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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.

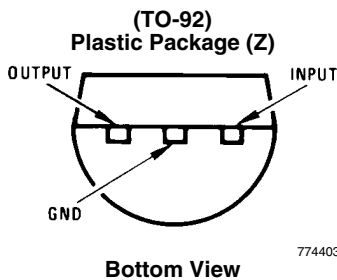
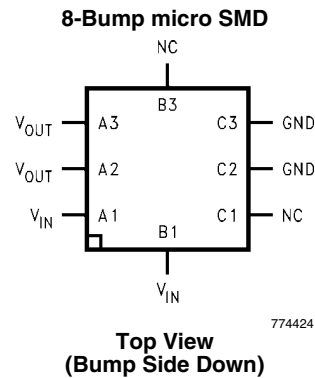
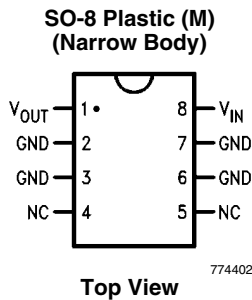
The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak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

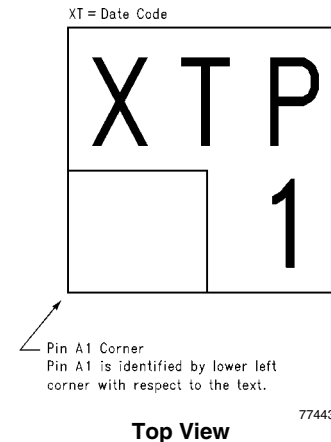
Features

- 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	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 <small>(Note 5)</small>	Internally Limited
Input Voltage	35V
Storage Temperature	-65°C to +150°C
ESD Susceptibility <small>(Note 2)</small>	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
		$7\text{V} \leq V_{IN} \leq 20\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ <small>(Note 3)</small>	4.75		5.25	
		$1\text{mA} \leq I_O \leq 70\text{mA}$ <small>(Note 3)</small>	4.75		5.25	
ΔV_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	
ΔV_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
ΔI_Q	Quiescent Current Change	$8\text{V} \leq V_{IN} \leq 20\text{V}$			1.0	
		$1\text{mA} \leq I_O \leq 40\text{mA}$			0.1	
V_n	Output Noise Voltage	$f = 10\text{ Hz to } 100\text{ kHz}$ <small>(Note 4)</small>		40		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	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
θ_{JA}	Thermal Resistance (8-Bump micro SMD)			230.9		$^\circ\text{C}/\text{W}$

LM78L62ACUnless 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	
ΔV_O	Line Regulation	$8.5V \leq V_{IN} \leq 20V$		65	175	mV
		$9V \leq V_{IN} \leq 20V$		55	125	
ΔV_O	Load Regulation	$1mA \leq I_O \leq 100mA$		13	80	mV
		$1mA \leq I_O \leq 40mA$		6	40	
I_Q	Quiescent Current			2	5.5	mA
ΔI_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		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	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

LM78L82ACUnless 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	
ΔV_O	Line Regulation	$11V \leq V_{IN} \leq 23V$		80	175	mV
		$12V \leq V_{IN} \leq 23V$		70	125	
ΔV_O	Load Regulation	$1mA \leq I_O \leq 100mA$		15	80	mV
		$1mA \leq I_O \leq 40mA$		8	40	
I_Q	Quiescent Current			2	5.5	mA
ΔI_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		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	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	
ΔV_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	
ΔV_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
ΔI_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		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	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	
ΔV_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	
ΔV_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
ΔI_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		μV

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	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
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:

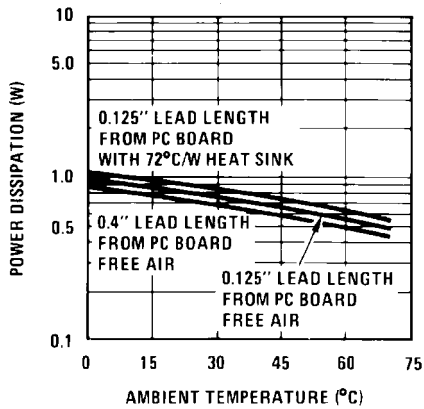
Z Package: θ_{JC} = 60 °C/W, = θ_{JA} = 230 °C/W

