

LM4250 Programmable Operational Amplifier

General Description

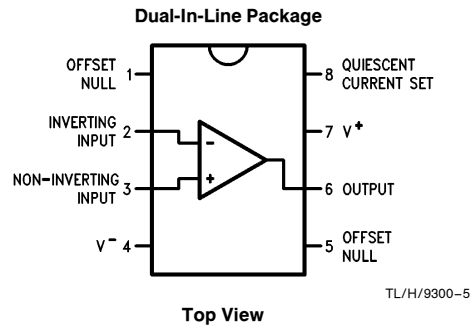
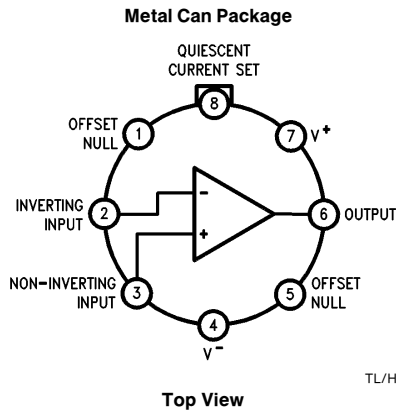
The LM4250 and LM4250C are extremely versatile programmable monolithic operational amplifiers. A single external master bias current setting resistor programs the input bias current, input offset current, quiescent power consumption, slew rate, input noise, and the gain-bandwidth product. The device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

- $\pm 1\text{V}$ to $\pm 18\text{V}$ 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 $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ | Commercial $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ | | |
| | 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°C ≤ T _A ≤ +125°C | 0°C ≤ T _A ≤ +70°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°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⁻

| 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 ($-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ unless otherwise specified.) $T_A = T_J$

| Parameter | Conditions | $V_S = \pm 1.5\text{V}$ | | | |
|--------------------------------|--|----------------------------|-------------------|-----------------------------|-------------------|
| | | $I_{SET} = 1\ \mu\text{A}$ | | $I_{SET} = 10\ \mu\text{A}$ | |
| | | Min | Max | Min | Max |
| V_{OS} | $R_S \leq 100\ \text{k}\Omega$, $T_A = 25^{\circ}\text{C}$ | | 3 mV | | 5 mV |
| I_{OS} | $T_A = 25^{\circ}\text{C}$ | | 3 nA | | 10 nA |
| I_{bias} | $T_A = 25^{\circ}\text{C}$ | | 7.5 nA | | 50 nA |
| Large Signal Voltage Gain | $R_L = 100\ \text{k}\Omega$, $T_A = 25^{\circ}\text{C}$ $V_O = \pm 0.6\text{V}$, $R_L = 10\ \text{k}\Omega$ | 40k | | 50k | |
| Supply Current | $T_A = 25^{\circ}\text{C}$ | | 7.5 μA | | 80 μA |
| Power Consumption | $T_A = 25^{\circ}\text{C}$ | | 23 μW | | 240 μW |
| V_{OS} | $R_S \leq 100\ \text{k}\Omega$ | | 4 mV | | 6 mV |
| I_{OS} | $T_A = +125^{\circ}\text{C}$ $T_A = -55^{\circ}\text{C}$ | | 5 nA 3 nA | | 10 nA 10 nA |
| I_{bias} | | | 7.5 nA | | 50 nA |
| Input Voltage Range | | $\pm 0.6\text{V}$ | | $\pm 0.6\text{V}$ | |
| Large Signal Voltage Gain | $V_O = \pm 0.5\text{V}$, $R_L = 100\ \text{k}\Omega$ $R_L = 10\ \text{k}\Omega$ | 30k | | 30k | |
| Output Voltage Swing | $R_L = 100\ \text{k}\Omega$ $R_L = 10\ \text{k}\Omega$ | $\pm 0.6\text{V}$ | | $\pm 0.6\text{V}$ | |
| Common Mode Rejection Ratio | $R_S \leq 10\ \text{k}\Omega$ | 70 dB | | 70 dB | |
| Supply Voltage Rejection Ratio | $R_S \leq 10\ \text{k}\Omega$ | 76 dB | | 76 dB | |
| Supply Current | | | 8 μA | | 90 μA |

