

## 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, TO-220FP, 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.

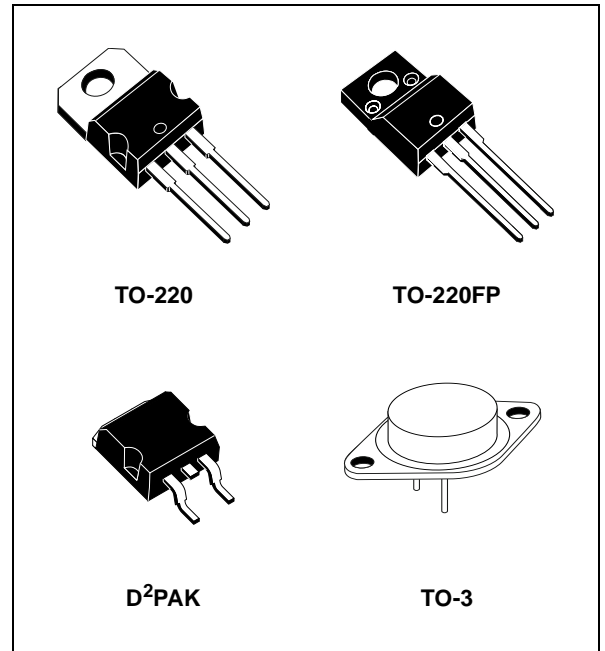
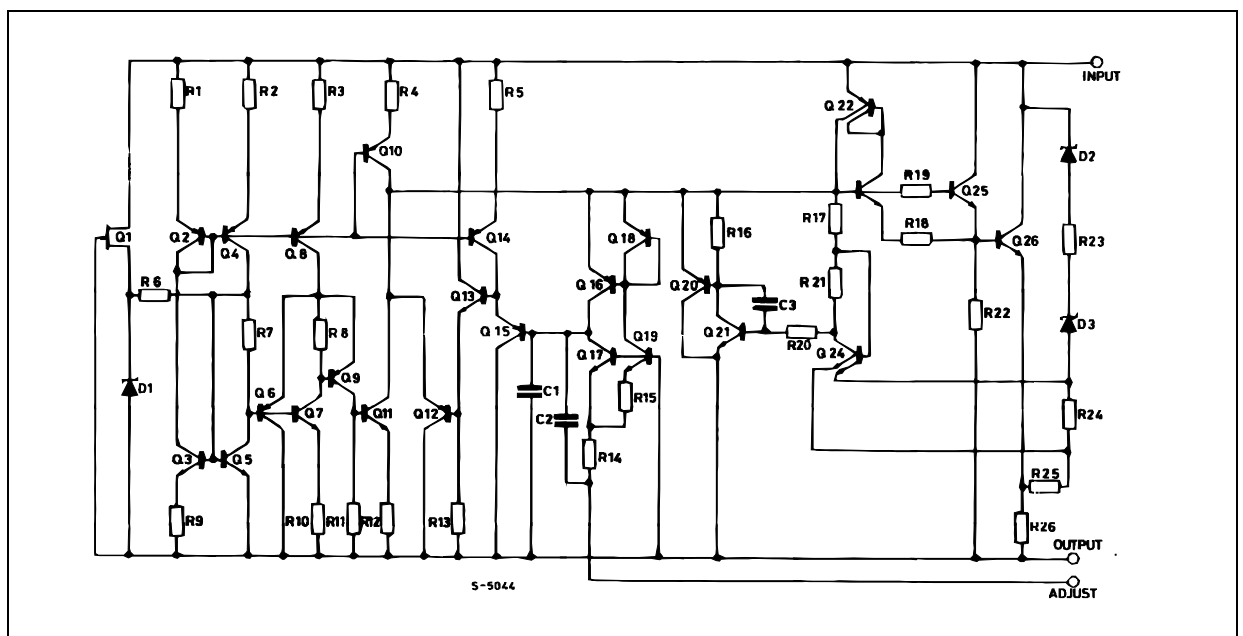


Figure 1: Schematic Diagram



**Table 1: Absolute Maximum Ratings**

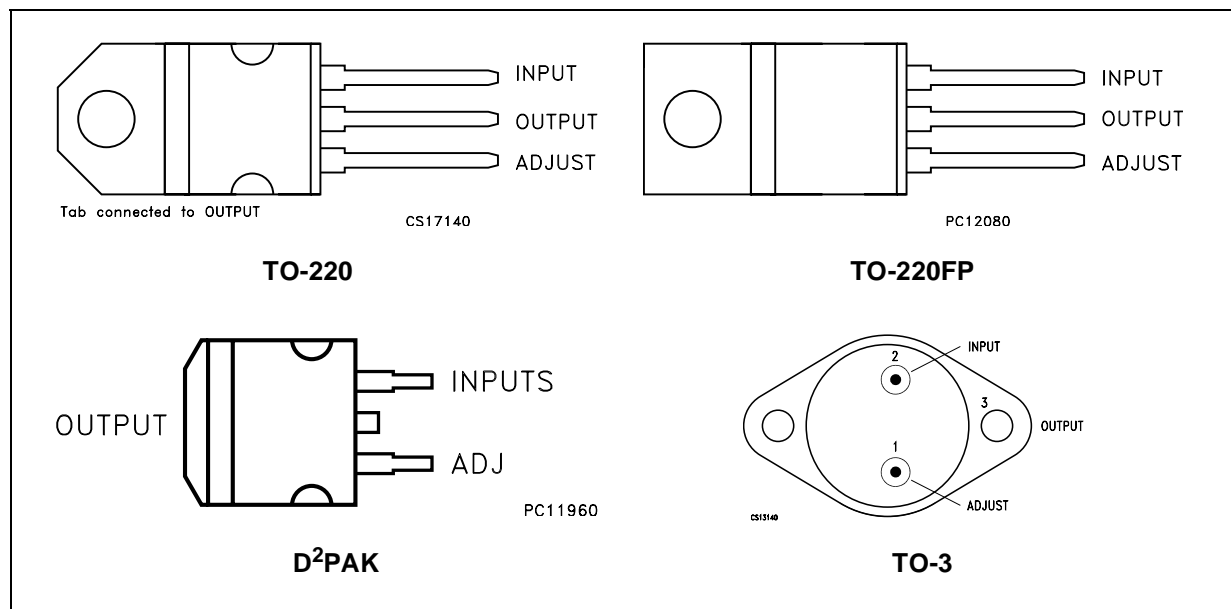
Symbol	Parameter	Value	Unit
$V_I - V_O$	Input-Reference Differential Voltage	40	V
$I_O$	Output Current	Internally Limited	
$T_{op}$	Operating Junction Temperature for:	LM117	-55 to 150
		LM217	-25 to 150
		LM317	0 to 125
$P_{tot}$	Power Dissipation	Internally Limited	
$T_{stg}$	Storage Temperature	-65 to 150	°C