M Package: θ_{JA} = 180 °C/W

micro SMD Package: θ_{JA} = 230.9°C/W

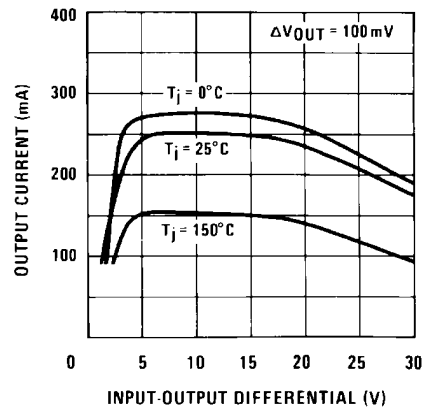
Typical Performance Characteristics

Maximum Average Power Dissipation (Z Package)



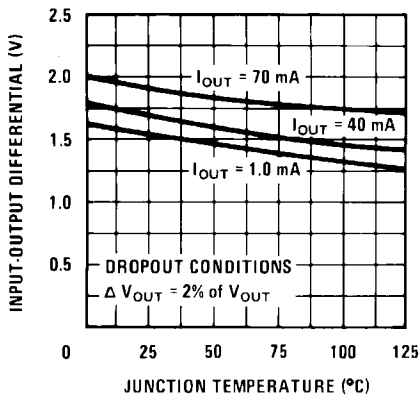
774414

Peak Output Current



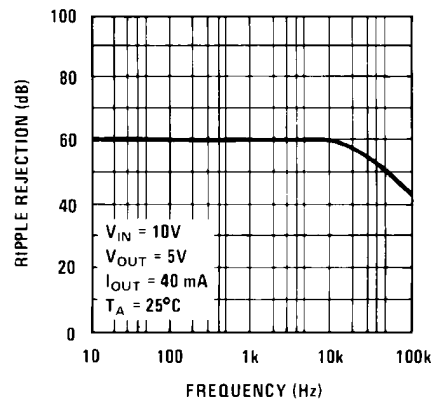
774416

Dropout Voltage



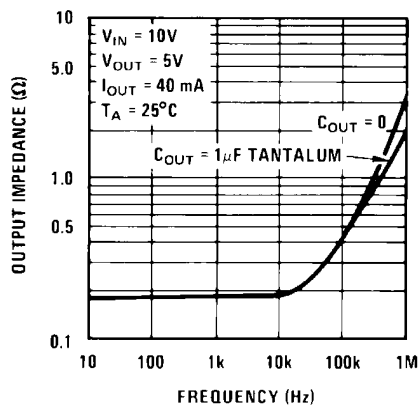
774417

Ripple Rejection



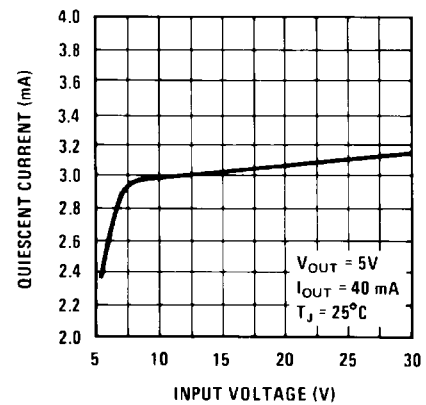
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Output Impedance



