

## 3-Terminal Positive Regulators

### General Description

The LM78LXX series of three terminal positive regulators is available with several fixed output voltages making them useful in a wide range of applications. When used as a zener diode/resistor combination replacement, the LM78LXX usually results in an effective output impedance improvement of two orders of magnitude, and lower quiescent current. These regulators can provide local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow the LM78LXX to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment.

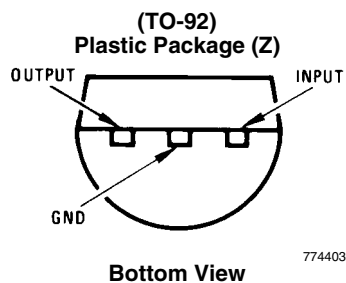
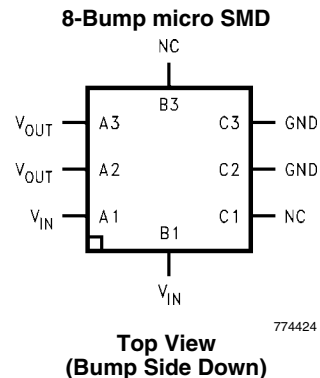
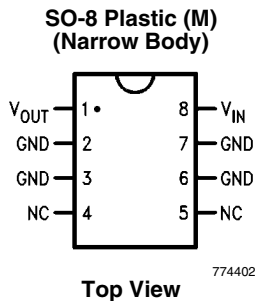
The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistors is provided to limit internal power dissipation.

If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

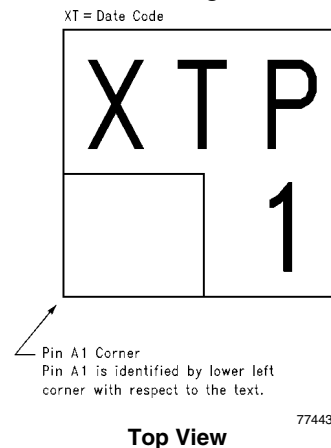
### Features

- LM78L05 in micro SMD package
- Output voltage tolerances of  $\pm 5\%$  over the temperature range
- Output current of 100mA
- Internal thermal overload protection
- Output transistor safe area protection
- Internal short circuit current limit
- Available in plastic TO-92 and plastic SO-8 low profile packages
- No external components
- Output voltages of 5.0V, 6.2V, 8.2V, 9.0V, 12V, 15V
- See AN-1112 for micro SMD considerations

### Connection Diagrams



### micro SMD Marking Orientation



## Ordering Information

Package	NSC Drawing	Output Voltage	Order Number	Supplied As
micro SMD	BPA08AAB	5V	LM78L05IBPX	Reel of 3000
Thin micro SMD	TPA08AAA	5V	LM78L05ITP	Reel of 250
			LM78L05ITPX	Reel of 3000
		9V	LM78L09ITPX	Reel of 3000
SOIC Narrow	M08A	5V	LM78L05ACM	Rail of 95
			LM78L05ACMX	Reel of 2500
			LM78L05AIM	Rail of 95
			LM78L05AIMX	Reel of 2500
		12V	LM78L12ACMX	Reel of 2500
		15V	LM78L15ACMX	Reel of 2500
TO-92	Z03A	5V	LM78L05ACZ	Box of 1800
		6.2V	LM78L62ACZ	Box of 1800
		9V	LM78L09ACZ	Box of 1800
		12V	LM78L12ACZ	Box of 1800
		15V	LM78L15ACZ	Box of 1800

**Absolute Maximum Ratings** (Note 1)

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

Power Dissipation (Note 5)	Internally Limited
Input Voltage	35V
Storage Temperature	-65°C to +150°C
ESD Susceptibility (Note 2)	1kV

Operating Junction Temperature	
SO-8, TO-92	0°C to 125°C
SO-8 (5V Only)	-40°C to 125°C
micro SMD	-40°C to 85°C
Soldering Information	
Infrared or Convection (20 sec.)	235°C
Wave Soldering (10 sec.)	260°C (lead time)

**LM78LXX Electrical Characteristics** Limits in standard typeface are for  $T_J = 25^\circ\text{C}$ , **Bold typeface applies over the entire operating temperature range of the indicated package.** Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. Unless otherwise specified:  $I_O = 40\text{mA}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ .

**LM78L05**

Unless otherwise specified,  $V_{IN} = 10\text{V}$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_O$	Output Voltage		4.8	5	5.2	V
		$7\text{V} \leq V_{IN} \leq 20\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3)	<b>4.75</b>		<b>5.25</b>	
		$1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3)	<b>4.75</b>		<b>5.25</b>	
$\Delta V_O$	Line Regulation	$7\text{V} \leq V_{IN} \leq 20\text{V}$		18	75	mV
		$8\text{V} \leq V_{IN} \leq 20\text{V}$		10	54	
$\Delta V_O$	Load Regulation	$1\text{mA} \leq I_O \leq 100\text{mA}$		20	60	
		$1\text{mA} \leq I_O \leq 40\text{mA}$		5	30	
$I_Q$	Quiescent Current			3	5	mA
$\Delta I_Q$	Quiescent Current Change	$8\text{V} \leq V_{IN} \leq 20\text{V}$			<b>1.0</b>	
		$1\text{mA} \leq I_O \leq 40\text{mA}$			<b>0.1</b>	
$V_n$	Output Noise Voltage	$f = 10\text{ Hz to } 100\text{ kHz}$ (Note 4)		40		$\mu\text{V}$
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120\text{ Hz}$ $8\text{V} \leq V_{IN} \leq 16\text{V}$	47	62		dB
$I_{PK}$	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	$I_O = 5\text{mA}$		-0.65		$\text{mV}/^\circ\text{C}$
$V_{IN} (\text{Min})$	Minimum Value of Input Voltage Required to Maintain Line Regulation			6.7	7	V
$\theta_{JA}$	Thermal Resistance (8-Bump micro SMD)			230.9		$^\circ\text{C}/\text{W}$

