

# LM78LXX Series

## 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.

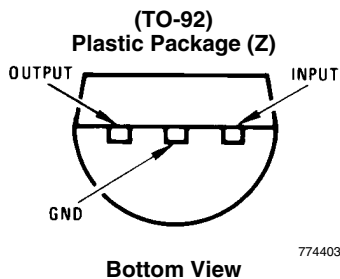
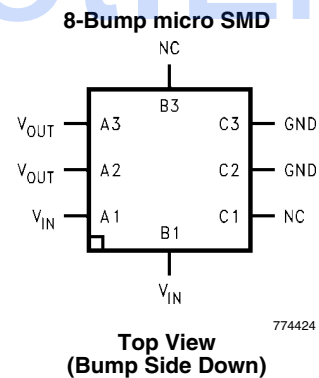
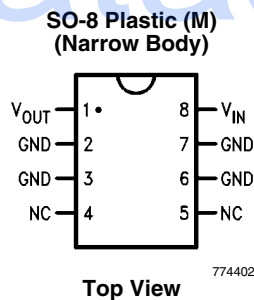
The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak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

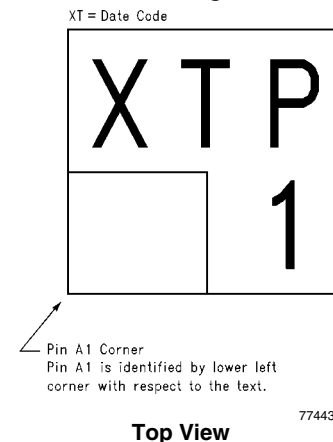
### Features

- 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 Type	NSC Drawing	Output Voltage	Operating Temperature Range	Order Number	Supplied As
micro SMD	BPA08AAB	5.0V	-40°C to 85°C	LM78L05IBP	OBSOLETE
				LM78L05IBPX	OBSOLETE
Thin micro SMD	TPA08AAA	5.0V	-40°C to 85°C	LM78L05ITP	Reel of 250
				LM78L05ITPX	Reel of 3000
		9.0V	-40°C to 85°C	LM78L09ITP	OBSOLETE
				LM78L09ITPX	Reel of 3000
SOIC Narrow	M08A	5.0V	0°C to 125°C	LM78L05ACM	Rail of 95
			-40°C to 125°C	LM78L05ACMX	Reel of 2500
		12V	0°C to 125°C	LM78L05AIM	Rail of 95
				LM78L05AIMX	Reel of 2500
		15V	0°C to 125°C	LM78L12ACM	Rail of 95
				LM78L12ACMX	Reel of 2500
TO-92	Z03A	5.0V	0°C to 125°C	LM78L05ACZ	Box of 1800
		6.2V	0°C to 125°C	LM78L62ACZ	Box of 1800
		8.2V	0°C to 125°C	LM78L82ACZ	OBSOLETE
		9.0V	0°C to 125°C	LM78L09ACZ	OBSOLETE
		12V	0°C to 125°C	LM78L12ACZ	Box of 1800
		15V	0°C to 125°C	LM78L15ACZ	Box of 1800

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the Texas Instruments 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	
LM78LxxACZ, TO-92	0°C to 125°C
LM78LxxACM, SO-8	0°C to 125°C
LM78LxxAIM, SO-8	-40°C to 125°C
LM78LxxIBPX, micro SMD	-40°C to 85°C
LM78LxxITP, Thin 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:  $I_O = 40\text{mA}$ ,  $C_1 = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ .

**LM78L05AC / LM78L05I**

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	mV
		$1\text{mA} \leq I_O \leq 40\text{mA}$		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		mV/°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		°C/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 / LM78L09I

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	$11.5\text{V} \leq V_{IN} \leq 24\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$			1.5 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	$16\text{V} \leq V_{IN} \leq 27\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$			1 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 Hz 15V ≤ V <sub>IN</sub> ≤ 25	40	54		dB
I <sub>PK</sub>	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I <sub>O</sub> = 5mA		-1.0		mV/°C
V <sub>IN</sub> (Min)	Minimum Value of Input Voltage Required to Maintain Line Regulation			13.7	14.5	V

