

## N-channel 600 V, 1.5 $\Omega$ , 2.2 A MDmesh™ II Power MOSFET in a PowerFLAT™ 3.3 x 3.3 HV package

Datasheet - production data

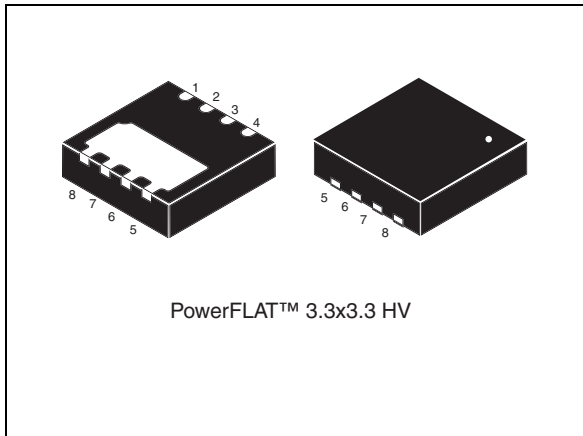
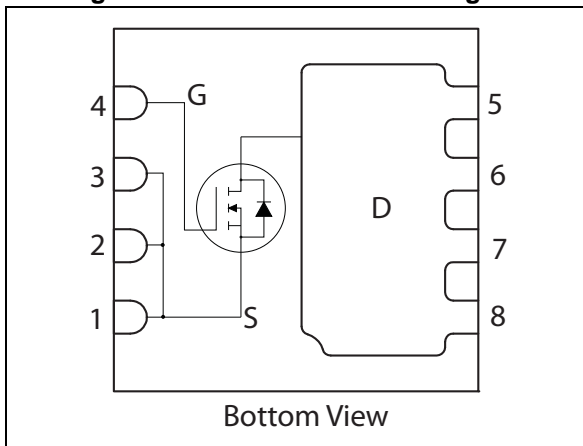


Figure 1. Internal schematic diagram



### Features

| Order code | $R_{DS(on)}$ max. | $I_D$ |
|------------|-------------------|-------|
| STL3NM60N  | 1.8 $\Omega$      | 2.2 A |

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

### Application

- 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 code | Marking | Package                 | Packaging     |
|------------|---------|-------------------------|---------------|
| STL3NM60N  | 3NM60N  | PowerFLAT™ 3.3 x 3.3 HV | Tape and reel |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol             | Parameter  | Value      | Unit |
|--------------------|--|------------|------|
| $V_{DS}$           | Drain-source voltage   | 600        | V    |
| $V_{GS}$           | Gate-source voltage  | $\pm 25$   | V    |
| $I_D^{(1)}$        | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$     | 2.2        | A    |
| $I_D^{(1)}$        | Drain current (continuous) at $T_C=100\text{ }^\circ\text{C}$      | 1.7        | A    |
| $I_D^{(2)}$        | Drain current (continuous) at $T_{amb} = 25\text{ }^\circ\text{C}$ | 0.65       | A    |
| $I_D^{(2)}$        | Drain current (continuous) at $T_{amb}=100\text{ }^\circ\text{C}$  | 0.5        | A    |
| $I_{DM}^{(2)(3)}$  | Drain current (pulsed)   | 2.6        | A    |
| $P_{TOT}^{(2)}$    | Total dissipation at $T_{amb} = 25\text{ }^\circ\text{C}$          | 2          | W    |
| $P_{TOT}^{(1)}$    | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$              | 22         | W    |
| $I_{AS}$           | Avalanche current, repetitive or not-repetitive <sup>(3)</sup>     | 1          | A    |
| $E_{AS}$           | Single pulse avalanche energy <sup>(4)</sup>                       | 119        | mJ   |
|                    | Derating factor <sup>(2)</sup>                                     | 0.016      | W/°C |
| $dv/dt^{(5)}$      | Peak diode recovery voltage slope                                  | 15         | V/ns |
| $T_J$<br>$T_{stg}$ | Operating junction temperature<br>storage temperature              | -55 to 150 | °C   |

