

N-channel 600 V, 0.17  $\Omega$  typ., 17 A FDmesh™ II Power MOSFET  
in D<sup>2</sup>PAK, TO-220FP, TO-220 and TO-247 packages

Datasheet - production data

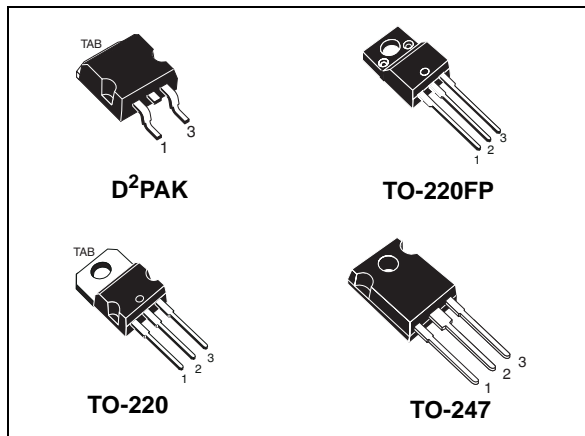
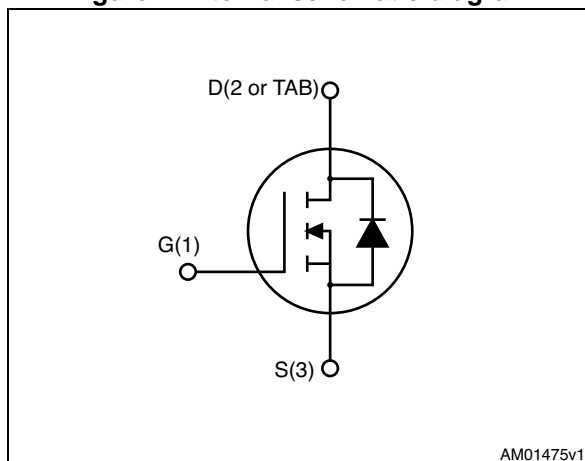


Figure 1. Internal schematic diagram



## Features

Order codes	V <sub>DSS</sub> @ T <sub>Jmax</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB21NM60ND	650 V	0.22 $\Omega$	17 A
STF21NM60ND	650 V	0.22 $\Omega$	17 A
STP21NM60ND	650 V	0.22 $\Omega$	17 A
STW21NM60ND	650 V	0.22 $\Omega$	17 A

- Intrinsic fast-recovery body diode
- Worldwide best R<sub>DS(on)</sub>\* area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

## Applications

- 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
STB21NM60ND	21NM60ND	D <sup>2</sup> PAK	Tape and reel
STF21NM60ND	21NM60ND	TO-220FP	Tube
STP21NM60ND	21NM60ND	TO-220	Tube
STW21NM60ND	21NM60ND	TO-247	Tube

## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>5</b>
	2.1 Electrical characteristics (curves) .....	7
<b>3</b>	<b>Test circuits</b> .....	<b>10</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>11</b>
<b>5</b>	<b>Packing mechanical data</b> .....	<b>19</b>
<b>6</b>	<b>Revision history</b> .....	<b>21</b>

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220, D <sup>2</sup> PAK TO-247	TO-220FP	
V <sub>DS</sub>	Drain-source voltage	600		V
V <sub>GS</sub>	Gate- source voltage	±25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	17	17 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	10	10 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	68	68 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	140	30	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	40		V/ns
V <sub>iso</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)		2500	V
T <sub>stg</sub>	Storage temperature	- 55 to 150		°C
T <sub>J</sub>	Max. operating junction temperature	150		

1. Limited by maximum junction temperature.

2. Pulse width limited by safe operating area.

3.  $I_{SD} \leq 17$  A,  $di/dt \leq 600$  A/ $\mu$ s,  $V_{DD} = 80\% V_{(BR)DSS}$ ;  $V_{DS(peak)} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		D <sup>2</sup> PAK	TO-220FP	TO-220	TO-247	
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.89	4.17	0.89		°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max		62.5		50	°C/W

**Table 4. Avalanche characteristics**

Symbol	Parameter	Max value	Unit
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	8.5	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AS</sub> , V <sub>DD</sub> = 50 V)	610	mJ

## 2 Electrical characteristics

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

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	600			V
$dv/dt^{(1)}$	Drain source voltage slope	$V_{DD} = 480 \text{ V}, I_D = 17 \text{ A}, V_{GS} = 10 \text{ V}$	48			V/ns
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600 \text{ V}$ $V_{DS} = 600 \text{ V}, T_C = 125^{\circ}C$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20 \text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10 \text{ V}, I_D = 8.5 \text{ A}$		0.170	0.220	$\Omega$

1. Characteristic value at turn off on inductive load

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0$	-	1800	-	pF
$C_{oss}$	Output capacitance			90		pF
$C_{rss}$	Reverse transfer capacitance			8		pF
$C_{oss \text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0 \text{ to } 480 \text{ V}$	-	300	-	pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300 \text{ V}, I_D = 8.5 \text{ A}$ $R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see Figure 23), (see Figure 18)	-	18	-	ns
$t_r$	Rise time			16		ns
$t_{d(off)}$	Turn-off delay time			70		ns
$t_f$	Fall time			48		ns
$Q_g$	Total gate charge	$V_{DD} = 480 \text{ V}, I_D = 17 \text{ A}, V_{GS} = 10 \text{ V},$ (see Figure 19)	-	60	-	nC
$Q_{gs}$	Gate-source charge			10		nC
$Q_{gd}$	Gate-drain charge			30		nC
$R_G$	Gate input resistance	f=1 MHz Gate DC Bias=0 Test signal level=20 mV Open drain	-	3	-	$\Omega$

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
$I_{SD}$	Source-drain current				17	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				68	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 17\text{ A}, V_{GS} = 0$			1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 17\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 20)		150		ns
$Q_{rr}$	Reverse recovery charge			0.90		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			13		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 17\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$ (see Figure 20)		210		ns
$Q_{rr}$	Reverse recovery charge			1.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			15		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-220, D<sup>2</sup>PAK Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK

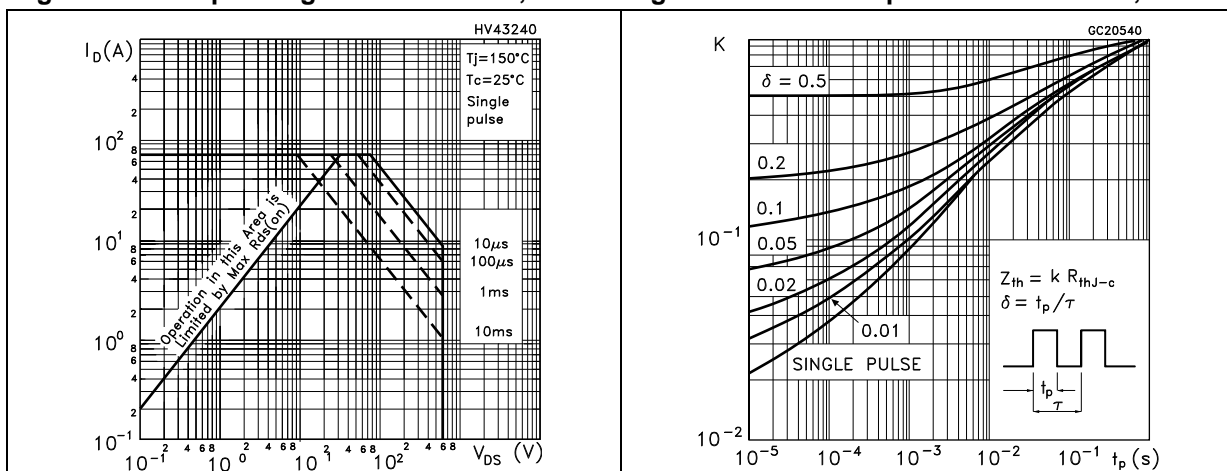


Figure 4. Safe operating area for TO-220FP

Figure 5. Thermal impedance for TO-220FP

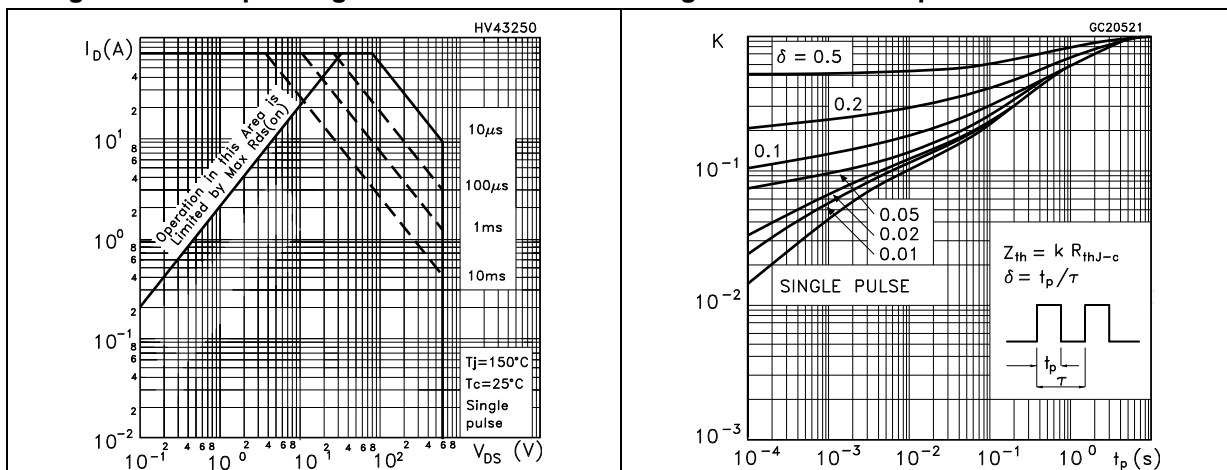


Figure 6. Safe operating area for TO-247

Figure 7. Thermal impedance for TO-247

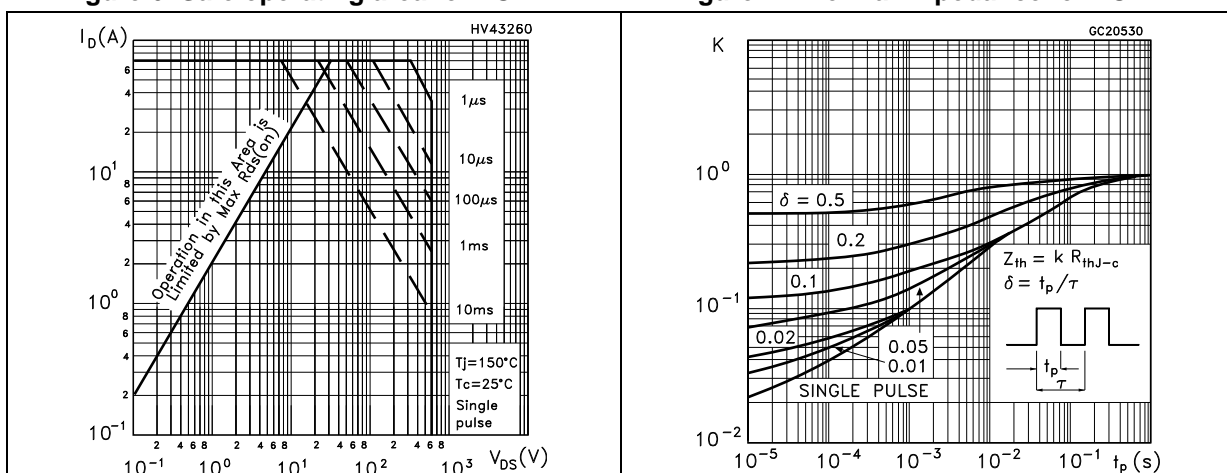


Figure 8. Output characteristics

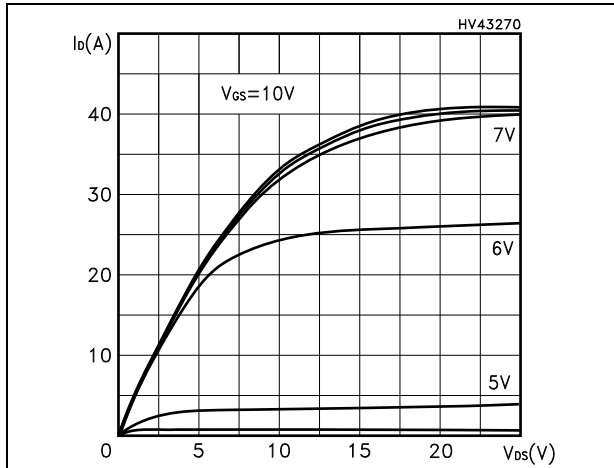


Figure 9. Transfer characteristics

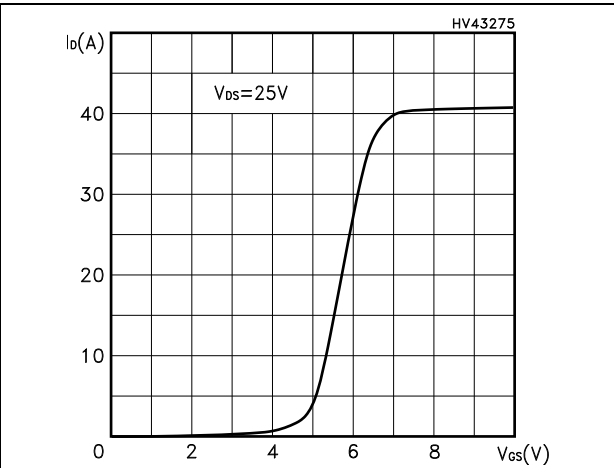


Figure 10. Transconductance

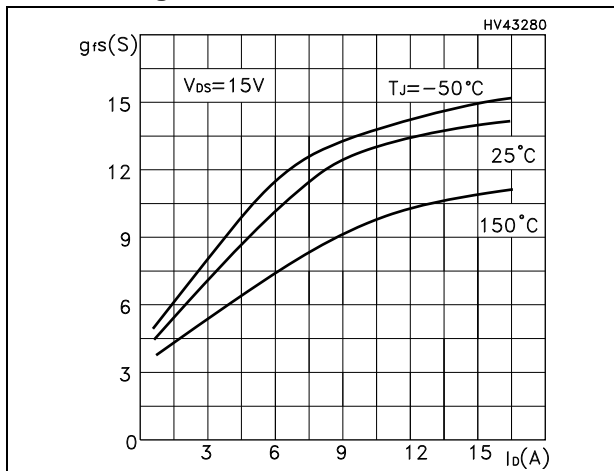


Figure 11. Static drain-source on-resistance

