



# STB57N65M5, STF57N65M5, STI57N65M5, STP57N65M5

N-channel 650 V, 0.056  $\Omega$  typ., 42 A MDmesh™ V Power MOSFET in I<sup>2</sup>PAK, TO-220, TO-220FP and D<sup>2</sup>PAK packages

Datasheet — production data

## Features

| Order codes                                          | V <sub>DSS</sub> @ T <sub>Jmax</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> |
|------------------------------------------------------|--------------------------------------|-------------------------|----------------|
| STB57N65M5<br>STF57N65M5<br>STI57N65M5<br>STP57N65M5 | 710 V                                | < 0.063 $\Omega$        | 42 A           |

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

## 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.

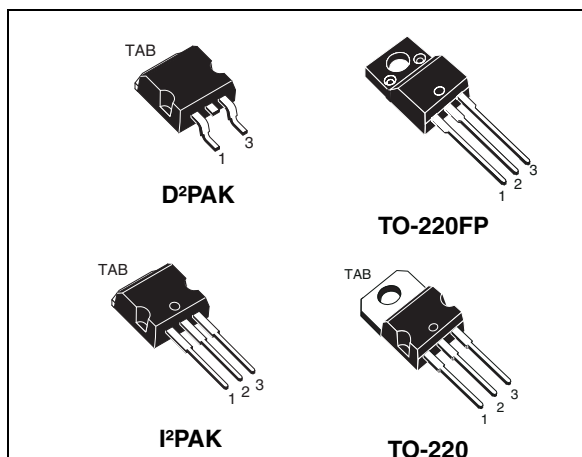


Figure 1. Internal schematic diagram

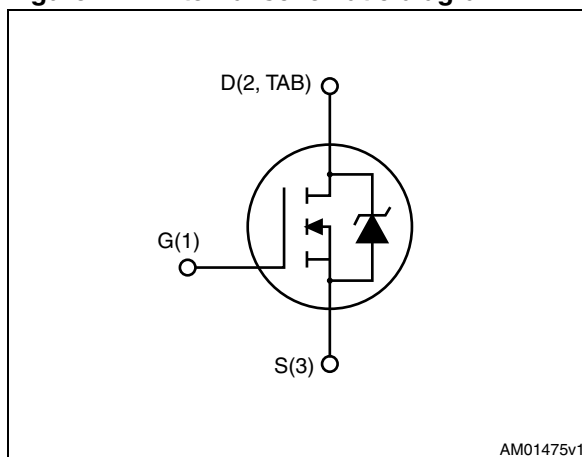


Table 1. Device summary

| Order codes                                          | Marking | Packages                                                       | Packaging                             |
|------------------------------------------------------|---------|----------------------------------------------------------------|---------------------------------------|
| STB57N65M5<br>STF57N65M5<br>STI57N65M5<br>STP57N65M5 | 57N65M5 | D <sup>2</sup> PAK<br>TO-220FP<br>I <sup>2</sup> PAK<br>TO-220 | Tape and reel<br>Tube<br>Tube<br>Tube |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                                | Value                                             |                     | Unit |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------|------|
|                                |                                                                                                                          | TO-220,<br>D <sup>2</sup> PAK, 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                                                                     | 42                                                | 42 <sup>(1)</sup>   | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                    | 26.5                                              | 26.5 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                                   | 168                                               | 168 <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> )                      | 11                                                |                     | 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) | 960                                               |                     | 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 by maximum junction temperature.

2. Pulse width limited by safe operating area.

3. I<sub>SD</sub> ≤ 42 A, di/dt ≤ 400 A/μs, V<sub>Peak</sub> < V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 400 V

**Table 3. Thermal data**

| Symbol                | Parameter                                          | Value              |                    |        |          | Unit |
|-----------------------|----------------------------------------------------|--------------------|--------------------|--------|----------|------|
|                       |                                                    | D <sup>2</sup> PAK | I <sup>2</sup> PAK | TO-220 | TO-220FP |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max               | 0.50               |                    |        | 3.1      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max            |                    | 62.5               |        | 62.5     | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb max <sup>(1)</sup> | 30                 |                    |        |          | °C/W |

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

## 2 Electrical characteristics

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

**Table 4. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                            | Min. | Typ.  | Max.      | Unit                           |
|---------------|--------------------------------------------------|----------------------------------------------------------------------------|------|-------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                         | 650  |       |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 650\text{ V}$<br>$V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$ |      |       | 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                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                         | 3    | 4     | 5         | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 21\text{ A}$                               |      | 0.056 | 0.063     | $\Omega$                       |

**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>$V_{GS} = 0$                                                | -    | 4200<br>115<br>9 | -    | pF<br>pF<br>pF |
| $C_{o(er)}^{(1)}$                   | Equivalent output capacitance energy related                            | $V_{GS} = 0$ , $V_{DS} = 0$ to 80%<br>$V_{(BR)DSS}$                                                           | -    | 93               | -    | pF             |
| $C_{o(tr)}^{(2)}$                   | Equivalent output capacitance time related                              | $V_{GS} = 0$ , $V_{DS} = 0$ to 80%<br>$V_{(BR)DSS}$                                                           | -    | 303              | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                                 | -    | 1.3              | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 520\text{ V}$ , $I_D = 21\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 18</a> ) | -    | 98<br>23<br>40   | -    | nC<br>nC<br>nC |

1.  $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$
2.  $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$

**Table 6. Switching times**

| Symbol       | Parameter          | Test conditions                                                                                                                     | Min. | Typ. | Max. | Unit |
|--------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(V)}$   | Voltage delay time | $V_{DD} = 400\text{ V}$ , $I_D = 28\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 19</a> ) | -    | 73   | -    | ns   |
| $t_{r(V)}$   | Voltage rise time  |                                                                                                                                     |      | 15   |      | ns   |
| $t_{f(i)}$   | Current fall time  |                                                                                                                                     |      | 12   |      | ns   |
| $t_{c(off)}$ | Crossing time      |                                                                                                                                     |      | 19   |      | ns   |

