

## 1.2V TO 37V ADJUSTABLE VOLTAGE REGULATOR

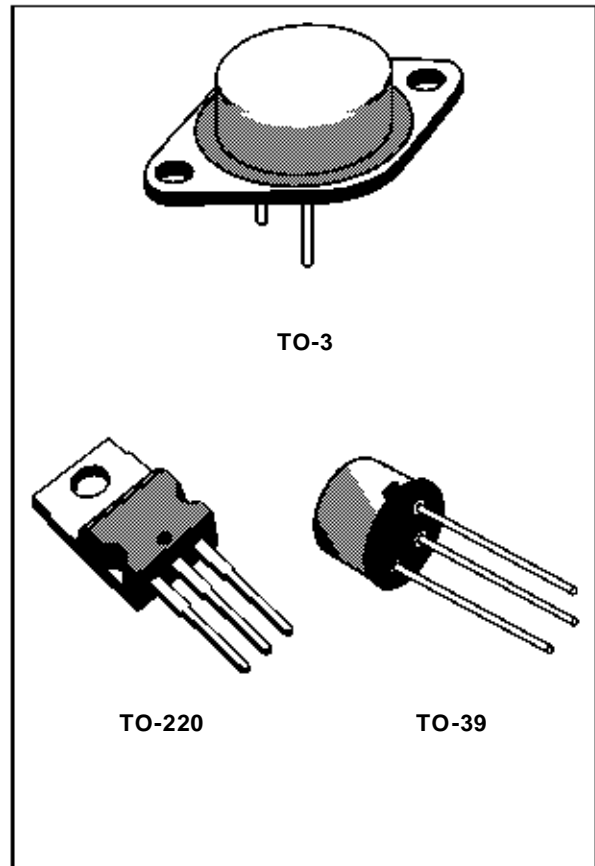
- OUTPUT VOLTAGE RANGE : 1.2 TO 37V
- OUTPUT CURRENT IN EXCESS OF 1.5A (0.5A for TO-39)
- 0.1% LINE AND LOAD REGULATION
- FLOATING OPERATION FOR HIGH VOLTAGES
- COMPLETE SERIES OF PROTECTIONS : CURRENT LIMITING, THERMAL SHUTDOWN AND SOA CONTROL

### DESCRIPTION

The LM117/LM217/LM317 are monolithic integrated circuit in TO-220 and TO-3 packages intended for use as positive adjustable voltage regulators.

They are designed to supply more than 1.5A of load current with an output voltage adjustable over a 1.2 to 37V range.

The nominal output voltage is selected by means of only a resistive divider, making the device exceptionally easy to use and eliminating the stocking of many fixed regulators.



### ABSOLUTE MAXIMUM RATING

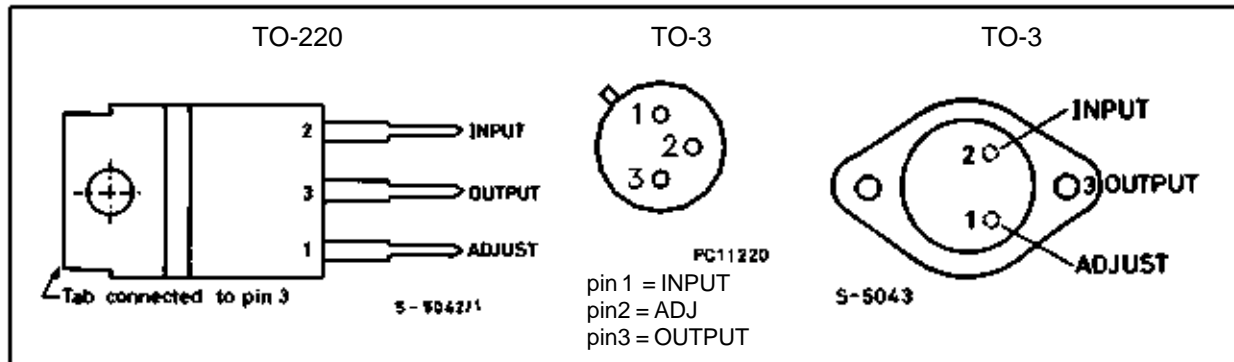
Symbol	Parameter	Value	Unit
$V_{i-o}$	Input-output Differential Voltage	40	V
$I_o$	Output Current	Internally Limited	
$T_{op}$	Operating Junction Temperature for:	LM117 LM217 LM317	-55 to 150 -25 to 150 0 to 125 °C °C °C
$P_{tot}$	Power Dissipation	Internally Limited	

