

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

Datasheet - production data

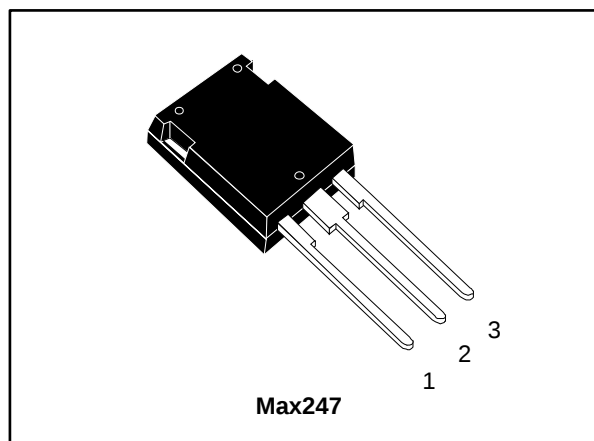


Figure 1: Internal schematic diagram

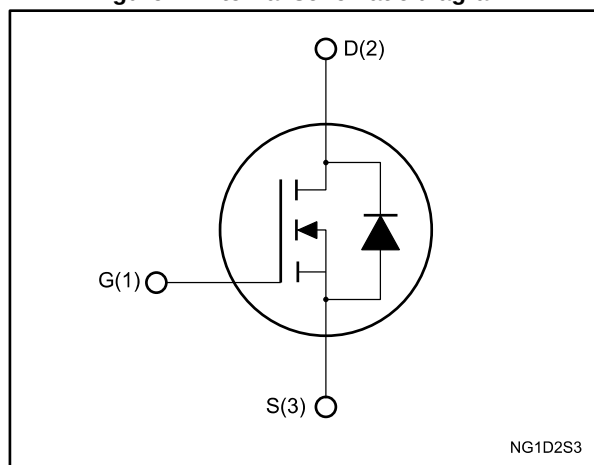


Table 1: Device summary

Order code	Marking	Package	Packaging
STY145N65M5	145N65M5	Max247	Tube

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.

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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 $T_C = 25\text{ }^{\circ}\text{C}$	138	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	87	A
$I_{DM}^{(1)}$	Drain current (pulsed)	552	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	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 $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	2420	mJ
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
T_{stg}	Storage temperature	- 55 to 150	$^{\circ}\text{C}$
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	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	30	$^{\circ}\text{C}/\text{W}$

2 Electrical characteristics

$T_C = 25\text{ }^{\circ}\text{C}$ 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
		$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$			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 2: Safe operating area

