

## LM118/LM218/LM318 Operational Amplifiers

### General Description

The LM118 series are precision high speed operational amplifiers designed for applications requiring wide bandwidth and high slew rate. They feature a factor of ten increase in speed over general purpose devices without sacrificing DC performance.

The LM118 series has internal unity gain frequency compensation. This considerably simplifies its application since no external components are necessary for operation. However, unlike most internally compensated amplifiers, external frequency compensation may be added for optimum performance. For inverting applications, feedforward compensation will boost the slew rate to over  $150V/\mu s$  and almost double the bandwidth. Overcompensation can be used with the amplifier for greater stability when maximum bandwidth is not needed. Further, a single capacitor can be added to reduce the 0.1% settling time to under  $1 \mu s$ .

The high speed and fast settling time of these op amps make them useful in A/D converters, oscillators, active fil-

ters, sample and hold circuits, or general purpose amplifiers. These devices are easy to apply and offer an order of magnitude better AC performance than industry standards such as the LM709.

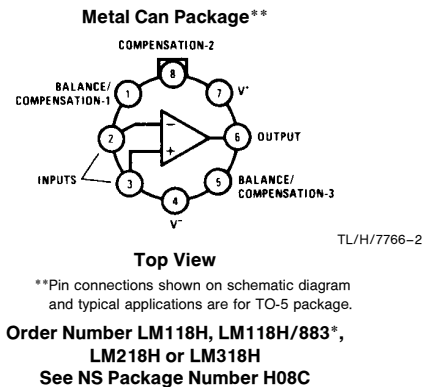
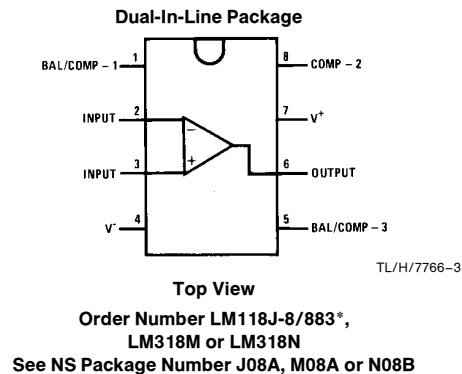
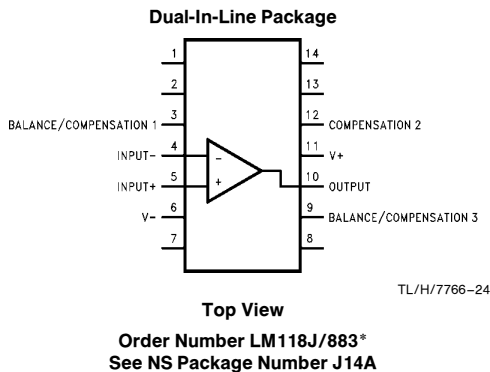
The LM218 is identical to the LM118 except that the LM218 has its performance specified over a  $-25^{\circ}C$  to  $+85^{\circ}C$  temperature range. The LM318 is specified from  $0^{\circ}C$  to  $+70^{\circ}C$ .

### Features

- 15 MHz small signal bandwidth
- Guaranteed  $50V/\mu s$  slew rate
- Maximum bias current of 250 nA
- Operates from supplies of  $\pm 5V$  to  $\pm 20V$
- Internal frequency compensation
- Input and output overload protected
- Pin compatible with general purpose op amps

LM118/LM218/LM318 Operational Amplifiers

### Connection Diagrams



\*Available per JM38510/10107.

## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications. (Note 6)

|                                     |            |
|-------------------------------------|------------|
| Supply Voltage                      | ±20V       |
| Power Dissipation (Note 1)          | 500 mW     |
| Differential Input Current (Note 2) | ±10 mA     |
| Input Voltage (Note 3)              | ±15V       |
| Output Short-Circuit Duration       | Continuous |

|   |                 |
|---|-----------------|
| Operating Temperature Range   |                 |
| LM118   | −55°C to +125°C |
| LM218   | −25°C to +85°C  |
| LM318   | 0°C to +70°C    |
| Storage Temperature Range   | −65°C to +150°C |
| Lead Temperature (Soldering, 10 sec.)   |                 |
| Hermetic Package  | 300°C           |
| Plastic Package   | 260°C           |
| Soldering Information   |                 |
| Dual-In-Line Package  |                 |
| Soldering (10 sec.)   | 260°C           |
| Small Outline Package   |                 |
| Vapor Phase (60 sec.)   | 215°C           |
| Infrared (15 sec.)  | 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 7)  | 2000V           |

## Electrical Characteristics (Note 4)

| Parameter                      | Conditions  | LM118/LM218 |     |     | LM318 |     |     | Units            |
|--------------------------------|---|-------------|-----|-----|-------|-----|-----|------------------|
|                                |   | Min         | Typ | Max | Min   | Typ | Max |                  |
| Input Offset Voltage           | $T_A = 25^\circ\text{C}$  |             | 2   | 4   |       | 4   | 10  | mV               |
| Input Offset Current           | $T_A = 25^\circ\text{C}$  |             | 6   | 50  |       | 30  | 200 | nA               |
| Input Bias Current             | $T_A = 25^\circ\text{C}$  |             | 120 | 250 |       | 150 | 500 | nA               |
| Input Resistance               | $T_A = 25^\circ\text{C}$  | 1           | 3   |     | 0.5   | 3   |     | MΩ               |
| Supply Current                 | $T_A = 25^\circ\text{C}$  |             | 5   | 8   |       | 5   | 10  | mA               |
| Large Signal Voltage Gain      | $T_A = 25^\circ\text{C}, V_S = \pm 15\text{V}$<br>$V_{OUT} = \pm 10\text{V}, R_L \geq 2\text{ k}\Omega$ | 50          | 200 |     | 25    | 200 |     | V/mV             |
| Slew Rate                      | $T_A = 25^\circ\text{C}, V_S = \pm 15\text{V}, A_V = 1$<br>(Note 5)                                     | 50          | 70  |     | 50    | 70  |     | V/ $\mu\text{s}$ |
| Small Signal Bandwidth         | $T_A = 25^\circ\text{C}, V_S = \pm 15\text{V}$  |             | 15  |     |       | 15  |     | MHz              |
| Input Offset Voltage           |   |             |     | 6   |       |     | 15  | mV               |
| Input Offset Current           |   |             |     | 100 |       |     | 300 | nA               |
| Input Bias Current             |   |             |     | 500 |       |     | 750 | nA               |
| Supply Current                 | $T_A = 125^\circ\text{C}$   |             | 4.5 | 7   |       |     |     | mA               |
| Large Signal Voltage Gain      | $V_S = \pm 15\text{V}, V_{OUT} = \pm 10\text{V}$<br>$R_L \geq 2\text{ k}\Omega$                         | 25          |     |     | 20    |     |     | V/mV             |
| Output Voltage Swing           | $V_S = \pm 15\text{V}, R_L = 2\text{ k}\Omega$  | ±12         | ±13 |     | ±12   | ±13 |     | V                |
| Input Voltage Range            | $V_S = \pm 15\text{V}$  | ±11.5       |     |     | ±11.5 |     |     | V                |
| Common-Mode Rejection Ratio    |   | 80          | 100 |     | 70    | 100 |     | dB               |
| Supply Voltage Rejection Ratio |   | 70          | 80  |     | 65    | 80  |     | dB               |

