# STY145N65M5

## N-channel 650 V, 0.012 Ω typ., 138 A MDmesh™ M5 Power MOSFET in a Max247 package

Datasheet - production data

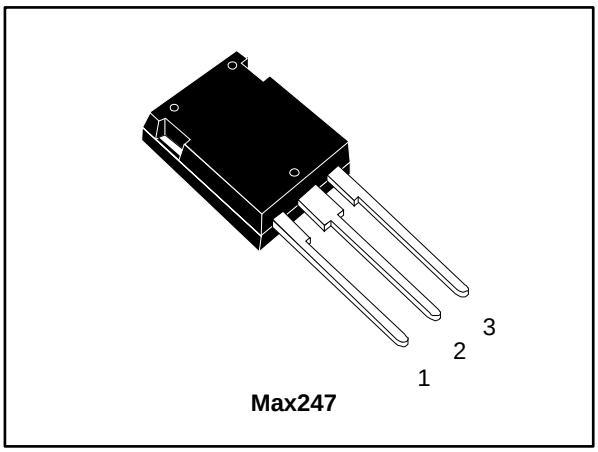
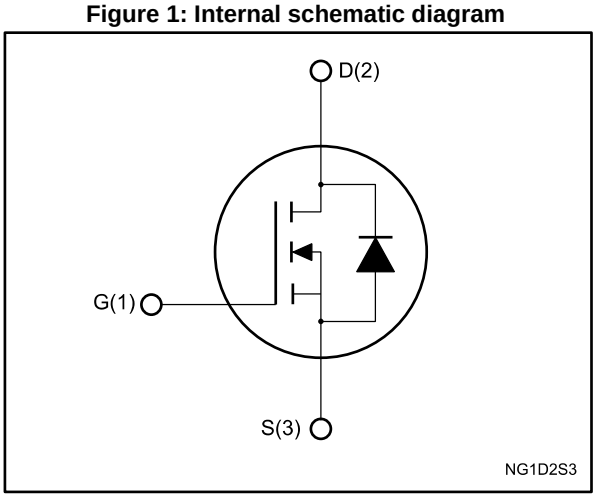



**Figure 1: Internal schematic diagram**




## Features

| Order code | $V_{DS}$ @ $T_{Jmax}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STY145N65M5 | 710 V | 0.015 Ω | 138 A |

- Extremely low $R_{DS(on)}$
- Low gate charge and input capacitance
- Excellent switching performance
- 100% avalanche tested

## Applications

- Switching applications

## Description

This device is an N-channel Power MOSFET based on the MDmesh™ M5 innovative vertical process technology combined with the well-known PowerMESH™ horizontal layout. The resulting product offers extremely low on-resistance, making it particularly suitable for applications requiring high power and superior efficiency.

**Table 1: Device summary**

| Order code | Marking | Package | Packaging |
|---|---|---|---|
| STY145N65M5 | 145N65M5 | Max247 | Tube |



This is information on a product in full production.

# Contents

# 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 °C | 138 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 87 | A |
| $I_{DM}$ (1) | Drain current (pulsed) | 552 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 625 | W |
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$) | 12 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 2420 | 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 | |

**Notes:**

(1)Pulse width limited by safe operating area.

(2)$I_{SD}$ ≤ 138 A, di/dt ≤ 400 A/µs; $V_{DS(peak)}$ < $V_{(BR)DSS}$, $V_{DD}$ = 400 V.

**Table 3: Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 0.2 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient max | 30 | °C/W |

# 2 Electrical characteristics

$T_C$ = 25 °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 V, $I_D$ = 1 mA | 650 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 650 V | | | 10 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 650 V, $T_C$ = 125 °C | | | 100 | µA |
| $I_{GSS}$ | Gate-body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±25 V | | | ±100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 69 A | | 0.012 | 0.015 | Ω |

**Table 5: Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$= 100 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 18500 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 413 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 11 | - | pF |
| $C_{o(er)}$ (1) | Equivalent output capacitance energy related | $V_{GS}$ = 0, $V_{DS}$ = 0 to 520 V | - | 415 | - | pF |
| $C_{o(tr)}$ (2) | Equivalent output capacitance time related | | - | 1950 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, open drain | - | 0.7 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 520 V, $I_D$ = 69 A, $V_{GS}$ = 10 V (see *Figure 15: "Test circuit for gate charge behavior"*) | - | 414 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 114 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 164 | - | nC |