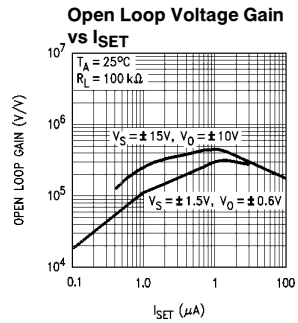
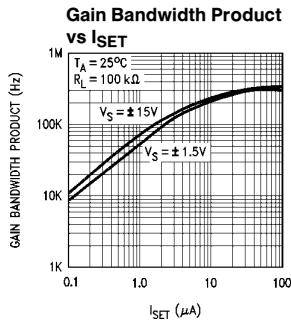
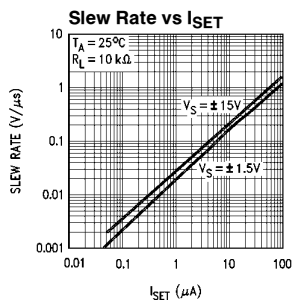
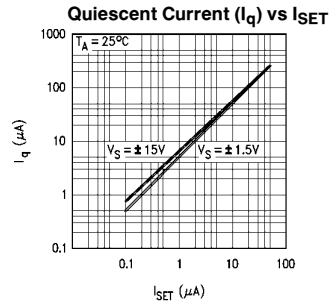
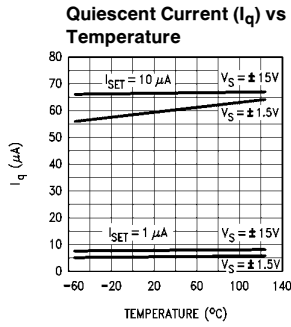
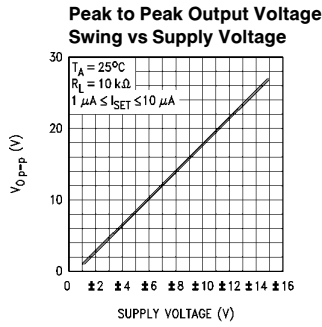
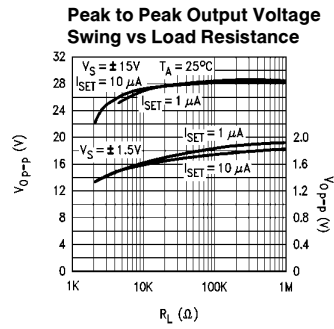
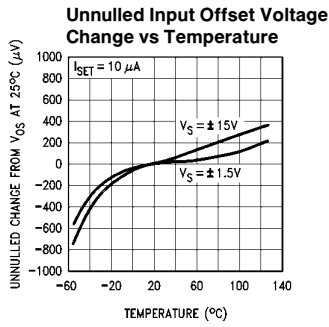
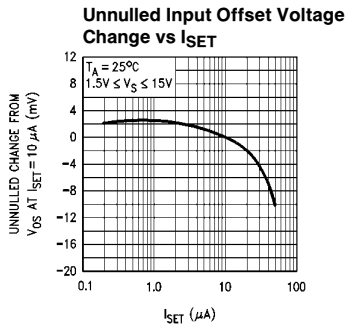
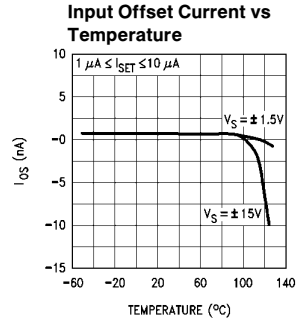
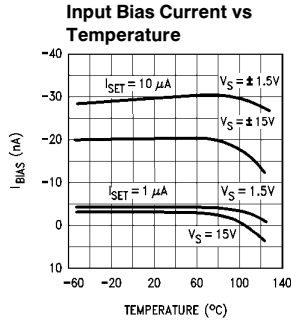
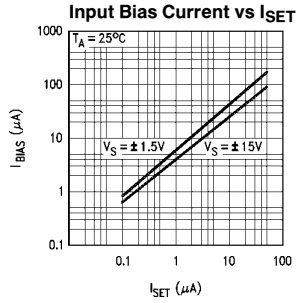
| Parameter | Conditions | $V_S = \pm 15\text{V}$ | | | |
|--------------------------------|---|----------------------------|-------------------|-----------------------------|-------------------|
| | | $I_{SET} = 1\ \mu\text{A}$ | | $I_{SET} = 10\ \mu\text{A}$ | |
| | | Min | Max | Min | Max |
| V_{OS} | $R_S \leq 100\ \text{k}\Omega$, $T_A = 25^{\circ}\text{C}$ | | 3 mV | | 5 mV |
| I_{OS} | $T_A = 25^{\circ}\text{C}$ | | 3 nA | | 10 nA |
| I_{bias} | $T_A = 25^{\circ}\text{C}$ | | 7.5 nA | | 50 nA |
