National Semiconductor

August 2000

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/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.

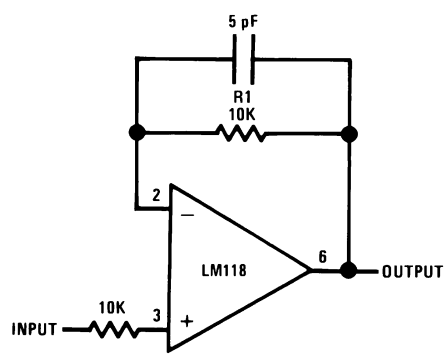
The LM218 is identical to the LM118 except that the LM218 has its performance specified over a −25˚C to +85˚C temperature range. The LM318 is specified from 0˚C to +70˚C.

Features

- 15 MHz small signal bandwidth
- Guaranteed 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

Fast Voltage Follower

(Note 1)



DS007766-13

Note 1: Do not hard-wire as voltage follower (R1 ≥ 5 kΩ)

Absolute Maximum Ratings (Note 7)

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

Supply Voltage	±20V
Power Dissipation (Note 2)	500 mW
Differential Input Current (Note 3)	±10 mA
Input Voltage (Note 4)	±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 8)	2000V

Electrical Characteristics (Note 5)

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

Note 2: 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 3: 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 4: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 5: These specifications apply for $\pm 5V \leq V_S \leq \pm 20V$ and $-55˚C \leq T_A \leq +125˚C$ (LM118), $-25˚C \leq T_A \leq +85˚C$ (LM218), and $0˚C \leq T_A \leq +70˚C$ (LM318). Also, power supplies must be bypassed with 0.1 µF disc capacitors.

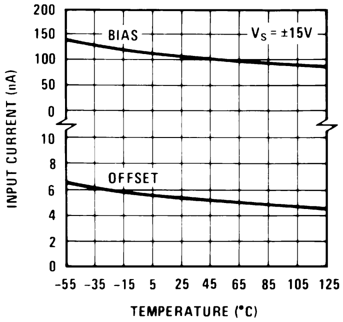
Note 6: Slew rate is tested with V_S = ±15V. The LM118 is in a unity-gain non-inverting configuration. V_{IN} is stepped from −7.5V to +7.5V and vice versa. The slew rates between −5.0V and +5.0V and vice versa are tested and guaranteed to exceed 50V/µs.

Note 7: Refer to RETS118X for LM118H and LM118J military specifications.

Note 8: Human body model, 1.5 kΩ in series with 100 pF.

Typical Performance Characteristics LM118, LM218

Input Current



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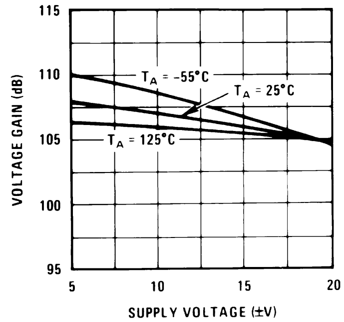
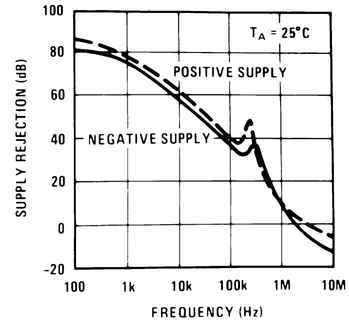
Voltage Gain



DS007766-26

Power Supply Rejection



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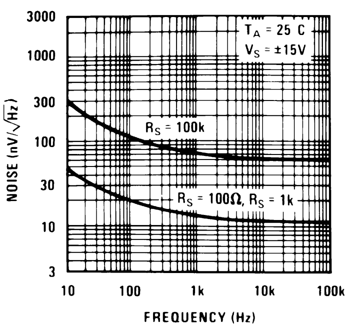
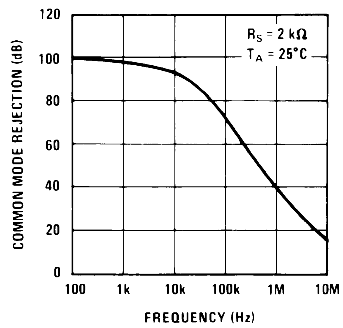
Input Noise Voltage



DS007766-28

Common Mode Rejection



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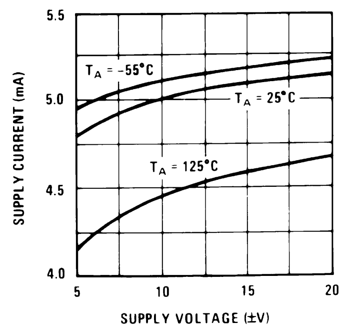
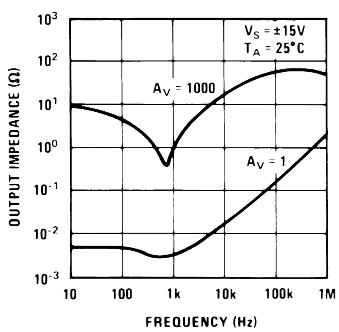
Supply Current



