National Semiconductor

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.

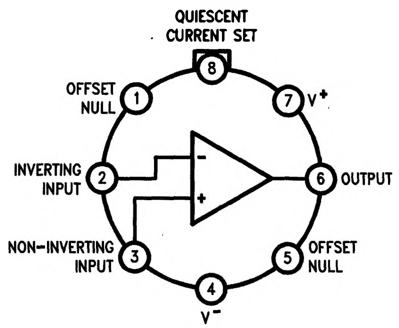
The LM4250C is identical to the LM4250 except that the LM4250C has its performance guaranteed over a 0°C to +70°C temperature range instead of the −55°C to +125°C temperature range of the LM4250.

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

Metal Can Package



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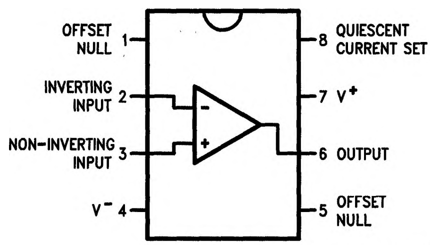
Top View

Dual-In-Line Package



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Top View

Ordering Information

Temperature Range		Package	NSC Package Number
Military $-55°C \leq T_A \leq +125°C$	**Commercial** $0°C \leq T_A \leq +70°C$		
	LM4250CN	8-Pin Molded DIP	N08E
	LM4250CM	8-Pin Surface Mount	M08A
LM4250J LM4250J-MIL		8-Pin Ceramic DIP	J08E
LM4250H LM4250H-MIL	LM4250CH	8-Pin Metal Can	H08C

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.
(Note 2)

	LM4250	LM4250C
Supply Voltage	±18V	±18V
Operating Temp. Range	$-55^\circ C \leq T_A \leq +125^\circ C$	$0^\circ C \leq T_A \leq +70^\circ C$
Differential Input Voltage	±30V	±30V
Input Voltage (Note 1)	±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 $T_A = 25^\circ C$		
H-Package (Still Air)	500 mW	300 mW
(400 LF/Min Air Flow)	1200 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)	165°C/W	165°C/W
(400 LF/Min Air Flow)	65°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°C	−65°C to +150°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 3) 800V

Note 1: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 2: Refer to RETS4250X for military specifications.

Note 3: Human body model, 1.5 kΩ in series with 100 pF.

Resistor Biasing

Set Current Setting Resistor to V−

	I_{SET}				
V_S	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 ($-55°C \leq T_A \leq +125°C$ 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}	$R_S \leq 100\ k\Omega$, $T_A = 25°C$		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	$R_L = 100\ k\Omega$, $T_A = 25°C$ $V_O = \pm 0.6V$, $R_L = 10\ k\Omega$	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}	$R_S \leq 100\ k\Omega$		4 mV		6 mV
I_{OS}	$T_A = +125°C$ $T_A = -55°C$		5 nA 3 nA		10 nA 10 nA
I_{bias}			7.5 nA		50 nA
Input Voltage Range		±0.6V		±0.6V	
Large Signal Voltage Gain	$V_O = \pm 0.5V$, $R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	30k		 30k	
Output Voltage Swing	$R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	±0.6V		 ±0.6V	
Common Mode Rejection Ratio	$R_S \leq 10\ k\Omega$	70 dB		70 dB	
Supply Voltage Rejection Ratio	$R_S \leq 10\ k\Omega$	76 dB		76 dB	
Supply Current			8 μA		90 μA

Parameter	Conditions	$V_S = \pm 15V$			
		$I_{SET} = 1\ \mu A$		$I_{SET} = 10\ \mu A$	
		Min	Max	Min	Max
V_{OS}	$R_S \leq 100\ k\Omega$, $T_A = 25°C$		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	$R_L = 100\ k\Omega$, $T_A = 25°C$ $V_O = \pm 10V$, $R_L = 10\ k\Omega$	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}	$R_S \leq 100\ k\Omega$		4 mV		6 mV
I_{OS}	$T_A = +125°C$ $T_A = -55°C$		25 nA 3 nA		25 nA 10 nA
I_{bias}			7.5 nA		50 nA
Input Voltage Range		±13.5V		±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	$R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	±12V		 ±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

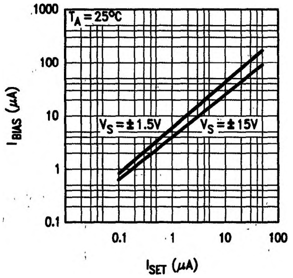
Electrical Characteristics LM4250C (0°C ≤ T_A ≤ +70°C unless otherwise specified.) $T_A = T_J$