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	D <sup>2</sup> PAK	TO-220	TO-220FP	TO-3	Unit
$R_{thj-case}$	Thermal Resistance Junction-case Max	3	3	5	4	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient Max	62.5	50	60	35	°C/W

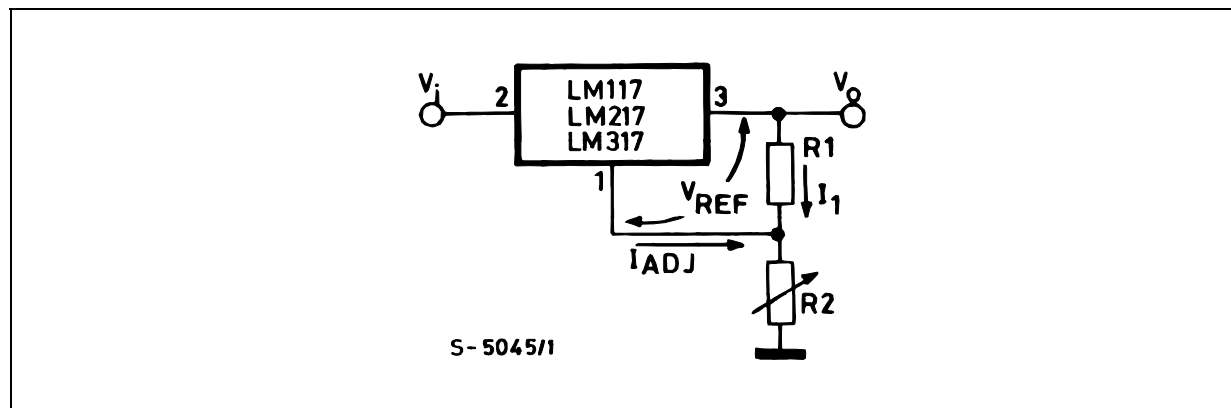
**Figure 2: Connection Diagram (top view)**



**Table 3: Order Codes**

TYPE	TO-220	D <sup>2</sup> PAK	TO-220FP	TO-3
LM117				LM117K
LM217	LM217T	LM217D2T		LM217K
LM317	LM317T	LM317D2T	LM317P	LM317K

Figure 3: Basic Adjustable Regulator



**Table 4: Electrical Characteristics For LM117/LM217** ( $V_I - V_O = 5\text{ V}$ ,  $I_O = 500\text{ mA}$ ,  $I_{MAX} = 1.5\text{ A}$  and  $P_{MAX} = 20\text{ W}$ ,  $T_J = -55\text{ to }150^\circ\text{C}$  for LM117,  $T_J = -25\text{ to }150^\circ\text{C}$  for LM217, unless otherwise specified).

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$\Delta V_O$	Line Regulation	$V_I - V_O = 3\text{ to }40\text{ V}$	$T_J = 25^\circ\text{C}$	0.01	0.02	%V
				0.02	0.05	
$\Delta V_O$	Load Regulation	$V_O \leq 5\text{ V}$ $I_O = 10\text{ mA to }I_{MAX}$	$T_J = 25^\circ\text{C}$	5	15	mV
				20	50	
		$V_O \geq 5\text{ V}$ $I_O = 10\text{ mA to }I_{MAX}$	$T_J = 25^\circ\text{C}$	0.1	0.3	%
				0.3	1	
$I_{ADJ}$	Adjustment Pin Current			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	$\mu\text{A}$
$V_{REF}$	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	V
$\Delta V_O/V_O$	Output Voltage Temperature Stability			1		%
$I_{O(min)}$	Minimum Load Current	$V_I - V_O = 40\text{ V}$		3.5	5	mA
$I_{O(max)}$	Maximum Load Current	$V_I - V_O \leq 15\text{ V}$ $P_D < P_{MAX}$	1.5	2.2		A
		$V_I - V_O = 40\text{ V}$ $P_D < P_{MAX}$		0.4		
		$T_J = 25^\circ\text{C}$				
eN	Output Noise Voltage (percentage of $V_O$ )	$B = 10\text{ Hz to }100\text{ KHz}$ $T_J = 25^\circ\text{C}$		0.003		%
SVR	Supply Voltage Rejection (*)	$T_J = 25^\circ\text{C}$ $f = 120\text{ Hz}$	$C_{ADJ} = 0$	65		dB
			$C_{ADJ} = 10\mu\text{F}$	66	80	

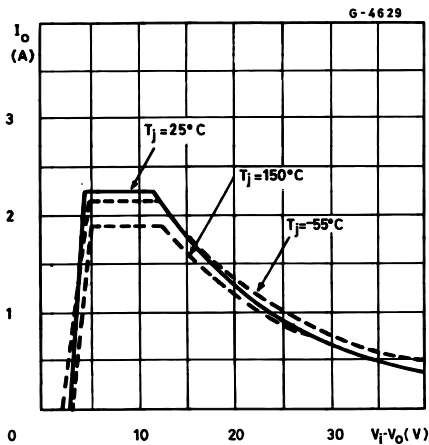
(\*)  $C_{ADJ}$  is connected between pin 1 and ground.

