

## Medium current 1.2 to 37 V adjustable voltage regulator

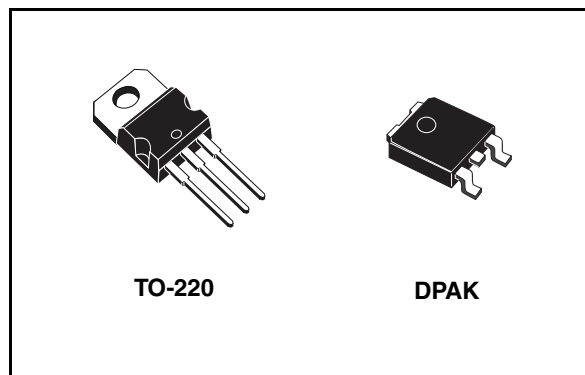
### Features

- Output voltage range: 1.2 to 37 V
- Output current in excess of 500 mA
- Line regulation typ. 0.01 %
- Load regulation typ. 0.1 %
- Thermal overload protection
- Short circuit protection
- Output transition safe area compensation
- Floating operation for high voltage applications

### Description

The LM217M/LM317M are monolithic integrated circuits in TO-220 and DPAK packages intended for use as positive adjustable voltage regulators. They are designed to supply until 500 mA 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 only a resistive divider, making the device



exceptionally easy to use and eliminating the stocking of many fixed regulators.

**Table 1. Device summary**

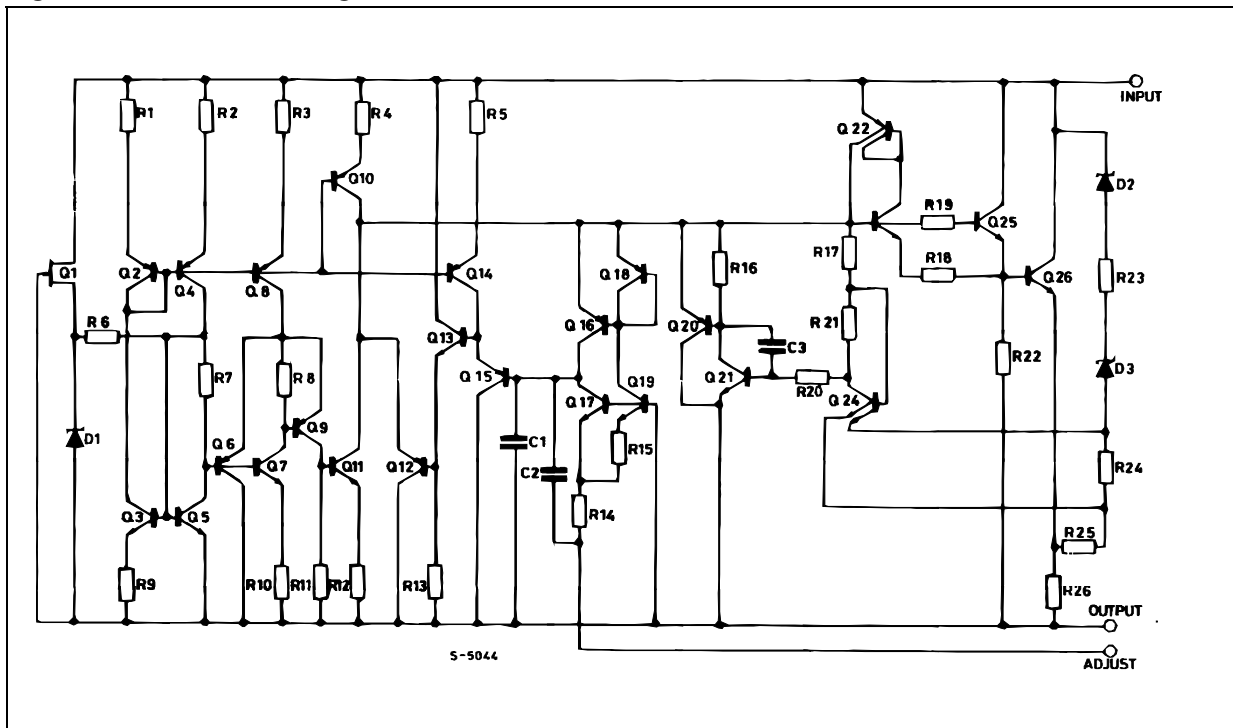
| Order codes |                      |
|-------------|----------------------|
| TO-220      | DPAK (tape and reel) |
|             | LM217MDT-TR          |
| LM317MT     | LM317MDT-TR          |

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Diagram</b> .....                              | <b>3</b>  |
| <b>2</b> | <b>Pin configuration</b> .....                    | <b>4</b>  |
| <b>3</b> | <b>Maximum ratings</b> .....                      | <b>5</b>  |
| <b>4</b> | <b>Electrical characteristics</b> .....           | <b>6</b>  |
| <b>5</b> | <b>Typical performance</b> .....                  | <b>8</b>  |
| <b>6</b> | <b>Application information</b> .....              | <b>9</b>  |
|          | 6.1 External capacitors ( <i>Figure 8</i> ) ..... | 9         |
|          | 6.2 Protection diodes ( <i>Figure 8</i> ) .....   | 9         |
|          | 6.3 Start-up block .....                          | 9         |
| <b>7</b> | <b>Application circuits</b> .....                 | <b>10</b> |
| <b>8</b> | <b>Package mechanical data</b> .....              | <b>12</b> |
| <b>9</b> | <b>Revision history</b> .....                     | <b>20</b> |

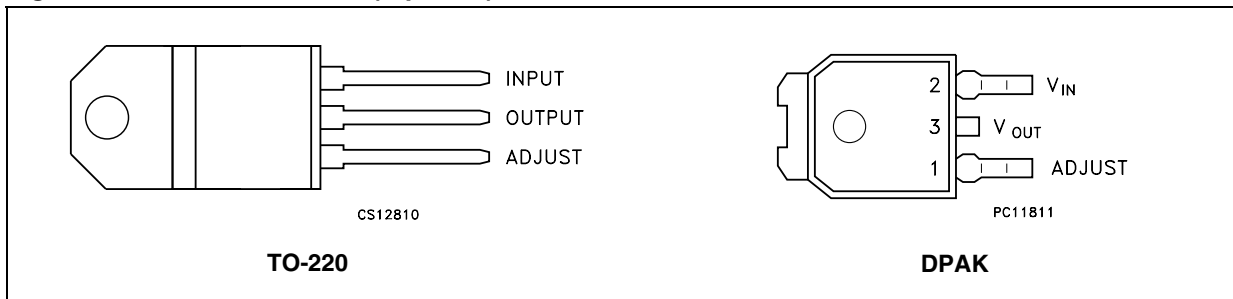
# 1 Diagram

Figure 1. Schematic diagram



## 2 Pin configuration

Figure 2. Pin connections (top view)



