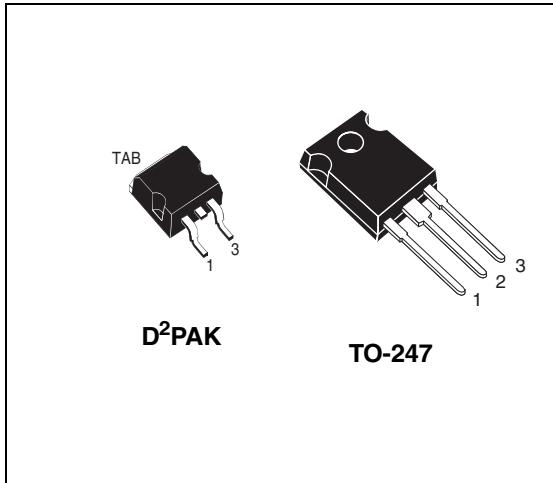
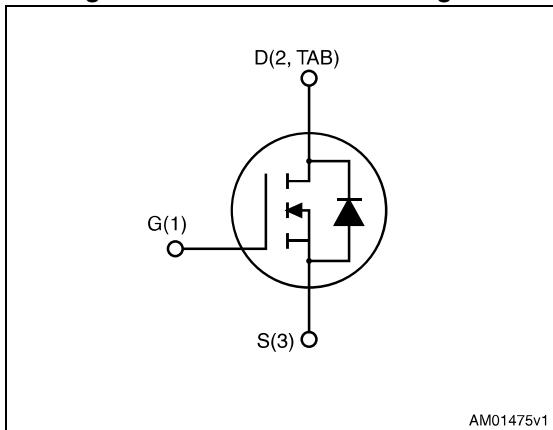


Automotive-grade N-channel 600 V, 0.097  $\Omega$  typ., 29 A FDmesh™ II Power MOSFETs (with fast diode) in D<sup>2</sup>PAK and TO-247 packages

Datasheet - production data



**Figure 1. Internal schematic diagram**



## Features

Order codes	V <sub>DSS</sub> @ T <sub>J</sub> max.	R <sub>D(on)</sub> max.	I <sub>D</sub>
STB36NM60ND	650 V	0.110 $\Omega$	29 A
STW36NM60ND			

- Designed for automotive applications and AEC-Q101 qualified
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

## Applications

- Automotive switching applications

## Description

These FDmesh™ II Power MOSFETs with intrinsic fast-recovery body diode are produced using the second generation of MDmesh™ technology. Utilizing a new strip-layout vertical structure, these revolutionary devices feature extremely low on-resistance and superior switching performance. They are ideal for bridge topologies and ZVS phase-shift converters.

**Table 1. Device summary**

Order codes	Marking	Package	Packaging
STB36NM60ND	36NM60ND	D <sup>2</sup> PAK	Tape and reel
STW36NM60ND	36NM60ND	TO-247	Tube

## 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>9</b>
<b>4</b>	<b>Package mechanical data</b>	<b>10</b>
<b>5</b>	<b>Packaging mechanical data</b>	<b>15</b>
<b>6</b>	<b>Revision history</b>	<b>17</b>

## 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate- source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25^\circ\text{C}$	29	A
$I_D$	Drain current (continuous) at $T_C = 100^\circ\text{C}$	18	A
$I_{DM}^{(1)}$	Drain current (pulsed)	116	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	190	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_J$	Max. operating junction temperature	150	

1. Pulse width limited by safe operating area  
 2.  $I_{SD} \leq 29 \text{ A}$ ,  $di/dt \leq 600 \text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(\text{BR})DSS}$ ,  $V_{DS\text{Peak}} < V_{(\text{BR})DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK	TO-247	
$R_{thj-case}$	Thermal resistance junction-case max	0.66		$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max		50	$^\circ\text{C/W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb max	30		$^\circ\text{C/W}$

1. When mounted on FR-4 board of 1 inch<sup>2</sup>, 2 oz Cu.

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max)	7	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50 \text{ V}$ )	110	mJ

## 2 Electrical characteristics

( $T_{CASE} = 25^\circ\text{C}$  unless otherwise specified)

