

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.

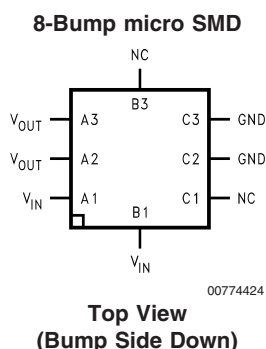
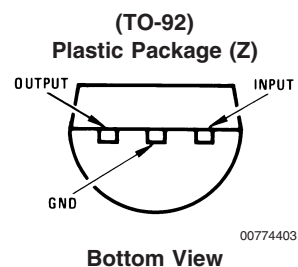
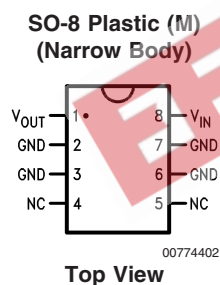
The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak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

nal 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.

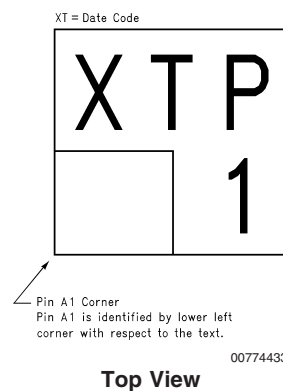
Features

- 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 | Order Number | Output Voltage | NSC Drawing | Supplied As |
|-------------|--------------|----------------|-------------|--------------|
| microSMD | LM78L05IBP | 5V | BPA08AAB | Reel of 250 |
| | LM78L05IBPX | 5V | BPA08AAB | Reel of 3000 |
| | LM78L09ITP | 9V | TPA08AAA | Reel of 250 |
| | LM78L09ITPX | 9V | TPA08AAA | Reel of 3000 |
| SOIC Narrow | LM78L05ACM | 5V | M08A | Rail of 95 |
| | LM78L05ACMX | 5V | M08A | Reel of 2500 |
| | LM78L12ACM | 12V | M08A | Rail of 95 |
| | LM78L12ACMX | 12V | M08A | Reel of 2500 |
| | LM78L15ACM | 15V | M08A | Rail of 95 |
| | LM78L15ACMX | 15V | M08A | Reel of 2500 |
| TO-92 | LM78L05ACZ | 5V | Z03A | Box of 1800 |
| | LM78L62ACZ | 6.2V | Z03A | Box of 1800 |
| | LM78L82ACZ | 8.2V | Z03A | Box of 1800 |
| | LM78L09ACZ | 9V | Z03A | Box of 1800 |
| | LM78L12ACZ | 12V | Z03A | Box of 1800 |
| | LM78L15ACZ | 15V | Z03A | Box of 1800 |

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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 $T_J = 25^\circ\text{C}$, **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: $I_O = 40\text{mA}$, $C_I = 0.33\mu\text{F}$, $C_O = 0.1\mu\text{F}$.

LM78L05Unless 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) | 4.75 | | 5.25 | |
| | | $1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3) | 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 | $8\text{V} \leq V_{IN} \leq 20\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ | | | 1.0 0.1 | |
| V_n | Output Noise Voltage | $f = 10\text{ Hz to } 100\text{ kHz}$ (Note 4) | | 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, $V_{IN} = 12\text{V}$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--------|----------------|---|------------|-----|------------|-------|
| V_O | Output Voltage | | 5.95 | 6.2 | 6.45 | V |
| | | $8.5\text{V} \leq V_{IN} \leq 20\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3) | 5.9 | | 6.5 | |
| | | $1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3) | 5.9 | | 6.5 | |

LM78LXX Electrical Characteristics Limits in standard typeface are for $T_J = 25^\circ\text{C}$, **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: $I_O = 40\text{mA}$, $C_I = 0.33\mu\text{F}$, $C_O = 0.1\mu\text{F}$. (Continued)

LM78L62AC (Continued)