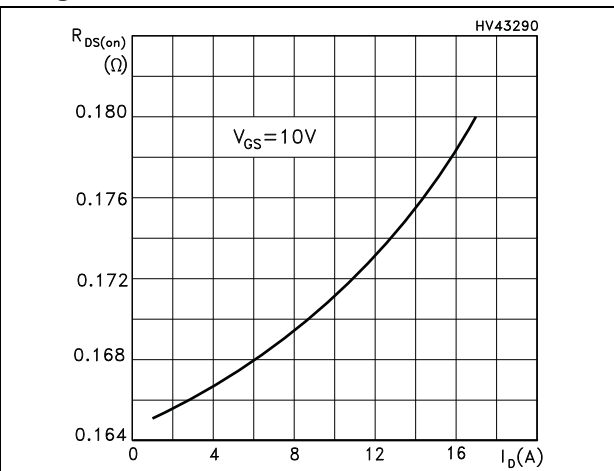


Figure 12. Gate charge vs gate-source voltage

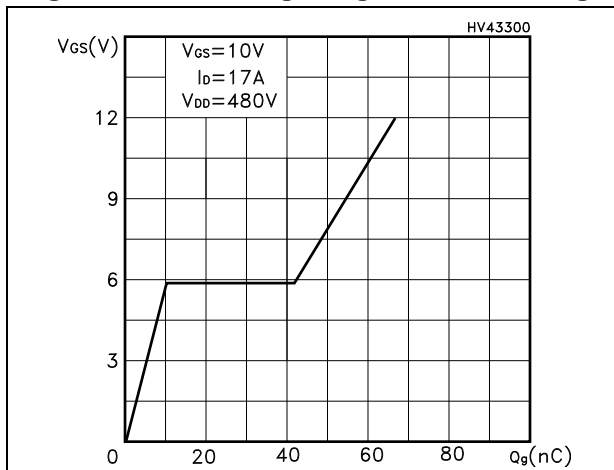


Figure 13. Capacitance variations

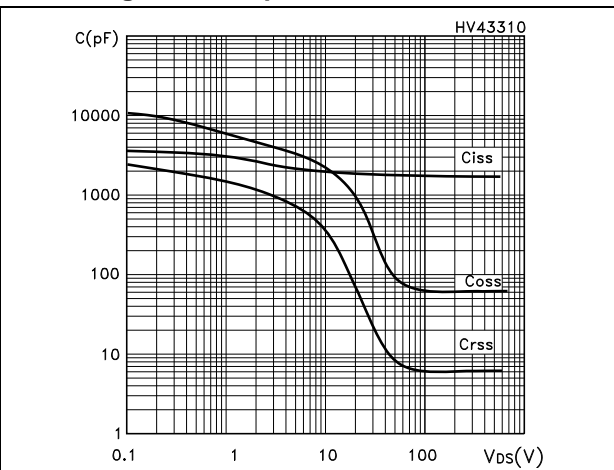


Figure 14. Normalized gate threshold voltage vs temperature

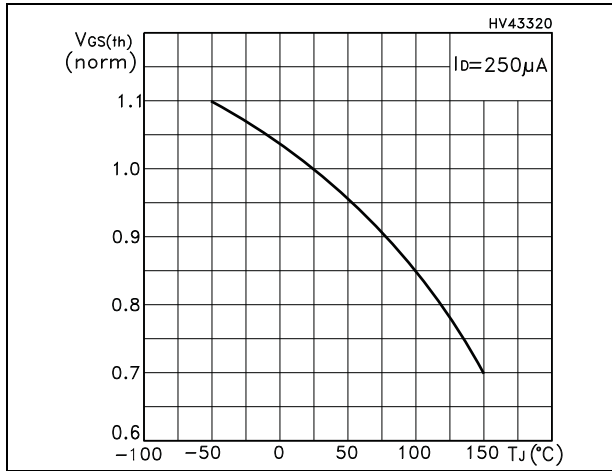


Figure 15. Normalized on-resistance vs temperature

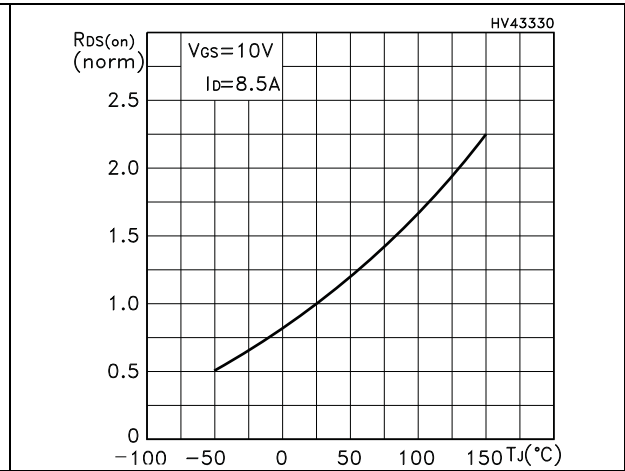


Figure 16. Source-drain diode forward characteristics

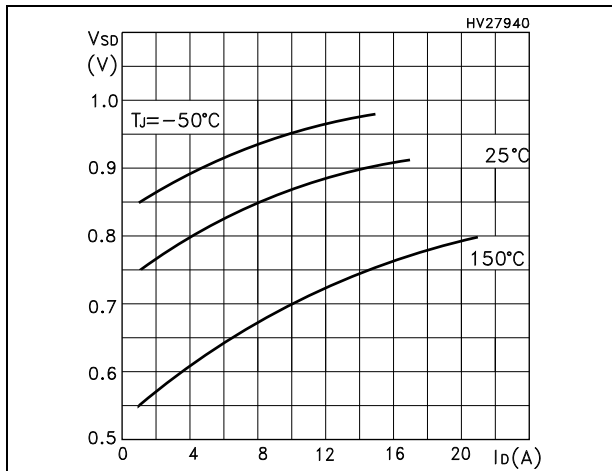
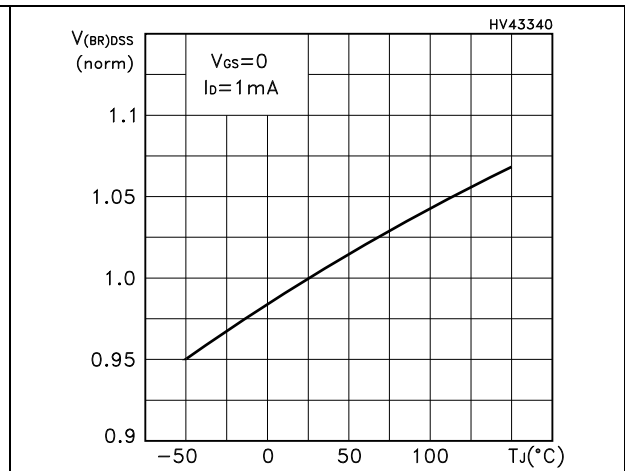


