

## N-channel 650 V, 0.014 $\Omega$ typ., 130 A, MDmesh™ V Power MOSFET in a ISOTOP package

Datasheet - preliminary data

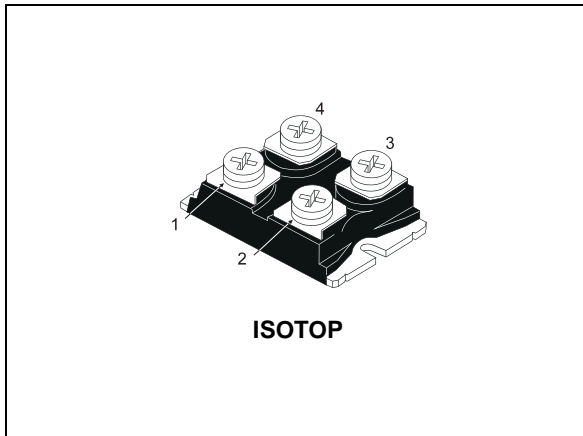
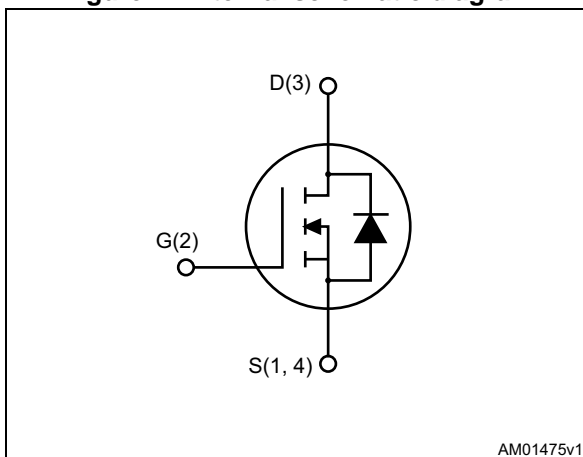


Figure 1. Internal schematic diagram



### Features

Order code	$V_{DS} @ T_{jmax}$	$R_{DS(on) max}$	$I_D$
STE139N65M5	710 V	0.017 W	130 A

- Very low  $R_{DS(on)}$
- Higher  $V_{DSS}$  rating
- Higher dv/dt capability
- Excellent switching performance
- 100% avalanche tested

### Applications

- Switching applications

### Description

This 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.

Table 1. Device summary

Order code	Marking	Packages	Packaging
STE139N65M5	139N65M5	ISOTOP	Tube

# Contents

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# 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 $T_C = 25\text{ }^\circ\text{C}$	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 $T_C = 25\text{ }^\circ\text{C}$	672	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.  $I_{SD} \leq 130\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 400\text{ V}$ ,  $V_{DS (peak)} < V_{(BR)DSS}$ .

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.186	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	30	$^\circ\text{C}/\text{W}$

## 2 Electrical characteristics

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

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	15600	-	pF
$C_{oss}$	Output capacitance		-	365	-	pF
$C_{riss}$	Reverse transfer capacitance		-	9	-	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	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 65\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 15</a> )	-	363	-	nC
$Q_{gs}$	Gate-source charge		-	88	-	nC
$Q_{gd}$	Gate-drain charge		-	164	-	nC

- $C_{o(tr)}^{(1)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- $C_{o(er)}^{(2)}$  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	$V_{DD} = 400\text{ V}$ , $I_D = 80\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> ) (see <a href="#">Figure 19</a> )	-	295	-	ns
$t_{r(v)}$	Voltage rise time		-	56	-	ns
$t_{f(i)}$	Current fall time		-	37	-	ns
$t_{c(off)}$	Crossing time		-	84	-	ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		130	A
	Source-drain current (pulsed)				520	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	$I_{SD} = 130\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see <a href="#">Figure 16</a> )	-	570		ns
$Q_{rr}$	Reverse recovery charge		-	15		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	53		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 130\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 16</a> )	-	720		ns
$Q_{rr}$	Reverse recovery charge		-	24		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	68		A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

