



# STB30N65M5, STF30N65M5, STI30N65M5 STP30N65M5, STW30N65M5

N-channel 650 V, 0.125  $\Omega$ , 22 A, MDmesh™ V Power MOSFET  
D<sup>2</sup>PAK, TO-220FP, I<sup>2</sup>PAK, TO-220, TO-247

## Features

| Order codes | V <sub>DSS</sub> @<br>T <sub>JMAX</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub>      |
|-------------|-----------------------------------------|--------------------------|---------------------|
| STB30N65M5  | 710 V                                   | < 0.139 $\Omega$         | 22 A                |
| STF30N65M5  | 710 V                                   | < 0.139 $\Omega$         | 22 A <sup>(1)</sup> |
| STI30N65M5  | 710 V                                   | < 0.139 $\Omega$         | 22 A                |
| STP30N65M5  | 710 V                                   | < 0.139 $\Omega$         | 22 A                |
| STW30N65M5  | 710 V                                   | < 0.139 $\Omega$         | 22 A                |

1. Limited only by maximum temperature allowed

- Worldwide best R<sub>DS(on)</sub>\*area
- Higher V<sub>DSS</sub> rating
- Excellent switching performance
- Easy to drive
- 100% avalanche tested
- High dv/dt capability

## Applications

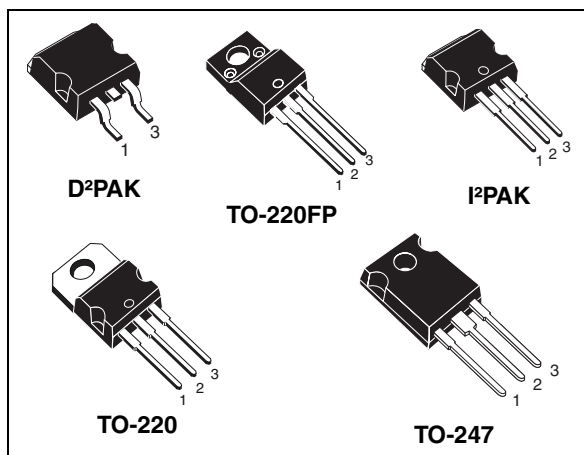
- Switching applications

## Description

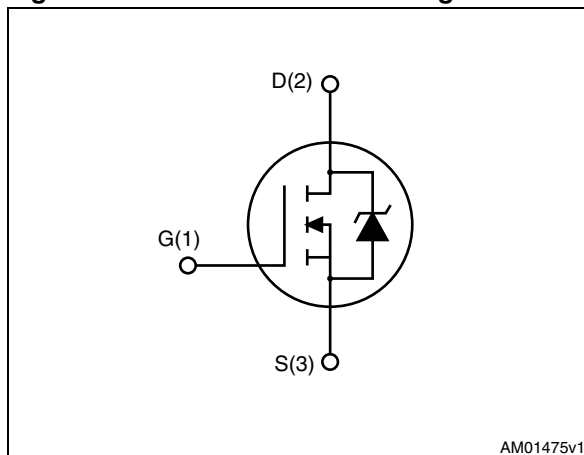
These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

**Table 1. Device summary**

| Order codes | Marking | Package            | Packaging     |
|-------------|---------|--------------------|---------------|
| STB30N65M5  | 30N65M5 | D <sup>2</sup> PAK | Tape and reel |
| STF30N65M5  | 30N65M5 | TO-220FP           | Tube          |
| STI30N65M5  | 30N65M5 | I <sup>2</sup> PAK | Tube          |
| STP30N65M5  | 30N65M5 | TO-220             | Tube          |
| STW30N65M5  | 30N65M5 | TO-247             | Tube          |



**Figure 1. Internal schematic diagram**



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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                                | Value                                                    |                   | Unit |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------|------|
|                                |                                                                                                                          | TO-220, D <sup>2</sup> PAK<br>TO-247, I <sup>2</sup> PAK | TO-220FP          |      |
| V <sub>GS</sub>                | Gate-source voltage                                                                                                      | ± 25                                                     |                   | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                                     | 22                                                       | 22 <sup>(1)</sup> | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                    | 13                                                       | 13 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                                   | 88                                                       | 88 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                              | 140                                                      | 30                | W    |
| I <sub>AR</sub>                | Max current during repetitive or single pulse avalanche (pulse width limited by T <sub>JMAX</sub> )                      | 7                                                        |                   | 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> = 50V) | 500                                                      |                   | 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                                                      |                   | °C   |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I<sub>SD</sub> ≤ 21 A, di/dt = 400 A/μs, V<sub>Peak</sub> < V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

| Symbol                | Parameter                                      | Value              |          |                    |        |        | Unit |
|-----------------------|------------------------------------------------|--------------------|----------|--------------------|--------|--------|------|
|                       |                                                | D <sup>2</sup> PAK | TO-220FP | I <sup>2</sup> PAK | TO-220 | TO-247 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max           | 0.83               | 3.6      | 0.83               |        |        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max        |                    | 62.5     |                    |        | 50     | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb max            | 30                 |          |                    |        |        | °C/W |
| T <sub>l</sub>        | Maximum lead temperature for soldering purpose |                    | 300      |                    |        |        | °C   |

## 2 Electrical characteristics

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

**Table 4. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                                       | Min. | Typ.  | Max.     | Unit                           |
|---------------|--------------------------------------------------|---------------------------------------------------------------------------------------|------|-------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ( $V_{GS} = 0$ )  | $I_D = 1\text{ mA}$                                                                   | 650  |       |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 650\text{ V}$<br>$V_{DS} = 650\text{ V}, T_C = 125\text{ }^{\circ}\text{C}$ |      |       | 1<br>100 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                                                            |      |       | 100      | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                       | 3    | 4     | 5        | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{ V}, I_D = 11\text{ A}$                                             |      | 0.125 | 0.139    | $\Omega$                       |

