

## N-channel 650 V, 0.012 $\Omega$ typ., 143 A MDmesh™ M5 Power MOSFET in an ISOTOP package

Datasheet - production data

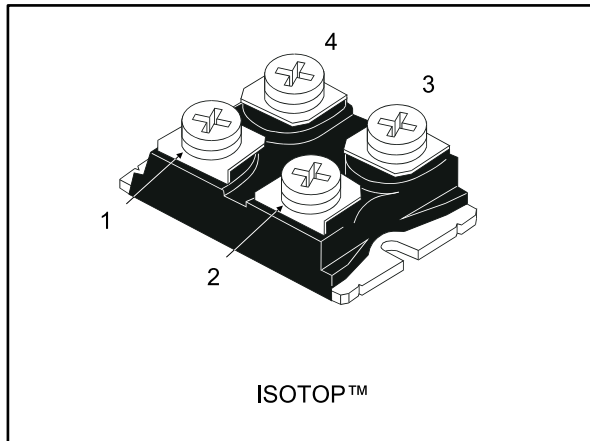


Figure 1: Internal schematic diagram

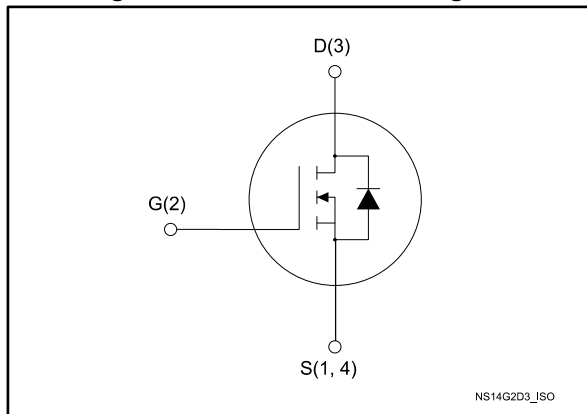


Table 1: Device summary

Order code	Marking	Package	Packaging
STE145N65M5	145N65M5	ISOTOP	Tube

### Features

Order code	$V_{DS}$ @ $T_{Jmax}$	$R_{DS(on)}$ max.	$I_D$
STE145N65M5	710 V	0.015 $\Omega$	143 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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**Contents**

<b>1</b>	<b>Electrical ratings .....</b>	<b>3</b>
<b>2</b>	<b>Electrical characteristics .....</b>	<b>4</b>
	2.1 Electrical characteristics (curves) .....	6
<b>3</b>	<b>Test circuits .....</b>	<b>8</b>
<b>4</b>	<b>Package information .....</b>	<b>9</b>
	4.1 ISOTOP package information .....	10
<b>5</b>	<b>Revision history .....</b>	<b>12</b>

# 1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	143	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	90	A
$I_{DM}^{(1)}$	Drain current (pulsed)	572	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	679	W
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_j$ max)	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
$V_{ISO}$	Isolation withstand voltage applied between each pin and heatsink plate (AC voltage, $t = 60\text{ s}$ )	2.5	kV
$T_{stg}$	Storage temperature	- 55 to 150	°C
$T_j$	Max. operating junction temperature	150	

**Notes:**

<sup>(1)</sup> Pulse width limited by safe operating area.

<sup>(2)</sup>  $I_{SD} \leq 143\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS(\text{peak})} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .

Table 3: Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-case}}$	Thermal resistance junction-case max	0.184	°C/W
$R_{thj\text{-amb}}$	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	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	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	$\Omega$

**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	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 69\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> )	-	414	-	nC
$Q_{gs}$	Gate-source charge		-	114	-	nC
$Q_{gd}$	Gate-drain charge		-	164	-	nC

**Notes:**

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

<sup>(2)</sup> $C_{o(tr)}$  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 <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> and <a href="#">Figure 19: "Switching time waveform"</a> )	-	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		-		143	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		572	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 143\text{ A}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 143\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 100\text{ V}$ (see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )	-	568		ns
$Q_{rr}$	Reverse recovery charge		-	14.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	51		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 143\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )	-	728		ns
$Q_{rr}$	Reverse recovery charge		-	24.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	67		A

