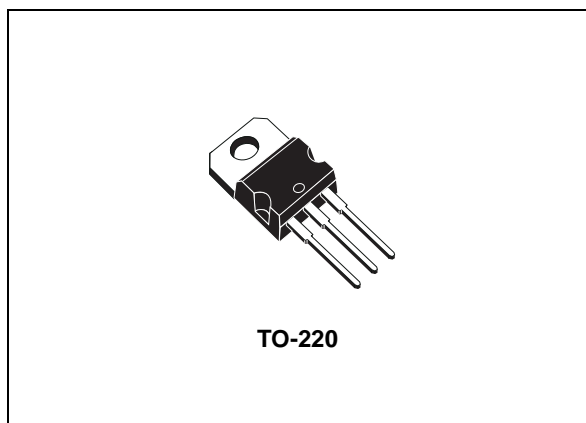


Three-terminal adjustable negative voltage regulators

Datasheet - production data



current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

Table 1. Device summary

Order codes	Packages	Temperature range
LM337SP	TO-220	0 °C to 125 °C

Features

- Output voltage adjustable down to V_{REF}
- 1.5 A guaranteed output current
- 0.3%/V typical load regulation
- 0.01%/V typical line regulation
- Current limit constant with temperature
- Ripple rejection: 77 dB
- Standard 3-lead transistor packages
- Excellent thermal regulation: 0.002%/V
- 50 ppm/°C temperature coefficient

Description

The LM337 series are adjustable 3-terminal negative voltage regulators capable of supplying in excess -1.5 A over a -1.2 to -37 V output voltage range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators. Also, LM337 regulators are supplied in standard transistor packages which are easily mounted and handled. In addition to higher performance than fixed regulators, the LM337 series offer full overload protection available only in integrated circuits. Included on the chip are

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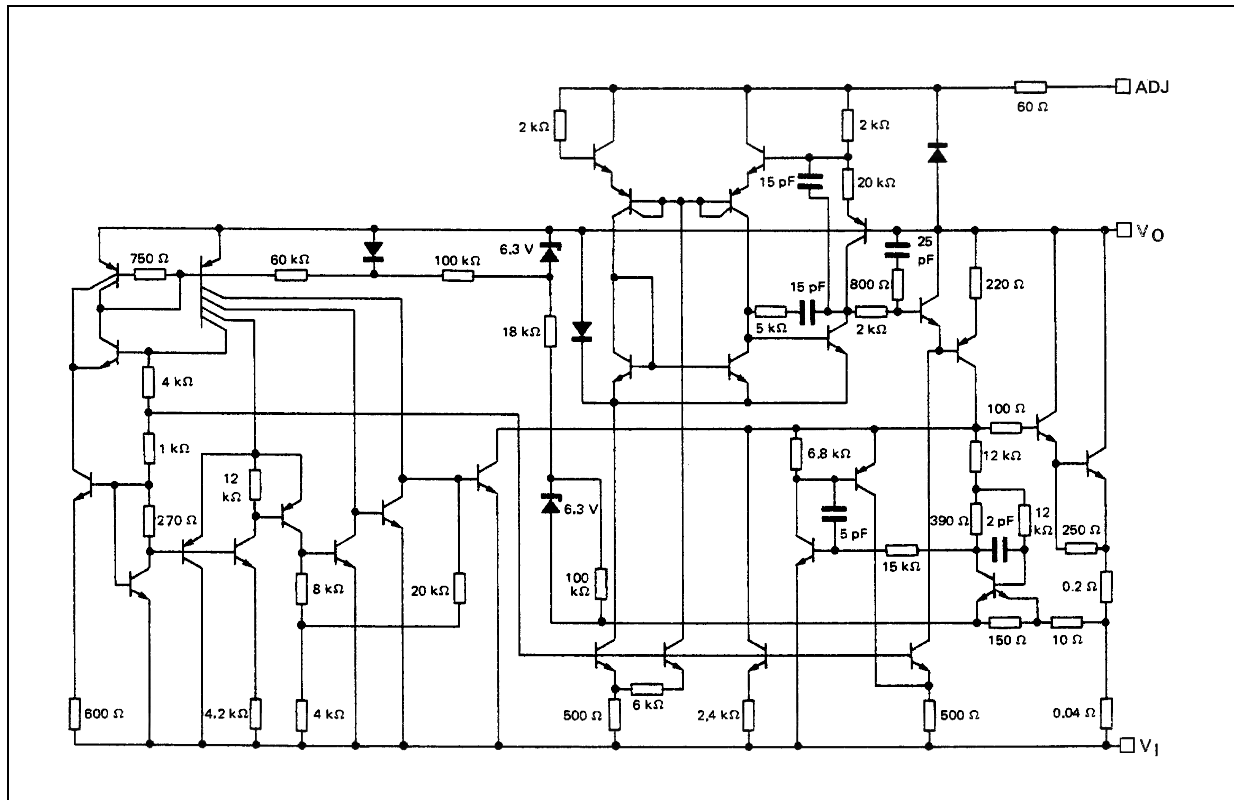
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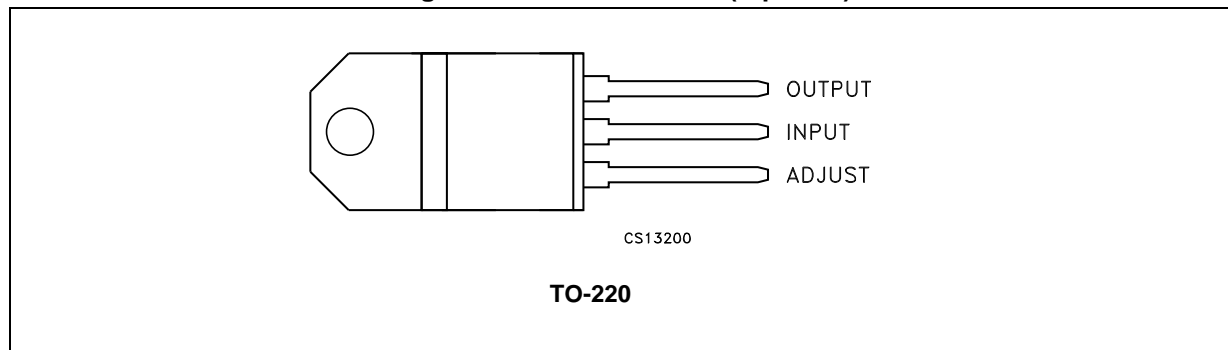
1 Diagram