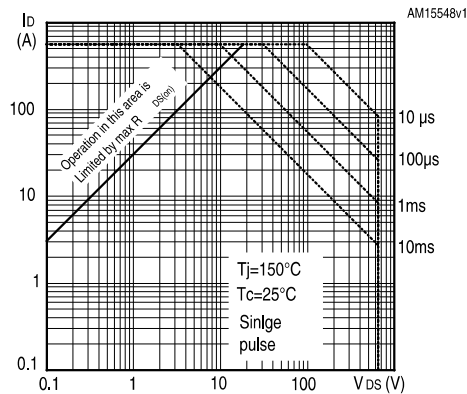


Figure 3: Thermal impedance

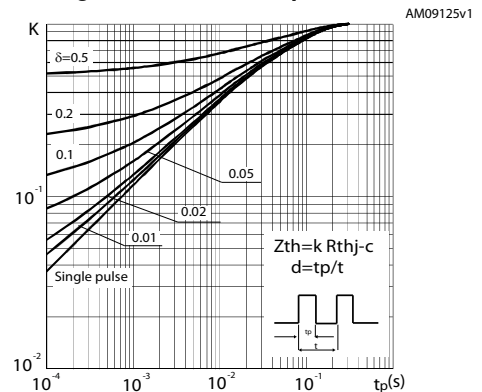


Figure 4: Output characteristics

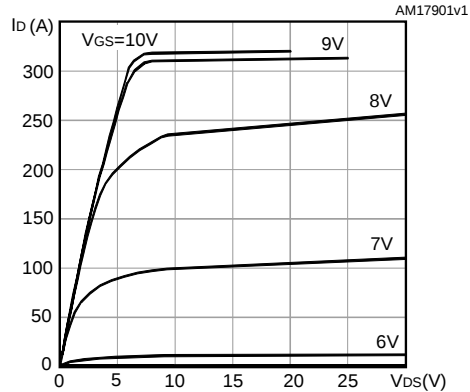


Figure 5: Transfer characteristics

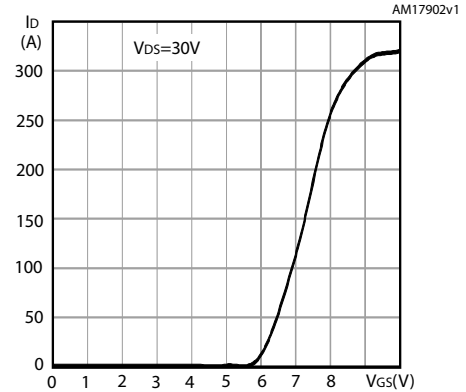


Figure 6: Gate charge vs gate-source voltage

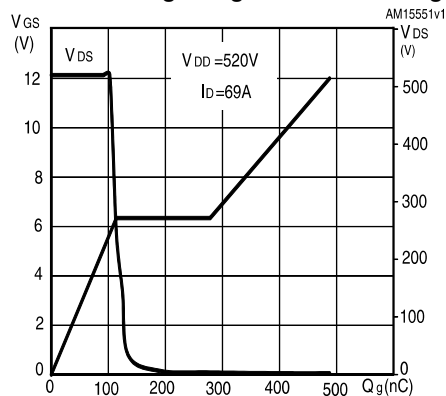


Figure 7: Static drain-source on-resistance

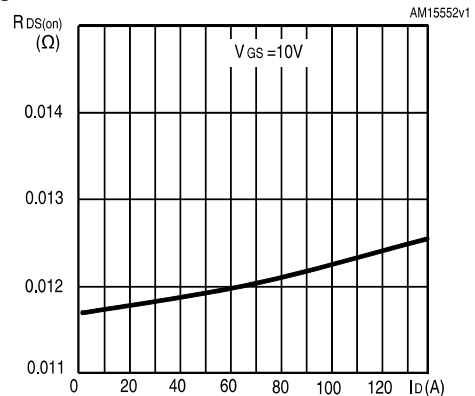


Figure 8: Capacitance variations

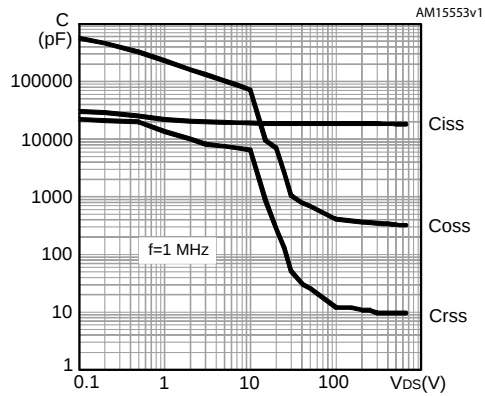


Figure 9: Normalized gate threshold voltage vs temperature

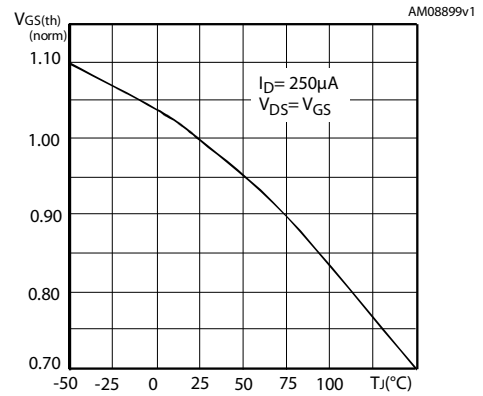


Figure 10: Normalized on-resistance vs temperature

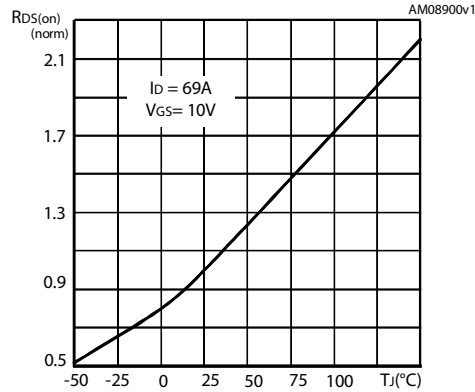


Figure 11: Normalized $V_{(BR)DSS}$ vs temperature

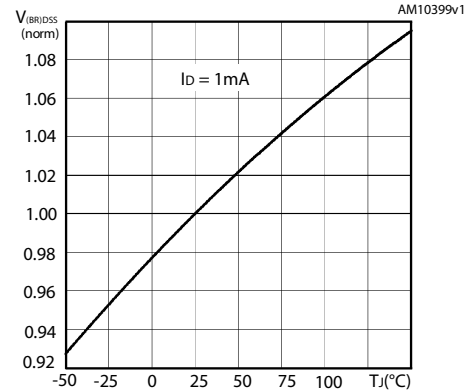


