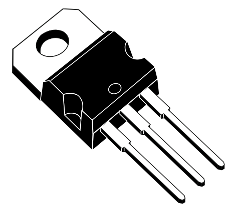
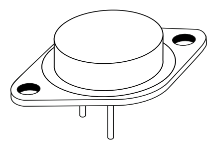
LM137/LM237
LM337

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-220



TO-3

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

Figure 1: Schematic Diagram

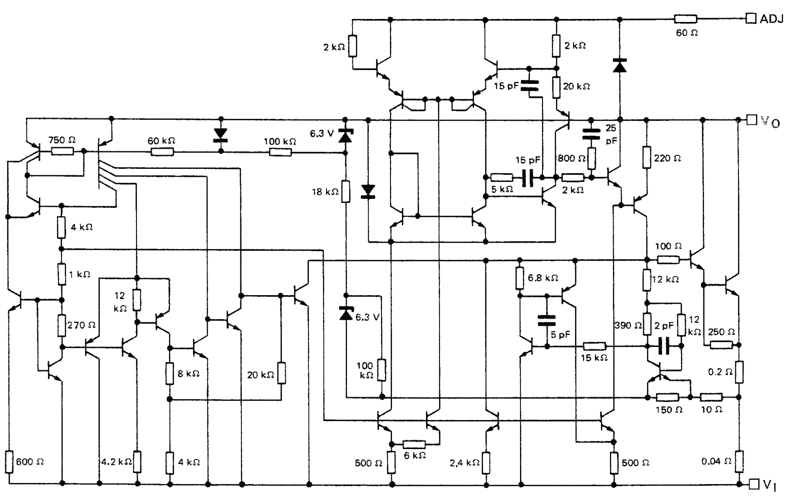


Table 1: Absolute Maximum Ratings

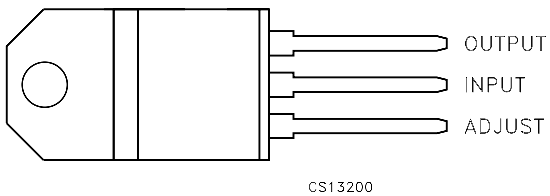
Symbol	Parameter		Value	Unit
$V_I - V_O$	Input Output Voltage Differential		40	V
I_O	Output Current		1.5	A
P_{tot}	Power Dissipation		Internally Limited	
T_{stg}	Storage Temperature Range		-65 to 150	°C
T_{oper}	Operating Junction Temperature Range	LM137	-55 to 150	°C
		LM237	-25 to 125	
		LM337	0 to 125	

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

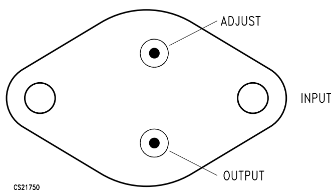
Table 2: Thermal Data

Symbol	Parameter		TO-220	TO-3	Unit
$R_{thj\text{-}case}$	Thermal Resistance Junction-case	Max	3	4	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient	Max	70	35	°C/W

Figure 2: Pin Connection (Top view for TO-220, bottom view for TO-3)



TO-220



TO-3

Table 3: Ordering Codes

TYPE	TO-3	TEMPERATURE RANGE
LM137	LM137K	-55°C to 150°C
LM237	LM237K	-25°C to 150°C
LM337	LM337K	0°C to 125°C

Table 4: Electrical Characteristics Of LM137/LM237 (T_J = -55 to 150°C for LM137, T_J = -25 to 150°C for LM237, V_I -V_O = 5V, I_O = 0.5 A unless otherwise specified).

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, $\|I_O\|$ = 10mA to $\|I_{O(max)}\|$	$T_J = T_{min}$ to T_{max} $P \le P_{max}$	-1.2	-1.25	-1.3	
K_{VI}	Line Regulation (Note 2)	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 (Note 2)	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 (Note 2)	$\|V_I - V_O\|$ = 3 to 40 V			0.02	0.05	%/V
K_{VO}	Load Regulation (Note 2)	$\|I_O\|$ = 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 =2 5°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	%

Notes: 1. Although power dissipation is internally limited, these specifications are applicable for power dissipation of: 15 W for TO-220 and 20 W for TO-3 Package; $I_{O(max)}$ is: 1.5 A
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.

Table 5: Electrical Characteristics Of LM337 (T_J = 0 to 150°C unless otherwise specified).

