National Semiconductor

LM137HV/LM237HV/LM337HV
3-Terminal Adjustable Negative Regulators (High Voltage)

General Description

The LM137HV/LM237HV/LM337HV are adjustable 3-terminal negative voltage regulators capable of supplying in excess of −1.5A over an output voltage range of −1.2V to −47V. These regulators are exceptionally easy to apply, requiring only 2 external resistors to set the output voltage and 1 output capacitor for frequency compensation. The circuit design has been optimized for excellent regulation and low thermal transients. Further, the LM137HV series features internal current limiting, thermal shutdown and safe-area compensation, making them virtually blowout-proof against overloads.

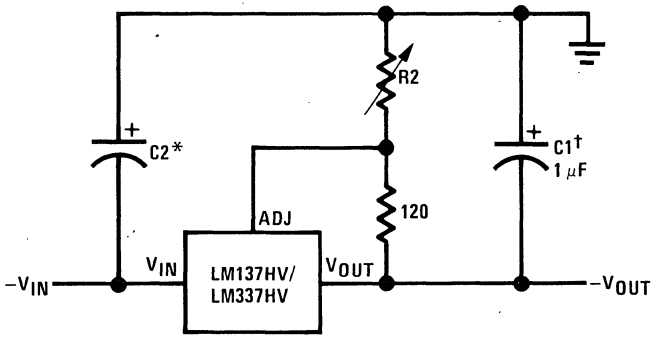
The LM137HV/LM237HV/LM337HV serve a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137HV/LM237HV/LM337HV are ideal complements to the LM117HV/LM217HV/LM317HV adjustable positive regulators.

Features

- Output voltage adjustable from −1.2V to −47V
- 1.5A output current guaranteed, −55°C to +150°C
- Line regulation typically 0.01%/V
- Load regulation typically 0.3%
- Excellent thermal regulation, 0.002%/W
- 77 dB ripple rejection
- Excellent rejection of thermal transients
- 50 ppm/°C temperature coefficient
- Temperature-independent current limit
- Internal thermal overload protection
- 100% electrical burn-in
- Standard 3-lead transistor package

Typical Applications

Adjustable Negative Voltage Regulator



$$-V_{OUT} = -1.25V\left(1 + \frac{R2}{120\Omega}\right)$$

†C1 = 1 μF solid tantalum or 10 μF aluminum electrolytic required for stability. Output capacitors in the range of 1 μF to 1000 μF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

*C2 = 1 μF solid tantalum is required only if regulator is more than 4" from power-supply filter capacitor

Absolute Maximum Ratings

Power Dissipation	Internally limited
Input–Output Voltage Differential	50V
Operating Junction Temperature Range	
LM137HV	−55°C to +150°C
LM237HV	−25°C to +150°C
LM337HV	0°C to +125°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Preconditioning

Burn-In in Thermal Limit	**100% All Devices**

Electrical Characteristics (Note 1)