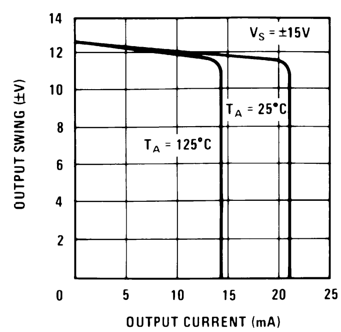
DS007766-30

Closed Loop Output Impedance



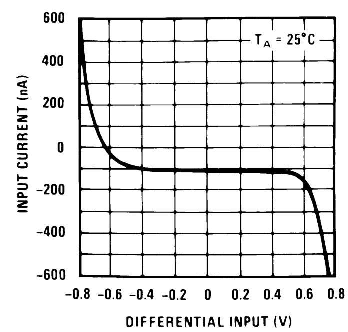
DS007766-31

Current Limiting



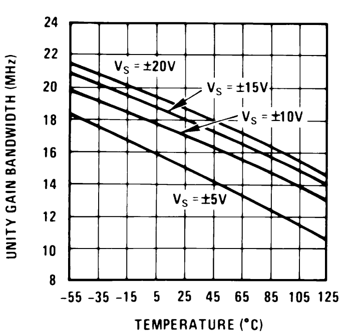
DS007766-32

Input Current



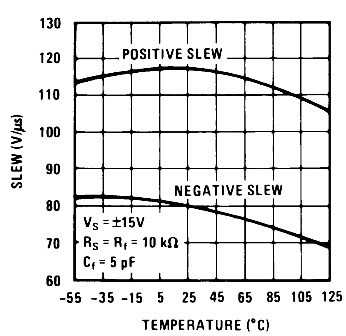
DS007766-33

Unity Gain Bandwidth



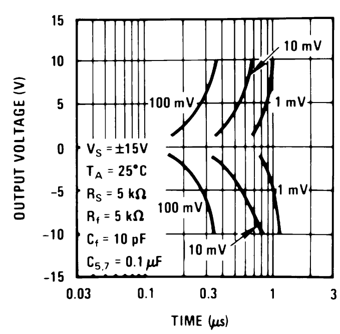
DS007766-34

Voltage Follower Slew Rate



DS007766-35

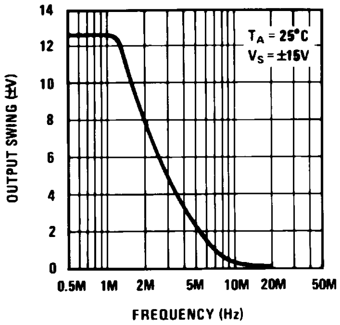
Inverter Settling Time



DS007766-36

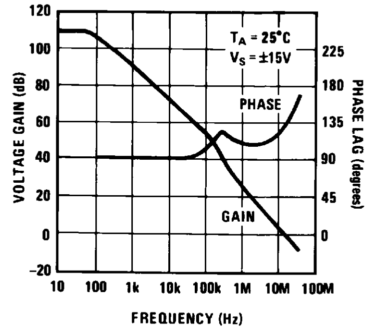
Typical Performance Characteristics LM118, LM218 (Continued)

Large Signal Frequency Response



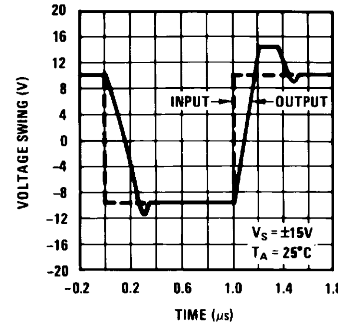
DS007766-37

Open Loop Frequency Response



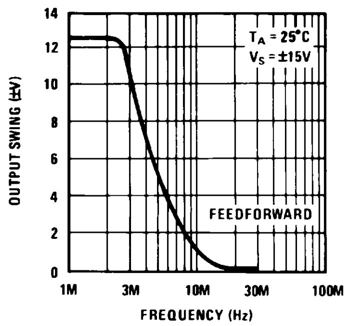
DS007766-38

Voltage Follower Pulse Response



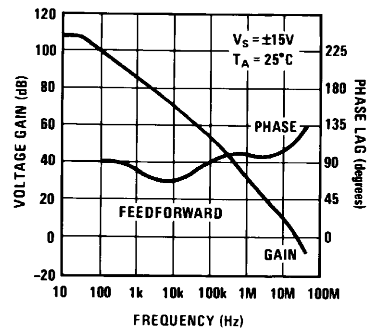
DS007766-39

Large Signal Frequency Response



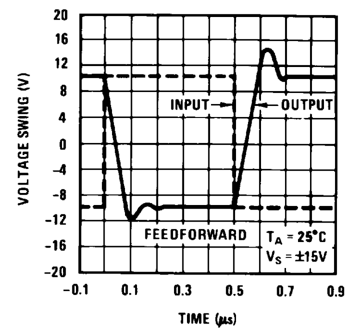
DS007766-40

Open Loop Frequency Response



DS007766-41

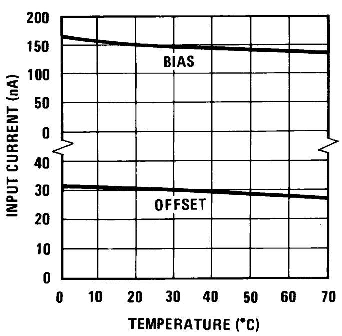
Inverter Pulse Response



DS007766-42

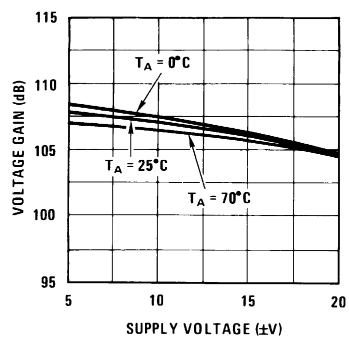
Typical Performance Characteristics LM318

Input Current



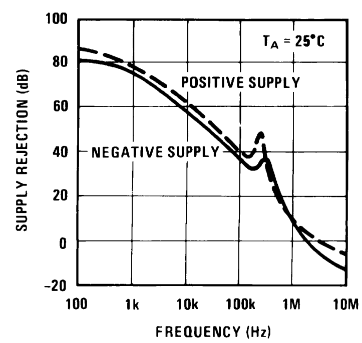
DS007766-43

Voltage Gain



DS007766-44

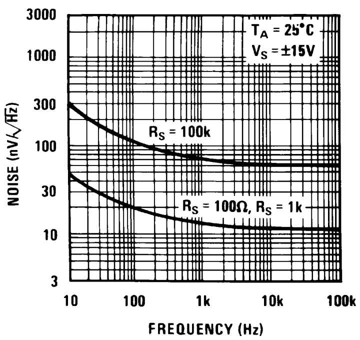
Power Supply Rejection



DS007766-45

Typical Performance Characteristics LM318 (Continued)

Input Noise Voltage



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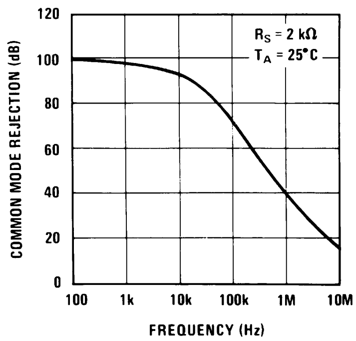
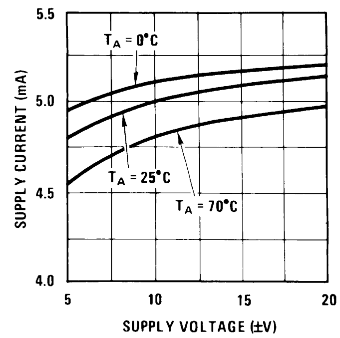
Common Mode Rejection