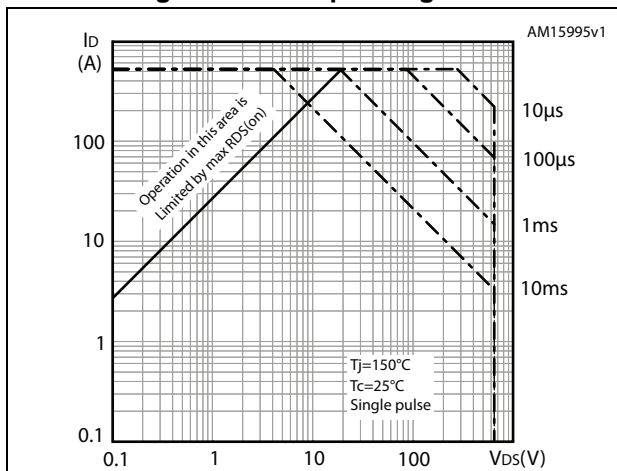


Figure 3. Thermal impedance

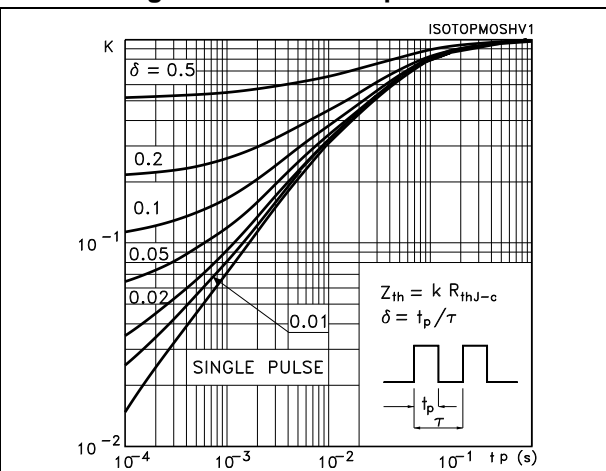


Figure 4. Output characteristics

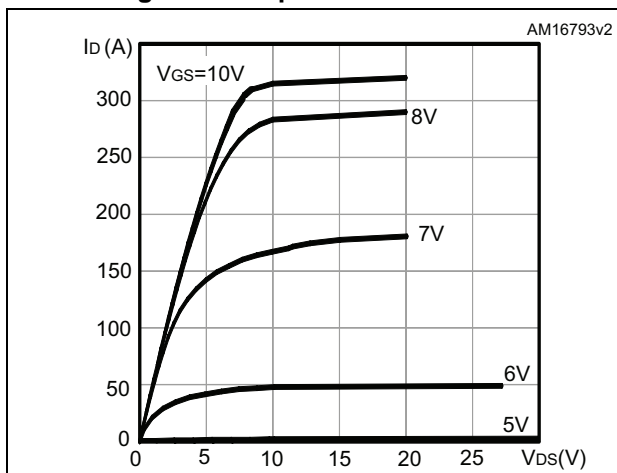


Figure 5. Transfer characteristics

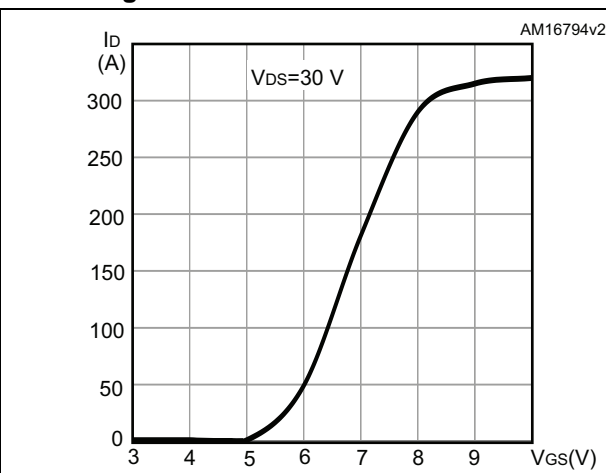


Figure 6. Normalized V<sub>DS</sub> vs temperature

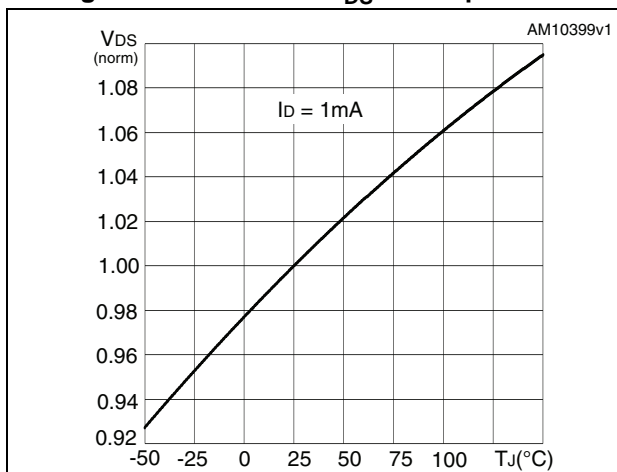


