

N-channel 800 V, 0.19  $\Omega$  typ., 19.5 A MDmesh™ K5 Power MOSFETs  
in D<sup>2</sup>PAK, TO-220FP, TO-220 and TO-247 packages

Datasheet – production data

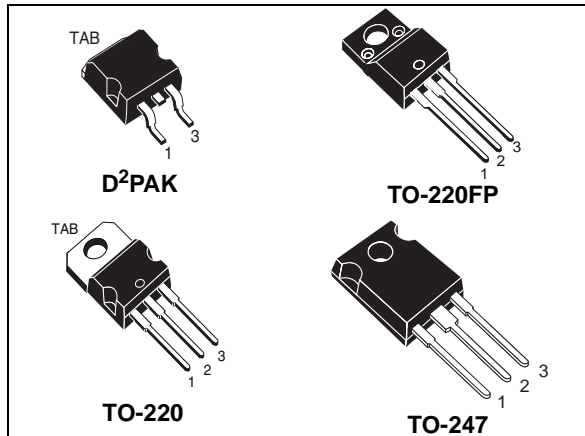
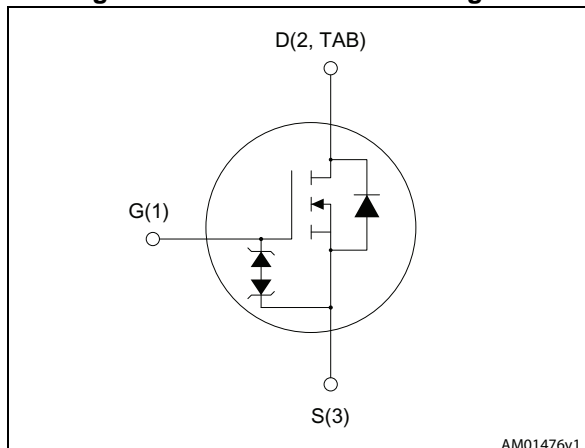


Figure 1. Internal schematic diagram



## Features

| Order code | $V_{DS}$ @<br>$T_{Jmax}$ | $R_{DS(on)}$<br>max | $I_D$  | $P_{TOT}$ |
|------------|--------------------------|---------------------|--------|-----------|
| STB25N80K5 | 800 V                    | < 0.260 $\Omega$    | 19.5 A | 250 W     |
| STF25N80K5 |                          |                     |        | 40 W      |
| STP25N80K5 |                          |                     |        | 250 W     |
| STW25N80K5 |                          |                     |        |           |

- Industry's lowest  $R_{DS(on)} \times \text{area}$
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1. Device summary

| Order code | Marking | Package            | Packaging     |
|------------|---------|--------------------|---------------|
| STB25N80K5 | 25N80K5 | D <sup>2</sup> PAK | Tape and reel |
| STF25N80K5 |         | TO-220FP           | Tube          |
| STP25N80K5 |         | TO-220             |               |
| STW25N80K5 |         | TO-247             |               |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                             | Parameter   | Value                                 |                     | Unit |
|------------------------------------|---|---------------------------------------|---------------------|------|
|                                    |   | D <sup>2</sup> PAK,<br>TO-220, TO-247 | TO-220FP            |      |
| V <sub>GS</sub>                    | Gate- source voltage  | ± 30                                  |                     | V    |
| I <sub>D</sub>                     | Drain current (continuous) at T <sub>C</sub> = 25 °C  | 19.5                                  | 19.5 <sup>(1)</sup> | A    |
| I <sub>D</sub>                     | Drain current (continuous) at T <sub>C</sub> = 100 °C   | 12.3                                  | 12.3 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup>     | Drain current (pulsed)  | 78                                    | 78 <sup>(1)</sup>   | A    |
| P <sub>TOT</sub>                   | Total dissipation at T <sub>C</sub> = 25 °C   | 250                                   | 40                  | W    |
| I <sub>AR</sub>                    | Max current during repetitive or single pulse avalanche (pulse width limited by T <sub>jmax</sub> )                       | 6.5                                   |                     | A    |
| E <sub>AS</sub>                    | Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> =I <sub>AS</sub> , V <sub>DD</sub> = 50 V) | 200                                   |                     | mJ   |
| V <sub>iso</sub>                   | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)              |                                       | 2500                | V    |
| dv/dt <sup>(3)</sup>               | Peak diode recovery voltage slope   | 6                                     |                     | V/ns |
| T <sub>j</sub><br>T <sub>stg</sub> | Operating junction temperature<br>Storage temperature   | -55 to 150                            |                     | °C   |

- Limited by package.
- Pulse width limited by safe operating area.
- $I_{SD} \leq 19.5$  A,  $di/dt \leq 100$  A/ $\mu$ s,  $V_{Peak} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol                              | Parameter                            | Value  |        |                    |          | Unit |
|-------------------------------------|--------------------------------------|--------|--------|--------------------|----------|------|
|                                     |                                      | TO-220 | TO-247 | D <sup>2</sup> PAK | TO-220FP |      |
| R <sub>thj-case</sub>               | Thermal resistance junction-case max | 0.5    |        |                    | 3.1      | °C/W |
| R <sub>thj-amb</sub>                | Thermal resistance junction-amb max  | 62.5   | 50     |                    | 62.5     |      |
| R <sub>thj-pcb</sub> <sup>(1)</sup> | Thermal resistance junction-pcb max  |        |        | 30                 |          |      |

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

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  unless otherwise specified).

**Table 4. On/off states**

| Symbol        | Parameter  | Test conditions                                 | Min. | Typ. | Max.     | Unit          |
|---------------|--|---|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ( $V_{GS} = 0$ )  | $I_D = 1\text{ mA}$                             | 800  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 800\text{ V}$                         |      |      | 1        | $\mu\text{A}$ |
|               |  | $V_{DS} = 800\text{ V}, T_C = 125\text{ °C}$    |      |      | 50       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                      |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$ | 3    | 4    | 5        | V             |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{ V}, I_D = 10\text{ A}$       |      | 0.19 | 0.260    | $\Omega$      |

**Table 5. Dynamic**

| Symbol            | Parameter                             | Test conditions  | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|--|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$  | -    | 1600 | -    | pF       |
| $C_{oss}$         | Output capacitance                    |  | -    | 130  | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |  | -    | 2    | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0, V_{DS} = 0\text{ to }640\text{ V}$  | -    | 185  | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |  | -    | 300  | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz open drain}$  | -    | 4    | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 640\text{ V}, I_D = 19.5\text{ A}$<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 19</a> ) | -    | 40   | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |  | -    | 10   |      | nC       |
| $Q_{gd}$          | Gate-drain charge                     |  | -    | 25   |      | nC       |

1. Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

Table 6. Switching times

| Symbol       | Parameter           | Test conditions   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 400\text{ V}$ , $I_D = 10\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 21</a> ) | -    | 25   | -    | ns   |
| $t_r$        | Rise time           |   | -    | 13   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |   | -    | 60   | -    | ns   |
| $t_f$        | Fall time           |   | -    | 15   | -    | ns   |

