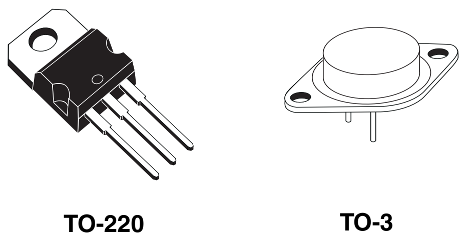
LM137
LM337

Three-terminal adjustable negative voltage regulators

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 LM137 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, LM137 regulators are supplied in standard transistor packages which are easily mounted and handled. In addition to higher performance than fixed regulators, the LM137 series offer full overload protection available only in integrated circuits. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

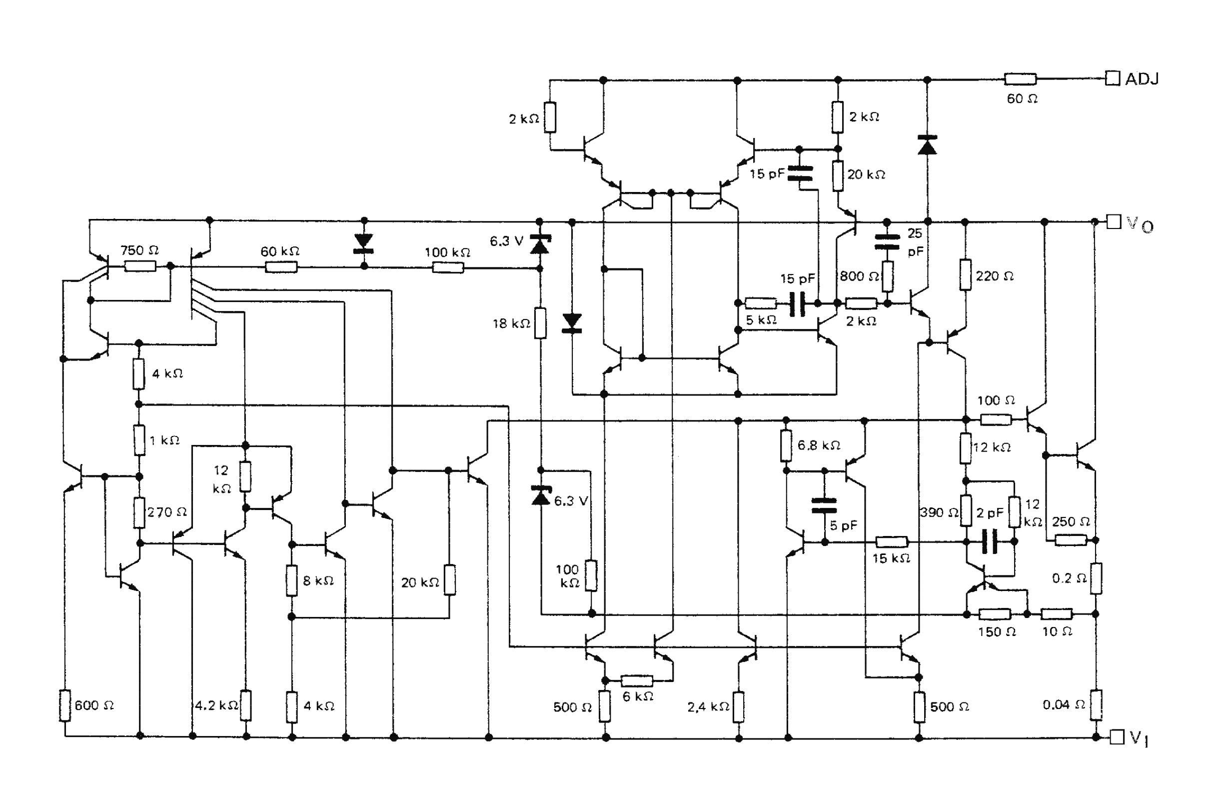
Table 1. Device summary

Part numbers	Order codes	Packages	Temperature range
LM137	LM137K	TO-3	- 55 °C to 150 °C
LM337	LM337K	TO-3	0 °C to 125 °C
LM337	LM337SP	TO-220	0 °C to 125 °C

