

## N-channel 500 V, 0.035 $\Omega$ , 68 A, MDmesh™ II Power MOSFET in a TO-247 package

Datasheet - production data

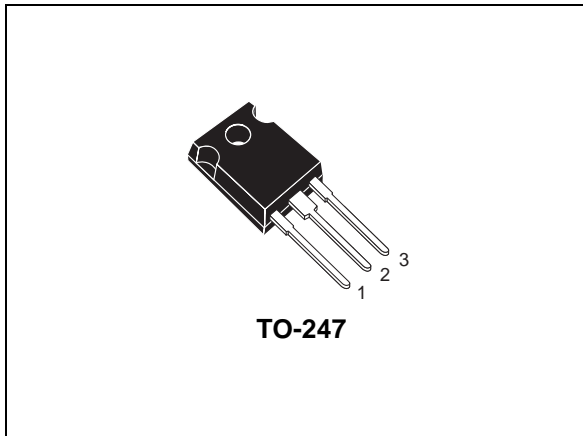
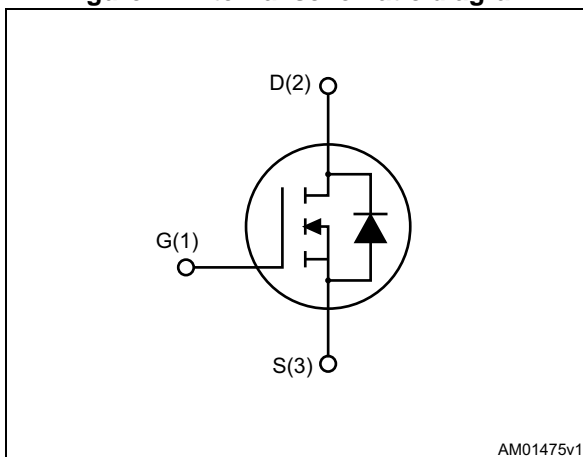


Figure 1. Internal schematic diagram



### Features

| Order code | $V_{DSS} (@T_{jmax})$ | $R_{DS(on) max}$ | $I_D$ |
|------------|-----------------------|------------------|-------|
| STW60NM50N | 550 V                 | <0.043 $\Omega$  | 68 A  |

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

### Applications

- Switching applications

### Description

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

Table 1. Device summary

| Order codes | Marking | Packages | Packaging |
|-------------|---------|----------|-----------|
| STW60NM50N  | 60NM50N | 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  | $\pm 25$   | V                |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$  | 68         | A                |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 43         | A                |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 272        | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$           | 446        | W                |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                               | 15         | V/ns             |
| $T_{stg}$      | Storage temperature   | -55 to 150 | $^\circ\text{C}$ |
| $T_j$          | Max. operating junction temperature                             | 150        | $^\circ\text{C}$ |

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 68\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol         | Parameter                               | Value | Unit                      |
|----------------|---|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max    | 0.28  | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 50    | $^\circ\text{C}/\text{W}$ |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter  | Value | Unit |
|----------|--|-------|------|
| $I_{AS}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{j\text{ Max}}$ )                         | 11    | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ ) | 551   | mJ   |

## 2 Electrical characteristics

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

**Table 5. On/off states**

| Symbol        | Parameter                         | Test conditions   | Min. | Typ.  | Max.      | Unit          |
|---------------|-----------------------------------|---|------|-------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0, I_D = 1\text{ mA}$   | 500  |       |           | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0, V_{DS} = 500\text{ V}$<br>$V_{GS} = 0, V_{DS} = 500\text{ V}, T_j = 125\text{ °C}$ |      |       | 1<br>100  | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0, V_{GS} = \pm 20\text{ V}$  |      |       | $\pm 100$ | nA            |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$   | 2    | 3     | 4         | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}, I_D = 34\text{ A}$   |      | 0.035 | 0.043     | $\Omega$      |

**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>$V_{GS} = 0$                                      | -    | 5790 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |   | -    | 365  | -    | pF       |
| $C_{riss}$                 | Reverse transfer capacitance  |   | -    | 14   | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 480\text{ V}$                                     | -    | 1008 | -    | pF       |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}, I_D = 68\text{ A},$<br>$V_{GS} = 10\text{ V}$<br><i>(see Figure 14)</i> | -    | 178  | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |   | -    | 28   | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |   | -    | 95   | -    | nC       |
| $R_g$                      | Gate input resistance         | f=1 MHz gate DC bias=0<br>Test signal level = 20 mV<br>open drain                               | -    | 2    | -    | $\Omega$ |