Unless otherwise specified, $V_{IN} = 12\text{V}$

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

LM78L82AC

Unless otherwise specified, $V_{IN} = 14\text{V}$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--|---|--|------------|------|------------|----------------------------|
| V_O | Output Voltage | | 7.87 | 8.2 | 8.53 | V |
| | | $11\text{V} \leq V_{IN} \leq 23\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3) | 7.8 | | 8.6 | |
| | | $1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3) | 7.8 | | 8.6 | |
| ΔV_O | Line Regulation | $11\text{V} \leq V_{IN} \leq 23\text{V}$ | | 80 | 175 | mV |
| | | $12\text{V} \leq V_{IN} \leq 23\text{V}$ | | 70 | 125 | |
| ΔV_O | Load Regulation | $1\text{mA} \leq I_O \leq 100\text{mA}$ | | 15 | 80 | mV |
| | | $1\text{mA} \leq I_O \leq 40\text{mA}$ | | 8 | 40 | |
| I_Q | Quiescent Current | | | 2 | 5.5 | mA |
| ΔI_Q | Quiescent Current Change | $12\text{V} \leq V_{IN} \leq 23\text{V}$ | | | 1.5 | mA |
| | | $1\text{mA} \leq I_O \leq 40\text{mA}$ | | | 0.1 | |
| V_n | Output Noise Voltage | $f = 10\text{ Hz to } 100\text{ kHz}$ (Note 4) | | 60 | | μV |
| $\frac{\Delta V_{IN}}{\Delta V_{OUT}}$ | Ripple Rejection | $f = 120\text{ Hz}$ $12\text{V} \leq V_{IN} \leq 22\text{V}$ | 39 | 45 | | dB |
| I_{PK} | Peak Output Current | | | 140 | | mA |
| $\frac{\Delta V_O}{\Delta T}$ | Average Output Voltage Tempco | $I_O = 5\text{mA}$ | | -0.8 | | $\text{mV}/^\circ\text{C}$ |
| $V_{IN}(\text{Min})$ | Minimum Value of Input Voltage Required to Maintain Line Regulation | | | 9.9 | | V |

LM78LXX Electrical Characteristics Limits in standard typeface are for $T_J = 25^\circ\text{C}$, **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: $I_O = 40\text{mA}$, $C_I = 0.33\mu\text{F}$, $C_O = 0.1\mu\text{F}$. (Continued)

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 | | $\text{mV}/^\circ\text{C}$ |
| $V_{IN}(\text{Min})$ | 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 |
| $\frac{\Delta V_{IN}}{\Delta V_{OUT}}$ | Ripple Rejection | $f = 120\text{ Hz}$ $15\text{V} \leq V_{IN} \leq 25\text{V}$ | 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 | | $\text{mV}/^\circ\text{C}$ |

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LM78L12AC (Continued)

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

| 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, $V_{IN} = 23\text{V}$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--|---|--|--------------|------|------------------------|----------------------------|
| V_O | Output Voltage | | 14.4 | 15.0 | 15.6 | V |
| | | $17.5\text{V} \leq V_{IN} \leq 30\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ (Note 3) | 14.25 | | 15.75 | |
| | | $1\text{mA} \leq I_O \leq 70\text{mA}$ (Note 3) | 14.25 | | 15.75 | |
| ΔV_O | Line Regulation | $17.5\text{V} \leq V_{IN} \leq 30\text{V}$ | | 37 | 250 | mV |
| | | $20\text{V} \leq V_{IN} \leq 30\text{V}$ | | 25 | 140 | |
| ΔV_O | Load Regulation | $1\text{mA} \leq I_O \leq 100\text{mA}$ | | 35 | 150 | mV |
| | | $1\text{mA} \leq I_O \leq 40\text{mA}$ | | 12 | 75 | |
| I_Q | Quiescent Current | | | 3 | 5 | mA |
| ΔI_Q | Quiescent Current Change | $20\text{V} \leq V_{IN} \leq 30\text{V}$ $1\text{mA} \leq I_O \leq 40\text{mA}$ | | | 1 0.1 | |
| V_n | Output Noise Voltage | | | 90 | | μV |
| $\frac{\Delta V_{IN}}{\Delta V_{OUT}}$ | Ripple Rejection | $f = 120\text{Hz}$ $18.5\text{V} \leq V_{IN} \leq 28.5\text{V}$ | 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 | | $\text{mV}/^\circ\text{C}$ |
| 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 k Ω in series with 100pF.

