

## 1.2V TO 37V VOLTAGE REGULATOR

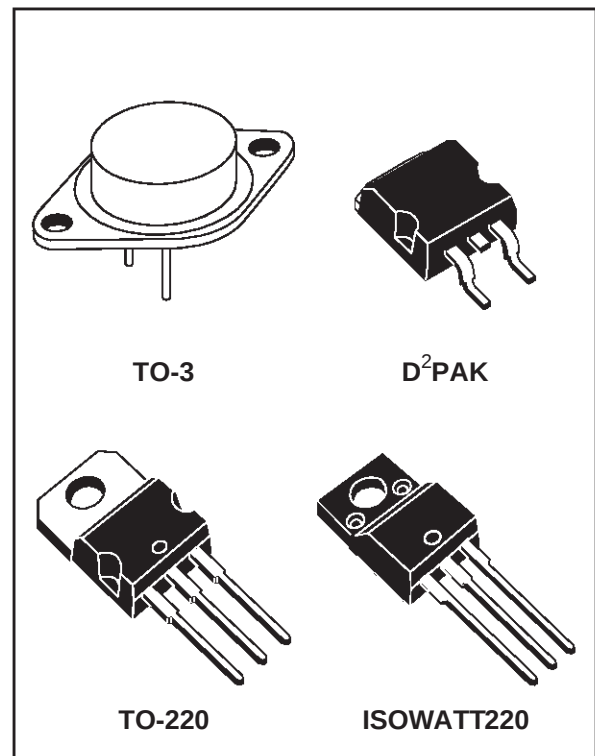
- OUTPUT VOLTAGE RANGE : 1.2 TO 37V
- OUTPUT CURRENT IN EXCESS OF 1.5A
- 0.1% LINE AND LOAD REGULATION
- FLOATING OPERATION FOR HIGH VOLTAGES
- COMPLETE SERIES OF PROTECTIONS :  
CURRENT LIMITING, THERMAL SHUTDOWN AND SOA CONTROL

### DESCRIPTION

The LM117/LM217/LM317 are monolithic integrated circuit in TO-220, ISOWATT220, TO-3 and D<sup>2</sup>PAK 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.



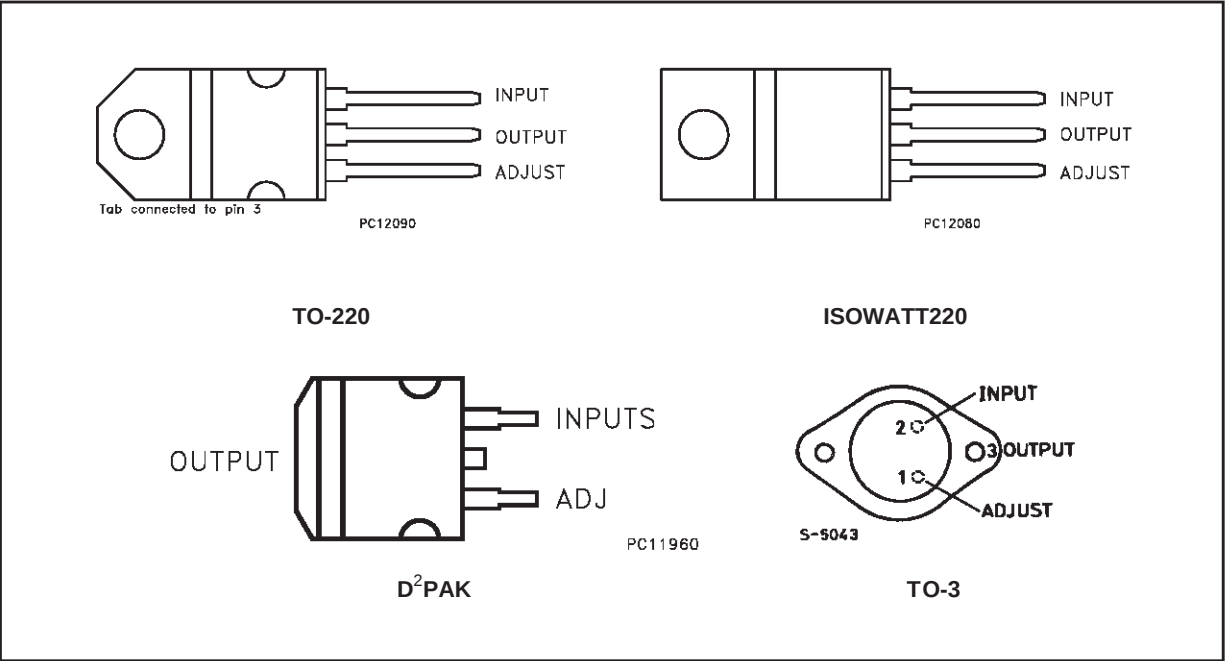
### ABSOLUTE MAXIMUM RATING

| 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<br>LM217<br>LM317 | -55 to 150<br>-25 to 150<br>0 to 125 | <sup>o</sup> C<br><sup>o</sup> C<br><sup>o</sup> C |
| $P_{tot}$ | Power Dissipation                                           | Internally Limited                   |                                                    |
| $T_{stg}$ | Storage Temperature                                         | - 65 to 150                          | <sup>o</sup> C                                     |

