



STY139N65M5

N-channel 650 V, 0.014 Ω typ., 130 A, MDmesh™ V Power MOSFET in Max247 package

Datasheet — production data

Features

| Order code | V_{DS} @ T_{jMAX} | $R_{DS(on)}$ max | I_D |
|-------------|--------------------------|------------------|-------|
| STY139N65M5 | 710 V | 0.017 Ω | 130 A |

- Max247 worldwide best $R_{DS(on)}$
- Higher V_{DSS} rating
- Higher dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% avalanche tested

Applications

- Switching applications

Description

The device is an 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.

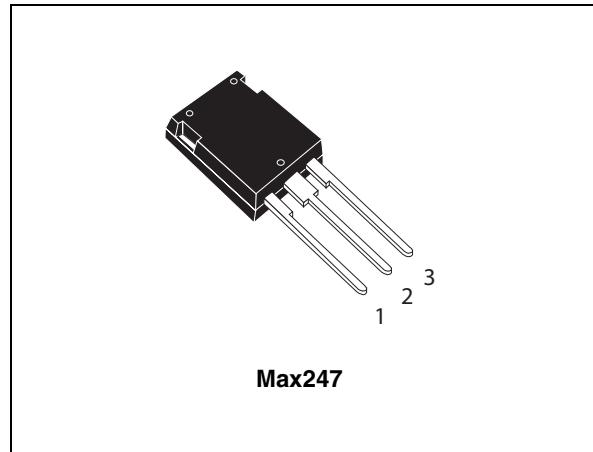


Figure 1. Internal schematic diagram

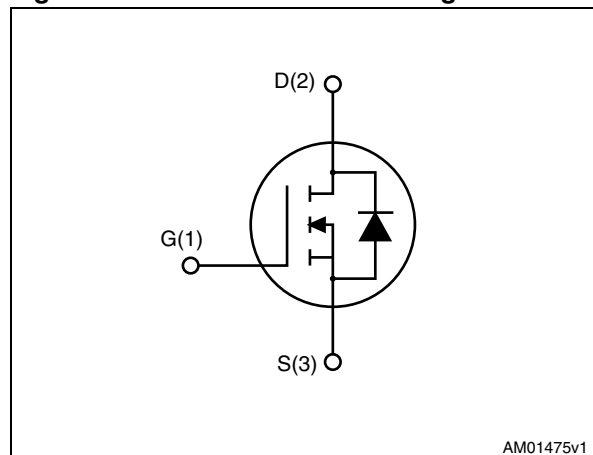


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|-------------|----------|---------|-----------|
| STY139N65M5 | 139N65M5 | Max247 | Tube |

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 4 |
| | 2.1 Electrical characteristics (curves) | 6 |
| 3 | Test circuits | 8 |
| 4 | Package mechanical data | 9 |
| 5 | Revision history | 12 |

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 $T_C = 25\text{ }^\circ\text{C}$ | 130 | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 78 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 520 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 625 | W |
| I_{AR} | Max current during repetitive or single pulse avalanche (pulse width limited by T_{JMAX}) | 17 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{V}$) | 2400 | mJ |
| $dv/dt^{(2)}$ | 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. $I_{SD} \leq 130\text{ A}$, $di/dt = 400\text{ A}/\mu\text{s}$, $V_{DD} = 400\text{ V}$, peak $V_{DS} < V_{(BR)DSS}$.