| Large Signal Voltage Gain | $R_L = 100\ \text{k}\Omega$, $T_A = 25^{\circ}\text{C}$ $V_O = \pm 10\text{V}$, $R_L = 10\ \text{k}\Omega$ | 100k | | 100k | |
| Supply Current | $T_A = 25^{\circ}\text{C}$ | | 10 μA | | 90 μA |
| Power Consumption | $T_A = 25^{\circ}\text{C}$ | | 300 μW | | 2.7 mW |
| V_{OS} | $R_S \leq 100\ \text{k}\Omega$ | | 4 mV | | 6 mV |
| I_{OS} | $T_A = +125^{\circ}\text{C}$ $T_A = -55^{\circ}\text{C}$ | | 25 nA 3 nA | | 25 nA 10 nA |
| I_{bias} | | | 7.5 nA | | 50 nA |
| Input Voltage Range | | $\pm 13.5\text{V}$ | | $\pm 13.5\text{V}$ | |
| Large Signal Voltage Gain | $V_O = \pm 10\text{V}$, $R_L = 100\ \text{k}\Omega$ $R_L = 10\ \text{k}\Omega$ | 50k | | 50k | |
| Output Voltage Swing | $R_L = 100\ \text{k}\Omega$ $R_L = 10\ \text{k}\Omega$ | $\pm 12\text{V}$ | | $\pm 12\text{V}$ | |
| Common Mode Rejection Ratio | $R_S \leq 10\ \text{k}\Omega$ | 70 dB | | 70 dB | |
| Supply Voltage Rejection Ratio | $R_S \leq 10\ \text{k}\Omega$ | 76 dB | | 76 dB | |
| Supply Current | | | 11 μA | | 100 μA |
| Power Consumption | | | 330 μW | | 3 mW |