Note 3: Power dissipation $\leq 0.75\text{W}$.

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

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

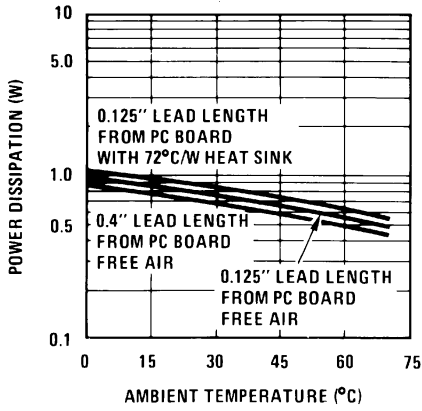
Z Package: $\theta_{JC} = 60^\circ\text{C}/\text{W}$, $\theta_{JA} = 230^\circ\text{C}/\text{W}$

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

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

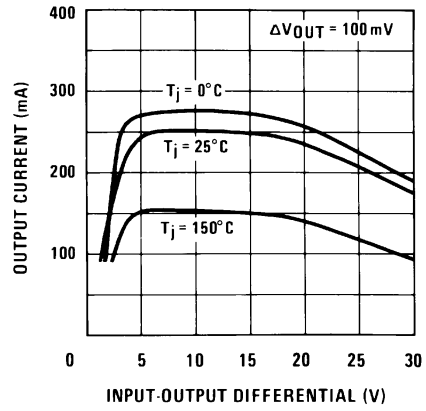
Typical Performance Characteristics

Maximum Average Power Dissipation (Z Package)



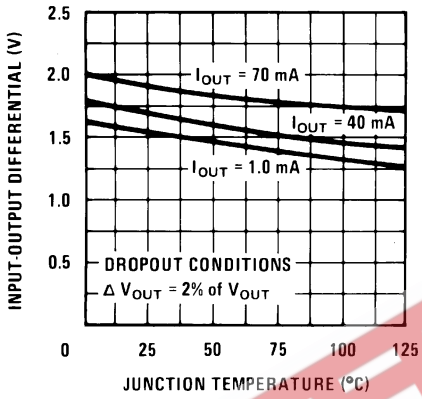
00774414

Peak Output Current



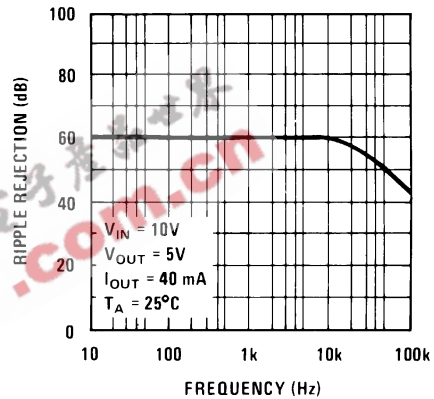
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Dropout Voltage