1. The value is rated according  $R_{thj-case}$ .
2. When mounted on FR-4 board of 1inch<sup>2</sup>, 2oz Cu,  $t < 10$  sec
3. Pulse width limited by  $T_{jmax}$
4. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = I_{AS}$ ,  $V_{DD} = 50\text{V}$
5.  $I_{SD} \leq 2.2\text{ A}$ ,  $dv/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS\ peak} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal resistance**

| Symbol              | Parameter                             | Value | Unit |
|---------------------|---------------------------------------|-------|------|
| $R_{thj-case}$      | Thermal resistance junction-case max. | 5.6   | °C/W |
| $R_{thj-amb}^{(1)}$ | Thermal resistance junction-amb max.  | 62.5  | °C/W |

1. When mounted on FR-4 board of 1inch<sup>2</sup>, 2oz Cu,  $t < 10$  sec.

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 4. On/off states**

| Symbol        | Parameter                                      | Test conditions                                  | Min. | Typ. | Max.      | Unit          |
|---------------|--|--|------|------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ( $V_{GS}=0$ )  | $I_D = 1\text{ mA}$                              | 600  |      |           | V             |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS}=0$ ) | $V_{DS} = 600\text{ V}$ ,                        |      |      | 1         | $\mu\text{A}$ |
|               |  | $V_{DS} = 600\text{ V}$ , $T_C = 125^{\circ}C$   |      |      | 100       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS}=0$ )       | $V_{GS} = \pm 25\text{ V}$                       |      |      | $\pm 100$ | nA            |
| $V_{GS(th)}$  | Gate threshold voltage                         | $V_{DS}=V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$ | 2    | 3    | 4         | V             |
| $R_{DS(on)}$  | Static drain-source on resistance              | $V_{GS}=10\text{ V}$ , $I_D=1\text{ A}$          |      | 1.5  | 1.8       | $\Omega$      |

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|---|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 50\text{ V}$ , $f=1\text{ MHz}$ ,<br>$V_{GS}=0$                             | -    | 188  | -    | pF       |
| $C_{oss}$                  | Output capacitance            |   | -    | 13   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |   | -    | 1.1  | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Output equivalent capacitance | $V_{GS}=0$ , $V_{DS}=0$ to $480\text{ V}$   | -    | 100  | -    | pF       |
| $R_g$                      | Gate input resistance         | $f = 1\text{ MHz}$ gate DC bias=0<br>test signal level = $20\text{ mV}$<br>open drain | -    | 6    | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD}=480\text{ V}$ , $I_D = 2.2\text{ A}$  | -    | 9.5  | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            | $V_{GS}=10\text{ V}$  | -    | 1.6  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             | (see <a href="#">Figure 15</a> )  | -    | 5.3  | -    | nC       |

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%  $V_{DSS}$

Table 6. Switching times

| Symbol       | Parameter           | Test conditions  | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 1.1\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14</a> ) | -    | 8.6  | -    | ns   |
| $t_r$        | Rise time           |  | -    | 6.2  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |  | -    | 20.8 | -    | ns   |
| $t_f$        | Fall time           |  | -    | 20   | -    | ns   |

Table 7. Source drain diode

| Symbol          | Parameter                     | Test conditions   | Min | Typ. | Max | Unit |
|-----------------|-------------------------------|---|-----|------|-----|------|
| $I_{SD}$        | Source-drain current          |   | -   |      | 2.2 | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   | -   |      | 8.8 | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 2.2\text{ A}$ , $V_{GS} = 0$  | -   |      | 1.6 | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.2\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$<br>(see <a href="#">Figure 16</a> )                                     | -   | 168  |     | ns   |
| $Q_{rr}$        | Reverse recovery charge       |   | -   | 672  |     | nC   |
| $I_{RRM}$       | Reverse recovery current      |   | -   | 8    |     | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.2\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 16</a> ) | -   | 2.3  |     | ns   |
| $Q_{rr}$        | Reverse recovery charge       |   | -   | 913  |     | nC   |
| $I_{RRM}$       | Reverse recovery current      |   | -   | 9    |     | 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

