



# STB34NM60N, STF34NM60N, STP34NM60N, STW34NM60N

N-channel 600 V, 0.092  $\Omega$ , 29 A MDmesh™ II Power MOSFET  
in D<sup>2</sup>PAK, TO-220FP, TO-220, TO-247 packages

Datasheet — production data

## Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub><br>max. | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|-----------------------------|----------------|------------------|
| STB34NM60N  | 600 V           | 0.105 $\Omega$              | 29 A           | 210 W            |
| STF34NM60N  | 600 V           | 0.105 $\Omega$              | 29 A           | 40 W             |
| STP34NM60N  | 600 V           | 0.105 $\Omega$              | 29 A           | 210 W            |
| STW34NM60N  | 600 V           | 0.105 $\Omega$              | 29 A           | 210 W            |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

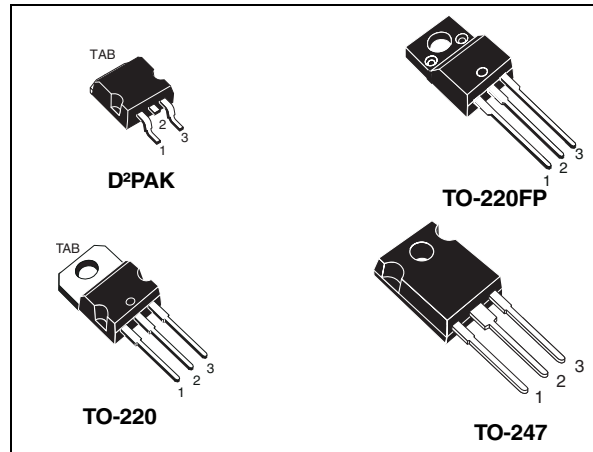


Figure 1. Internal schematic diagram

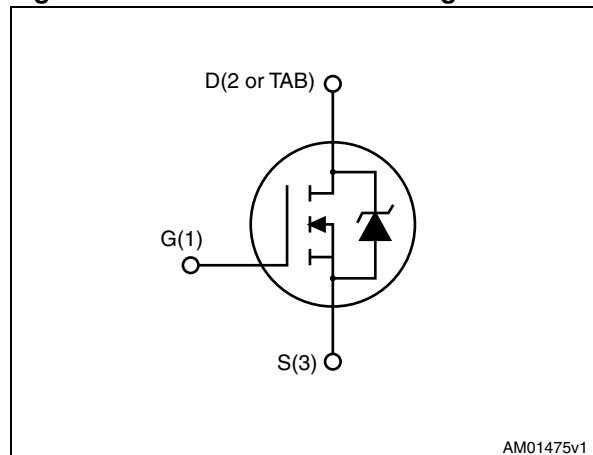


Table 1. Device summary

| Order codes | Marking | Package            | Packaging     |
|-------------|---------|--------------------|---------------|
| STB34NM60N  | 34NM60N | D <sup>2</sup> PAK | Tape and reel |
| STF34NM60N  |         | TO-220FP           | Tube          |
| STP34NM60N  |         | TO-220             | Tube          |
| STW34NM60N  |         | TO-247             | Tube          |

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter  | Value                              |                   | Unit |
|--------------------------------|--|------------------------------------|-------------------|------|
|                                |  | D <sup>2</sup> PAK, TO-220, TO-247 | TO-220FP          |      |
| V <sub>DS</sub>                | Drain-source voltage   | 600                                |                   | V    |
| V <sub>GS</sub>                | Gate- source voltage   | ± 25                               |                   | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C   | 29                                 | 29 <sup>(1)</sup> | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C  | 18                                 | 18 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)   | 116                                | 116               | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C  | 210                                | 40                | W    |
| I <sub>AR</sub>                | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)                                | 10.5                               |                   | A    |
| E <sub>AS</sub>                | Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 345                                |                   | mJ   |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope  | 15                                 |                   | V/ns |
| 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    |
| T <sub>stg</sub>               | Storage temperature  | - 55 to 150                        |                   | °C   |
| T <sub>J</sub>                 | Max. operating junction temperature  | 150                                |                   |      |

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 29 A, di/dt ≤ 400 A/μs, V<sub>DS</sub> peak ≤ V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

| Symbol                              | Parameter                               | D <sup>2</sup> PAK | TO-220FP | TO-220 | TO-247 | Unit |
|-------------------------------------|---|--------------------|----------|--------|--------|------|
| R <sub>thj-case</sub>               | Thermal resistance junction-case max    | 0.6                | 3.1      | 0.6    |        | °C/W |
| R <sub>thj-amb</sub>                | Thermal resistance junction-ambient max |                    | 62.5     | 50     |        |      |
| R <sub>thj-pcb</sub> <sup>(1)</sup> | Thermal resistance junction-pcb max     | 30                 |          |        |        |      |

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

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter  | Test conditions   | Value |       |           | Unit                           |
|---------------|--|---|-------|-------|-----------|--------------------------------|
|               |  |   | Min.  | Typ.  | Max.      |                                |
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ( $V_{GS} = 0$ )  | $I_D = 1\text{ mA}$   | 600   |       |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 600\text{ V}$<br>$V_{DS} = 600\text{ V}, T_C = 125\text{ °C}$ |       |       | 1<br>100  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$  |       |       | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                         | 2     | 3     | 4         | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}, I_D = 14.5\text{ A}$                             |       | 0.092 | 0.105     | $\Omega$                       |