**Table 7. Source drain diode**

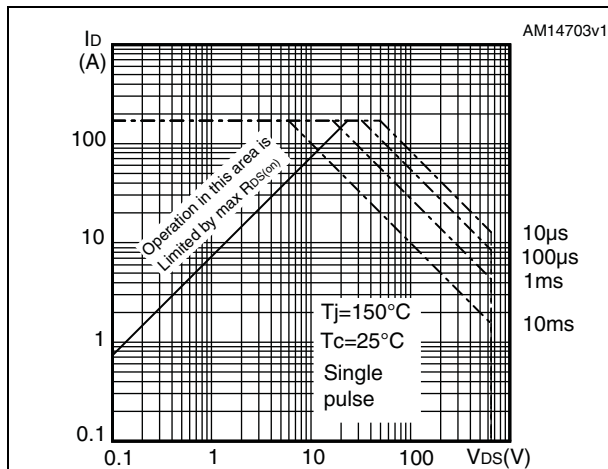
| Symbol          | Parameter                     | Test conditions                                                                                                                                                | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                | -    |      | 42   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                |      |      | 168  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 42\text{ A}$ , $V_{GS} = 0$                                                                                                                          | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 42\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ (see <a href="#">Figure 19</a> )                                        | -    | 418  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                |      | 8    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                |      | 40   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 42\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 19</a> ) | -    | 528  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                |      | 12   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                |      | 44   |      | A             |

1. Pulse width limited by safe operating area

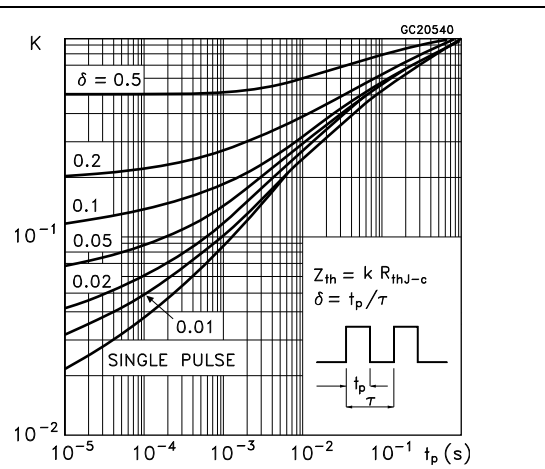
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

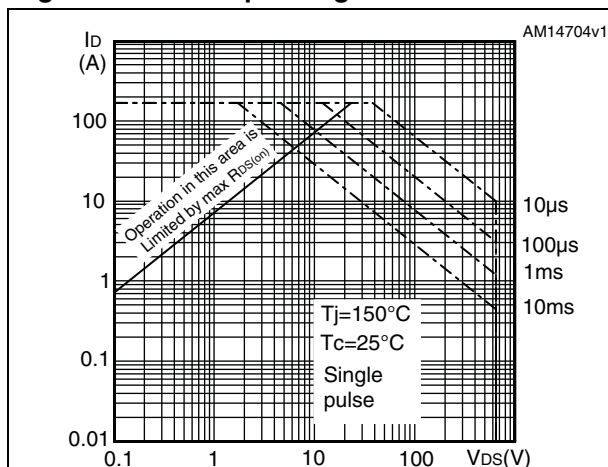
**Figure 2. Safe operating area for D<sup>2</sup>PAK, I<sup>2</sup>PAK and TO-220**



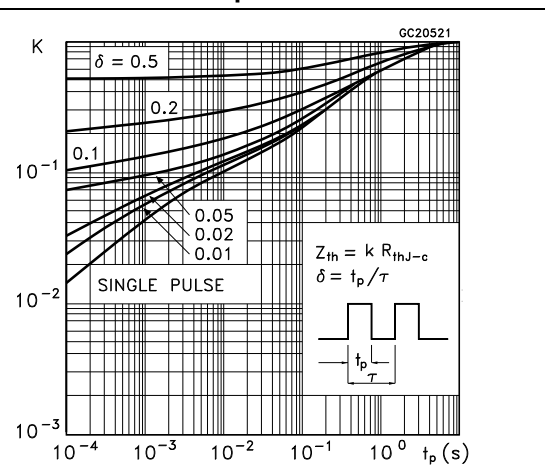
**Figure 3. Thermal impedance for D<sup>2</sup>PAK, I<sup>2</sup>PAK and TO-220**



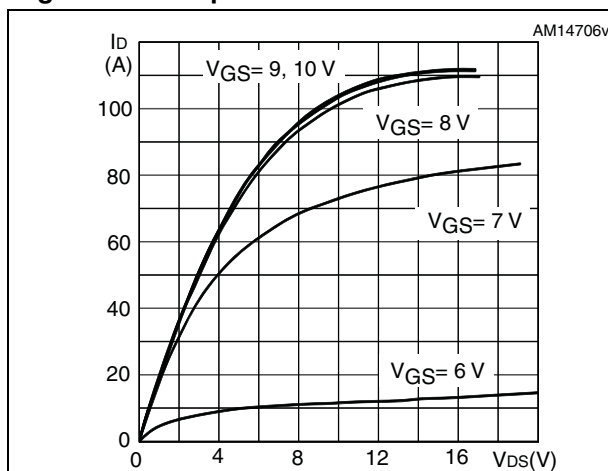
**Figure 4. Safe operating area for TO-220FP**