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	600			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600 \text{ V}$ $V_{DS} = 600 \text{ V}, T_C = 125^\circ\text{C}$			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
$V_{GS(\text{th})}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$	3	4	5	V
$R_{DS(\text{on})}$	Static drain-source on-resistance	$V_{GS} = 10 \text{ V}, I_D = 14.5 \text{ A}$		0.097	0.110	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0$	-	2785	-	pF
$C_{oss}$	Output capacitance		-	168	-	pF
$C_{rss}$	Reverse transfer capacitance		-	5	-	pF
$C_{oss \text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0 \text{ to } 480 \text{ V}$	-	438	-	pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300 \text{ V}, I_D = 14.5 \text{ A}$ $R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 16</a> and <a href="#">21</a> )	-	30	-	ns
$t_r$	Rise time		-	53.4	-	ns
$t_{d(off)}$	Turn-off delay time		-	111	-	ns
$t_f$	Fall time		-	61.8	-	ns
$Q_g$	Total gate charge	$V_{DD} = 480 \text{ V}, I_D = 29 \text{ A}, V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 17</a> )	-	80.4	-	nC
$Q_{gs}$	Gate-source charge		-	16	-	nC
$Q_{gd}$	Gate-drain charge		-	41.4	-	nC
$R_g$	Gate input resistance	f=1 MHz, open drain	-	2.87	-	$\Omega$

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

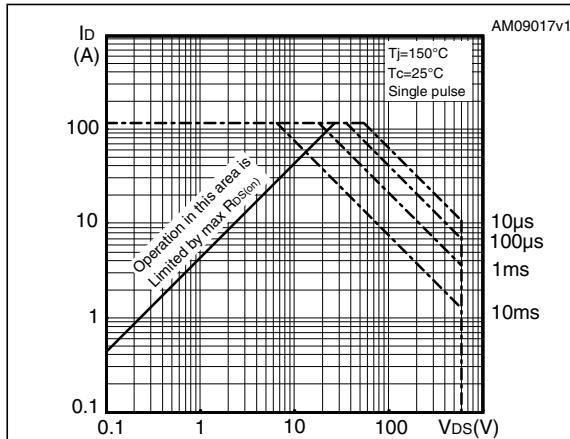
Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}^{(1)}$	Source-drain current Source-drain current (pulsed)		-		29 116	A A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 29 \text{ A}, V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 29 \text{ A}, V_{DD} = 60 \text{ V}$ $di/dt=100 \text{ A}/\mu\text{s}$ (see <a href="#">Figure 18</a> )	-	175		ns
$Q_{rr}$	Reverse recovery charge		-	1.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	16		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 29 \text{ A}, V_{DD} = 60 \text{ V}$ $di/dt=100 \text{ A}/\mu\text{s},$ $T_J = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 18</a> )	-	255		ns
$Q_{rr}$	Reverse recovery charge		-	2.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	20		A

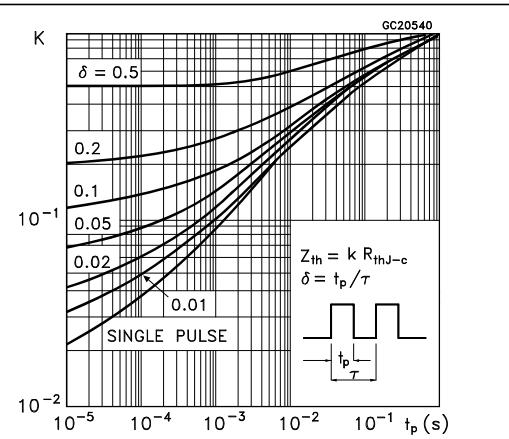
1. Pulse width limited by safe operating area.
2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

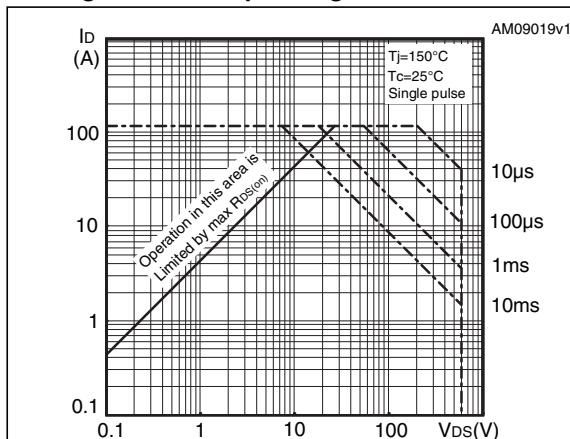
**Figure 2. Safe operating area for D<sup>2</sup>PAK**



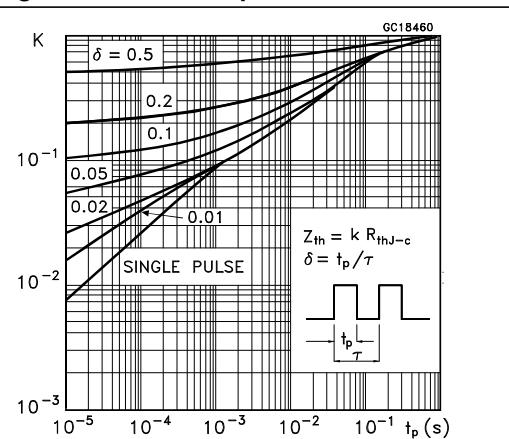
**Figure 3. Thermal impedance for D<sup>2</sup>PAK**



