



LM4250

Programmable Operational Amplifier

General Description

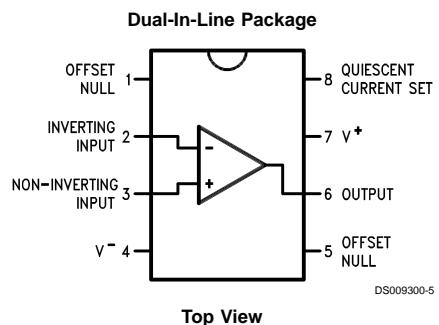
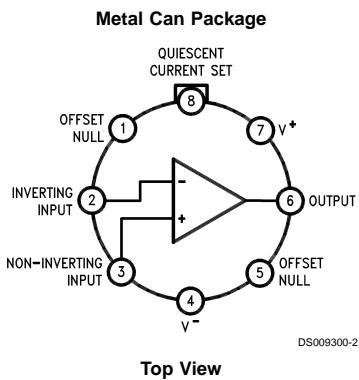
The LM4250 and LM4250C are extremely versatile programmable monolithic operational amplifiers. A single external master bias current setting resistor programs the input bias current, input offset current, quiescent power consumption, slew rate, input noise, and the gain-bandwidth product. The device is a truly general purpose operational amplifier.

The LM4250C is identical to the LM4250 except that the LM4250C has its performance guaranteed over a 0°C to +70°C temperature range instead of the -55°C to +125°C temperature range of the LM4250.

Features

- ±1V to ±18V power supply operation
- 3 nA input offset current
- Standby power consumption as low as 500 nW
- No frequency compensation required
- Programmable electrical characteristics
- Offset voltage nulling capability
- Can be powered by two flashlight batteries
- Short circuit protection

Connection Diagrams



Ordering Information

Temperature Range		Package	NSC Package Number
Military	Commercial		
-55°C ≤ TA ≤ +125°C	0°C ≤ TA ≤ +70°C	LM4250CN	N08E
		LM4250CM	M08A
LM4250J LM4250J-MIL		8-Pin Ceramic DIP	J08E
LM4250H LM4250H-MIL	LM4250CH	8-Pin Metal Can	H08C

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required,
please contact the National Semiconductor Sales Office/
Distributors for availability and specifications.

(Note 3)

	LM4250	LM4250C
Supply Voltage	±18V	±18V
Operating Temp. Range	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	$0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$
Differential Input Voltage	±30V	±30V
Input Voltage (Note 2)	±15V	±15V
I_{SET} Current	150 nA	150 nA
Output Short Circuit Duration	Continuous	Continuous
T_{JMAX}		
H-Package	150°C	100°C
N-Package		100°C
J-Package	150°C	100°C
M-Package		100°C
Power Dissipation at $T_A = 25^{\circ}\text{C}$		
H-Package (Still Air) (400 LF/Min Air Flow)	500 mW 1200 mW	300 mW 1200 mW
N-Package		500 mW
J-Package	1000 mW	600 mW
M-Package		350 mW
Thermal Resistance (Typical) θ_{JA}		
H-Package (Still Air) (400 LF/Min Air Flow)	165°C/W 65°C/W	165°C/W 65°C/W
N-Package		130°C/W
J-Package	108°C/W	108°C/W
M-Package		190°C/W
(Typical) θ_{JC}		
H-Package	21°C/W	21°C/W
Storage Temperature Range	-65°C to $+150^{\circ}\text{C}$	-65°C to $+150^{\circ}\text{C}$
Soldering Information		
Dual-In-Line Package		
Soldering (10 seconds)	260°C	
Small Outline Package		
Vapor Phase (60 seconds)	215°C	
Infrared (15 seconds)	220°C	
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.		
ESD tolerance (Note 4)	800V	

Note 1: "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

Note 2: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 3: Refer to RETS4250X for military specifications.

Note 4: Human body model, 1.5 kΩ in series with 100 pF.