**LM78L62AC**Unless otherwise specified,  $V_{IN} = 12V$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_O$	Output Voltage		5.95	6.2	6.45	V
		$8.5V \leq V_{IN} \leq 20V$ $1mA \leq I_O \leq 40mA$ (Note 3)	5.9		6.5	
		$1mA \leq I_O \leq 70mA$ (Note 3)	5.9		6.5	
$\Delta V_O$	Line Regulation	$8.5V \leq V_{IN} \leq 20V$		65	175	mV
		$9V \leq V_{IN} \leq 20V$		55	125	
$\Delta V_O$	Load Regulation	$1mA \leq I_O \leq 100mA$		13	80	
		$1mA \leq I_O \leq 40mA$		6	40	
$I_Q$	Quiescent Current			2	5.5	mA
$\Delta I_Q$	Quiescent Current Change	$8V \leq V_{IN} \leq 20V$			1.5	
		$1mA \leq I_O \leq 40mA$			0.1	
$V_n$	Output Noise Voltage	$f = 10 \text{ Hz to } 100 \text{ kHz}$ (Note 4)		50		$\mu V$
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120 \text{ Hz}$ $10V \leq V_{IN} \leq 20V$	40	46		dB
$I_{PK}$	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	$I_O = 5mA$		-0.75		$mV/^{\circ}C$
$V_{IN} \text{ (Min)}$	Minimum Value of Input Voltage Required to Maintain Line Regulation			7.9		V

**LM78L82AC**Unless otherwise specified,  $V_{IN} = 14V$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_O$	Output Voltage		7.87	8.2	8.53	V
		$11V \leq V_{IN} \leq 23V$ $1mA \leq I_O \leq 40mA$ (Note 3)	7.8		8.6	
		$1mA \leq I_O \leq 70mA$ (Note 3)	7.8		8.6	
$\Delta V_O$	Line Regulation	$11V \leq V_{IN} \leq 23V$		80	175	mV
		$12V \leq V_{IN} \leq 23V$		70	125	
$\Delta V_O$	Load Regulation	$1mA \leq I_O \leq 100mA$		15	80	
		$1mA \leq I_O \leq 40mA$		8	40	
$I_Q$	Quiescent Current			2	5.5	mA
$\Delta I_Q$	Quiescent Current Change	$12V \leq V_{IN} \leq 23V$			1.5	
		$1mA \leq I_O \leq 40mA$			0.1	
$V_n$	Output Noise Voltage	$f = 10 \text{ Hz to } 100 \text{ kHz}$ (Note 4)		60		$\mu V$
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120 \text{ Hz}$ $12V \leq V_{IN} \leq 22V$	39	45		dB
$I_{PK}$	Peak Output Current			140		mA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	$I_O = 5\text{mA}$		-0.8		mV/°C
$V_{IN}(\text{Min})$	Minimum Value of Input Voltage Required to Maintain Line Regulation			9.9		V

## LM78L09AC

Unless otherwise specified,  $V_{IN} = 15\text{V}$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_O$	Output Voltage		8.64	9.0	9.36	V
		$11.5\text{V} \leq V_{IN} \leq 24\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3)	8.55		9.45	
		$1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3)	8.55		9.45	
$\Delta V_O$	Line Regulation	$11.5\text{V} \leq V_{IN} \leq 24\text{V}$		100	200	mV
		$13\text{V} \leq V_{IN} \leq 24\text{V}$		90	150	
$\Delta V_O$	Load Regulation	$1\text{mA} \leq I_O \leq 100\text{mA}$		20	90	mV
		$1\text{mA} \leq I_O \leq 40\text{mA}$		10	45	
$I_Q$	Quiescent Current			2	5.5	mA
$\Delta I_Q$	Quiescent Current Change	$11.5\text{V} \leq V_{IN} \leq 24\text{V}$			1.5	
		$1\text{mA} \leq I_O \leq 40\text{mA}$			0.1	
$V_n$	Output Noise Voltage			70		$\mu\text{V}$
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120\text{Hz}$ $15\text{V} \leq V_{IN} \leq 25\text{V}$	38	44		dB
$I_{PK}$	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	$I_O = 5\text{mA}$		-0.9		mV/°C
$V_{IN}(\text{Min})$	Minimum Value of Input Voltage Required to Maintain Line Regulation			10.7		V

