

## LM118-N/LM218-N/LM318-N Operational Amplifiers

Check for Samples: [LM118-N](#), [LM218-N](#), [LM318-N](#)

### FEATURES

- 15 MHz Small Signal Bandwidth
- Ensured 50V/μs Slew Rate
- Maximum Bias Current of 250 nA
- Operates from Supplies of ±5V to ±20V
- Internal Frequency Compensation
- Input and Output Overload Protected
- Pin Compatible with General Purpose Op Amps

### DESCRIPTION

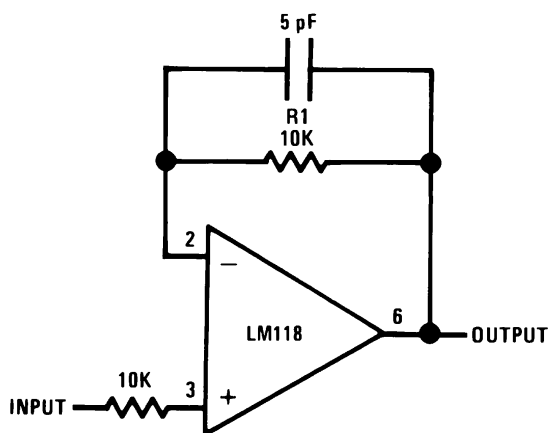
The LM118 series are precision high speed operational amplifiers designed for applications requiring wide bandwidth and high slew rate. They feature a factor of ten increase in speed over general purpose devices without sacrificing DC performance.

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/μs 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 μs.

The high speed and fast settling time of these op amps make them useful in A/D converters, oscillators, active filters, 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-N is identical to the LM118 except that the LM218-N has its performance specified over a -25°C to +85°C temperature range. The LM318-N is specified from 0°C to +70°C.

### Fast Voltage Follower


Do not hard-wire as voltage follower ( $R1 \geq 5 \text{ k}\Omega$ )


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings<sup>(1)(2)</sup>

|                                           |                 |
|-------------------------------------------|-----------------|
| Supply Voltage                            | ±20V            |
| Power Dissipation <sup>(3)</sup>          | 500 mW          |
| Differential Input Current <sup>(4)</sup> | ±10 mA          |
| Input Voltage <sup>(5)</sup>              | ±15V            |
| Output Short-Circuit Duration             | Continuous      |
| Operating Temperature Range               |                 |
| lm118-n                                   | –55°C to +125°C |
| LM218-N                                   | –25°C to +85°C  |
| LM318-N                                   | 0°C to +70°C    |
| Storage Temperature Range                 | –65°C to +150°C |
| Lead Temperature (Soldering, 10 sec.)     |                 |
| TO-99 Package                             | 300°C           |
| PDIP Package                              | 260°C           |
| Soldering Information                     |                 |
| Dual-In-Line Package                      |                 |
| Soldering (10 sec.)                       | 260°C           |
| SOIC Package                              |                 |
| Vapor Phase (60 sec.)                     | 215°C           |
| Infrared (15 sec.)                        | 220°C           |
| ESD Tolerance <sup>(6)</sup>              | 2000V           |

- (1) Refer to RETS118X for LM118H and LM118J military specifications.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
- (3) The maximum junction temperature of the lm118-n is 150°C, the LM218-N is 110°C, and the LM318-N is 110°C. For operating at elevated temperatures, devices in the LMC 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.
- (4) 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.
- (5) For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
- (6) Human body model, 1.5 kΩ in series with 100 pF.

## Electrical Characteristics<sup>(1)</sup>

| Parameter                 | Conditions                                                                                                    | LM118-N/LM218-N |     |     | LM318-N |     |     | 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>(2)                                          | 50              | 70  |     | 50      | 70  |     | V/μs  |
| 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    |

- (1) 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-n),  $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  (LM218-N), and  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$  (LM318-N). Also, power supplies must be bypassed with 0.1 μF disc capacitors.
- (2) Slew rate is tested with  $V_S = \pm 15\text{V}$ . The lm118-n 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 specified to exceed 50V/μs.

**Electrical Characteristics <sup>(1)</sup> (continued)**

| Parameter                      | Conditions                                                                         | LM118-N/LM218-N |          |     | LM318-N    |          |     | Units |
|--------------------------------|------------------------------------------------------------------------------------|-----------------|----------|-----|------------|----------|-----|-------|
|                                |                                                                                    | Min             | Typ      | Max | Min        | Typ      | Max |       |
| 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           | $V_S = \pm 15\text{V}$ , $R_L = 2\text{ k}\Omega$                                  | $\pm 12$        | $\pm 13$ |     | $\pm 12$   | $\pm 13$ |     | V     |
| Input Voltage Range            | $V_S = \pm 15\text{V}$                                                             | $\pm 11.5$      |          |     | $\pm 11.5$ |          |     | V     |
| Common-Mode Rejection Ratio    |                                                                                    | 80              | 100      |     | 70         | 100      |     | dB    |
| Supply Voltage Rejection Ratio |                                                                                    | 70              | 80       |     | 65         | 80       |     | dB    |

## TYPICAL PERFORMANCE CHARACTERISTICS

LM118-N, LM218-N

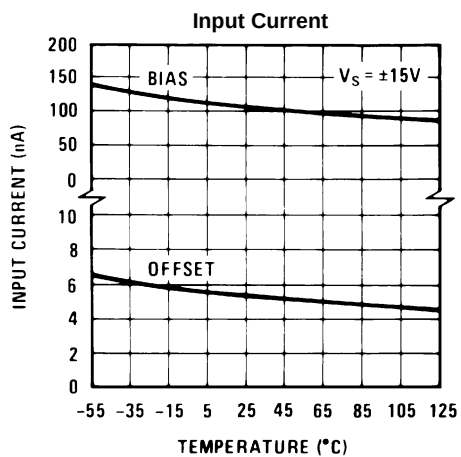


Figure 1.

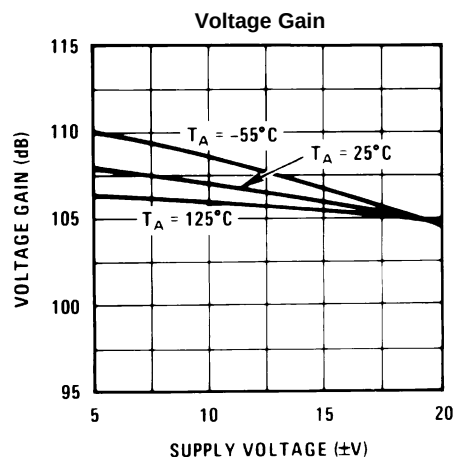


Figure 2.

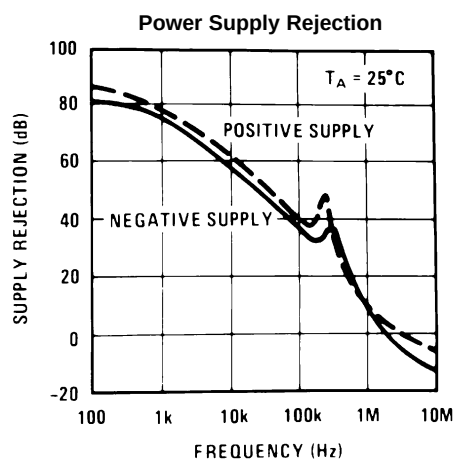


Figure 3.

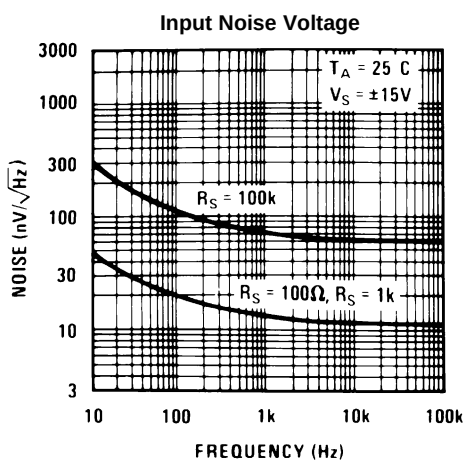


Figure 4.

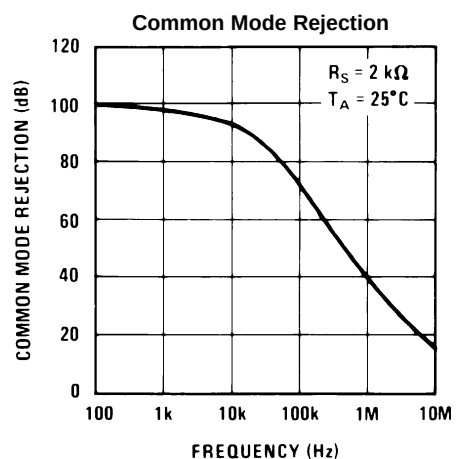


Figure 5.