### 3 Maximum ratings

**Table 2. Absolute maximum ratings**

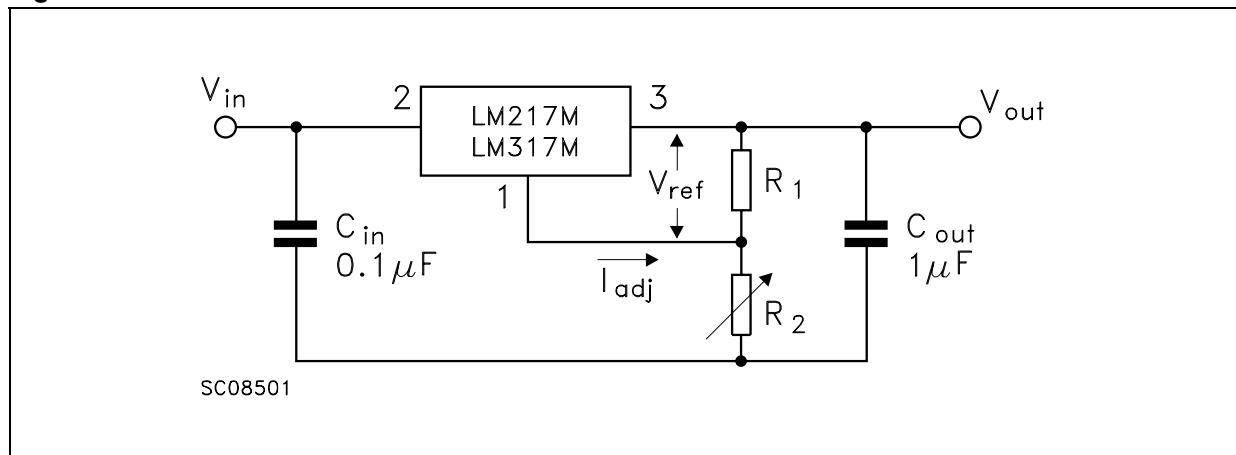
| Symbol    | Parameter   | Value              | Unit       |
|-----------|---|--------------------|------------|
| $V_I-V_O$ | Input-output differential voltage                   | 40                 | V          |
| $P_D$     | Power dissipation                                   | Internally limited | mW         |
| $T_{OP}$  | Operating junction temperature range <sup>(1)</sup> | for LM217M         | -40 to 125 |
|           |   | for LM317M         | 0 to 125   |
| $T_{STG}$ | Storage temperature range                           | -55 to 150         | °C         |

1. Re-Boot is not guaranteed for  $T_J \geq 85^\circ\text{C}$ .

**Table 3. Thermal data**

| Symbol     | Parameter                           | TO-220 | DPAK | Unit |
|------------|-------------------------------------|--------|------|------|
| $R_{thJC}$ | Thermal resistance junction-case    | 3      | 8    | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50     | 100  | °C/W |

**Figure 3. Test circuit**



## 4 Electrical characteristics

**Table 4. Electrical characteristics of LM217M** (refer to the test circuits,  $T_J = -40$  to  $125$  °C,  $V_I - V_O = 5$  V,  $I_O = 100$  mA,  $P_D \leq 7.5$  W, unless otherwise specified)

| 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>$I_O = 10$ to $500$ mA             | $T_J = 25$ °C     |      | 5     | 15   | mV              |
|                  |   |  |                   |      | 20    | 50   |                 |
|                  |   | $V_O \geq 5$ V<br>$I_O = 10$ to $500$ mA             | $T_J = 25$ °C     |      | 0.1   | 0.3  | %V <sub>O</sub> |
|                  |   |  |                   |      | 0.3   | 1    |                 |
| $I_{ADJ}$        | Adjustment pin current                      |  |                   |      | 50    | 100  | μA              |
| $\Delta I_{ADJ}$ | Adjustment pin current                      | $V_I - V_O = 3$ to $40$ V, $I_O = 10$ to $500$ mA    |                   |      | 0.2   | 5    | μA              |
| $V_{REF}$        | Reference voltage                           | $V_I - V_O = 3$ to $40$ V, $I_O = 10$ to $500$ mA    |                   | 1.2  | 1.25  | 1.3  | V               |
| $\Delta V_O/V_O$ | Output voltage temperature stability        |  |                   |      | 0.7   |      | %               |
| $I_{O(min)}$     | Minimum load current                        | $V_I - V_O = 40$ V                                   |                   |      | 3.5   | 5    | mA              |
| $I_{O(max)}$     | Maximum output current                      | $V_I - V_O \leq 15$ V                                |                   | 500  | 1000  |      | mA              |
|                  |   | $V_I - V_O = 40$ V, $P_d < P_{DMAX}$ , $T_J = 25$ °C |                   |      | 200   |      |                 |
| eN               | Output noise voltage (percentage of $V_O$ ) | B = 10 Hz to 100 kHz, $T_J = 25$ °C                  |                   |      | 0.003 |      | %               |
| SVR              | Supply voltage rejection <sup>(1)</sup>     | $T_J = 25$ °C<br>$f = 120$ Hz                        | $C_{ADJ} = 0$     |      | 65    |      | dB              |
|                  |   |  | $C_{ADJ} = 10$ μF | 66   | 80    |      |                 |

1.  $C_{ADJ}$  is connected between Adjust pin and Ground.

**Table 5. Electrical characteristics of LM317M** (refer to the test circuits,  $T_J = 0$  to  $125\text{ }^\circ\text{C}$ ,  $V_I - V_O = 5\text{ V}$ ,  $I_O = 100\text{ mA}$ ,  $P_D \leq 7.5\text{ W}$ , unless otherwise specified)

| Symbol           | Parameter                                   | Test conditions  |                                   | Min. | Typ.  | Max.          | Unit            |
|------------------|---|--|-----------------------------------|------|-------|---------------|-----------------|
| $\Delta V_O$     | Line regulation                             | $V_I - V_O = 3$ to $40\text{ V}$   | $T_J = 25\text{ }^\circ\text{C}$  |      | 0.01  | 0.04          | %V              |
|                  |   |  |                                   |      | 0.02  | 0.07          |                 |
| $\Delta V_O$     | Load regulation                             | $V_O \leq 5\text{ V}$<br>$I_O = 10$ to $500\text{ mA}$                                 | $T_J = 25\text{ }^\circ\text{C}$  |      | 5     | 25            | mV              |
|                  |   |  |                                   |      | 20    | 70            |                 |
|                  |   | $V_O \geq 5\text{ V}$<br>$I_O = 10$ to $500\text{ mA}$                                 | $T_J = 25\text{ }^\circ\text{C}$  |      | 0.1   | 0.5           | %V <sub>O</sub> |
|                  |   |  |                                   |      | 0.3   | 1.5           |                 |
| $I_{ADJ}$        | Adjustment pin current                      |  |                                   | 50   | 100   | $\mu\text{A}$ |                 |
| $\Delta I_{ADJ}$ | Adjustment pin current                      | $V_I - V_O = 3$ to $40\text{ V}$ , $I_O = 10$ to $500\text{ mA}$                       |                                   |      | 0.2   | 5             | $\mu\text{A}$   |
| $V_{REF}$        | Reference voltage                           | $V_I - V_O = 3$ to $40\text{ V}$ , $I_O = 10$ to $500\text{ mA}$                       |                                   | 1.2  | 1.25  | 1.3           | V               |
| $\Delta V_O/V_O$ | Output voltage temperature stability        |  |                                   |      | 0.7   |               | %               |
| $I_{O(\min)}$    | Minimum load current                        | $V_I - V_O = 40\text{ V}$  |                                   |      | 3.5   | 10            | mA              |
| $I_{O(\max)}$    | Maximum output current                      | $V_I - V_O \leq 15\text{ V}$   |                                   | 500  | 1000  |               | mA              |
|                  |   | $V_I - V_O = 40\text{ V}$ , $P_d < P_{D\text{MAX}}$ , $T_J = 25\text{ }^\circ\text{C}$ |                                   |      | 200   |               |                 |
| eN               | Output noise voltage (percentage of $V_O$ ) | B = 10 Hz to 100 kHz, $T_J = 25\text{ }^\circ\text{C}$                                 |                                   |      | 0.003 |               | %               |
| SVR              | Supply voltage rejection <sup>(1)</sup>     | $T_J = 25\text{ }^\circ\text{C}$<br>$f = 120\text{ Hz}$                                | $C_{ADJ} = 0$                     |      | 65    |               | dB              |
|                  |   |  | $C_{ADJ} = 10\text{ }\mu\text{F}$ | 66   | 80    |               |                 |

1.  $C_{ADJ}$  is connected between Adjust pin and Ground.