## LM78L15AC

Unless otherwise specified, V<sub>IN</sub> = 23V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V <sub>O</sub>	Output Voltage		14.4	15.0	15.6	V
		17.5V ≤ V <sub>IN</sub> ≤ 30V 1mA ≤ I <sub>O</sub> ≤ 40mA (Note 3)	14.25		15.75	
		1mA ≤ I <sub>O</sub> ≤ 70mA (Note 3)	14.25		15.75	
ΔV <sub>O</sub>	Line Regulation	17.5V ≤ V <sub>IN</sub> ≤ 30V		37	250	mV
		20V ≤ V <sub>IN</sub> ≤ 30V		25	140	
ΔV <sub>O</sub>	Load Regulation	1mA ≤ I <sub>O</sub> ≤ 100mA		35	150	
		1mA ≤ I <sub>O</sub> ≤ 40mA		12	75	
I <sub>Q</sub>	Quiescent Current			3	5	mA
ΔI <sub>Q</sub>	Quiescent Current Change	20V ≤ V <sub>IN</sub> ≤ 30V			1	
		1mA ≤ I <sub>O</sub> ≤ 40mA			0.1	
V <sub>n</sub>	Output Noise Voltage			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 18.5V ≤ V <sub>IN</sub> ≤ 28.5V	37	51		dB
I <sub>PK</sub>	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I <sub>O</sub> = 5mA		-1.3		mV/°C
V <sub>IN</sub> (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 ≤ 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:

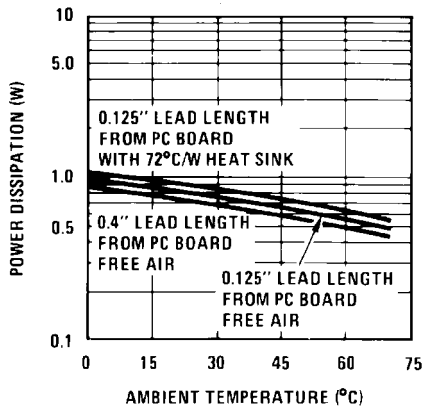
**Z** Package: θ<sub>JC</sub> = 60 °C/W, θ<sub>JA</sub> = 230 °C/W

**M** Package: θ<sub>JA</sub> = 180 °C/W

**micro SMD** Package: θ<sub>JA</sub> = 230.9°C/W

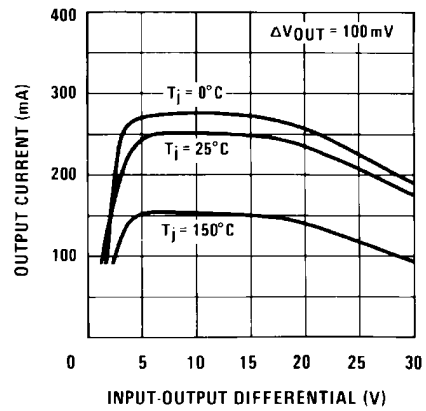
# Typical Performance Characteristics

Maximum Average Power Dissipation (Z Package)



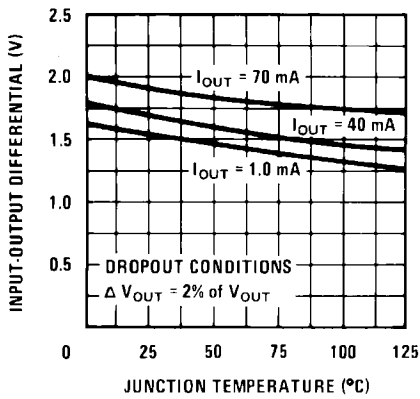
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Peak Output Current



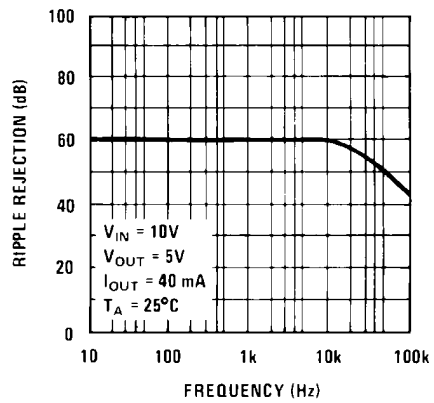
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Dropout Voltage