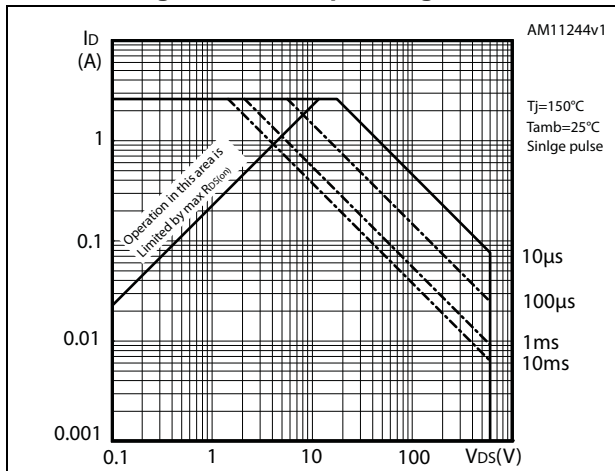


Figure 3. Thermal impedance

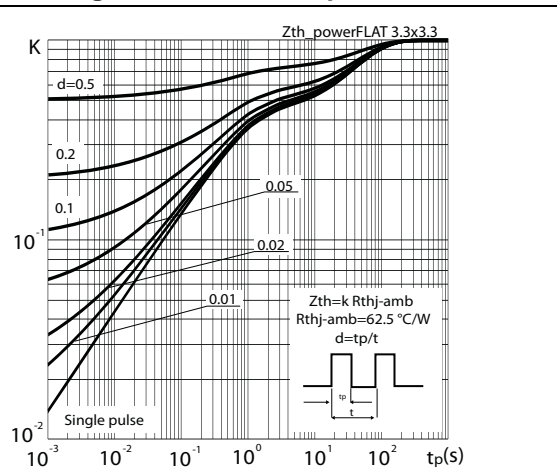


Figure 4. Output characteristics

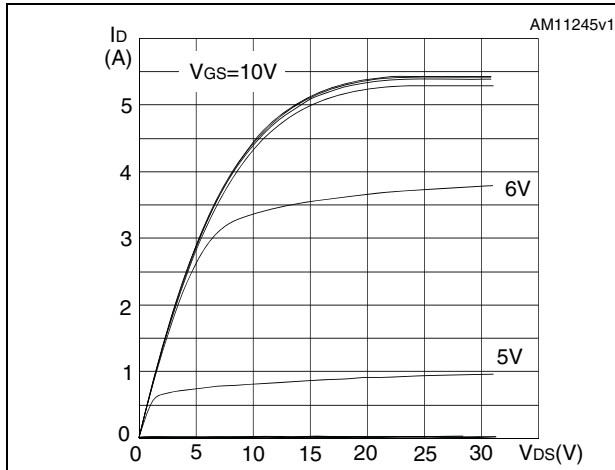


Figure 5. Transfer characteristics

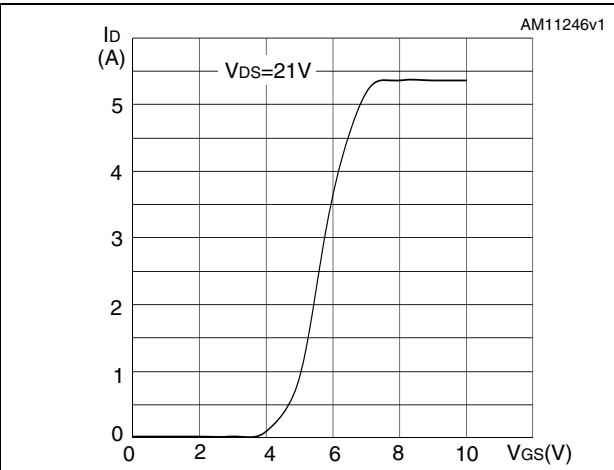


Figure 6. Gate charge vs gate-source voltage

