

N-channel 620 V, 2.2  $\Omega$  typ., 4.0 A Power MOSFET  
in DPAK, I<sup>2</sup>PAKFP, TO-220 and IPAK packages

Datasheet – preliminary data

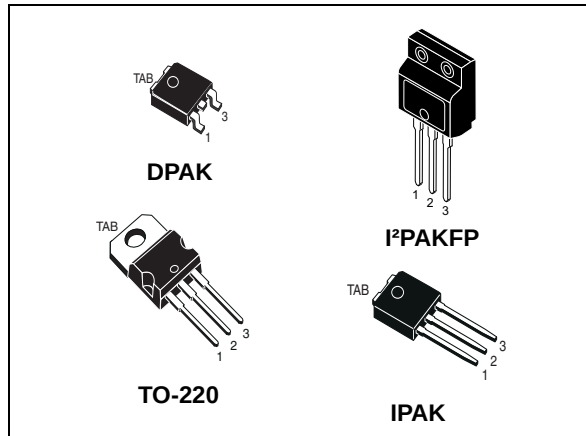
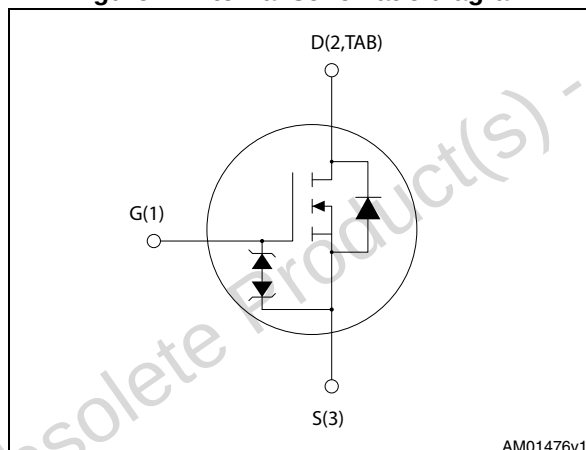


Figure 1. Internal schematic diagram



## Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub><br>max | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|----------------------------|----------------|------------------|
| STDLED624   | 620 V           | 2.5 $\Omega$               | 4.0 A          | 45 W             |
| STFILED624  |                 |                            |                | 20 W             |
| STPLED624   |                 |                            |                | 45 W             |
| STULED624   |                 |                            |                |                  |

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

## Applications

- LED lighting applications

## Description

These Power MOSFETs boast extremely low on-resistance, superior dynamic performance and high avalanche capability, making them suitable for the buck-boost and flyback topology.

Table 1. Device summary

| Order codes | Marking | Package                       | Packaging     |
|-------------|---------|-------------------------------|---------------|
| STDLED624   | LED624  | DPAK                          | Tape and reel |
| STFILED624  |         | I <sup>2</sup> PAKFP (TO-281) | Tube          |
| STPLED624   |         | TO-220                        |               |
| STULED624   |         | IPAK                          |               |

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Obsolete Product(s) - Obsolete Product(s)



# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol                         | Parameter                                                                                                             | Value         |                      |        | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------|----------------------|--------|------|
|                                |                                                                                                                       | DPAK,<br>IPAK | I <sup>2</sup> PAKFP | TO-220 |      |
| V <sub>DS</sub>                | Drain-source voltage (V <sub>GS</sub> = 0)                                                                            | 620           |                      |        | V    |
| V <sub>GS</sub>                | Gate- source voltage                                                                                                  | ± 30          |                      |        | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                                  | 4.0           | 4.0 <sup>(1)</sup>   | 4.0    | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                 | 2.5           | 2.5 <sup>(1)</sup>   | 2.5    | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                                | 14            | 14 <sup>(1)</sup>    | 14     | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                           | 45            | 20                   | 45     | W    |
|                                | Derating factor                                                                                                       | 0.36          | 0.16                 | 0.36   | W/°C |
| ESD                            | Gate-source human body model<br>(C = 100 pF, R = 1.5 kΩ)                                                              | 2.5           |                      |        | kV   |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                                     | 9             |                      |        | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all<br>three leads to external heat sink<br>(t = 1 s; T <sub>C</sub> = 25 °C) |               | 2500                 |        | V    |
| T <sub>stg</sub>               | Storage temperature                                                                                                   | -55 to 150    |                      |        | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature                                                                                   | 150           |                      |        | °C   |

1. Limited by package.

2. Pulse width limited by safe operating area.

3. I<sub>SD</sub> ≤ 2.7 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

Table 3. Thermal data

| Symbol                              | Parameter                            | TO-220 | DPAK | IPAK | I <sup>2</sup> PAKFP | Unit |
|-------------------------------------|--------------------------------------|--------|------|------|----------------------|------|
| R <sub>thj-case</sub>               | Thermal resistance junction-case max | 2.78   |      |      | 6.25                 | °C/W |
| R <sub>thj-pcb</sub> <sup>(1)</sup> | Thermal resistance junction-pcb max  |        | 50   |      |                      | °C/W |
| R <sub>thj-amb</sub>                | Thermal resistance junction-amb max  | 62.5   |      |      | 62.5                 | °C/W |

1. When mounted on 1 inch<sup>2</sup> FR-4 board, 2 oz Cu

Table 4. Avalanche characteristics

| Symbol          | Parameter                                                                                                                     | Max. value | Unit |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------|------------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)                                   | 2.7        | A    |
| E <sub>AS</sub> | Single pulse avalanche energy<br>(starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 100        | mJ   |

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified)

**Table 5. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                            | Min. | Typ. | Max.     | Unit                           |
|---------------|--------------------------------------------------|----------------------------------------------------------------------------|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                         | 620  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 620\text{ V}$<br>$V_{DS} = 620\text{ V}$ , $T_C = 125\text{ °C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                                                 |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$                          | 3    | 3.6  | 4.5      | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 1.4\text{ A}$                              |      | 2.2  | 2.5      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                                | Min. | Typ.               | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------|--------------------|------|----------------|
| $g_{fs}$ (1)                        | Forward transconductance                                                | $V_{DS} = 15\text{ V}$ , $I_D = 1.4\text{ A}$                                                                  | -    | 2.1                | -    | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$                                                     | -    | 395<br>57<br>7     | -    | pF<br>pF<br>pF |
| $C_{OSS\ eq}$ (1)                   | Equivalent output capacitance                                           | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }496\text{ V}$                                                             | -    | 33                 | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                                  | -    | 10                 | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 496\text{ V}$ , $I_D = 2.7\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 17</a> ) | -    | 13.5<br>2.7<br>7.7 | -    | nC<br>nC<br>nC |

1.  $C_{OSS\ eq}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{OSS}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

