



# STW88N65M5

N-channel 650 V, 0.024  $\Omega$ , 84 A, MDmesh™ V Power MOSFET  
in TO-247

## Features

| Order code | $V_{DSS}$<br>@ $T_{jmax.}$ | $R_{DS(on)}$ max. | $I_D$ |
|------------|----------------------------|-------------------|-------|
| STW88N65M5 | 710 V                      | < 0.029 $\Omega$  | 84 A  |

- Worldwide best  $R_{DS(on)}$  in TO-247
- Higher  $V_{DSS}$  rating
- Higher dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% avalanche tested

## Applications

- High efficiency switching applications: servers, PV inverters, telecom infrastructure, multi kW battery chargers.

## Description

This device is a N-channel MDmesh™ V Power MOSFET 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.

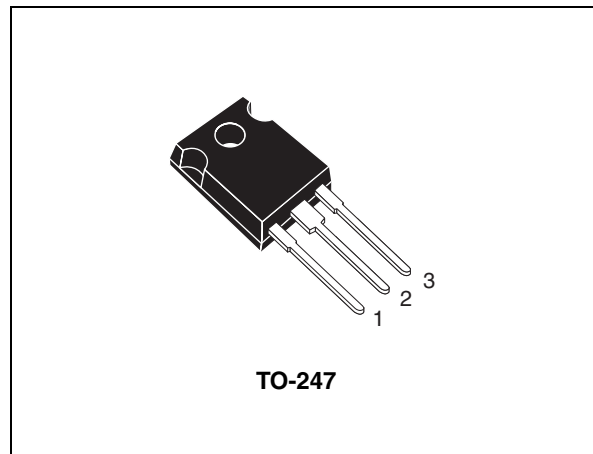


Figure 1. Internal schematic diagram

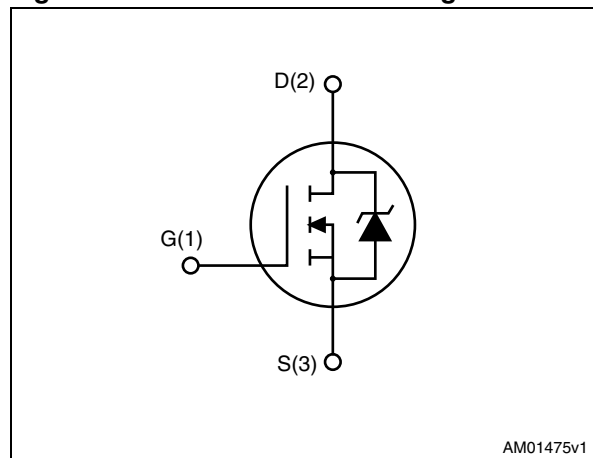


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|------------|---------|---------|-----------|
| STW88N65M5 | 88N65M5 | TO-247  | Tube      |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter  | Value       | Unit |
|----------------|--|-------------|------|
| $V_{GS}$       | Gate- source voltage   | 25          | V    |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ °C}$   | 84          | A    |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ °C}$  | 50.5        | A    |
| $I_{DM}^{(1)}$ | Drain current (pulsed)   | 336         | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$  | 450         | W    |
| $I_{AR}$       | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{JMAX}$ )             | 15          | A    |
| $E_{AS}$       | Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 2000        | mJ   |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope  | 15          | V/ns |
| $T_{stg}$      | Storage temperature  | - 55 to 150 | °C   |
| $T_j$          | Max. operating junction temperature  | 150         | °C   |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 84\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ , peak  $V_{DS} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$

**Table 3. Thermal data**

| Symbol         | Parameter                                      | Value | Unit |
|----------------|--|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case max           | 0.28  | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max        | 50    | °C/W |
| $T_l$          | Maximum lead temperature for soldering purpose | 300   | °C   |

## 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                | $V_{GS} = 10\text{ V}$ , $I_D = 42\text{ A}$                               |      | 0.024 | 0.029     | $\Omega$                       |