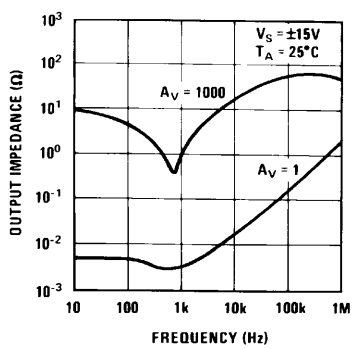
DS007766-47

Supply Current



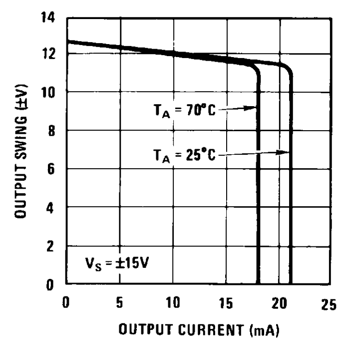
DS007766-48

Closed Loop Output Impedance



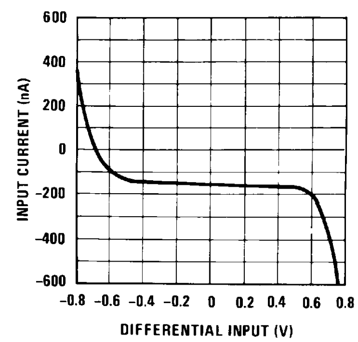
DS007766-49

Current Limiting



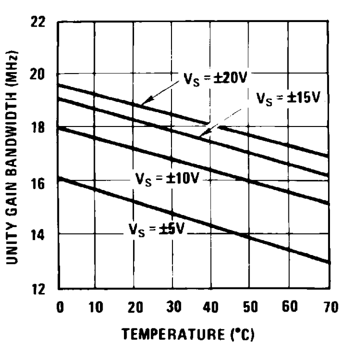
DS007766-50

Input Current



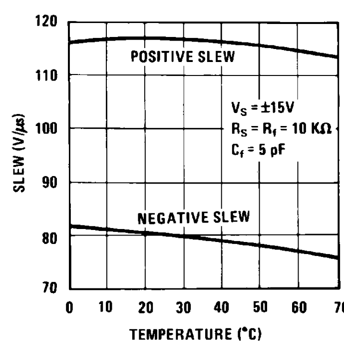
DS007766-51

Unity Gain Bandwidth



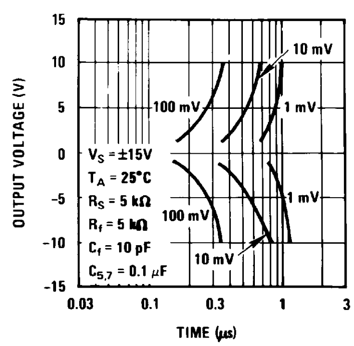
DS007766-52

Voltage Follower Slew Rate



DS007766-53

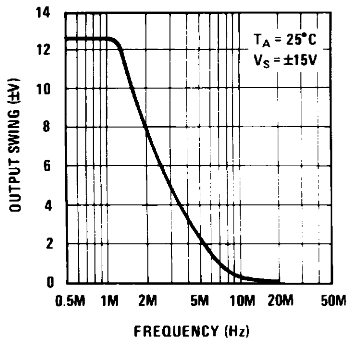
Inverter Settling Time



DS007766-54

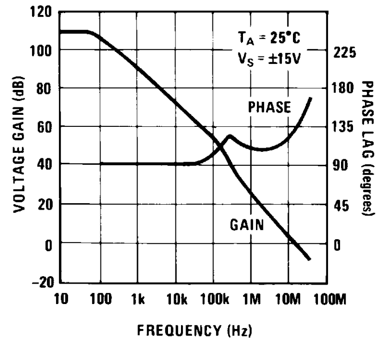
Typical Performance Characteristics LM318 (Continued)

Large Signal Frequency Response



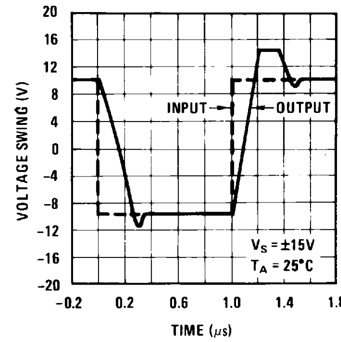
DS007766-55

Open Loop Frequency Response



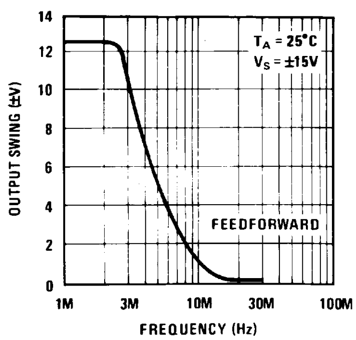
DS007766-56

Voltage Follower Pulse Response



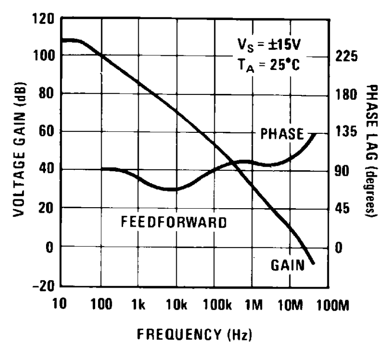
DS007766-57

Large Signal Frequency Response



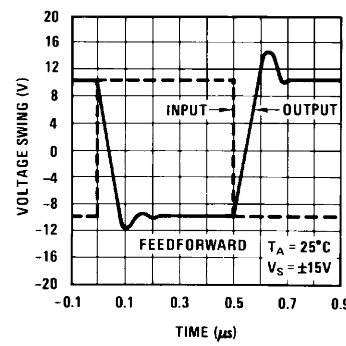
DS007766-58

Open Loop Frequency Response



DS007766-59

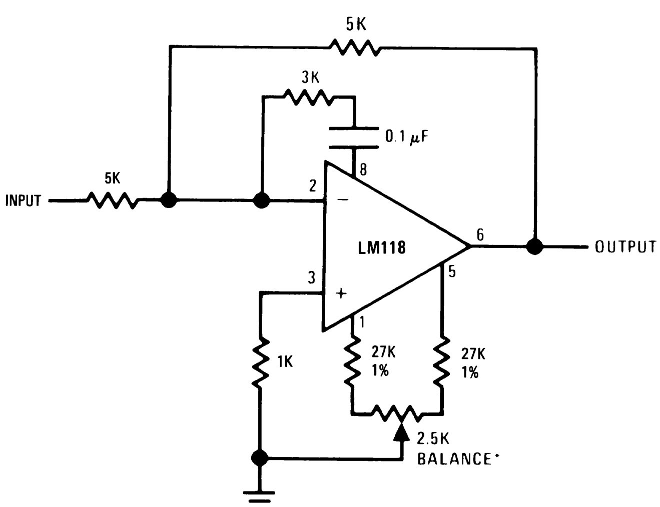
Inverter Pulse Response



DS007766-60

Auxiliary Circuits

Feedforward Compensation for Greater Inverting Slew Rate
(Note 9)