Table 7. Source drain diode

| Symbol         | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}$       | Source-drain current          |  | -    |      | 19.5 | A             |
| $I_{SDM}$      | Source-drain current (pulsed) |  | -    |      | 78   | A             |
| $V_{SD}^{(1)}$ | Forward on voltage            | $I_{SD} = 19.5\text{ A}$ , $V_{GS} = 0$  | -    |      | 1.5  | V             |
| $t_{rr}$       | Reverse recovery time         | $I_{SD} = 19.5\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>(see <a href="#">Figure 20</a> )                                      | -    | 515  |      | ns            |
| $Q_{rr}$       | Reverse recovery charge       |  | -    | 11   |      | $\mu\text{C}$ |
| $I_{RRM}$      | Reverse recovery current      |  | -    | 43.2 |      | A             |
| $t_{rr}$       | Reverse recovery time         | $I_{SD} = 19.5\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$T_J = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 20</a> ) | -    | 615  |      | ns            |
| $Q_{rr}$       | Reverse recovery charge       |  | -    | 13   |      | $\mu\text{C}$ |
| $I_{RRM}$      | Reverse recovery current      |  | -    | 43   |      | A             |

1. Pulsed: pulse duration = 300 $\mu\text{s}$ , duty cycle 1.5%

Table 8. Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                        | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|--|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{ mA}$ , $I_D = 0$ | 30   | -    | -    | V    |

The built-in back-to-back Zener diodes have been specifically designed to enhance the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D<sup>2</sup>PAK

