

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

Datasheet - production data

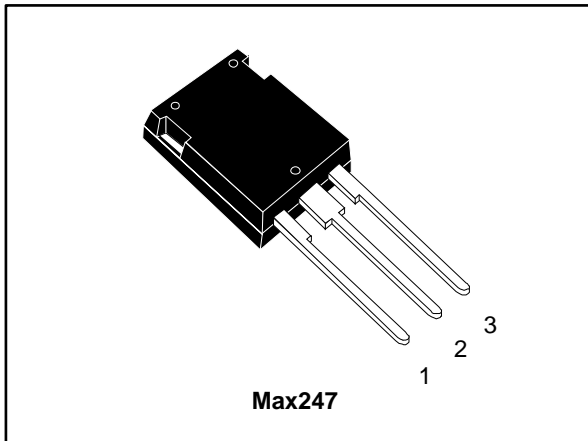
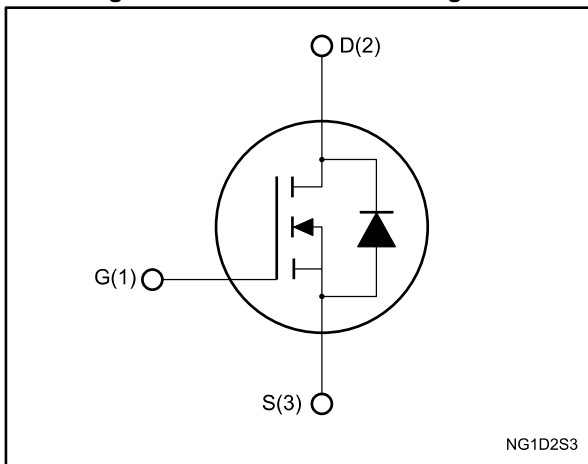


Figure 1: Internal schematic diagram



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 |

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 $T_C = 25\text{ °C}$ | 138 | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ °C}$ | 87 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 552 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 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 $T_j = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 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⁾ $I_{SD} \leq 138\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS(peak)} < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$.

Table 3: Thermal data

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

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 | $V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$ | | | 10 | μA |
| | | $V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}$ | | | 100 | μA |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$ | | | ± 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 | $V_{GS} = 10\text{ V}$, $I_D = 69\text{ A}$ | | 0.012 | 0.015 | Ω |

Table 5: Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------|--|---|------|-------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$ | - | 18500 | - | pF |
| C_{oss} | Output capacitance | | - | 413 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 11 | - | pF |
| $C_{o(er)}^{(1)}$ | Equivalent output capacitance energy related | $V_{GS} = 0$, $V_{DS} = 0\text{ to }520\text{ V}$ | - | 415 | - | pF |
| $C_{o(tr)}^{(2)}$ | Equivalent output capacitance time related | | - | 1950 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$, open drain | - | 0.7 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}$, $I_D = 69\text{ A}$, $V_{GS} = 10\text{ V}$ (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 | $V_{DD} = 400\text{ V}$, $I_D = 85\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (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 | $V_{GS} = 0\text{ V}$, $I_{SD} = 138\text{ A}$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 138\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$ (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 | $I_{SD} = 138\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (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)