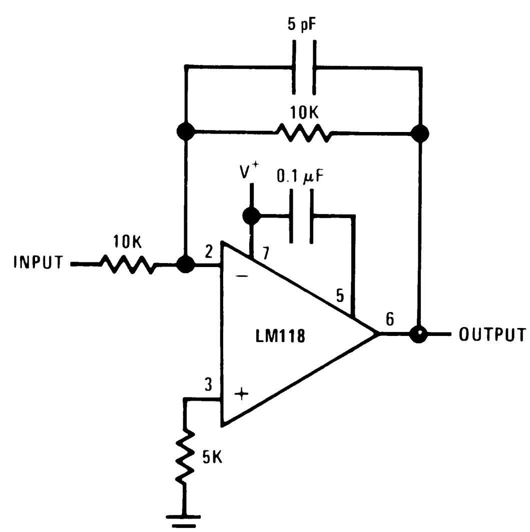


DS007766-8

*Balance circuit necessary for increased slew.

Note 9: Slew rate typically 150V/μs.

Compensation for Minimum Settling Time
(Note 10)



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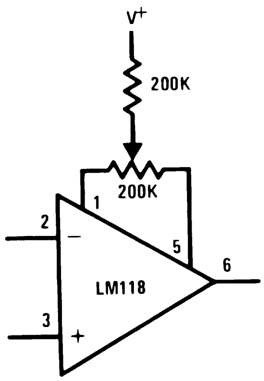
Note 10: Slew and settling time to 0.1% for a 10V step change is 800 ns.

Auxiliary Circuits (Continued)

Offset Balancing



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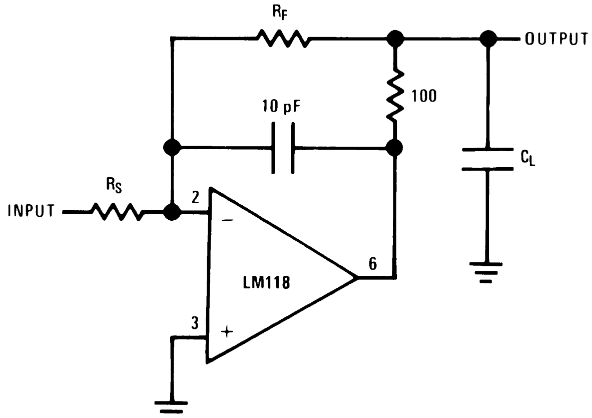
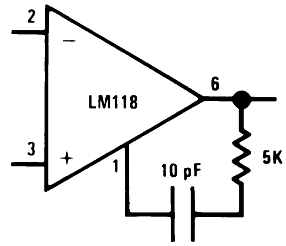
Isolating Large Capacitive Loads



DS007766-11

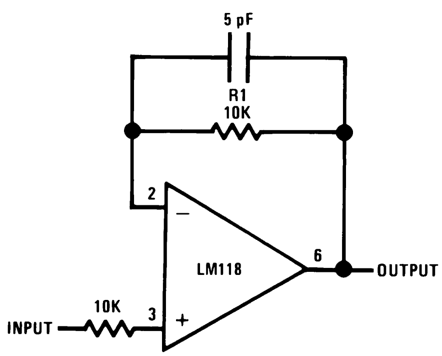
Overcompensation



DS007766-12

Typical Applications

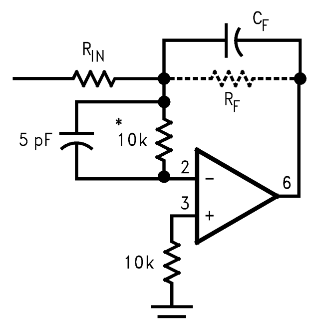
Fast Voltage Follower
(Note 11)



DS007766-13

Note 11: Do not hard-wire as voltage follower (R1 ≥ 5 kΩ)

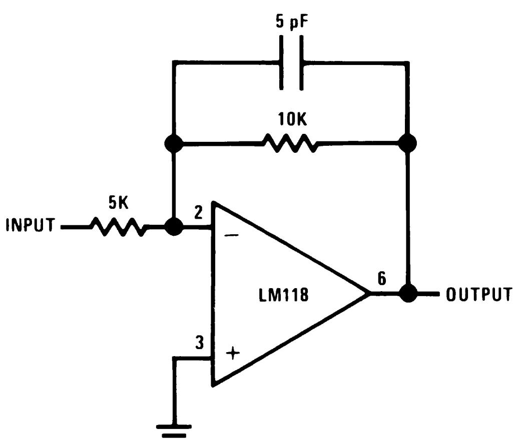
Integrator or Slow Inverter



DS007766-14

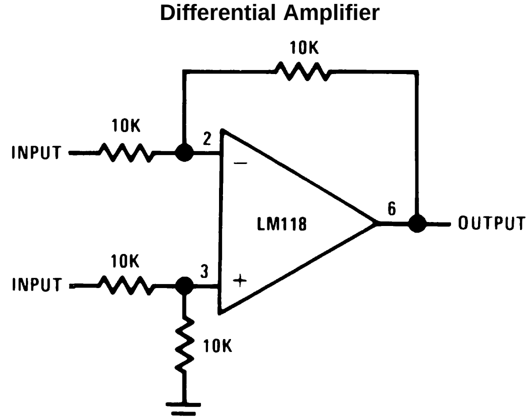
C_F = Large
($C_F \geq 50$ pF)
*Do not hard-wire as integrator or slow inverter; insert a 10k-5 pF network in series with the input, to prevent oscillation.

