LM118QML Operational Amplifier

Check for Samples: LM118QML

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**

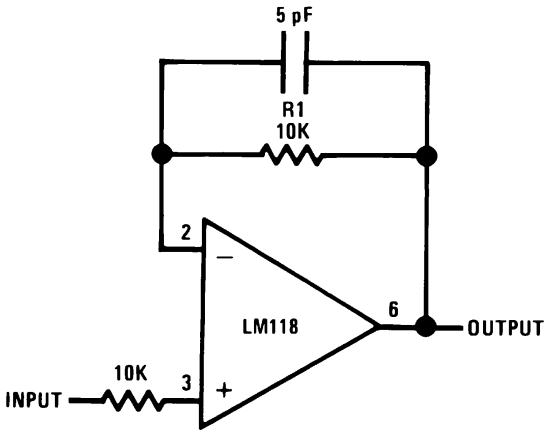
DESCRIPTION

The LM118 is a precision high speed operational amplifier designed for applications requiring wide bandwidth and high slew rate. It features a factor of ten increase in speed over general purpose devices without sacrificing DC performance.

The LM118 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, feed forward 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 this op amp makes it useful in A/D converters, oscillators, active filters, sample and hold circuits, or general purpose amplifiers. This device is easy to apply and offers an order of magnitude better AC performance than industry standards such as the LM709.

Fast Voltage Follower



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

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.

Connection Diagram

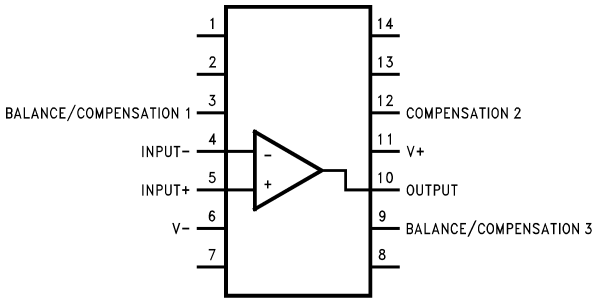


Figure 1. CDIP Package
Top View
See Package Number J0014A

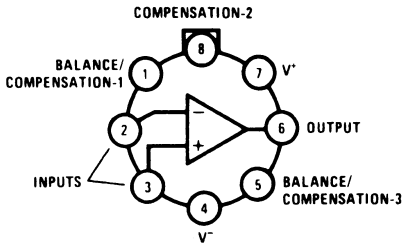


Figure 2. TO-99
Top View
See Package Number LMC

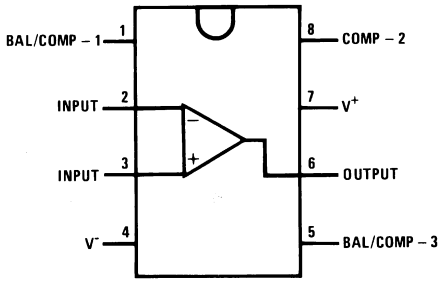
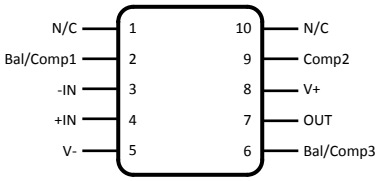


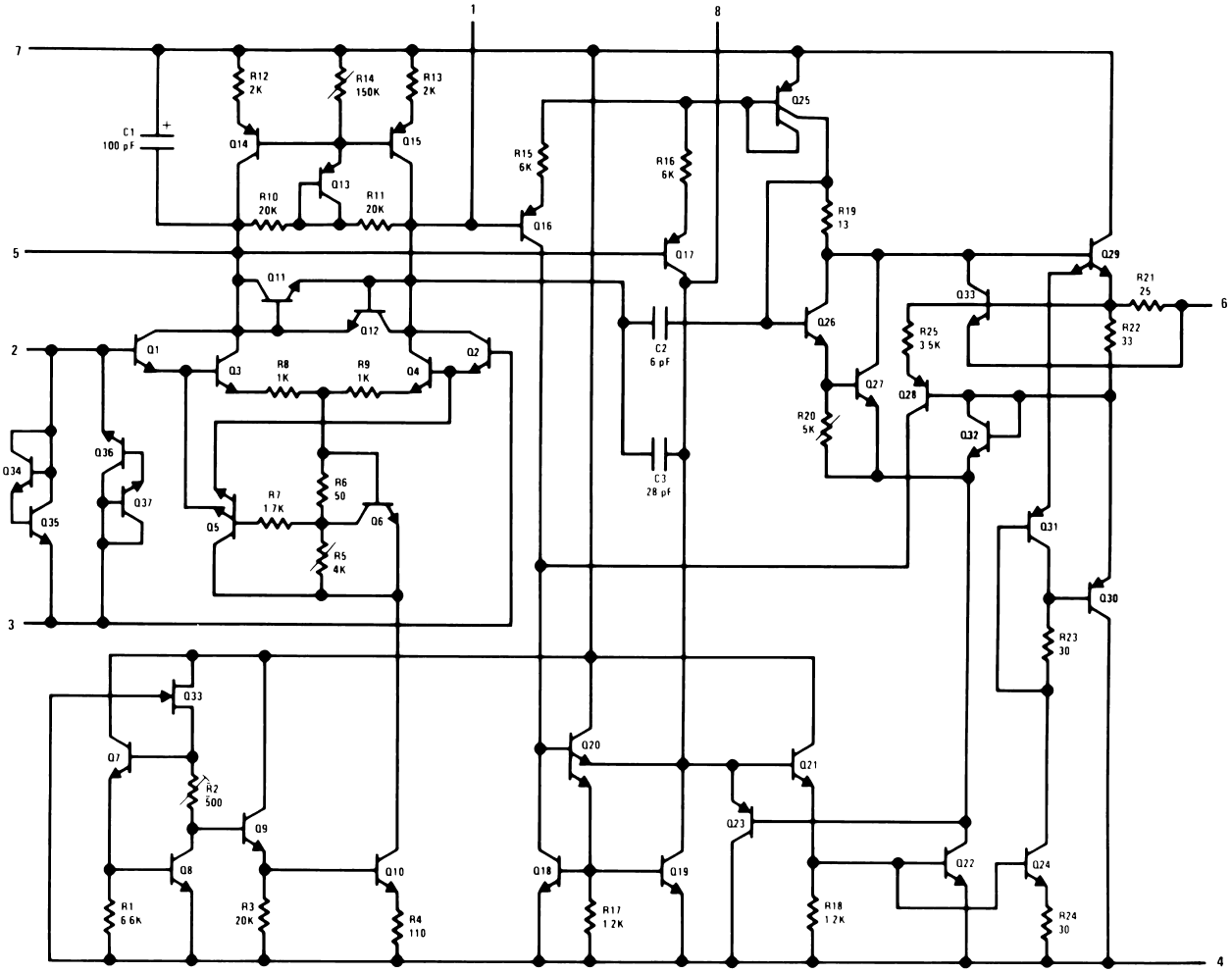
Figure 3. CDIP Package
Top View
See Package Number NAB0008A