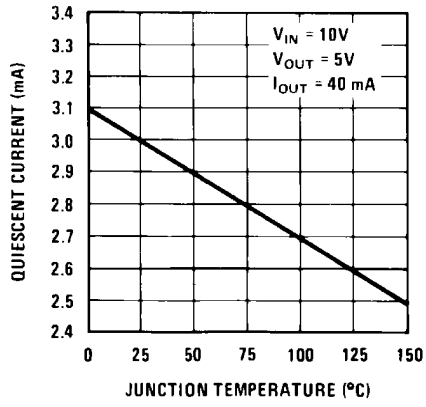
774419

Quiescent Current



774420

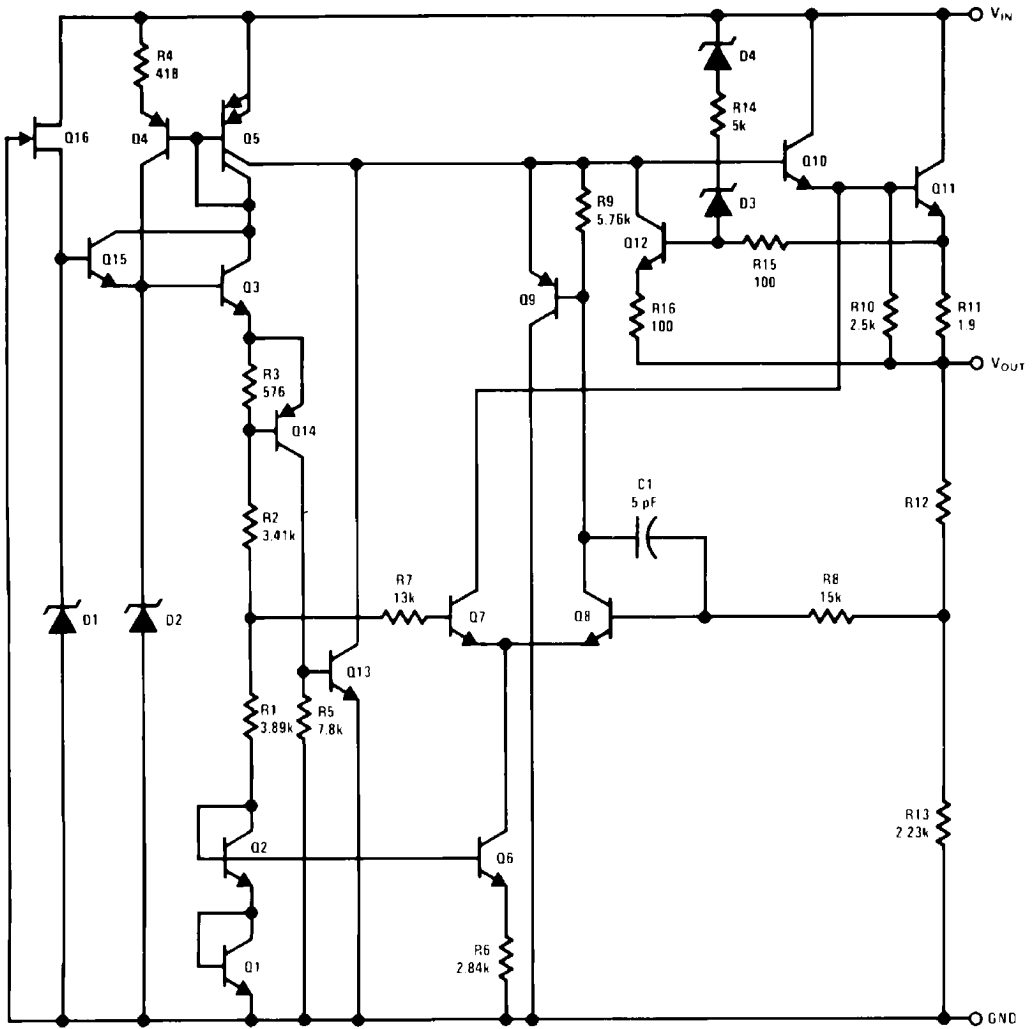
Quiescent Current



774421

Equivalent Circuit

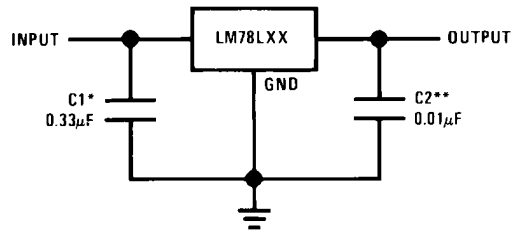
LM78LXX



774407

Typical Applications

Fixed Output Regulator

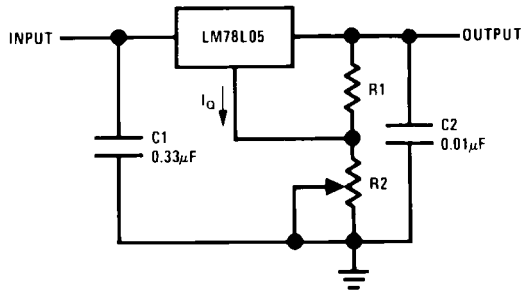


774408

*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

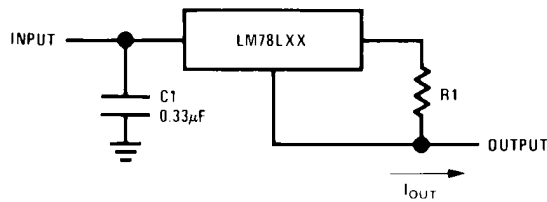


774409

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

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

Current Regulator

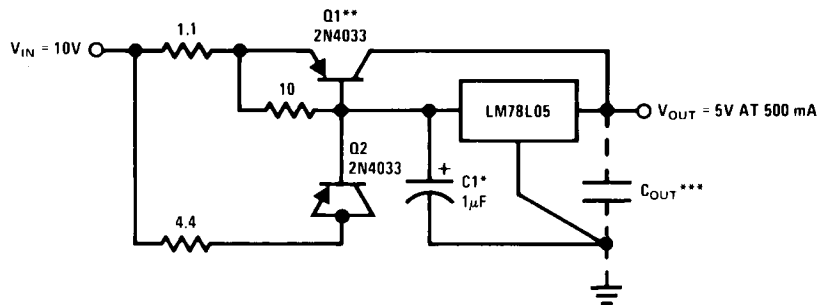