1.  $C_{oss\text{ eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DS}$

Table 7. Switching times

| Symbol       | Parameter           | Test conditions  | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 32.5\text{ A}$<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 13) | -    | 206  | -    | ns   |
| $t_r$        | Rise time           |  | -    | 36   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |  | -    | 40   | -    | ns   |
| $t_f$        | Fall time           |  | -    | 27.5 | -    | ns   |

Table 8. Source drain diode

| Symbol          | Parameter   | Test conditions   | Min. | Typ. | Max. | Unit |
|-----------------|---|---|------|------|------|------|
| $I_{SD}$        | Source-drain current<br>Source-drain current (pulsed) |   | -    |      | 68   | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed)                         |   | -    |      | 272  | A    |
| $V_{SD}^{(2)}$  | Forward on voltage                                    | $I_{SD} = 68\text{ A}$ , $V_{GS} = 0$   | -    |      | 1.6  | V    |
| $t_{rr}$        | Reverse recovery time                                 | $I_{SD} = 68\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$<br>(see Figure 15)                                     | -    | 476  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge                               |   | -    | 10.5 |      | nC   |
| $I_{RRM}$       | Reverse recovery current                              |   | -    | 44   |      | A    |
| $t_{rr}$        | Reverse recovery time                                 | $I_{SD} = 68\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see Figure 15) | -    | 586  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge                               |   | -    | 15   |      | nC   |
| $I_{RRM}$       | Reverse recovery current                              |   | -    | 51   |      | 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

