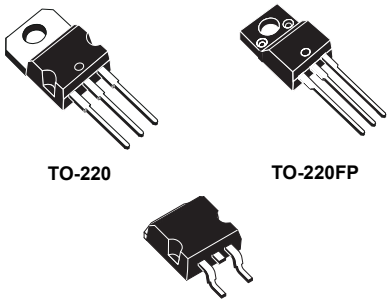
# LM217, LM317

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.

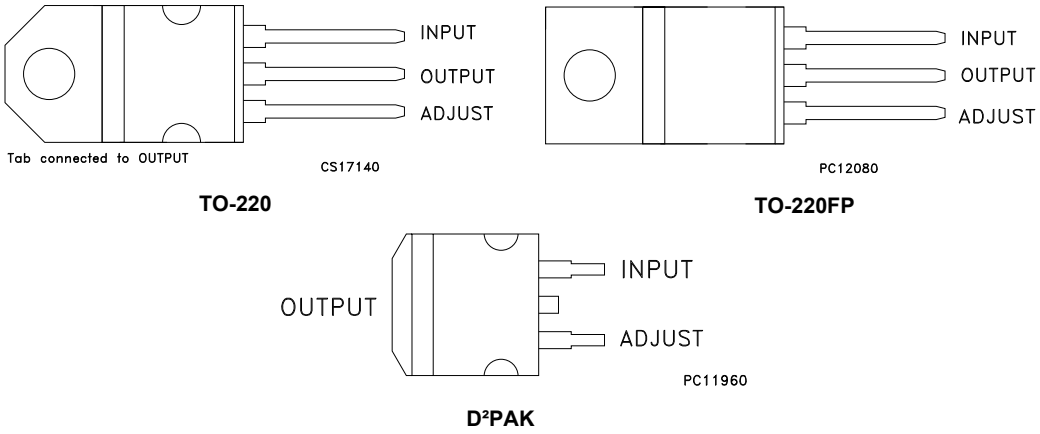
They are designed to supply more than 1.5 A of load current with an output voltage adjustable over a 1.2 to 37 V range.

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.

| Maturity 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 |

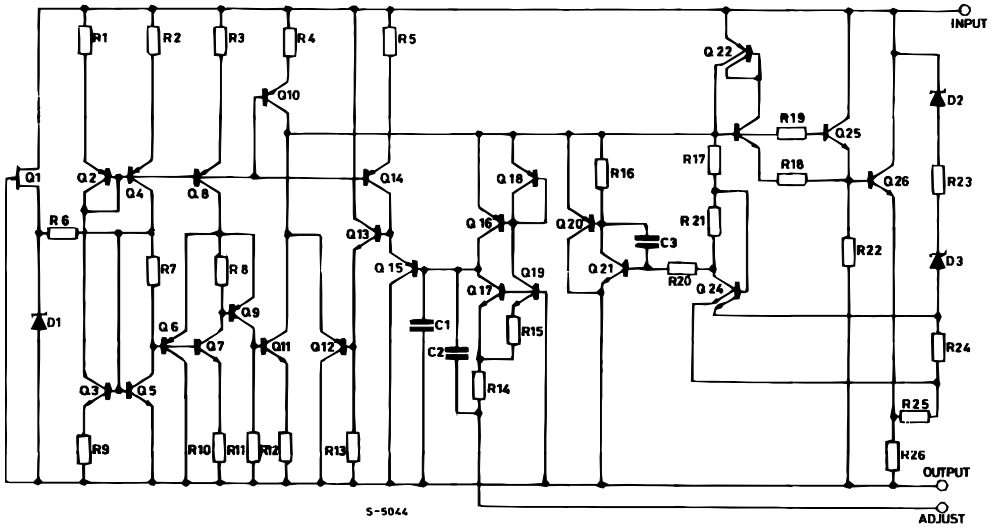
*Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.*