**Table 5: Electrical Characteristics For LM317** ( $V_I - V_O = 5\text{ V}$ ,  $I_O = 500\text{ mA}$ ,  $I_{MAX} = 1.5\text{ A}$  and  $P_{MAX} = 20\text{ W}$ ,  $T_J = 0\text{ to }125^\circ\text{C}$ , unless otherwise specified).

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$\Delta V_O$	Line Regulation	$V_I - V_O = 3\text{ to }40\text{ V}$	$T_J = 25^\circ\text{C}$	0.01	0.04	%V
				0.02	0.07	
$\Delta V_O$	Load Regulation	$V_O \leq 5\text{ V}$ $I_O = 10\text{ mA to }I_{MAX}$	$T_J = 25^\circ\text{C}$	5	25	mV
				20	70	
		$V_O \geq 5\text{ V}$ $I_O = 10\text{ mA to }I_{MAX}$	$T_J = 25^\circ\text{C}$	0.1	0.5	%
				0.3	1.5	
$I_{ADJ}$	Adjustment Pin Current			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	$\mu\text{A}$
$V_{REF}$	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	V
$\Delta V_O/V_O$	Output Voltage Temperature Stability			1		%
$I_{O(min)}$	Minimum Load Current	$V_I - V_O = 40\text{ V}$		3.5	10	mA
$I_{O(max)}$	Maximum Load Current	$V_I - V_O \leq 15\text{ V}$ $P_D < P_{MAX}$	1.5	2.2		A
		$V_I - V_O = 40\text{ V}$ $P_D < P_{MAX}$ $T_J = 25^\circ\text{C}$		0.4		
eN	Output Noise Voltage (percentage of $V_O$ )	$B = 10\text{ Hz to }100\text{ KHz}$ $T_J = 25^\circ\text{C}$		0.003		%
SVR	Supply Voltage Rejection (*)	$T_J = 25^\circ\text{C}$ $f = 120\text{ Hz}$	$C_{ADJ} = 0$	65		dB
			$C_{ADJ} = 10\mu\text{F}$	66	80	

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

**Figure 4: Output Current vs Input-output Differential Voltage**



**Figure 5: Dropout Voltage vs Junction Temperature**

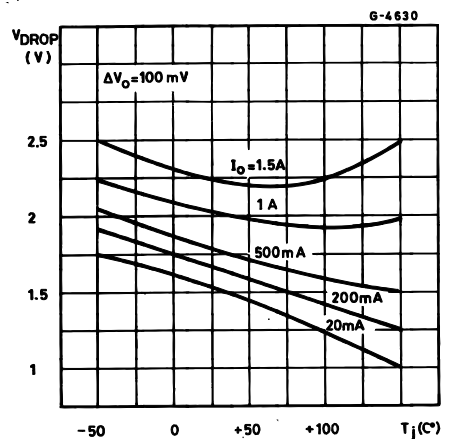


Figure 6: Reference Voltage vs Junction

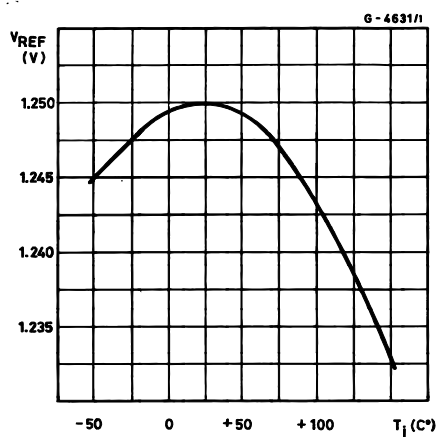
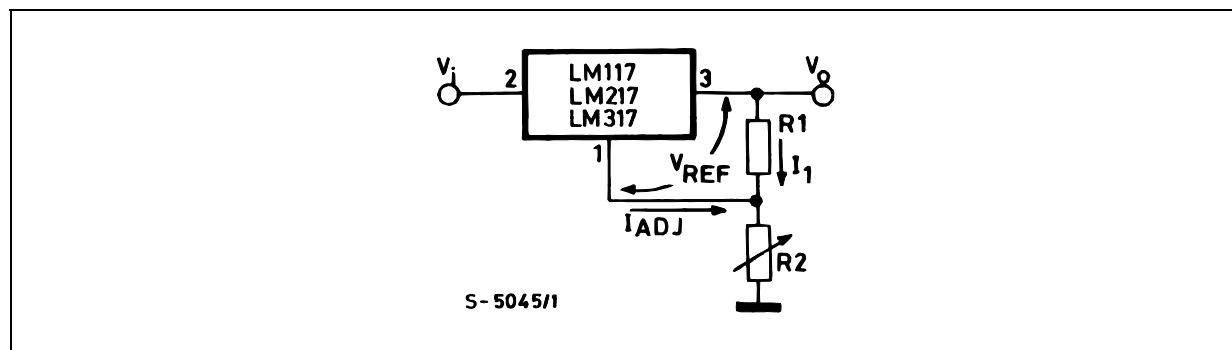