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_{ref}	Reference Voltage	T_a = 25°C		-1.213	-1.25	-1.287	V
		$\lvert V_I - V_O\rvert$ = 3 to 40 V, $\lvert I_O\rvert$ = 10mA to $\lvert I_{O(max)}\rvert$	$T_J = T_{min}$ to T_{max}, $P \le P_{max}$	-1.2	-1.25	-1.3	
K_{VI}	Line Regulation (Note 2)	T_a = 25°C $\lvert V_I - V_O\rvert$ = 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 (Note 2)	T_a = 25°C $\lvert I_O\rvert$ = 10mA to $\lvert I_{O(max)}\rvert$	$\lvert V_O\rvert \le 5$ V		15	50	mV
			$\lvert V_O\rvert \ge 5$ 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, $\lvert I_O\rvert$ = 10 mA to $\lvert I_{O(max)}\rvert$ $\lvert V_I - V_O\rvert$ = 3 to 40 V			2	5	µA
K_{VI}	Line Regulation (Note 2)	$\lvert V_I - V_O\rvert$ = 3 to 40 V			0.02	0.07	%/V
K_{VO}	Load Regulation (Note 2)	$\lvert I_O\rvert$ = 10mA to $\lvert I_{O(max)}\rvert$	$\lvert V_O\rvert \le 5$ V		20	70	mV
			$\lvert V_O\rvert \ge 5$ V		0.3	1.5	%
$\lvert I_{O(min)}\rvert$	Minimum Load Current	$\lvert V_I - V_O\rvert \le 40$ V			2.5	10	mA
		$\lvert V_I - V_O\rvert \le 10$ V			1.5	6	
I_{OS}	Short Circuit Output Current	$\lvert V_I - V_O\rvert \le 15$ V		1.5	2.2		A
		$\lvert V_I - V_O\rvert$ = 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	%

Notes:
1. Although power dissipation is internally limited, these specifications are applicable for power dissipation of: 15 W for TO-220 and 20 W for TO-3 Package; $I_{O(max)}$ is: 1.5 A
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.