# 5 Typical performance

Figure 4. Current limit

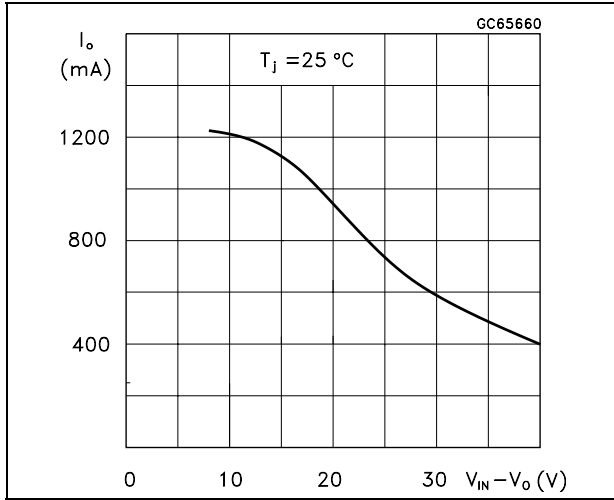


Figure 5. Minimum operating current

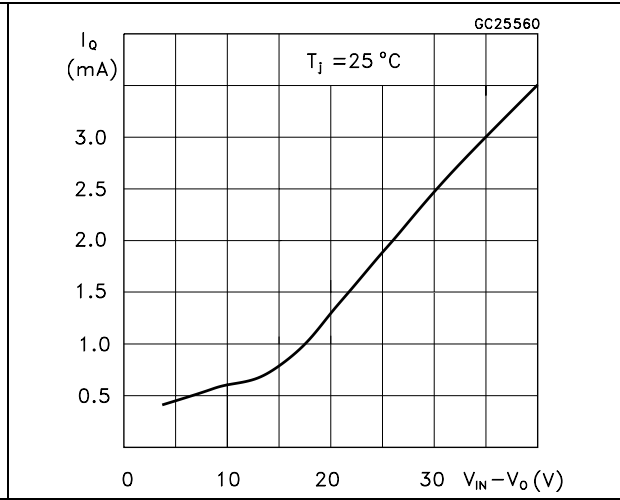


Figure 6. Basic adjustable regulator

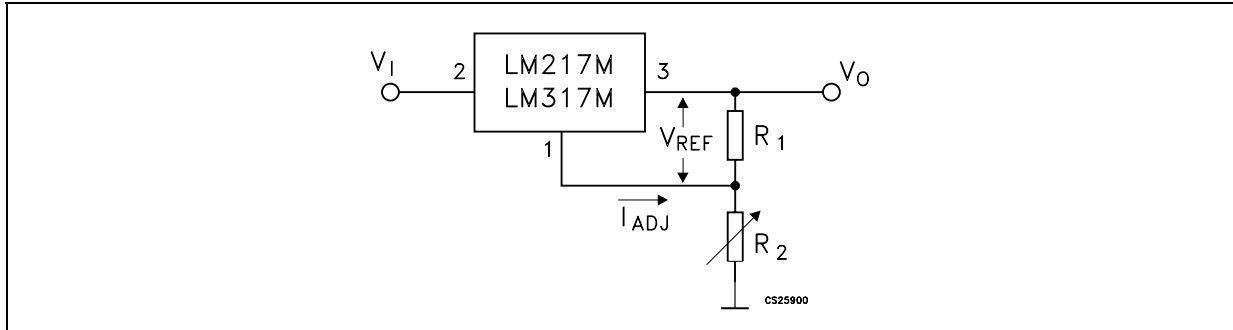
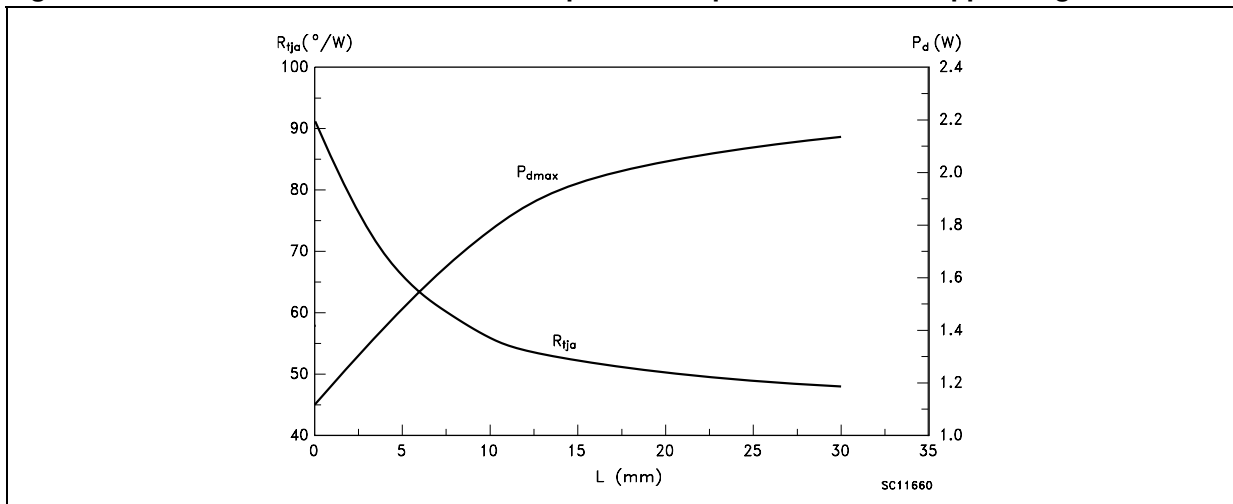


Figure 7. Thermal resistance & maximum power dissipation vs P.C.B. copper length for DPAK



Note:  $P_{dmax}$  calculated for  $T_a = 50^{\circ}C$ .



## 6 Application information

The LM217M/LM317M provide an internal reference voltage of 1.25 V between the output and adjustment terminals. These devices are 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 devices were designed to minimize the term  $I_{ADJ}$  (100  $\mu$ A max) and to maintain it very constant in 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 LM217M/LM317M devices are floating regulators and "see" 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 obtained and, by connecting a fixed resistor between the adjustment and output, the devices 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.

### 6.1 External capacitors ([Figure 8](#))

Normally no capacitors are needed unless the devices are situated far from the input filter capacitors; in which case an input bypass is needed.

A 0.1  $\mu$ F disc or 1  $\mu$ F tantalum input bypass capacitor ( $C_1$ ) is recommended to reduce the sensitivity to input line impedance.

