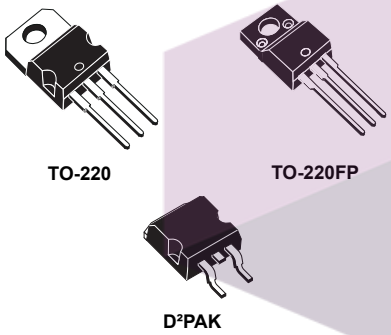
LM217, LM317

Datasheet

1.2 V to 37 V adjustable voltage 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

Description

The LM217, LM317 are monolithic integrated circuits in TO-220, TO-220FP and D²PAK packages intended for use as positive adjustable voltage regulators.

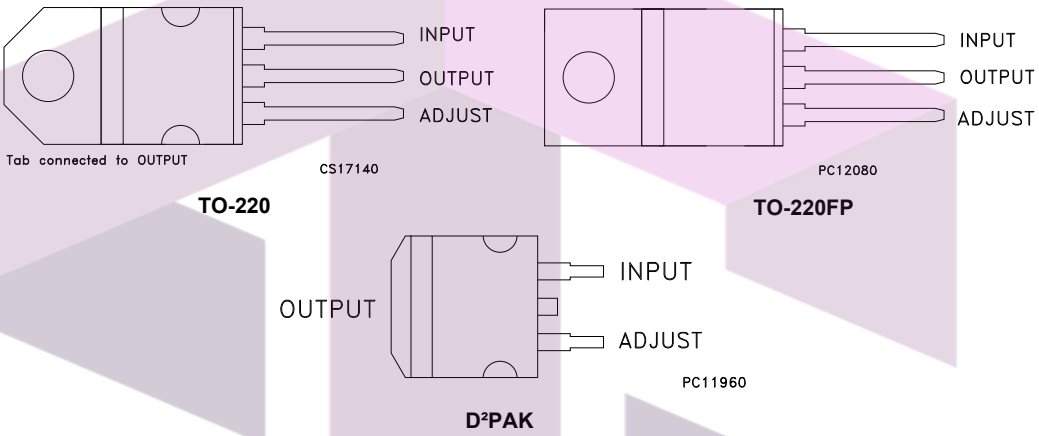
They are designed to supply more than 1.5 A of load current with an output voltage adjustable over a 1.2 to 37 V range.

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.

Product status link
LM217
LM317

1 Pin configuration

Figure 1. **Pin connections (top view)**



2 Maximum ratings

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	A
T_{OP}	Operating junction temperature for:	LM217	- 25 to 150	°C
		LM317	0 to 125	
		LM317B	-40 to 125	
P_D	Power dissipation		Internally limited	
T_{STG}	Storage temperature		- 65 to 150	°C

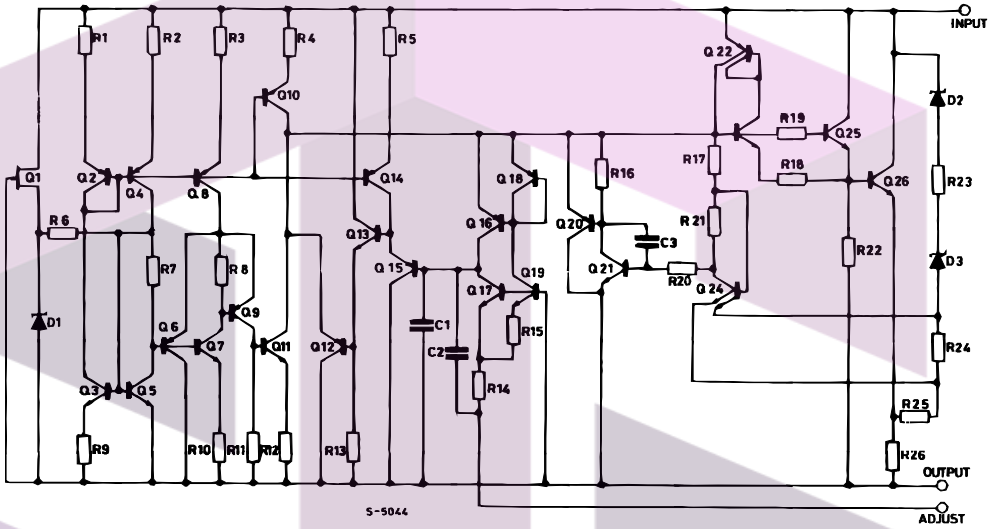
Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 2. Thermal data

Symbol	Parameter	D²PAK	TO-220	TO-220FP	Unit
R_{thJA}	Thermal resistance junction-ambient	62.5	50	60	°C/W
R_{thJC}	Thermal resistance junction-case	3	5	5	°C/W

3 Diagram

Figure 2. Schematic diagram



4 Electrical characteristics

V_I - V_O = 5 V, I_O = 500 mA, I_{MAX} = 1.5 A and P_{MAX} = 20 W, T_J = - 25 to 150 °C, unless otherwise specified.

Table 3. Electrical characteristics for LM217

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
ΔV_O	Line regulation	V_I - V_O = 3 to 40 V	T_J = 25°C		0.01	0.02	%/V
					0.02	0.05	
ΔV_O	Load regulation	$V_O \leq 5$ V I_O = 10 mA to I_{MAX}	T_J= 25°C		5	15	mV
					20	50	
		$V_O \geq 5$ V, I_O = 10 mA to I_{MAX}	T_J = 25°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 to 40 V I_O = 10 mA to I_{MAX}			0.2	5	µA
V_{REF}	Reference voltage	V_I - V_O = 2.5 to 40 V I_O = 10 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 V			3.5	5	mA
$I_{O(max)}$	Maximum load current	V_I - $V_O \leq$ 15 V, $P_D < P_{MAX}$		1.5	2.2		A
		V_I - V_O = 40 V, $P_D < P_{MAX}$, T_J = 25°C			0.4		
eN	Output noise voltage (percentage of V_O)	B = 10 Hz to 100 kHz, T_J = 25°C			0.003		%
SVR	Supply voltage rejection (1)	T_J = 25°C, f = 120 Hz	C_{ADJ} = 0		65		dB
			C_{ADJ} = 10 µF	66	80		

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

V_I - V_O = 5 V, I_O = 500 mA, I_{MAX} = 1.5 A and P_{MAX} = 20 W, T_J = 0 to 125 °C, unless otherwise specified.

