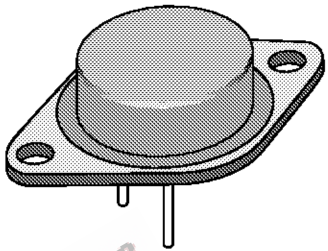
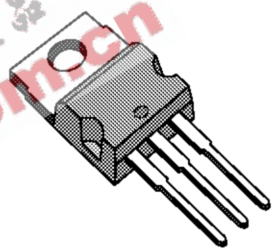
SGS-THOMSON MICROELECTRONICS

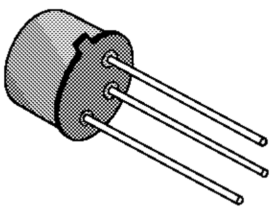
LM137/LM237
LM337

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


TO-3


TO-220

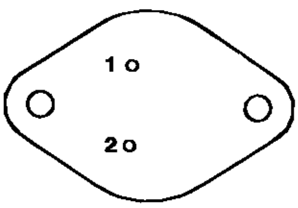

TO-39

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.

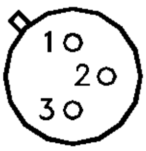
PIN CONNECTIONS

TO-3 (bottom view)



1 - Output
2 - Adj
Case is input

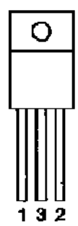
TO-39 (bottom view)



PC11220

1 - Adj
2 - Output
3 - input

TO-220 (front view)