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



**Figure 6. Output characteristics**



**Figure 7. Transfer characteristics**

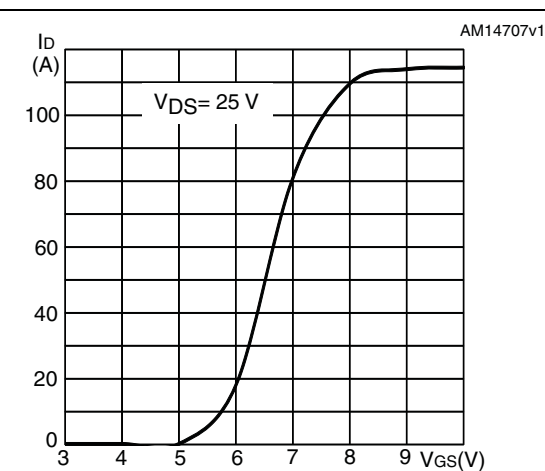


Figure 8. Gate charge vs gate-source voltage Figure 9. Static drain-source on-resistance

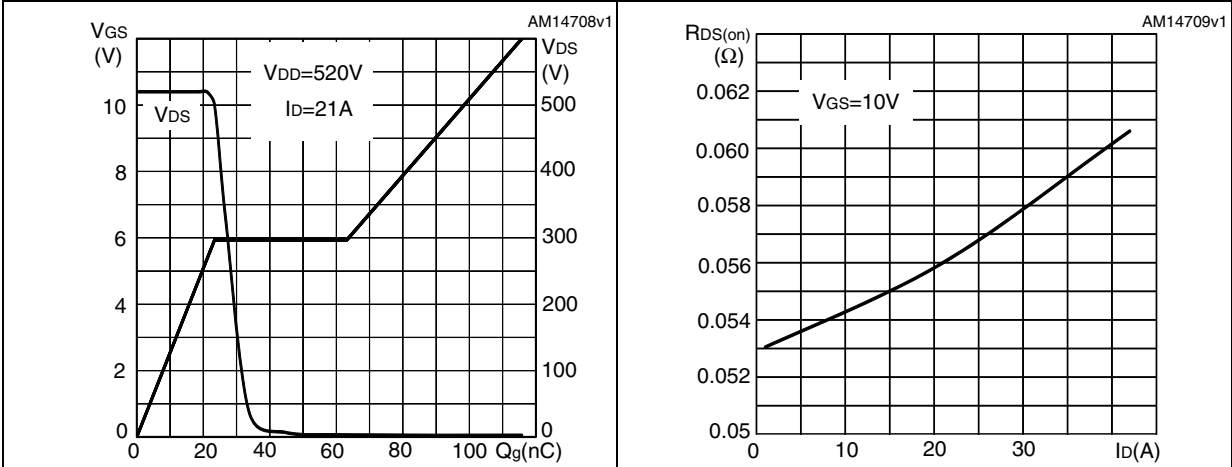


Figure 10. Capacitance variations Figure 11. Output capacitance stored energy

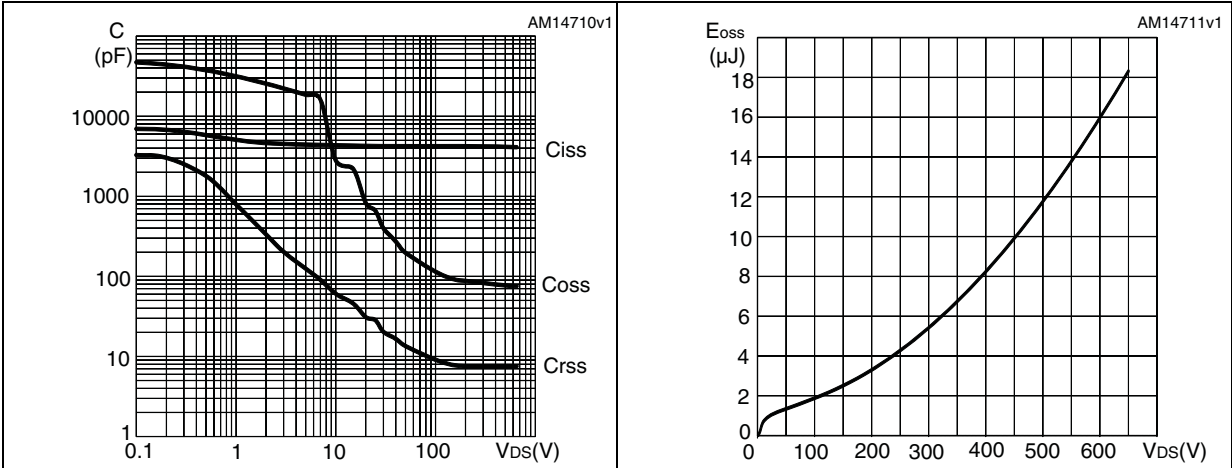


Figure 12. Normalized gate threshold voltage vs temperature Figure 13. Normalized on-resistance vs temperature

