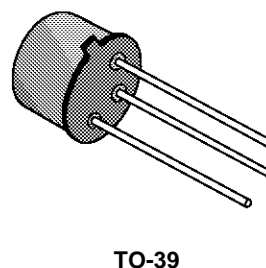
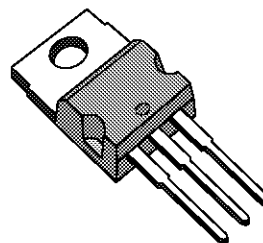
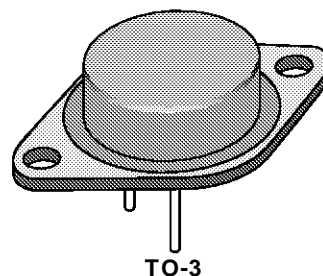


## THREE-TERMINAL ADJUSTABLE NEGATIVE VOLTAGE REGULATORS

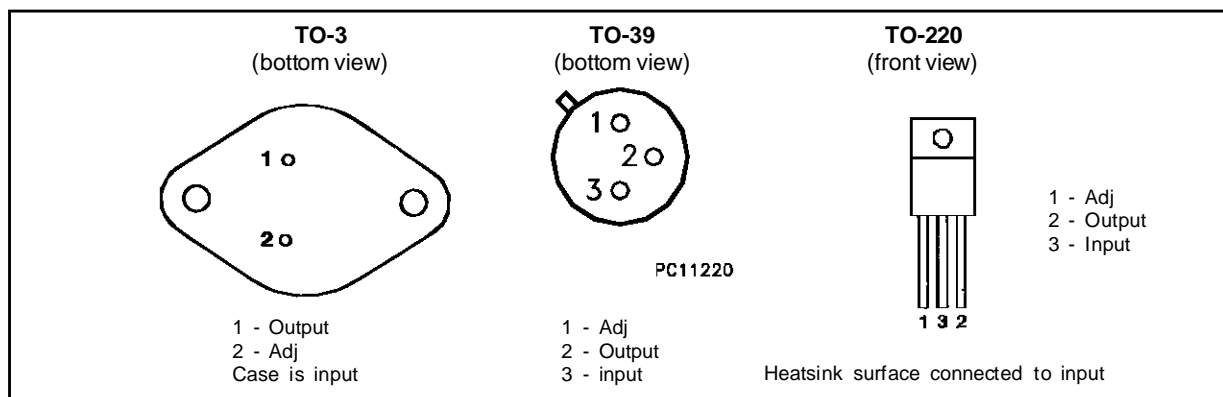
- OUTPUT VOLTAGE ADJUSTABLE DOWN TO  $V_{ref}$
- 1.5A GUARANTEED OUTPUT CURRENT
- 0.3%/V TYPICAL LOAD REGULATION
- 0.01%/V TYPICAL LINE REGULATION
- CURRENT LIMIT CONSTANT WITH TEMPERATURE
- RIPPLE REJECTION : 77dB
- STANDARD 3-LEAD TRANSISTOR PACKAGES
- EXCELLENT THERMAL REGULATION: 0.002%/V
- 50ppm/°C TEMPERATURE COEFFICIENT

### DESCRIPTION

The LM137 series are adjustable 3-terminal negative voltage regulators capable of supplying in excess - 1.5A over a - 1.2 to - 37V 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.



### PIN CONNECTIONS



## LM137-LM237-LM337

### ABSOLUTE MAXIMUM RATING

Symbol	Parameter		Value	Unit
$V_I - V_O$	Input Output Voltage Differential		40	V
$I_O$	Output Current	TO-220/TO-3	1.5	A
		TO-39	0.5	
$T_{oper}$		LM137	-55 to 150	°C
		LM237	-25 to 150	
		LM337	0 to 125	
$T_{stg}$			-65 to 150	°C
$P_{tot}$			Internally Limited	W