**Table 7. Switching times**

| Symbol                                        | Parameter                                                           | Test conditions                                                                                                                            | Min. | Typ.                   | Max. | Unit                 |
|-----------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------|------|----------------------|
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off-delay time<br>Fall time | $V_{DD} = 310\text{ V}$ , $I_D = 1.7\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 16</a> ) | -    | 9<br>6.8<br>22<br>15.6 | -    | ns<br>ns<br>ns<br>ns |

Table 8. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                   | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                   | -    |      | 2.7  | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                   | -    |      | 10.8 | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 2.7$ A, $V_{GS} = 0$                                                                                    | -    |      | 1.6  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.7$ A, $di/dt = 100$ A/ $\mu$ s<br>$V_{DD} = 60$ V (see <a href="#">Figure 21</a> )                    | -    | 190  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                   |      | 825  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                   |      | 9    |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.7$ A, $di/dt = 100$ A/ $\mu$ s<br>$V_{DD} = 60$ V, $T_j = 150$ °C<br>(see <a href="#">Figure 21</a> ) | -    | 255  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                   |      | 1100 |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                   |      | 10   |      | A    |

1. Pulse width limited by safe operating area.

2. Pulsed: Pulse duration = 300  $\mu$ s, duty cycle 1.5%

Table 9. Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                  | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|----------------------------------|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1$ mA (open drain) | 30   | -    | -    | V    |

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK, TO-220 and IPAK

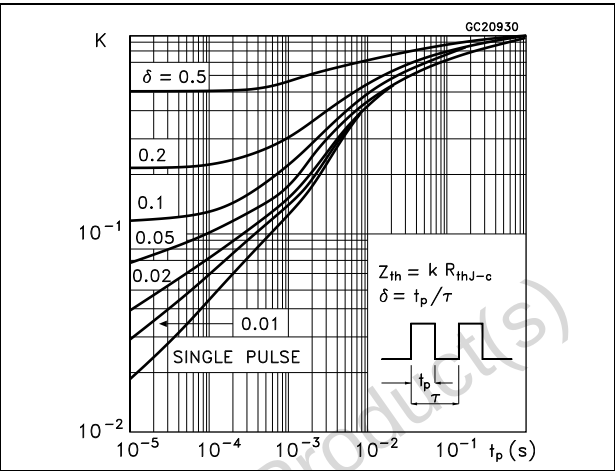
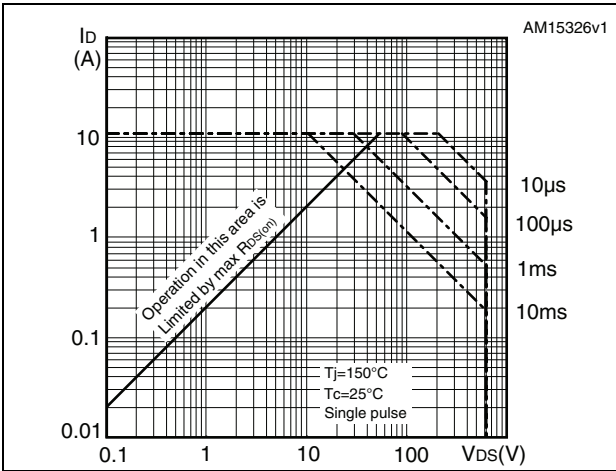