Resistor Biasing

Set Current Setting Resistor to V⁻

V _S	I _{SET}				
	0.1 μA	0.5 μA	1.0 μA	5 μA	10 μA
±1.5V	25.6 MΩ	5.04 MΩ	2.5 MΩ	492 kΩ	244 kΩ
±3.0V	55.6 MΩ	11.0 MΩ	5.5 MΩ	1.09 MΩ	544 kΩ
±6.0V	116 MΩ	23.0 MΩ	11.5 MΩ	2.29 MΩ	1.14 MΩ
±9.0V	176 MΩ	35.0 MΩ	17.5 MΩ	3.49 MΩ	1.74 MΩ
±12.0V	236 MΩ	47.0 MΩ	23.5 MΩ	4.69 MΩ	2.34 MΩ
±15.0V	296 MΩ	59.0 MΩ	29.5 MΩ	5.89 MΩ	2.94 MΩ

Electrical Characteristics

LM4250 (-55°C ≤ T_A ≤ +125°C unless otherwise specified.) T_A = T_J

Parameter	Conditions	V _S = ±1.5V			
		I _{SET} = 1 μA		I _{SET} = 10 μA	
		Min	Max	Min	Max
V _{OS}	R _S ≤ 100 kΩ, T _A = 25°C		3 mV		5 mV
I _{OS}	T _A = 25°C		3 nA		10 nA
I _{bias}	T _A = 25°C		7.5 nA		50 nA
Large Signal Voltage Gain	R _L = 100 kΩ, T _A = 25°C V _O = ±0.6V, R _L = 10 kΩ	40k		50k	
Supply Current	T _A = 25°C		7.5 μA		80 μA
Power Consumption	T _A = 25°C		23 μW		240 μW
V _{OS}	R _S ≤ 100 kΩ		4 mV		6 mV
I _{OS}	T _A = +125°C T _A = -55°C		5 nA		10 nA
			3 nA		10 nA
I _{bias}			7.5 nA		50 nA
Input Voltage Range		±0.6V		±0.6V	
Large Signal Voltage Gain	V _O = ±0.5V, R _L = 100 kΩ R _L = 10 kΩ	30k		30k	
Output Voltage Swing	R _L = 100 kΩ R _L = 10 kΩ	±0.6V		±0.6V	
Common Mode Rejection Ratio	R _S ≤ 10 kΩ	70 dB		70 dB	
Supply Voltage Rejection Ratio	R _S ≤ 10 kΩ	76 dB		76 dB	
Supply Current			8 μA		90 μA
Parameter	Conditions	V _S = ±15V			
		I _{SET} = 1 μA		I _{SET} = 10 μA	
		Min	Max	Min	Max
V _{OS}	R _S ≤ 100 kΩ, T _A = 25°C		3 mV		5 mV
I _{OS}	T _A = 25°C		3 nA		10 nA
I _{bias}	T _A = 25°C		7.5 nA		50 nA
Large Signal Voltage Gain	R _L = 100 kΩ, T _A = 25°C V _O = ±10V, R _L = 10 kΩ	100k		100k	
Supply Current	T _A = 25°C		10 μA		90 μA
Power Consumption	T _A = 25°C		300 μW		2.7 mW
V _{OS}	R _S ≤ 100 kΩ		4 mV		6 mV
I _{OS}	T _A = +125°C T _A = -55°C		25 nA		25 nA
			3 nA		10 nA
I _{bias}			7.5 nA		50 nA
Input Voltage Range		±13.5V		±13.5V	

Electrical Characteristics (Continued)

Parameter	Conditions	$V_S = \pm 15V$			
		$I_{SET} = 1 \mu A$		$I_{SET} = 10 \mu A$	
		Min	Max	Min	Max
Large Signal Voltage Gain	$V_O = \pm 10V, R_L = 100 k\Omega$ $R_L = 10 k\Omega$	50k		50k	
Output Voltage Swing	$R_L = 100 k\Omega$ $R_L = 10 k\Omega$	$\pm 12V$		$\pm 12V$	
Common Mode Rejection Ratio	$R_S \leq 10 k\Omega$	70 dB		70 dB	
Supply Voltage Rejection Ratio	$R_S \leq 10 k\Omega$	76 dB		76 dB	
Supply Current			11 μA		100 μA
Power Consumption			330 μW		3 mW

Electrical Characteristics

LM4250C ($0^\circ C \leq T_A \leq +70^\circ C$ unless otherwise specified.) $T_A = T_J$