**Notes:**

(1) $C_{o(er)}$ is defined as a constant equivalent capacitance giving the same stored energy as $C_{oss}$ when $V_{DS}$ increases from 0 to 80% $V_{DSS}$

(2) $C_{o(tr)}$ 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 |
|---|---|---|---|---|---|---|
| $t_{d(V)}$ | Voltage delay time | $V_{DD}$ = 400 V, $I_D$ = 85 A $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 16: "Test circuit for inductive load switching and diode recovery times"* and *Figure 19: "Switching time waveform"*) | - | 255 | - | ns |
| $t_{r(V)}$ | Voltage rise time | | - | 11 | - | ns |
| $t_{f(i)}$ | Current fall time | | - | 82 | - | ns |
| $t_{C(off)}$ | Crossing time | | - | 88 | - | ns |

**Table 7: Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 138 | A |
| $I_{SDM}$, (1) | Source-drain current (pulsed) | | - | | 552 | A |
| $V_{SD}$ (2) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 138 A | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 138 A, di/dt = 100 A/µs, $V_{DD}$ = 100 V (see *Figure 16: "Test circuit for inductive load switching and diode recovery times"*) | - | 568 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 14.5 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 51 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 138 A, di/dt = 100 A/µs, $V_{DD}$ = 100 V, $T_j$ = 150 °C (see *Figure 16: "Test circuit for inductive load switching and diode recovery times"*) | - | 728 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 24.5 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 67 | | A |