1 - Adj
2 - Output
3 - Input

Heatsink surface connected to input

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

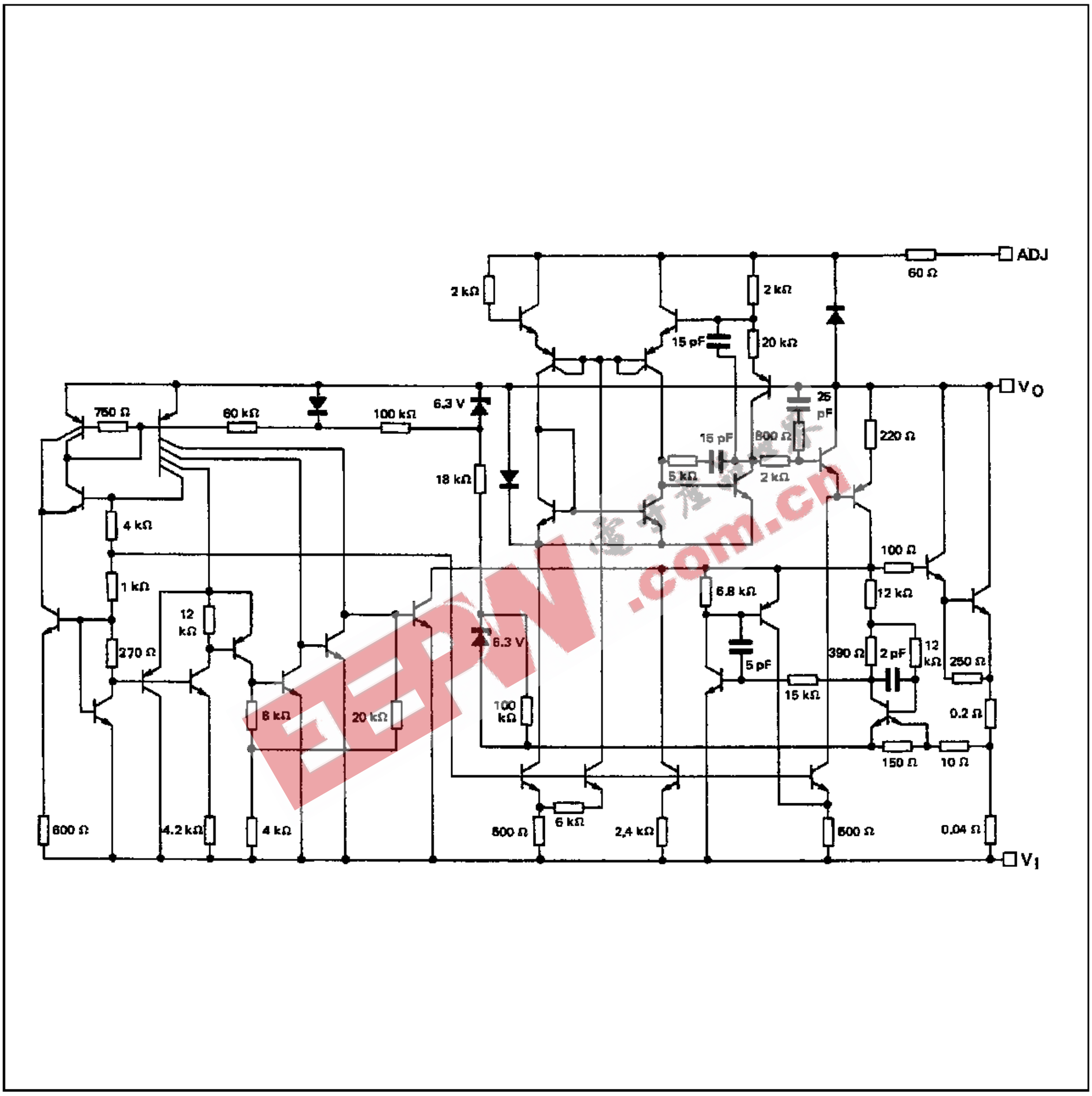
THERMAL CHARACTERISTICS

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



ELECTRICAL CHARACTERISICS

LM137: -55 ^{o}C < Tj < 150 ^{o}C
LM237: -25 ^{o}C < Tj < 150 ^{o}C
LM337: 0 ^{o}C < Tj < 150 ^{o}C
V_I - V_O = 5V, I_O = 0.5 A (unless otherwise specified)

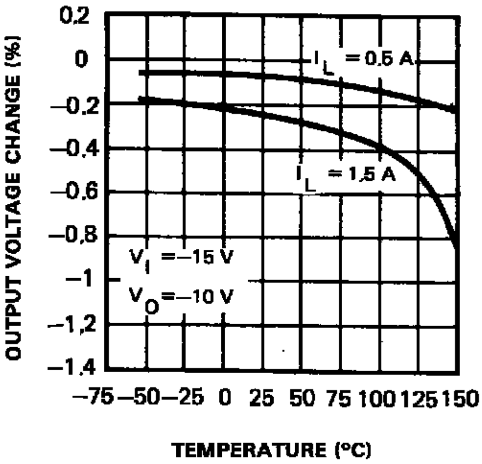
Symbol	Parameter	LM137/LM237			LM337			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{ref}	Reference Voltage T_{amb} = 25 ^{o}C $T_{min} \leq T_j \leq T_{max}$ 3V ≤ $\|V_I$ - $V_O\|$ ≤ 40V, 10mA ≤ $\|I_O\|$ ≤ $\|I_{O(max)}\|$ P ≤ P_{max}	 -1.225 -1.2	 -1.25 -1.25	 -1.275 -1.3	 -1.213 -1.2	 -1.25 -1.25	 -1.287 -1.3	 V
K_{VI}	Line Regulation (T_{amb} = 25 ^{o}C, 3V ≤ $\|V_I$ -$V_O\|$ ≤ 40V) - Note 2 I_O = 0.1 A I_O = 20 mA		 0.01 0.01	 0.02 0.02		 0.01 0.01	 0.04 0.04	 %/V %/V
K_{VO}	Load Regulation (T_{amb} = 25 ^{o}C, 10mA ≤ $\|I_O\|$ ≤ $\|I_{O(max)}\|$) - Note 2 $\|V_O\|$ ≤ 5V $\|V_O\|$ ≥ 5V		 15 0.3	 25 0.5		 15 0.3	 50 1	 mV %
	Thermal Regulation (T_{amb} = 25 ^{o}C, pulse 10 ms)		0.002	0.02		0.003	0.04	%/W