**Note 1:** The maximum junction temperature of the LM118 is 150°C, the LM218 is 110°C, and the LM318 is 110°C. For operating at elevated temperatures, devices in the H08 package must be derated based on a thermal resistance of 160°C/W, junction to ambient, or 20°C/W, junction to case. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.

**Note 2:** The inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1V is applied between the inputs unless some limiting resistance is used.

**Note 3:** For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

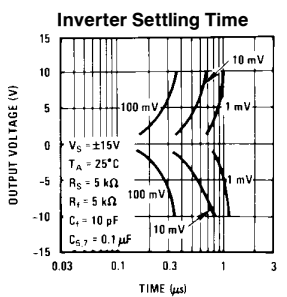
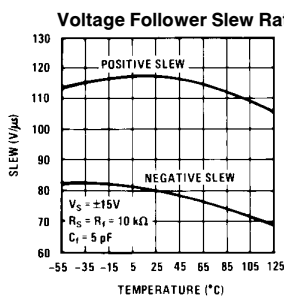
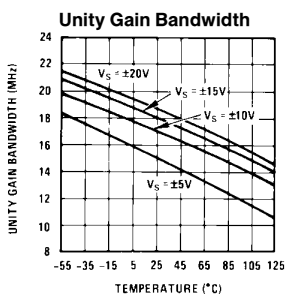
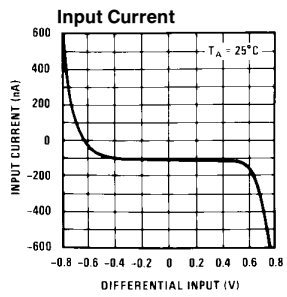
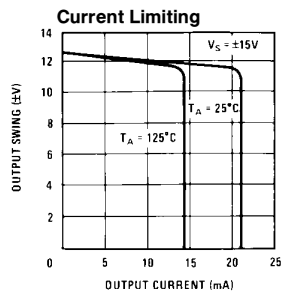
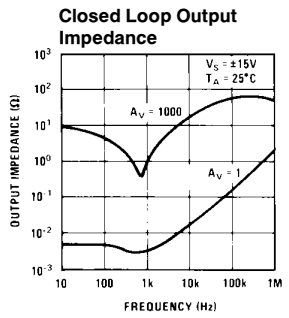
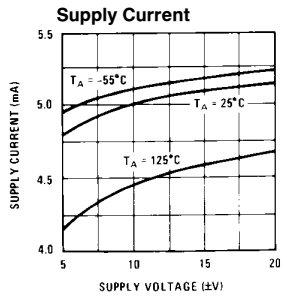
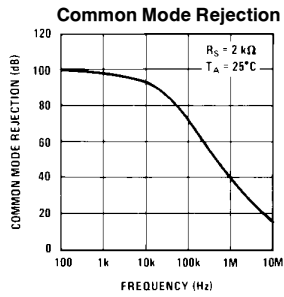
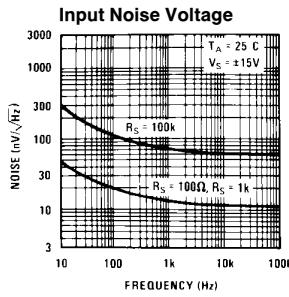
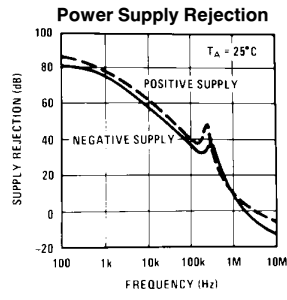
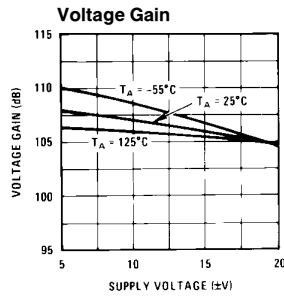
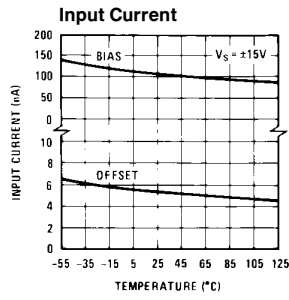
**Note 4:** These specifications apply for  $\pm 5\text{V} \leq V_S \leq \pm 20\text{V}$  and  $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  (LM118),  $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  (LM218), and  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$  (LM318). Also, power supplies must be bypassed with 0.1  $\mu\text{F}$  disc capacitors.

**Note 5:** Slew rate is tested with  $V_S = \pm 15\text{V}$ . The LM118 is in a unity-gain non-inverting configuration.  $V_{IN}$  is stepped from −7.5V to +7.5V and vice versa. The slew rates between −5.0V and +5.0V and vice versa are tested and guaranteed to exceed 50V/ $\mu\text{s}$ .