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

Figure 4. CLGA Package
Top View
See NS Package Number NAC0010A

Schematic Diagram



Absolute Maximum Ratings(1)

Supply Voltage			±20V
Power Dissipation(2)	8 LD TO-99		750mW
	8LD CDIP		1000mW
	14LD CDIP		1250mW
	10LD CLGA		600mW
Differential Input Current(3)			±10 mA
Input Voltage(4)			±15V
Output Short-Circuit Duration			Continuous
Operating Temperature Range			$-55°C \le T_A \le +125°C$
Thermal Resistance	θ_{JA}	8 LD TO-99 (Still Air @ 0.5W)	160°C/W
		8 LD TO-99 (500LF / Min Air flow @ 0.5W)	86°C/W
		8LD CDIP (Still Air @ 0.5W)	120°C/W
		8LD CDIP (500LF / Min Air flow @ 0.5W)	66°C/W
		14LD CDIP (Still Air @ 0.5W)	87°C/W
		14LD CDIP (500LF / Min Air flow @ 0.5W)	51°C/W
		10LD CLGA (Still Air @ 0.5W)	198°C/W
		10LD CLGA (500LF / Min Air flow @ 0.5W)	124°C/W
	θ_{JC}	8 LD TO-99	48°C/W
		8LD CDIP	17°C/W
		14LD CDIP	17°C/W
		10LD CLGA	22°C/W
Storage Temperature Range			$-65°C \le T_A \le +150°C$
Lead Temperature (Soldering, 10 seconds)			300°C
ESD Tolerance(5)			2000V

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For specifications and test conditions, see the Electrical Characteristics. The specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(2) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.

(3) The inputs are shunted with back-to-back diodes for over voltage 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.

(4) For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

(5) Human body model, 1.5 kΩ in series with 100 pF.

Quality Conformance Inspection

Mil-Std-883, Method 5005; Group A

Subgroup	Description	Temp°C
1	Static tests at	25
2	Static tests at	125
3	Static tests at	-55
4	Dynamic tests at	25
5	Dynamic tests at	125
6	Dynamic tests at	-55
7	Functional tests at	25
8A	Functional tests at	125
8B	Functional tests at	-55
9	Switching tests at	25
10	Switching tests at	125
11	Switching tests at	-55
12	Settling time at	25
13	Settling time at	125
14	Settling time at	-55

LM118/883 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified.

DC V_{CC} = ±15V, V_{CM} = 0V

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{IO}	Input Offset Voltage	V_{CM} = ± 11.5V, R_S = 50Ω		-4.0	+4.0	mV	1
				-6.0	+6.0	mV	2, 3
		V_{CC} = ± 20V, R_S = 50Ω		-4.0	+4.0	mV	1
				-6.0	+6.0	mV	2, 3
		V_{CC} = ± 20V, V_{CM} = ± 15V, R_S = 50Ω		-4.0	+4.0	mV	1
				-6.0	+6.0	mV	2, 3
		V_{CC} = ± 5V, R_S = 50Ω		-4.0	+4.0	mV	1
				-6.0	+6.0	mV	2, 3
I_{IO}	Input Offset Current	V_{CM} = ± 11.5V, R_S = 10KΩ		-50	+50	nA	1
				-100	+100	nA	2, 3
		V_{CC} = ± 20V, R_S = 10KΩ		-50	+50	nA	1
				-100	+100	nA	2, 3
		V_{CC} = ± 5V, R_S = 10KΩ		-50	+50	nA	1
				-100	+100	nA	2, 3
I_{IB}	Input Bias Current	V_{CM} = ± 11.5V, R_S= 10KΩ		1.0	250	nA	1
				1.0	500	nA	2, 3
		V_{CC} = ± 20V, R_S = 10KΩ		1.0	250	nA	1
				1.0	500	nA	2, 3
		V_{CC} = ± 5V, R_S = 10KΩ		1.0	250	nA	1
				1.0	500	nA	2, 3
PSRR	Power Supply Rejection Ratio	+V_{CC} = 20V to 5V, R_S = 50Ω		70		dB	1, 2, 3
		-V_{CC} = -20V to -5V, R_S = 50Ω		70		dB	1, 2, 3
CMRR	Common Mode Rejection Ratio	V_{CC} = ± 15V, V_{CM} = ± 11.5V, R_S = 50Ω		80		dB	1, 2, 3
+I_{OS}	Short Circuit Current	t < 25mS		-65	-5.0	mA	1, 2, 3

LM118/883 Electrical Characteristics DC Parameters (continued)

The following conditions apply, unless otherwise specified.
DC V_{CC} = ±15V, V_{CM} = 0V

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$-I_{OS}$	Short Circuit Current	t < 25mS		5.0	65	mA	1, 2
				5.0	80	mA	3
I_{CC}	Power Supply Current	V_{CC} = ± 20V			8.0	mA	1
					7.0	mA	2
					11	mA	3
V_{IO} adj.	Input Offset Voltage Adjust	V_{CC} = ± 20V		4.0	-4.0	mV	1
R_I	Input Resistance		See(1)	1.0		MΩ	1
V_I	Input Voltage Range	V_{CC} = ± 15V	See(2)	-11.5	+11.5	V	1, 2, 3
A_{VS}	Large Signal Voltage Gain	R_L = 2KΩ, V_O = 0 to -10V	See(3)	50		V/mV	4
			See(3)	25		V/mV	5, 6
		R_L = 2KΩ, V_O = 0 to +10V	See(3)	50		V/mV	4
			See(3)	25		V/mV	5, 6
V_O	Output Voltage Swing	R_L= 2KΩ		+12	-12	V	4, 5, 6

(1) Specified by design not tested
(2) Specified by CMRR
(3) Datalog in K = V/mV

LM118/883 Electrical Characteristics AC Parameters

The following conditions apply parameters, unless otherwise specified.
AC V_{CC} = ±15V, V_{CM} = 0V, R_S = 0Ω, R_L = 2KΩ,, C_L = 33pF

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
S_R	Slew Rate	V_{CC} = ± 20V, V_I = -5V to +5V, A_V=1		50		V/µS	7
		V_{CC} = ± 20V, V_I = +5V to -5V, A_V=1		50		V/µS	7

Typical Performance Characteristics

Input Current

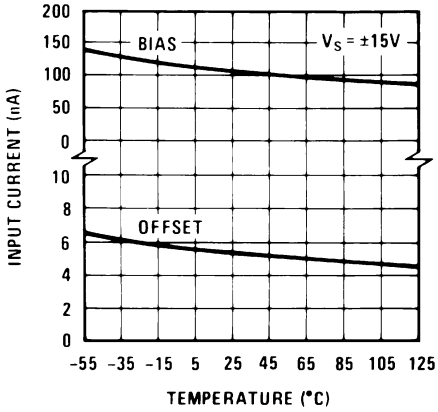


Figure 5.