**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>$V_{GS} = 0$  | -    | 8825<br>223<br>11 | -    | pF<br>pF<br>pF |
| $C_{o(tr)}^{(1)}$                   | Equivalent capacitance time related                                     | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }520\text{ V}$  | -    | 778               | -    | pF             |
| $C_{o(er)}^{(2)}$                   | Equivalent capacitance energy related                                   | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }520\text{ V}$  | -    | 202               | -    | pF             |
| $R_G$                               | Intrinsic gate resistance   | $f = 1\text{ MHz}$ open drain   | -    | 1.79              | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 520\text{ V}$ , $I_D = 42\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 16</a> ) | -    | 204<br>51<br>84   | -    | nC<br>nC<br>nC |

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

**Table 6. Switching times**

| Symbol       | Parameter          | Test conditions                                 | Min. | Typ. | Max. | Unit |
|--------------|--------------------|---|------|------|------|------|
| $t_{d(V)}$   | Voltage delay time | $V_{DD} = 400\text{ V}$ , $I_D = 56\text{ A}$ , |      | 141  |      | ns   |
| $t_{r(V)}$   | Voltage rise time  | $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$    |      | 16   |      | ns   |
| $t_{f(i)}$   | Current fall time  | (see <a href="#">Figure 17</a> )                | -    | 29   | -    | ns   |
| $t_{c(off)}$ | Crossing time      | (see <a href="#">Figure 20</a> )                |      | 56   |      | ns   |

**Table 7. Source drain diode**

| Symbol          | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |   |      |      | 84   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   | -    |      | 336  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 84\text{ A}$ , $V_{GS} = 0$   | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 84\text{ A}$ ,  |      | 544  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $di/dt = 100\text{ A}/\mu\text{s}$  | -    | 14   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | $V_{DD} = 100\text{ V}$ (see <a href="#">Figure 17</a> )  |      | 50   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 84\text{ A}$ ,  |      | 660  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $di/dt = 100\text{ A}/\mu\text{s}$  | -    | 20   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 17</a> ) |      | 60   |      | 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

