



# STFW69N65M5 STW69N65M5

N-channel 650 V, 0.037  $\Omega$  typ., 58 A MDmesh™ V Power MOSFET  
in TO-3PF and TO-247 packages

Datasheet – production data

## Features

Order codes	$V_{DSS}$ @ $T_{Jmax}$	$R_{DS(on)}$ max	$I_D$
STFW69N65M5	710 V	< 0.045 $\Omega$	58 A
STW69N65M5			

- Worldwide best  $R_{DS(on)}$  \* area
- Higher  $V_{DSS}$  rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

## Applications

- Switching applications

## Description

These devices are N-channel MDmesh™ V Power MOSFETs 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.

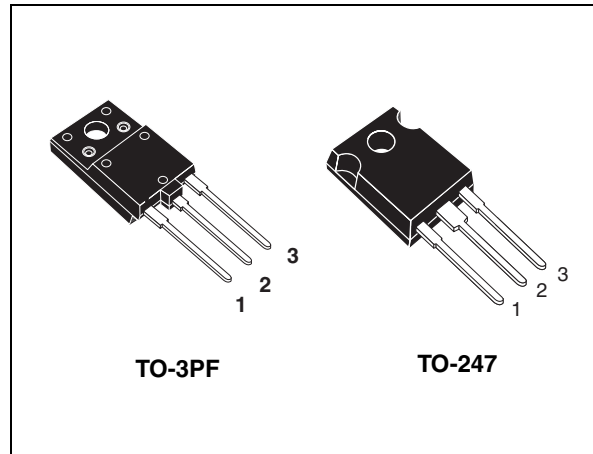


Figure 1. Internal schematic diagram

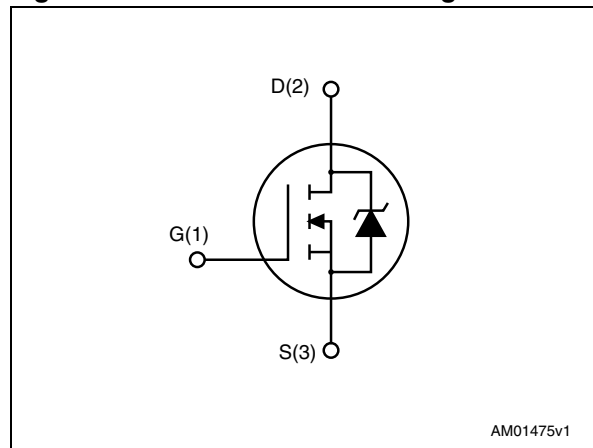


Table 1. Device summary

Order codes	Marking	Package	Packaging
STFW69N65M5	69N65M5	TO-3PF	Tube
STW69N65M5		TO-247	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-3PF	TO-247	
$V_{GS}$	Gate-source voltage	± 25		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	58 <sup>(1)</sup>	58	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	36.5 <sup>(1)</sup>	36.5	A
$I_{DM}$ <sup>(2)</sup>	Drain current (pulsed)	232 <sup>(1)</sup>	232	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	79	330	W
$dv/dt$ <sup>(3)</sup>	Peak diode recovery voltage slope	15		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; Tc=25°C)	3500		V
$T_{stg}$	Storage temperature	- 55 to 150		°C
$T_j$	Max. operating junction temperature	150		°C

1. Limited by maximum junction temperature.

2. Pulse width limited by safe operating area

3.  $I_{SD} \leq 58\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD}=400\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-3PF	TO-247	
$R_{thj\text{-case}}$	Thermal resistance junction-case max	1.58	0.38	°C/W
$R_{thj\text{-amb}}$	Thermal resistance junction-ambient max	50		°C/W

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{j\text{max}}$ )	12	A
$E_{AS}$	Single pulse avalanche energy (starting $t_j=25\text{ °C}$ , $I_d=I_{AR}$ ; $V_{dd}=50$ )	1410	mJ

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified)