Figure 3: Load Regulation

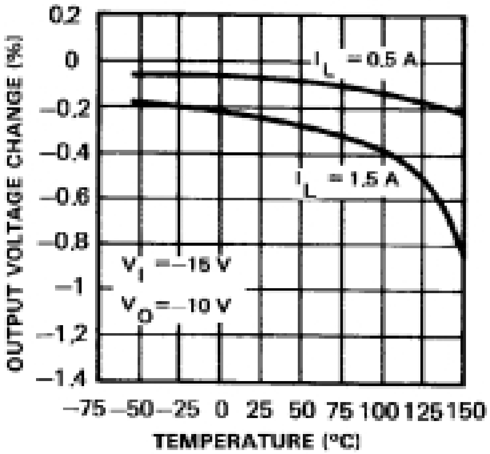


Figure 6: Dropout Voltage

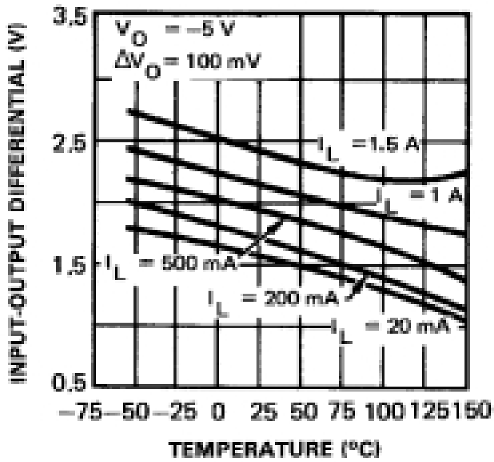


Figure 4: Current Limit

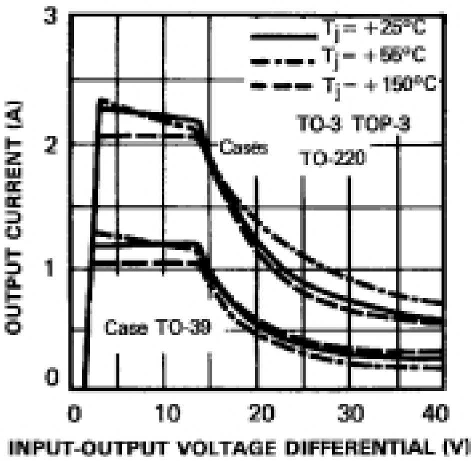


Figure 7: Temperature Stability

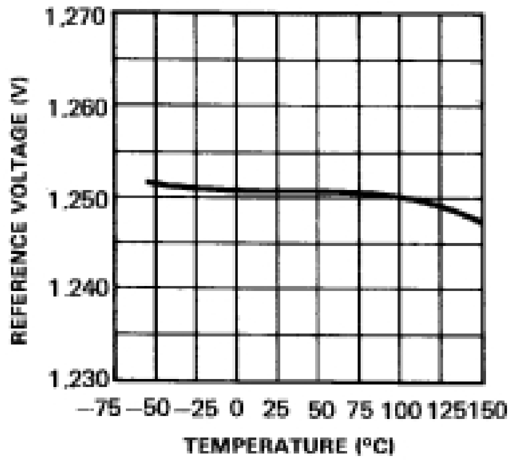


Figure 5: Adjustment Current

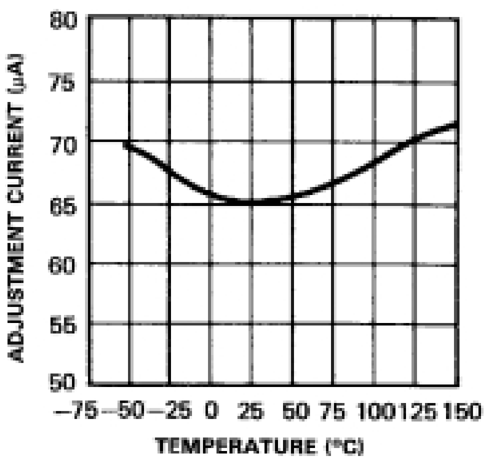


Figure 8: Minimum Operating Current

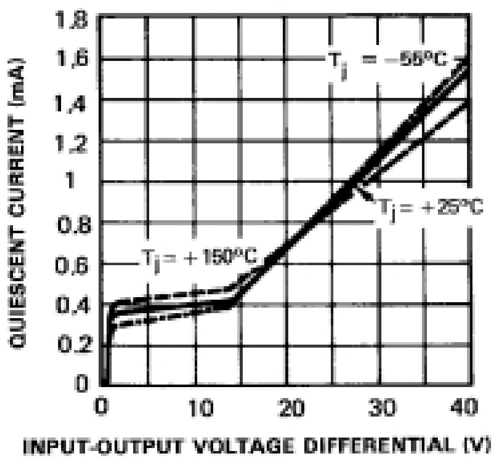


Figure 9: Ripple Rejection Versus Output Voltage