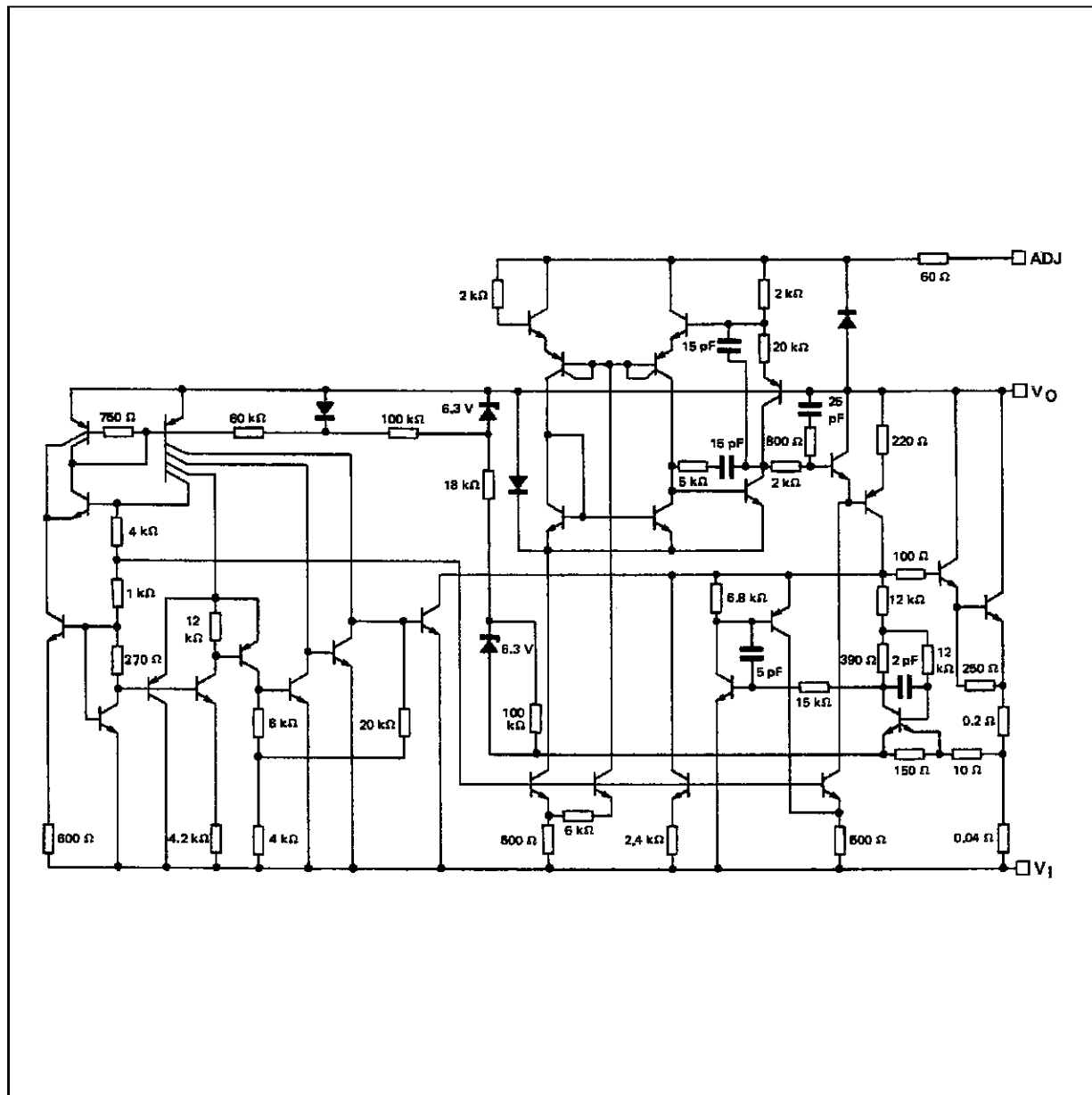
### THERMAL CHARACTERISTICS

Symbol	Parameter		Typ.	Max.	Unit
$R_{thj-case}$	Junction-case Thermal Resistance	TO-3		4	°C/W
		TO-220		3	
		TO-39		15	
$R_{thj-amb}$	Junction-ambient Thermal Resistance	TO-3		35	°C/W
		TO-220		70	
		TO-39		160	

### ORDER CODES

PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		TO-3	TO-220	TO-39
LM137	-55 to 150 °C	LM137K		LM137H
LM237	-25 to 150 °C	LM237K	LM237SP	LM237H
LM337	0 to 125 °C	LM337K	LM337SP	LM337H