Figure 17. Normalized BV<sub>DSS</sub> vs temperature





### 3 Test circuits

Figure 18. Switching times test circuit for resistive load



Figure 19. Gate charge test circuit

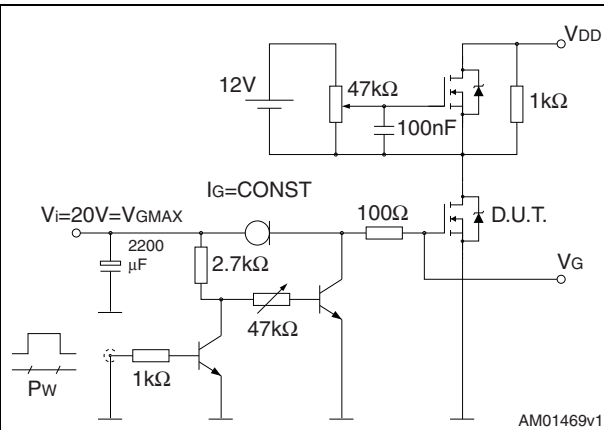


Figure 20. Test circuit for inductive load switching and diode recovery times

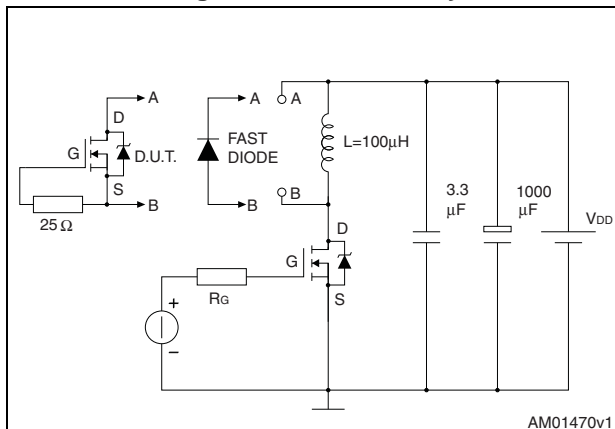


Figure 21. Unclamped inductive load test circuit

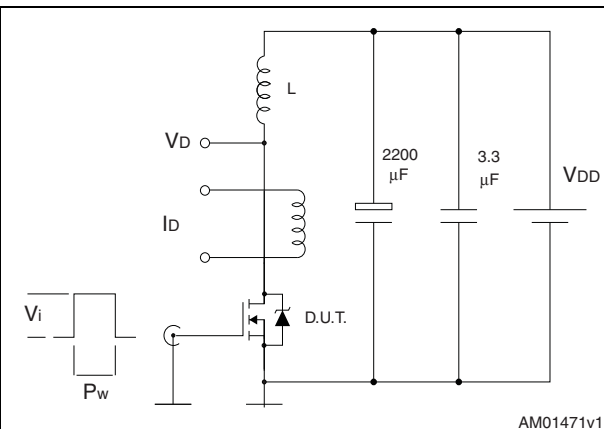


Figure 22. Unclamped inductive waveform

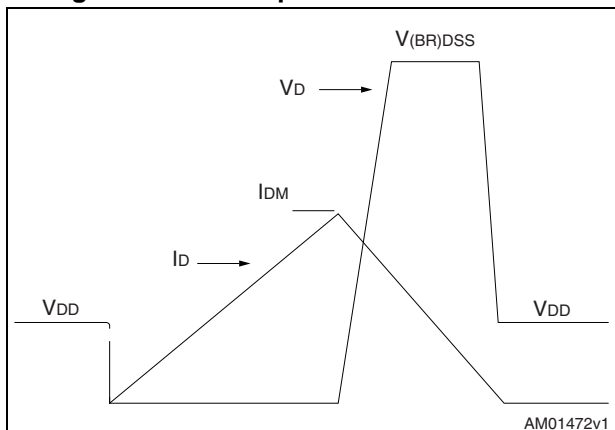
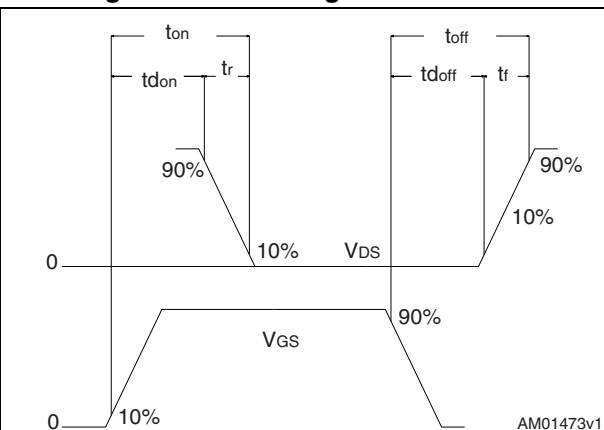