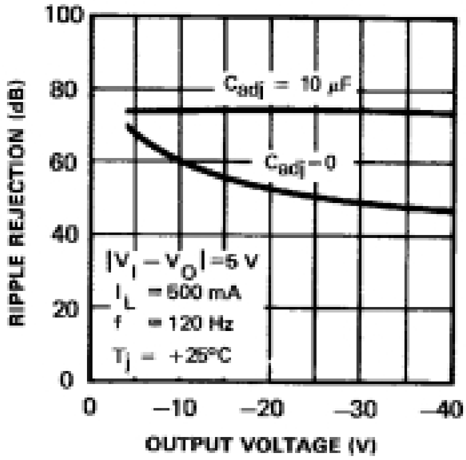


Figure 12: Output Impedance

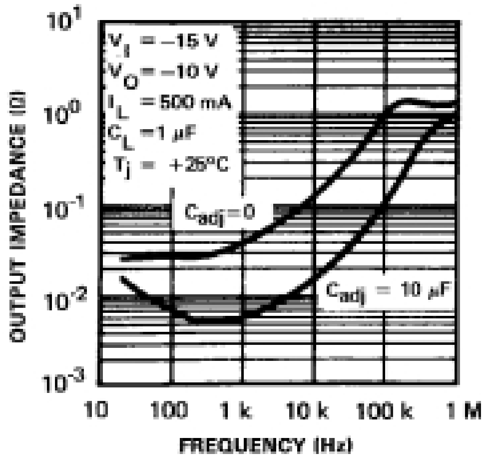


Figure 10: Ripple Rejection Versus Frequency

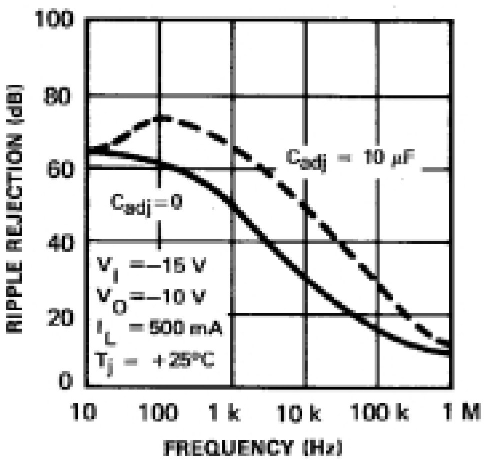


Figure 13: Line Transient Response

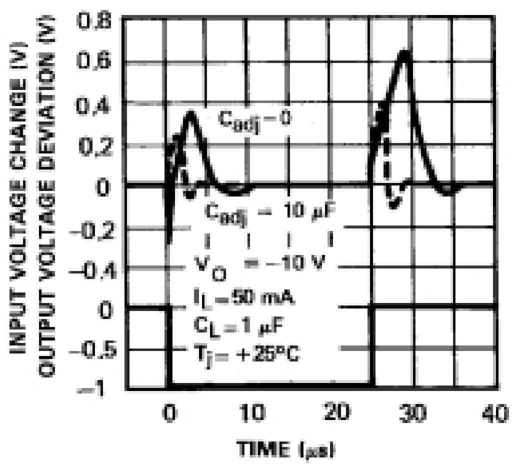


Figure 11: Ripple Rejection Versus Output Current

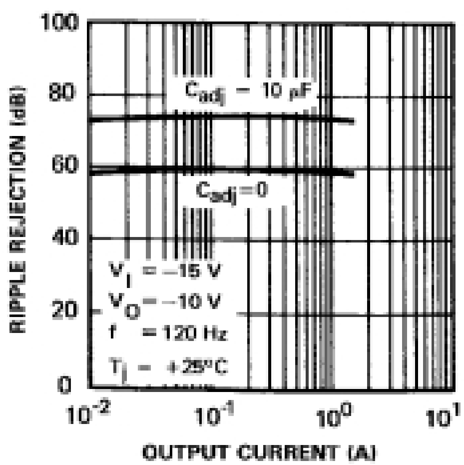
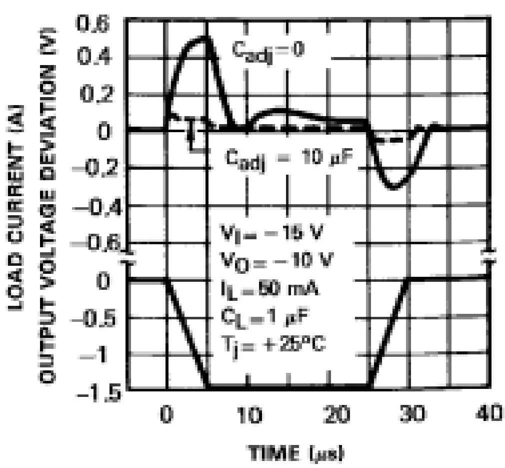


Figure 14: Load Transient Response



THERMAL REGULATION

