



STx25NM60ND

N-channel 600 V, 0.13 Ω , 21 A FDmesh™ II Power MOSFET
(with fast diode) in D²PAK, TO-220FP, TO-220, TO-247

Features

Type	V _{DSS} @ T _{JMAX}	R _{DS(on)} max	I _D
STB25NM60ND	650 V	0.16 Ω	21 A
STF25NM60ND			21 A ⁽¹⁾
STP25NM60ND			21 A
STW25NM60ND			21 A

1. Limited only by maximum temperature allowed

- The worldwide best R_{DS(on)}*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

Application

- 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.

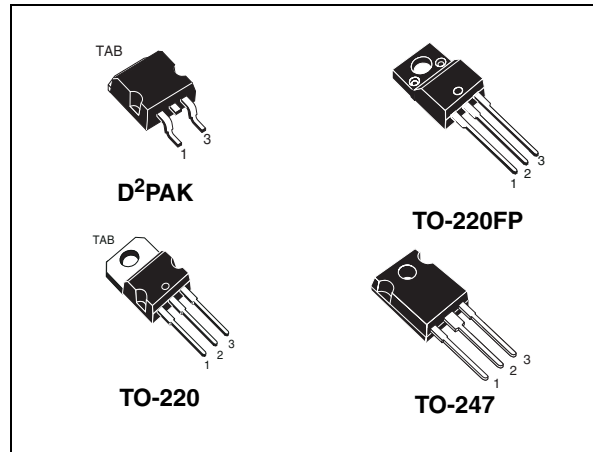
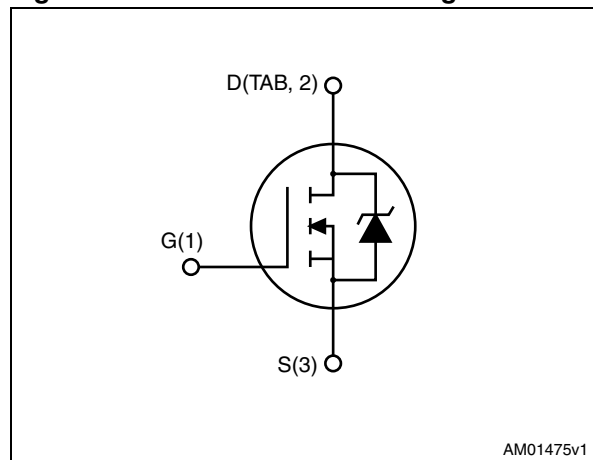


Figure 1. Internal schematic diagram



AM01475v1

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB25NM60ND	25NM60ND	D ² PAK	Tape and reel
STF25NM60ND	25NM60ND	TO-220FP	Tube
STP25NM60ND	25NM60ND	TO-220	Tube
STW25NM60ND	25NM60ND	TO-247	Tube

Contents

1 **Electrical ratings** 3

2 **Electrical characteristics** 4

 2.1 Electrical characteristics (curves) 6

3 **Test circuits** 9

4 **Package mechanical data** 10

5 **Packing mechanical data** 18

6 **Revision history** 20



1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK, TO-220, TO-247	TO-220FP	
V _{DS}	Drain-source voltage	600		V
V _{GS}	Gate-source voltage	±25		V
I _D	Drain current (continuous) at T _C = 25 °C	21	21 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	13	13 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	84	84 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	160	40	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	40		V/ns
V _{iso}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C)		2500	V
T _{stg}	Storage temperature	-55 to 150		°C
T _J	Max. operating junction temperature	150		°C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 21 A, di/dt ≤ 600 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	D ² PAK	TO-220FP	TO-220	TO-247	Unit
R _{thj-case}	Thermal resistance junction-case max	0.78	3.1	0.78		°C/W
R _{thj-amb}	Thermal resistance junction-ambient max		62.5		50	°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-ambient max	30				°C/W

1. When mounted on 1inch² FR-4 board, 2 oz Cu

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I _{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _J max)	10	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AS} , V _{DD} = 50 V)	850	mJ

2 Electrical characteristics

($T_{CASE}=25\text{ }^{\circ}\text{C}$ 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	$V_{DD} = 480\text{ V}$, $I_D = 21\text{ A}$, $V_{GS} = 10\text{ V}$	48			V/ns
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = 600\text{ V}$ $V_{DS} = 600\text{ V}$ @ $T_C = 125\text{ }^{\circ}\text{C}$			1 100	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20\text{ V}$			± 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	$V_{GS} = 10\text{ V}$, $I_D = 10.5\text{ A}$		0.13	0.16	Ω