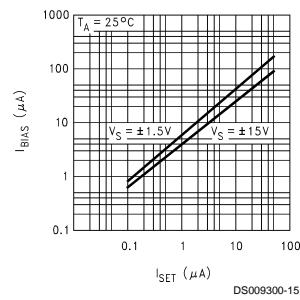
Parameter	Conditions	$V_S = \pm 1.5V$			
		$I_{SET} = 1 \mu A$		$I_{SET} = 10 \mu A$	
		Min	Max	Min	Max
V_{OS}	$R_S \leq 100 k\Omega, T_A = 25^\circ C$		5 mV		6 mV
I_{OS}	$T_A = 25^\circ C$		6 nA		20 nA
I_{bias}	$T_A = 25^\circ C$		10 nA		75 nA
Large Signal Voltage Gain	$R_L = 100 k\Omega, T_A = 25^\circ C$ $V_O = \pm 0.6V, R_L = 10 k\Omega$	25k		25k	
Supply Current	$T_A = 25^\circ C$		8 μA		90 μA
Power Consumption	$T_A = 25^\circ C$		24 μW		270 μW
V_{OS}	$R_S \leq 10 k\Omega$		6.5 mV		7.5 mV
I_{OS}			8 nA		25 nA
I_{bias}			10 nA		80 nA
Input Voltage Range		$\pm 0.6V$		$\pm 0.6V$	
Large Signal Voltage Gain	$V_O = \pm 0.5V, R_L = 100 k\Omega$ $R_L = 10 k\Omega$	25k		25k	
Output Voltage Swing	$R_L = 100 k\Omega$ $R_L = 10 k\Omega$	$\pm 0.6V$		$\pm 0.6V$	
Common Mode Rejection Ratio	$R_S \leq 10 k\Omega$	70 dB		70 dB	
Supply Voltage Rejection Ratio	$R_S \leq 10 k\Omega$	74 dB		74 dB	
Supply Current			8 μA		90 μA
Power Consumption			24 μW		270 μW
Parameter	Conditions	$V_S = \pm 15V$			
		$I_{SET} = 1 \mu A$		$I_{SET} = 10 \mu A$	
		Min	Max	Min	Max
V_{OS}	$R_S \leq 100 k\Omega, T_A = 25^\circ C$		5 mV		6 mV
I_{OS}	$T_A = 25^\circ C$		6 nA		20 nA
I_{bias}	$T_A = 25^\circ C$		10 nA		75 nA
Large Signal Voltage Gain	$R_L = 100 k\Omega, T_A = 25^\circ C$ $V_O = \pm 10V, R_L = 10 k\Omega$	60k		60k	
Supply Current	$T_A = 25^\circ C$		11 μA		100 μA
Power Consumption	$T_A = 25^\circ C$		330 μW		3 mW
V_{OS}	$R_S \leq 100 k\Omega$		6.5 mV		7.5 mV
I_{OS}			8 nA		25 nA
I_{bias}			10 nA		80 nA

Electrical Characteristics (Continued)

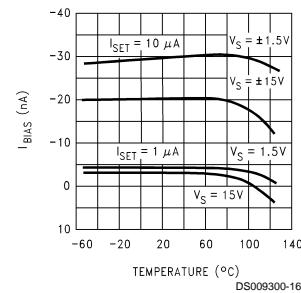
Parameter	Conditions	$V_S = \pm 15V$			
		$I_{SET} = 1 \mu A$		$I_{SET} = 10 \mu A$	
		Min	Max	Min	Max
Input Voltage Range		$\pm 13.5V$		$\pm 13.5V$	
Large Signal Voltage Gain	$V_O = \pm 10V$, $R_L = 100 k\Omega$ $R_L = 10 k\Omega$	50k		50k	
Output Voltage Swing	$R_L = 100 k\Omega$ $R_L = 10 k\Omega$	$\pm 12V$		$\pm 12V$	
Common Mode Rejection Ratio	$R_S \leq 10 k\Omega$	70 dB		70 dB	
Supply Voltage Rejection Ratio	$R_S \leq 10 k\Omega$	74 dB		74 dB	
Supply Current			11 μA		100 μA
Power Consumption			330 μW		3 mW