## SCHEMATIC DIAGRAM



## LM137-LM237-LM337

### ELECTRICAL CHARACTERISTICS

**LM137:**  $-55^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$

**LM237:**  $-25^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$

**LM337:**  $0^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$

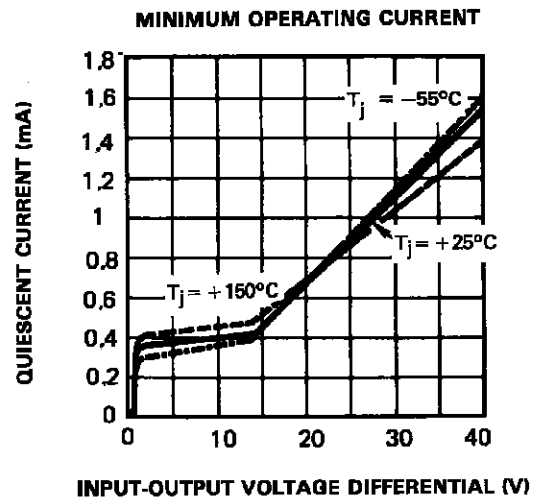
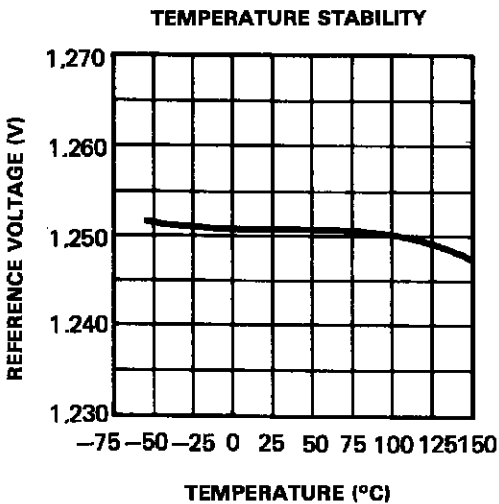
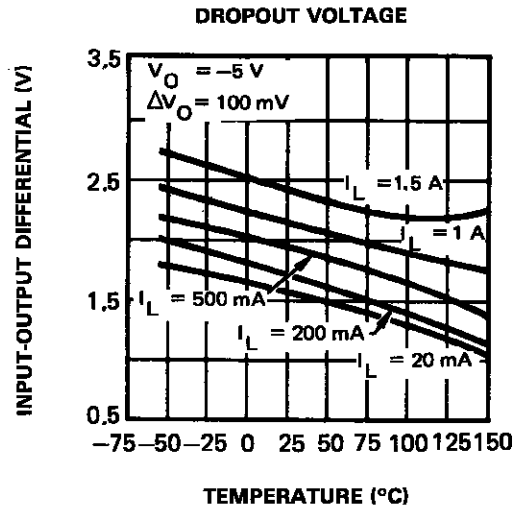
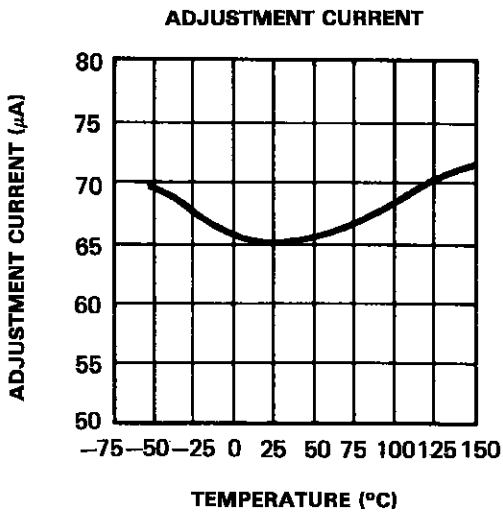
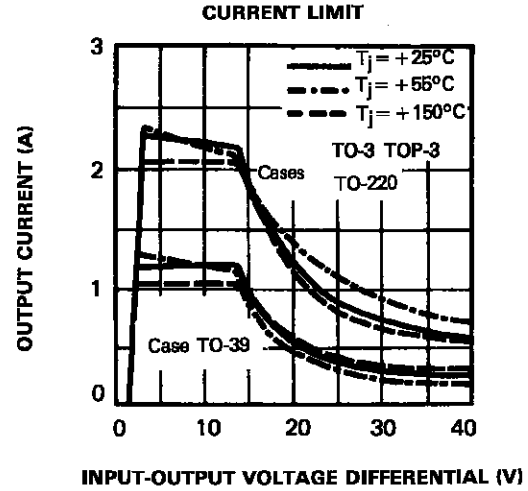
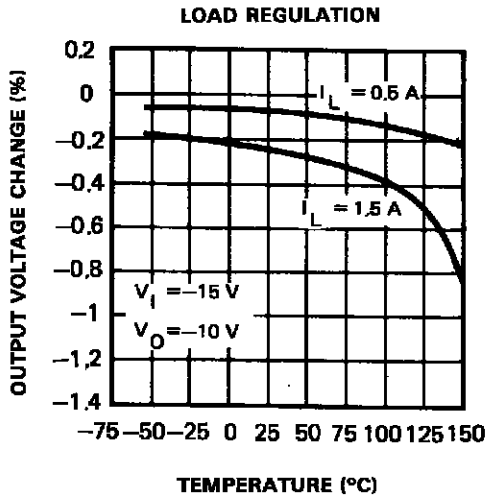
$V_I - V_O = 5\text{V}$ ,  $I_O = 0.5\text{A}$  (unless otherwise specified)

