National Semiconductor

LM7900 Series
3-Terminal Negative Voltage Regulators

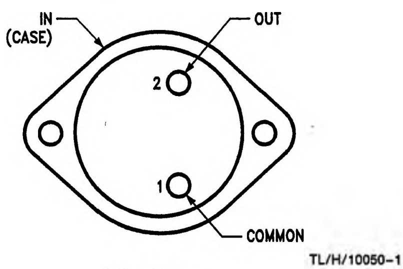
General Description

The LM7900 series of monolithic 3-terminal negative regulators are intended as complements to the popular LM7800 series of positive voltage regulators, and they are available in voltage options from −5.0V to −15V. The LM7900 series employ internal current-limiting, thermal shutdown, and safe-area compensation, making them virtually indestructible.

Features

- Output current in excess of 1.0A
- Internal thermal overload protection
- Internal short circuit current-limiting
- Output transistor safe-area compensation
- Available in JEDEC TO-220 and TO-3 packages
- Output voltage of −8V (See Note)

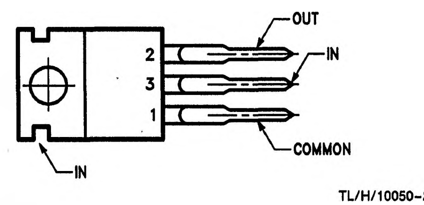
Connection Diagrams



Top View

Order Number LM7908K and LM7908CK
See NS Package Number K02A

Note: See the LM79xx datasheet in the General Purpose Linear Databook for specifications on products in this series with −5V, −12V, and −15V outputs. Refer to the LM120/LM320 datasheet for −5V, −12V, and −15V regulators specified over extended temperature ranges.



Lead 3 connected to case.

Top View

Order Number LM7908CT
See NS Package Number T03B

Absolute Maximum Ratings

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

Storage Temperature Range	
TO-3 Metal Can	−65°C to +175°C
TO-220 Package	−65°C to +150°C
Operating Junction Temperature Range	
Extended (LM7900)	−55°C to +150°C
Commercial (LM7900C)	0°C to +150°C
Lead Temperature	
TO-3 Metal (soldering, 60 sec.)	300°C
TO-220 Package (soldering, 10 sec.)	265°C
Power Dissipation	Internally Limited
Input Voltage	
−5V to −15V	−35V
ESD Susceptibility	2000V

Note 1: The convention for Negative Regulators is the Algebraic value, thus −15V is less then −10V.

LM7908
Electrical Characteristics

$-55°C \leq T_A \leq 125°C$, $V_I = -14V$, $I_O = 500$ mA, $C_I = 2.0\ \mu F$, $C_O = 1.0\ \mu F$, unless otherwise specified

Symbol	Parameter		Conditions (Note 1)		Min	Typ	Max	Units
V_O	Output Voltage		$T_J = 25°C$		−7.7	−8.0	−8.3	V
$V_{R\ LINE}$	Line Regulation		$T_J = 25°C$	$-10.5V \leq V_I \leq -25V$		6.0	80	mV
				$-11V \leq V_I \leq -17V$		2.0	40	
$V_{R\ LOAD}$	Load Regulation		$T_J = 25°C$	$5.0\ mA \leq I_O \leq 1.5A$		12	100	mV
				$250\ mA \leq I_O \leq 750\ mA$		4.0	40	
V_O	Output Voltage		$-11.5V \leq V_I \leq -23V$, $5.0\ mA \leq I_O \leq 1.0A$, $P \leq 15W$		−7.6		−8.4	V
I_Q	Quiescent Current		$T_J = 25°C$			3.5	7.0	mA
ΔI_Q	Quiescent Current Change	With Line	$-11.5V \leq V_I \leq -25V$				1.0	mA
		With Load	$5.0\ mA \leq I_O \leq 1.0A$				0.5	
N_O	Noise		$T_A = 25°C$, $10\ Hz \leq f \leq 100\ kHz$			25	80	$\mu V/V_O$
$\Delta V_I/\Delta V_O$	Ripple Rejection		$f = 2400\ Hz$, $V_I = -13V$, $I_O = 350\ mA$, $T_J = 25°C$		54	60		dB
V_{DO}	Dropout Voltage		$I_O = 1.0A$, $T_J = 25°C$			1.1	2.3	V
I_{pk}	Peak Output Current		$T_J = 25°C$		1.3	2.1	3.3	A
$\Delta V_O/\Delta T$	Average Temperature Coefficient of Output Voltage		$I_O = 5.0\ mA$, $-55°C \leq T_A \leq 125°C$				0.3	$mV/°C/V_O$
I_{OS}	Output Short Circuit Current		$V_I = -35V$, $T_J = 25°C$				1.2	A