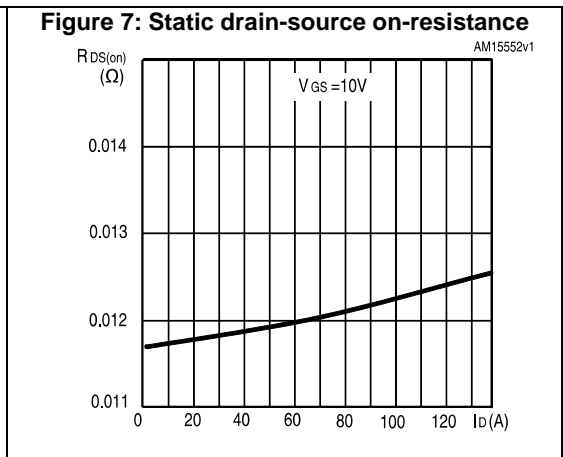
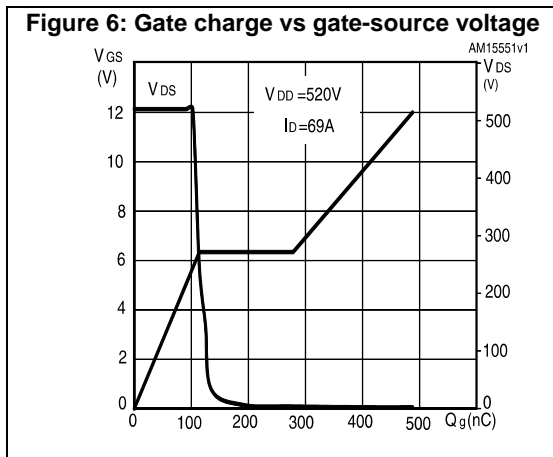
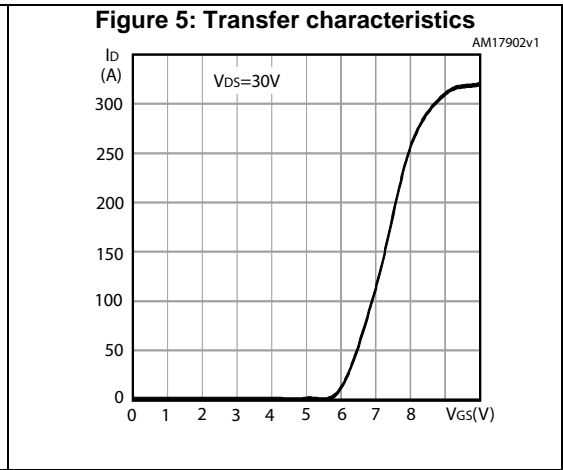
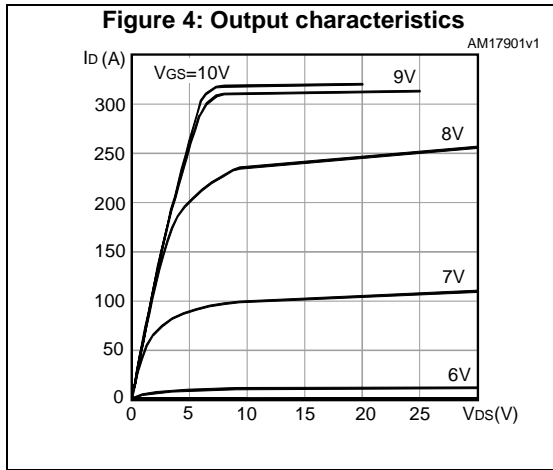
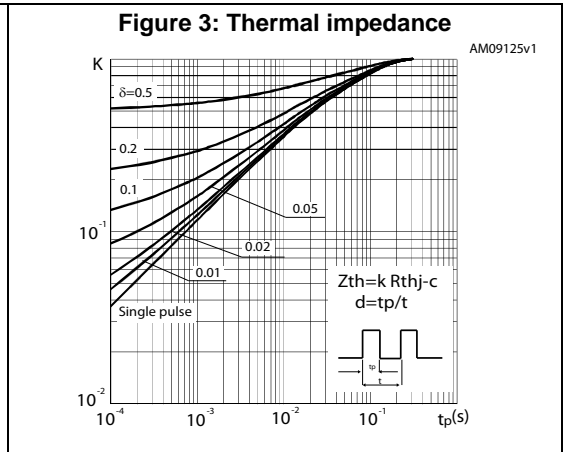
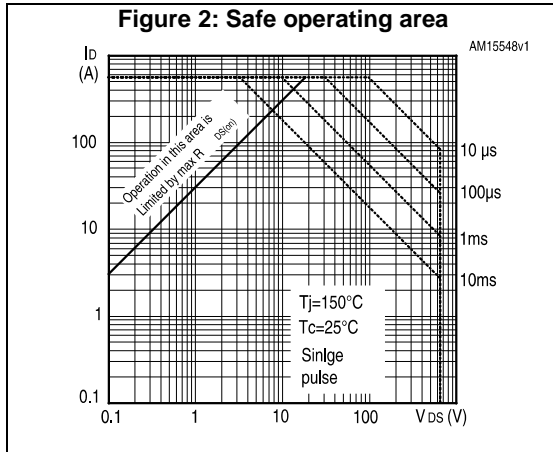