**Table 5. 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 ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}, T_C = 125\text{ °C}$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	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	$V_{GS} = 10\text{ V}, I_D = 29\text{ A}$		0.037	0.045	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0$	-	6420	-	pF
$C_{oss}$	Output capacitance			170		pF
$C_{rss}$	Reverse transfer capacitance			11		pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}, V_{GS} = 0$	-	536	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related			146		pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz open drain}$	-	1.2	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}, I_D = 29\text{ A},$ $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	143	-	nC
$Q_{gs}$	Gate-source charge			38		nC
$Q_{gd}$	Gate-drain charge			64		nC

1. Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

2. Energy related is defined as a constant equivalent capacitance giving the same stored energy as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(v)}$	Voltage delay time	$V_{DD} = 400\text{ V}$ , $I_D = 38\text{ A}$ ,		102		ns
$t_{r(v)}$	Voltage rise time	$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$	-	13.5	-	ns
$t_{f(i)}$	Current fall time	(see <a href="#">Figure 19</a> and		10		ns
$t_{c(off)}$	Crossing time	<a href="#">Figure 22</a> )		19		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		58	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		232	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 58\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 58\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	480		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$ (see <a href="#">Figure 19</a> )		11		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			46		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 58\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	592		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$		16		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 19</a> )		53		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 for TO-3PF