Typical Performance Characteristics

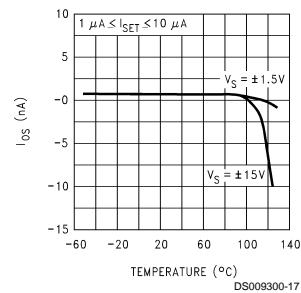
Input Bias Current vs I_{SET}



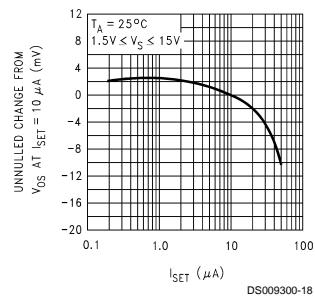
Input Bias Current vs Temperature



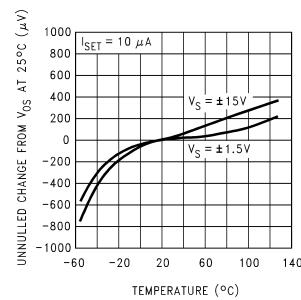
Input Offset Current vs Temperature



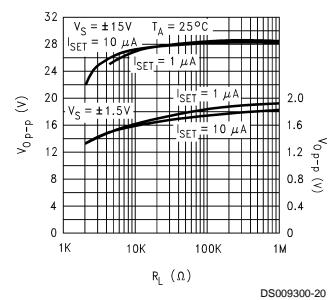
Unnullled Input Offset Voltage Change vs I_{SET}



Unnullled Input Offset Voltage Change vs Temperature

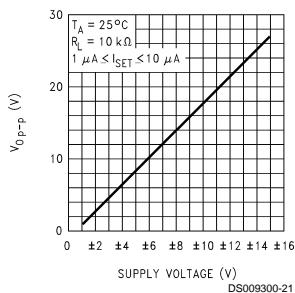


Peak to Peak Output Voltage Swing vs Load Resistance

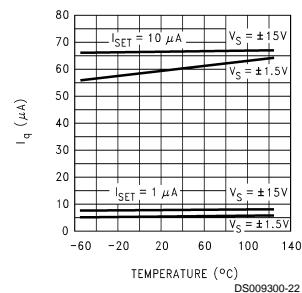


Typical Performance Characteristics (Continued)

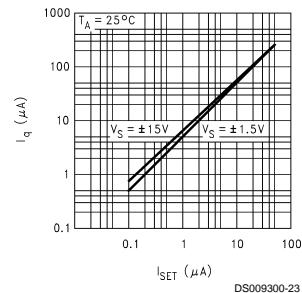
Peak to Peak Output Voltage Swing vs Supply Voltage