**Notes:**

(1)Pulse width is limited by safe operating area

(2)Pulsed: pulse duration = 300 µs, duty cycle 1.5%

## 2.2 Electrical characteristics (curves)

**Figure 2: Safe operating area**

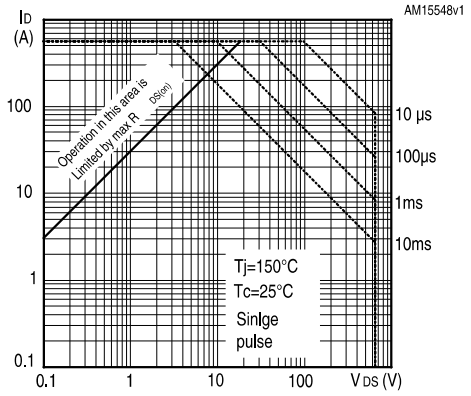



**Figure 3: Thermal impedance**

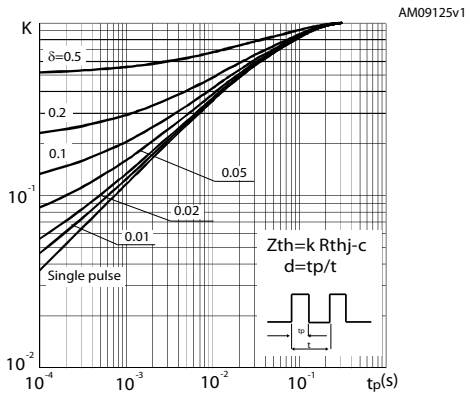



**Figure 4: Output characteristics**

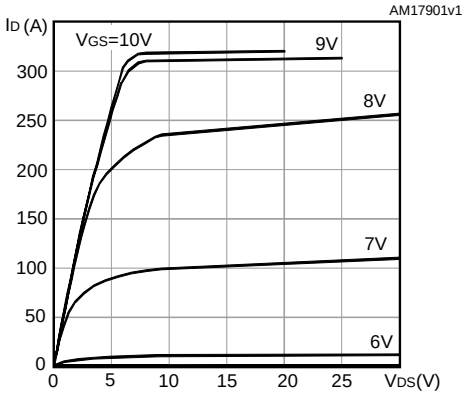



**Figure 5: Transfer characteristics**

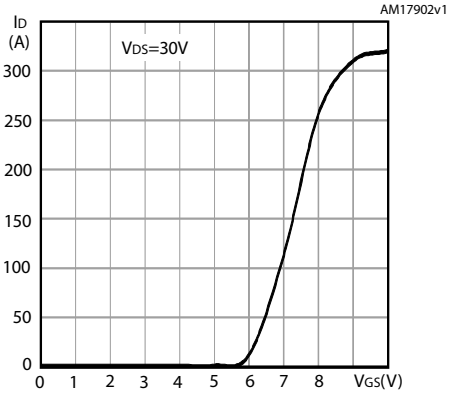



**Figure 6: Gate charge vs gate-source voltage**

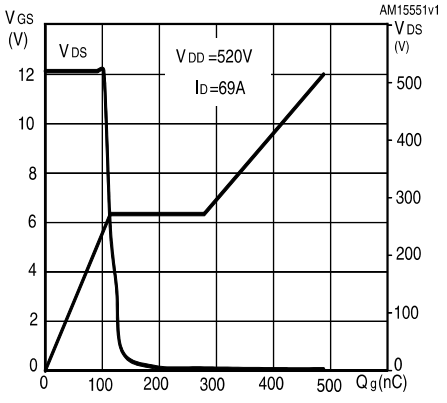



**Figure 7: Static drain-source on-resistance**

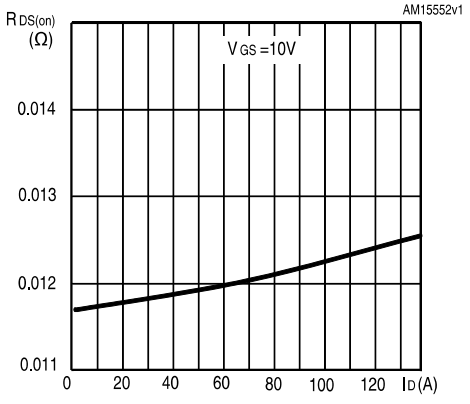


**Figure 8: Capacitance variations**

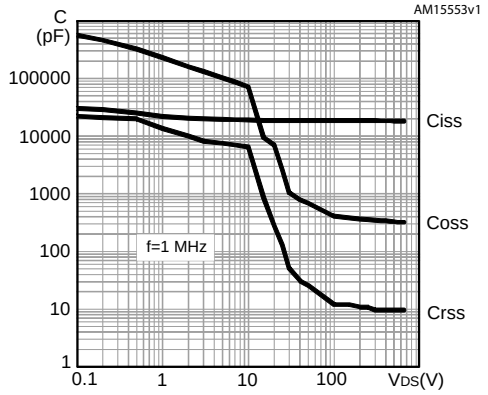



**Figure 9: Normalized gate threshold voltage vs temperature**

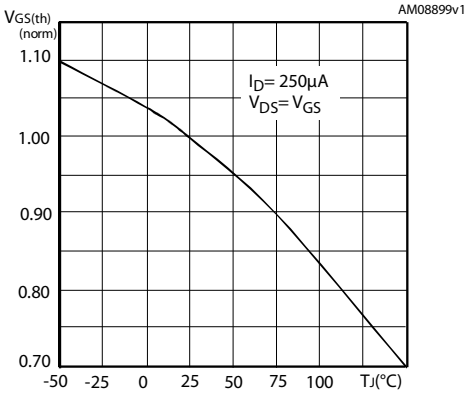



**Figure 10: Normalized on-resistance vs temperature**

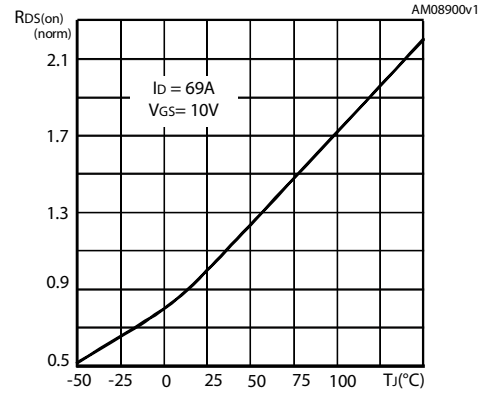