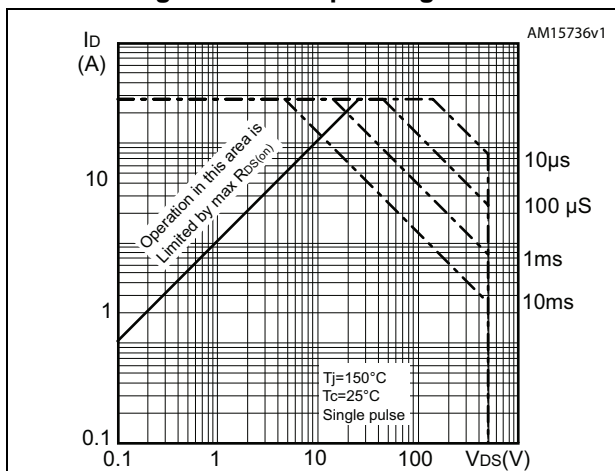


Figure 3. Thermal impedance

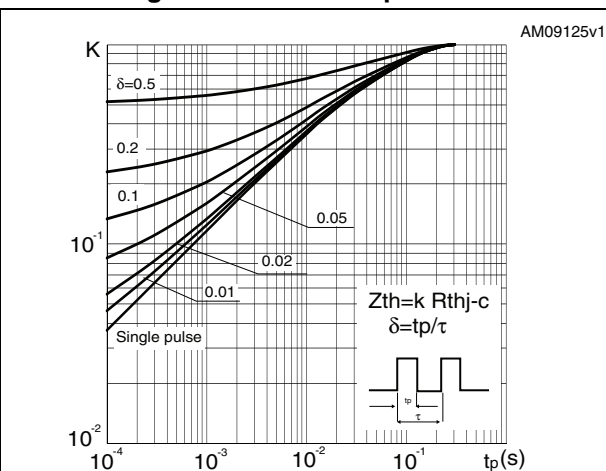


Figure 4. Output characteristics

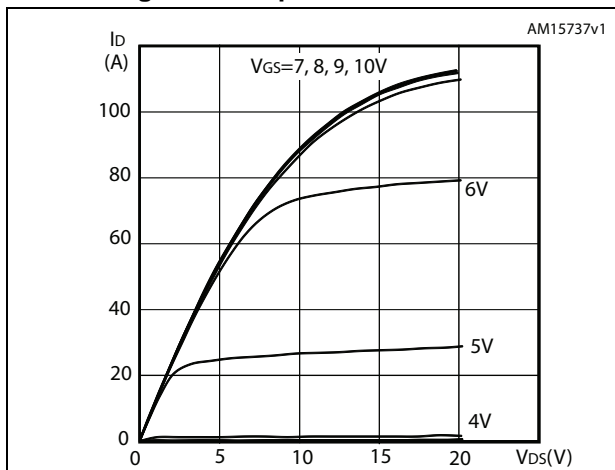


Figure 5. Transfer characteristics

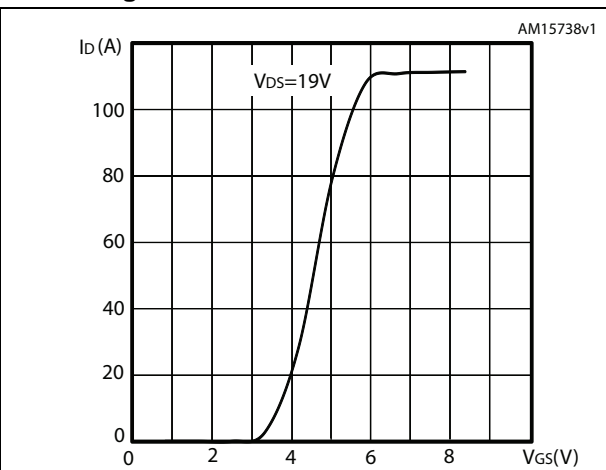


Figure 6. Normalized  $V_{(BR)DSS}$  vs temperature

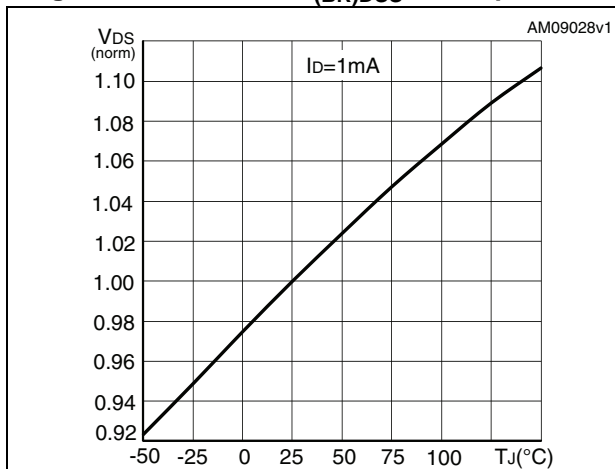


Figure 7. Static drain-source on-resistance