LM7908C

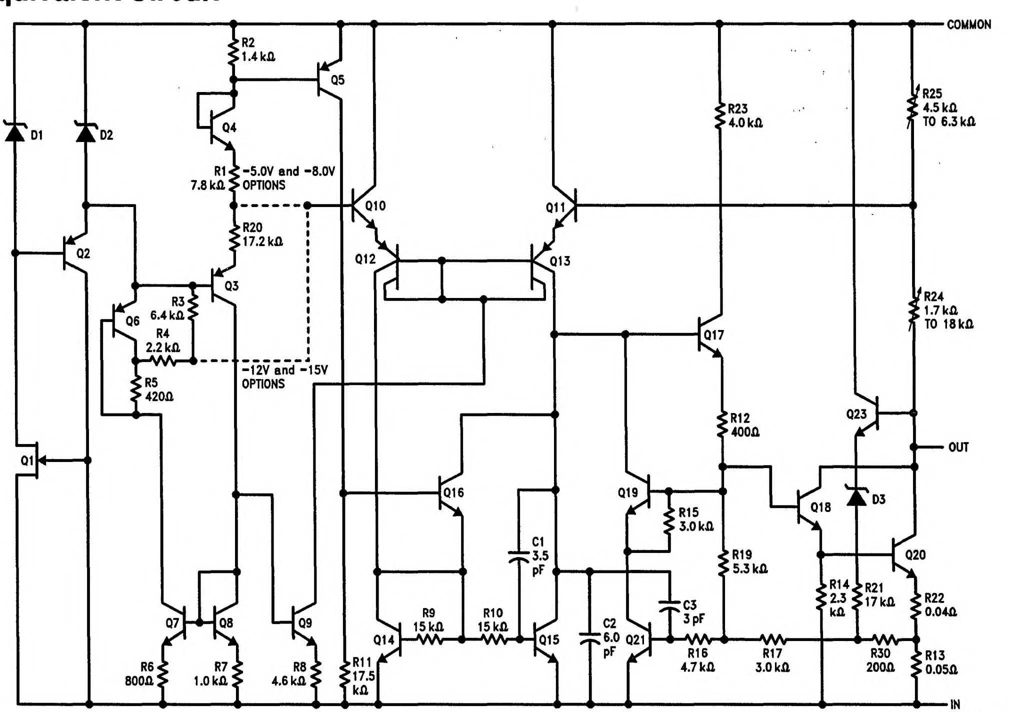
Electrical Characteristics

0°C ≤ T_A ≤ 125°C, V_I = −14V, I_O = 500 mA, C_I = 2.0 μF, C_O = 1.0 μF, unless otherwise specified

Symbol	Parameter		Conditions (Note 1)		Min	Typ	Max	Units
V_O	Output Voltage		T_J = 25°C		−7.7	−8.0	−8.3	V
$V_{R\ LINE}$	Line Regulation		T_J = 25°C	−10.5V ≤ V_I ≤ −25V		6.0	160	mV
				−11V ≤ V_I ≤ − 17V		2.0	80	
$V_{R\ LOAD}$	Load Regulation		T_J = 25°C	5.0 mA ≤ I_O ≤ 1.5A		12	160	mV
				250 mA ≤ I_O ≤ 750 mA		4.0	80	
V_O	Output Voltage		−10.5V ≤ V_I ≤ 23V, 5.0 mA ≤ I_O ≤ 1.0A, P ≤ 15W		−7.6		−8.4	V
I_Q	Quiescent Current		T_J = 25°C			3.5	7.0	mA
ΔI_Q	Quiescent Current Change	With Line	−10.5V ≤ V_I ≤ −25V				1.0	mA
		With Load	5.0 mA ≤ I_O ≤ 1.0A				0.5	
N_O	Noise		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			200		μV
$\Delta V_I/\Delta V_O$	Ripple Rejection		f = 2400 Hz, V_I = −13V, I_O = 350 mA, T_J = 25°C		54	60		dB
V_{DO}	Dropout Voltage		I_O = 1.0A, T_J = 25°C			1.1		V
I_{pk}	Peak Output Current		T_J = 25°C			2.1		A
$\Delta V_O/\Delta T$	Average Temperature Coefficient of Output Voltage		I_O = 5.0 mA, 0°C ≤ T_A ≤ 125°C			0.6		mV/°C

