National Semiconductor

April 2006

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.

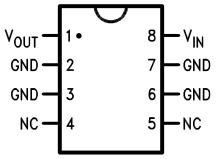
The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak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

SO-8 Plastic (M)
(Narrow Body)



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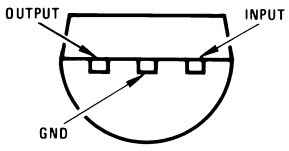
Top View

(TO-92)
Plastic Package (Z)



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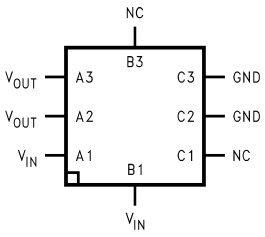
Bottom View

8-Bump micro SMD



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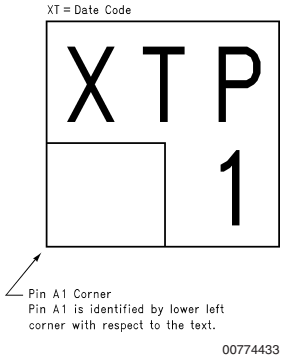
Top View
(Bump Side Down)

micro SMD Marking Orientation



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Top View

Ordering Information

Package	NSC Drawing	Output Voltage	Order Number	Supplied As
micro SMD	BPA08AAB	5V	LM78L05IBP	Reel of 250
			LM78L05IBPX	Reel of 3000
Thin micro SMD	TPA08AAA	5V	LM78L05ITP	Reel of 250
			LM78L05ITPX	Reel of 3000
		9V	LM78L09ITP	Reel of 250
			LM78L09ITPX	Reel of 3000
SOIC Narrow	M08A	5V	LM78L05ACM	Rail of 95
			LM78L05ACMX	Reel of 2500
		12V	LM78L12ACM	Rail of 95
			LM78L12ACMX	Reel of 2500
		15V	LM78L15ACM	Rail of 95
			LM78L15ACMX	Reel of 2500
TO-92	Z03A	5V	LM78L05ACZ	Box of 1800
		6.2V	LM78L62ACZ	Box of 1800
		8.2V	LM78L82ACZ	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
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˚C, **Bold typeface applies over 0˚C to 125˚C for SO-8 and TO-92 packages, and −40˚C to 85˚C for micro SMD package.** Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. Unless otherwise specified: I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF.

LM78L05

Unless otherwise specified, V_{IN} = 10V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage		4.8	5	5.2	V
		7V ≤ V_{IN} ≤ 20V 1mA ≤ I_O ≤ 40mA (Note 3)	**4.75**		**5.25**	
		1mA ≤ I_O ≤ 70mA (Note 3)	**4.75**		**5.25**	
ΔV_O	Line Regulation	7V ≤ V_{IN} ≤ 20V		18	75	mV
		8V ≤ V_{IN} ≤ 20V		10	54	
ΔV_O	Load Regulation	1mA ≤ I_O ≤ 100mA		20	60	
		1mA ≤ I_O ≤ 40mA		5	30	
I_Q	Quiescent Current			3	5	mA
ΔI_Q	Quiescent Current Change	8V ≤ V_{IN} ≤ 20V			**1.0**	
		1mA ≤ I_O ≤ 40mA			**0.1**	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz (Note 4)		40		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 8V ≤ V_{IN} ≤ 16V	47	62		dB
I_{PK}	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I_O = 5mA		−0.65		mV/˚C
V_{IN} (Min)	Minimum Value of Input Voltage Required to Maintain Line Regulation			6.7	7	V
θ_{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 ≤ V_{IN} ≤ 20V 1mA ≤ I_O ≤ 40mA (Note 3)	**5.9**		**6.5**	
		1mA ≤ I_O ≤ 70mA (Note 3)	**5.9**		**6.5**	

LM78LXX Electrical Characteristics

Limits in standard typeface are for T_J = 25˚C, **Bold typeface applies over 0˚C to 125˚C for SO-8 and TO-92 packages, and –40˚C to 85˚C for micro SMD package.** Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. Unless otherwise specified: I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF. (Continued)

LM78L62AC (Continued)