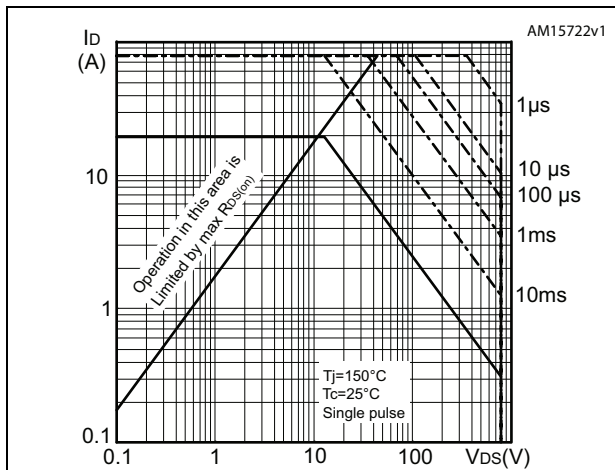


Figure 3. Thermal impedance for D<sup>2</sup>PAK and TO-220

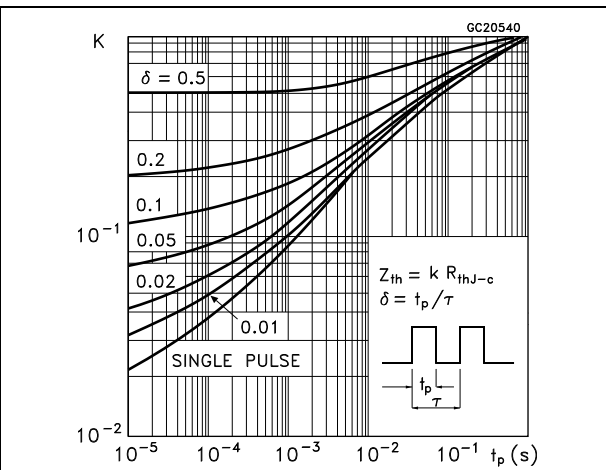


Figure 4. Safe operating area for TO-220FP

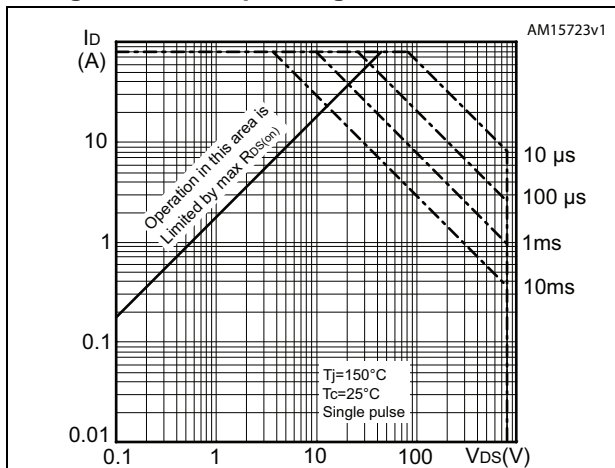


Figure 5. Thermal impedance for TO-220FP

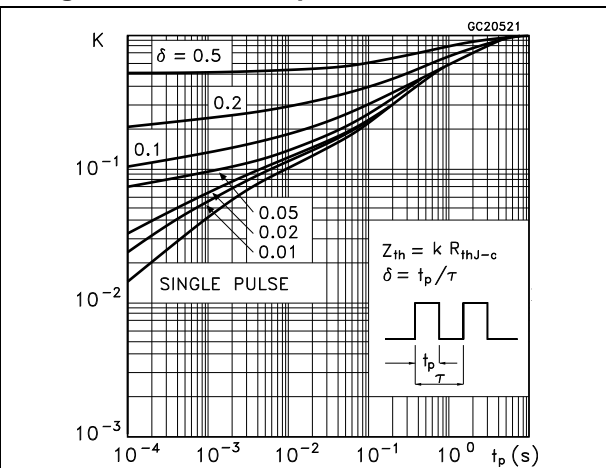


Figure 6. Safe operating area for TO-220

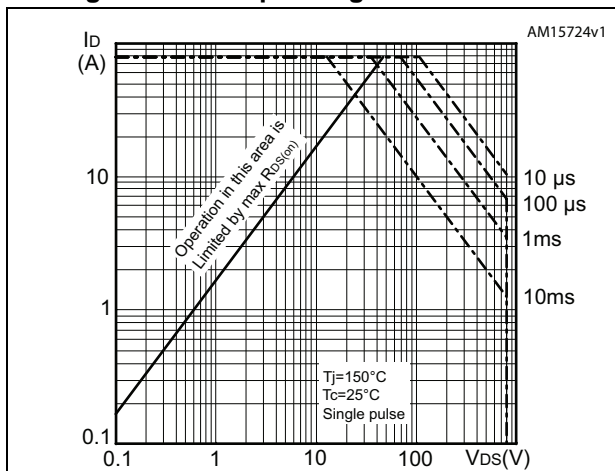


Figure 7. Normalized  $B_{V_{DS}}$  vs temperature

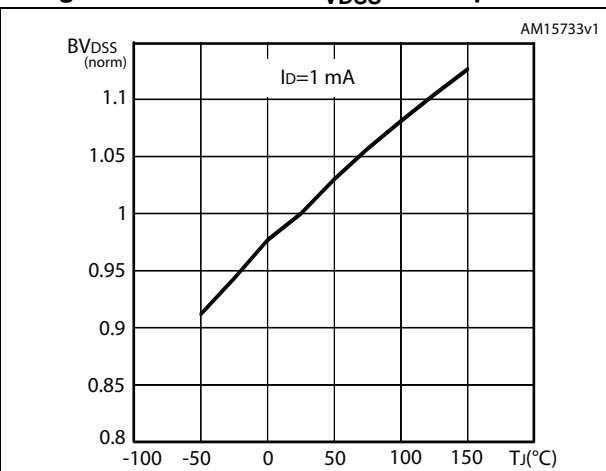


Figure 8. Safe operating area for TO-247

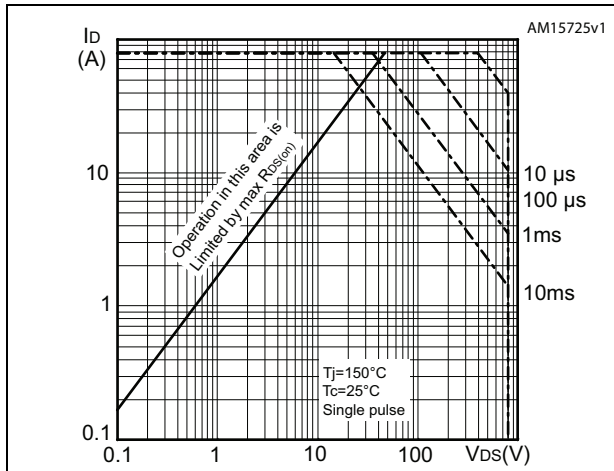


Figure 9. Thermal impedance for TO-247

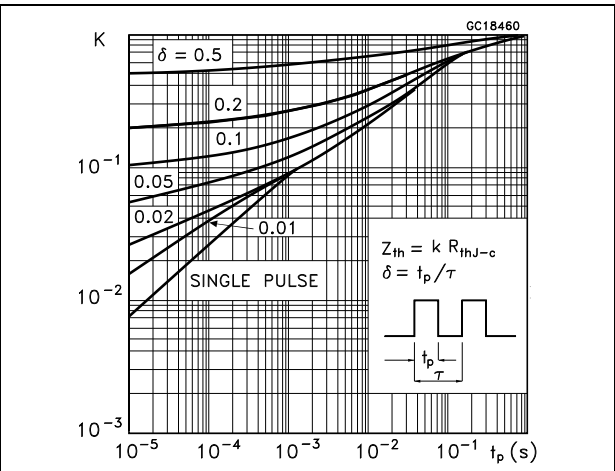


Figure 10. Output characteristics