Figure 1. Schematic diagram



2 Pin configuration

Figure 2. Pin connections (top view)



3 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_I - V_O$	Input output voltage differential	40	V
I_O	Output current	1.5	A
P_D	Power dissipation	Internally limited	
T_{STG}	Storage temperature range	- 65 to 150	°C
T_{OP}	Operating junction temperature range	0 to 125	°C

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 3. Thermal data

Symbol	Parameter	TO-220	Unit
R_{thJC}	Thermal resistance junction-case max.	3	°C/W
R_{thJA}	Thermal resistance junction-ambient max.	70	°C/W

4 Electrical characteristics

$T_J = 0$ to $150\text{ }^{\circ}\text{C}$ $V_I - V_O = 5\text{ V}$, $I_O = 0.5\text{ A}$ unless otherwise specified.

Table 4. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{REF}	Reference voltage	$T_a = 25^{\circ}\text{C}$	-1.213	-1.25	-1.287	V
		$ V_I - V_O = 3$ to 40 V , $T_J = T_{min}$ to T_{max} $ I_O = 10\text{ mA}$ to $ I_{O(max)} $, $P \leq P_{max}$	-1.2	-1.25	-1.3	
K_{VI}	Line regulation ⁽¹⁾	$T_a = 25^{\circ}\text{C}$ $ V_I - V_O = 3$ to 40 V		0.01	0.04	% / V
		$I_O = 0.1\text{ A}$ $I_O = 20\text{ mA}$		0.01	0.04	
K_{VO}	Load regulation ⁽¹⁾	$T_a = 25^{\circ}\text{C}$ $ I_O = 10\text{ mA}$ to $ I_{O(max)} $		15	50	mV
		$ V_O \leq 5\text{ V}$ $ V_O \geq 5\text{ V}$		0.3	1	%
	Thermal regulation	$T_a = 25^{\circ}\text{C}$, pulse 10 ms		0.003	0.04	% / W
I_{ADJ}	Adjustment pin current			65	100	μA
ΔI_{ADJ}	Adjustment pin current change	$T_a = 25^{\circ}\text{C}$, $ I_O = 10\text{ mA}$ to $ I_{O(max)} $ $ V_I - V_O = 3$ to 40 V		2	5	μA
K_{VI}	Line regulation ⁽¹⁾	$ V_I - V_O = 3$ to 40 V		0.02	0.07	% / V
K_{VO}	Load regulation ⁽¹⁾	$ I_O = 10\text{ mA}$ to $ I_{O(max)} $		20	70	mV
		$ V_O \leq 5\text{ V}$ $ V_O \geq 5\text{ V}$		0.3	1.5	%
$ I_{O(min)} $	Minimum load current	$ V_I - V_O \leq 40\text{ V}$		2.5	10	mA
		$ V_I - V_O \leq 10\text{ V}$		1.5	6	
I_{OS}	Short circuit output current	$ V_I - V_O \leq 15\text{ V}$	1.5	2.2		A
		$ V_I - V_O = 40\text{ V}$, $T_J = 25^{\circ}\text{C}$	0.15	0.4		
V_{NO}	RMS output noise (% of V_O)	$T_a = 25^{\circ}\text{C}$, $f = 10\text{ Hz}$ to 10 kHz		0.003		%
R_{VF}	Ripple rejection ratio	$V_O = -10\text{ V}$, $f = 120\text{ Hz}$		60		dB
		$C_{ADJ} = 10\text{ }\mu\text{F}$	66	77		
K_{VT}	Temperature stability			0.6		%
K_{VH}	Long term stability	$T_a = 125^{\circ}\text{C}$, 1000 H		0.3	1	%

1. 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.