Contents

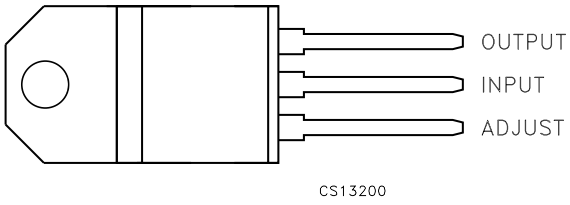
1 Diagram

Figure 1. Schematic diagram

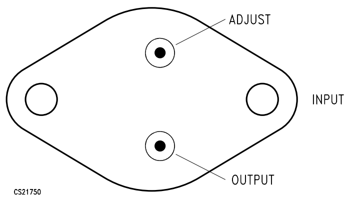


2 Pin configuration

Figure 2. Pin connections (top view)



TO-220



TO-3

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	LM137	- 55 to 150	°C
		LM337	0 to 125	

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	TO-3	Unit
R_{thJC}	Thermal resistance junction-case max.	3	4	°C/W
R_{thJA}	Thermal resistance junction-ambient max.	70	35	°C/W

4 Electrical characteristics

T_J = -55 to 150 °C, V_I - V_O = 5 V, I_O = 0.5 A unless otherwise specified.

Table 4. Electrical characteristics of LM137

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
V_{REF}	Reference voltage	T_a = 25°C		-1.225	-1.25	-1.275	V
		$\|V_I - V_O\|$ = 3 to 40 V, $T_J = T_{min}$ to T_{max} $\|I_O\|$ = 10mA to $\|I_{O(max)}\|$ $P \le P_{max}$		-1.2	-1.25	-1.3	
K_{VI}	Line regulation (1)	T_a = 25°C $\|V_I - V_O\|$ = 3 to 40 V	I_O = 0.1 A		0.01	0.02	%/V
			I_O = 20 mA		0.01	0.02	
K_{VO}	Load regulation (1)	T_a = 25°C $\|I_O\|$ = 10mA to $\|I_{O(max)}\|$	$\|V_O\| \le 5$ V		15	25	mV
			$\|V_O\| \ge 5$ V		0.3	0.5	%
	Thermal regulation	T_a = 25°C, pulse 10 ms			0.002	0.02	%/W
I_{ADJ}	Adjustment pin current				65	100	µA
ΔI_{ADJ}	Adjustment pin current change	T_a = 25°C, $\|I_O\|$ = 10 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	0.05	%/V
K_{VO}	Load regulation (1)	$\|I_O\|$ = 10mA to $\|I_{O(max)}\|$	$\|V_O\| \le 5$ V		20	50	mV
			$\|V_O\| \ge 5$ V		0.3	1	%
$\|I_{O(min)}\|$	Minimum load current	$\|V_I - V_O\| \le 40$ V			2.5	5	mA
		$\|V_I - V_O\| \le 10$ V			1.2	3	
I_{OS}	Short circuit output current	$\|V_I - V_O\| \le 15$ V		1.5	2.2		A
		$\|V_I - V_O\|$ = 40 V, T_J =25°C		0.24	0.4		
V_{NO}	RMS output noise (% of V_O)	T_a = 25°C, f = 10 Hz to 10 kHz			0.003		%
R_{VF}	Ripple rejection ratio	V_O = -10 V, f = 120 Hz			60		dB
		C_{ADJ} = 10 µF		66	77		
K_{VT}	Temperature stability				0.6		%
K_{VH}	Long term stability	T_a = 125°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.

T_J = 0 to 150 °C unless otherwise specified.