Voltage Gain

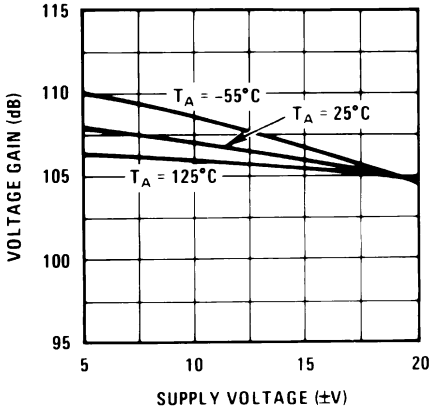


Figure 6.

Power Supply Rejection

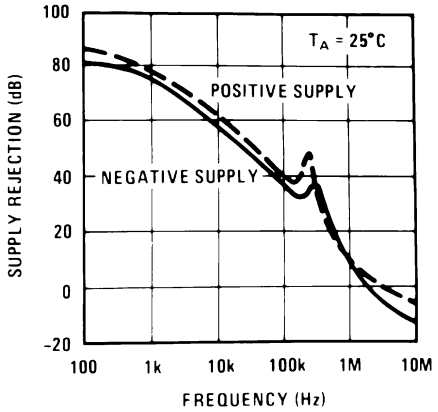


Figure 7.

Input Noise Voltage

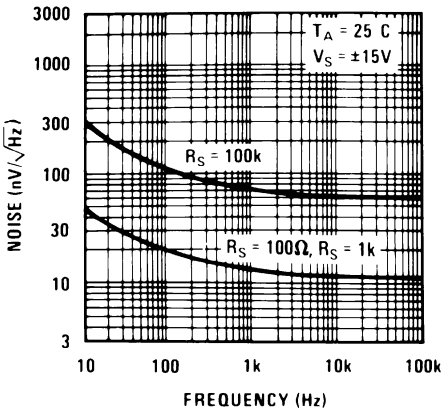


Figure 8.

Common Mode Rejection

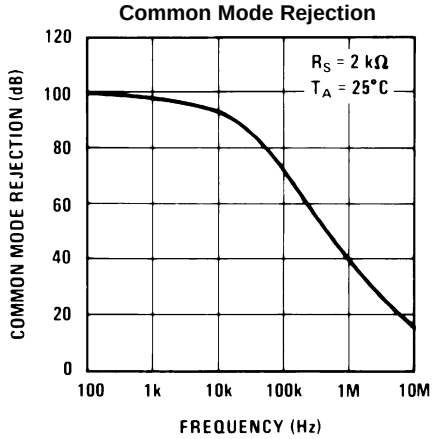


Figure 9.

Supply Current

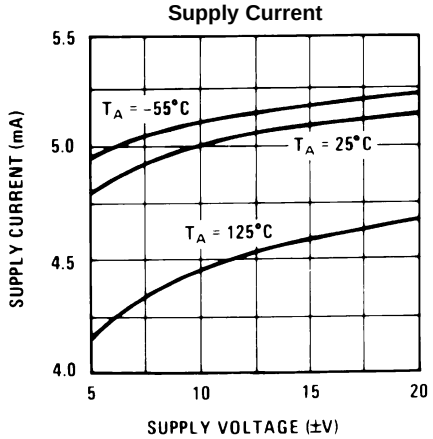


Figure 10.

Typical Performance Characteristics (continued)

Closed Loop Output Impedance

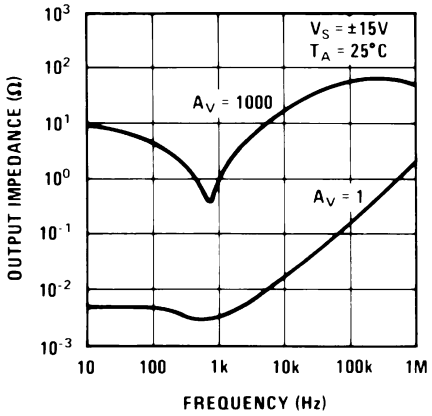


Figure 11.

Current Limiting

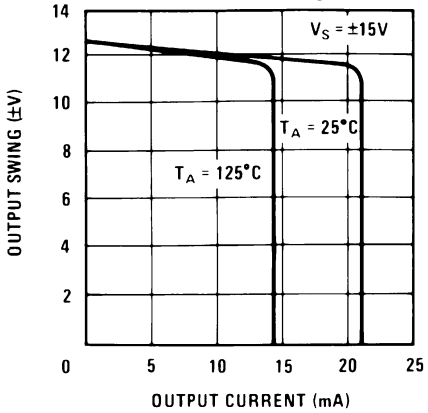


Figure 12.

Input Current

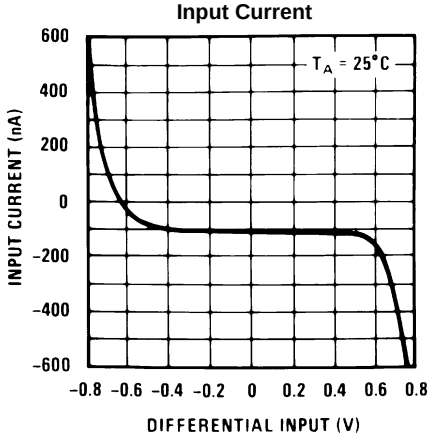


Figure 13.

Unity Gain Bandwidth

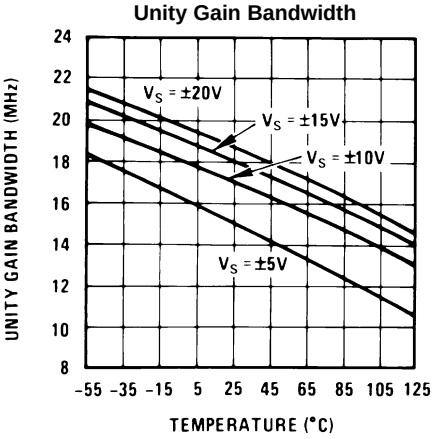


Figure 14.

Voltage Follower Slew Rate

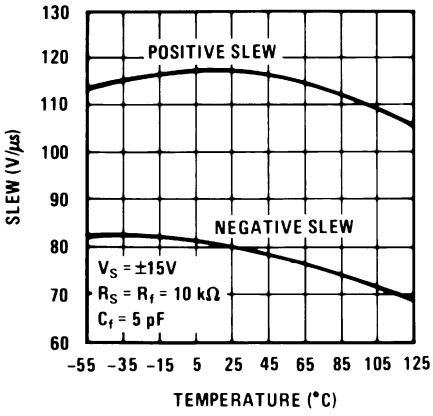


Figure 15.

Inverter Settling Time

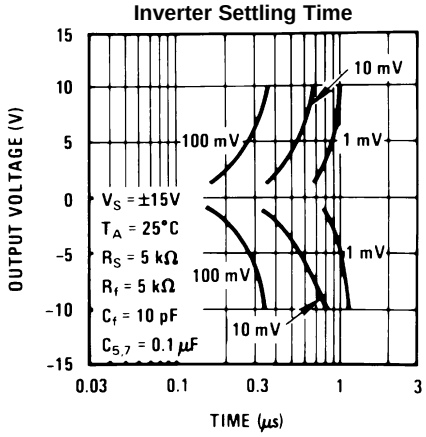


Figure 16.

