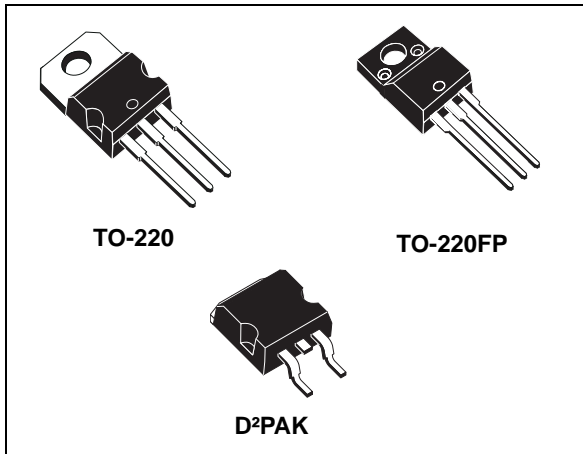


1.2 V to 37 V adjustable voltage regulators

Datasheet - production data



Description

The LM217, LM317 are monolithic integrated circuits in TO-220, TO-220FP and D²PAK packages intended for use as positive adjustable voltage regulators. They are designed to supply more than 1.5 A of load current with an output voltage adjustable over a 1.2 to 37 V range. The nominal output voltage is selected by means of a resistive divider, making the device exceptionally easy to use and eliminating the stocking of many fixed regulators.

Features

- Output voltage range: 1.2 to 37 V
- Output current in excess of 1.5 A
- 0.1 % line and load regulation
- Floating operation for high voltages
- Complete series of protections: current limiting, thermal shutdown and SOA control

Table 1. Device summary

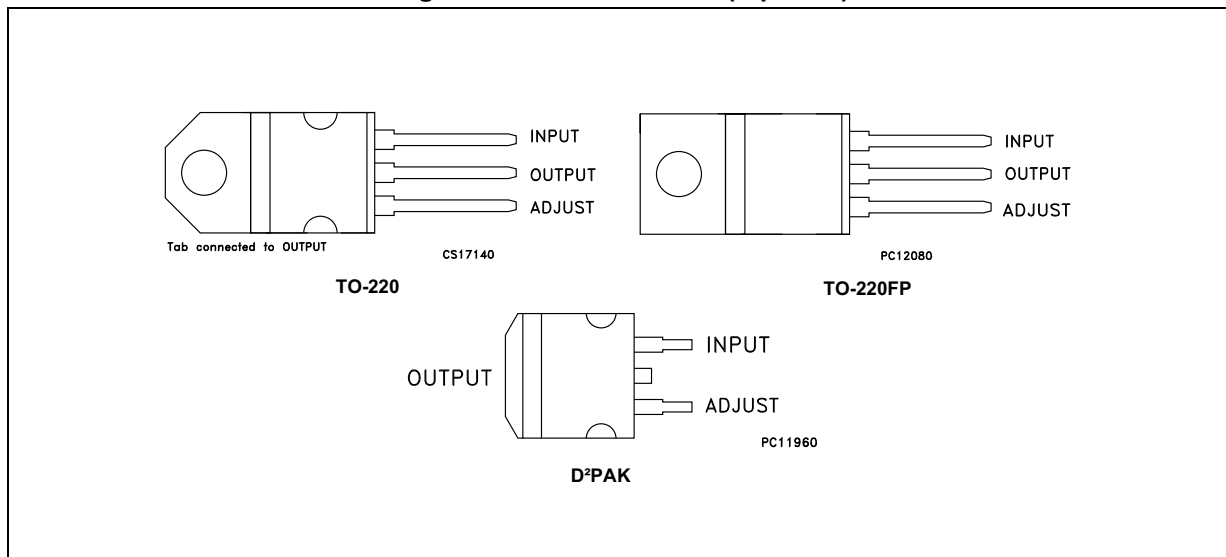
Order codes			
TO-220 (single gauge)	TO-220 (double gauge)	D ² PAK (tape and reel)	TO-220FP
LM217T	LM217T-DG	LM217D2T-TR	
LM317T	LM317T-DG	LM317D2T-TR	LM317P
LM317BT			

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1 Pin configuration

Figure 1. Pin connections (top view)



2 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_I - V_O$	Input-reference differential voltage	40	V
I_O	Output current	Internally limited	A
T_{OP}	Operating junction temperature for:	LM217	- 25 to 150
		LM317	0 to 125
		LM317B	-40 to 125
P_D	Power dissipation	Internally limited	
T_{STG}	Storage temperature	- 65 to 150	°C

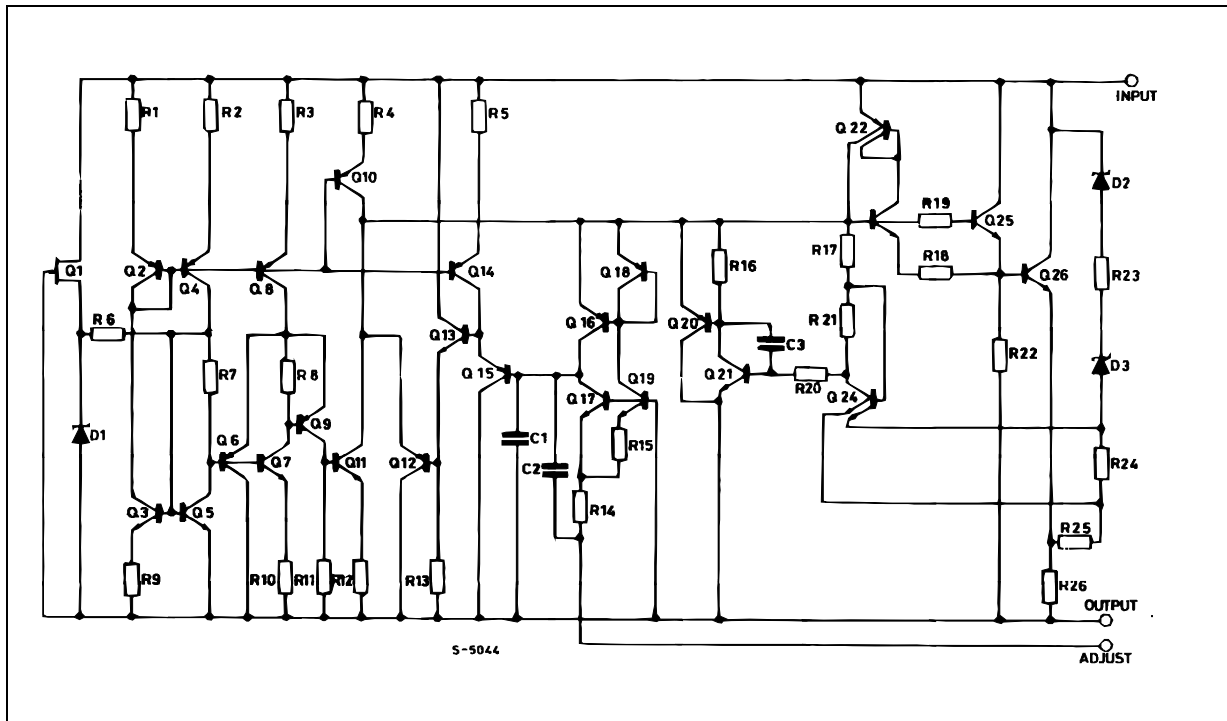
Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 3. Thermal data