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|----------------|--|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 0.2 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 30 | $^\circ\text{C}/\text{W}$ |
| T_l | Maximum lead temperature for soldering purpose | 300 | $^\circ\text{C}$ |

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 ($V_{GS} = 0$) | $V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}$ | | | 10 100 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 25\text{ V}$ | | | ± 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 | $V_{GS} = 10\text{ V}$, $I_D = 65\text{ A}$ | | 0.014 | 0.017 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|---|------|-------------------|------|----------------|
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 15600 365 9 | - | pF pF pF |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related | $V_{GS} = 0$, $V_{DS} = 0\text{ to }520\text{ V}$ | - | 1559 | - | pF |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | $V_{GS} = 0$, $V_{DS} = 0\text{ to }520\text{ V}$ | - | 360 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 1.2 | - | Ω |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 520\text{ V}$, $I_D = 65\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 15) | - | 363 88 164 | - | nC nC 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 | $V_{DD} = 400\text{ V}$, $I_D = 80\text{ A}$, | | 295 | | ns |
| $t_{r(v)}$ | Voltage rise time | $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ | | 56 | | ns |
| $t_{f(i)}$ | Current fall time | (see Figure 16) | - | 37 | - | ns |
| $t_{c(off)}$ | Crossing time | (see Figure 19) | | 84 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | | | 130 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 520 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 130\text{ A}$, $V_{GS} = 0$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 130\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | | 570 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$ (see Figure 16) | - | 15 | | μC |
| I_{RRM} | Reverse recovery current | | | 53 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 130\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | | 720 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ | - | 24 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 16) | | 68 | | A |