**Table 5. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                           | Min. | Typ.            | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------|-----------------|------|----------------|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 100\text{ V}, f = 1\text{ MHz},$<br>$V_{GS} = 0$                                                | -    | 2880<br>68<br>5 | -    | pF<br>pF<br>pF |
| $C_{o(tr)}^{(1)}$                   | Equivalent capacitance time related                                     | $V_{GS} = 0, V_{DS} = 0\text{ to }520\text{ V}$                                                           | -    | 190             | -    | pF             |
| $C_{o(er)}^{(2)}$                   | Equivalent capacitance energy related                                   | $V_{GS} = 0, V_{DS} = 0\text{ to }520\text{ V}$                                                           | -    | 65              | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz open drain}$                                                                             | -    | 1.6             | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 520\text{ V}, I_D = 11\text{ A},$<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 20</a> ) | -    | 64<br>16<br>25  | -    | nC<br>nC<br>nC |

1.  $C_{oss\text{ eq.}}$  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.  $C_{oss\text{ eq.}}$  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 |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------|------|------|-----|------|
| $t_{d(off)}$ | Turn-off delay time | $V_{DD} = 400\text{ V}$ , $I_D = 14\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 21</a> ) | -    | 50   | -   | ns   |
| $t_r$        | Rise time           |                                                                                                                                     |      | 8    |     | ns   |
| $t_c$        | Cross time          |                                                                                                                                     |      | 20   |     | ns   |
| $t_f$        | Fall time           |                                                                                                                                     |      | 10   |     | ns   |

**Table 7. Source drain diode**

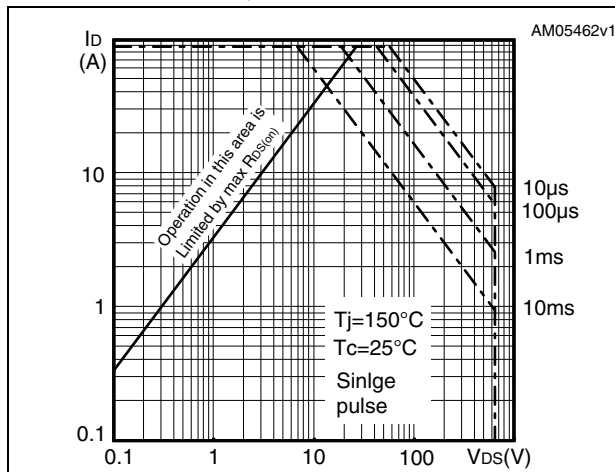
| Symbol          | Parameter                     | Test conditions                                                                                                                                               | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                               | -    |      | 22   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                               |      |      | 88   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 22\text{ A}$ , $V_{GS} = 0$                                                                                                                         | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 22\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 21</a> )                                        | -    | 336  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                               |      | 6    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                               |      | 32   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 22\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 21</a> ) | -    | 395  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                               |      | 7    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                               |      | 34   |      | A             |

1. Pulse width limited by safe operating area

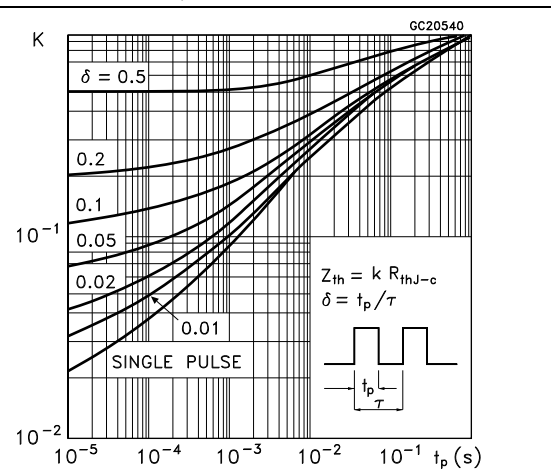
2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

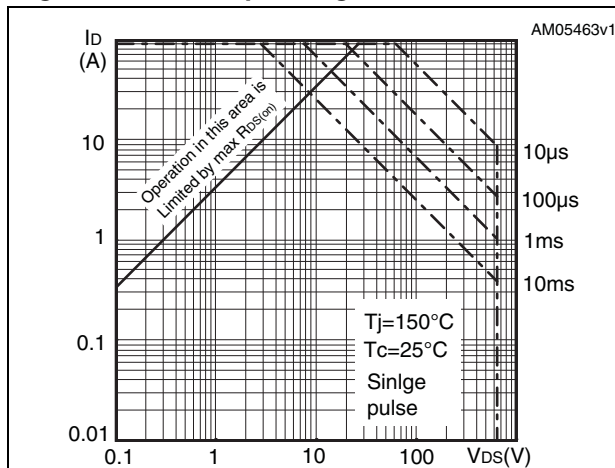
**Figure 2. Safe operating area for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK**



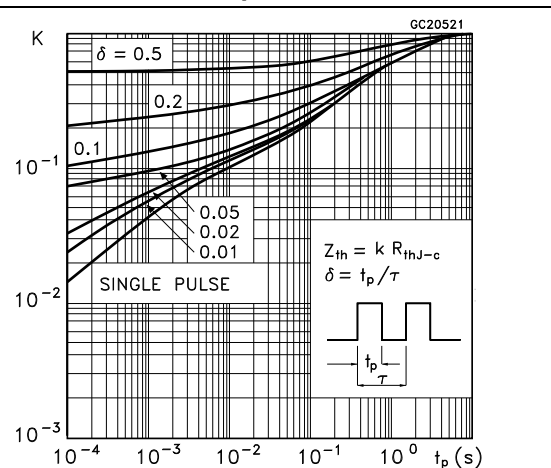
**Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK**



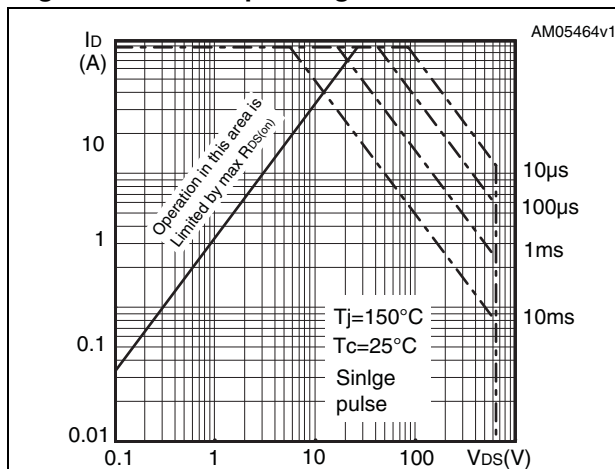
**Figure 4. Safe operating area for TO-220FP**