The adjustment terminal may be bypassed to ground to improve ripple rejection. This capacitor ( $C_{ADJ}$ ) prevents ripple from being amplified as the output voltage is increased. A 10  $\mu$ F capacitor should improve ripple rejection of about 80 dB at 120 Hz in a 10 V application.

Although the LM217M/LM317M devices are stable with no output capacitance like any feedback circuit, certain values of external capacitance can cause excessive ringing. An output capacitance ( $C_O$ ) in the form of a 1  $\mu$ F tantalum or 25  $\mu$ F aluminium electrolytic capacitor on the output swamps this effect and insures stability.

### 6.2 Protection diodes ([Figure 8](#))

When external capacitors are used with any IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator.

[Figure 6](#) shows the LM217M/LM317M with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values ( $C_3 > 25 \mu$ F,  $C_2 > 10 \mu$ F). Diode D1 prevents  $C_3$  from discharging through the IC during an input short-circuit. The combination of diodes D1 and D2 prevents  $C_2$  from discharging through the regulator during an input or output short-circuit.

### 6.3 Start-up block

It's not guaranteed the Re-Boot of the device when the junction temperature is over 85 °C.

## 7 Application circuits

Figure 8. Voltage regulator with protection diodes

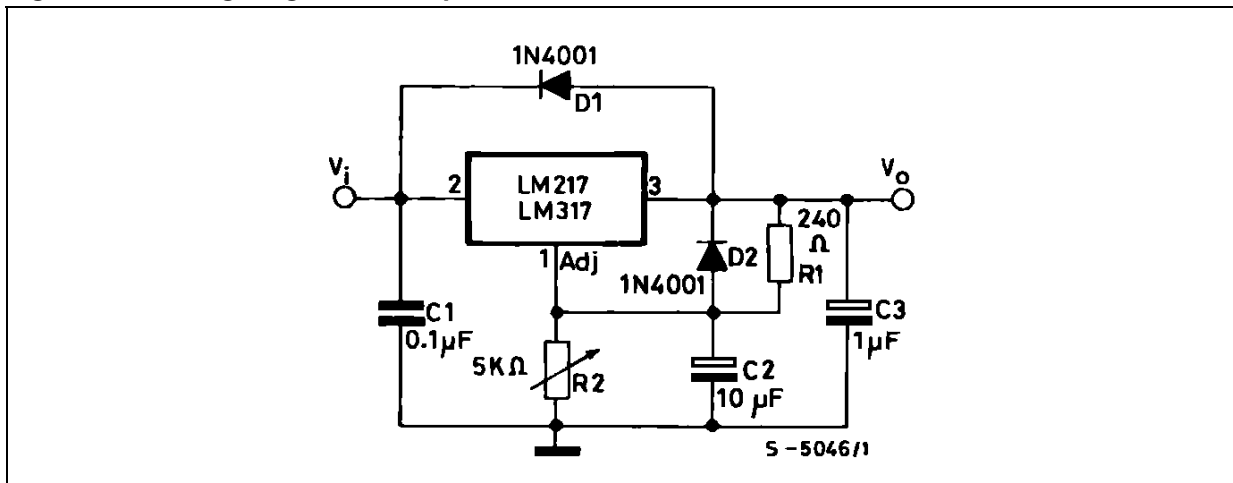


Figure 9. Slow turn-on 15 V regulator

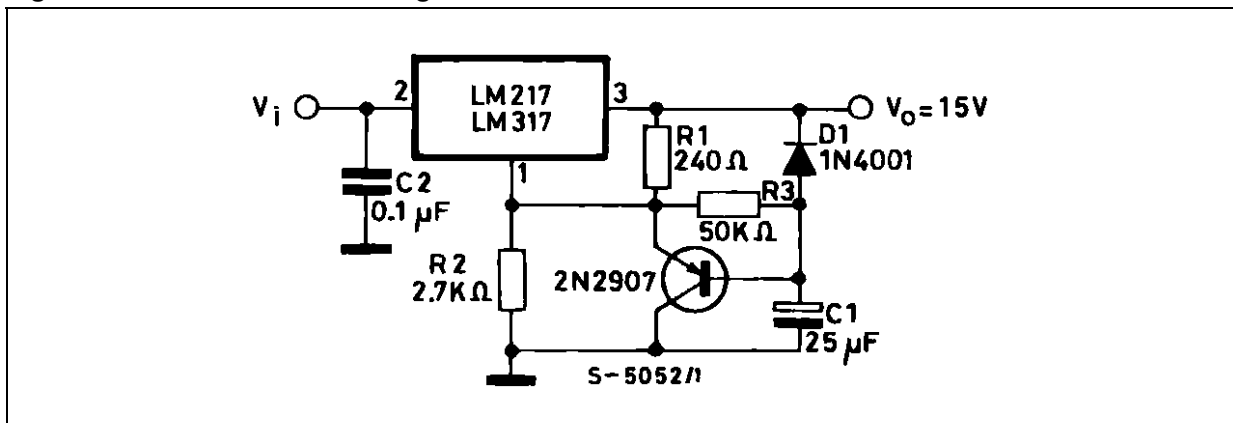


Figure 10. Current regulator

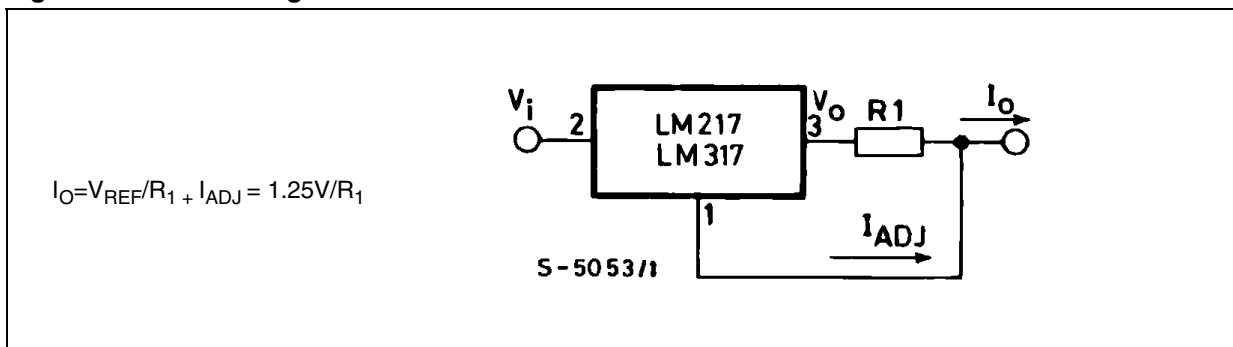


Figure 11. 5 V electronic shut-down regulator

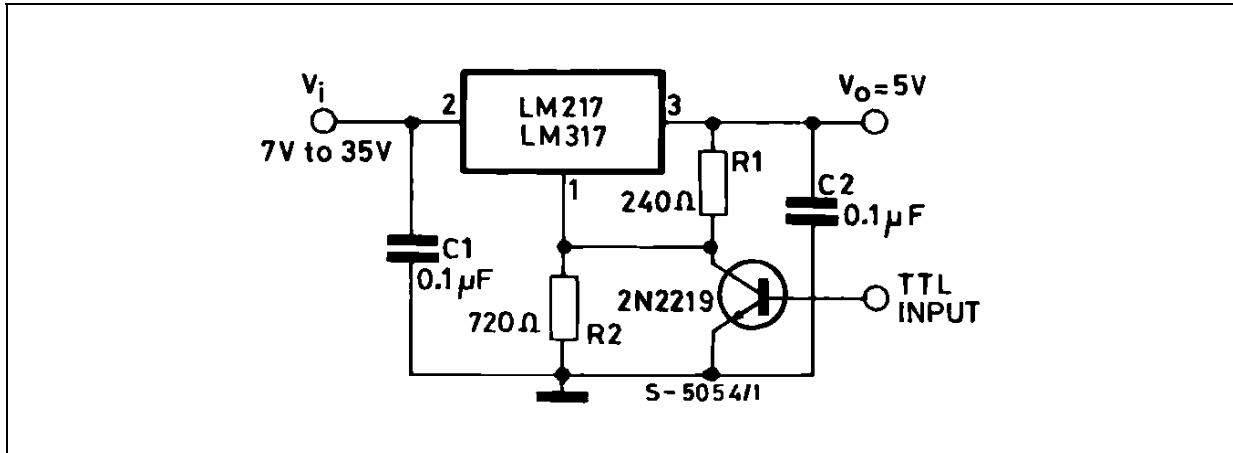
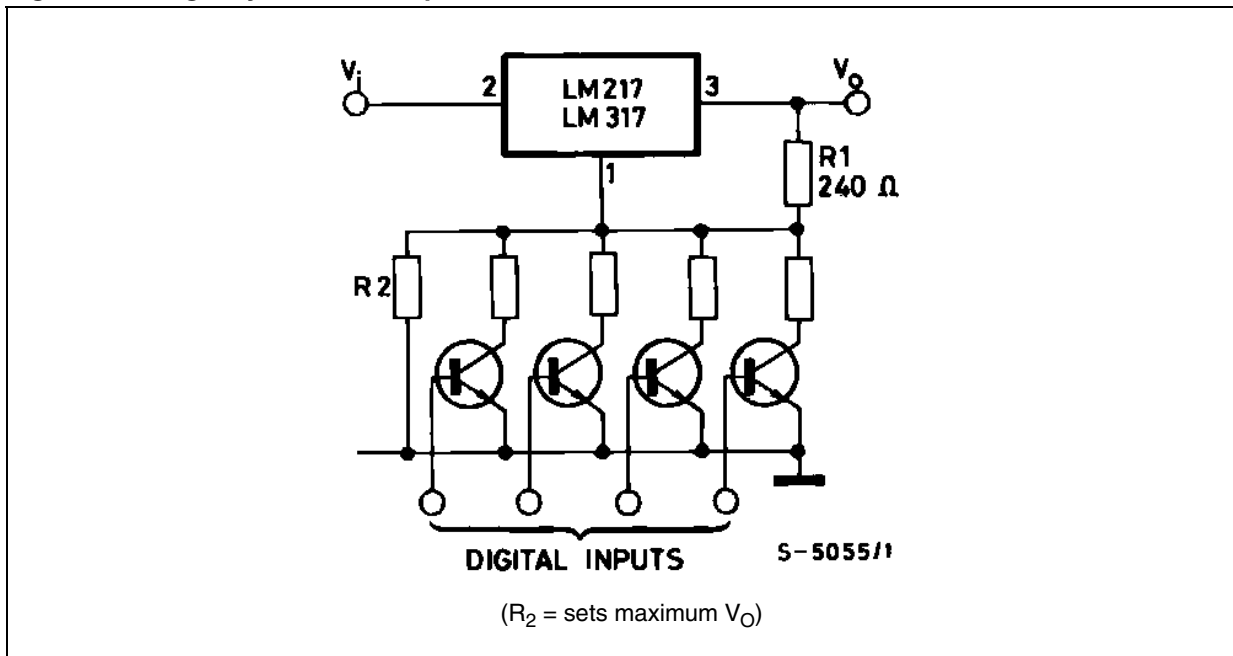


Figure 12. Digitally selected outputs

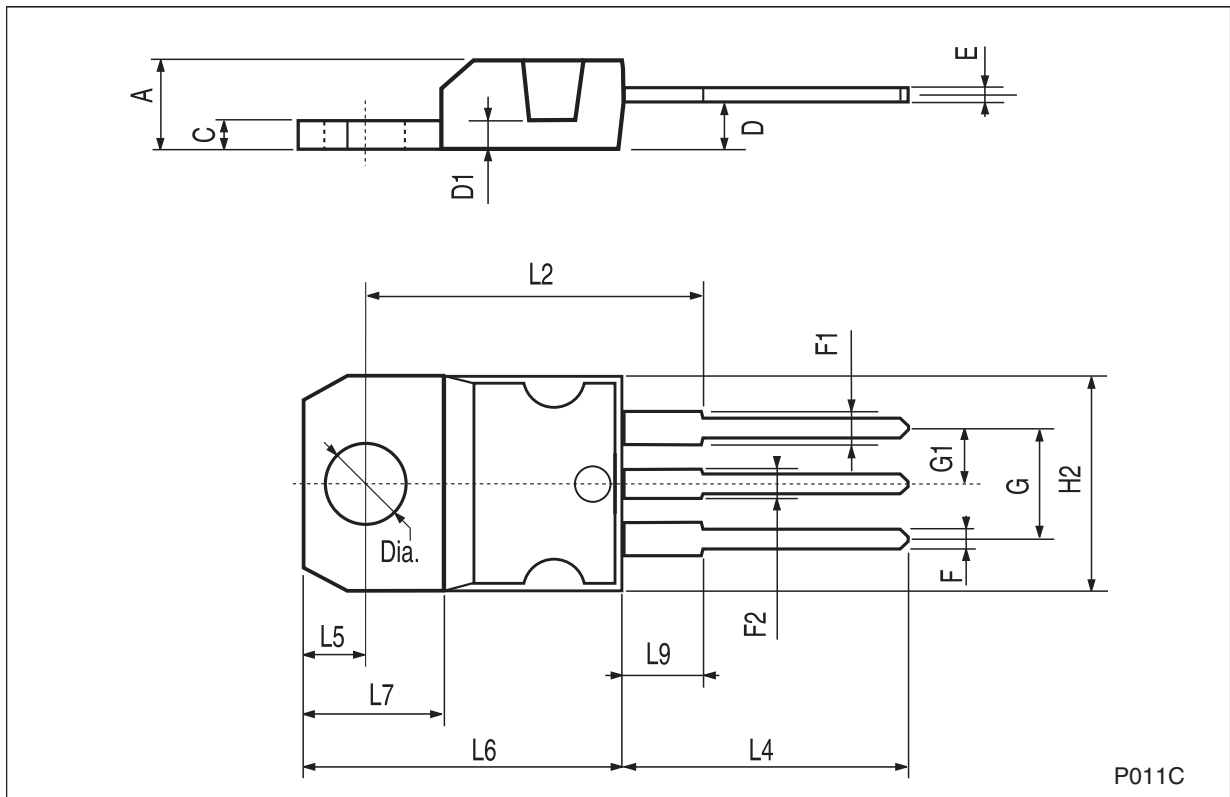


## 8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

**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 |



P011C

Figure 13. Drawing dimension DPAK (type STD-ST)