Typical Performance Characteristics (continued)

Large Signal Frequency Response

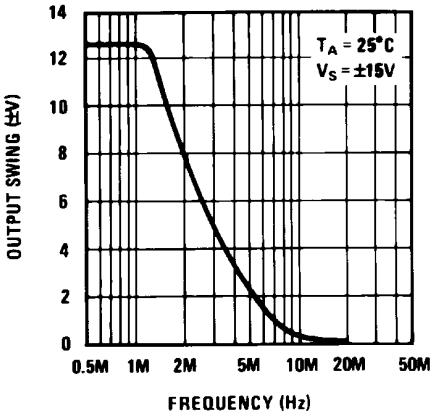


Figure 17.

Open Loop Frequency Response

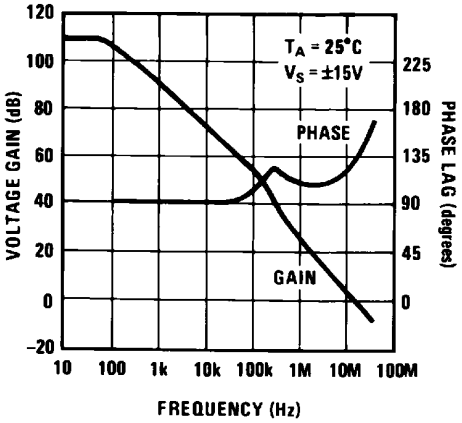


Figure 18.

Voltage Follower Pulse Response

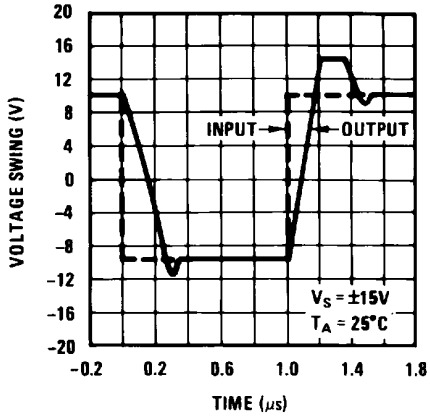


Figure 19.

Large Signal Frequency Response

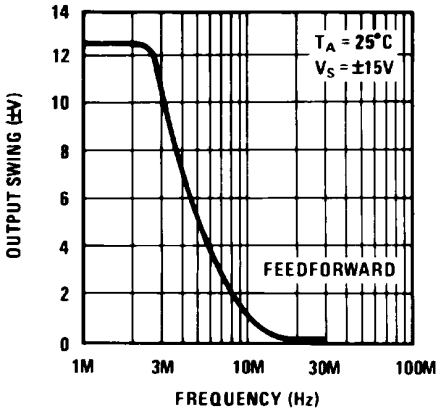


Figure 20.

Open Loop Frequency Response

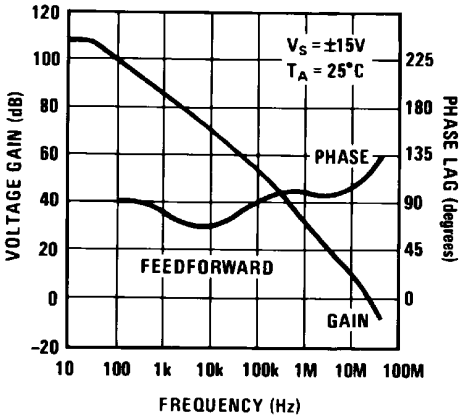


Figure 21.

Inverter Pulse Response

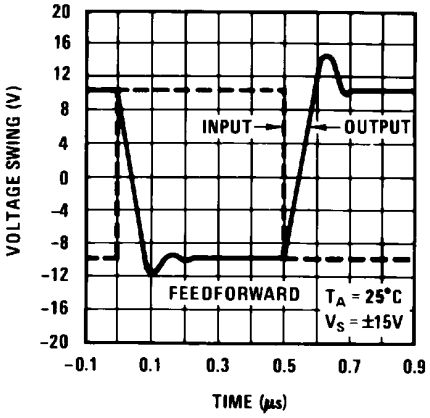
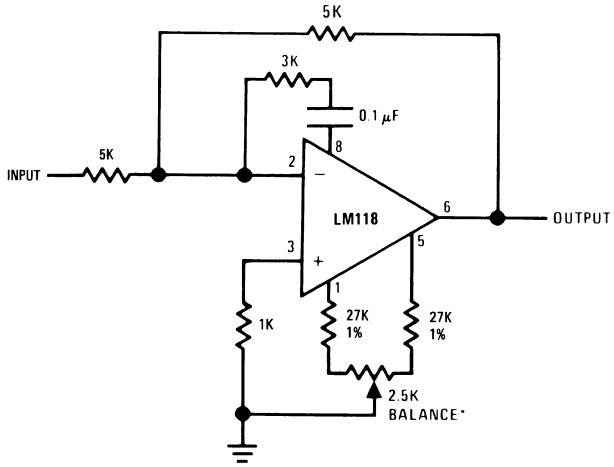


Figure 22.

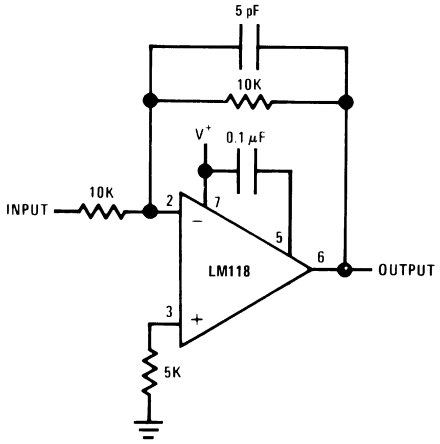
AUXILIARY CIRCUITS

Feedforward Compensation for Greater Inverting Slew Rate



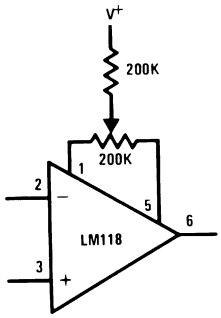
Slew rate typically 150V/µs.

Compensation for Minimum Settling Time

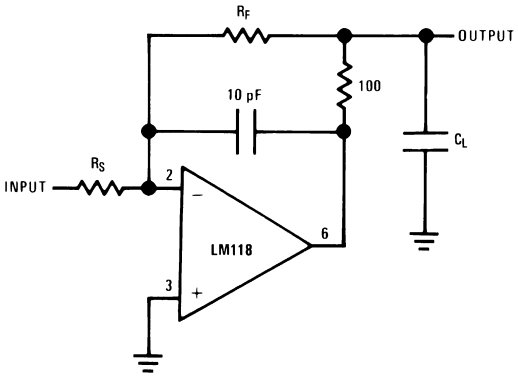


Slew and settling time to 0.1% for a 10V step change is 800 ns.

