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# STF18N65M5, STI18N65M5, STP18N65M5, STW18N65M5

N-channel 650 V, 0.198  $\Omega$  typ., 15 A MDmesh™ V Power MOSFET in TO-220FP, I<sup>2</sup>PAK, TO-220 and TO-247 packages

Datasheet — production data

## Features

| Order code | V <sub>DSS</sub> @ T <sub>Jmax</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> |
|------------|--------------------------------------|-------------------------|----------------|
| STF18N65M5 | 710 V                                | < 0.22 $\Omega$         | 15 A           |
| STI18N65M5 |                                      |                         |                |
| STP18N65M5 |                                      |                         |                |
| STW18N65M5 |                                      |                         |                |

- Worldwide best R<sub>DS(on)</sub> \* area
- Higher V<sub>DSS</sub> rating and high dv/dt capability
- Excellent switching performance
- 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.

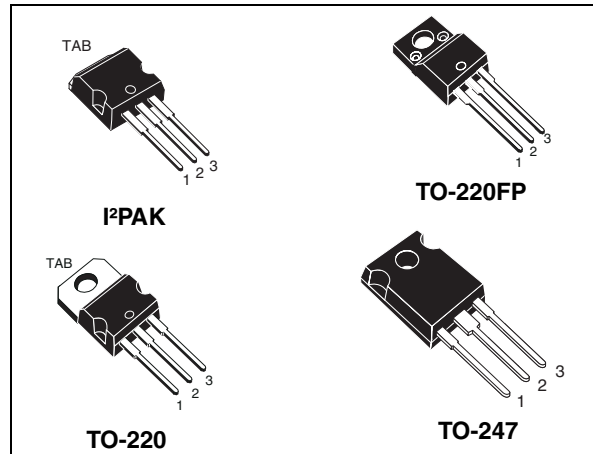
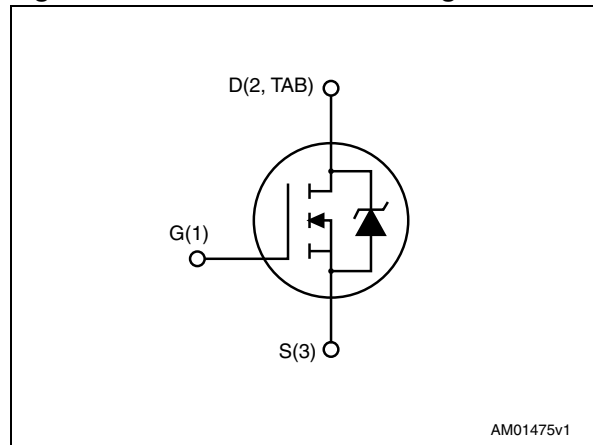


Figure 1. Internal schematic diagram



AM01475v1

Table 1. Device summary

| Order code | Marking | Package            | Packaging |
|------------|---------|--------------------|-----------|
| STF18N65M5 | 18N65M5 | TO-220FP           | Tube      |
| STI18N65M5 |         | I <sup>2</sup> PAK |           |
| STP18N65M5 |         | TO-220             |           |
| STW18N65M5 |         | TO-247             |           |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter   | Value              |        |                    |          | Unit |
|--------------------------------|---|--------------------|--------|--------------------|----------|------|
|                                |   | I <sup>2</sup> PAK | TO-220 | TO-247             | 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  | 15                 |        | 15 <sup>(1)</sup>  |          | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C   | 9.4                |        | 9.4 <sup>(1)</sup> |          | A    |
| I <sub>DM</sub> <sup>(1)</sup> | Drain current (pulsed)  | 60                 |        | 60 <sup>(1)</sup>  |          | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C   | 110                |        | 25                 |          | W    |
| dv/dt <sup>(2)</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. I<sub>SD</sub> ≤ 15 A, di/dt ≤ 400 A/μs; V<sub>DSPeak</sub> < V<sub>(BR)DSS</sub>; V<sub>DD</sub> = 400 V

**Table 3. Thermal data**

| Symbol                | Parameter                               | Value              |        |        |          | Unit |
|-----------------------|---|--------------------|--------|--------|----------|------|
|                       |   | I <sup>2</sup> PAK | TO-220 | TO-247 | TO-220FP |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max    | 1.14               |        |        | 5        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max | 62.5               |        | 50     | 62.5     | °C/W |

**Table 4. Avalanche characteristics**

| Symbol          | Parameter  | Value | Unit |
|-----------------|--|-------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>jmax</sub> )                                | 4     | 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) | 210   | mJ   |



## 2 Electrical characteristics

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

**Table 5. On /off states**

| Symbol        | Parameter  | Test conditions  | Min. | Typ.  | Max.      | Unit                           |
|---------------|--|--|------|-------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$   | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 7.5\text{ A}$                              |      | 0.198 | 0.22      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol            | Parameter                             | Test conditions  | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|--|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$   | -    | 1240 | -    | pF       |
| $C_{oss}$         | Output capacitance                    |  |      | 32   |      | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |  |      | 3.2  |      | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$   | -    | 99   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |  |      | 30   |      | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}$ open drain  | -    | 3    | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 520\text{ V}$ , $I_D = 7.5\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 20</a> ) | -    | 31   | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |  |      | 8    |      | nC       |
| $Q_{gd}$          | Gate-drain charge                     |  |      | 14   |      | 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 7. Switching times**

| Symbol       | Parameter          | Test conditions                                  | Min. | Typ. | Max | Unit |
|--------------|--------------------|--|------|------|-----|------|
| $t_{d(V)}$   | Voltage delay time | $V_{DD} = 400\text{ V}$ , $I_D = 9.5\text{ A}$ , |      | 36   |     | ns   |
| $t_{r(V)}$   | Voltage rise time  | $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$     |      | 7    |     | ns   |
| $t_{f(i)}$   | Current fall time  | (see <a href="#">Figure 21</a> and               | -    | 9    | -   | ns   |
| $t_{c(off)}$ | Crossing time      | <a href="#">Figure 24</a> )                      |      | 11   |     | ns   |