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

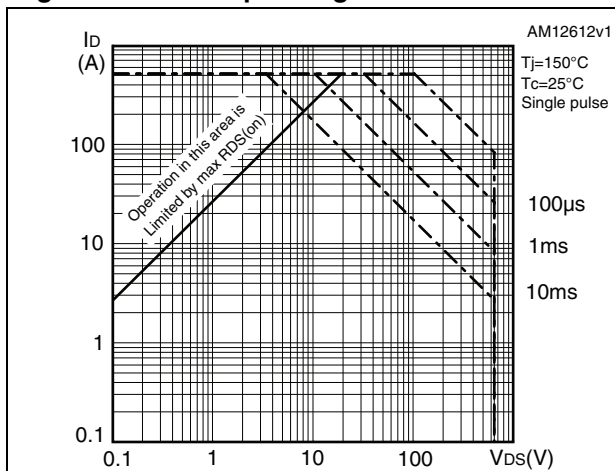


Figure 3. Thermal impedance

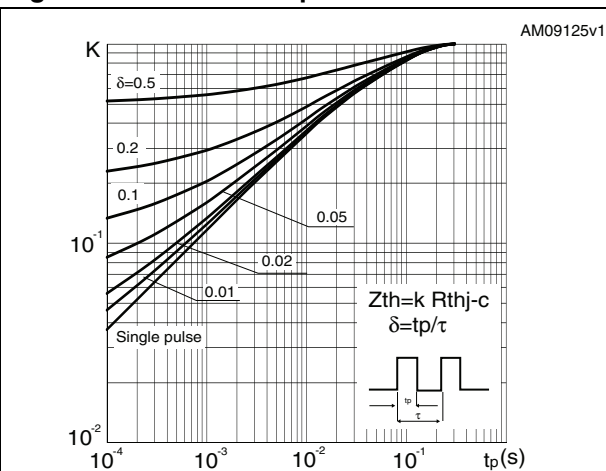


Figure 4. Output characteristics

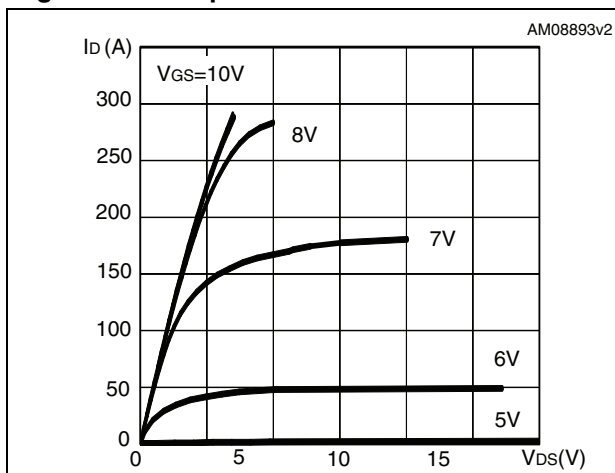