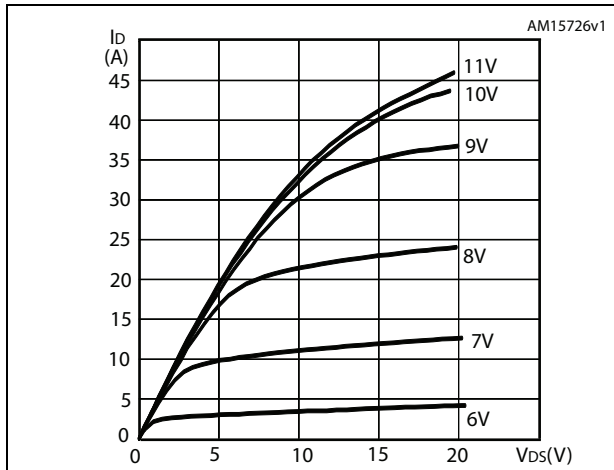


Figure 11. Transfer characteristics

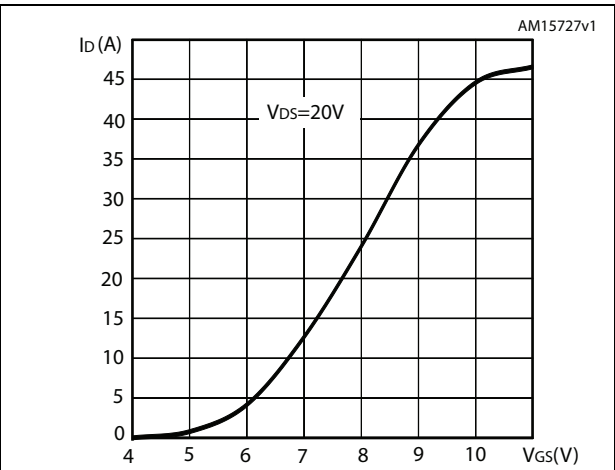


Figure 12. Static drain-source on-resistance

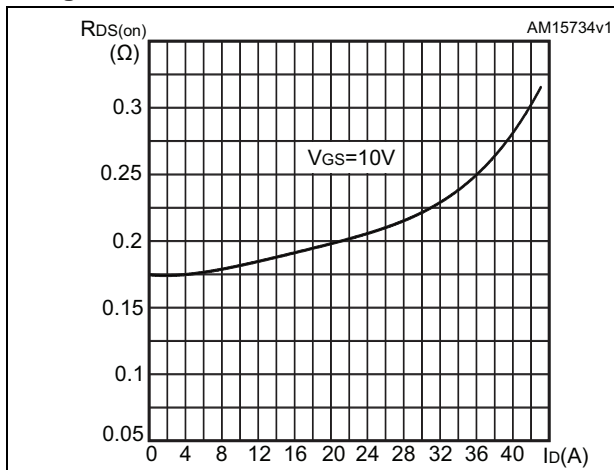


Figure 13. Gate charge vs gate-source voltage

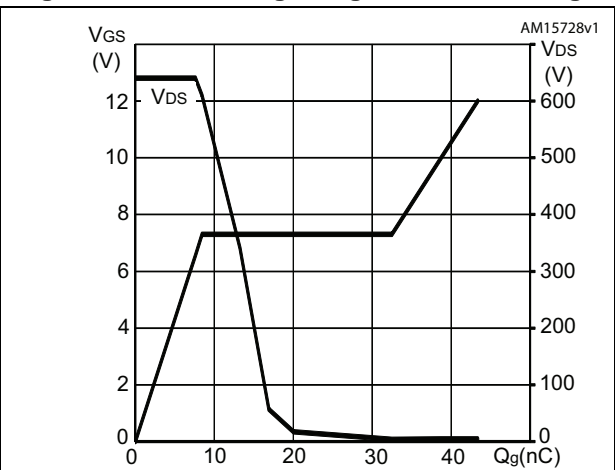


Figure 14. Capacitance variations

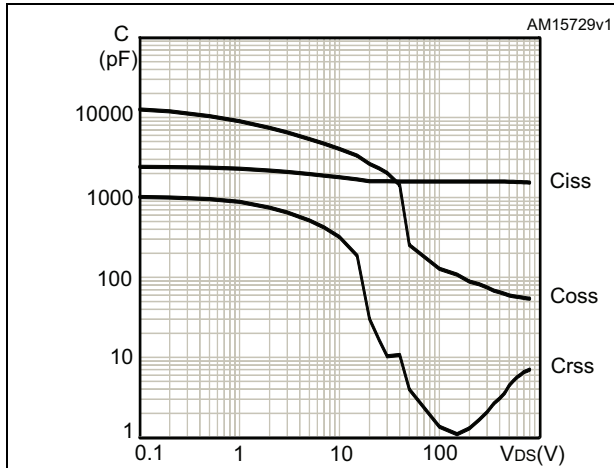


Figure 15. Output capacitance stored energy

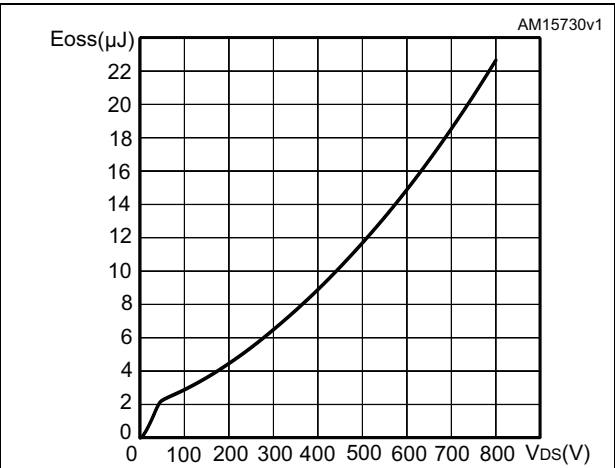


Figure 16. Normalized on-resistance vs temperature

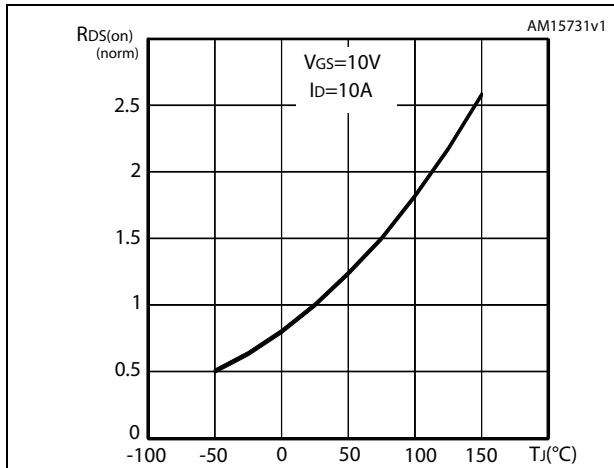
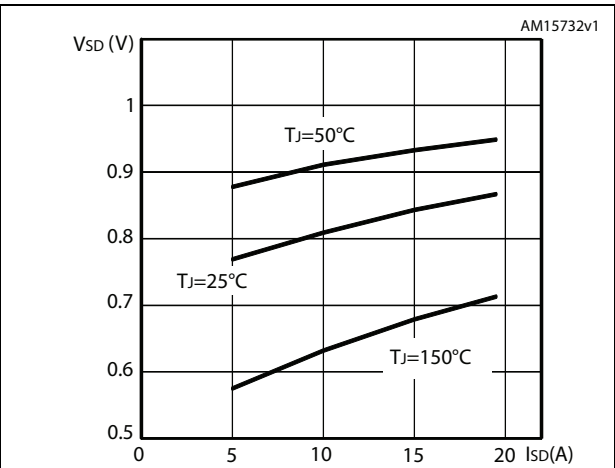


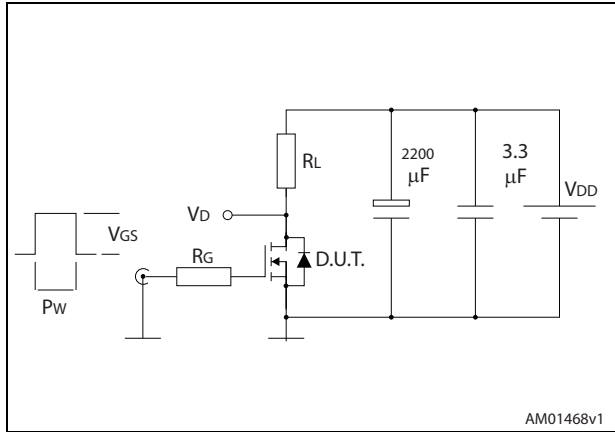
Figure 17. Source-drain diode forward characteristics