Electrical Characteristics LM4250C ($0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ unless otherwise specified.) $T_A = T_J$

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

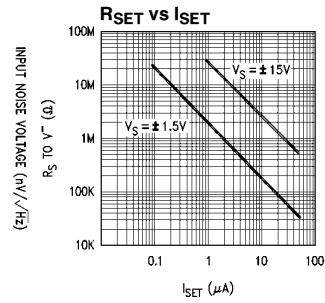
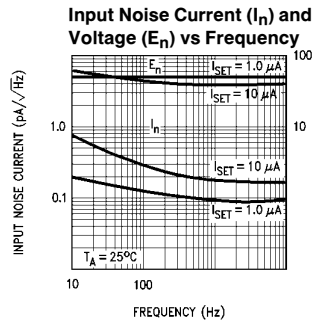
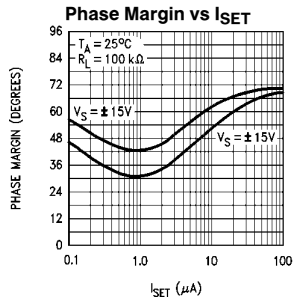
| Parameter | Conditions | $V_S = \pm 15\text{V}$ | | | |
|--------------------------------|---|---------------------------|-------------------|----------------------------|-------------------|
| | | $I_{SET} = 1 \mu\text{A}$ | | $I_{SET} = 10 \mu\text{A}$ | |
| | | Min | Max | Min | Max |
| V_{OS} | $R_S \leq 100 \text{ k}\Omega$, $T_A = 25^{\circ}\text{C}$ | | 5 mV | | 6 mV |
| I_{OS} | $T_A = 25^{\circ}\text{C}$ | | 6 nA | | 20 nA |
| I_{bias} | $T_A = 25^{\circ}\text{C}$ | | 10 nA | | 75 nA |
| Large Signal Voltage Gain | $R_L = 100 \text{ k}\Omega$, $T_A = 25^{\circ}\text{C}$ $V_O = \pm 10\text{V}$, $R_L = 10 \text{ k}\Omega$ | 60k | | 60k | |
| Supply Current | $T_A = 25^{\circ}\text{C}$ | | 11 μA | | 100 μA |
| Power Consumption | $T_A = 25^{\circ}\text{C}$ | | 330 μW | | 3 mW |
| V_{OS} | $R_S \leq 100 \text{ k}\Omega$ | | 6.5 mV | | 7.5 mV |
| I_{OS} | | | 8 nA | | 25 nA |
| I_{bias} | | | 10 nA | | 80 nA |
| Input Voltage Range | | $\pm 13.5\text{V}$ | | $\pm 13.5\text{V}$ | |
| Large Signal Voltage Gain | $V_O = \pm 10\text{V}$, $R_L = 100 \text{ k}\Omega$ $R_L = 10 \text{ k}\Omega$ | 50k | | 50k | |
| Output Voltage Swing | $R_L = 100 \text{ k}\Omega$ $R_L = 10 \text{ k}\Omega$ | $\pm 12\text{V}$ | | $\pm 12\text{V}$ | |
| Common Mode Rejection Ratio | $R_S \leq 10 \text{ k}\Omega$ | 70 dB | | 70 dB | |
| Supply Voltage Rejection Ratio | $R_S \leq 10 \text{ k}\Omega$ | 74 dB | | 74 dB | |
| Supply Current | | | 11 μA | | 100 μA |
| Power Consumption | | | 330 μW | | 3 mW |

Typical Performance Characteristics



TL/H/9300-6

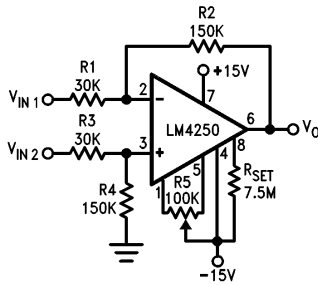
Typical Performance Characteristics (Continued)