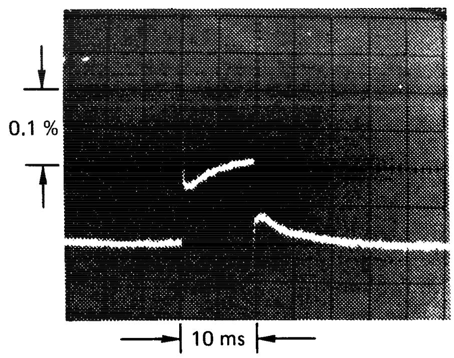
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large.

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.

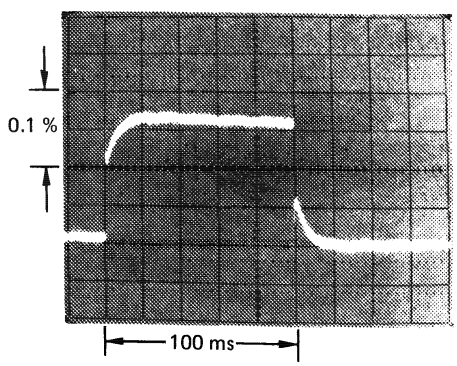
In figure 2, when the 10W pulse is applied for 100ms, the output drifts only slightly beyond the drift in the first 10ms and the thermal error stays well within 0.1% (10mV).

Figure 15: Typical Output Drift



LM337, VO = -10V, V_I - V_O = - 40V, I_L = 0A → 0.25A → 0A. Vertical sensitivity 5mV/div.