**Table 8. Source drain diode**

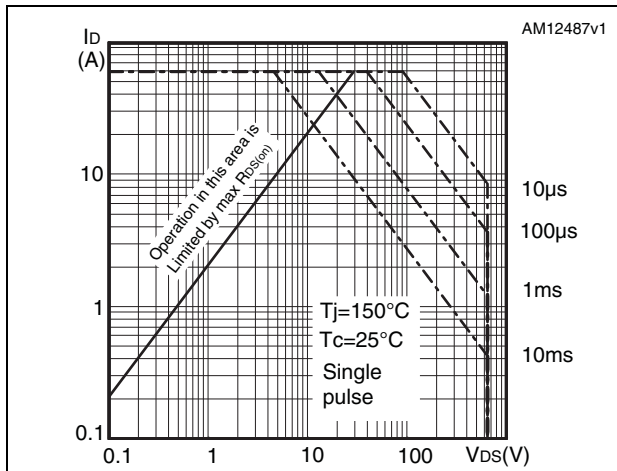
| Symbol          | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |   |      |      | 15   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   | -    |      | 60   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 15\text{ A}$ , $V_{GS} = 0$                       | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 15\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ |      | 290  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 100\text{ V}$ (see <a href="#">Figure 24</a> )    | -    | 3.4  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   |      | 23.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 15\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ |      | 352  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ | -    | 4    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see <a href="#">Figure 24</a> )                            |      | 24   |      | A             |

1. Pulse width limited by safe operating area.

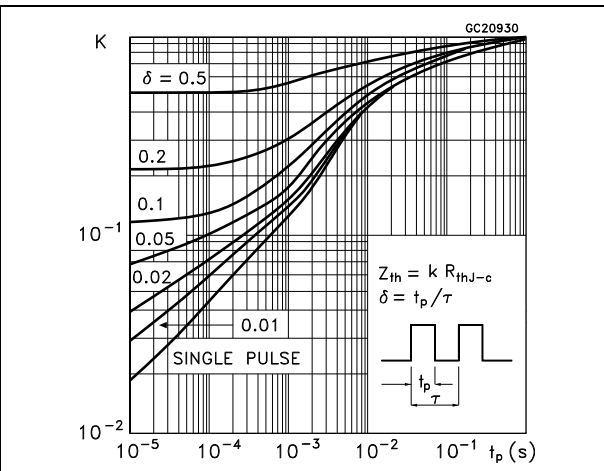
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

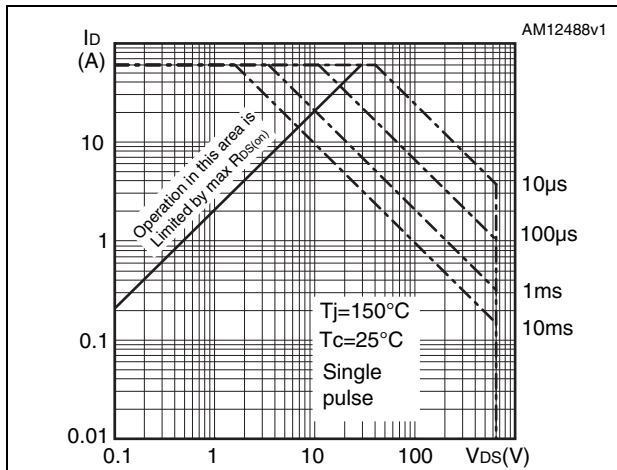
**Figure 2. Safe operating area for I<sup>2</sup>PAK and TO-220**



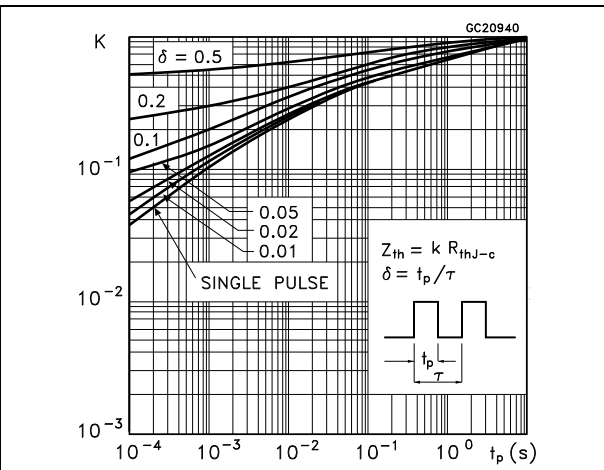
**Figure 3. Thermal impedance for I<sup>2</sup>PAK and TO-220**



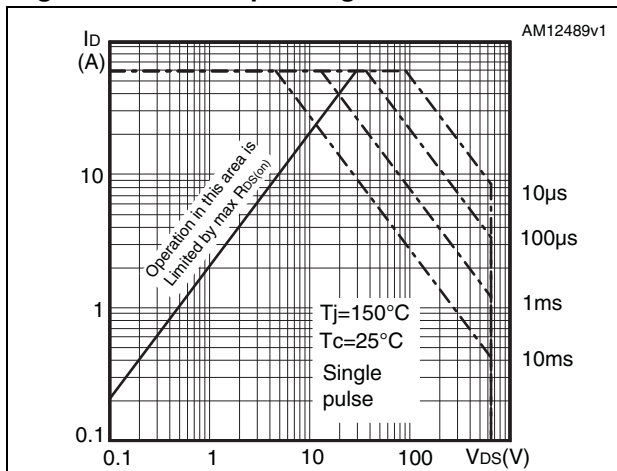
**Figure 4. Safe operating area TO220FP**