Note 1: All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_W ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

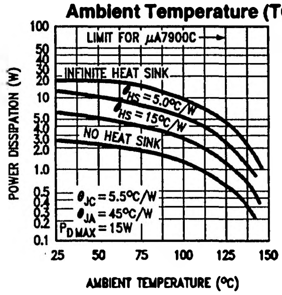
Equivalent Circuit



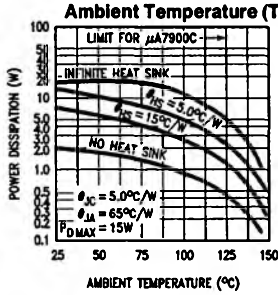
TL/H/10050-3

Typical Performance Characteristics

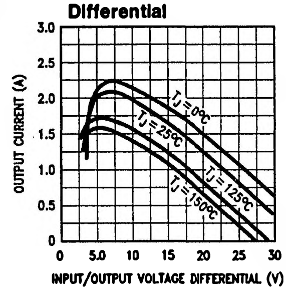
Worst Case Power Dissipation vs Ambient Temperature (TO-3)



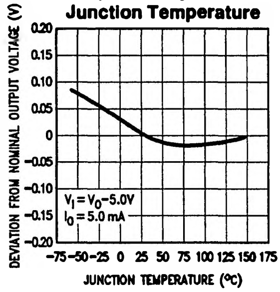
Worst Case Power Dissipation vs Ambient Temperature (TO-220)



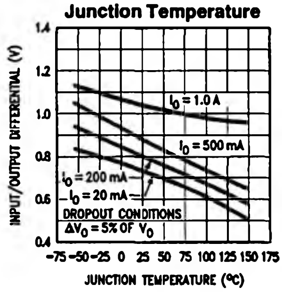
Peak Output Current vs Input/Output Voltage Differential



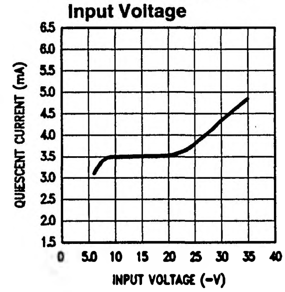
Output Voltage vs Junction Temperature



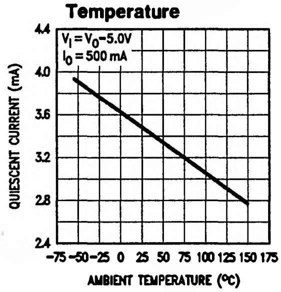
Dropout Voltage vs Junction Temperature



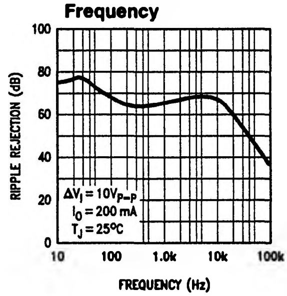
Quiescent Current vs Input Voltage



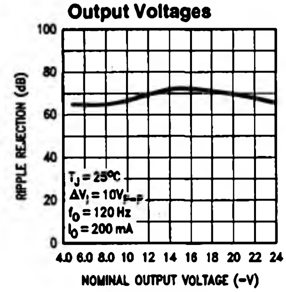
Quiescent Current vs Temperature



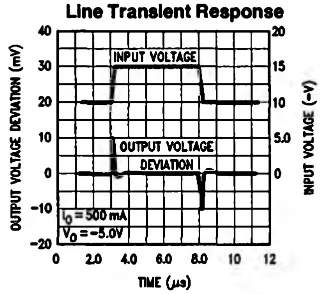
Ripple Rejection vs Frequency



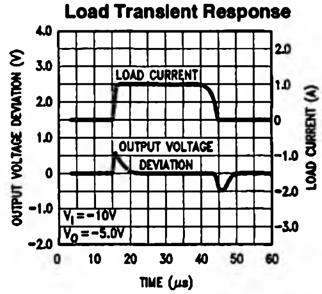
Ripple Rejection vs Output Voltages



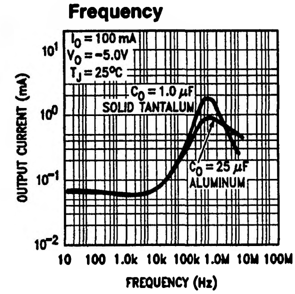
Line Transient Response



Load Transient Response



Output Impedance vs Frequency



TL/H/10050-4

Design Considerations

The LM7900 fixed voltage regulator series has thermal overload protection from excessive power dissipation, internal short circuit protection which limits the circuit's maximum current, and output transistor safe-area compensation for reducing the output current as the voltage across the pass transistor is increased.