1. Characteristic value at turn off on inductive load.

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}$, $I_D = 10.5\text{ A}$	-	17	-	S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 50\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$	-	2400 150 15	-	pF pF pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$, $V_{DS} = 0\text{ to }480\text{ V}$	-	320	-	pF
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off delay time Fall time	$V_{DD} = 300\text{ V}$, $I_D = 10.5\text{ A}$ $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 23), (see Figure 18)	-	60 30 50 40	-	ns ns ns ns
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 480\text{ V}$, $I_D = 21\text{ A}$, $V_{GS} = 10\text{ V}$, (see Figure 19)	-	80 15 40	-	nC nC nC
R_g	Gate input resistance	$f = 1\text{ MHz}$ gate DC bias=0 Test signal level = 20 mV open drain	-	1.6	-	Ω

1. Pulsed: pulse duration=300 μs , duty cycle 1.5%

2. $C_{oss\text{ eq.}}$ 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		-		21	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		84	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 21\text{ A}$, $V_{GS} = 0$	-		1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 21\text{ A}$, $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 20)	-	160		ns
Q_{rr}	Reverse recovery charge			1		μC
I_{RRM}	Reverse recovery current			15		A
t_{rr}	Reverse recovery time	$I_{SD} = 21\text{ A}$, $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 20)	-	230		ns
Q_{rr}	Reverse recovery charge			2		μC
I_{RRM}	Reverse recovery current			19		A