I_{adj}	Adjustment Pin Current		65	100		65	100	µA
ΔI_{adj}	Adjustment Pin Current Change (T_{amb} = 25 ^{o}C, 10mA ≤ $\|I_O\|$ ≤ $\|I_{O(max)}\|$, 3V ≤ $\|V_I$ -$V_O\|$ ≤ 40V)		2	5		2	5	µA
K_{VI}	Line Regulation (3V ≤ $\|V_I$ -$V_O\|$ ≤ 40V) - Note 2		0.02	0.05		0.02	0.07	%/V
K_{VO}	Load Regulation (10mA ≤ $\|I_O\|$ ≤ $\|I_{O(max)}\|$) - Note 2 $\|V_O\|$ ≤ 5V $\|V_O\|$ ≥ 5V		 20 0.3	 50 1		 20 0.3	 70 1.5	 mV %
$\|I_{O(min)}\|$	Minimum Load Current $\|V_I$ -$V_O\|$ ≤ 40V $\|V_I$ -$V_O\|$ ≤ 10V		 2.5 1.2	 5 3		 2.5 1.5	 10 6	 mA mA
I_{OS}	Short Circuit Output Current $\|V_I$ -$V_O\|$ ≤ 15V (TO-3 and TO-220) $\|V_I$ -$V_O\|$ ≤ 15V (TO-39) $\|V_I$ -$V_O\|$ = 40V, T_j = 25 ^{o}C (TO-3 and TO-220) $\|V_I$ -$V_O\|$ = 40V, T_j = 25 ^{o}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_{NO}	RMS Output Noise (% of V_O) T_{amb} = 25 ^{o}C, 10Hz ≤ f ≤ 10KHz		0.003			0.003		%
R_{vf}	Ripple Rejection Ratio V_O = - 10 V, f = 120 Hz C_{adj} = 10 µF	 66	 60 77		 66	 60 77		 dB dB
K_{VT}	Temperature Stability		0.6			0.6		%
K_{VH}	Long Term Stability (T_{amb} = 125 ^{o}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