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



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



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

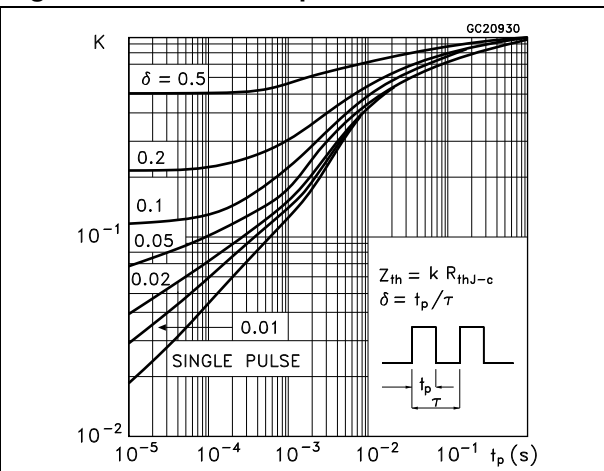


Figure 8. Output characteristics

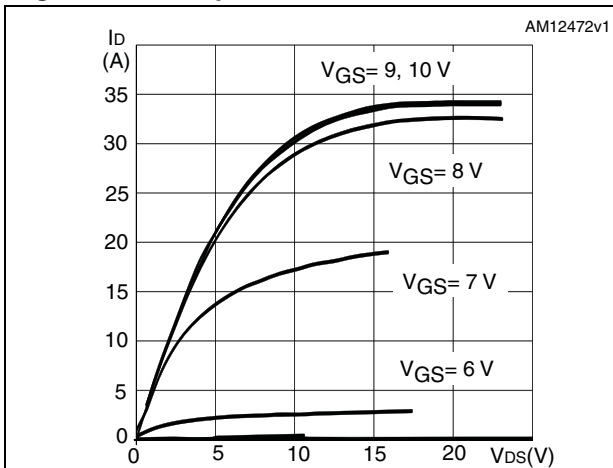


Figure 9. Transfer characteristics

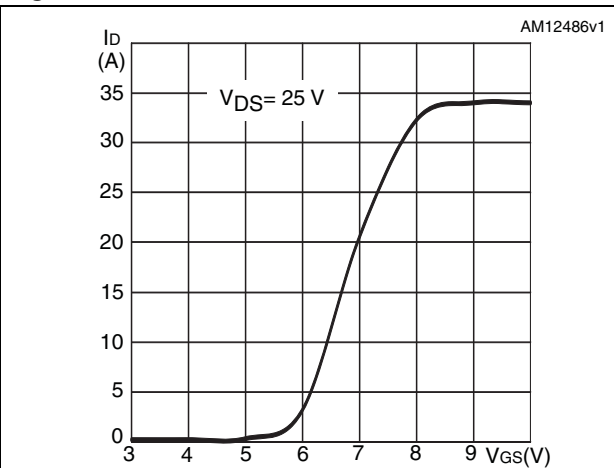


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on-resistance

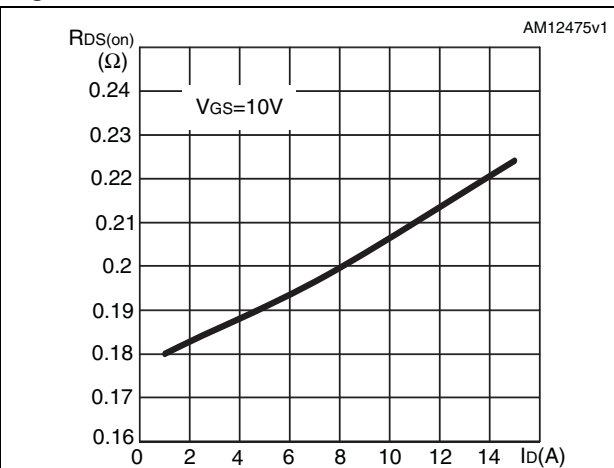
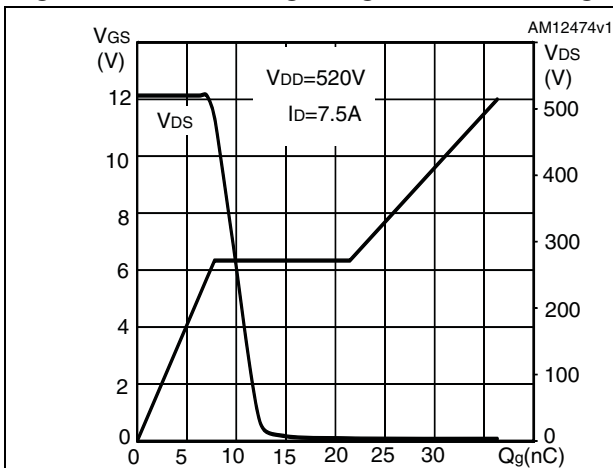