1. Pulse width limited by safe operating area

2. Pulsed: Pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D²PAK and TO-220

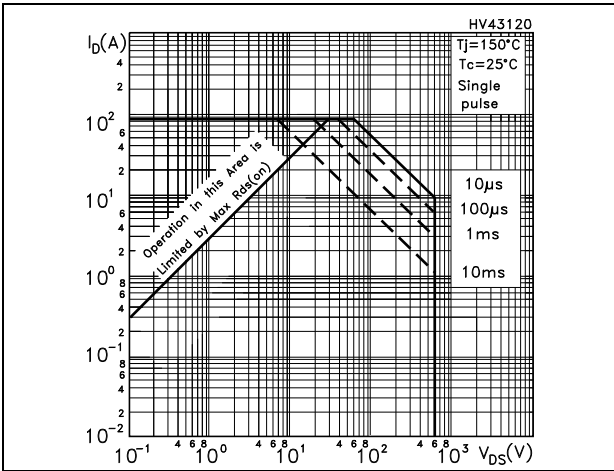


Figure 3. Thermal impedance for D²PAK and TO-220

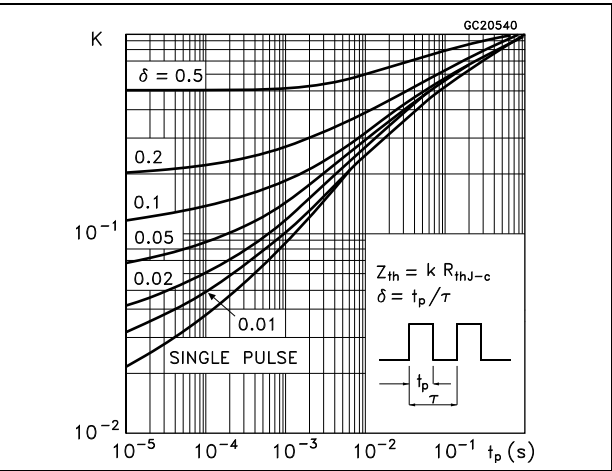


Figure 4. Safe operating area for TO-220FP

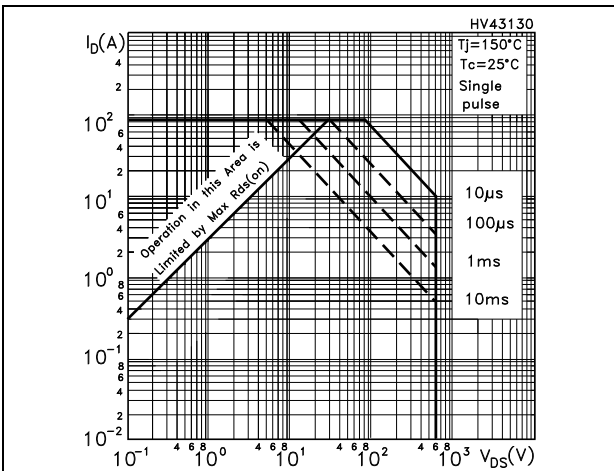


Figure 5. Thermal impedance for TO-220FP

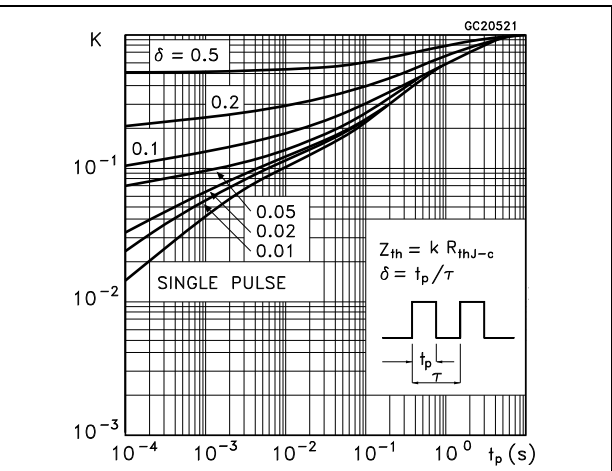


Figure 6. Safe operating area for TO-247