Unless otherwise specified, V_{IN} = 12V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
ΔV_O	Line Regulation	8.5V ≤ V_{IN} ≤ 20V		65	175	mV
		9V ≤ V_{IN} ≤ 20V		55	125	
ΔV_O	Load Regulation	1mA ≤ I_O ≤ 100mA		13	80	
		1mA ≤ I_O ≤ 40mA		6	40	
I_Q	Quiescent Current			2	5.5	mA
ΔI_Q	Quiescent Current Change	8V ≤ V_{IN} ≤ 20V			**1.5**	
		1mA ≤ I_O ≤ 40mA			**0.1**	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz (Note 4)		50		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 10V ≤ V_{IN} ≤ 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/˚C
V_{IN} (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 ≤ V_{IN} ≤ 23V 1mA ≤ I_O ≤ 40mA (Note 3)	**7.8**		**8.6**	
		1mA ≤ I_O ≤ 70mA (Note 3)	**7.8**		**8.6**	
ΔV_O	Line Regulation	11V ≤ V_{IN} ≤ 23V		80	175	mV
		12V ≤ V_{IN} ≤ 23V		70	125	
ΔV_O	Load Regulation	1mA ≤ I_O ≤ 100mA		15	80	
		1mA ≤ I_O ≤ 40mA		8	40	
I_Q	Quiescent Current			2	5.5	mA
ΔI_Q	Quiescent Current Change	12V ≤ V_{IN} ≤ 23V			**1.5**	
		1mA ≤ I_O ≤ 40mA			**0.1**	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz (Note 4)		60		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 12V ≤ V_{IN} ≤ 22V	39	45		dB
I_{PK}	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I_O = 5mA		–0.8		mV/˚C
V_{IN} (Min)	Minimum Value of Input Voltage Required to Maintain Line Regulation			9.9		V

LM78LXX Electrical Characteristics

Limits in standard typeface are for T_J = 25˚C, **Bold typeface applies over 0˚C to 125˚C for SO-8 and TO-92 packages, and –40˚C to 85˚C for micro SMD package.** Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. Unless otherwise specified: I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF. (Continued)

LM78L09AC

Unless otherwise specified, V_{IN} = 15V

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

LM78L12AC

Unless otherwise specified, V_{IN} = 19V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage		11.5	12	12.5	V
		14.5V ≤ V_{IN} ≤ 27V 1mA ≤ I_O ≤ 40mA (Note 3)	**11.4**		**12.6**	
		1mA ≤ I_O ≤ 70mA (Note 3)	**11.4**		**12.6**	
ΔV_O	Line Regulation	14.5V ≤ V_{IN} ≤ 27V		30	180	mV
		16V ≤ V_{IN} ≤ 27V		20	110	
ΔV_O	Load Regulation	1mA ≤ I_O ≤ 100mA		30	100	
		1mA ≤ I_O ≤ 40mA		10	50	
I_Q	Quiescent Current			3	5	mA
ΔI_Q	Quiescent Current Change	16V ≤ V_{IN} ≤ 27V			**1**	
		1mA ≤ I_O ≤ 40mA			**0.1**	
V_n	Output Noise Voltage			80		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 15V ≤ V_{IN} ≤ 25	40	54		dB
I_{PK}	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I_O = 5mA		–1.0		mV/˚C

LM78LXX Electrical Characteristics

Limits in standard typeface are for T_J = 25˚C, **Bold typeface applies over 0˚C to 125˚C for SO-8 and TO-92 packages, and –40˚C to 85˚C for micro SMD package.** Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. Unless otherwise specified: I_O = 40mA, C_I = 0.33µF, C_O = 0.1µF. (Continued)

LM78L12AC (Continued)

Unless otherwise specified, V_{IN} = 19V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IN} (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 ≤ V_{IN} ≤ 30V 1mA ≤ I_O ≤ 40mA (Note 3)	**14.25**		**15.75**	
		1mA ≤ I_O ≤ 70mA (Note 3)	**14.25**		**15.75**	
ΔV_O	Line Regulation	17.5V ≤ V_{IN} ≤ 30V		37	250	mV
		20V ≤ V_{IN} ≤ 30V		25	140	
ΔV_O	Load Regulation	1mA ≤ I_O ≤ 100mA		35	150	
		1mA ≤ I_O ≤ 40mA		12	75	
I_Q	Quiescent Current			3	5	mA
ΔI_Q	Quiescent Current Change	20V ≤ V_{IN} ≤ 30V			**1**	
		1mA ≤ I_O ≤ 40mA			**0.1**	
V_n	Output Noise Voltage			90		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 18.5V ≤ V_{IN} ≤ 28.5V	37	51		dB
I_{PK}	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I_O = 5mA		–1.3		mV/˚C
V_{IN} (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:

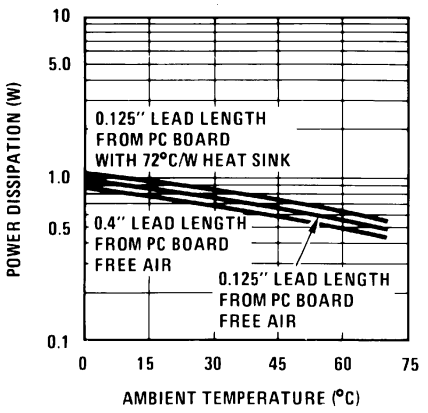
Z Package: θ_{JC} = 60 ˚C/W, = θ_{JA} = 230 ˚C/W

M Package: θ_{JA} = 180 ˚C/W

micro SMD Package: θ_{JA} = 230.9˚C/W

Typical Performance Characteristics

Maximum Average Power Dissipation (Z Package)



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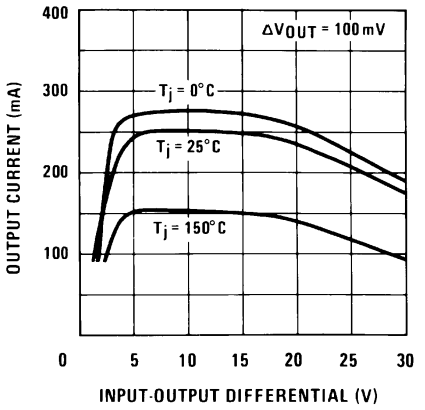
Peak Output Current



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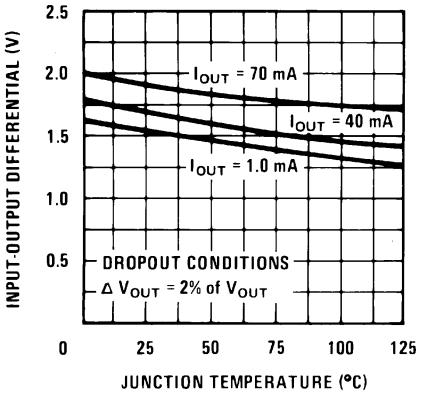
Dropout Voltage



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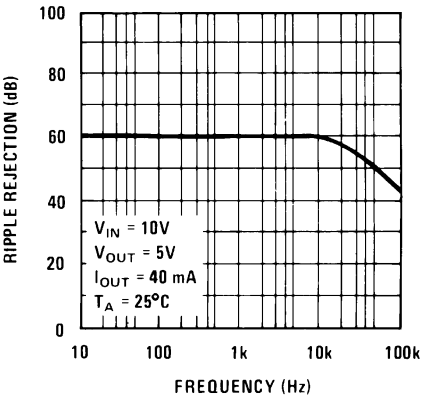
Ripple Rejection



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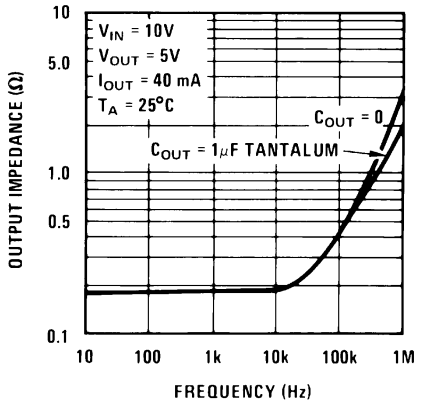
Output Impedance



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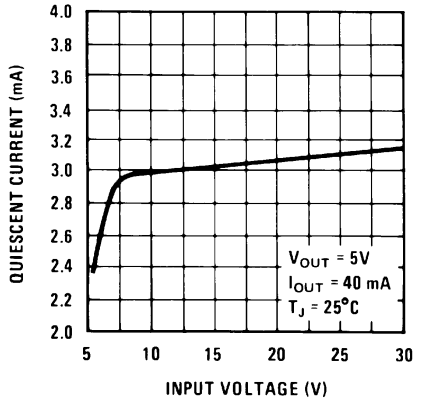
Quiescent Current