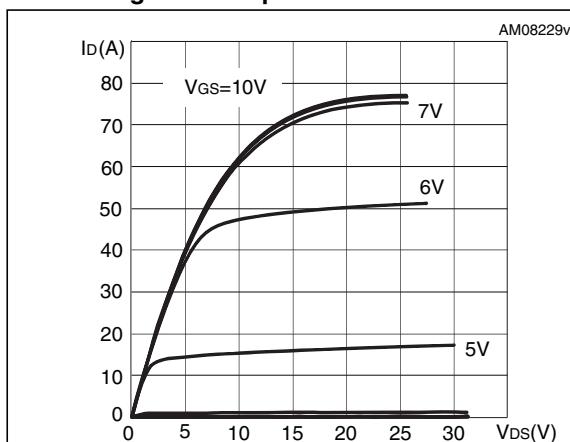
**Figure 4. Safe operating area for TO-247**



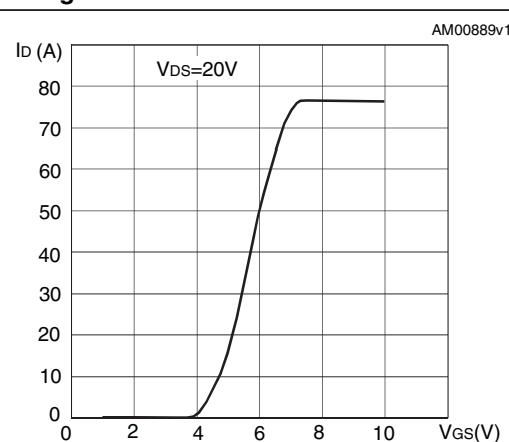
**Figure 5. Thermal impedance for TO-247**

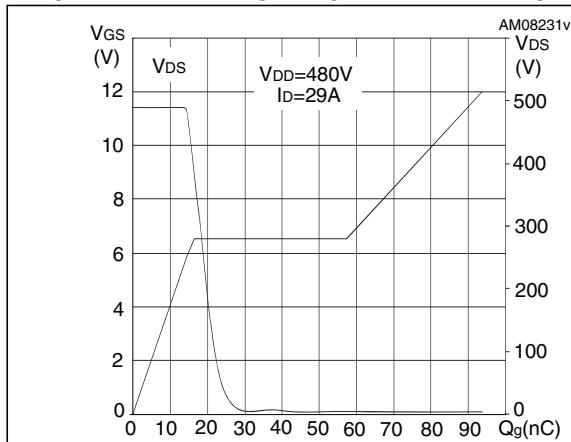
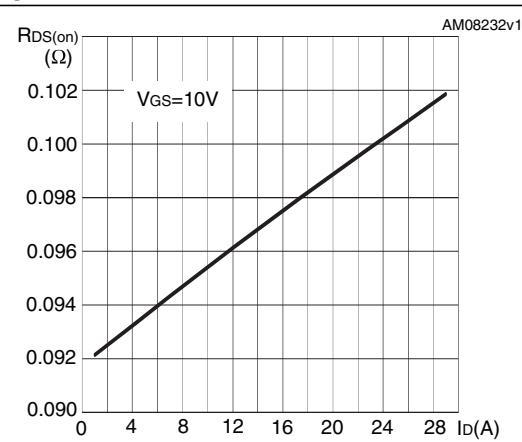
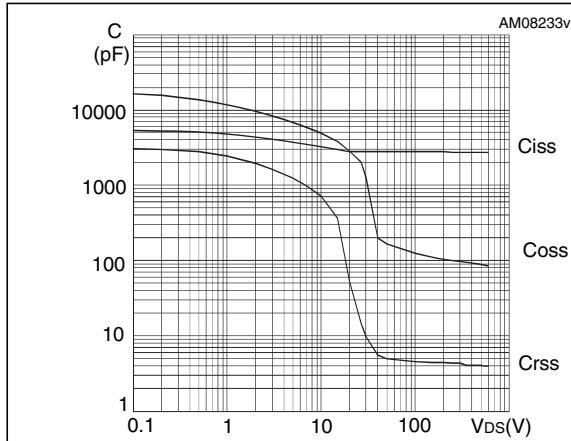
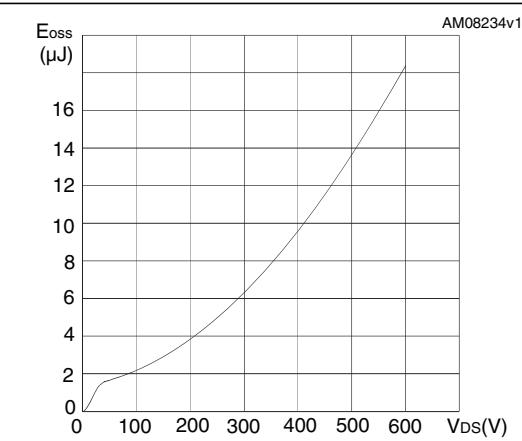
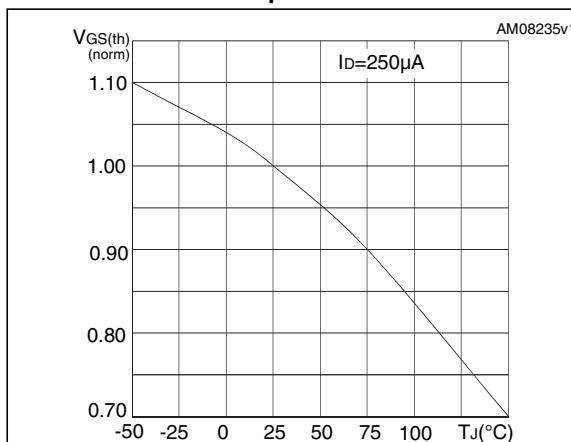
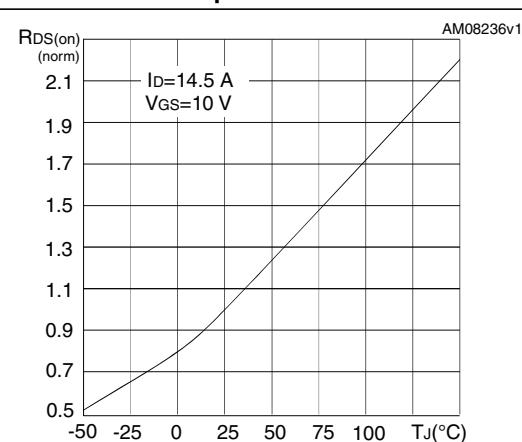