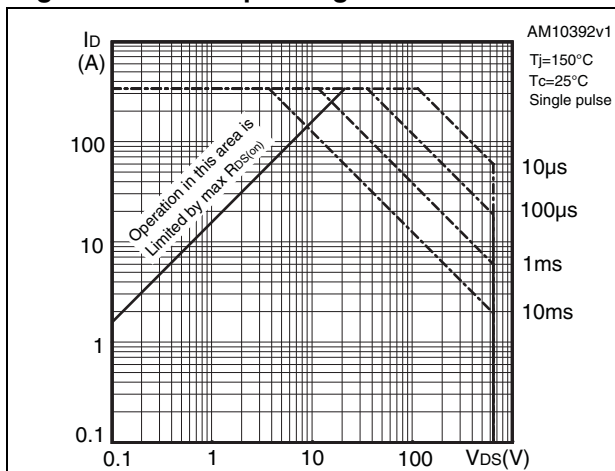


Figure 3. Thermal impedance

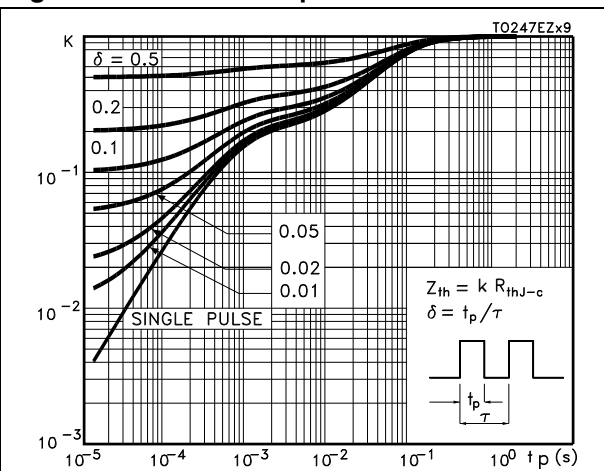


Figure 4. Output characteristics

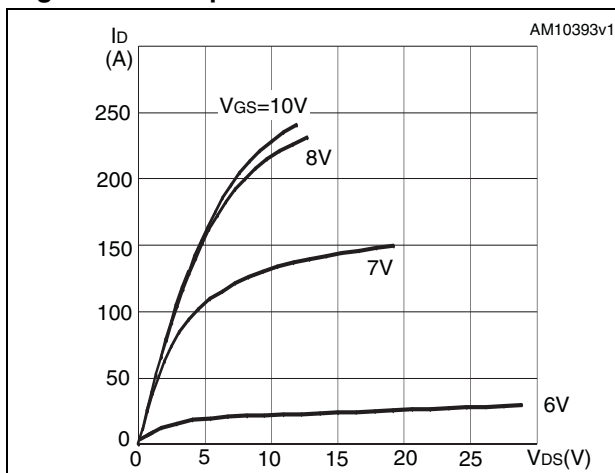


Figure 5. Transfer characteristics

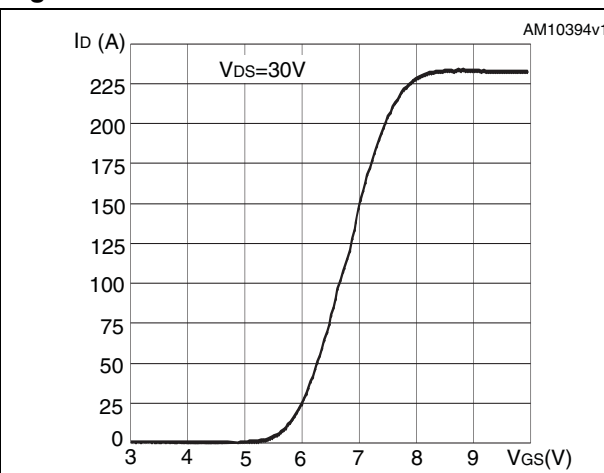


Figure 6. Gate charge vs gate-source voltage

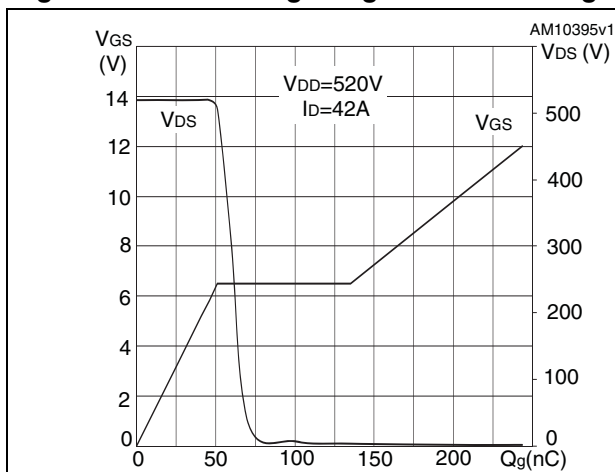