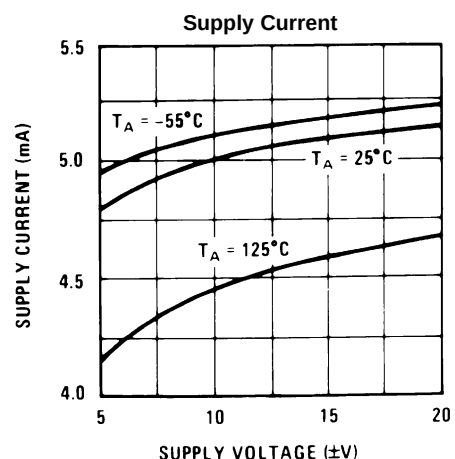
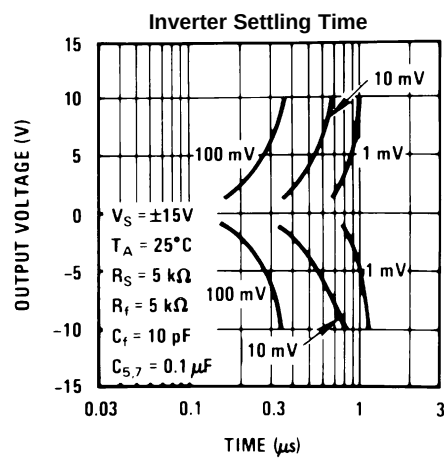
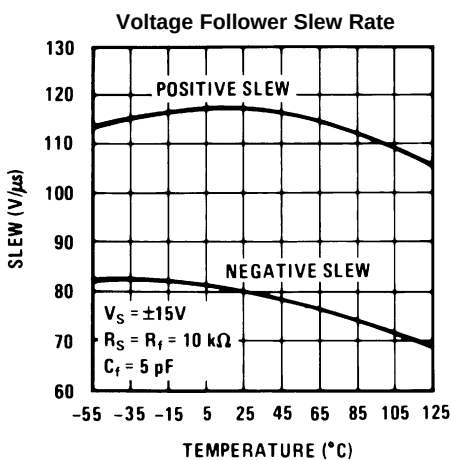
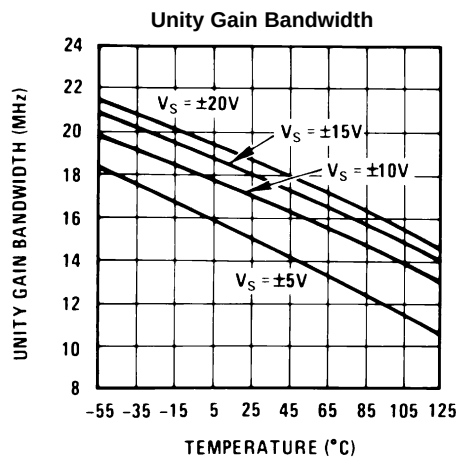
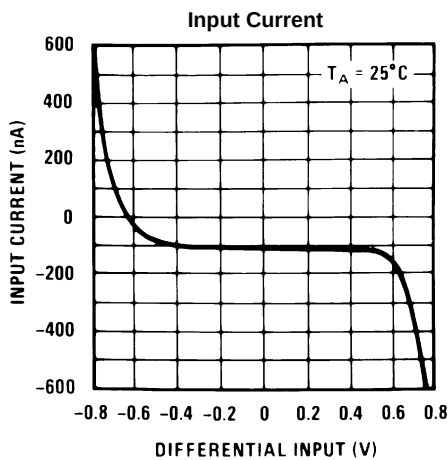
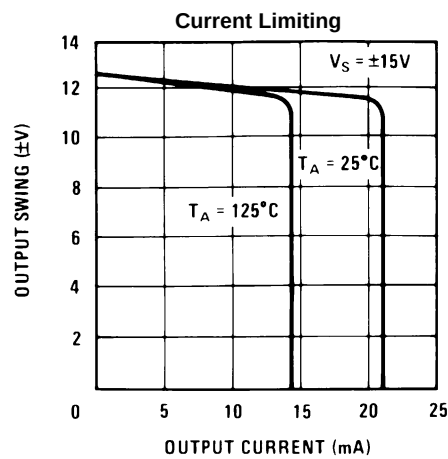
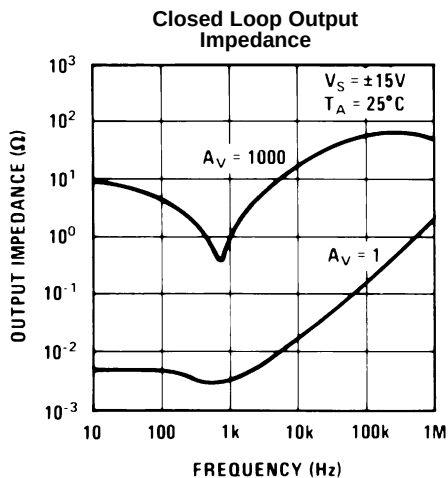


Figure 6.

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

LM118-N, LM218-N



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

LM118-N, LM218-N

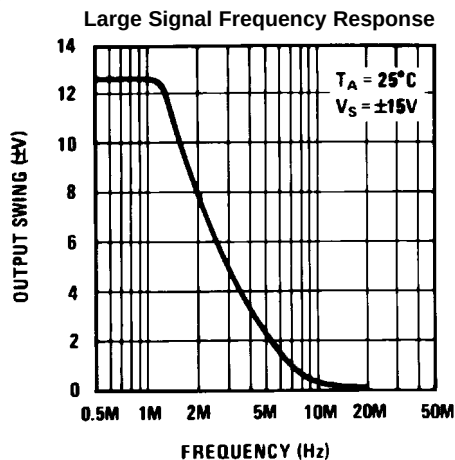


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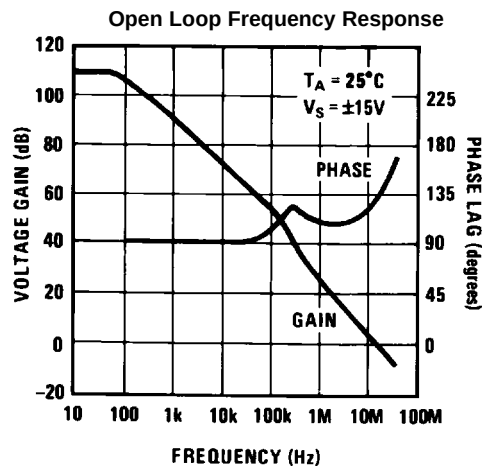


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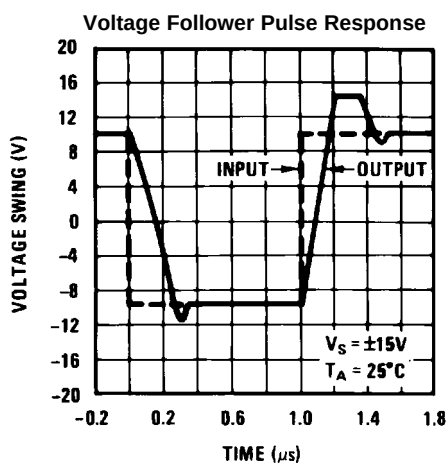


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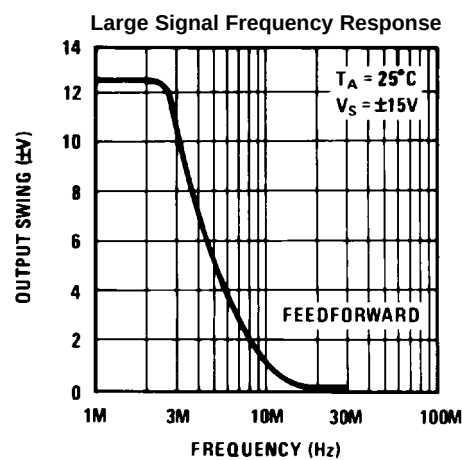


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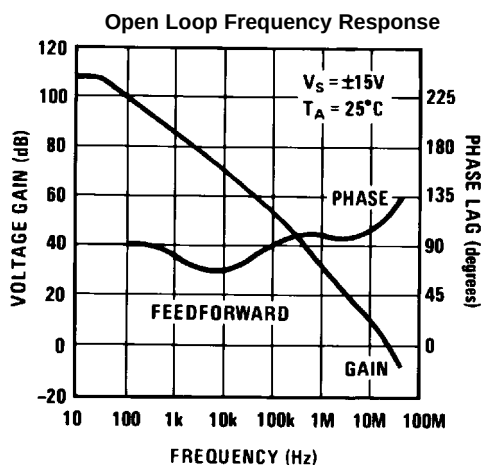


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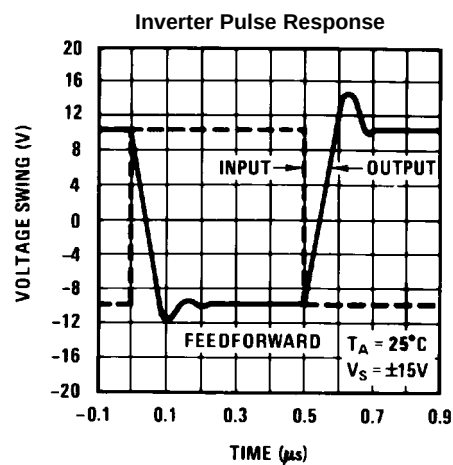


Figure 18.