### THERMAL DATA

			TO-3	TO-220	ISOWATT220	TO-39	
$R_{thj-case}$	Thermal Resistance Junction-case	Max	4	3	4	15	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient	Max	35	50	60	160	°C/W

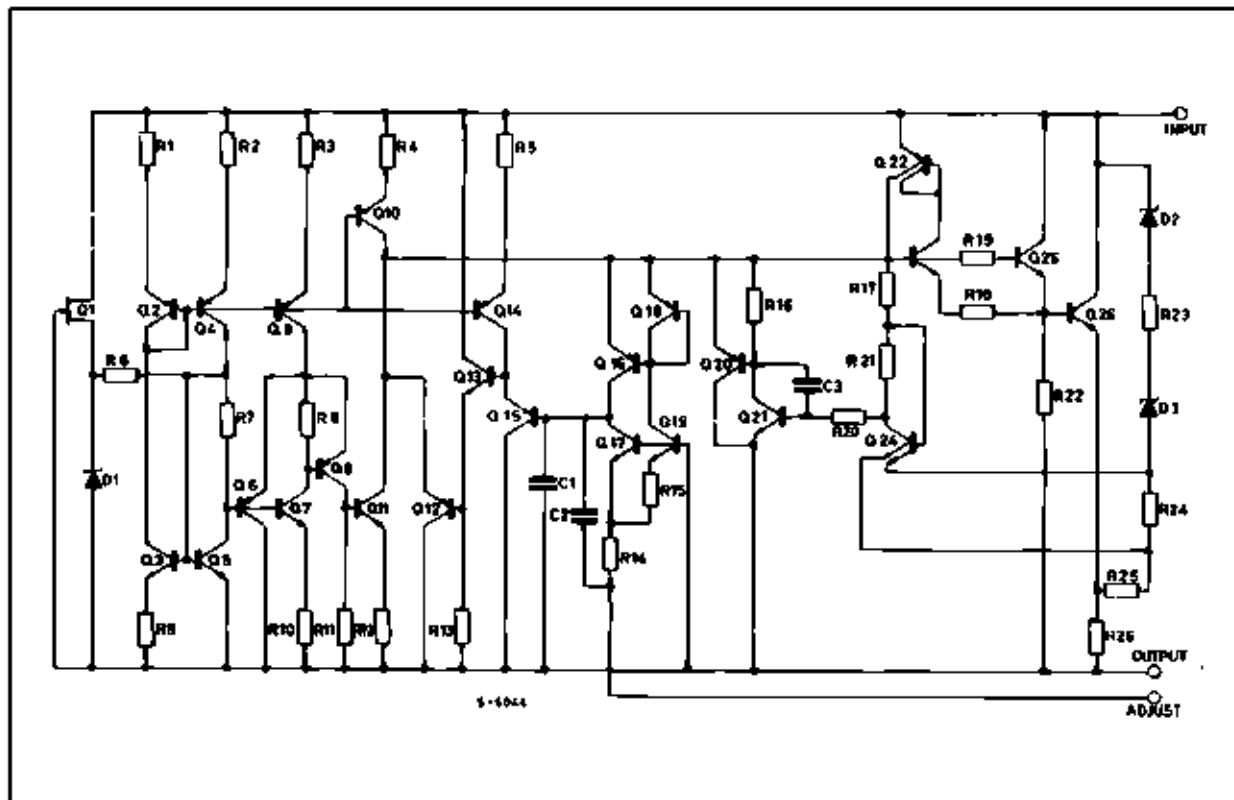
# LM117/LM217/LM317

## PIN CONNECTION AND ORDERING NUMBER

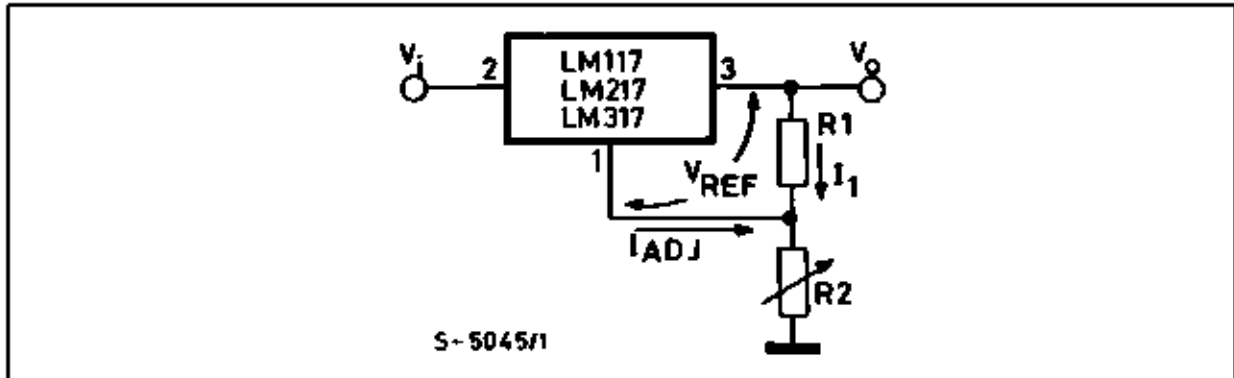


Type	TO-3	TO-220	ISOWATT220	TO-39
LM117	LM117K			LM117H
LM217	LM217K	LM217T	LM217P	LM217H
LM317	LM317K	LM317T	LM317P	LM317H

## SCHEMATIC DIAGRAM



Basic adjustable regulator.



**ELECTRICAL CHARACTERISTICS** ( $V_i - V_o = 5\text{ V}$ ,  $I_o = 500\text{ mA}$  for TO-3 and TO-220,  $I_o = 100\text{ mA}$  for TO-39,  $I_{MAX}$  and  $P_{MAX}$  according to note 2, unless otherwise specified)

Symbol	Parameter	Test Conditions	LM117/LM217			LM317			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.		
$\Delta V_o$	Line Regulation	$V_i - V_o = 3\text{ to }40\text{ V}$ $T_j = 25\text{ }^\circ\text{C}$		0.01	0.02		0.01	0.04	%/V	
				0.02	0.05		0.02	0.07	%/V	
$\Delta V_o$	Load Regulation	$V_o \leq 5\text{ V}$ $I_o = 10\text{ mA to }I_{MAX}$ $T_j = 25\text{ }^\circ\text{C}$		5	15		5	25	mV	
				20	50		20	70	mV	
		$V_o \geq 5\text{ V}$ $I_o = 10\text{ mA to }I_{MAX}$ $T_j = 25\text{ }^\circ\text{C}$		0.1	0.3		0.1	0.5	%	