**Figure 5. Thermal impedance for TO-220FP**



**Figure 6. Safe operating area for TO-247**



**Figure 7. Thermal impedance for TO-247**

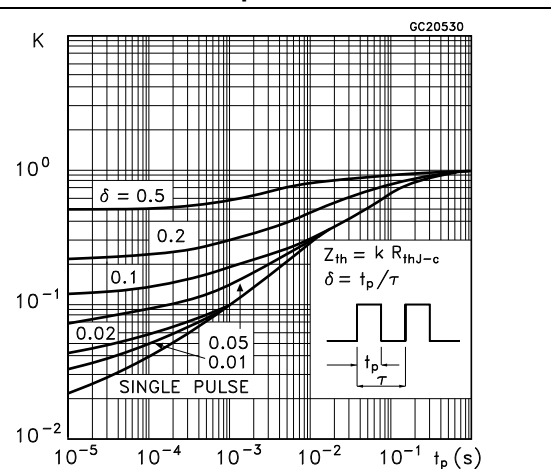


Figure 8. Output characteristics

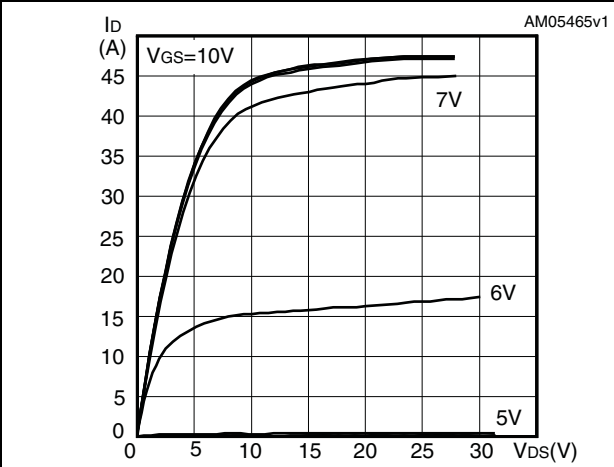


Figure 9. Transfer characteristics

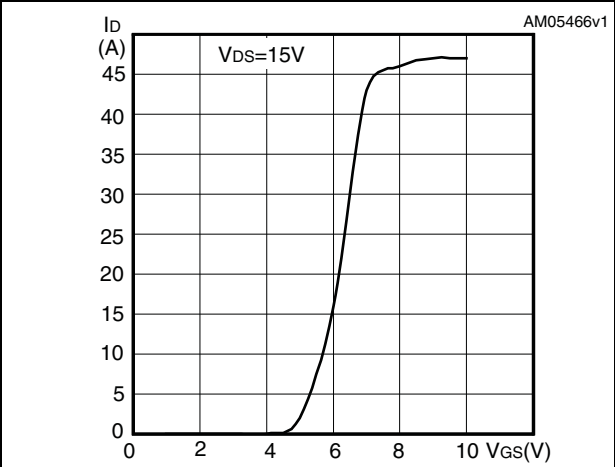


Figure 10. Gate charge vs gate-source voltage

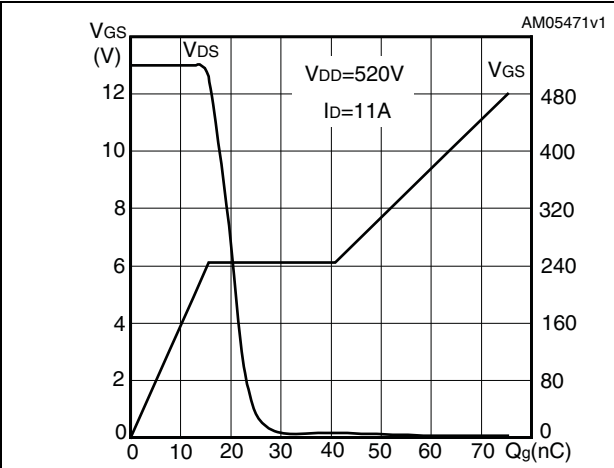


Figure 11. Static drain-source on resistance

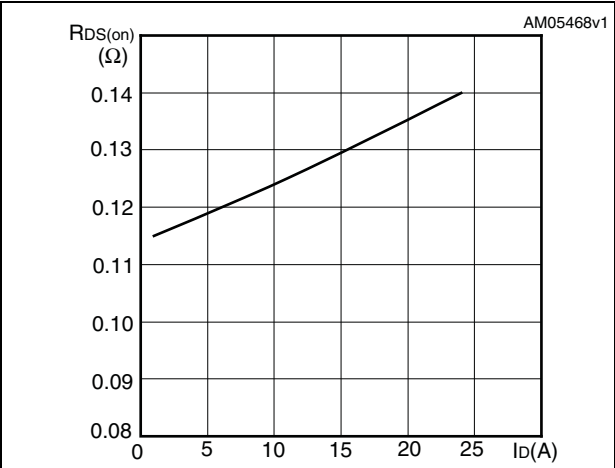


Figure 12. Capacitance variations