**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, $T_J$ = - 55 to 150 °C, unless otherwise specified.

**Table 3. Electrical characteristics for LM217**

| Symbol | Parameter | Test conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $\Delta V_O$ | Line regulation | $V_I$ - $V_O$ = 3 to 40 V | $T_J$ = 25°C | | 0.01 | 0.02 | %/V |
| | | | | | 0.02 | 0.05 | |
| $\Delta V_O$ | Load regulation | $V_O \leq 5$ V<br>$I_O$ = 10 mA to $I_{MAX}$ | $T_J$= 25°C | | 5 | 15 | mV |
| | | | | | 20 | 50 | |
| | | $V_O \geq 5$ V,<br>$I_O$ = 10 mA to $I_{MAX}$ | $T_J$ = 25°C | | 0.1 | 0.3 | % |
| | | | | | 0.3 | 1 | |
| $I_{ADJ}$ | Adjustment pin current | | | | 50 | 100 | µA |
| $\Delta I_{ADJ}$ | 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 $I_{MAX}$<br>$P_D \leq P_{MAX}$ | | 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 |
|---|---|---|---|---|---|---|---|
| $\Delta V_O$ | Line regulation | $V_I$ - $V_O$ = 3 to 40 V | $T_J$ = 25°C | | 0.01 | 0.04 | %/V |
| | | | | | 0.02 | 0.07 | |
| $\Delta V_O$ | Load regulation | $V_O \leq 5$ V<br>$I_O$ = 10 mA to $I_{MAX}$ | $T_J$= 25°C | | 5 | 25 | mV |
| | | | | | 20 | 70 | |
| | | $V_O \geq 5$ V,<br>$I_O$ = 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 |
| $\Delta I_{ADJ}$ | Adjustment pin current | $V_I$ - $V_O$ = 2.5 to 40 V<br>$I_O$ = 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<br>$I_O$ = 10 mA to $I_{MAX}$<br>$P_D \leq P_{MAX}$ | | 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 |
|---|---|---|---|---|---|---|---|
| $\Delta V_O$ | Line regulation | $V_I$ - $V_O$ = 3 to 40 V | $T_J$ = 25°C | | 0.01 | 0.04 | %/V |
| | | | | | 0.02 | 0.07 | |
| $\Delta V_O$ | Load regulation | $V_O \leq 5$ V<br>$I_O$ = 10 mA to $I_{MAX}$ | $T_J$= 25°C | | 5 | 25 | mV |
| | | | | | 20 | 70 | |
| | | $V_O \geq 5$ V,<br>$I_O$ = 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 |
| $\Delta I_{ADJ}$ | Adjustment pin current | $V_I$ - $V_O$ = 2.5 to 40 V<br>$I_O$ = 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<br>$I_O$ = 10 mA to 500 mA<br>$P_D \leq P_{MAX}$ | | 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**

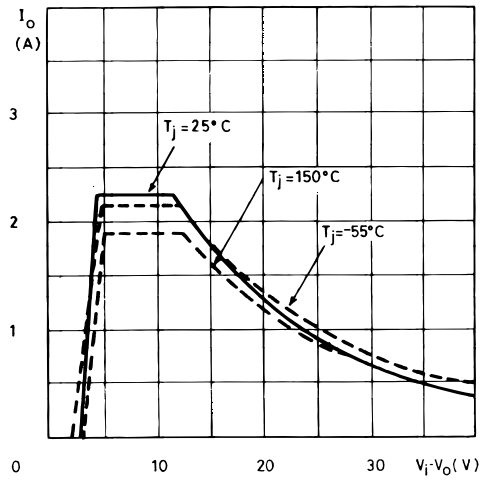



**Figure 4. Dropout voltage vs. junction temperature**

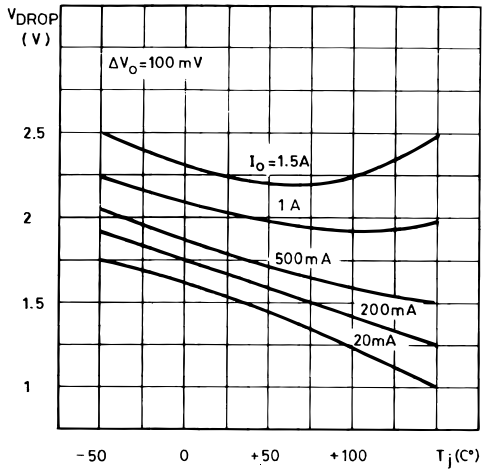



**Figure 5. Reference voltage vs. junction**

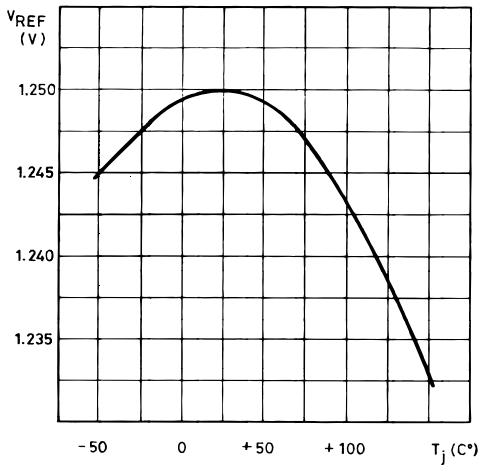
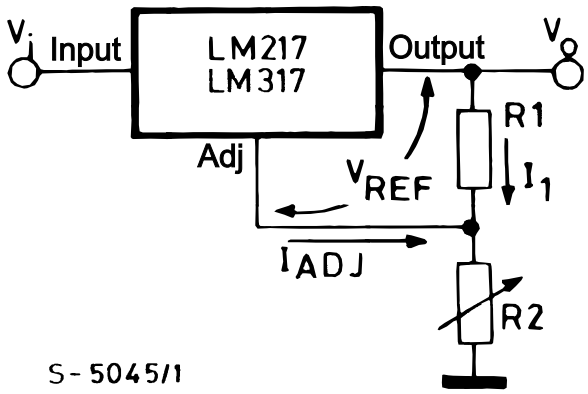


Figure 6. **Basic adjustable regulator**



# 6 Application information

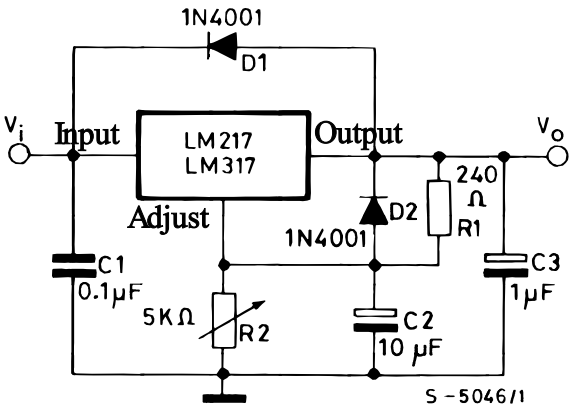
The LM217, LM317 provides an internal reference voltage of 1.25 V between the output and adjustments terminals. This is used to set a constant current flow across an external resistor divider (see Figure 6. Basic adjustable regulator), giving an output voltage $V_O$ of:

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

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**

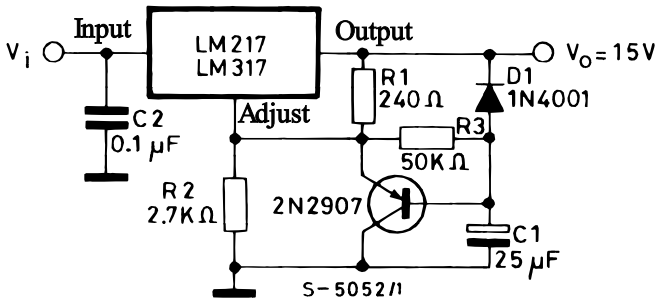
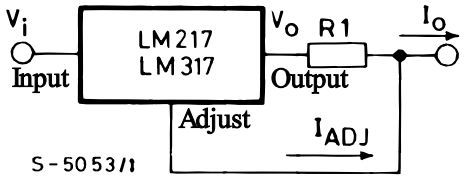



Figure 9. **Current regulator**




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

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

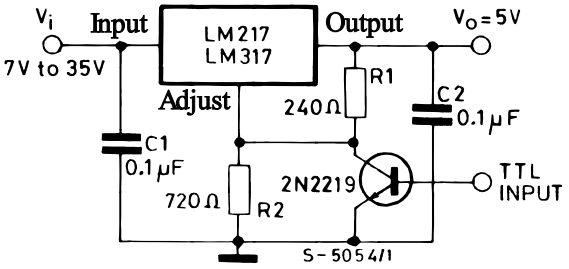
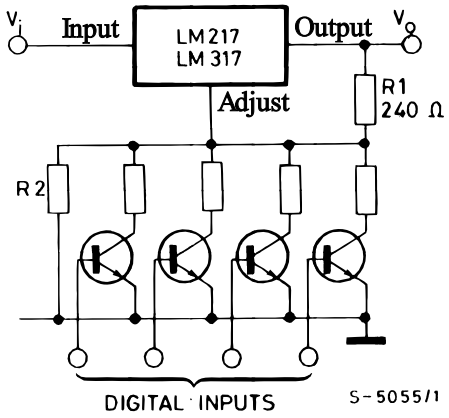
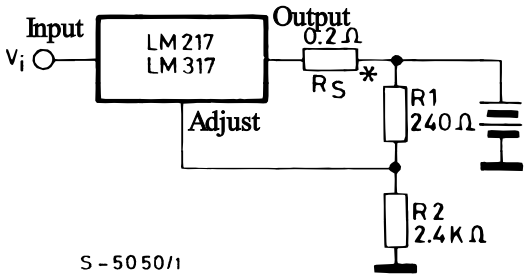


Figure 11. **Digitally selected outputs**



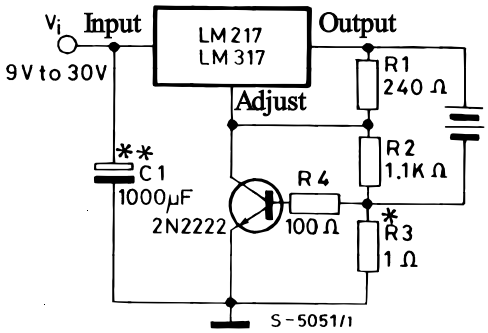

($R_2$ sets maximum $V_O$)