774410

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

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

5V, 500mA Regulator with Short Circuit Protection



774411

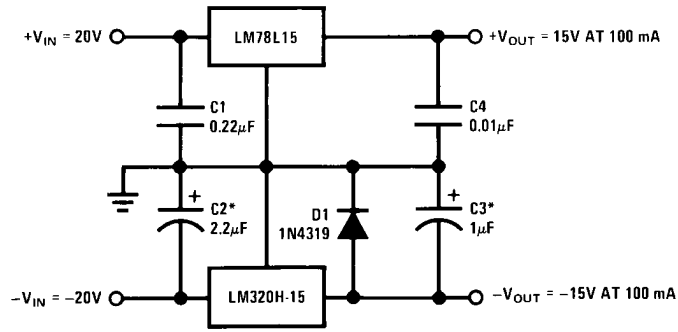
*Solid tantalum.

**Heat sink Q1.

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

Load Regulation: $0.6\% \ 0 \leq I_L \leq 250\text{mA}$ pulsed with $t_{ON} = 50\text{ms}$.

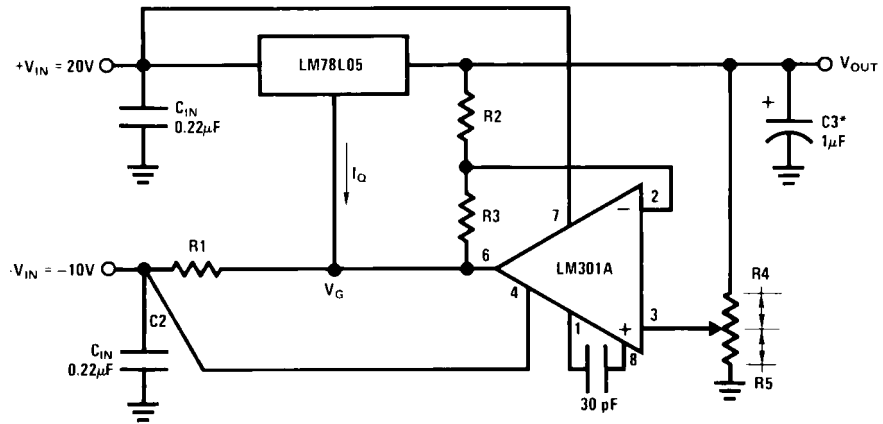
±15V, 100mA Dual Power Supply



774412

*Solid tantalum.

Variable Output Regulator 0.5V-18V



774413

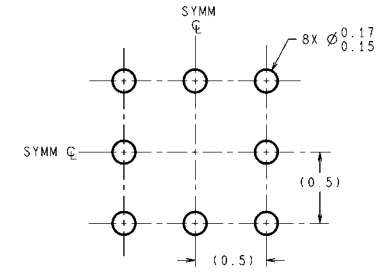
*Solid tantalum.