				0.3	1		0.3	1.5	%	
$I_{ADJ}$	Adjustment Pin Current			50	100		50	100	$\mu\text{A}$	
$\Delta I_{ADJ}$	Adjustment Pin Current	$V_i - V_o = 2.5\text{ to }40\text{ V}$ $I_o = 10\text{ mA to }I_{MAX}$		0.2	5		0.2	5	$\mu\text{A}$	
$V_{REF}$	Reference Voltage (between pin 3 and pin 1)	$V_i - V_o = 2.5\text{ to }40\text{ V}$ $I_o = 10\text{ mA to }I_{MAX}$ $P_D \leq P_{MAX}$	1.2	1.25	1.3	1.2	1.25	1.3	V	
$\frac{\Delta V_o}{V_o}$	Output Voltage Temperature Stability			1			1		%	
$I_{o(min)}$	Minimum Load Current	$V_i - V_o = 40\text{ V}$		3.5	5		3.5	10	mA	
$I_{o(max)}$	Maximum Load Current	$V_i - V_o \leq 15\text{ V}$ $P_D < P_{MAX}$	TO-3	1.5	2.2		1.5	2.2	A	
			TO-220							
		$V_i - V_o = 40\text{ V}$ $P_D < P_{MAX}$ $T_j = 25\text{ }^\circ\text{C}$	TO-3		0.4			0.4		A
			TO-220							
		$T_j = 25\text{ }^\circ\text{C}$	TO-39		0.07			0.07	A	
			TO-220							
$e_N$	Output Noise Voltage (percentage of $V_o$ )	$B = 10\text{ Hz to }10\text{ KHz}$ $T_j = 25\text{ }^\circ\text{C}$		0.003			0.003		%	
SVR	Supply Voltage Rejection (*)	$T_j = 25\text{ }^\circ\text{C}$ $f = 120\text{ Hz}$	$C_{ADJ}=0$		65			65		dB
			$C_{ADJ}=10\mu\text{F}$	66	80		66	80		dB

(\*)  $C_{ADJ}$  is connected between pin 1 and ground.