## Typical Performance Characteristics

LM318-N

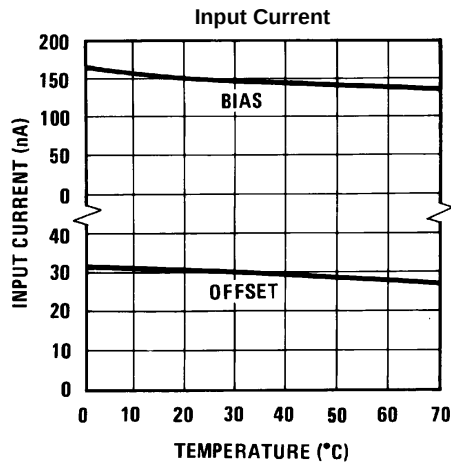


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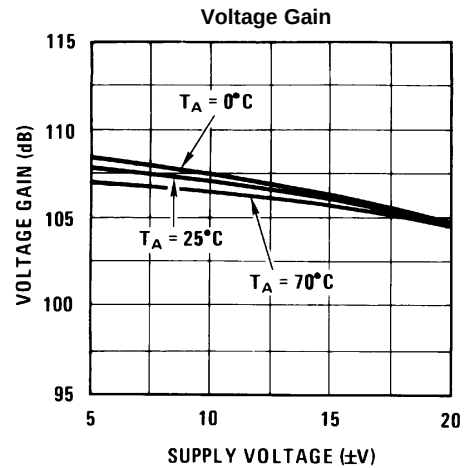


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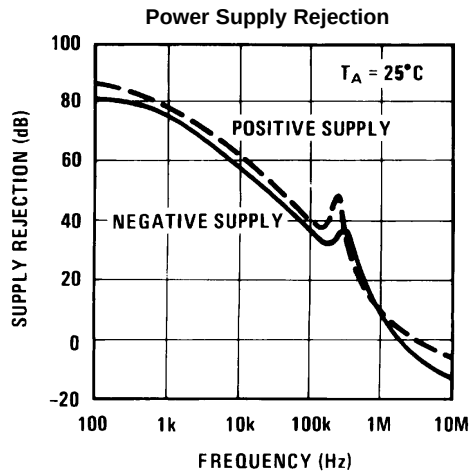


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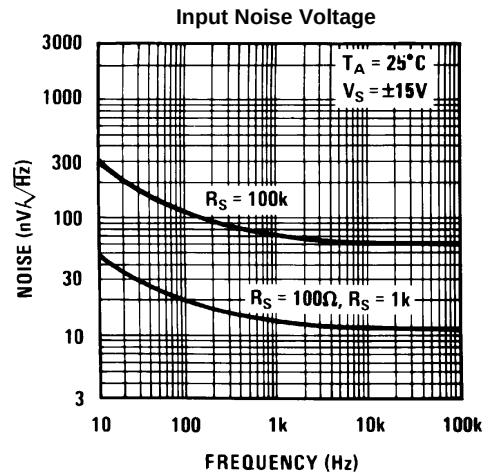


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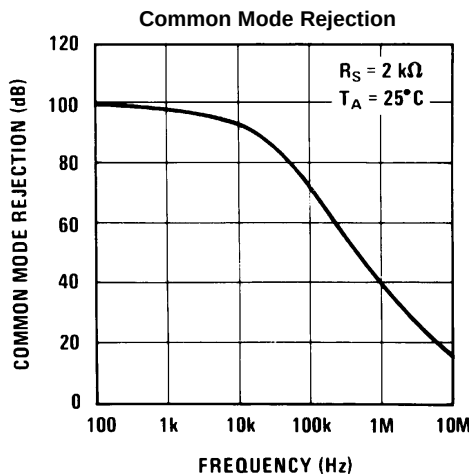


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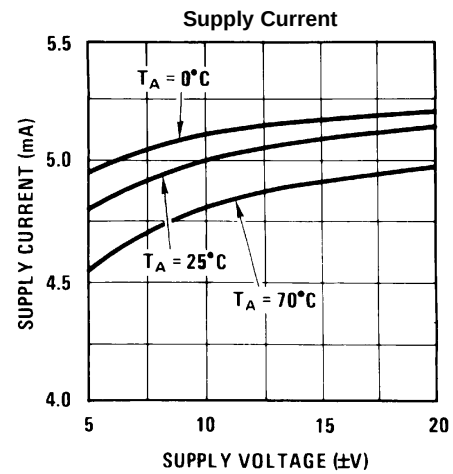
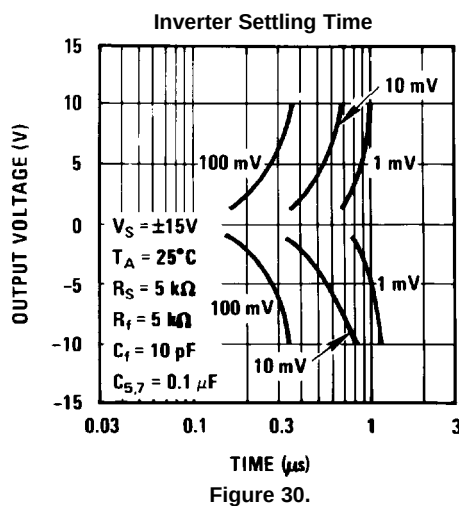
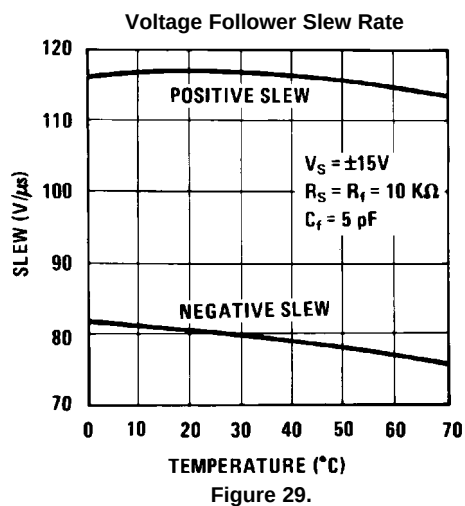
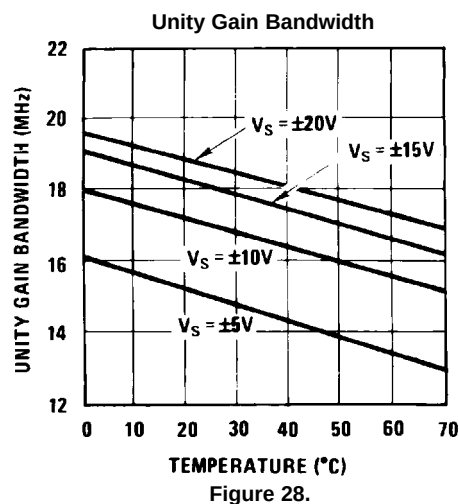
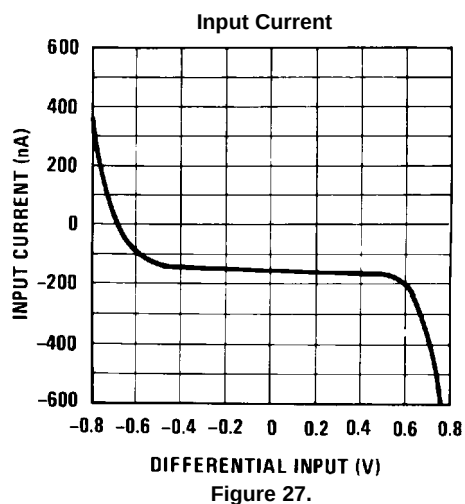
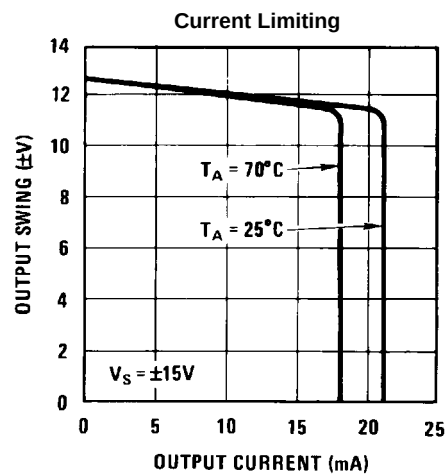
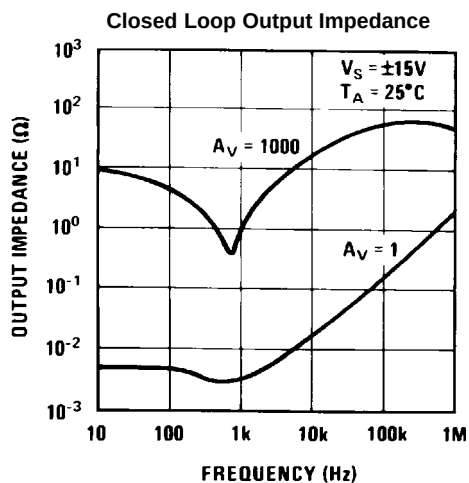


Figure 24.

## Typical Performance Characteristics (continued)

LM318-N



## Typical Performance Characteristics (continued)

LM318-N

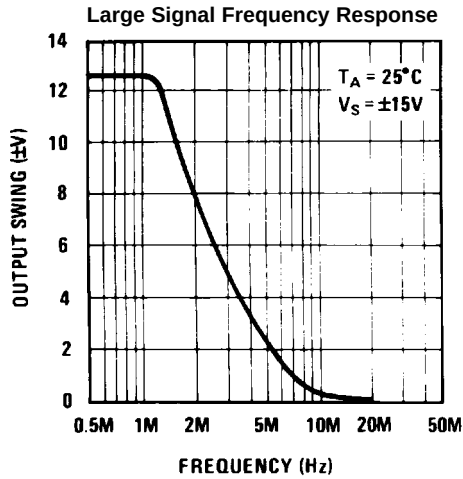


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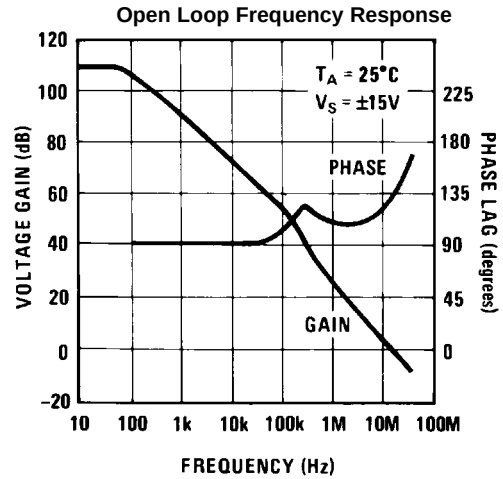


Figure 32.