### THERMAL DATA

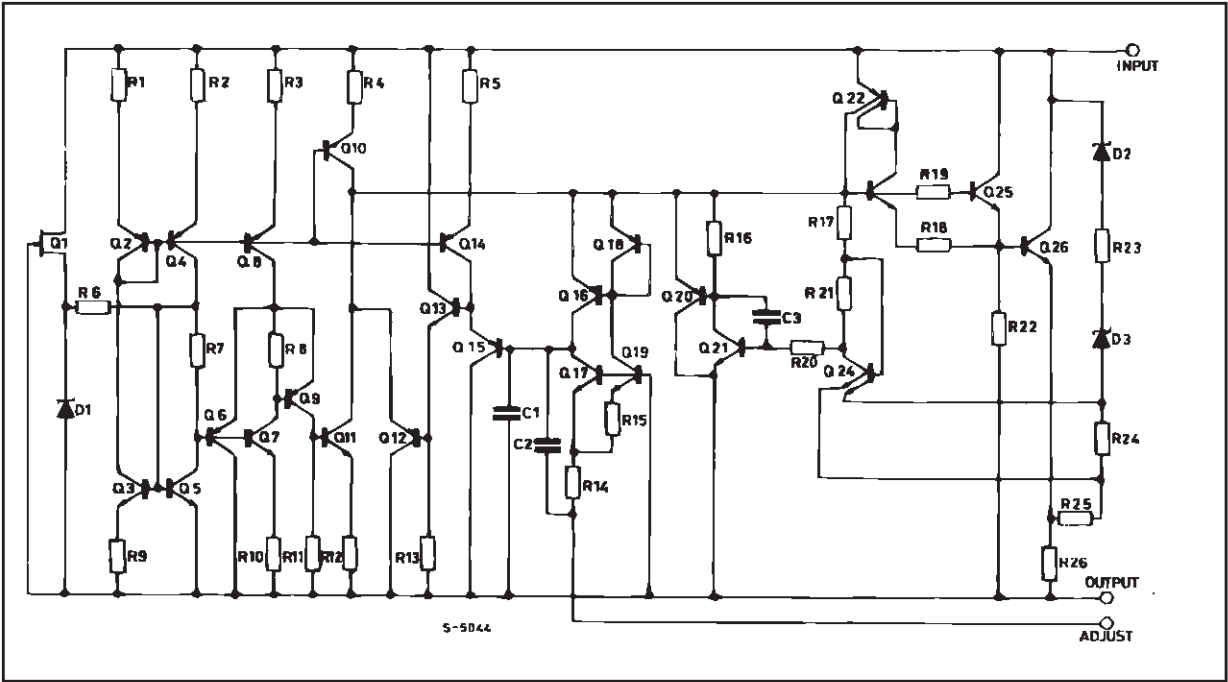
| Symbol         | Parameter                           | TO-3 | TO-220 | ISOWATT220 | D <sup>2</sup> PAK | Unit             |
|----------------|-------------------------------------|------|--------|------------|--------------------|------------------|
| $R_{thj-case}$ | Thermal Resistance Junction-case    | 4    | 3      | 4          | 3                  | <sup>o</sup> C/W |
| $R_{thj-amb}$  | Thermal Resistance Junction-ambient | 35   | 50     | 60         | 62.5               | <sup>o</sup> C/W |

CONNECTION DIAGRAM AND ORDERING NUMBERS (top view)