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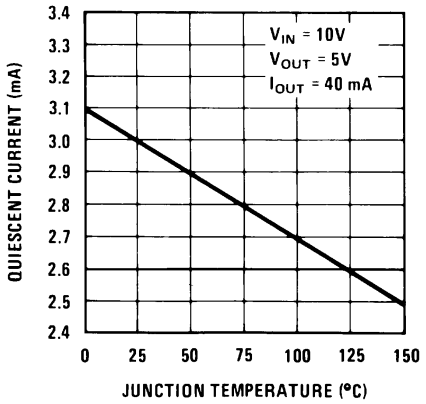
Typical Performance Characteristics (Continued)

Quiescent Current



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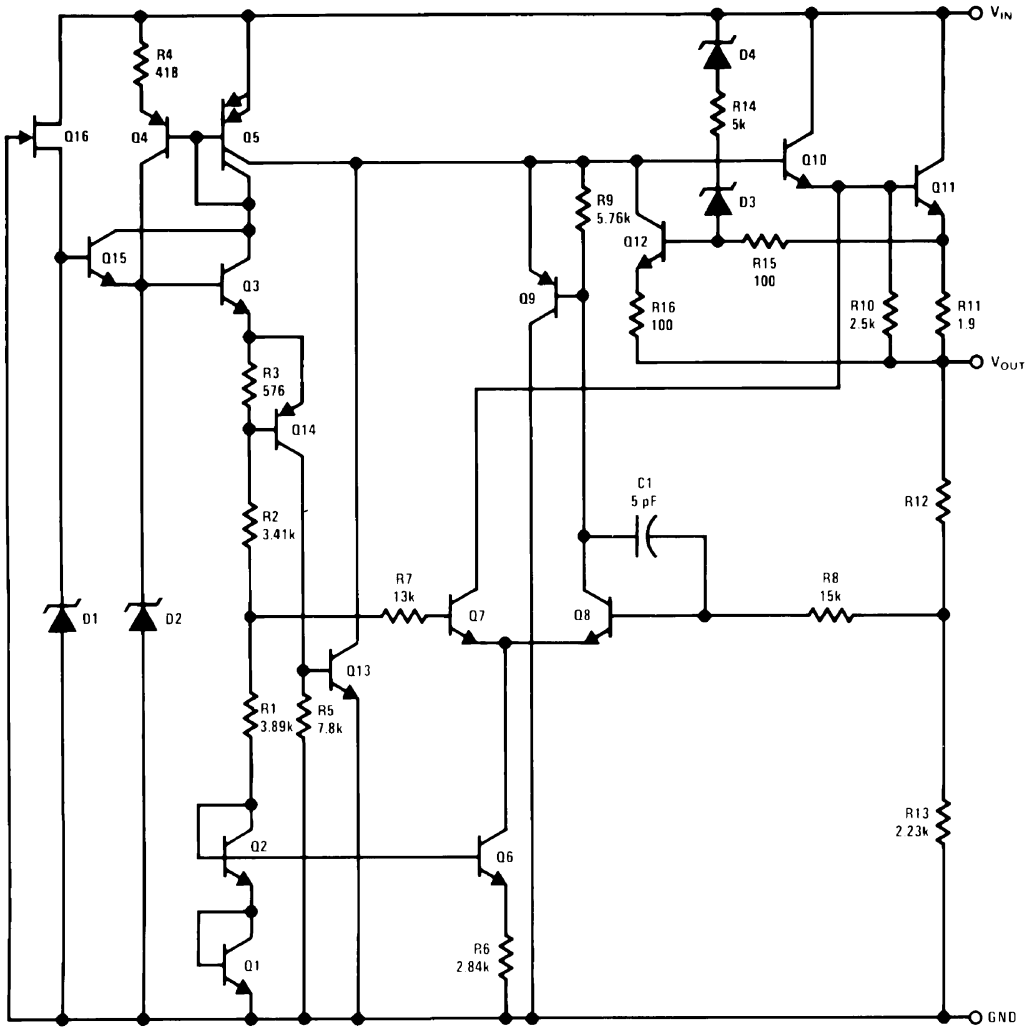
Equivalent Circuit