**Notes:**

<sup>(1)</sup>Pulse width is limited by safe operating area

<sup>(2)</sup>Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.2 Electrical characteristics (curves)

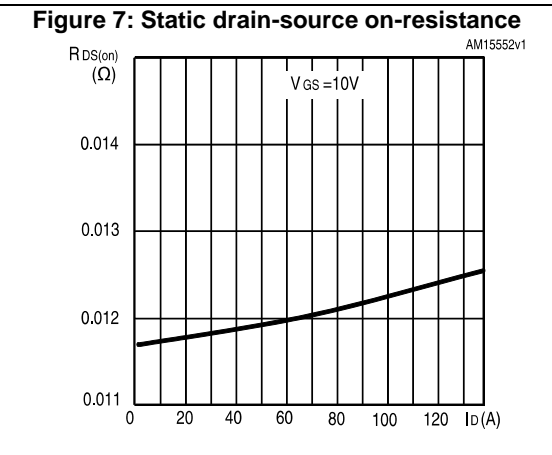
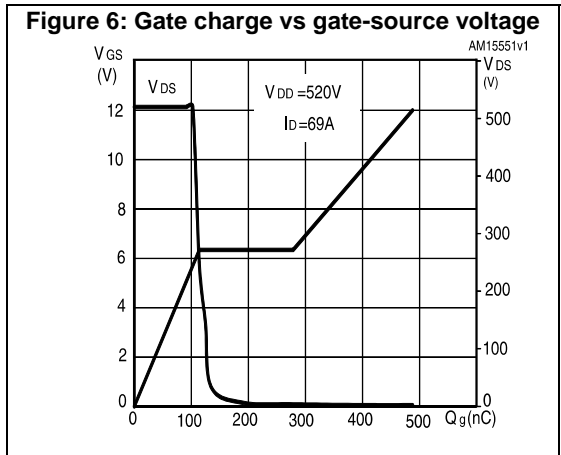
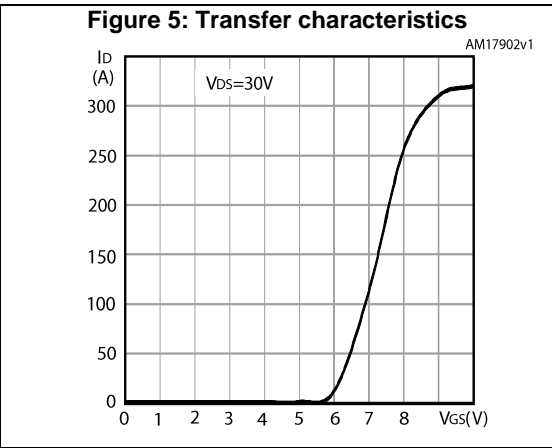
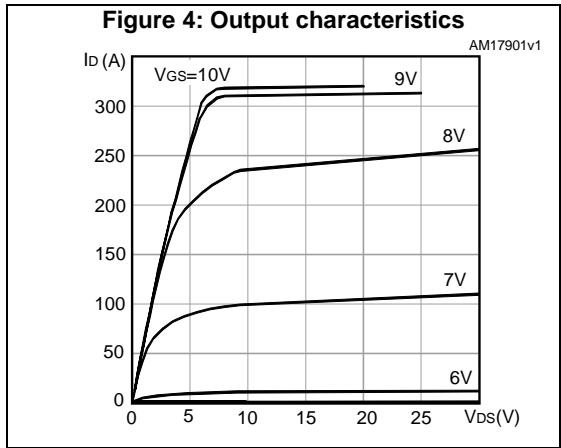
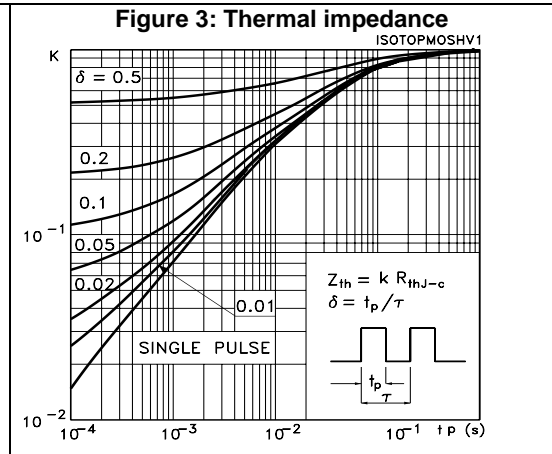
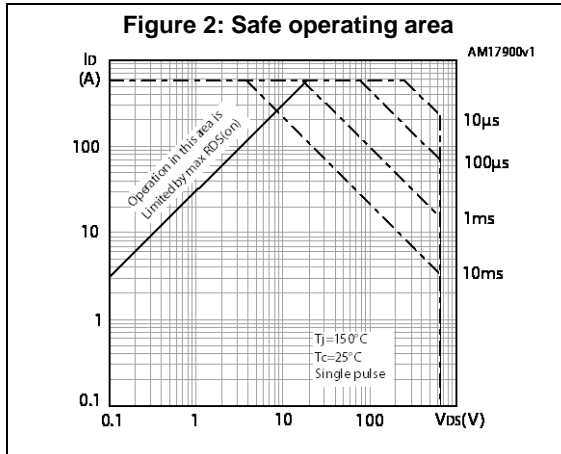