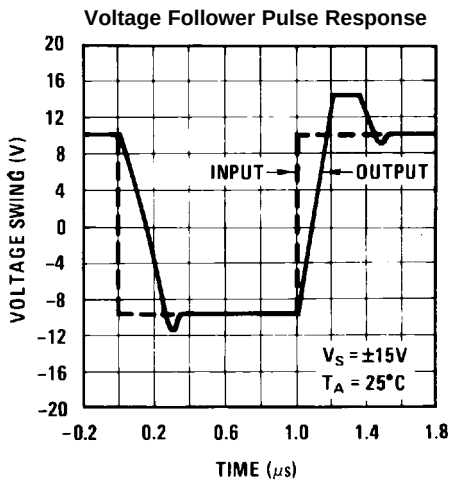


Figure 33.

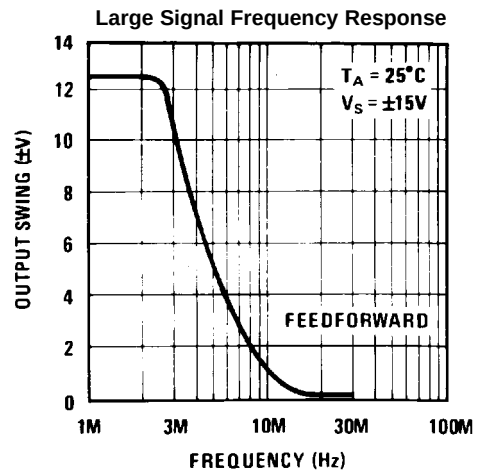


Figure 34.

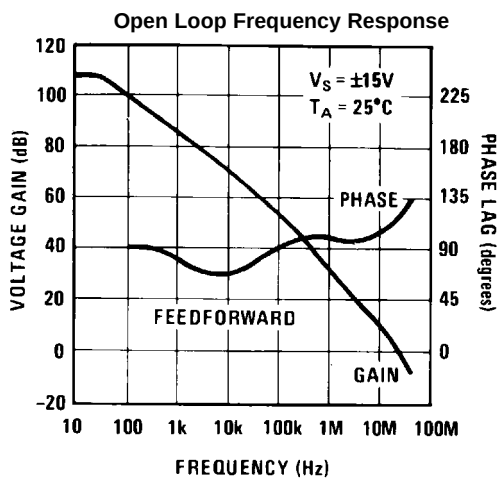


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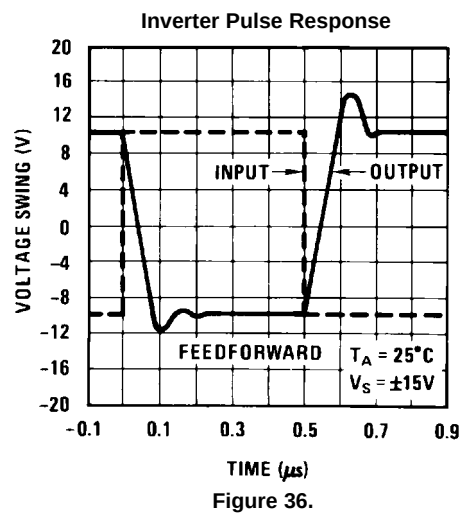
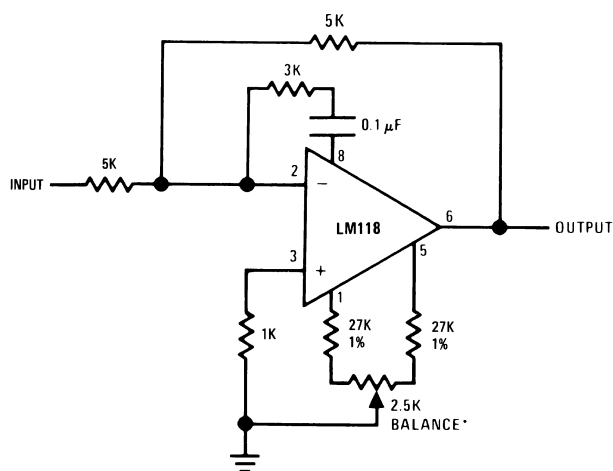


Figure 36.

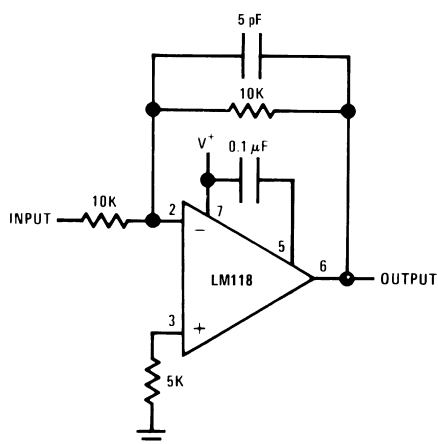
## AUXILIARY CIRCUITS



\*Balance circuit necessary for increased slew.

Slew rate typically 150V/μs.

**Figure 37. Feedforward Compensation for Greater Inverting Slew Rate**



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

**Figure 38. Compensation for Minimum Settling Time**

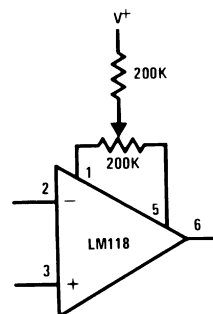


**Figure 39. Offset Balancing**

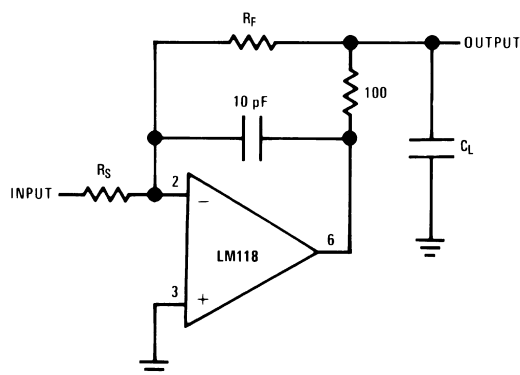


**Figure 40. Isolating Large Capacitive Loads**

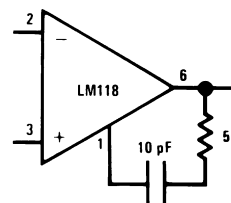
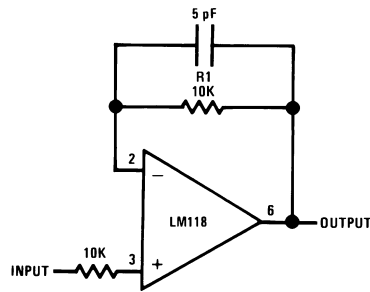


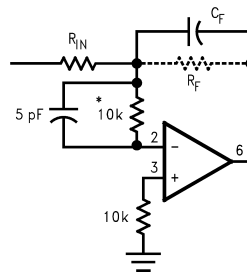
**Figure 41. Overcompensation**

## TYPICAL APPLICATIONS



Do not hard-wire as voltage follower ( $R1 \geq 5 \text{ k}\Omega$ )

Figure 42. Fast Voltage Follower



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

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

Do not hard-wire as voltage follower ( $R1 \geq 5 \text{ k}\Omega$ )

Figure 43.