LM78LXX



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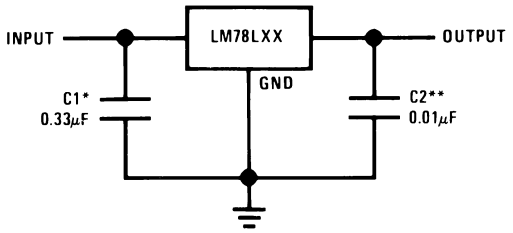
Typical Applications

Fixed Output Regulator



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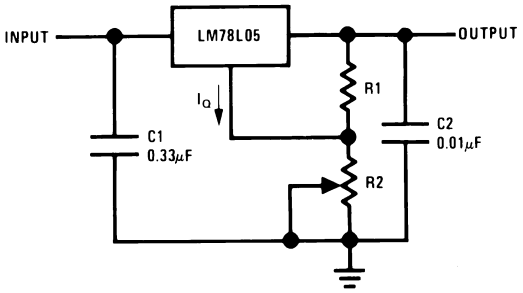
*Required if the regulator is located more than 3" from the power supply filter.

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

Adjustable Output Regulator



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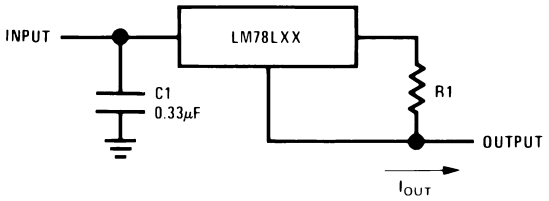
V_{OUT} = 5V + (5V/R1 + I_Q) R2

5V/R1 > 3 I_Q, load regulation (L_r) ≈ [(R1 + R2)/R1] (L_r of LM78L05)

Current Regulator



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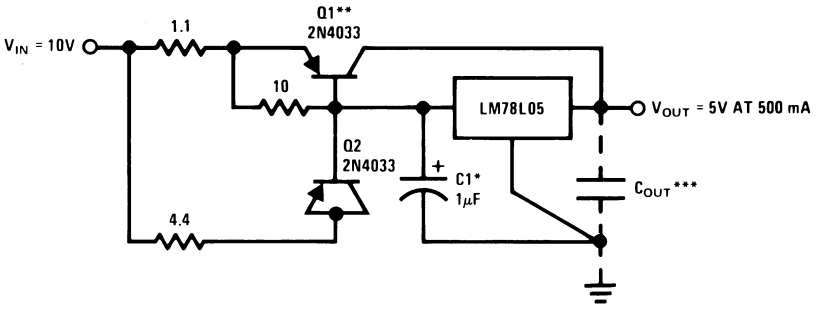
I_{OUT} = (V_{OUT}/R1) + I_Q

>I_Q = 1.5mA over line and load changes

5V, 500mA Regulator with Short Circuit Protection



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*Solid tantalum.

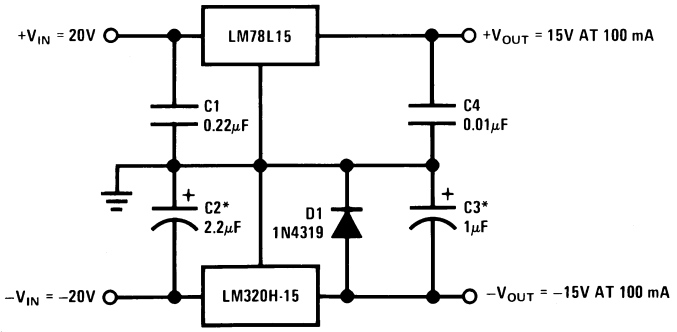
**Heat sink Q1.

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

Load Regulation: 0.6% 0 ≤ I_L ≤ 250mA pulsed with t_{ON} = 50ms.