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|--|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}, f = 1\text{ MHz},$<br>$V_{GS} = 0$   | -    | 2722 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |  |      | 173  |      | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |  |      | 1.75 |      | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$  | -    | 458  | -    | pF       |
| $t_{d(on)}$                | Turn-on delay time            | $V_{DD} = 300\text{ V}, I_D = 14.5\text{ A}$<br>$R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 23</a> ),<br>(see <a href="#">Figure 18</a> ) | -    | 17   | -    | ns       |
| $t_r$                      | Rise time                     |  |      | 34   |      | ns       |
| $t_{d(off)}$               | Turn-off delay time           |  |      | 106  |      | ns       |
| $t_f$                      | Fall time                     |  |      | 70   |      | ns       |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}, I_D = 29\text{ A},$<br>$V_{GS} = 10\text{ V},$<br>(see <a href="#">Figure 19</a> )   | -    | 84   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |  |      | 14   |      | nC       |
| $Q_{gd}$                   | Gate-drain charge             |  |      | 45   |      | nC       |
| $R_g$                      | Gate input resistance         | f=1MHz Gate DC Bias=0<br>Test signal level=20 mV<br>Open drain   | -    | 2.9  | -    | $\Omega$ |

1.  $C_{oss\text{ eq.}}$  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 6. Source drain diode**

| Symbol          | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit |    |               |
|-----------------|-------------------------------|---|------|------|------|------|----|---------------|
| $I_{SD}$        | Source-drain current          |   | -    |      | 29   | A    |    |               |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   | -    |      | 116  | A    |    |               |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 29\text{ A}, V_{GS} = 0$  | -    |      | 1.6  | V    |    |               |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 29\text{ A}, V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$<br>(see <a href="#">Figure 20</a> )  | -    | 408  |      | ns   |    |               |
| $Q_{rr}$        | Reverse recovery charge       |   |      |      |      |      | 8  | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   |      |      |      |      | 39 | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 29\text{ A}, V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$T_J = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 20</a> ) | -    | 480  |      | ns   |    |               |
| $Q_{rr}$        | Reverse recovery charge       |   |      |      |      |      | 10 | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   |      |      |      |      | 42 | A             |

1. Pulse width limited by safe operating area.
2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D<sup>2</sup>PAK and TO-220