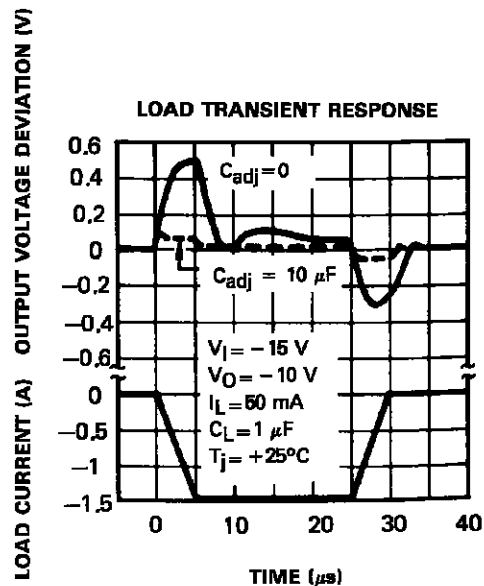
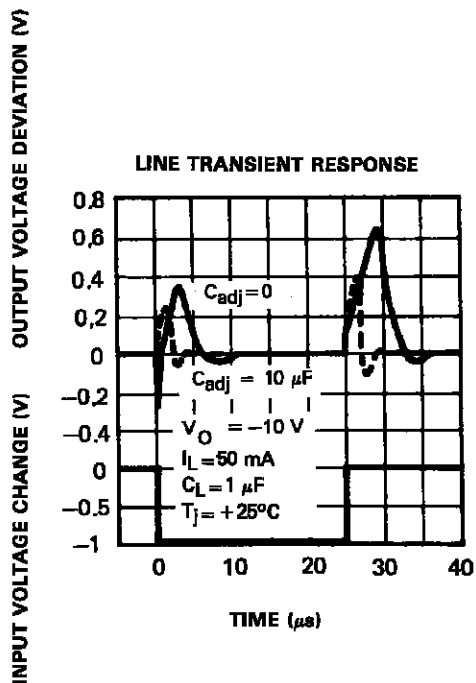
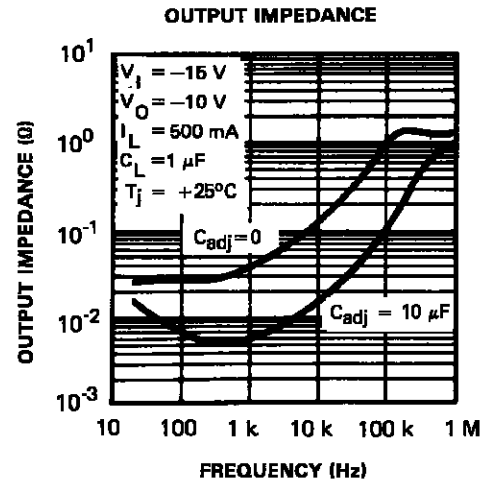
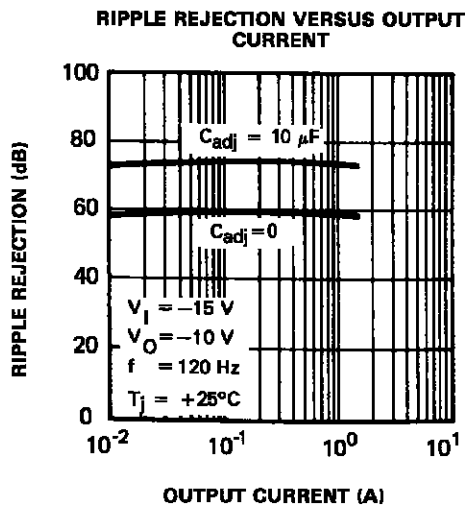
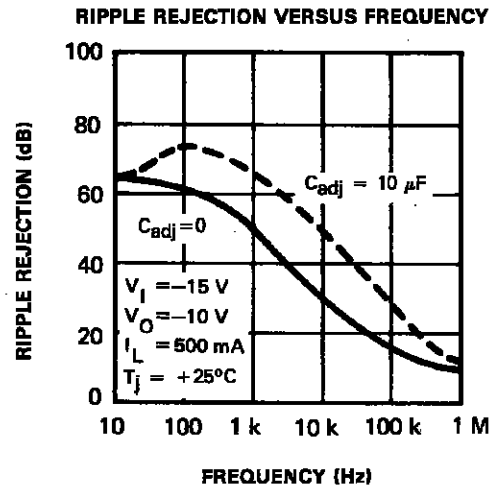
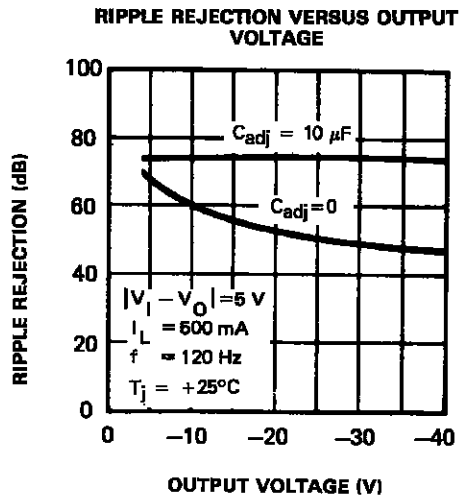
Symbol	Parameter	LM137/LM237			LM337			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{\text{ref}}$	Reference Voltage $T_{\text{amb}} = 25^{\circ}\text{C}$ $T_{\text{min}} \leq T_j \leq T_{\text{max}}$ $3\text{V} \leq  V_I - V_O  \leq 40\text{V}$ , $10\text{mA} \leq  I_O  \leq  I_{O(\text{max})} $ $P \leq P_{\text{max}}$	-1.225	-1.25	-1.275	-1.213	-1.25	-1.287	V
$K_{V_I}$	Line Regulation ( $T_{\text{amb}} = 25^{\circ}\text{C}$ , $3\text{V} \leq  V_I - V_O  \leq 40\text{V}$ ) - Note 2 $I_O = 0.1\text{A}$ $I_O = 20\text{mA}$		0.01 0.01	0.02 0.02		0.01 0.01	0.04 0.04	%/V %/V
$K_{V_O}$	Load Regulation ( $T_{\text{amb}} = 25^{\circ}\text{C}$ , $10\text{mA} \leq  I_O  \leq  I_{O(\text{max})} $ ) - Note 2 $ V_O  \leq 5\text{V}$ $ V_O  \geq 5\text{V}$		15 0.3	25 0.5		15 0.3	50 1	mV %
	Thermal Regulation ( $T_{\text{amb}} = 25^{\circ}\text{C}$ , pulse 10 ms)		0.002	0.02		0.003	0.04	%/W
$I_{\text{adj}}$	Adjustment Pin Current		65	100		65	100	$\mu\text{A}$
$\Delta I_{\text{adj}}$	Adjustment Pin Current Change ( $T_{\text{amb}} = 25^{\circ}\text{C}$ , $10\text{mA} \leq  I_O  \leq  I_{O(\text{max})} $ , $3\text{V} \leq  V_I - V_O  \leq 40\text{V}$ )		2	5		2	5	$\mu\text{A}$
$K_{V_I}$	Line Regulation ( $3\text{V} \leq  V_I - V_O  \leq 40\text{V}$ ) - Note 2		0.02	0.05		0.02	0.07	%/V
$K_{V_O}$	Load Regulation ( $10\text{mA} \leq  I_O  \leq  I_{O(\text{max})} $ ) - Note 2 $ V_O  \leq 5\text{V}$ $ V_O  \geq 5\text{V}$		20 0.3	50 1		20 0.3	70 1.5	mV %
$ I_{O(\text{min})} $	Minimum Load Current $ V_I - V_O  \leq 40\text{V}$ $ V_I - V_O  \leq 10\text{V}$		2.5 1.2	5 3		2.5 1.5	10 6	mA mA
$I_{\text{OS}}$	Short Circuit Output Current $ V_I - V_O  \leq 15\text{V}$ (TO-3 and TO-220) $ V_I - V_O  \leq 15\text{V}$ (TO-39) $ V_I - V_O  = 40\text{V}$ , $T_j = 25^{\circ}\text{C}$ (TO-3 and TO-220) $ V_I - V_O  = 40\text{V}$ , $T_j = 25^{\circ}\text{C}$ (TO-39)	1.5 0.5 0.24 0.15	2.2  0.4 0.2		1.5 0.5 0.15 0.1	2.2  0.4 0.2		A A A A
$V_{\text{NO}}$	RMS Output Noise (% of $V_O$ ) $T_{\text{amb}} = 25^{\circ}\text{C}$ , $10\text{Hz} \leq f \leq 10\text{KHz}$		0.003			0.003		%
$R_{\text{vf}}$	Ripple Rejection Ratio $V_O = -10\text{V}$ , $f = 120\text{Hz}$ $C_{\text{adj}} = 10\mu\text{F}$	66	60 77		66	60 77		dB dB
$K_{\text{VT}}$	Temperature Stability		0.6			0.6		%
$K_{\text{VH}}$	Long Term Stability ( $T_{\text{amb}} = 125^{\circ}\text{C}$ , 1000H)		0.3	1		0.3	1	%