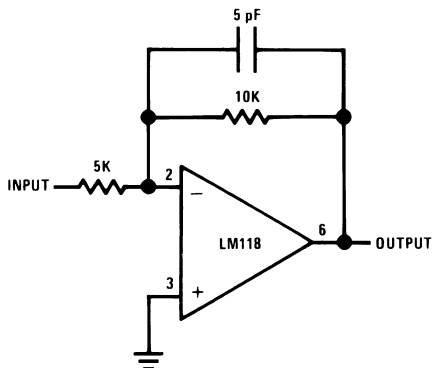


Figure 44. Fast Summing Amplifier

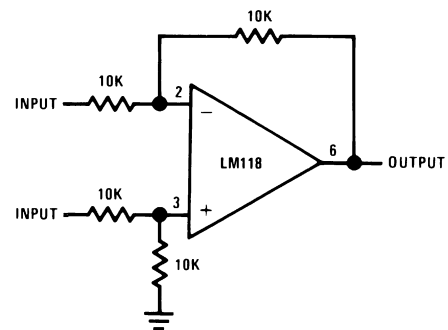


Figure 45. Differential Amplifier

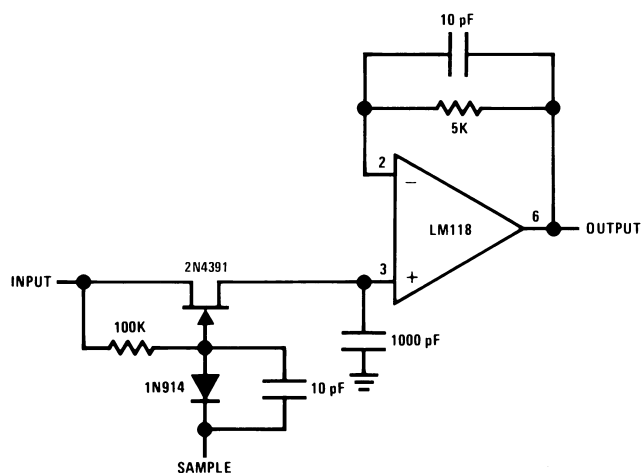
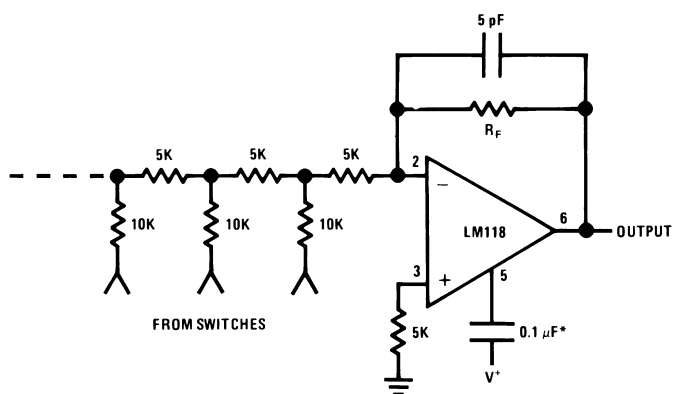
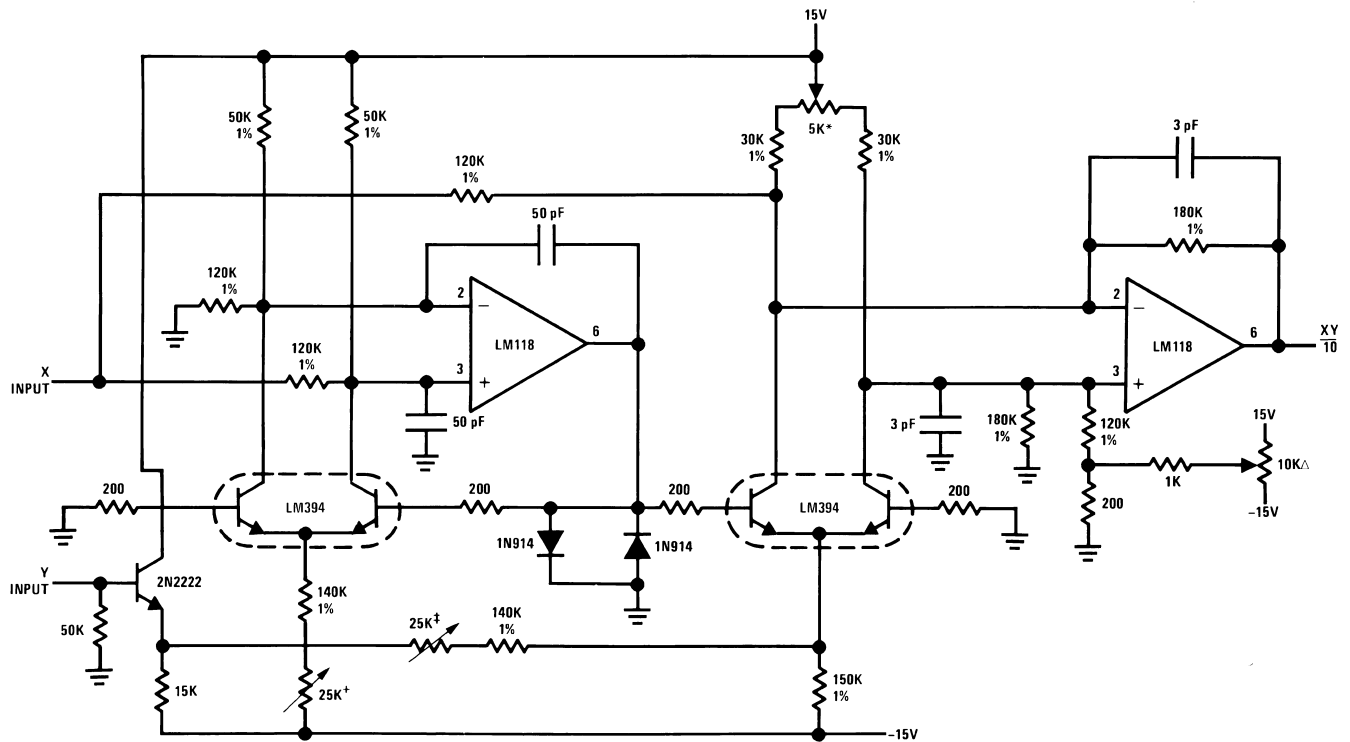


Figure 46. Fast Sample and Hold



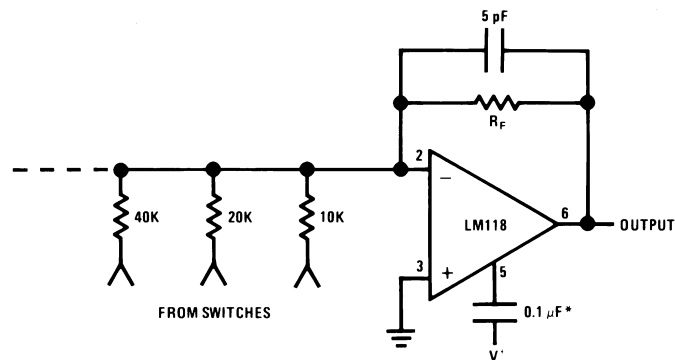
\*Optional—Reduces settling time.

Figure 47. D/A Converter Using Ladder Network



ΔOutput zero.  
 \*"Y" zero  
 + "X" zero  
 ‡Full scale adjust.

Figure 48. Four Quadrant Multiplier



\*Optional—Reduces settling time.

Figure 49. D/A Converter Using Binary Weighted Network

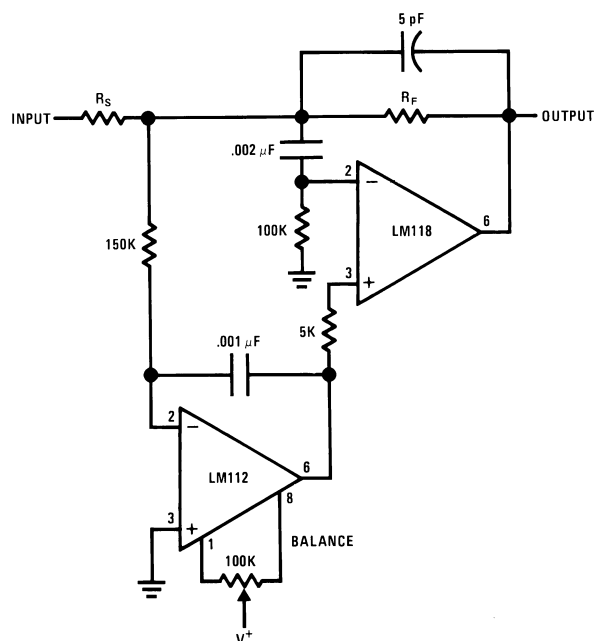
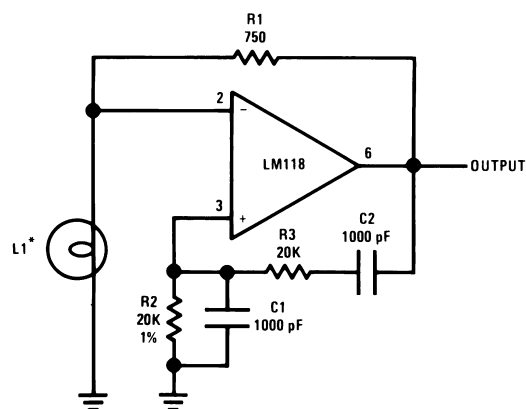