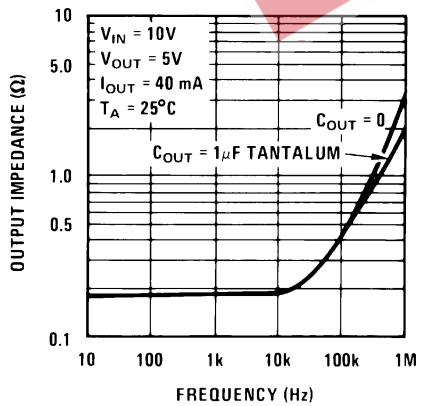
00774417

Ripple Rejection



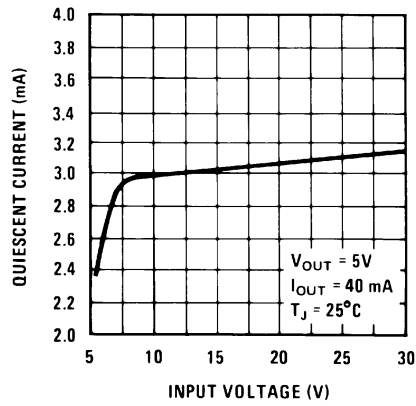
00774418

Output Impedance



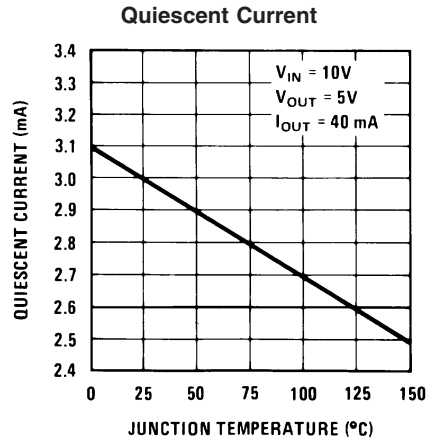
00774419

Quiescent Current

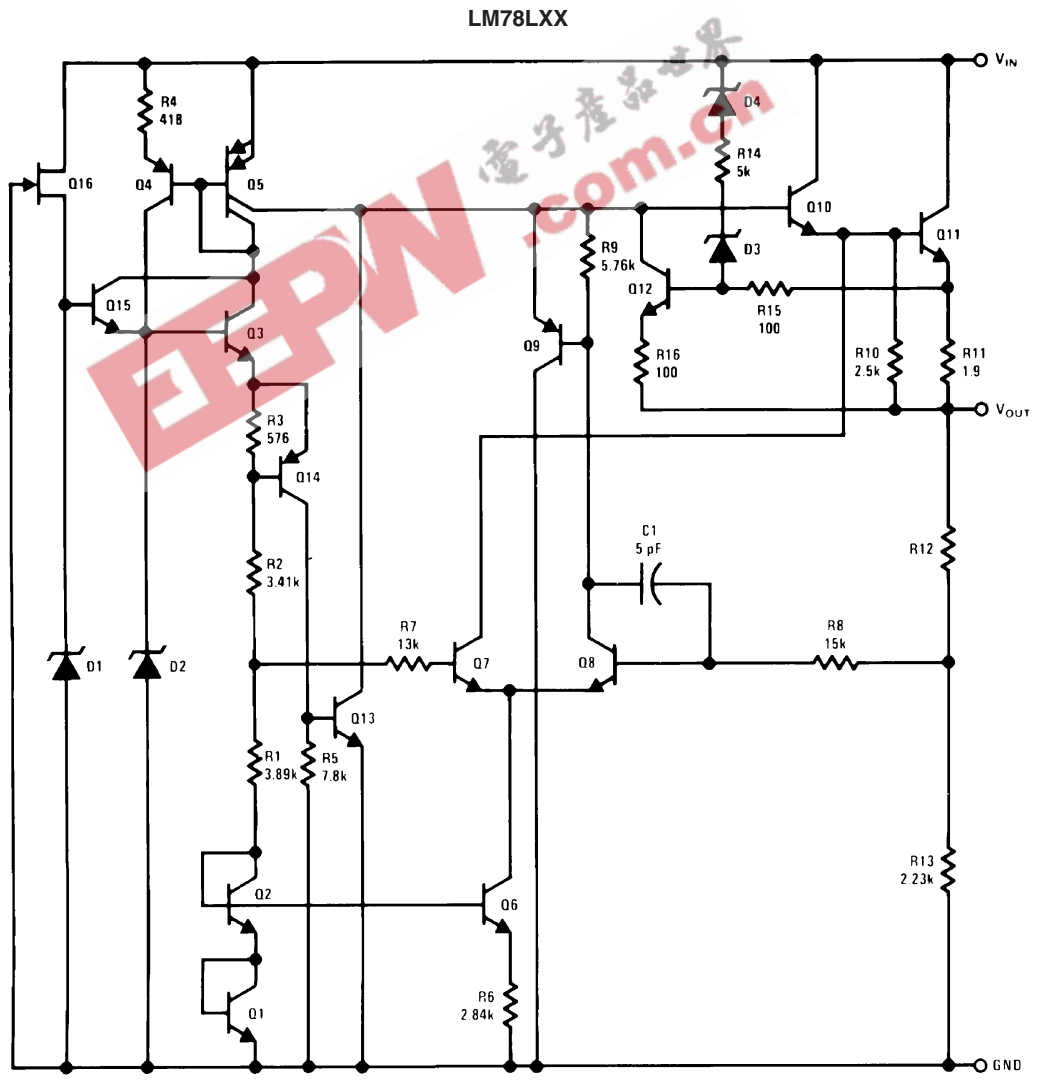


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Typical Performance Characteristics (Continued)

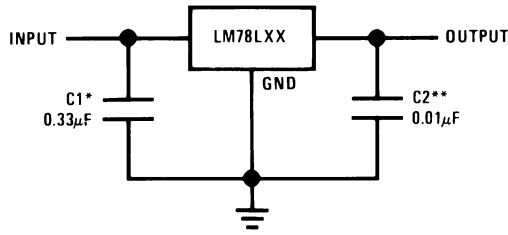


Equivalent Circuit



Typical Applications

Fixed Output Regulator

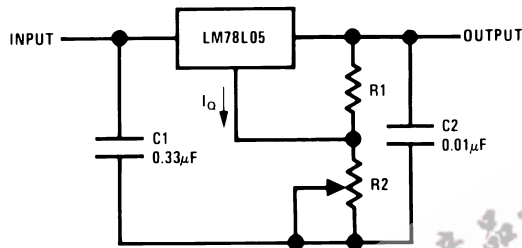


00774408