Parameter	Conditions	$V_S = \pm1.5V$			
		$I_{SET} = 1\ \mu A$		$I_{SET} = 10\ \mu A$	
		Min	Max	Min	Max
V_{OS}	$R_S \le 100\ k\Omega$, $T_A = 25°C$		5 mV		6 mV
I_{OS}	$T_A = 25°C$		6 nA		20 nA
I_{bias}	$T_A = 25°C$		10 nA		75 nA
Large Signal Voltage Gain	$R_L = 100\ k\Omega$, $T_A = 25°C$ $V_O = \pm0.6V$, $R_L = 10\ k\Omega$	25k		 25k	
Supply Current	$T_A = 25°C$		8 μA		90 μA
Power Consumption	$T_A = 25°C$		24 μW		270 μW
V_{OS}	$R_S \le 10\ k\Omega$		6.5 mV		7.5 mV
I_{OS}			8 nA		25 nA
I_{bias}			10 nA		80 nA
Input Voltage Range		±0.6V		±0.6V	
Large Signal Voltage Gain	$V_O = \pm0.5V$, $R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	25k		 25k	
Output Voltage Swing	$R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	±0.6V		 ±0.6V	
Common Mode Rejection Ratio	$R_S \le 10\ k\Omega$	70 dB		70 dB	
Supply Voltage Rejection Ratio	$R_S \le 10\ k\Omega$	74 dB		74 dB	
Supply Current			8 μA		90 μA
Power Consumption			24 μW		270 μW

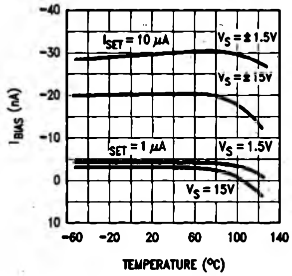
Parameter	Conditions	$V_S = \pm15V$			
		$I_{SET} = 1\ \mu A$		$I_{SET} = 10\ \mu A$	
		Min	Max	Min	Max
V_{OS}	$R_S \le 100\ k\Omega$, $T_A = 25°C$		5 mV		6 mV
I_{OS}	$T_A = 25°C$		6 nA		20 nA
I_{bias}	$T_A = 25°C$		10 nA		75 nA
Large Signal Voltage Gain	$R_L = 100\ k\Omega$, $T_A = 25°C$ $V_O = \pm10V$, $R_L = 10\ k\Omega$	60k		 60k	
Supply Current	$T_A = 25°C$		11 μA		100 μA
Power Consumption	$T_A = 25°C$		330 μW		3 mW
V_{OS}	$R_S \le 100\ k\Omega$		6.5 mV		7.5 mV
I_{OS}			8 nA		25 nA
I_{bias}			10 nA		80 nA
Input Voltage Range		±13.5V		±13.5V	
Large Signal Voltage Gain	$V_O = \pm10V$, $R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	50k		 50k	
Output Voltage Swing	$R_L = 100\ k\Omega$ $R_L = 10\ k\Omega$	±12V		 ±12V	
Common Mode Rejection Ratio	$R_S \le 10\ k\Omega$	70 dB		70 dB	
Supply Voltage Rejection Ratio	$R_S \le 10\ k\Omega$	74 dB		74 dB	
Supply Current			11 μA		100 μA
Power Consumption			330 μW		3 mW

Typical Performance Characteristics

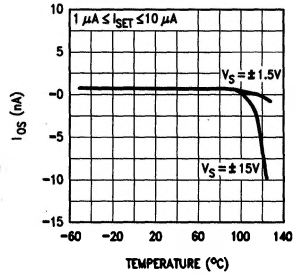
Input Bias Current vs I_{SET}



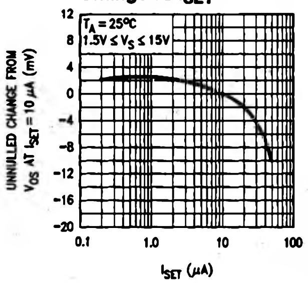
Input Bias Current vs Temperature



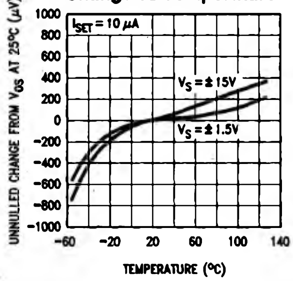
Input Offset Current vs Temperature



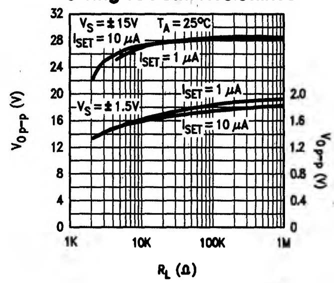
Unnulled Input Offset Voltage Change vs I_{SET}