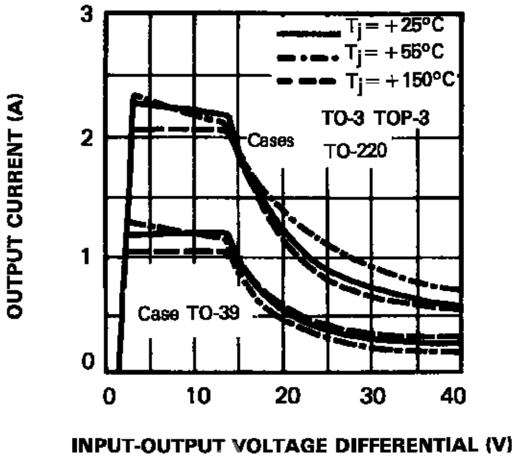
$I_{O(max)}$ is :
- 1.5A for TO-3 and TO-220
- 0.5A for TO-39

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.

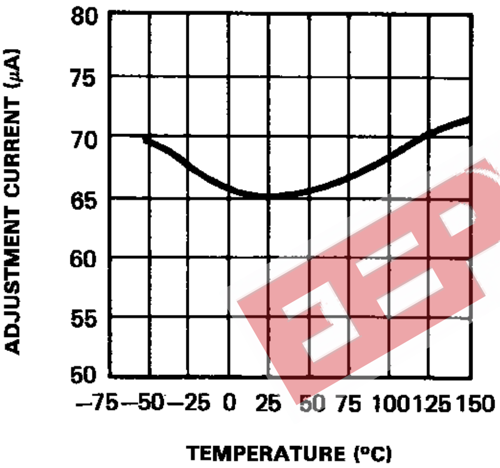
LOAD REGULATION



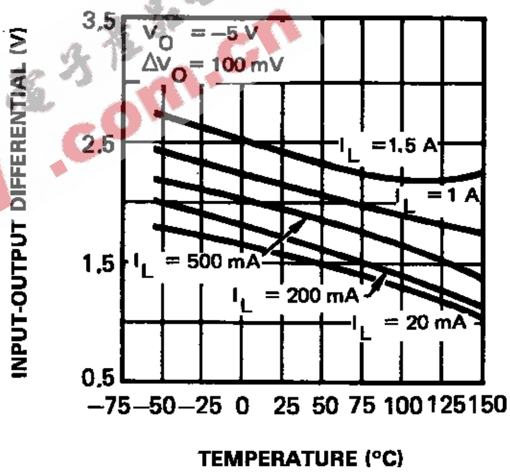
CURRENT LIMIT



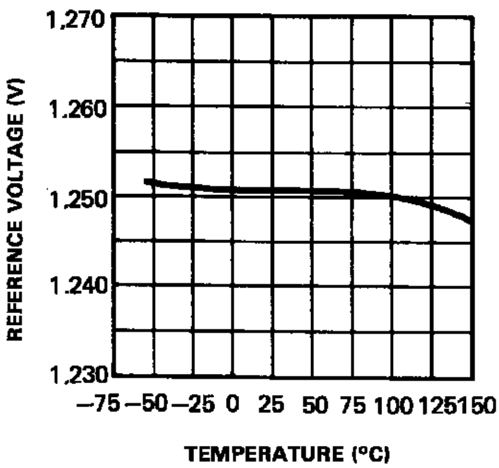
ADJUSTMENT CURRENT



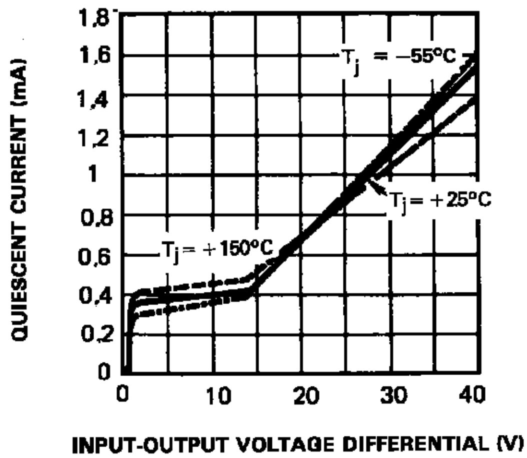
DROPOUT VOLTAGE



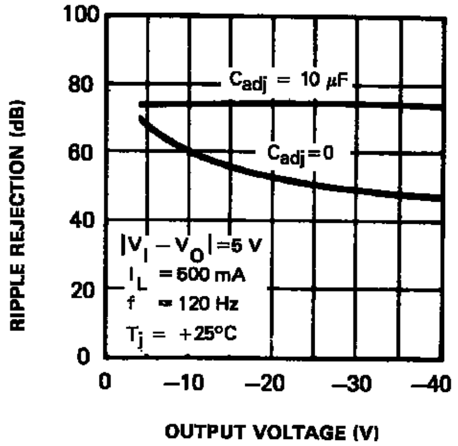
TEMPERATURE STABILITY



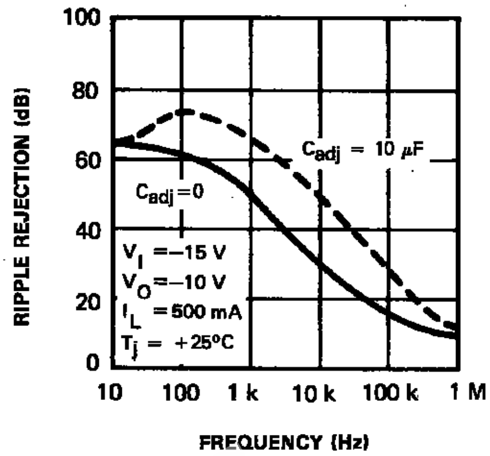
MINIMUM OPERATING CURRENT



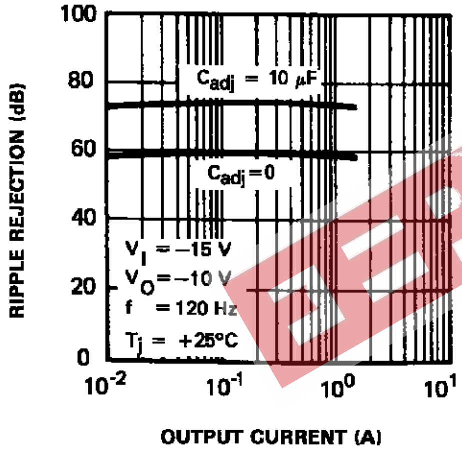
RIPPLE REJECTION VERSUS OUTPUT VOLTAGE



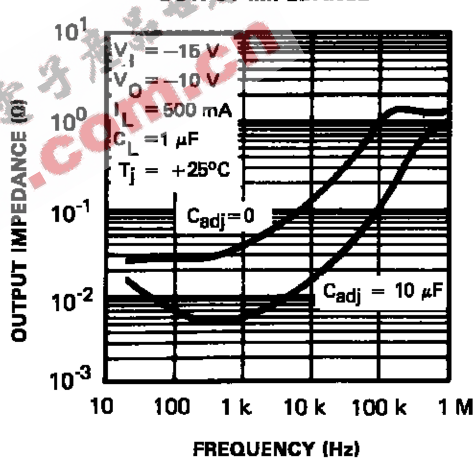
RIPPLE REJECTION VERSUS FREQUENCY



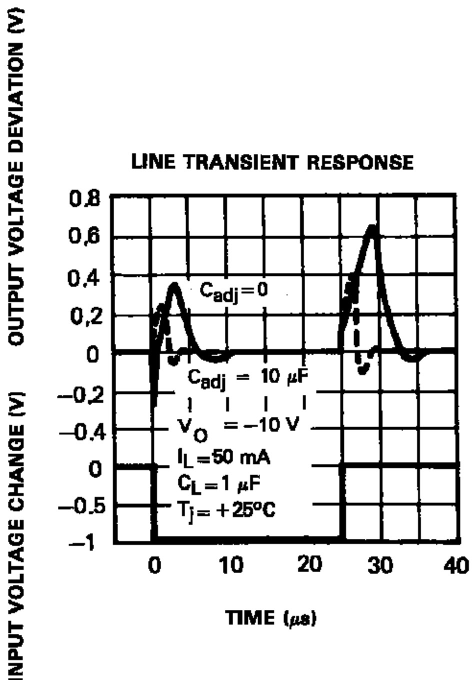