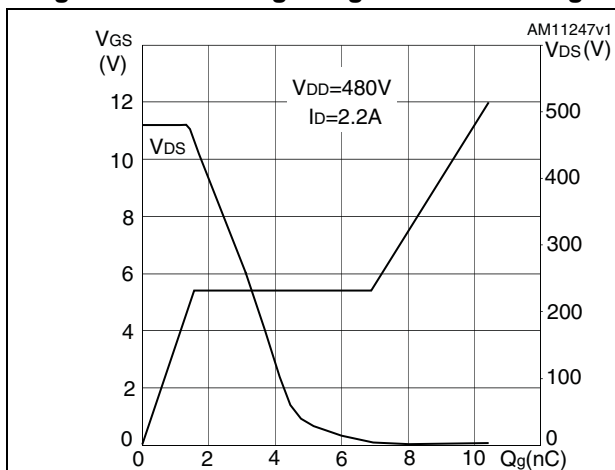


Figure 7. Static drain-source on resistance

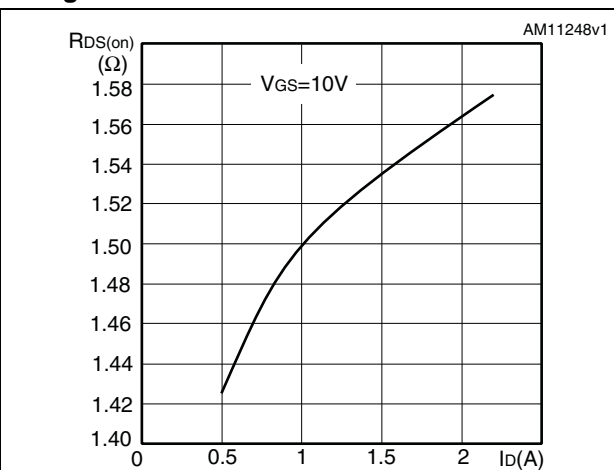


Figure 8. Capacitance variations

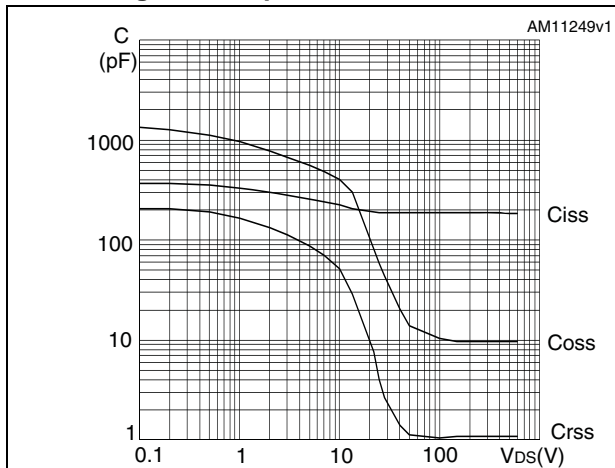


Figure 9. Output capacitance stored energy

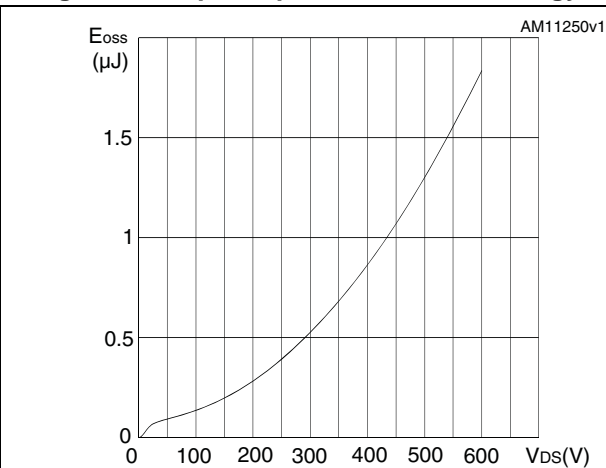