## LM78L12AC

Unless otherwise specified,  $V_{IN} = 19\text{V}$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_O$	Output Voltage		11.5	12	12.5	V
		$14.5\text{V} \leq V_{IN} \leq 27\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3)	11.4		12.6	
		$1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3)	11.4		12.6	
$\Delta V_O$	Line Regulation	$14.5\text{V} \leq V_{IN} \leq 27\text{V}$		30	180	mV
		$16\text{V} \leq V_{IN} \leq 27\text{V}$		20	110	
$\Delta V_O$	Load Regulation	$1\text{mA} \leq I_O \leq 100\text{mA}$		30	100	mV
		$1\text{mA} \leq I_O \leq 40\text{mA}$		10	50	
$I_Q$	Quiescent Current			3	5	mA
$\Delta I_Q$	Quiescent Current Change	$16\text{V} \leq V_{IN} \leq 27\text{V}$			1	
		$1\text{mA} \leq I_O \leq 40\text{mA}$			0.1	
$V_n$	Output Noise Voltage			80		$\mu\text{V}$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120 \text{ Hz}$ $15V \leq V_{IN} \leq 25$	40	54		dB
$I_{PK}$	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	$I_O = 5\text{mA}$		-1.0		mV/°C
$V_{IN} \text{ (Min)}$	Minimum Value of Input Voltage Required to Maintain Line Regulation			13.7	14.5	V

## LM78L15AC

Unless otherwise specified,  $V_{IN} = 23V$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_O$	Output Voltage		14.4	15.0	15.6	V
		$17.5V \leq V_{IN} \leq 30V$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3)	14.25		15.75	
		$1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3)	14.25		15.75	
$\Delta V_O$	Line Regulation	$17.5V \leq V_{IN} \leq 30V$		37	250	mV
		$20V \leq V_{IN} \leq 30V$		25	140	
$\Delta V_O$	Load Regulation	$1\text{mA} \leq I_O \leq 100\text{mA}$		35	150	
		$1\text{mA} \leq I_O \leq 40\text{mA}$		12	75	
$I_Q$	Quiescent Current			3	5	mA
$\Delta I_Q$	Quiescent Current Change	$20V \leq V_{IN} \leq 30V$			1	
		$1\text{mA} \leq I_O \leq 40\text{mA}$			0.1	
$V_n$	Output Noise Voltage			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120 \text{ Hz}$ $18.5V \leq V_{IN} \leq 28.5V$	37	51		dB
$I_{PK}$	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	$I_O = 5\text{mA}$		-1.3		mV/°C
$V_{IN} \text{ (Min)}$	Minimum Value of Input Voltage Required to Maintain Line Regulation			16.7	17.5	V

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device outside of its stated operating conditions.

**Note 2:** Human body model, 1.5 kΩ in series with 100pF.

**Note 3:** Power dissipation  $\leq 0.75W$ .

**Note 4:** Recommended minimum load capacitance of 0.01μF to limit high frequency noise.

**Note 5:** Typical thermal resistance values for the packages are:

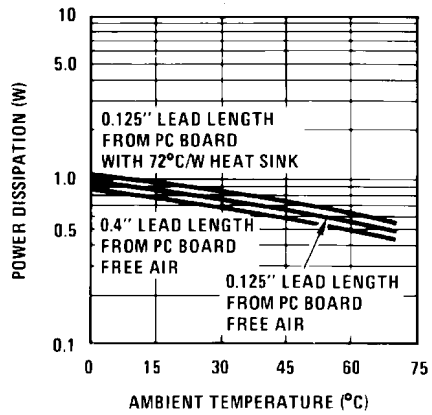
**Z** Package:  $\theta_{JC} = 60 \text{ }^\circ\text{C/W}$ ,  $\theta_{JA} = 230 \text{ }^\circ\text{C/W}$

**M** Package:  $\theta_{JA} = 180 \text{ }^\circ\text{C/W}$

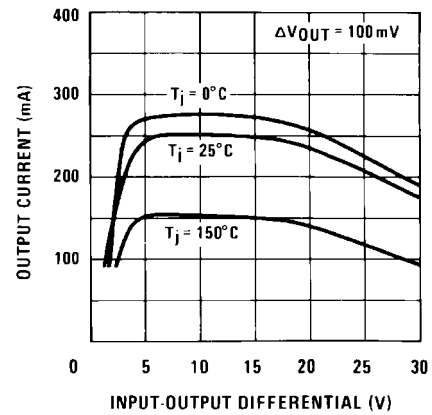
**micro SMD** Package:  $\theta_{JA} = 230.9 \text{ }^\circ\text{C/W}$

## Typical Performance Characteristics

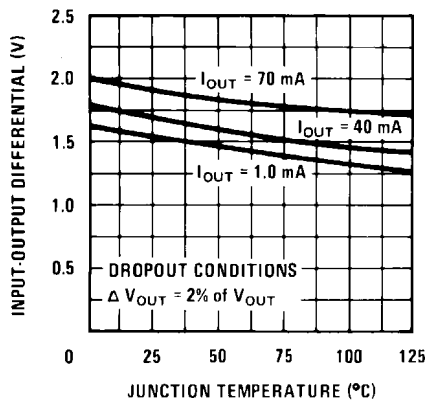
### Maximum Average Power Dissipation (Z Package)