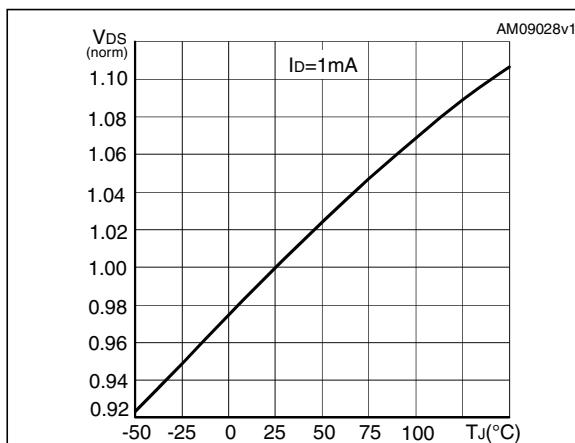
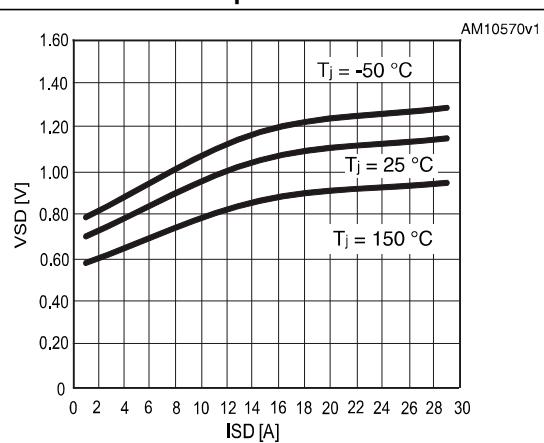
**Figure 6. Output characteristics**



**Figure 7. Transfer characteristics**

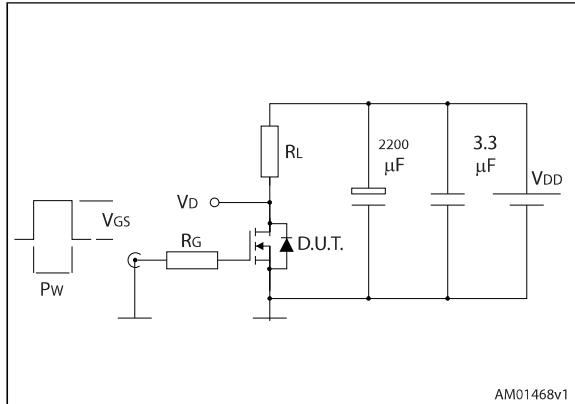


**Figure 8. Gate charge vs gate-source voltage****Figure 9. Static drain-source on-resistance****Figure 10. Capacitance variations****Figure 11. Output capacitance stored energy****Figure 12. Normalized gate threshold voltage vs temperature****Figure 13. Normalized on-resistance vs temperature**