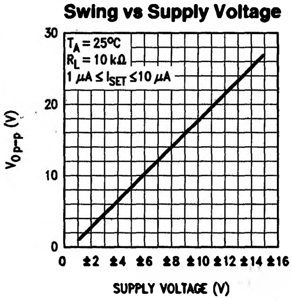
Unnulled Input Offset Voltage Change vs Temperature



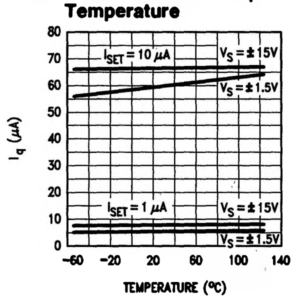
Peak to Peak Output Voltage Swing vs Load Resistance



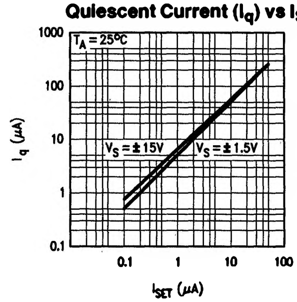
Peak to Peak Output Voltage Swing vs Supply Voltage



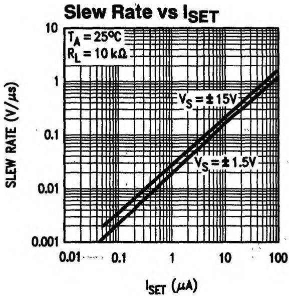
Quiescent Current (I_q) vs Temperature



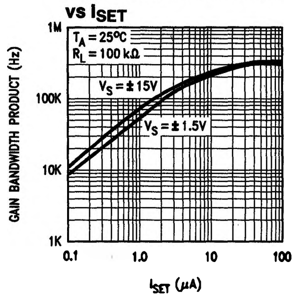
Quiescent Current (I_q) vs I_{SET}



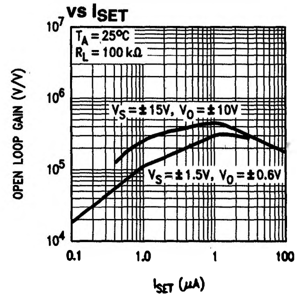
Slew Rate vs I_{SET}



Gain Bandwidth Product vs I_{SET}



Open Loop Voltage Gain vs I_{SET}



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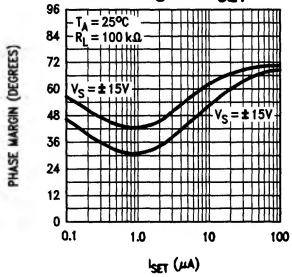
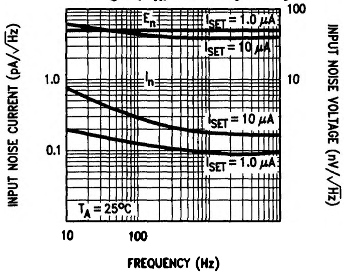
Typical Performance Characteristics (Continued)

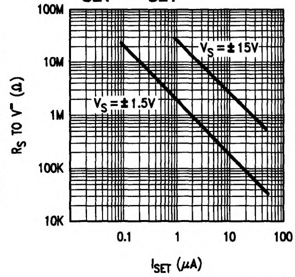
Phase Margin vs I_{SET}



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



R_{SET} vs I_{SET}



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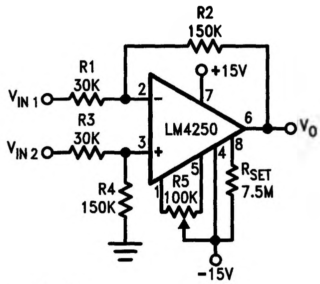
Typical Applications

X5 Difference Amplifier



Quiescent P_D = 0.6 mW

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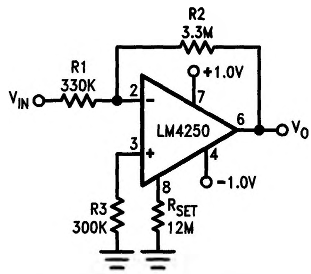
500 Nano-Watt X10 Amplifier



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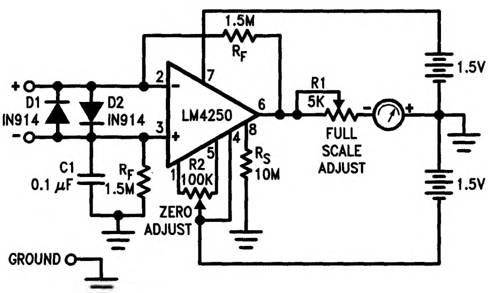
Quiescent P_D = 500 nW

Floating Input Meter Amplifier
100 nA Full Scale



Quiescent P_D = 1.8 μW

*Meter movement (0–100 μA, 2 kΩ) marked for 0–100 nA full scale.