RIPPLE REJECTION VERSUS OUTPUT CURRENT



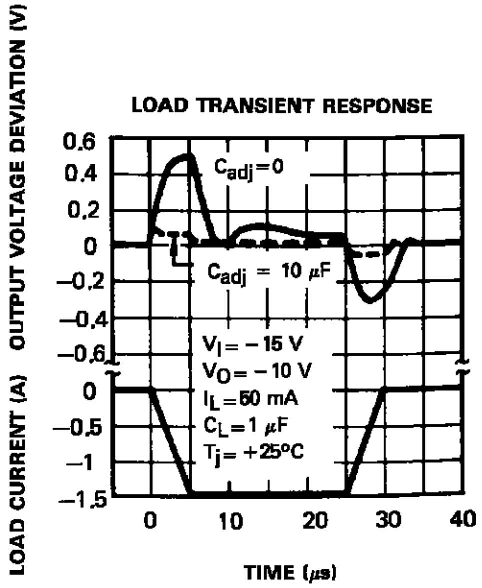
OUTPUT IMPEDANCE



LINE TRANSIENT RESPONSE



LOAD TRANSIENT RESPONSE



THERMAL REGULATION

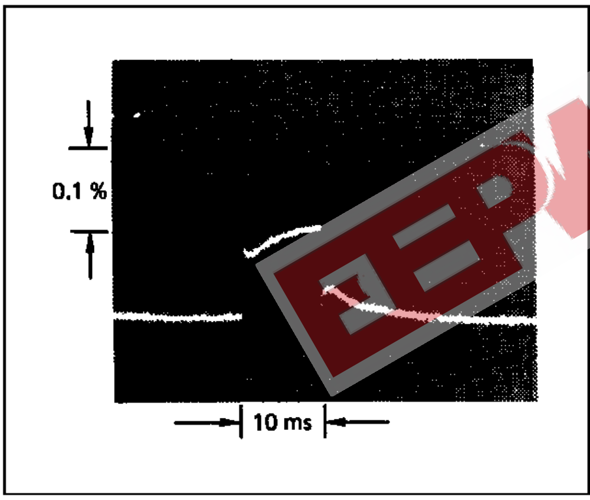
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large.

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 x 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.



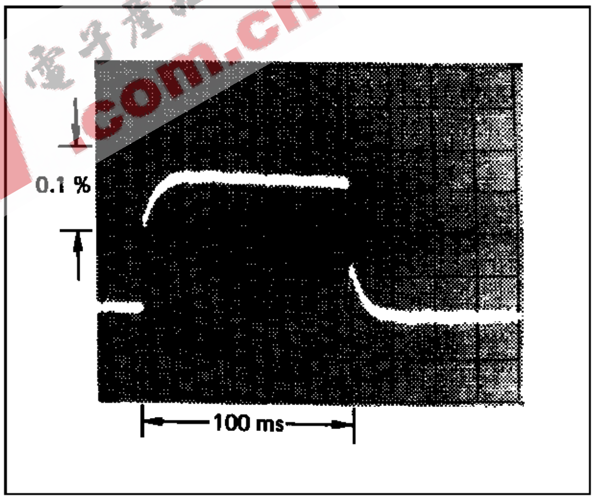
LM 337, V_0 = – 10V

V_I – V_0 = – 40V

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

Vertical sensitivity 5mV/div.

Figure 2.



LM 337, V_0 = – 10V

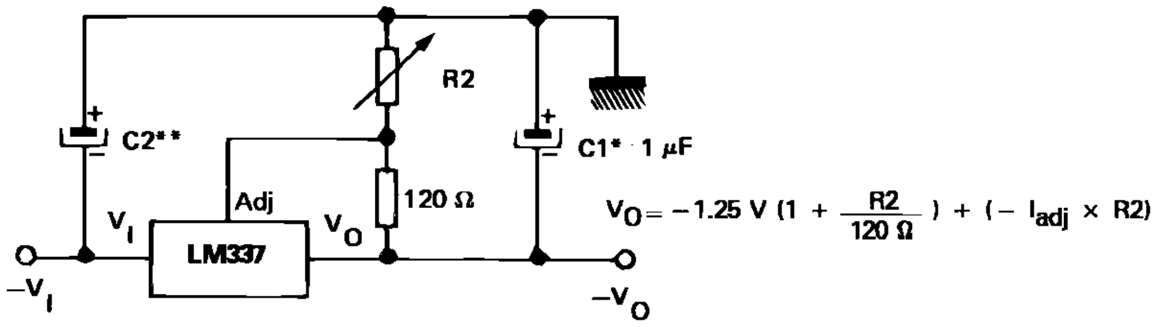
V_I – V_0 = – 40V

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

Horizontal sensitivity 20msN/div.