Figure 10. Normalized gate threshold voltage vs temperature

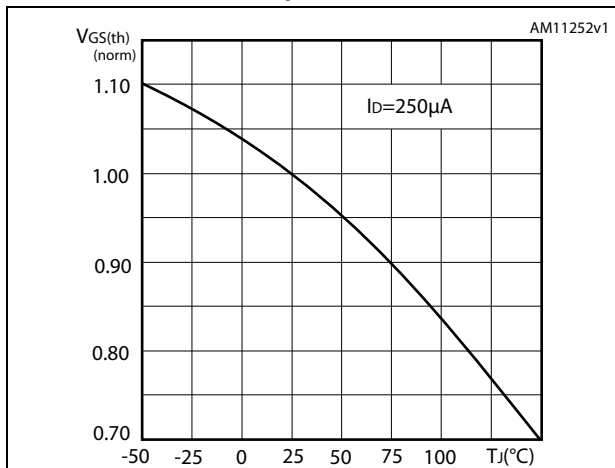


Figure 11. Normalized on resistance vs temperature

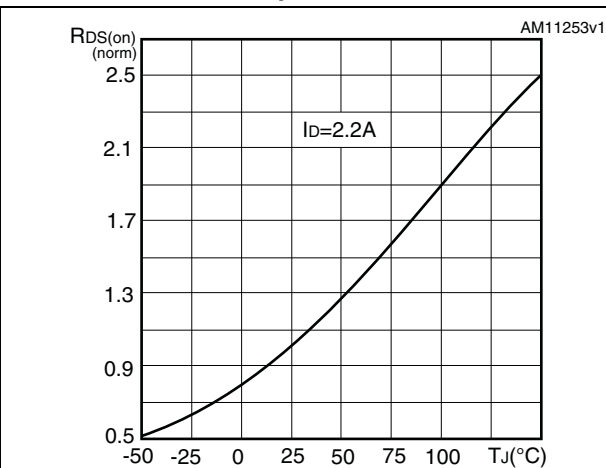


Figure 12. Normalized V(BR)DSS vs temperature

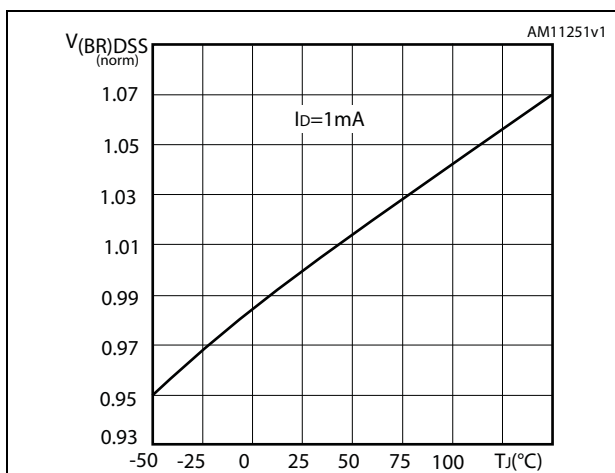
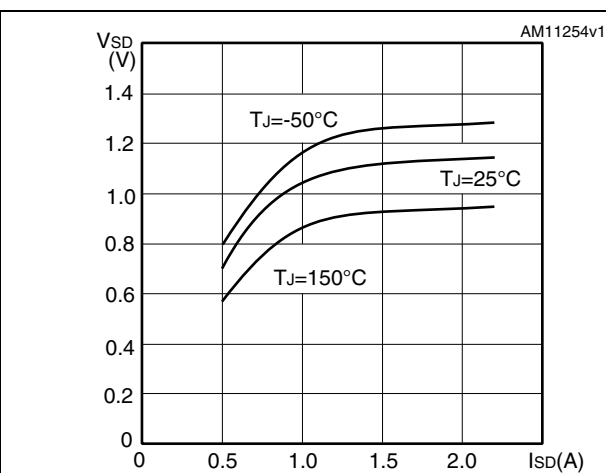


