National Semiconductor

Voltage Regulators

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 adjustable voltages and currents.

The LM78LXX is available in the metal three lead TO-39 (H) and the plastic TO-92 (Z). 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 transistor 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 applications requiring other voltages, see LM117 data sheet.

Features

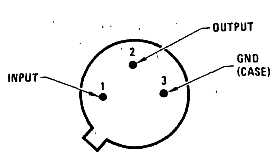
- Output voltage tolerances of ±5% (LM78LXXAC) and ±10% (LM78LXXC) over the temperature range
- Output current of 100 mA
- Internal thermal overload protection
- Output transistor safe area protection
- Internal short circuit current limit
- Available in plastic TO-92 and metal TO-39 low profile packages

Voltage Range

LM78L05	5V
LM78L12	12V
LM78L15	15V

Connection Diagrams

Metal Can Package



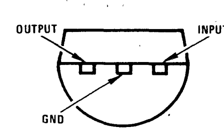
BOTTOM VIEW

Order Numbers:

LM78L05ACH	LM78L05CH
LM78L12ACH	LM78L12CH
LM78L15ACH	LM78L12CH

See NS Package H03A

Plastic Package



BOTTOM VIEW

Order Numbers:

LM78L05ACZ	LM78L05CZ
LM78L12ACZ	LM78L12CZ
LM78L15ACZ	LM78L15CZ

See NS Package Z03A

Absolute Maximum Ratings

Input Voltage	V_O = 5V	30V
	V_O = 12V and 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 seconds)		300°C

LM78LXXAC Electrical Characteristics (Note 2)

T_J = 0°C to +125°C, I_O = 40 mA, C_{IN} = 0.33μF, C_O = 0.1μF (unless noted)

LM78LXXAC OUTPUT VOLTAGE			5V			12V			15V			UNITS
INPUT VOLTAGE (unless otherwise noted)			10V			19V			23V			
PARAMETER		CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_O	Output Voltage (Note 4)	T_J = 25°C	4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		1 mA ≤ I_O ≤ 70 mA	4.75		5.25	11.4		12.6	14.25		15.75	V
		1 mA ≤ I_O ≤ 40 mA and	4.75		5.25	11.4		12.6	14.25		15.75	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)		V
ΔV_O	Line Regulation	T_J = 25°C		10	54		20	110		25	140	mV
				(8 ≤ V_{IN} ≤ 20)			(16 ≤ V_{IN} ≤ 27)			(20 ≤ V_{IN} ≤ 30)		V
				18	75		30	180		37	250	mV
				(7 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)		V
ΔV_O	Load Regulation	T_J = 25°C, 1 mA ≤ I_O ≤ 40 mA		5	30		10	50		12	75	mV
		T_J = 25°C, 1 mA ≤ I_O ≤ 100 mA		20	60		30	100		35	150	mV
ΔV_O	Long Term Stability			12			24			30		mV/1000 hrs
I_Q	Quiescent Current	T_J = 25°C		3	5		3	5		3.1	5	mA
		T_J = 125°C			4.7			4.7			4.7	
ΔI_Q	Quiescent Current Change	1 mA ≤ I_O ≤ 40 mA			0.1			0.1			0.1	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}			1.0			1.0			1.0	mA
				(8 ≤ V_{IN} ≤ 20)			(16 ≤ V_{IN} ≤ 27)			(20 ≤ V_{IN} ≤ 30)		V
V_n	Output Noise Voltage	T_J = 25°C, (Note 3) f = 10 Hz – 10 kHz		40			80			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz	47	62		40	54		37	51		dB
				(8 ≤ V_{IN} ≤ 16)			(15 ≤ V_{IN} ≤ 25)			18.5 ≤ V_{IN} ≤ 28.5)		V
	Input Voltage Required to Maintain Line Regulation	T_J = 25°C	7			14.5			17.5			V

Note 1: Thermal resistance of the Metal Can Package (H) without a heat sink is 15°C/W junction to case and 140°C/W junction to ambient. Thermal resistance of the TO-92 package is 180°C/W junction to ambient with 0.4" leads from a PC board and 160°C/W junction to ambient with 0.125" lead length to a PC board.

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 0.01μF to limit high frequency noise bandwidth.

Note 4: The temperature coefficient of V_{OUT} is typically within ±0.01% V_O/°C.