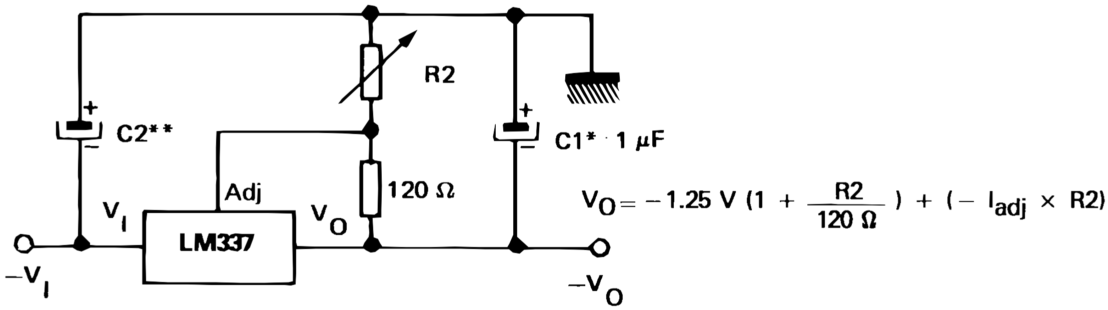
Figure 16: Typical Output Drift



LM337, VO = -10V, V_I - V_O = - 40V, I_L = 0A → 0.25A → 0A. Horizontal sensitivity 5msN/div.

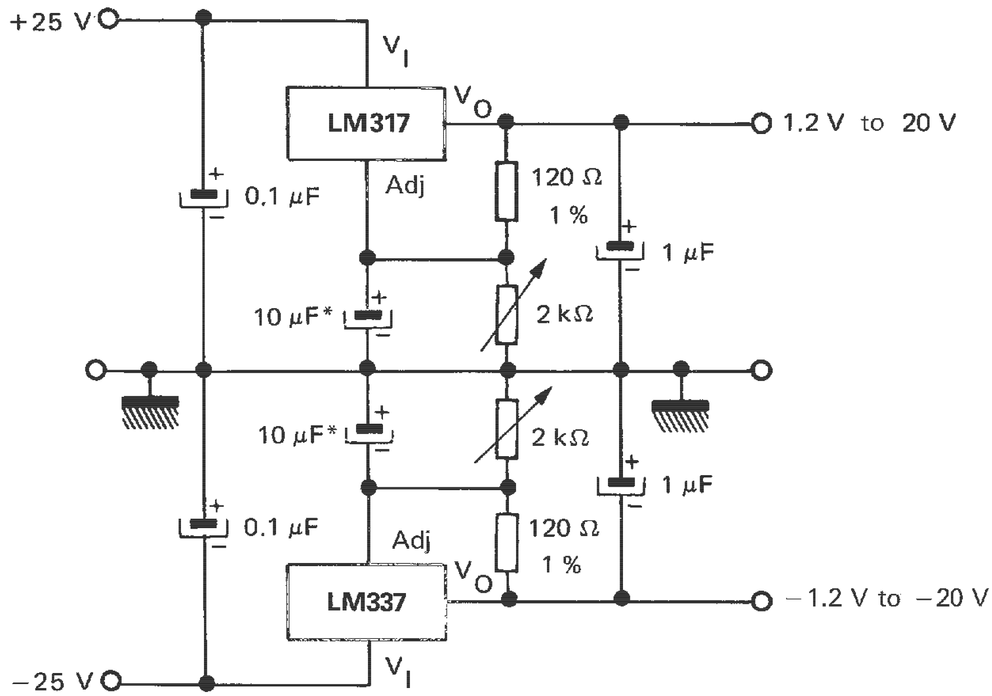
TYPICAL APPLICATIONS

Figure 17: Adjustable Negative Voltage Regulator



* C1 = 1 µF solid tantalum or 10µF 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 18: Adjustable Lab Voltage Regulator