**Note:**

(1) Unless otherwise specified the above specs, apply over the following conditions : LM 117  $T_j = -55\text{ to }150\text{ }^\circ\text{C}$ ; LM 217  $T_j = -25\text{ to }150\text{ }^\circ\text{C}$  ; LM 317  $T_j = 0\text{ to }125\text{ }^\circ\text{C}$ .

(2)  $I_{MAX}$ : 1.5 A for TO-3 and TO-220; 0.5 A for TO-39  
 $P_{MAX}$ : 20 W for TO-3 and TO-220; 2 W for TO-39

Figure 1 : Output Current vs. Input-output Differential Voltage.

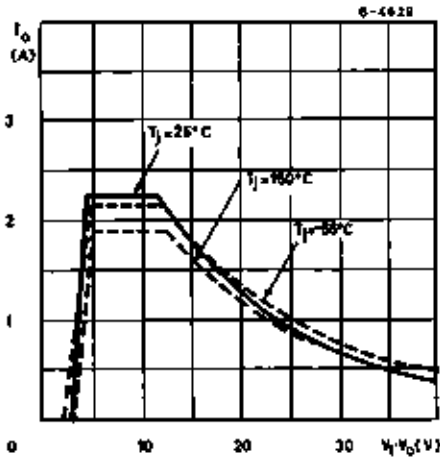
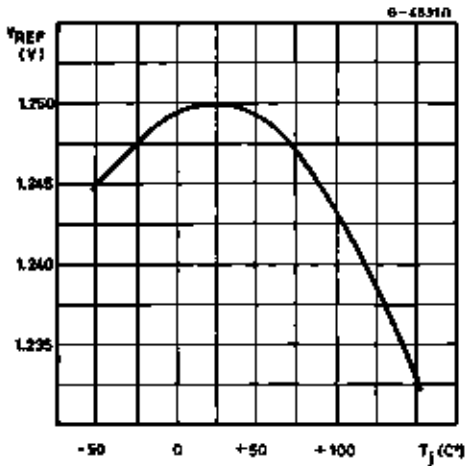


Figure 3 : Reference Voltage vs. Junction



APPLICATION INFORMATION

The LM117/217/317 provides an internal reference voltage of 1.25V between the output and adjustments terminals. This is used to set a constant current flow across an external resistor divider (see fig. 4), giving an output voltage  $V_O$  of:

$$V_O = V_{REF} \left( 1 + \frac{R_2}{R_1} \right) + I_{ADJ} R_2$$

The device was designed to minimize the term  $I_{ADJ}$  (100μA max) and to maintain it very constant with line and load changes. Usually, the error term  $I_{ADJ} \cdot R_2$  can be neglected. To obtain the previous requirement, all the regulator quiescent current is returned to the output terminal, imposing a minimum load current condition. If the load is insufficient, the output voltage will rise.

Since the LM117/217/317 is a floating regulator and "sees" only the input-to-output differential voltage,

Figure 2 : Dropout Voltage vs. Junction Temperature.

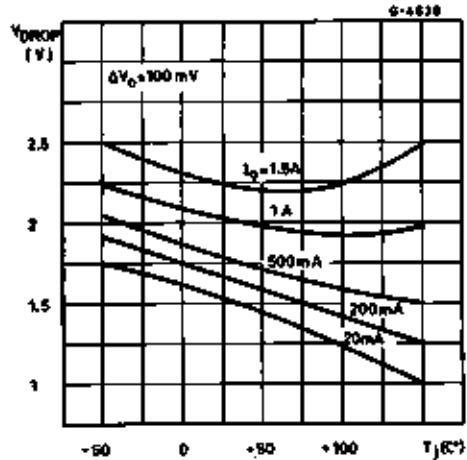
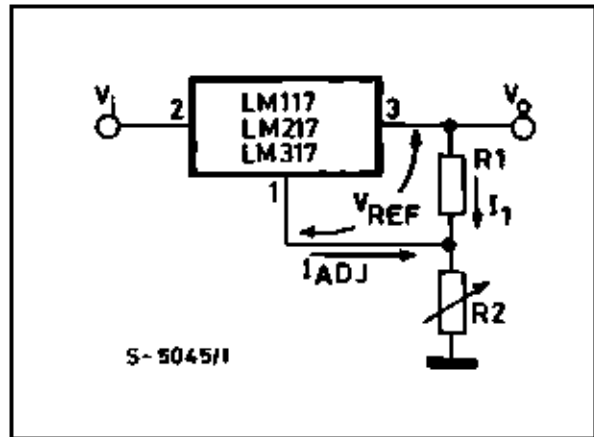