**Notes :** 1. Although power dissipation is internally limited, these specifications are applicable for power dissipation of :

- 2W for TO-39
- 15W for TO-220
- 20W for TO-3 Package
- $I_{O(\text{max})}$  is :
  - 1.5A for TO-3 and TO-220
  - 0.5A for TO-39

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.





## THERMAL REGULATION

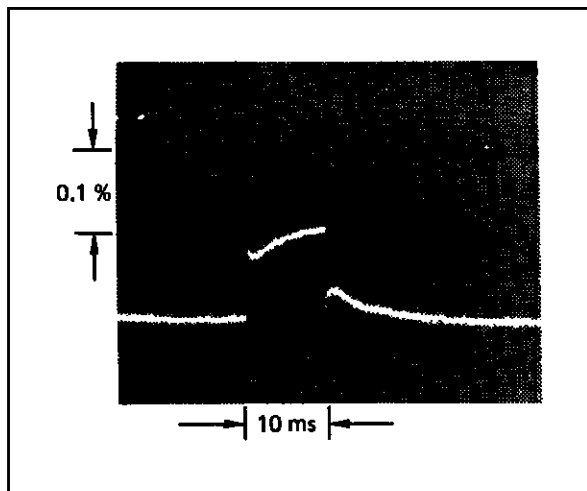
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large.

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 5ms to 50ms 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 3mV for 0.03% of  $V_O = -10V$  when a 10W pulse is applied for 10ms. This performance is thus well inside the specification limit of  $0.02\%/W \times 10W = 0.2\%$  max. When the 10W pulse is ended the thermal regulation again shows a 3mV step as the LM137 chip cools off. Note that the load regulation error of about 8mV (0.08%) is additional to the thermal regulation error.

In figure 2, when the 10W pulse is applied for 100ms, the output drifts only slightly beyond the drift in the first 10ms and the thermal error stays well within 0.1% (10mV).

Figure 1.



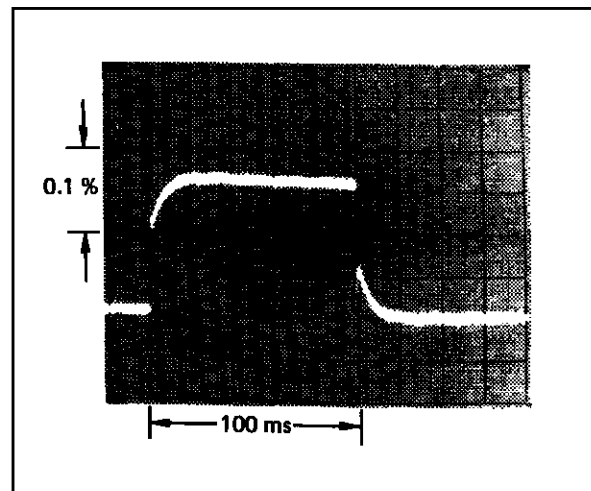
LM 337,  $V_O = -10V$

$V_I - V_O = -40V$

$I_L = 0A \rightarrow 0.25A \rightarrow 0A$

Vertical sensitivity 5mV/div.

Figure 2.