Figure 5. Transfer characteristics

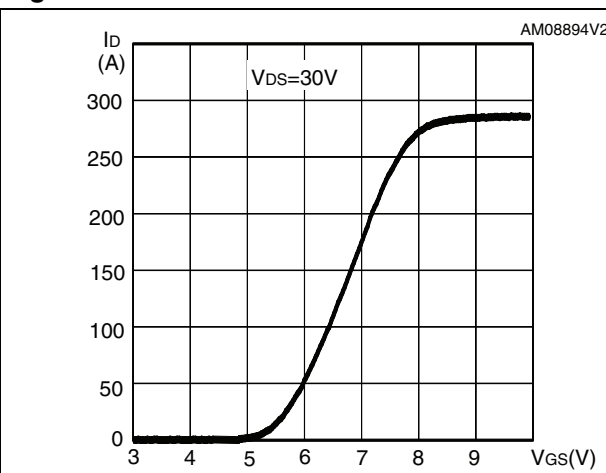


Figure 6. Normalized $B_{V_{DS}}$ vs temperature

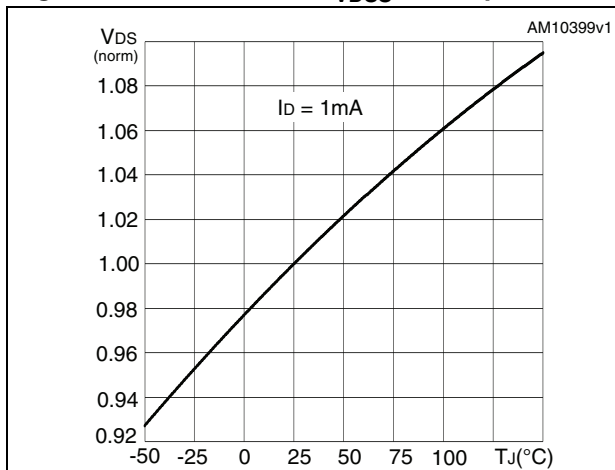


Figure 7. Static drain-source on resistance

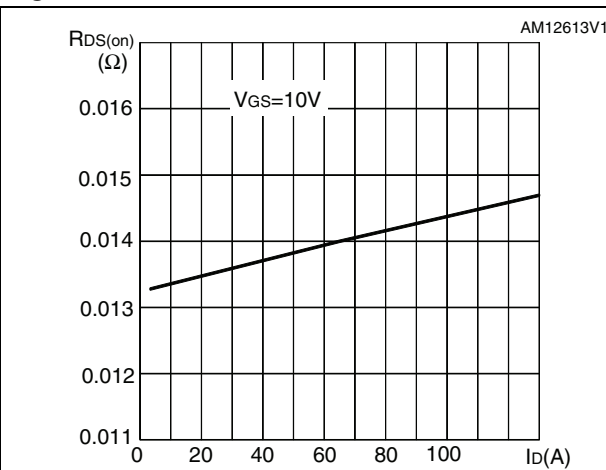