*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

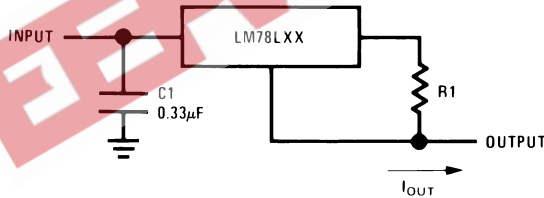


00774409

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

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

Current Regulator

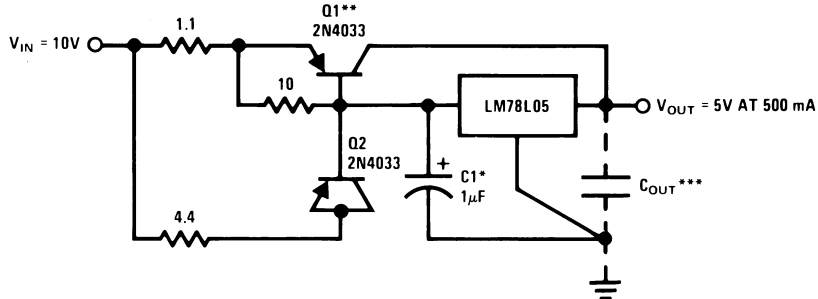


00774410

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

>I_Q = 1.5mA over line and load changes

5V, 500mA Regulator with Short Circuit Protection



00774411

*Solid tantalum.

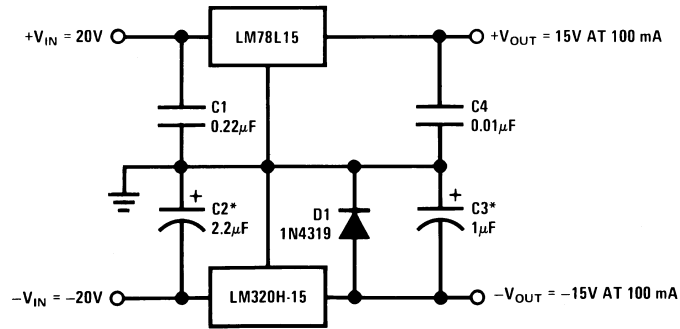
**Heat sink Q1.