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**

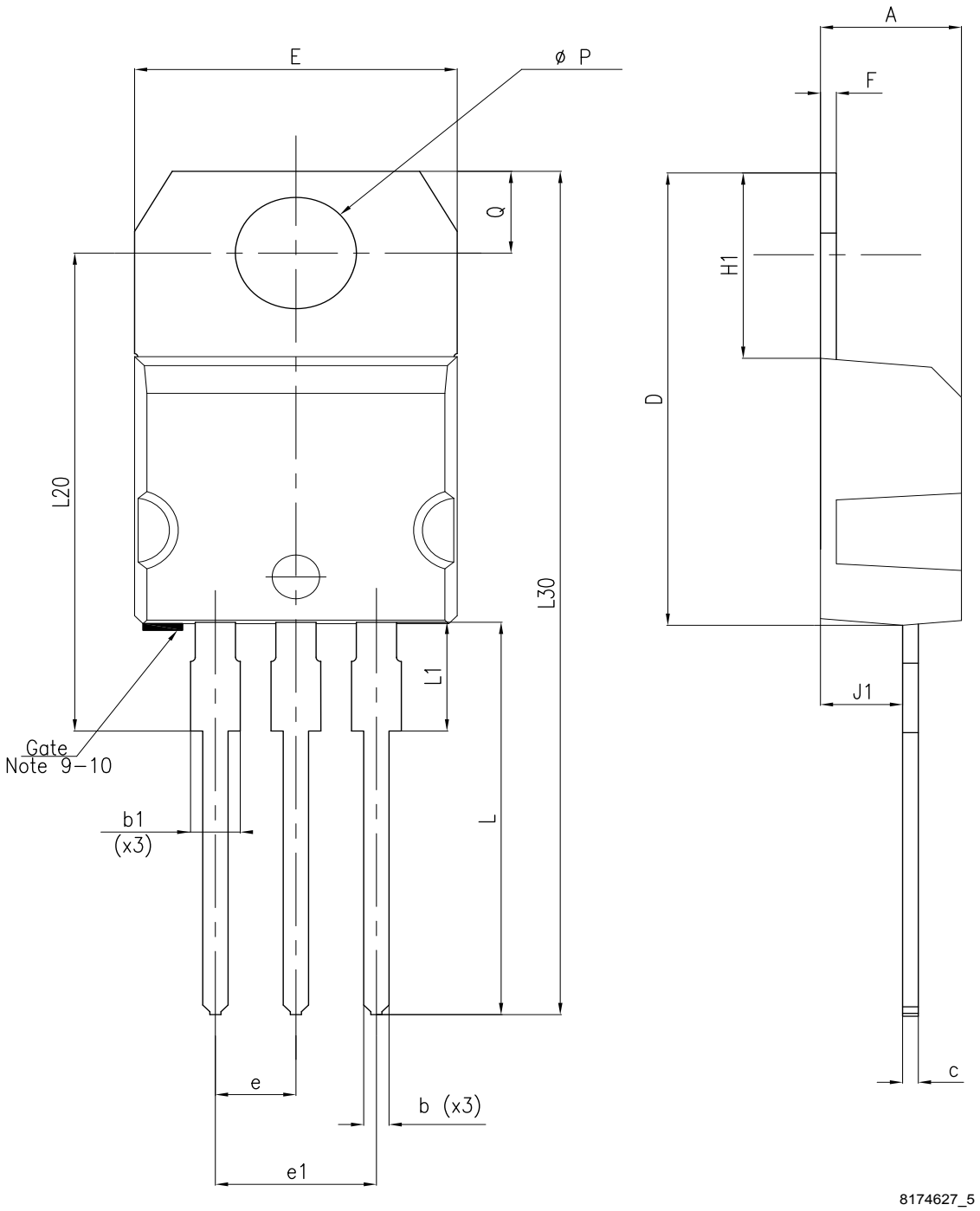


Table 7. **TO-220 (single gauge) mechanical data**