Table 4. Electrical characteristics for LM317

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
ΔV_O	Line regulation	V_I - V_O = 3 to 40 V	T_J = 25°C		0.01	0.04	%/V
					0.02	0.07	
ΔV_O	Load regulation	$V_O \leq 5$ V I_O = 10 mA to I_{MAX}	T_J= 25°C		5	25	mV
					20	70	
		$V_O \geq 5$ V, I_O = 10 mA to I_{MAX}	T_J = 25°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 to 40 V I_O = 10 mA to I_{MAX}			0.2	5	µA
V_{REF}	Reference voltage (between pin 3 and pin 1)	V_I - V_O = 2.5 to 40 V I_O = 10 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 V			3.5	10	mA
$I_{O(max)}$	Maximum load current	V_I - $V_O \leq$ 15 V, $P_D < P_{MAX}$		1.5	2.2		A
		V_I - V_O = 40 V, $P_D < P_{MAX}$, T_J = 25°C		0.4			
eN	Output noise voltage (percentage of V_O)	B = 10 Hz to 100 kHz, T_J = 25°C			0.003		%
SVR	Supply voltage rejection (1)	T_J = 25°C, f = 120 Hz	C_{ADJ} = 0		65		dB
			C_{ADJ} = 10 µF	66	80		

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

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

Table 5. Electrical characteristics for LM317B

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
ΔV_O	Line regulation	V_I - V_O = 3 to 40 V	T_J = 25°C		0.01	0.04	%/V
					0.02	0.07	
ΔV_O	Load regulation	$V_O \leq 5$ V I_O = 10 mA to I_{MAX}	T_J= 25°C		5	25	mV
					20	70	
		$V_O \geq 5$ V, I_O = 10 mA to I_{MAX}	T_J = 25°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 to 40 V I_O = 10 mA to 500 mA			0.2	5	µA
V_{REF}	Reference voltage (between pin 3 and pin 1)	V_I - V_O = 2.5 to 40 V I_O = 10 mA to 500 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 V			3.5	10	mA
$I_{O(max)}$	Maximum load current	V_I - $V_O \leq$ 15 V, $P_D < P_{MAX}$		1.5	2.2		A
		V_I - V_O = 40 V, $P_D < P_{MAX}$, T_J = 25°C		0.4			
eN	Output noise voltage (percentage of V_O)	B = 10 Hz to 100 kHz, T_J = 25°C			0.003		%
SVR	Supply voltage rejection (1)	T_J = 25°C, f = 120 Hz	C_{ADJ} = 0		65		dB
			C_{ADJ} = 10 µF	66	80		

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

5 Typical characteristics

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

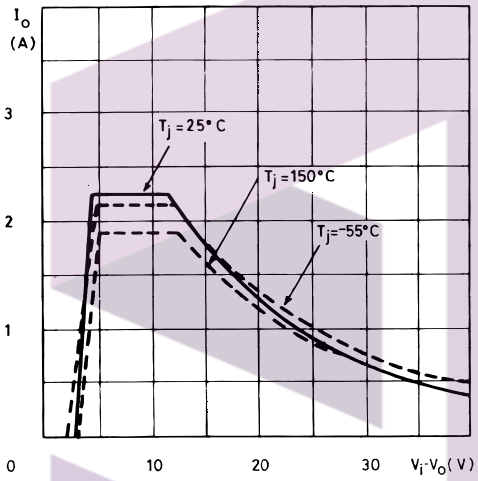


Figure 4. Dropout voltage vs. junction temperature

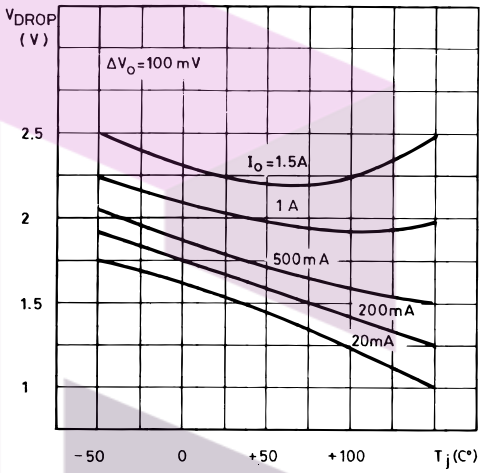


Figure 5. Reference voltage vs. junction

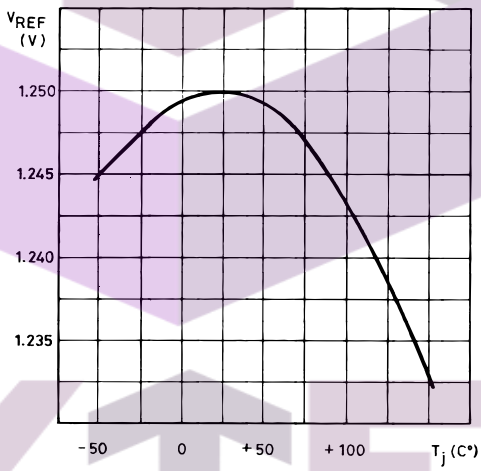
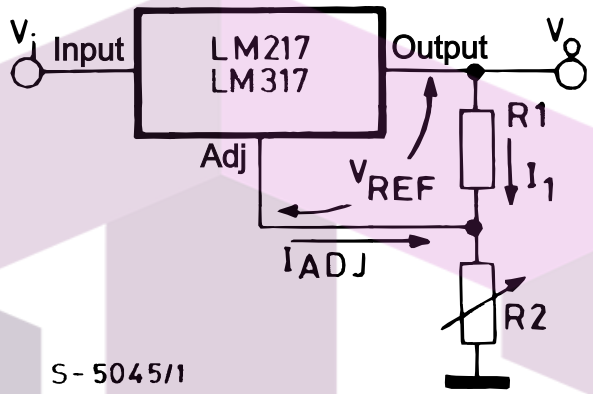