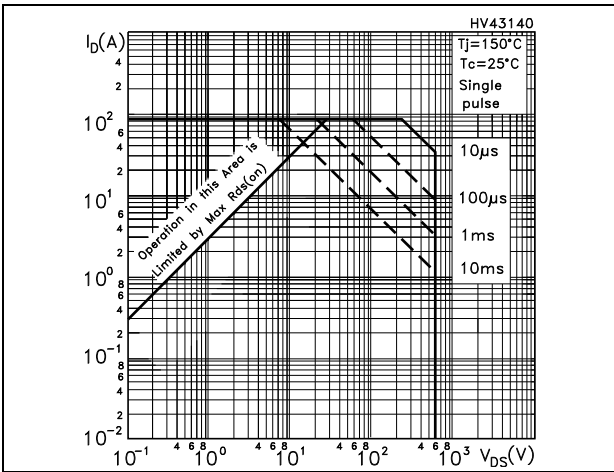


Figure 7. Thermal impedance for TO-247

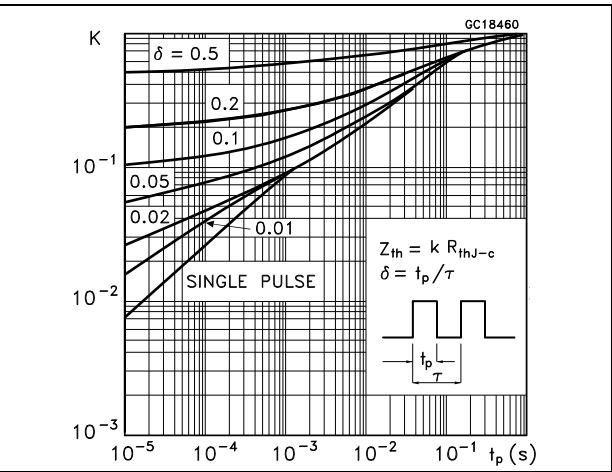


Figure 8. Output characteristics

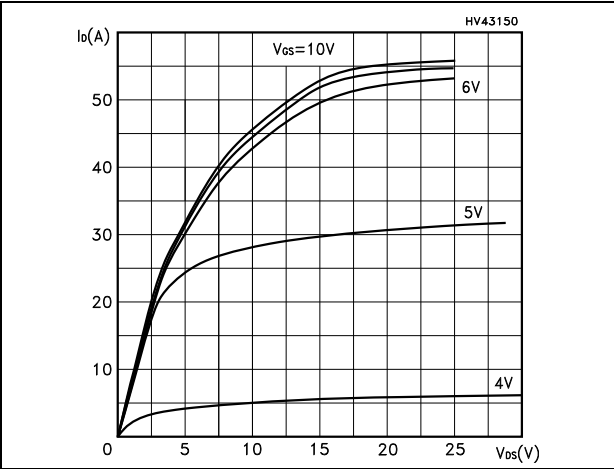


Figure 9. Transfer characteristics

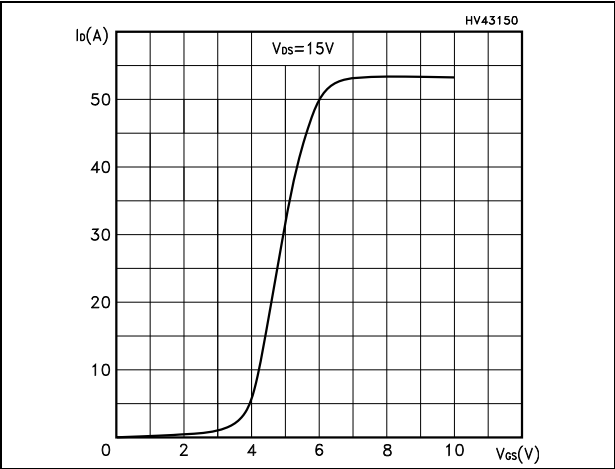


Figure 10. Transconductance

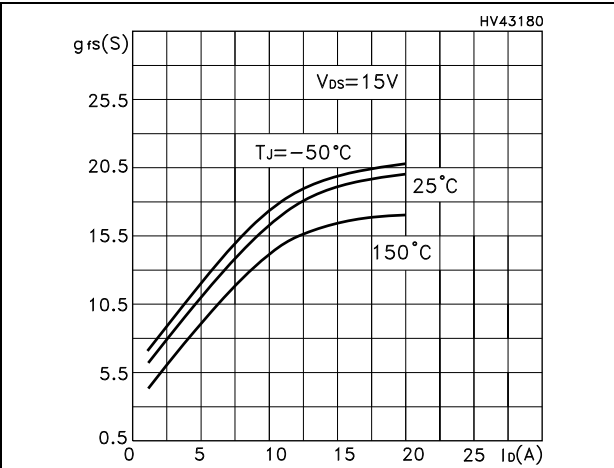


Figure 11. Static drain-source on resistance

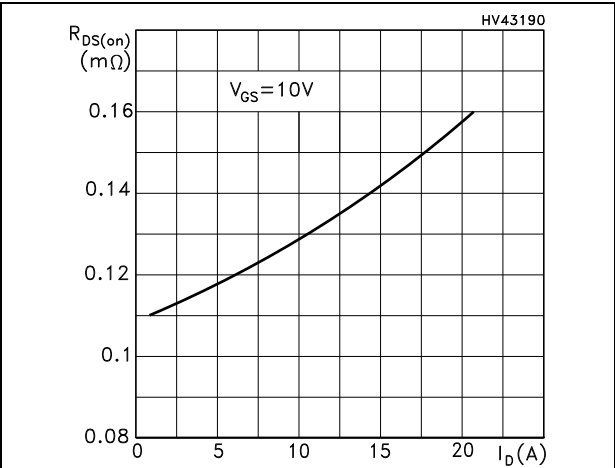


Figure 12. Gate charge vs gate-source voltage