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

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

Typical Applications (Continued)

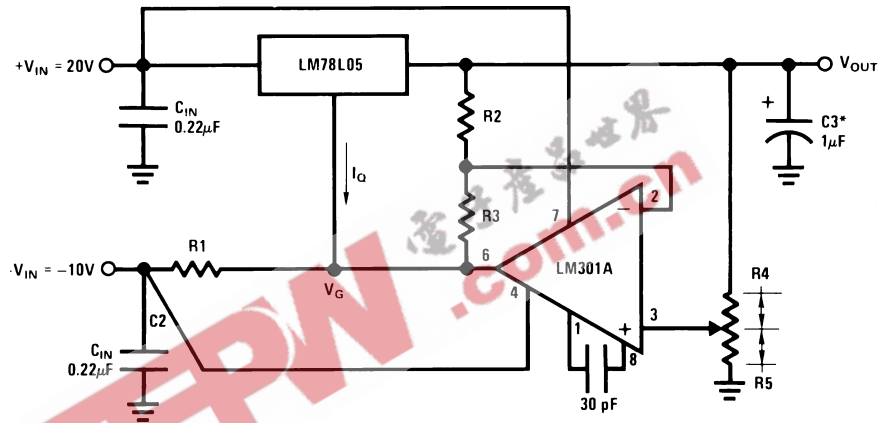
±15V, 100mA Dual Power Supply



00774412

*Solid tantalum.

Variable Output Regulator 0.5V-18V



00774413

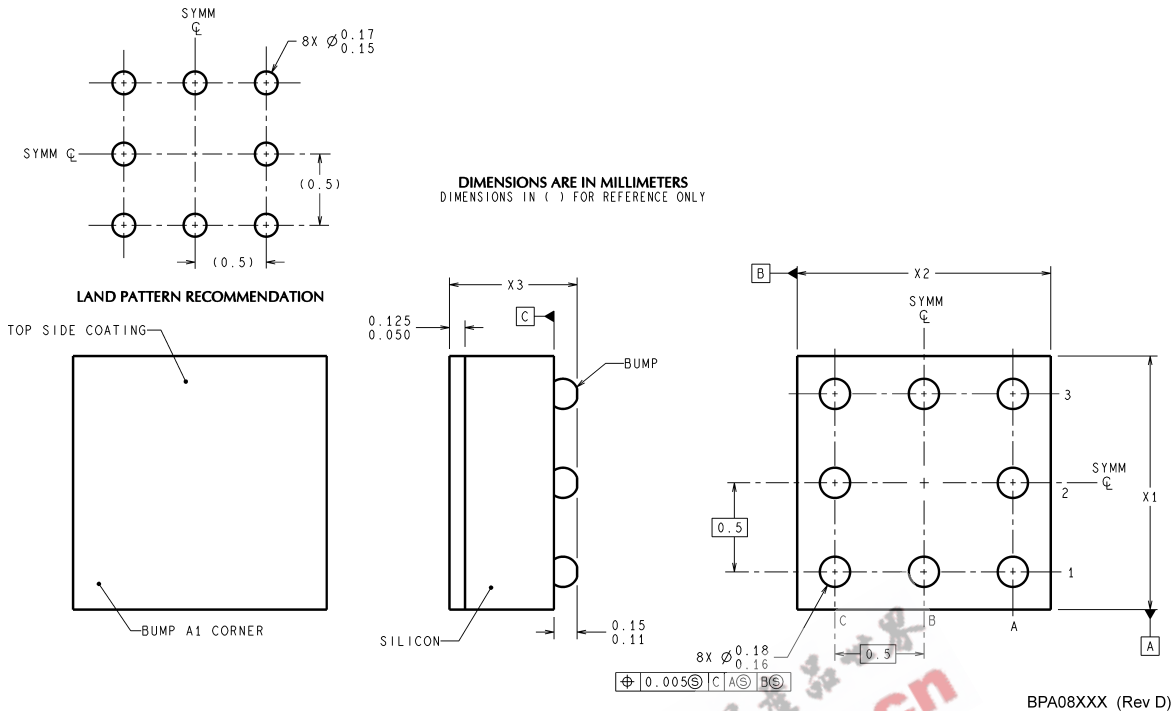
*Solid tantalum.