Figure 8: Capacitance variations

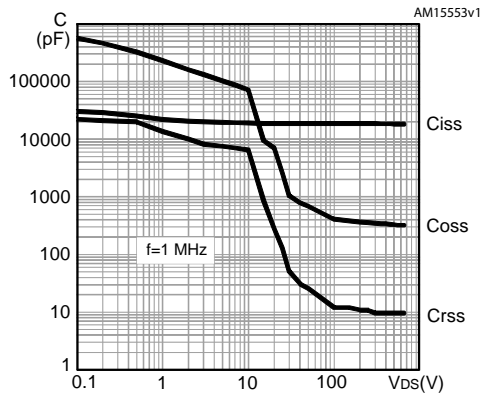


Figure 9: Normalized gate threshold voltage vs temperature

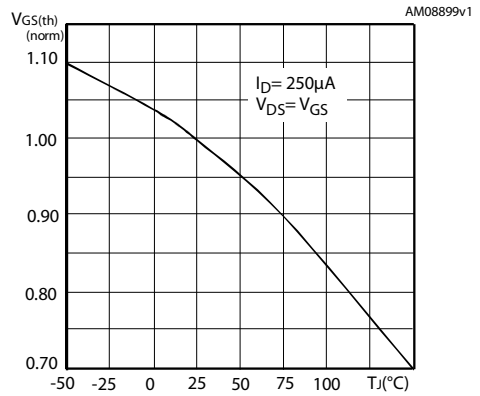


Figure 10: Normalized on-resistance vs temperature

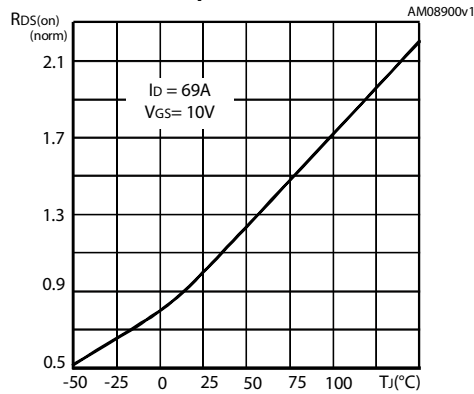


Figure 11: Normalized V(BR)DSS vs temperature

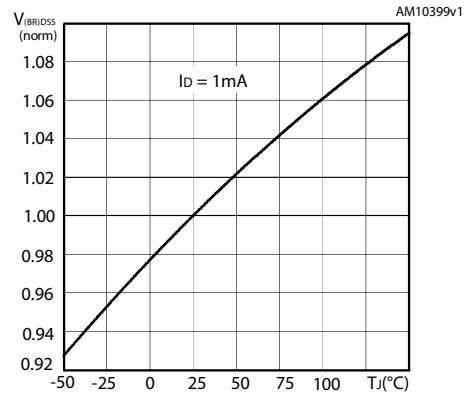


Figure 12: Output capacitance stored energy

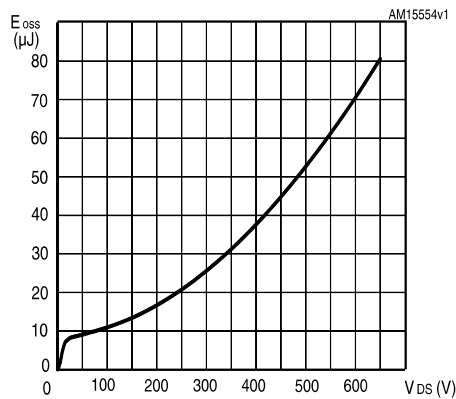
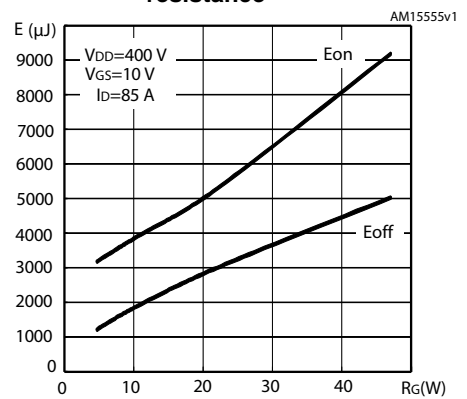