Figure 13. Source-drain diode forward characteristics



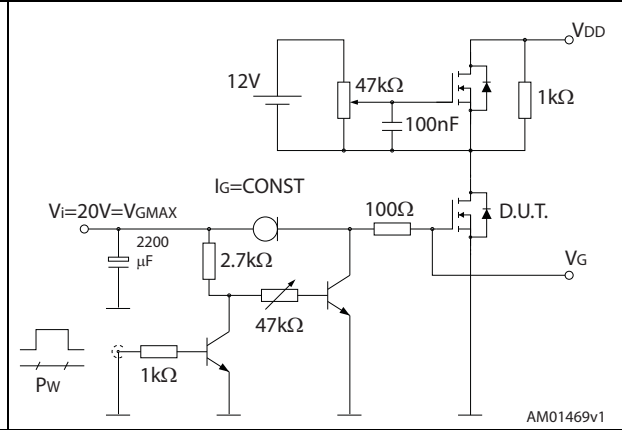
### 3 Test circuits

Figure 14. Switching times test circuit for resistive load



AM01468v1

Figure 15. Gate charge test circuit



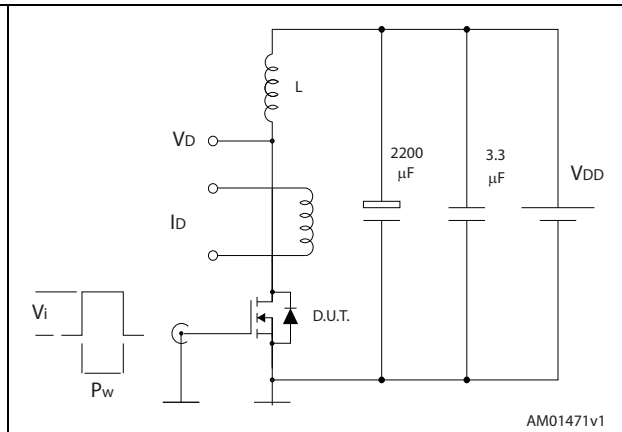
AM01469v1

Figure 16. Test circuit for inductive load switching and diode recovery times



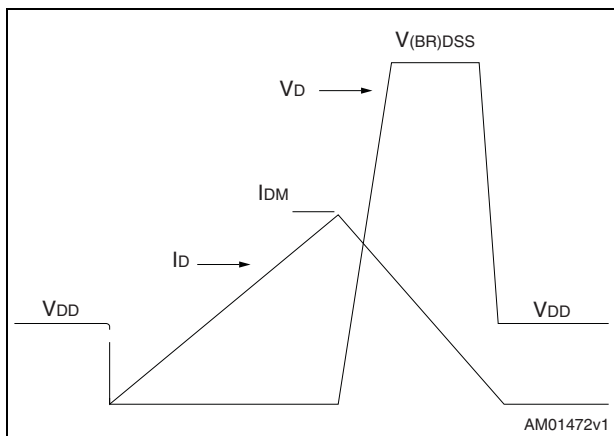