Figure 6. **Basic adjustable regulator**



6 Application information

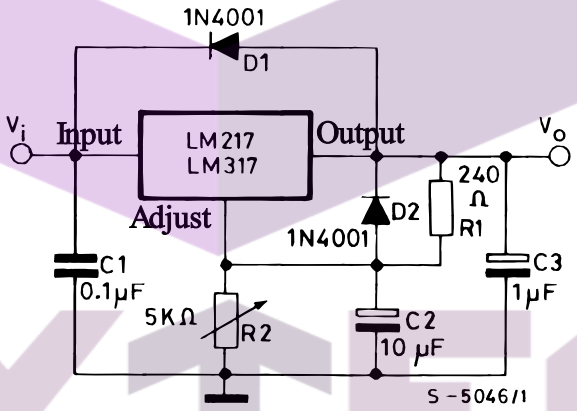
The LM217, LM317 provides an internal reference voltage of 1.25 V between the output and adjustments terminals. This is used to set a constant current flow across an external resistor divider (see Figure 6. Basic adjustable regulator), giving an output voltage V_O of:

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

The device was designed to minimize the term I_{ADJ} (100 µA 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. Basic adjustable regulator) 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 µF
- An adjustment terminal to ground 10 µF capacitor to improve the ripple rejection of about 15 dB (C_{ADJ}).
- An 1 µF tantalum (or 25 µF 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 below 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**

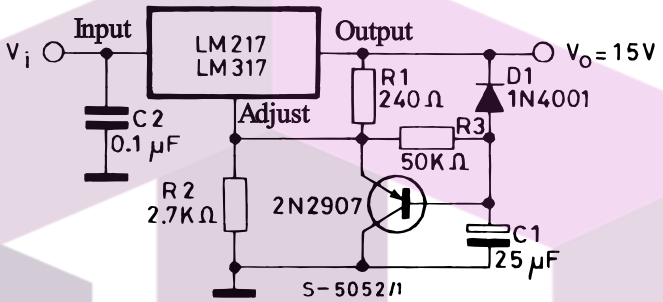
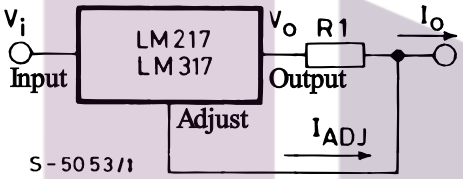


Figure 9. **Current regulator**



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

Figure 10. **5 V electronic shut-down regulator**

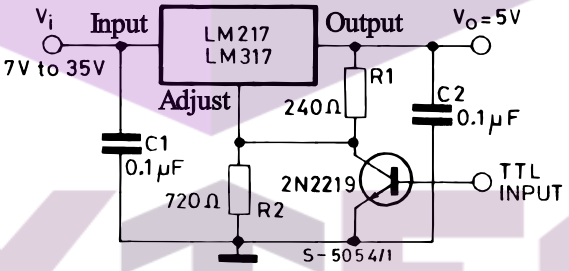
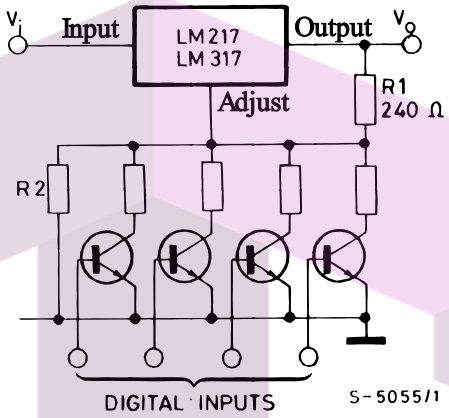
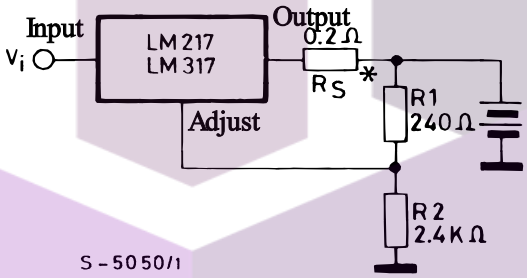


Figure 11. **Digitally selected outputs**



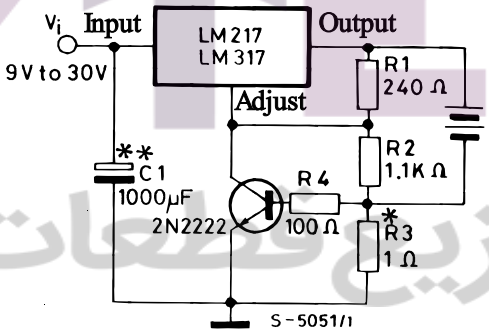
(R_2 sets maximum V_O)

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 10).

** C1 recommended to filter out input transients.

7 Device summary

Table 6. Device summary

Order codes			
TO-220 (single gauge)	TO-220 (double gauge)	D²PAK (tape and reel)	TO-220FP
LM217T	LM217T-DG	LM217D2T-TR	
LM317T	LM317T-DG	LM317D2T-TR	LM317P
LM317BT			

8 Package information

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.