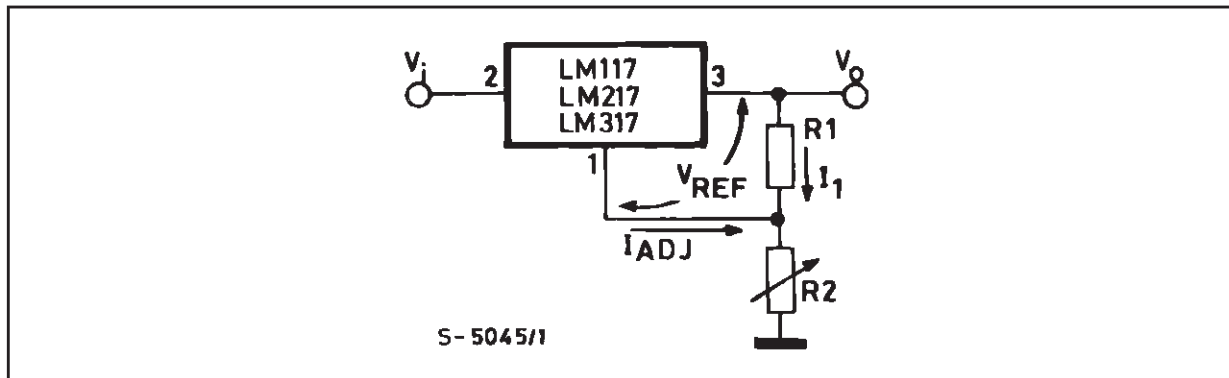


| Type  | TO-3   | TO-220 | ISOWATT220 | D²PAK    |
|-------|--------|--------|------------|----------|
| LM117 | LM117K |        |            |          |
| LM217 | LM217K | LM217T |            | LM217D2T |
| LM317 | LM317K | LM317T | LM317P     | LM317D2T |

SCHEMATIC DIAGRAM



## BASIC ADJUSTABLE REGULATOR



**ELECTRICAL CHARACTERISTICS** ( $V_i - V_o = 5\text{ V}$ ,  $I_o = 500\text{ mA}$ ,  $I_{MAX} = 1.5\text{ A}$  and  $P_{MAX} = 20\text{ W}$ , unless otherwise specified)

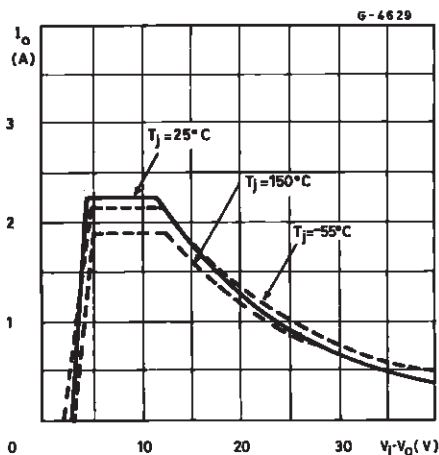
| Symbol                   | Parameter                                      | Test Conditions                                                                                  |                          | LM117/LM217 |       |      | LM317 |       |      | Unit          |
|--------------------------|------------------------------------------------|---------------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

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

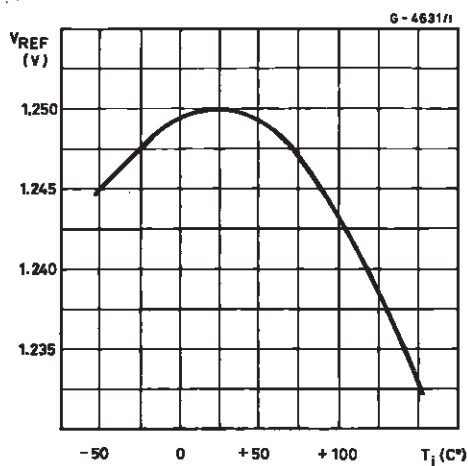
**Note:**

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

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



**Figure 3 :** Reference Voltage vs. Junction



## APPLICATION INFORMATION

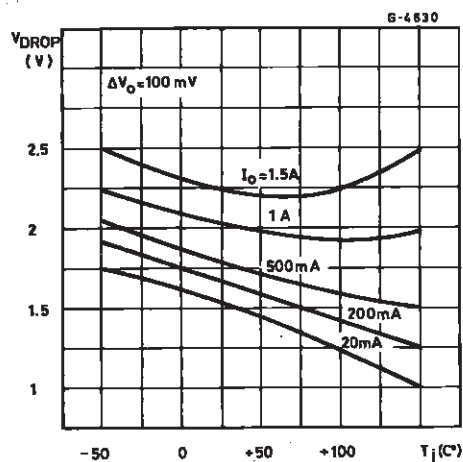
The LM117/217/317 provides an internal reference voltage of 1.25V between the output and adjustments terminals. This is used to set a constant current flow across an external resistor divider (see fig. 4), giving an output voltage  $V_O$  of:

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

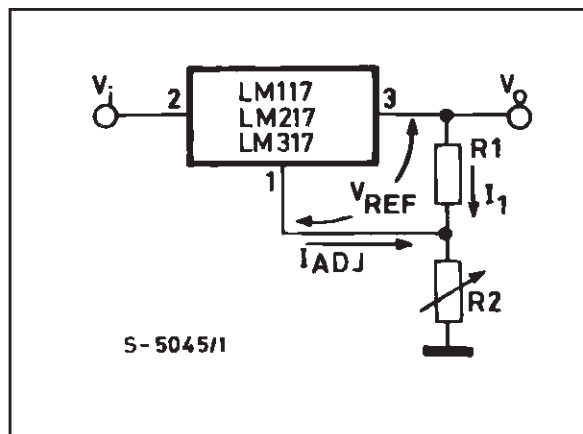
The device was designed to minimize the term  $I_{ADJ}$  (100μA max) and to maintain it very constant with line and load changes. Usually, the error term  $I_{ADJ} \cdot R_2$  can be neglected. To obtain the previous requirement, all the regulator quiescent current is returned to the output terminal,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