Figure 12. Capacitance variations

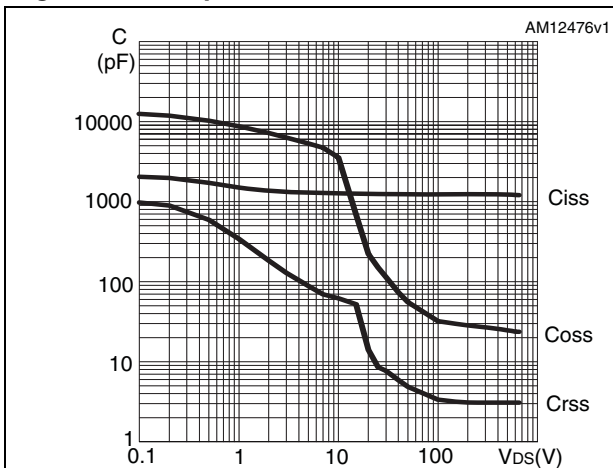


Figure 13. Output capacitance stored energy

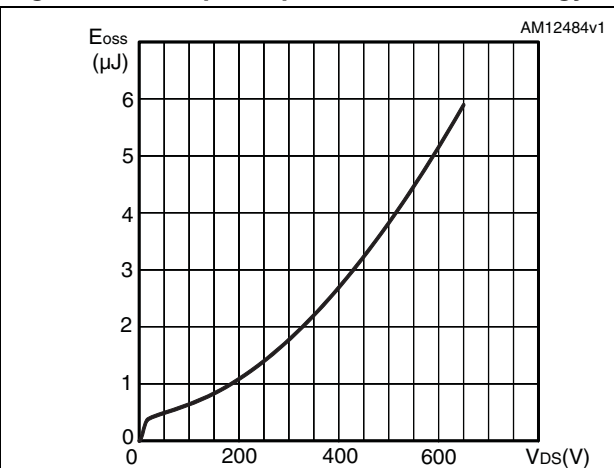




Figure 14. Normalized gate threshold voltage vs temperature

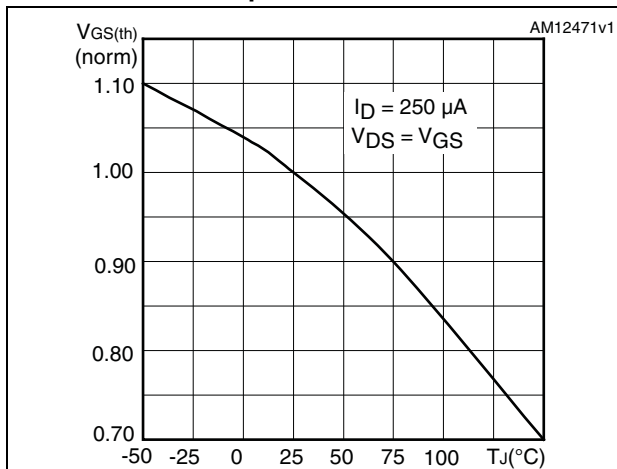


Figure 15. Normalized on-resistance vs temperature

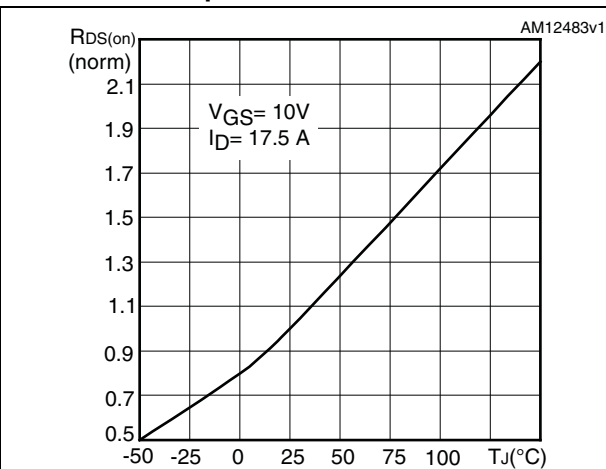


Figure 16. Drain-source diode forward characteristics

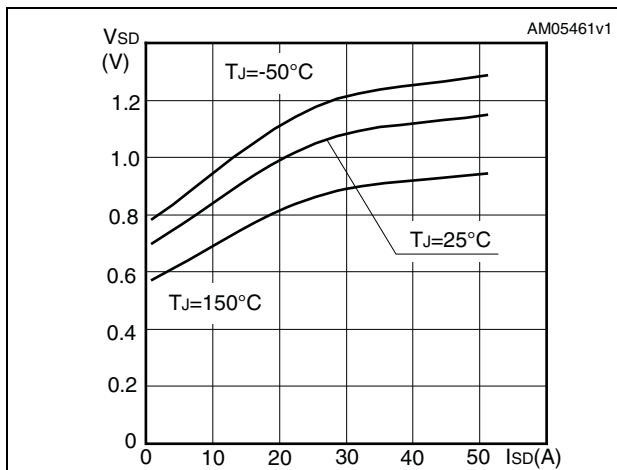


Figure 17. Normalized BV<sub>DSS</sub> vs temperature

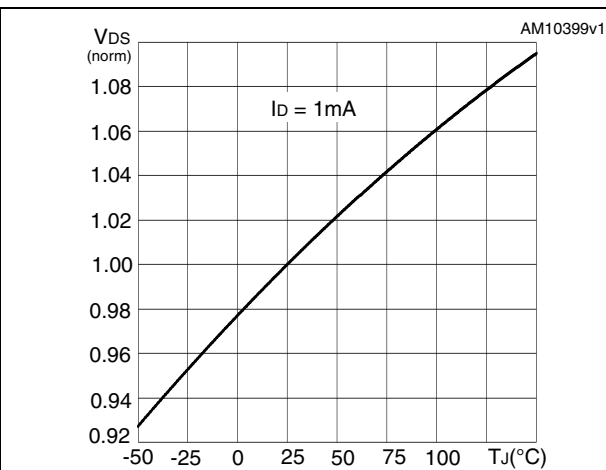