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

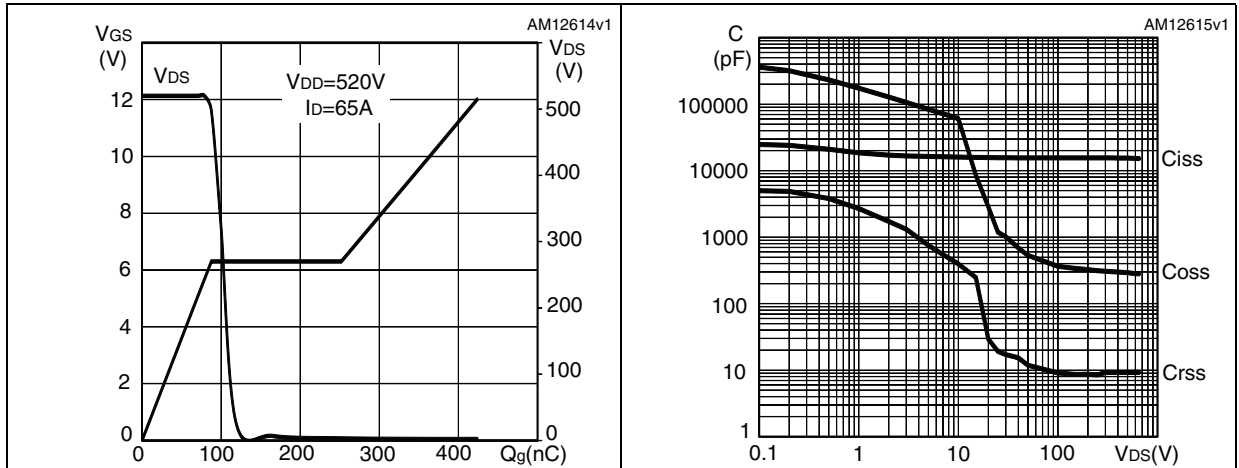


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

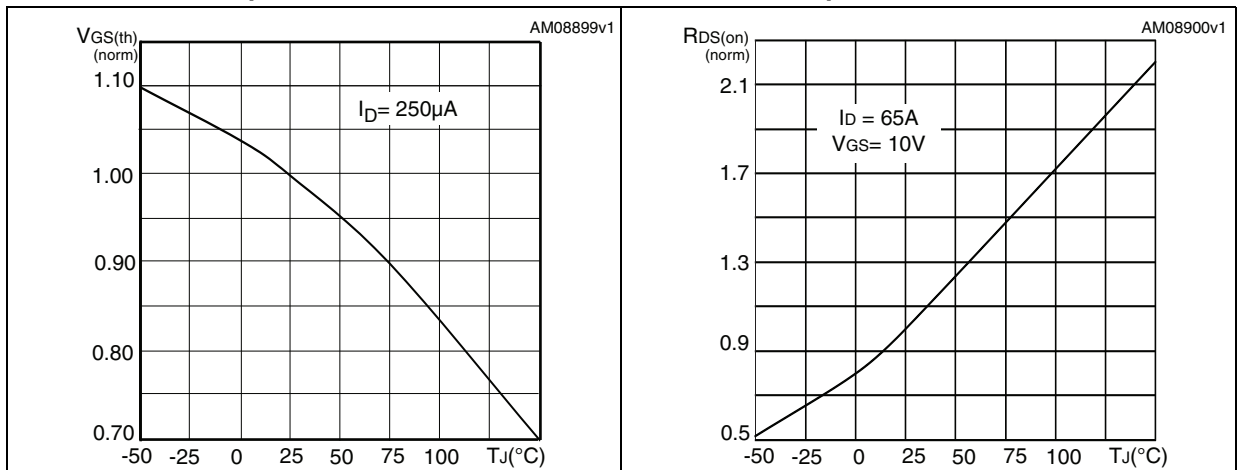
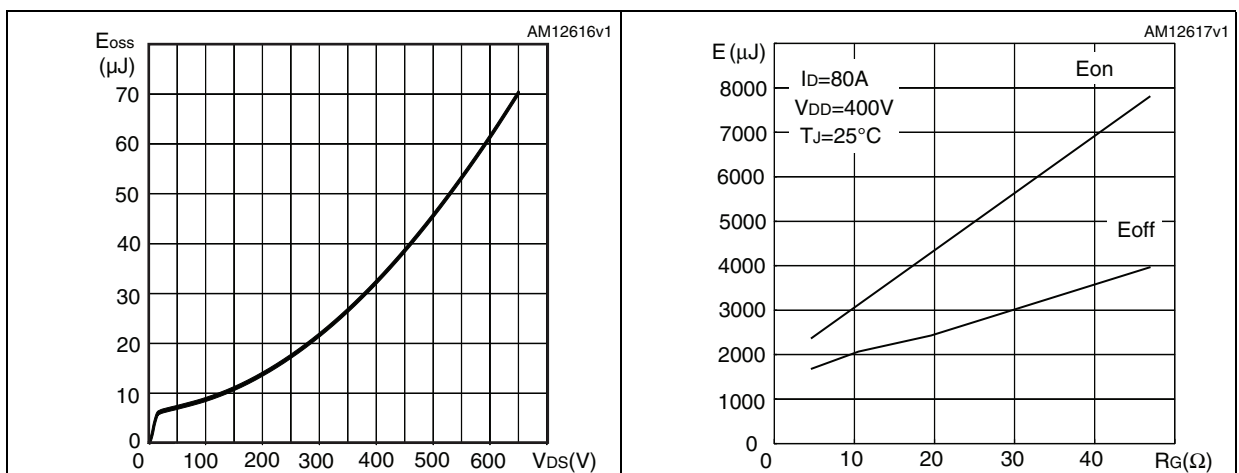