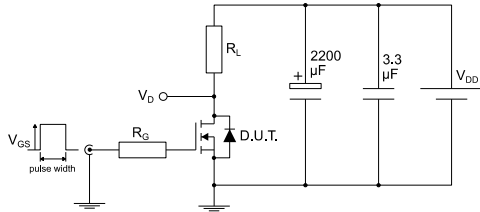
Figure 13: Switching losses vs gate resistance



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

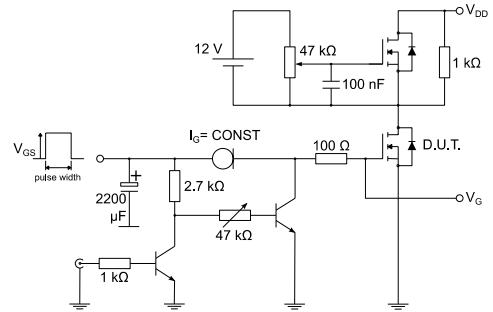
3 Test circuits

Figure 14: Test circuit for resistive load switching times



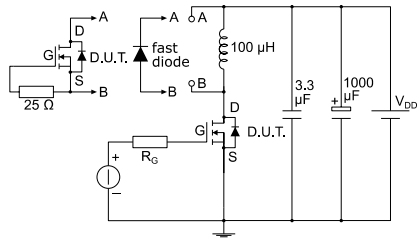
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Figure 15: Test circuit for gate charge behavior



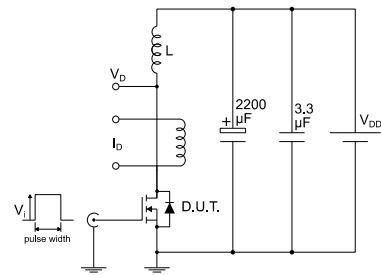
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Figure 16: Test circuit for inductive load switching and diode recovery times



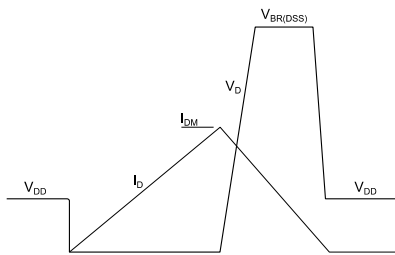
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Figure 17: Unclamped inductive load test circuit



