



## 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. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustment voltages and currents.

The LM78LXX is available in the metal three lead TO-39(H) the plastic TO-92 (Z), and SO-8 plastic. With adequate heat sinking the regulator can deliver 100 mA 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.

For output voltage other than 5V, 12V and 15V the LM117L series provides an output voltage range from 1.2V to 37V.

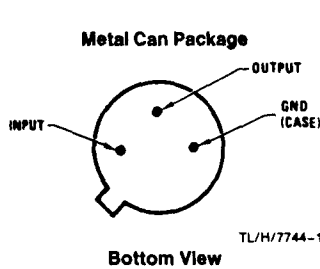
### Features

- Output voltage tolerances of  $\pm 5\%$  (LM78LXXAC) over the temperature range
- Output current of 100 mA
- Internal thermal overload protection
- Output transistor safe area protection
- Internal short circuit current limit
- Available in plastic TO-92 and metal TO-39 and plastic SO-8 low profile packages

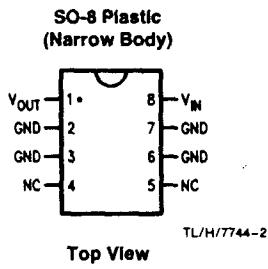
### Voltage Range

LM78L05	5V
LM78L12	12V
LM78L15	15V

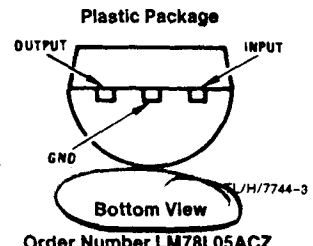
### Connection Diagrams



Bottom View  
 Order Number LM78L05ACH,  
 LM78L12ACH or LM78L15ACH  
 See NS Package Number H03A



Top View  
 Order Number LM78L05ACM,  
 LM78L12ACM or LM78L15ACM  
 See NS Package Number M08A



Bottom View  
 Order Number LM78L05ACZ,  
 LM78L12ACZ or LM78L15ACZ  
 See NS Package Number Z03A

**Absolute**  
 # Military/  
 please cor  
 Office/Distr  
 Input Voltag  
 $V_O = 5V$   
 $V_O = 12V$   
 Internal Pow

**LM78LJ**  
 (Note 2)  $T_j$

Symbol	F
$V_O$	Outp (Not
$\Delta V_O$	Line
$\Delta V_O$	Load
$\Delta V_O$	Load Stat
$I_Q$	Quie
$\Delta I_Q$	Quie Cha
$V_n$	Outp Volt
$\Delta V_{IN}$	Ripp
$\Delta V_{OUT}$	
	Inpt Rec Mail Reg

Note 1: Therm and 88°C/W parameters.

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Note 5: Hum

## Absolute Maximum Ratings

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

### Input Voltage

$V_O = 5V$  30V

$V_O = 12V$  to 15V 35V

Internal Power Dissipation (Note 1) Internally Limited

Operating Temperature Range 0°C to +70°C

Maximum Junction Temperature 125°C

### Storage Temperature Range

Metal Can (H Package) -65°C to +150°C

Molded TO-92 (Z Package) -55°C to +150°C

Lead Temperature (Soldering, 10 sec.) 260°C

ESD Tolerance (Note 5) 2000V

## LM78LXXAC Electrical Characteristics

(Note 2)  $T_J = 0^\circ\text{C}$  to  $125^\circ\text{C}$ ,  $I_O = 40\text{ mA}$ ,  $C_{IN} = 0.33\ \mu\text{F}$ ,  $C_O = 0.1\ \mu\text{F}$  (unless noted)