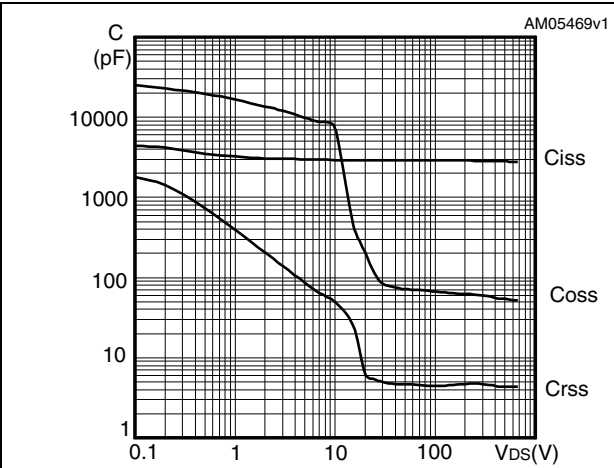


Figure 13. Output capacitance stored energy

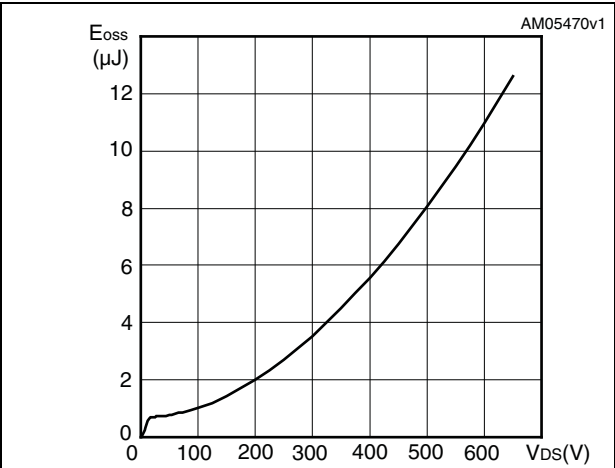


Figure 14. Normalized gate threshold voltage vs temperature

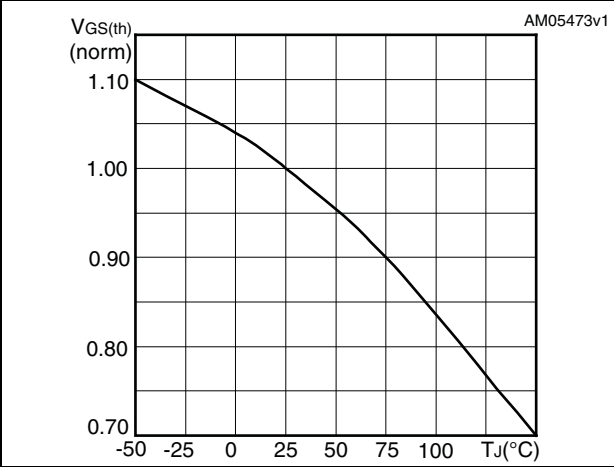


Figure 15. Normalized on resistance vs temperature

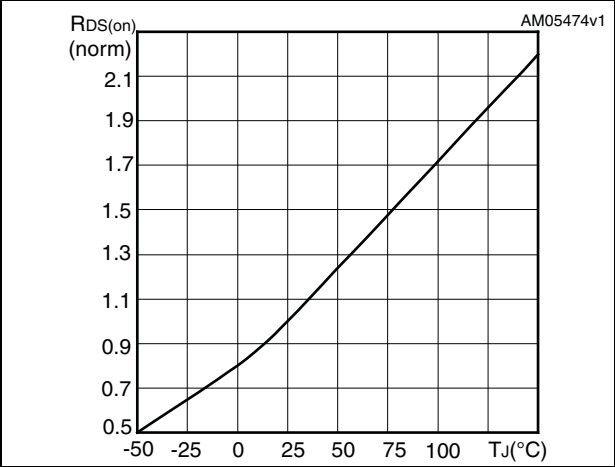


Figure 16. Source-drain diode forward characteristics

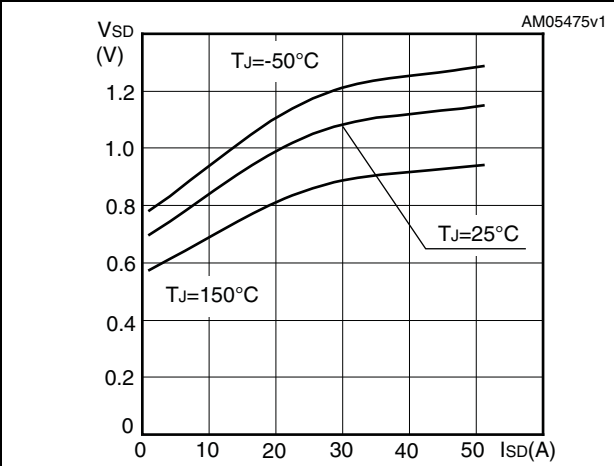


Figure 17. Normalized BV<sub>DSS</sub> vs temperature

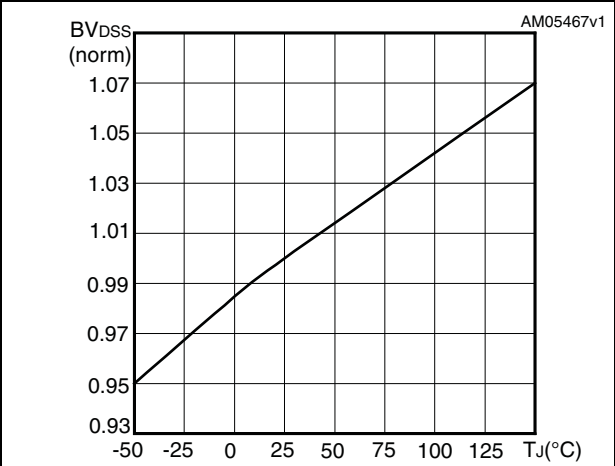
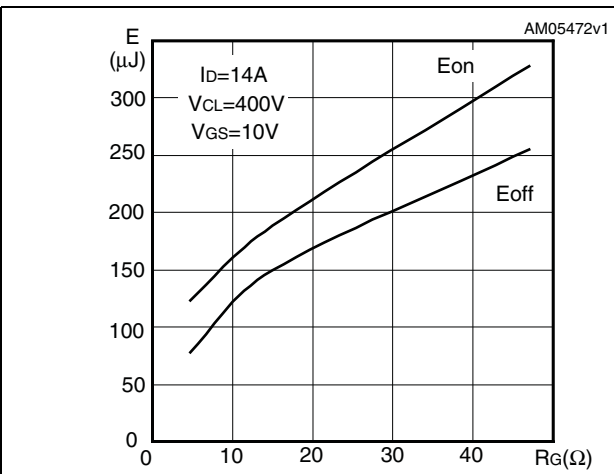