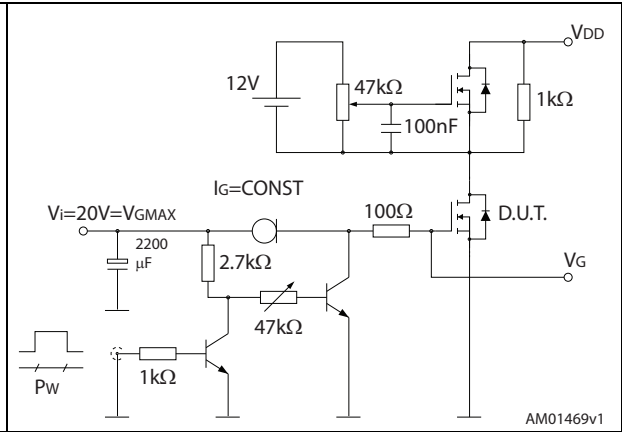
### 3 Test circuits

Figure 18. Switching times test circuit for resistive load



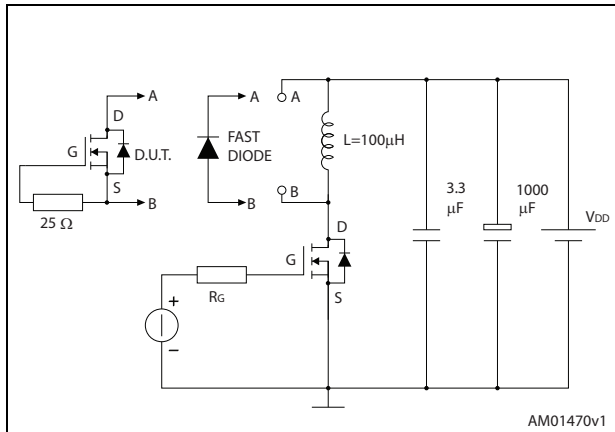
AM01468v1

Figure 19. Gate charge test circuit



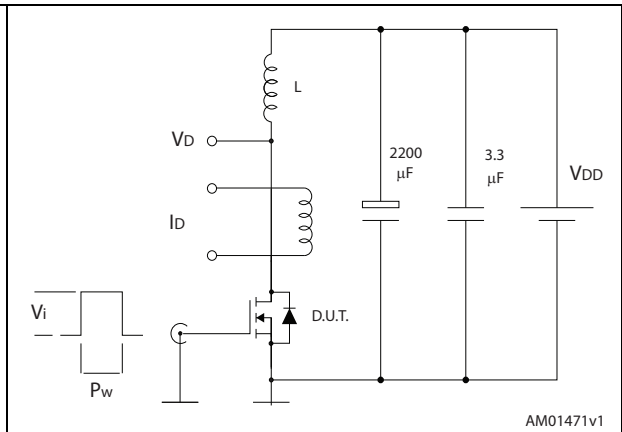
AM01469v1

Figure 20. Test circuit for inductive load switching and diode recovery times



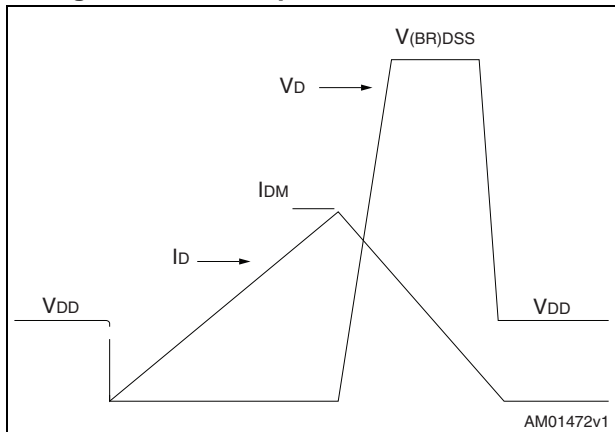
AM01470v1

Figure 21. Unclamped inductive load test circuit



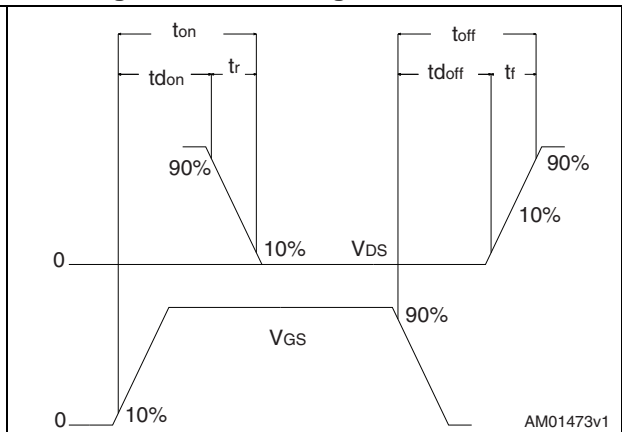
AM01471v1

Figure 22. Unclamped inductive waveform



AM01472v1

Figure 23. Switching time waveform



AM01473v1

## 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.

### 4.1 STB25N80K5, D<sup>2</sup>PAK

Figure 24. D<sup>2</sup>PAK (TO-263) drawing

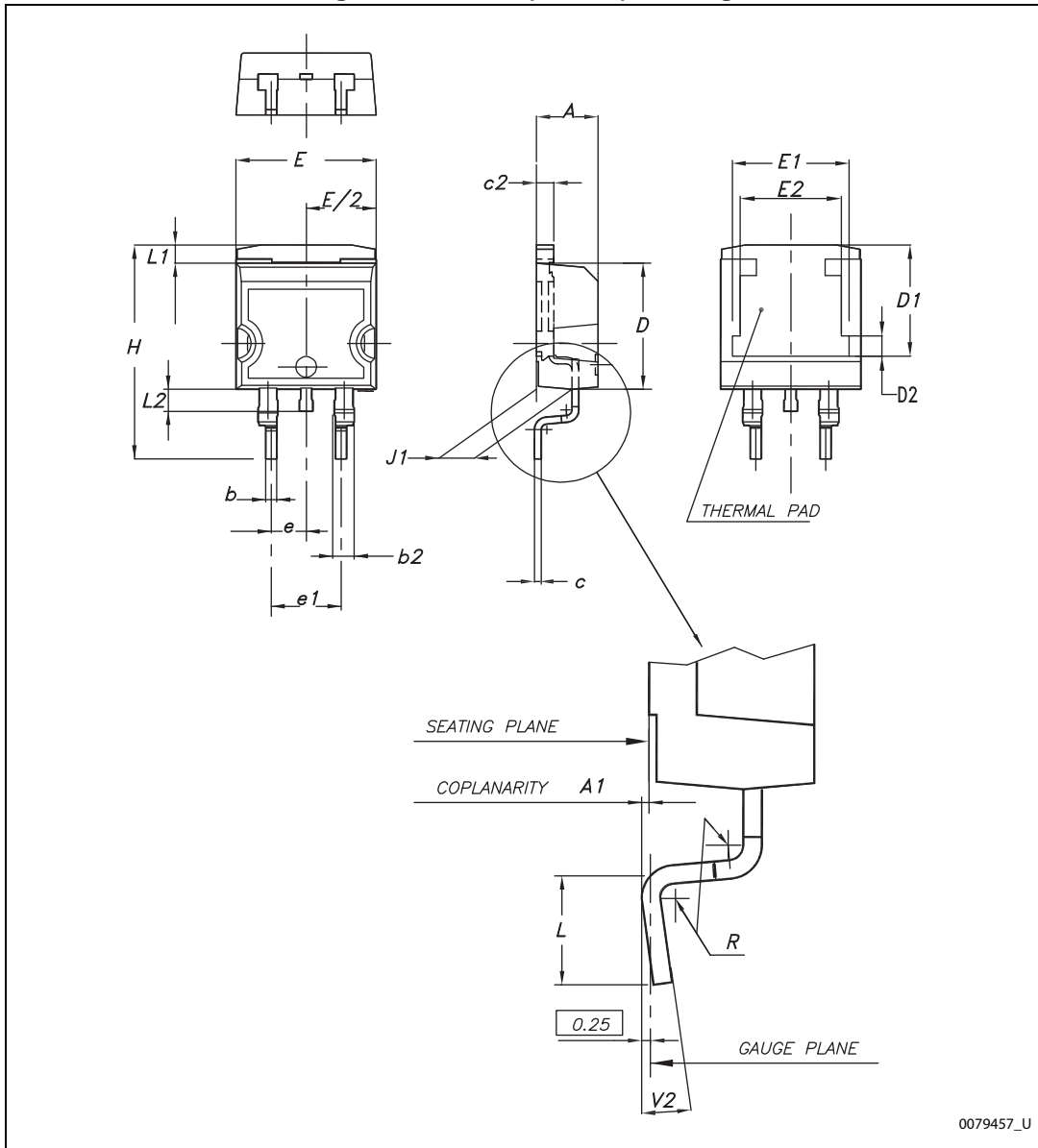
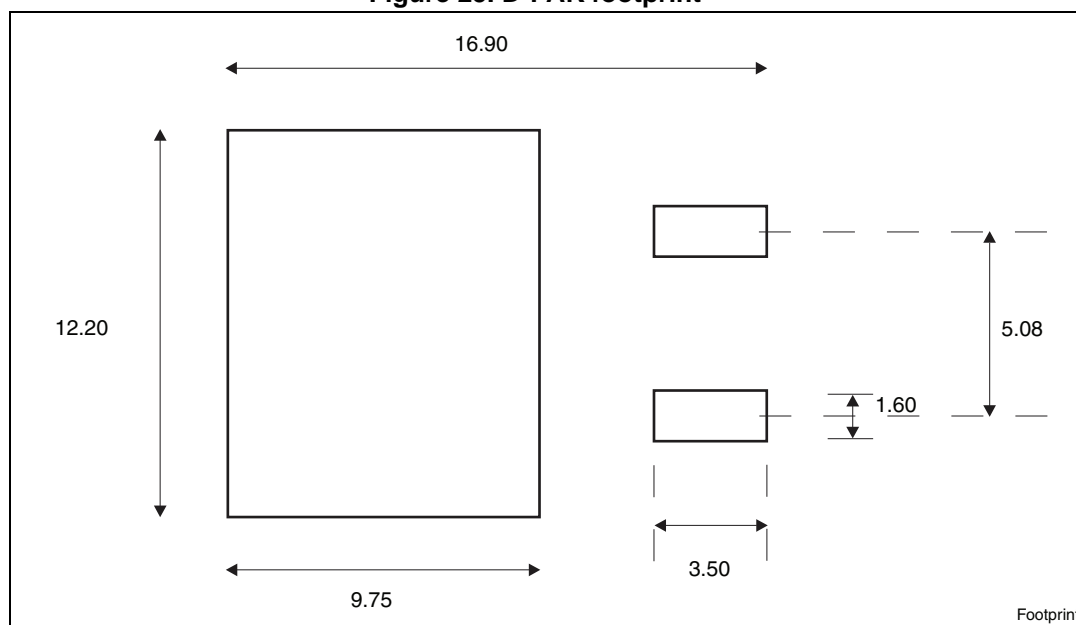