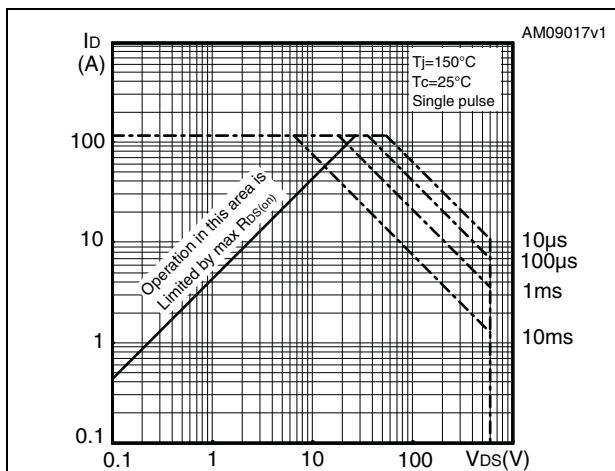


Figure 3. Thermal impedance for for D<sup>2</sup>PAK and TO-220

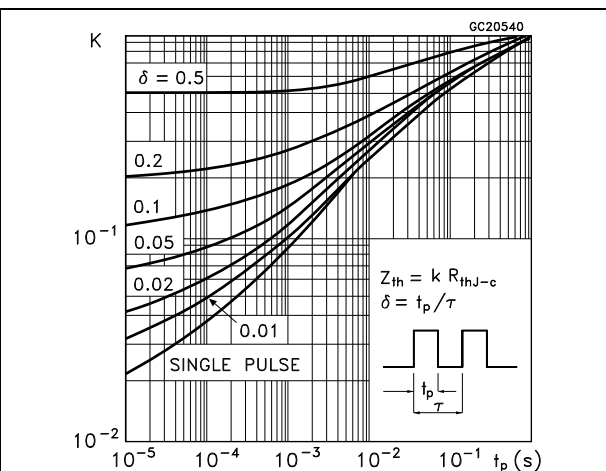


Figure 4. Safe operating area for TO-220FP

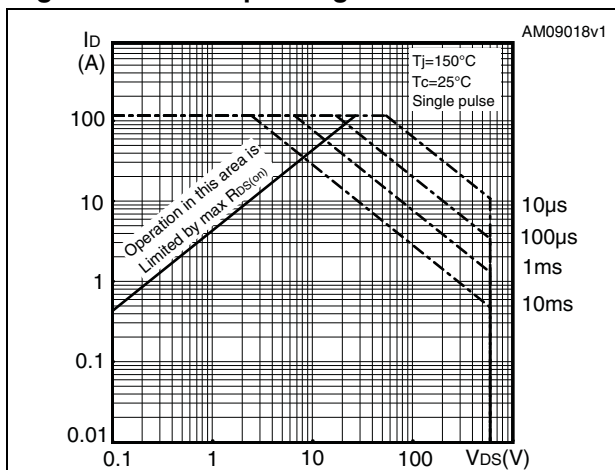


Figure 5. Thermal impedance for TO-220FP

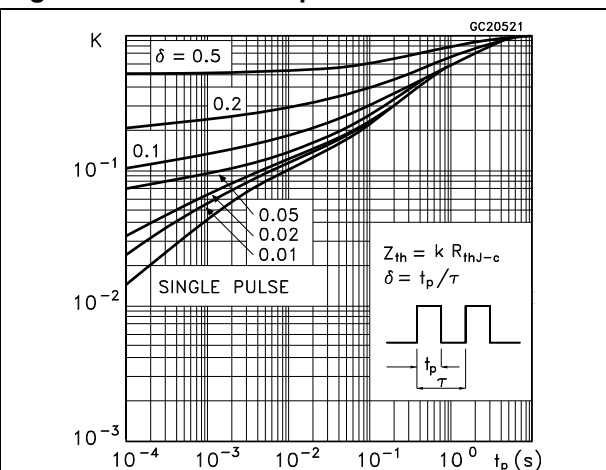


Figure 6. Safe operating area for TO-247

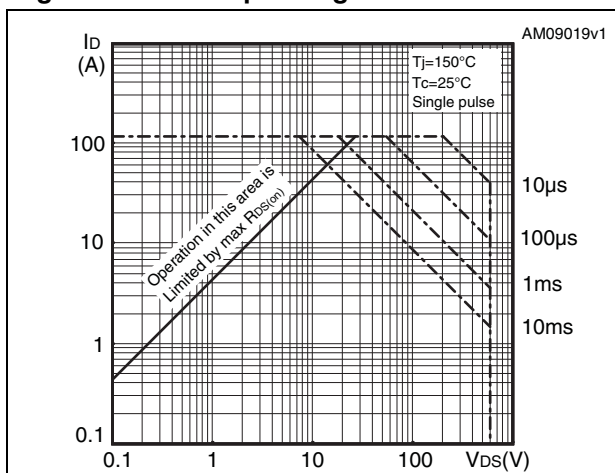