5 Typical characteristics

Figure 3. Load regulation

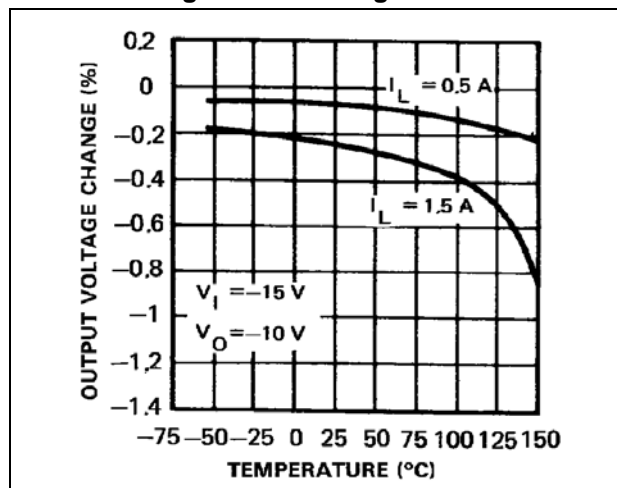


Figure 4. Current limit

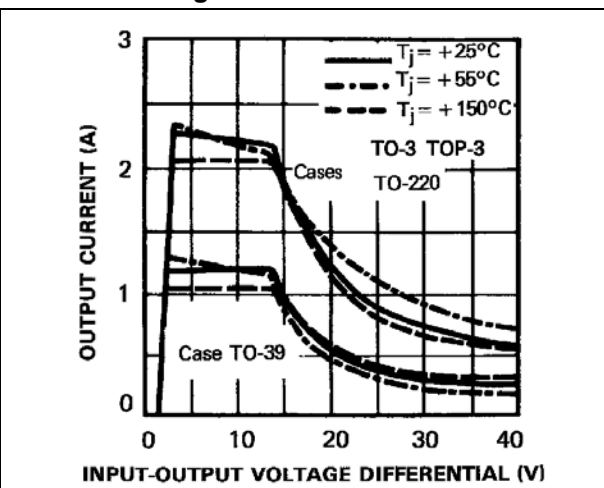


Figure 5. Adjustment current

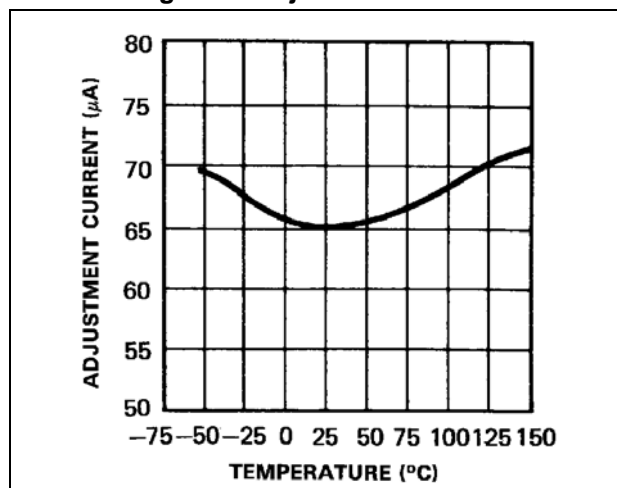


Figure 6. Dropout voltage

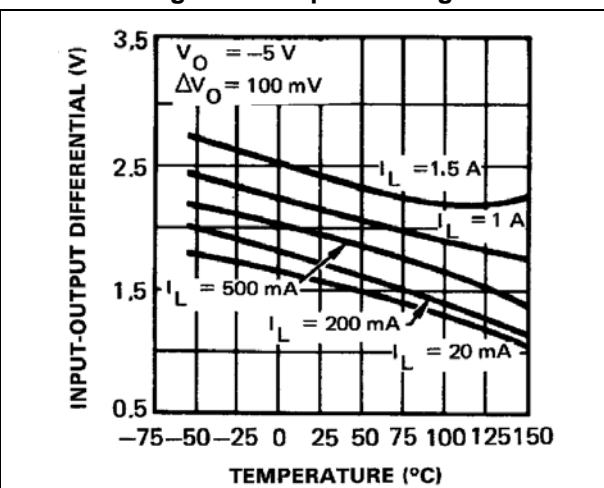


Figure 7. Temperature stability

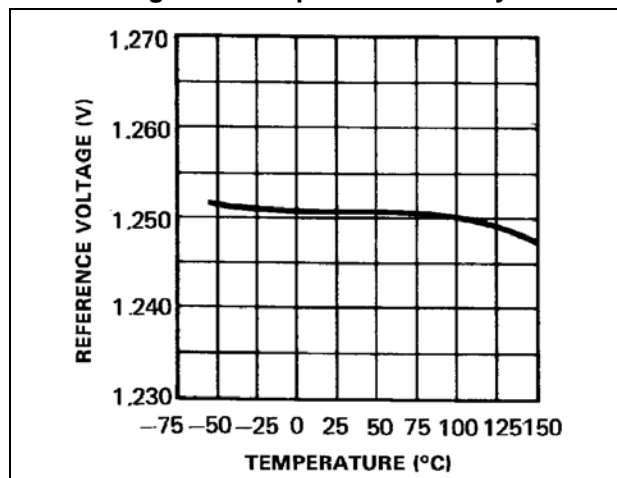


Figure 8. Minimum operating current

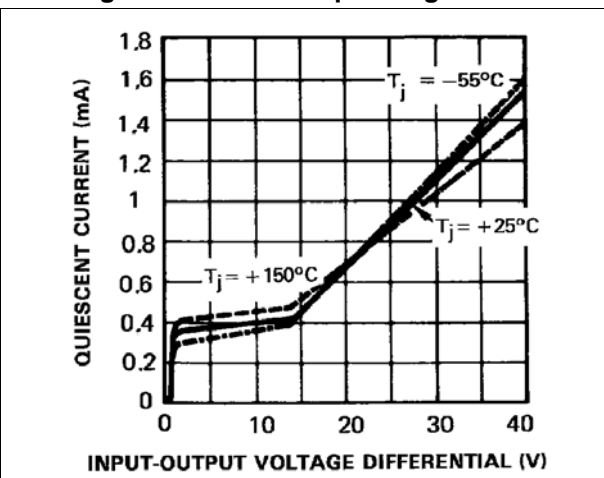


Figure 9. Ripple rejection vs. output voltage

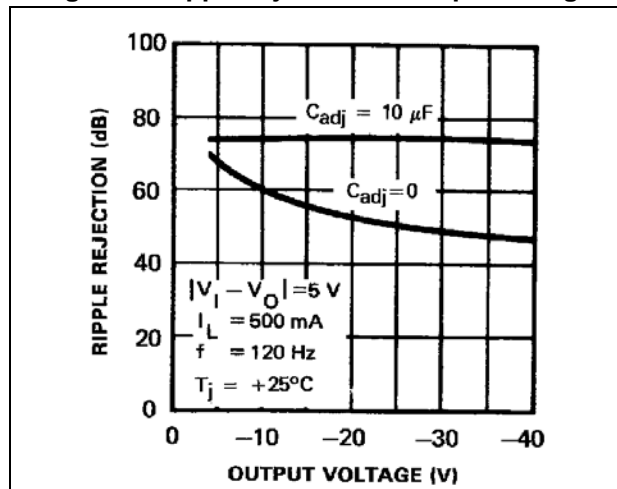