Symbol	Parameter	D ² PAK	TO-220	TO-220FP	Unit
R_{thJC}	Thermal resistance junction-case	3	5	5	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5	50	60	°C/W

3 Diagram

Figure 2. Schematic diagram



4 Electrical characteristics

$V_I - V_O = 5\text{ V}$, $I_O = 500\text{ mA}$, $I_{MAX} = 1.5\text{ A}$ and $P_{MAX} = 20\text{ W}$, $T_J = -55\text{ to }150\text{ }^\circ\text{C}$, unless otherwise specified.

Table 4. Electrical characteristics for LM217

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
ΔV_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	
ΔV_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	μA	
ΔI_{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	μA
V_{REF}	Reference voltage	$V_I - V_O = 2.5\text{ to }40\text{ V}$	$I_O = 10\text{ mA to }I_{MAX}$ $P_D \leq P_{MAX}$	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
		$V_I - V_O = 40\text{ V}$, $P_D < P_{MAX}$, $T_J = 25^\circ\text{C}$			0.4		
eN	Output noise voltage (percentage of V_O)	B = 10Hz to 100kHz, $T_J = 25^\circ\text{C}$			0.003		%
SVR	Supply voltage rejection ⁽¹⁾	$T_J = 25^\circ\text{C}$, $f = 120\text{ Hz}$	$C_{ADJ}=0$		65		dB
			$C_{ADJ}=10\mu\text{F}$	66	80		

1. C_{ADJ} is connected between adjust pin and ground.

$V_1 - V_O = 5\text{ V}$, $I_O = 500\text{ mA}$, $I_{MAX} = 1.5\text{ A}$ and $P_{MAX} = 20\text{ W}$, $T_J = 0\text{ to }125\text{ }^\circ\text{C}$, unless otherwise specified.

Table 5. Electrical characteristics for LM317

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
ΔV_O	Line regulation	$V_1 - V_O = 3\text{ to }40\text{ V}$	$T_J = 25^\circ\text{C}$	0.01	0.04	%V
				0.02	0.07	
ΔV_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	μA
ΔI_{ADJ}	Adjustment pin current	$V_1 - V_O = 2.5\text{ to }40\text{ V}$, $I_O = 10\text{ mA to }500\text{ mA}$		0.2	5	μA
V_{REF}	Reference voltage (between pin 3 and pin 1)	$V_1 - V_O = 2.5\text{ to }40\text{ V}$ $I_O = 10\text{ mA to }500\text{ mA}$ $P_D \leq P_{MAX}$	1.2	1.25	1.3	V
$\Delta V_O/V_O$	Output voltage temperature stability			1		%
$I_{O(min)}$	Minimum load current	$V_1 - V_O = 40\text{ V}$		3.5	10	mA
$I_{O(max)}$	Maximum load current	$V_1 - V_O \leq 15\text{ V}$, $P_D < P_{MAX}$	1.5	2.2		A
		$V_1 - V_O = 40\text{ V}$, $P_D < P_{MAX}$, $T_J = 25^\circ\text{C}$		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 ⁽¹⁾	$T_J = 25^\circ\text{C}$, $f = 120\text{ Hz}$	$C_{ADJ}=0$		65	dB
			$C_{ADJ}=10\mu\text{F}$	66	80	

1. C_{ADJ} is connected between adjust pin and ground.

$V_I - V_O = 5\text{ V}$, $I_O = 500\text{ mA}$, $I_{MAX} = 1.5\text{ A}$ and $P_{MAX} = 20\text{ W}$, $T_J = -40\text{ to }125\text{ }^\circ\text{C}$, unless otherwise specified.

Table 6. Electrical characteristics for LM317B

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
ΔV_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	
ΔV_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	μA	
ΔI_{ADJ}	Adjustment pin current	$V_I - V_O = 2.5\text{ to }40\text{ V}$, $I_O = 10\text{ mA to }500\text{ mA}$		0.2	5	μA	
V_{REF}	Reference voltage (between pin 3 and pin 1)	$V_I - V_O = 2.5\text{ to }40\text{ V}$ $I_O = 10\text{ mA to }500\text{ mA}$ $P_D \leq P_{MAX}$	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 ⁽¹⁾	$T_J = 25^\circ\text{C}$, $f = 120\text{ Hz}$	$C_{ADJ}=0$		65		dB
			$C_{ADJ}=10\mu\text{F}$	66	80		