**Figure 14. Normalized  $V_{DS}$  vs temperature****Figure 15. Source-drain diode forward vs temperature**

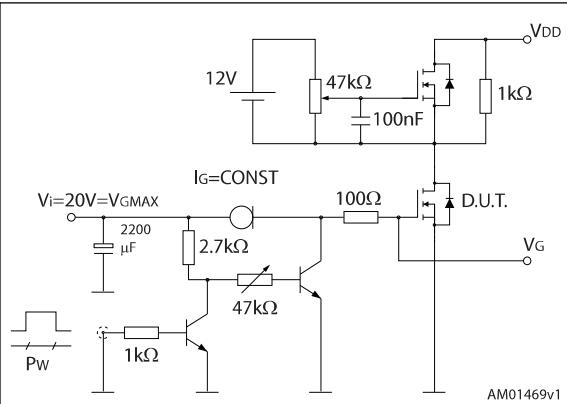
### 3 Test circuits

**Figure 16. Switching times test circuit for resistive load**



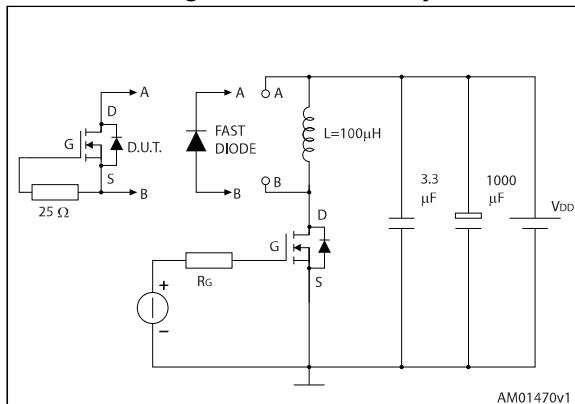
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**Figure 17. Gate charge test circuit**



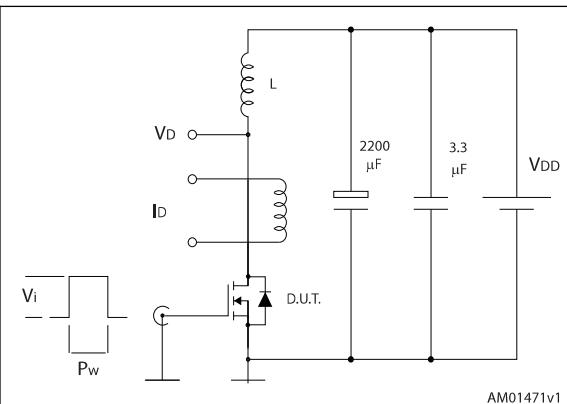
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**Figure 18. Test circuit for inductive load switching and diode recovery times**



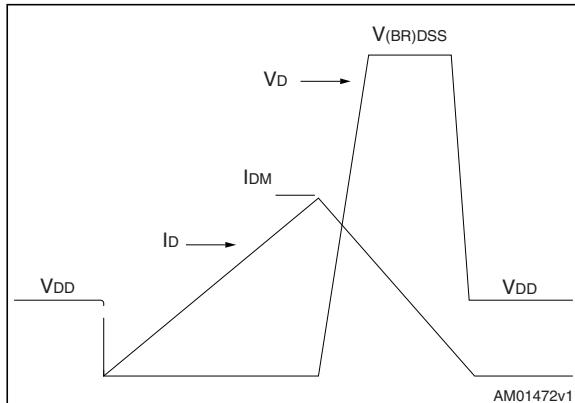
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**Figure 19. Unclamped inductive load test circuit**



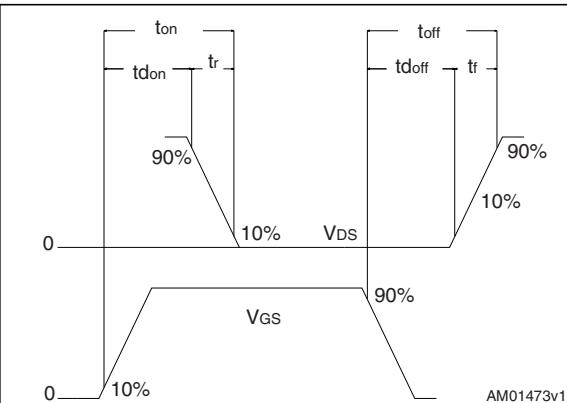
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**Figure 20. Unclamped inductive waveform**