Figure 10. Ripple rejection vs. frequency

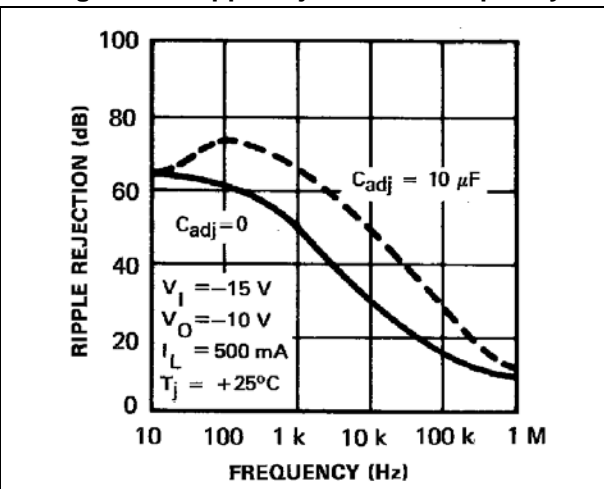


Figure 11. Ripple rejection vs. output current

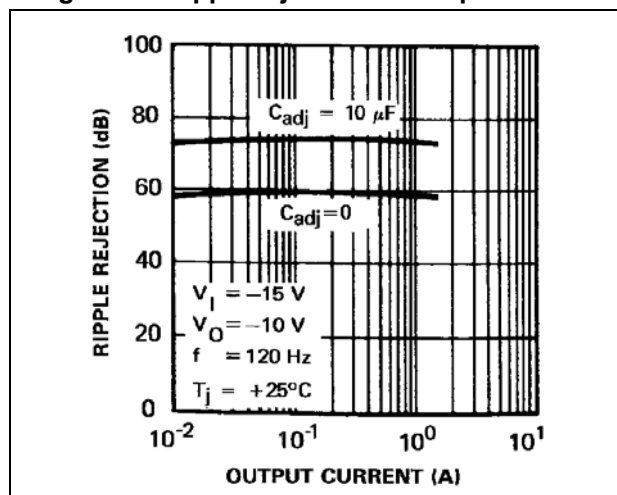


Figure 12. Output impedance

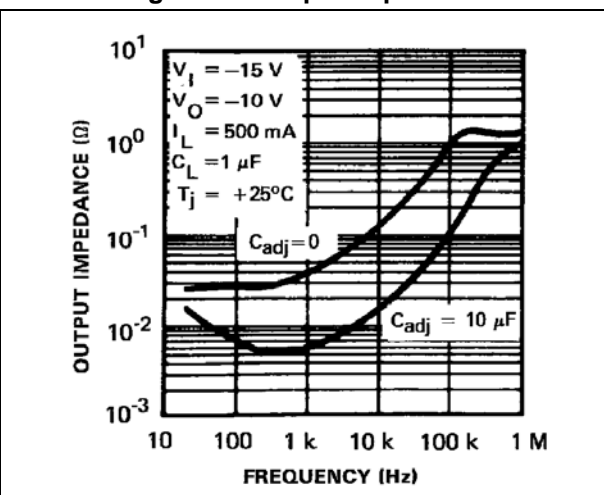


Figure 13. Line transient response

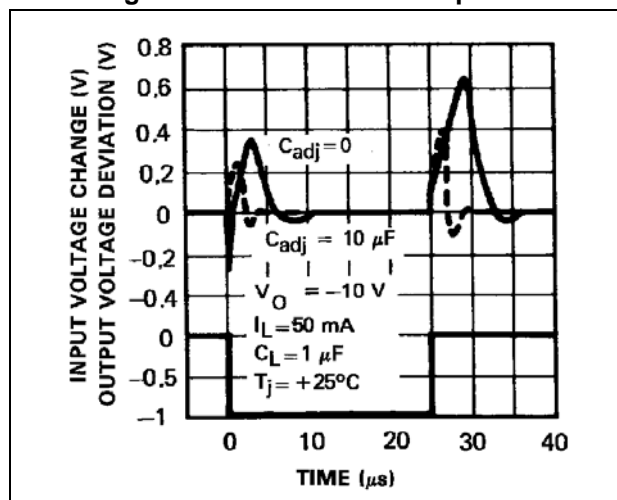
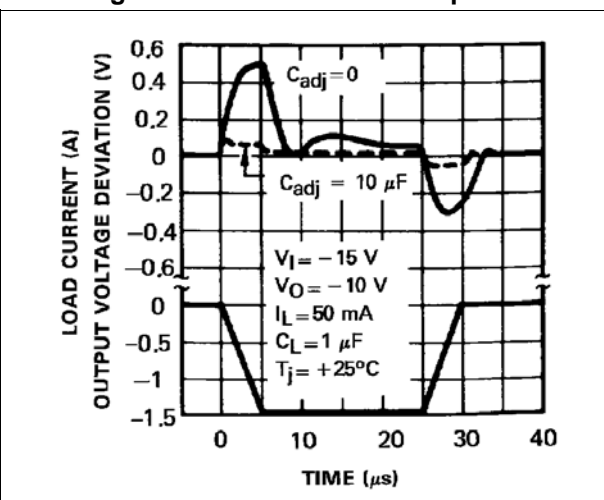


Figure 14. Load transient response



6 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.

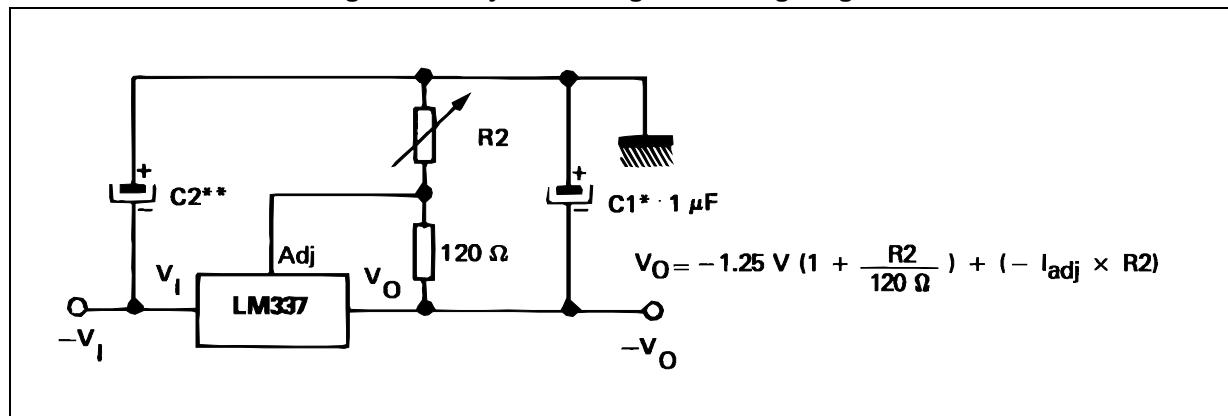
Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5 ms to 50 ms after a change in 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_O , per watt, within the first 10ms after a step of power, is applied.

In [Figure 1](#), a typical LM337's output drifts only 3 mV for 0.03% of $V_O = -10$ V) when a 10 W pulse is applied for 10 ms. This performance is thus well inside the specification limit of $0.02\%/W \times 10\text{ W} = 0.2\%$ max. When the 10 W pulse is ended the thermal regulation again shows a 3 mV step as the LM337 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 10 W 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).