1. C_{ADJ} is connected between adjust pin and ground.



5 Typical characteristics

Figure 3. Output current vs. input-output differential voltage

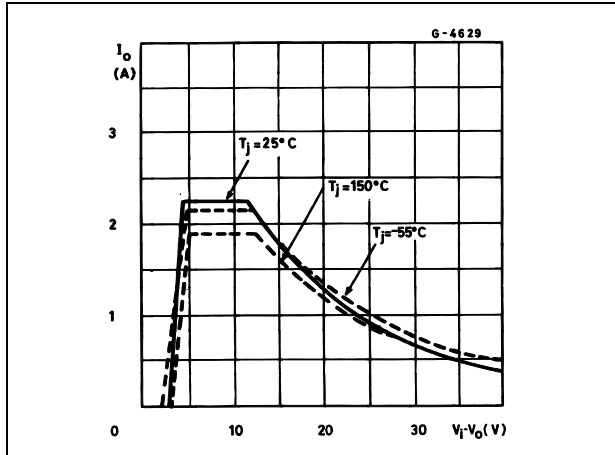


Figure 4. Dropout voltage vs. junction temperature

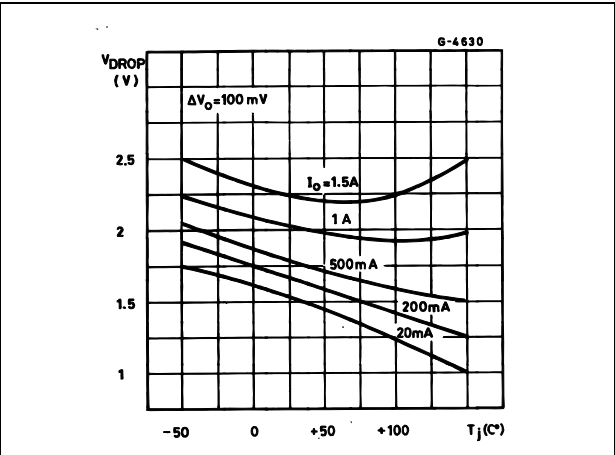


Figure 5. Reference voltage vs. junction

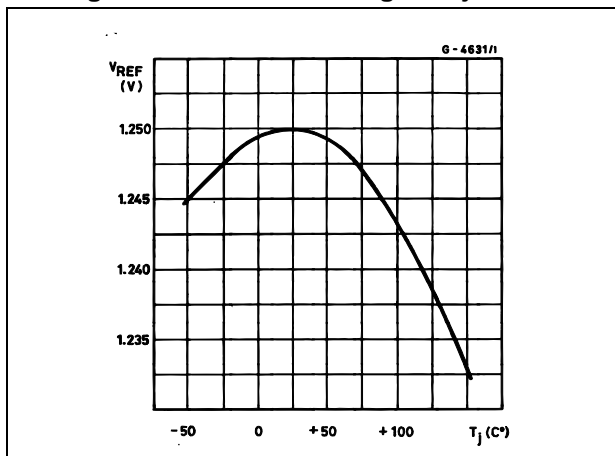
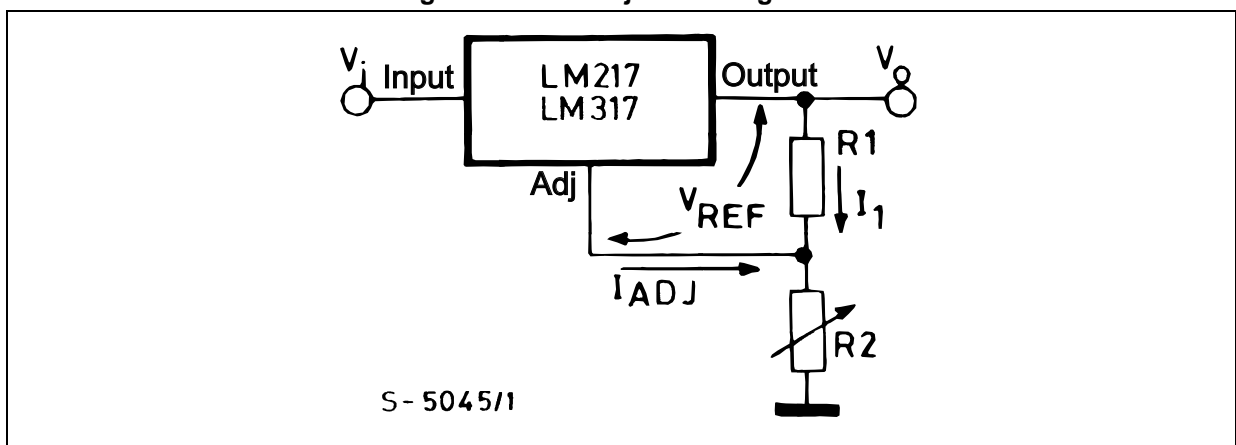


Figure 6. Basic adjustable regulator



6 Application information

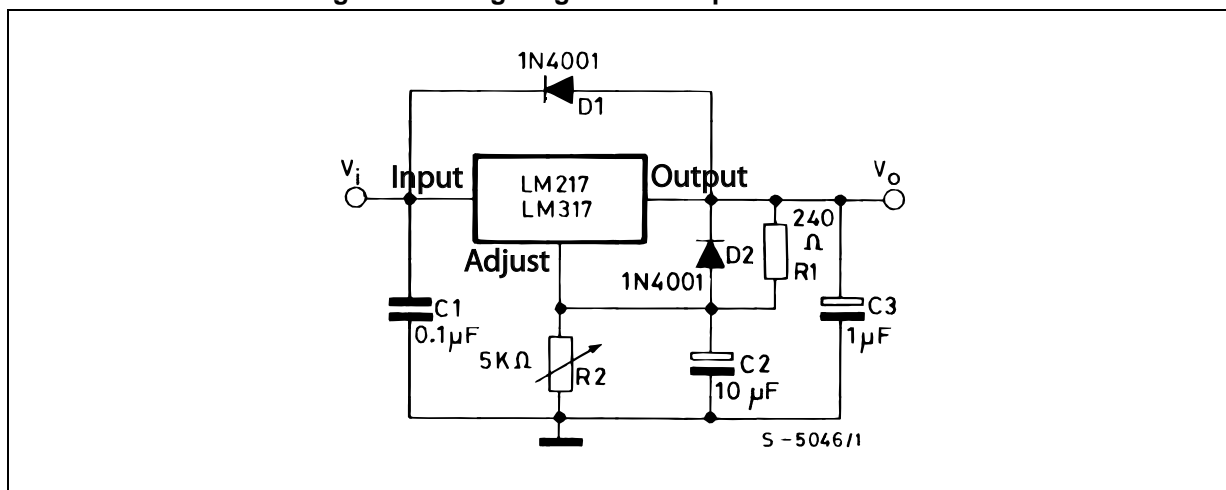
The LM217, LM317 provides an internal reference voltage of 1.25 V between the output and adjustments terminals. This is used to set a constant current flow across an external resistor divider (see [Figure 6](#)), giving an output voltage V_O of:

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

The device was designed to minimize the term I_{ADJ} (100 μ 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 LM217, LM317 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 regulators 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 [Figure 6](#)) 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 μ F
- An adjustment terminal to ground 10 μ F capacitor to improve the ripple rejection of about 15 dB (C_{ADJ}).
- An 1 μ F tantalum (or 25 μ 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 [Figure 7](#) D1 protect the device against input short circuit, while D2 protect against output short circuit for capacitance discharging.