Typical Applications (Continued)

±15V, 100mA Dual Power Supply



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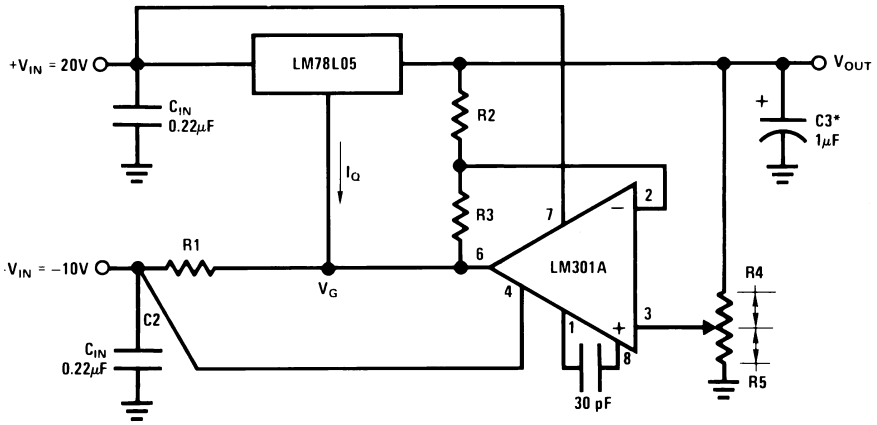
*Solid tantalum.

Variable Output Regulator 0.5V-18V



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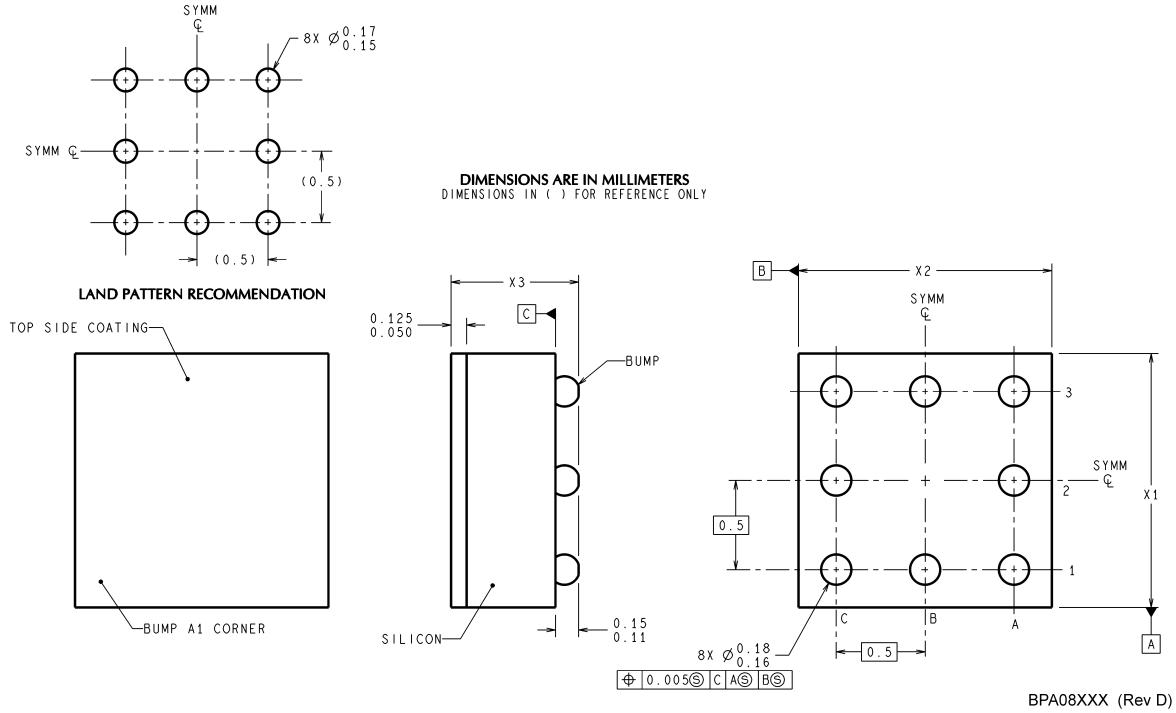
*Solid tantalum.