Figure 7. Static drain-source on-resistance

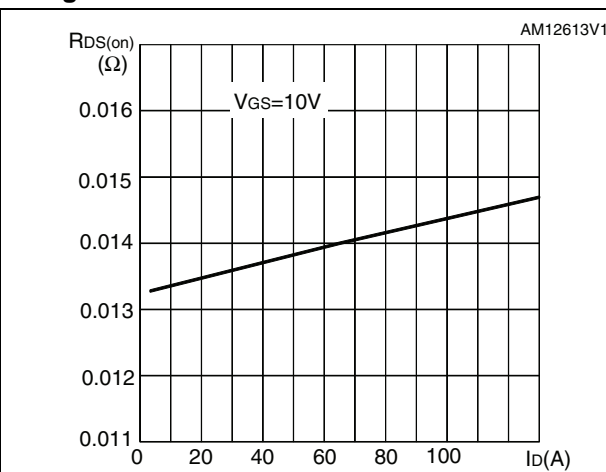


Figure 8. Gate charge vs gate-source voltage

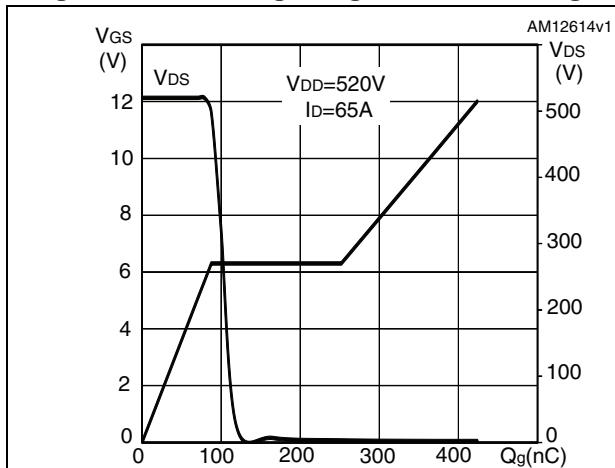


Figure 9. Capacitance variations

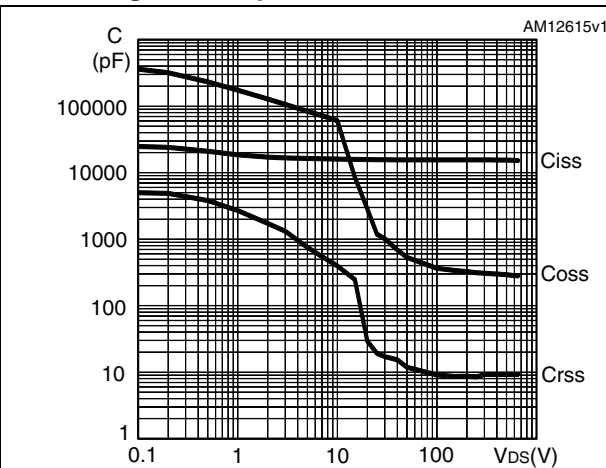


Figure 10. Normalized gate threshold voltage vs temperature