**Figure 2 :** Dropout Voltage vs. Junction Temperature.



**Figure 4 :** Basic Adjustable Regulator.



voltage, 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  $R_1$  (see fig. 4) should be tied as close as possible to the regulator, while the ground terminal of  $R_2$  should be near the ground of the load to provide remote ground sensing.

Performance may be improved with added capacitance as follow:

An input bypass capacitor of 0.1μF

An adjustment terminal to ground 10μF capacitor

to improve the ripple rejection of about 15 dB ( $C_{ADJ}$ ).

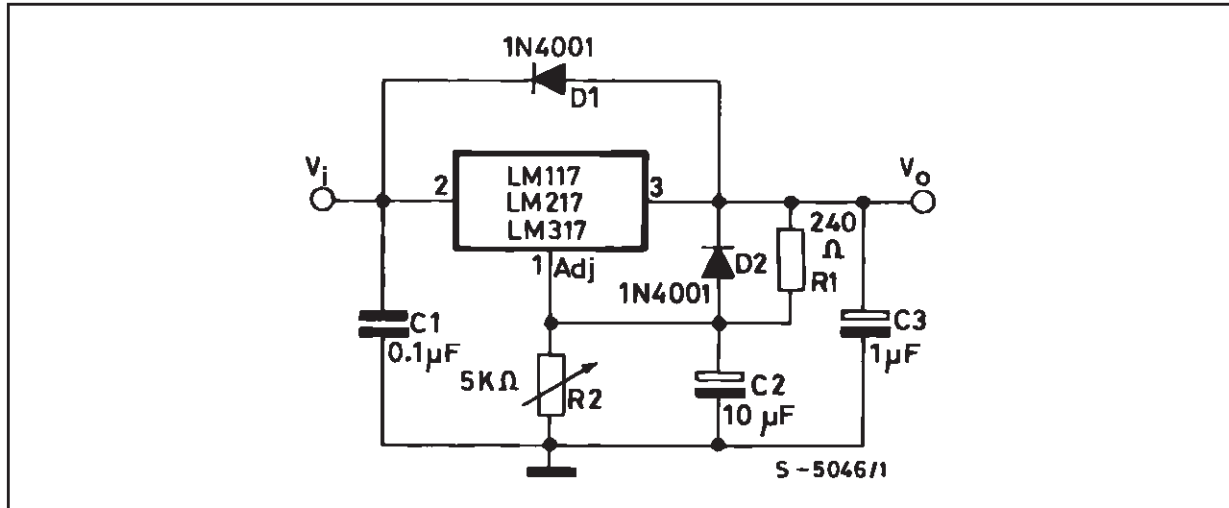
An  $1\mu\text{F}$  tantalum (or  $25\mu\text{F}$  Aluminium electrolytic) capacitor on the output to improve transient response.

In addition to external capacitors, it is good

practice to add protection diodes, as shown in fig.5.

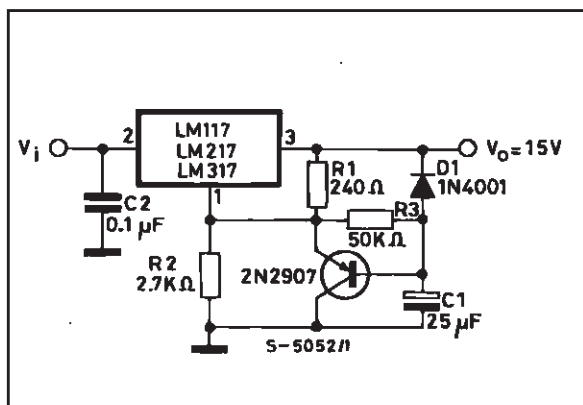
D1 protect the device against input short circuit, while D2 protect against output short circuit for capacitance discharging.