Figure 7. Static drain-source on resistance

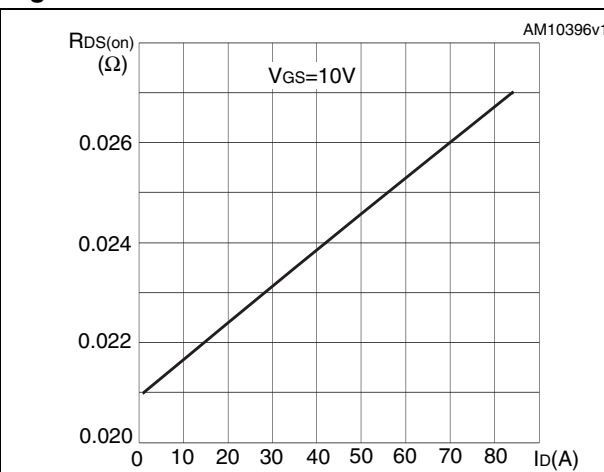


Figure 8. Capacitance variations

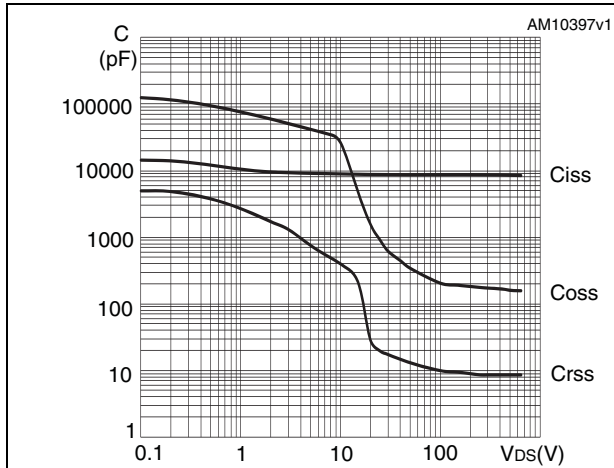


Figure 9. Output capacitance stored energy

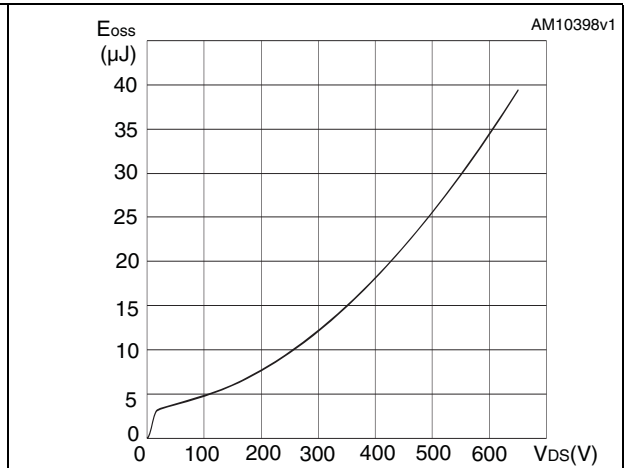


Figure 10. Normalized gate threshold voltage vs temperature

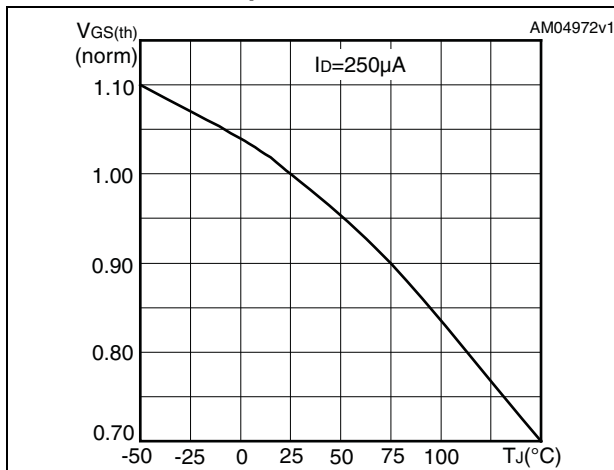