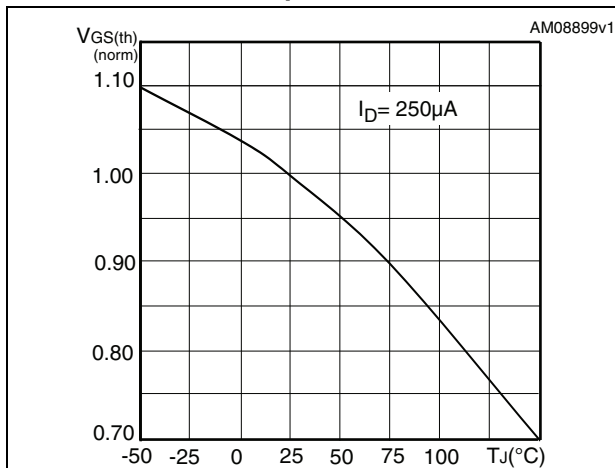


Figure 11. Normalized on-resistance vs temperature

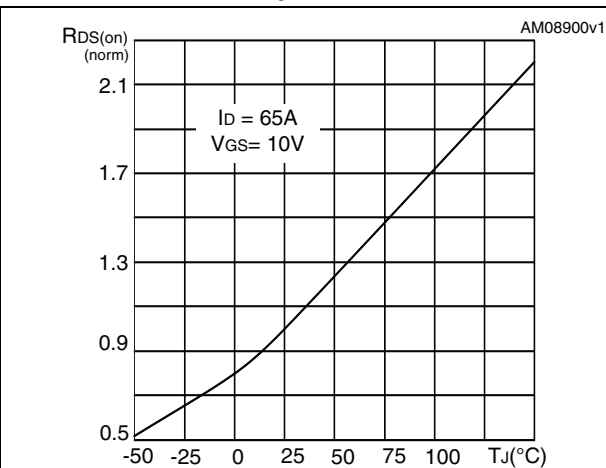


Figure 12. Output capacitance stored energy

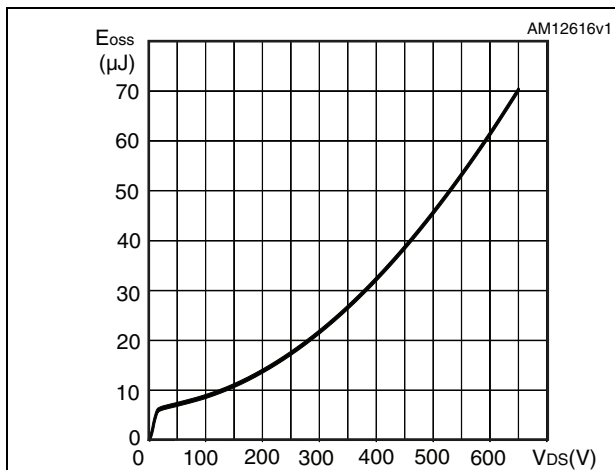
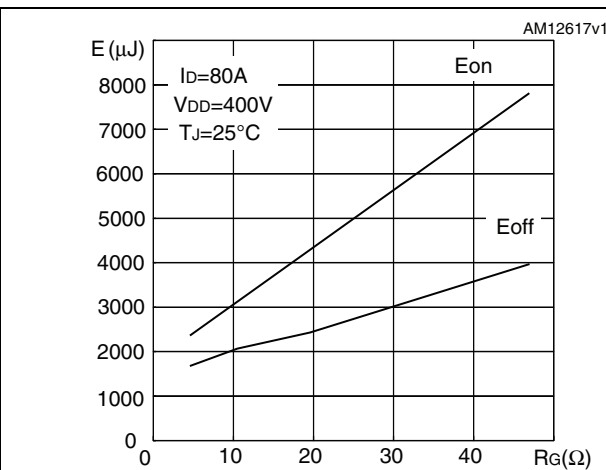


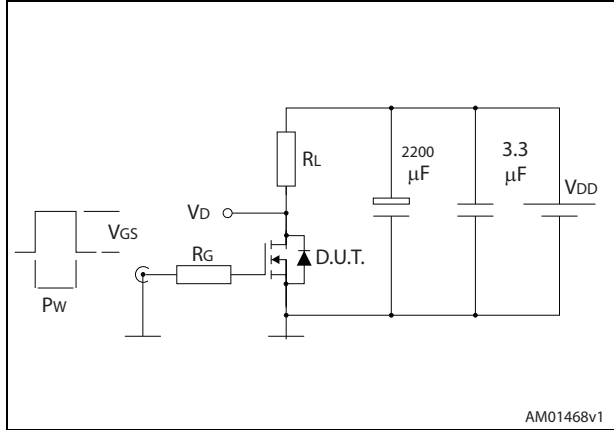
Figure 13. Switching losses vs gate resistance (1)