AM01472v1

**Figure 21. Switching time waveform**



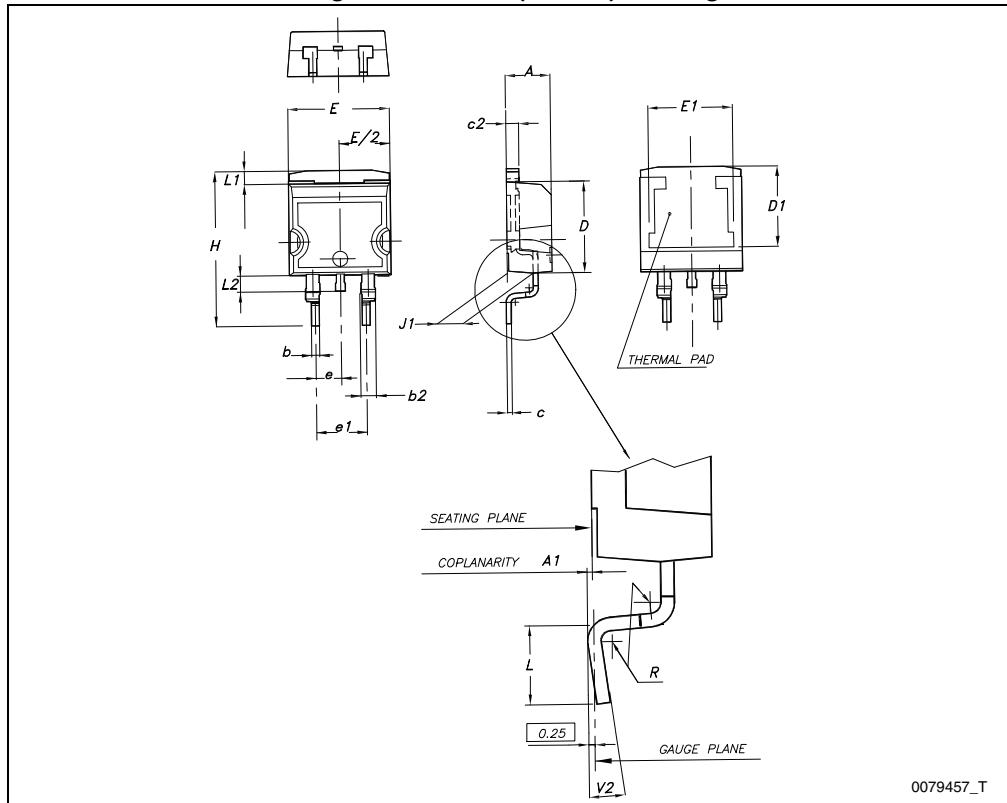
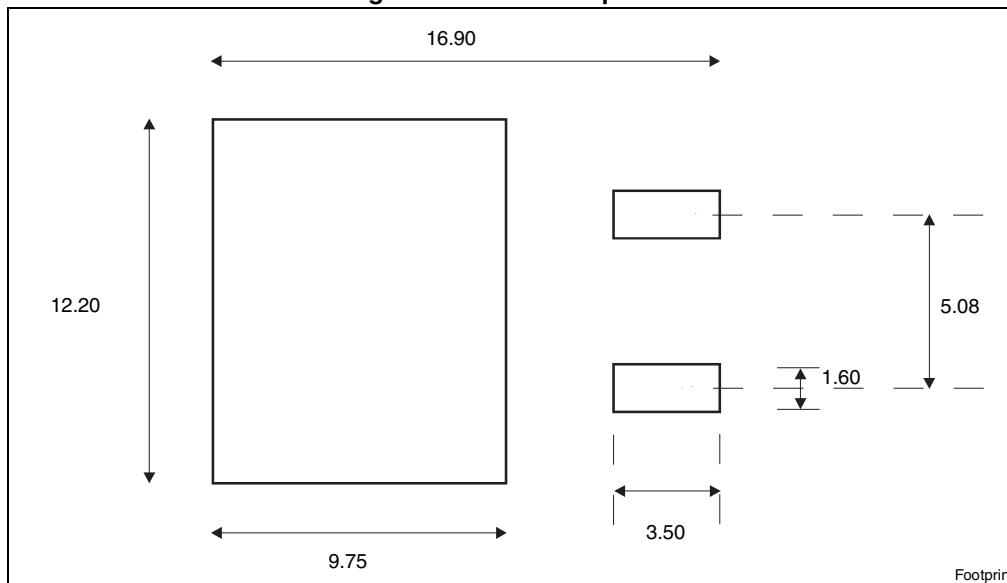
AM01473v1

## 4 Package mechanical data

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.