**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.

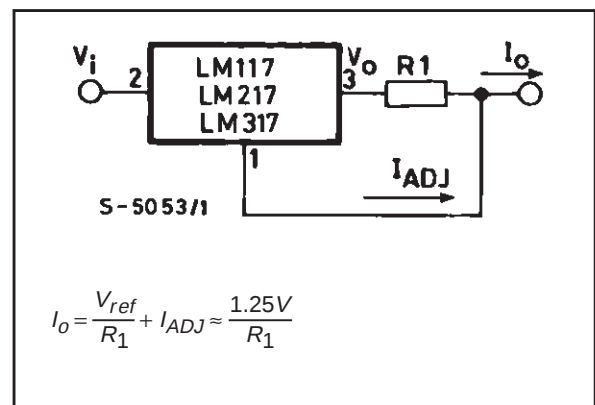


Figure 8 : 5V Electronic Shut-down Regulator

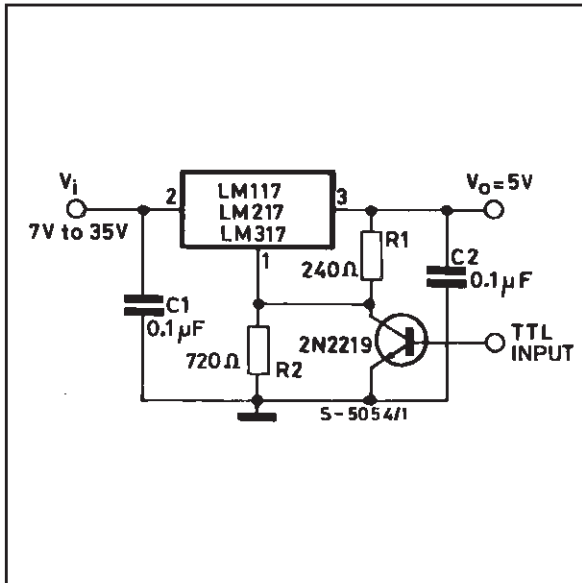


Figure 9 : Digitally Selected Outputs

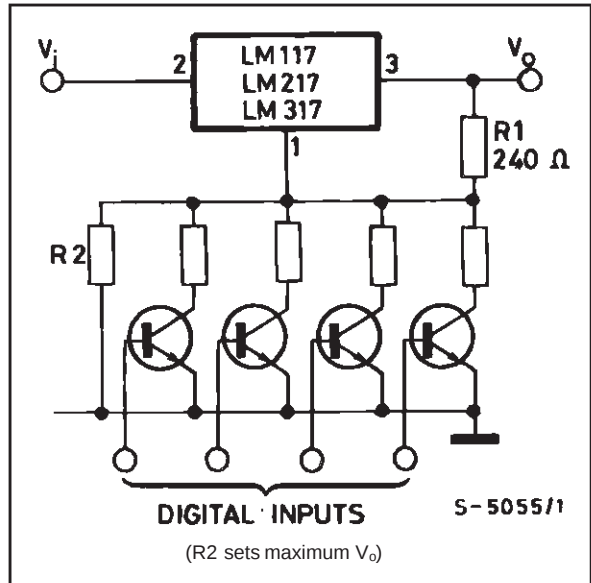


Figure 10 : Battery Charger (12V)