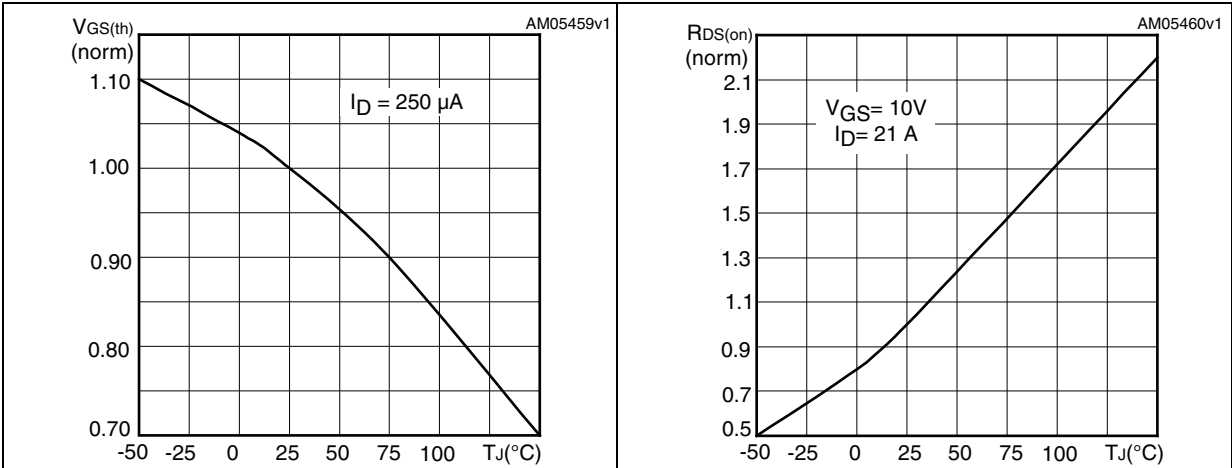


Figure 14. Source-drain diode forward characteristics

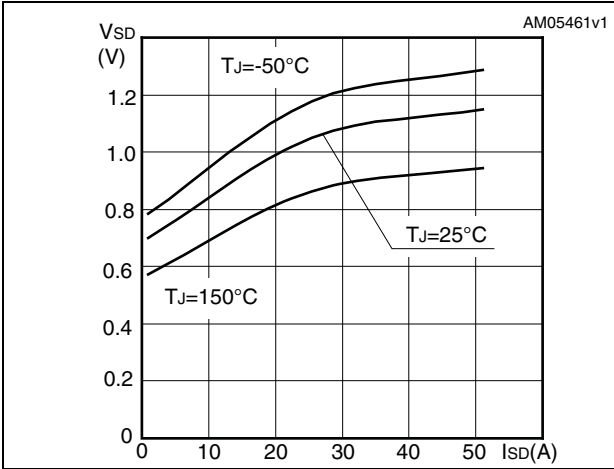


Figure 15. Normalized  $B_{VDSS}$  vs temperature

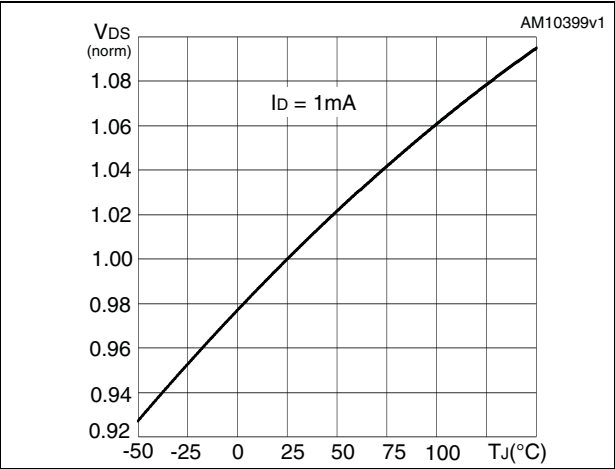
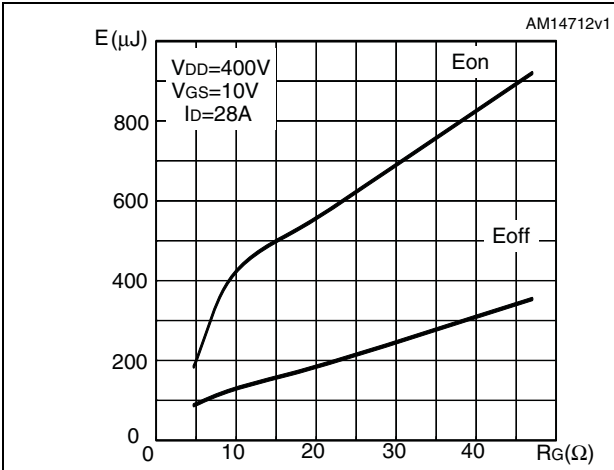


Figure 16. Switching losses vs gate resistance (1)



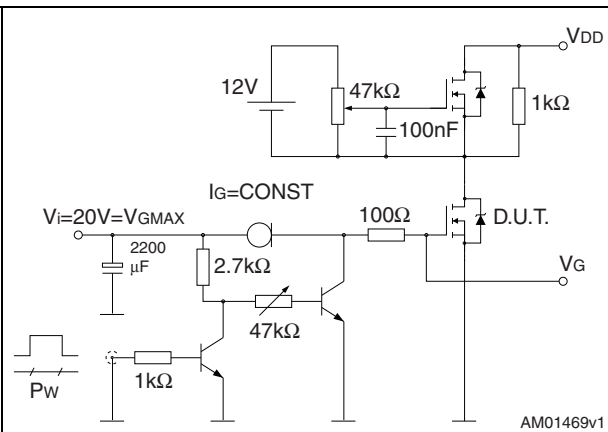
1.  $E_{on}$  including reverse recovery of a SiC diode

### 3 Test circuits

**Figure 17. Switching times test circuit for resistive load**



**Figure 18. Gate charge test circuit**



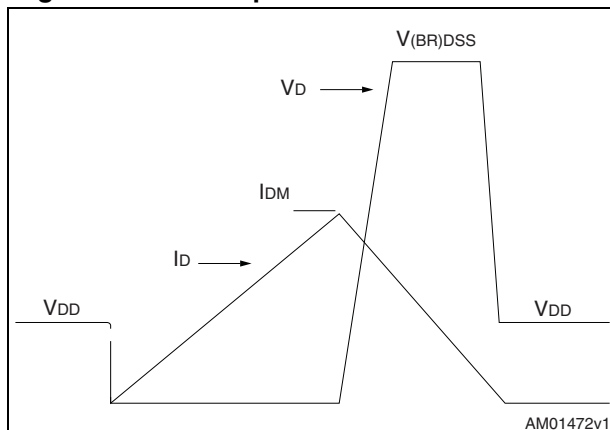
**Figure 19. Test circuit for inductive load switching and diode recovery times**