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

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

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

Physical Dimensions inches (millimeters) unless otherwise noted

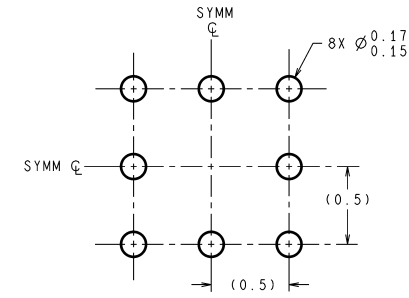


NOTES: UNLESS OTHERWISE SPECIFIED

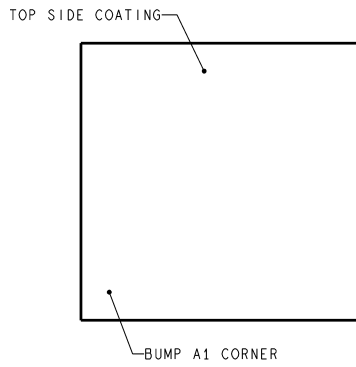
1. EPOXY COATING
2. 63Sn/37Pb EUTECTIC BUMP
3. RECOMMEND NON-SOLDER MASK DEFINED LANDING PAD.
4. PIN A1 IS ESTABLISHED BY LOWER LEFT CORNER WITH RESPECT TO TEXT ORIENTATION. REMAINING PINS ARE NUMBERED COUNTERCLOCKWISE.
5. XXX IN DRAWING NUMBER REPRESENTS PACKAGE SIZE VARIATION WHERE X₁ IS PACKAGE WIDTH, X₂ IS PACKAGE LENGTH AND X₃ IS PACKAGE HEIGHT.
6. REFERENCE JEDEC REGISTRATION MO-211, VARIATION BC.

8-Bump micro SMD for LM78L05IBP Only
NS Package Number BPA08AAB
X1 = 1.285mm X2 = 1.285mm X3 = 0.850mm

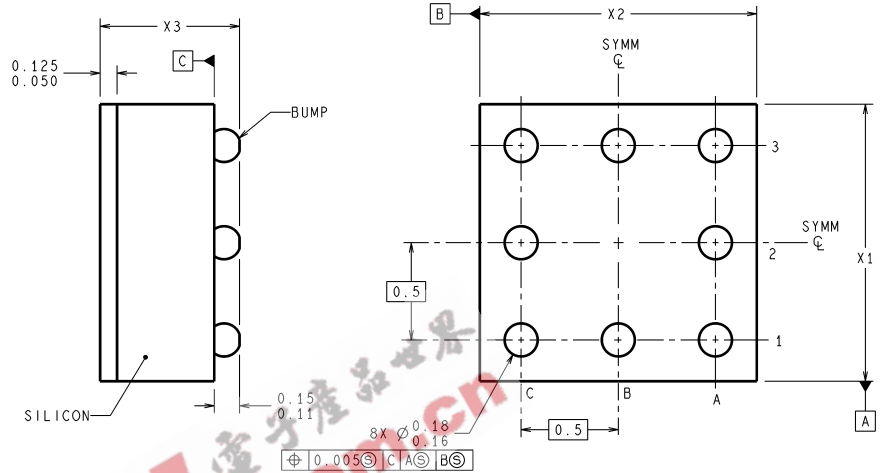
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