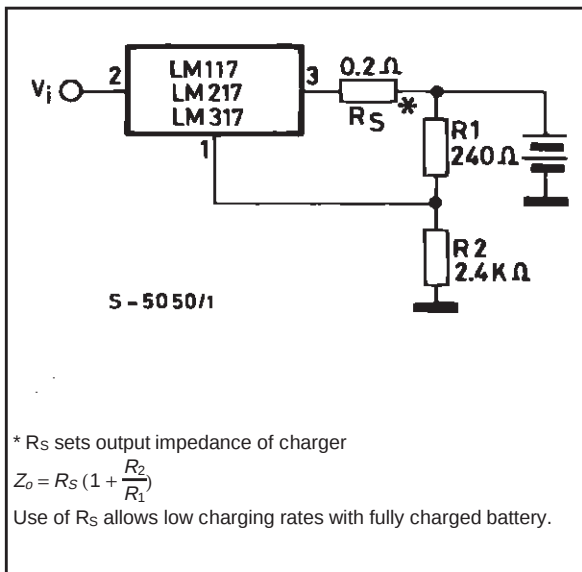
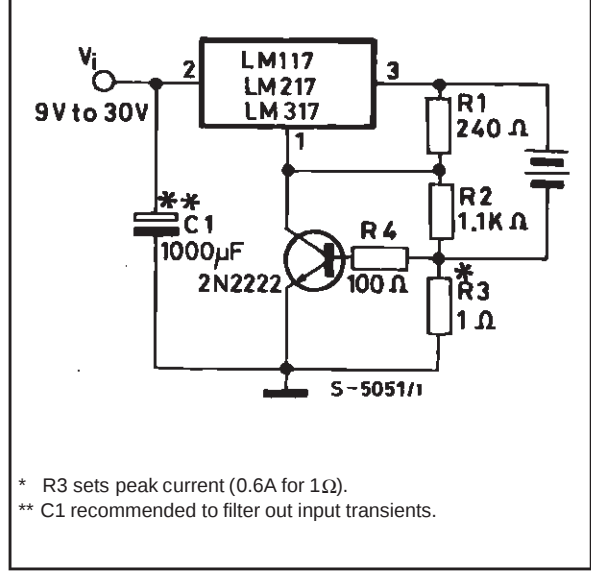
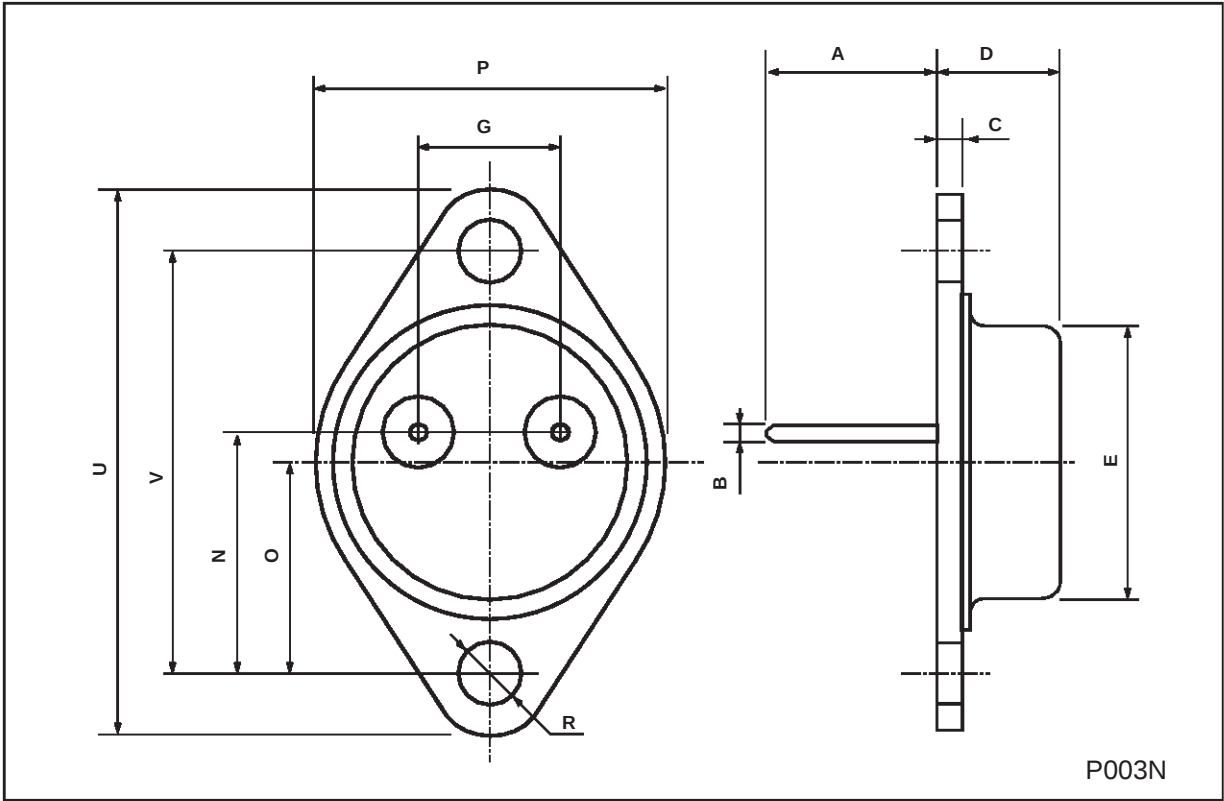