**Table 8. D<sup>2</sup>PAK (TO-263) mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

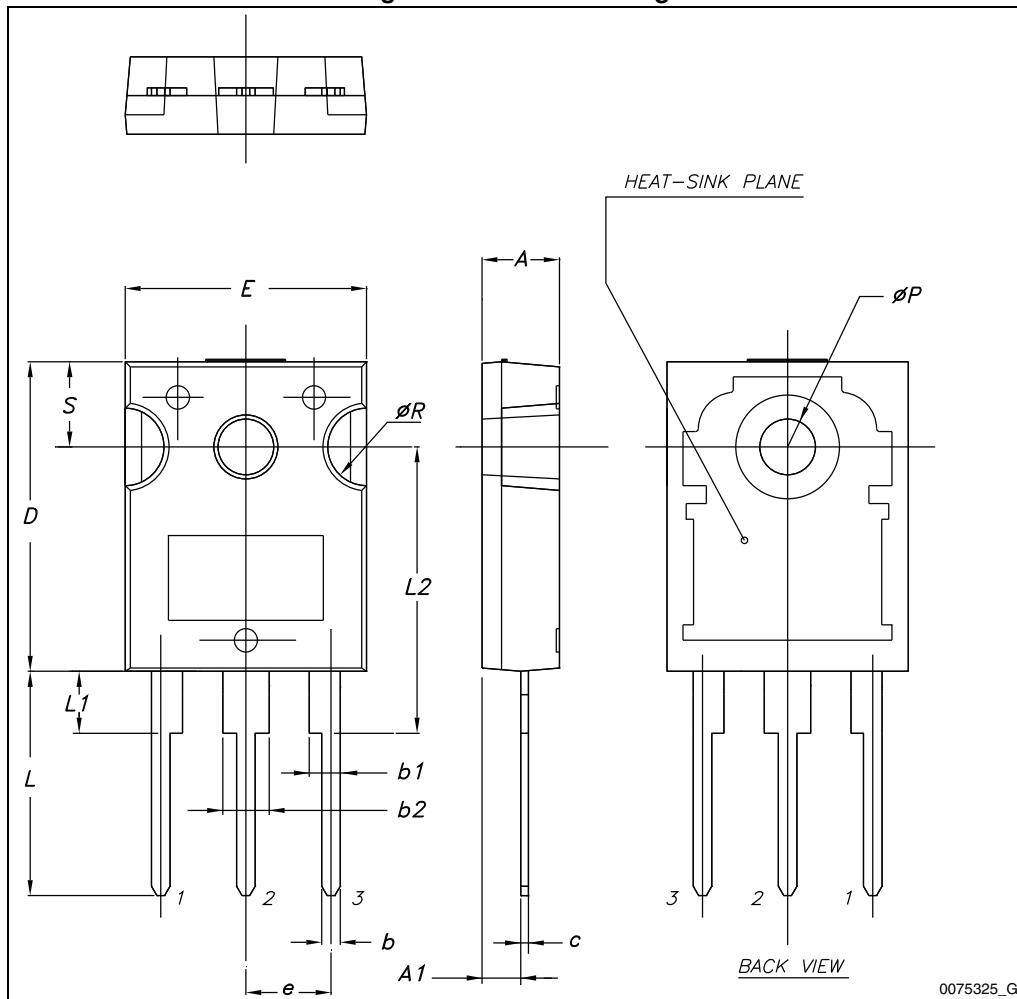
Figure 22. D<sup>2</sup>PAK (TO-263) drawingFigure 23. D<sup>2</sup>PAK footprint<sup>(a)</sup>

a. All dimensions are in millimeters

**Table 9. 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 Packaging mechanical data

Table 10. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

Dim.	Tape		Reel		
	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1		Base qty	1000
P2	1.9	2.1		Bulk qty	1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 25. Tape