1. Eon including reverse recovery of a SiC diode.

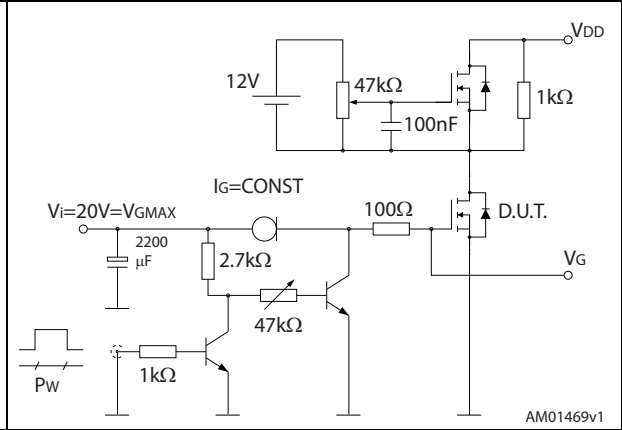
### 3 Test circuits

Figure 14. Switching times test circuit for resistive load



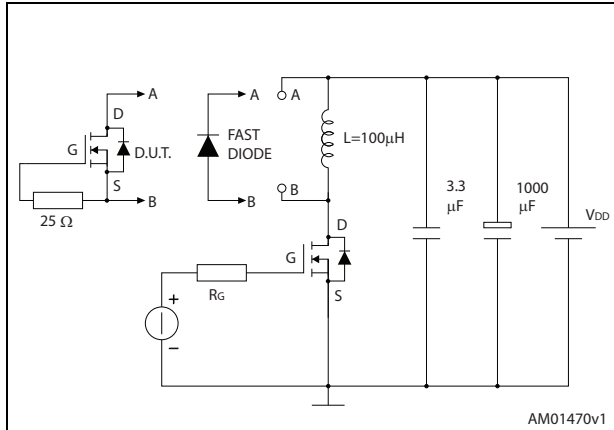
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Figure 15. Gate charge test circuit



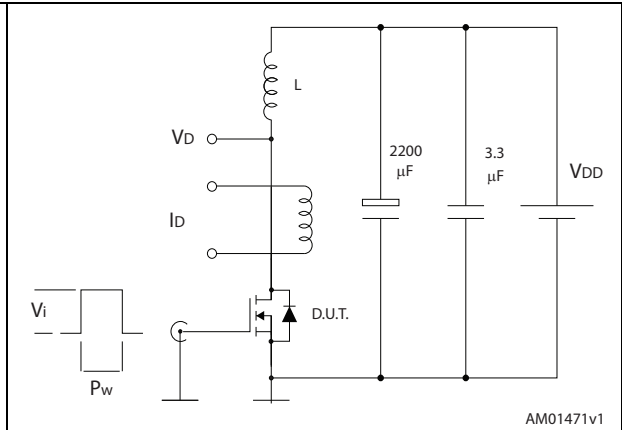
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Figure 16. Test circuit for inductive load switching and diode recovery times



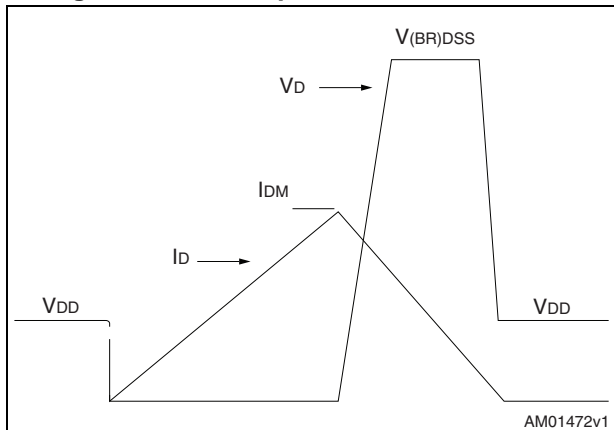
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Figure 17. Unclamped inductive load test circuit