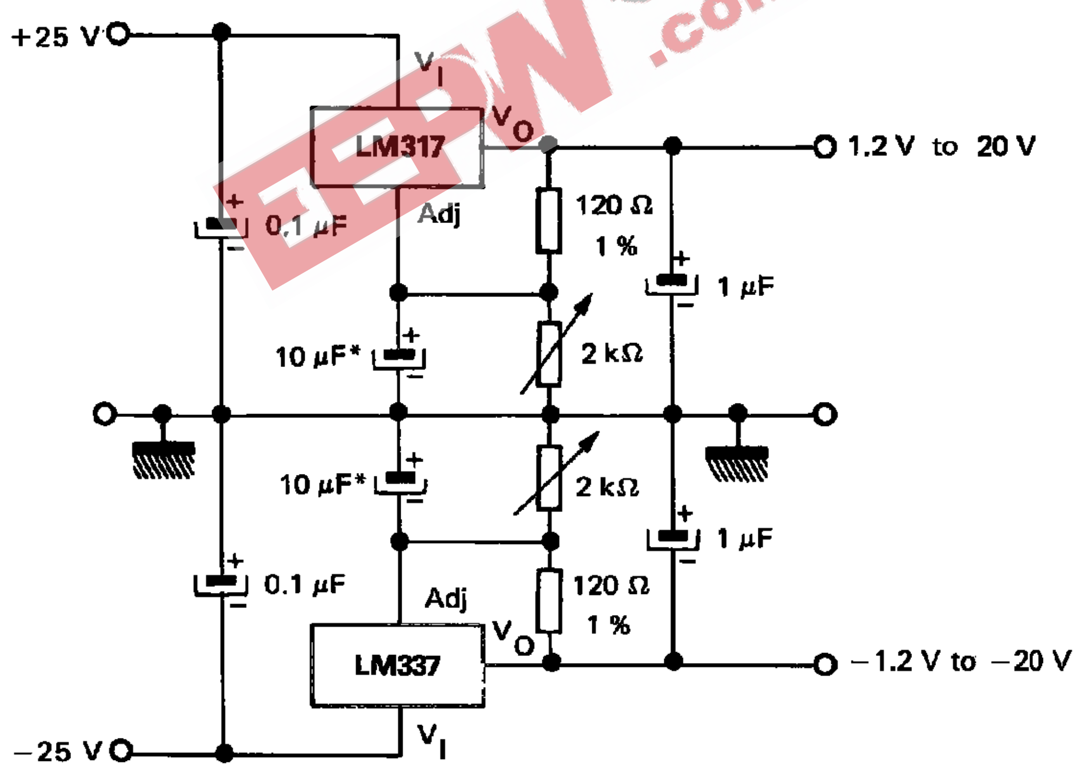
TYPICAL APPLICATIONS

ADJUSTABLE NEGATIVE VOLTAGE REGULATOR



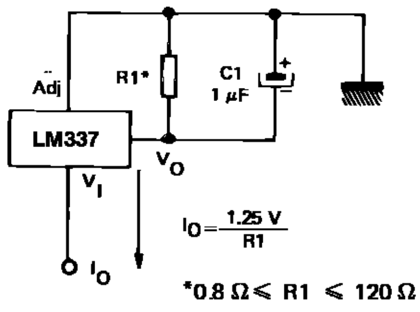
* C1 = 1µF solid tantalum or 10µF aluminium electrolytic required for stability.
* * C2 = 1µF solid tantalum is required only if regulator is more than 10cm from power supply filter capacitor.

ADJUSTABLE LAB VOLTAGE REGULATOR

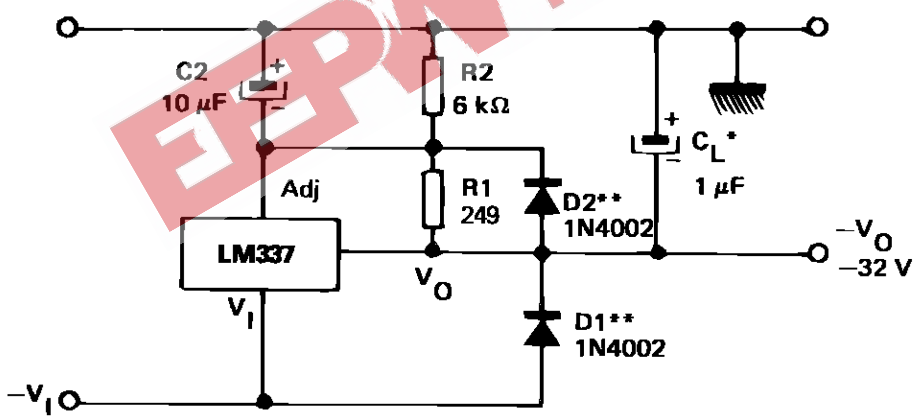


* The 10µF capacitors are optimal to improve ripple rejection.