TL/H/9300-7

Typical Applications

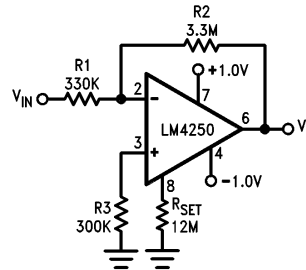
X5 Difference Amplifier



Quiescent $P_D = 0.6\text{ mW}$

TL/H/9300-3

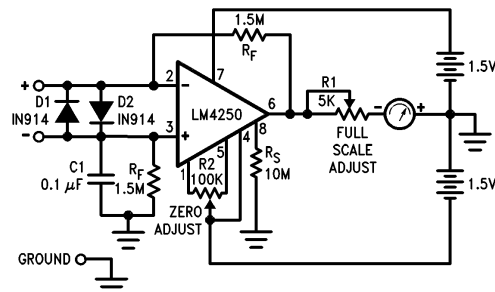
500 Nano-Watt X10 Amplifier



Quiescent $P_D = 500\text{ nW}$

TL/H/9300-4

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



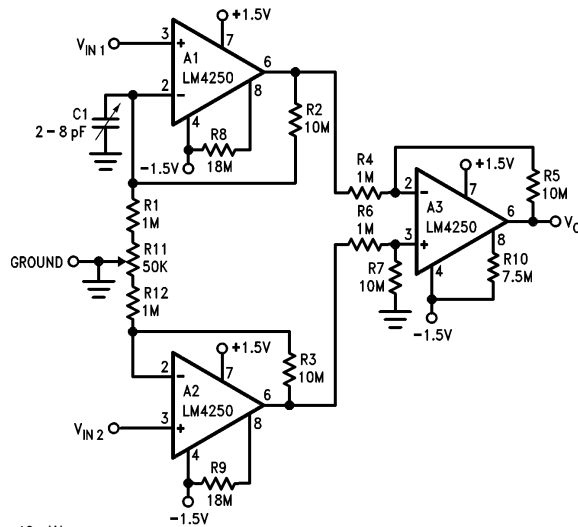
Quiescent $P_D = 1.8\ \mu\text{W}$

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

TL/H/9300-8

Typical Applications (Continued)

X100 Instrumentation Amplifier 10 μ W



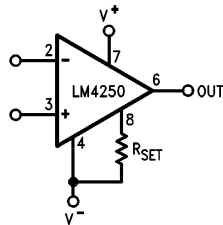
Note 1: Quiescent $P_D = 10 \mu$ W.

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.

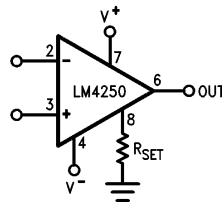
TL/H/9300-9

R_{SET} Connected to V⁻



TL/H/9300-10

R_{SET} Connected to Ground



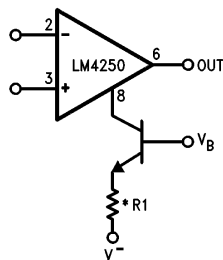
TL/H/9300-11

I_{SET} Equations:

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

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

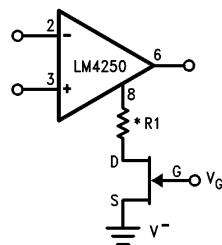
Transistor Current Sourcing Biasing



*R1 limits I_{SET} maximum

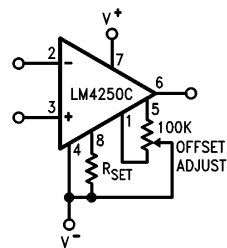
TL/H/9300-12

FET Current Sourcing Biasing



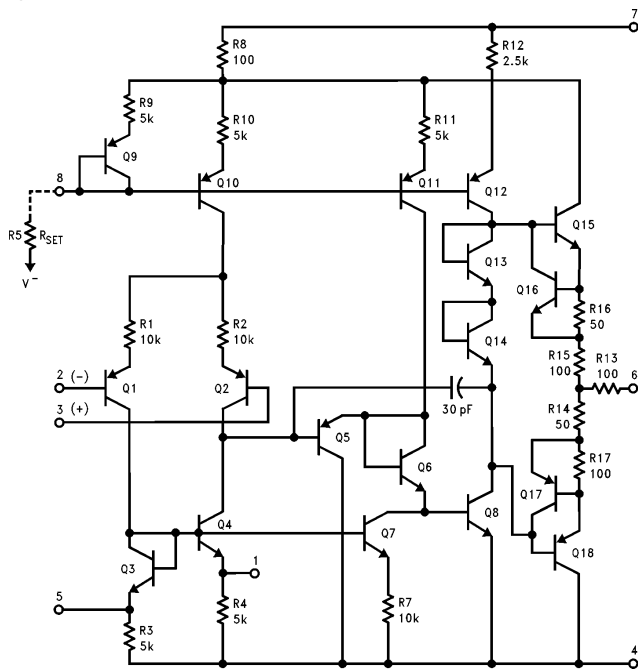
TL/H/9300-13

Offset Null Circuit



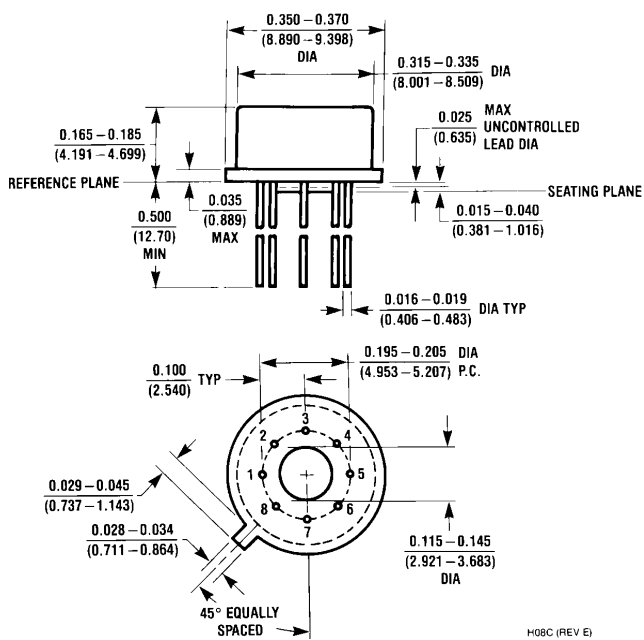
TL/H/9300-14

Schematic Diagram



TL/H/9300-1

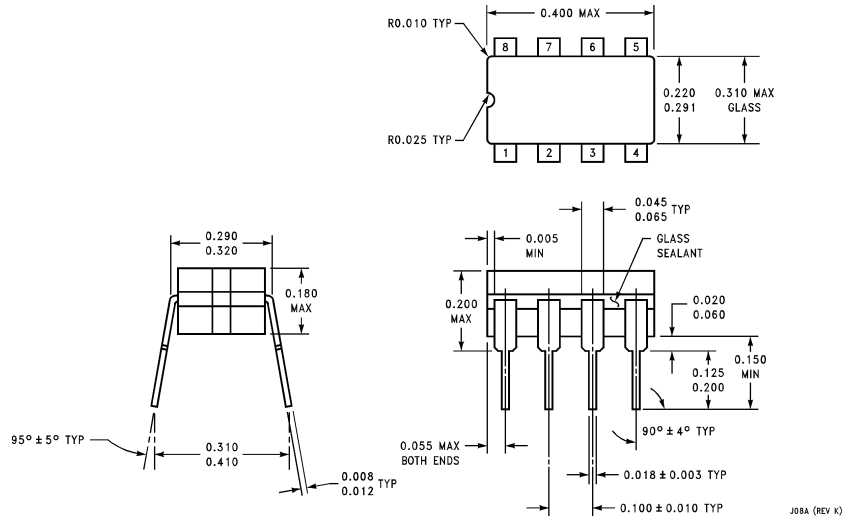
Physical Dimensions inches (millimeters)



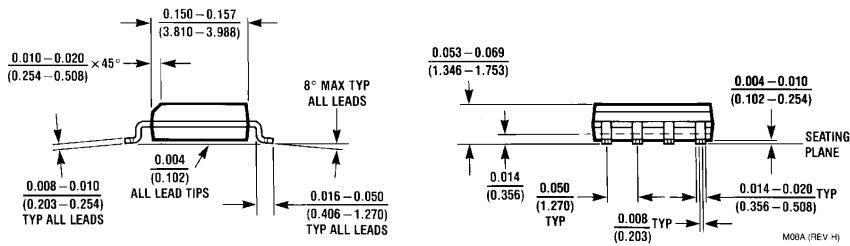
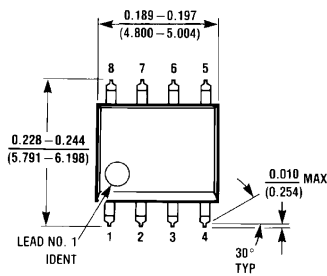
Metal Can Package (H)
Order Number LM4250H, LM4250CH or LM4250H-MIL
NS Package Number H08C