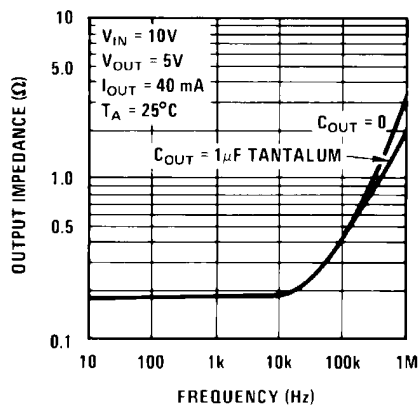
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Ripple Rejection



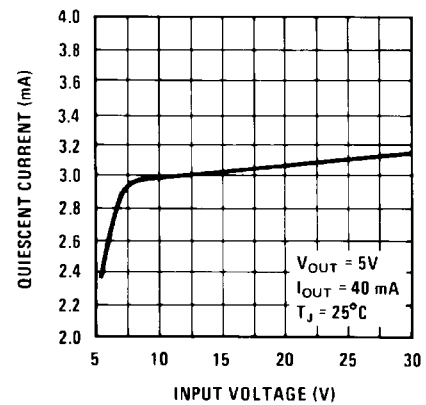
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Output Impedance



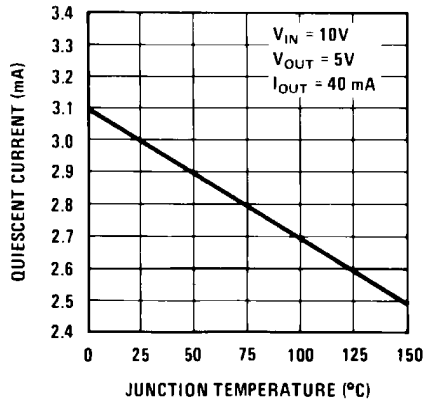
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Quiescent Current