**Figure 11: Normalized $V_{(BR)DSS}$ vs temperature**

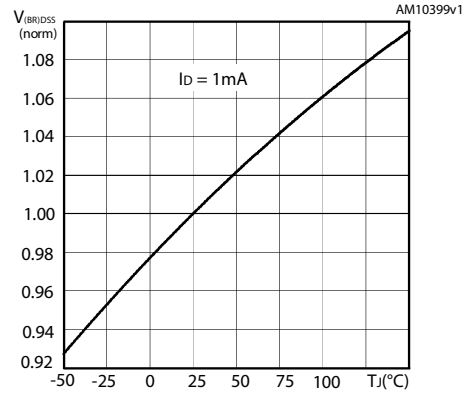



**Figure 12: Output capacitance stored energy**

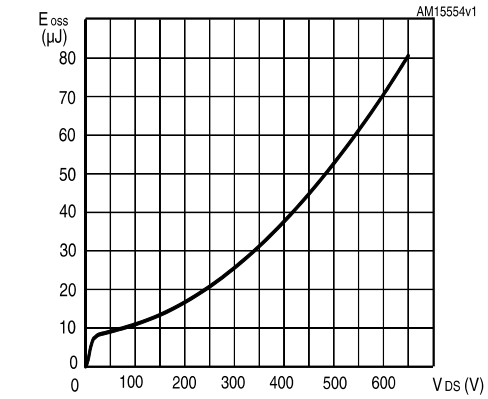
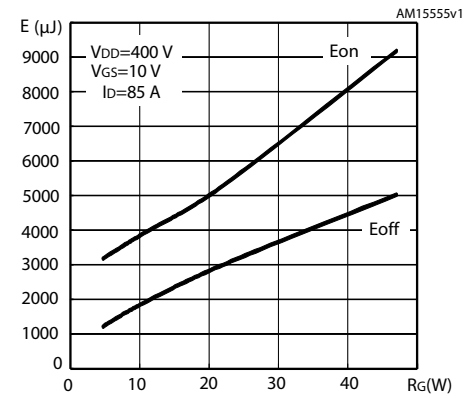



**Figure 13: Switching losses vs gate resistance**




The previous figure $E_{on}$ includes reverse recovery of a SiC diode.

# 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**

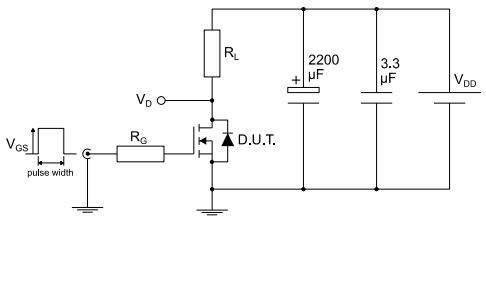



**Figure 15: Test circuit for gate charge behavior**

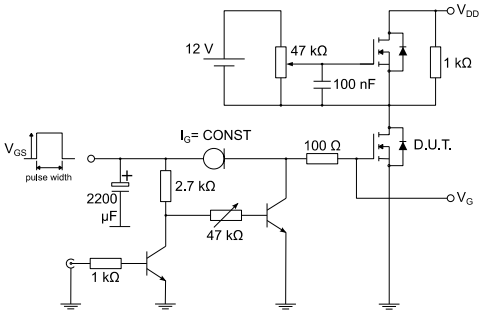



**Figure 16: Test circuit for inductive load switching and diode recovery times**

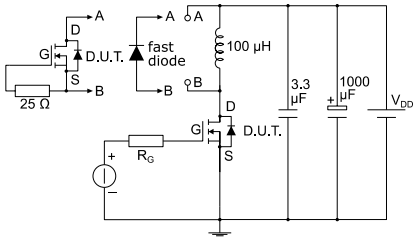



**Figure 17: Unclamped inductive load test circuit**

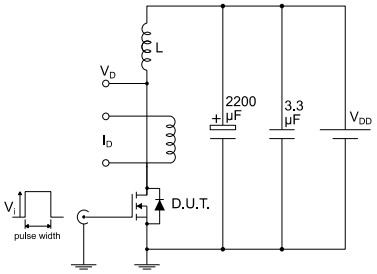



**Figure 18: Unclamped inductive waveform**

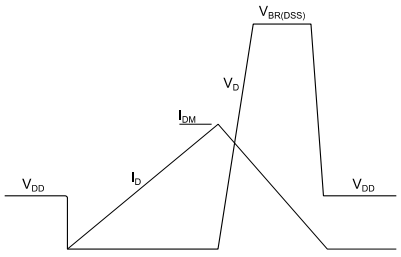
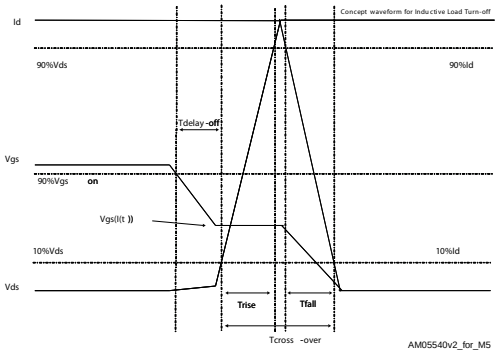



**Figure 19: Switching time waveform**



# 4 Package information

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.