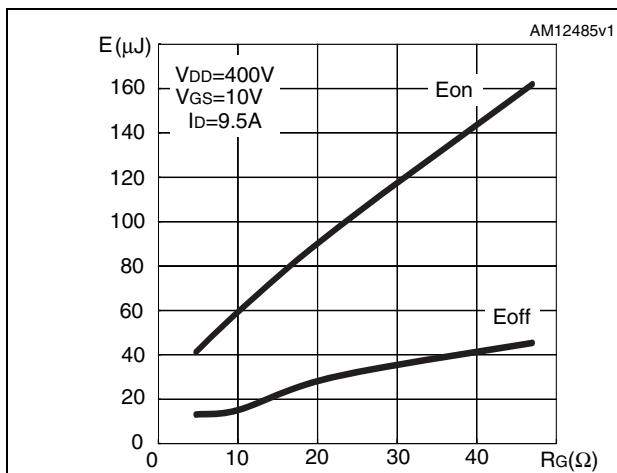


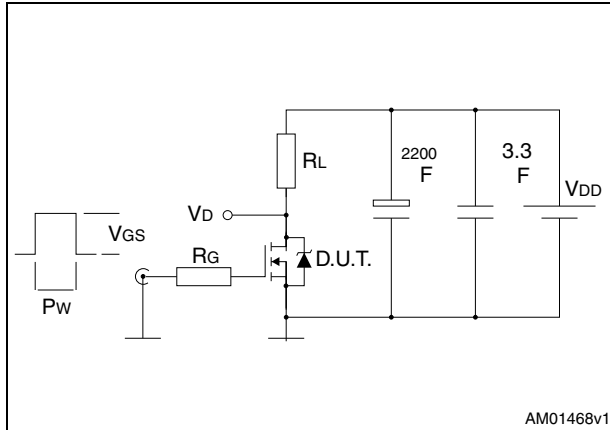
Figure 18. Switching losses vs gate resistance (1)



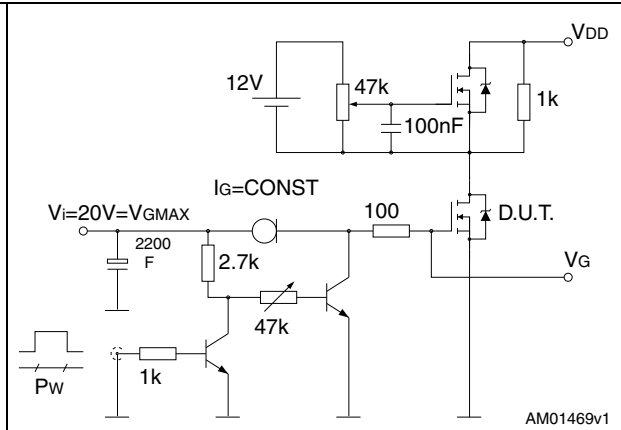
1. Eon including reverse recovery of a SiC diode

### 3 Test circuits

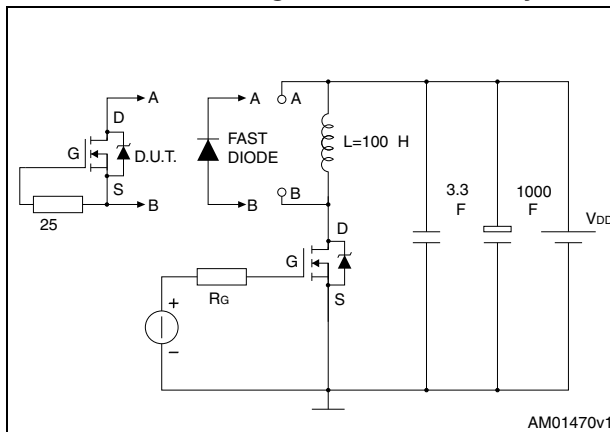
**Figure 19. Switching times test circuit for resistive load**



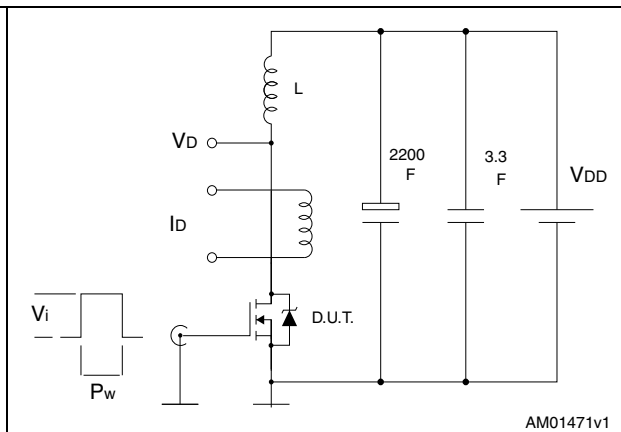
**Figure 20. Gate charge test circuit**



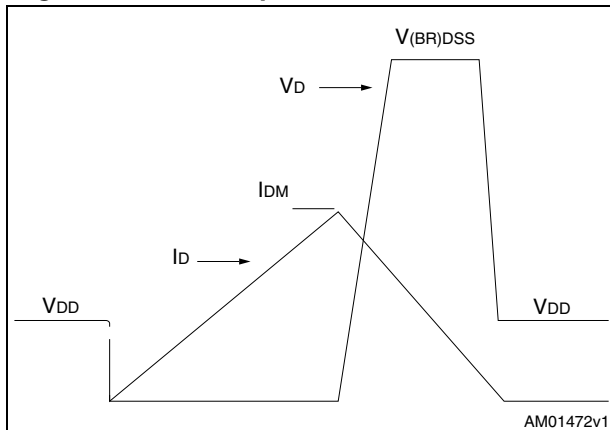
**Figure 21. Test circuit for inductive load switching and diode recovery times**