Figure 7. Thermal impedance for TO-247

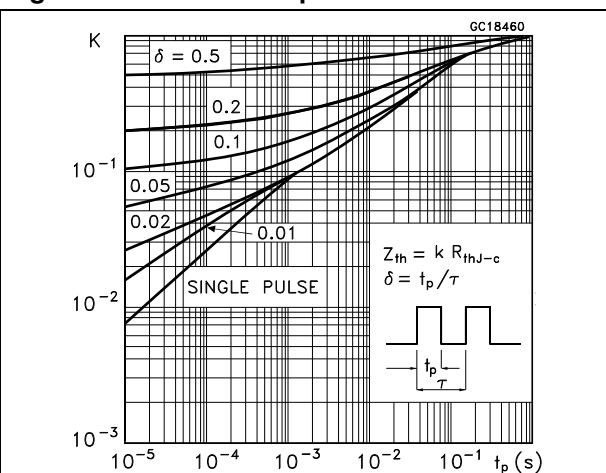


Figure 8. Output characteristics

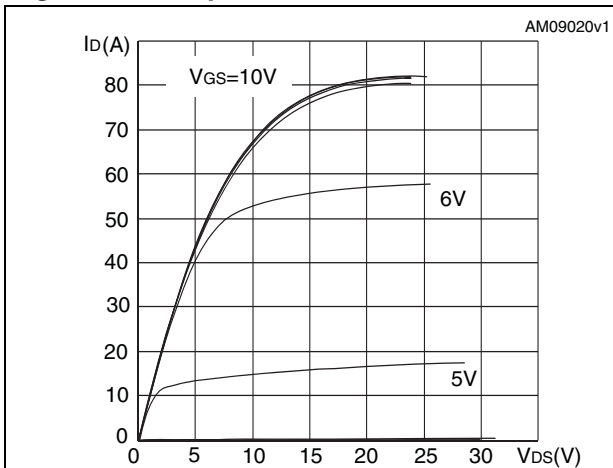


Figure 9. Transfer characteristics

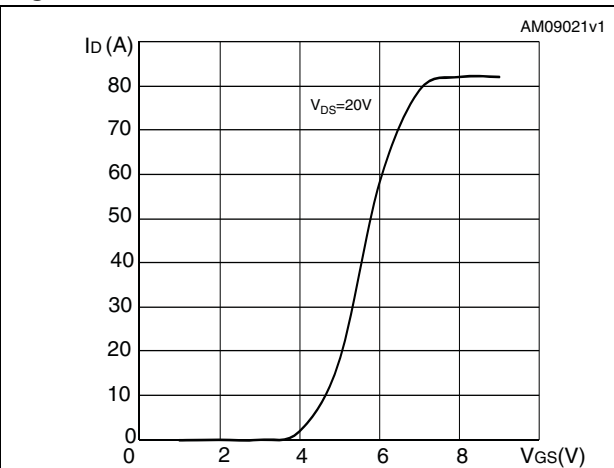


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on-resistance

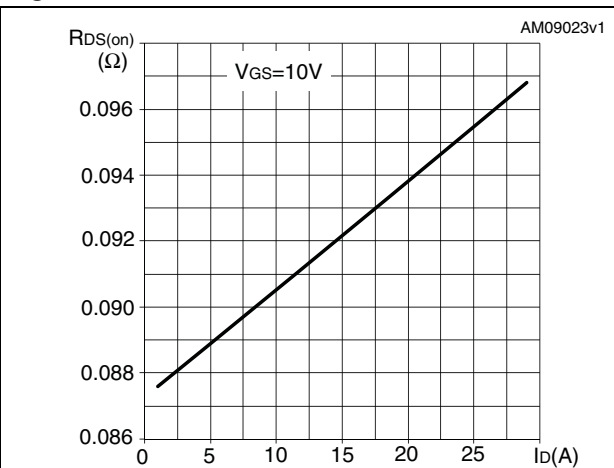
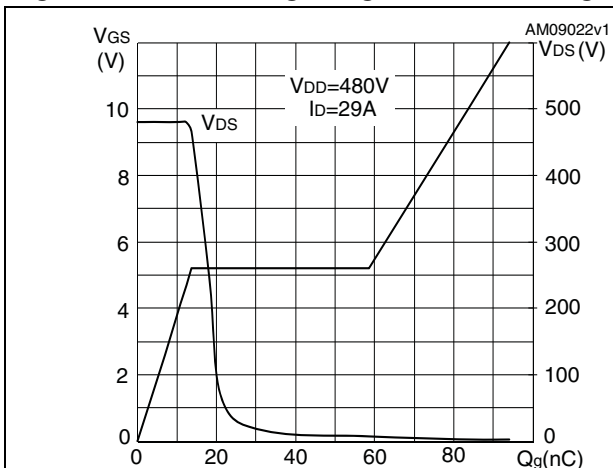