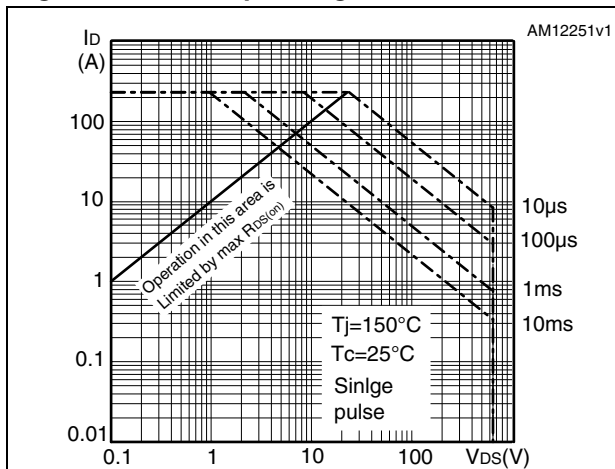


Figure 3. Thermal impedance for TO-3PF

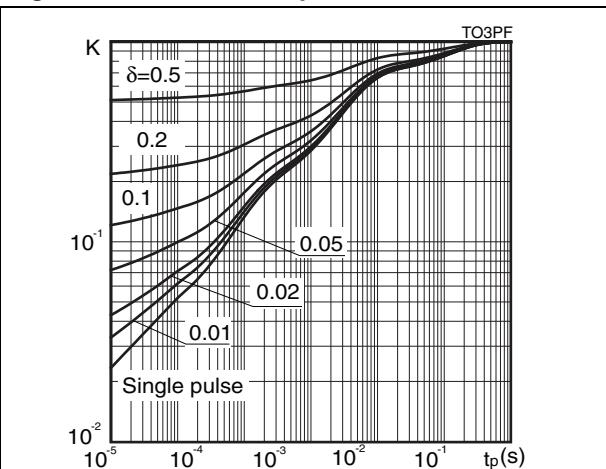


Figure 4. Safe operating area for TO-247

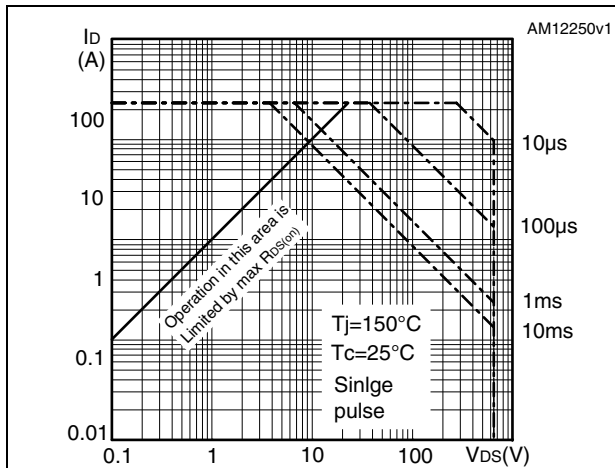


Figure 5. Thermal impedance for TO-247

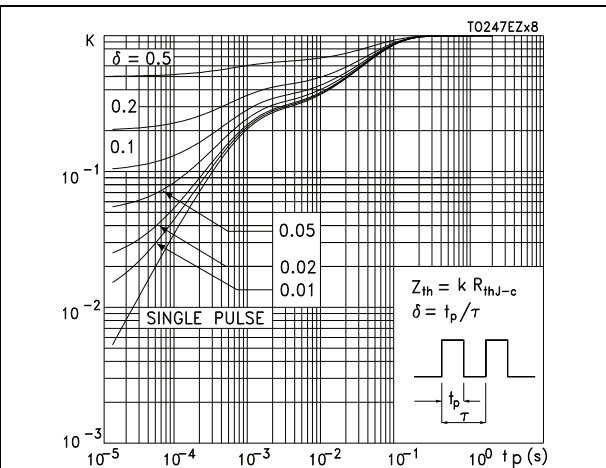


Figure 6. Output characteristics

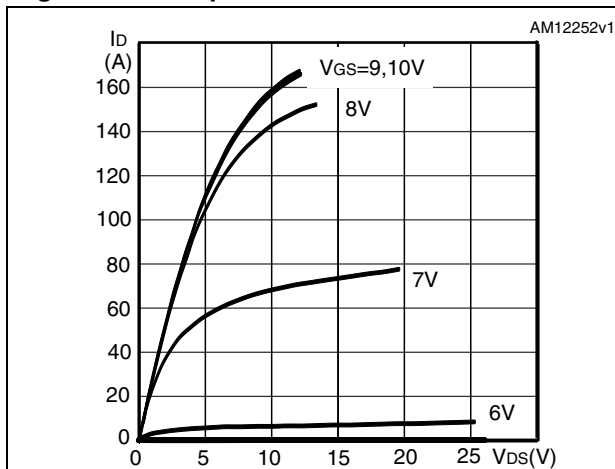


Figure 7. Transfer characteristics

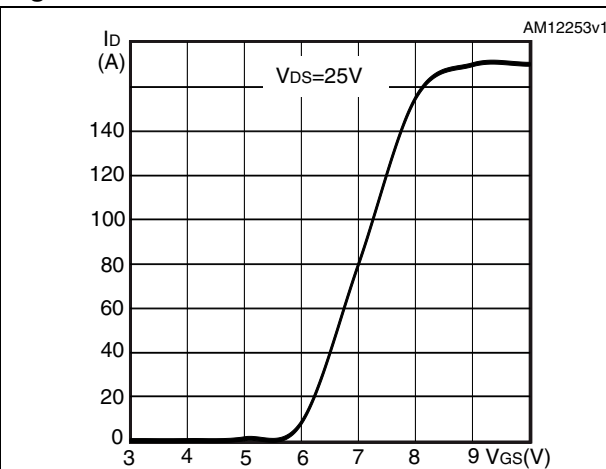


Figure 8. Gate charge vs gate-source voltage Figure 9. Static drain-source on-resistance