7 Typical application

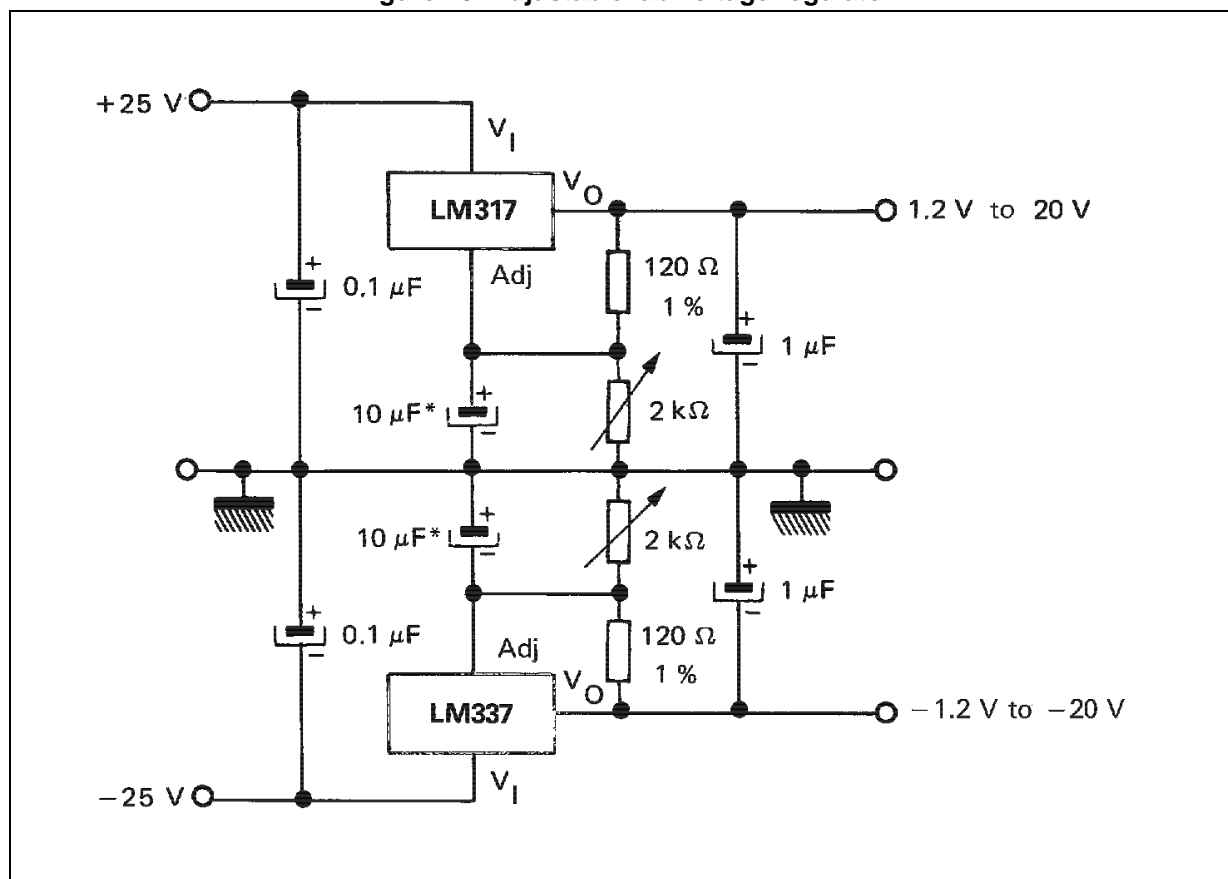
Figure 15. Adjustable negative voltage regulator



* C1 = 1 μF solid tantalum or 10 μF aluminium electrolytic required for stability.

** C2 = 1 μF solid tantalum is required only if regulator is more than 10 cm from power supply filter capacitors

Figure 16. Adjustable lab voltage regulator



* The 10 μF capacitors are optimal to improve ripple rejection.