Figure 4 : Basic Adjustable Regulator.



supplies of very high voltage with respect to ground can be regulated as long as the maximum input-to-output differential is not exceeded. Furthermore, programmable regulator are easily obtainable and, by connecting a fixed resistor between the adjustment and output, the device can be used as a precision current regulator.

In order to optimise the load regulation, the current set resistor R1 (see fig. 4) should be tied as close as possible to the regulator, while the ground terminal of R2 should be near the ground of the load to provide remote ground sensing.

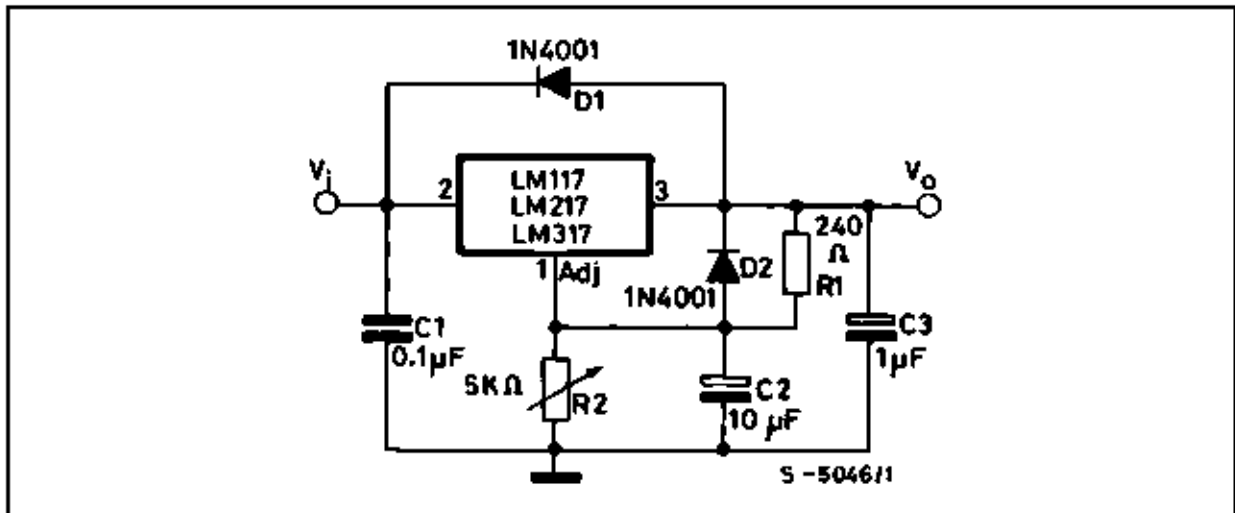
No external capacitors are required, but performance may be improved with added capacitance as follow:

An input bypass capacitor of 0.1 μF

An adjustment terminal to ground 10 mF capacitor to improve the ripple rejection of about 15 dB ( $C_{ADJ}$ ). An 1mF tantalum capacitor on the output to improve transient response. In addition to external capacitors, it is good prac-

tice to add protection diodes, as shown in fig.5. D1 protect the device against input short circuit, while D2 protect against output short circuit for capacitance discharging.

Figure 5 : Voltage Regulator with Protection Diodes.



D1 protect the device against input short circuit, while D2 protects against output short circuit for capacitors discharging

Figure 6 : Slow Turn-on 15V Regulator.