Figure 11. Normalized on resistance vs temperature

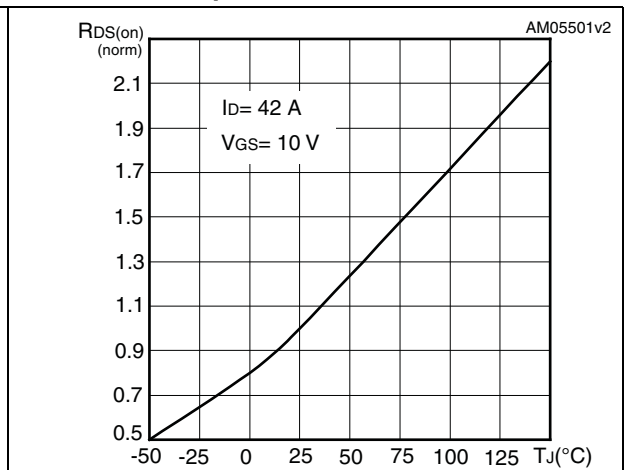


Figure 12. Source-drain diode forward characteristics

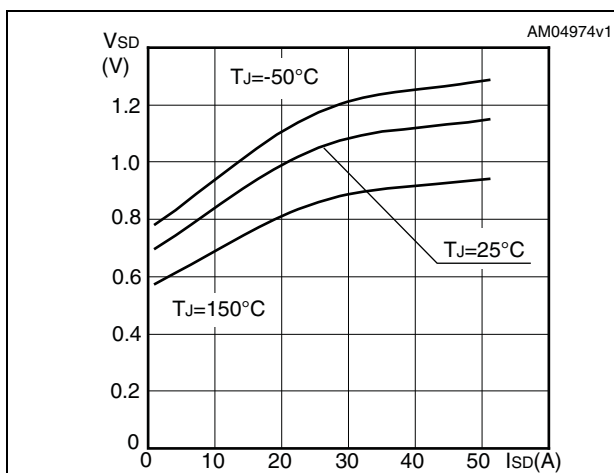


Figure 13. Normalized VDS vs temperature

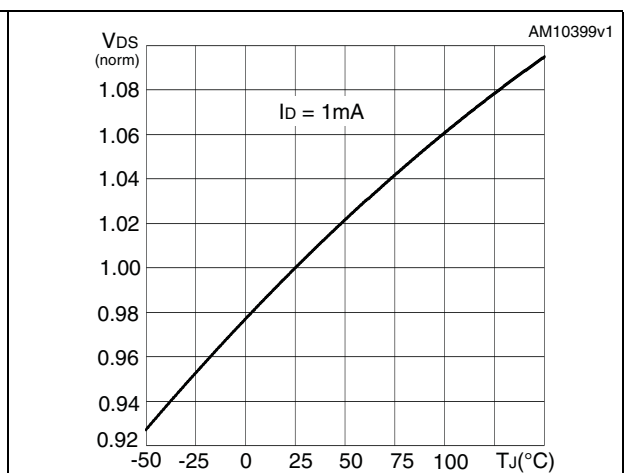
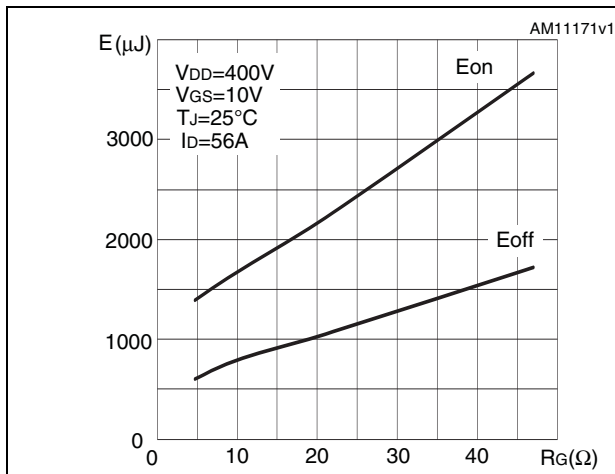


Figure 14. Switching losses vs gate resistance  
(1)