Figure 7. Voltage regulator with protection diodes



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

Figure 8. Slow turn-on 15 V regulator

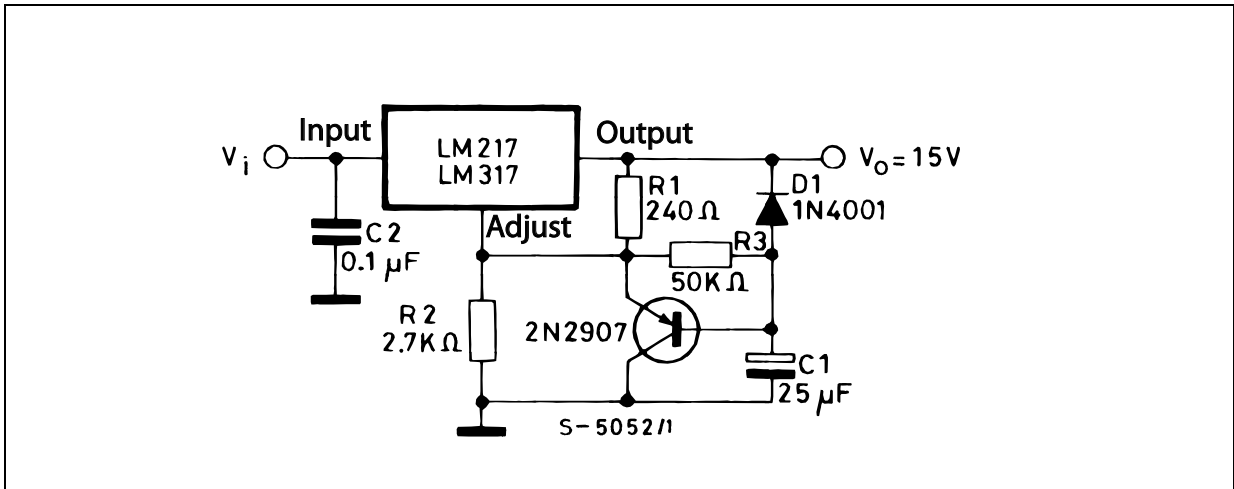
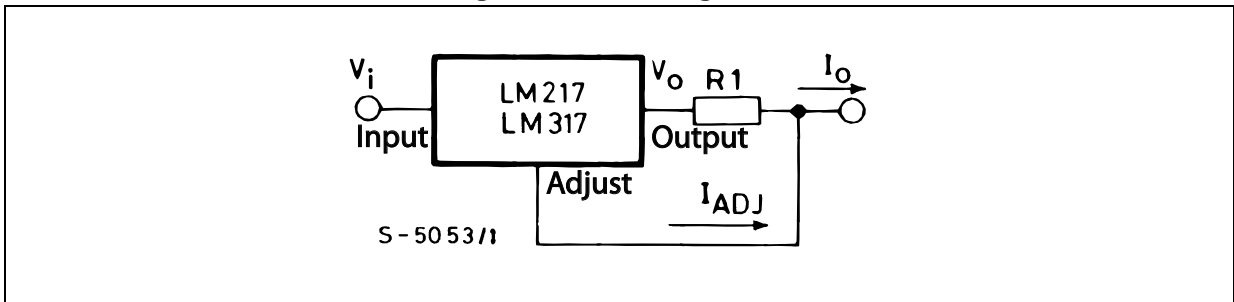


Figure 9. Current regulator



$$I_O = (V_{REF} / R_1) + I_{ADJ} = 1.25 \text{ V} / R_1$$

Figure 10. 5 V electronic shut-down regulator

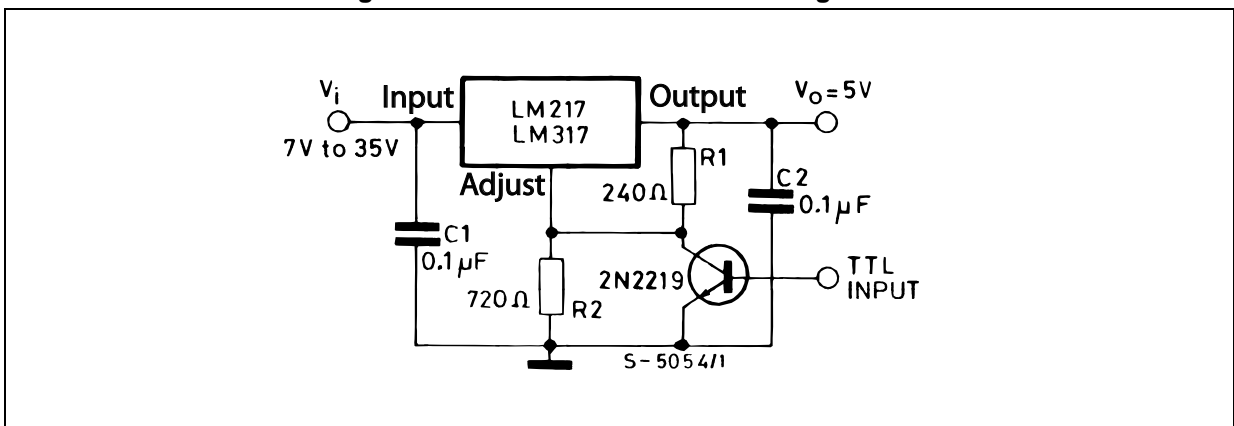
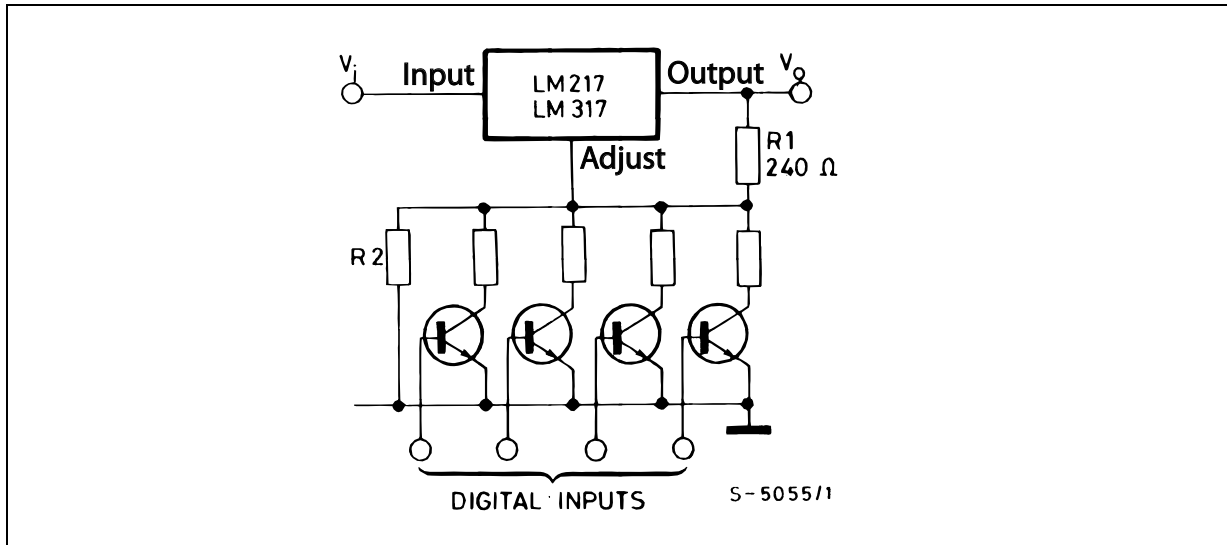
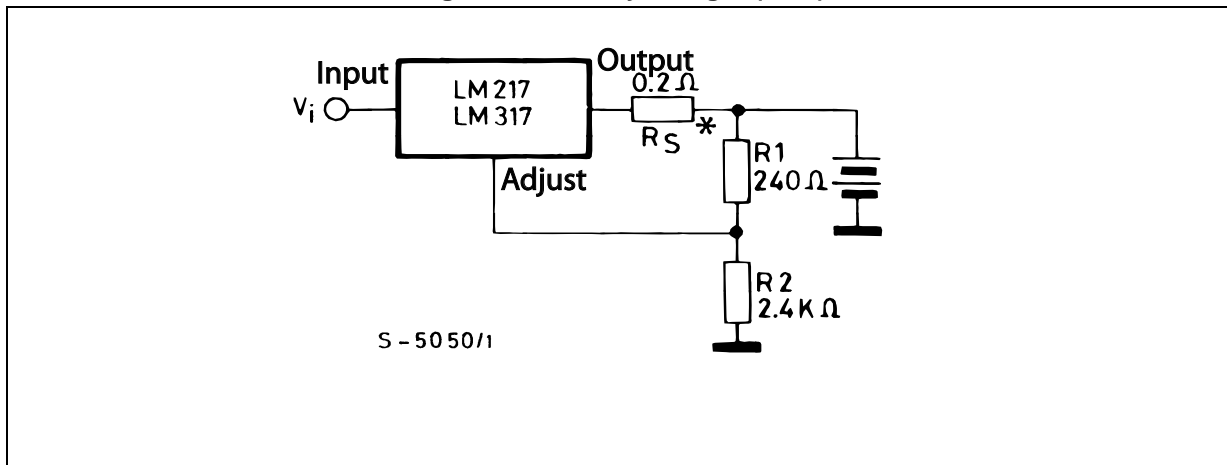