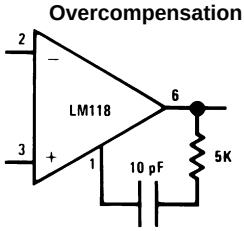
Offset Balancing



Isolating Large Capacitive Loads

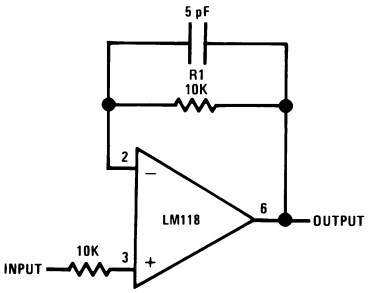


Overcompensation



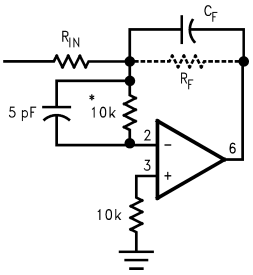
Typical Applications

Fast Voltage Follower



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

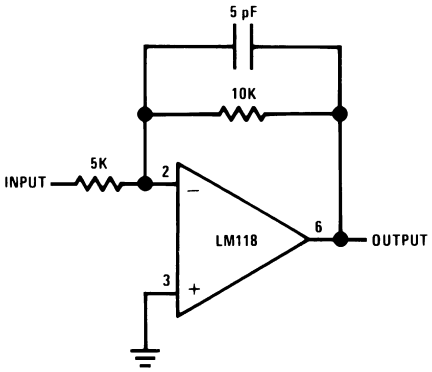
Integrator or Slow Inverter



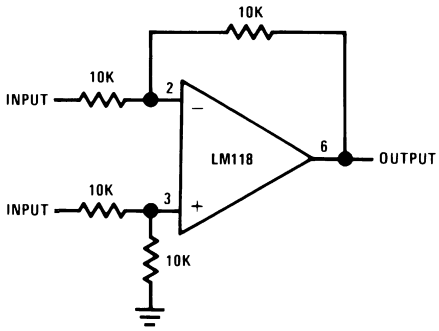
C_F = Large (C_F ≥ 50 pF)