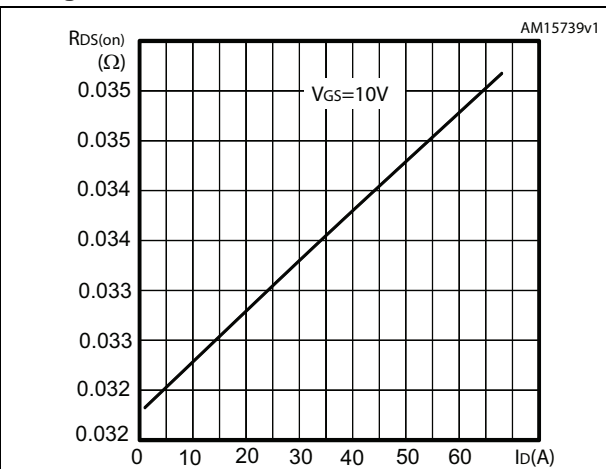


Figure 8. Gate charge vs gate-source voltage

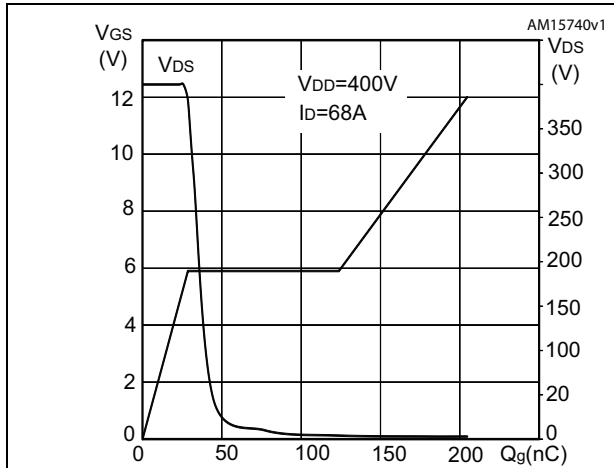


Figure 9. Capacitance variations

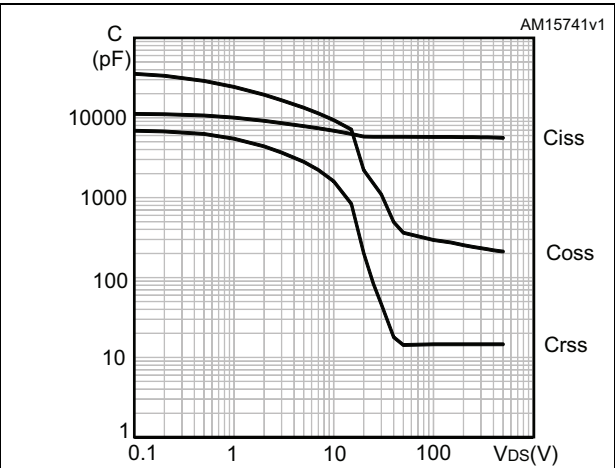


Figure 10. Normalized gate threshold voltage vs temperature

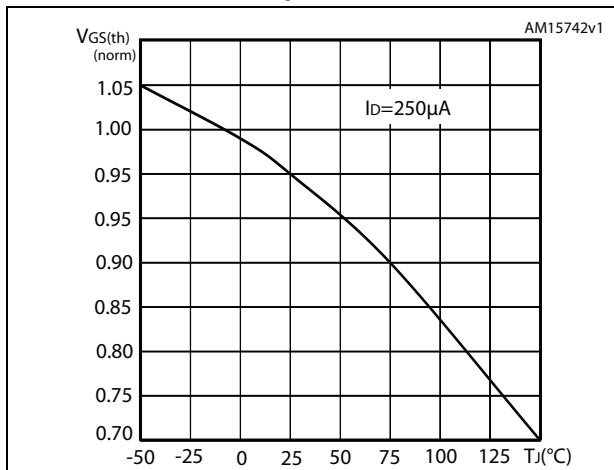


Figure 11. Normalized on-resistance vs temperature

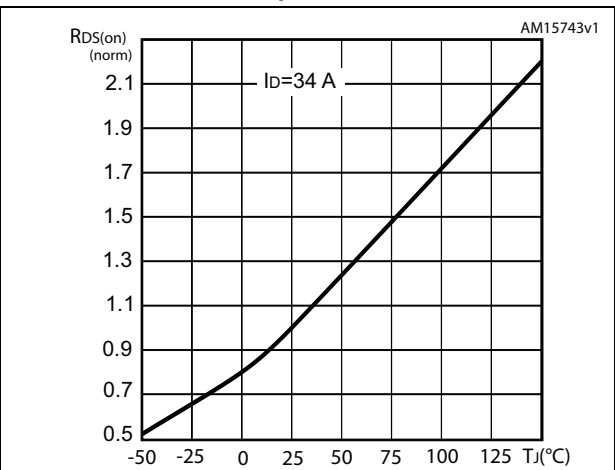
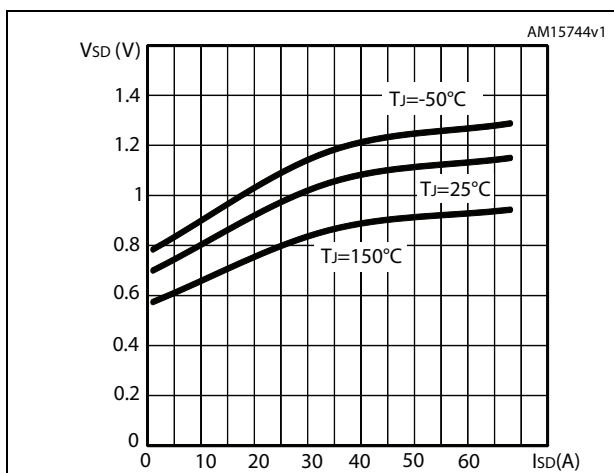