Figure 12. Capacitance variations

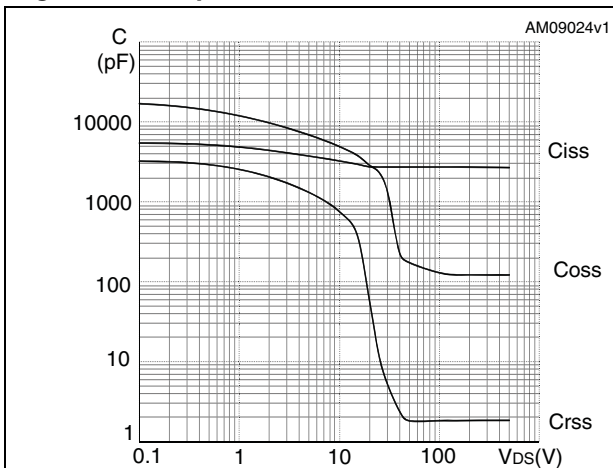


Figure 13. Output capacitance stored energy

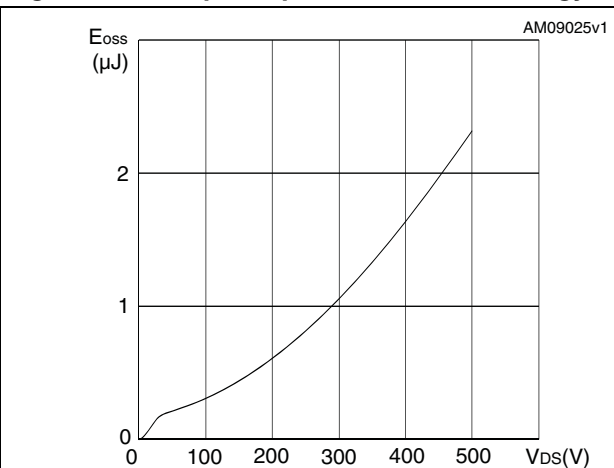


Figure 14. Normalized gate threshold voltage vs temperature

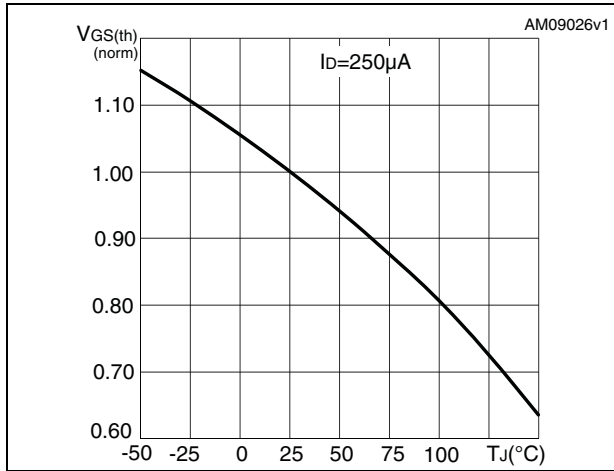


Figure 15. Normalized on-resistance vs temperature

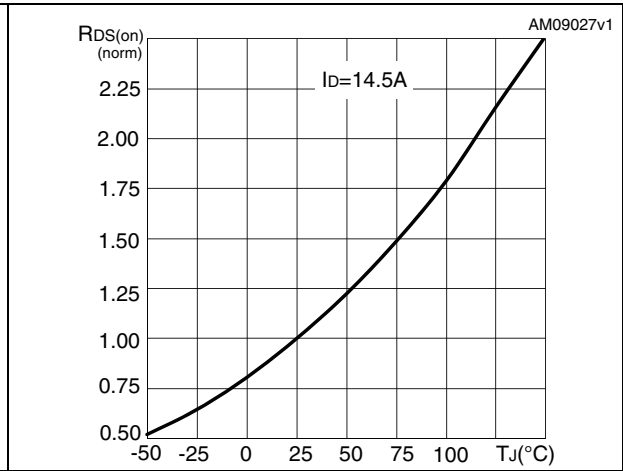


Figure 16. Normalized  $V_{DS}$  vs temperature

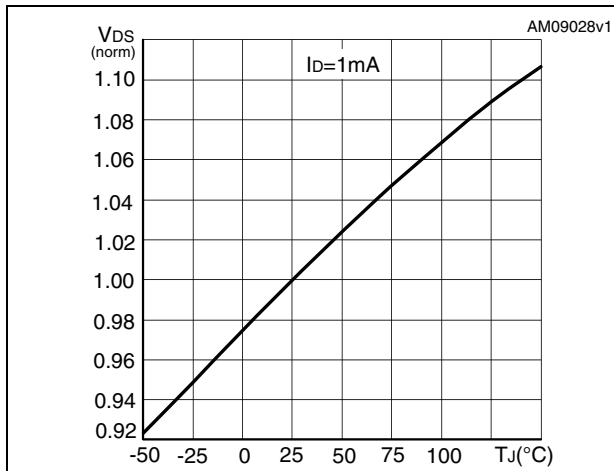
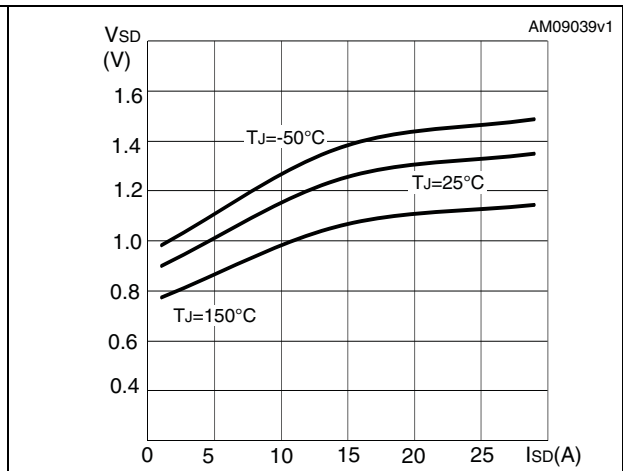


Figure 17. Source-drain diode forward characteristics