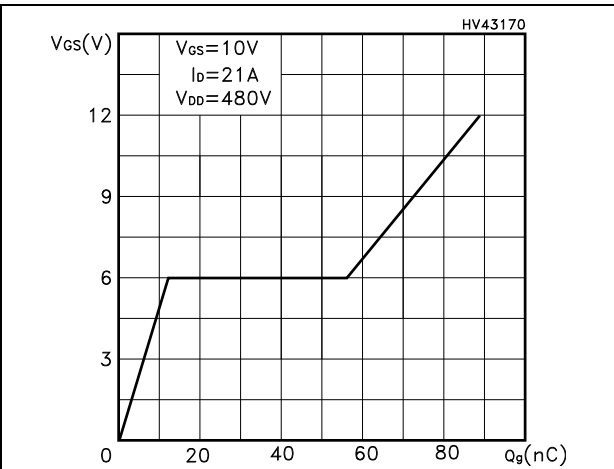


Figure 13. Capacitance variations

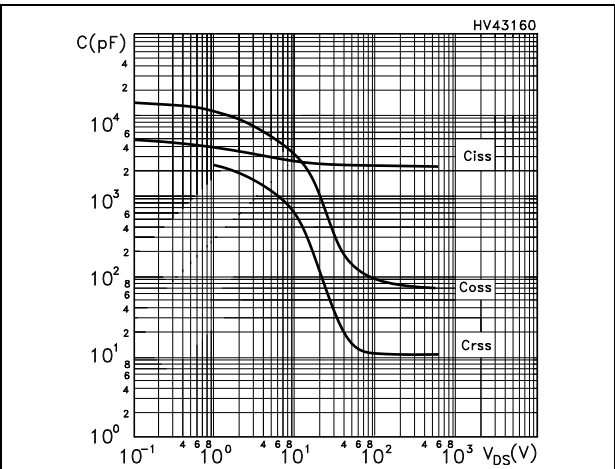


Figure 14. Normalized gate threshold voltage vs temperature

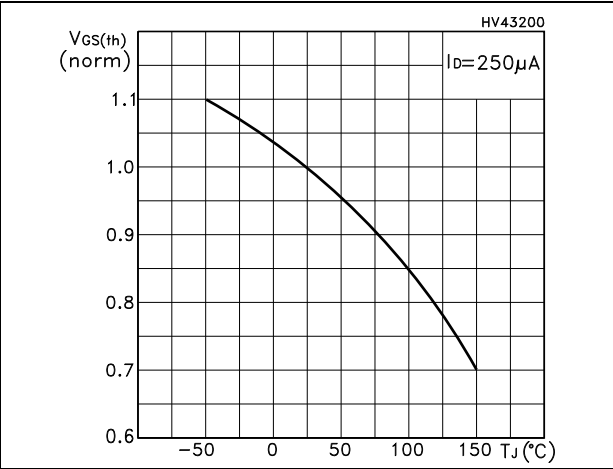


Figure 15. Normalized on resistance vs temperature

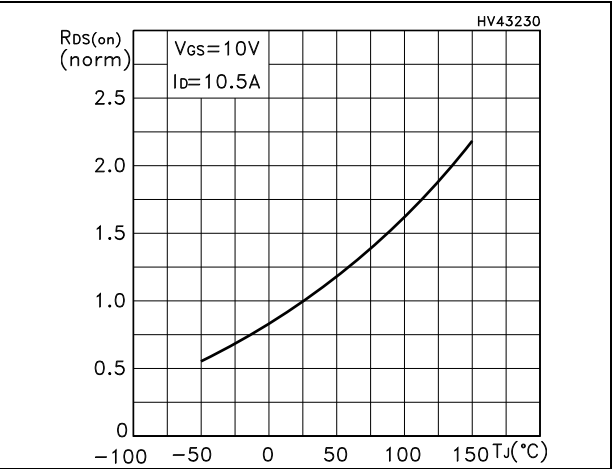


Figure 16. Source-drain diode forward characteristics

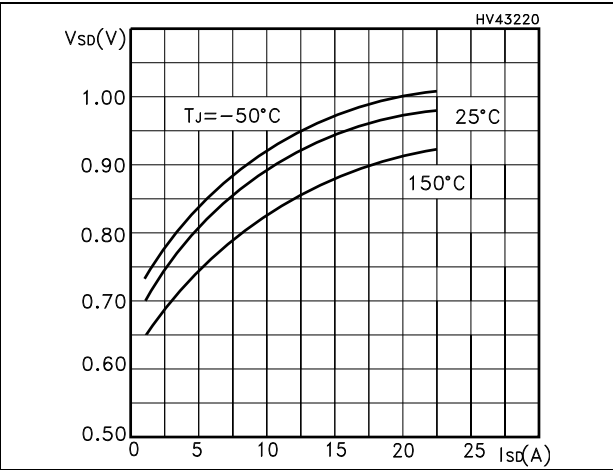
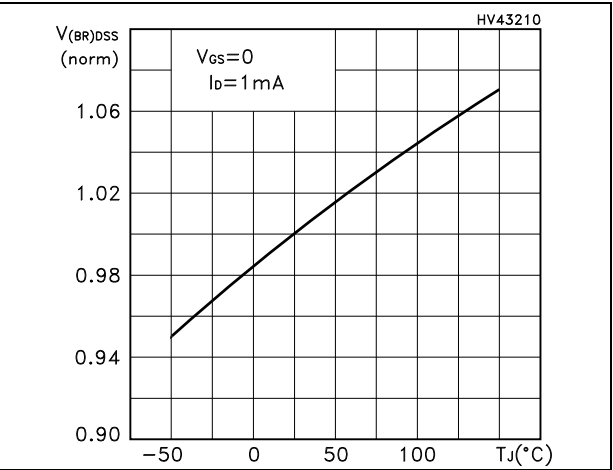