8.1 TO-220 (single gauge) package information

Figure 14. TO-220 (single gauge) package outline

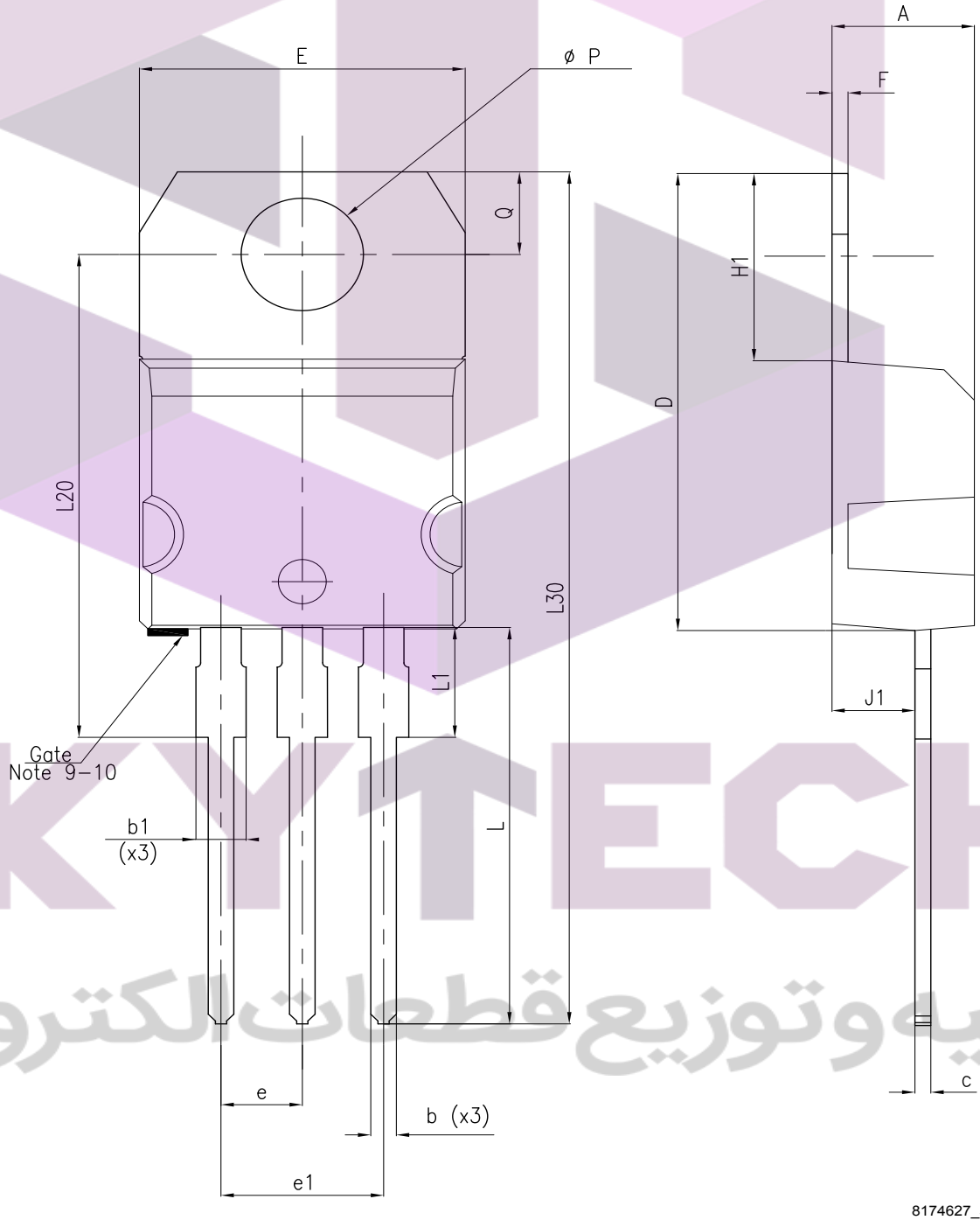
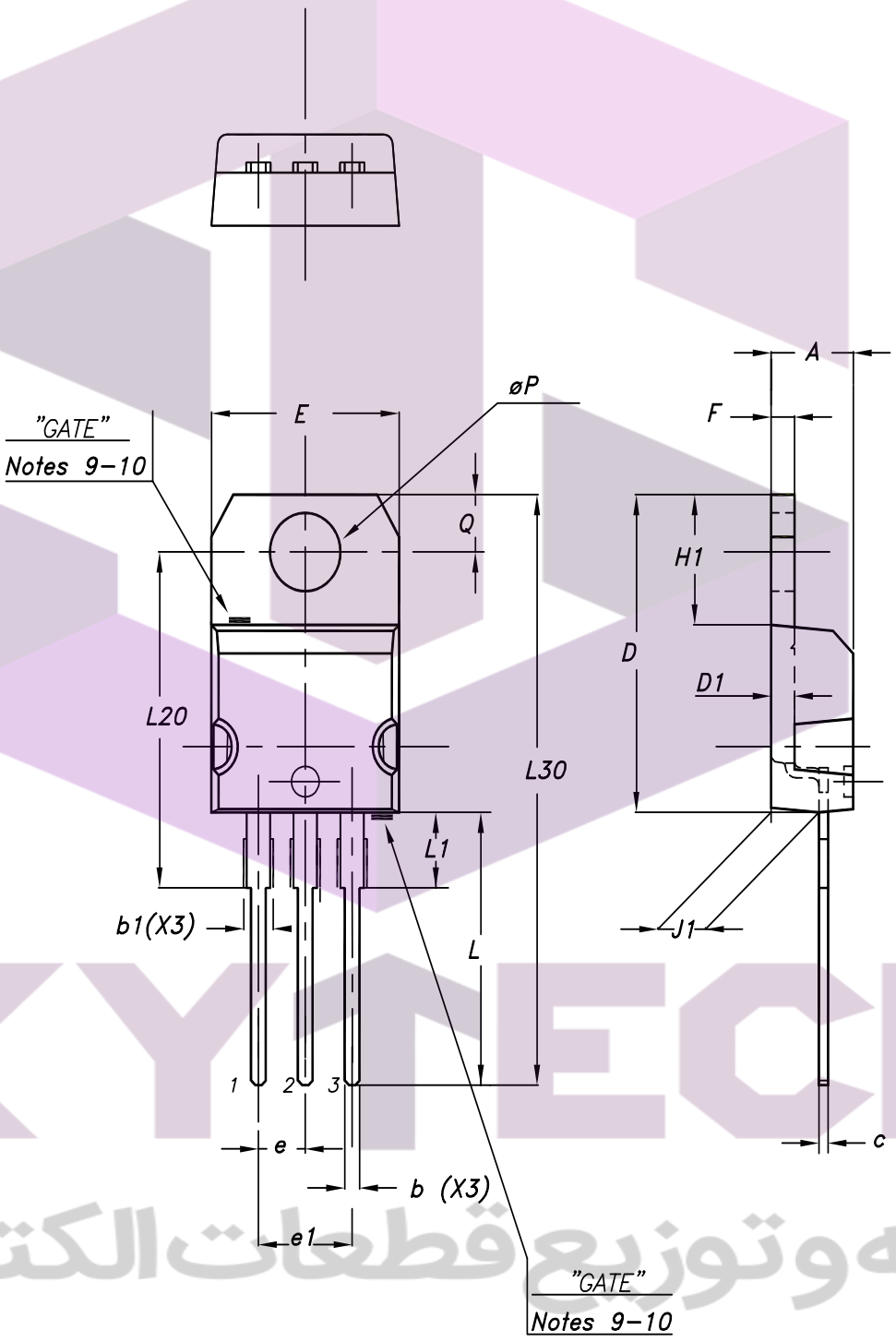