### 3 Test circuits

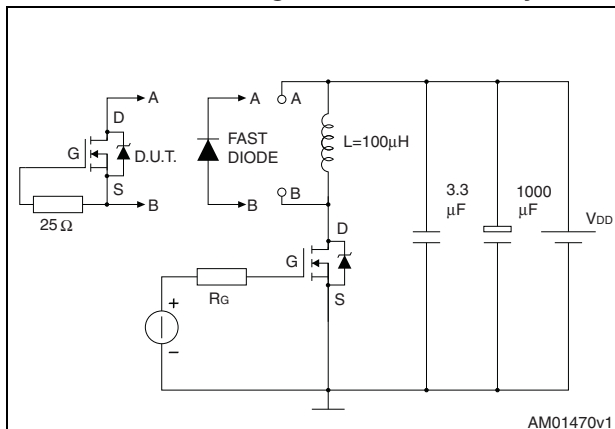
**Figure 18. Switching times test circuit for resistive load**



**Figure 19. Gate charge test circuit**



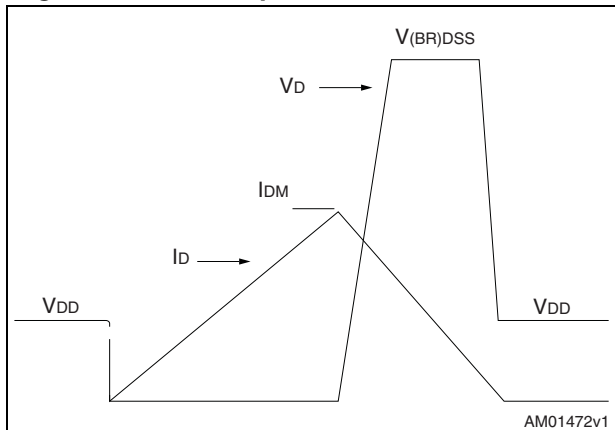
**Figure 20. Test circuit for inductive load switching and diode recovery times**



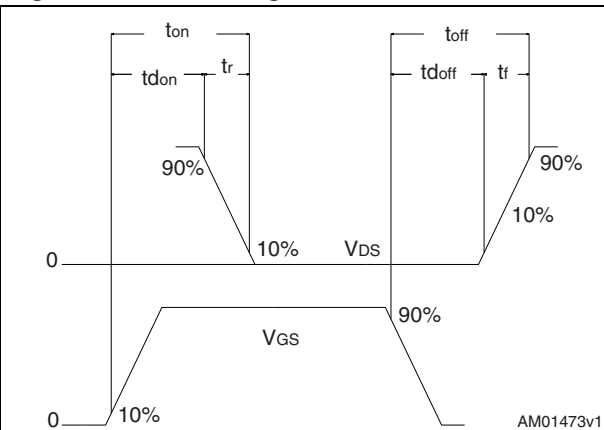
**Figure 21. Unclamped inductive load test circuit**



**Figure 22. Unclamped inductive waveform**



**Figure 23. Switching time waveform**



## 4 Package mechanical data

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](http://www.st.com). ECOPACK® is an ST trademark.