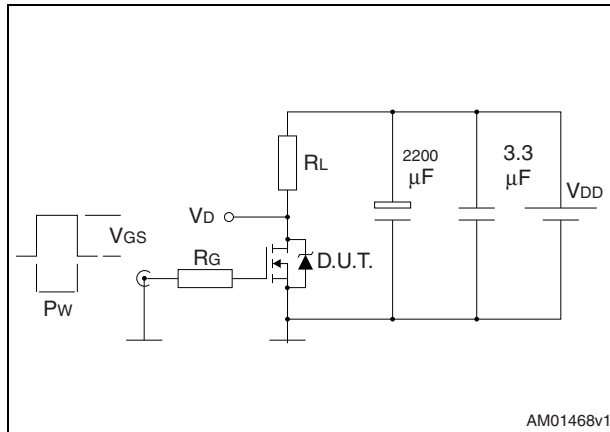
Figure 18. Switching losses vs gate resistance (1)



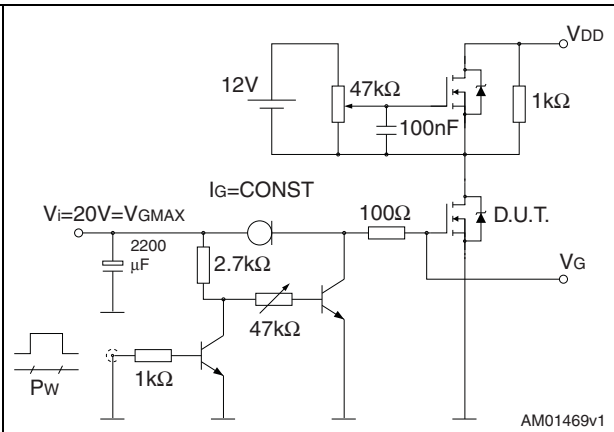
1. Eon including reverse recovery of a SiC diode

### 3 Test circuits

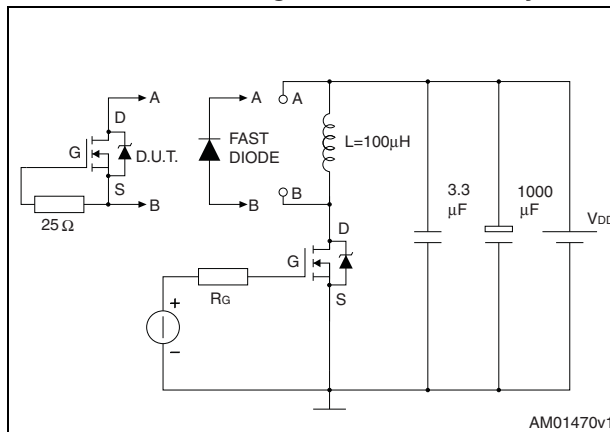
**Figure 19. Switching times test circuit for resistive load**



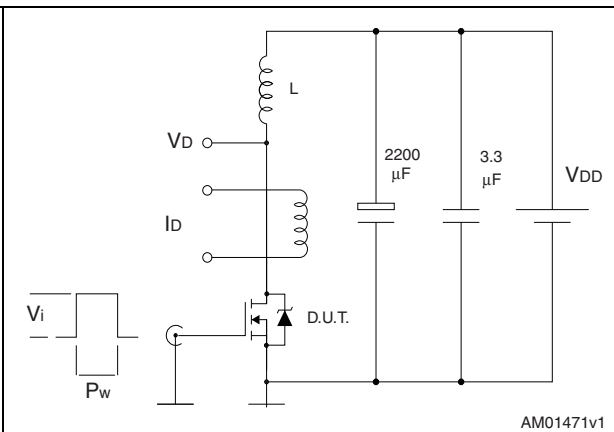
**Figure 20. Gate charge test circuit**



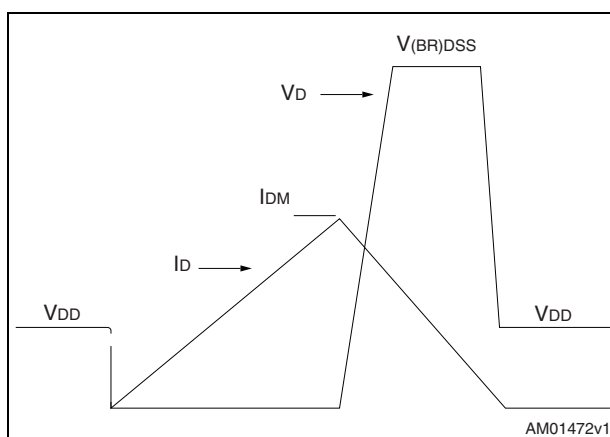
**Figure 21. Test circuit for inductive load switching and diode recovery times**



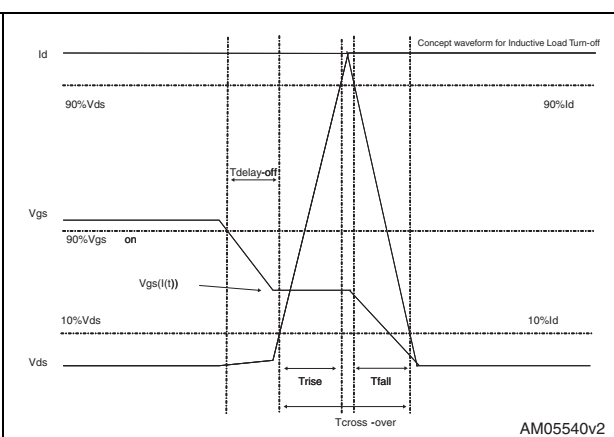
**Figure 22. Unclamped inductive load test circuit**



**Figure 23. Unclamped inductive waveform**



**Figure 24. 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). ECOPACKm is an ST trademark.

Table 8. 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 25. D<sup>2</sup>PAK (TO-263) drawing