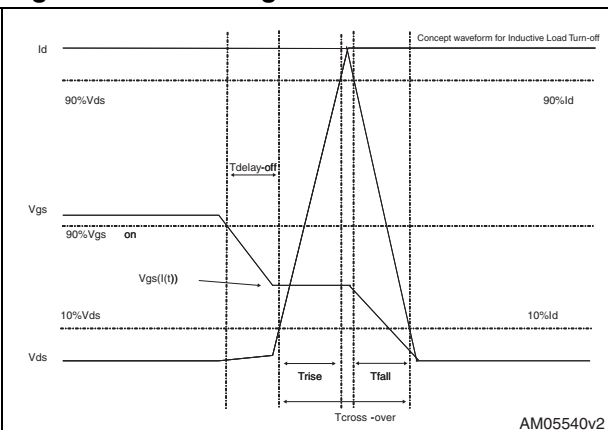
**Figure 20. Unclamped inductive load test circuit**



**Figure 21. Unclamped inductive waveform**



**Figure 22. Switching time waveform**

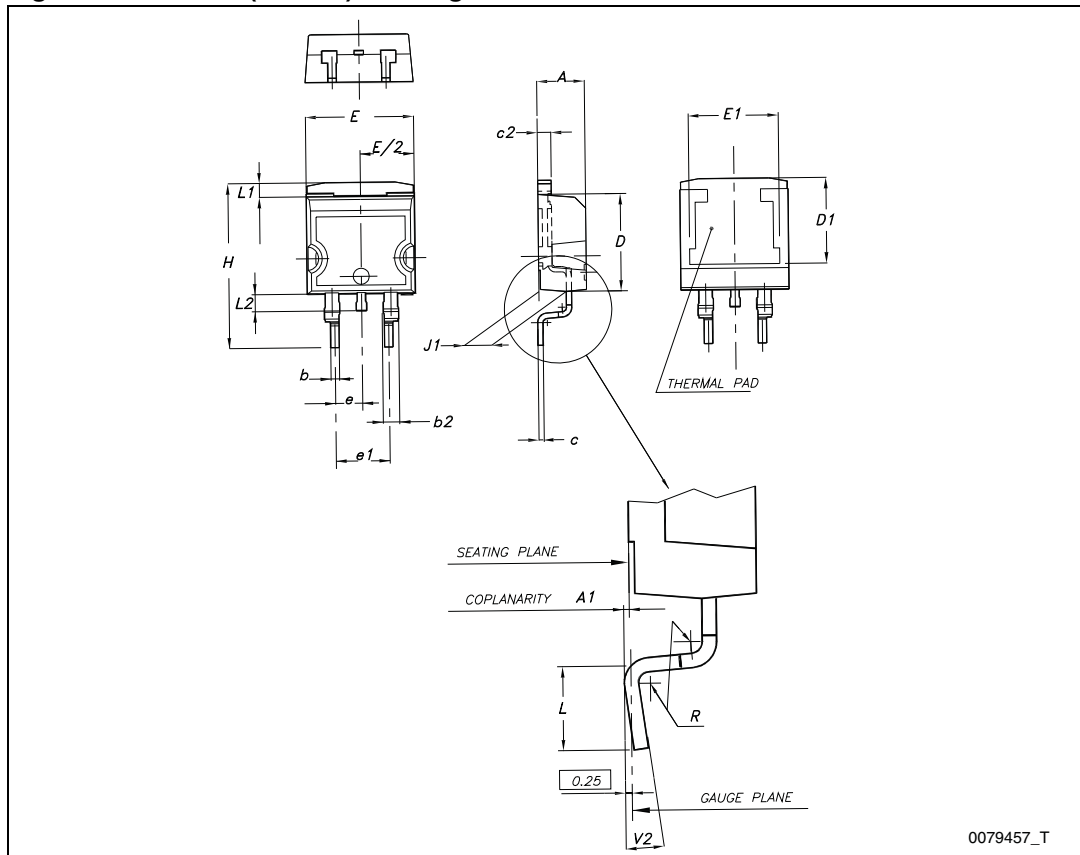
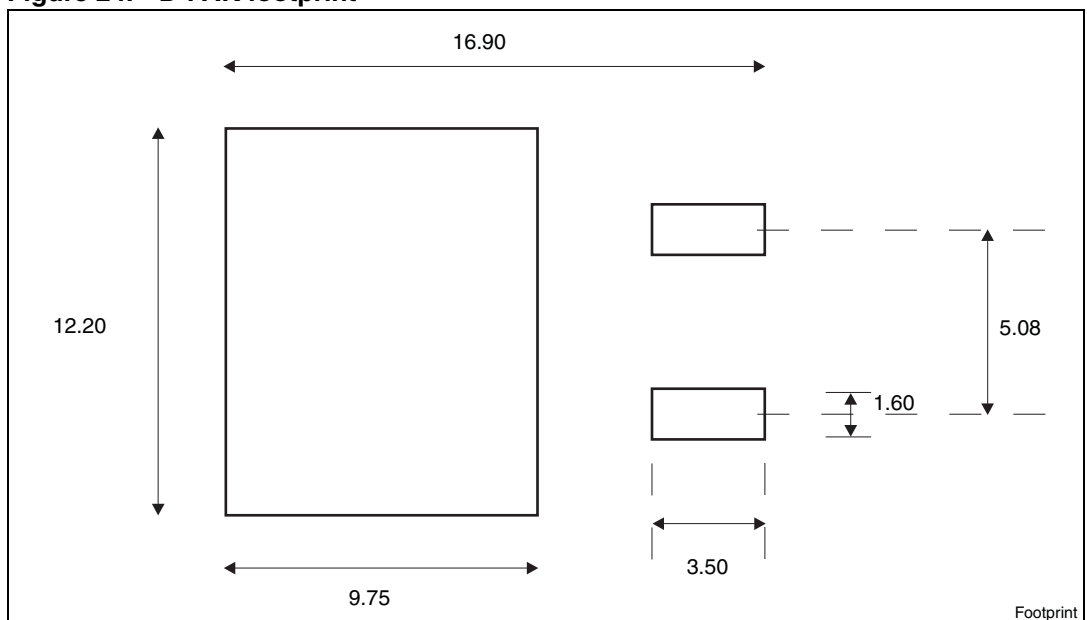