Absolute Maximum Ratings

Input Voltage $V_O = 5V$	30V
V_O = 12V and 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	−55°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

LM78LXXC Electrical Characteristics (Note 2)

T_J = 0°C to +125°C, I_O = 40 mA, C_{IN} = 0.33μF, C_O = 0.1μF (unless noted)

LM78LXXC OUTPUT VOLTAGE			5V			12V			15V			UNITS
INPUT VOLTAGE (unless otherwise noted)			10V			19V			23V			
PARAMETER		CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_O	Output Voltage	T_J = 25°C	4.6	5	5.4	11.1	12	12.9	13.8	15	16.2	V
	(Note 4)	1 mA ≤ I_O ≤ 70 mA or	4.5		5.5	10.8		13.2	13.5		16.5	V
		1 mA ≤ I_O ≤ 40 mA and ΔV_{IN}	(7 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(18 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	T_J = 25°C		10	150		20	200		25	250	mV
			(8 ≤ V_{IN} ≤ 20)			(16 ≤ V_{IN} ≤ 27)			(20 ≤ V_{IN} ≤ 30)			V
				18	200		30	250		30	300	mV
			(7 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(18 ≤ V_{IN} ≤ 30)			V
ΔV_O	Load Regulation	T_J = 25°C, 1 mA ≤ I_O ≤ 40 mA		5	30		10	50		12	75	mV
		T_J = 25°C, 1 mA ≤ I_O ≤ 100 mA		20	60		30	100		35	150	mV
ΔV_O	Long Term Stability			12			24			30		mV/1000 hrs
I_Q	Quiescent Current	T_J = 25°C		3	6		3	6.5		3.1	6.5	mA
		T_J = 125°C			5.5			6			6	
ΔI_Q	Quiescent Current	T_J = 25°C, 1 mA ≤ I_O ≤ 40 mA			0.2			0.2			0.2	mA
					1.5			1.5			1.5	mA
	Change	T_J = 25°C	(8 ≤ V_{IN} ≤ 20)			(16 ≤ V_{IN} ≤ 27)			(20 ≤ V_{IN} ≤ 30)			V
V_n	Output Noise Voltage	T_J = 25°C, (Note 3) f = 10 Hz – 10 kHz		40			80			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 125 Hz	40	60		36	52		33	49		dB
			(8 ≤ V_{IN} ≤ 18)			(15 ≤ V_{IN} ≤ 25)			(18.5 ≤ V_{IN} ≤ 28.5)			V
	Input Voltage Required to Maintain Line Regulation	T_J = 25°C		7			14.5			18		V

Note 1: Thermal resistance of the Metal Can Package (H) without a heat sink is 15°C/W junction to case and 140°C/W junction to ambient. Thermal resistance of the TO-92 package is 180°C/W junction to ambient with 0.4" leads from a PC board and 160°C/W junction to ambient with 0.125" lead length to a PC board.

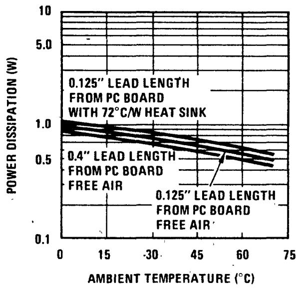
Note 2: The maximum steady state usable output current and input voltage are very dependent on the heat sinking and/or lead length of the package. The data above represent pulse test conditions with junction temperatures as indicated at the initiation of test.

Note 3: Recommended minimum load capacitance of 0.01μF to limit high frequency noise bandwidth.

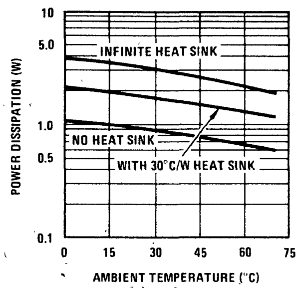
Note 4: The temperature coefficient of V_{OUT} is typically within ±0.01% V_O/°C.

Typical Performance Characteristics

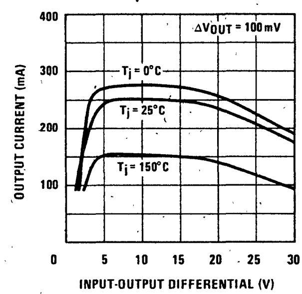
Maximum Average Power Dissipation (Plastic Package)



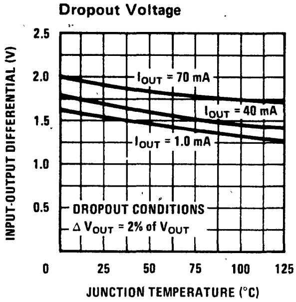
Maximum Average Power Dissipation (Metal Can Package)