Figure 4. Safe operating area for I<sup>2</sup>PAKFP

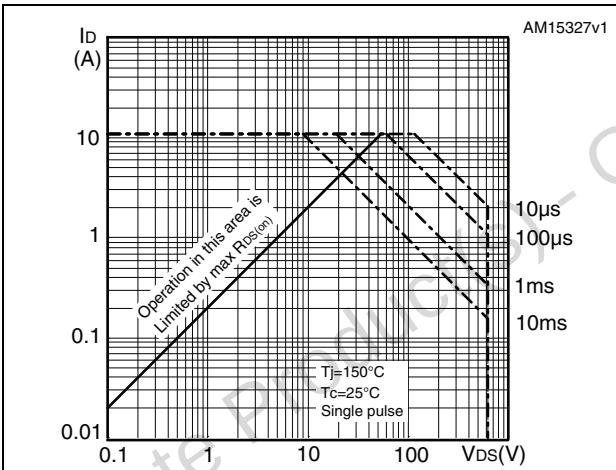


Figure 5. Thermal impedance for I<sup>2</sup>PAKFP

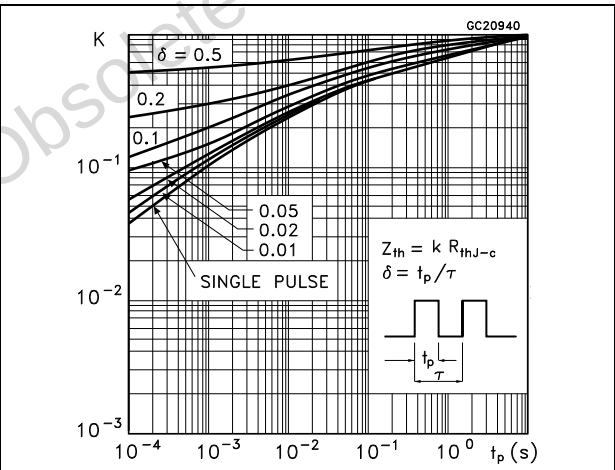


Figure 6. Output characteristics

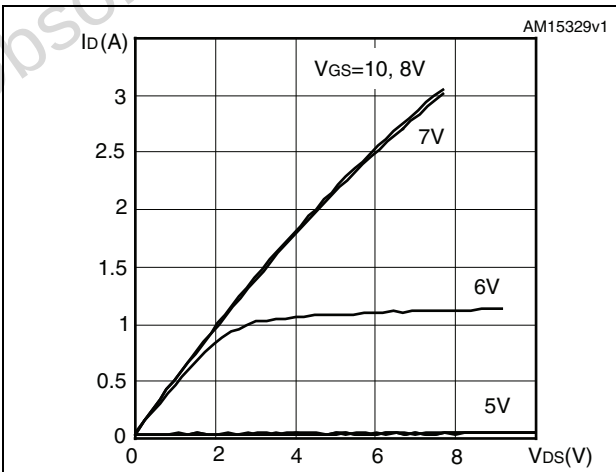


Figure 7. Transfer characteristics

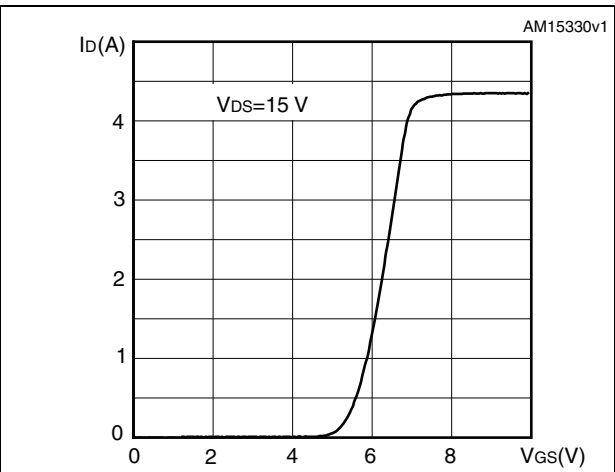


Figure 8. Normalized  $BV_{DSS}$  vs temperature

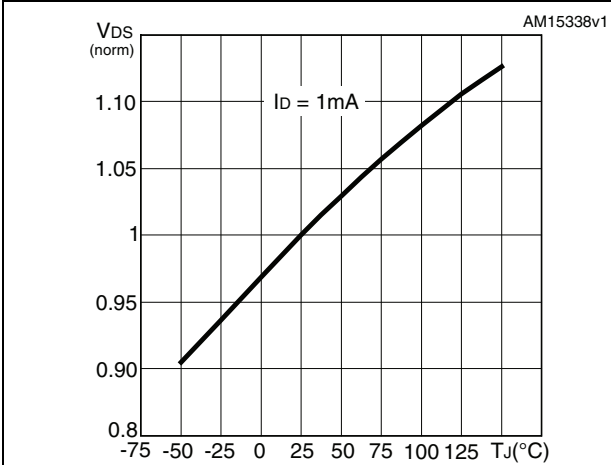


Figure 9. Static drain-source on-resistance

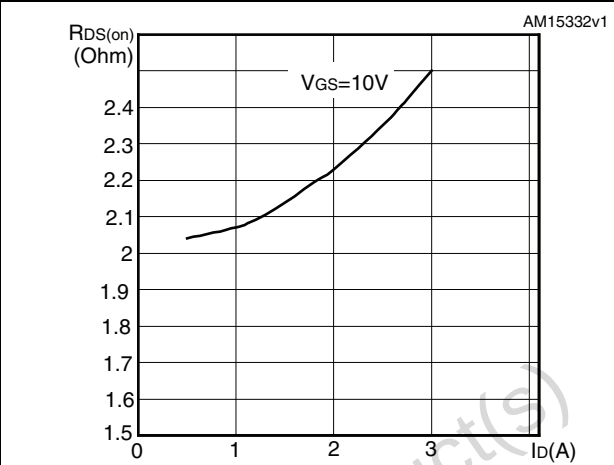


Figure 10. Gate charge vs gate-source voltage

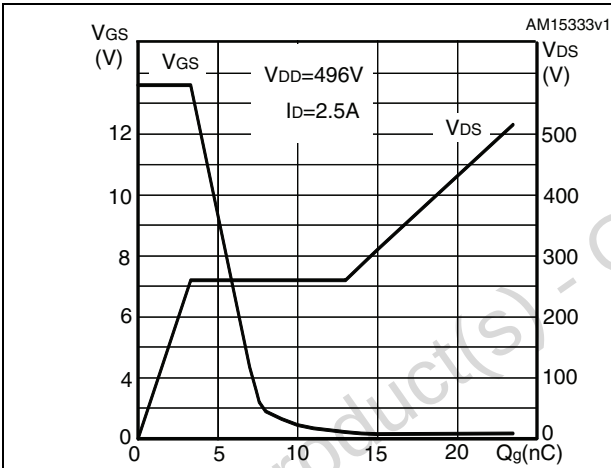


Figure 11. Capacitance variations

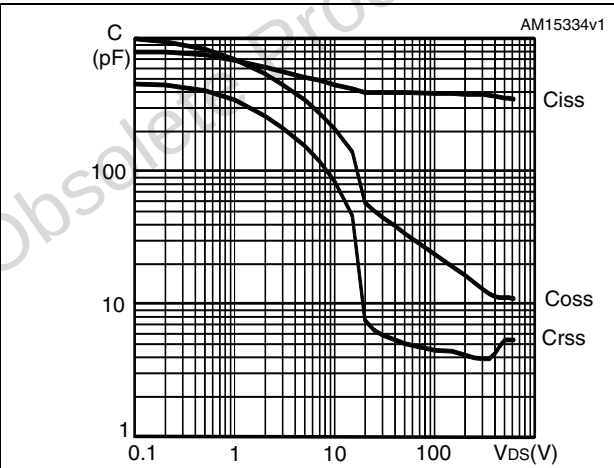


Figure 12. Normalized gate threshold voltage vs temperature

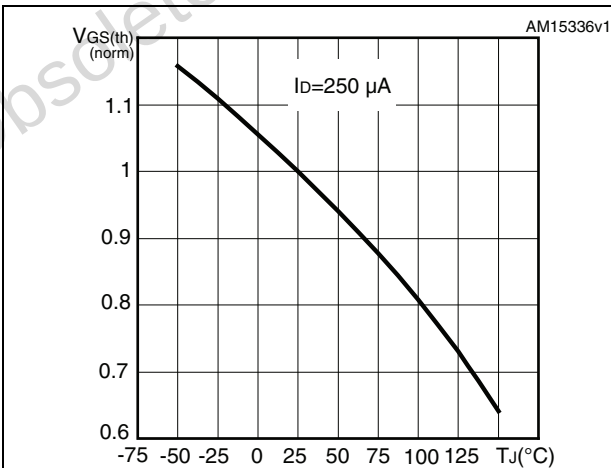