## 4 Package mechanical data

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 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 23. D<sup>2</sup>PAK (TO-263) drawingFigure 24. D<sup>2</sup>PAK footprint<sup>(a)</sup>

a. All dimension 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 25. TO-220FP drawing

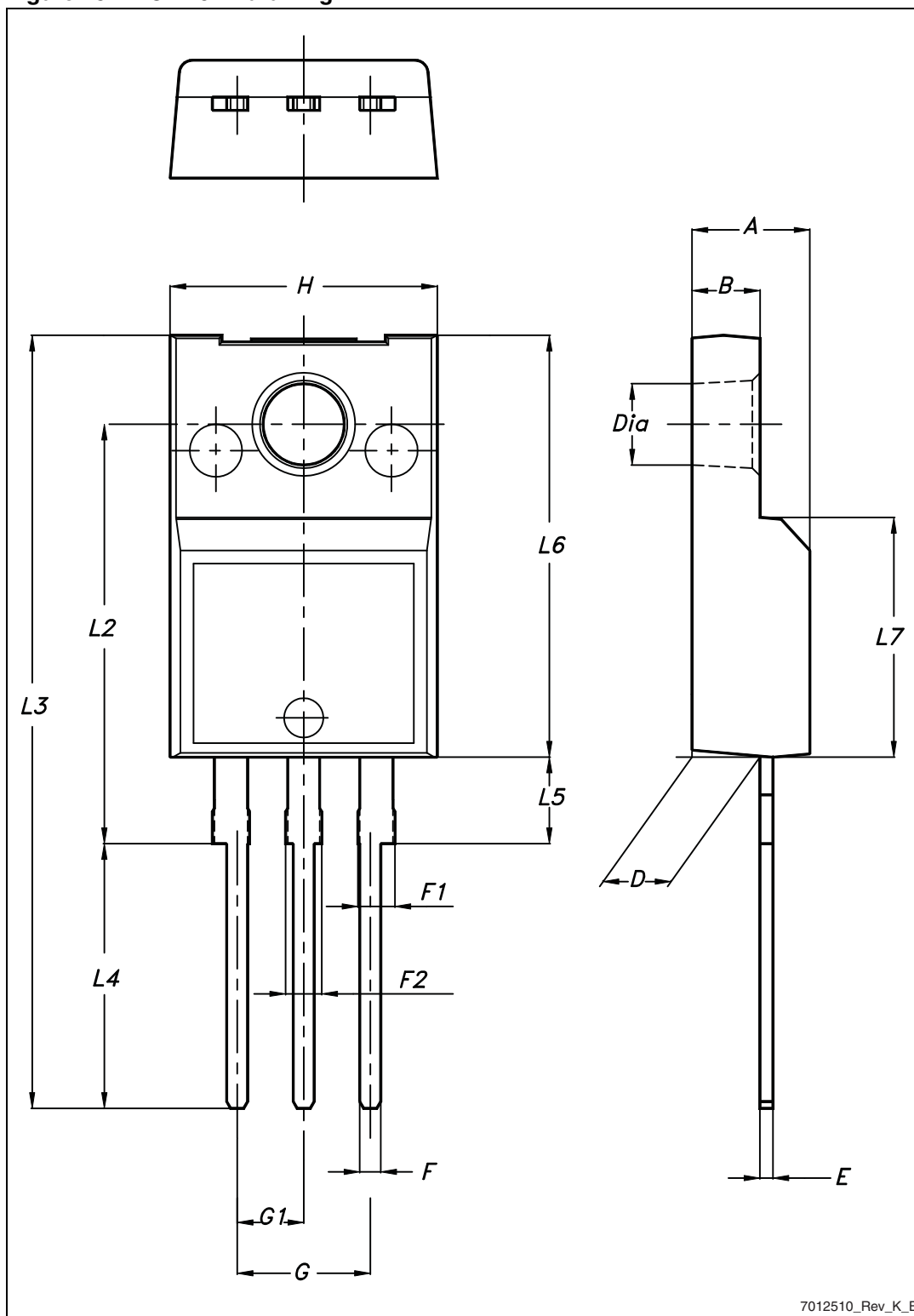


Table 10. I<sup>2</sup>PAK (TO-262) mechanical data

| 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  |

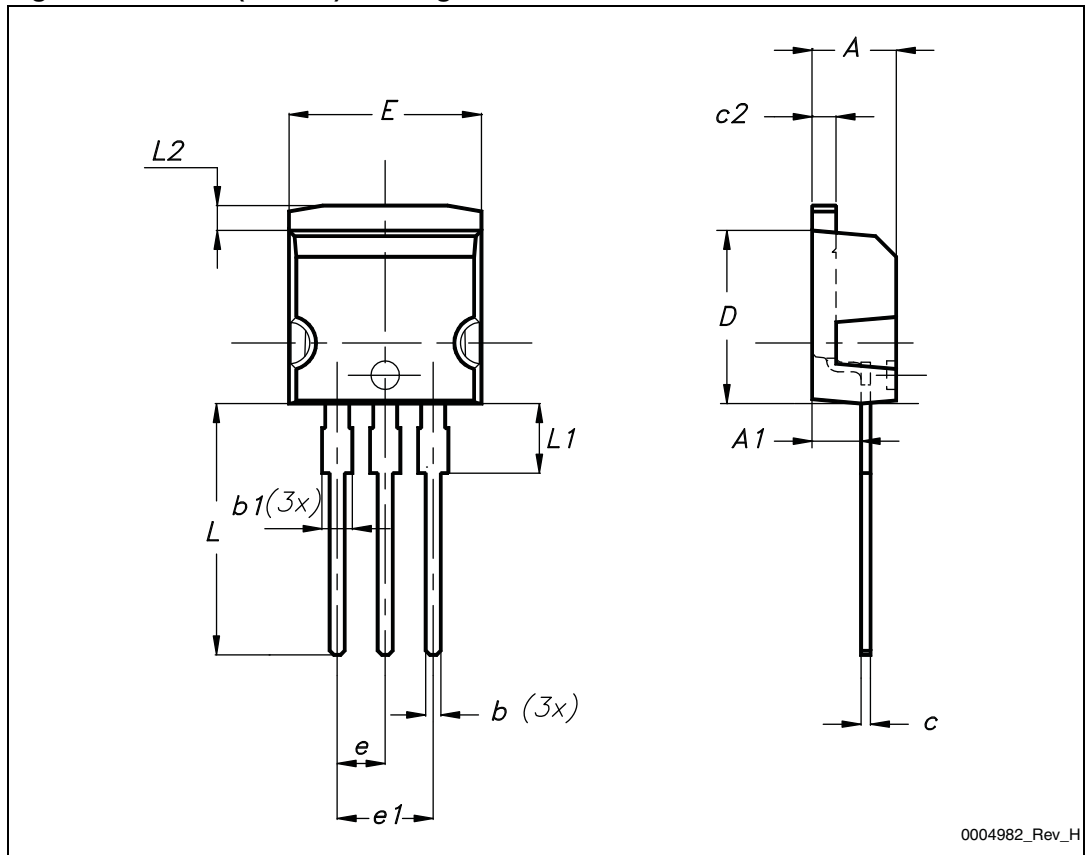
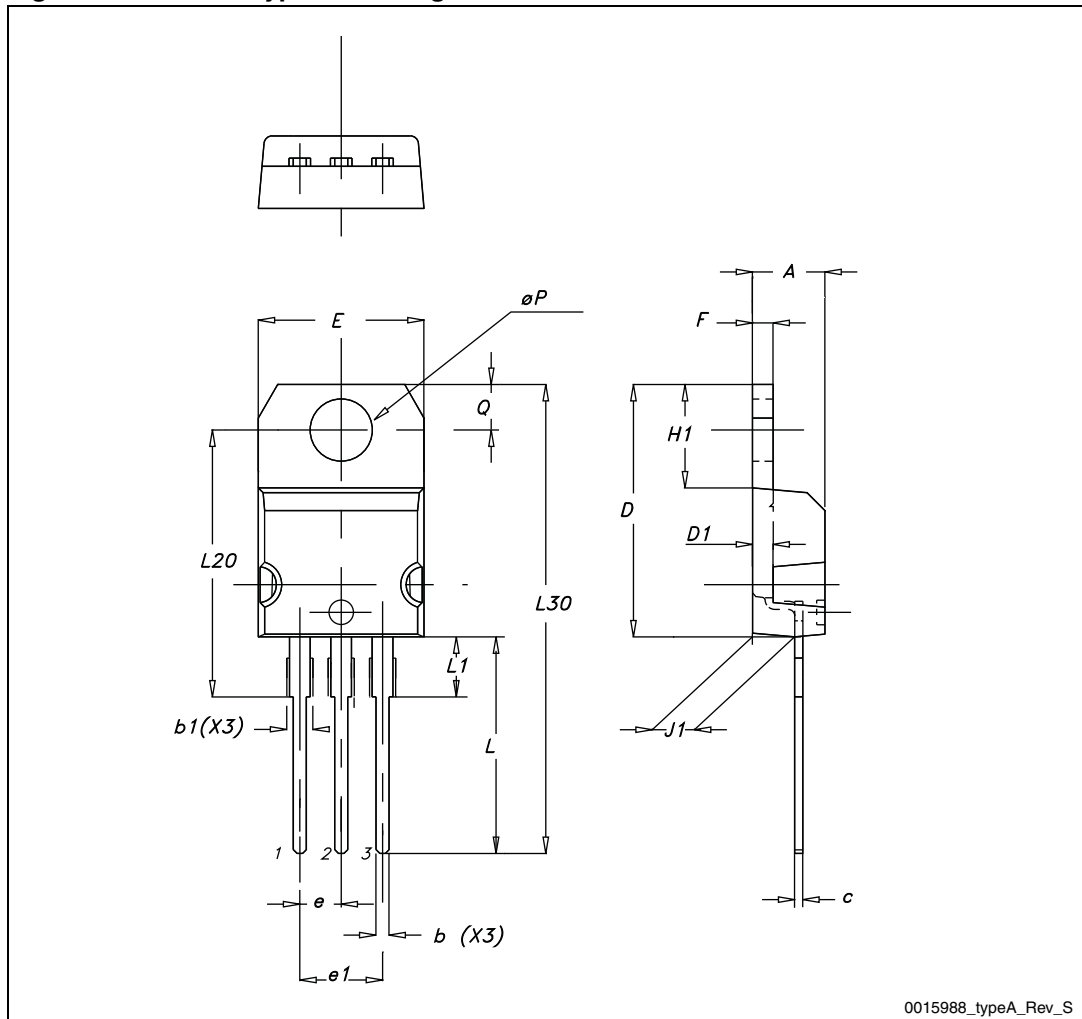
Figure 26. I<sup>2</sup>PAK (TO-262) drawing