Table 9. D<sup>2</sup>PAK (TO-263) mechanical data

| 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°    |

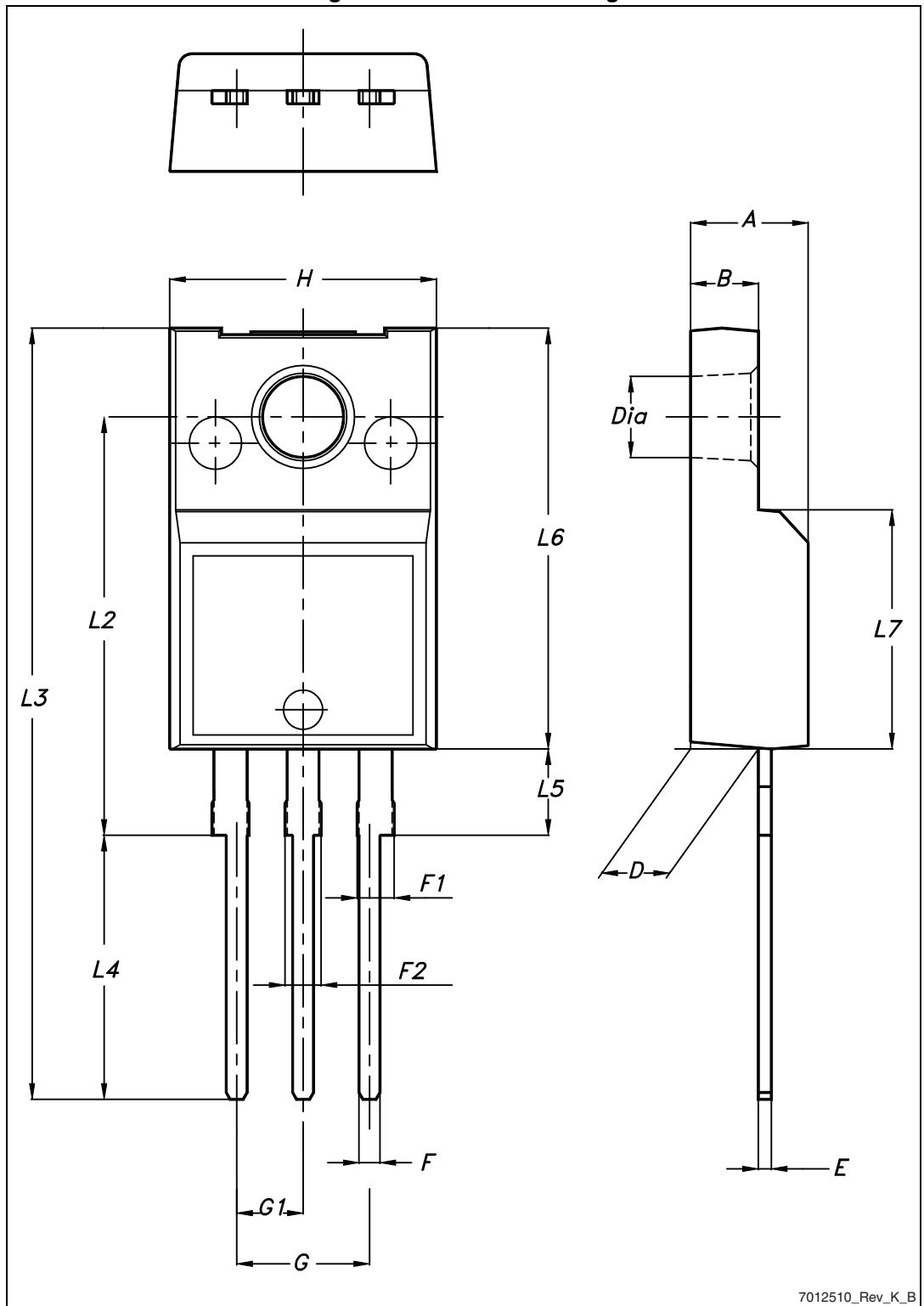
Figure 25. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