Table 7. **TO-220 (single gauge) mechanical data**

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	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

8.2 TO-220 (dual gauge) package information

Figure 15. TO-220 (dual gauge) package outline



0015988_21_Type A

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	
∅P	3.75		3.85
Q	2.65		2.95

8.3 TO-220FP type A package information

Figure 16. TO-220FP package outline

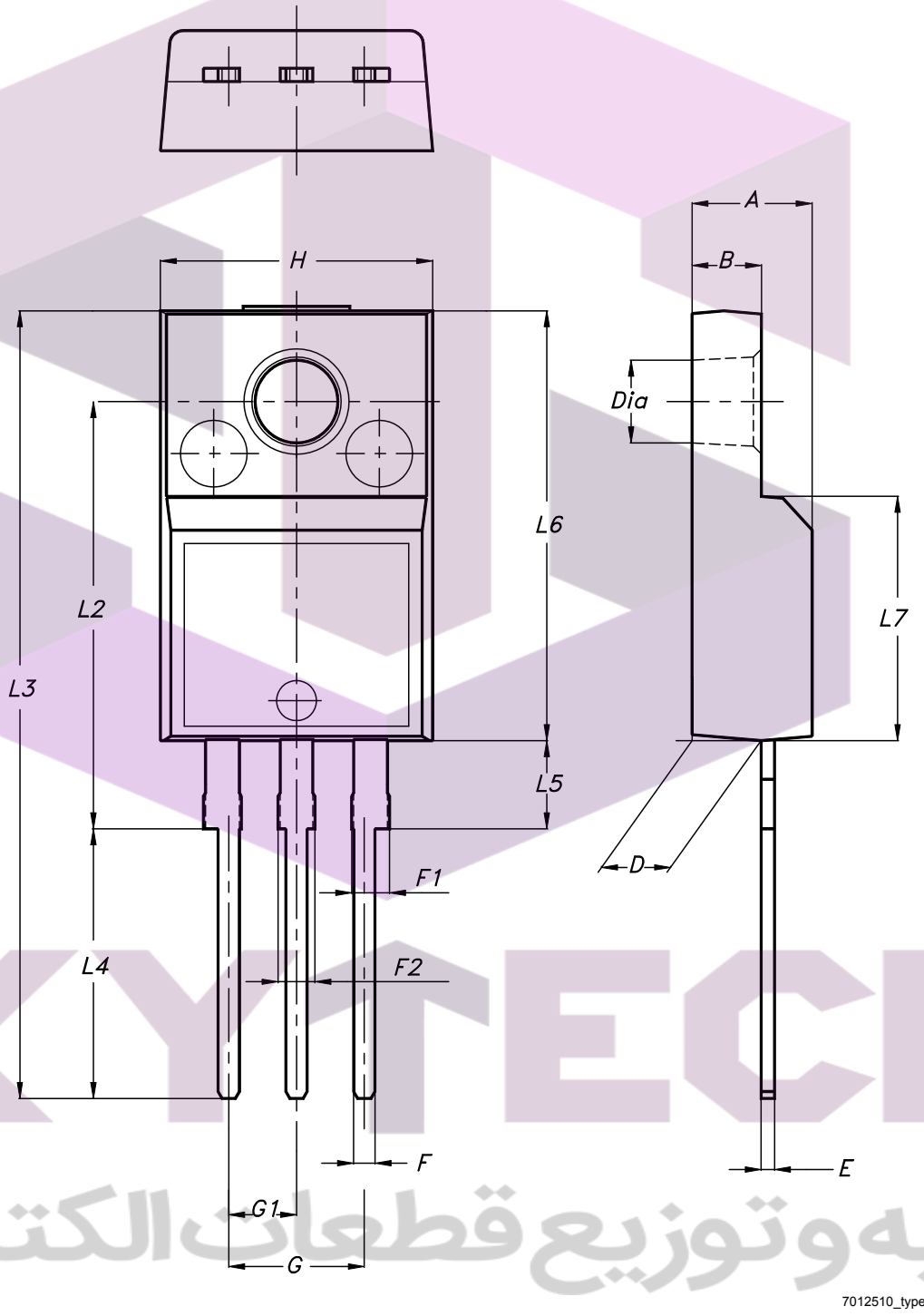


Table 9. **TO-220FP package mechanical data**

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

8.4 D²PAK (SMD 2L STD-ST) type A package information

Figure 17. D²PAK (SMD 2L STD-ST) type A package outline

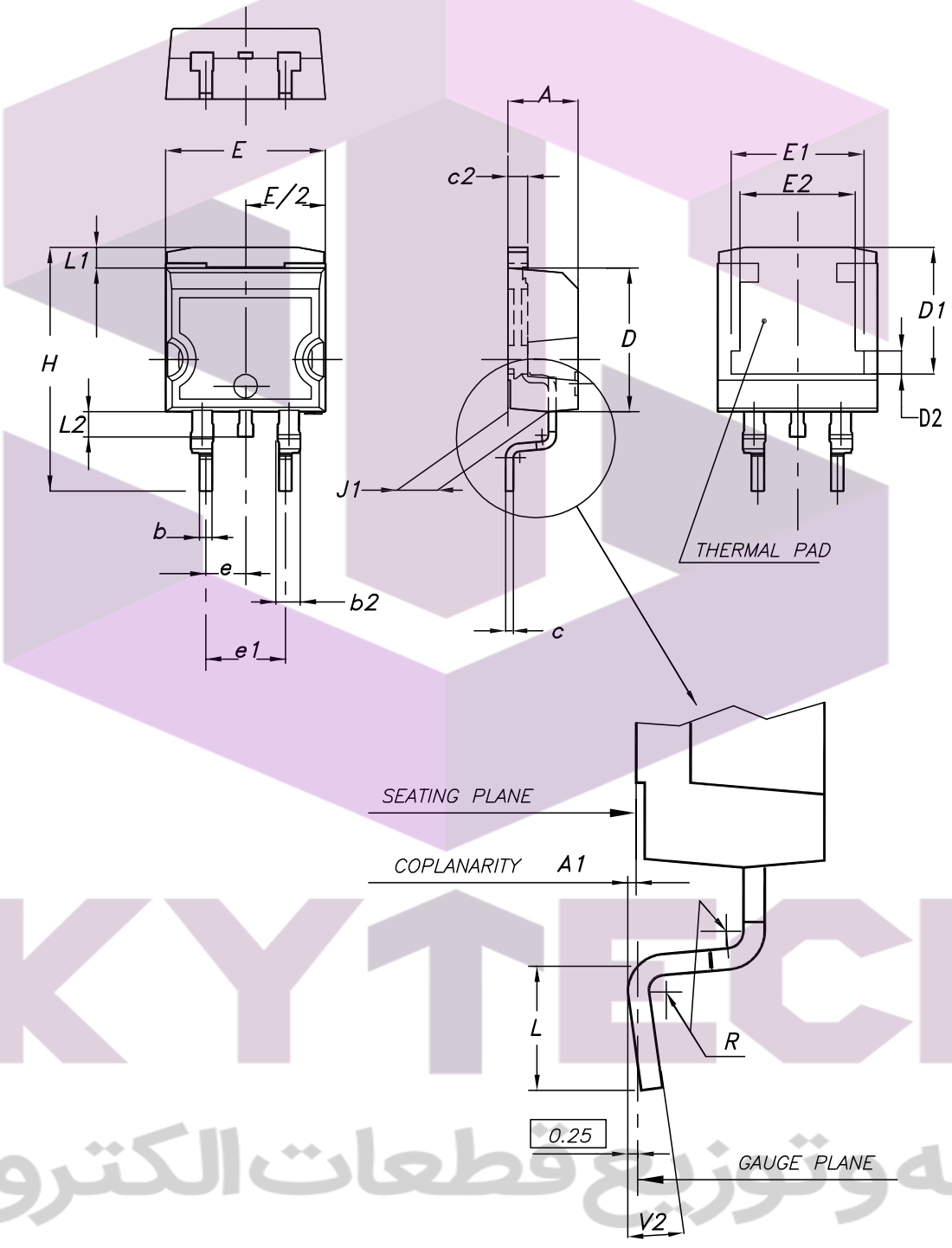
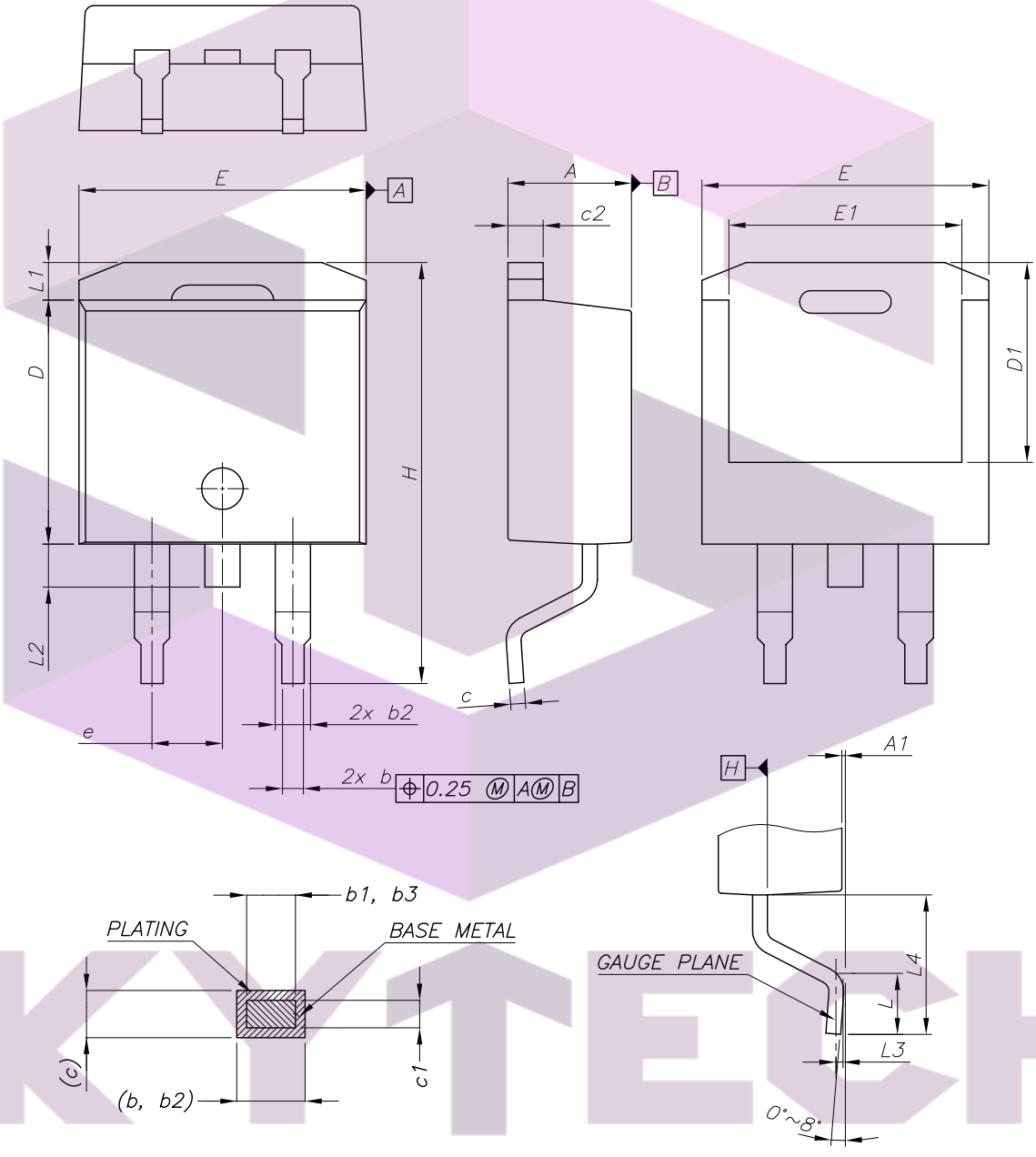