Figure 11 : Current Limited 6V Charger



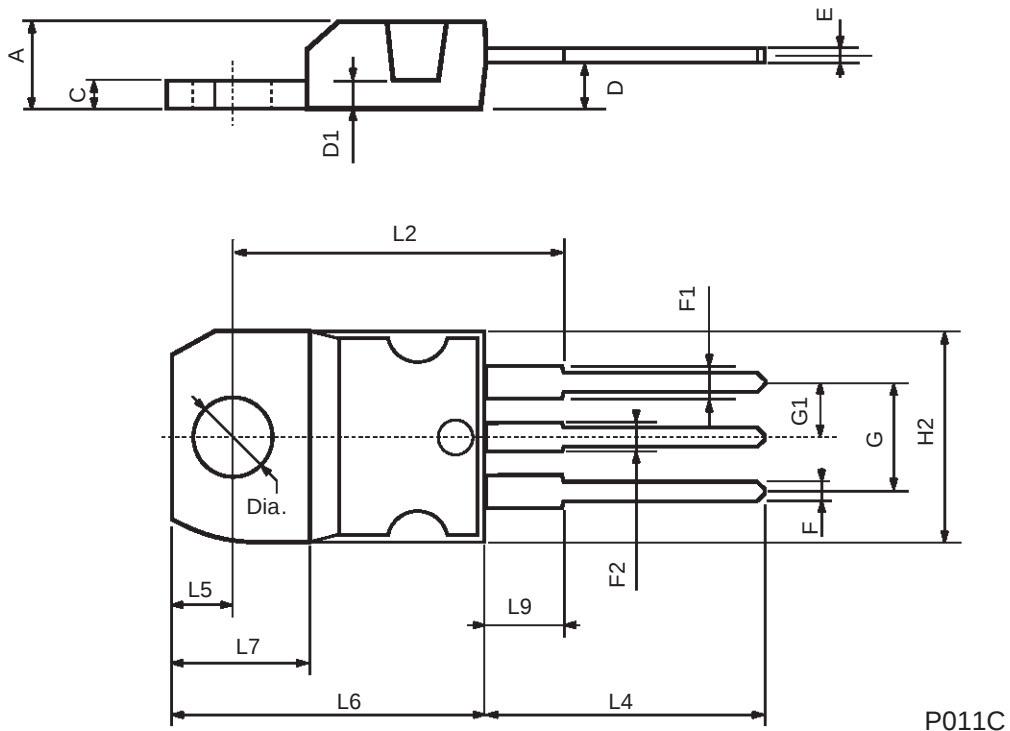
TO-3 (R) MECHANICAL DATA

| DIM. | mm   |       |       | inch  |       |       |
|------|------|-------|-------|-------|-------|-------|
|      | MIN. | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |      | 11.7  |       |       | 0.460 |       |
| B    | 0.96 |       | 1.10  | 0.037 |       | 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    |      |       | 39.50 |       |       | 1.555 |
| V    |      | 30.10 |       |       | 1.185 |       |