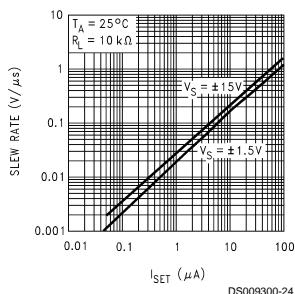
Quiescent Current (I_q) vs Temperature



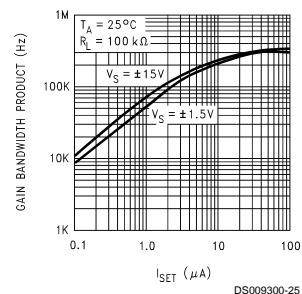
Quiescent Current (I_q) vs I_{SET}



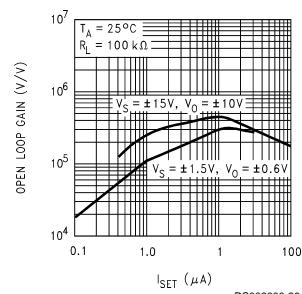
Slew Rate vs I_{SET}



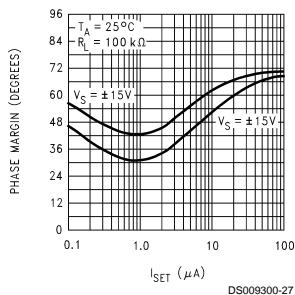
Gain Bandwidth Product vs I_{SET}



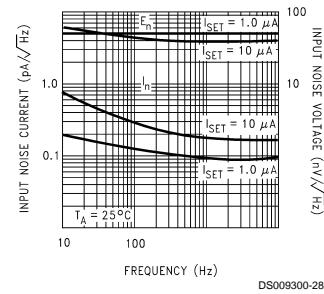
Open Loop Voltage Gain vs I_{SET}



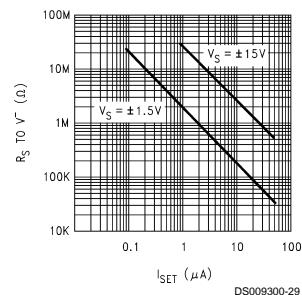
Phase Margin vs I_{SET}



Input Noise Current (I_n) and Voltage (E_n) vs Frequency

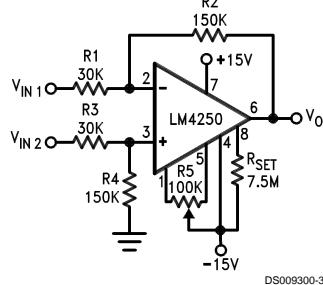


R_{SET} vs I_{SET}



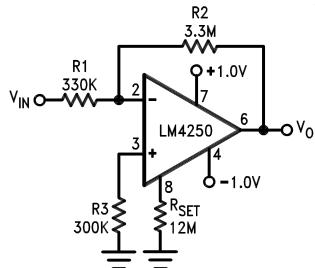
Typical Applications

X5 Difference Amplifier



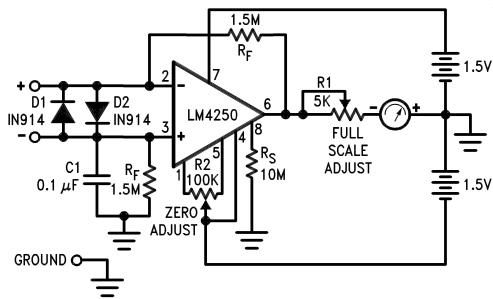
Quiescent $P_D = 0.6 \text{ mW}$

500 Nano-Watt X10 Amplifier



Quiescent $P_D = 500 \text{ nW}$

**Floating Input Meter Amplifier
100 nA full Scale**

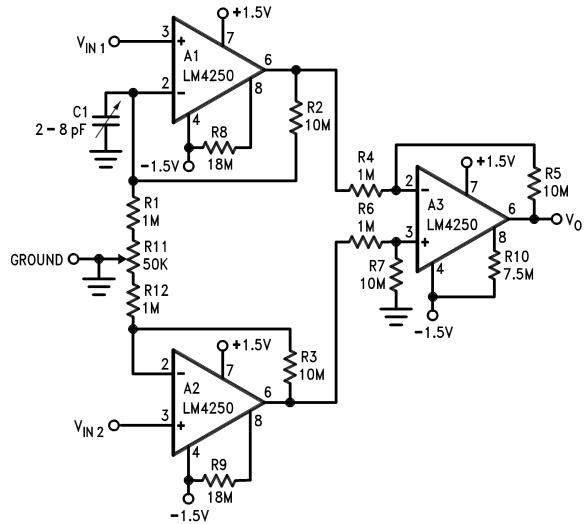


Quiescent $P_D = 1.8 \mu\text{W}$

*Meter movement (0–100 μA , $2 \text{ k}\Omega$) marked for 0–100 nA full scale.

Typical Applications (Continued)

X100 Instrumentation Amplifier 10 μW



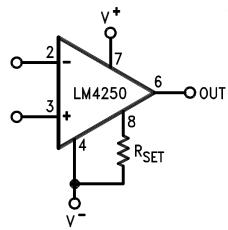
DS009300-9

Note 5: Quiescent $P_D = 10 \mu\text{W}$.

Note 6: R2, R3, R4, R5, R6 and R7 are 1% resistors.

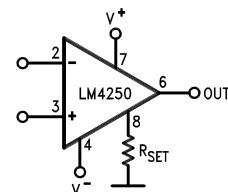
Note 7: R11 and C1 are for DC and AC common mode rejection adjustments.