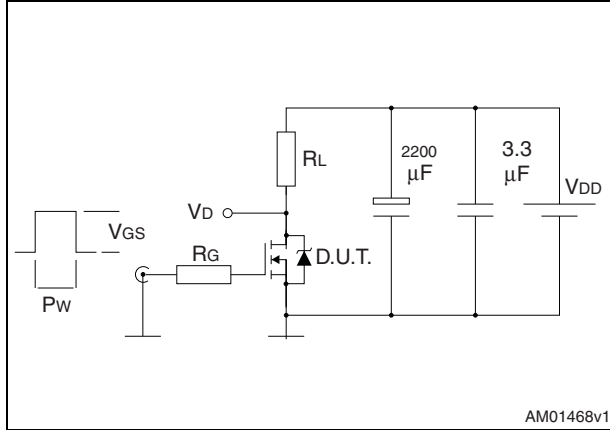


1.  $E_{on}$  including reverse recovery of a SiC diode



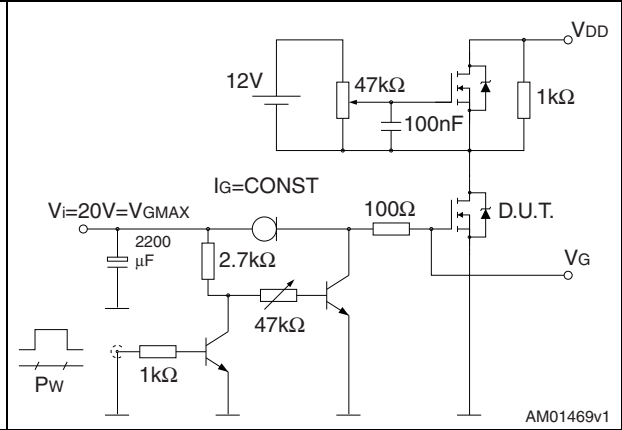
### 3 Test circuits

Figure 15. Switching times test circuit for resistive load



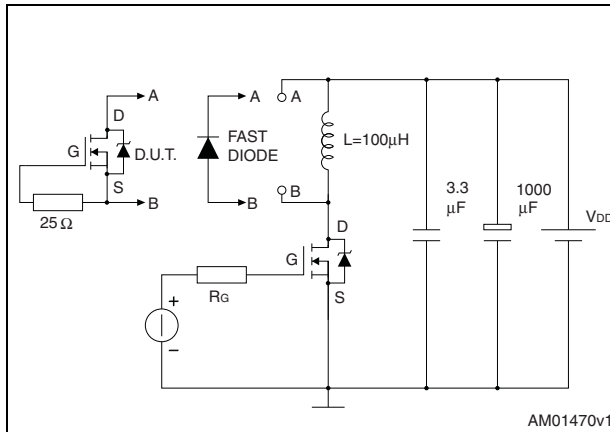
AM01468v1

Figure 16. Gate charge test circuit



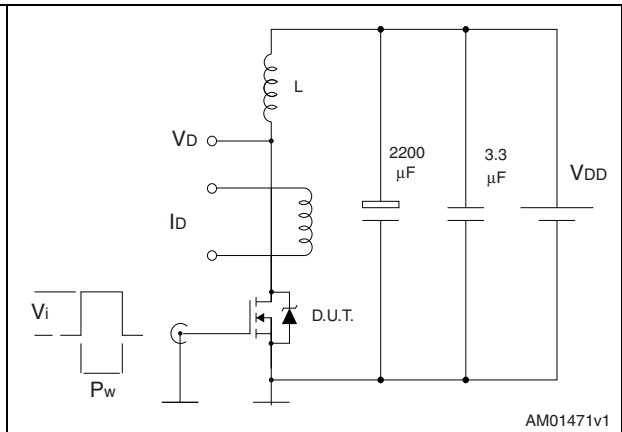
AM01469v1

Figure 17. Test circuit for inductive load switching and diode recovery times



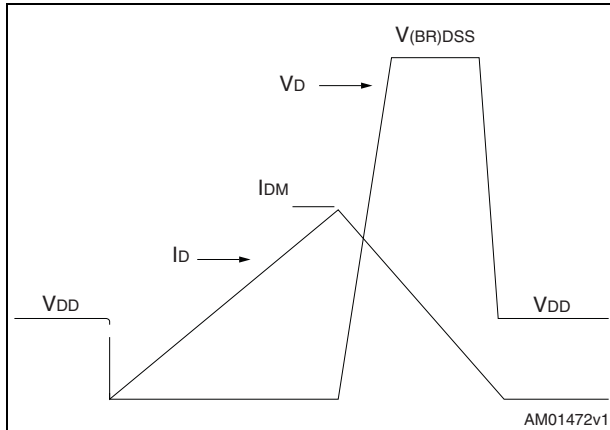
AM01470v1

Figure 18. Unclamped inductive load test circuit



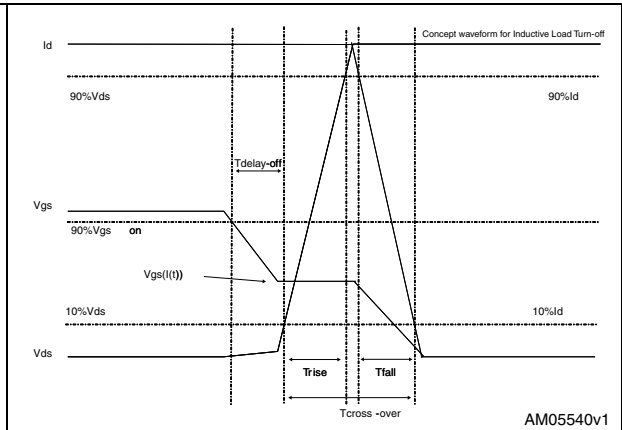