Figure 11. Digitally selected outputs



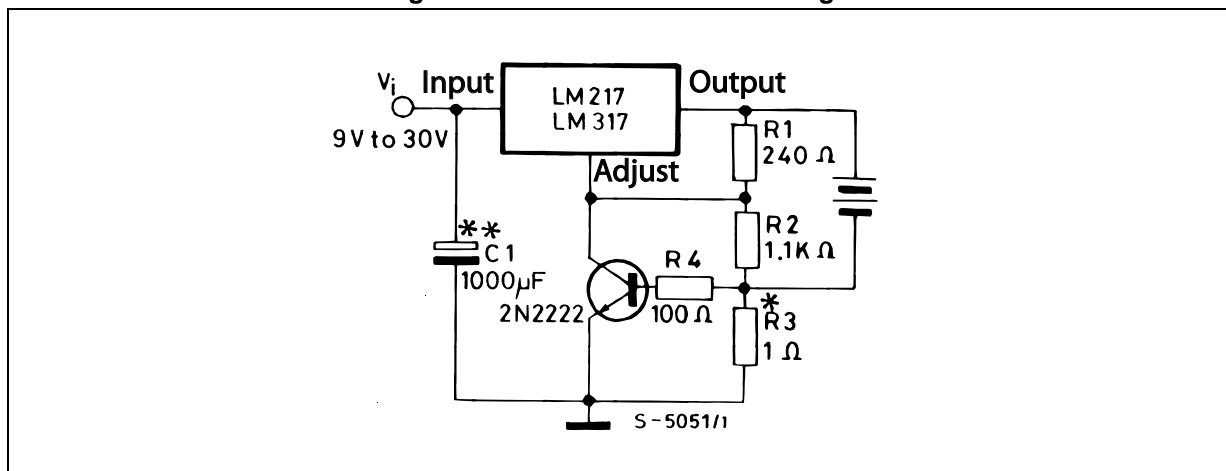
(R₂ sets maximum V_O)

Figure 12. Battery charger (12 V)



* R_S sets output impedance of charger $Z_O = R_S (1 + R_2/R_1)$. Use of R_S allows low charging rates whit fully charged battery.

Figure 13. Current limited 6 V charger



* $R3$ sets peak current (0.6 A for 1 Ω).

** $C1$ recommended to filter out input transients.

7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Figure 14. TO-220 (single gauge) drawing