Table 5. Electrical characteristics of LM337

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

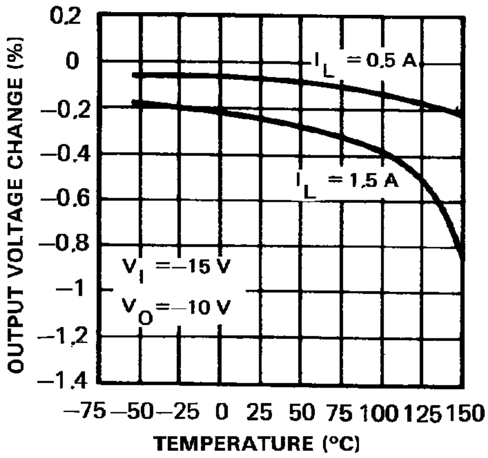


Figure 4. Current limit

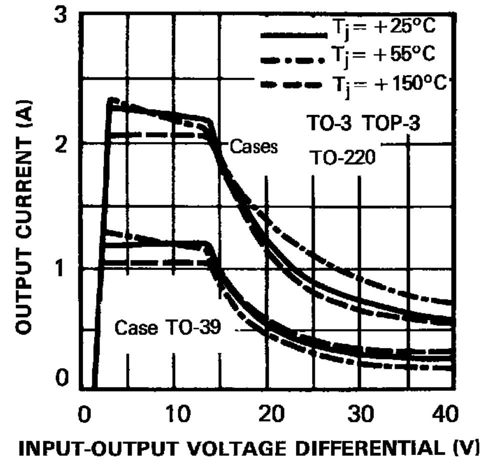


Figure 5. Adjustment current

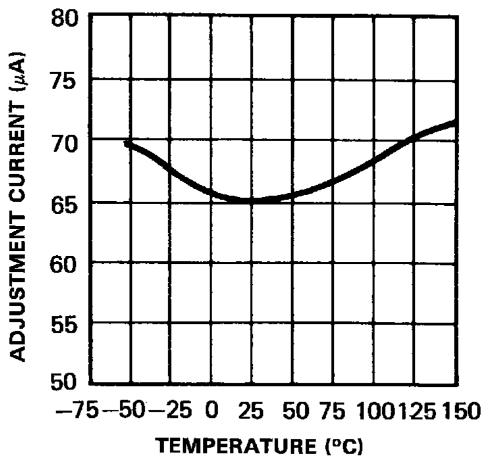


Figure 6. Dropout voltage

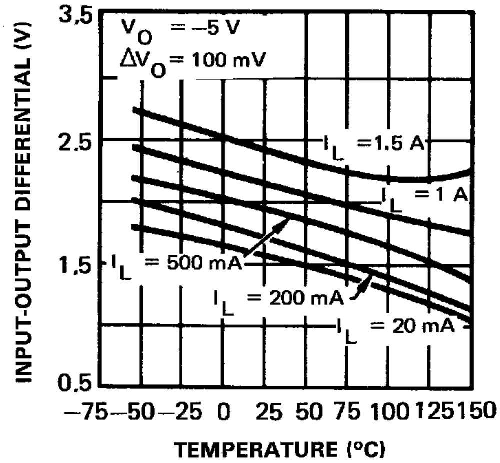


Figure 7. Temperature stability

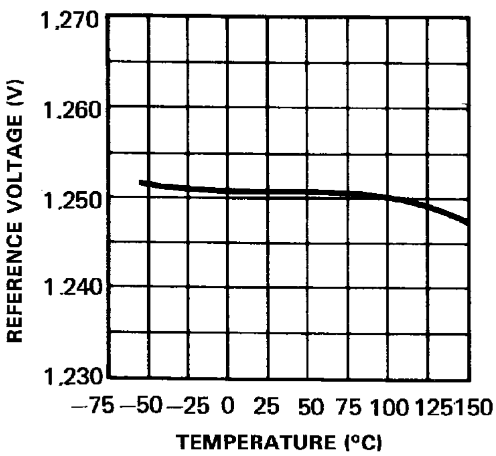


Figure 8. Minimum operating current

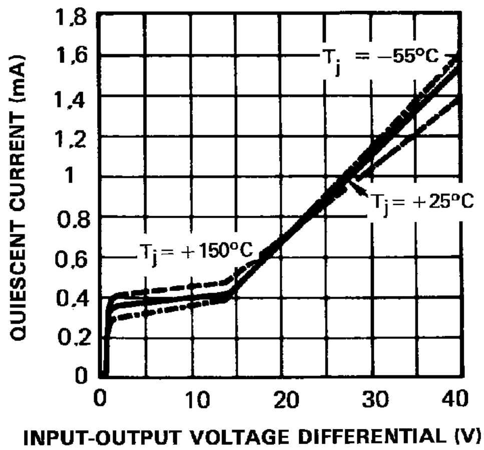