Figure 12. Source-drain diode forward characteristics



### 3 Test circuits

Figure 13. Switching times test circuit for resistive load

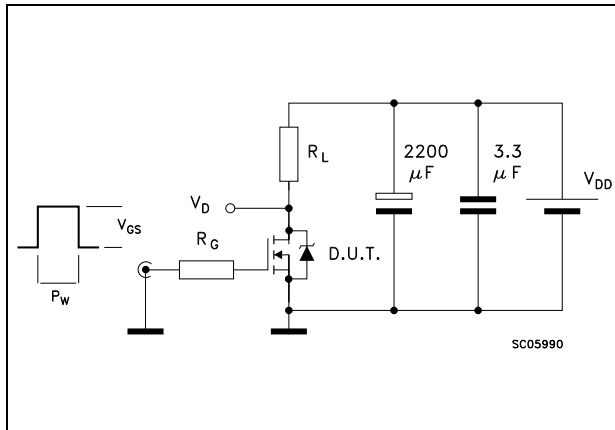


Figure 14. Gate charge test circuit

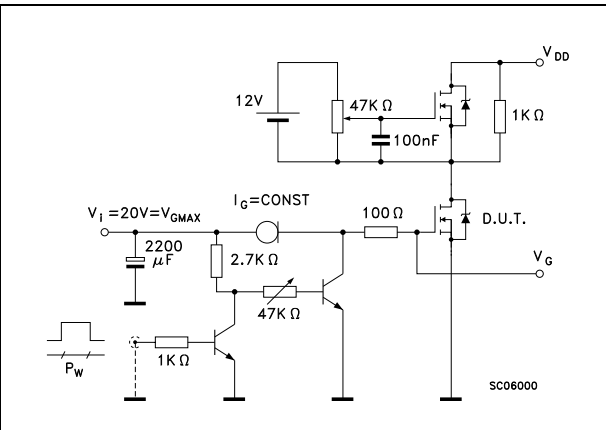


Figure 15. Test circuit for inductive load switching and diode recovery times

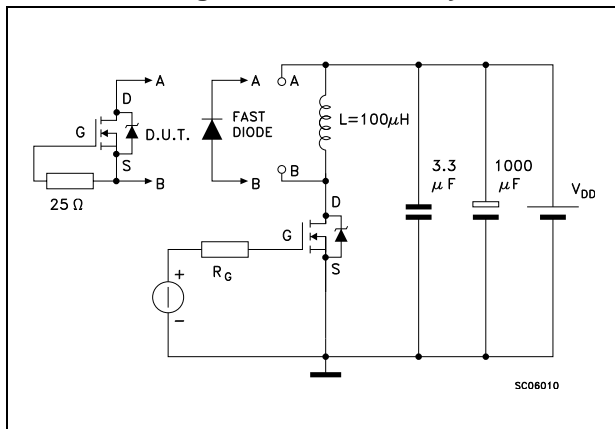


Figure 16. Unclamped Inductive load test circuit

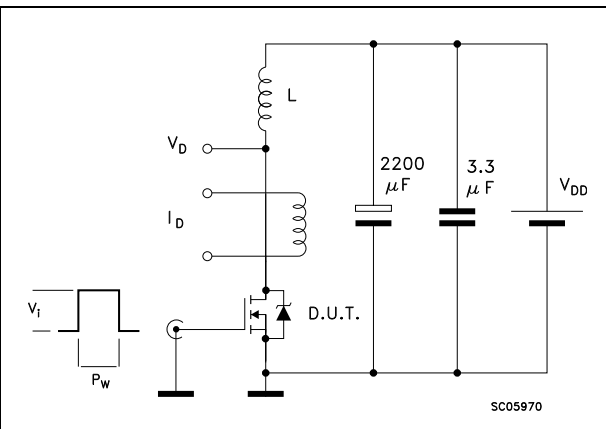


Figure 17. Unclamped inductive waveform

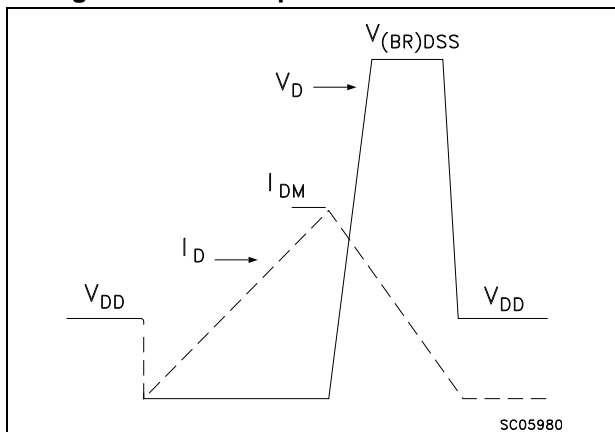
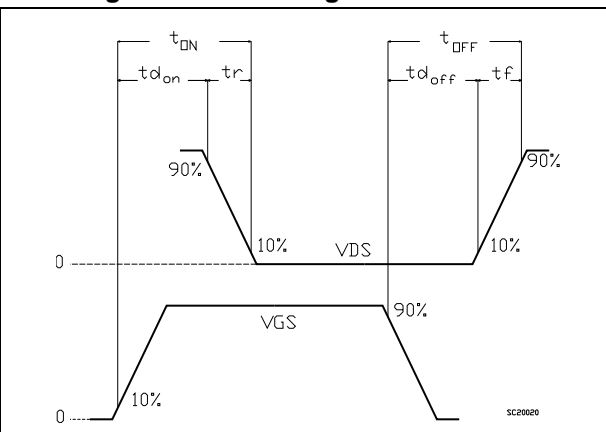