Figure 23. Switching time waveform



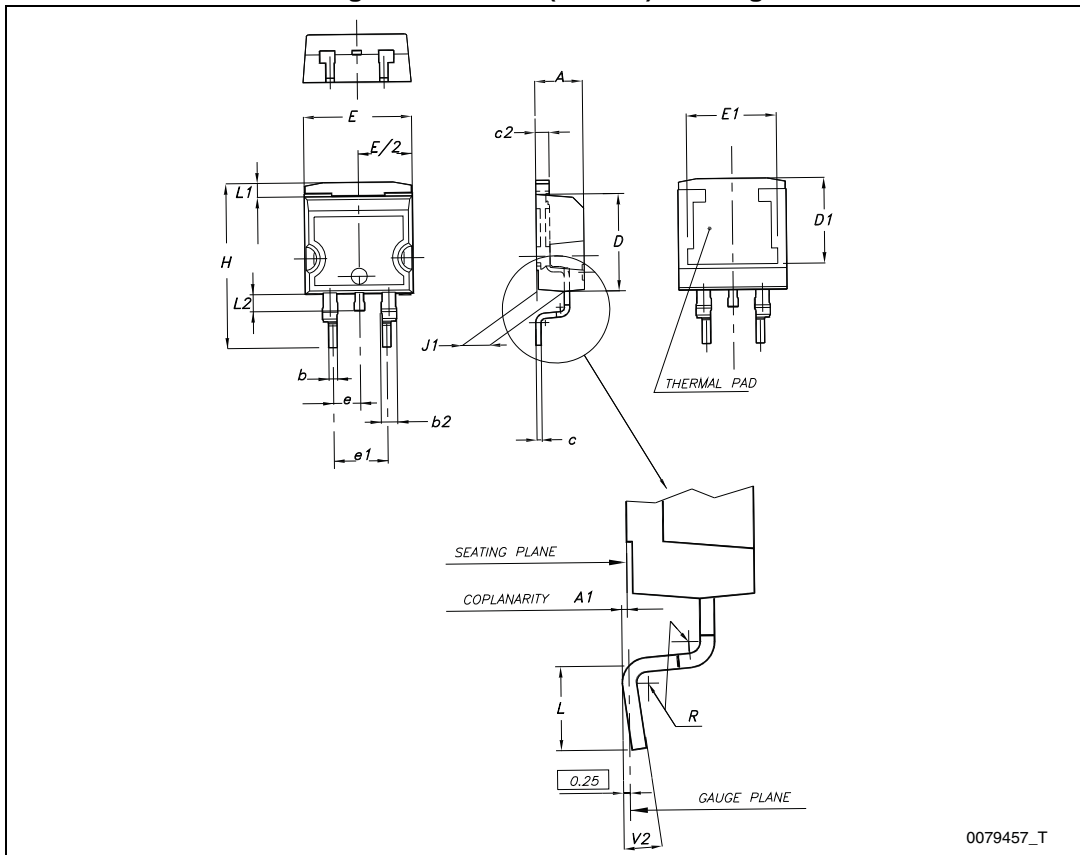
## 4 Package mechanical data

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

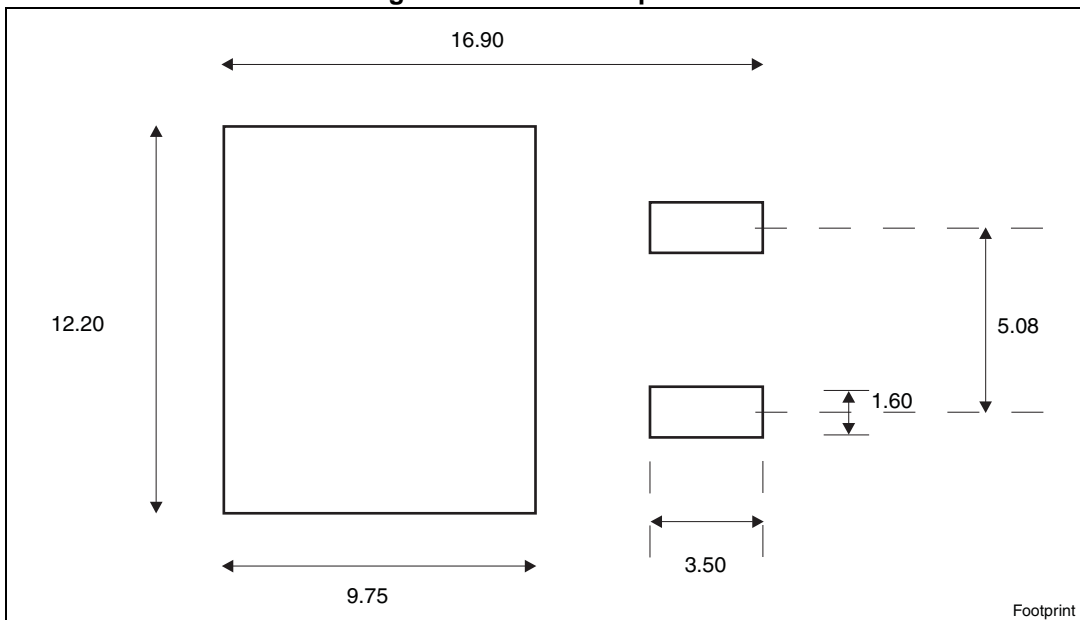
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 24. D<sup>2</sup>PAK (TO-263) drawing