Figure 26. D<sup>2</sup>PAK footprint<sup>(a)</sup>

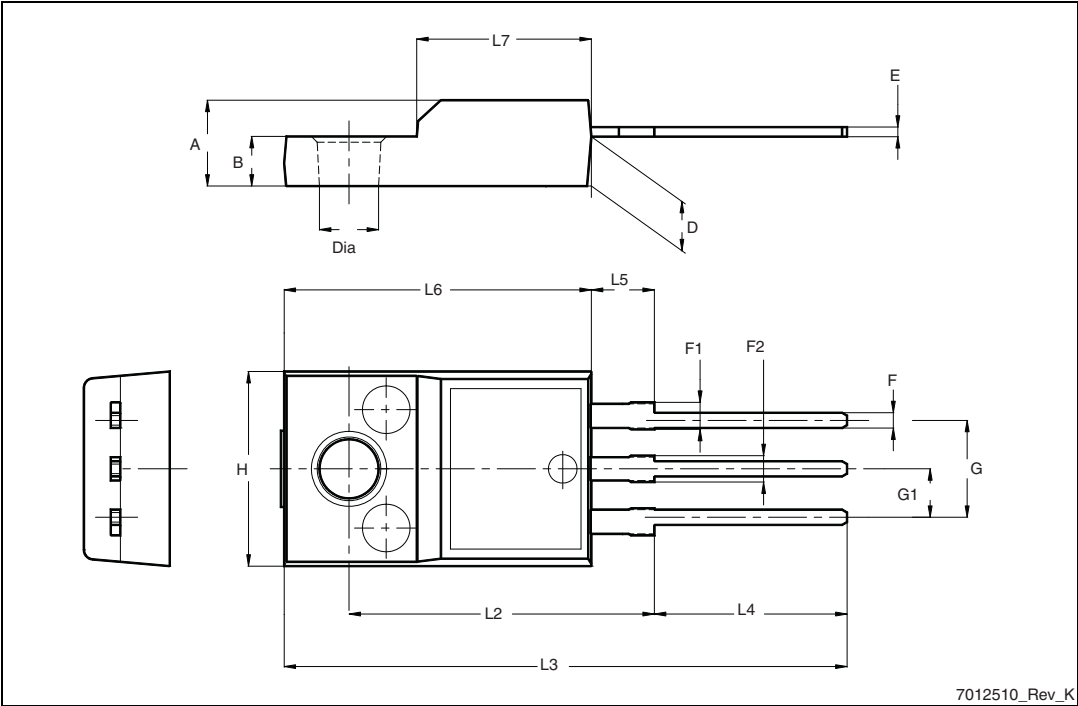


a. All dimensions are in millimeters

Table 9. 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 27. TO-220FP drawing



7012510\_Rev\_K

Table 10. I<sup>2</sup>PAK (TO-262) mechanical data

| DIM. | mm.  |     |       |
|------|------|-----|-------|
|      | min. | typ | max.  |
| A    | 4.40 |     | 4.60  |
| A1   | 2.40 |     | 2.72  |
| b    | 0.61 |     | 0.88  |
| b1   | 1.14 |     | 1.70  |
| c    | 0.49 |     | 0.70  |
| c2   | 1.23 |     | 1.32  |
| D    | 8.95 |     | 9.35  |
| e    | 2.40 |     | 2.70  |
| e1   | 4.95 |     | 5.15  |
| E    | 10   |     | 10.40 |
| L    | 13   |     | 14    |
| L1   | 3.50 |     | 3.93  |
| L2   | 1.27 |     | 1.40  |