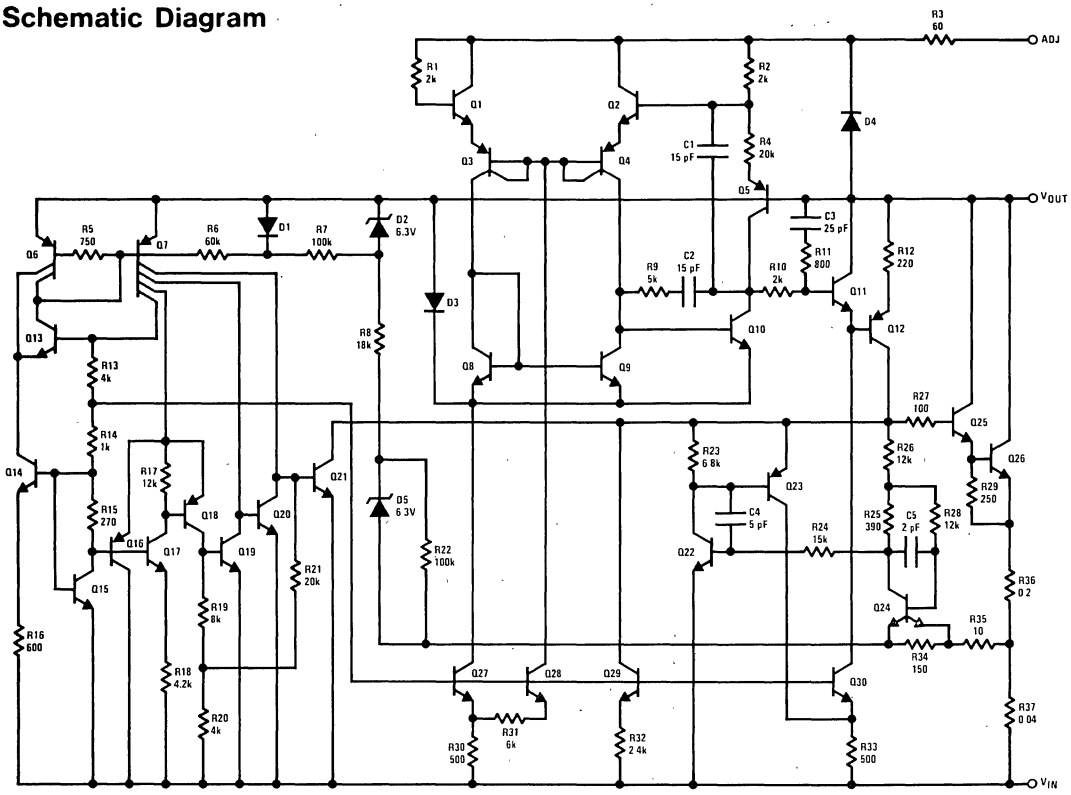
PARAMETER	CONDITIONS	LM137HV/LM237HV			LM337HV			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	$T_A = 25°C$, $3V \le \lvert V_{IN}-V_{OUT}\rvert \le 50V$, (Note 2)		0.01	0.02		0.01	0.04	%/V
Load Regulation	$T_A = 25°C$, $10\ mA \le I_{OUT} \le I_{MAX}$							
	$\lvert V_{OUT}\rvert \le 5V$, (Note 2)		15	25		15	50	mV
	$\lvert V_{OUT}\rvert \ge 5V$, (Note 2)		0.3	0.5		0.3	1.0	%
Thermal Regulation	$T_A = 25°C$, 10 ms Pulse		0.002	0.02		0.003	0.04	%/W
Adjustment Pin Current			65	100		65	100	μA
Adjustment Pin Current Change	$10\ mA \le I_L \le I_{MAX}$		2	5		2	5	μA
	$2.5V \le \lvert V_{IN}-V_{OUT}\rvert \le 50V$, $T_A = 25°C$		3	6		3	6	μA
Reference Voltage	$T_A = 25°C$, (Note 3)	−1.225	−1.250	−1.275	−1.213	−1.250	−1.287	V
	$3 \le \lvert V_{IN}-V_{OUT}\rvert \le 50V$, (Note 3)	−1.200	−1.250	−1.300	−1.200	−1.250	−1.300	V
	$10\ mA \le I_{OUT} \le I_{MAX}$, $P \le P_{MAX}$							
Line Regulation	$3V \le \lvert V_{IN}-V_{OUT}\rvert \le 50V$, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	$10\ mA \le I_{OUT} \le I_{MAX}$, (Note 2)							
	$\lvert V_{OUT}\rvert \le 5V$		20	50		20	70	mV
	$\lvert V_{OUT}\rvert \ge 5V$		0.3	1		0.3	1.5	%
Temperature Stability	$T_{MIN} \le T_j \le T_{MAX}$		0.6			0.6		%
Minimum Load Current	$\lvert V_{IN}-V_{OUT}\rvert \le 50V$		2.5	5		2.5	10	mA
	$\lvert V_{IN}-V_{OUT}\rvert \le 10V$		1.2	3		1.5	6	mA
Current Limit	$\lvert V_{IN}-V_{OUT}\rvert \le 13V$							
	K Package	1.5	2.2	3.2	1.5	2.2	3.5	A
	H Package	0.5	0.8	1.6	0.5	0.8	1.8	A
	$\lvert V_{IN}-V_{OUT}\rvert = 50V$							
	K Package	0.2	0.4	0.8	0.1	0.4	0.8	A
	H Package	0.1	0.17	0.5	0.050	0.17	0.5	A
RMS Output Noise, % of V_{OUT}	$T_A = 25°C$, $10\ Hz \le f \le 10\ kHz$		0.003			0.003		%
Ripple Rejection Ratio	$V_{OUT} = -10V$, f = 120 Hz		60			60		dB
	$C_{ADJ} = 10\ \mu F$	66	77		66	77		dB
Long-Term Stability	$T_A = 125°C$, 1000 Hours		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case	H Package		12	15		12	15	°C/W
	K Package		2.3	3		2.3	3	°C/W

Note 1: Unless otherwise specified, these specifications apply $-55°C \le T_j \le +150°C$ for the LM137HV, $-25°C \le T_j \le +150°C$ for the LM237HV, $0°C \le T_j \le +125°C$ for the LM337HV; $V_{IN} - V_{OUT} = 5V$; and $I_{OUT} = 0.1A$ for the TO-39 package and $I_{OUT} = 0.5A$ for the TO-3 package. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO-39 and 20W for the TO-3. I_{MAX} is 1.5A for the TO-3 package and 0.2A for the TO-39 package.