Figure 13. Normalized on-resistance vs temperature

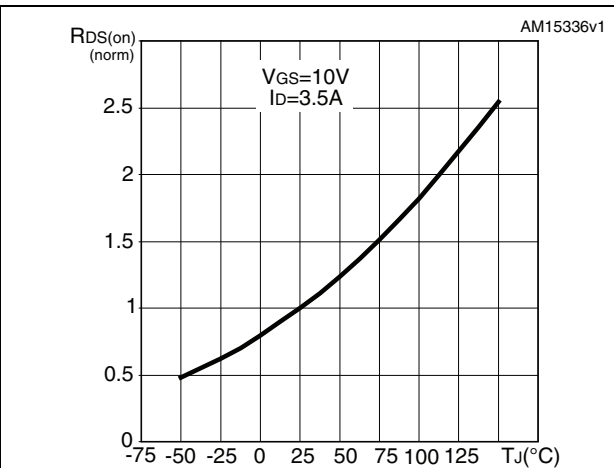


Figure 14. Source-drain diode forward characteristics

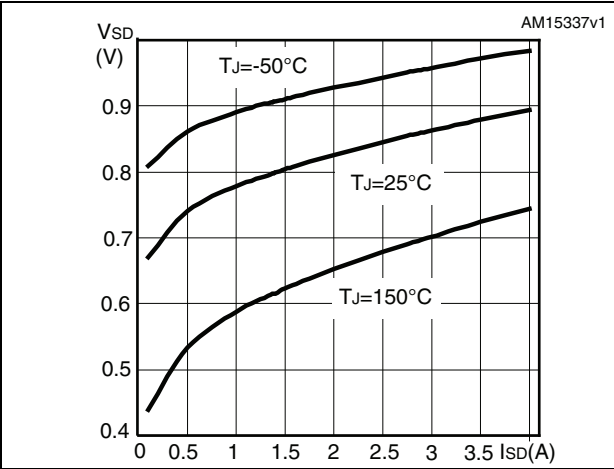
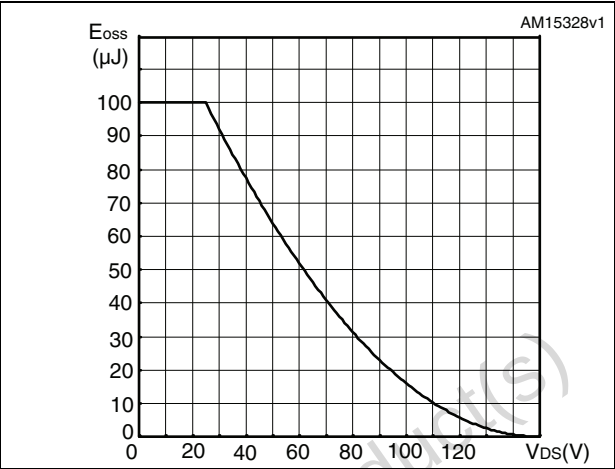


Figure 15. Maximum avalanche energy vs temperature



### 3 Test circuits

Figure 16. Switching times test circuit for resistive load

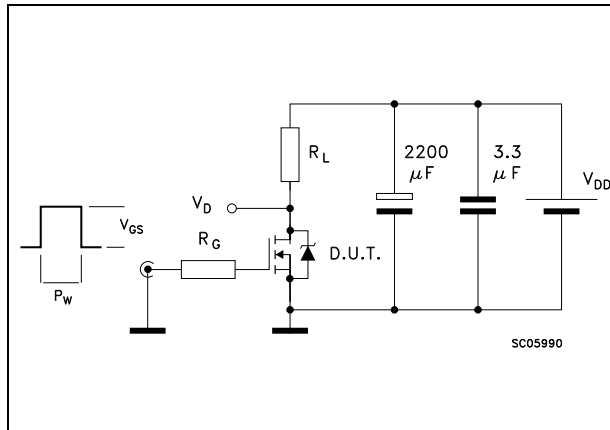


Figure 17. Gate charge test circuit

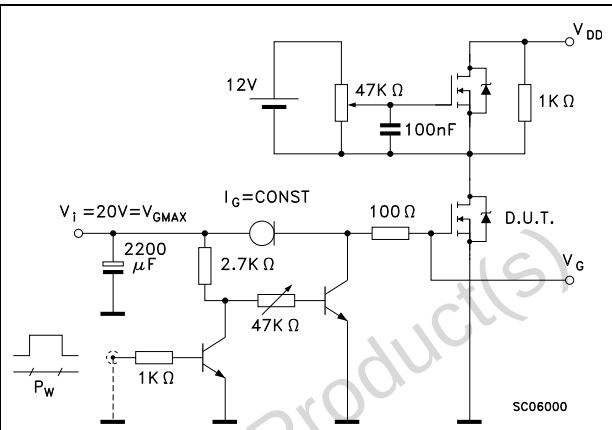


Figure 18. Test circuit for inductive load switching and diode recovery times

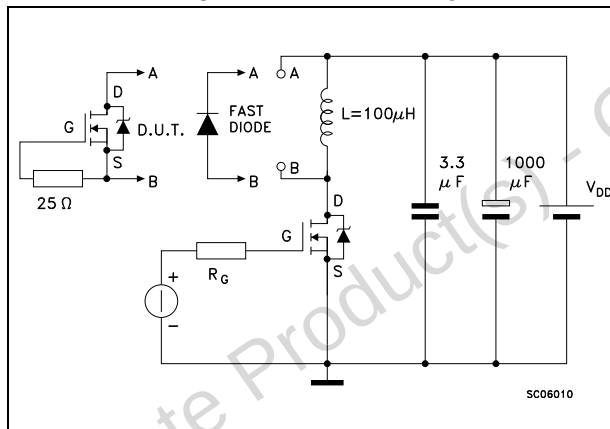


Figure 19. Unclamped Inductive load test circuit

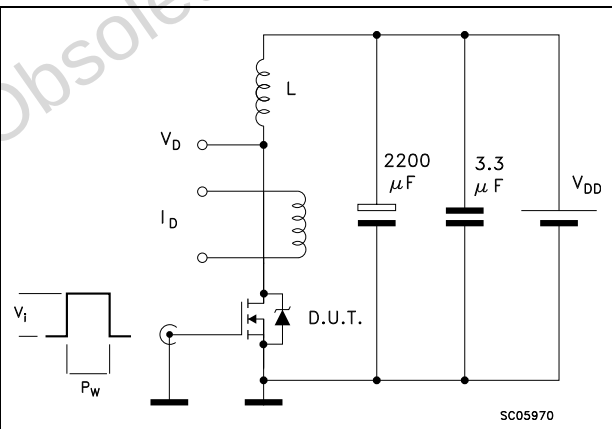


Figure 20. Unclamped inductive waveform

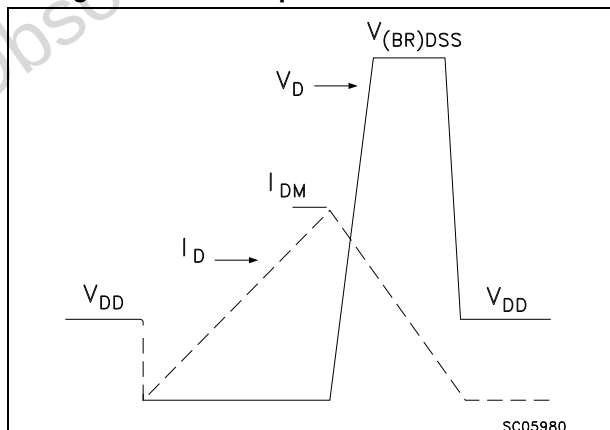
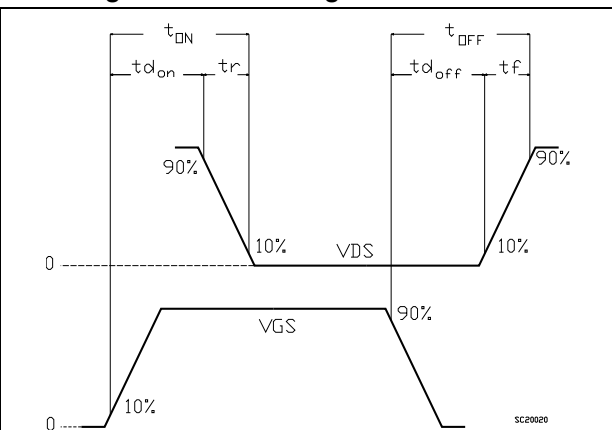