Figure 50. Fast Summing Amplifier with Low Input Current



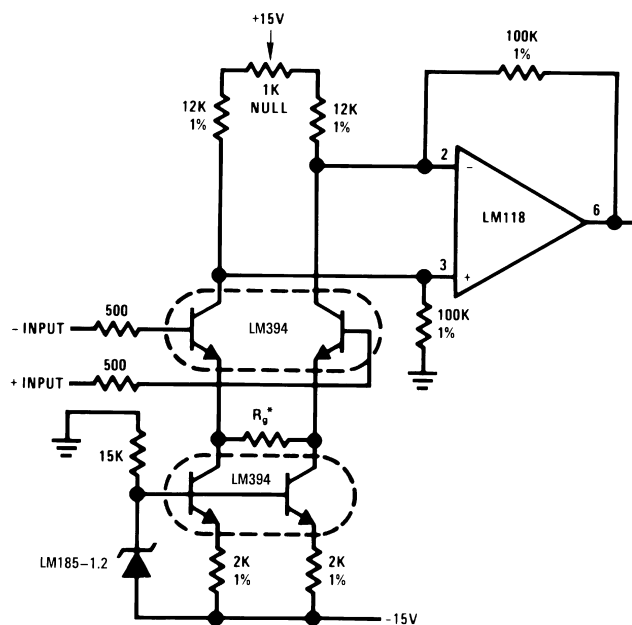
\*L1—10V—14 mA bulb ELDEMA 1869

R1 = R2

C1 = C2

$$f = \frac{1}{2\pi R_2 C_1}$$

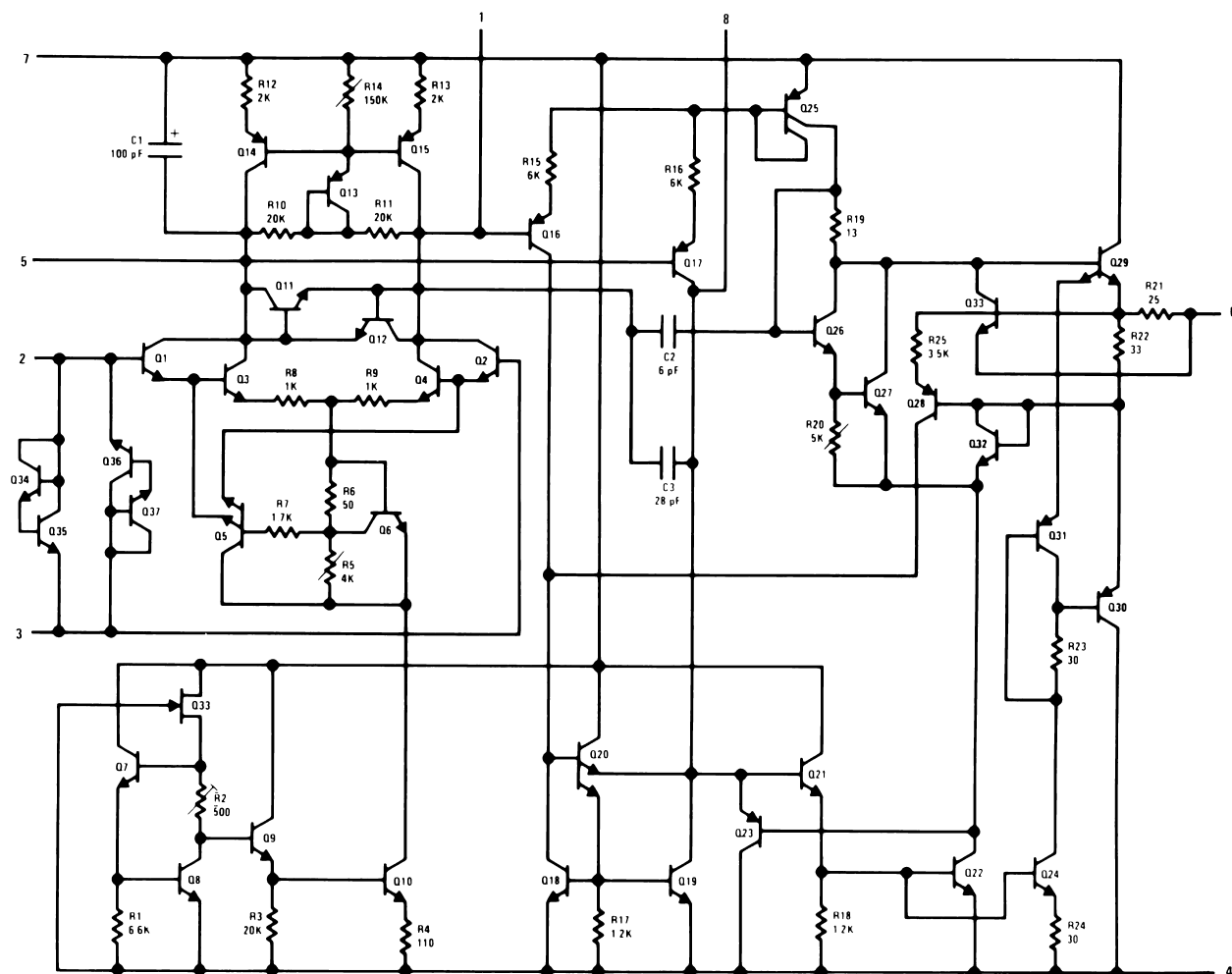
Figure 51. Wein Bridge Sine Wave Oscillator



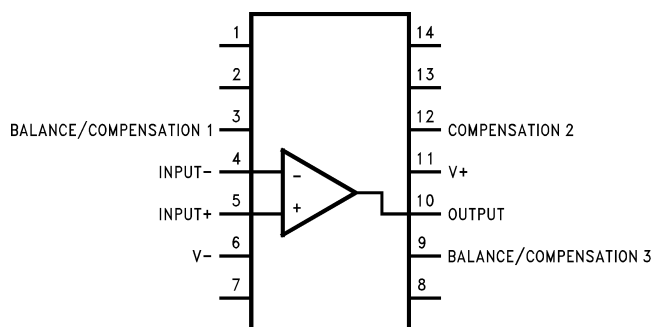
$$*Gain \geq \frac{200K}{R_g} \text{ for } 1.5K \leq R_g \leq 200K$$

Figure 52. Instrumentation Amplifier

## Schematic Diagram

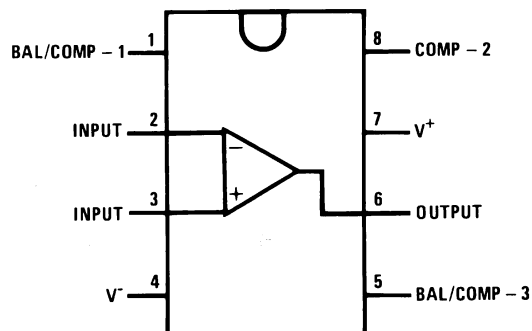


## Pin Diagram



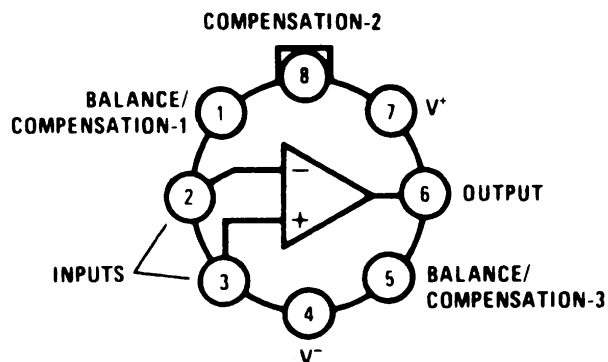
Available per JM38510/10107.

**Dual-In-Line Package  
(Top View)**  
See Package Number J (R-GDIP-T14)



Available per JM38510/10107.

**Dual-In-Line Package  
(Top View)**  
See Package Number NAB008A, D (R-PDSO-G8),  
or P (R-PDIP-T8)



Pin connections shown on schematic diagram and typical applications are for TO-99 package.

**TO-99 Package  
(Top View)**  
See Package Number LMC (O-MBCY-W8)

## REVISION HISTORY

### Changes from Revision B (March 2013) to Revision C

**Page**

- Changed layout of National Data Sheet to TI format ..... [16](#)

## PACKAGING INFORMATION

| Orderable part number        | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">LM118H</a>       | Active        | Production           | TO-99 (LMC)   8 | 500   OTHER           | No          | SNPB                                 | Level-1-NA-UNLIM                  | -55 to 125   | ( LM118H, LM118H)   |
| <a href="#">LM118H/NOPB</a>  | Active        | Production           | TO-99 (LMC)   8 | 500   TRAY NON-STD    | Yes         | SNAGCU                               | Level-1-NA-UNLIM                  | -55 to 125   | ( LM118H, LM118H)   |
| <a href="#">LM318M/NOPB</a>  | Active        | Production           | SOIC (D)   8    | 95   TUBE             | Yes         | SN                                   | Level-1-260C-UNLIM                | 0 to 70      | LM<br>318M          |
| LM318M/NOPB.B                | Active        | Production           | SOIC (D)   8    | 95   TUBE             | Yes         | SN                                   | Level-1-260C-UNLIM                | 0 to 70      | LM<br>318M          |
| <a href="#">LM318MX/NOPB</a> | Active        | Production           | SOIC (D)   8    | 2500   LARGE T&R      | Yes         | SN                                   | Level-1-260C-UNLIM                | 0 to 70      | LM<br>318M          |
| LM318MX/NOPB.B               | Active        | Production           | SOIC (D)   8    | 2500   LARGE T&R      | Yes         | SN                                   | Level-1-260C-UNLIM                | 0 to 70      | LM<br>318M          |
| <a href="#">LM318N/NOPB</a>  | Active        | Production           | PDIP (P)   8    | 40   TUBE             | Yes         | NIPDAU                               | Level-1-NA-UNLIM                  | 0 to 70      | LM<br>318N          |
| LM318N/NOPB.B                | Active        | Production           | PDIP (P)   8    | 40   TUBE             | Yes         | NIPDAU                               | Level-1-NA-UNLIM                  | 0 to 70      | LM<br>318N          |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

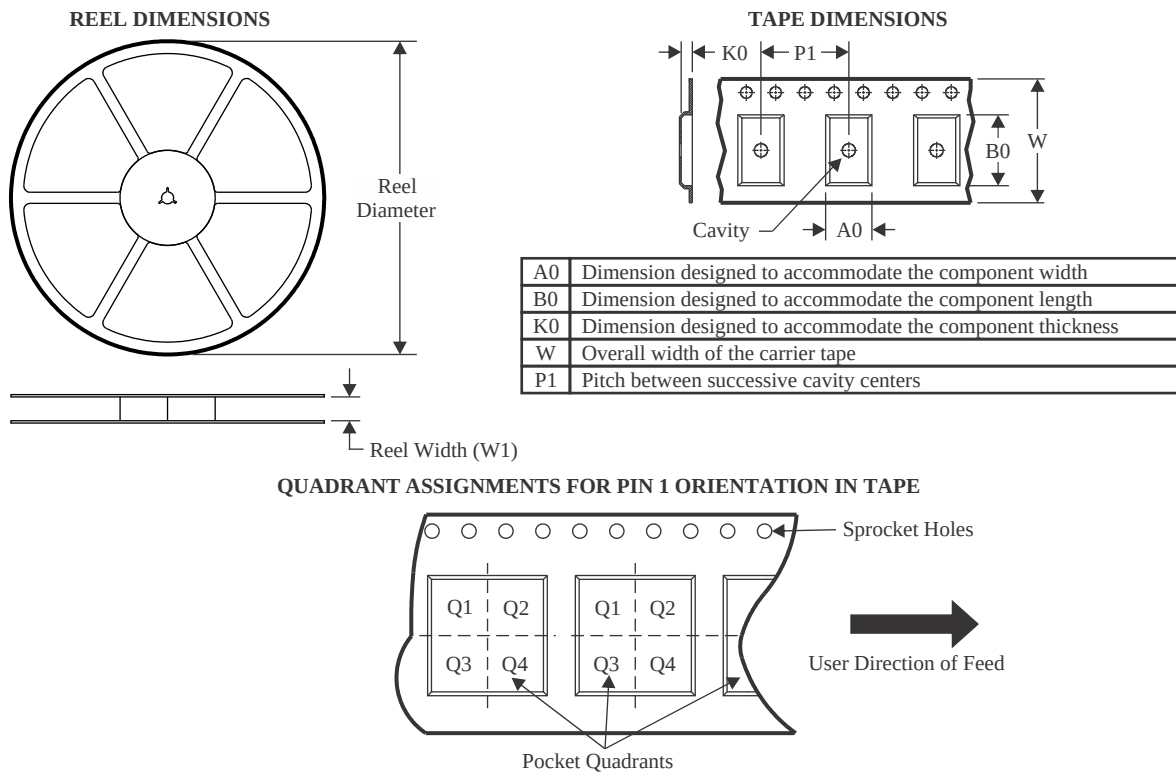
<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