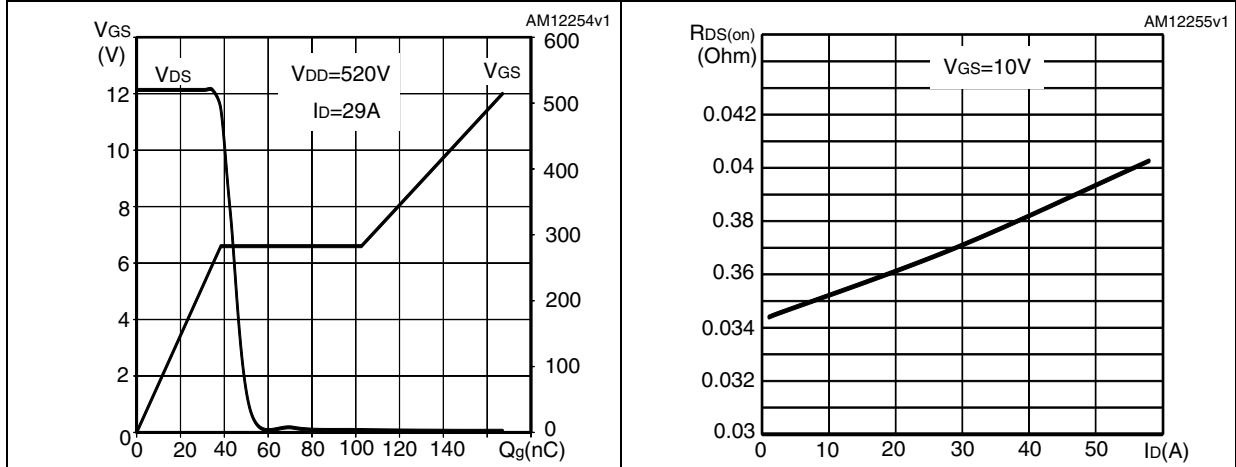


Figure 10. Capacitance variations Figure 11. Output capacitance stored energy

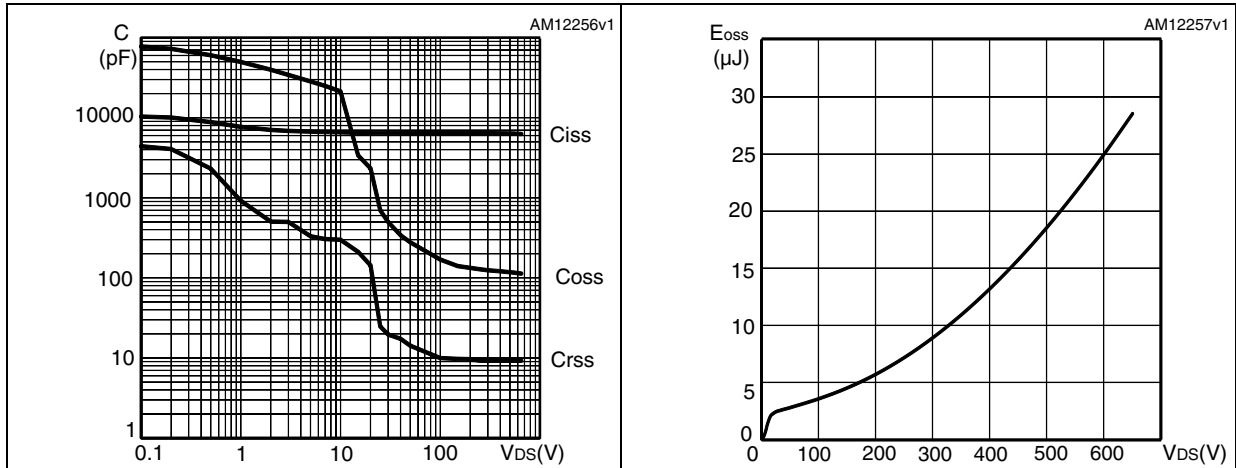


Figure 12. Normalized gate threshold voltage vs temperature Figure 13. Normalized on-resistance vs temperature