Figure 18. Switching time waveform





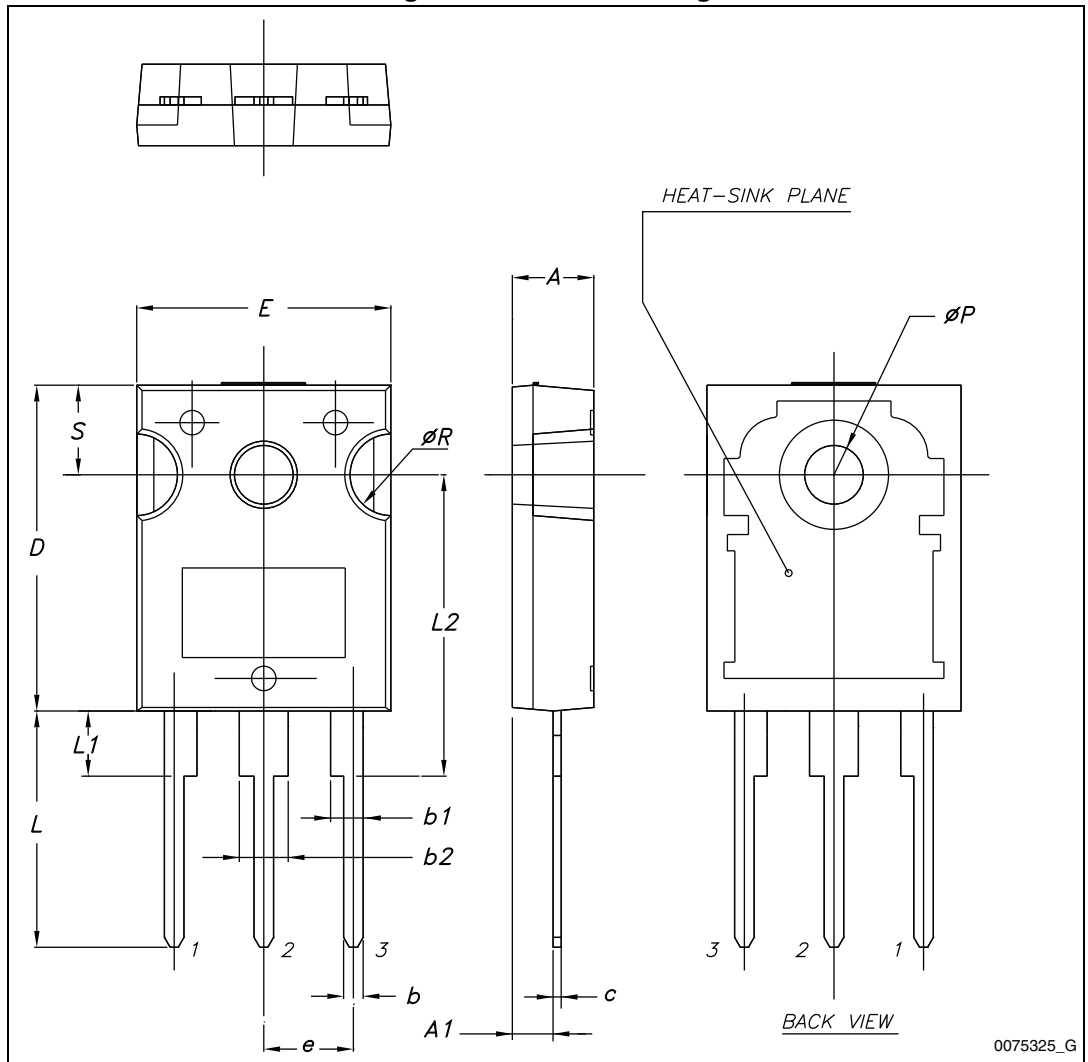
## 4 Package mechanical data

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<sup>®</sup> is an ST trademark.

Table 9. 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 19. TO-247 drawing



## 5 Revision history

Table 10. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 26-Apr-2012 | 1        | First release.   |
| 16-Apr-2013 | 2        | <ul style="list-style-type: none"><li>– Inserted: <a href="#">Section 2.1: Electrical characteristics (curves)</a></li><li>– Modified: <math>I_{AS}</math> value on <a href="#">Table 4</a></li><li>– Minor text changes</li></ul> |

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