CURRENT REGULATOR

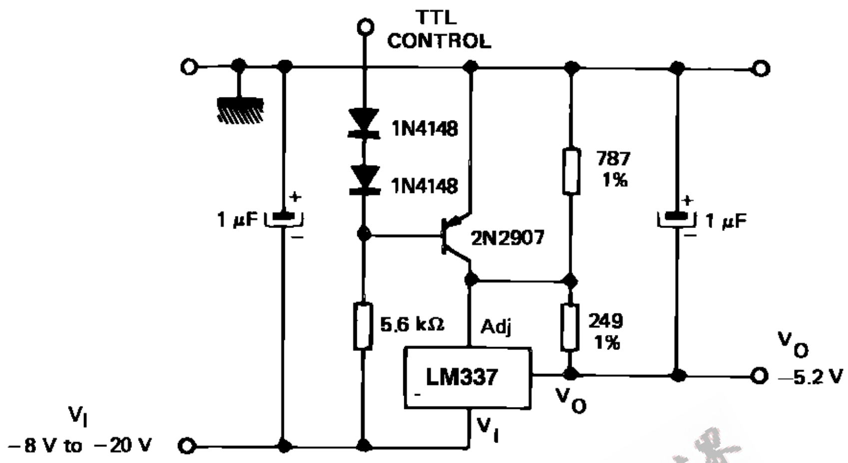


NEGATIVE REGULATOR WITH PROTECTION DIODES



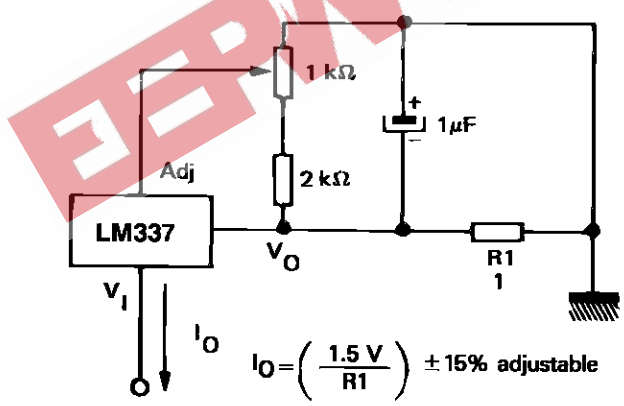
* When C_L is larger than 20μF, D1 protects the LM137 in case the input supply is shorted.
* * When C2 is larger than 10μF and V_0 is larger than – 25V, D2 protects the LM137 in case the output is shorted.

* – 5.2V REGULATOR WITH ELECTRONIC SHUTDOWN



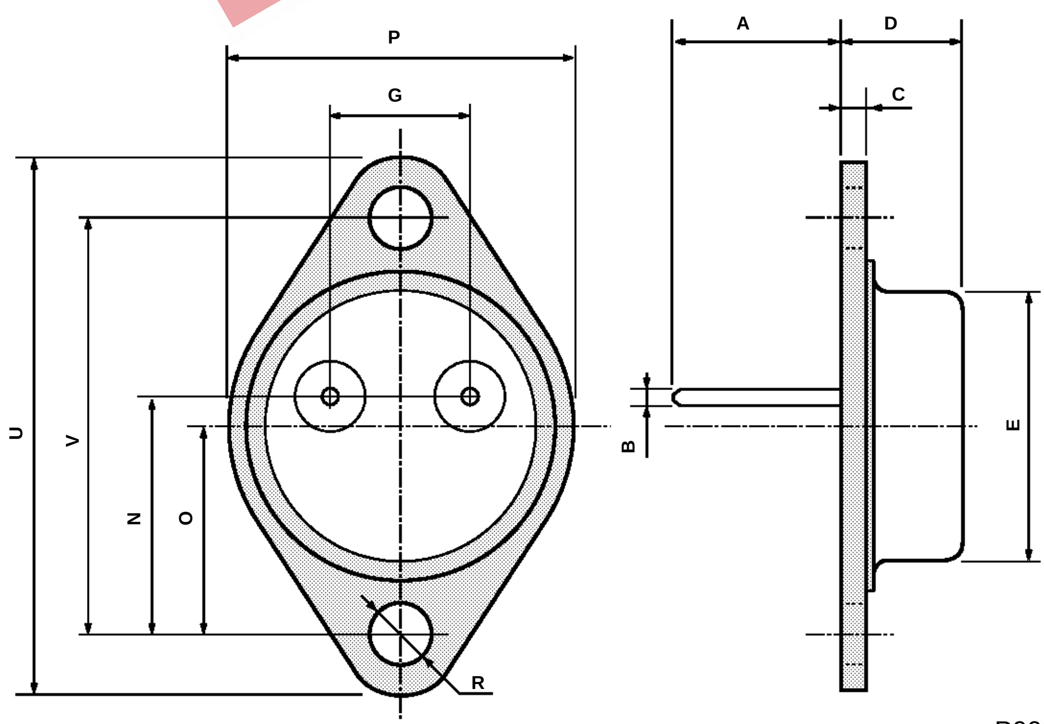
* Minimum output ≅ – 1.3V when control input is low.