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

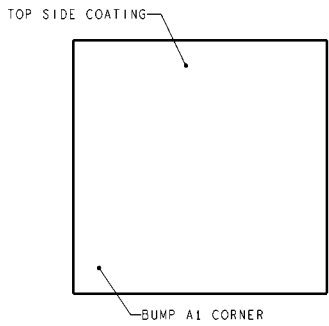
$$V_{OUT} = 5V (R2/R4) \text{ for } (R2 + R3) = (R4 + R5)$$

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

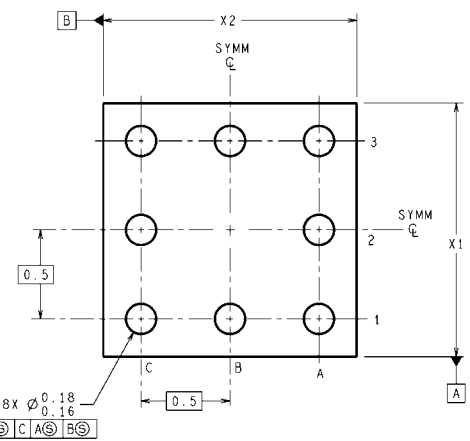
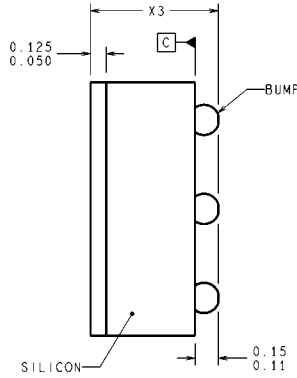
Physical Dimensions inches (millimeters) unless otherwise noted



LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS IN () FOR REFERENCE ONLY



8X \varnothing 0.18
0.16

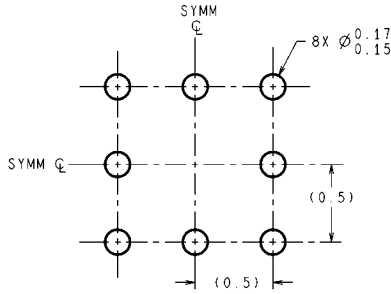
\oplus 0.005 C A B

BPA08XXX (Rev D)

NOTES: UNLESS OTHERWISE SPECIFIED

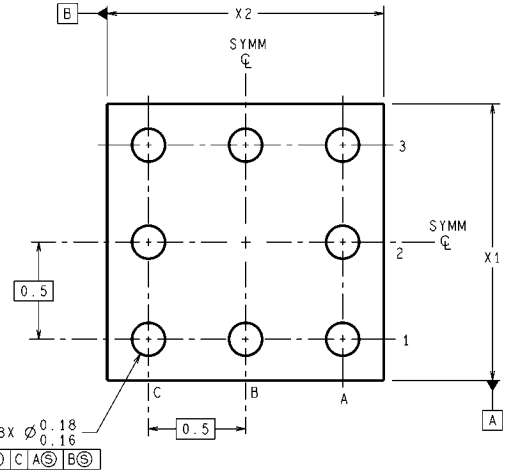
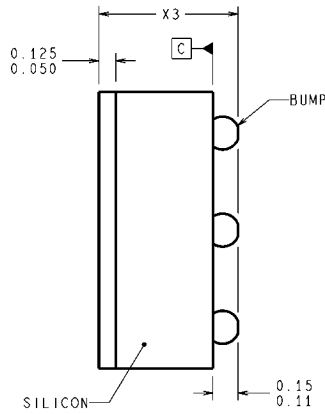
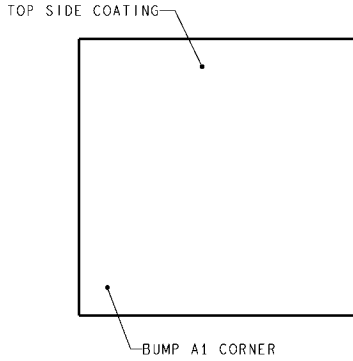
1. EPOXY COATING
2. 63Sn/37Pb EUTECTIC BUMP
3. RECOMMEND NON-SOLDER MASK DEFINED LANDING PAD.
4. PIN A1 IS ESTABLISHED BY LOWER LEFT CORNER WITH RESPECT TO TEXT ORIENTATION. REMAINING PINS ARE NUMBERED COUNTERCLOCKWISE.
5. XXX IN DRAWING NUMBER REPRESENTS PACKAGE SIZE VARIATION WHERE X₁ IS PACKAGE WIDTH, X₂ IS PACKAGE LENGTH AND X₃ 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