R_{SET} Connected to V^-



DS009300-10

R_{SET} Connected to Ground



DS009300-11

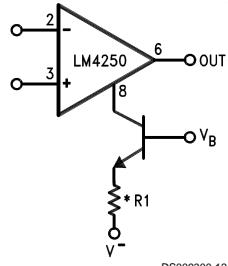
I_{SET} Equations:

$$I_{SET} \approx \frac{V^+ + |V^-| - 0.5}{R_{SET}} \quad \text{where } R_{SET} \text{ is connected to } V^-.$$

$$I_{SET} \approx \frac{V^+ - 0.5}{R_{SET}} \quad \text{where } R_{SET} \text{ is connected to ground.}$$

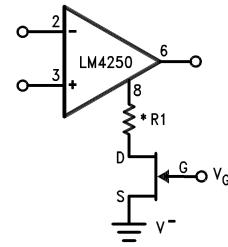
DS009300-30

Transistor Current Sourcing Biasing



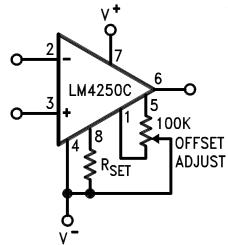
DS009300-12

FET Current Sourcing Biasing



DS009300-13

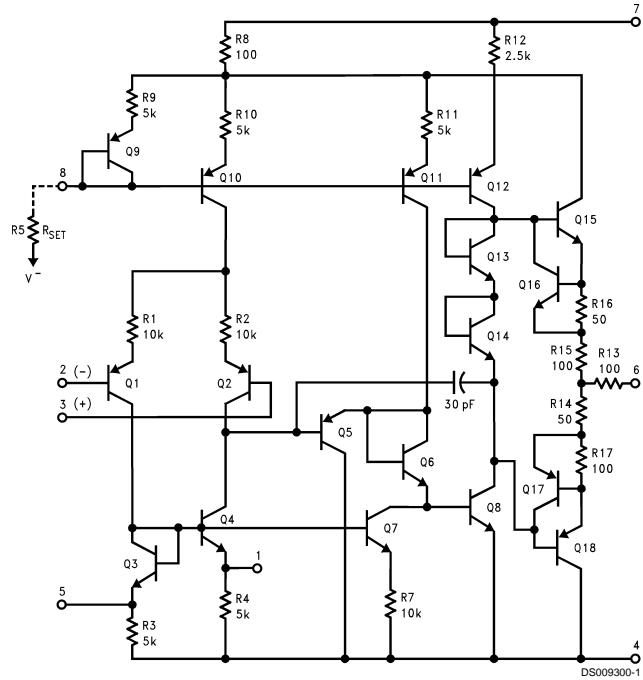
Offset Null Circuit



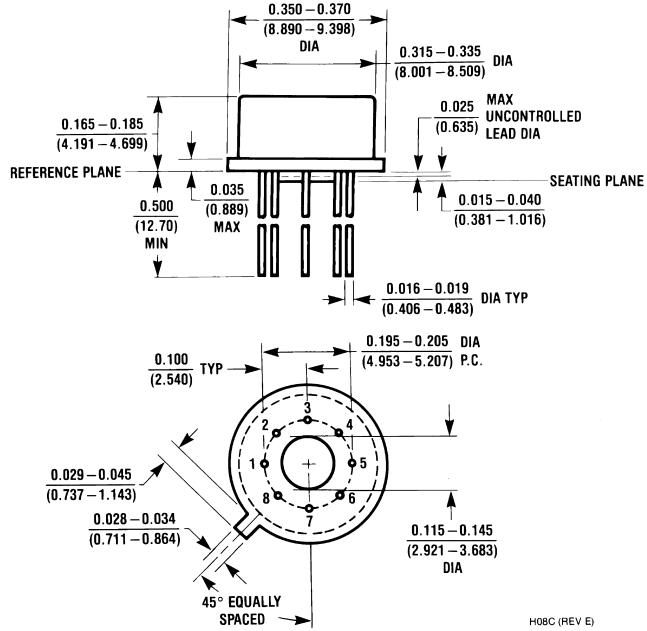
DS009300-14

*R1 limits I_{SET} maximum

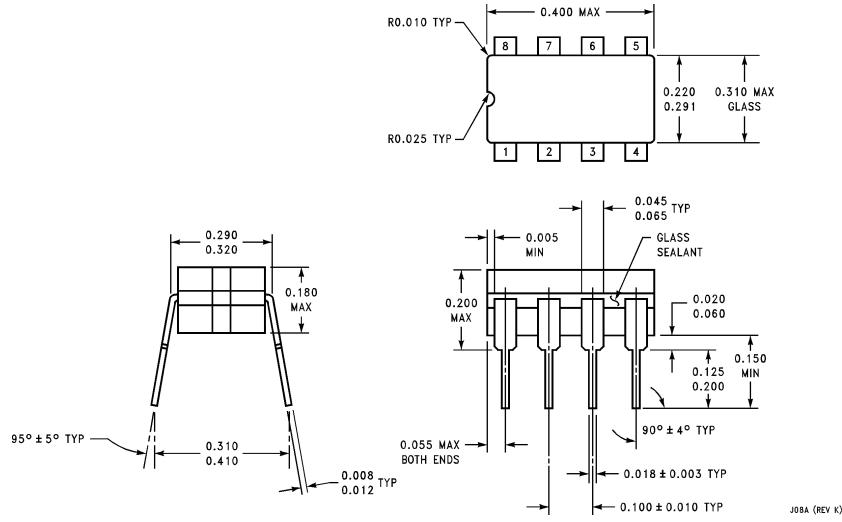
Schematic Diagram