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

$V_{OUT} = 5V\ (R2/R4)$ 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

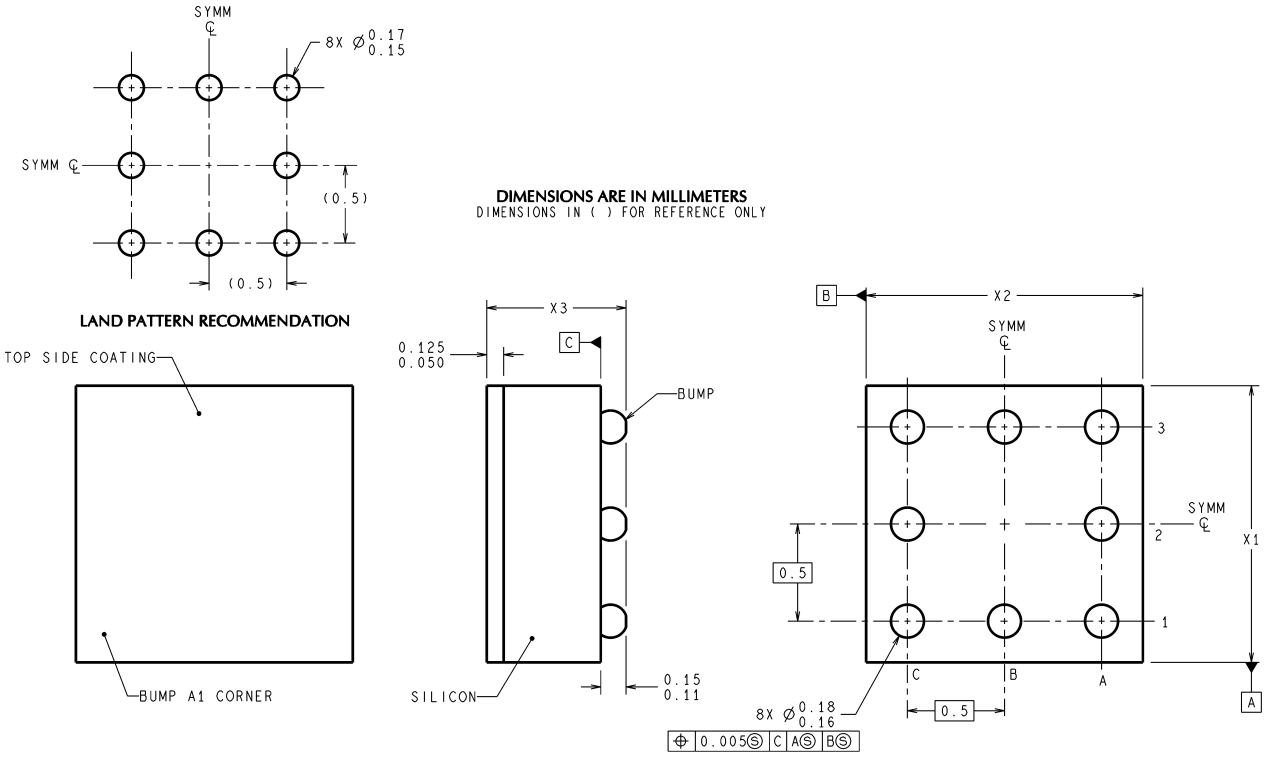


NOTES: UNLESS OTHERWISE SPECIFIED

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_1 IS PACKAGE WIDTH, X_2 IS PACKAGE LENGTH AND X_3 IS PACKAGE HEIGHT.
6. REFERENCE JEDEC REGISTRATION MO-211, VARIATION BC.