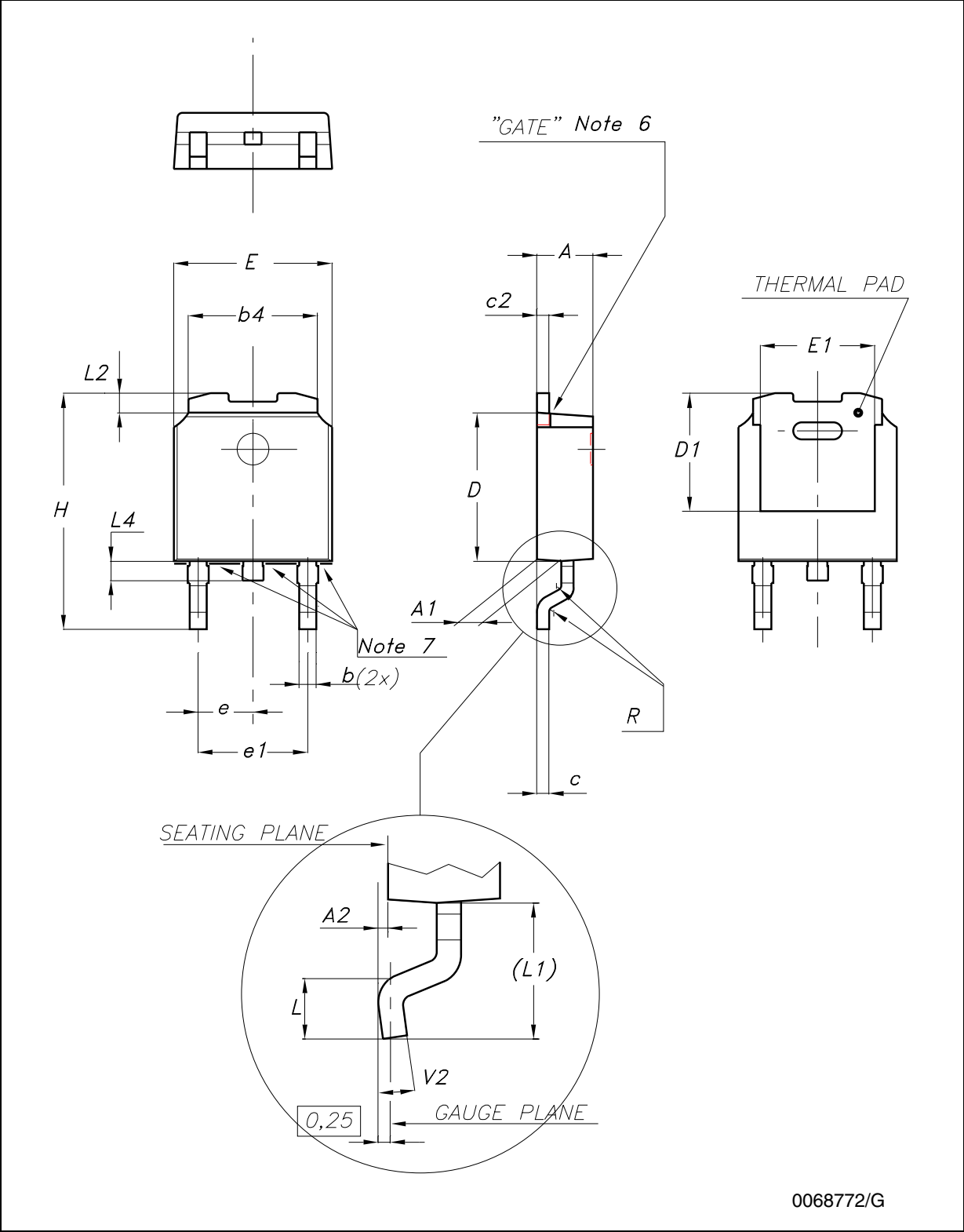
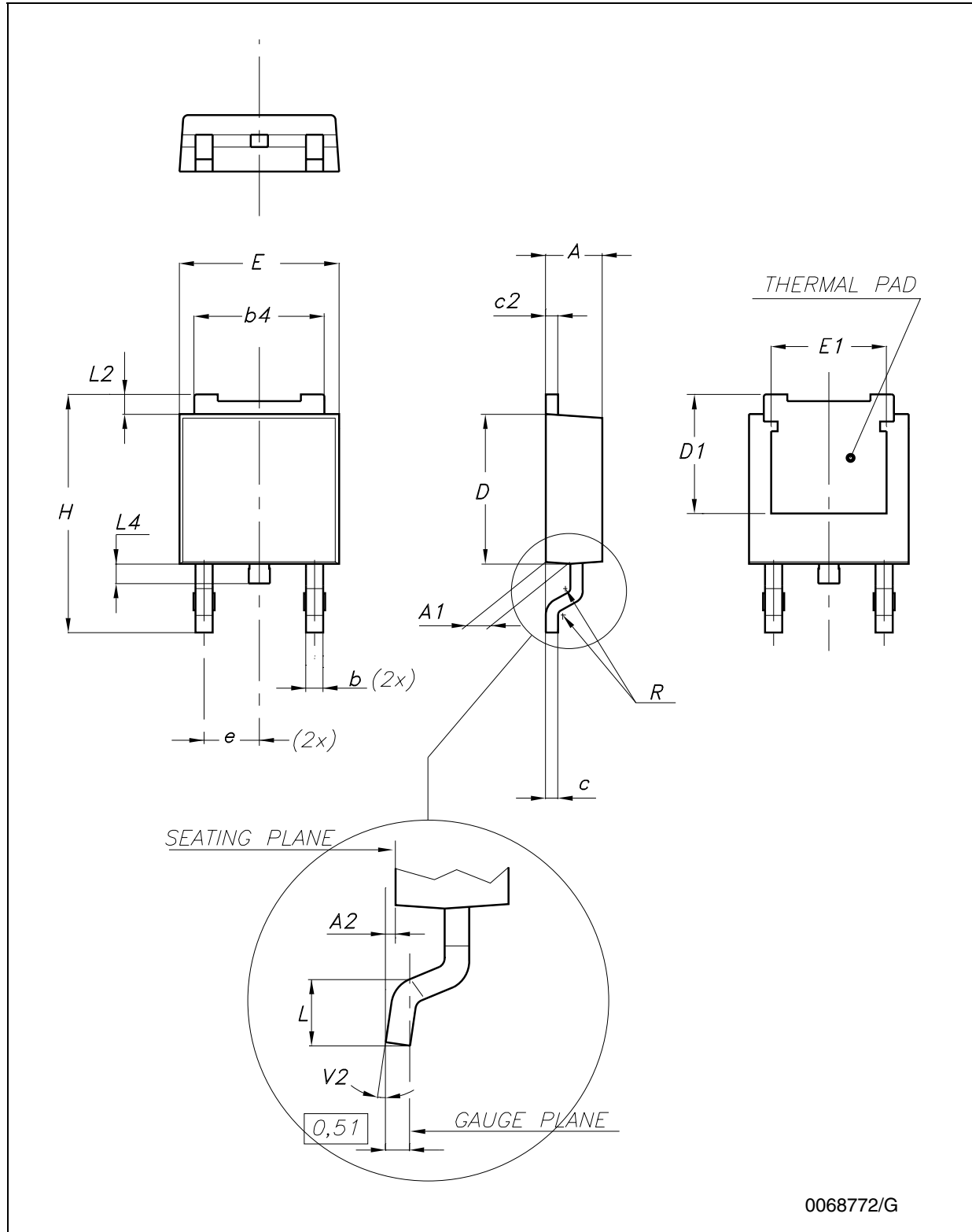
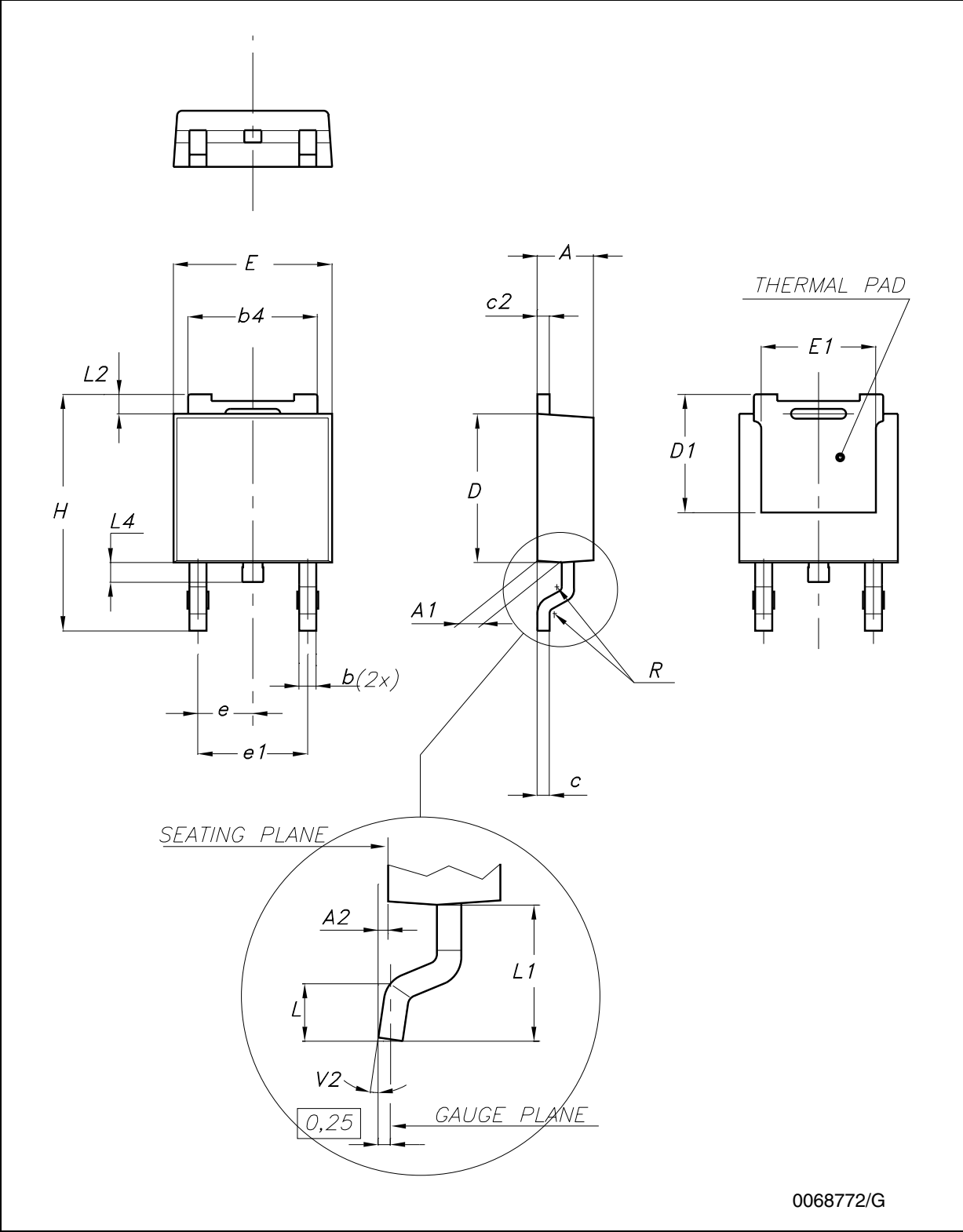