LM 337,  $V_O = -10V$

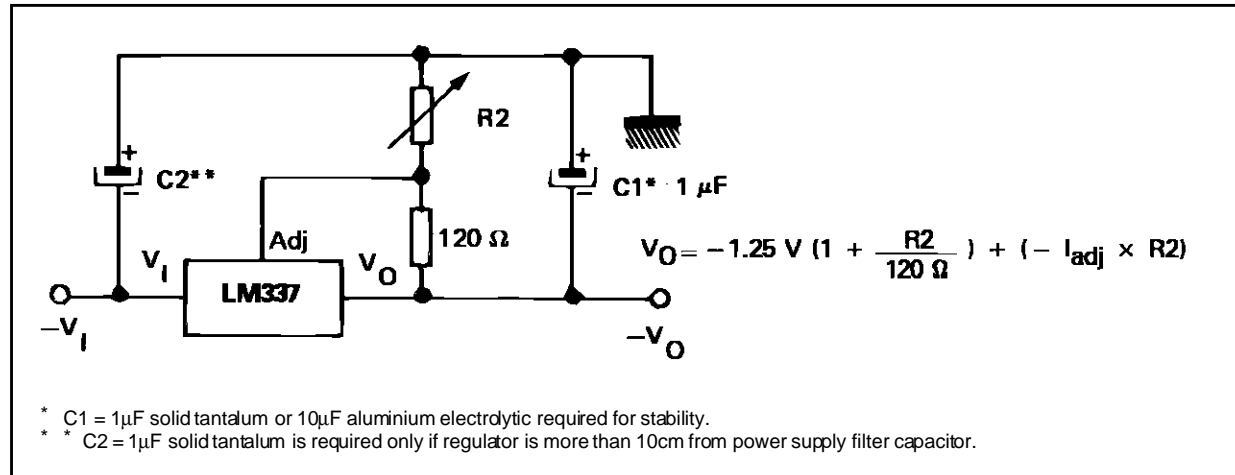
$V_I - V_O = -40V$

$I_L = 0A \rightarrow 0.25A \rightarrow 0A$

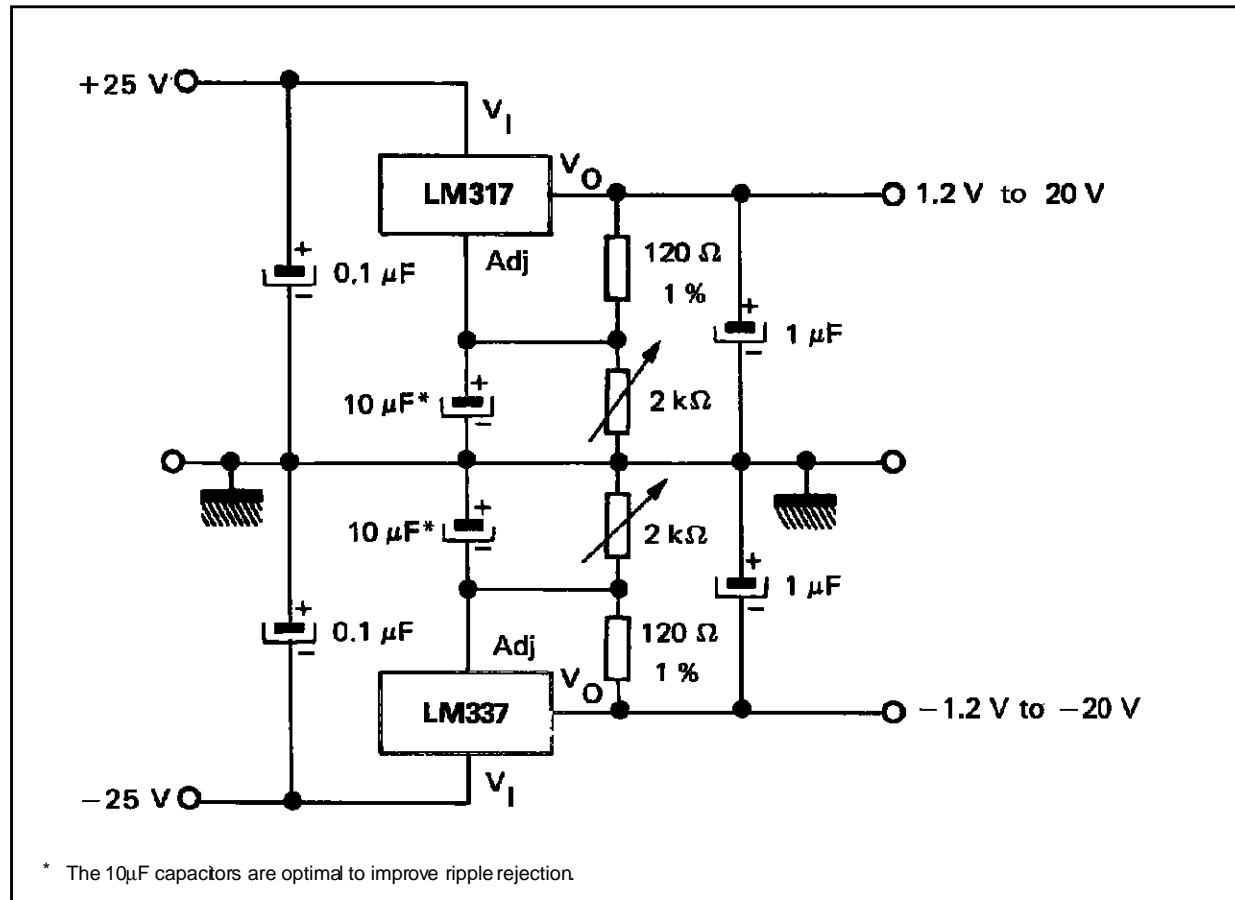
Horizontal sensitivity 20msN/div.