Figure 12: Output capacitance stored energy

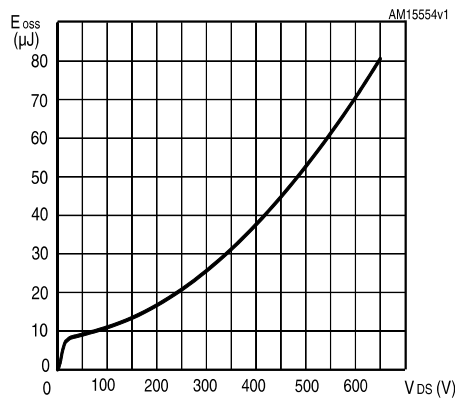
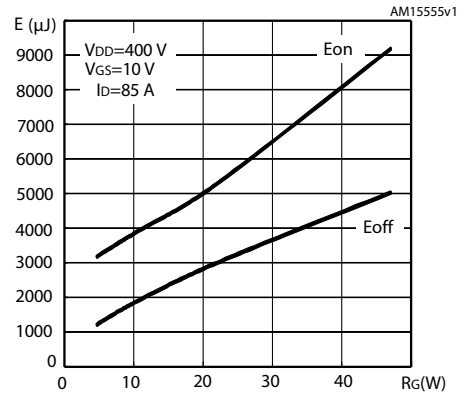


Figure 13: Switching losses vs gate resistance



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

3 Test circuits

Figure 14: Test circuit for resistive load switching times

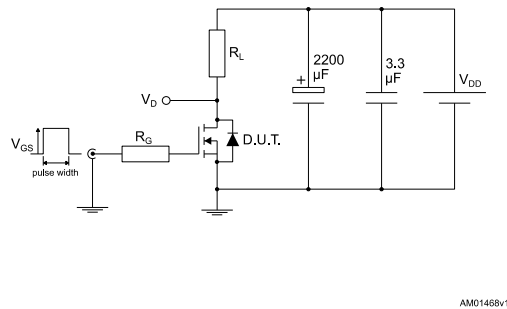


Figure 15: Test circuit for gate charge behavior

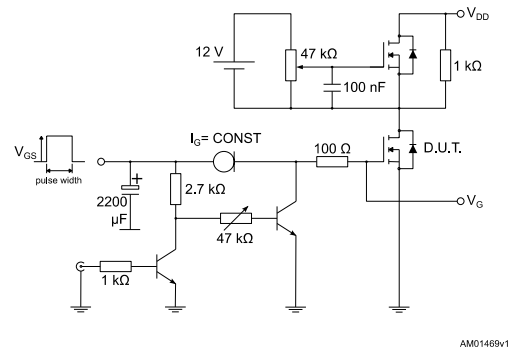


Figure 16: Test circuit for inductive load switching and diode recovery times

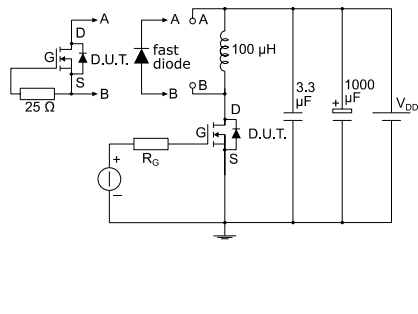


Figure 17: Unclamped inductive load test circuit

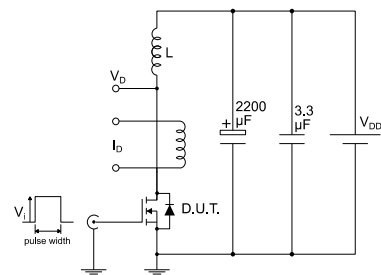


Figure 18: Unclamped inductive waveform

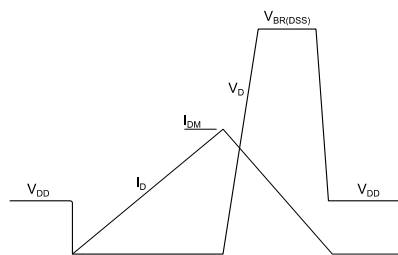
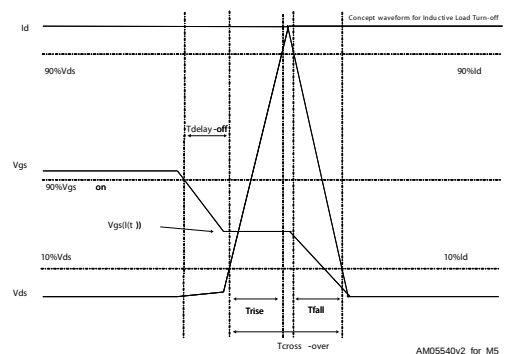