Figure 9. Ripple rejection vs. output voltage

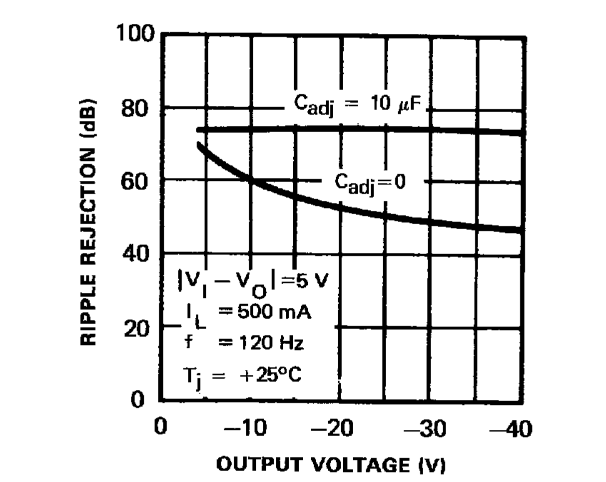


Figure 10. Ripple rejection vs. frequency

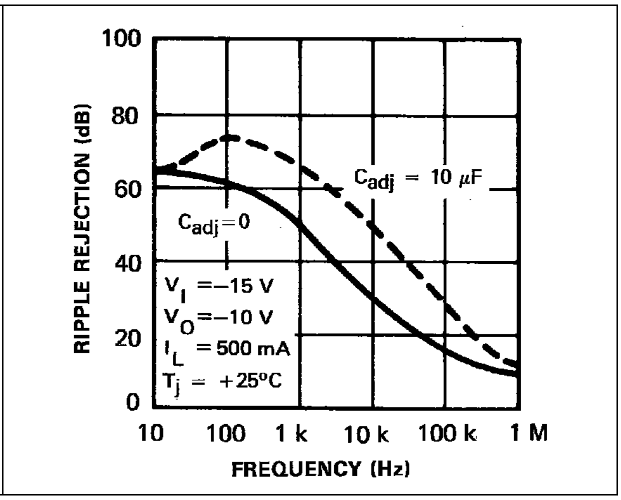


Figure 11. Ripple rejection vs. output current

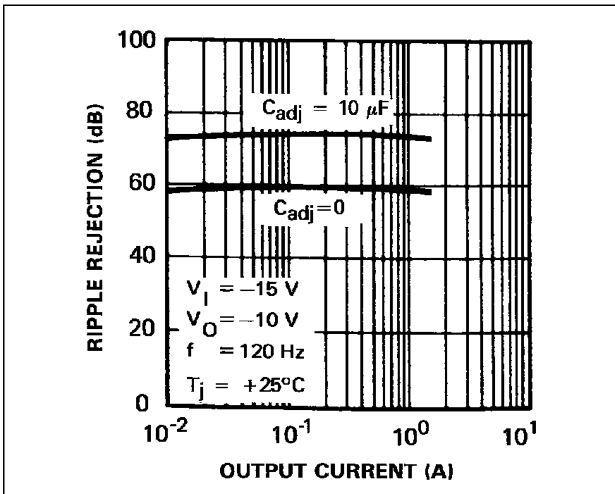


Figure 12. Output impedance

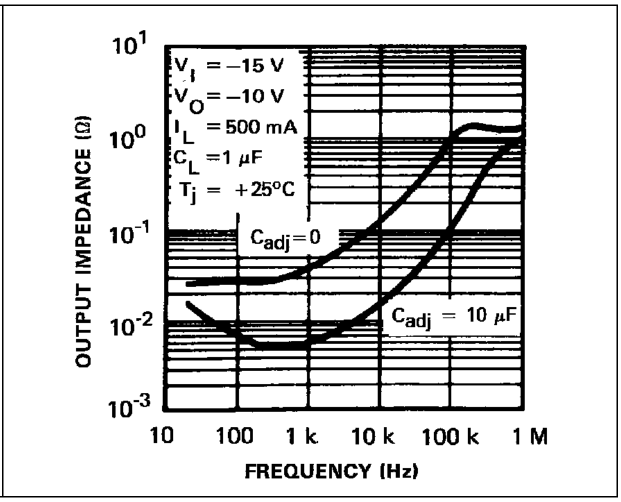


Figure 13. Line transient response

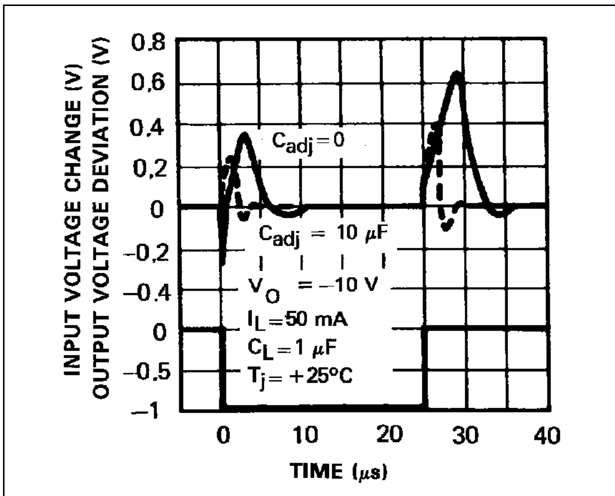
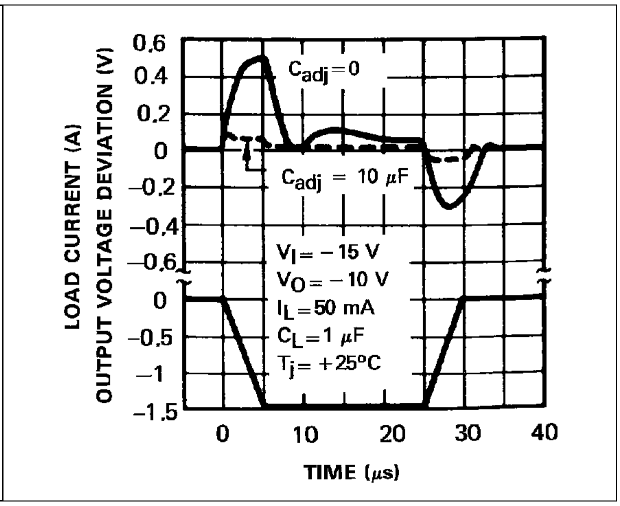


Figure 14. Load transient response