Fast Summing Amplifier



DS007766-15

Differential Amplifier



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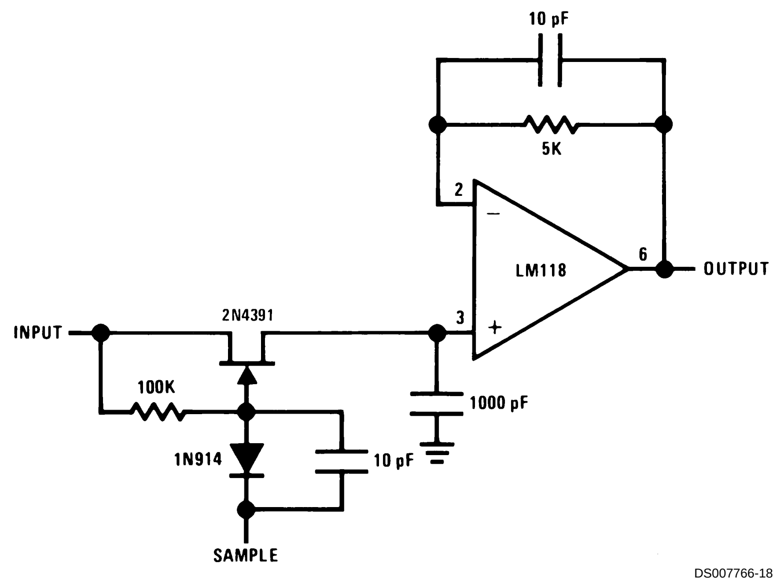
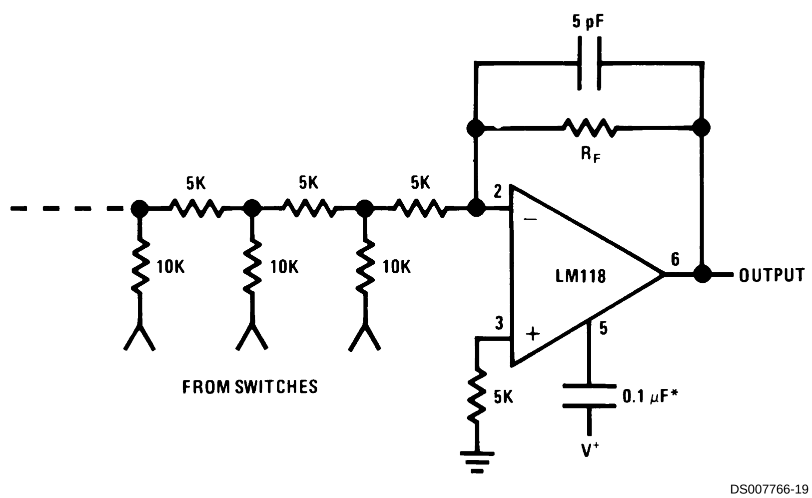
Typical Applications (Continued)

Fast Sample and Hold



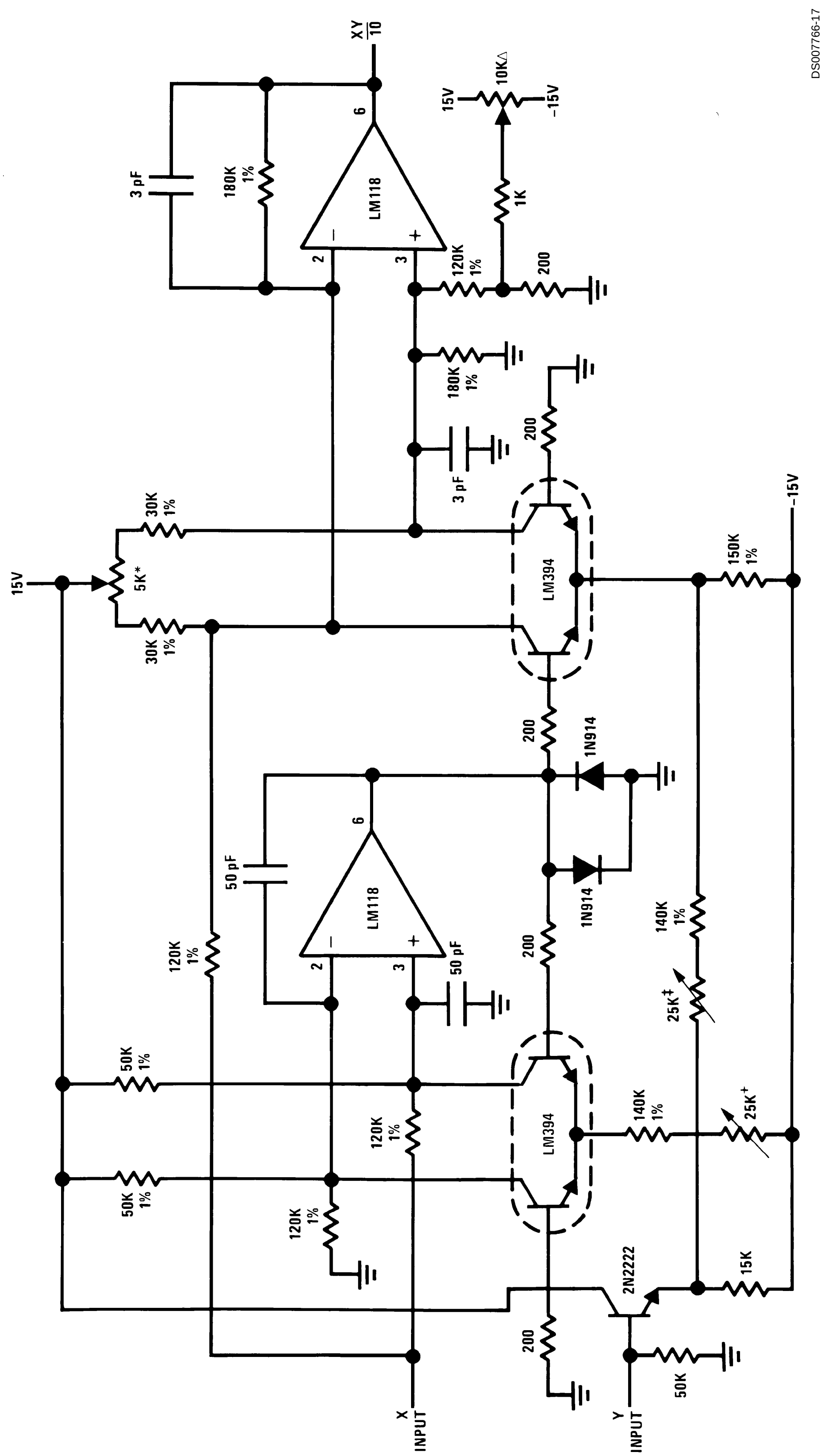
D/A Converter Using Ladder Network



*Optional — Reduces settling time.