H08C (REV E)

Physical Dimensions inches (millimeters) (Continued)

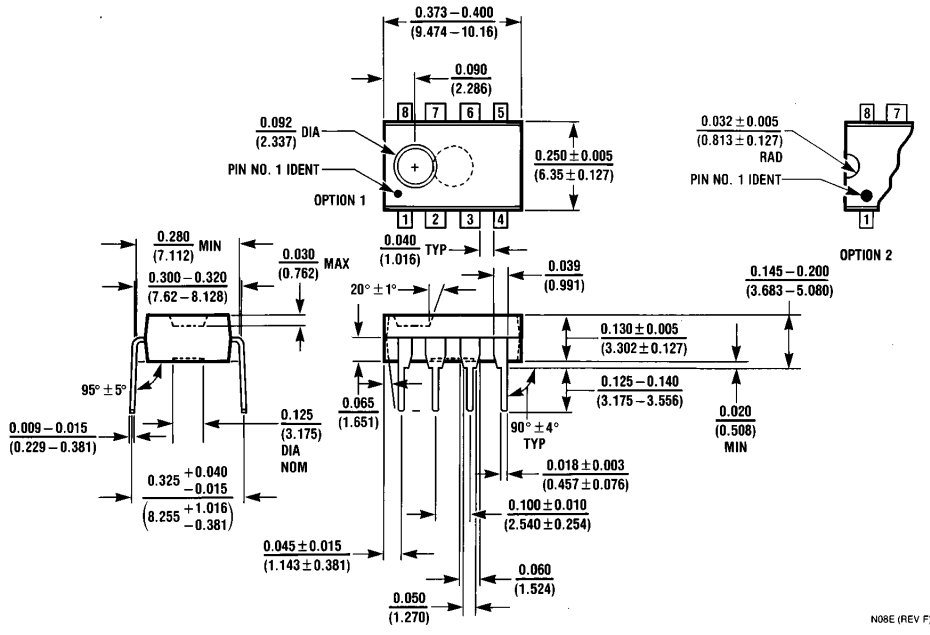


Ceramic Dual-In-Line Package (J)
Order Number LM4250J, or LM4250J-MIL
NS Package Number J08A



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


Physical Dimensions inches (millimeters) (Continued)



LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
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.

| | | | |
|--|---|---|---|
|  <p>National Semiconductor Corporation 1111 West Bardin Road Arlington, TX 76017 Tel: 1(800) 272-9959 Fax: 1(800) 737-7018</p> | <p>National Semiconductor Europe</p> <p>Fax: (+49) 0-180-530 85 86 Email: cnjwge@tevm2.nsc.com Deutsch Tel: (+49) 0-180-530 85 85 English Tel: (+49) 0-180-532 78 32 Français Tel: (+49) 0-180-532 93 58 Italiano Tel: (+49) 0-180-534 16 80</p> | <p>National Semiconductor Hong Kong Ltd. 19th Floor, Straight Block, Ocean Centre, 5 Canton Rd. Tsimshatsui, Kowloon Hong Kong Tel: (852) 2737-1600 Fax: (852) 2736-9960</p> | <p>National Semiconductor Japan Ltd. Tel: 81-043-299-2309 Fax: 81-043-299-2408</p> |
|--|---|---|---|

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

This datasheet has been download from:

www.datasheetcatalog.com

Datasheets for electronics components.