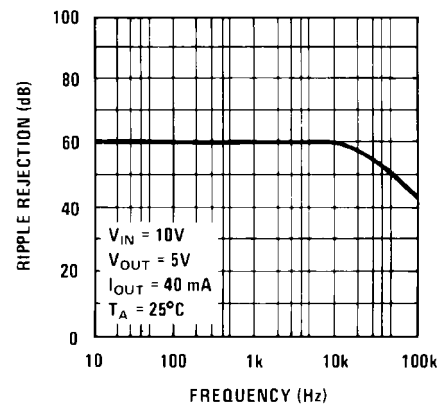
### Peak Output Current



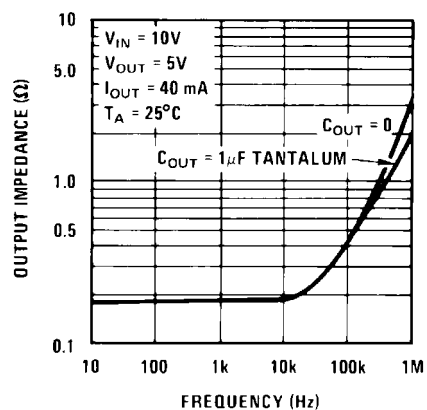
### Dropout Voltage



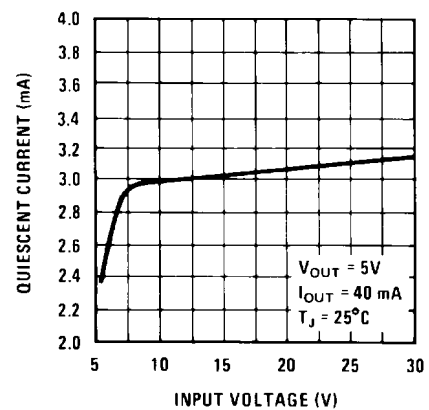
### Ripple Rejection

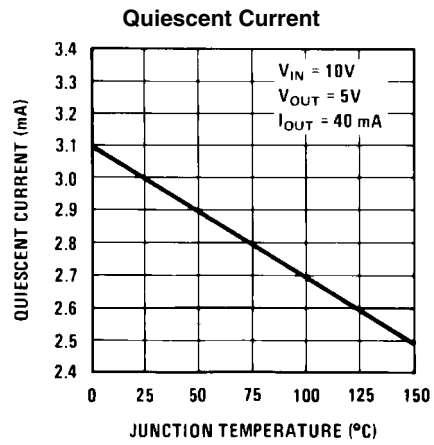


### Output Impedance



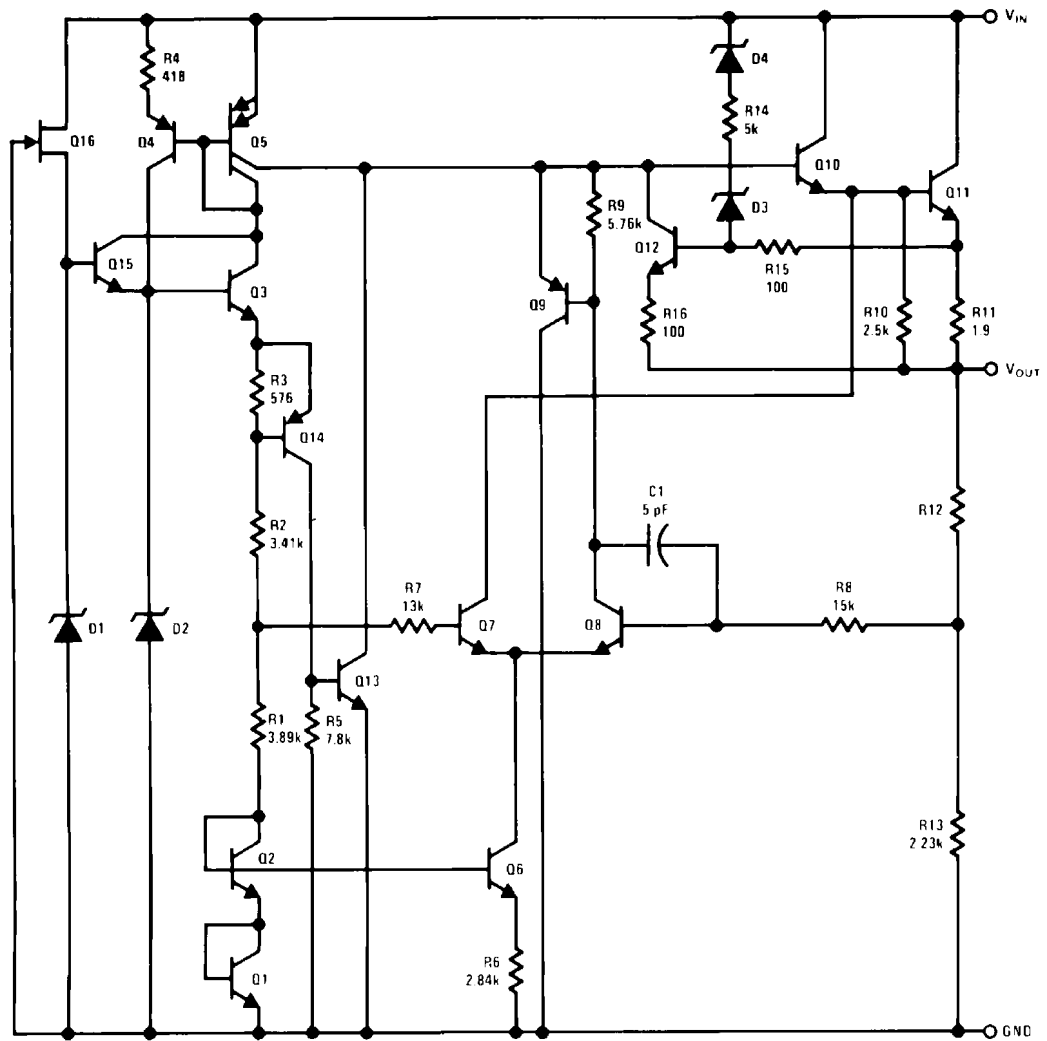
### Quiescent Current





## Equivalent Circuit

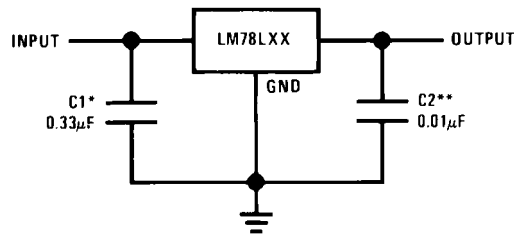
### LM78LXX





## Typical Applications

### Fixed Output Regulator

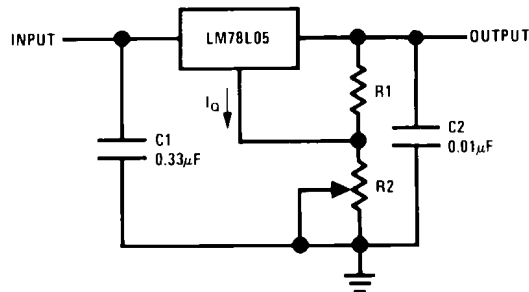


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\*Required if the regulator is located more than 3" from the power supply filter.