Figure 12. Output capacitance stored energy Figure 13. Switching losses vs gate resistance (1)



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

3 Test circuits

Figure 14. Switching times test circuit for resistive load

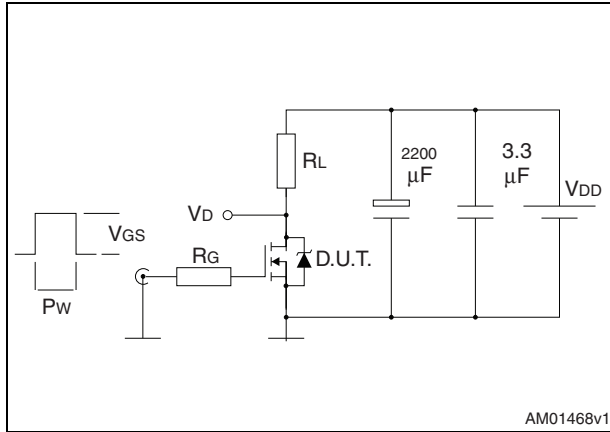


Figure 15. Gate charge test circuit

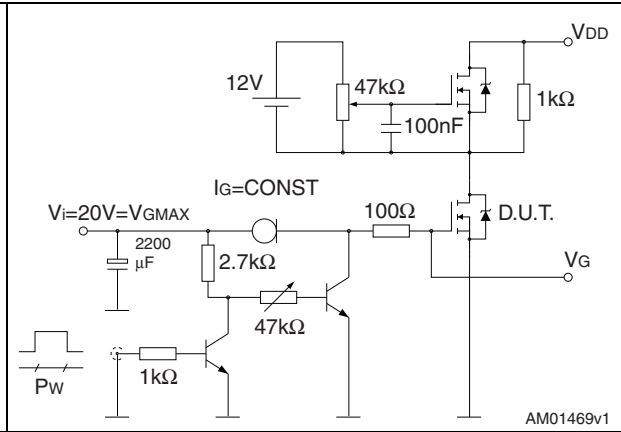


Figure 16. Test circuit for inductive load switching and diode recovery times

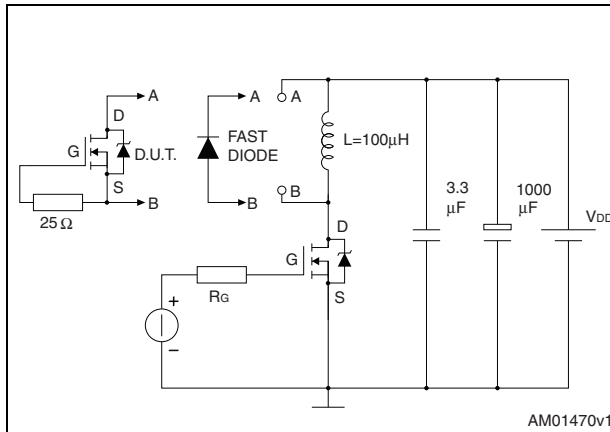


Figure 17. Unclamped inductive load test circuit

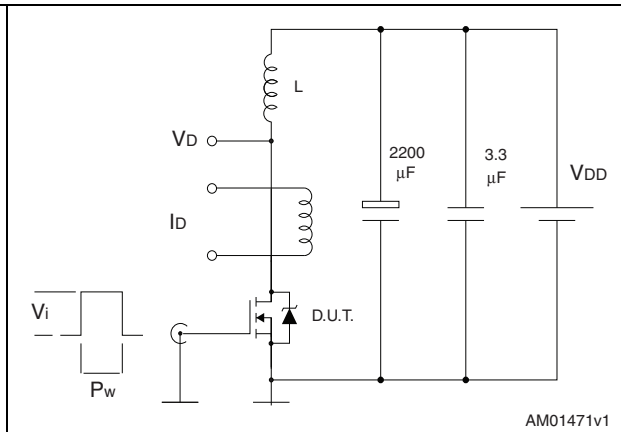


Figure 18. Unclamped inductive waveform

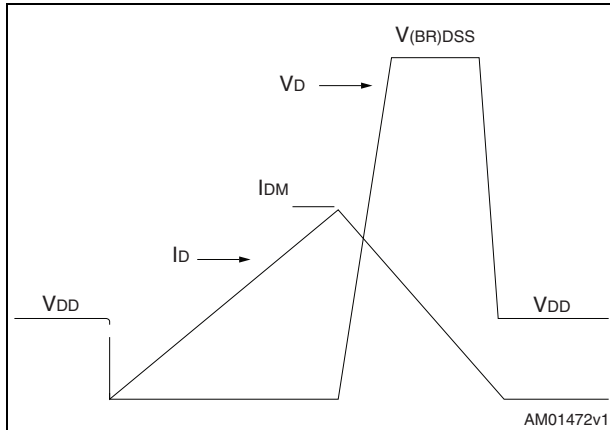
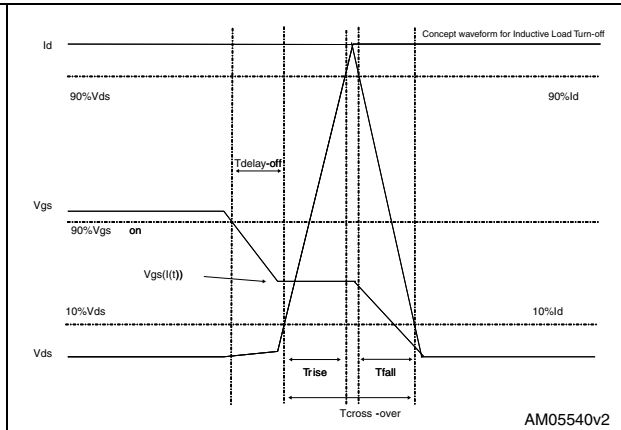