Figure 17. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

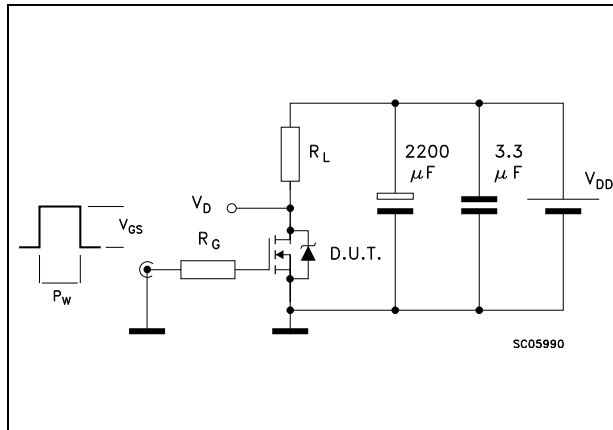


Figure 19. Gate charge test circuit

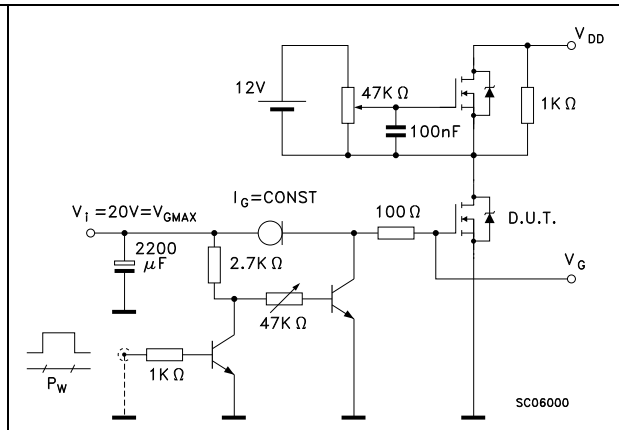


Figure 20. Test circuit for inductive load switching and diode recovery times

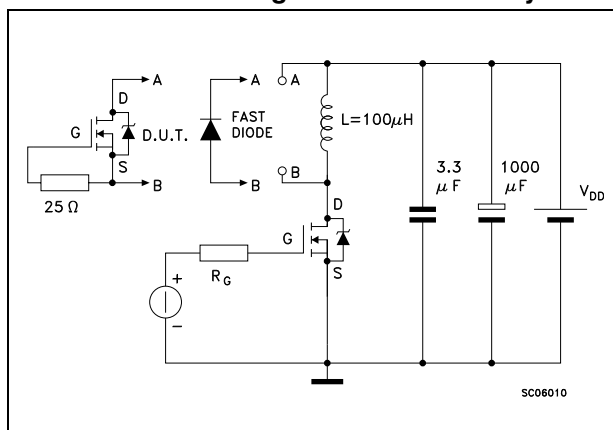


Figure 21. Unclamped inductive load test circuit

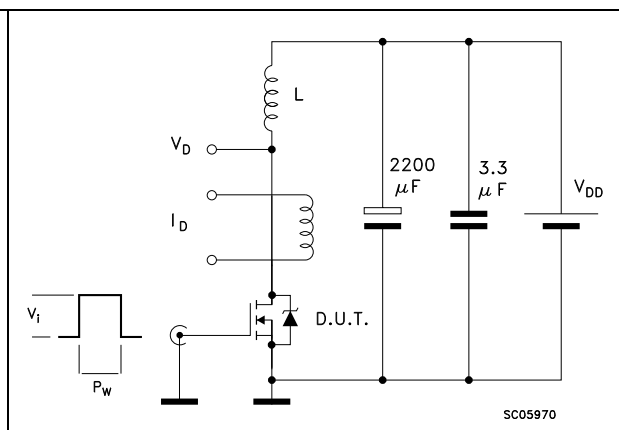


Figure 22. Unclamped inductive waveform

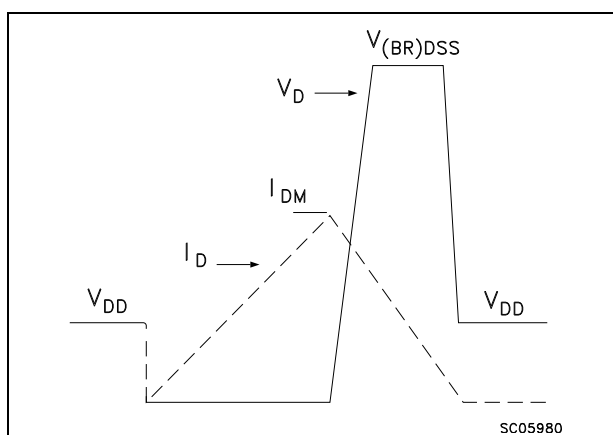
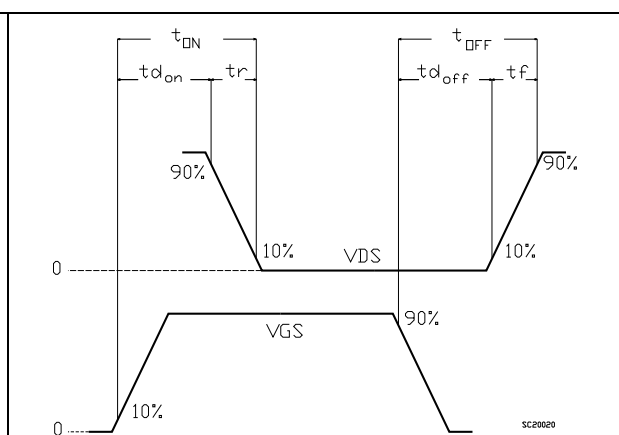


Figure 23. Switching time waveform



4 **Package mechanical data**

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

Table 8. D²PAK (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. D²PAK (TO-263) drawing