LM78LXXAC Output Voltage			5V			12V			15V			Units
Input Voltage (unless otherwise noted)			10V			19V			23V			
Symbol	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$V_O$	Output Voltage (Note 4)	$T_J = 25^\circ\text{C}$	4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		$1\text{ mA} \leq I_O \leq 70\text{ mA}$	4.75		5.25	11.4		12.6	14.25		15.75	V
		$1\text{ mA} \leq I_O \leq 40\text{ mA}$ and $V_{MIN} \leq V_{IN} \leq V_{MAX}$	4.75		5.25	11.4		12.6	14.25		15.75	V
			( $7 \leq V_{IN} \leq 20$ )			( $14.5 \leq V_{IN} \leq 27$ )			( $17.5 \leq V_{IN} \leq 30$ )			V
$\Delta V_O$	Line Regulation	$T_J = 25^\circ\text{C}$		10	54		20	110		25	140	mV
				( $8 \leq V_{IN} \leq 20$ )		( $16 \leq V_{IN} \leq 27$ )		( $20 \leq V_{IN} \leq 30$ )			V	
				18	75		30	180		37	250	mV
		( $7 \leq V_{IN} \leq 20$ )		( $14.5 \leq V_{IN} \leq 27$ )		( $17.5 \leq V_{IN} \leq 30$ )			V			
$\Delta V_O$	Load Regulation	$T_J = 25^\circ\text{C}$ , $1\text{ mA} \leq I_O \leq 40\text{ mA}$		5	30		10	50		12	75	mV
				$T_J = 25^\circ\text{C}$ , $1\text{ mA} \leq I_O \leq 100\text{ mA}$		20	60		30	100		35
$\Delta V_O$	Long Term Stability			12			24			30	mV/1000 hrs	
$I_Q$	Quiescent Current	$T_J = 25^\circ\text{C}$		3	5		3	5		3.1	5	mA
		$T_J = 125^\circ\text{C}$			4.7			4.7			4.7	mA
$\Delta I_Q$	Quiescent Current Change	$1\text{ mA} \leq I_O \leq 40\text{ mA}$			0.1			0.1			0.1	mA
		$V_{MIN} \leq V_{IN} \leq V_{MAX}$			1.0			1.0			1.0	mA
			( $8 \leq V_{IN} \leq 20$ )			( $16 \leq V_{IN} \leq 27$ )			( $20 \leq V_{IN} \leq 30$ )		V	
$V_n$	Output Noise Voltage	$T_J = 25^\circ\text{C}$ , (Note 3) $f = 10\text{ Hz} - 10\text{ kHz}$		40			80			90	$\mu\text{V}$	
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	$f = 120\text{ Hz}$	47	62		40	54		37	51		dB
			( $8 \leq V_{IN} \leq 18$ )			( $15 \leq V_{IN} \leq 25$ )			( $18.5 \leq V_{IN} \leq 28.5$ )			V
	Input Voltage Required to Maintain Line Regulation	$T_J = 25^\circ\text{C}$		7			14.5			17.5	V	

Note 1: Thermal resistance of H package is typically  $26^\circ\text{C/W}$   $\theta_{JC}$  still air, and  $94^\circ\text{C/W}$   $\theta_{JA}$  400 ft/min of air. For the Z package is  $80^\circ\text{C/W}$   $\theta_{JC}$ ,  $232^\circ\text{C/W}$   $\theta_{JA}$  still air, and  $88^\circ\text{C/W}$   $\theta_{JA}$  at 400 ft/min of air. For the M package,  $\theta_{JA}$  is  $180^\circ\text{C/W}$  in still air. The maximum junction temperature shall not exceed  $125^\circ\text{C}$  on Electrical parameters.

Note 2: The maximum steady state usable output current and input voltage are very dependent on the heat sinking and/or lead length of the package. The data above represent pulse test conditions with junction temperatures as indicated at the initiation of test.

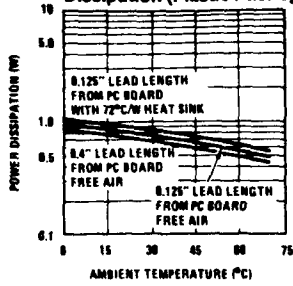
Note 3: Recommended minimum load capacitance of  $0.01\ \mu\text{F}$  to limit high frequency noise bandwidth.

Note 4: The temperature coefficient of  $V_{OUT}$  is typically within  $\pm 0.01\%$   $V_O/^\circ\text{C}$ .

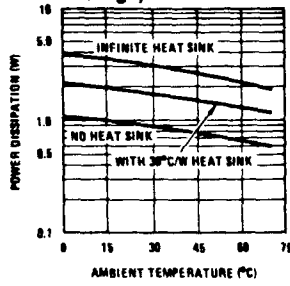
Note 5: Human body model,  $1.5\text{ k}\Omega$  in series with  $100\text{ pF}$ .