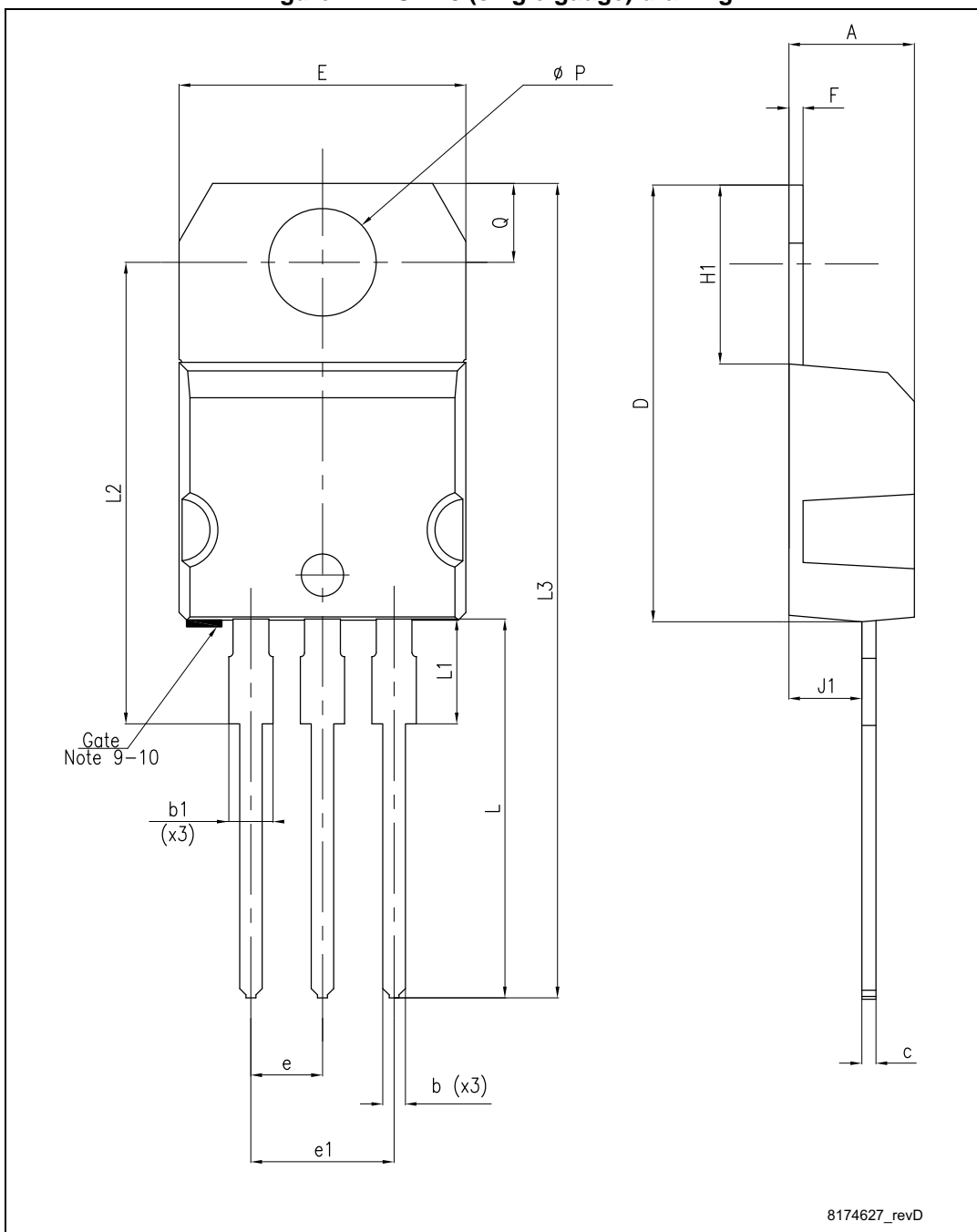


Table 7. TO-220 (single gauge) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	0.51		0.60
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

Figure 15. TO-220 (dual gauge) drawing

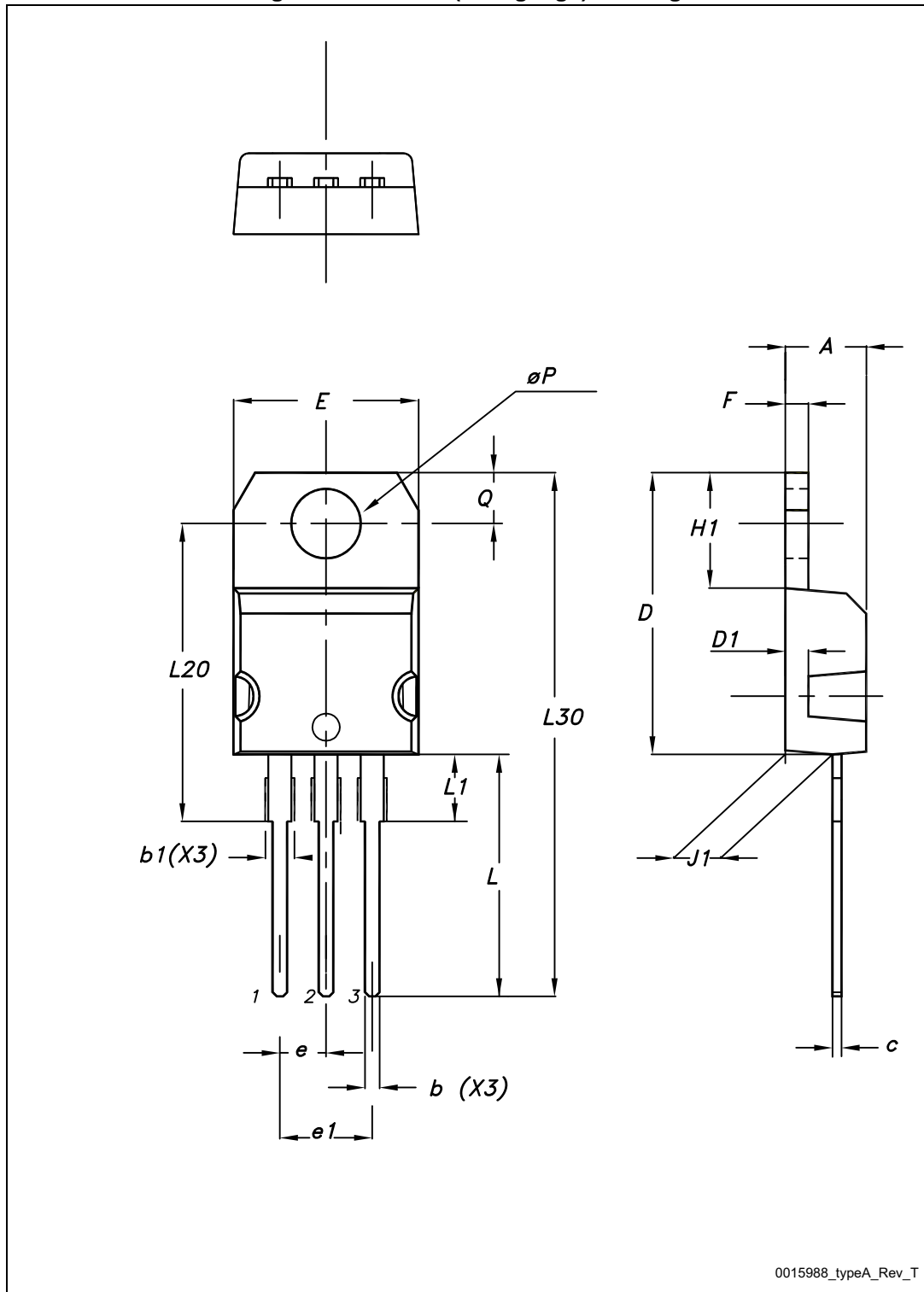


Table 8. TO-220 (dual gauge) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