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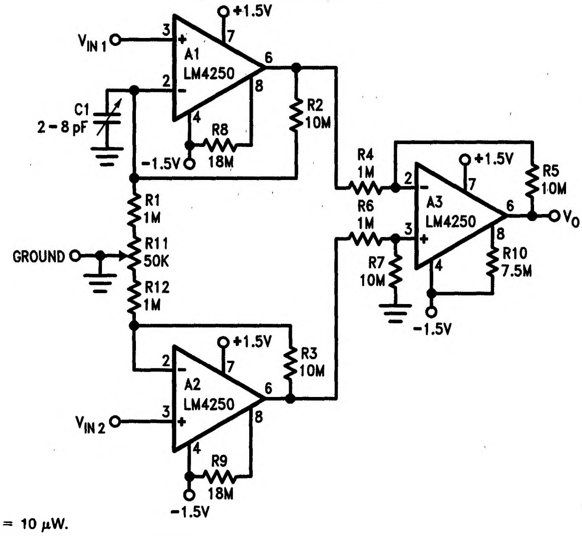
Typical Applications (Continued)

X100 Instrumentation Amplifier 10 μW



Note 1: Quiescent P_D = 10 μW.

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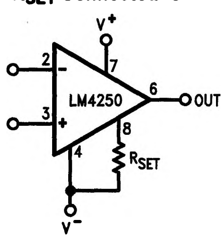
Note 2: R2, R3, R4, R5, R6 and R7 are 1% resistors.

Note 3: R11 and C1 are for DC and AC common mode rejection adjustments.

R_{SET} Connected to V^-



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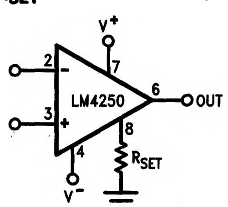
R_{SET} Connected to Ground



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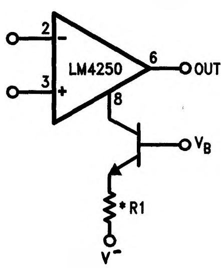
I_{SET} Equations:

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

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

Transistor Current Sourcing Biasing



*R1 limits I_{SET} maximum

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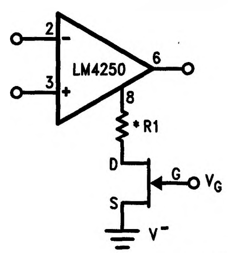
FET Current Sourcing Biasing



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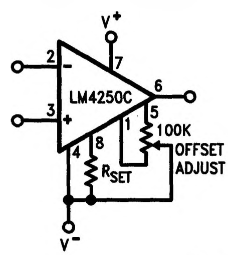
Offset Null Circuit



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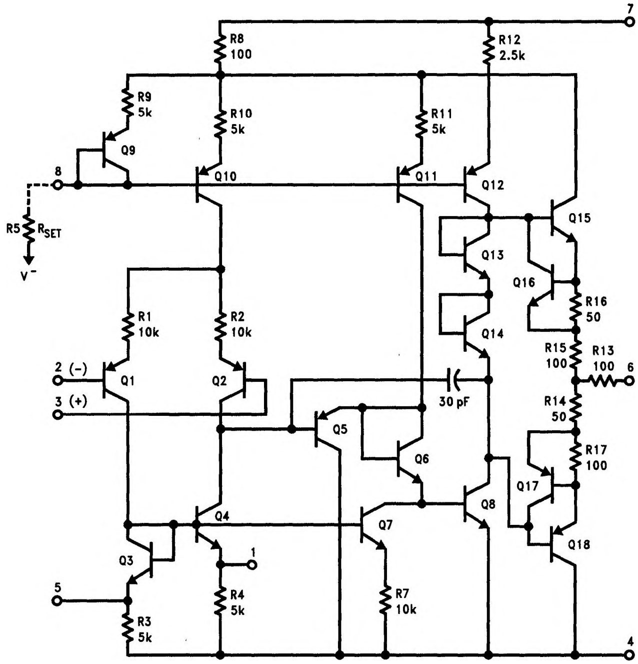
Schematic Diagram



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