0079457\_T

Figure 25. D<sup>2</sup>PAK footprint<sup>(a)</sup>

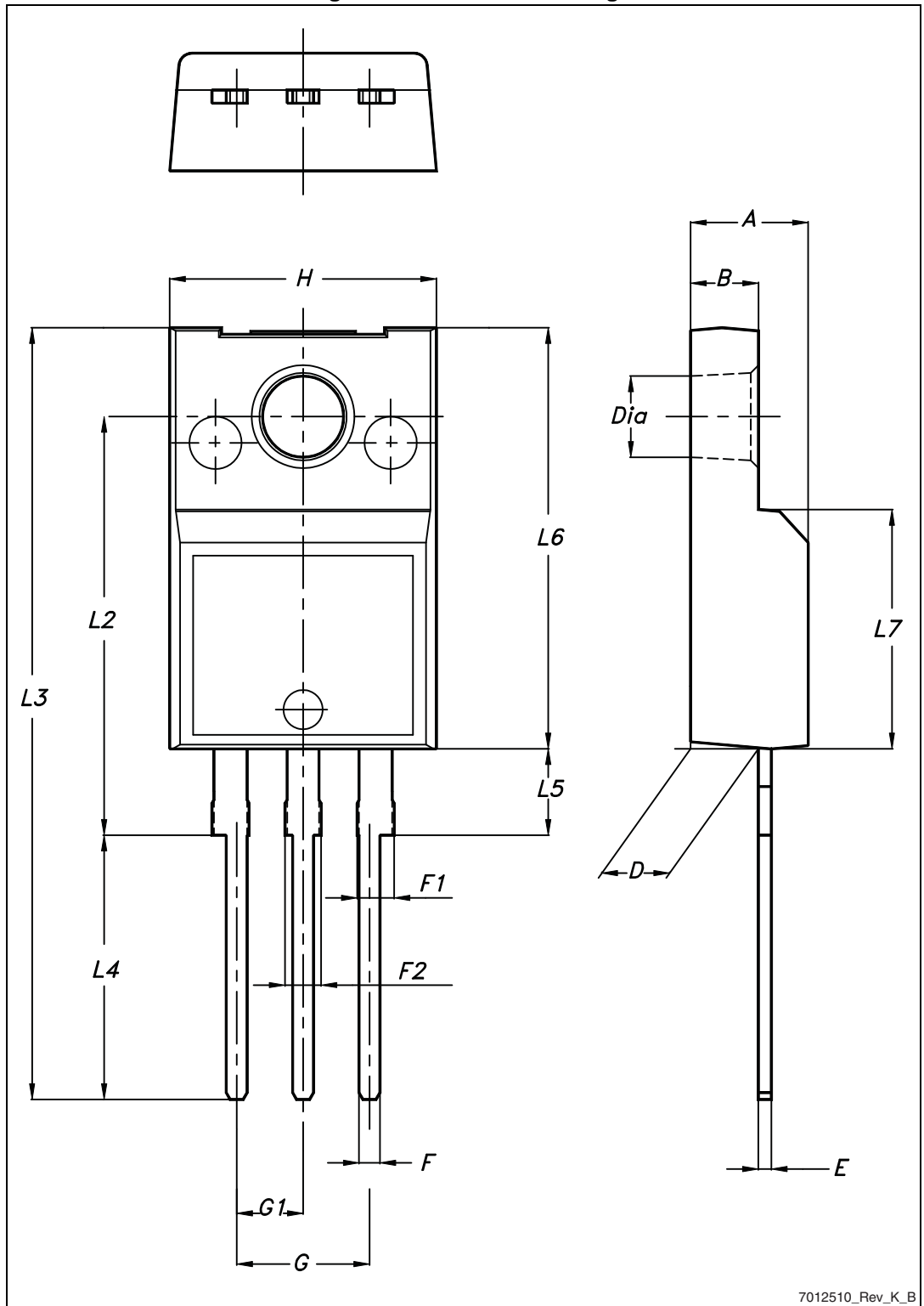


a. All dimensions are in millimeters

Table 9. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 26. TO-220FP drawing