**Table 7. 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 |      |       |
| E    | 10   |      | 10.40 |
| E1   | 8.50 |      |       |
| 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 24. D<sup>2</sup>PAK (TO-263) drawing



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



a. All dimensions are in millimeters

Table 8. 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  |

Figure 26. TO-220FP drawing

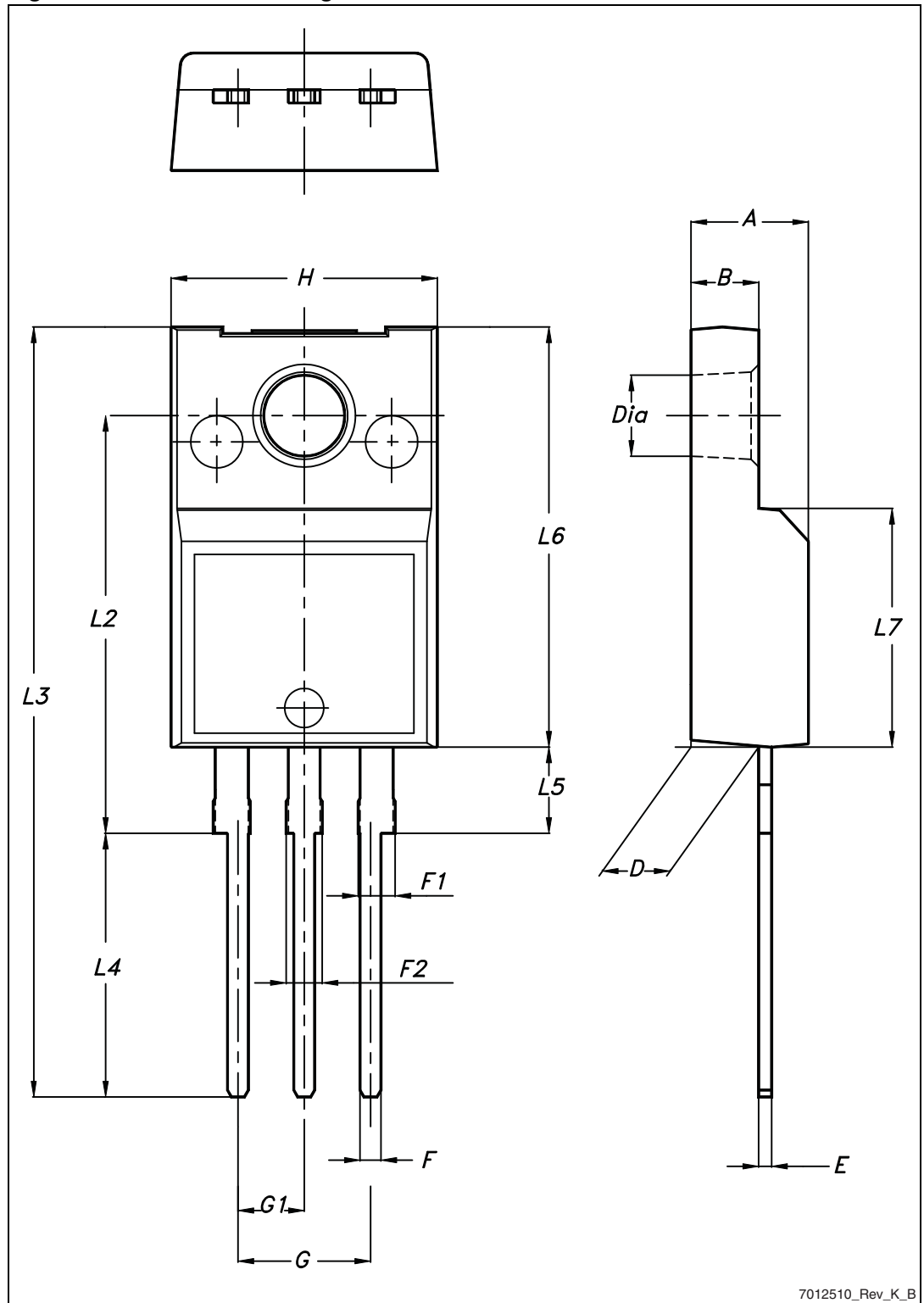
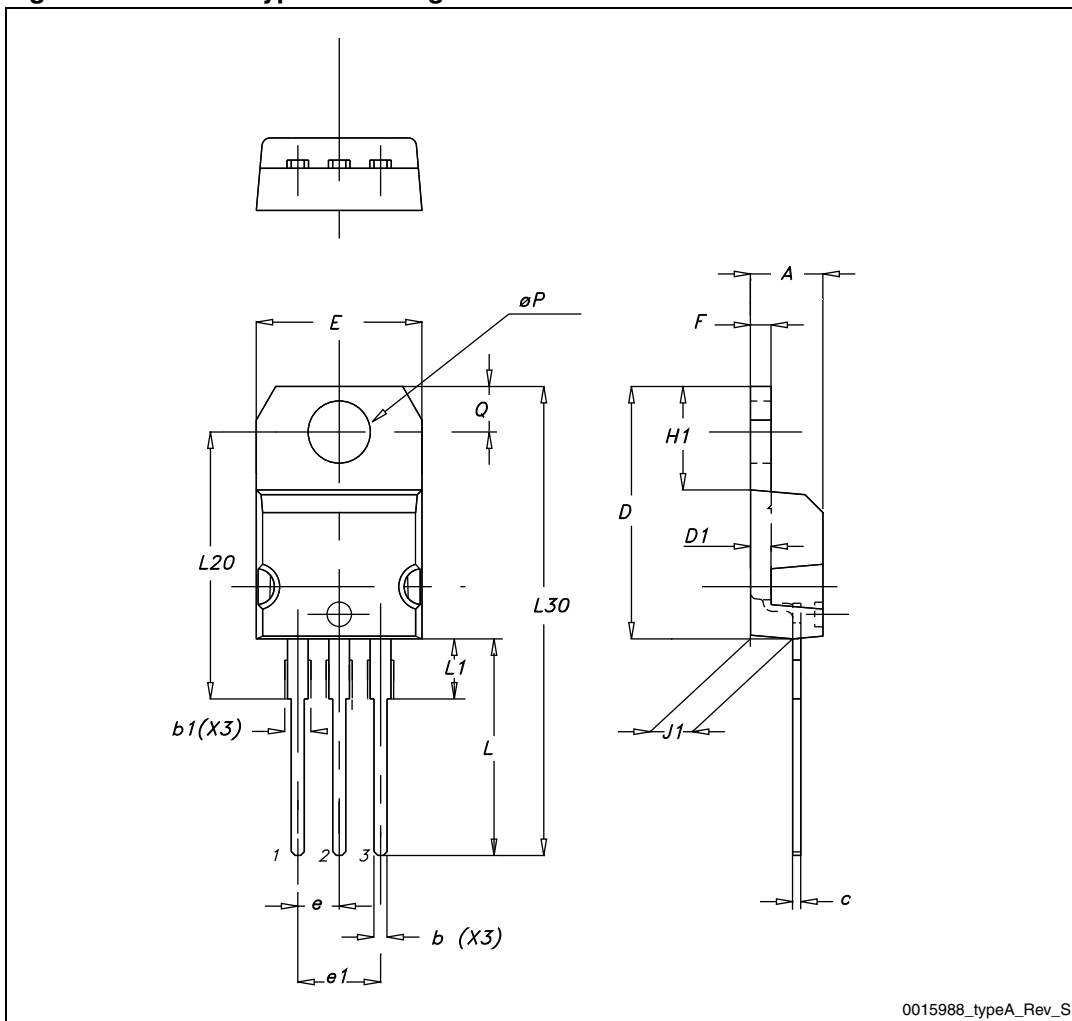