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



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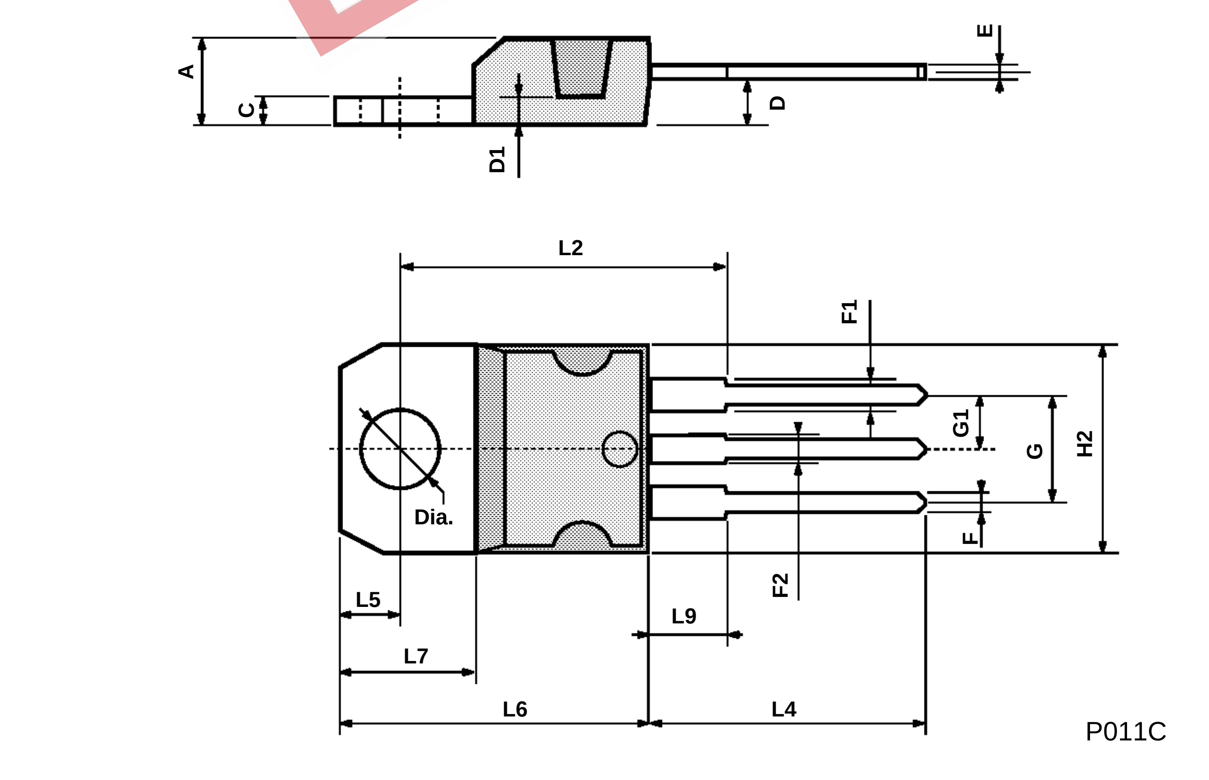
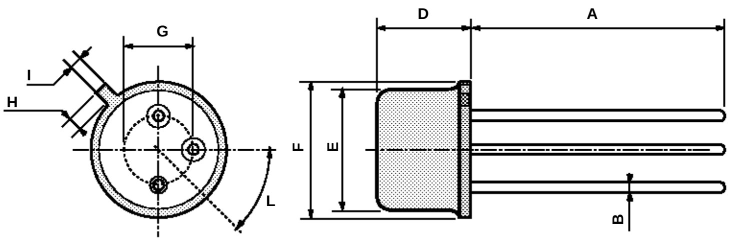
TO-220 MECHANICAL DATA

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^{o} (typ.)					



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