Although the internal power dissipation is limited, the junction temperature must be kept below the maximum specified temperature (150°C for LM7900, 125°C for LM7900C) in order to meet data sheet specifications. To calculate the maximum junction temperature or heat sink required, the following thermal resistance values should be used:

Package	Typ θ_{JC} °C/W	Max θ_{JC} °C/W	Typ θ_{JA} °C/W	Max θ_{JA} °C/W
TO-3	3.5	5.5	40	35
TO-220	3.0	5.0	60	40

$$P_{D\,MAX} = \frac{T_{J\,Max} - T_A}{\theta_{JC} + \theta_{CA}} \text{ or } \frac{T_{J\,Max}\,T_A}{\theta_{JA}}$$

$\theta_{CA} = \theta_{CS} + \theta_{SA}$ (without heat sink)

Solving for T_J:

$T_J = T_A + P_D(\theta_{JC} + \theta_{CA})$ or

$= T_A + P_D\theta_{JA}$ (without heat sink)

Where:

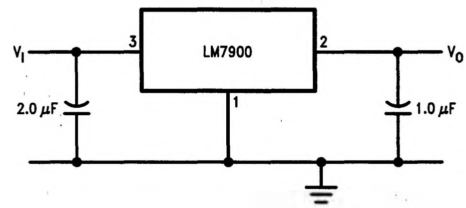
- T_J = Junction Temperature
- T_A = Ambient Temperature
- P_D = Power Dissipation
- θ_{JA} = Junction-to-Ambient Thermal Resistance
- θ_{JC} = Junction-to-Case Thermal Resistance
- θ_{CA} = Case-to-Ambient Thermal Resistance
- θ_{CS} = Case-to-Heat Sink Thermal Resistance
- θ_{SA} = Heat Sink-to-Ambient Thermal Resistance

Typical Applications

Bypass capacitors are necessary for stable operation of the LM7900 series of regulators over the input voltage and output current ranges. Output bypass capacitors will improve the transient response by the regulator.

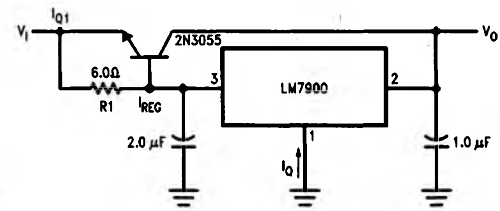
The bypass capacitors, (2.0 µF on the input, 1.0 µF on the output) should be ceramic or solid tantalum which have good high frequency characteristics. If aluminum electrolytics are used, their values should be 10 µF or larger. The bypass capacitors should be mounted with the shortest leads, and if possible, directly across the regulator terminals.

Fixed Output Regulator



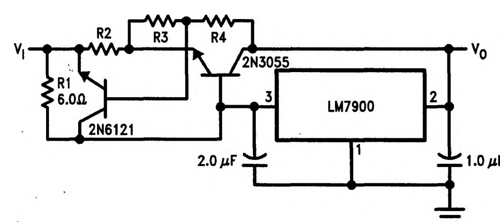
TL/H/10050-5

High Current Voltage Regulator



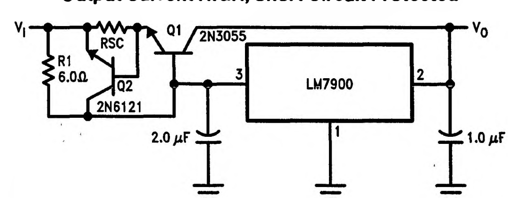
TL/H/10050-6

Output Current HIGH, Foldback Current-Limited



TL/H/10050-7

Output Current HIGH, Short Circuit Protected



TL/H/10050-8

$$RSC = \frac{V_{BE(Q2)}}{I_{OS}}$$