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

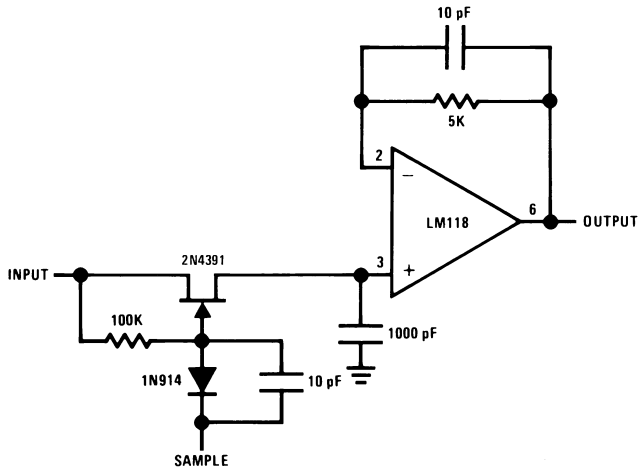
Fast Summing Amplifier



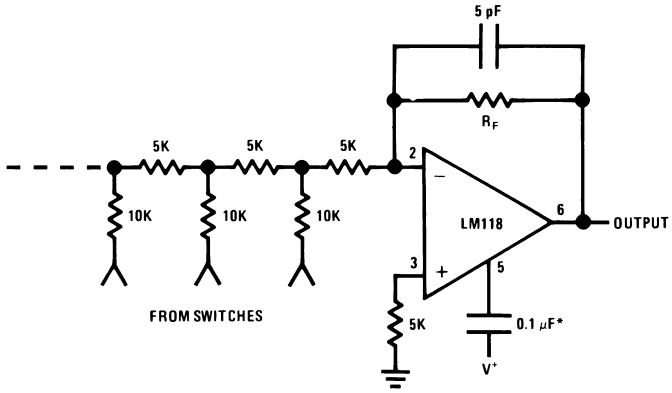
Differential Amplifier



Fast Sample and Hold

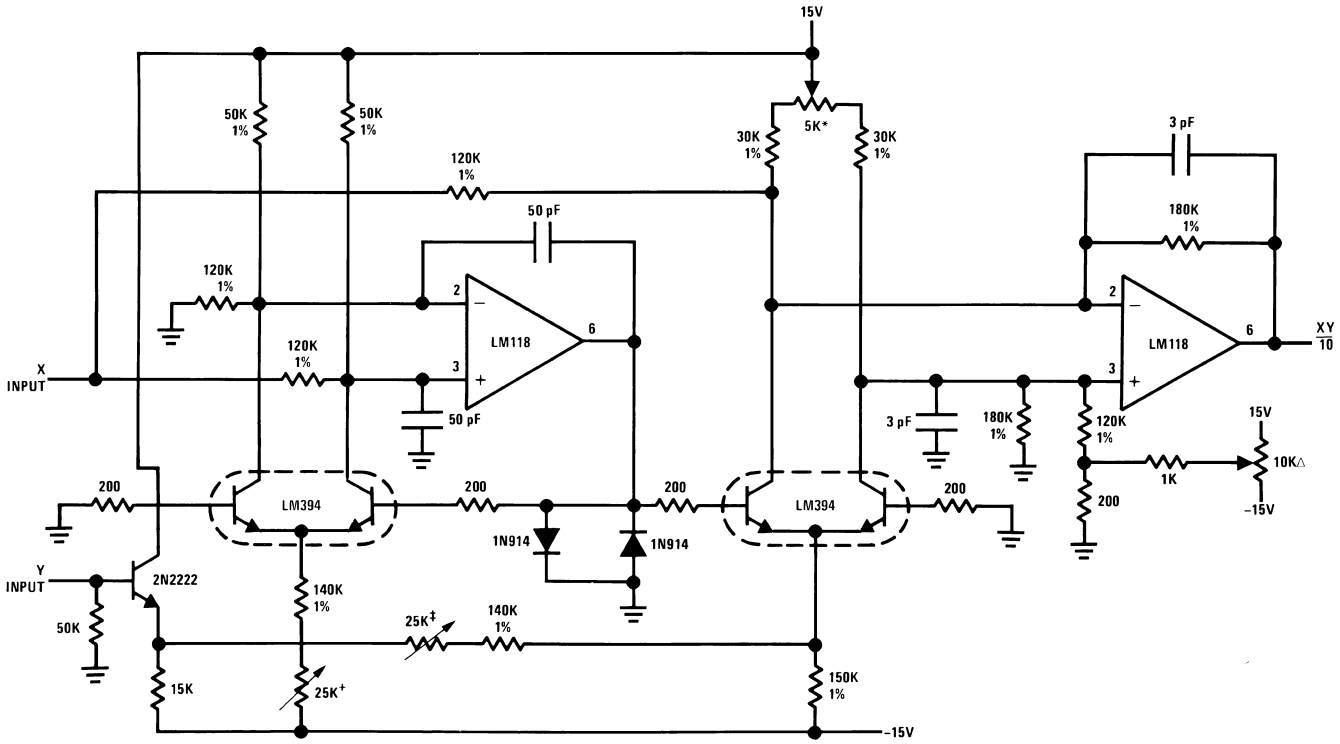


D/A Converter Using Ladder Network



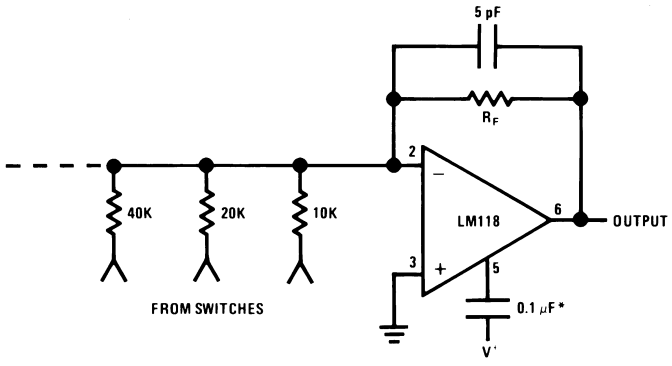
*Optional—Reduces settling time.

Four Quadrant Multiplier



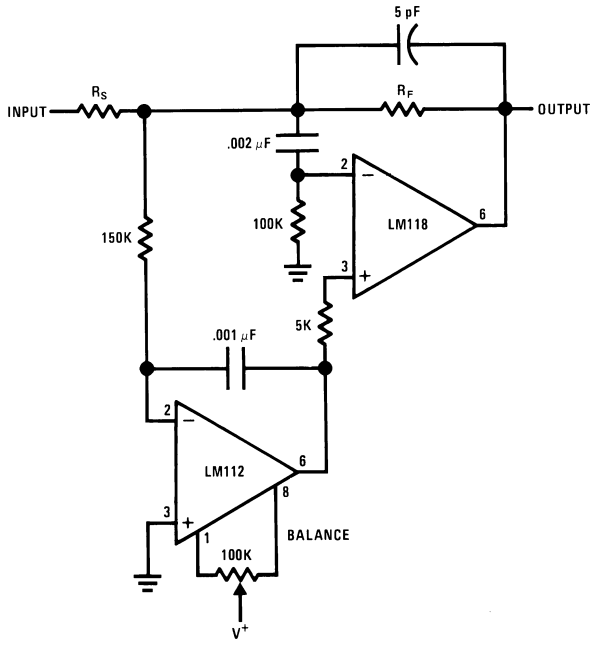
ΔOutput zero.
*"Y" zero
+"X" zero
‡Full scale adjust.

D/A Converter Using Binary Weighted Network



*Optional—Reduces settling time.

Fast Summing Amplifier with Low Input Current



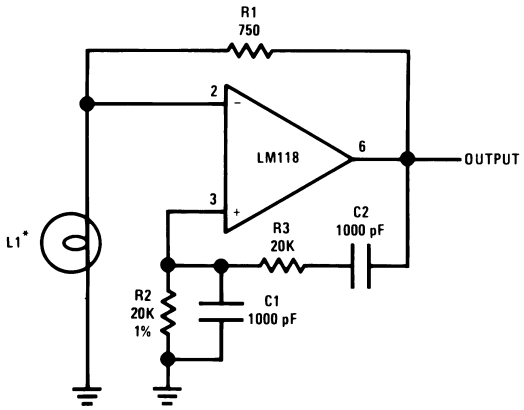
*L1—10V—14 mA bulb ELDEMA 1869

R1 = R2

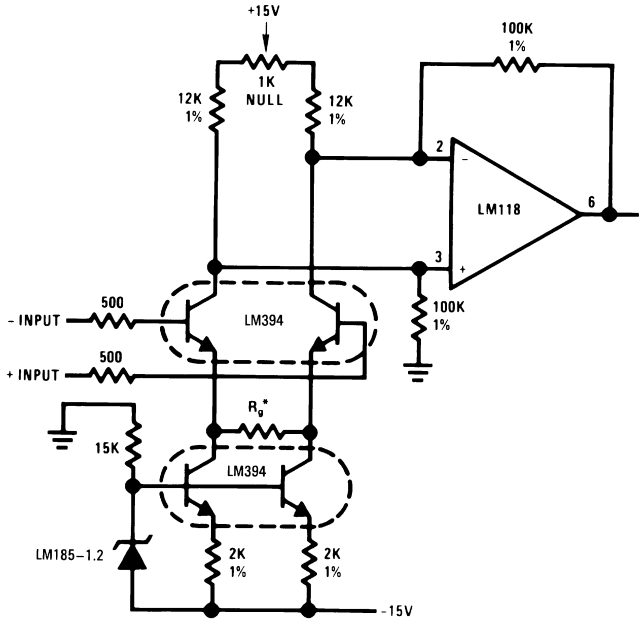
C1 = C2

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

Wein Bridge Sine Wave Oscillator



Instrumentation Amplifier



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

REVISION HISTORY SECTION

Date Released	Revision	Section	Originator	Changes
07/12/05	A	New Release, Corporate format	L. Lytle	1 MDS data sheet, MNLM118–X Rev 0A0 was converted into the Corp. datasheet format. MDS datasheet will be archived.
03/20/2013	A	All Sections		Changed Layout of National Data Sheet to TI format

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM118 MD8	Active	Production	DIESALE (Y) | 0	182 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM118H/883	Active	Production	TO-99 (LMC) | 8	20 | JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	LM118H/883 Q ACO LM118H/883 Q >T
LM118J-8/883	Active	Production	CDIP (NAB) | 8	40 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM118J-8 /883 Q ACO /883 Q >T

(1) Status: For more details on status, see our product life cycle.

(2) 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.

(3) RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

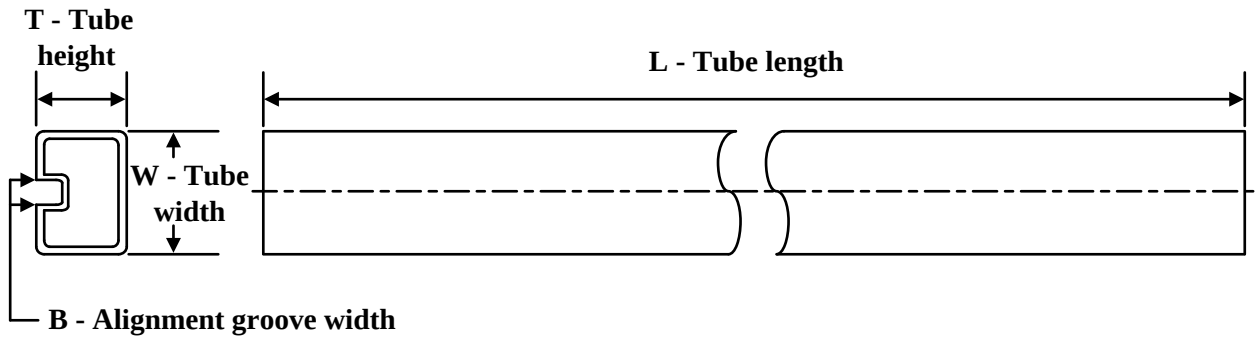
(4) Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) 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.