## 4.1 Max247 package information

**Figure 20: Max247 package outline**

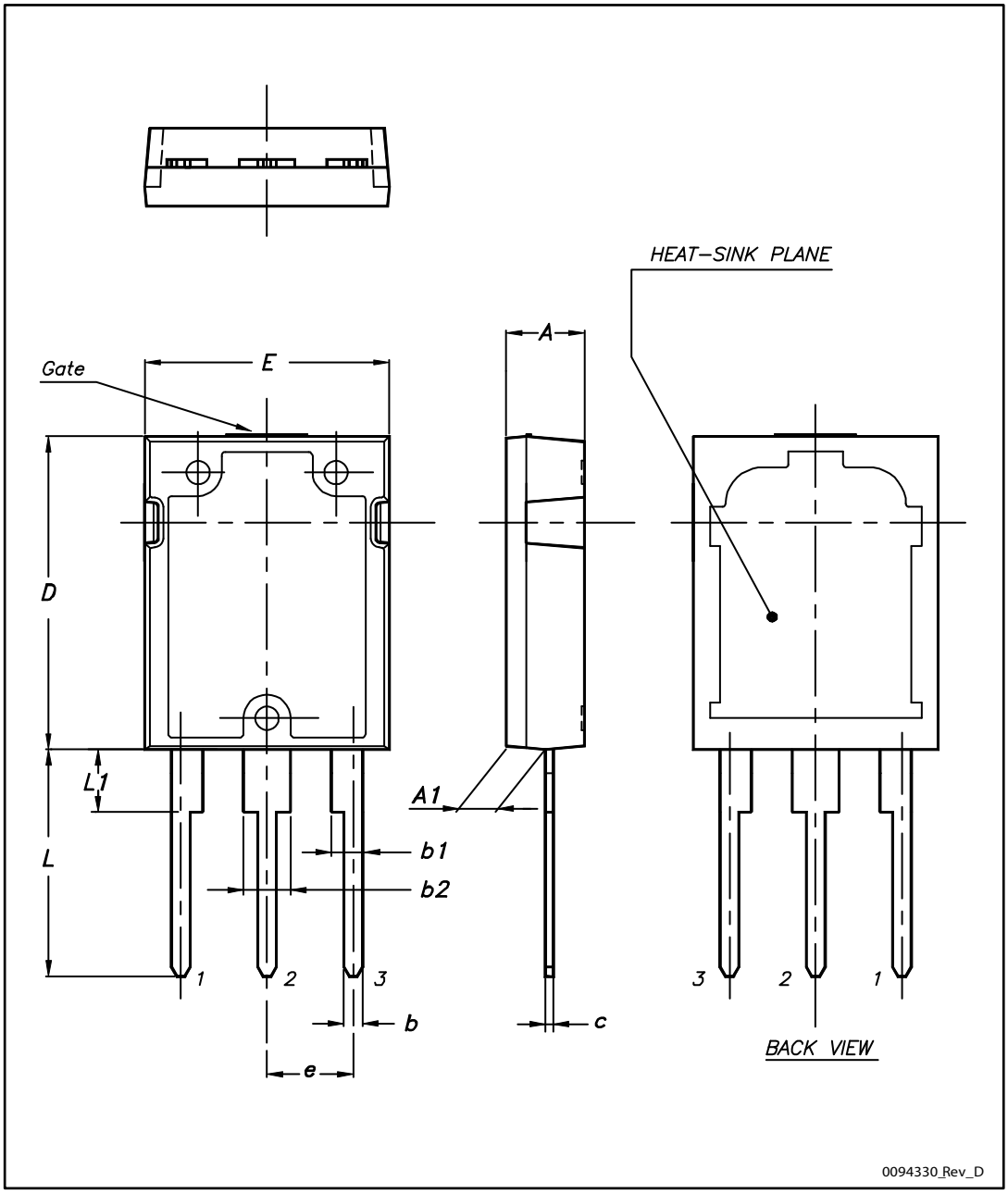


Table 8: Max247 package mechanical data

| 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 |

# 5 Revision history

Table 9: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 25-Sep-2012 | 1 | First release. |
| 17-Jan-2013 | 2 | Modified: $I_{AR}$ and $E_{AS}$ values<br>Modified: typical values on Table 5, 6 and 7 |
| 13-Nov-2015 | 3 | Updated title, features and description on cover page.<br>Document status promoted from preliminary to production data.<br>Modified: *Table 2: "Absolute maximum ratings"* and *Table 3: "Thermal data"*<br>Updated: *Figure 4: "Output characteristics"* and *Figure 5: "Transfer characteristics"*<br>Minor text changes. |

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