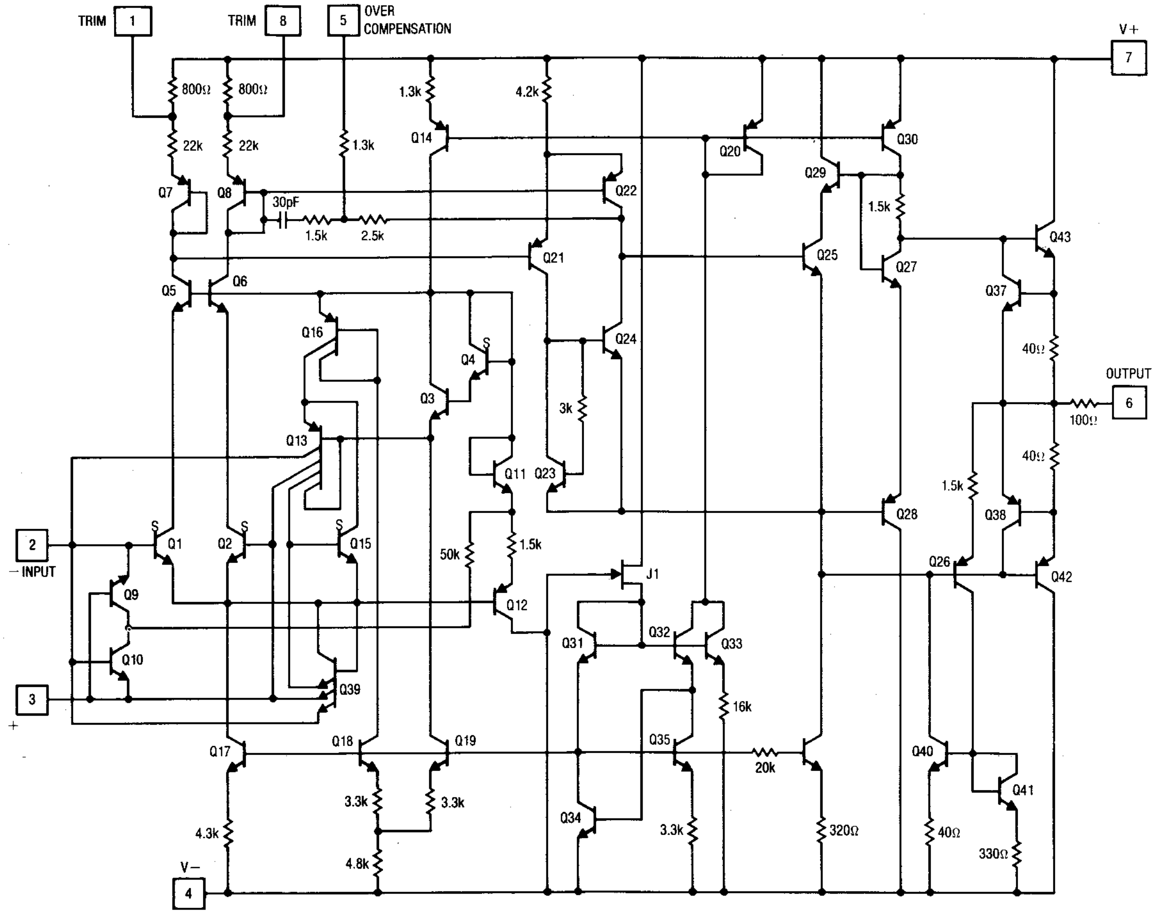
The LT1012 is specified over a wide range of power supply voltages from ±2V to ±18V. Operation with lower supplies is possible down to ±1.2V (two Ni-Cad batteries).

Achieving Picoampere/Microvolt Performance

In order to realize the picoampere — microvolt level accuracy of the LT1012, proper care must be exercised. For example, leakage currents in circuitry external to the op amp can significantly degrade performance. High quality insulation should be used (e.g. Teflon, Kel-F); cleaning of all insulating surfaces to remove fluxes and other residues will probably be required. Surface coating may be necessary to provide a moisture barrier in high humidity environments.

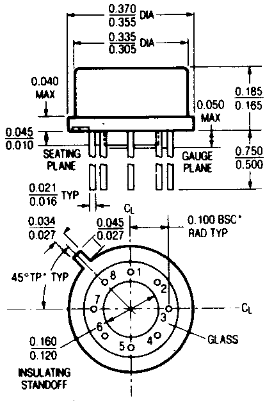


SCHEMATIC DIAGRAM



PACKAGE DESCRIPTION

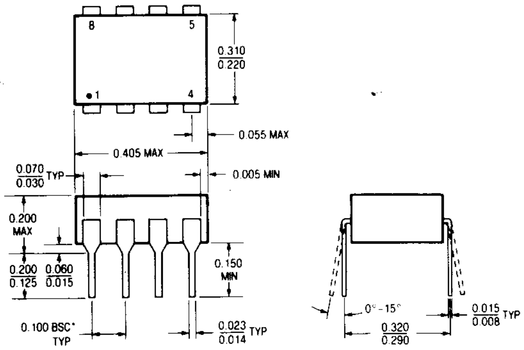
H Package
Metal Can



NOTE: DIMENSIONS IN INCHES

$T_j$max	Θ_{ja}	Θ_{jc}
150°C	150°C/W	45°C/W

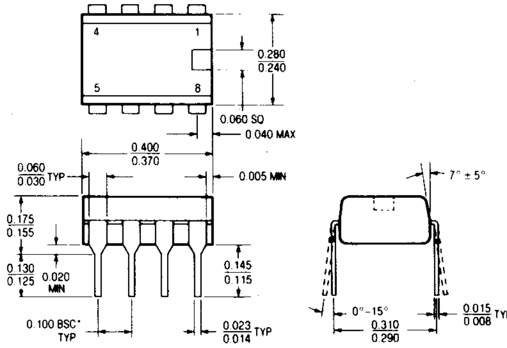
J8 Package
8 Lead Hermetic Dip



NOTE: DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED.
*LEADS WITHIN 0.007 OF TRUE POSITION (TP) AT GAUGE PLANE

$T_j$max	Θ_{ja}
150°C	100°C/W

N8 Package
8 Lead Plastic



NOTE: DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED.
*LEADS WITHIN 0.007 OF TRUE POSITION (TP) AT GAUGE PLANE

$T_j$max	Θ_{ja}
100°C	130°C/W

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