7012510\_Rev\_K\_B

Table 10. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

Figure 27. TO-220 type A drawing

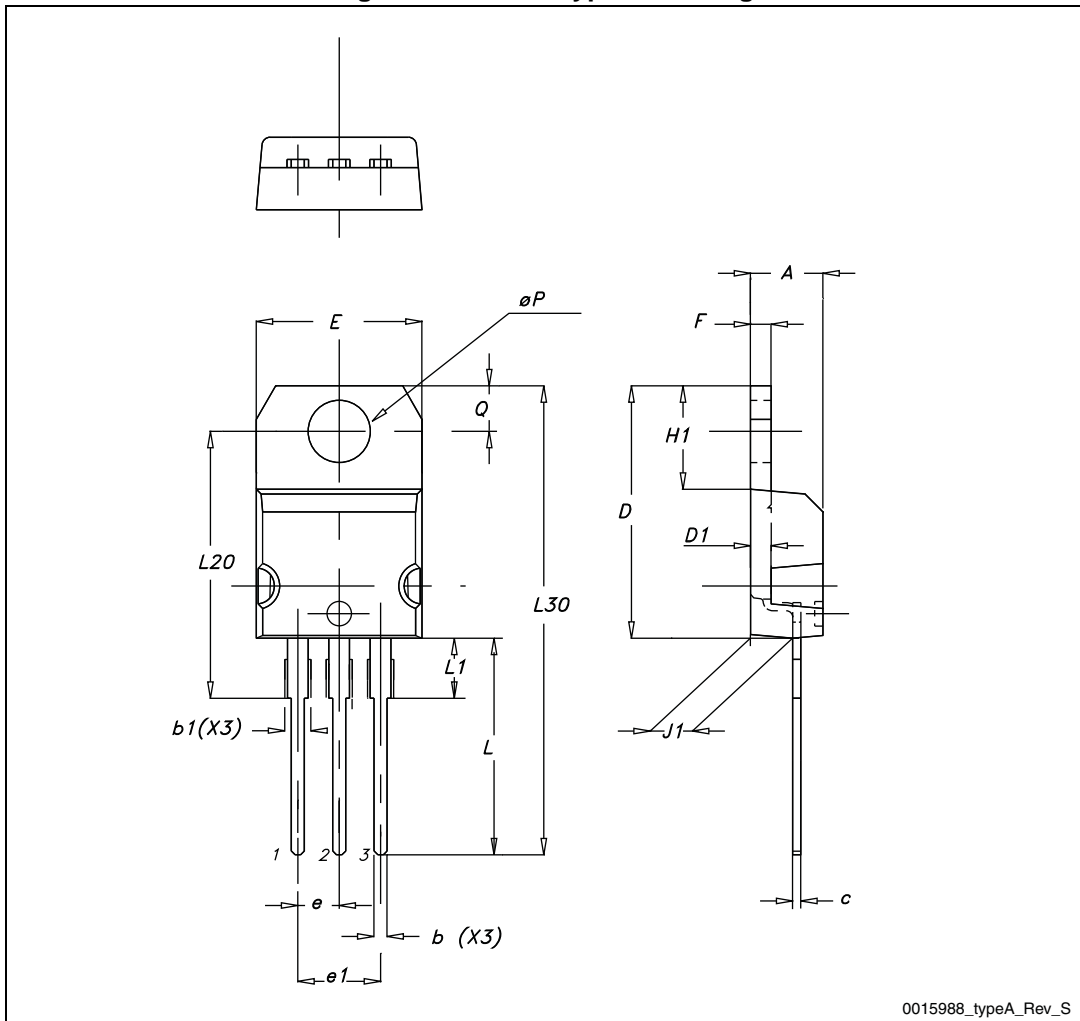
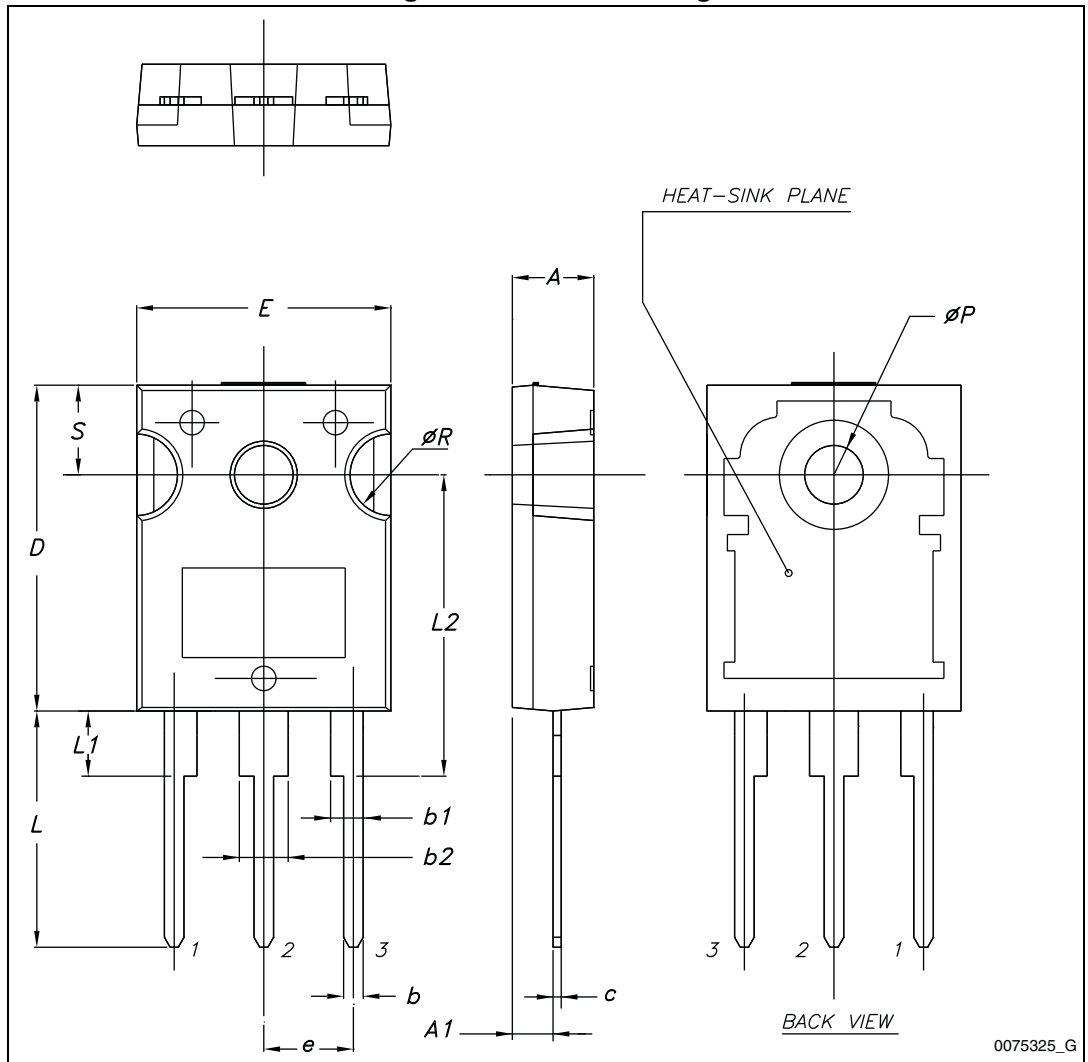