Table 10. D²PAK (SMD 2L STD-ST) mechanical data

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	7.75	8.00
D2	1.10	1.30	1.50
E	10		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
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°

8.5 D²PAK (ASE) type B package information

Figure 18. D²PAK (ASE subcon) type B package outline

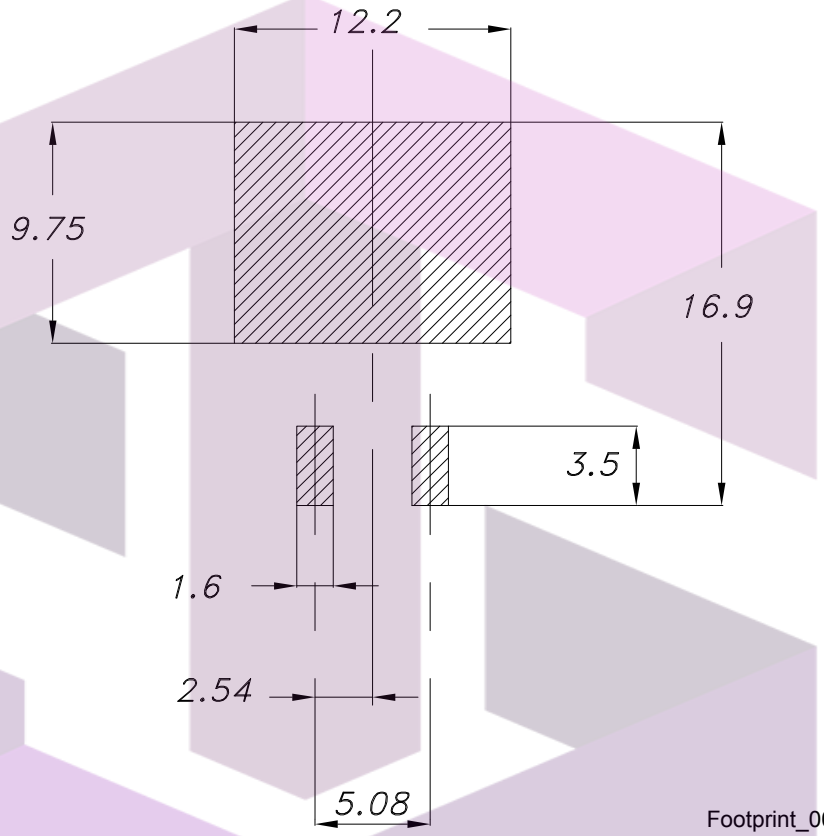


0079457_23_type B

Table 11. D²PAK (ASE) type B mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
b3	1.36		1.46
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e		2.54	
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 19. D²PAK recommended footprint (dimensions are in mm)