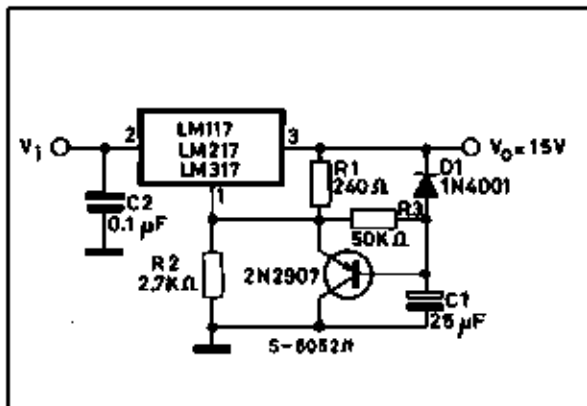
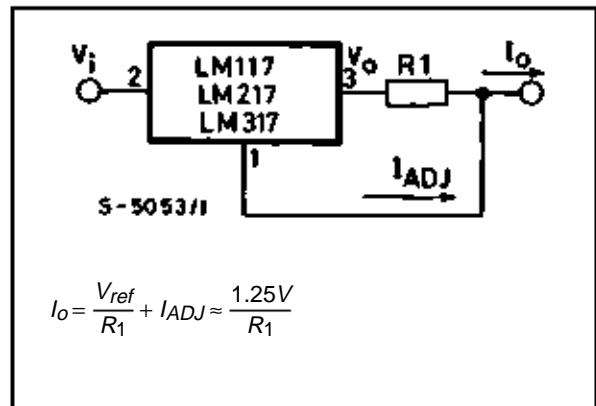


Figure 7 : Current Regulator.



$$I_o = \frac{V_{ref}}{R_1} + I_{ADJ} \approx \frac{1.25V}{R_1}$$

Figure 8 : 5V Electronic Shut-down Regulator.

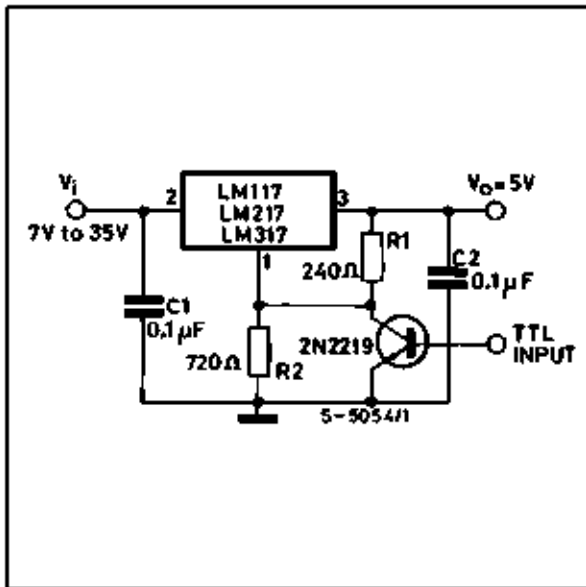


Figure 9 : Digitally Selected Outputs.

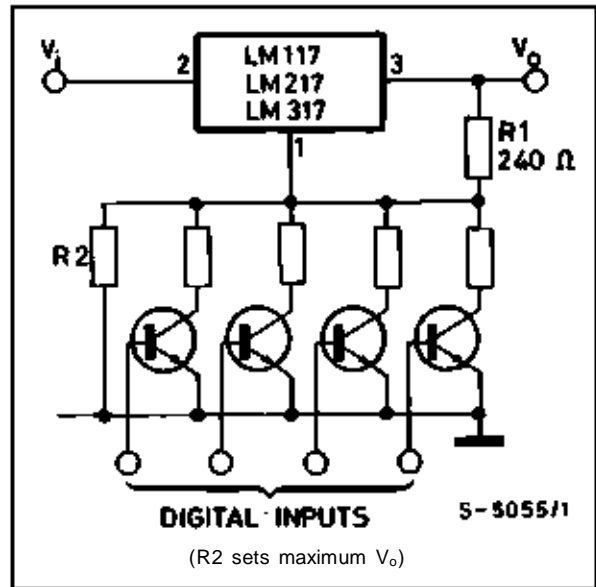


Figure 10 : Battery Charger (12V).