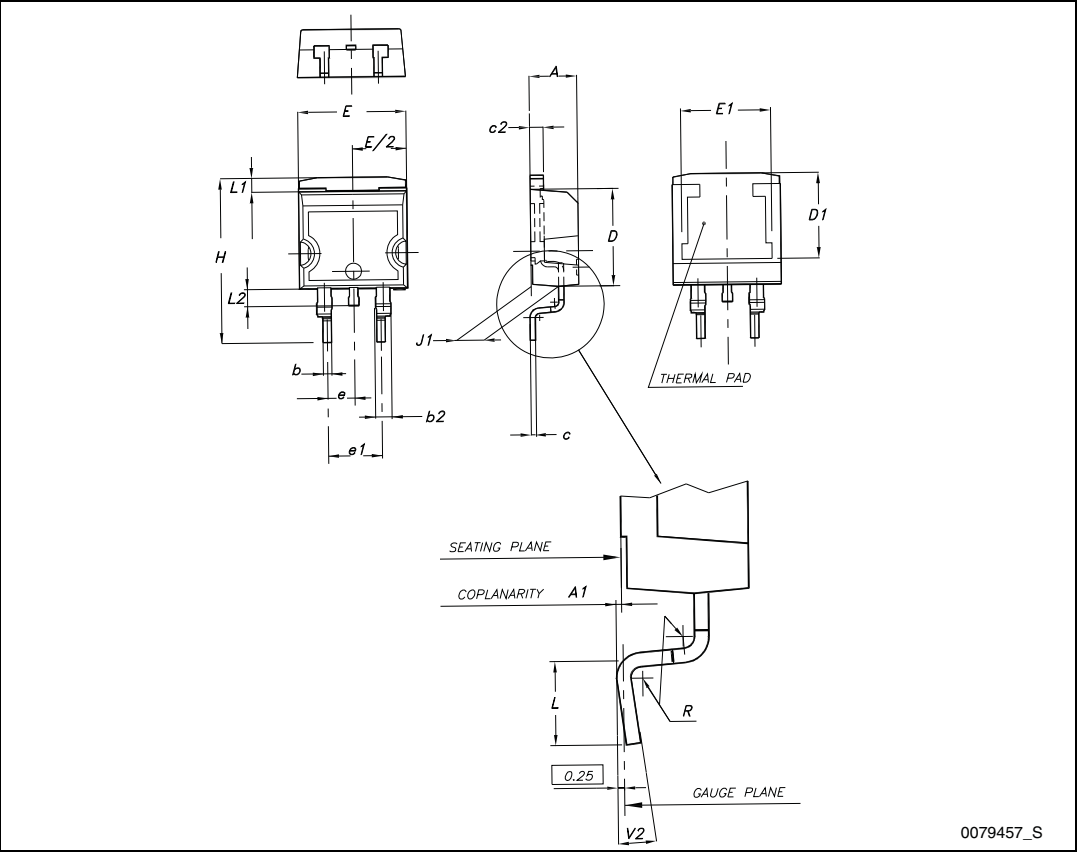
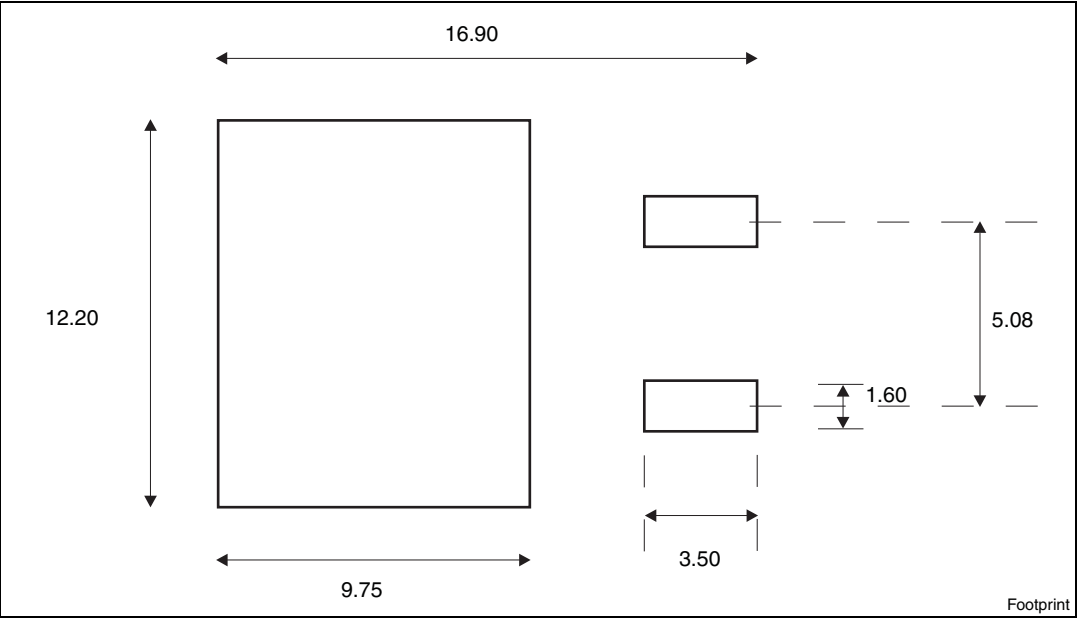


Figure 25. D²PAK footprint^(a)