AM01471v1

Figure 19. Unclamped inductive waveform



AM01472v1

Figure 20. Switching time waveform



AM05540v1

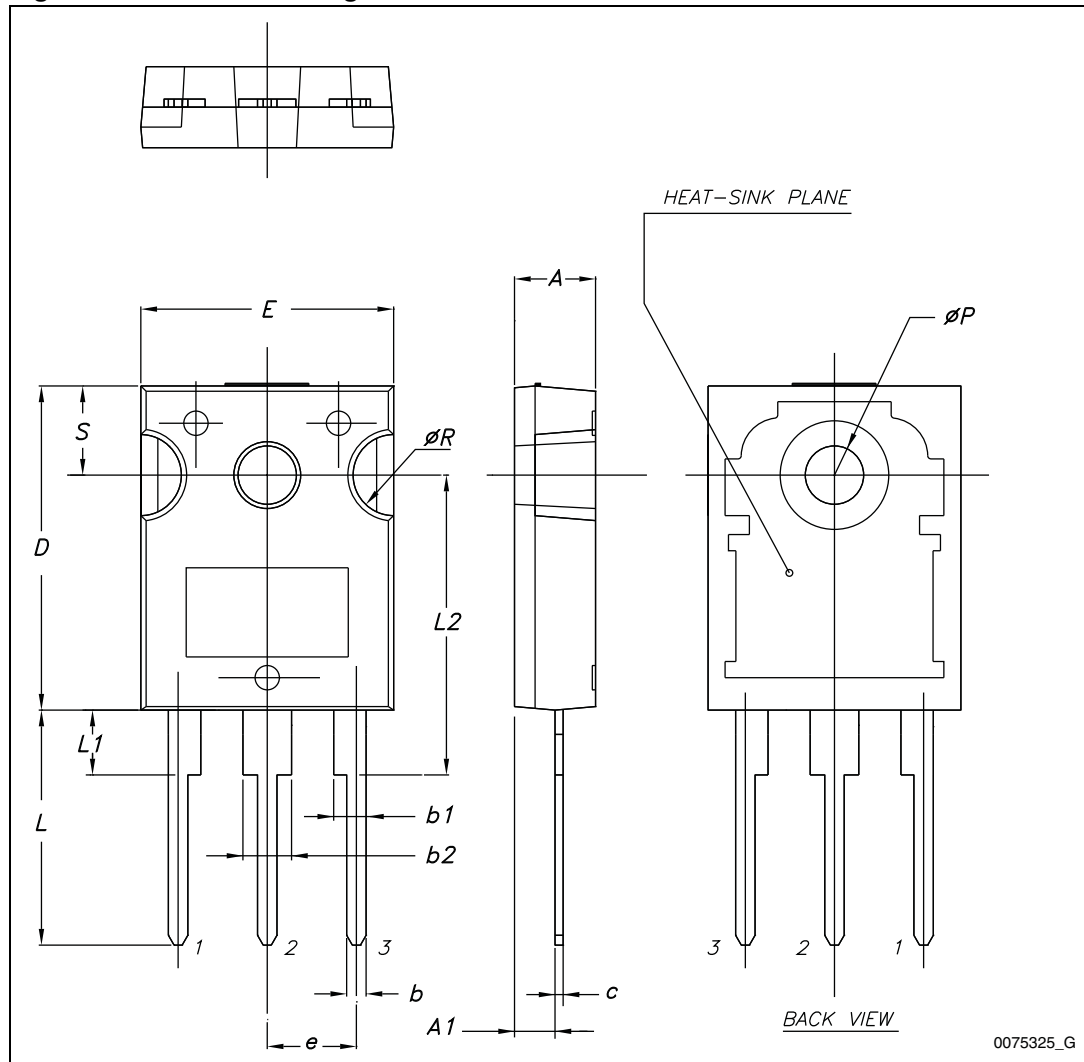
## 4 Package mechanical data

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 8. 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 21. TO-247 drawing



## 5 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 23-Nov-2011 | 1        | First release.   |
| 09-Dec-2011 | 2        | Document status promoted from preliminary data to datasheet. |

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