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.

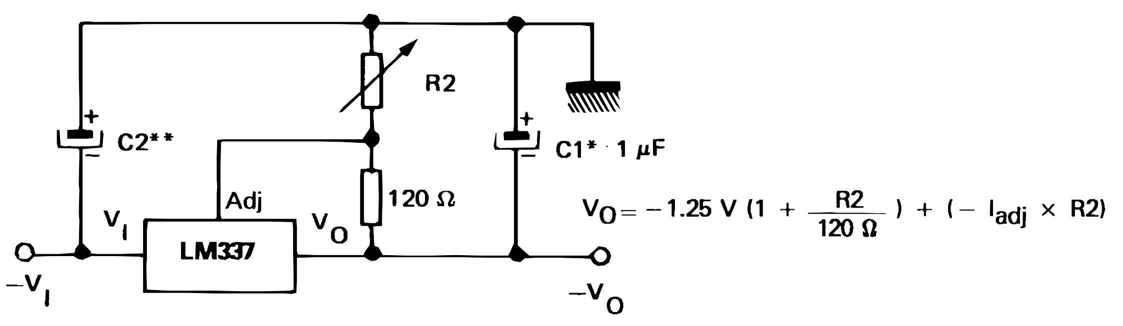
Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5 ms to 50 ms after a change in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

The LM137 specification is 0.02%/W max. 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 x 10 W = 0.2% max. When the 10 W pulse is ended the thermal regulation again shows a 3 mV step as the LM137 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