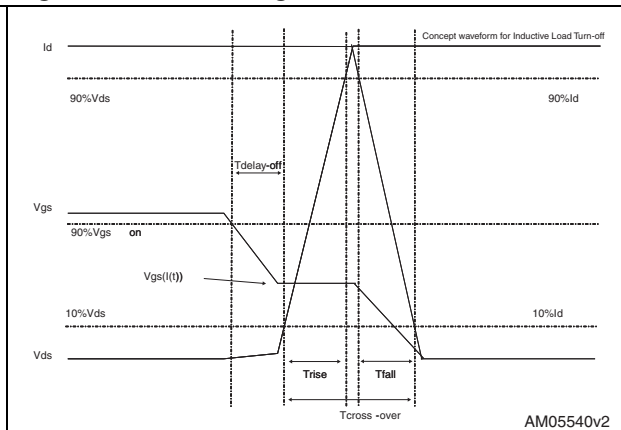
**Figure 22. Unclamped inductive load test circuit**



**Figure 23. Unclamped inductive waveform**



**Figure 24. Switching time waveform**



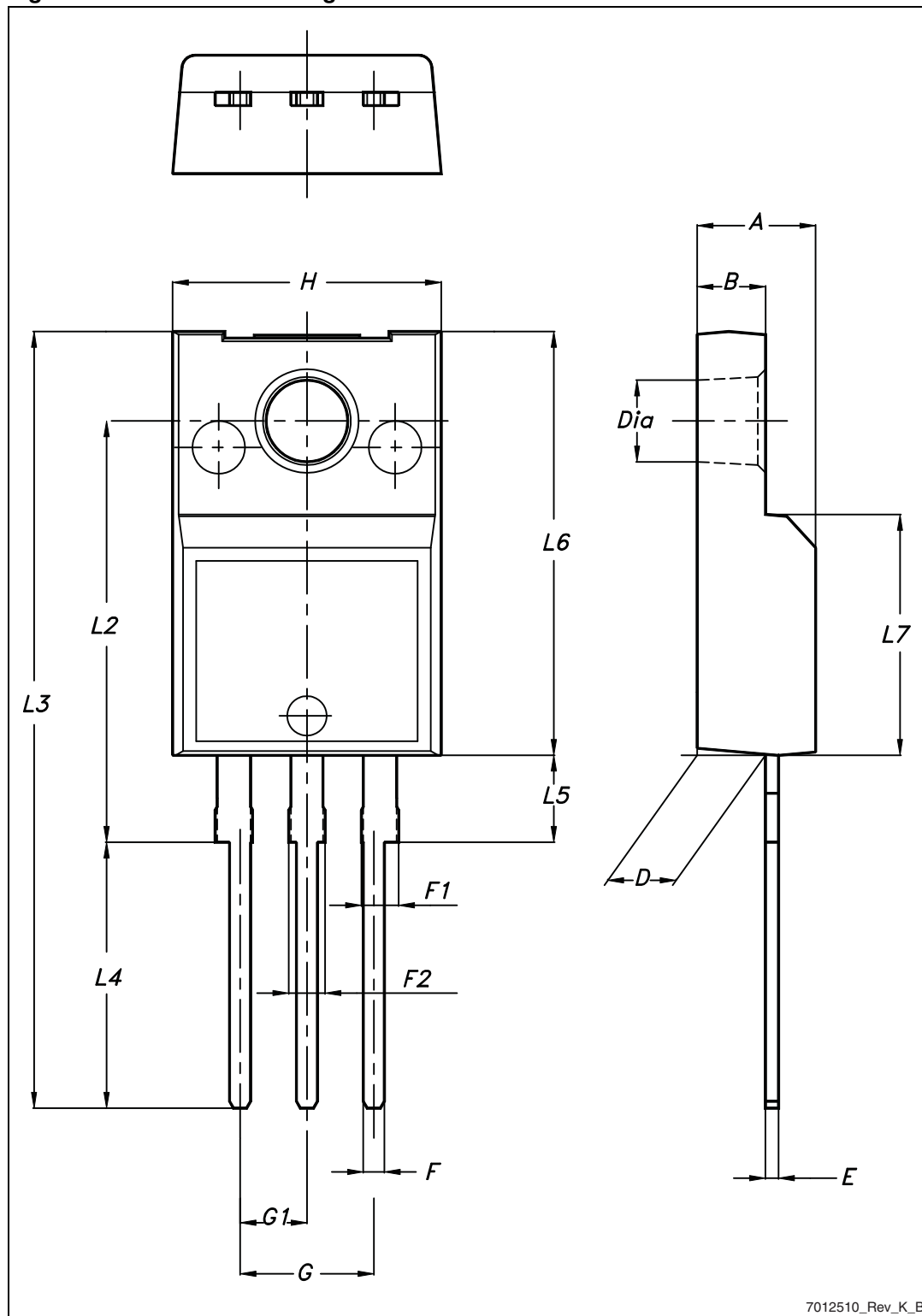
## 4 Package mechanical data

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). ECOPACK is an ST trademark.