Figure 14. Drawing dimension DPAK (type FUJITSU-Subcon.)



0068772/G

Figure 15. Drawing dimension DPAK (type IDS-Subcon.)



0068772/G



Table 6. DPAK mechanical data

| Dim. | type STD-ST |      |       | type FUJITSU-Subcon. |      |       | type IDS-Subcon |      |       |
|------|-------------|------|-------|----------------------|------|-------|-----------------|------|-------|
|      | mm.         |      |       | mm.                  |      |       | mm.             |      |       |
|      | Min.        | Typ. | Max.  | Min.                 | Typ. | Max.  | Min.            | Typ. | Max.  |
| A    | 2.20        |      | 2.40  | 2.25                 | 2.30 | 2.35  | 2.19            |      | 2.38  |
| A1   | 0.90        |      | 1.10  | 0.96                 |      | 1.06  | 0.89            |      | 1.14  |
| A2   | 0.03        |      | 0.23  | 0                    |      | 0.10  | 0.03            |      | 0.23  |
| b    | 0.64        |      | 0.90  | 0.76                 |      | 0.86  | 0.64            |      | 0.88  |
| b4   | 5.20        |      | 5.40  | 5.28                 |      | 5.38  | 5.21            |      | 5.46  |
| c    | 0.45        |      | 0.60  | 0.46                 |      | 0.56  | 0.46            |      | 0.58  |
| c2   | 0.48        |      | 0.60  | 0.46                 |      | 0.56  | 0.46            |      | 0.58  |
| D    | 6.00        |      | 6.20  | 6.05                 |      | 6.15  | 5.97            |      | 6.22  |
| D1   |             | 5.10 |       | 5.27                 |      | 5.47  |                 | 5.20 |       |
| E    | 6.40        |      | 6.60  | 6.55                 | 6.60 | 6.65  | 6.35            |      | 6.73  |
| E1   |             | 4.70 |       |                      | 4.77 |       |                 | 4.70 |       |
| e    |             | 2.28 |       | 2.23                 | 2.28 | 2.33  |                 | 2.28 |       |
| e1   | 4.40        |      | 4.60  |                      |      |       | 4.51            |      | 4.61  |
| H    | 9.35        |      | 10.10 | 9.90                 |      | 10.30 | 9.40            |      | 10.42 |
| L    | 1.00        |      |       | 1.40                 |      | 1.60  | 0.90            |      |       |
| L1   |             | 2.80 |       |                      |      |       | 2.50            |      | 2.65  |
| L2   |             | 0.80 |       | 1.03                 |      | 1.13  | 0.89            |      | 1.27  |
| L4   | 0.60        |      | 1.00  | 0.70                 |      | 0.90  | 0.64            |      | 1.02  |
| R    |             | 0.20 |       |                      | 0.40 |       |                 | 0.20 |       |
| V2   | 0°          |      | 8°    | 0°                   |      | 8°    | 0°              |      | 8°    |

*Note: The DPAK package coming from the two subcontractors (Fujitsu and IDS) are fully compatible with the ST's package suggested footprint.*