LAND PATTERN RECOMMENDATION



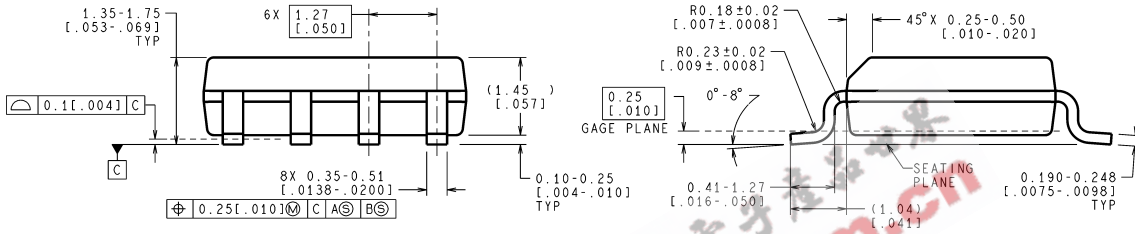
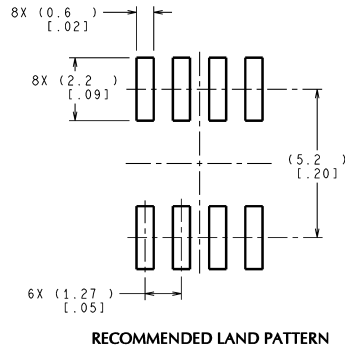
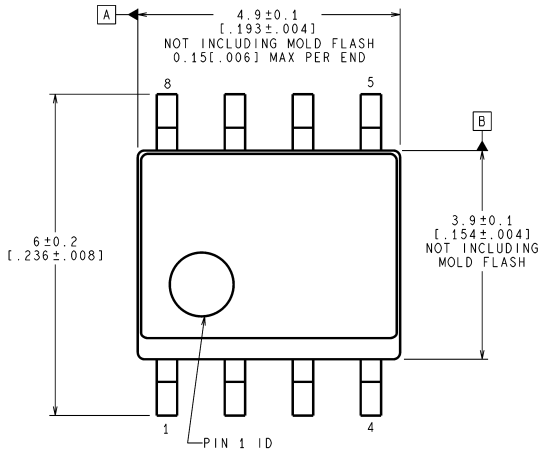
DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS IN () FOR REFERENCE ONLY



TPA08XXX (Rev B)

8-Bump micro SMD for LM78L09ITP Only
NS Package Number TPA08AAA
X1 = 1.285mm X2 = 1.285mm X3 = 0.500mm

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

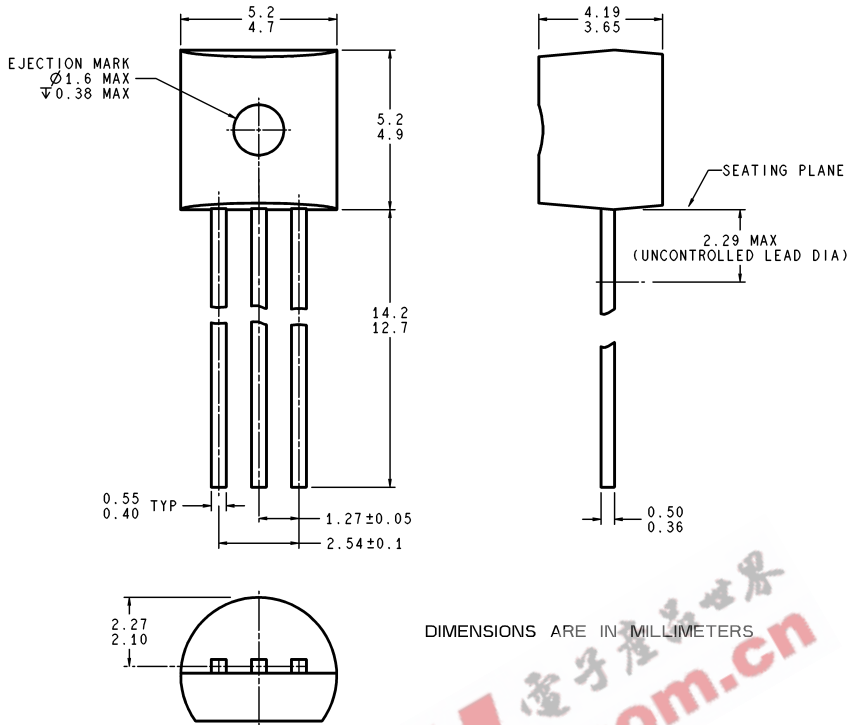


CONTROLLING DIMENSION IS MILLIMETER
VALUES IN [] ARE INCHES
DIMENSIONS IN () FOR REFERENCE ONLY

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**

Z03A (Rev G)

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

BANNED SUBSTANCE COMPLIANCE

National Semiconductor manufactures products and uses packing materials that meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.



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