Figure 7: Basic Adjustable Regulator



## 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:

$$V_O = V_{REF} (1 + R_2/R_1) + I_{ADJ} R_2$$

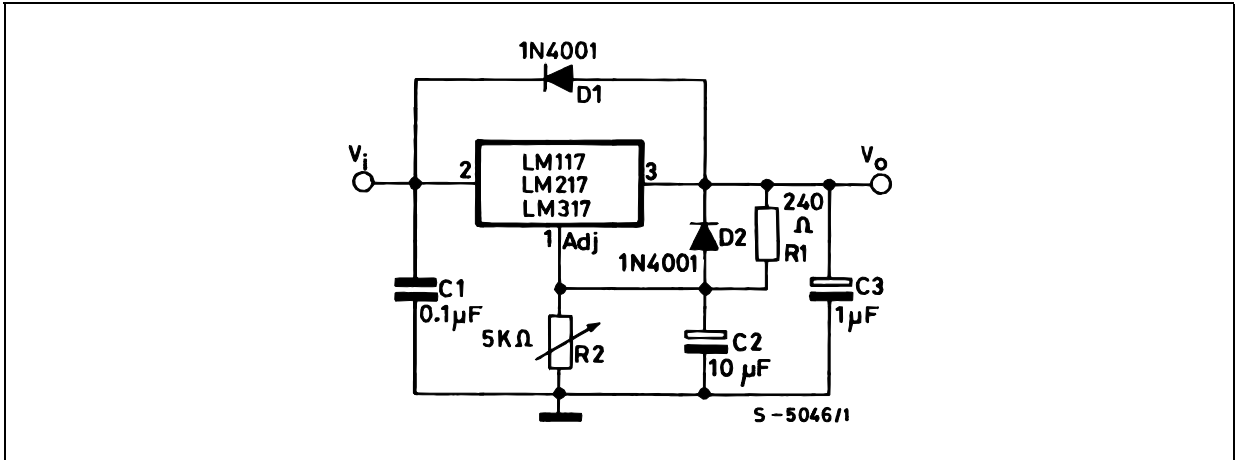
The device was designed to minimize the term  $I_{ADJ}$  (100 $\mu$ A max) and to maintain it very constant with line and load changes. Usually, the error term  $I_{ADJ} \times R_2$  can be neglected. To obtain the previous requirement, all the regulator quiescent current is returned to the output terminal, imposing a minimum load current condition. If the load is insufficient, the output voltage will rise. Since the LM117/217317 is a floating regulator and "sees" only the input-to-output differential 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 optimize 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 0.1 $\mu$ F

An adjustment terminal to ground 10 $\mu$ F capacitor to improve the ripple rejection of about 15 dB ( $C_{ADJ}$ ).

An 1 $\mu$ F tantalum (or 25 $\mu$ 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 8: Voltage Regulator with Protection Diodes