Figure 19. Switching time waveform



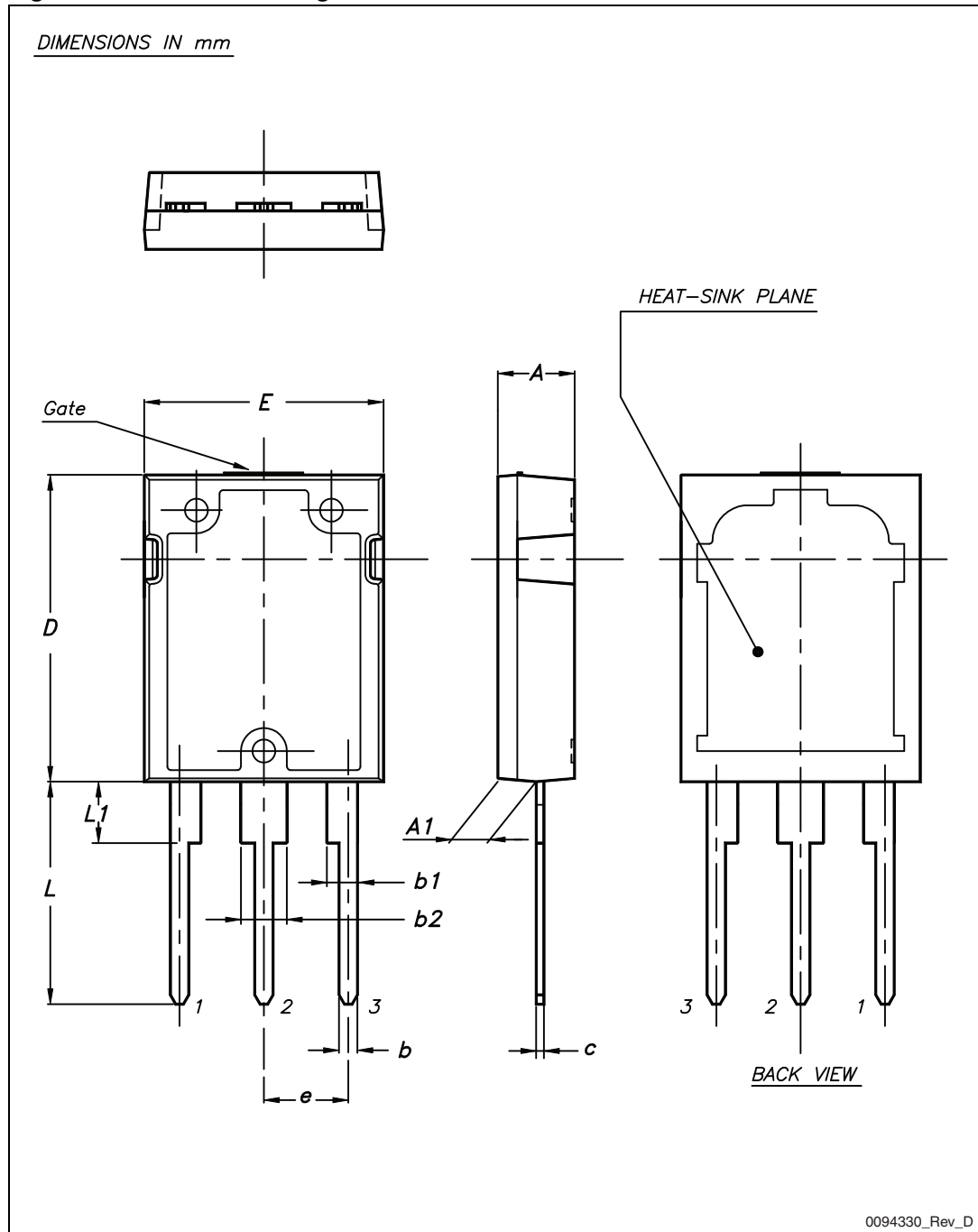
4 Package mechanical data

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. ECOPACK[®] is an ST trademark.

Table 8. Max247 mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.70 | | 5.30 |
| A1 | 2.20 | | 2.60 |
| b | 1.00 | | 1.40 |
| b1 | 2.00 | | 2.40 |
| b2 | 3.00 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.70 | | 20.30 |
| e | 5.35 | | 5.55 |
| E | 15.30 | | 15.90 |
| L | 14.20 | | 15.20 |
| L1 | 3.70 | | 4.30 |

Figure 20. Max247 drawing



5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 09-Mar-2012 | 1 | First release. |
| 04-Apr-2012 | 2 | Inserted new Section 2.1: Electrical characteristics (curves) . Updated Section 4: Package mechanical data . |
| 19-Apr-2012 | 3 | Document promoted from preliminary data to production data. Updated Section 4: Package mechanical data . |
| 24-Jan-2013 | 4 | – Minor text changes – Modified: I_{AR} E_{AS} values on Table 2 |

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY TWO AUTHORIZED ST REPRESENTATIVES, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