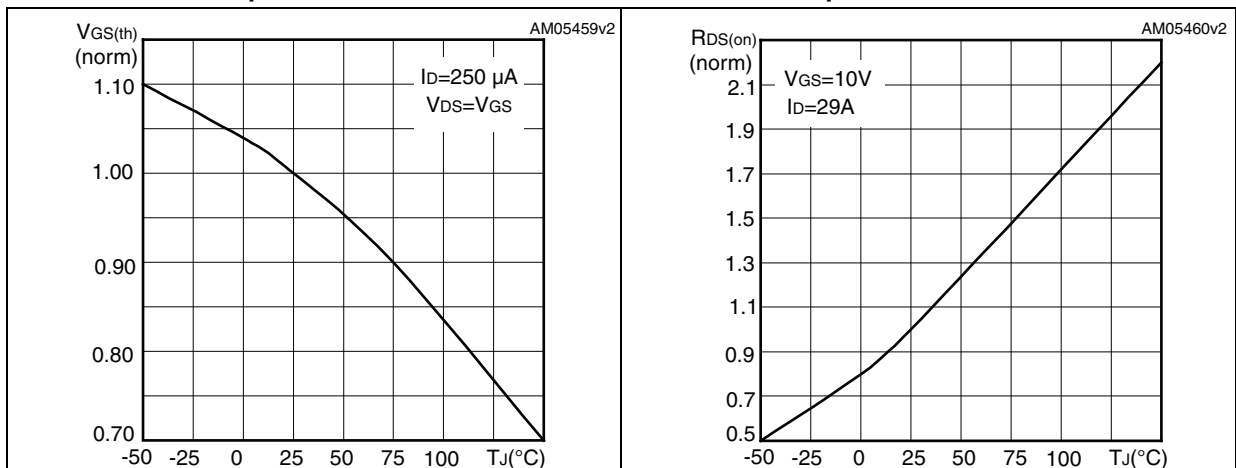


Figure 14. Source-drain diode forward characteristics

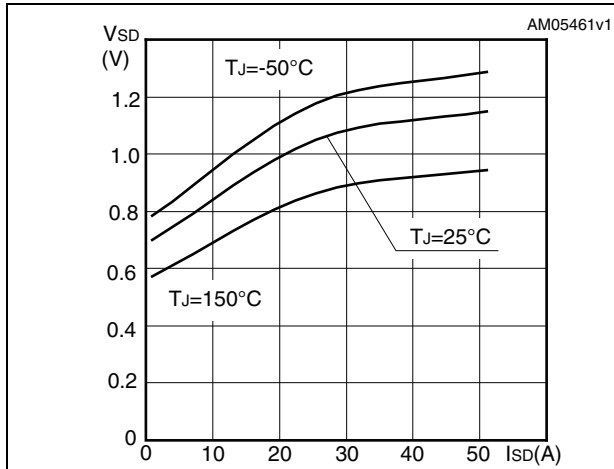


Figure 15. Normalized  $B_{VDSS}$  vs temperature

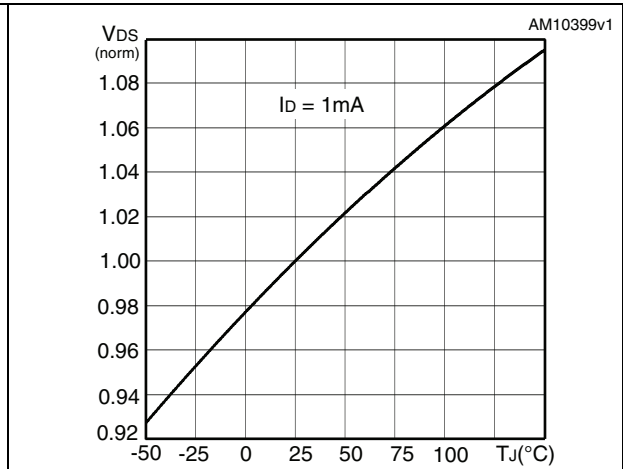
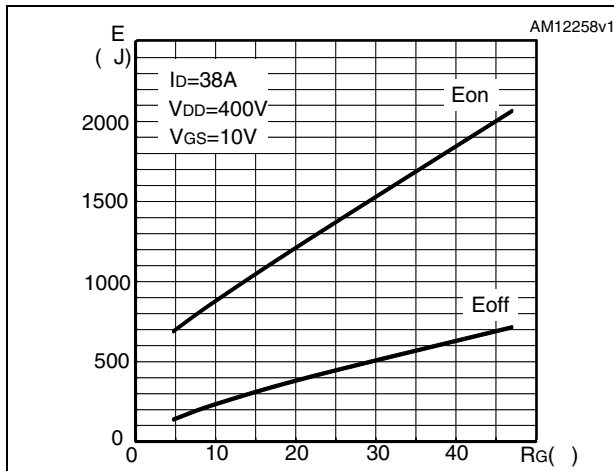