Table 9. TO-220 type A mechanical data

| 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 27. TO-220 type A drawing



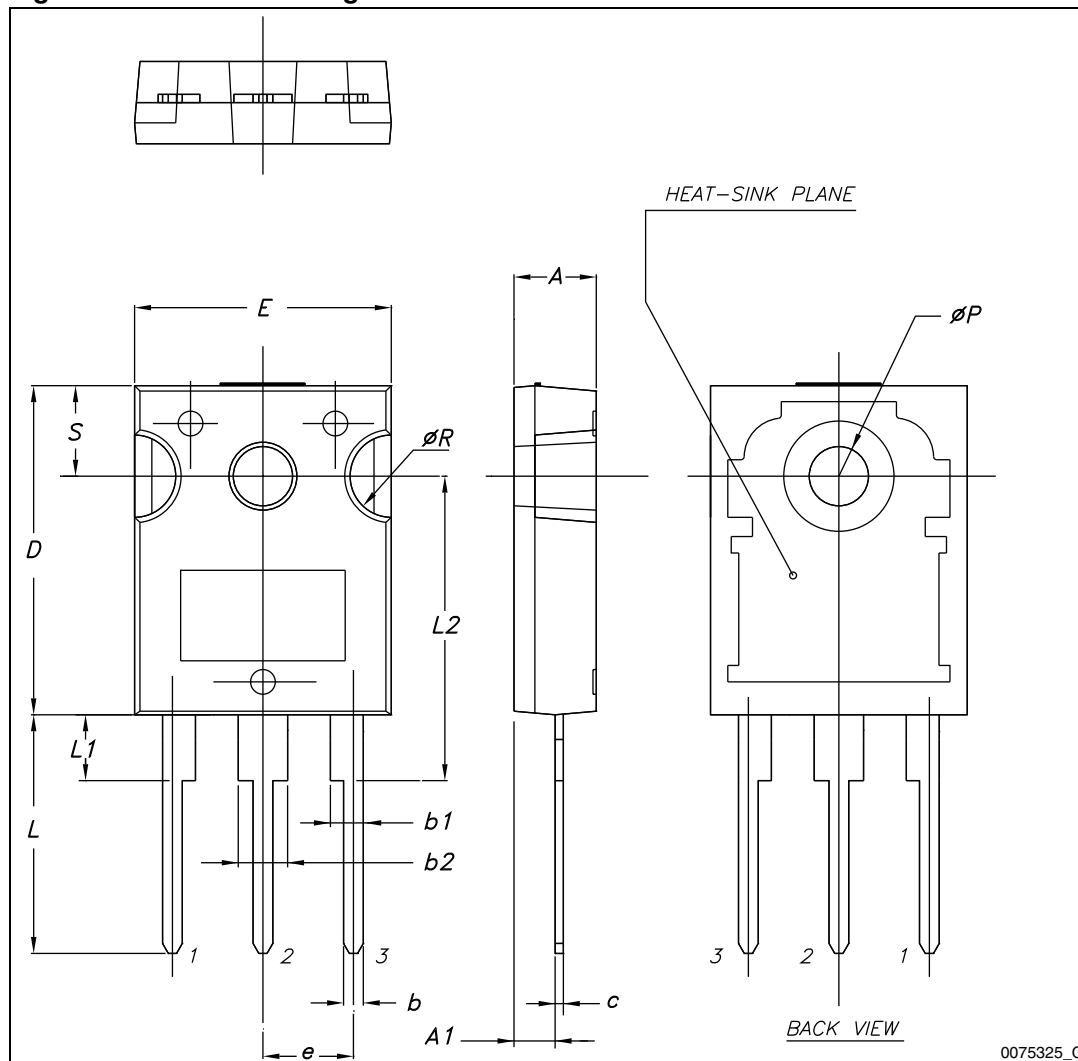
0015988\_typeA\_Rev\_S

Table 10. 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  |



Figure 28. TO-247 drawing



## 5 Packaging mechanical data

Table 11. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

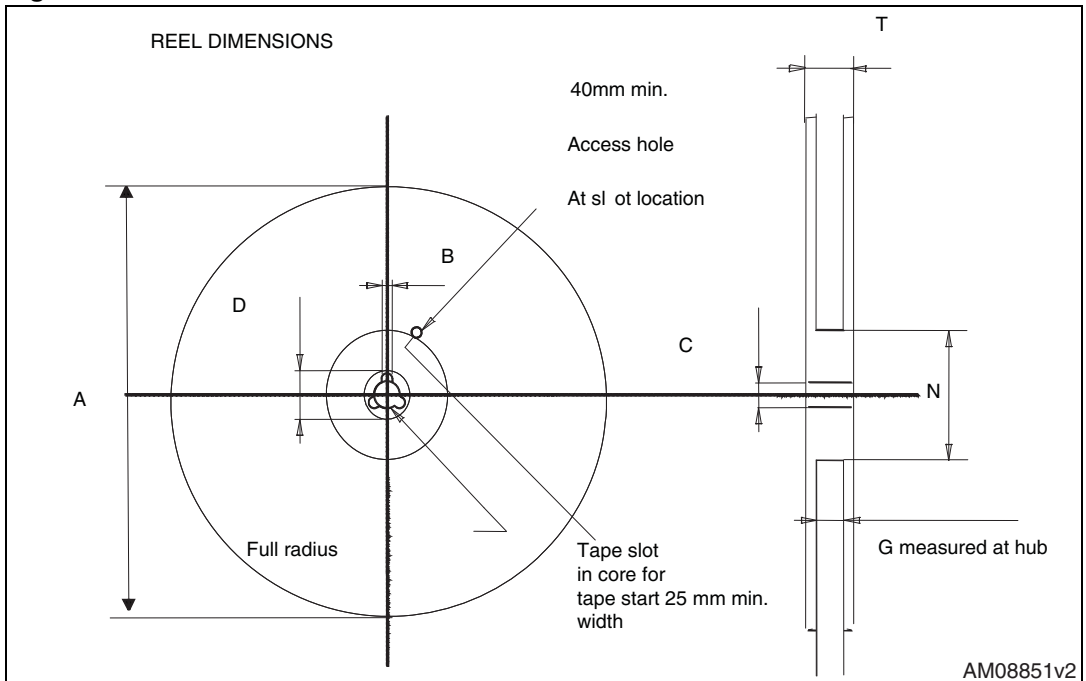
| Tape |      |      | Reel     |      |      |
|------|------|------|----------|------|------|
| Dim. | mm   |      | Dim.     | mm   |      |
|      | Min. | Max. |          | Min. | Max. |
| A0   | 10.5 | 10.7 | A        |      | 330  |
| B0   | 15.7 | 15.9 | B        | 1.5  |      |
| D    | 1.5  | 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 |          |      |      |

Figure 29. Tape



AM08852v2

Figure 30. Reel



AM08851v2

## 6 Revision history

**Table 12. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 05-Aug-2010 | 1        | Initial release.  |
| 02-Sep-2010 | 2        | Updated title on cover page and <a href="#">Table 4: On/off states</a> .  |
| 07-Apr-2011 | 3        | Document status promoted from preliminary data to datasheet.  |
| 10-Oct-2011 | 4        | Inserted new device in D <sup>2</sup> PAK:<br>Updated: <a href="#">Table 2: Absolute maximum ratings</a> , <a href="#">Table 3: Thermal data</a> and <a href="#">Section 4: Package mechanical data</a> with the new device.<br>Inserted <a href="#">Section 5: Packaging mechanical data</a> .<br>Minor text changes.  |
| 12-Dec-2011 | 5        | <ul style="list-style-type: none"> <li>– <a href="#">Figure 11: Static drain-source on-resistance</a> has been updated.</li> <li>– <a href="#">Figure 14: Normalized gate threshold voltage vs temperature</a> has been updated.</li> <li>– <a href="#">Figure 15: Normalized on-resistance vs temperature</a> has been updated.</li> <li>– <a href="#">Figure 16: Normalized <math>V_{DS}</math> vs temperature</a> has been updated.</li> </ul> |
| 21-Dec-2011 | 6        | Updated: <a href="#">Table 2: Absolute maximum ratings</a> ( $V_{ISO}$ value for TO-220FP)  |
| 10-May-2012 | 7        | <a href="#">Figure 10: Gate charge vs gate-source voltage</a> has been updated.   |

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