Figure 8: Capacitance variations

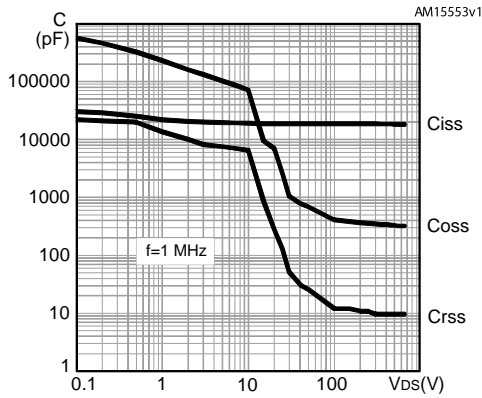


Figure 9: Normalized gate threshold voltage vs temperature

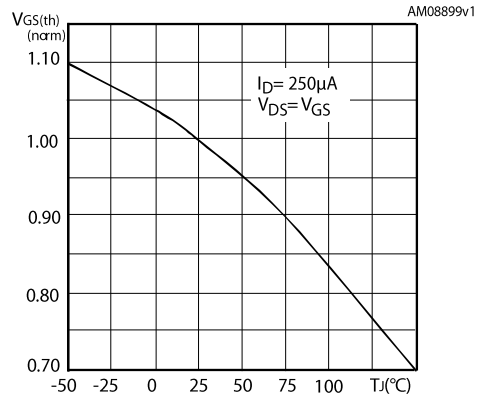


Figure 10: Normalized on-resistance vs temperature

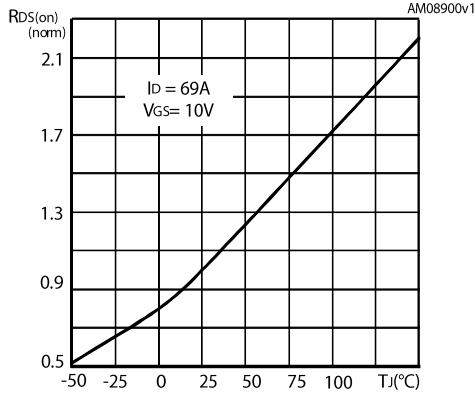


Figure 11: Normalized V<sub>(BR)DSS</sub> vs temperature

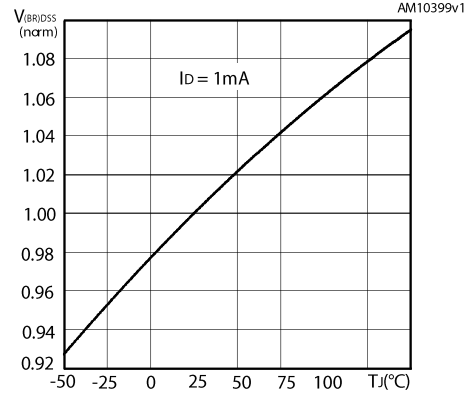


Figure 12: Output capacitance stored energy

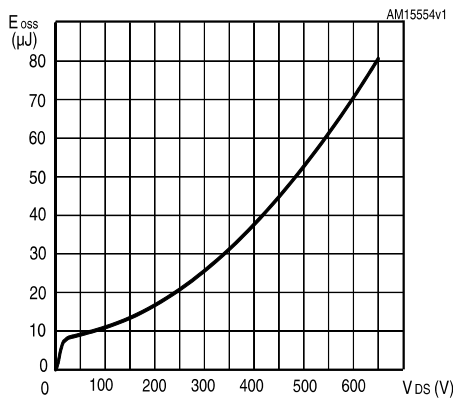
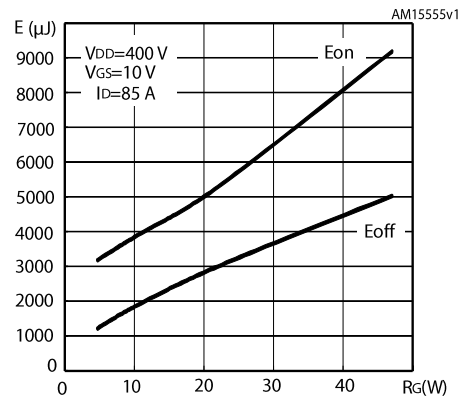


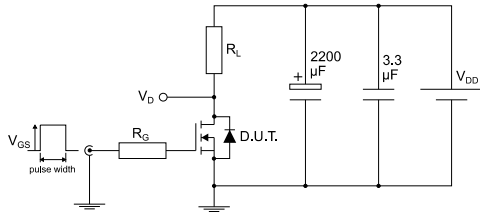
Figure 13: Switching losses vs gate resistance



The previous figure E<sub>on</sub> includes reverse recovery of a SiC diode.