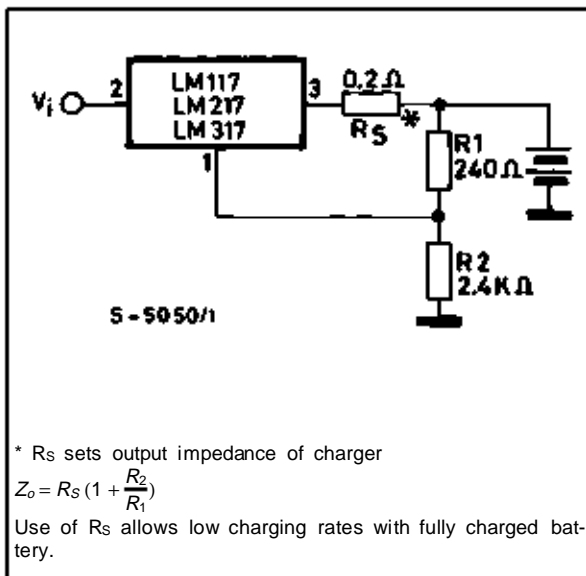
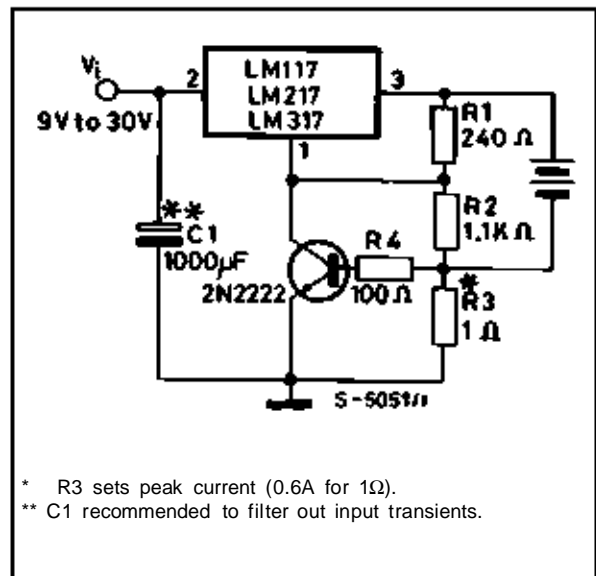
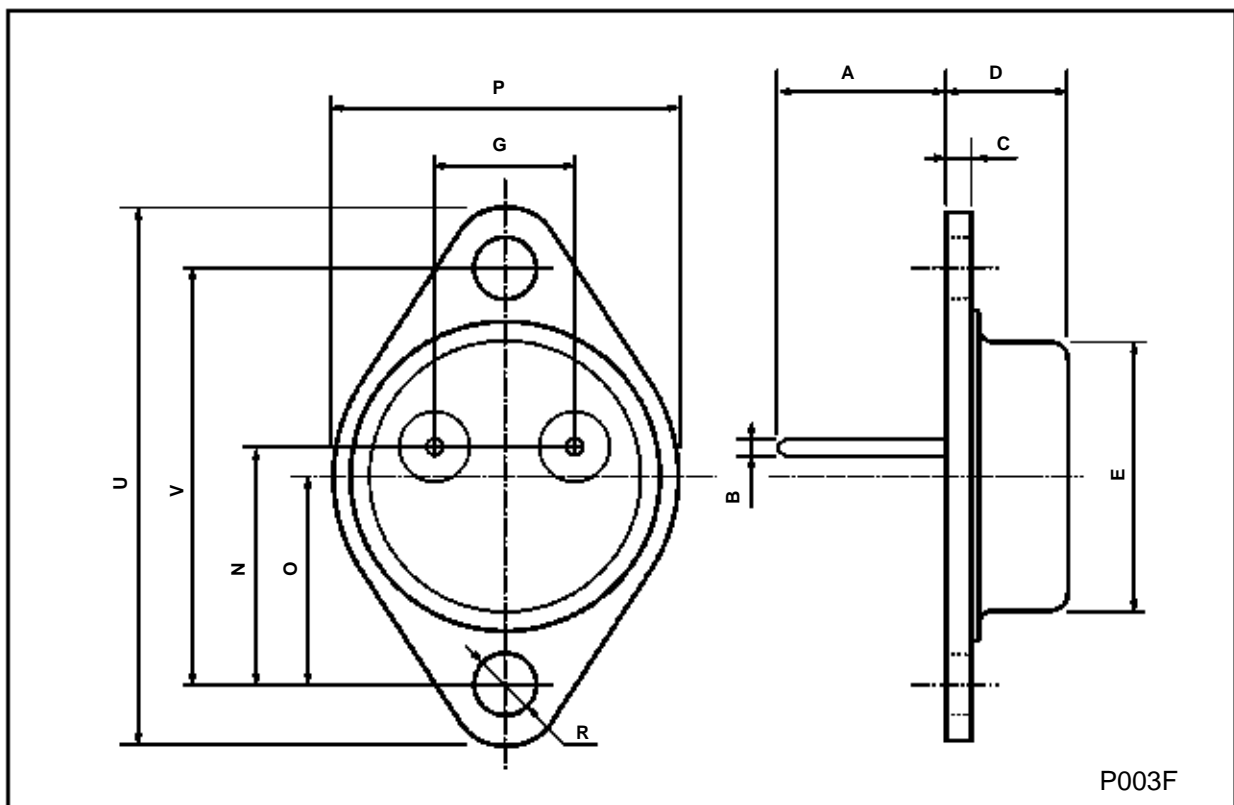


Figure 11 : Current Limited 6V Charger.