Note 2: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation. Load regulation is measured on the output pin at a point 1/8″ below the base of the TO-3 and TO-39 packages.

Note 3: Selected devices with tightened tolerance reference voltage available.

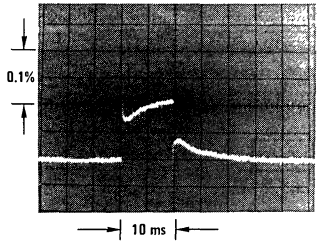
Schematic Diagram



Thermal Regulation

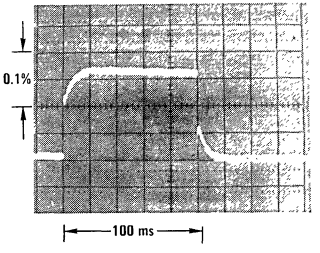
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per Watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5 ms to 50 ms after a change in power dissipation. Thermal regulation depends on IC layout as well as electrical design. The thermal regulation of a voltage regulator is defined as the percentage change of V_{OUT}, per Watt, within the first 10 ms after a step of power is applied. The LM137HV's specification is 0.02%/W, max.

In *Figure 1*, a typical LM137HV's output drifts only 3 mV (or 0.03% of $V_{OUT} = -10V$) when a 10W pulse is applied for 10 ms. This performance is thus well inside the specification limit of 0.02%/W x 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV chip cools off. Note that the load regulation error of about 8 mV (0.08%) is additional to the thermal regulation error. In *Figure 2*, when the 10W pulse is applied for 100 ms, the output drifts only slightly beyond the drift in the first 10 ms, and the thermal error stays well within 0.1% (10 mV).



LM137HV, $V_{OUT} = -10V$
$V_{IN} - V_{OUT} = -40V$
$I_L = 0A \rightarrow 0.25A \rightarrow 0A$
Vertical sensitivity, 5 mV/div

FIGURE 1

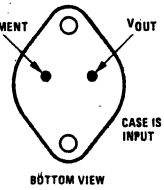


LM137HV, $V_{OUT} = -10V$
$V_{IN} - V_{OUT} = -40V$
$I_L = 0A \rightarrow 0.25A \rightarrow 0A$
Horizontal sensitivity, 20 ms/div

FIGURE 2

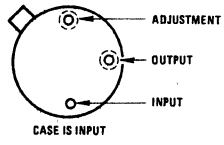
Connection Diagrams

TO-3
Metal Can Package



Ordering Information
LM137HVK STEEL
LM237HVK STEEL
LM337HVK STEEL
See Package K02A

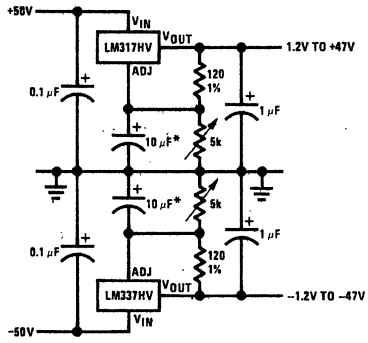
TO-39
Metal Can Package



Ordering Information
LM137HVH
Lm237HVH
LM337HVH
See Package H03B

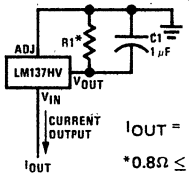
Typical Applications (Continued)

Adjustable High Voltage Regulator



*The 10 μF capacitors are optional to improve ripple rejection

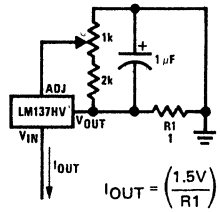
Current Regulator



$I_{OUT} = \frac{1.250V}{R1}$

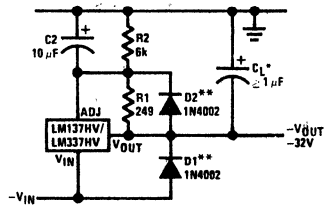
*0.8Ω ≤ R1 ≤ 120Ω

Adjustable Current Regulator



$I_{OUT} = \left(\frac{1.5V}{R1}\right)$ ±15% adjustable

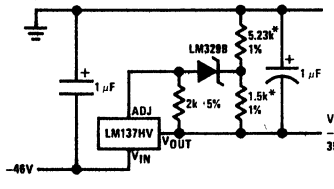
Negative Regulator with Protection Diodes