\*\*See (Note 4) in the electrical characteristics table.

### Adjustable Output Regulator

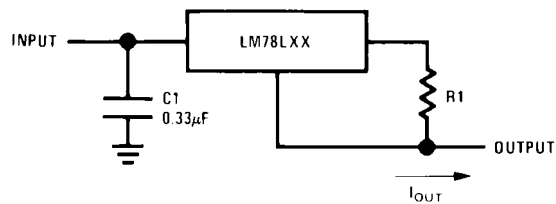


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$$V_{OUT} = 5V + (5V/R1 + I_Q) R2$$

$$5V/R1 > 3 I_Q, \text{ load regulation } (L_r) \approx [(R1 + R2)/R1] (L_r \text{ of LM78L05})$$

### Current Regulator

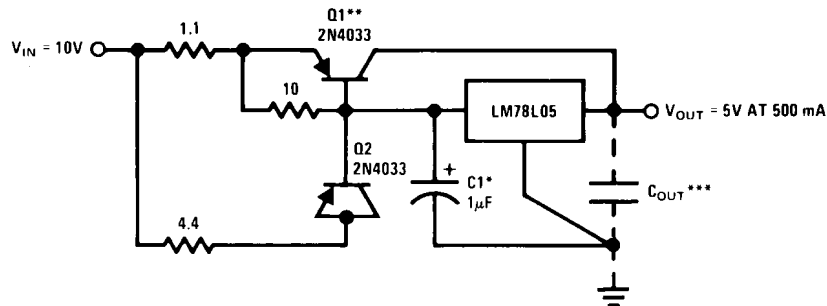


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$$I_{OUT} = (V_{OUT}/R1) + I_Q$$

$>I_Q = 1.5\text{mA}$  over line and load changes

### 5V, 500mA Regulator with Short Circuit Protection



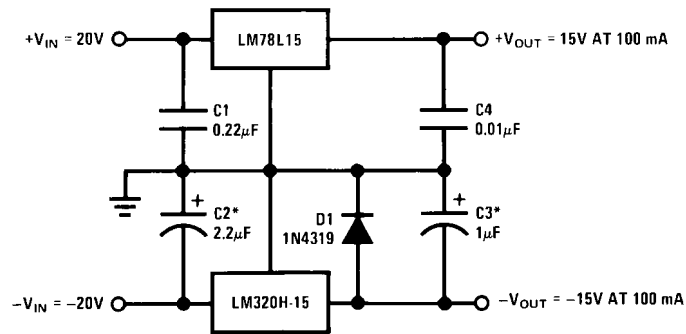
774411

\*Solid tantalum.

\*\*Heat sink Q1.