774420

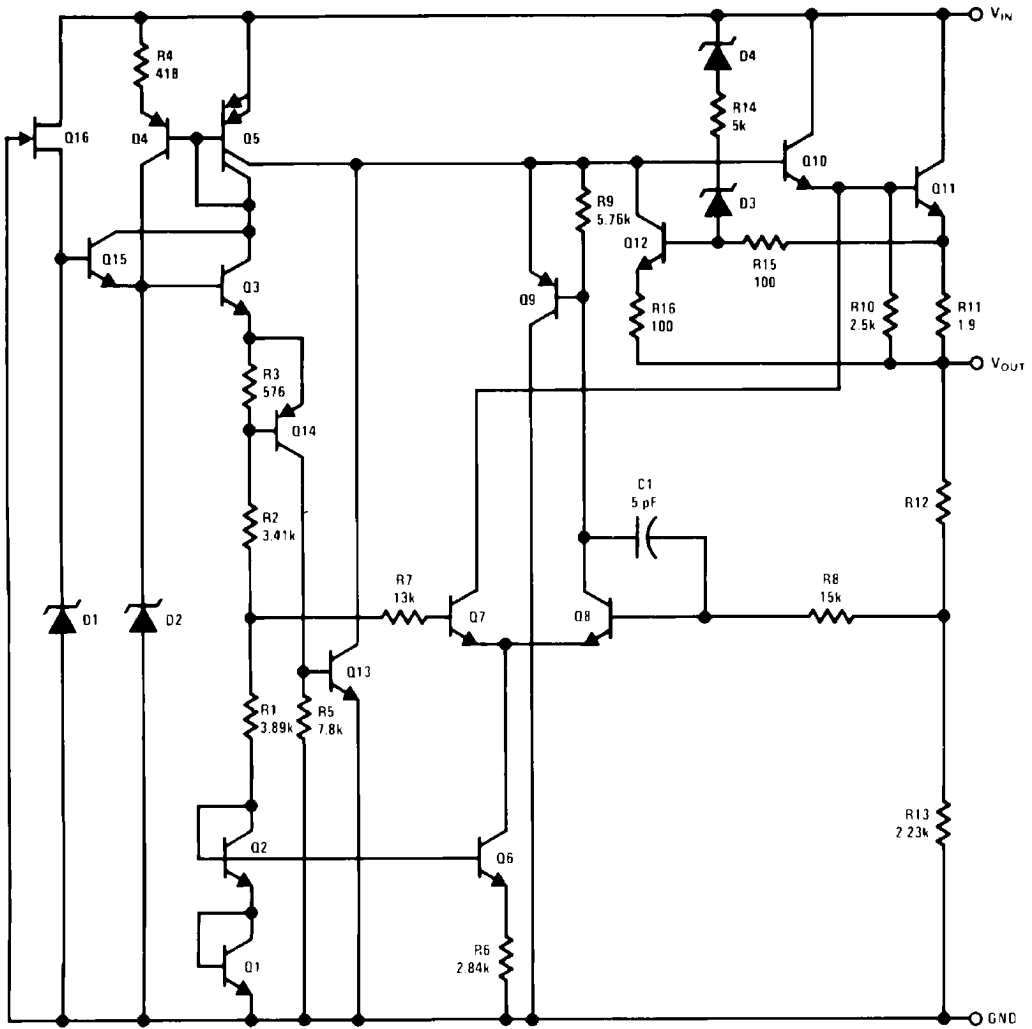
Quiescent Current



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Equivalent Circuit

LM78LXX

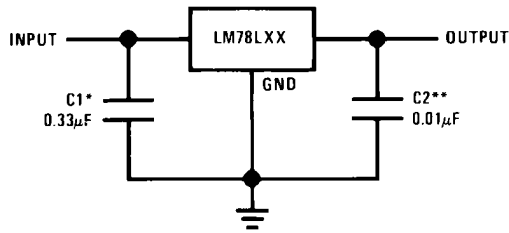


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# Typical Applications

## Fixed Output Regulator

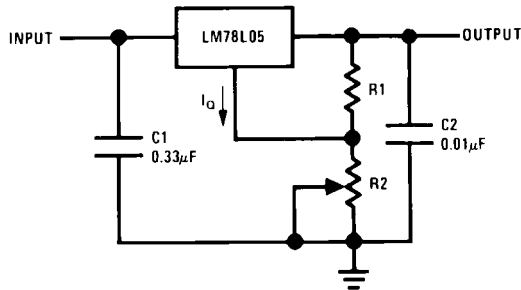


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\*Required if the regulator is located more than 3' from the power supply filter.

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

## Adjustable Output Regulator

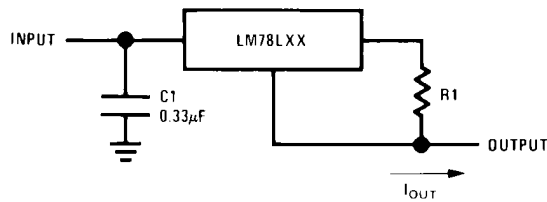


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$$V_{OUT} = 5V + (5V/R1 + I_Q) R2$$

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

## Current Regulator

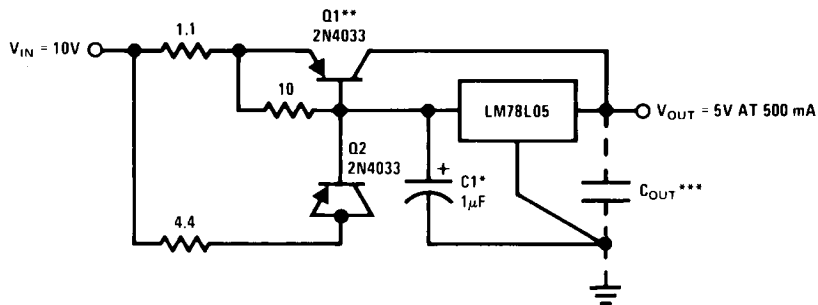


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$$I_{OUT} = (V_{OUT}/R1) + I_Q$$