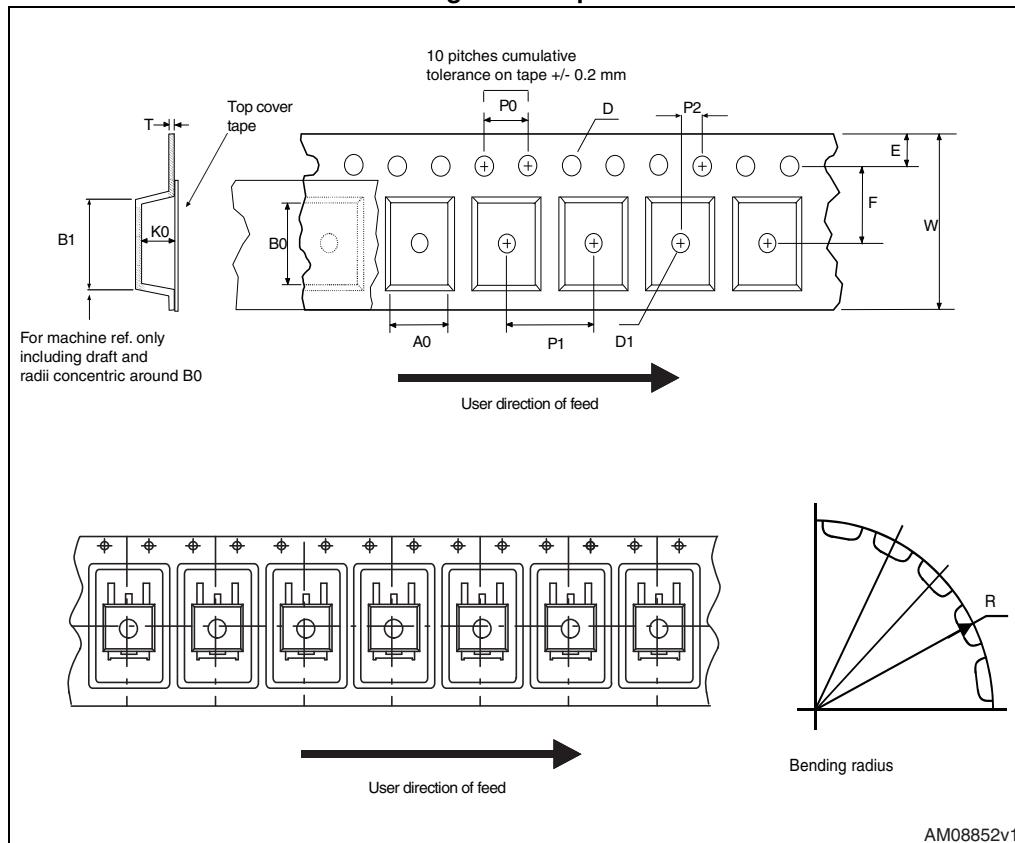
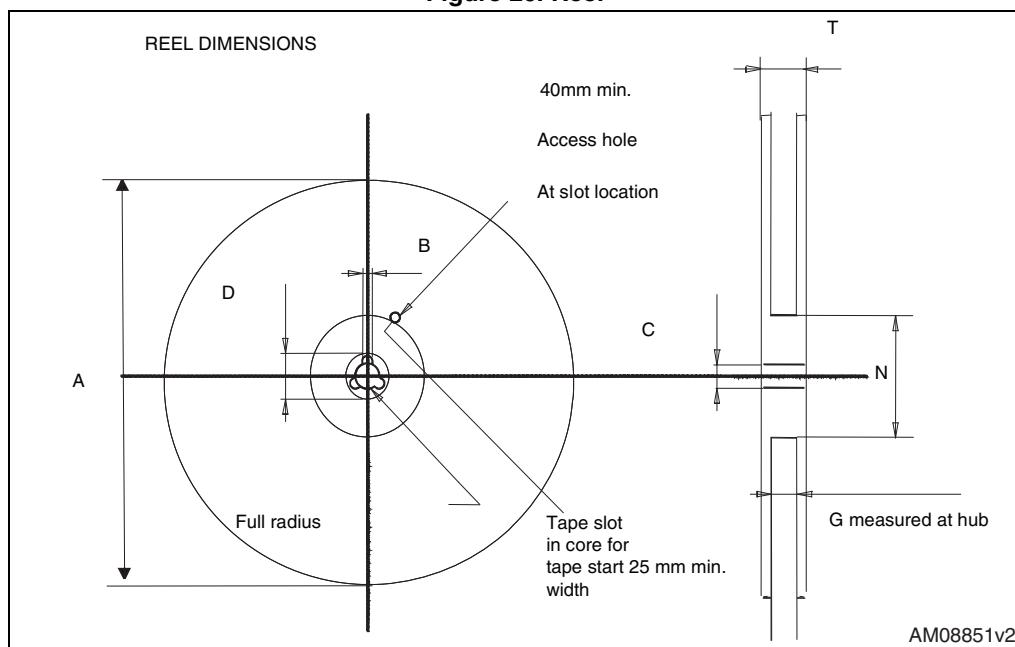


Figure 26. Reel



## 6 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
24-Oct-2012	1	Initial release.
01-Jul-2013	2	<ul style="list-style-type: none"><li>– Updated <a href="#">Figure 1: Internal schematic diagram</a>.</li><li>– Added <a href="#">Section 2.1: Electrical characteristics (curves)</a>.</li></ul>
02-Oct-2013	3	<ul style="list-style-type: none"><li>– Modified: <math>E_{AS}</math> in <a href="#">Table 4</a>, <math>C_{oss}</math> eq. typical value in <a href="#">Table 6</a>, <a href="#">Figure 13</a></li><li>– Minor text changes</li></ul>

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