Figure 16. TO-220FP drawing

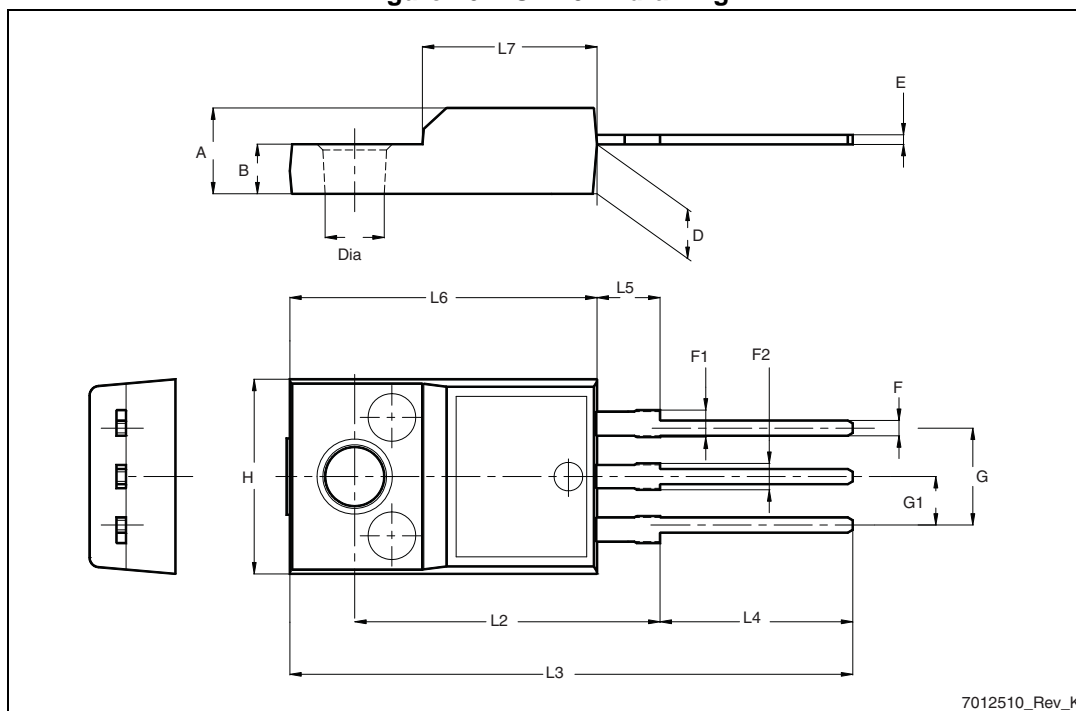
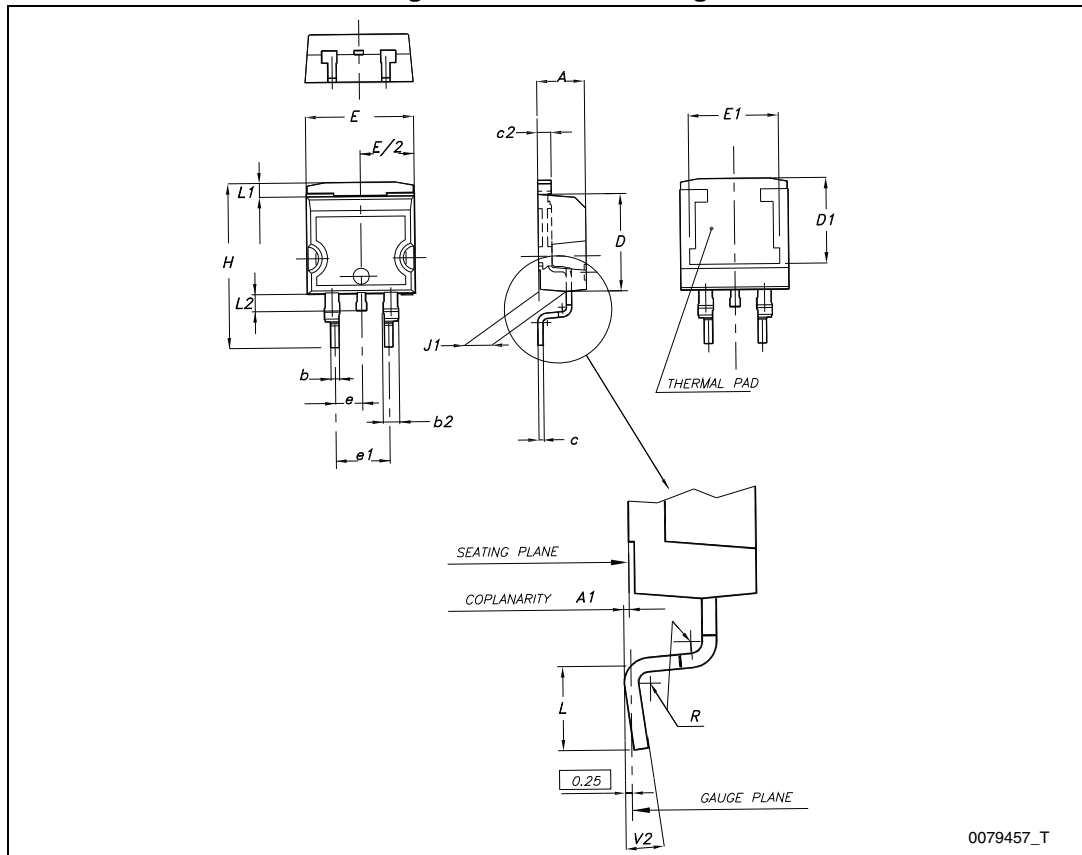