**Note 6:** Refer to RETS118X for LM118H and LM118J military specifications.

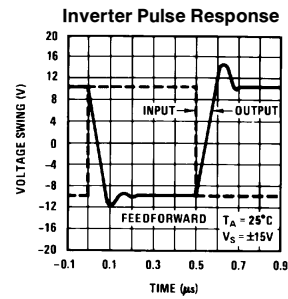
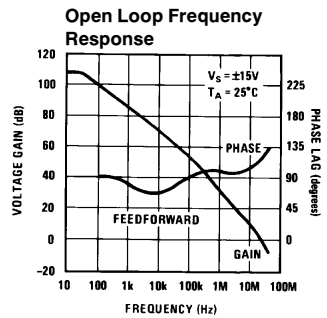
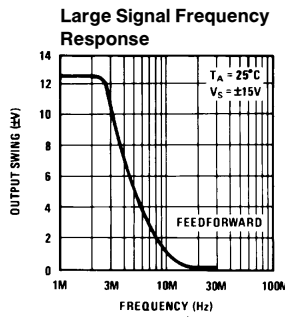
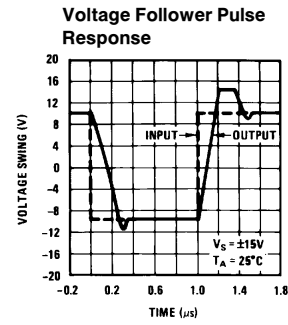
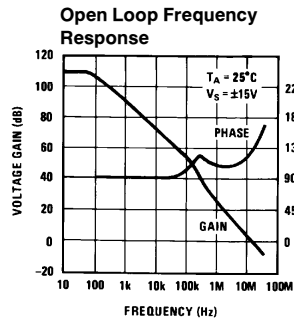
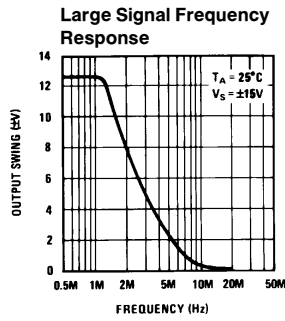
**Note 7:** Human body model, 1.5 kΩ in series with 100 pF.

# Typical Performance Characteristics LM118, LM218



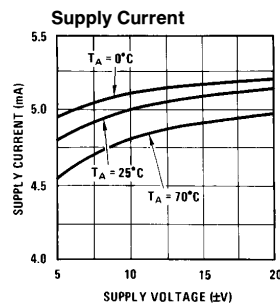
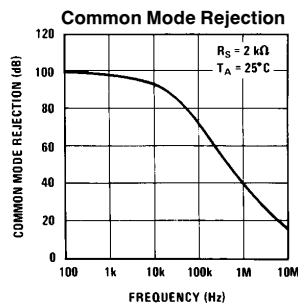
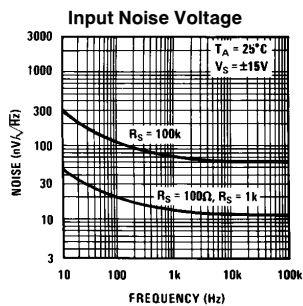
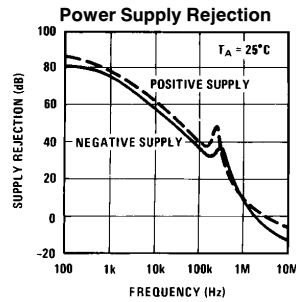
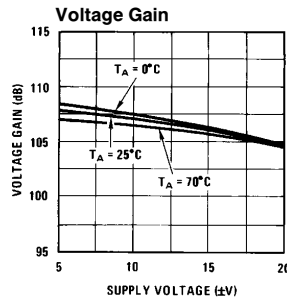
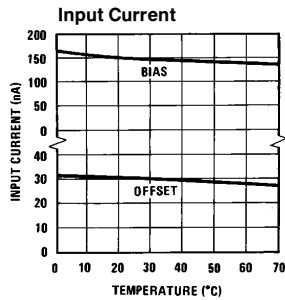
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## Typical Performance Characteristics LM118, LM218 (Continued)



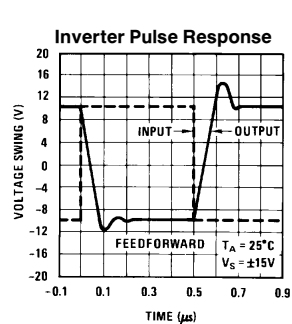
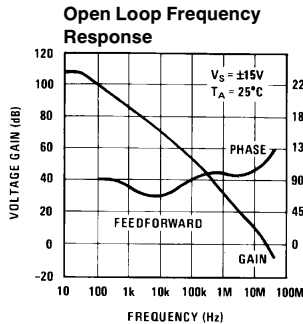
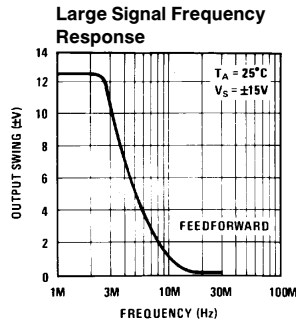
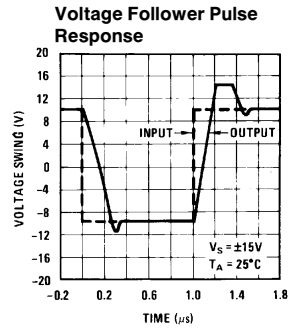
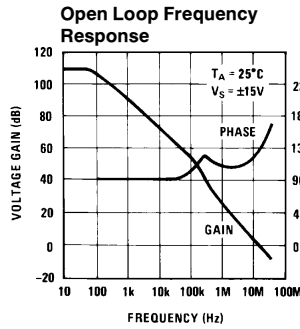
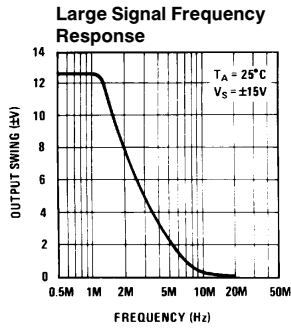
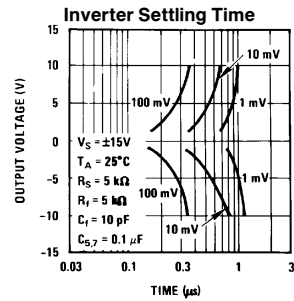
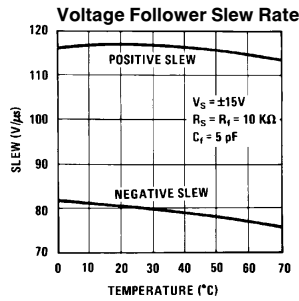
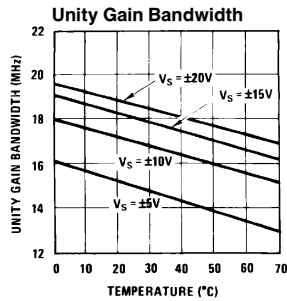
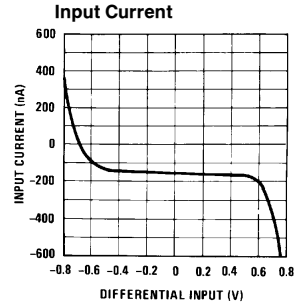
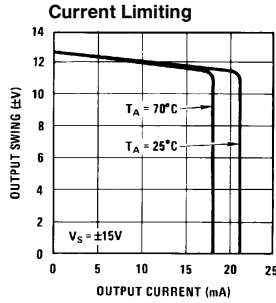
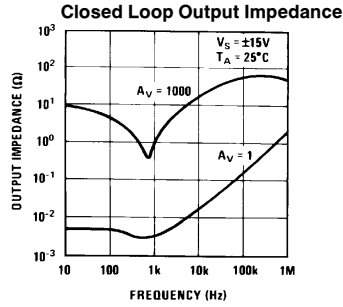
TL/H/7766-5