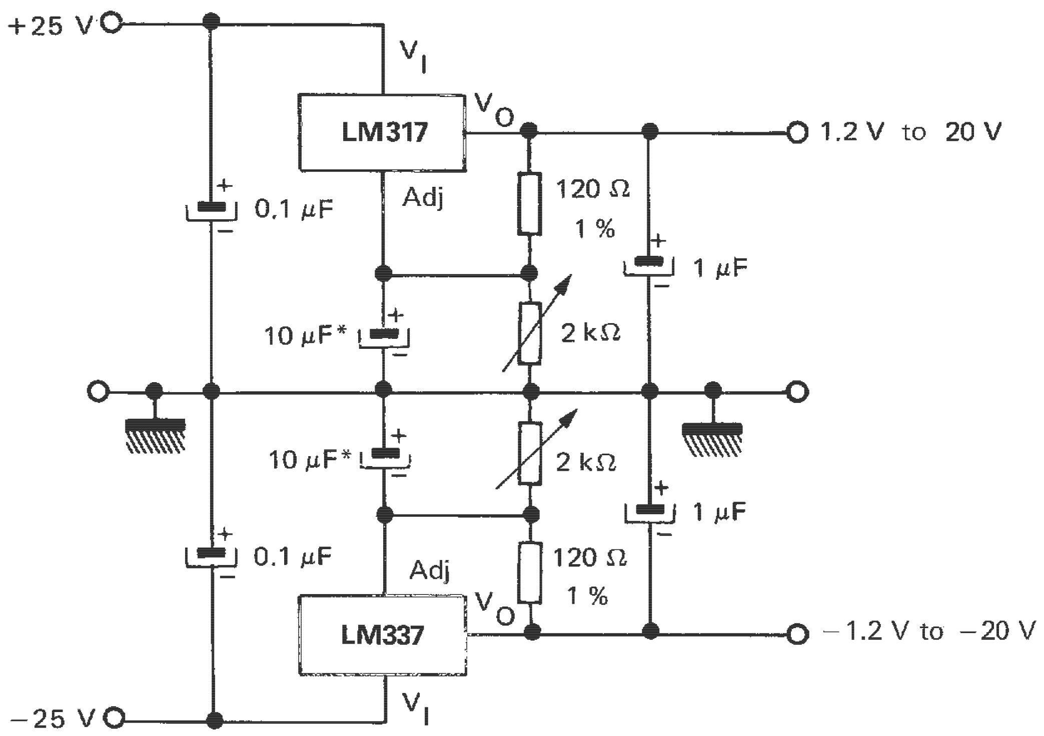
Figure 15. Adjustable negative voltage regulator



* 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

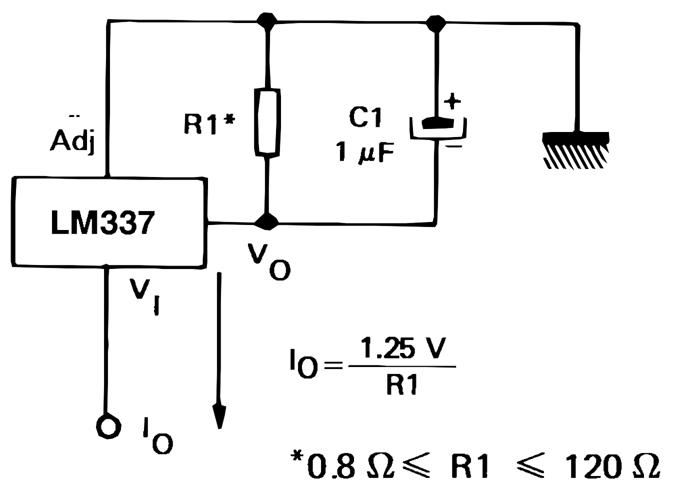
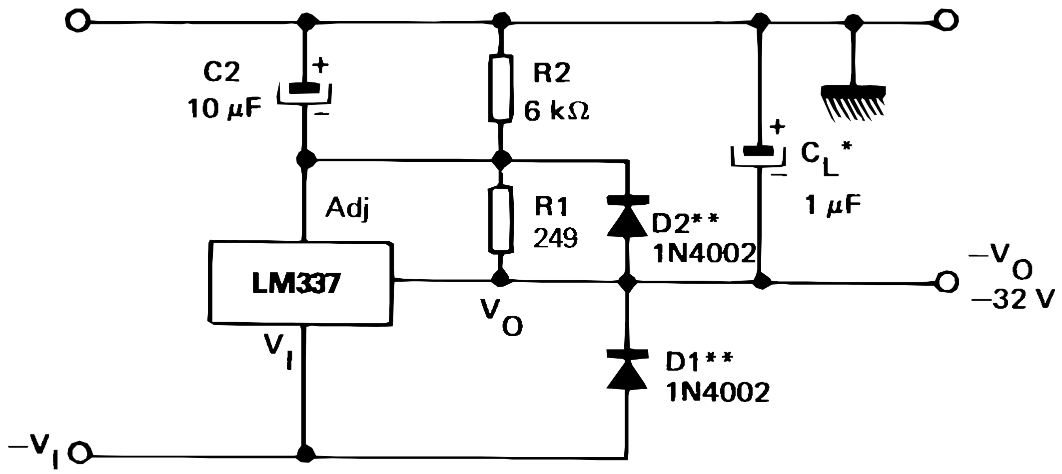