Figure 16. DPAK footprint recommended data

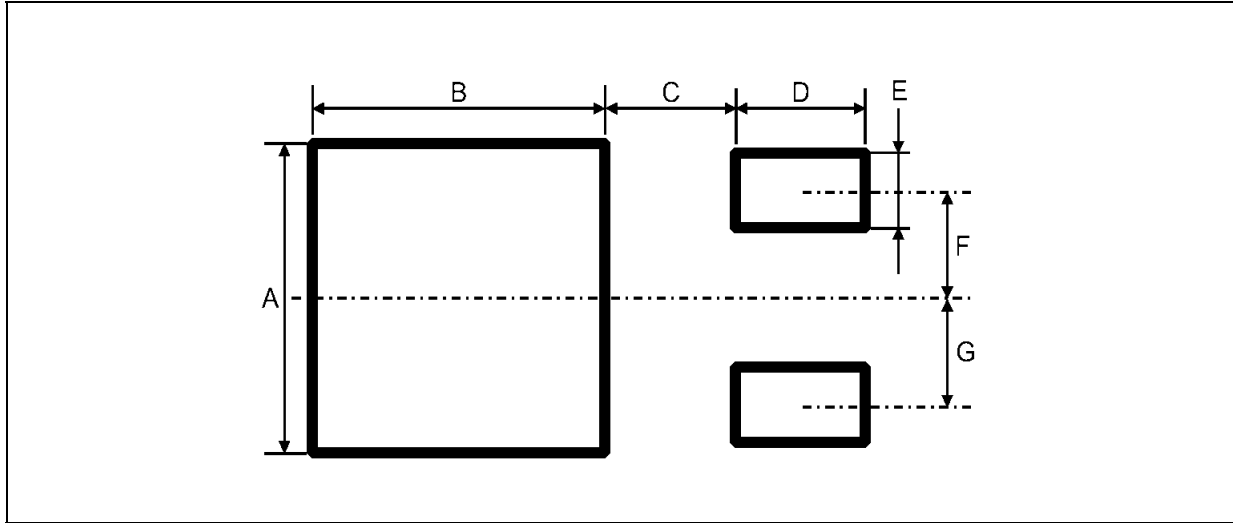
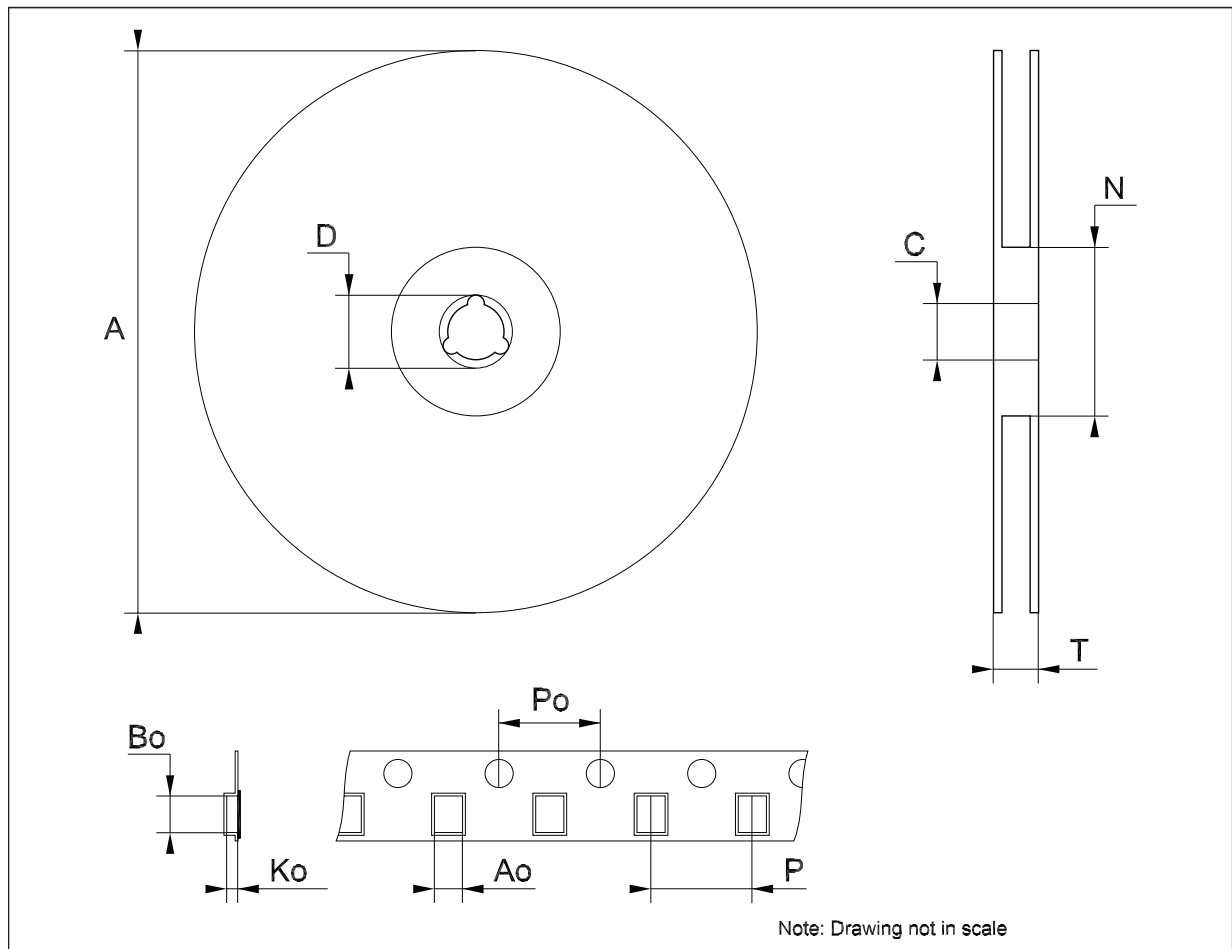


Table 7. Footprint data

| Dim. | Values |       |
|------|--------|-------|
|      | mm.    | inch. |
| A    | 6.70   | 0.264 |
| B    | 6.70   | 0.64  |
| C    | 1.8    | 0.070 |
| D    | 3.0    | 0.118 |
| E    | 1.60   | 0.063 |
| F    | 2.30   | 0.091 |
| G    | 2.30   | 0.091 |

**Tape & reel DPAK-PPAK mechanical data**

| Dim. | mm.   |       |       | inch. |       |        |
|------|-------|-------|-------|-------|-------|--------|
|      | Min.  | Typ.  | Max.  | Min.  | Typ.  | Max.   |
| A    |       |       | 330   |       |       | 12.992 |
| C    | 12.8  | 13.0  | 13.2  | 0.504 | 0.512 | 0.519  |
| D    | 20.2  |       |       | 0.795 |       |        |
| N    | 60    |       |       | 2.362 |       |        |
| T    |       |       | 22.4  |       |       | 0.882  |
| Ao   | 6.80  | 6.90  | 7.00  | 0.268 | 0.272 | 0.276  |
| Bo   | 10.40 | 10.50 | 10.60 | 0.409 | 0.413 | 0.417  |
| Ko   | 2.55  | 2.65  | 2.75  | 0.100 | 0.104 | 0.105  |
| Po   | 3.9   | 4.0   | 4.1   | 0.153 | 0.157 | 0.161  |
| P    | 7.9   | 8.0   | 8.1   | 0.311 | 0.315 | 0.319  |



## 9 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 21-Jun-2004 | 5        | The document has been reformatted.                  |
| 06-Dec-2006 | 6        | DPAK mechanical data updated, added footprint data. |
| 11-Feb-2008 | 7        | Added: <a href="#">Table 1 on page 1</a> .          |

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