## Typical Performance Characteristics LM318



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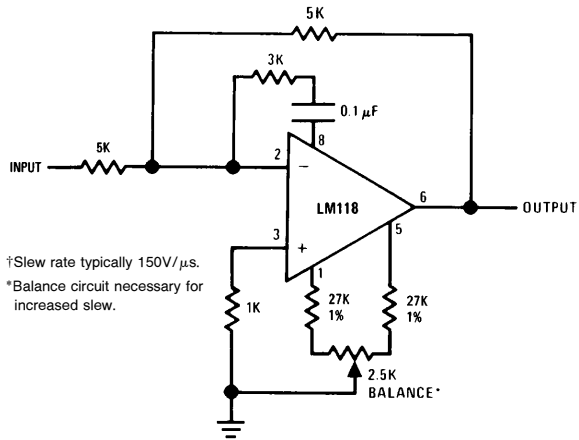
# Typical Performance Characteristics LM318 (Continued)



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## Auxiliary Circuits

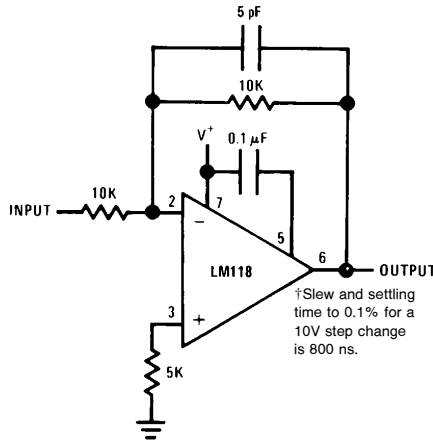
### Feedforward Compensation for Greater Inverting Slew Rate†



†Slew rate typically 150V/μs.  
\*Balance circuit necessary for increased slew.

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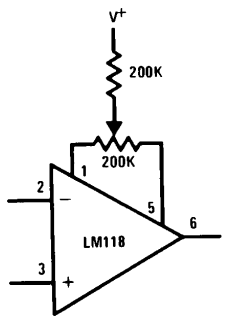
### Compensation for Minimum Settling† Time



†Slew and settling time to 0.1% for a 10V step change is 800 ns.

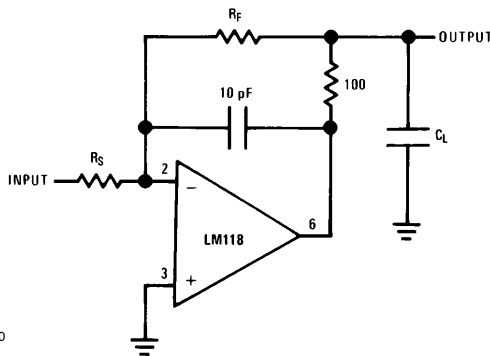
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### Offset Balancing



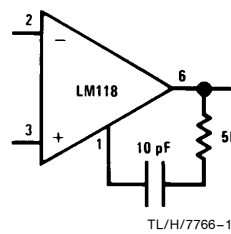
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### Isolating Large Capacitive Loads



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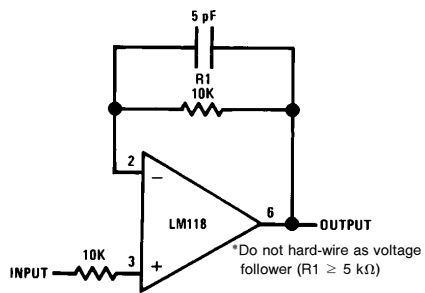
### Overcompensation



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## Typical Applications

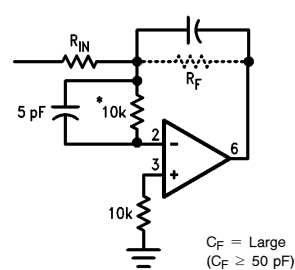
### Fast Voltage Follower\*



\*Do not hard-wire as voltage follower ( $R_1 \geq 5 \text{ k}\Omega$ )

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### Integrator or Slow Inverter



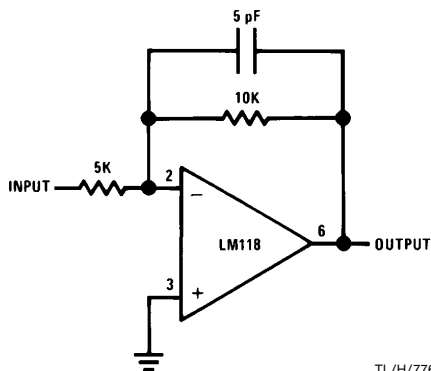
$C_F = \text{Large}$   
( $C_F \geq 50 \text{ pF}$ )

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\*Do not hard-wire as integrator or slow inverter; insert a 10k-5 pF network in series with the input, to prevent oscillation.