Figure 28. I<sup>2</sup>PAK (TO-262) drawing

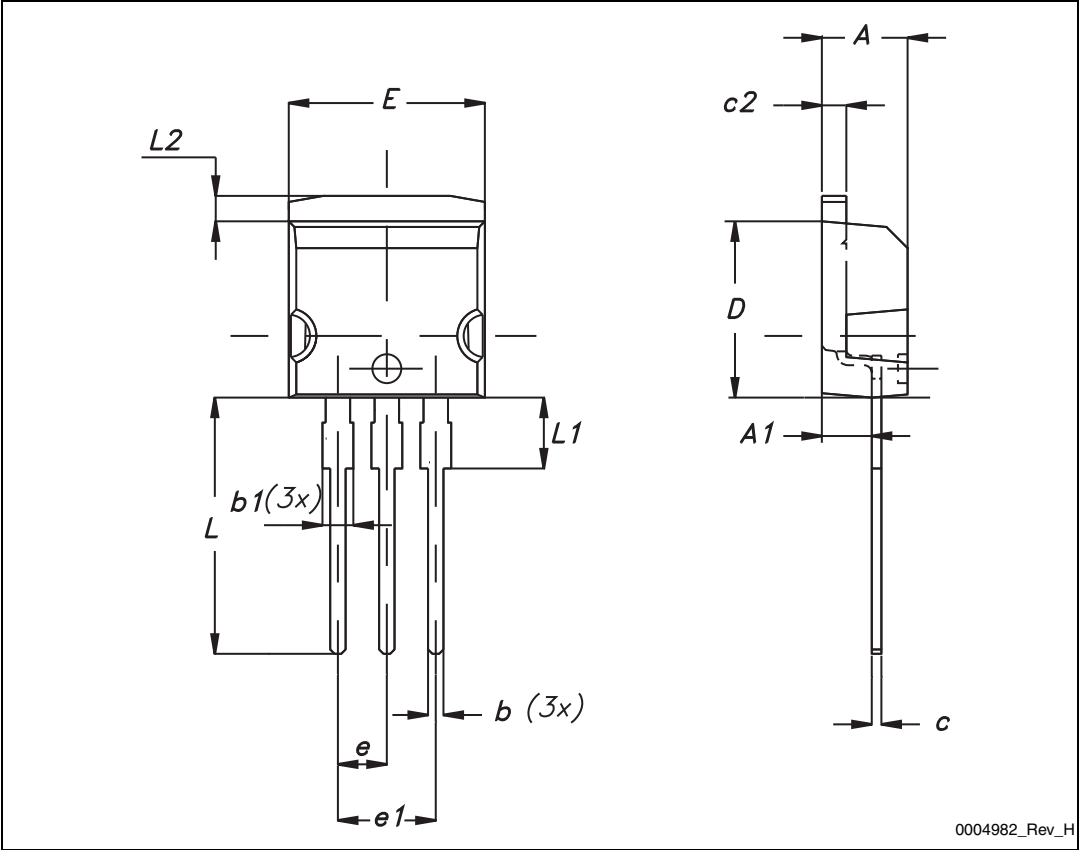


Table 11. TO-220 type A mechanical data

| 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  |

Figure 29. TO-220 type A drawing

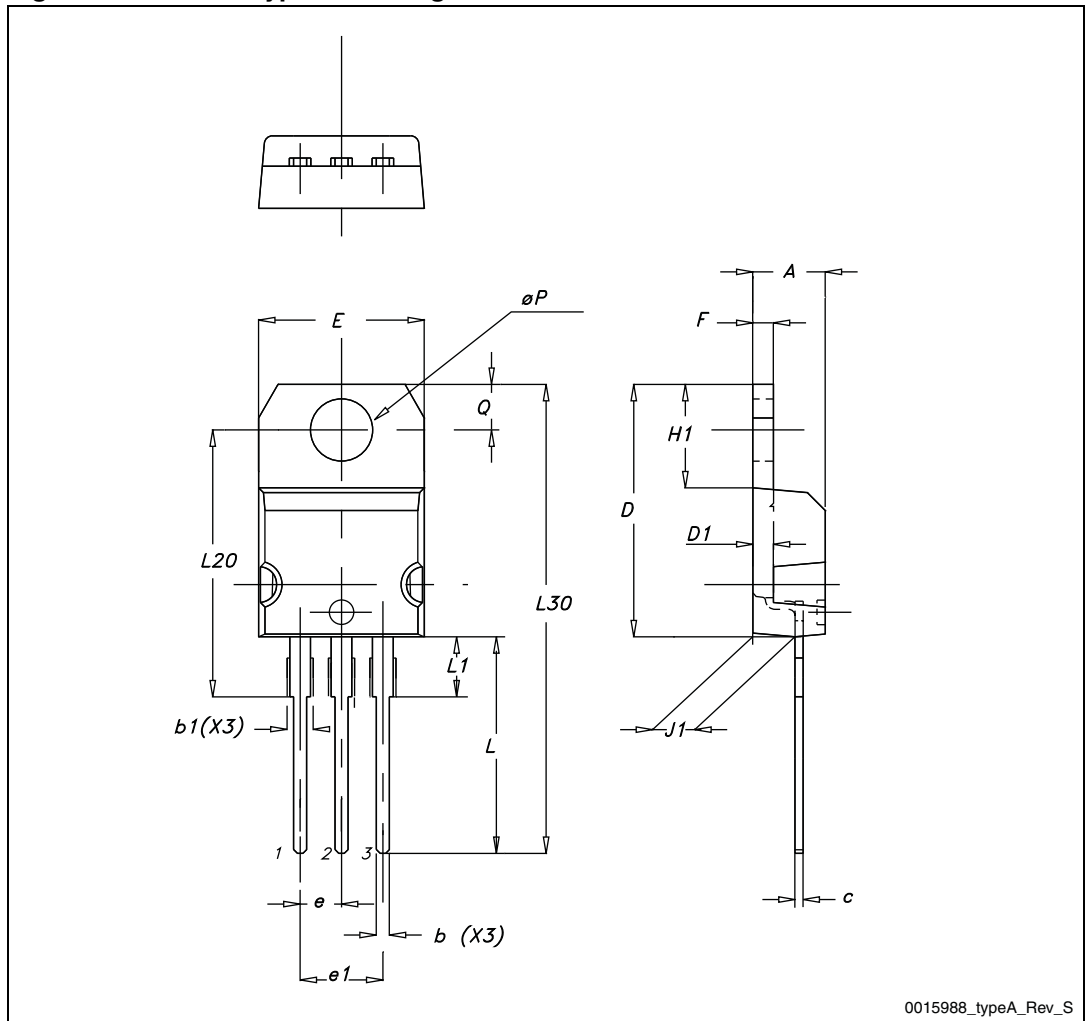
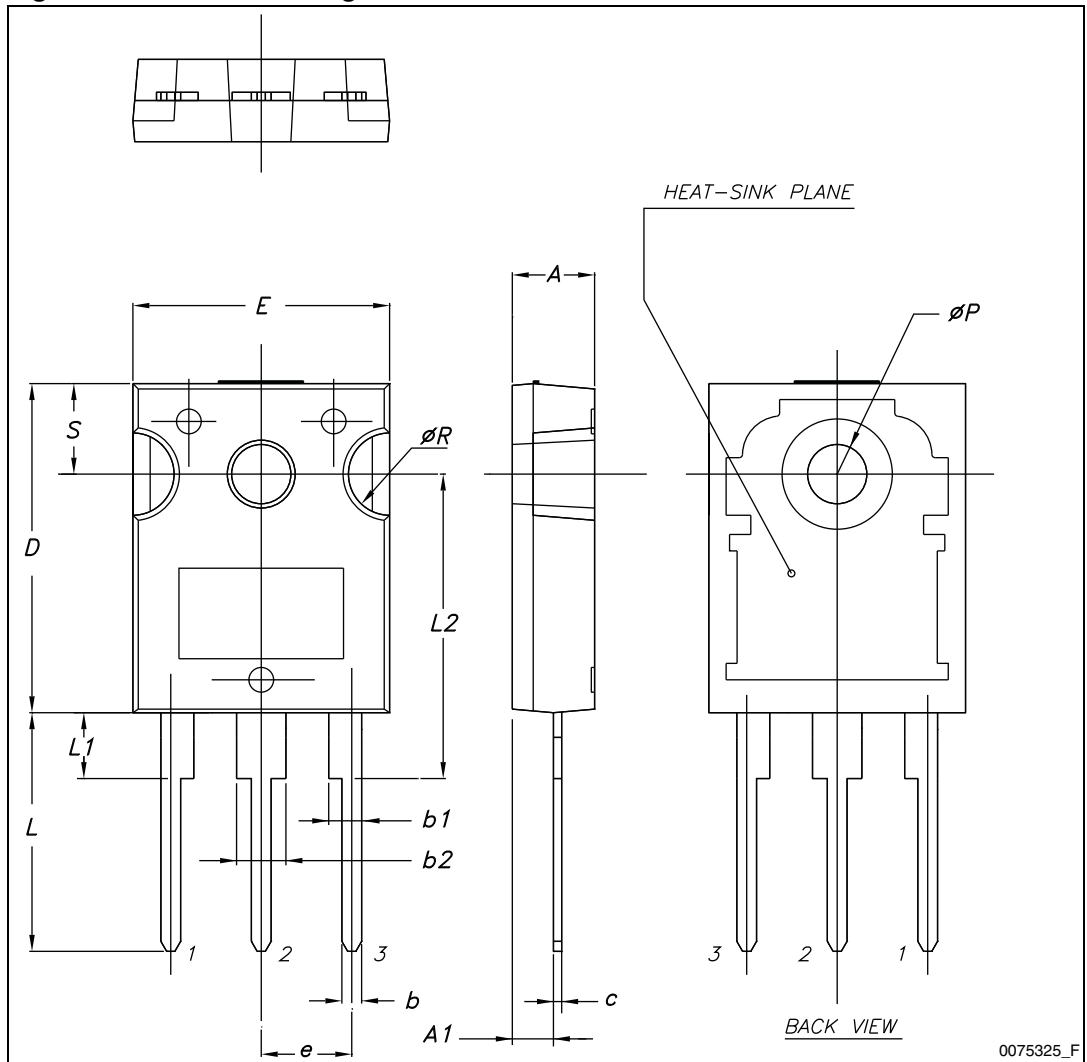