Typical Performance Characteristics

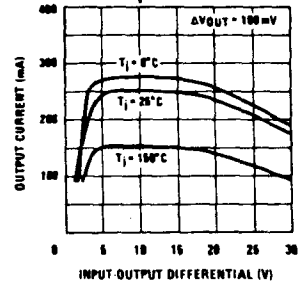
Maximum Average Power Dissipation (Plastic Package)



Maximum Average Power Dissipation (Metal Can Package)

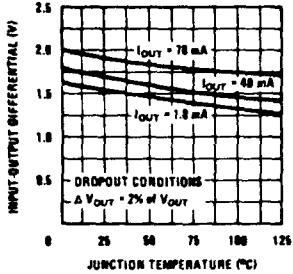


Peak Output Current

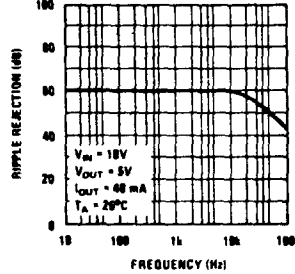


TL/H/7744-4

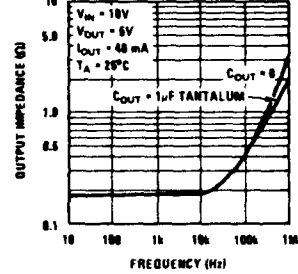
Dropout Voltage



Ripple Rejection

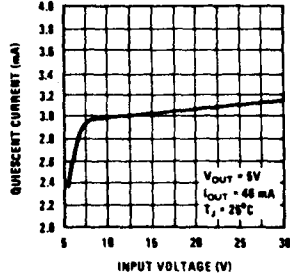


Output Impedance

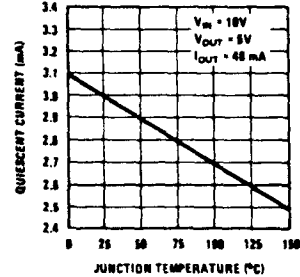


TL/H/7744-5

Quiescent Current



Quiescent Current



TL/H/7744-6

Equivalent



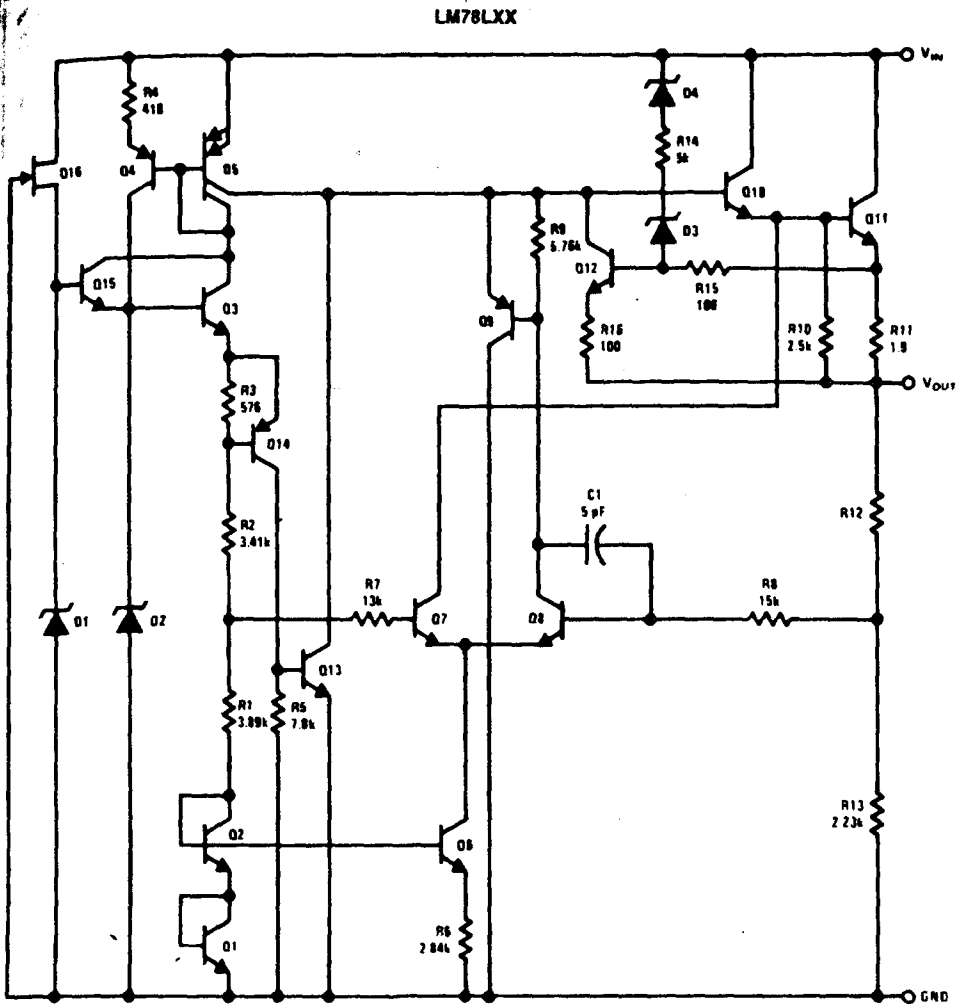
Typical

INPUT —  
C1\*  
0.33µF

\*Required if th  
\*\* See Note 3 in

# Equivalent Circuit

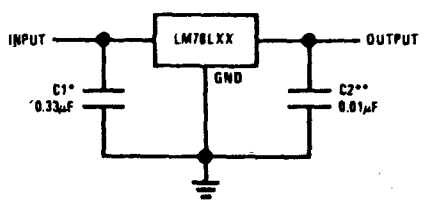
LM78LXX



TL/H/7744-7

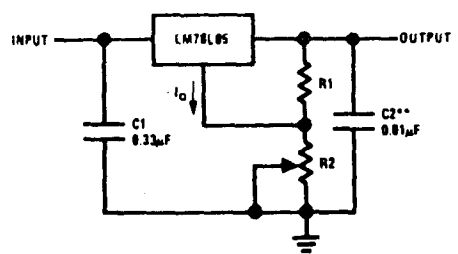
## Typical Applications

Fixed Output Regulator



TL/H/7744-8

Adjustable Output Regulator



TL/H/7744-9

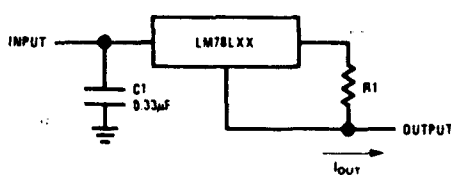
\*Required if the regulator is located far from the power supply filter.  