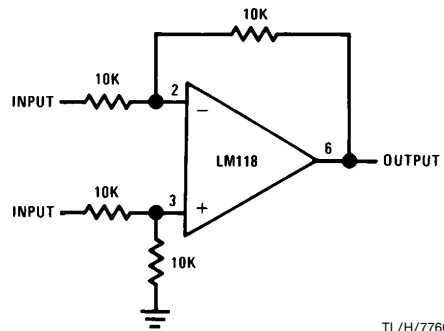
## Typical Applications (Continued)

### Fast Summing Amplifier



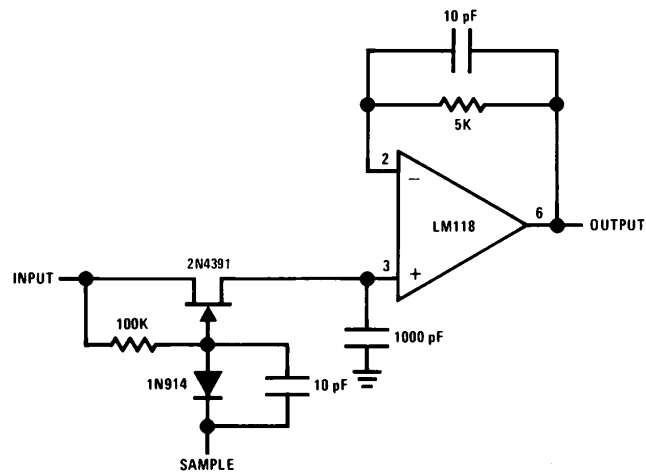
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### Differential Amplifier



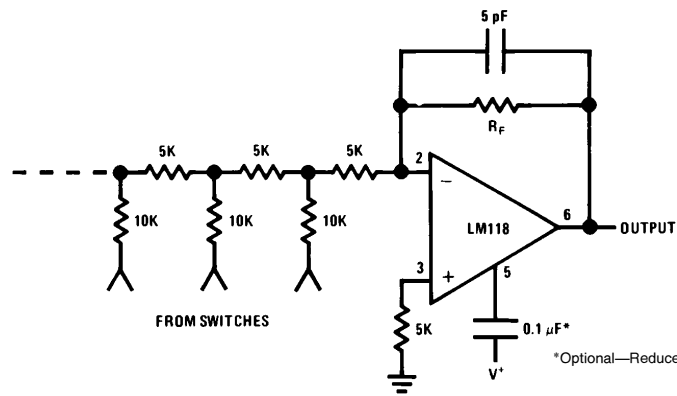
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### Fast Sample and Hold



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### D/A Converter Using Ladder Network



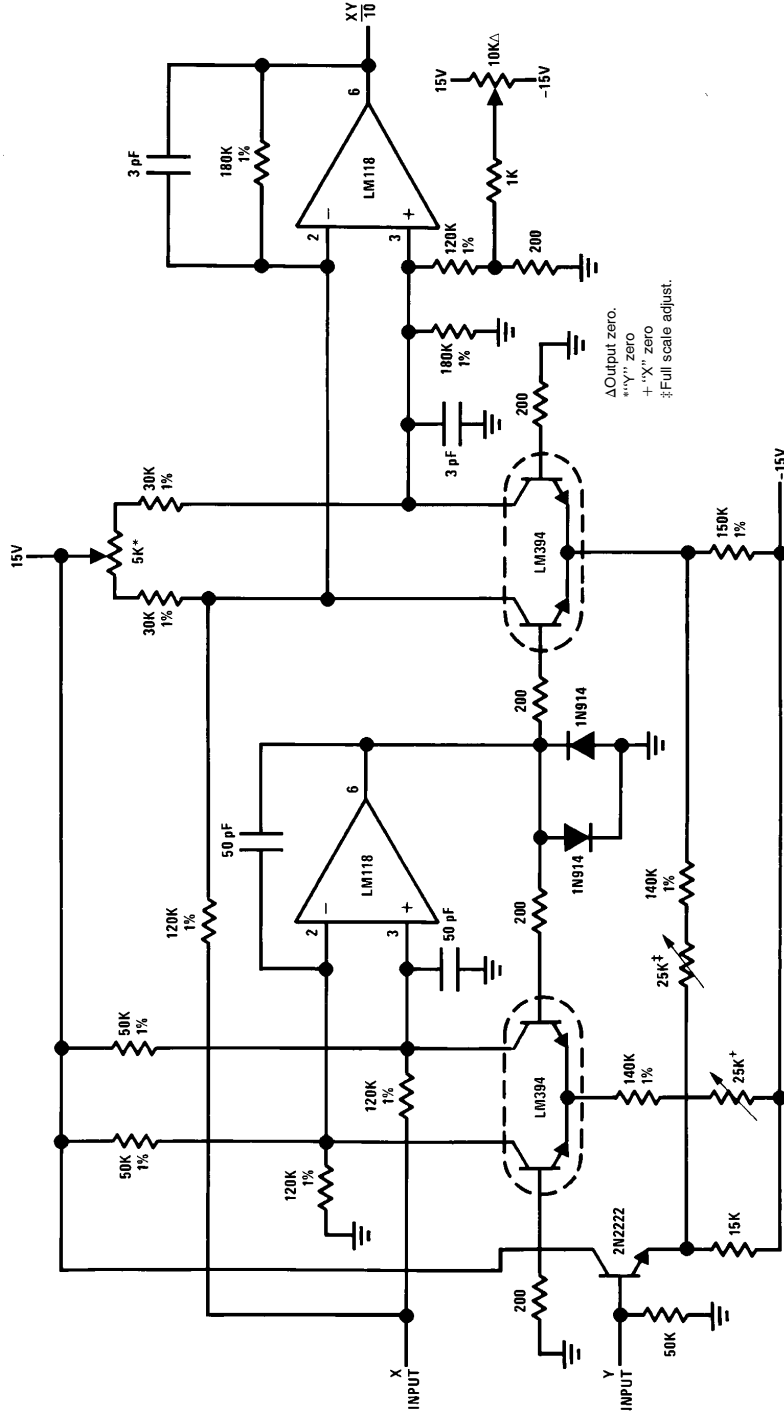
\*Optional—Reduces settling time.