(6) 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.

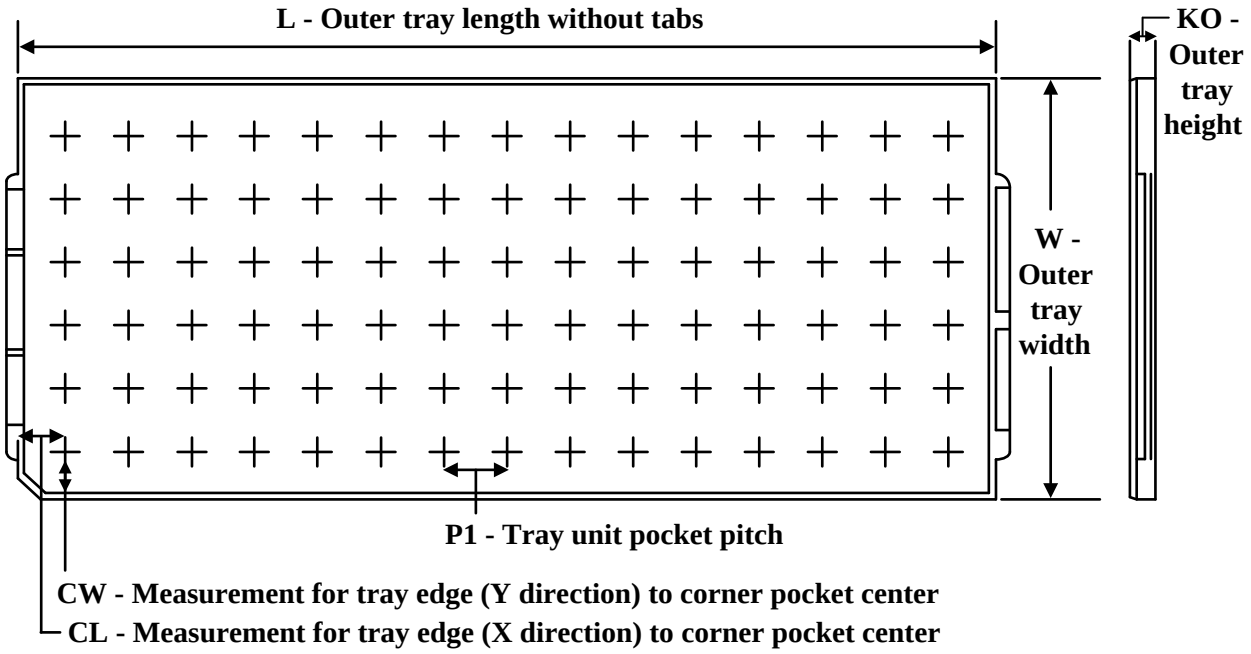
TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM118J-8/883	NAB	CDIP	8	40	506.98	15.24	13440	NA

TRAY

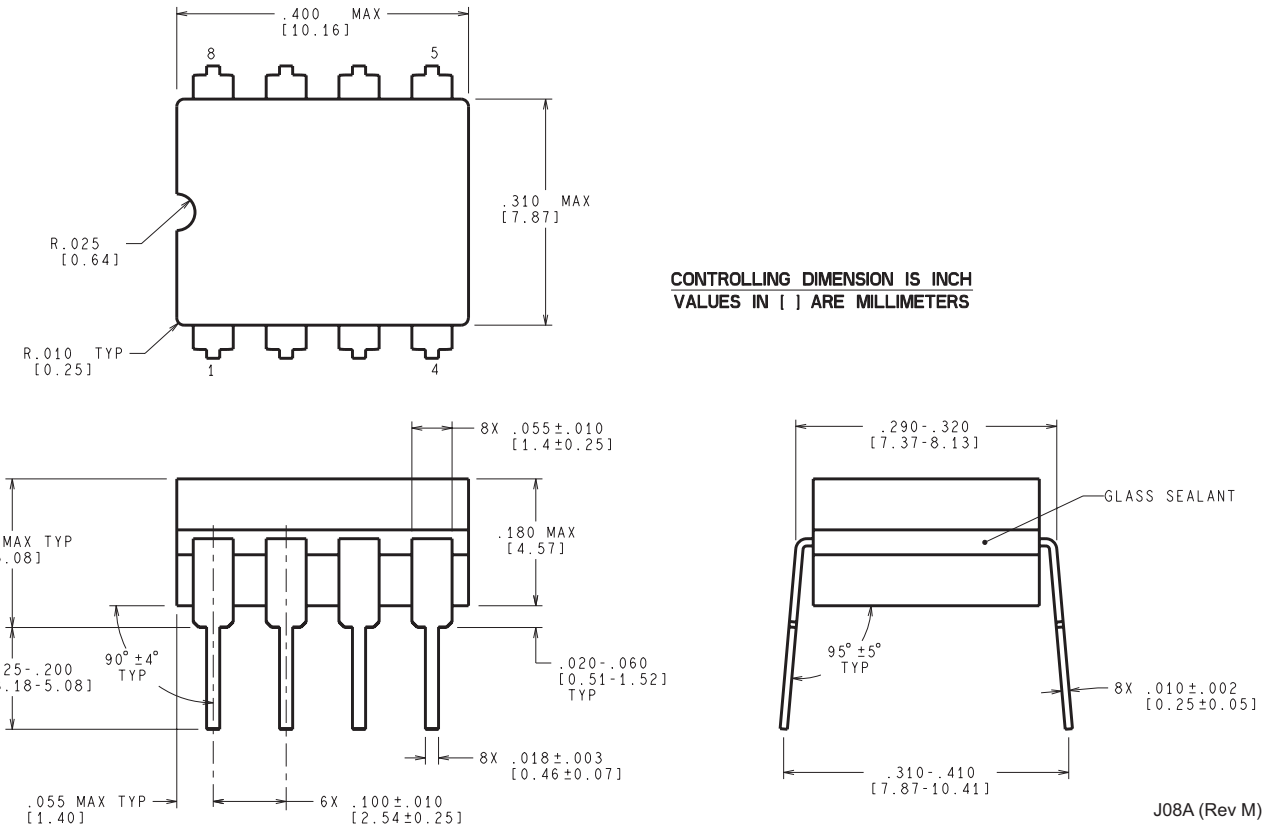


Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
LM118H/883	LMC	TO-CAN	8	20	2 X 10	150	126.49	61.98	8890	11.18	12.95	18.54