Physical Dimensions inches (millimeters) unless otherwise noted

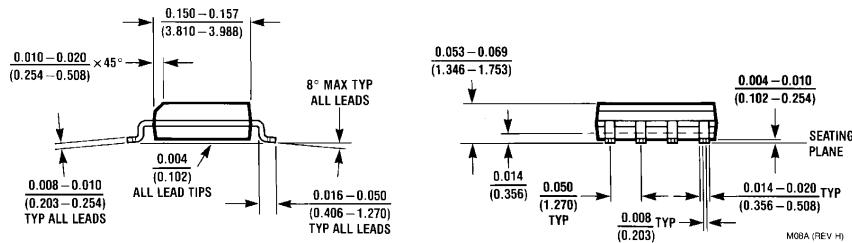
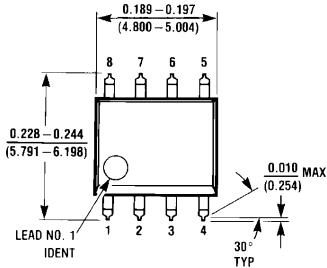


Metal Can Package (H)
Order Number LM4250H, LM4250CH or LM4250H-MIL
NS Package Number H08C

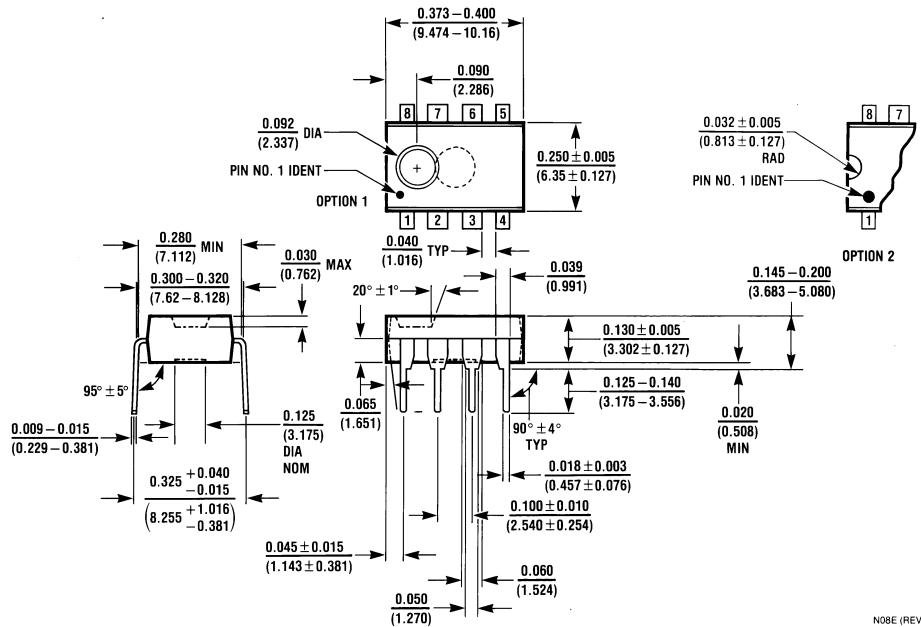


Ceramic Dual-In-Line Package (J)
Order Number LM4250J, or LM4250J-MIL
NS Package Number J08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



**Small Outline Package (M)
Order Number LM4250M
NS Package Number M08A**



**Molded Dual-In-Line Package (N)
Order Number LM4250CN
NS Package Number N08E**

LM4250 Programmable Operational Amplifier

Notes

LIFE SUPPORT POLICY

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



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