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

Figure 9: Slow Turn-on 15V Regulator

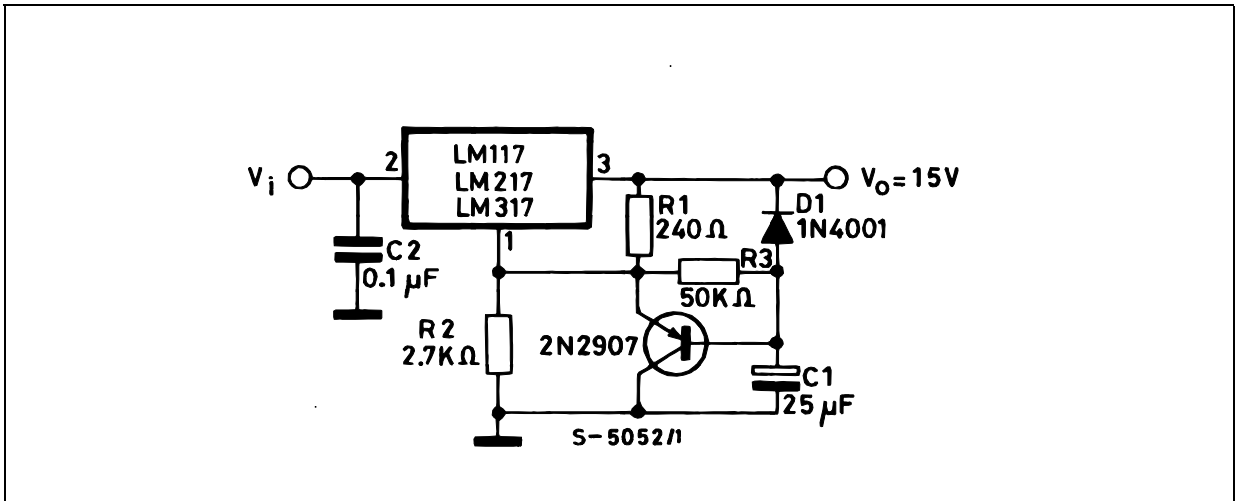


Figure 10: Current Regulator

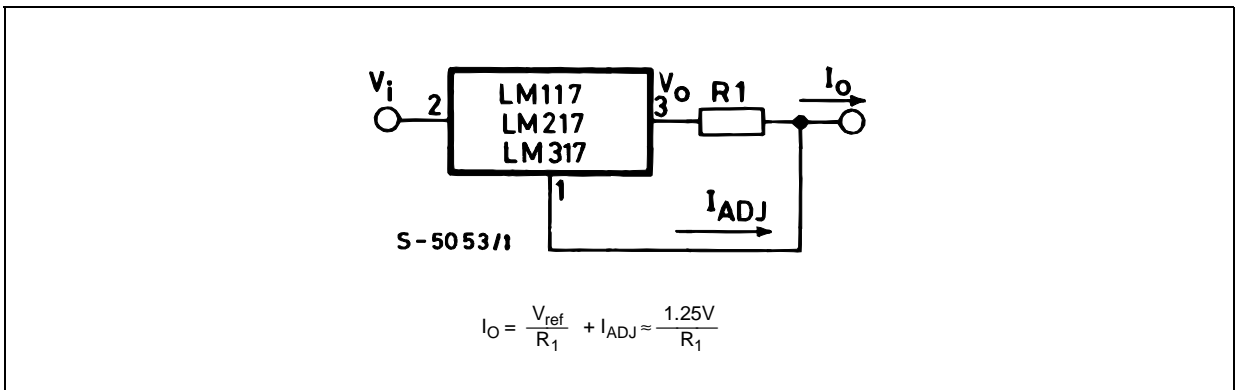


Figure 11: 5V Electronic Shut-down Regulator

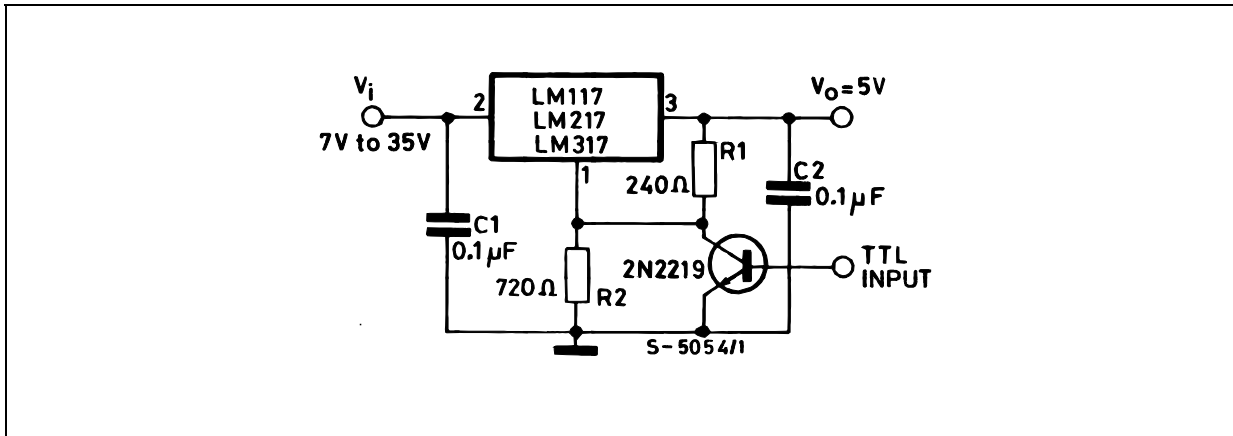
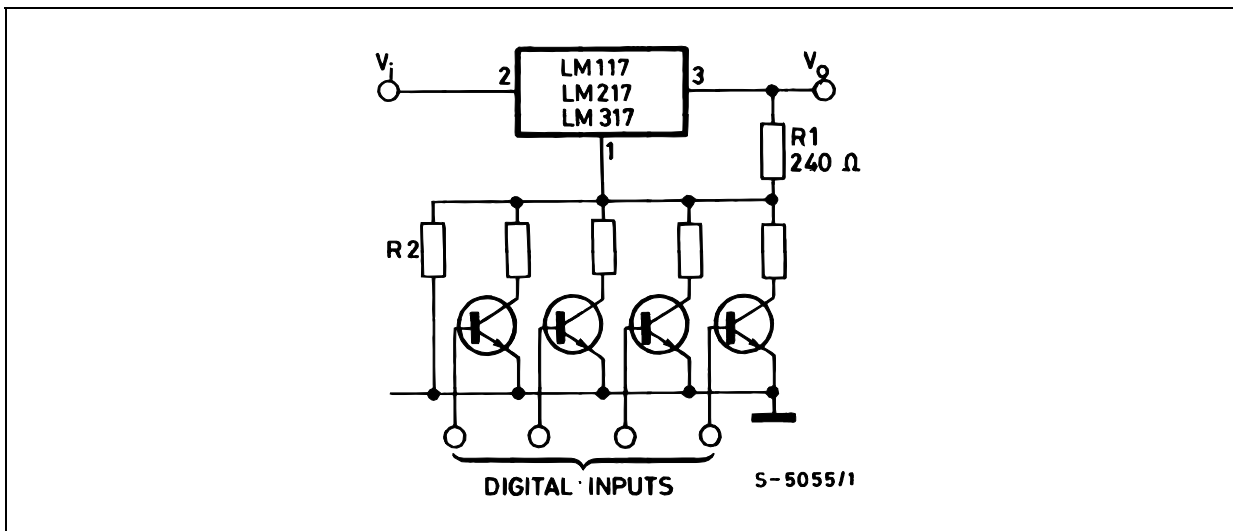
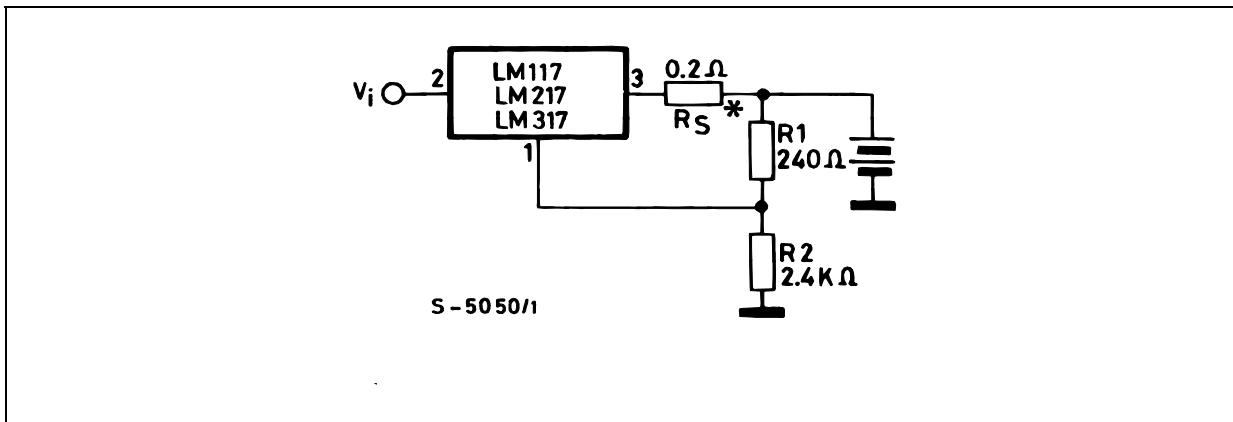