8.6 D²PAK packaging information

Figure 20. D²PAK tape outline

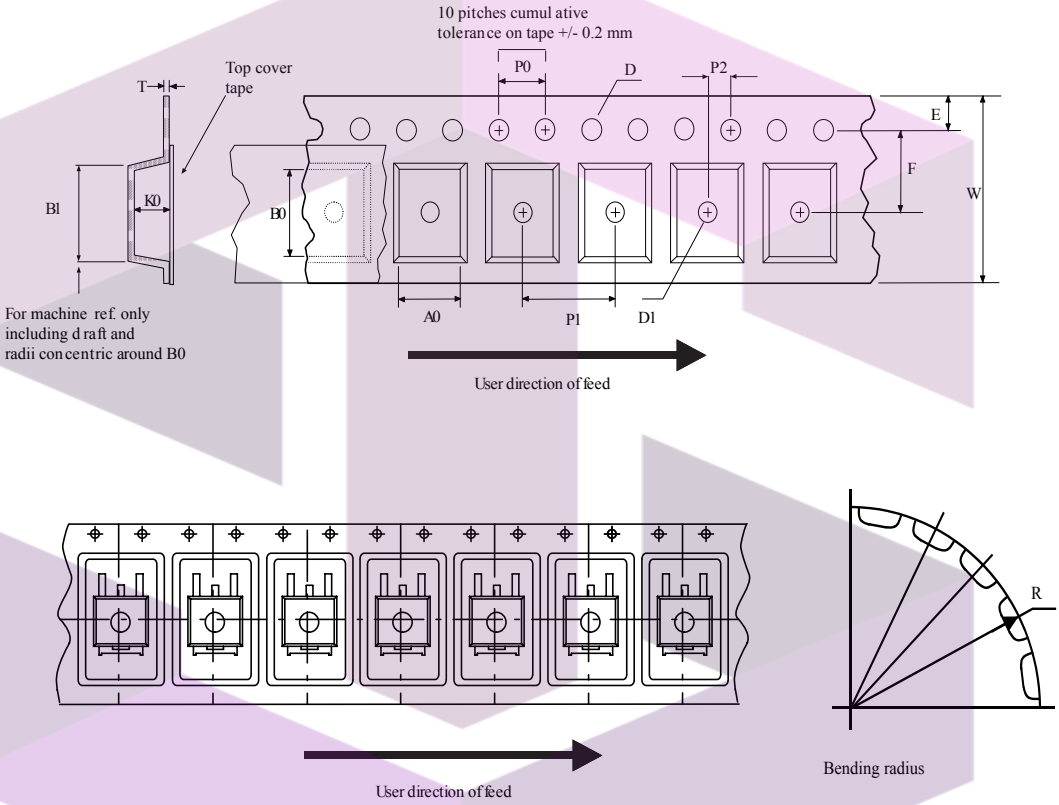


Figure 21. **Reel for D²PAK**

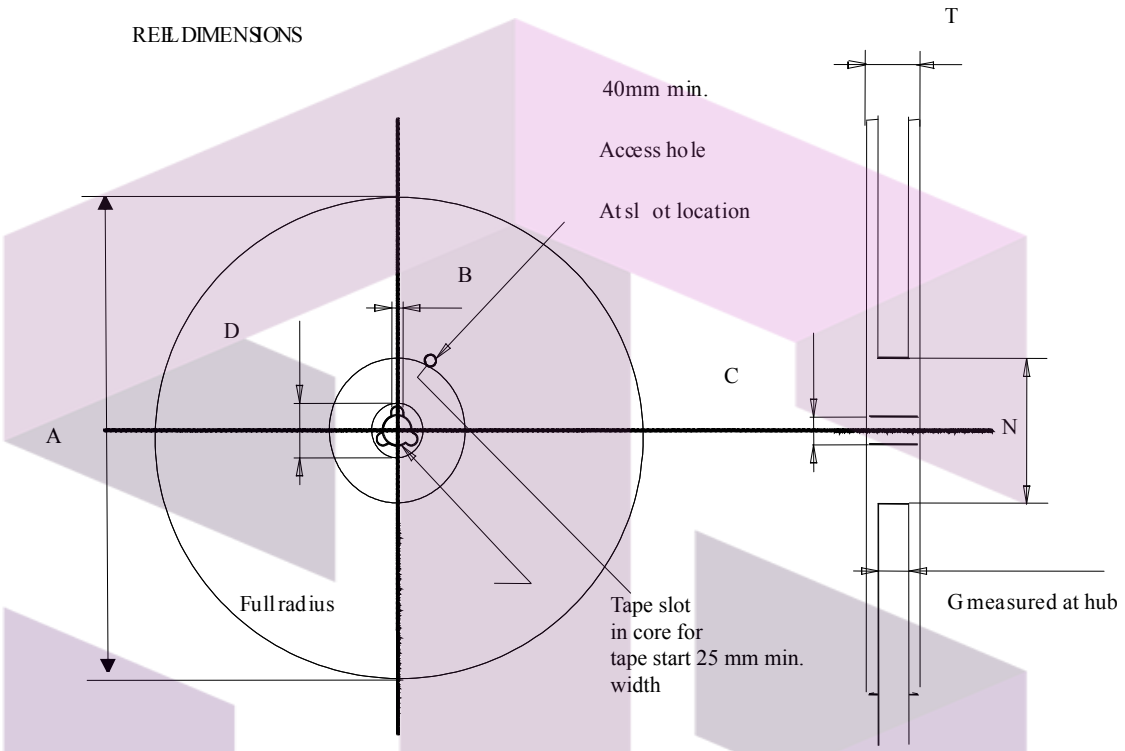


Table 12. **D²PAK tape and reel mechanical data**

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			

Revision history

Table 13. **Document revision history**

Date	Revision	Changes
01-Sep-2004	10	Mistake VREF==> V_O, tables 1, 4 and 5.
19-Jan-2007	11	D²PAK 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 mA to I_{MAX} ==> I_O = 10 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} valuefor 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	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. Added Section 8: Packaging mechanical data. Minor text changes.
28-May-2018	20	Updated Section 8.5 D²PAK (ASE) type B package information.
31-Jul-2019	21	Updated T_{OP} unit in Table 1. Absolute maximum ratings.

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