Table 9. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 17. D²PAK drawing



0079457_T

Table 10. D²PAK mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

8 Packaging mechanical data

Figure 18. Tape for D²PAK

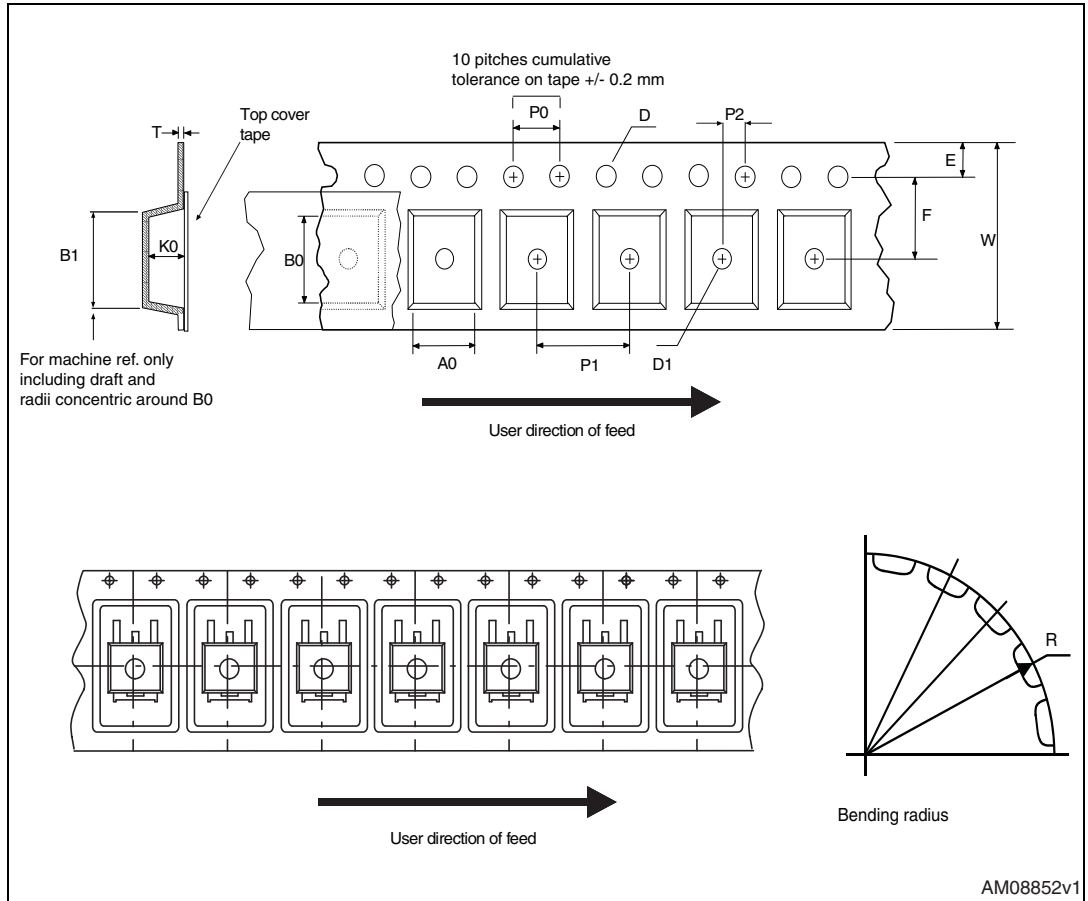
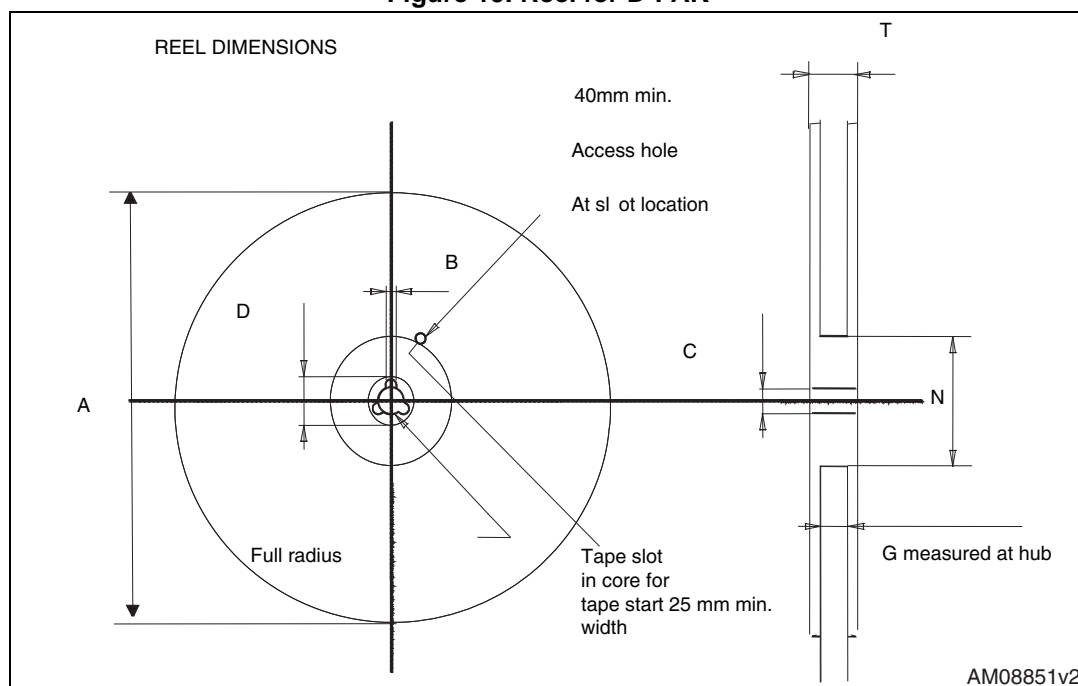


Figure 19. Reel for D²PAKTable 11. D²PAK tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

9 Revision history

Table 12. Document revision history

Date	Revision	Changes
01-Sep-2004	10	Mistake $V_{REF} \Rightarrow V_O$, tables 1, 4 and 5.
19-Jan-2007	11	D ² PAK mechanical data has been updated, add footprint data and the document has been reformatted.
13-Jun-2007	12	Change values ΔI_{ADJ} and V_{REF} test condition of $I_O = 10 \text{ mA}$ to $I_{MAX} \Rightarrow I_O = 10 \text{ mA}$ to 500 mA on Table 5 .
23-Nov-2007	13	Added Table 1 .
06-Feb-2008	14	Added: TO-220 mechanical data Figure 14 on page 14 and Table 6 on page 13 .
02-Mar-2010	15	Added: notes Figure 14 on page 14 , Figure 15 on page 15 , Figure 16 and Figure 17 on page 16 .
17-Nov-2010	16	Modified: R_{thJC} value for TO-220 Table 3 on page 4 .
18-Nov-2011	17	Added: order code LM317T-DG Table 1 on page 1 .
13-Feb-2012	18	Added: order code LM217T-DG Table 1 on page 1 .
12-Mar-2014	19	<p>The part number LM117 has been moved to a separate datasheet. Removed TO-3 package. Updated the description in cover page Modified Table 1: Device summary, Table 3: Thermal data, Figure 1: Pin connections (top view), Section 4: Electrical characteristics, Section 5: Typical characteristics, Section 6: Application information, Section 7: Package mechanical data.</p> <p>Added Section 8: Packaging mechanical data. Minor text changes.</p>

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