Figure 12: Digitally Selected Outputs



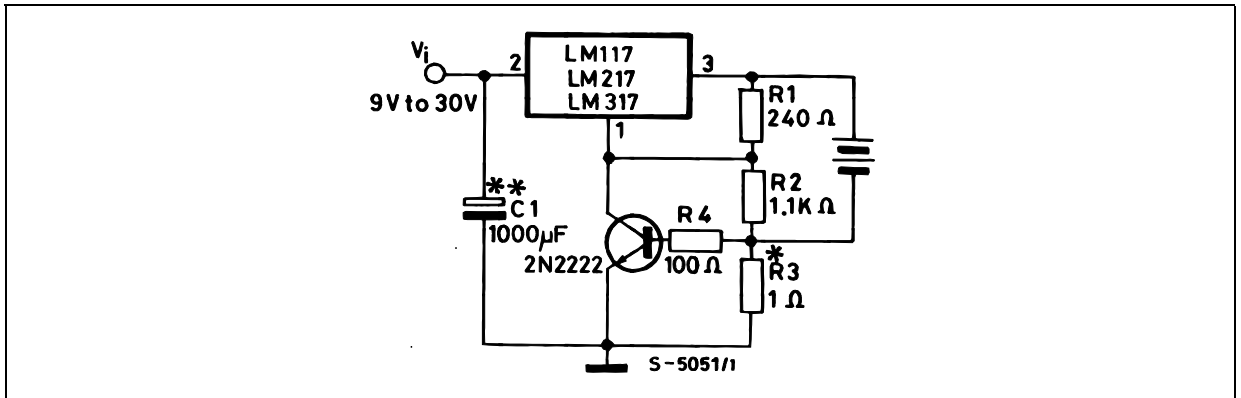
(R<sub>2</sub> sets maximum V<sub>O</sub>)

Figure 13: Battery Charger (12V)



\* R<sub>S</sub> sets output impedance of charger  $Z_0 = R_S (1 + R_2/R_1)$ . Use of R<sub>S</sub> allows low charging rates whit fully charged battery.

Figure 14: Current Limited 6V Charger



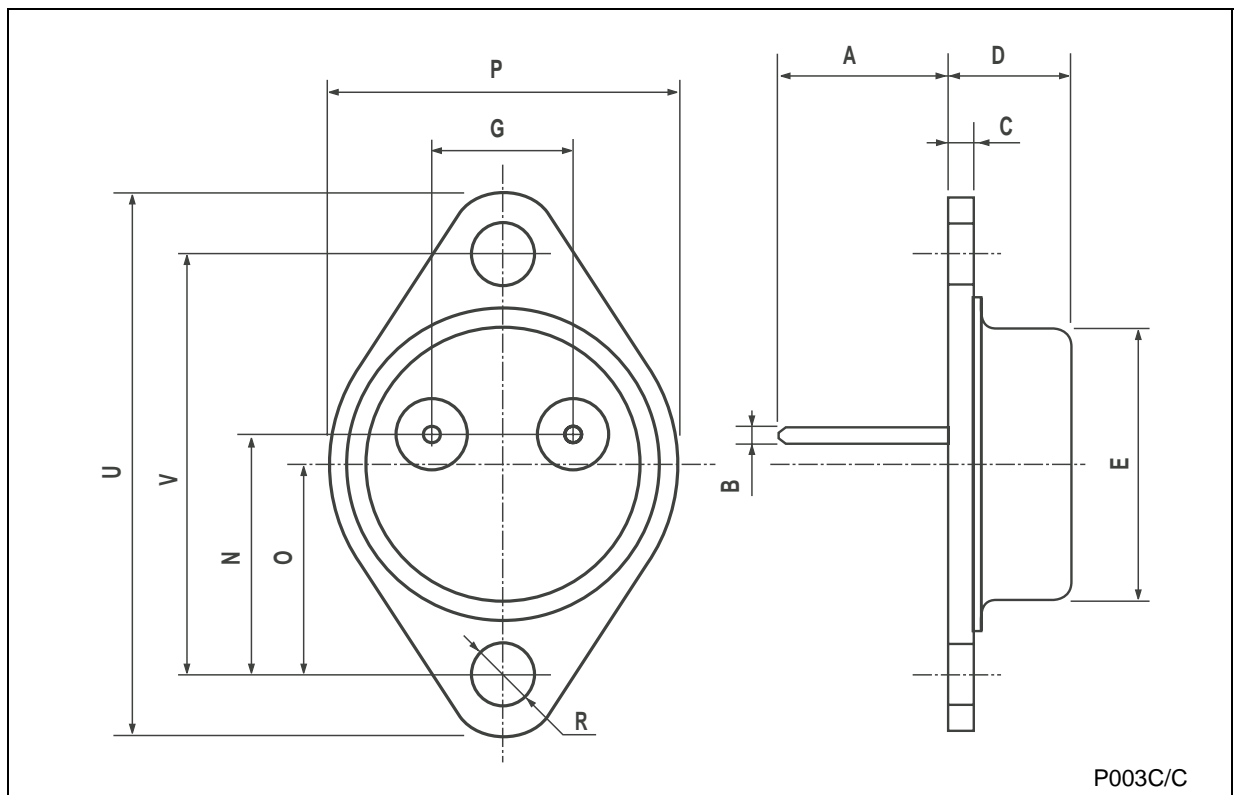
\*  $R_3$  sets peak current (0.6A for 1  $\Omega$ ).