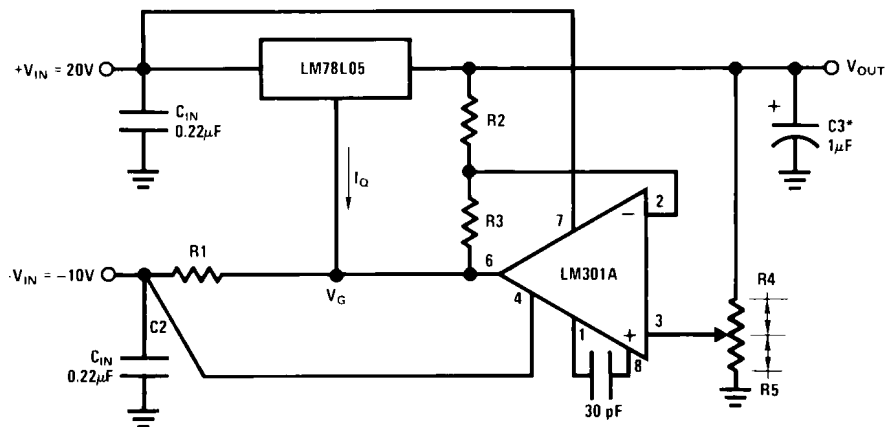
\*\*\*Optional: Improves ripple rejection and transient response.

Load Regulation:  $0.6\% \leq I_L \leq 250\text{mA}$  pulsed with  $t_{ON} = 50\text{ms}$ .

**±15V, 100mA Dual Power Supply**

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\*Solid tantalum.

**Variable Output Regulator 0.5V-18V**

774413

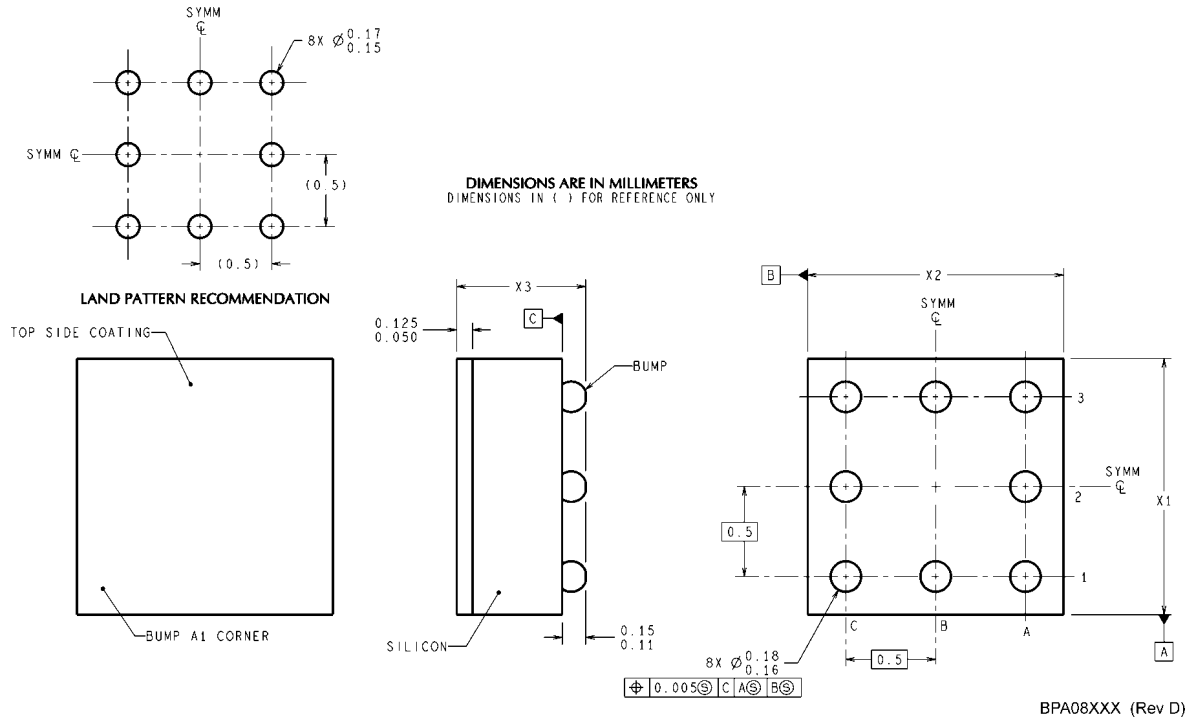
\*Solid tantalum.

$$V_{OUT} = V_G + 5V, R1 = (-V_{IN}/I_{Q \text{ LM78L05}})$$

$$V_{OUT} = 5V (R2/R4) \text{ for } (R2 + R3) = (R4 + R5)$$

$$\text{A } 0.5V \text{ output will correspond to } (R2/R4) = 0.1 \text{ } (R3/R4) = 0.9$$