 \*\*See Note 3 in the electrical characteristics table.

$$V_{out} = 5V + (5V/R1 + I_a) R2$$

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

Typical Applications (Continued)

Current Regulator

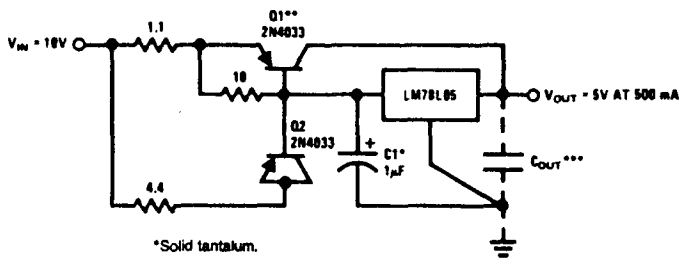


$$I_{OUT} = (V_{25}/R1) + I_Q$$

$I_Q > 1.5$  mA over line and load changes

TL/H/7744-10

5V, 500 mA Regulator with Short Circuit Protection



\*Solid tantalum.

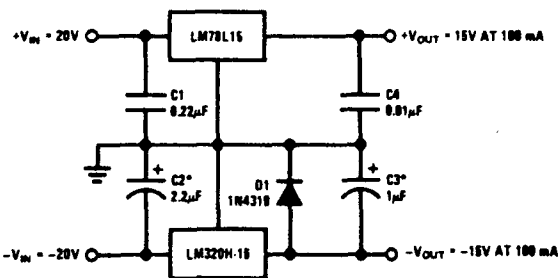
\*\*Heat sink Q1.

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

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

TL/H/7744-11

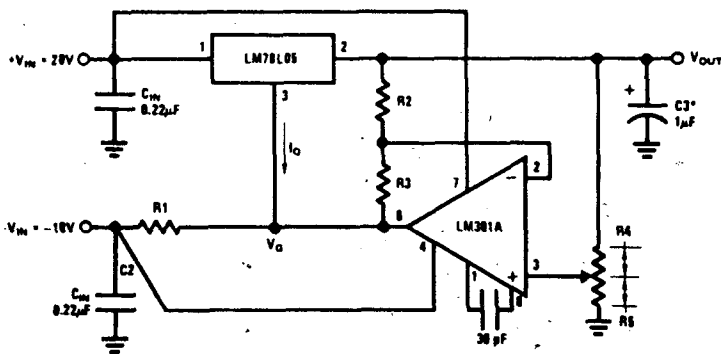
± 15V, 100 mA Dual Power Supply



\*Solid tantalum.

TL/H/7744-12

Variable Output Regulator 0.5V-18V



\*Solid tantalum.

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

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

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

TL/H/7744-13



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