**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

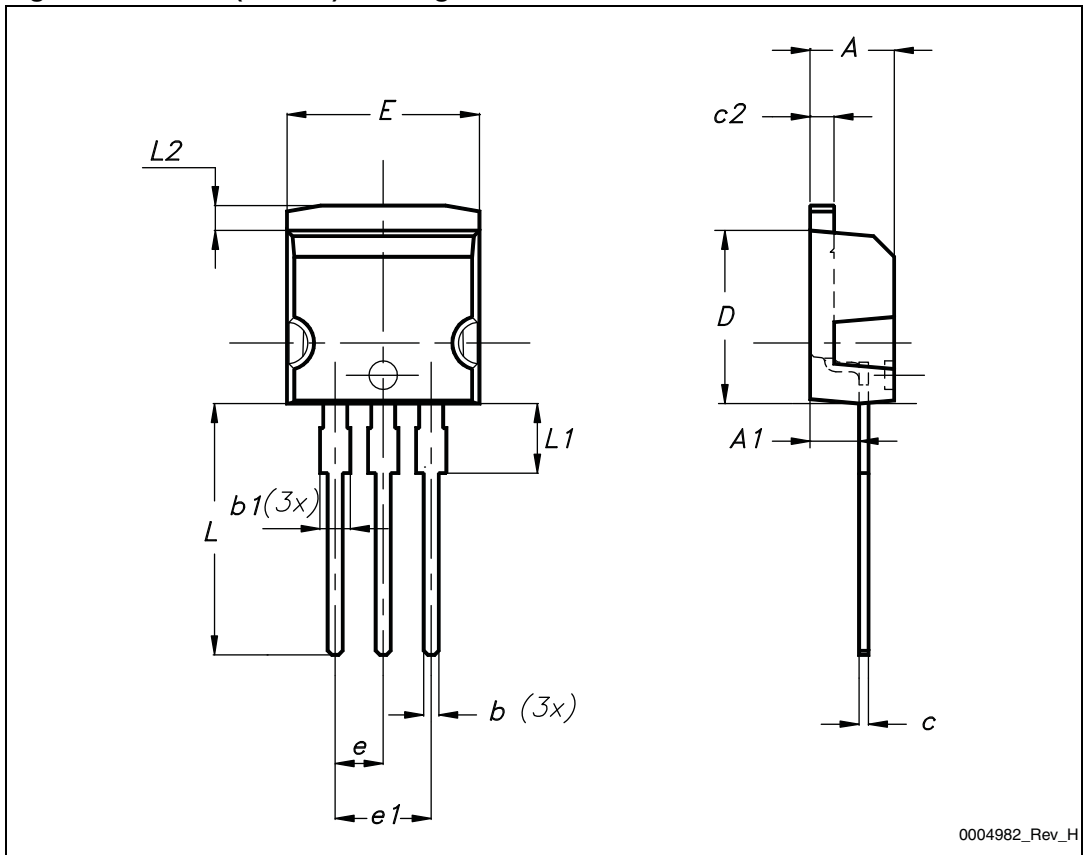


7012510\_Rev\_K\_B

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



0004982\_Rev\_H



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

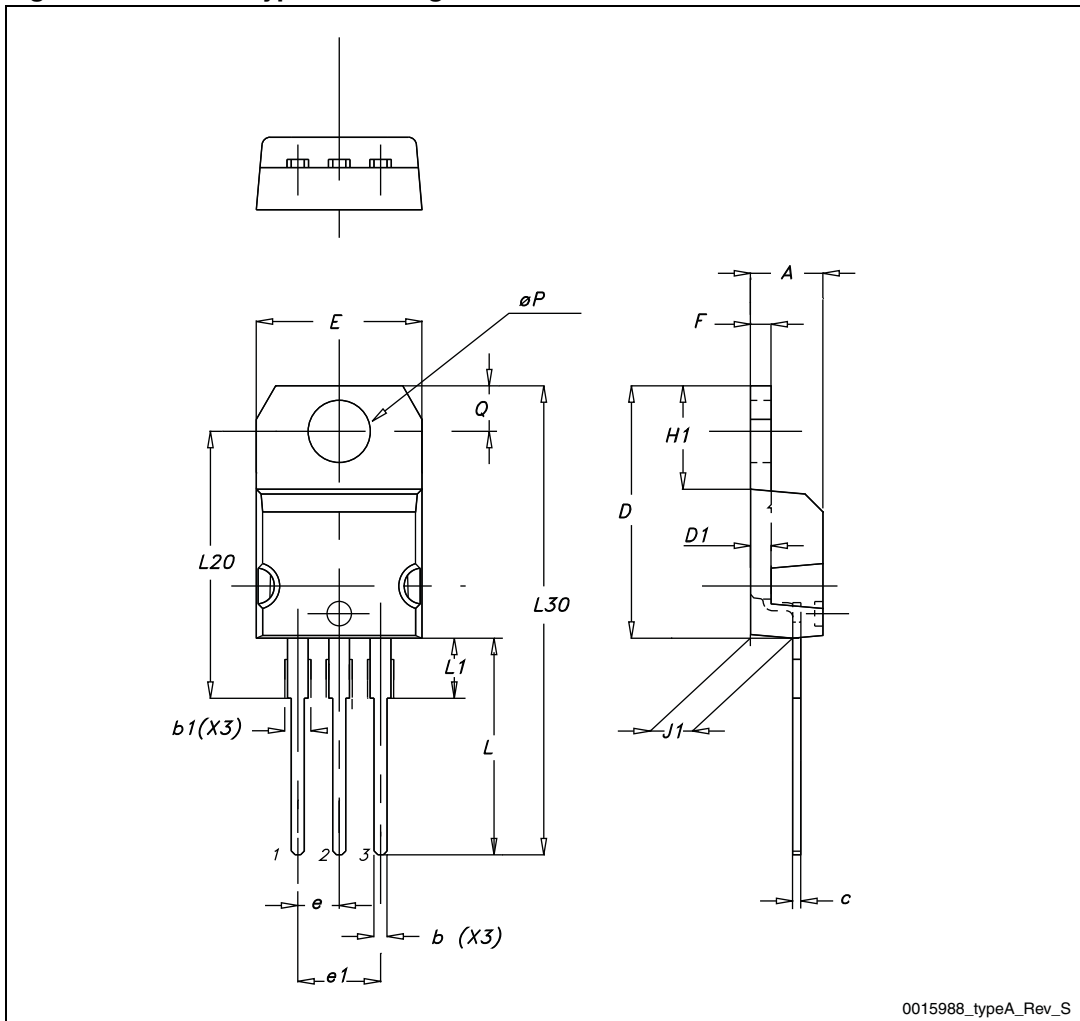
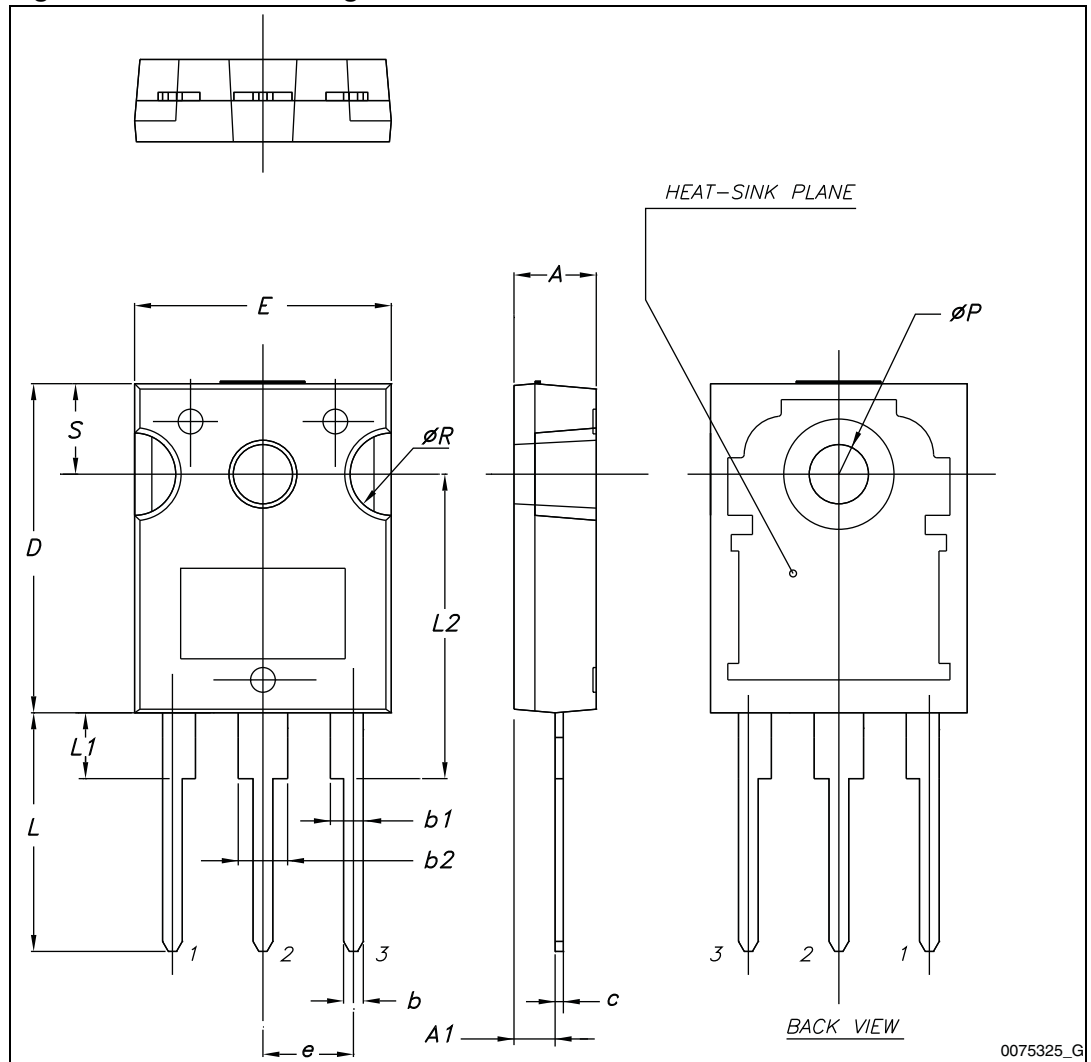


Table 12. TO-247 mechanical data

| 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  |

Figure 28. TO-247 drawing



## 5 Revision history

Table 13. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 01-Mar-2012 | 1        | First release.   |
| 11-Jul-2012 | 2        | The part numbers STB18N65M5 and STD18N65M5 have been moved to a separate datasheet.<br>The part numbers STI18N65M5 and STW18N65M5 in I <sup>2</sup> PAK and TO-247 packages have been added.<br>Document status promoted from preliminary data to production data.<br>Added <a href="#">Section 2.1: Electrical characteristics (curves)</a> . |
| 19-Jul-2012 | 3        | Updated <a href="#">Figure 8: Output characteristics</a> , <a href="#">Figure 11: Static drain-source on-resistance</a> and <a href="#">Figure 14: Normalized gate threshold voltage vs temperature</a> .  |

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