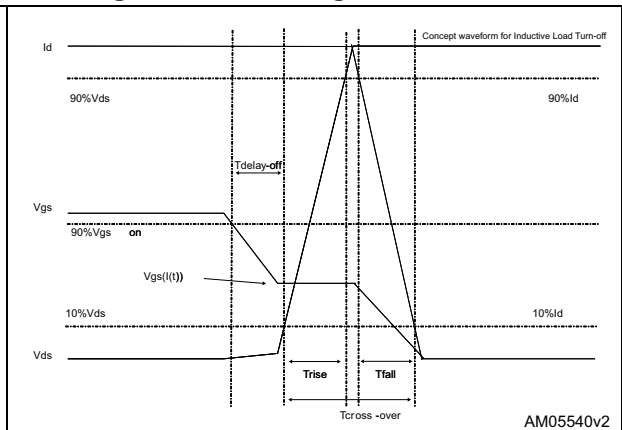
AM01471v1

Figure 18. Unclamped inductive waveform



AM01472v1

Figure 19. Switching time waveform



AM05540v2



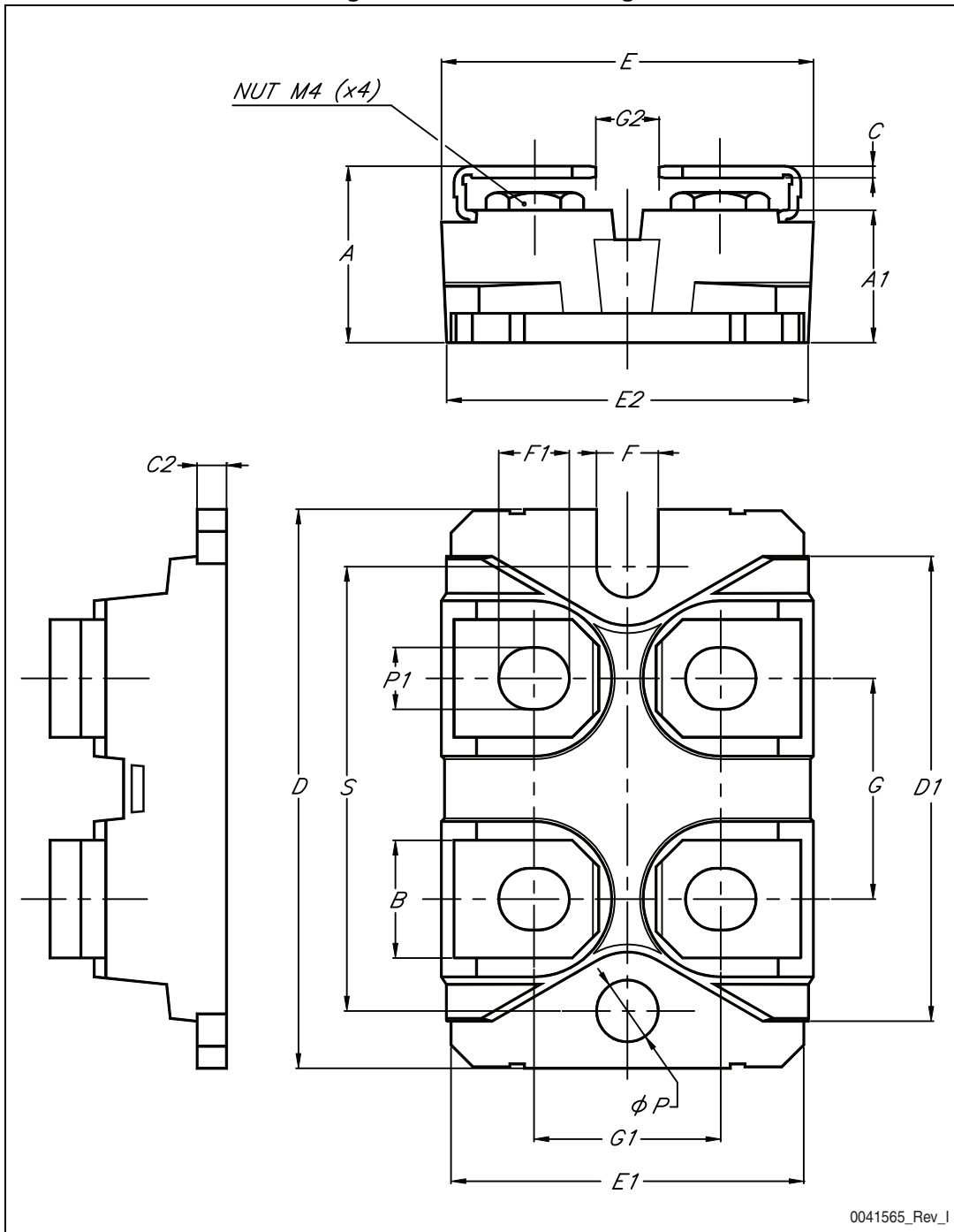
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

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
φP	4		4.30
P1	4		4.40
S	30.10		30.30

Figure 20. ISOTOP drawing



0041565\_Rev\_I

## 5 Revision history

Table 9. Document revision history

Date	Revision	Changes
13-Aug-2013	1	Initial release.

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