Figure 21. Switching time waveform



## 4 Package mechanical data

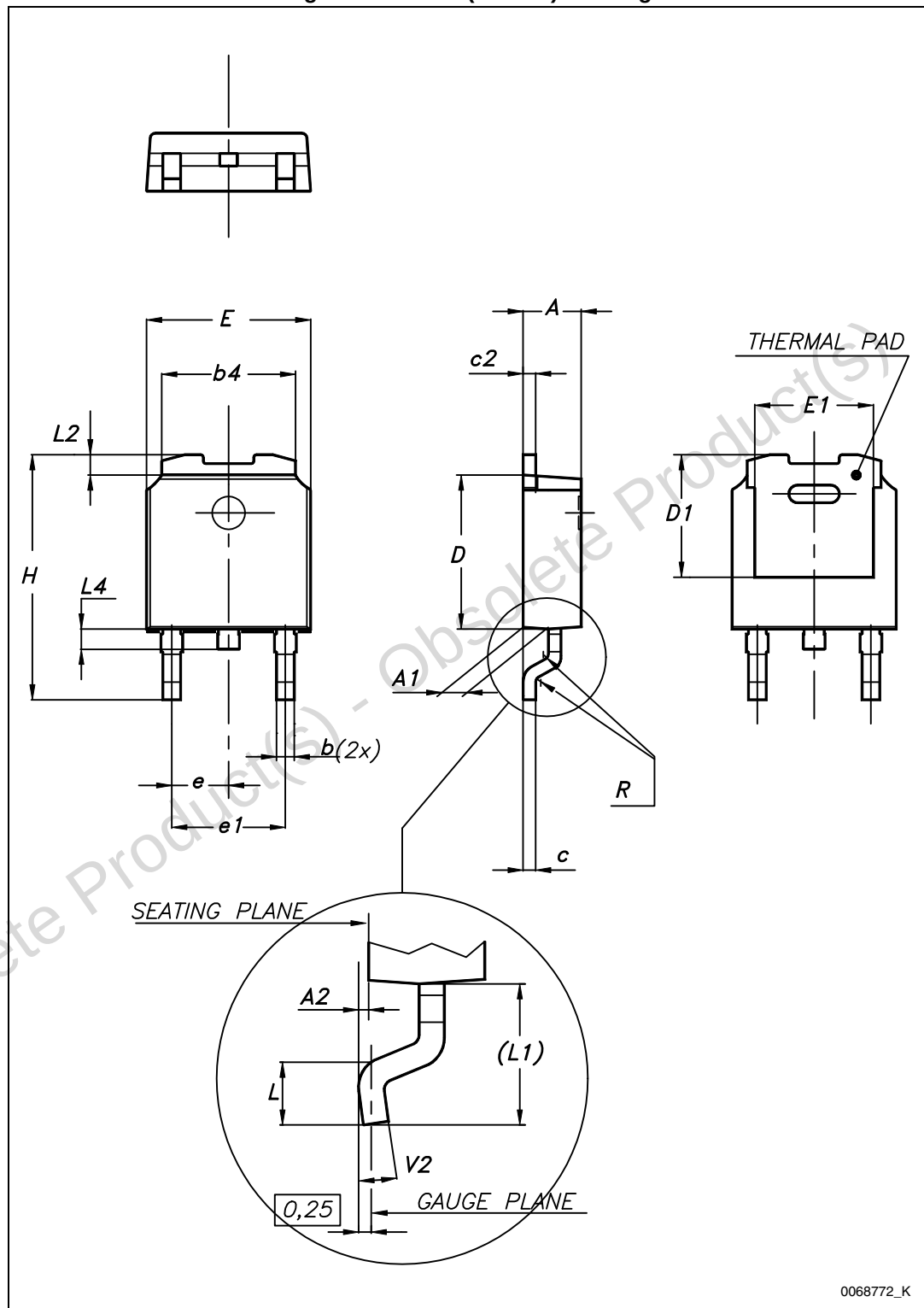
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK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

Obsolete Product(s) - Obsolete Product(s)

Table 10. DPAK (TO-252) mechanical data

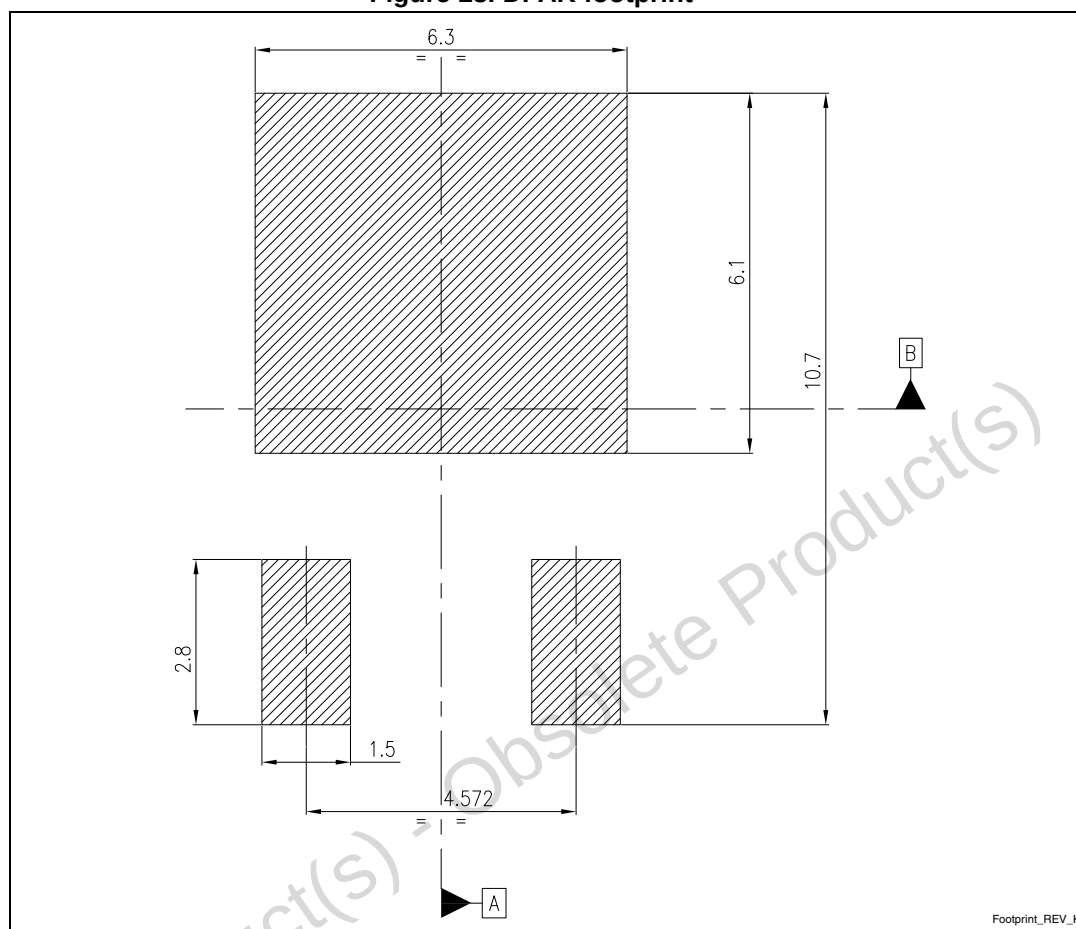
| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 2.20 |      | 2.40  |
| A1   | 0.90 |      | 1.10  |
| A2   | 0.03 |      | 0.23  |
| b    | 0.64 |      | 0.90  |
| b4   | 5.20 |      | 5.40  |
| c    | 0.45 |      | 0.60  |
| c2   | 0.48 |      | 0.60  |
| D    | 6.00 |      | 6.20  |
| D1   |      | 5.10 |       |
| E    | 6.40 |      | 6.60  |
| E1   |      | 4.70 |       |
| e    |      | 2.28 |       |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1.00 |      | 1.50  |
| (L1) |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1.00  |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |

Figure 22. DPAK (TO-252) drawing



0068772\_K

Figure 23. DPAK footprint (a)

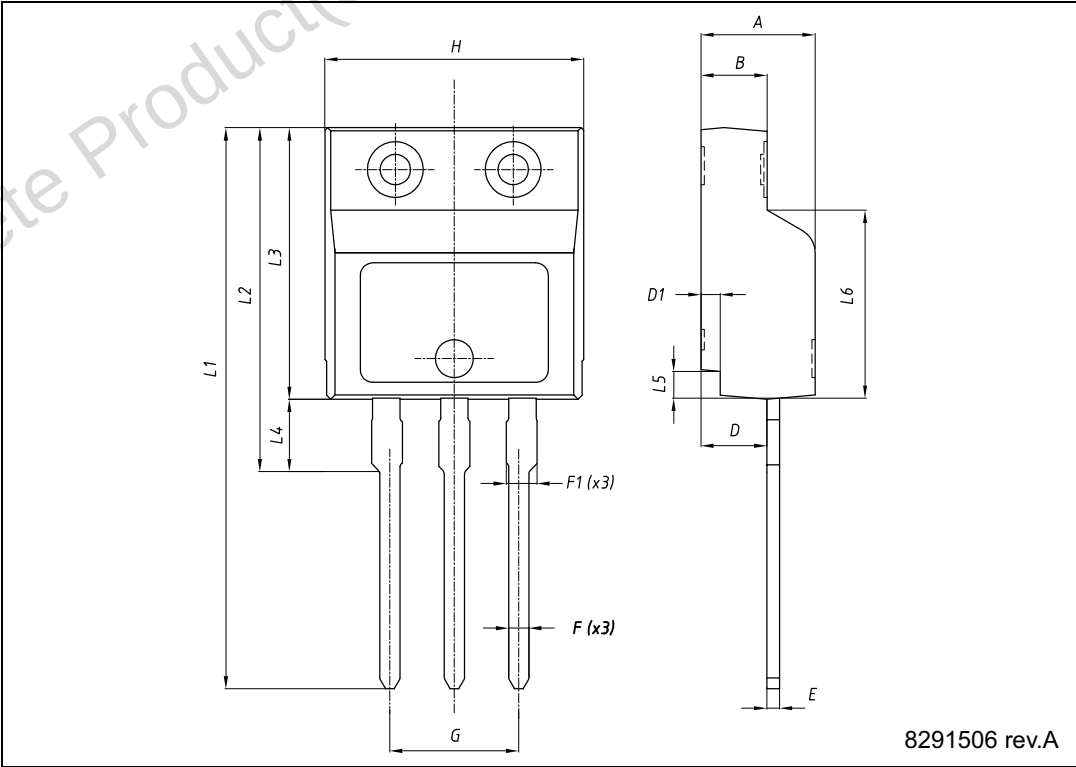


a. All dimensions are in millimeters

Table 11. I<sup>2</sup>PAKFP (TO-281) mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.40  | -    | 4.60  |
| B    | 2.50  |      | 2.70  |
| D    | 2.50  |      | 2.75  |
| D1   | 0.65  |      | 0.85  |
| E    | 0.45  |      | 0.70  |
| F    | 0.75  |      | 1.00  |
| F1   |       |      | 1.20  |
| G    | 4.95  |      | 5.20  |
| H    | 10.00 |      | 10.40 |
| L1   | 21.00 |      | 23.00 |
| L2   | 13.20 |      | 14.10 |
| L3   | 10.55 |      | 10.85 |
| L4   | 2.70  |      | 3.20  |
| L5   | 0.85  |      | 1.25  |
| L6   | 7.30  |      | 7.50  |

Figure 24. I<sup>2</sup>PAKFP (TO-281) drawing



8291506 rev.A

Table 12. TO-220 type A 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 25. TO-220 type A drawing