Figure 17. Current regulator

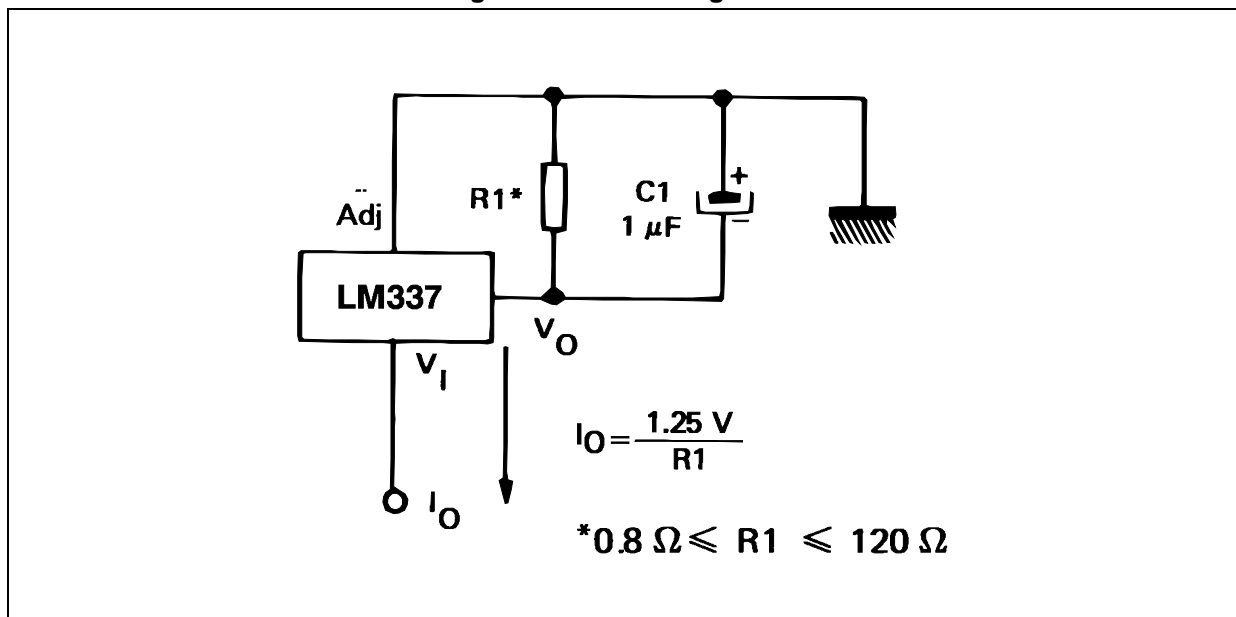
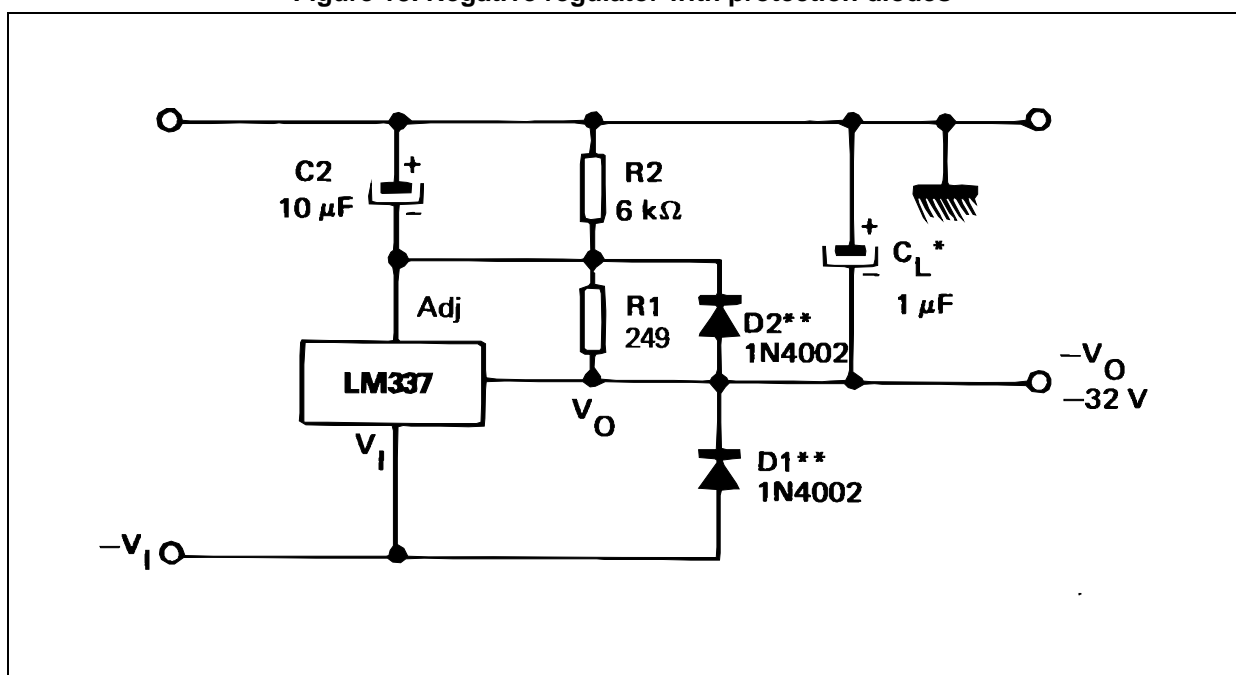


Figure 18. Negative regulator with protection diodes



* When C_L is larger than 20 μF , D1 protects the LM337 in case the input supply is shorted.