### 4.2 STF25N80K5, TO-220FP

Figure 26. TO-220FP drawing



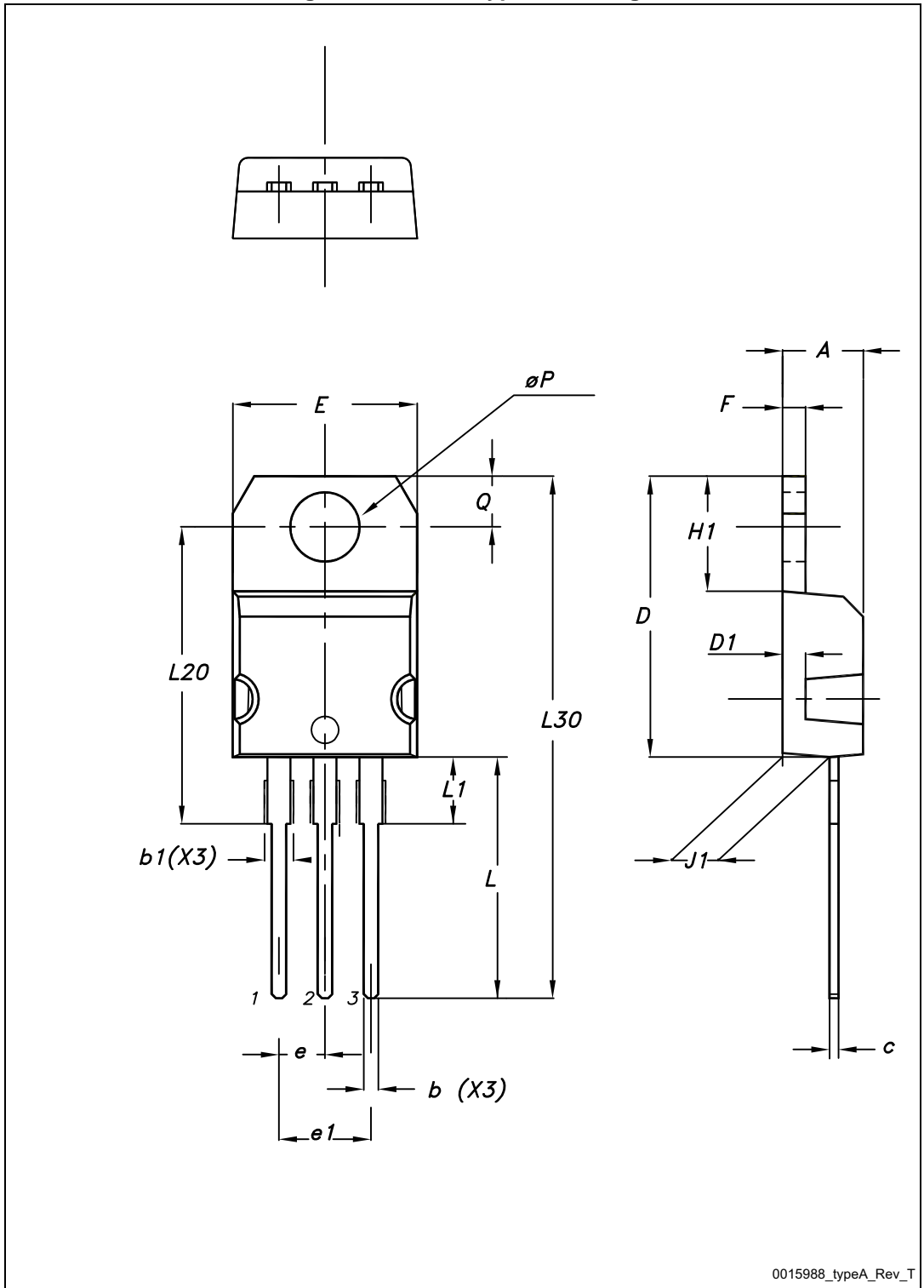
7012510\_Rev\_K\_B

Table 10. 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  |

### 4.3 STP25N80K5, TO-220

Figure 27. TO-220 type A drawing



0015988\_typeA\_Rev\_T



Table 11. 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  |

### 4.4 STW25N80K5, TO-247

Figure 28. TO-247 drawing

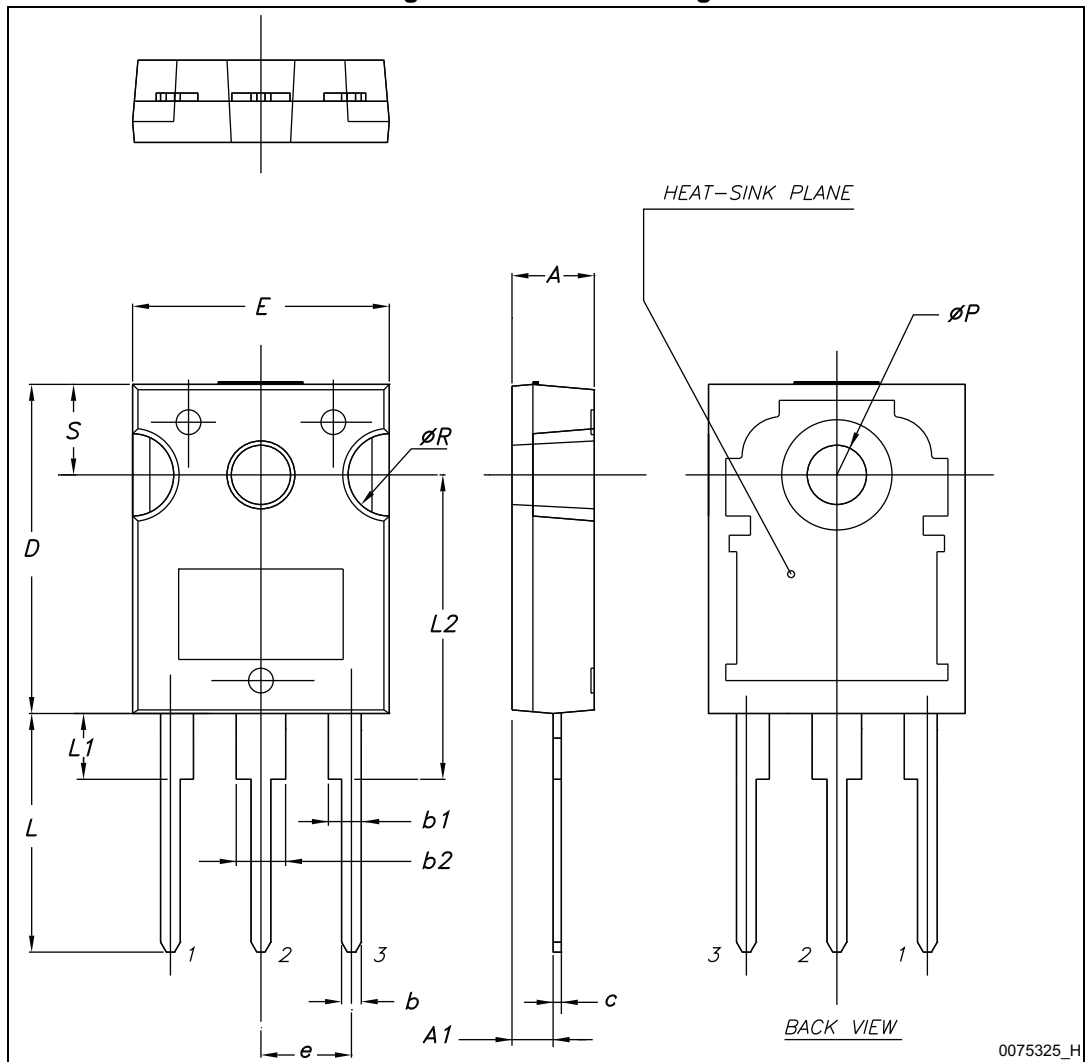


Table 12. TO-247 mechanical data

| Dim. | mm.   |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| b    | 1.0   |       | 1.40  |
| b1   | 2.0   |       | 2.40  |
| b2   | 3.0   |       | 3.40  |
| c    | 0.40  |       | 0.80  |
| D    | 19.85 |       | 20.15 |
| E    | 15.45 |       | 15.75 |
| e    | 5.30  | 5.45  | 5.60  |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    | 5.30  | 5.50  | 5.70  |