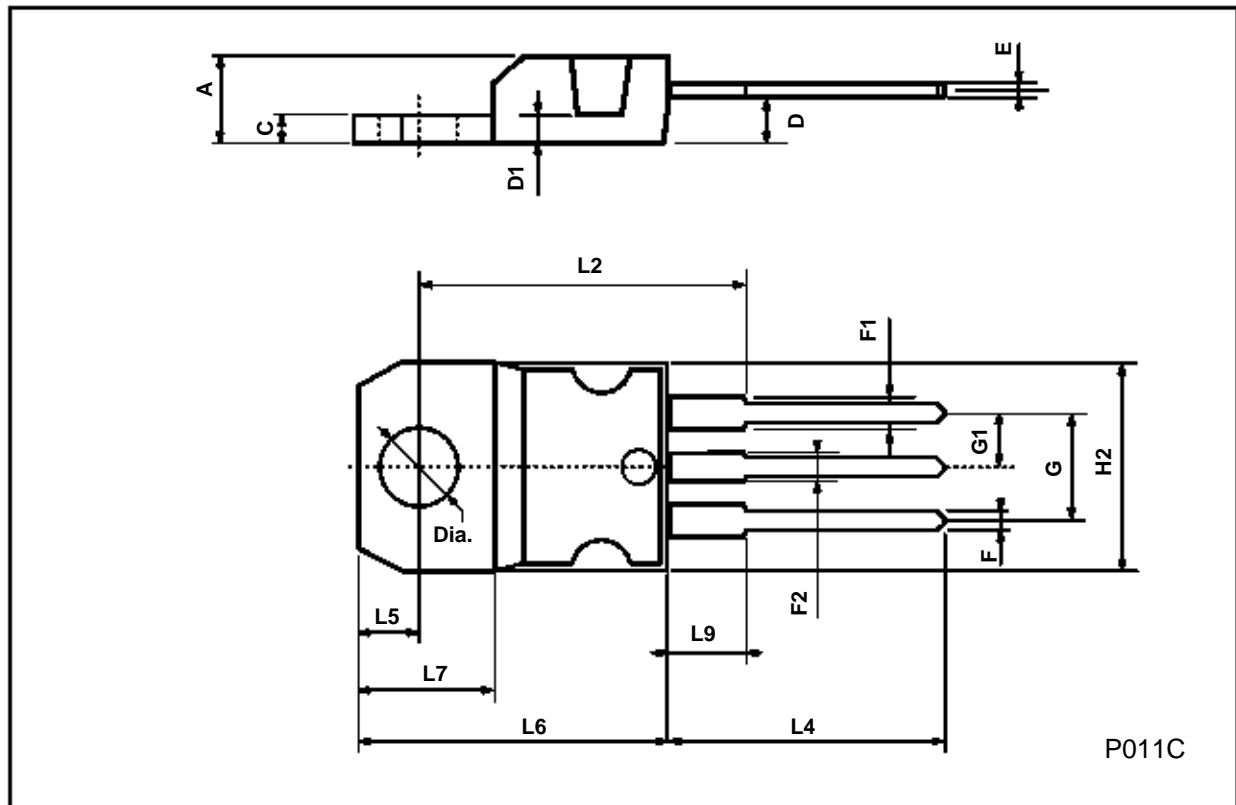
## TO-3 MECHANICAL DATA

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

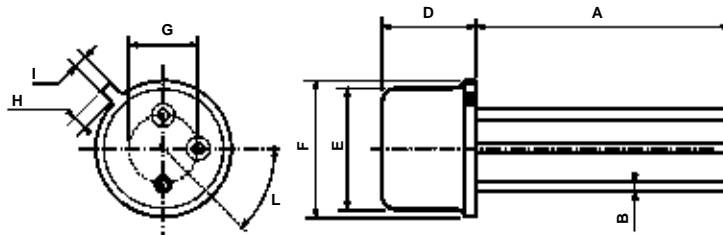
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
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.)					



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