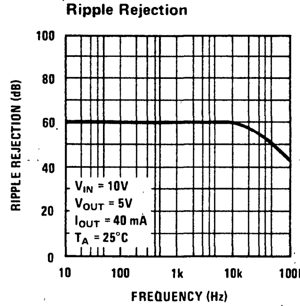
Peak Output Current



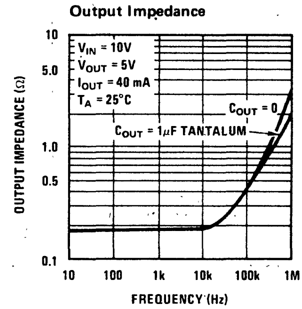
Dropout Voltage



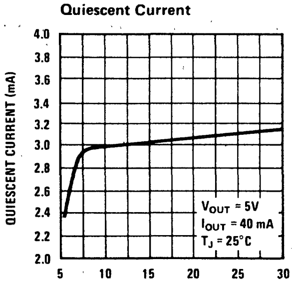
Ripple Rejection



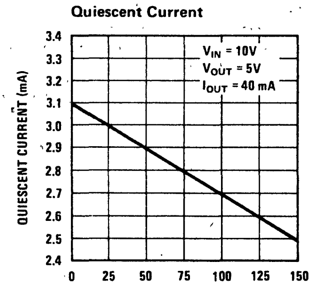
Output Impedance



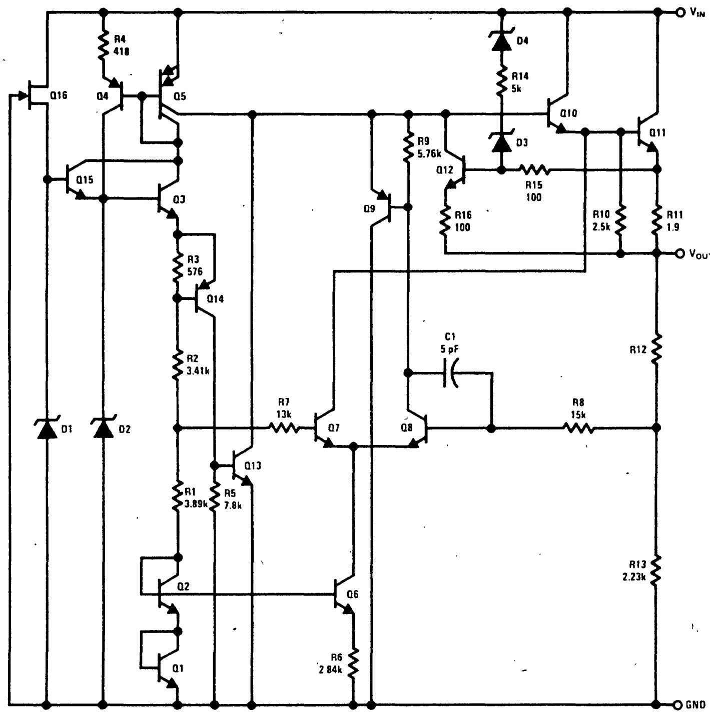
Quiescent Current



Quiescent Current

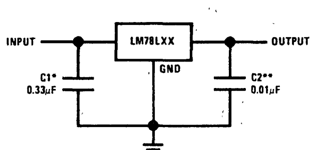


Equivalent Circuit



LM78LXX

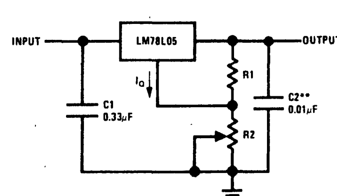
Typical Applications



*Required if the regulator is located far from the power supply filter.

**See Note 3 in the electrical characteristics table.

Fixed Output Regulator

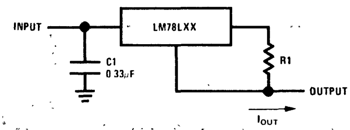


$V_{OUT} = 5V + (5V/R1 + I_Q)\ R2$

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

Adjustable Output Regulator

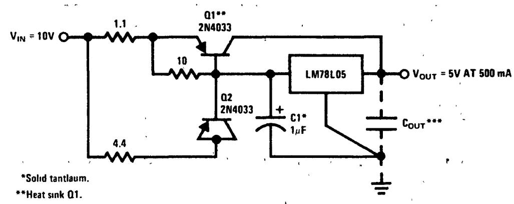
Typical Applications (Continued)



$I_{OUT} = (V_{23}/R1) + I_Q$

ΔI_Q = 1.5 mA over line and load changes

Current Regulator



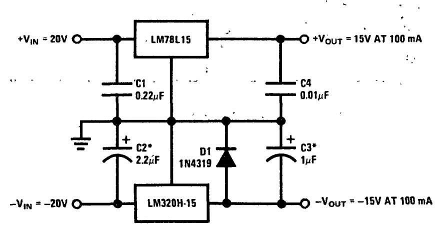
*Solid tantlaum.

**Heat sink Q1.

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

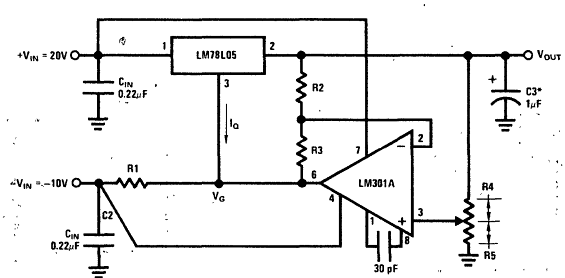
Load Regulation: 0.6% $0 \leq I_L \leq 250$ mA pulsed with t_{ON} = 50 ms.

5V, 500 mA Regulator with Short Circuit Protection



*Solid tantalum.

±15V, 100 mA Dual Power Supply



*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 $(R2/R4) = 0.1$, $(R3/R4) = 0.9$

Variable Output Regulator 0.5V — 18V