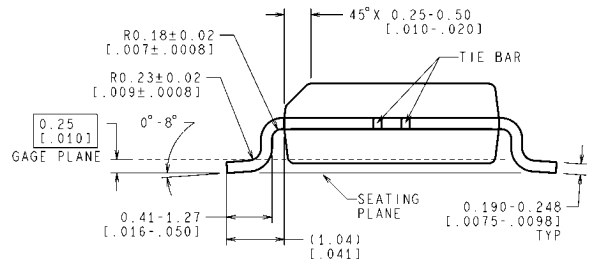
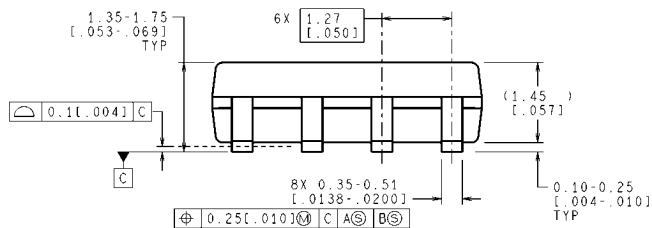
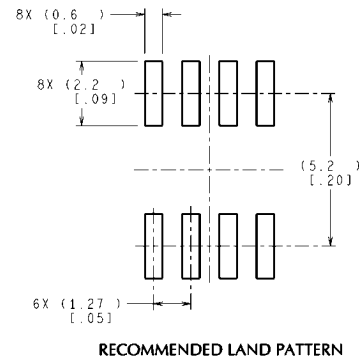
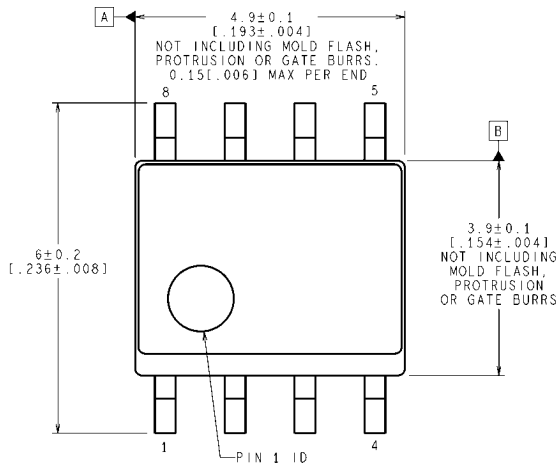
DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS IN () FOR REFERENCE ONLY

LAND PATTERN RECOMMENDATION



TPA08XXX (Rev B)

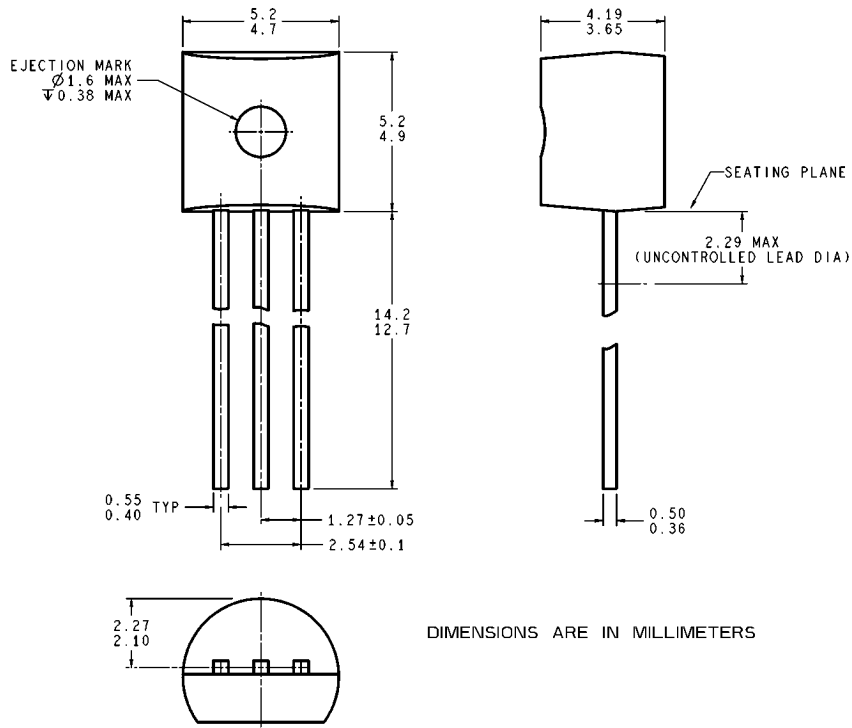
8-Bump Thin micro SMD
NS Package Number TPA08AAA
X1 = 1.285mm X2 = 1.285mm X3 = 0.500mm



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

M08A (Rev M)

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



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

Z03A (Rev G)

Notes

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