AM01470v1

Figure 17. Unclamped inductive load test circuit



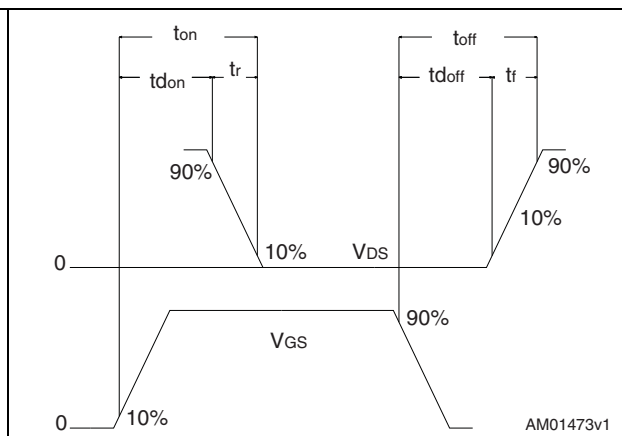
AM01471v1

Figure 18. Unclamped inductive waveform



AM01472v1

Figure 19. Switching time waveform



AM01473v1



## 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.

Figure 20. PowerFLAT™ 3.3 x 3.3 HV drawing

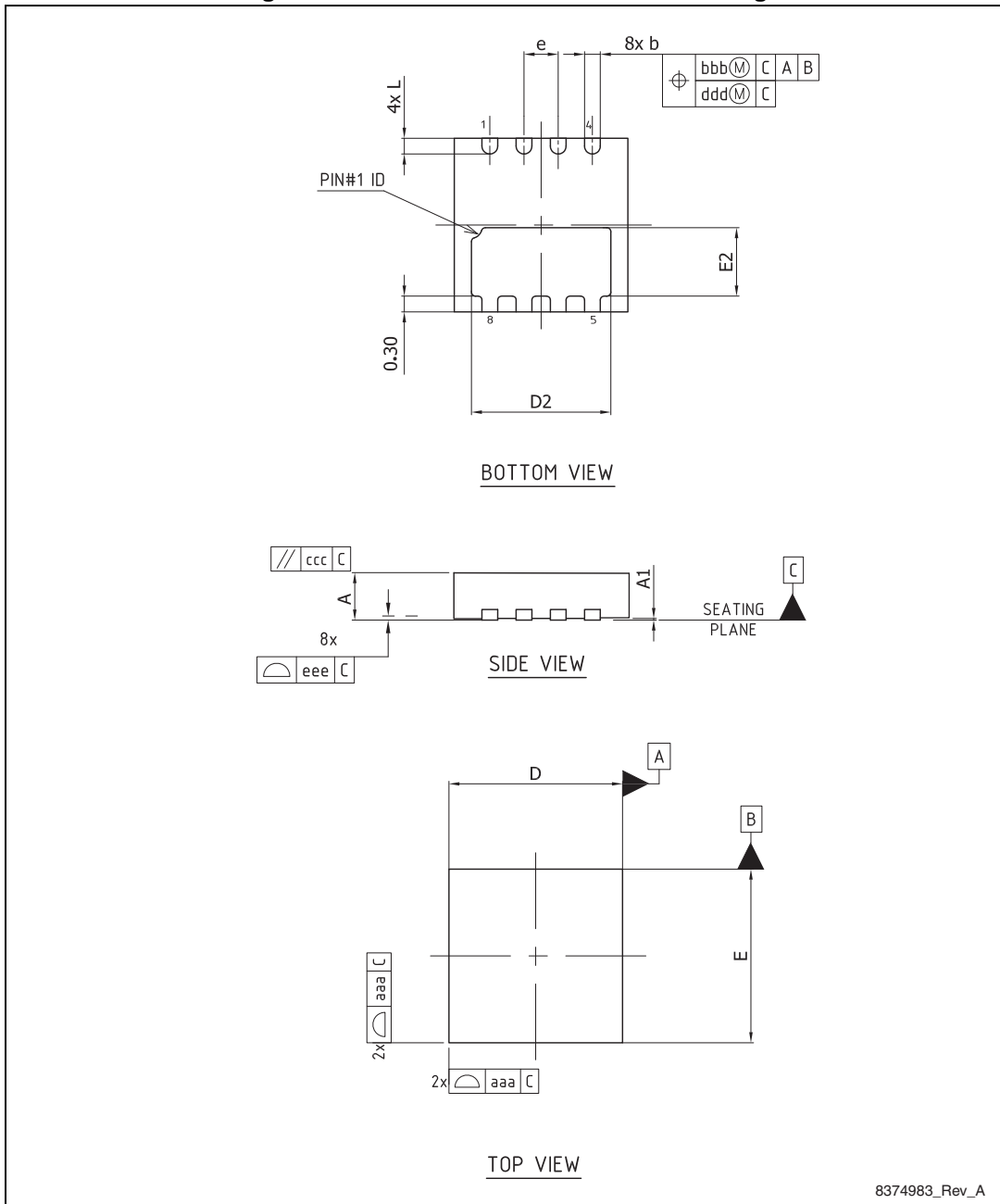
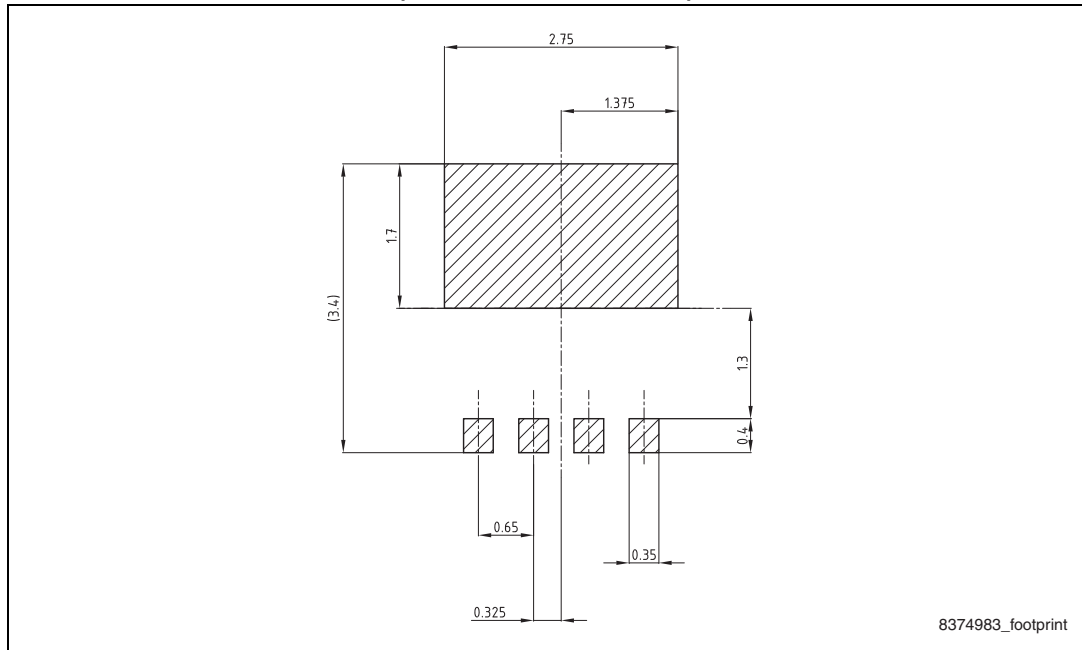