### 3 Test circuits

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



AM01468v1

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



AM01469v1

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



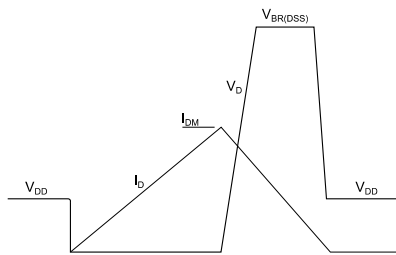
AM01470v1

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



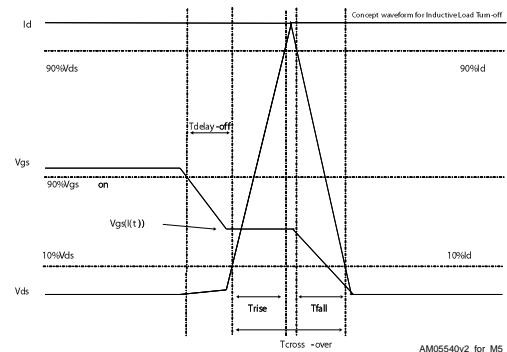
AM01471v1

**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



AM05540v2\_for\_M5

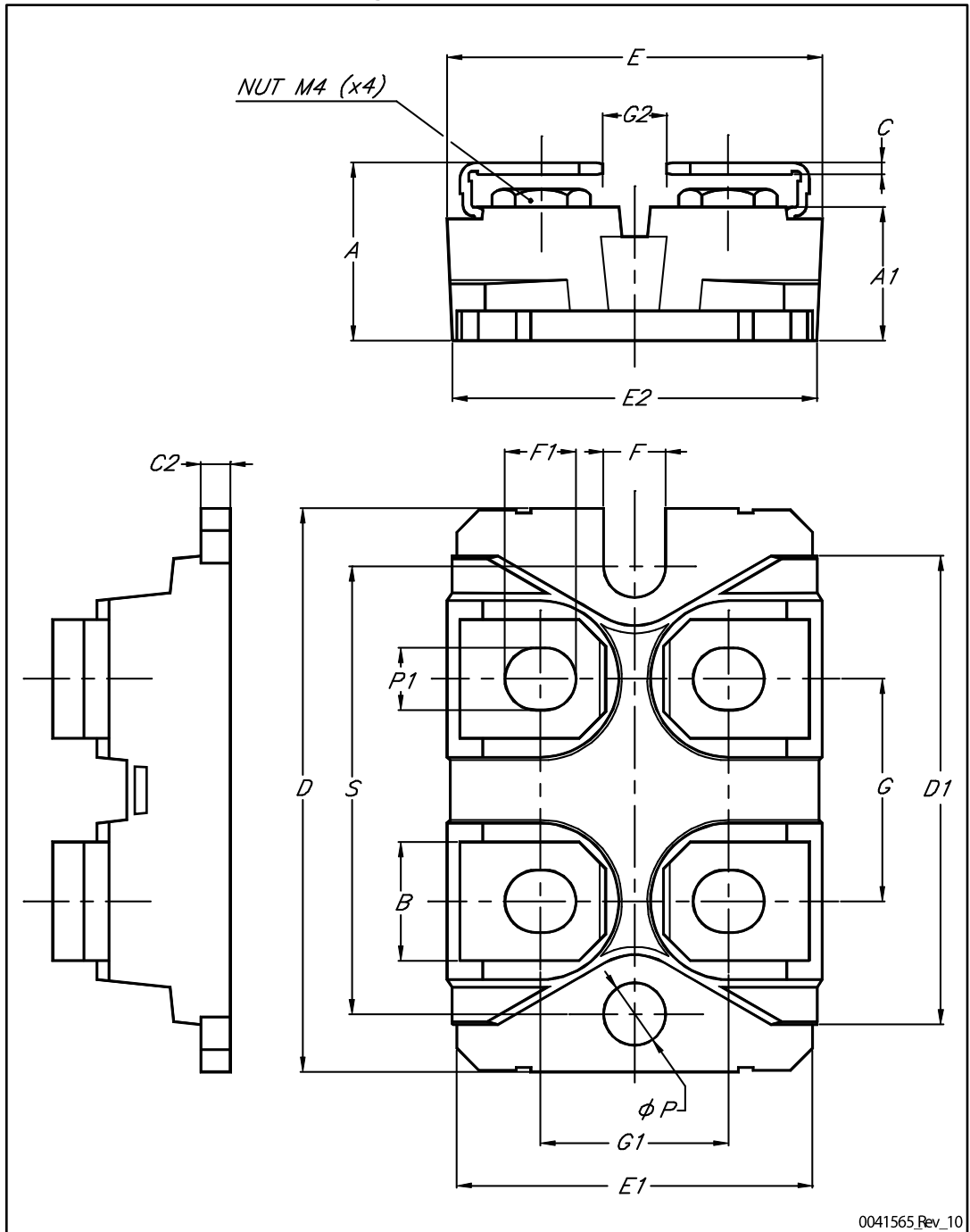


## 4 Package information

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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 ISOTOP package information

Figure 20: ISOTOP outline



0041565\_Rev\_10

Table 8: ISOTOP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	11.80		12.20
A1	8.90		9.10
B	7.80		8.20
C	0.75		0.85
C2	1.95		2.05
D	37.80		38.20
D1	31.50		31.70
E	25.15		25.50
E1	23.85		24.15
E2		24.80	
G	14.90		15.10
G1	12.60		12.80
G2	3.50		4.30
F	4.10		4.30
F1	4.60		5
ØP	4		4.30
P1	4		4.40
S	30.10		30.30

## 5 Revision history

**Table 9: Document revision history**

Date	Revision	Changes
18-Nov-2013	1	First release.
12-Nov-2015	2	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>Figure 12: "Output capacitance stored energy"</i> Minor text changes.

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