Figure 19: Switching time waveform



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

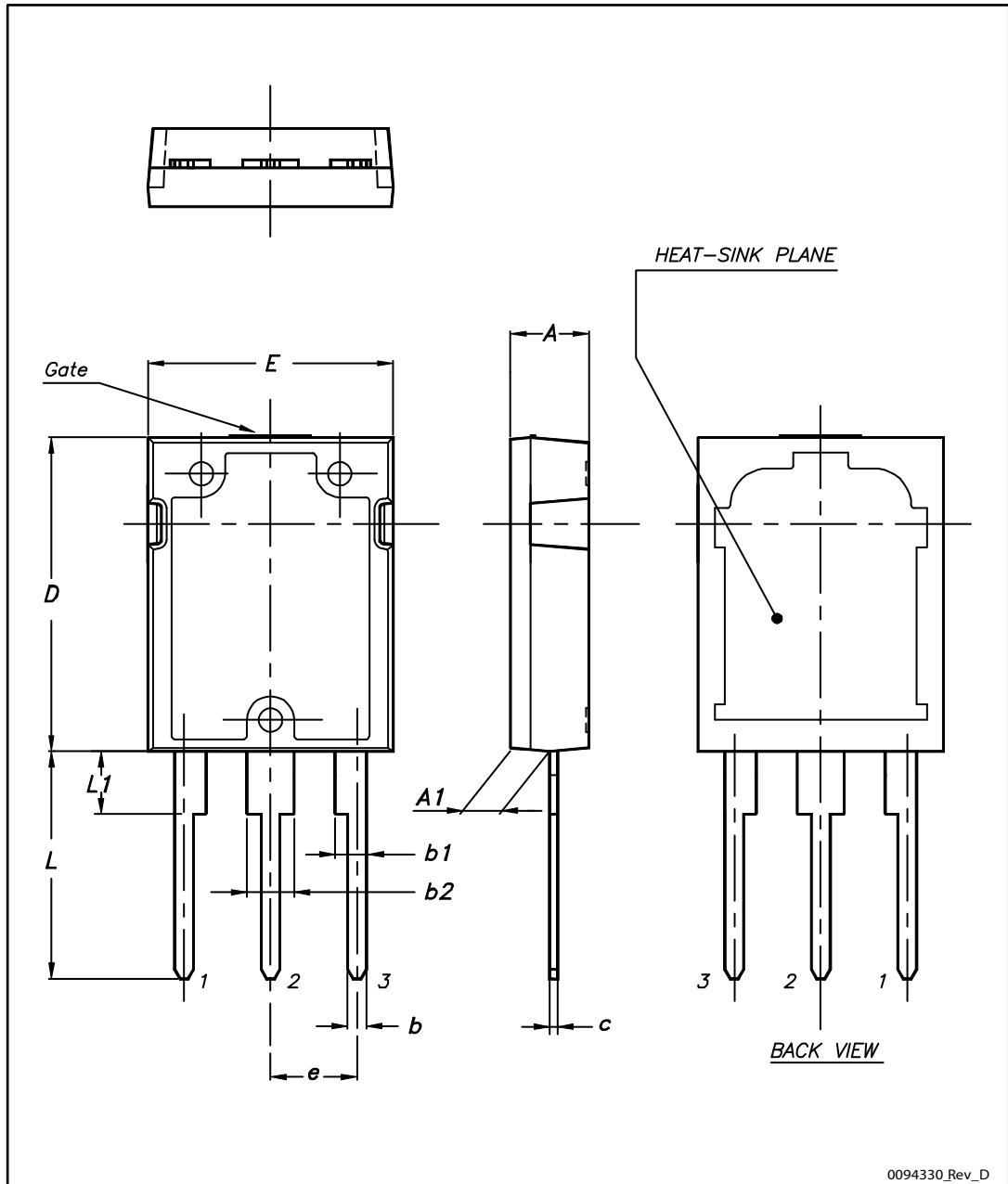


Table 8: Max247 package mechanical data

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 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: Table 2: "Absolute maximum ratings" and Table 3: "Thermal data" Updated: Figure 4: "Output characteristics" and Figure 5: "Transfer characteristics" Minor text changes.

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