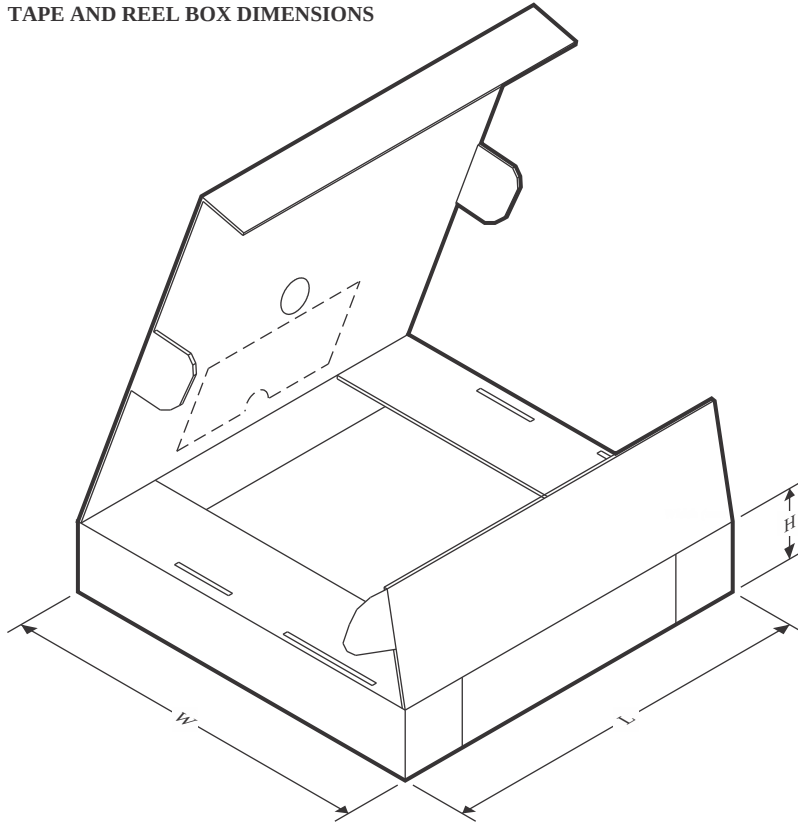
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM318MX/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |

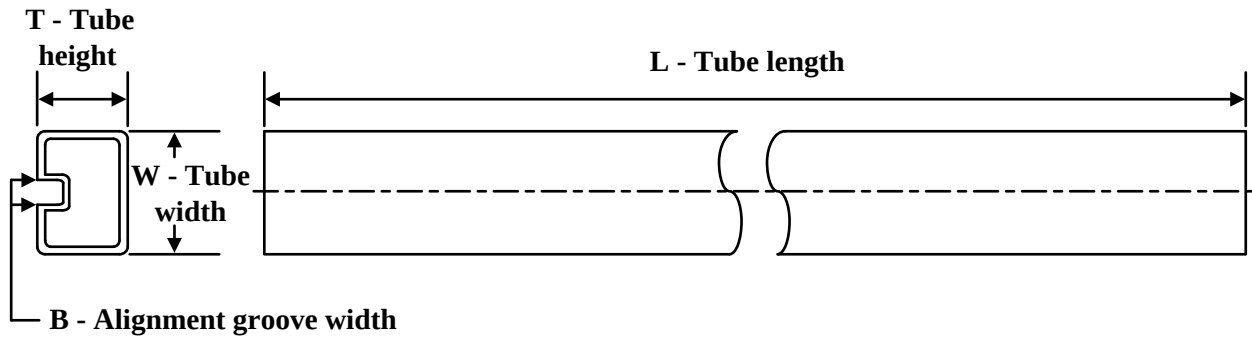
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM318MX/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |

## TUBE



\*All dimensions are nominal

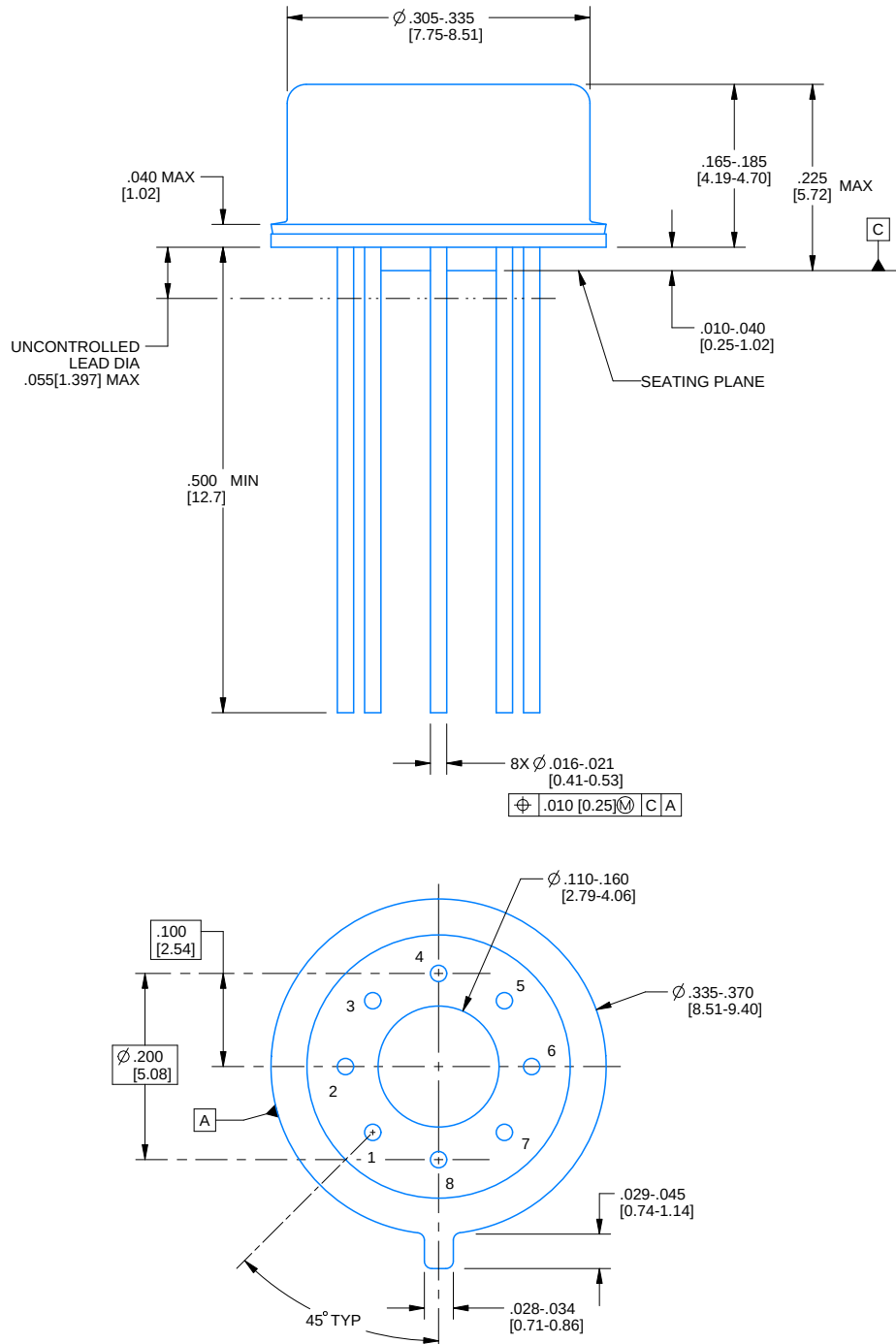
| Device        | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|---------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| LM318M/NOPB   | D            | SOIC         | 8    | 95  | 495    | 8      | 4064   | 3.05   |
| LM318M/NOPB.B | D            | SOIC         | 8    | 95  | 495    | 8      | 4064   | 3.05   |
| LM318N/NOPB   | P            | PDIP         | 8    | 40  | 502    | 14     | 11938  | 4.32   |
| LM318N/NOPB.B | P            | PDIP         | 8    | 40  | 502    | 14     | 11938  | 4.32   |