>I<sub>Q</sub> = 1.5mA over line and load changes

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



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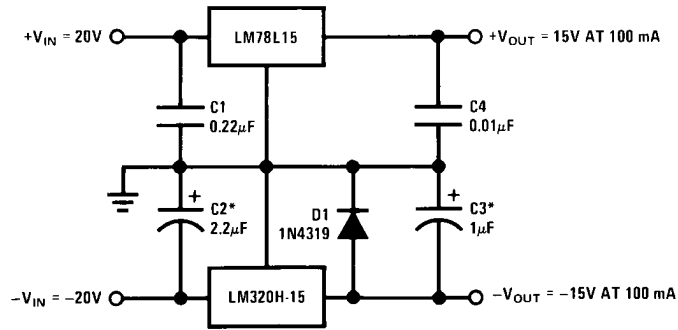
\*Solid tantalum.

\*\*Heat sink Q1.

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

Load Regulation: 0.6% 0 ≤ I<sub>L</sub> ≤ 250mA pulsed with t<sub>ON</sub> = 50ms.

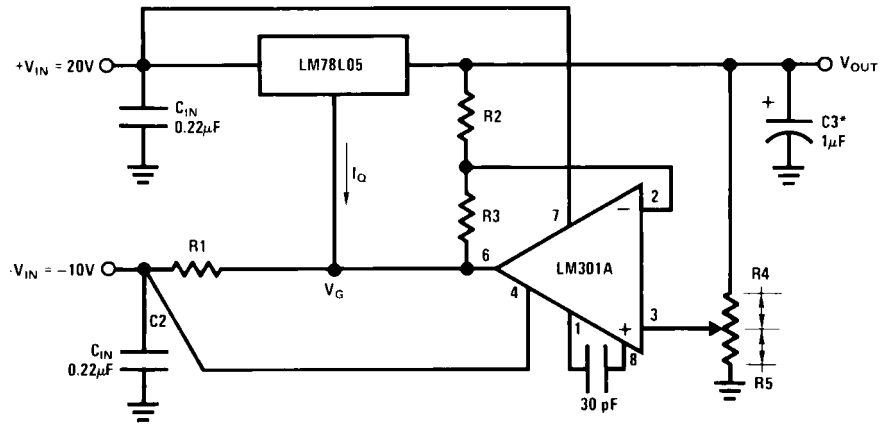
±15V, 100mA Dual Power Supply



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\*Solid tantalum.

Variable Output Regulator 0.5V-18V



774413

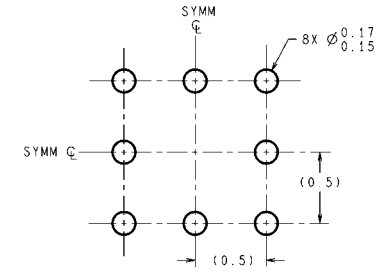
\*Solid tantalum.

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

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

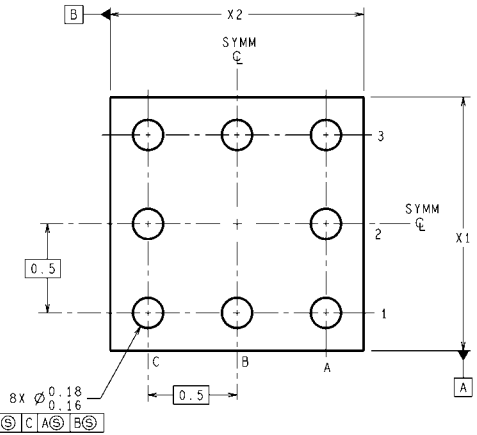
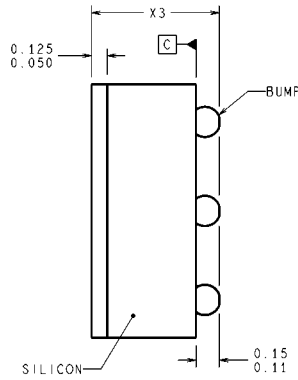
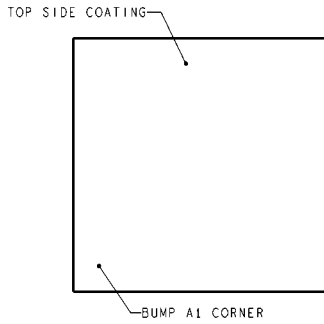
A 0.5V output will correspond to  $(R2/R4) = 0.1$   $(R3/R4) = 0.9$