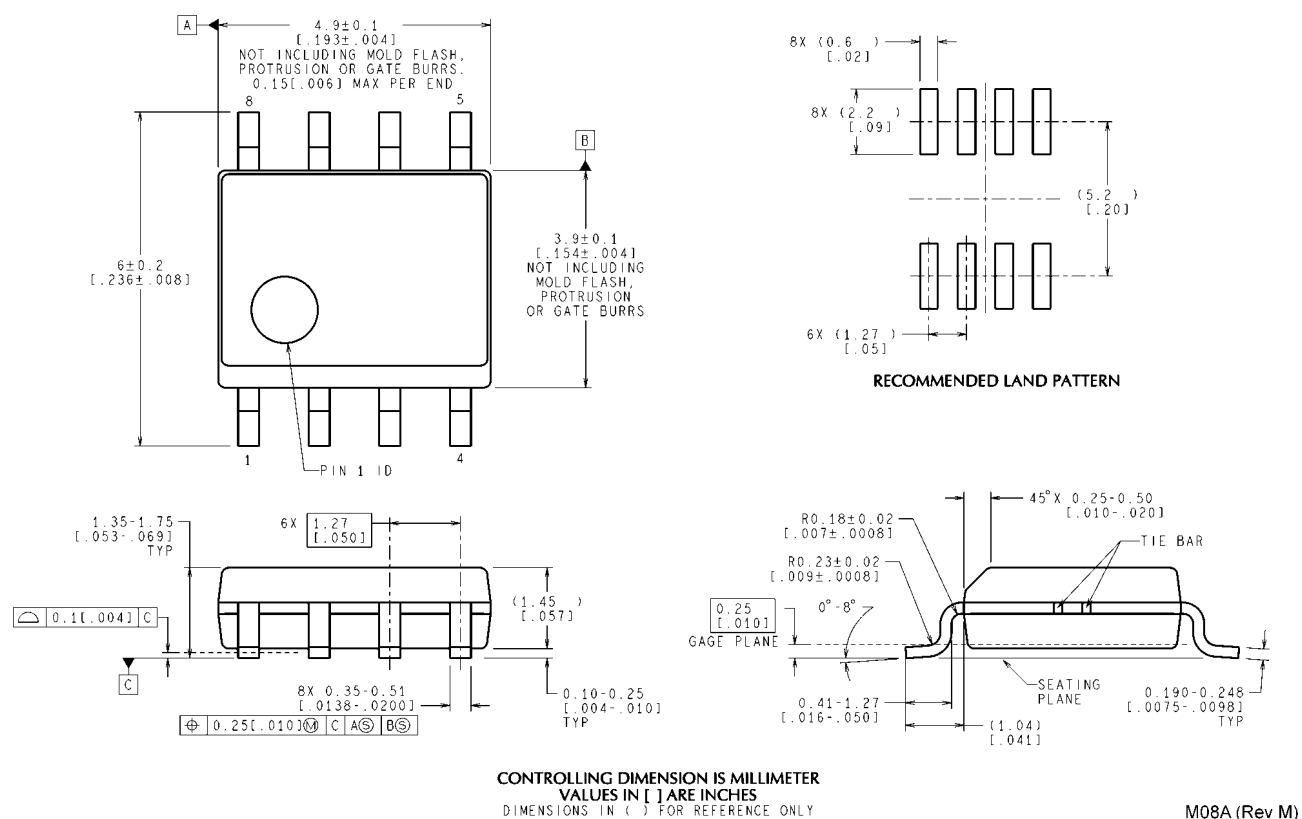
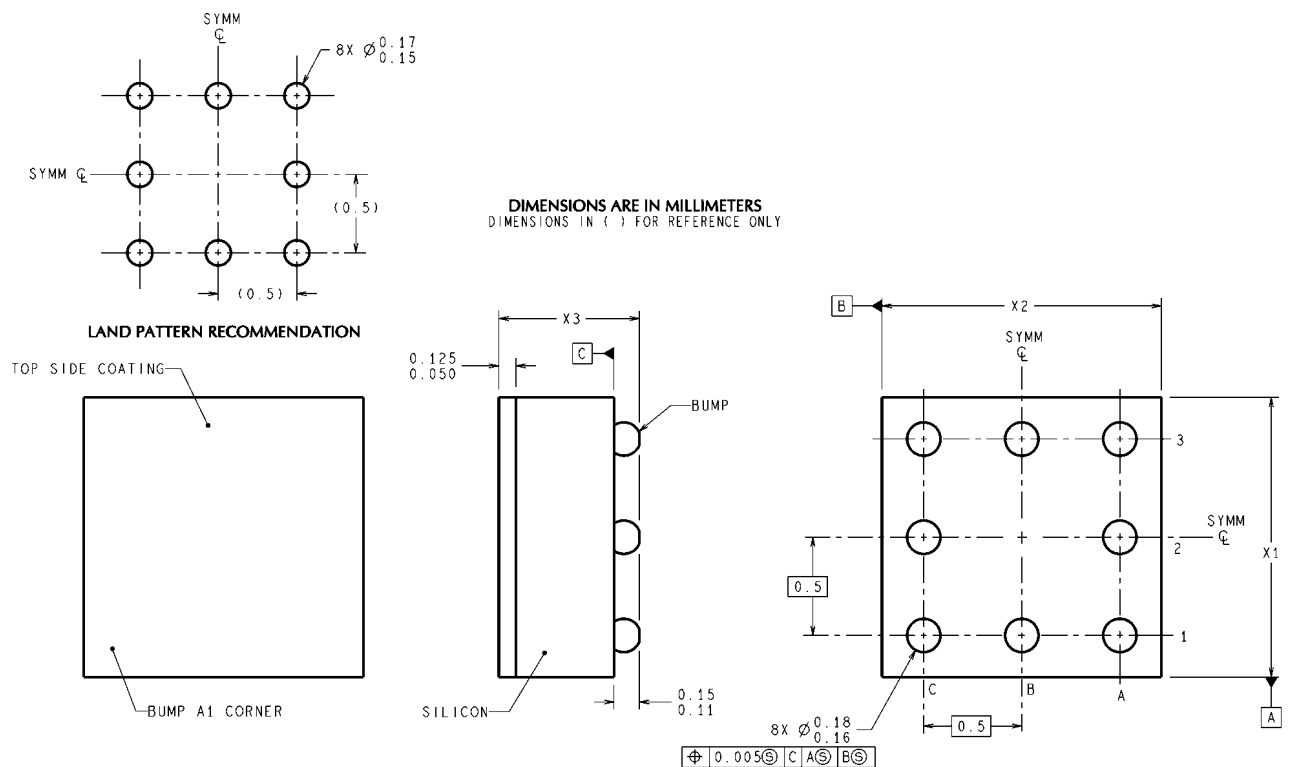
# Physical Dimensions