Typical Applications (Continued)

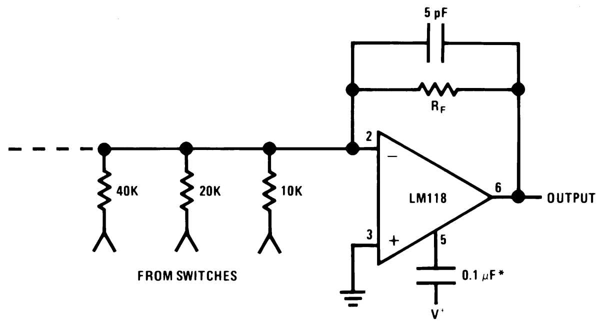
Four Quadrant Multiplier



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

Typical Applications (Continued)

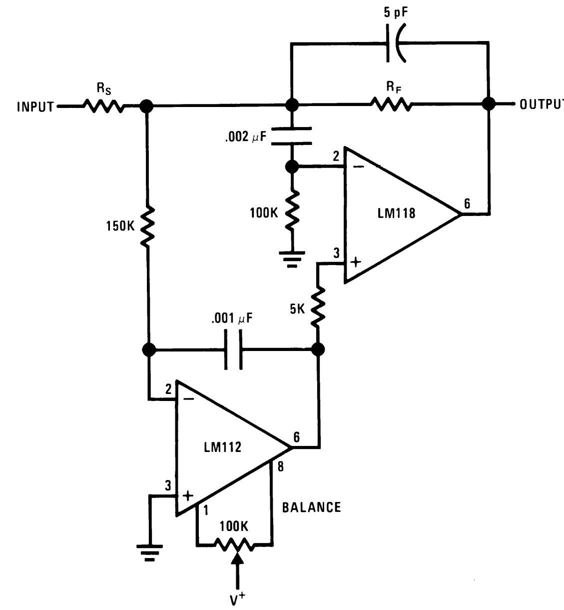
D/A Converter Using Binary Weighted Network



DS007766-20

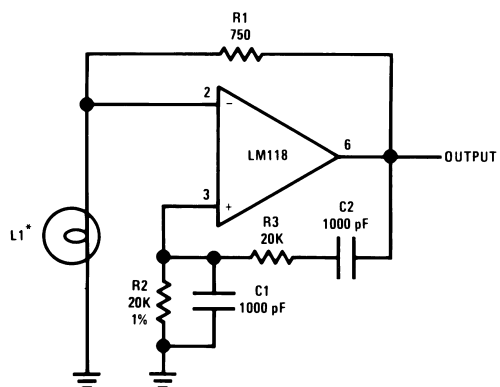
*Optional — Reduces settling time.