Table 11. TO-247 mechanical data

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 28. TO-247 drawing

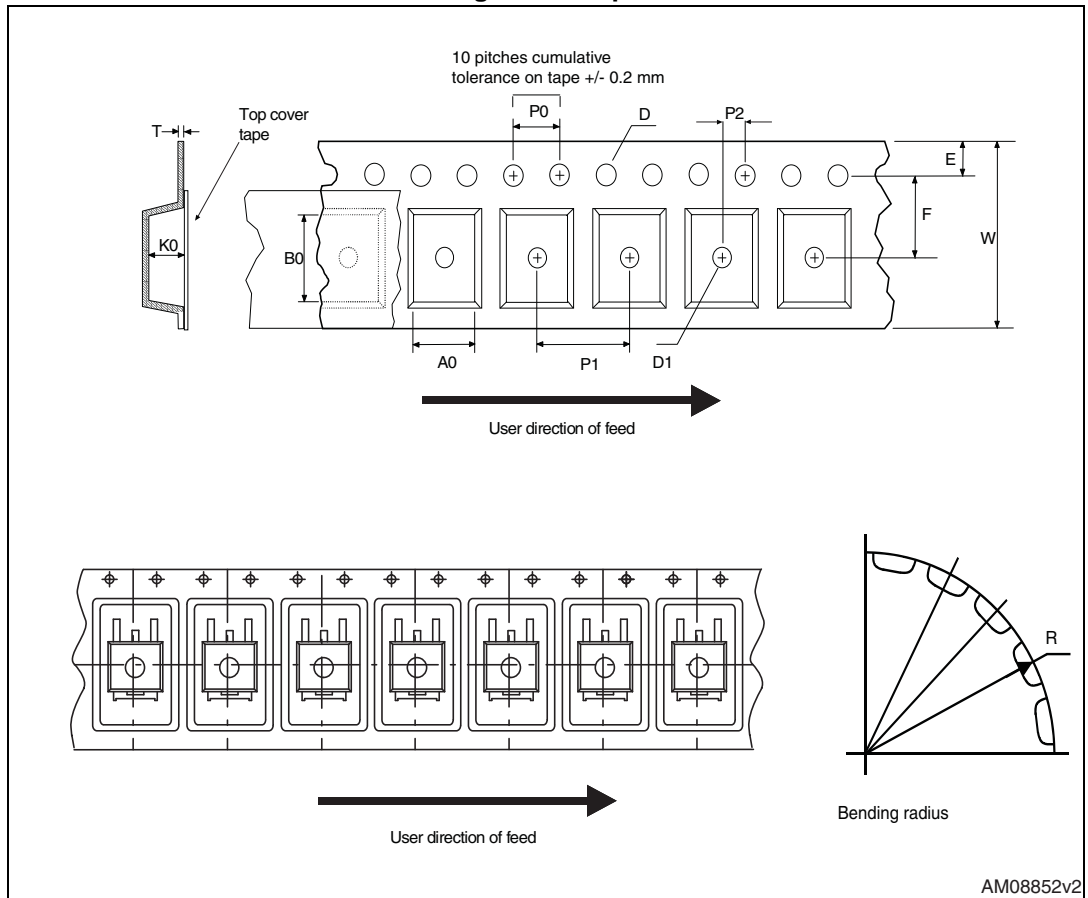


## 5 Packing mechanical data

Table 12. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

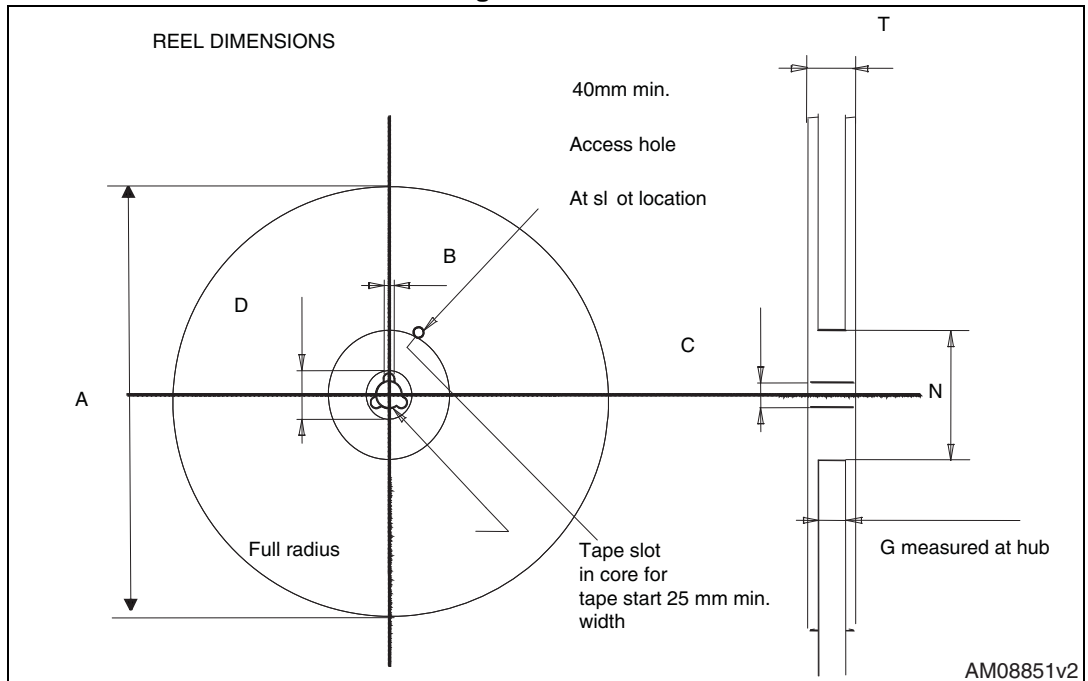
Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1		Base qty	1000
P2	1.9	2.1		Bulk qty	1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 29. Tape



AM08852v2

Figure 30. Reel



AM08851v2

## 6 Revision history

Table 13. Document revision history

Date	Revision	Changes
05-Sep-2007	1	First release.
22-Apr-2008	2	Datasheet status promoted from preliminary data to datasheet.
27-Mar-2009	3	<i>Figure 13</i> has been updated. Updated ECOPACK <sup>®</sup> statement ( <i>Section 4: Package mechanical data</i> )
16-Nov-2012	4	<i>Section 4: Package mechanical data</i> has been updated Minor text changes.
06-Mar-2013	5	Updated dv/dt value on <i>Table 2: Absolute maximum ratings</i> .

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**ST PRODUCTS ARE NOT AUTHORIZED FOR USE IN WEAPONS. NOR ARE ST PRODUCTS DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)



## X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for [MOSFET](#) category:*

*Click to view products by [STMicroelectronics](#) manufacturer:*

Other Similar products are found below :

[614233C](#) [648584F](#) [IRFD120](#) [JANTX2N5237](#) [SPP20N60S5XK](#) [FCA20N60\\_F109](#) [FDZ595PZ](#) [2SK2545\(Q,T\)](#) [405094E](#) [423220D](#)  
[TPCC8103,L1Q\(CM](#) [MIC4420CM-TR](#) [VN1206L](#) [SBVS138LT1G](#) [614234A](#) [715780A](#) [NTNS3166NZT5G](#) [SSM6J414TU,LF\(T](#) [751625C](#)  
[BUK954R8-60E](#) [DMN3404LQ-7](#) [NTE6400](#) [SQJ402EP-T1-GE3](#) [2SK2614\(TE16L1,Q\)](#) [2N7002KW-FAI](#) [DMN1017UCP3-7](#)  
[EFC2J004NUZTDG](#) [ECH8691-TL-W](#) [FCAB21350L1](#) [P85W28HP2F-7071](#) [DMN1053UCP4-7](#) [NTE221](#) [NTE2384](#) [NTE2903](#) [NTE2941](#)  
[NTE2945](#) [NTE2946](#) [NTE2960](#) [NTE2967](#) [NTE2969](#) [NTE2976](#) [NTE455](#) [NTE6400A](#) [NTE2910](#) [NTE2916](#) [NTE2956](#) [NTE2911](#)  
[DMN2080UCB4-7](#) [TK10A80W,S4X\(S](#) [SSM6P69NU,LF](#)