Table 8. PowerFLAT™ 3.3 x 3.3 HV mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 0.80 | 0.90 | 1.00 |
| A1   | 0    | 0.02 | 0.05 |
| b    | 0.25 | 0.30 | 0.40 |
| D    |      | 3.30 |      |
| D2   | 2.50 | 2.65 | 2.75 |
| E    |      | 3.30 |      |
| E2   | 1.15 | 1.30 | 1.40 |
| e    |      | 0.65 |      |
| L    | 0.20 | 0.30 | 0.40 |
| aaa  |      | 0.10 |      |
| bbb  |      | 0.10 |      |
| ccc  |      | 0.10 |      |
| ddd  |      | 0.05 |      |
| eee  |      | 0.08 |      |

Figure 21. PowerFLAT™ 3.3 x 3.3 HV recommended footprint (dimensions are in mm)



## 5 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 12-Mar-2012 | 1        | First release.  |
| 19-Nov-2014 | 2        | Document status changed from preliminary to production data.<br>Updated <a href="#">Figure 1.: Internal schematic diagram</a> , <a href="#">Figure 2.: Safe operating area</a> , <a href="#">Figure 3.: Thermal impedance</a> and <a href="#">Figure 12.: Normalized <math>V_{(BR)DSS}</math> vs temperature</a> .<br>Updated <a href="#">Table 5.: Dynamic</a> and <a href="#">Table 7.: Source drain diode</a> .<br>Minor text changes. |

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