Figure 16. Switching losses vs gate resistance<sup>(1)</sup>



1. Eon including reverse recovery of a SiC diode



### 3 Test circuits

Figure 17. Switching times test circuit for resistive load

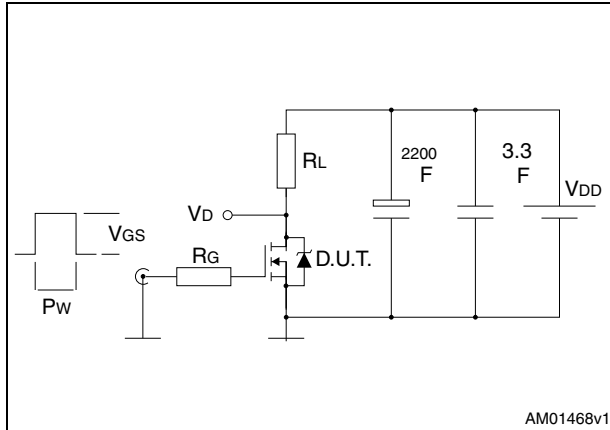


Figure 18. Gate charge test circuit

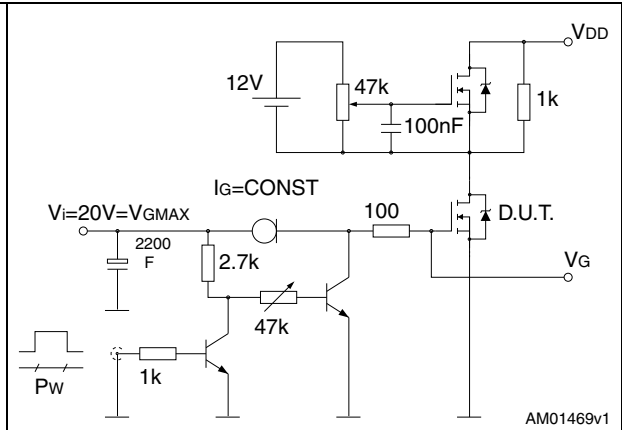


Figure 19. Test circuit for inductive load switching and diode recovery times

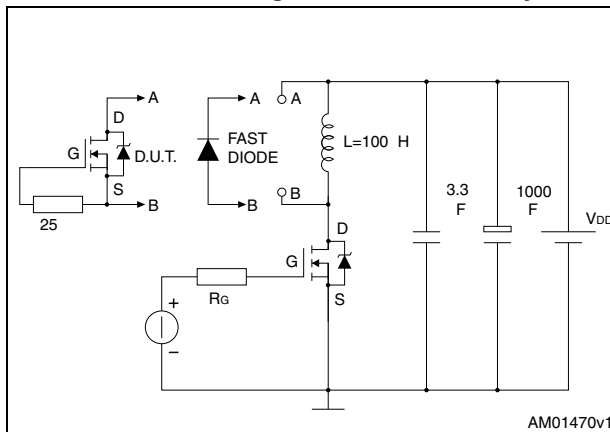