| 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**

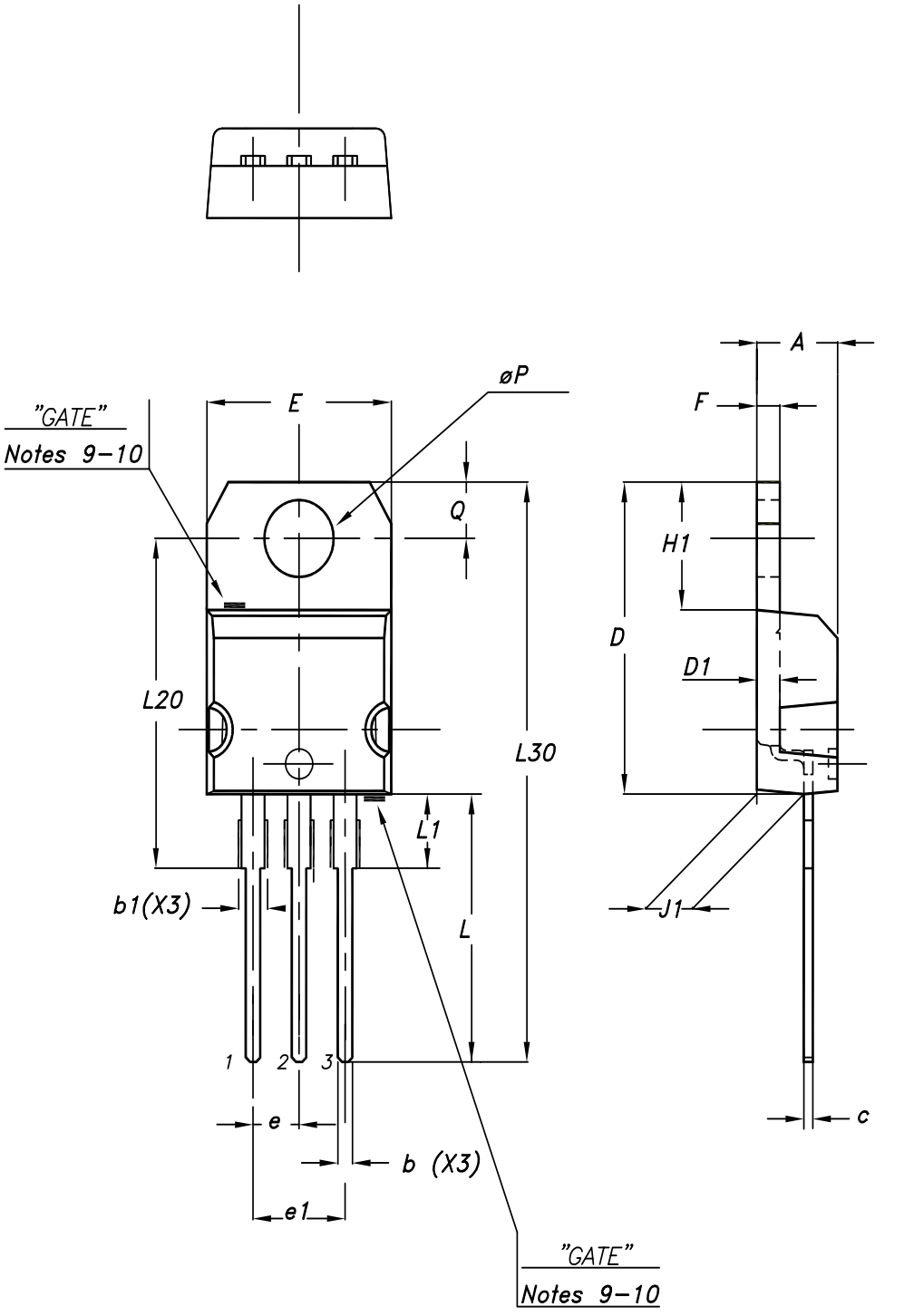


Table 8. **TO-220 (dual gauge) mechanical data**