\*\*  $C_1$  recommended to filter out input transients



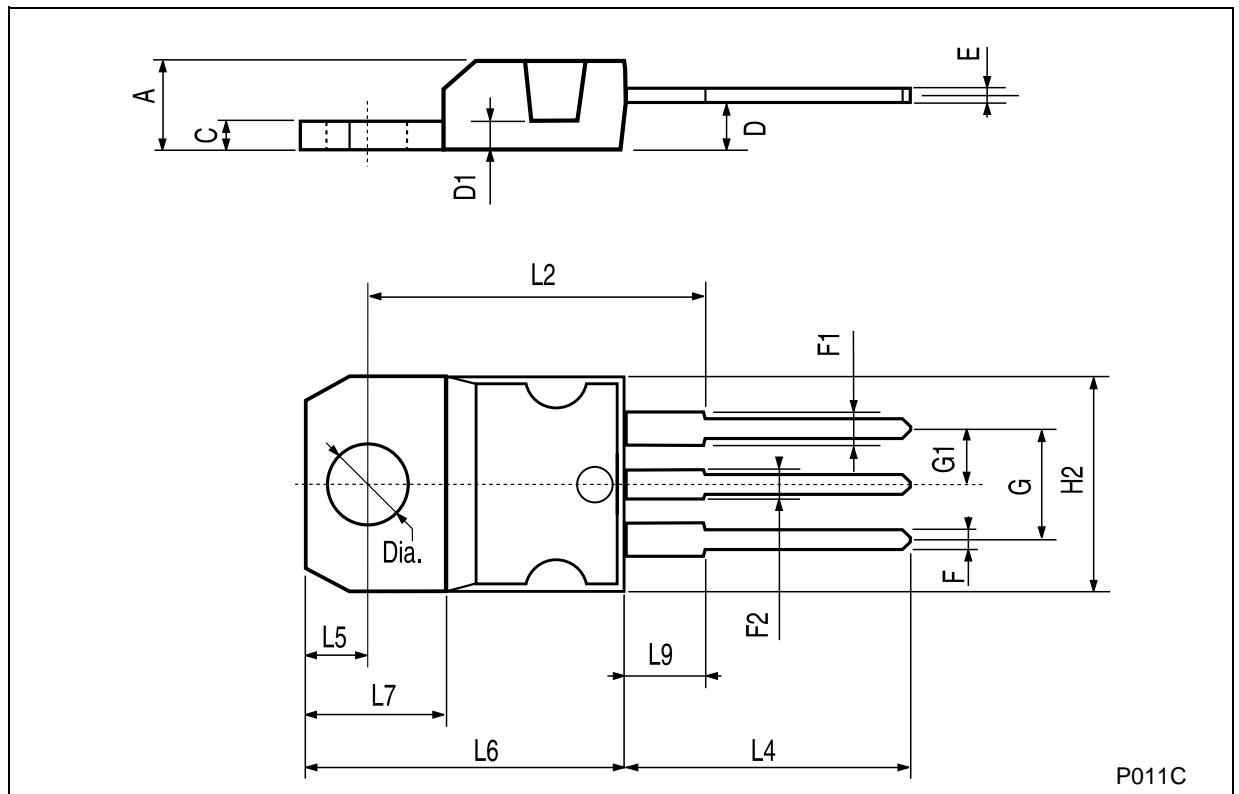
### TO-3 MECHANICAL DATA

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	



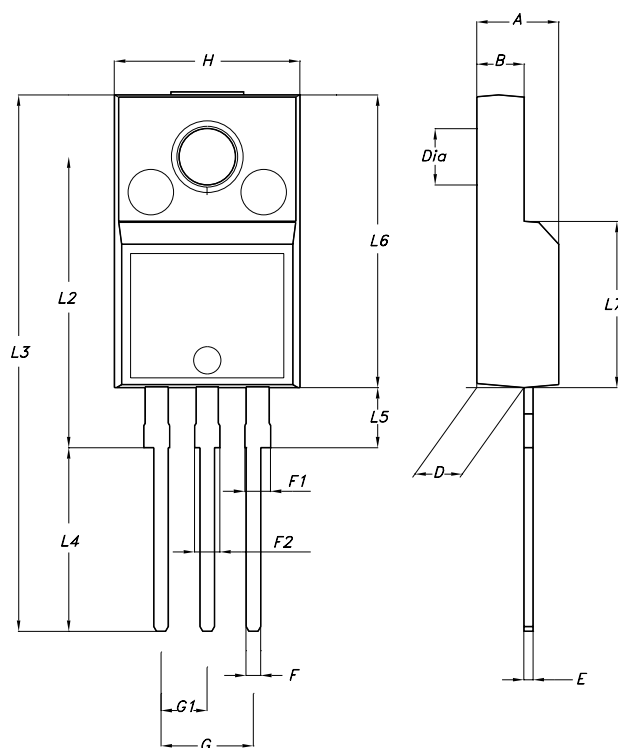
## TO-220 MECHANICAL DATA

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



## TO-220FP MECHANICAL DATA

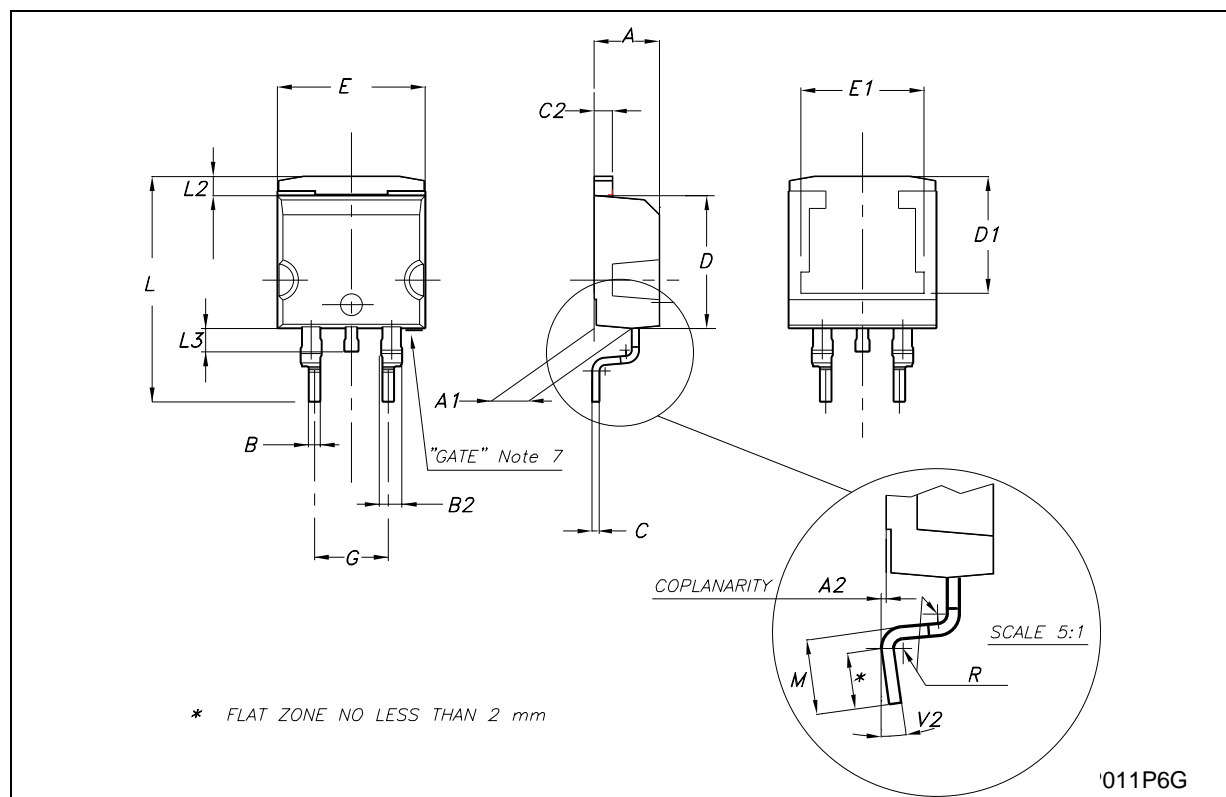
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.70	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.50	0.045		0.059
F2	1.15		1.50	0.045		0.059
G	4.95		5.2	0.194		0.204
G1	2.4		2.7	0.094		0.106
H	10.0		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L5	2.9		3.6	0.114		0.142
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
DIA.	3		3.2	0.118		0.126