*When C_L is larger than 20 μF, D1 protects the LM137HV is case the input supply is shorted

**When C2 is larger than 10 μF and $-V_{OUT}$ is larger than −25V, D2 protects the LM137HV in case the output is shorted

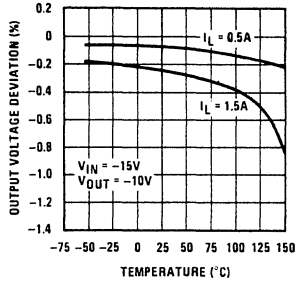
High Stability −40V Regulator



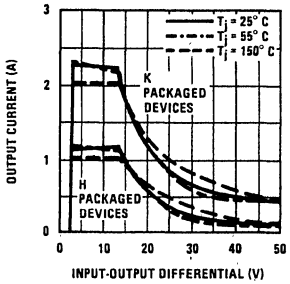
*Use resistors with good tracking TC < 25 ppm/°C

Typical Performance Characteristics (H and K-STEEL Package)

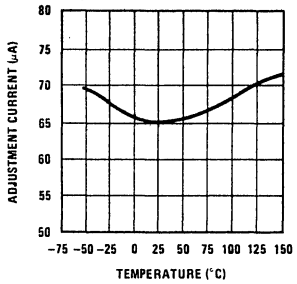
Load Regulation



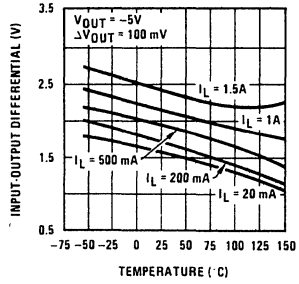
Current Limit



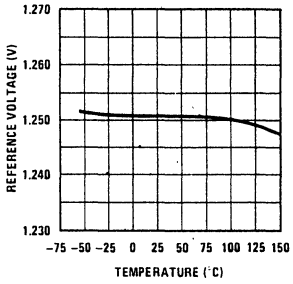
Adjustment Current



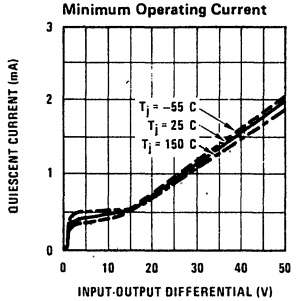
Dropout Voltage



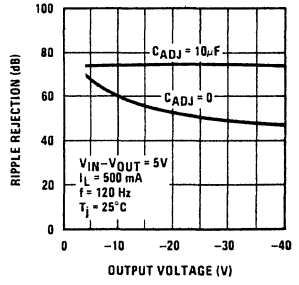
Temperature Stability



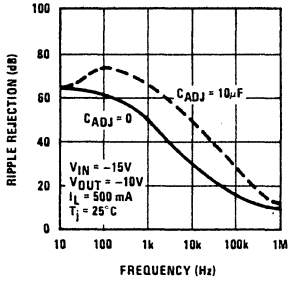
Minimum Operating Current



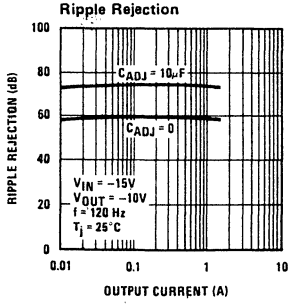
Ripple Rejection



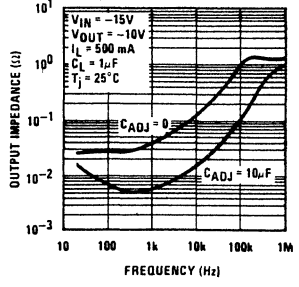
Ripple Rejection



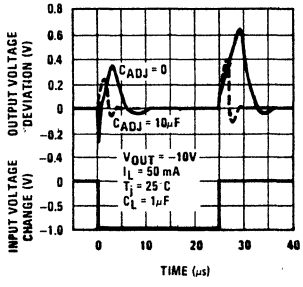
Ripple Rejection



Output Impedance



Line Transient Response



Load Transient Response