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# Typical Applications (Continued)

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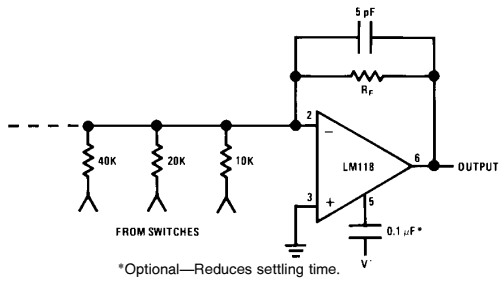
## Four Quadrant Multiplier



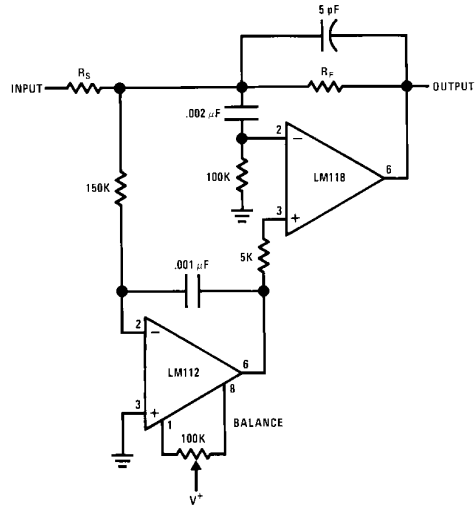


## Typical Applications (Continued)

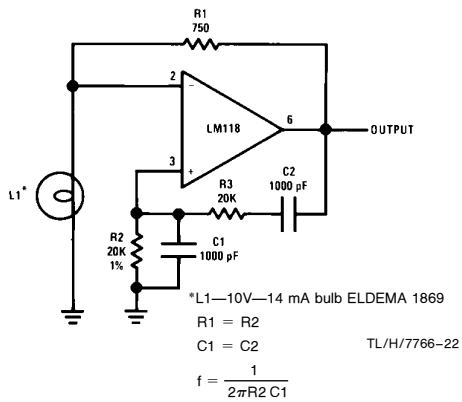
### D/A Converter Using Binary Weighted Network



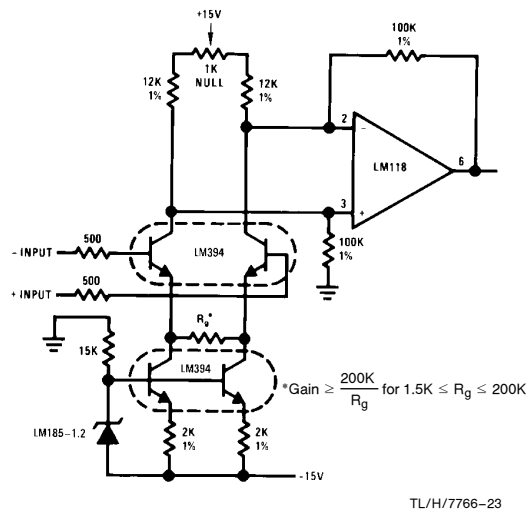
### Fast Summing Amplifier with Low Input Current