Figure 20. Unclamped inductive load test circuit

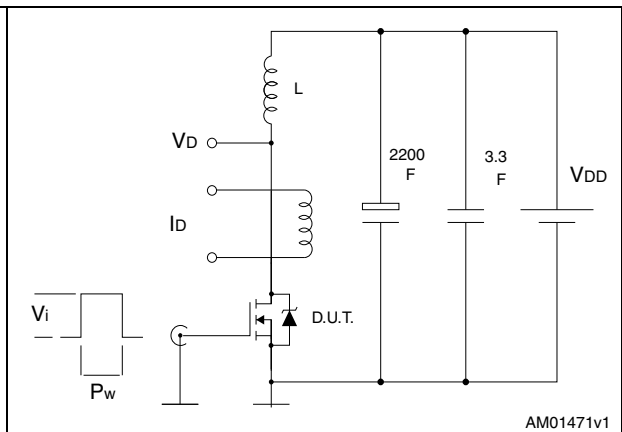


Figure 21. Unclamped inductive waveform

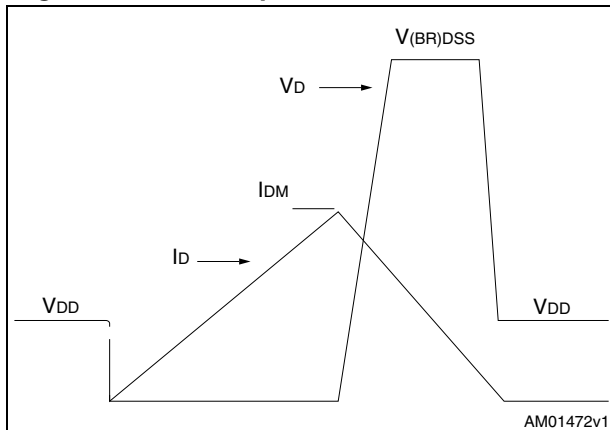
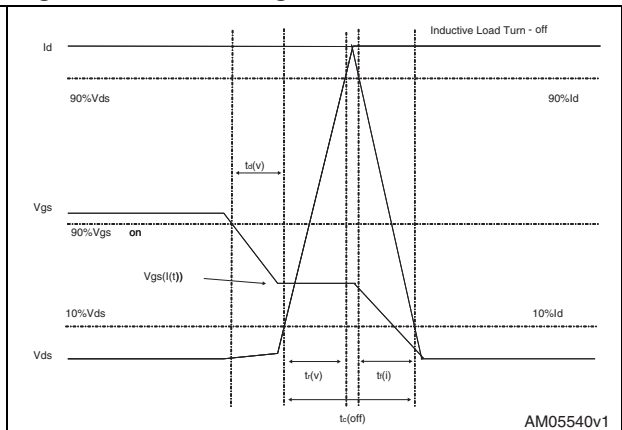


Figure 22. Switching time waveform



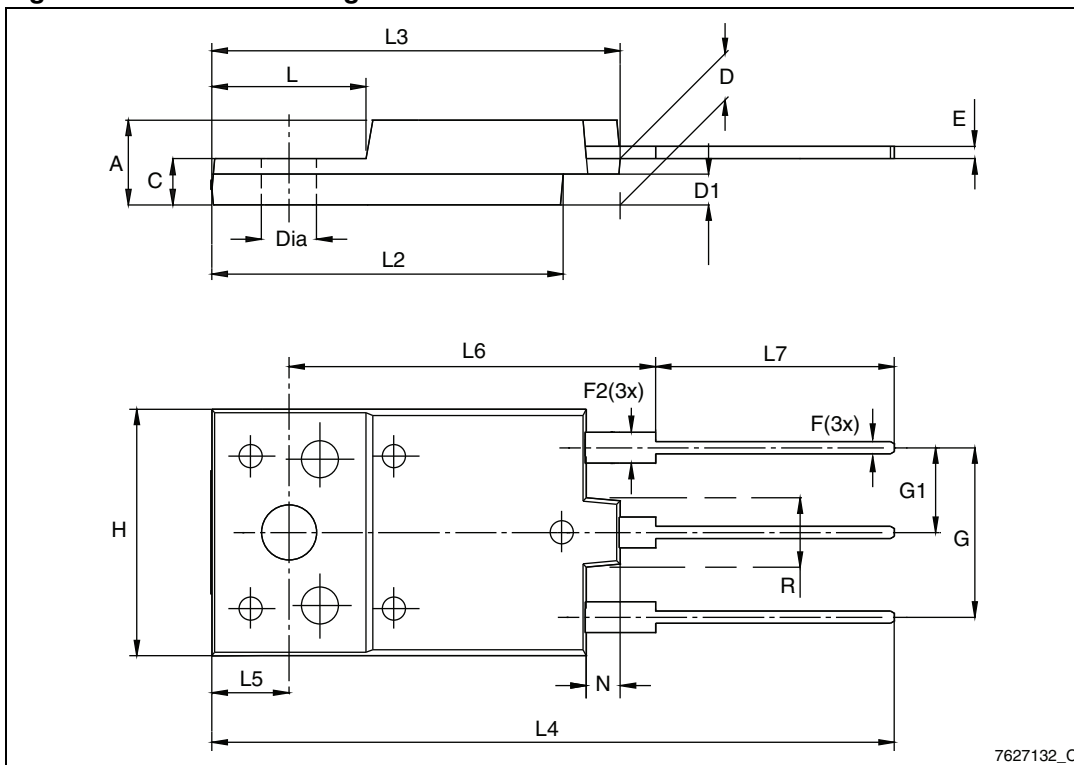
## 4 Package mechanical data

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 9. TO-3PF mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80