# PACKAGE OUTLINE

LMC0008A

TO-CAN - 5.72 mm max height

TRANSISTOR OUTLINE



4220610/B 09/2024

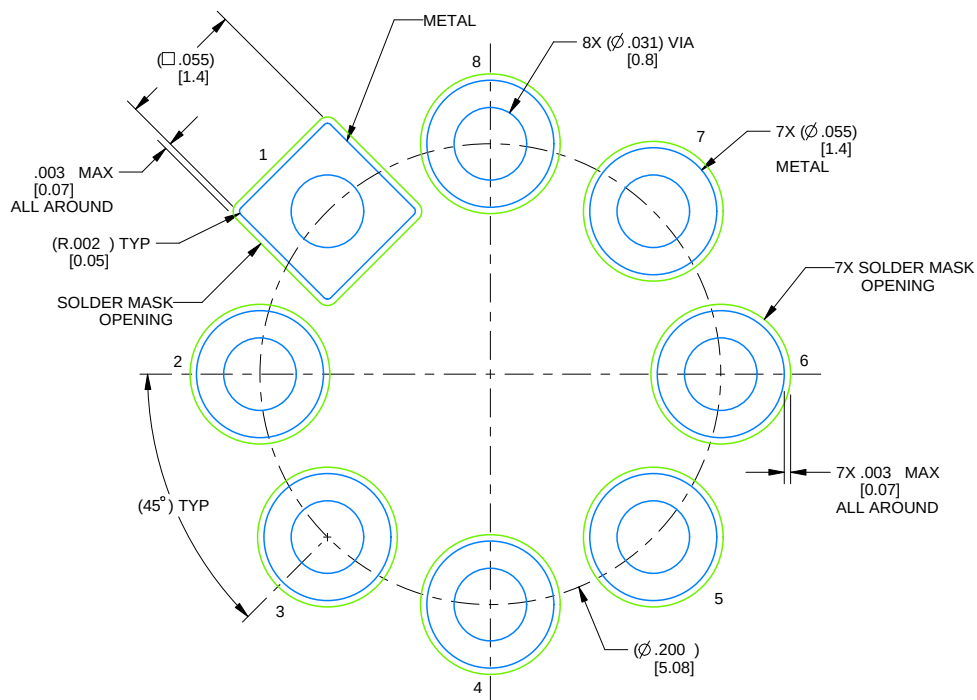
## NOTES:

1. All linear dimensions are in inches [millimeters]. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Pin numbers shown for reference only. Numbers may not be marked on package.
4. Reference JEDEC registration MO-002/TO-99.

# LMC0008A

**TO-CAN - 5.72 mm max height**

## TRANSISTOR OUTLINE



LAND PATTERN EXAMPLE  
NON-SOLDER MASK DEFINED  
SCALE: 12X

4220610/B 09/2024



## PACKAGE OUTLINE

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



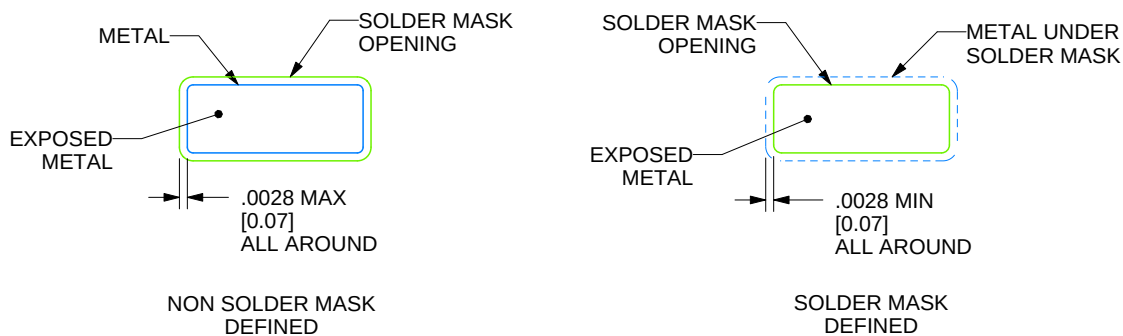
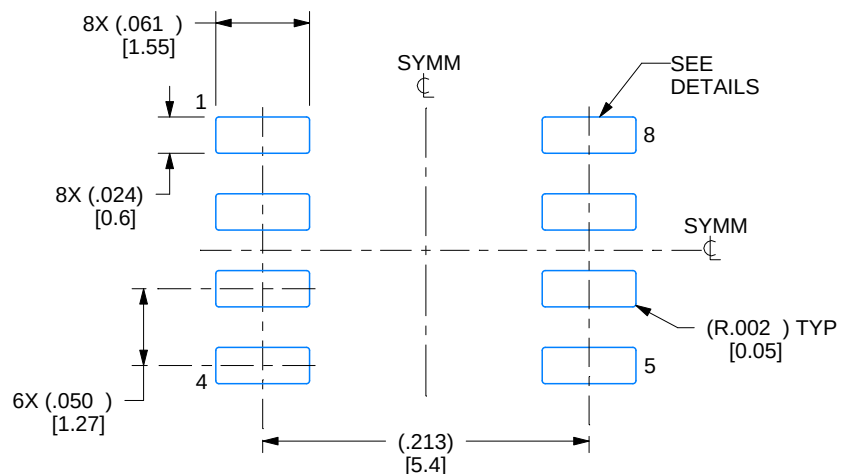
1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

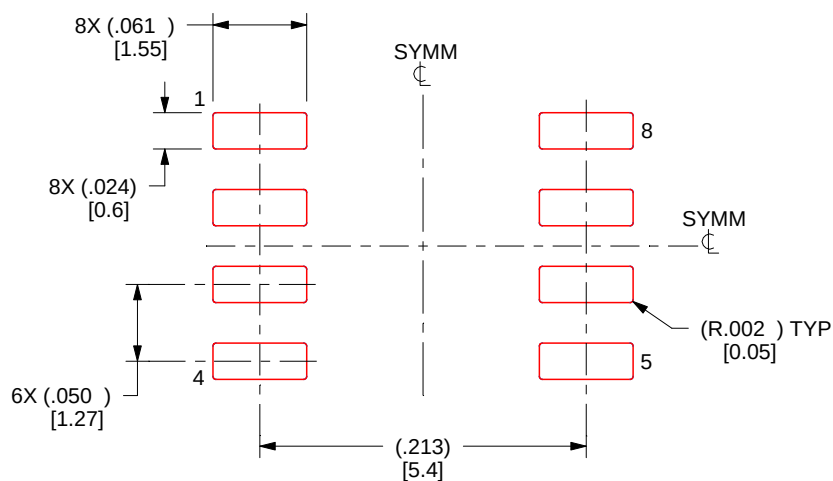
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

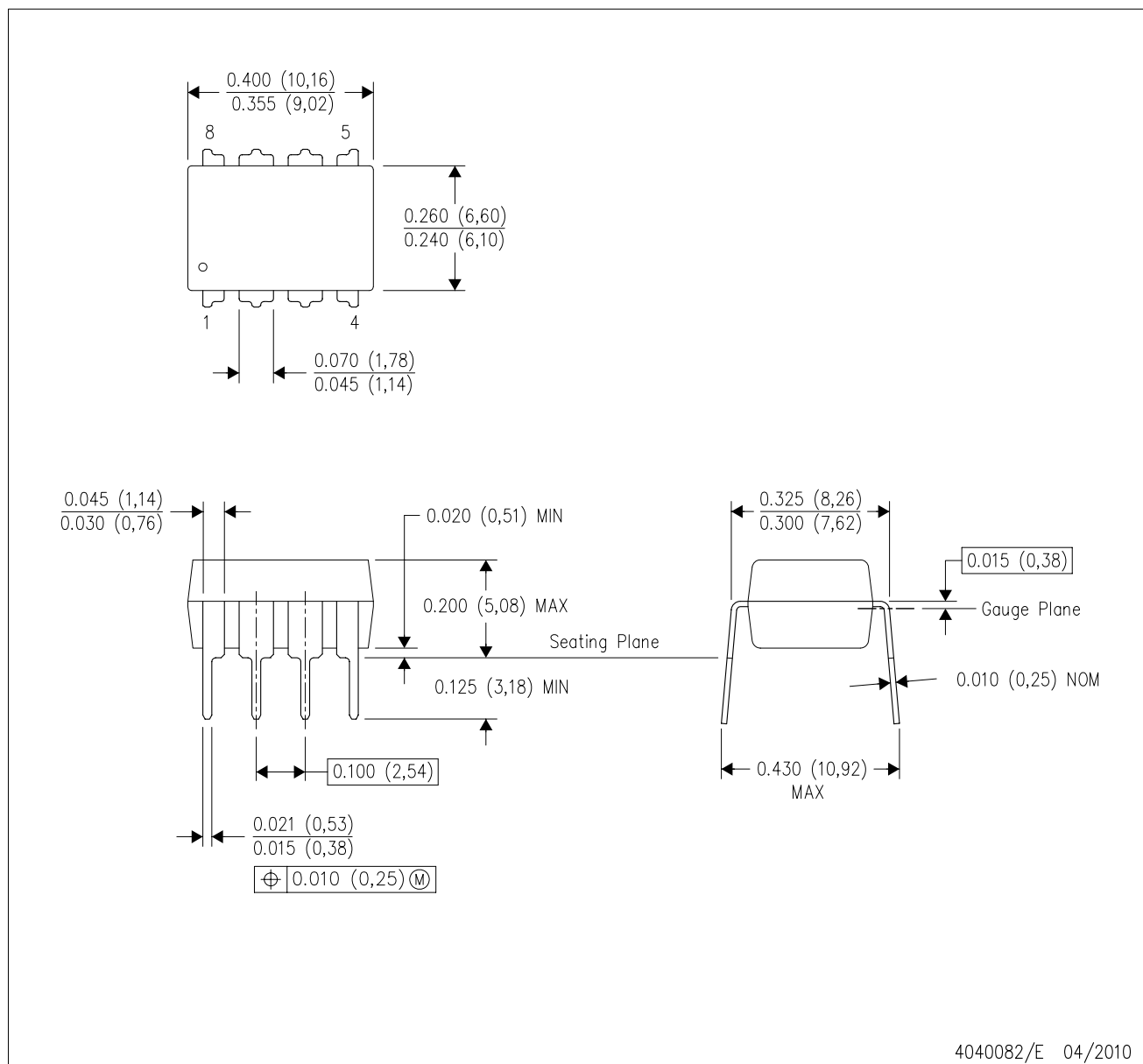
4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

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