### Wein Bridge Sine Wave Oscillator

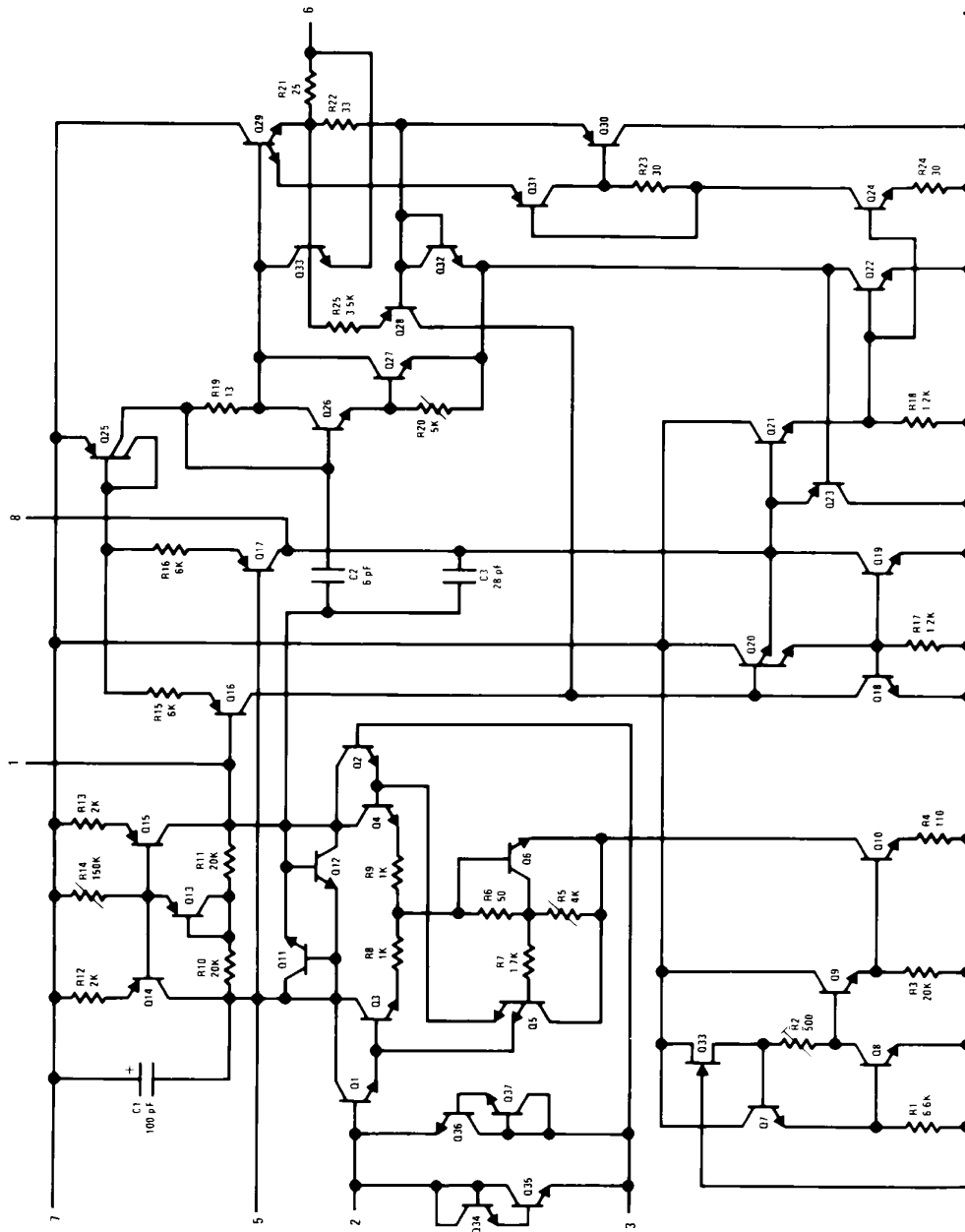


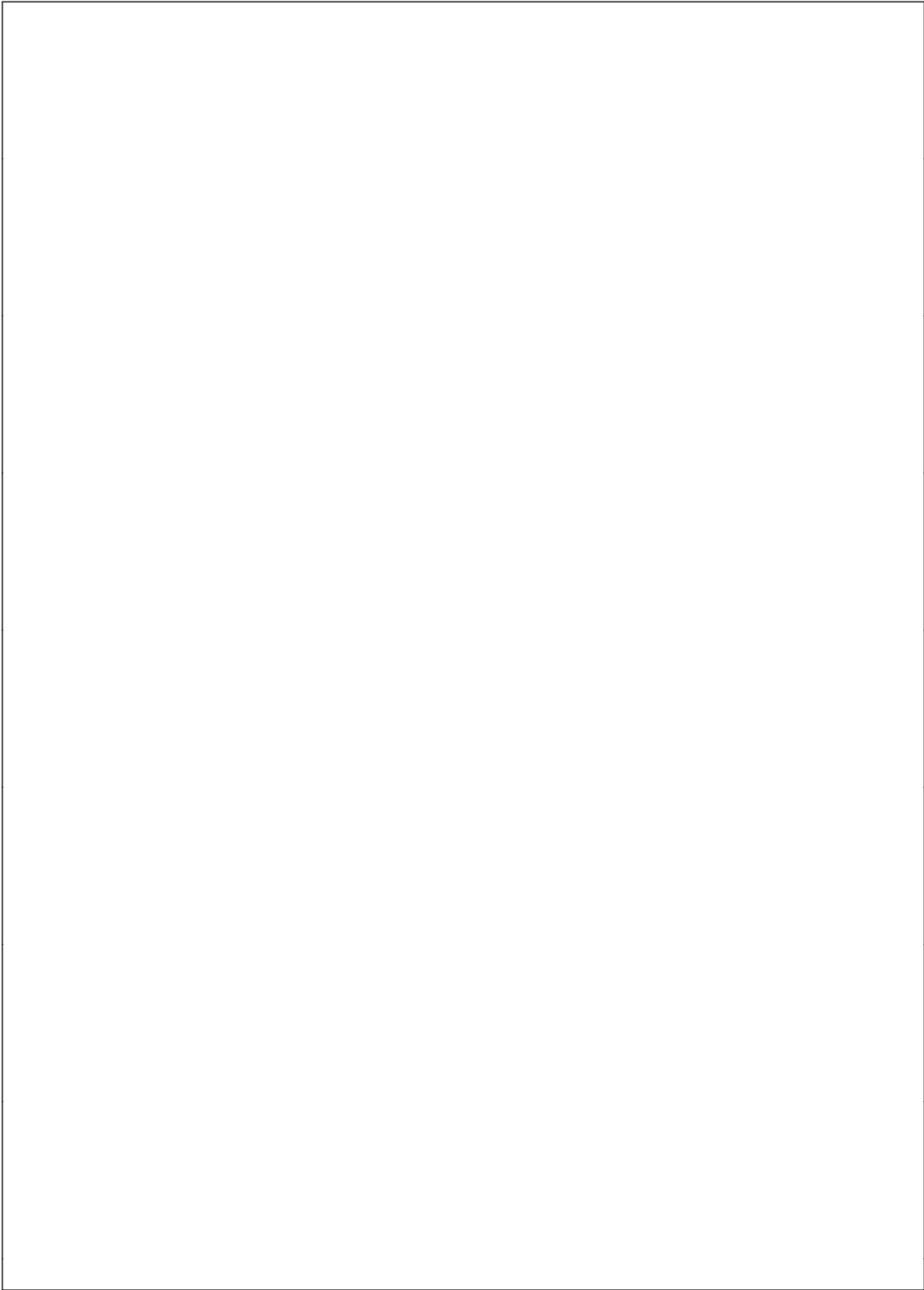
### Instrumentation Amplifier



# Schematic Diagram

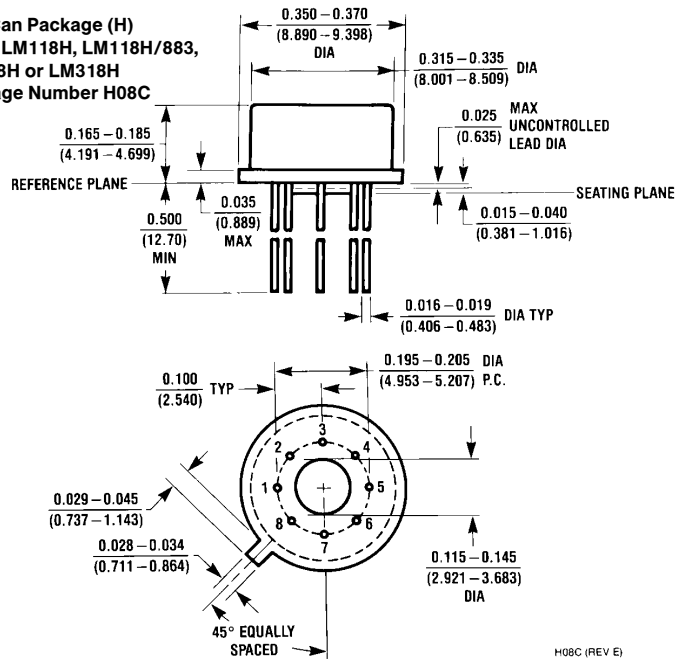
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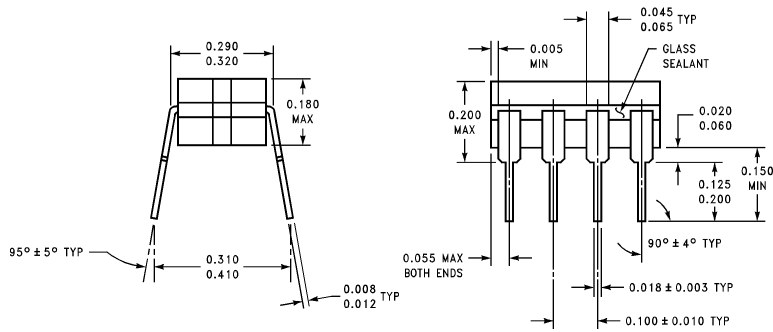
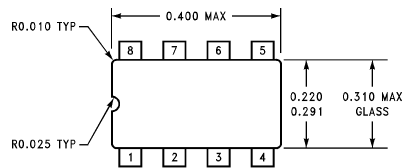


**Physical Dimensions** inches (millimeters)

**Metal Can Package (H)**  
**Order Number LM118H, LM118H/883,**  
**LM218H or LM318H**  
**NS Package Number H08C**



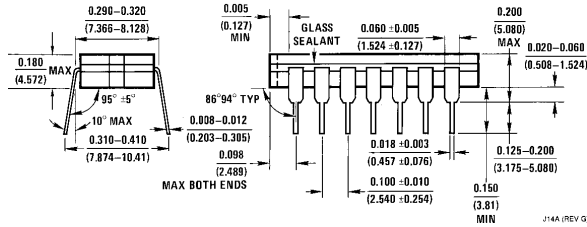
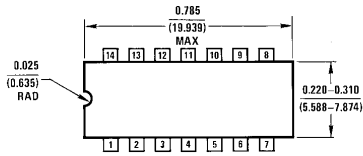
H08C (REV E)



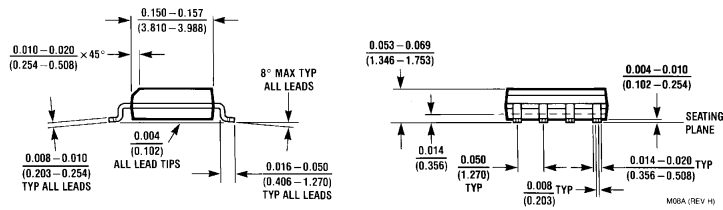
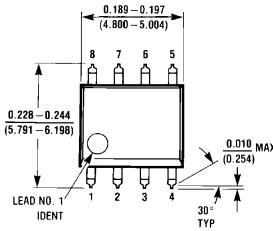
J08A (REV K)

**Ceramic Dual-In-Line Package (J)**  
**Order Number LM118J-8/883**  
**NS Package Number J08A**

**Physical Dimensions** inches (millimeters) (Continued)

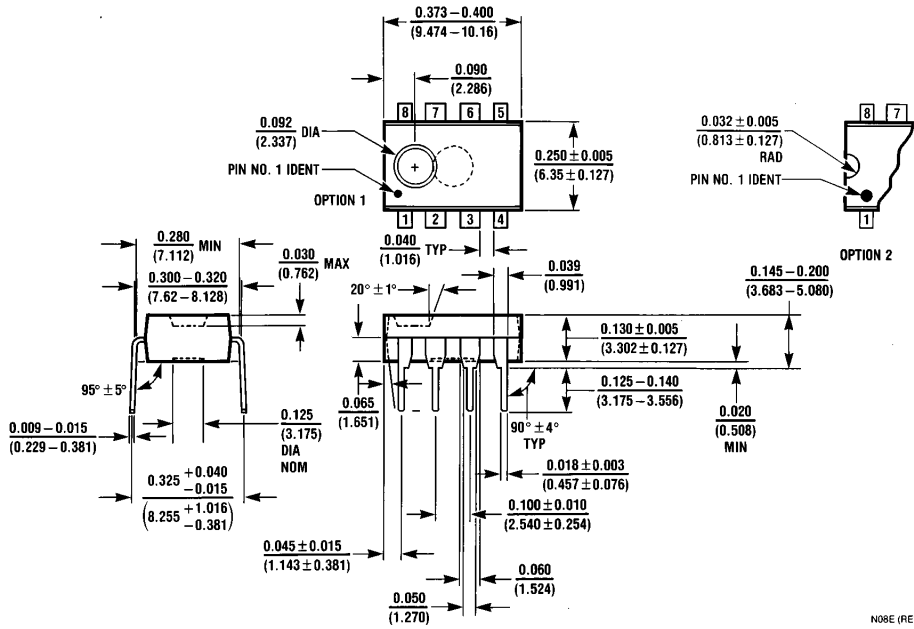


**Ceramic Dual-In-Line Package (J)**  
**Order Number LM118J/883**  
**NS Package Number J14A**



**S.O. Package (M)**  
**Order Number LM318M**  
**NS Package Number M08A**

**Physical Dimensions** inches (millimeters) (Continued)



**Molded Dual-In-Line Package (N)**  
**Order Number LM318N**  
**NS Package Number N08E**

**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.



**National Semiconductor Corporation**  
 1111 West Bardin Road  
 Arlington, TX 76017  
 Tel: 1(800) 272-9959  
 Fax: 1(800) 737-7018

**National Semiconductor Europe**  
 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

**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

**National Semiconductor Japan Ltd.**  
 Tel: 81-043-299-2309  
 Fax: 81-043-299-2408

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