## TYPICAL APPLICATIONS

### ADJUSTABLE NEGATIVE VOLTAGE REGULATOR

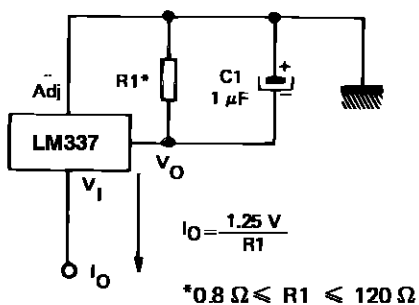


### ADJUSTABLE LAB VOLTAGE REGULATOR

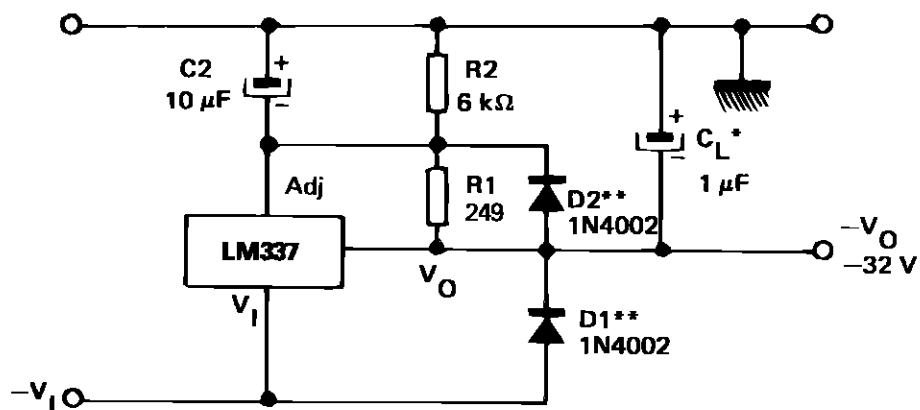




## CURRENT REGULATOR



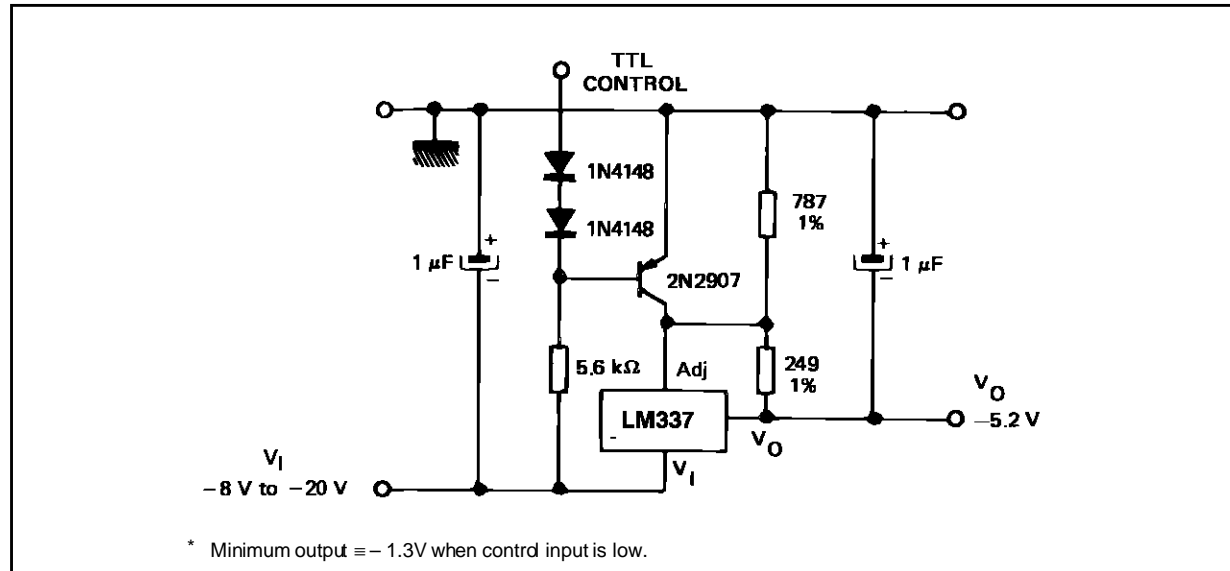
## NEGATIVE REGULATOR WITH PROTECTION DIODES



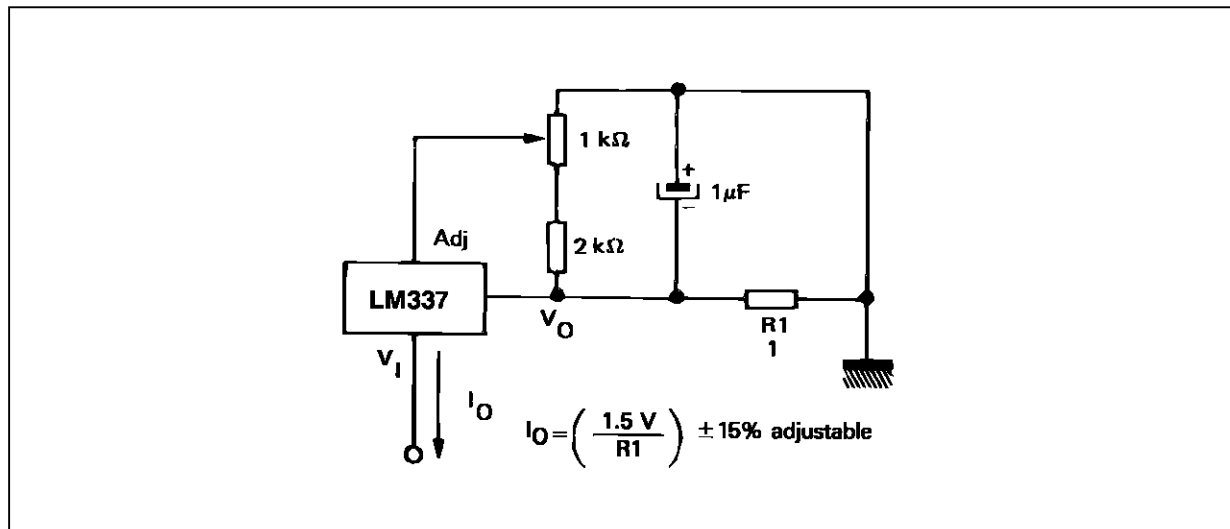
\* When  $C_L$  is larger than  $20 \mu\text{F}$ , D1 protects the LM137 in case the input supply is shorted.

\* \* When C2 is larger than  $10 \mu\text{F}$  and  $V_O$  is larger than  $-25 \text{ V}$ , D2 protects the LM137 in case the output is shorted.