Table 12. TO-247 mechanical data

| 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    |       | 5.45  |       |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    |       | 5.50  |       |

Figure 30. TO-247 drawing



## 5 Packaging mechanical data

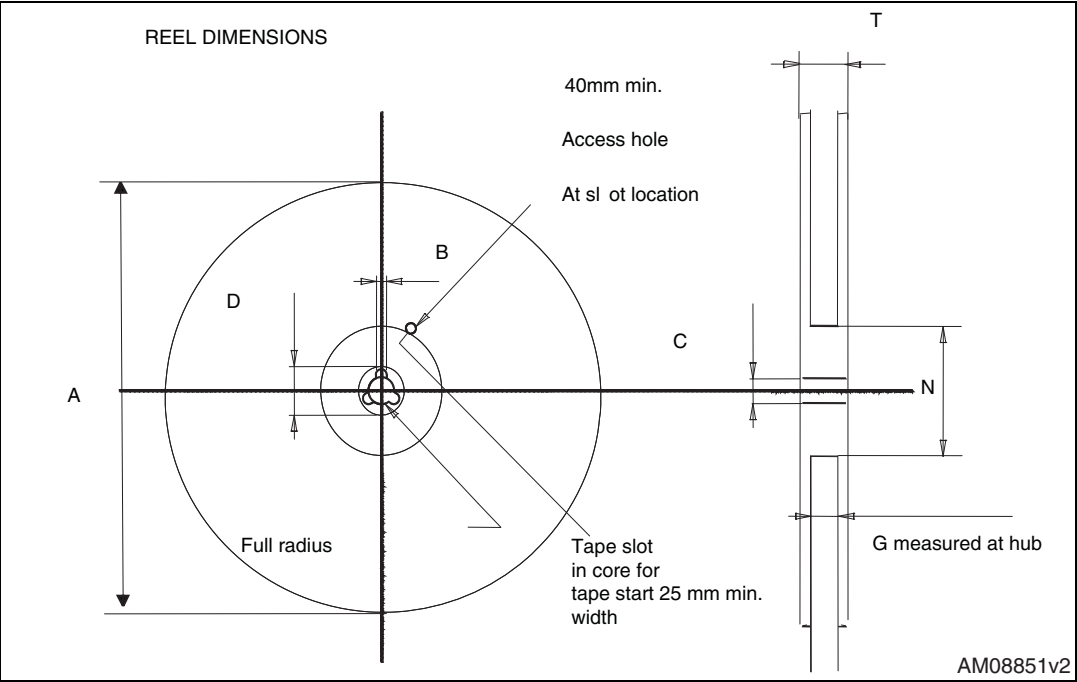
Table 13. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

| 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 |          |      |      |

Figure 31. Tape



Figure 32. Reel



## 6 Revision history

**Table 14. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16-Jan-2009 | 1        | First release                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 21-Sep-2009 | 2        | Document status promoted from preliminary data to datasheet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 22-Sep-2011 | 3        | <p><math>C_{o(er)}</math> and <math>C_{o(tr)}</math> values changed in <a href="#">Table 5: Dynamic</a><br/> <a href="#">Table 6: Switching times</a> parameters updates<br/> <a href="#">Figure 24: Switching time waveform</a> has been corrected<br/>           Minor text changes<br/> <a href="#">Section 4: Package mechanical data</a> has been modified. Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 8: D<sup>2</sup>PAK (TO-263) mechanical data</a>, <a href="#">Figure 25: D<sup>2</sup>PAK (TO-263) drawing</a> and <a href="#">Figure 26: D<sup>2</sup>PAK footprint</a>;</li> <li>– <a href="#">Table 9: TO-220FP mechanical data</a>, and <a href="#">Figure 27: TO-220FP drawing</a>;</li> <li>– <a href="#">Table 10: I<sup>2</sup>PAK (TO-262) mechanical data</a>, and <a href="#">Figure 28: I<sup>2</sup>PAK (TO-262) drawing</a>;</li> <li>– <a href="#">Table 11: TO-220 type A mechanical data</a>, and <a href="#">Figure 29: TO-220 type A drawing</a>;</li> <li>– <a href="#">Table 12: TO-247 mechanical data</a>, and <a href="#">Figure 30: TO-247 drawing</a>;</li> </ul> <p><a href="#">Section 5: Packaging mechanical data</a> has been modified. Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 13: D<sup>2</sup>PAK (TO-263) tape and reel mechanical data</a>, <a href="#">Figure 31: Tape</a> and <a href="#">Figure 32: Reel</a>;</li> </ul> |

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