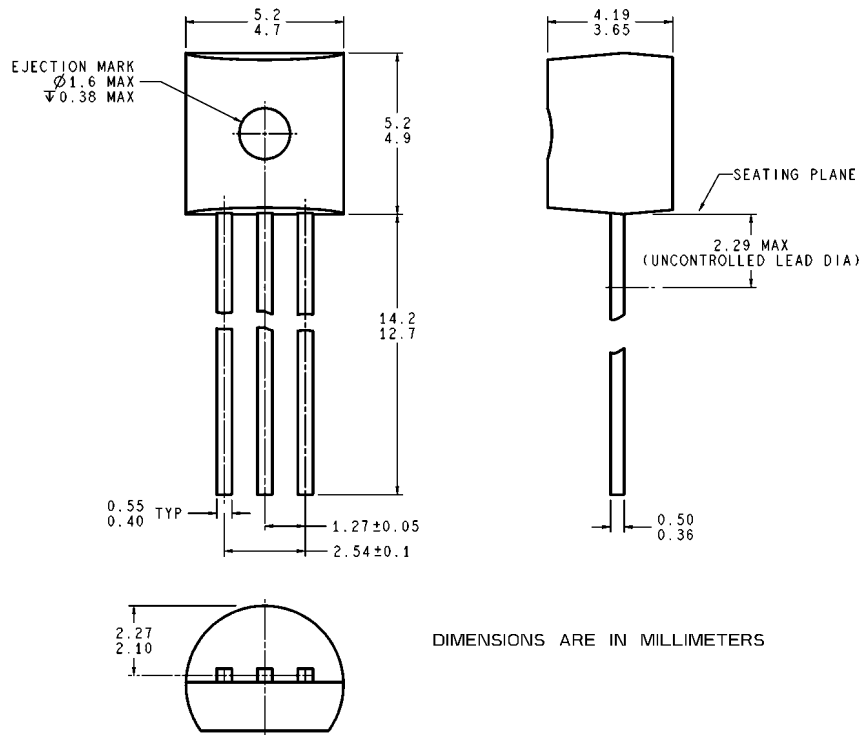
 inches (millimeters) unless otherwise noted


NOTES: UNLESS OTHERWISE SPECIFIED

1. EPOXY COATING
2. 63Sn/37Pb EUTECTIC BUMP
3. RECOMMEND NON-SOLDER MASK DEFINED LANDING PAD.
4. PIN A1 IS ESTABLISHED BY LOWER LEFT CORNER WITH RESPECT TO TEXT ORIENTATION. REMAINING PINS ARE NUMBERED COUNTERCLOCK-WISE.
5. XXX IN DRAWING NUMBER REPRESENTS PACKAGE SIZE VARIATION WHERE  $X_1$  IS PACKAGE WIDTH,  $X_2$  IS PACKAGE LENGTH AND  $X_3$  IS PACKAGE HEIGHT.
6. REFERENCE JEDEC REGISTRATION MO-211, VARIATION BC.

**8-Bump micro SMD**  
**NS Package Number BPA08AAB**  
 **$X_1 = 1.285\text{mm}$   $X_2 = 1.285\text{mm}$   $X_3 = 0.850\text{mm}$**





**Molded Offset TO-92 (Z)  
NS Package Number Z03A**

Z03A (Rev G)

## Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:  
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Audio	<a href="http://www.national.com/audio">www.national.com/audio</a>	App Notes	<a href="http://www.national.com/appnotes">www.national.com/appnotes</a>
Clock and Timing	<a href="http://www.national.com/timing">www.national.com/timing</a>	Reference Designs	<a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>
Data Converters	<a href="http://www.national.com/adac">www.national.com/adac</a>	Samples	<a href="http://www.national.com/samples">www.national.com/samples</a>
Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Eval Boards	<a href="http://www.national.com/evalboards">www.national.com/evalboards</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Applications & Markets	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempsensors">www.national.com/tempsensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
PLL/VCO	<a href="http://www.national.com/wireless">www.national.com/wireless</a>	PowerWise® Design University	<a href="http://www.national.com/training">www.national.com/training</a>

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