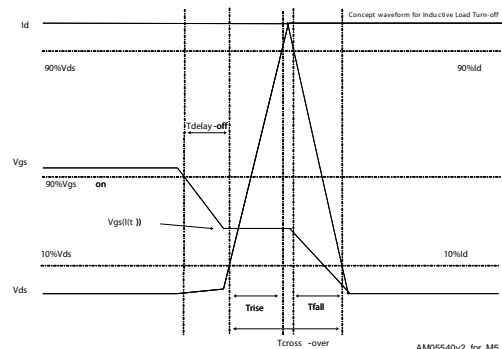
AM01471v1

Figure 18: Unclamped inductive waveform



AM01472v1

Figure 19: Switching time waveform



AM05540v2_for_M5

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

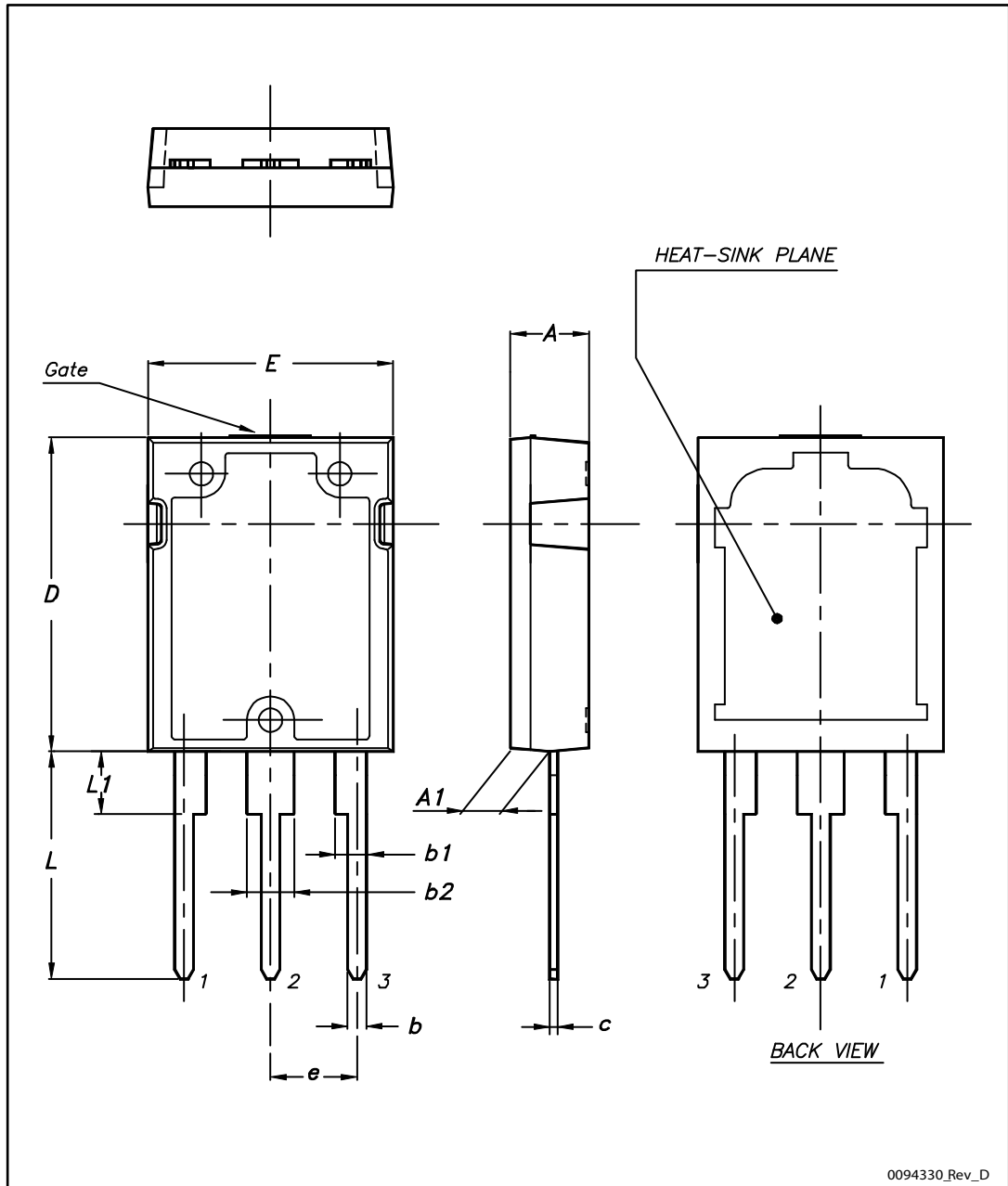


Table 8: Max247 package mechanical data

| 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 Modified: typical values on Table 5, 6 and 7 |
| 13-Nov-2015 | 3 | Updated title, features and description on cover page. Document status promoted from preliminary to production data. Modified: <i>Table 2: "Absolute maximum ratings"</i> and <i>Table 3: "Thermal data"</i> Updated: <i>Figure 4: "Output characteristics"</i> and <i>Figure 5: "Transfer characteristics"</i> Minor text changes. |

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