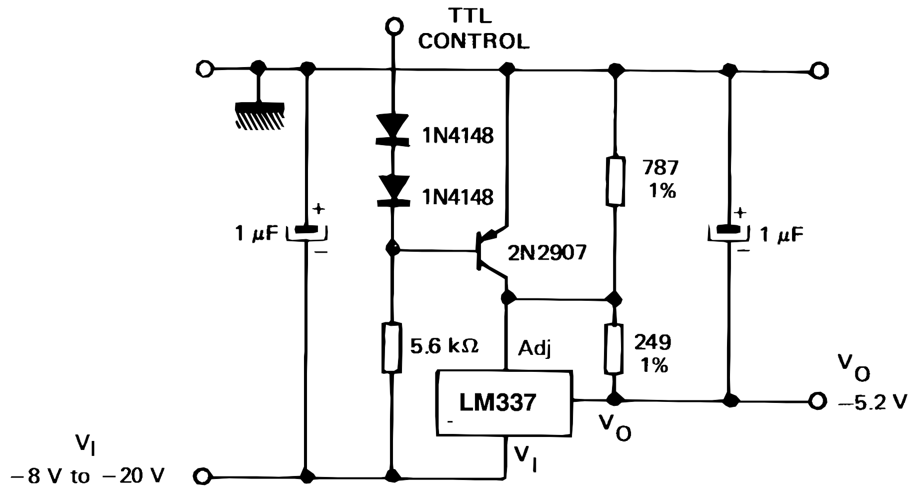
Figure 18. Negative regulator with protection diodes



* When CL is larger than 20 µF, D1 protects the LM137 in case the input supply is shorted.

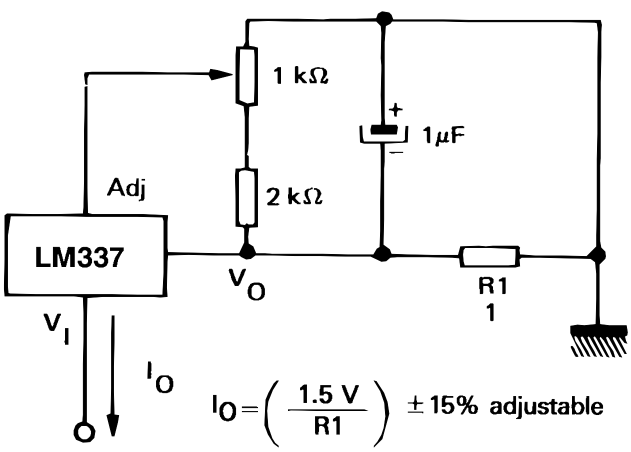
** When C2 is larger than 10 µF and V_O is larger than - 25 V, D2 protects the LM137 in case the output is shorted.

Figure 19. - 5.2 V regulator with electronic shutdown (1)