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

Figure 19: Current Regulator

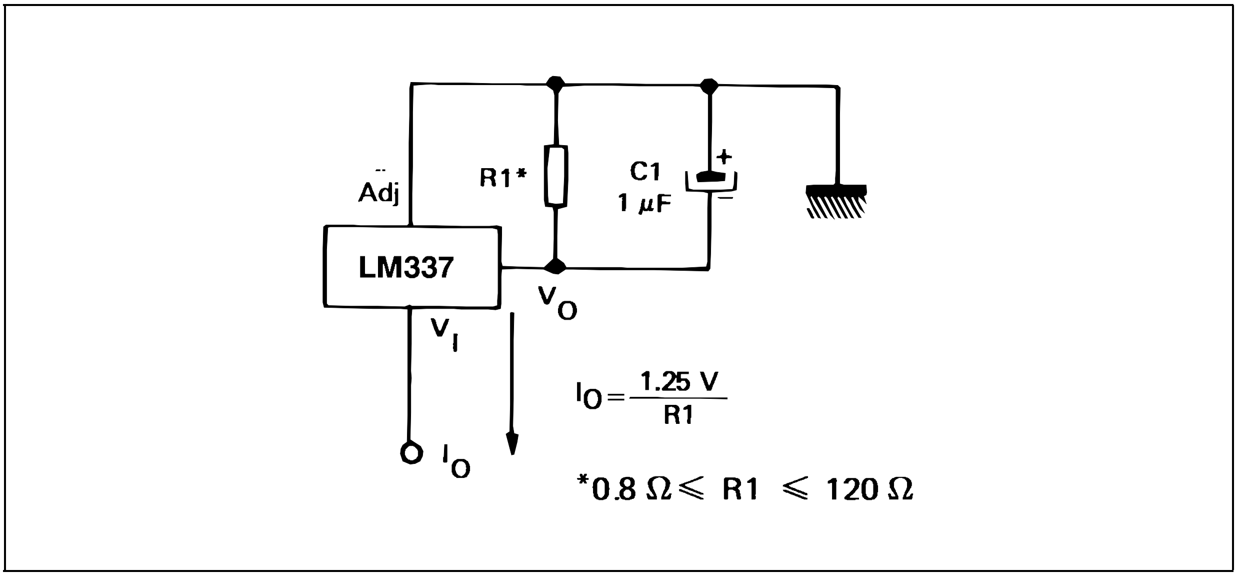
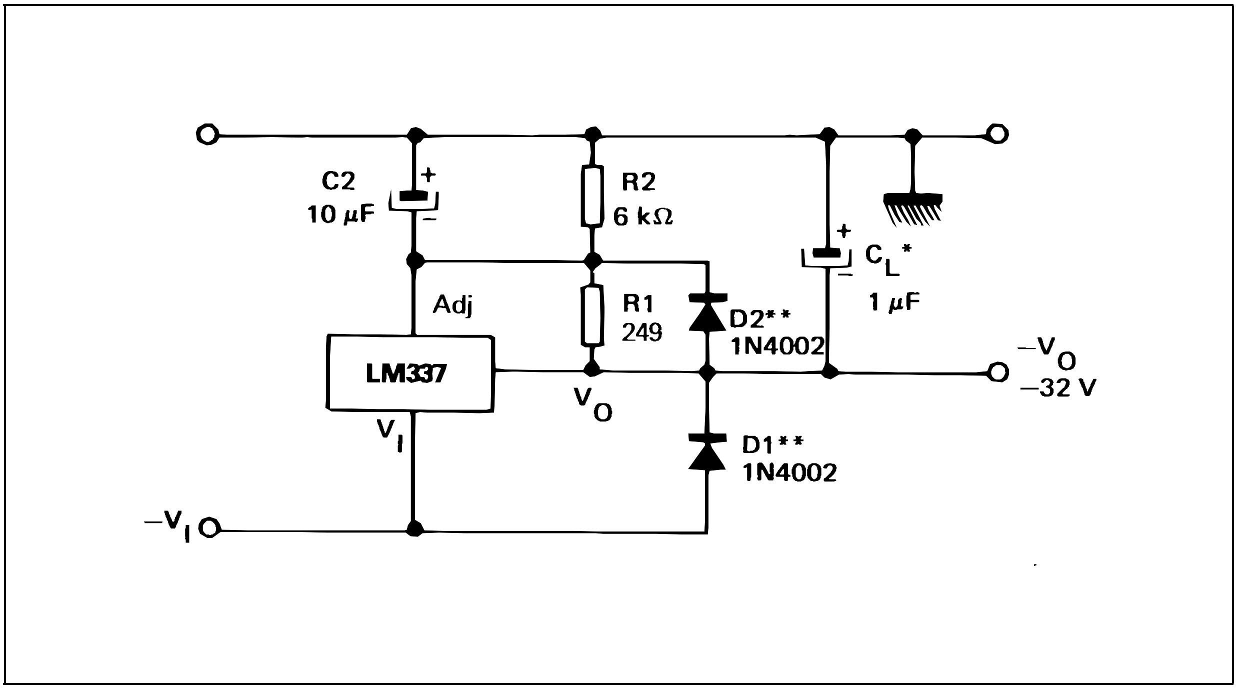
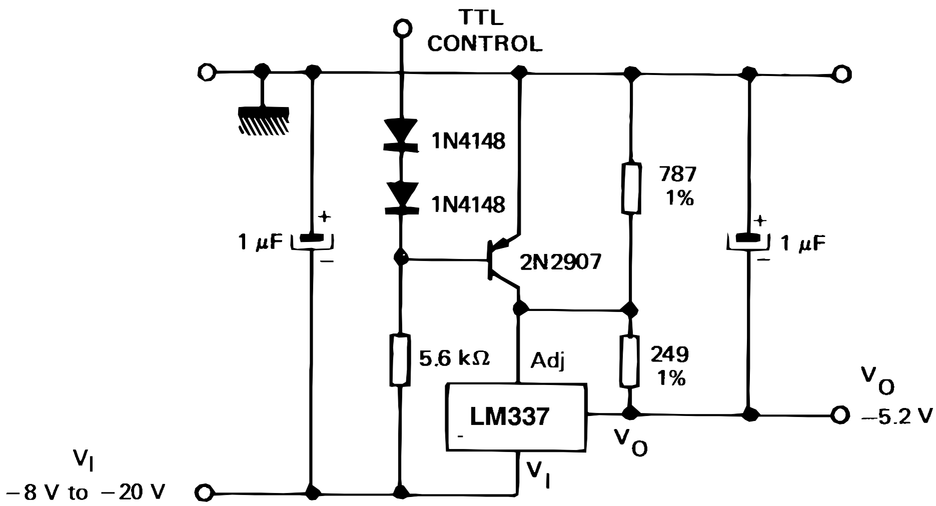