| 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**

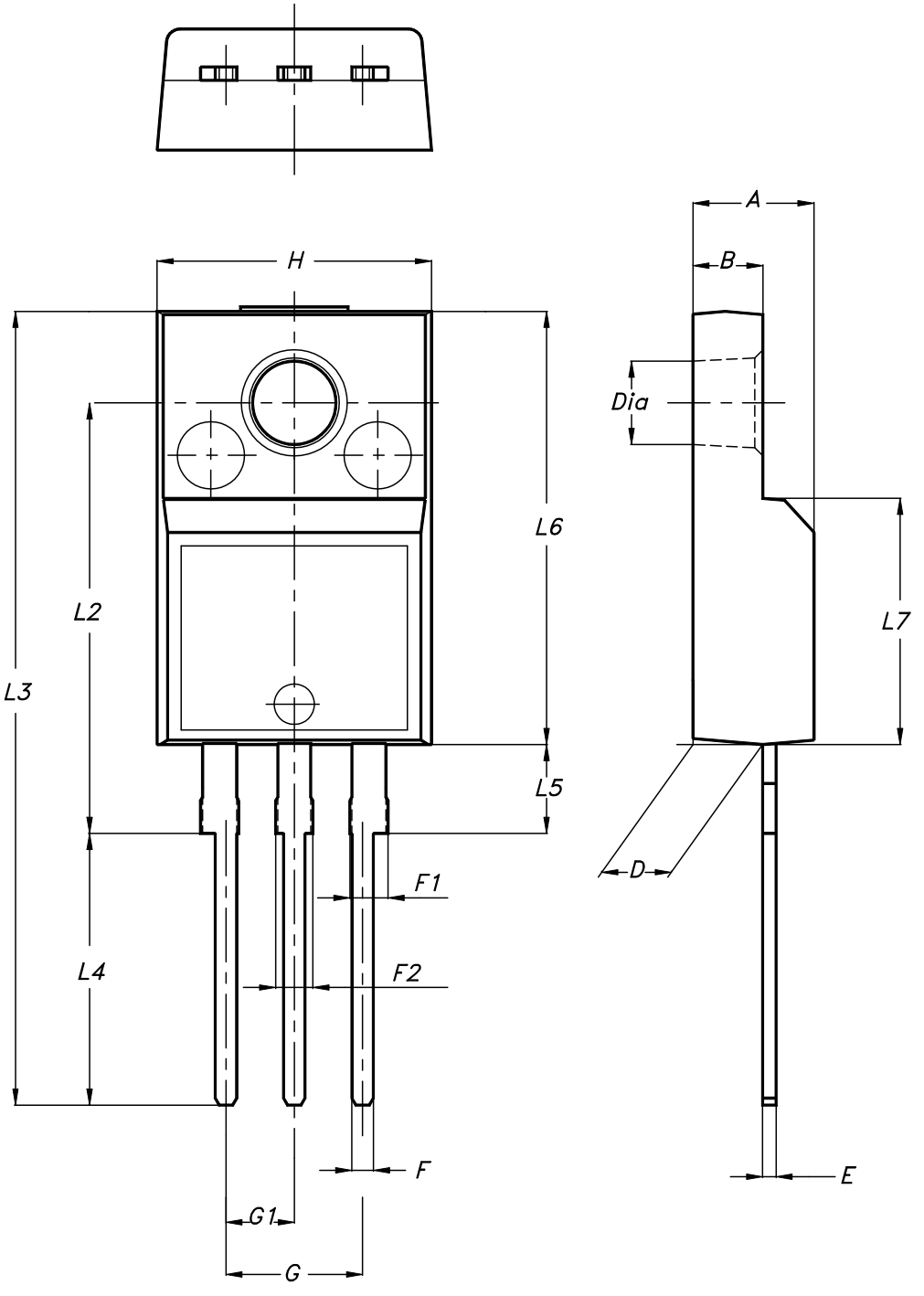
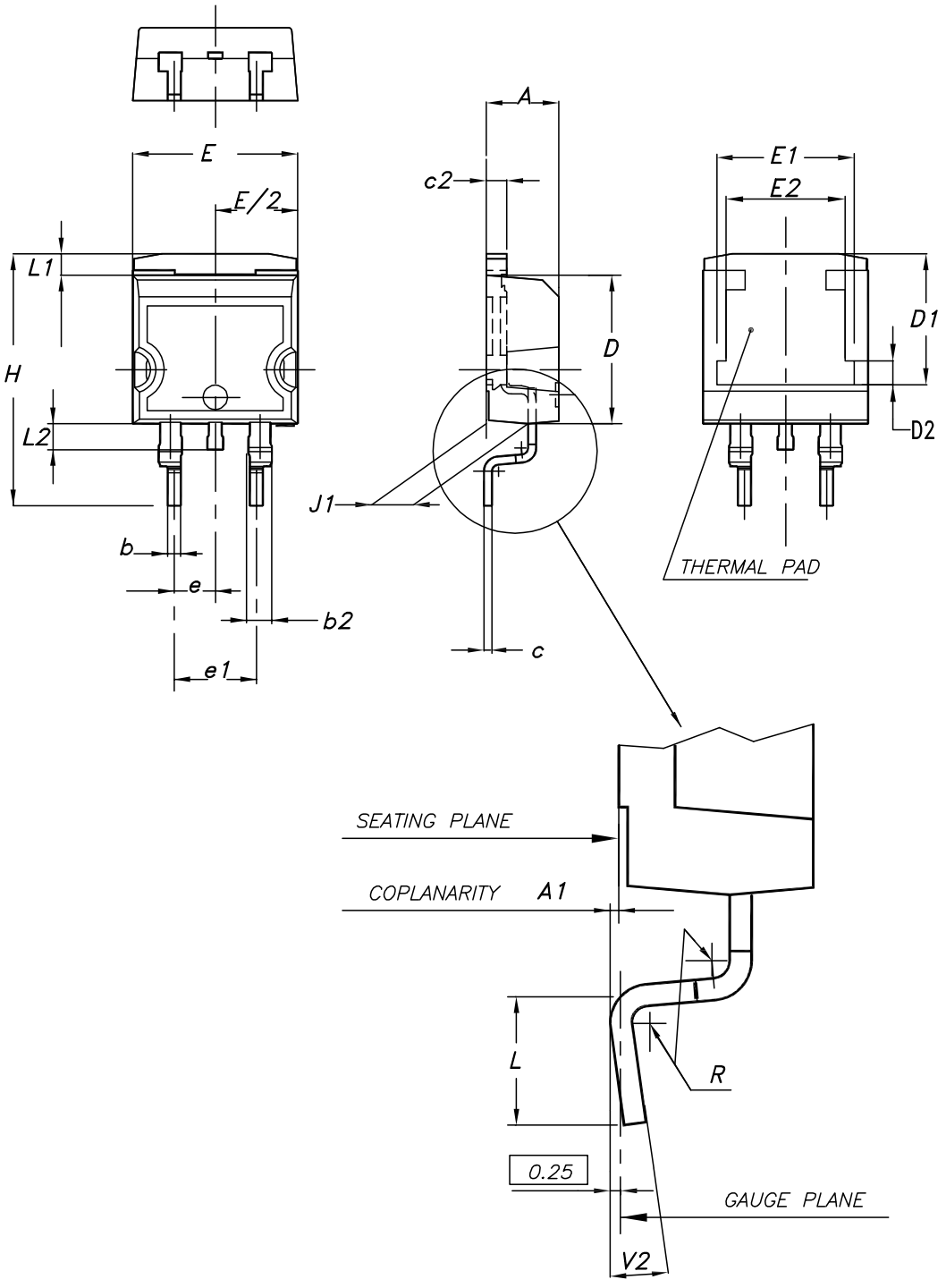