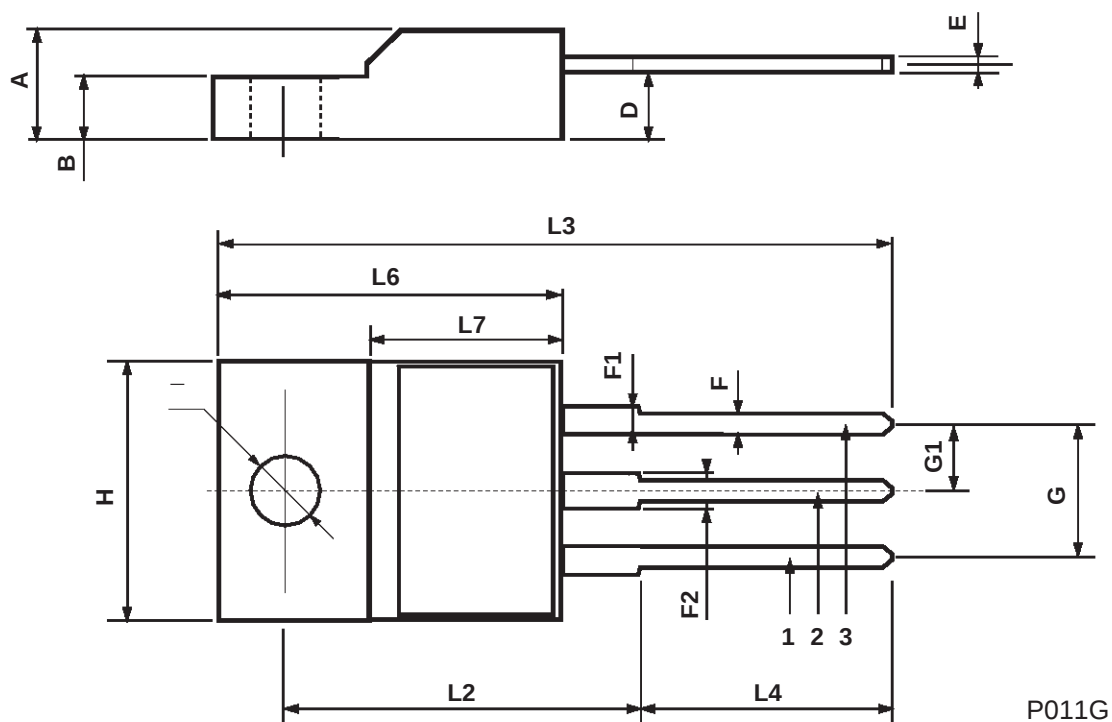
TO-220 MECHANICAL DATA

| 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 |



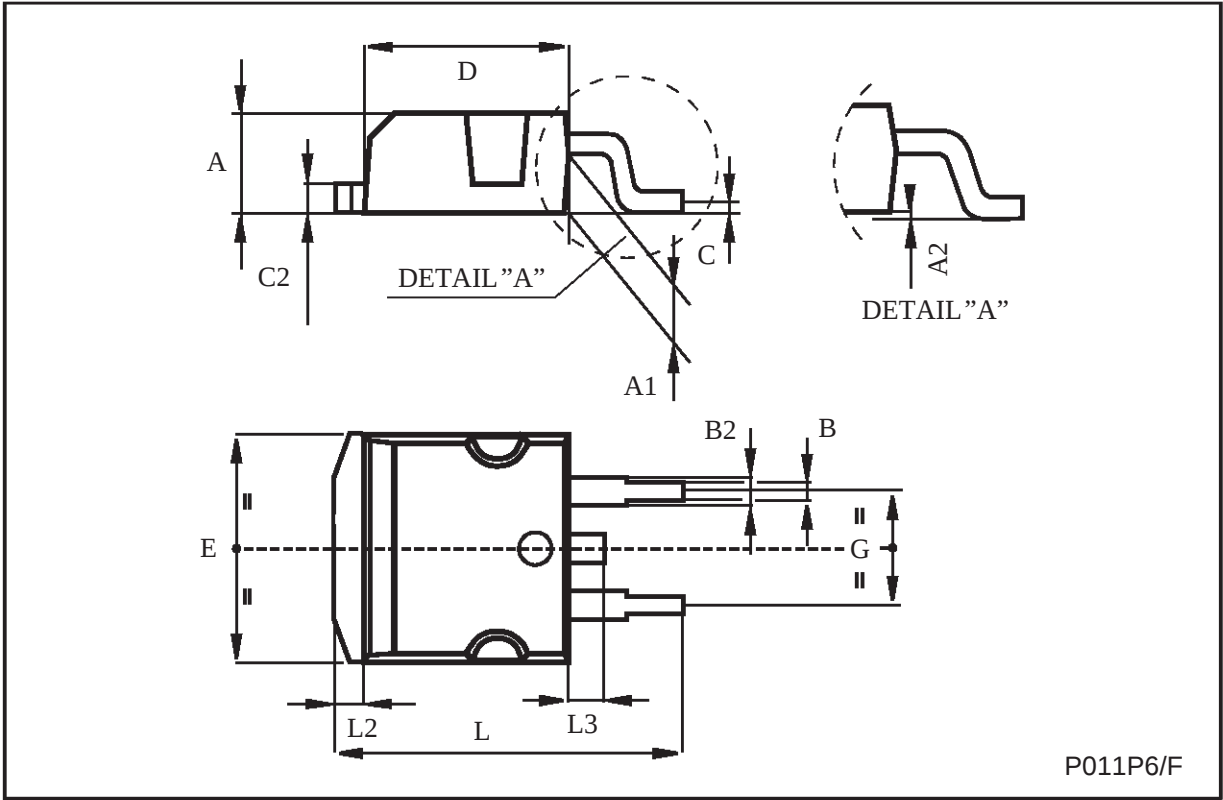
## ISOWATT220 MECHANICAL DATA

| DIM. | mm   |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 0.108 |
| E    | 0.4  |      | 0.7  | 0.015 |       | 0.027 |
| F    | 0.75 |      | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |      | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |      | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |      | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16   |      |       | 0.630 |       |
| L3   | 28.6 |      | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |      | 10.6 | 0.385 |       | 0.417 |
| L6   | 15.9 |      | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |      | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |      | 3.2  | 0.118 |       | 0.126 |



TO-263 (D<sup>2</sup>PAK) MECHANICAL DATA

| DIM. | mm   |      |       | inch  |      |       |
|------|------|------|-------|-------|------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP. | MAX.  |
| A    | 4.4  |      | 4.6   | 0.173 |      | 0.181 |
| A1   | 2.49 |      | 2.69  | 0.098 |      | 0.106 |
| B    | 0.7  |      | 0.93  | 0.027 |      | 0.036 |
| B2   | 1.14 |      | 1.7   | 0.044 |      | 0.067 |
| C    | 0.45 |      | 0.6   | 0.017 |      | 0.023 |
| C2   | 1.23 |      | 1.36  | 0.048 |      | 0.053 |
| D    | 8.95 |      | 9.35  | 0.352 |      | 0.368 |
| E    | 10   |      | 10.4  | 0.393 |      | 0.409 |
| G    | 4.88 |      | 5.28  | 0.192 |      | 0.208 |
| L    | 15   |      | 15.85 | 0.590 |      | 0.624 |
| L2   | 1.27 |      | 1.4   | 0.050 |      | 0.055 |
| L3   | 1.4  |      | 1.75  | 0.055 |      | 0.068 |



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