Fast Summing Amplifier with Low Input Current



DS007766-21

Wein Bridge Sine Wave Oscillator



DS007766-22

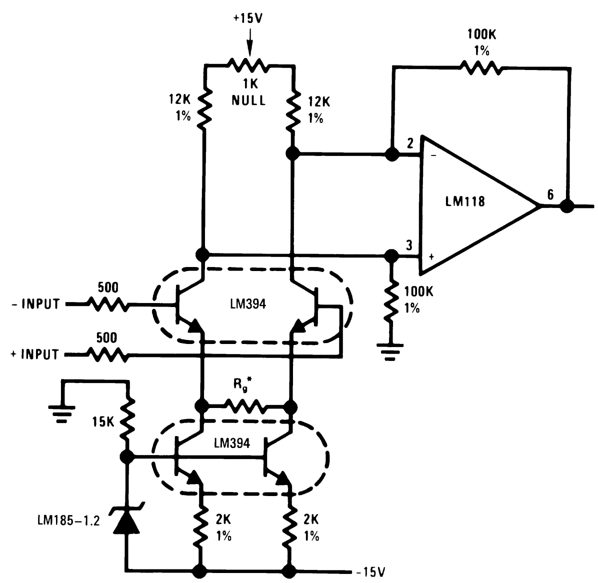
*L1—10V—14 mA bulb ELDEMA 1869

R1 = R2

C1 = C2

$$f = \frac{1}{2\pi R2\ C1}$$

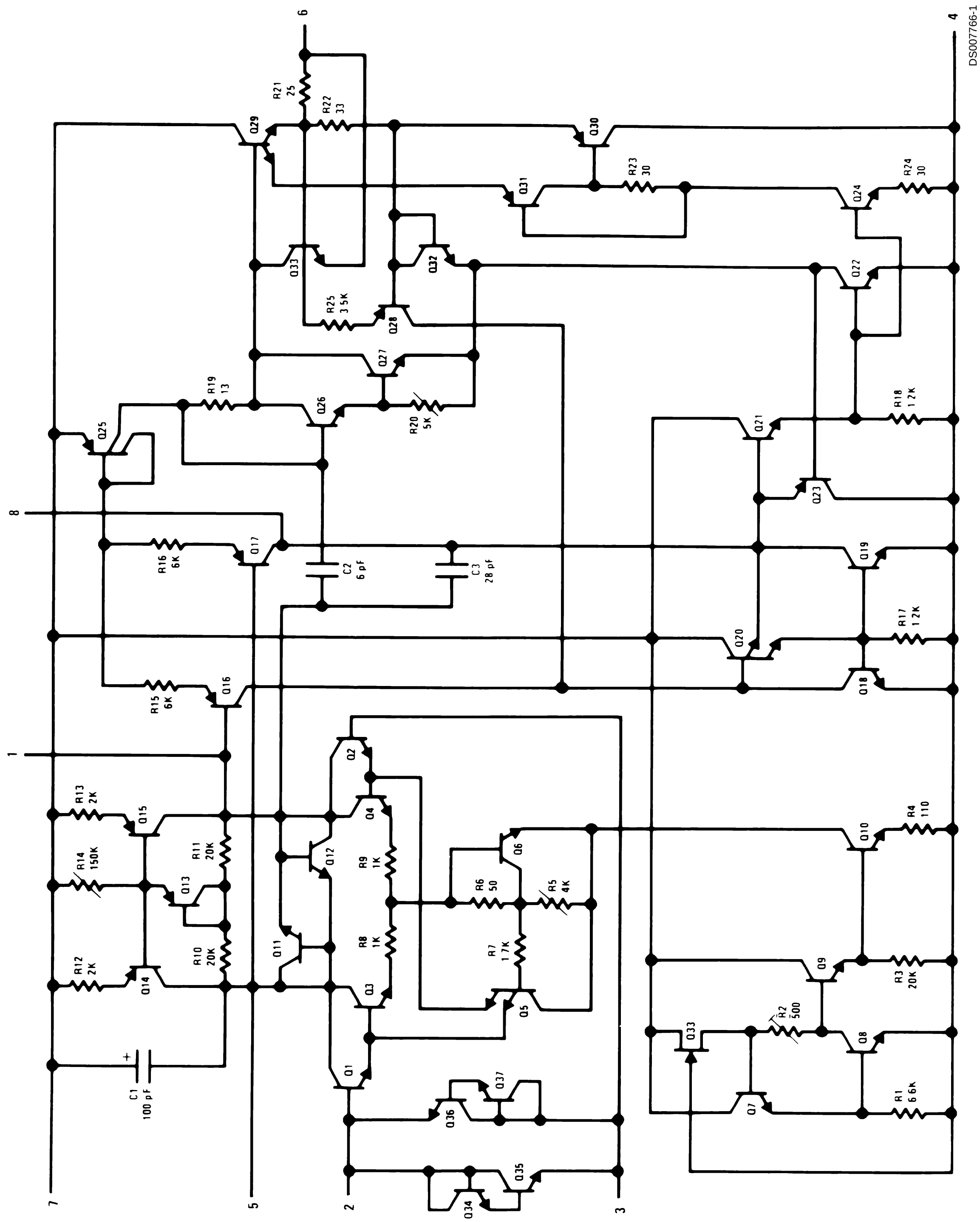
Instrumentation Amplifier



DS007766-23

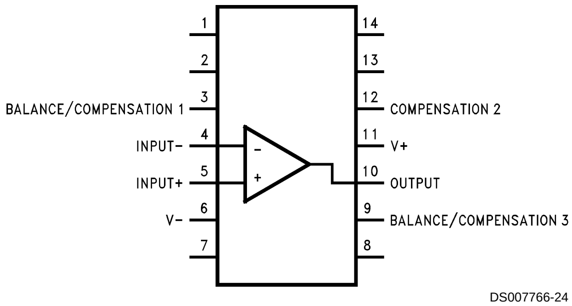
$$\text{*Gain} \geq \frac{200K}{R_g} \text{ for } 1.5K \leq R_g \leq 200K$$

Schematic Diagram



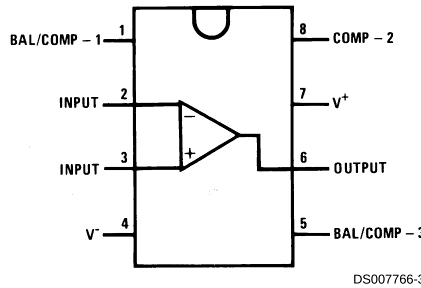
Connection Diagram

Dual-In-Line Package



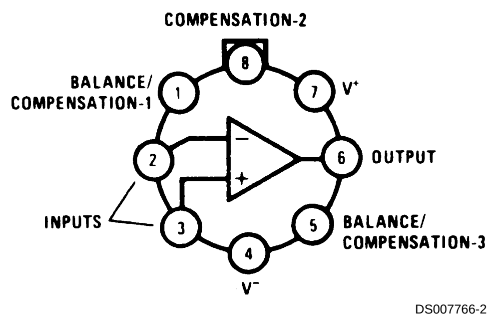
Top View
Order Number LM118J/883 (Note 13)
See NS Package Number J14A

Dual-In-Line Package



Top View
Order Number LM118J-8/883 (Note 13)**,**
LM318M or LM318N
See NS Package Number J08A, M08A or N08B

Metal Can Package
(Note 12)

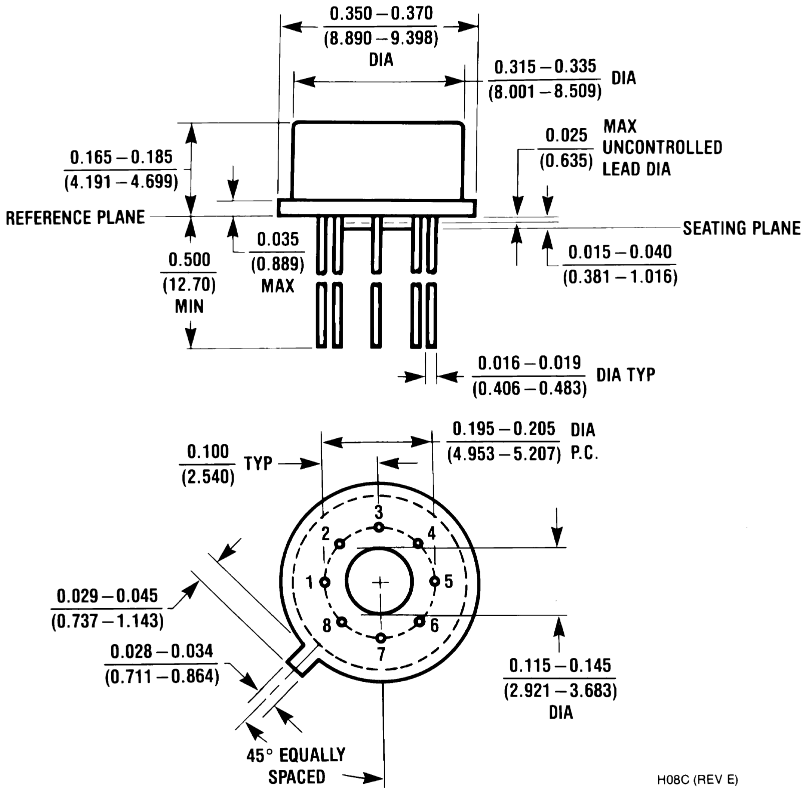


Top View
Order Number LM118H, LM118H/883 (Note 13)**,**
LM218H or LM318H
See NS Package Number H08C

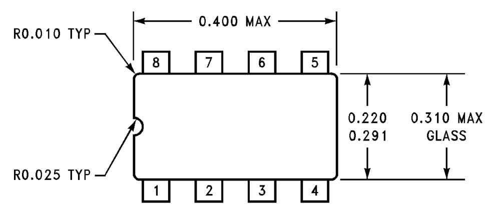
Note 12: Pin connections shown on schematic diagram and typical applications are for TO-5 package.

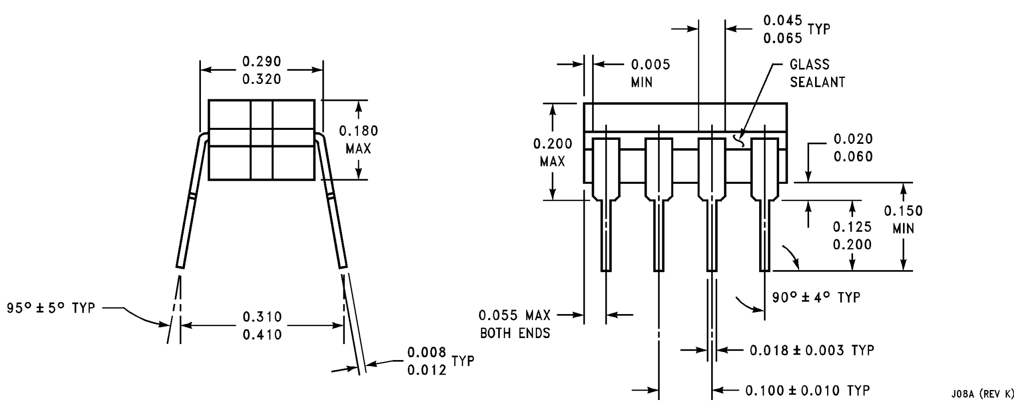
Note 13: Available per JM38510/10107.