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



DIMENSIONS ARE IN MILLIMETERS  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

**LAND PATTERN RECOMMENDATION**

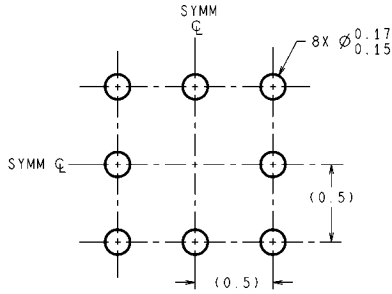


BPA08XXX (Rev D)

NOTES: UNLESS OTHERWISE SPECIFIED

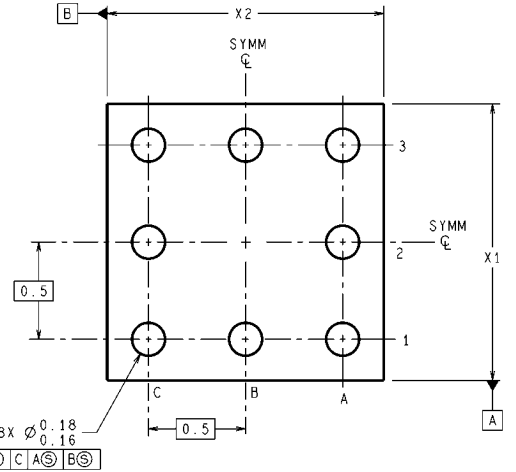
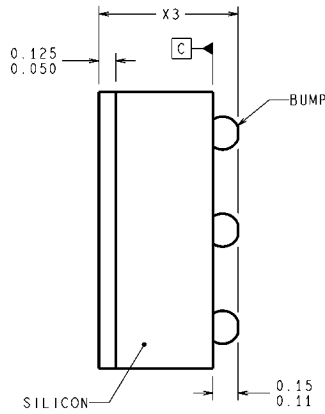
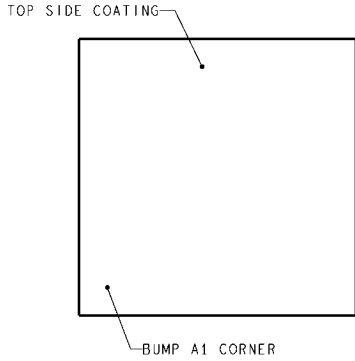
1. EPOXY COATING
2. 63Sn/37Pb EUTECTIC BUMP
3. RECOMMEND NON-SOLDER MASK DEFINED LANDING PAD.
4. PIN A1 IS ESTABLISHED BY LOWER LEFT CORNER WITH RESPECT TO TEXT ORIENTATION. REMAINING PINS ARE NUMBERED COUNTERCLOCKWISE.
5. XXX IN DRAWING NUMBER REPRESENTS PACKAGE SIZE VARIATION WHERE X<sub>1</sub> IS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