Figure 20: Negative Regulator With Protection Diodes



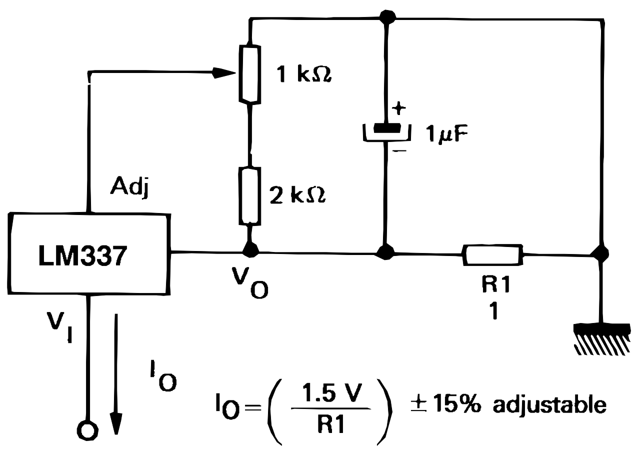
* When CL is larger than 20 µF, D1 protects the LM137 in case the input supply is shorted.
** When C2 is larger than 10µF and VO is larger than -25V, D2 protects the LM137 in case the output is shorted.

Figure 21: * - 5.2V Regulator With Electronic Shutdown



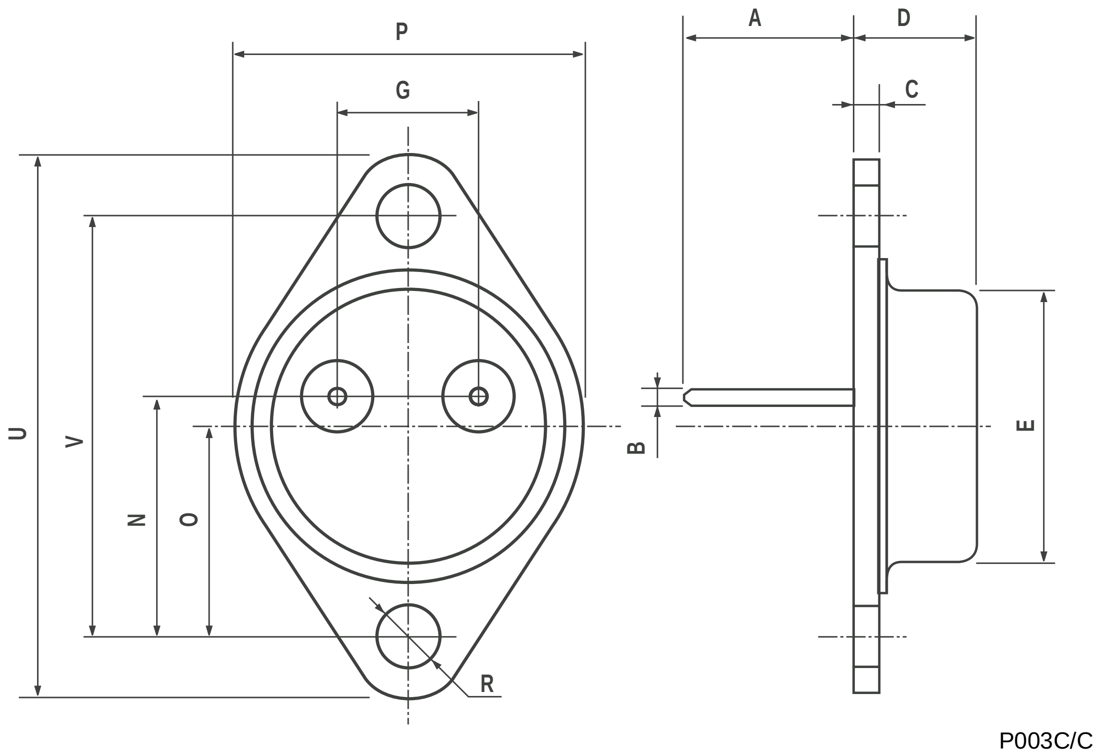
* Minimum output = - 1.3V when control input is low.

Figure 22: Current Regulator



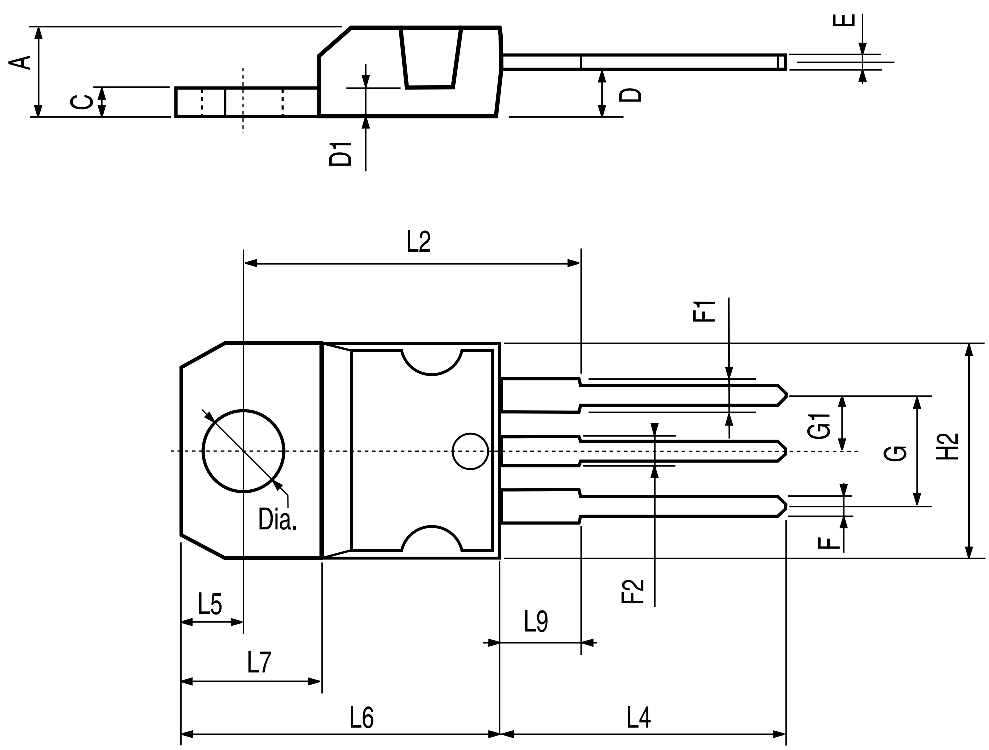
TO-3 MECHANICAL DATA

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	



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

Table 6: Revision History

Date	Revision	Description of Changes
19-Jul-2004	2	Mistake Pin Connection for TO-3 figure 1, page 2.
10-Jan-2005	3	Mistake Pin Connection for TO-3 figure 2, page 2.