Figure 23. TO-3PF drawing

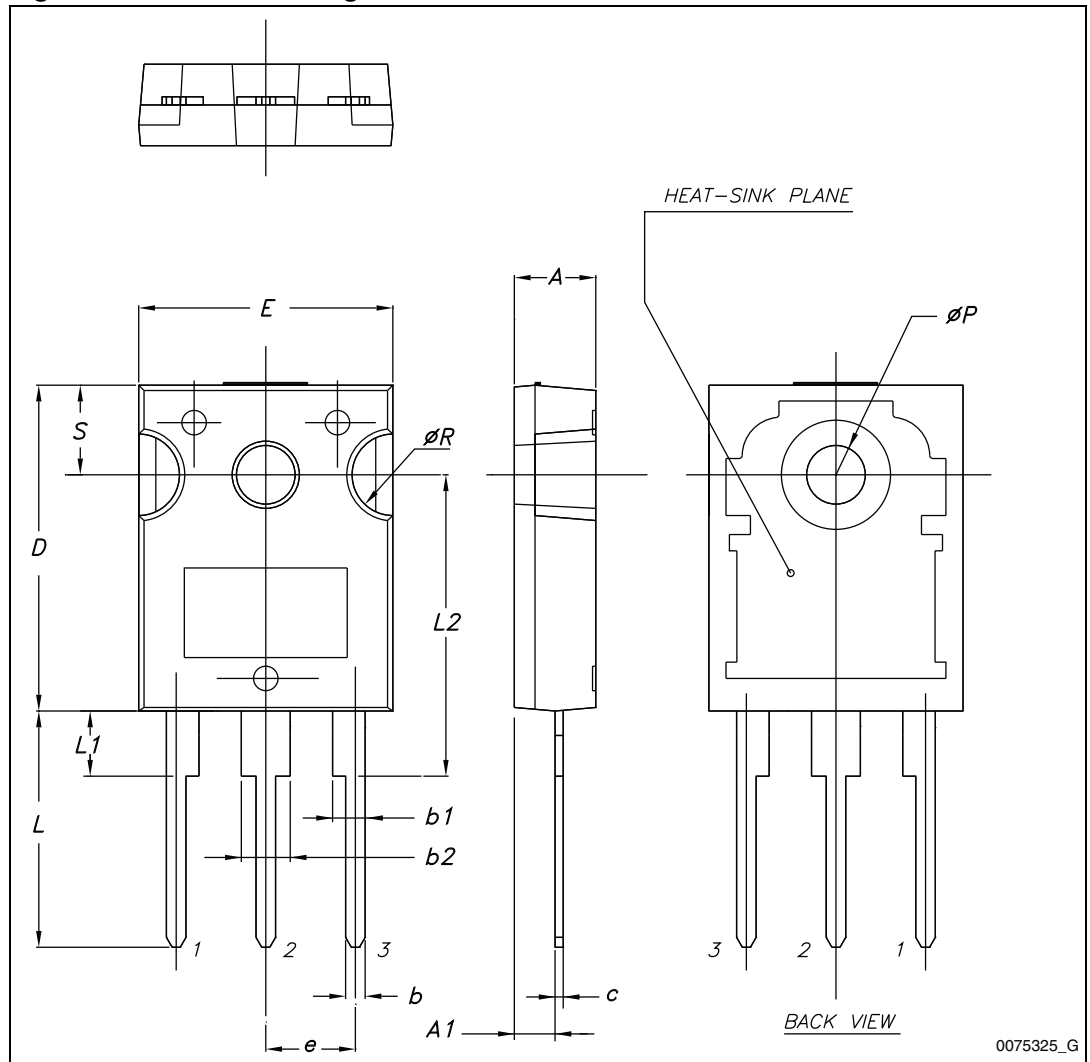


7627132\_C

Table 10. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Figure 24. TO-247 drawing



## 5 Revision history

Table 11. Document revision history

Date	Revision	Changes
27-Feb-2012	1	First release.
28-Sep-2012	2	<ul style="list-style-type: none"><li>– Modified: <a href="#">note 3</a> of <a href="#">Table 2</a>, values in <a href="#">Table 4</a>, typ. values in <a href="#">Table 6, 7</a> and <a href="#">8</a></li><li>– Curves inserted</li><li>– Minor text changes</li></ul>

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