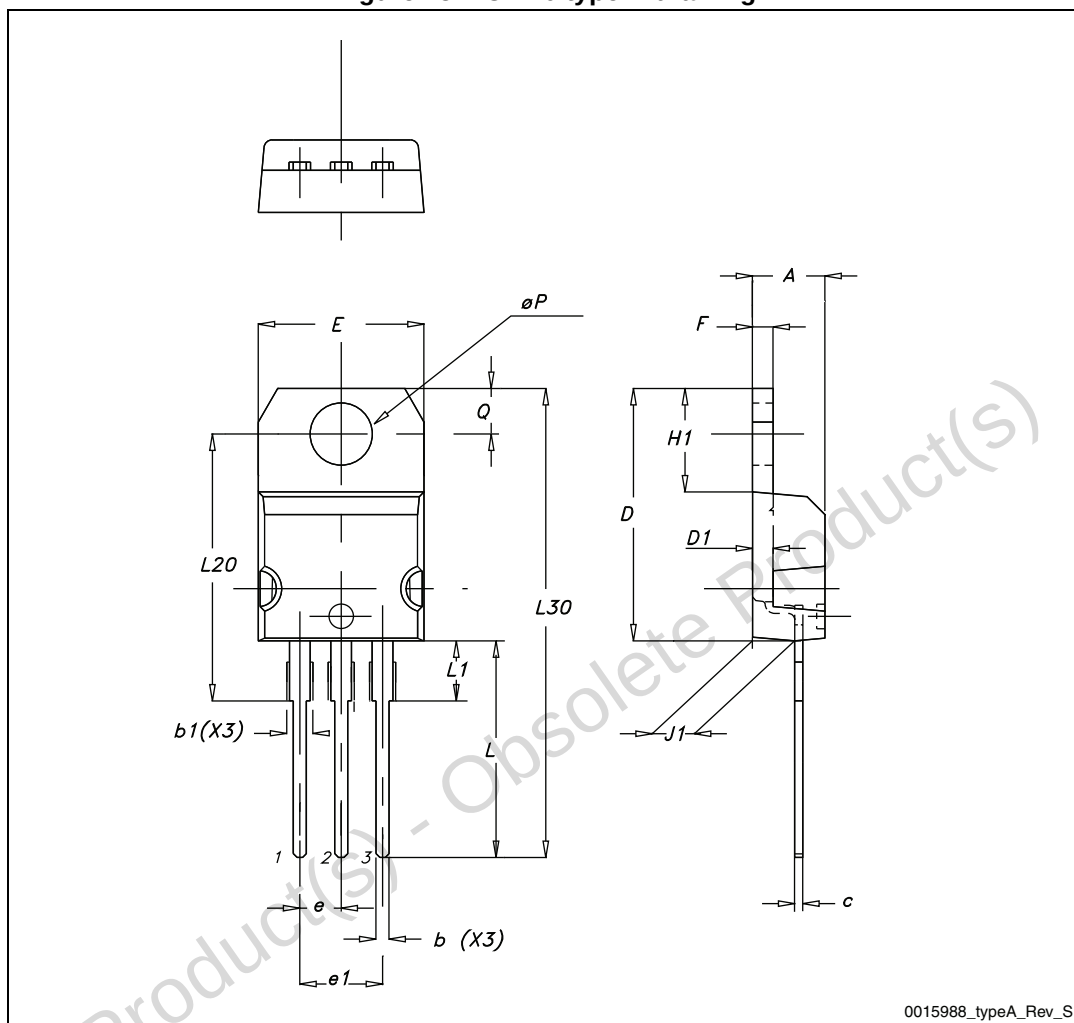
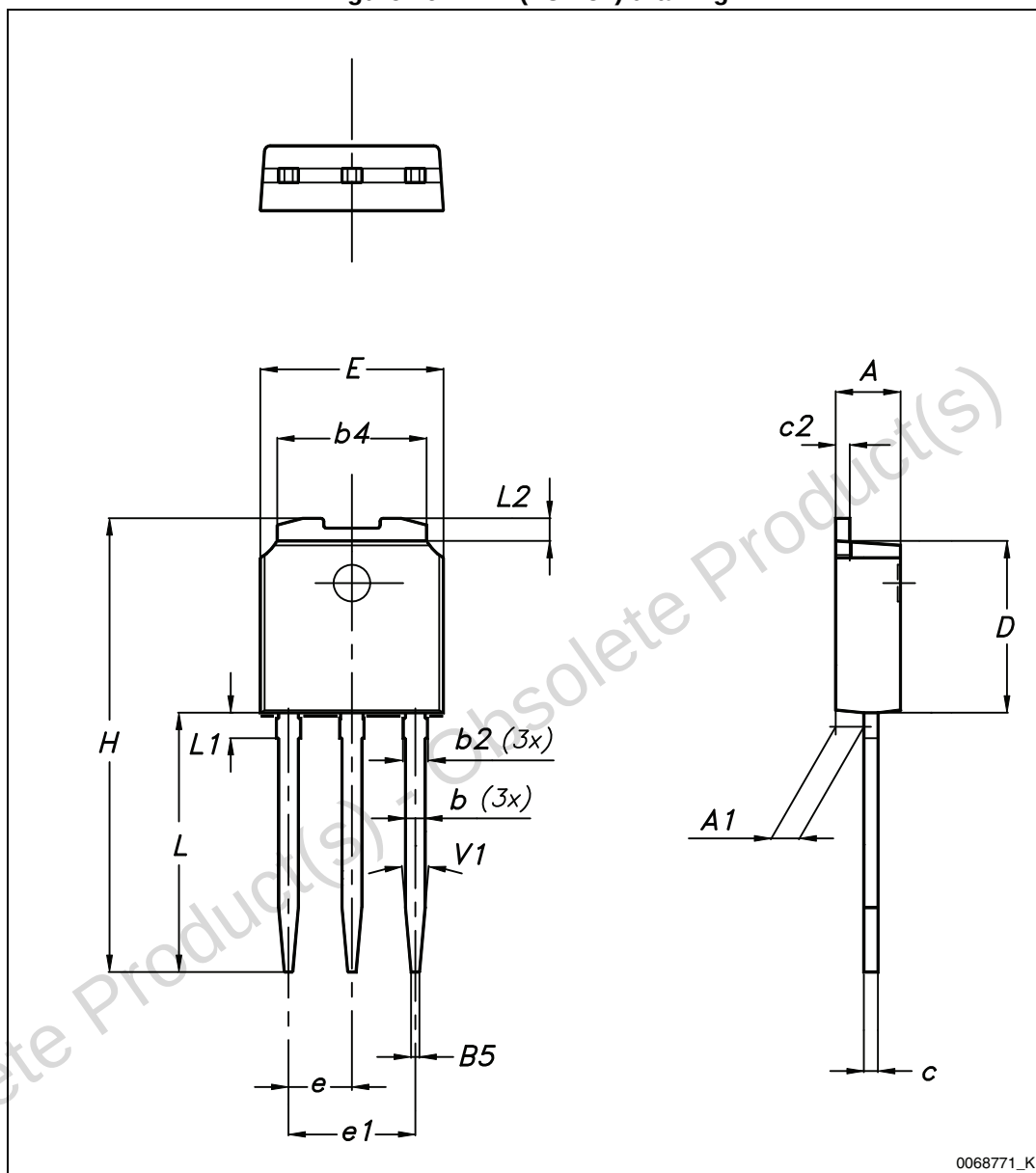


Table 13. IPAK (TO-251) mechanical data

| DIM | mm.  |       |      |
|-----|------|-------|------|
|     | min. | typ.  | max. |
| A   | 2.20 |       | 2.40 |
| A1  | 0.90 |       | 1.10 |
| b   | 0.64 |       | 0.90 |
| b2  |      |       | 0.95 |
| b4  | 5.20 |       | 5.40 |
| B5  |      | 0.30  |      |
| c   | 0.45 |       | 0.60 |
| c2  | 0.48 |       | 0.60 |
| D   | 6.00 |       | 6.20 |
| E   | 6.40 |       | 6.60 |
| e   |      | 2.28  |      |
| e1  | 4.40 |       | 4.60 |
| H   |      | 16.10 |      |
| L   | 9.00 |       | 9.40 |
| L1  | 0.80 |       | 1.20 |
| L2  |      | 0.80  | 1.00 |
| V1  |      | 10°   |      |