Physical Dimensions inches (millimeters) unless otherwise noted



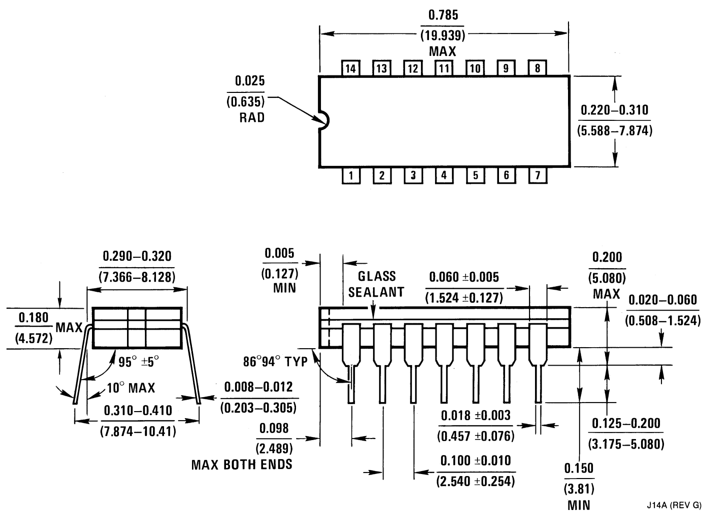
Metal Can Package (H)
Order Number LM118H, LM118H/883, LM218H or LM318H
NS Package Number H08C



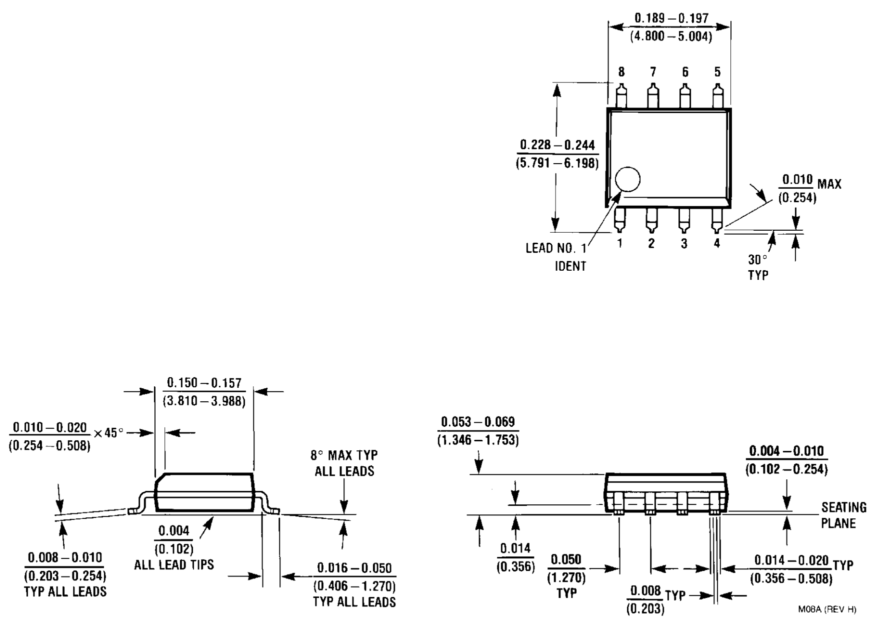


Ceramic Dual-In-Line Package (J)
Order Number LM118J-8/883
NS Package Number J08A

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

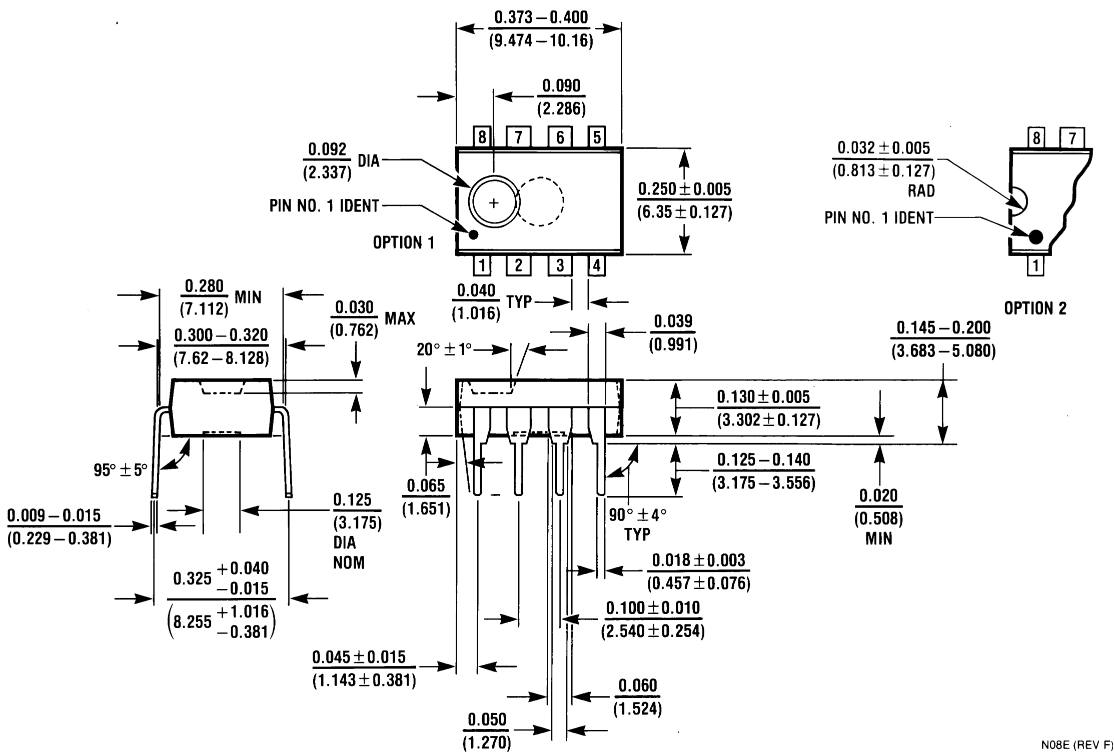


Ceramic Dual-In-Line Package (J)
Order Number LM118J/883
NS Package Number J14A



S.O. Package (M)
Order Number LM318M or LM318MX
NS Package Number M08A

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



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

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