NAB0008A

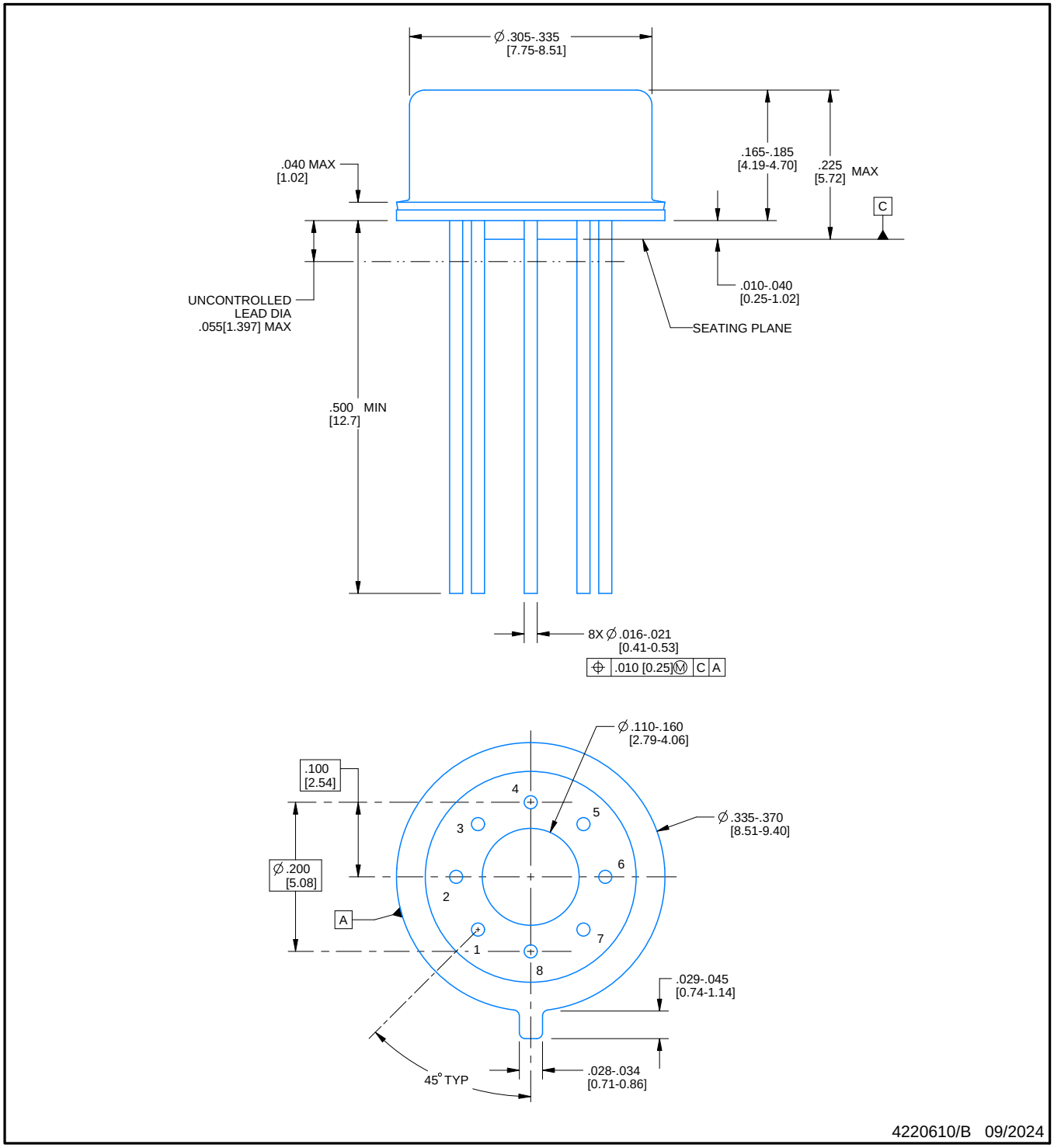

.400 MAX
[10.16]
8
5
.310 MAX
[7.87]
R.025
[0.64]
R.010 TYP
[0.25]
1
4
CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS
8X .055±.010
[1.4±0.25]
.200 MAX TYP
[5.08]
.180 MAX
[4.57]
8X .125-.200
[3.18-5.08]
90° ±4°
TYP
.020-.060
[0.51-1.52]
TYP
8X .018±.003
[0.46±0.07]
.055 MAX TYP
[1.40]
6X .100±.010
[2.54±0.25]
.290-.320
[7.37-8.13]
GLASS SEALANT
95° ±5°
TYP
8X .010±.002
[0.25±0.05]
.310-.410
[7.87-10.41]
J08A (Rev M)

PACKAGE OUTLINE

LMC0008A

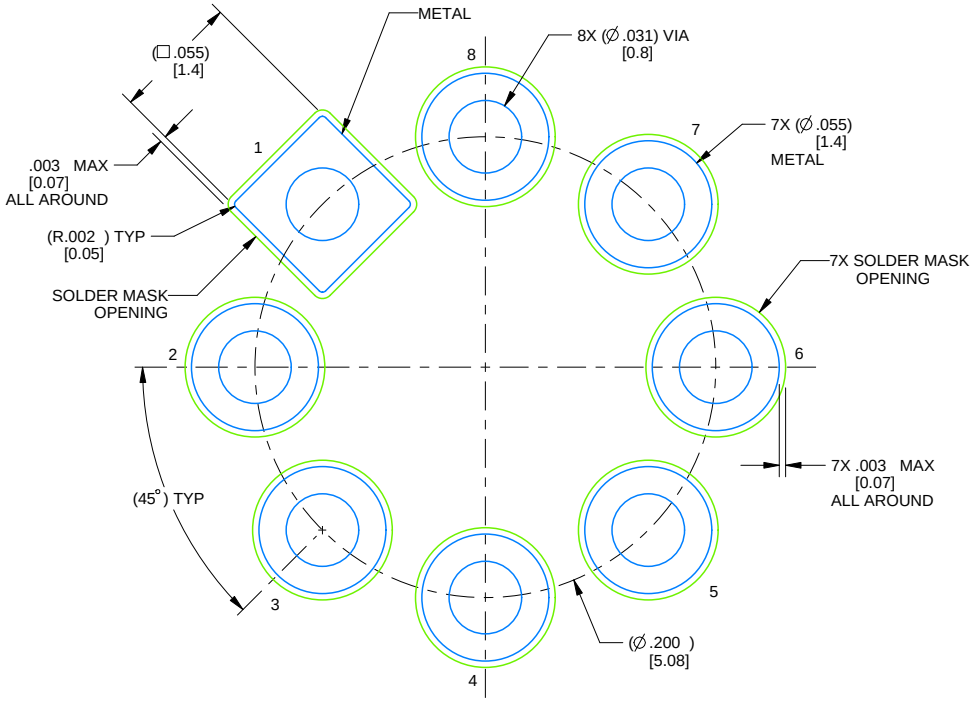
TO-CAN - 5.72 mm max height

TRANSISTOR OUTLINE



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.



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

4220610/B 09/2024

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