Figure 26. IPAK (TO-251) drawing

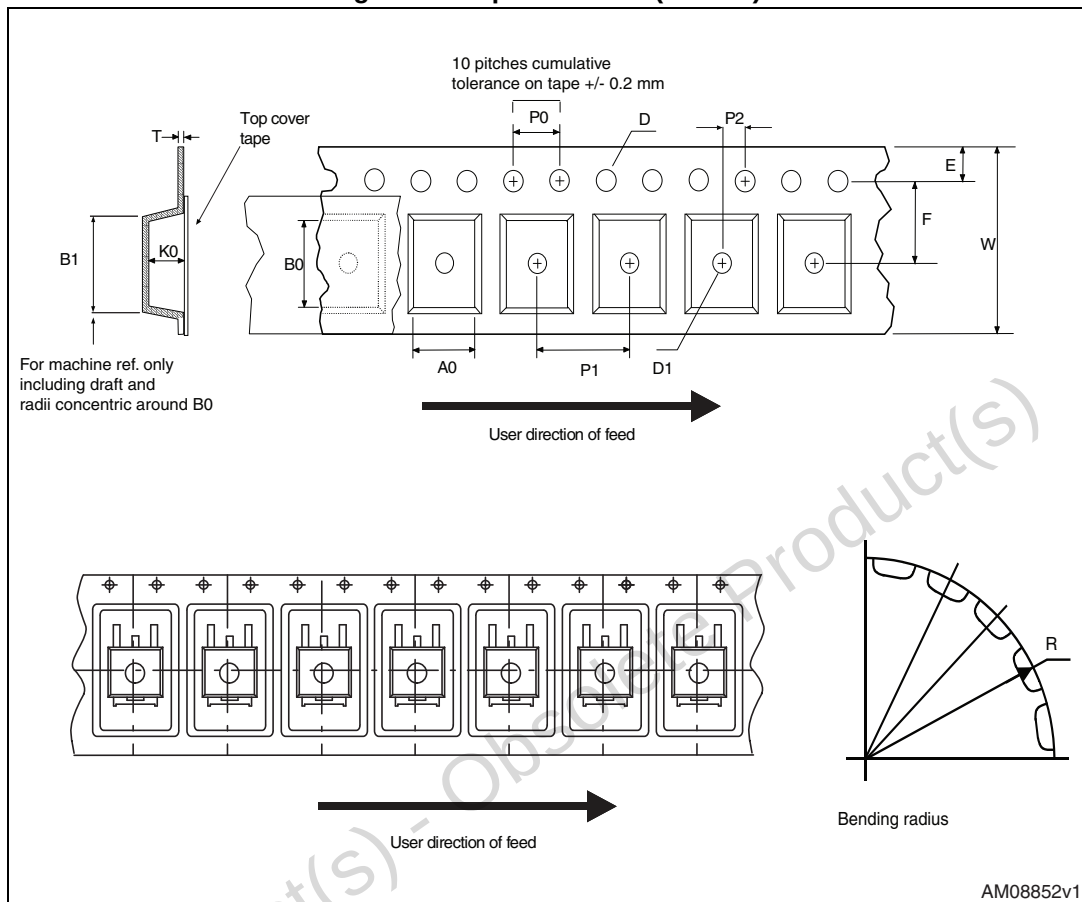


## 5 Packaging mechanical data

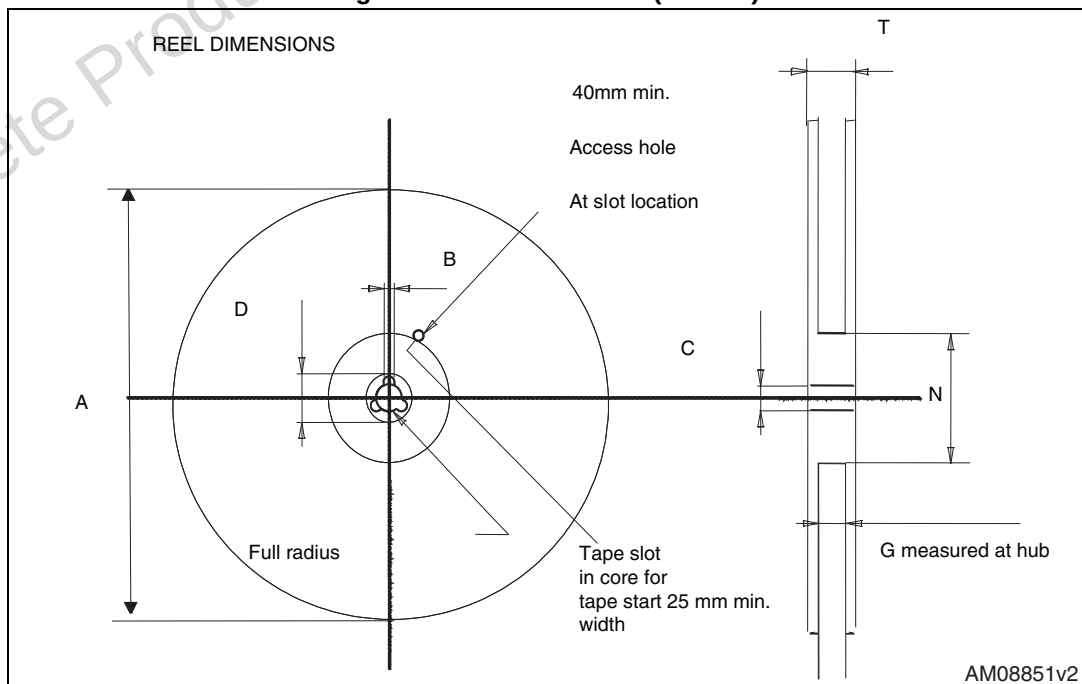
Table 14. DPAK (TO-252) tape and reel mechanical data

| Tape |      |      | Reel      |      |      |
|------|------|------|-----------|------|------|
| Dim. | mm   |      | Dim.      | mm   |      |
|      | Min. | Max. |           | Min. | Max. |
| A0   | 6.8  | 7    | A         |      | 330  |
| B0   | 10.4 | 10.6 | B         | 1.5  |      |
| B1   |      | 12.1 | C         | 12.8 | 13.2 |
| D    | 1.5  | 1.6  | D         | 20.2 |      |
| D1   | 1.5  |      | G         | 16.4 | 18.4 |
| E    | 1.65 | 1.85 | N         | 50   |      |
| F    | 7.4  | 7.6  | T         |      | 22.4 |
| K0   | 2.55 | 2.75 |           |      |      |
| P0   | 3.9  | 4.1  | Base qty. |      | 2500 |
| P1   | 7.9  | 8.1  | Bulk qty. |      | 2500 |
| P2   | 1.9  | 2.1  |           |      |      |
| R    | 40   |      |           |      |      |
| T    | 0.25 | 0.35 |           |      |      |
| W    | 15.7 | 16.3 |           |      |      |

### Figure 27. Tape for DPAK (TO-252)



**Figure 28. Reel for DPAK (TO-252)**



## 6 Revision history

Table 15. Document revision history

| Date        | Revision | Changes        |
|-------------|----------|----------------|
| 21-Mar-2013 | 1        | First release. |

Obsolete Product(s) - Obsolete Product(s)

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