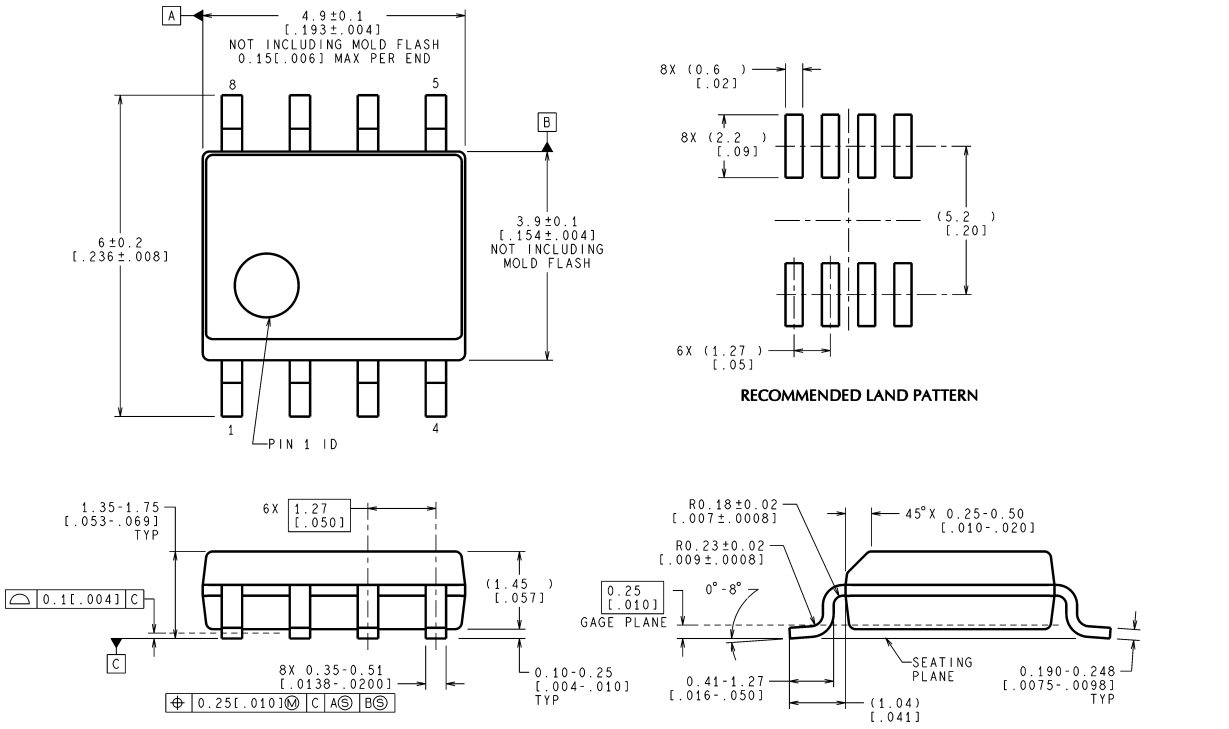
8-Bump micro SMD
NS Package Number BPA08AAB
X1 = 1.285mm X2 = 1.285mm X3 = 0.850mm

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



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

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

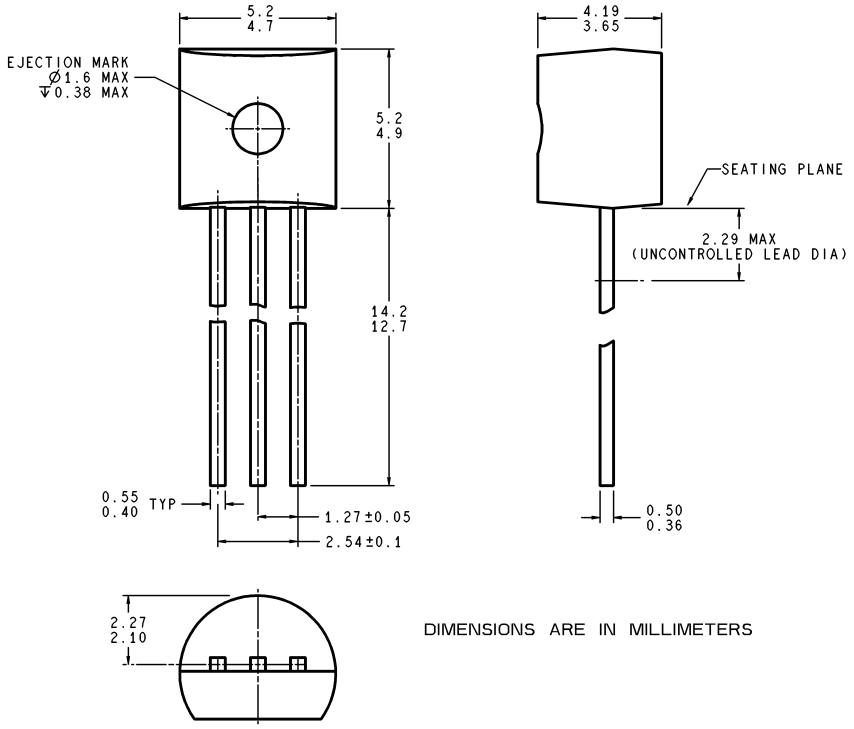


CONTROLLING DIMENSION IS MILLIMETER
VALUES IN [ ] ARE INCHES
DIMENSIONS IN ( ) FOR REFERENCE ONLY

M08A (Rev K)

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

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



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

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