**8-Bump micro SMD**  
**NS Package Number BPA08AAB**  
**X1 = 1.285mm X2 = 1.285mm X3 = 0.850mm**



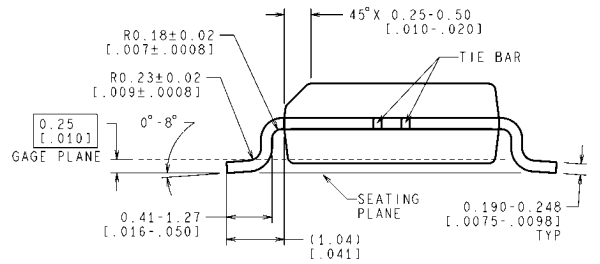
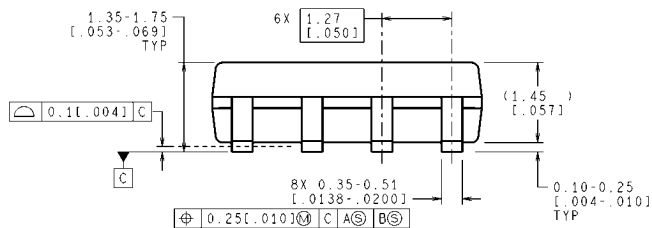
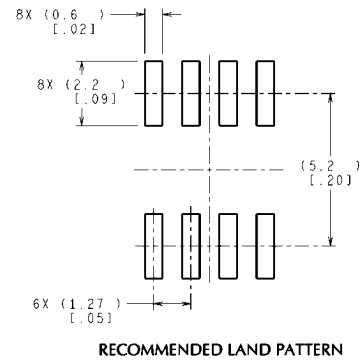
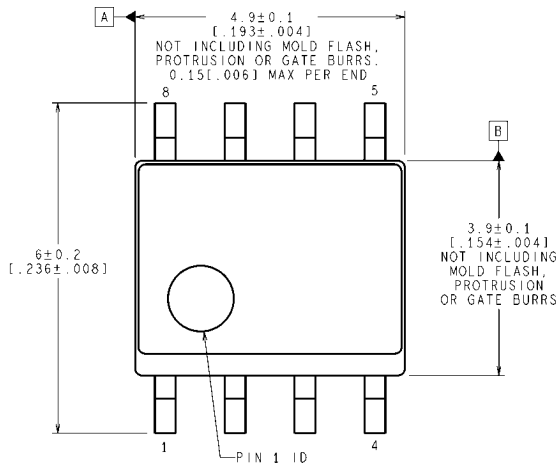
DIMENSIONS ARE IN MILLIMETERS  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

LAND PATTERN RECOMMENDATION



TPA08XXX (Rev B)

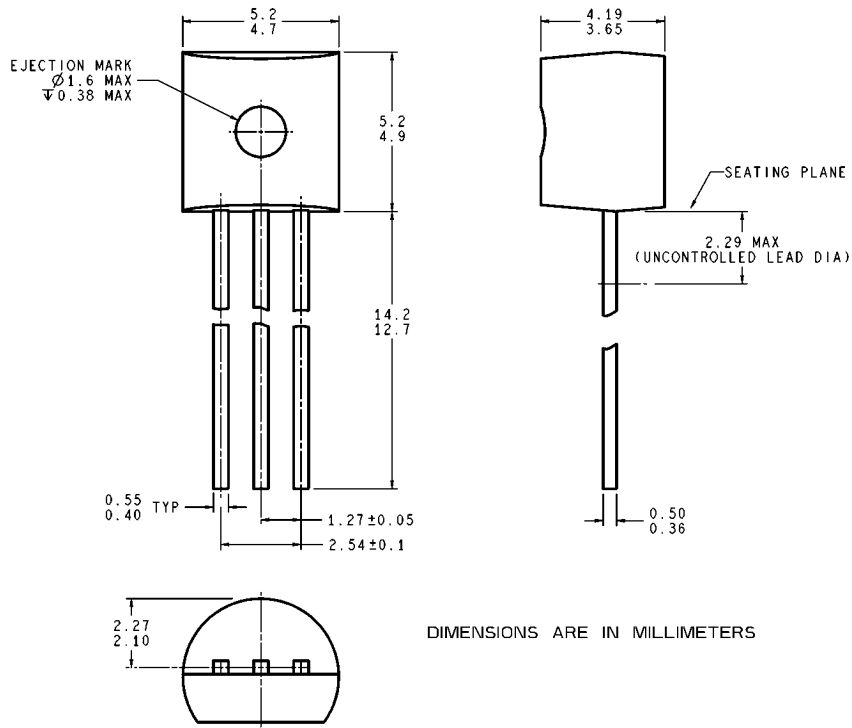
**8-Bump Thin micro SMD**  
**NS Package Number TPA08AAA**  
**X1 = 1.285mm X2 = 1.285mm X3 = 0.500mm**



CONTROLLING DIMENSION IS MILLIMETER  
VALUES IN [ ] ARE INCHES  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

M08A (Rev M)

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



DIMENSIONS ARE IN MILLIMETERS

Z03A (Rev G)

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

**Notes**

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Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
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