1. Minimum output = - 1.3 V when control input is low.

Figure 20. Current regulator

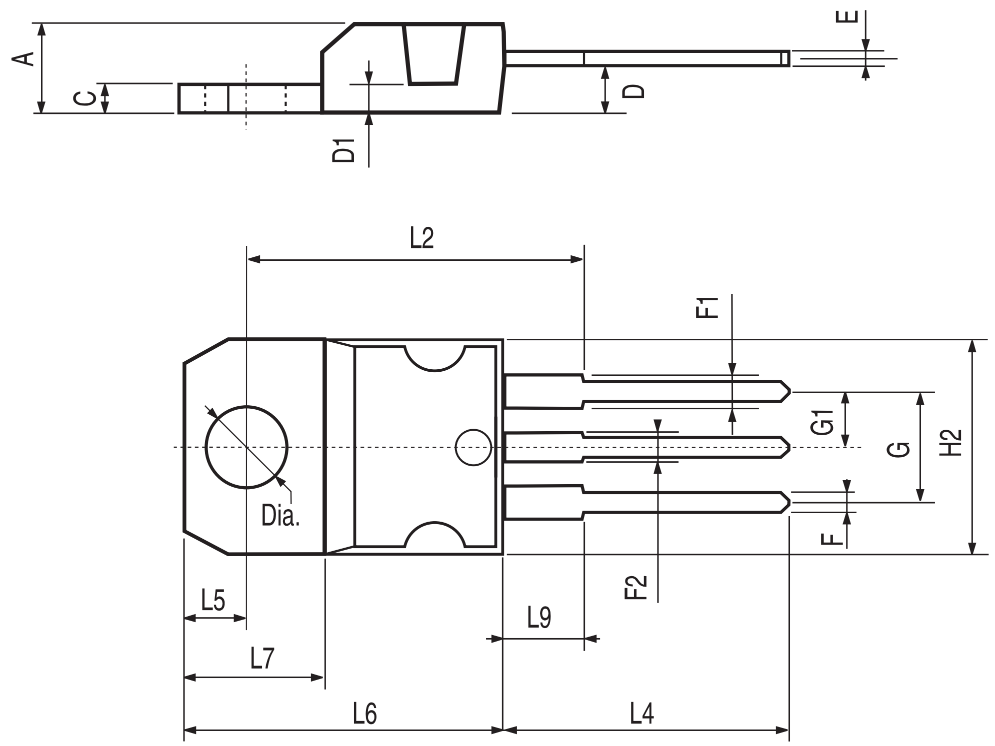


8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

TO-220 mechanical data

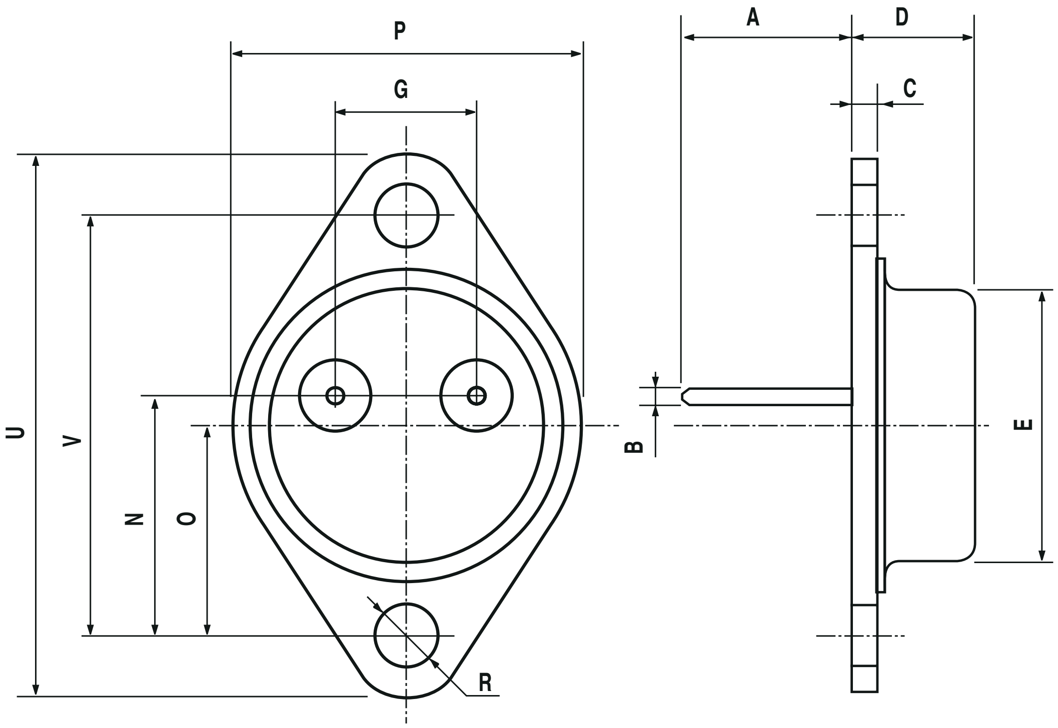
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
H2	10.0		10.40	0.393		0.409
L2		16.4			0.645	
L4	13.0		14.0	0.511		0.551
L5	2.65		2.95	0.104		0.116
L6	15.25		15.75	0.600		0.620
L7	6.2		6.6	0.244		0.260
L9	3.5		3.93	0.137		0.154
DIA.	3.75		3.85	0.147		0.151



P011C

TO-3 mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		11.85			0.466	
B	0.96	1.05	1.10	0.037	0.041	0.043
C			1.70			0.066
D			8.7			0.342
E			20.0			0.787
G		10.9			0.429	
N		16.9			0.665	
P			26.2			1.031
R	3.88		4.09	0.152		0.161
U			39.5			1.555
V		30.10			1.185	



P003C/C

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*.