# 5 Packaging information

Figure 29. Tape

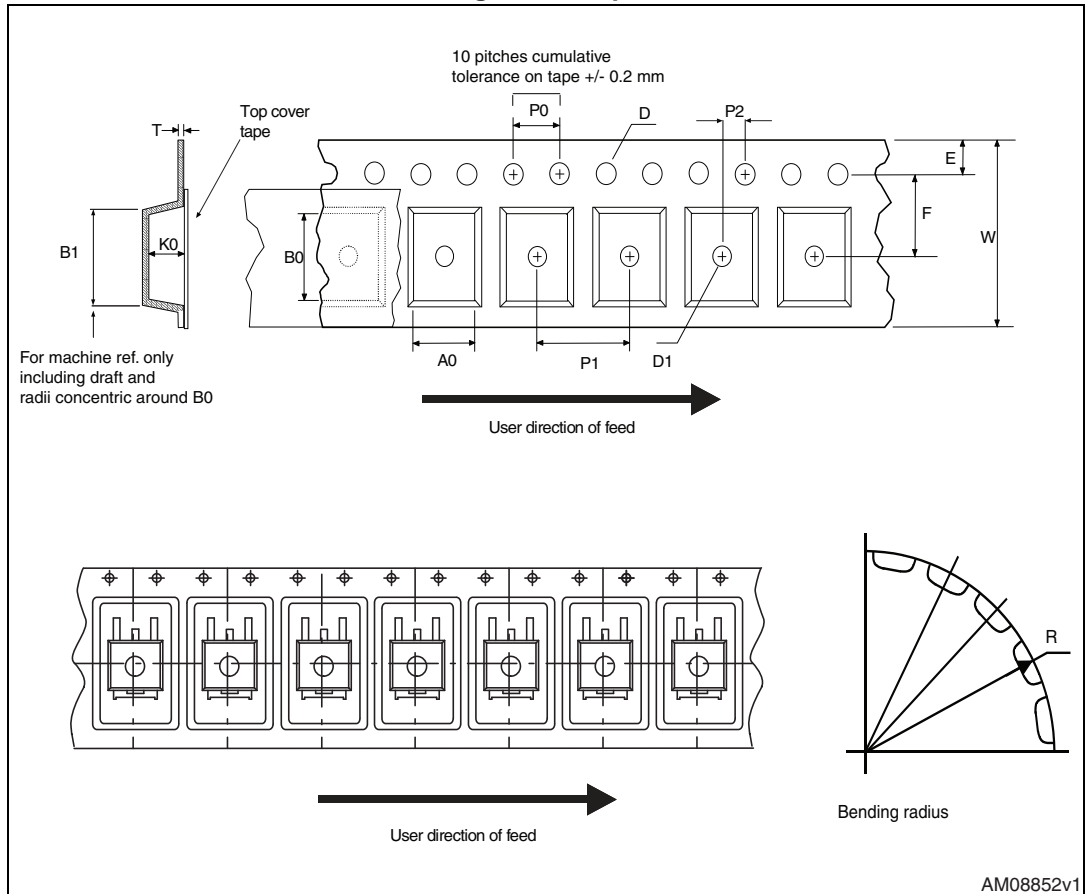


Figure 30. Reel

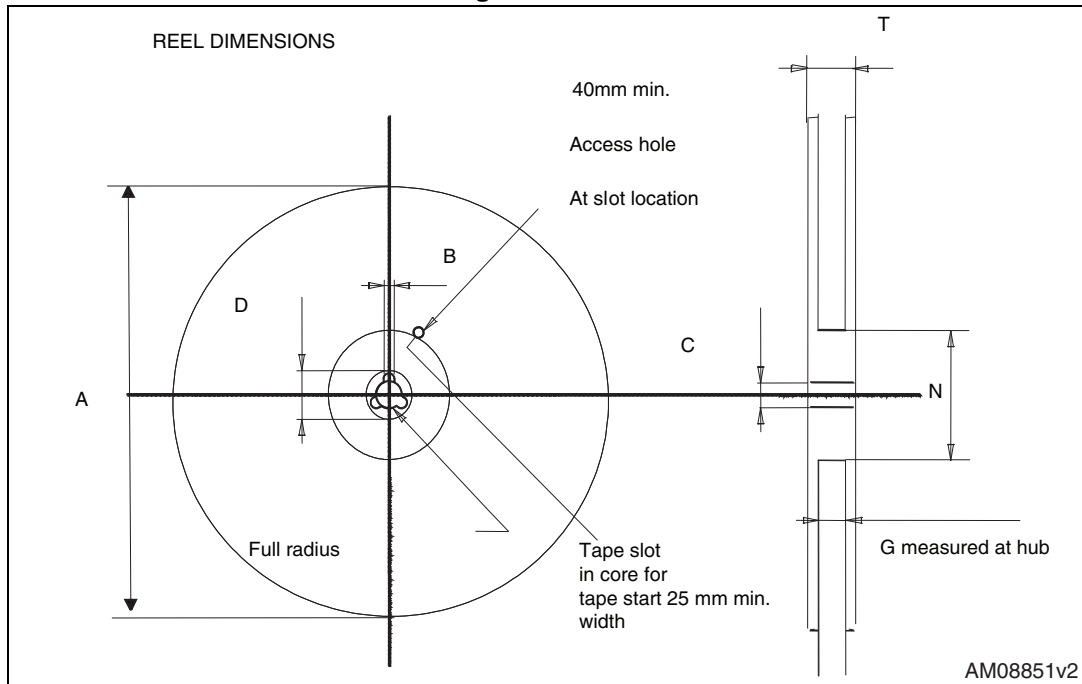


Table 13. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

| 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 |      |          |      |

## 6 Revision history

Table 14. Document revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 17-Jul-2012 | 1        | First release.  |
| 04-Jun-2013 | 2        | <ul style="list-style-type: none"><li>– Modified: <math>I_{AR}</math>, <math>E_{AS}</math>, <math>dv/dt</math> on <a href="#">Table 2</a>, <math>R_{DS(on)}</math> value on <a href="#">Table 4</a>, entire values on <a href="#">Table 5</a>, <a href="#">6</a> and <a href="#">7</a></li><li>– Updated: <a href="#">Section 4: Package mechanical data</a></li><li>– Minor text changes</li><li>– Updated: <a href="#">Table 11</a> and <a href="#">Figure 27</a></li><li>– Document status promoted from preliminary data to production data</li></ul> |
| 31-Oct-2014 | 3        | <p>Updated title, description and features in cover page.<br/>Updated <a href="#">Figure 12: Static drain-source on-resistance</a>.<br/>Updated <a href="#">Section 4.1: STB25N80K5, D<sup>2</sup>PAK</a> and <a href="#">Section 4.4: STW25N80K5, TO-247</a><br/>Minor text change</p>   |

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