** When $C2$ is larger than 10 μF and V_O is larger than -25 V, D2 protects the LM337 in case the output is shorted.

-
- The diagram shows an LM337 adjustable negative voltage regulator circuit. The input voltage V_I is applied to the input pin. The output pin is connected to the output terminal, which is also connected to a load resistor $R1$ and a $1\mu F$ capacitor to ground. The adjustment pin is connected to a voltage divider consisting of a $1 k\Omega$ resistor and a $2 k\Omega$ resistor, with the wiper connected to the output. The output voltage is V_O . The load current is I_O .
- $$I_O = \left(\frac{1.5 V}{R1} \right) \pm 15\% \text{ adjustable}$$

8 Package mechanical data

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Figure 21. TO-220 (dual gauge) drawing

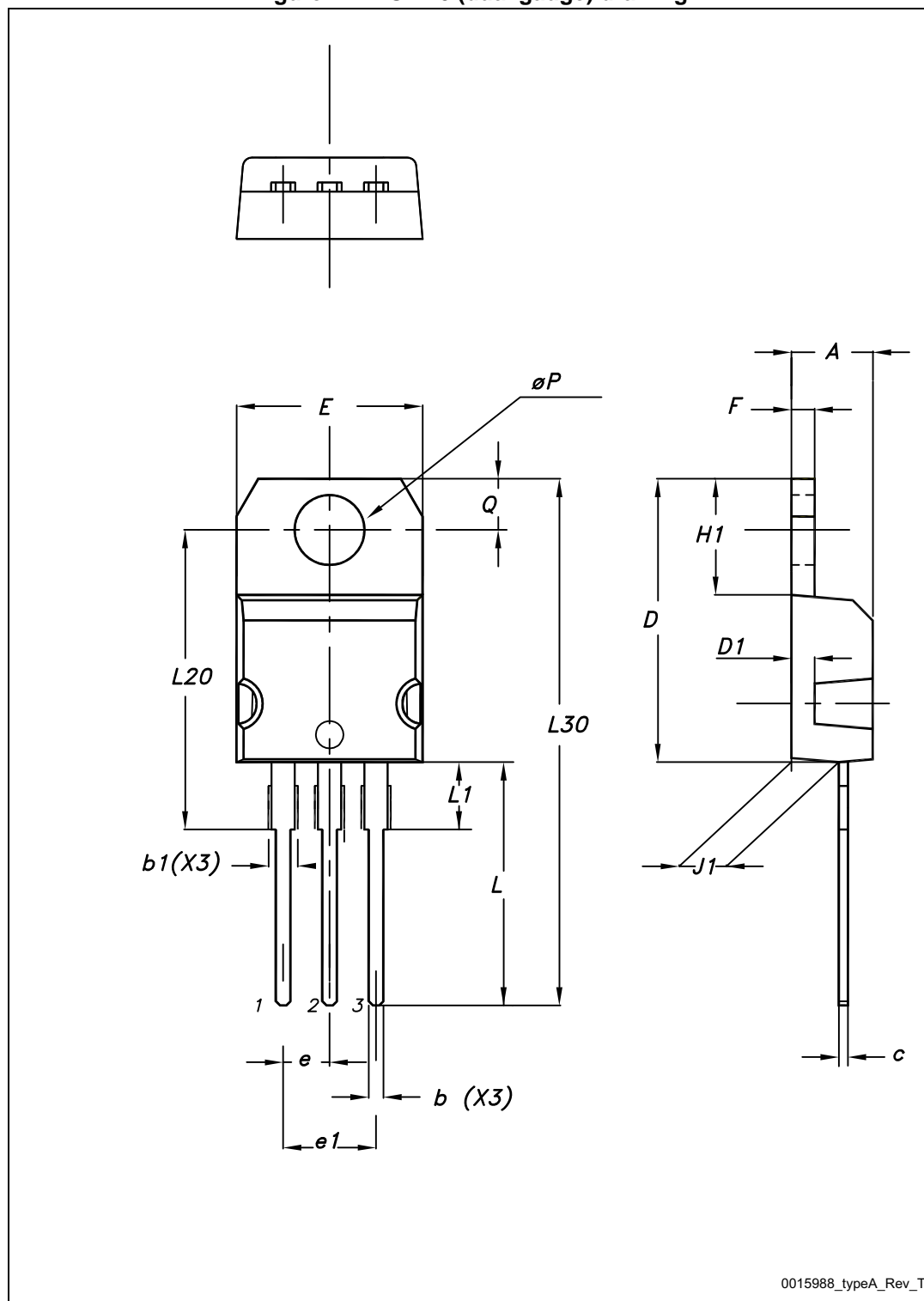


Table 5. TO-220 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

9 Revision history

Table 6. Document revision history

Date	Revision	Changes
19-Jul-2004	1	First issue.
10-Jan-2005	2	Modified pin connection for TO-3.
17-Jul-2008	3	Added: Table 1 on page 1 .
03-Oct-2011	4	Modified: Table 1 on page 1 .
05-May-2014	5	The part number LM137 has been moved to a separate datasheet. Removed TO-3 package. Updated the description in cover page. Modified Table 1: Device summary , Section 2: Pin configuration , Section 3: Maximum ratings , Section 4: Electrical characteristics , Section 6: Thermal regulation and Section 8: Package mechanical data . Minor text changes.

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