Table 9. **TO-220FP package mechanical data**

| 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**



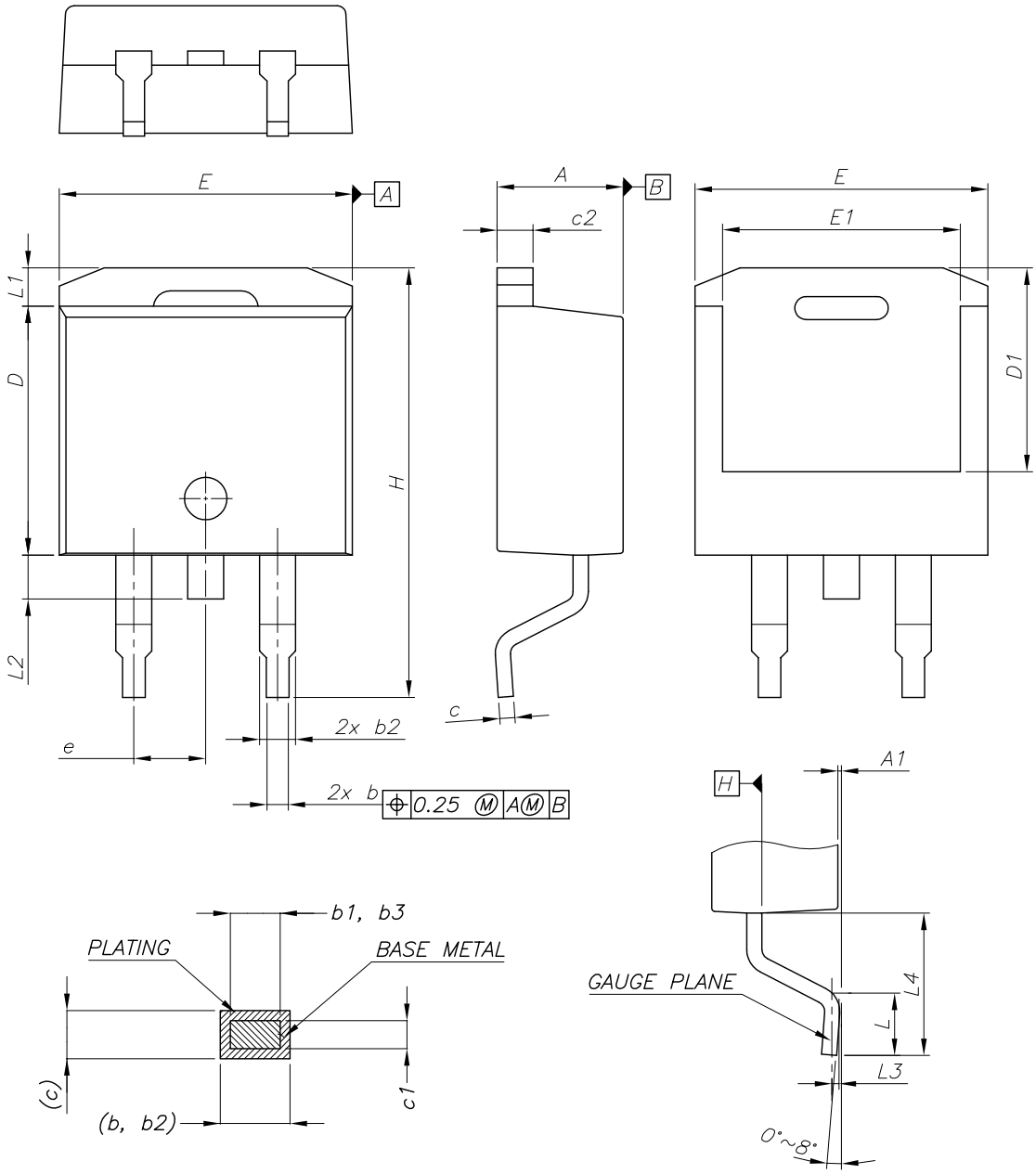

0079457_22_type A

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**

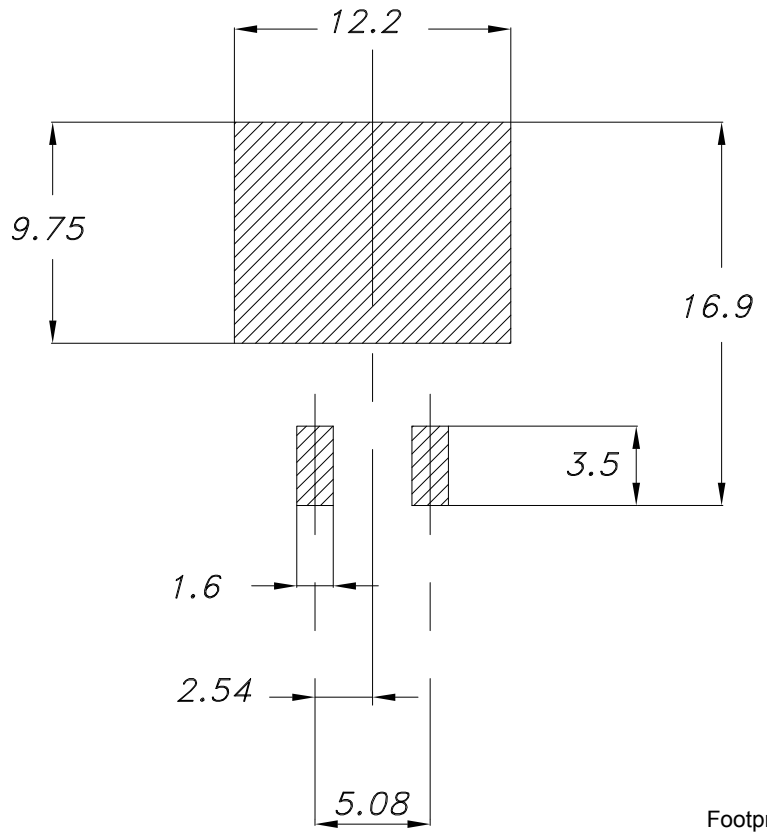



0079457_23_type B

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 packing information

Figure 20. D²PAK tape outline

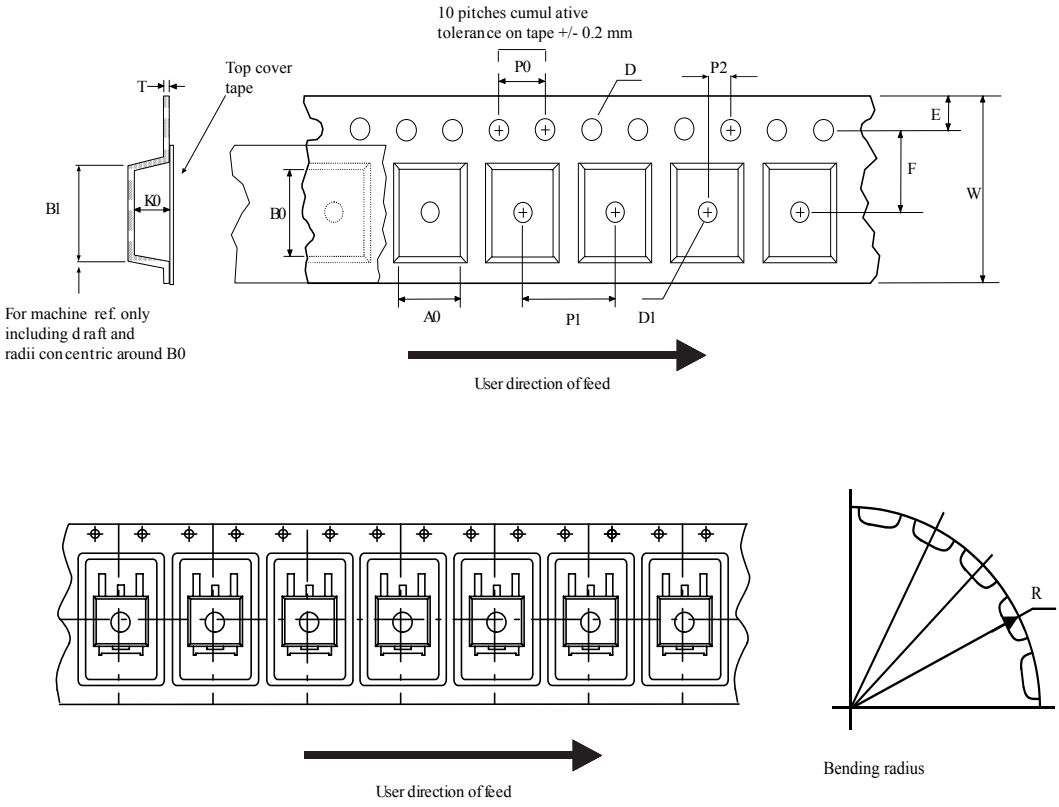


Figure 21. **Reel for D²PAK**

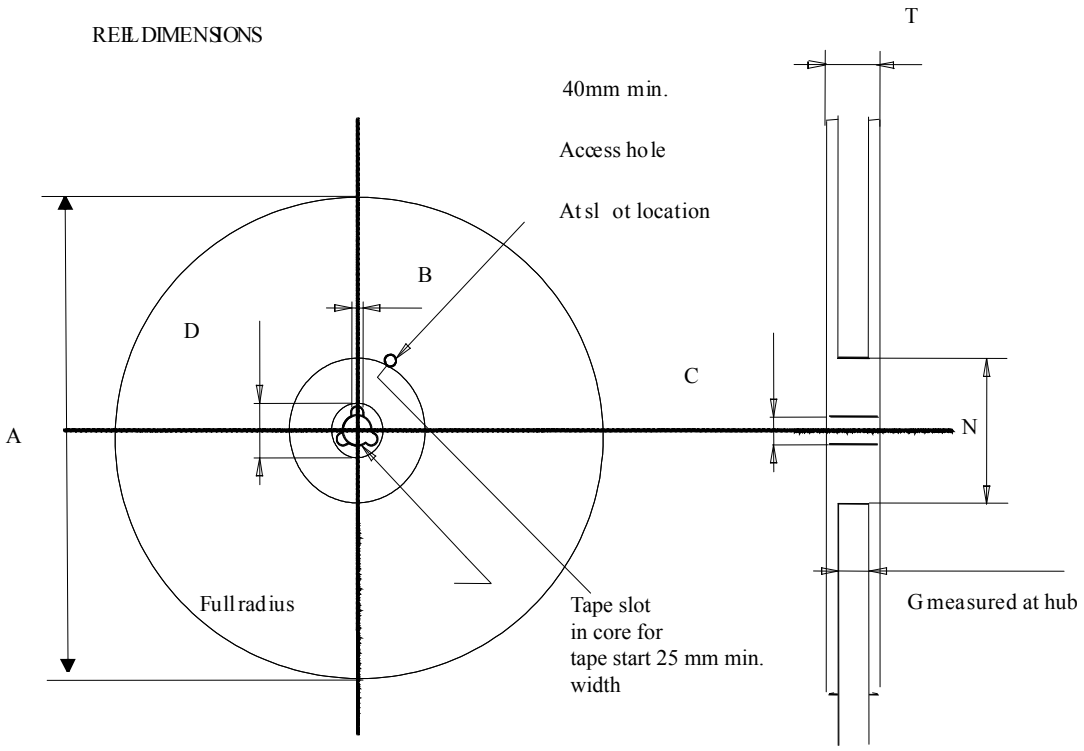



Table 12. **D²PAK tape and reel mechanical data**

| 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 $\Delta I_{ADJ}$ 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.<br>Updated the description in cover page<br>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.<br>Added Section 8: Packaging mechanical data. Minor text changes. |
| 28-May-2018 | 20 | Updated Section 8.5 D²PAK (ASE) type B package information. |

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