\* -5.2V REGULATOR WITH ELECTRONIC SHUTDOWN

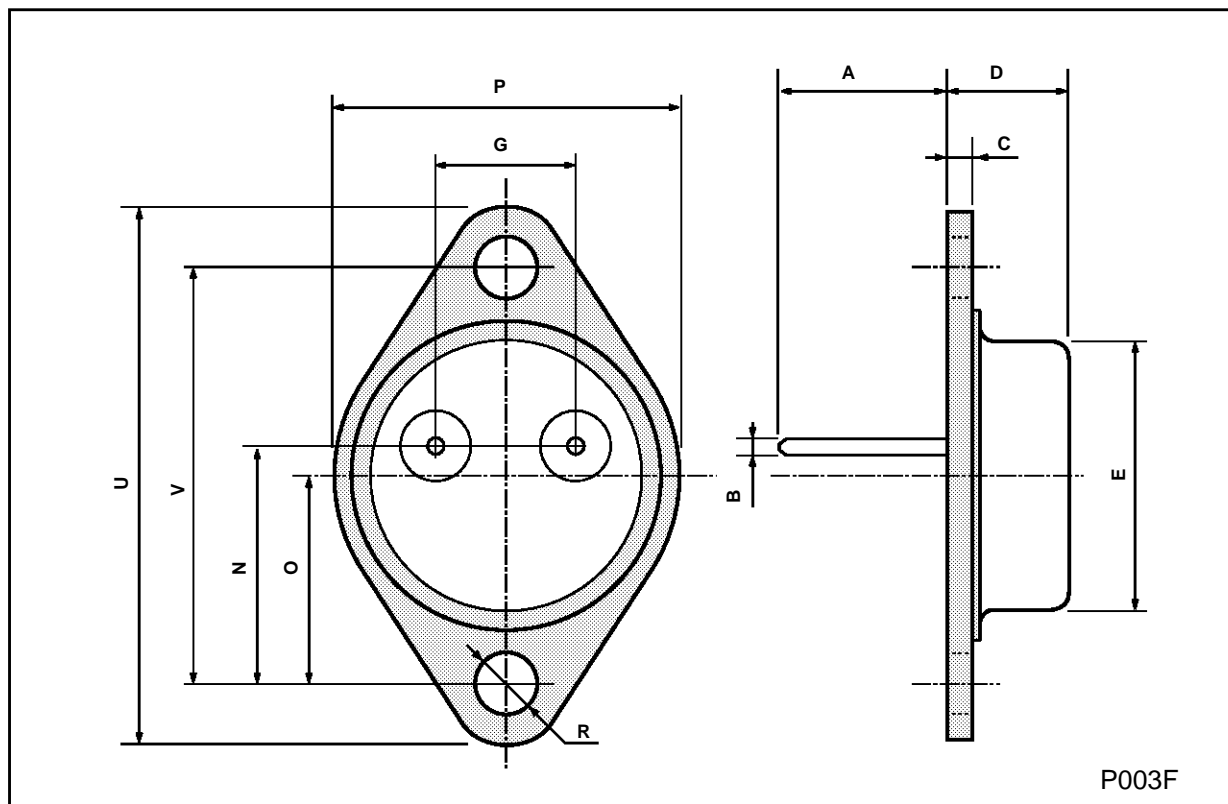


ADJUSTABLE CURRENT REGULATOR



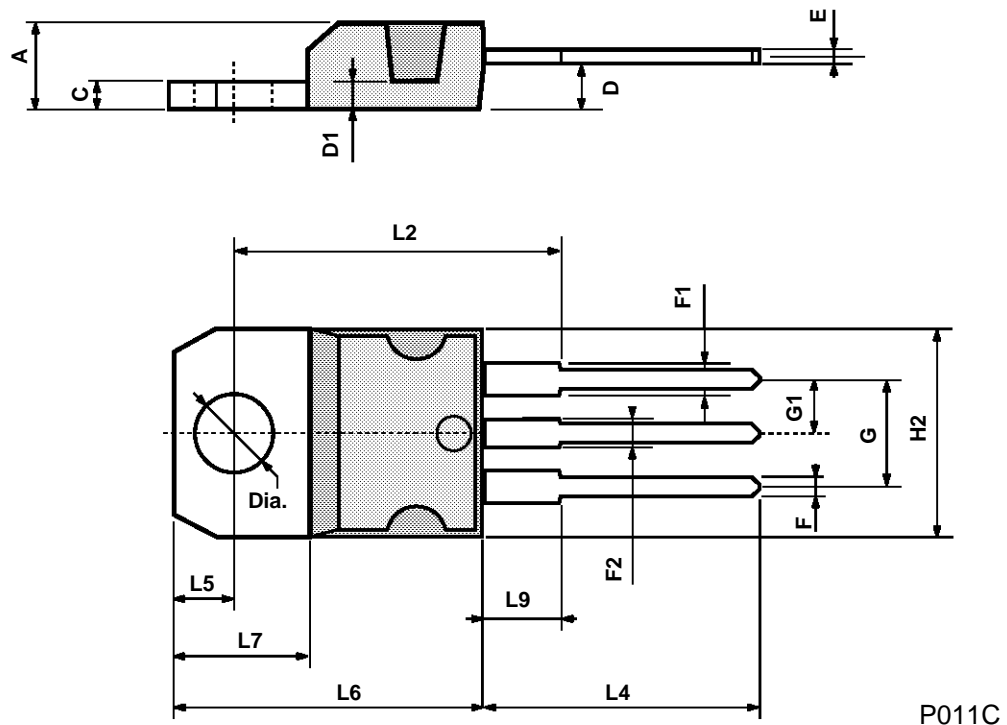
## TO-3 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	11.00		13.10	0.433		0.516
B	0.97		1.15	0.038		0.045
C	1.50		1.65	0.059		0.065
D	8.32		8.92	0.327		0.351
E	19.00		20.00	0.748		0.787
G	10.70		11.10	0.421		0.437
N	16.50		17.20	0.649		0.677
P	25.00		26.00	0.984		1.023
R	4.00		4.09	0.157		0.161
U	38.50		39.30	1.515		1.547
V	30.00		30.30	1.187		1.193



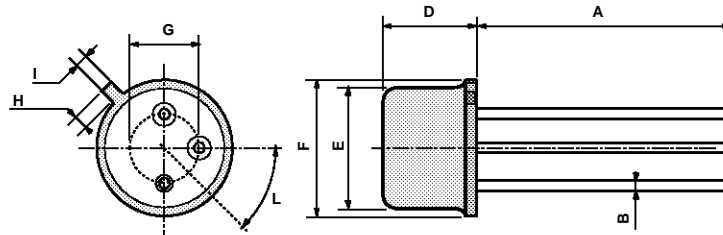
## TO-220 MECHANICAL DATA

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	15.2		15.9	0.598		0.625
L7	6.2		6.6	0.244		0.260
L9	3.5		4.2	0.137		0.165
DIA.	3.75		3.85	0.147		0.151



## TO39 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	12.7			0.500		
B			0.49			0.019
D			6.6			0.260
E			8.5			0.334
F			9.4			0.370
G	5.08			0.200		
H			1.2			0.047
I			0.9			0.035
L	45° (typ.)					



P008B

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