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D<sup>2</sup>PAK MECHANICAL DATA

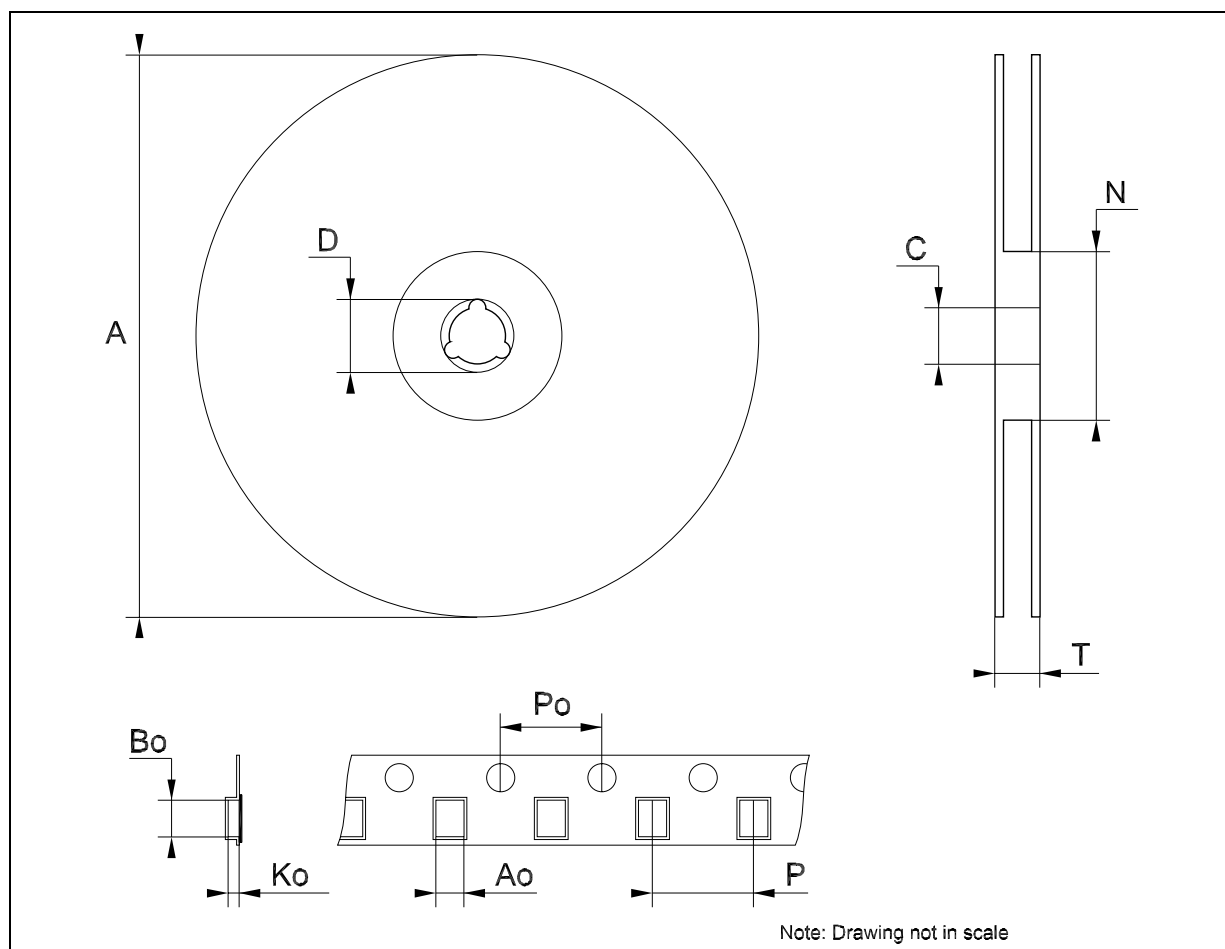
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		0.409
E1		8.5			0.335	
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
M	2.4		3.2	0.094		0.126
R		0.4			0.016	
V2	0°		8°	0°		8°



'011P6G

## Tape & Reel D<sup>2</sup>PAK-P<sup>2</sup>PAK-D<sup>2</sup>PAK/A-P<sup>2</sup>PAK/A MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	10.50	10.6	10.70	0.413	0.417	0.421
Bo	15.70	15.80	15.90	0.618	0.622	0.626
Ko	4.80	4.90	5.00	0.189	0.193	0.197
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	11.9	12.0	12.1	0.468	0.472	0.476



**Table 6: Revision History**

Date	Revision	Description of Changes
01-Sep-2004	10	Mistake $V_{REF} \Rightarrow V_O$ , tables 1, 4 and 5.

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