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 27. TO-220 type A drawing



## 5 Packaging mechanical data

Table 12. 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 28. Tape

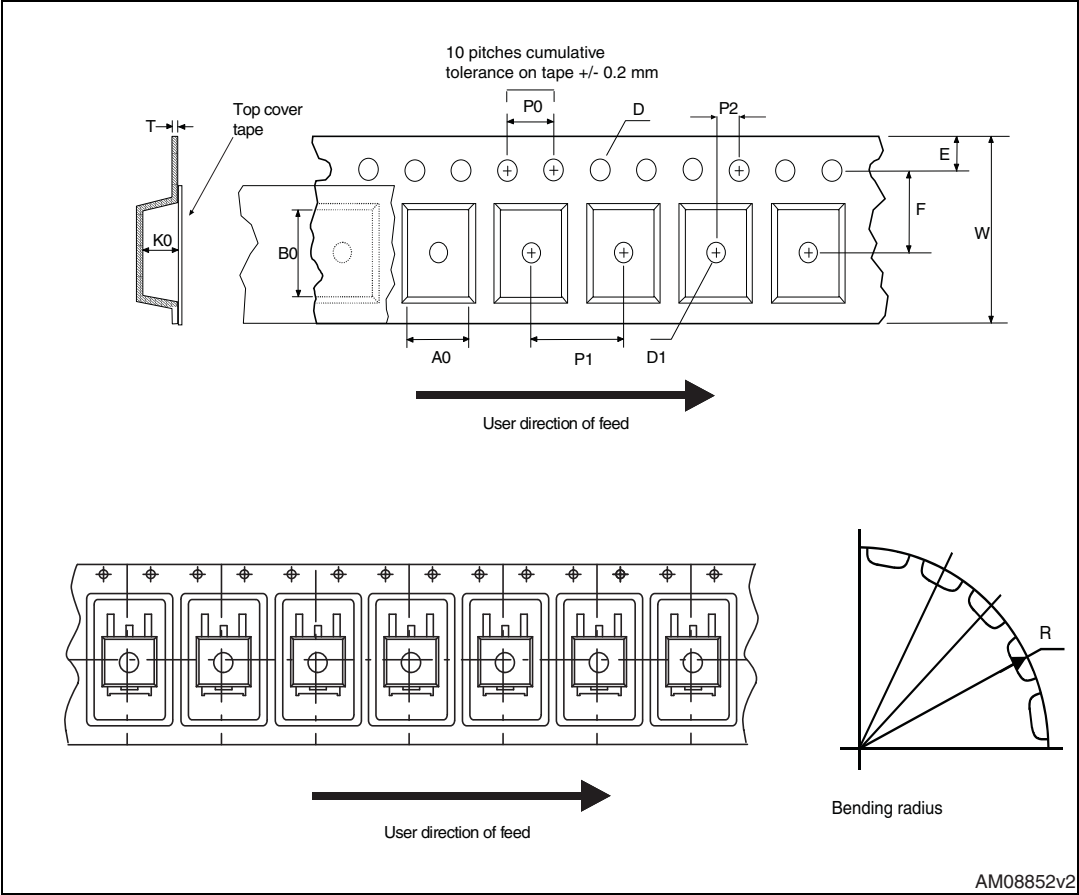
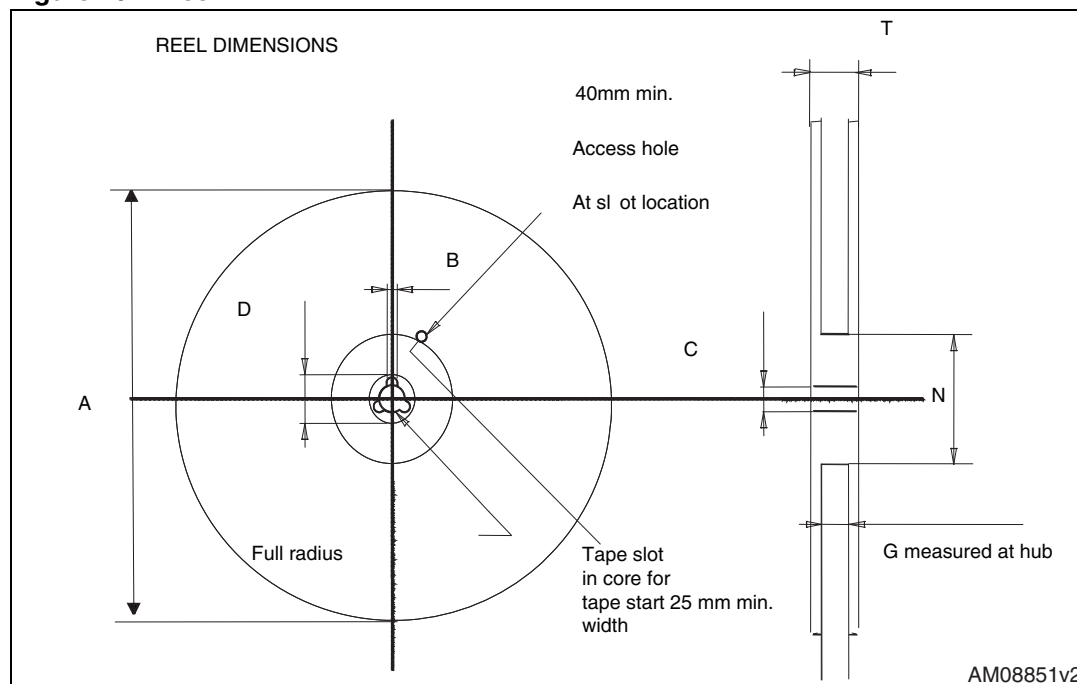


Figure 29. Reel



## 6 Revision history

**Table 13. Document revision history**

| Date        | Revision | Changes                                                                                                                                   |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 06-Apr-2012 | 1        | First release.                                                                                                                            |
| 04-Jul-2012 | 2        | Document status promoted from preliminary to production data.<br>Added <a href="#">Section 2.1: Electrical characteristics (curves)</a> . |
| 21-Aug-2012 | 3        | Updated symbols and parameters in <a href="#">Table 6: Switching times</a> .<br>Minor text change on the cover page.                      |
| 04-Dec-2012 | 4        | The part number STW57N65M5 has been moved to a separate datasheet.                                                                        |

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