a. All dimension 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

TO-220FP drawing

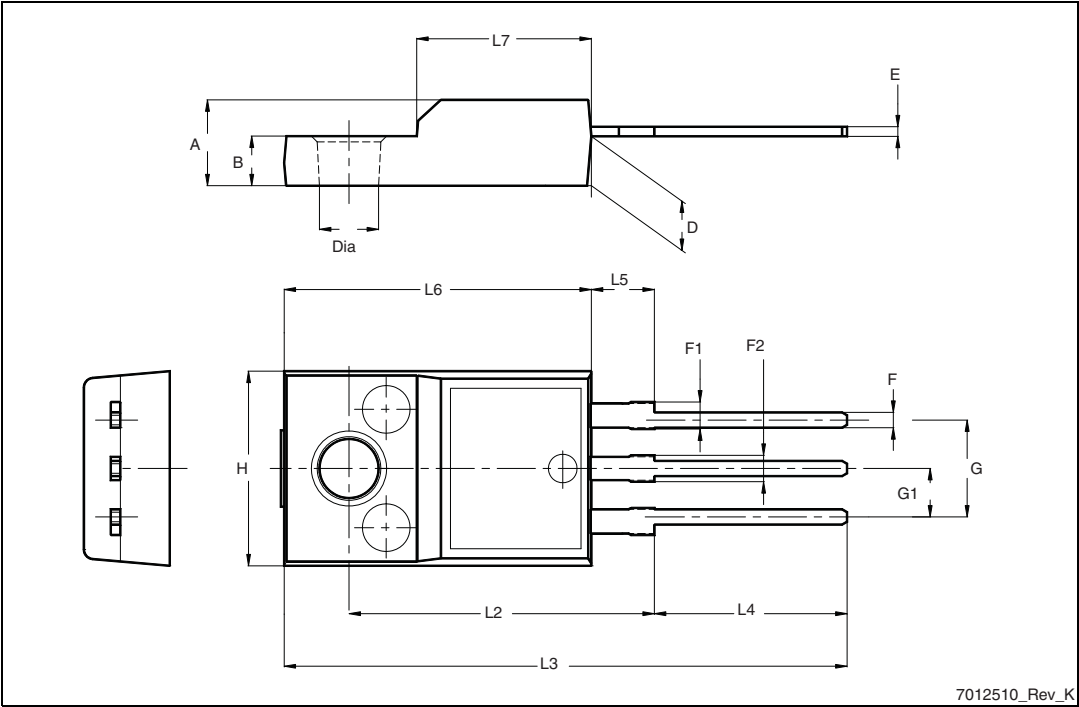


Table 10. TO-220 type A mechanical data

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 26. TO-220 type A drawing

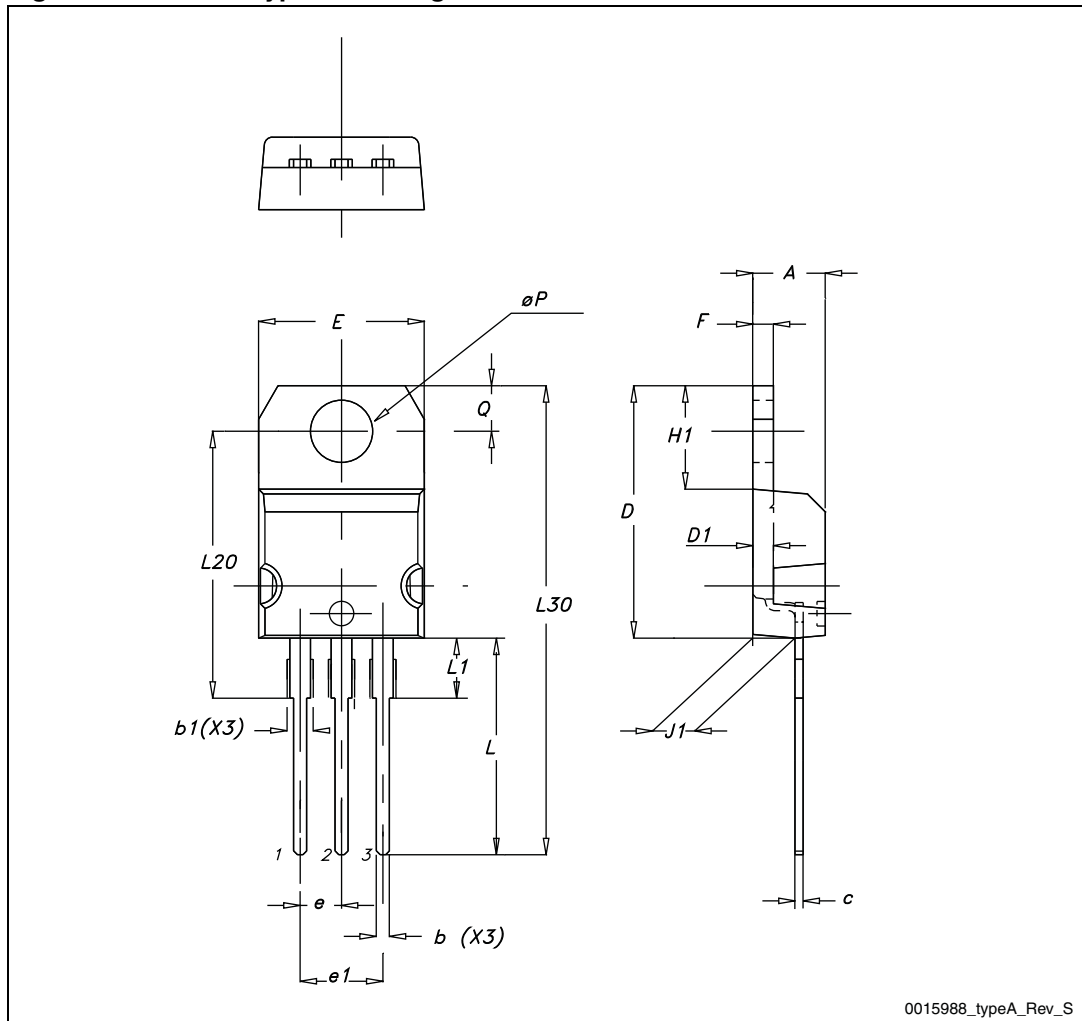
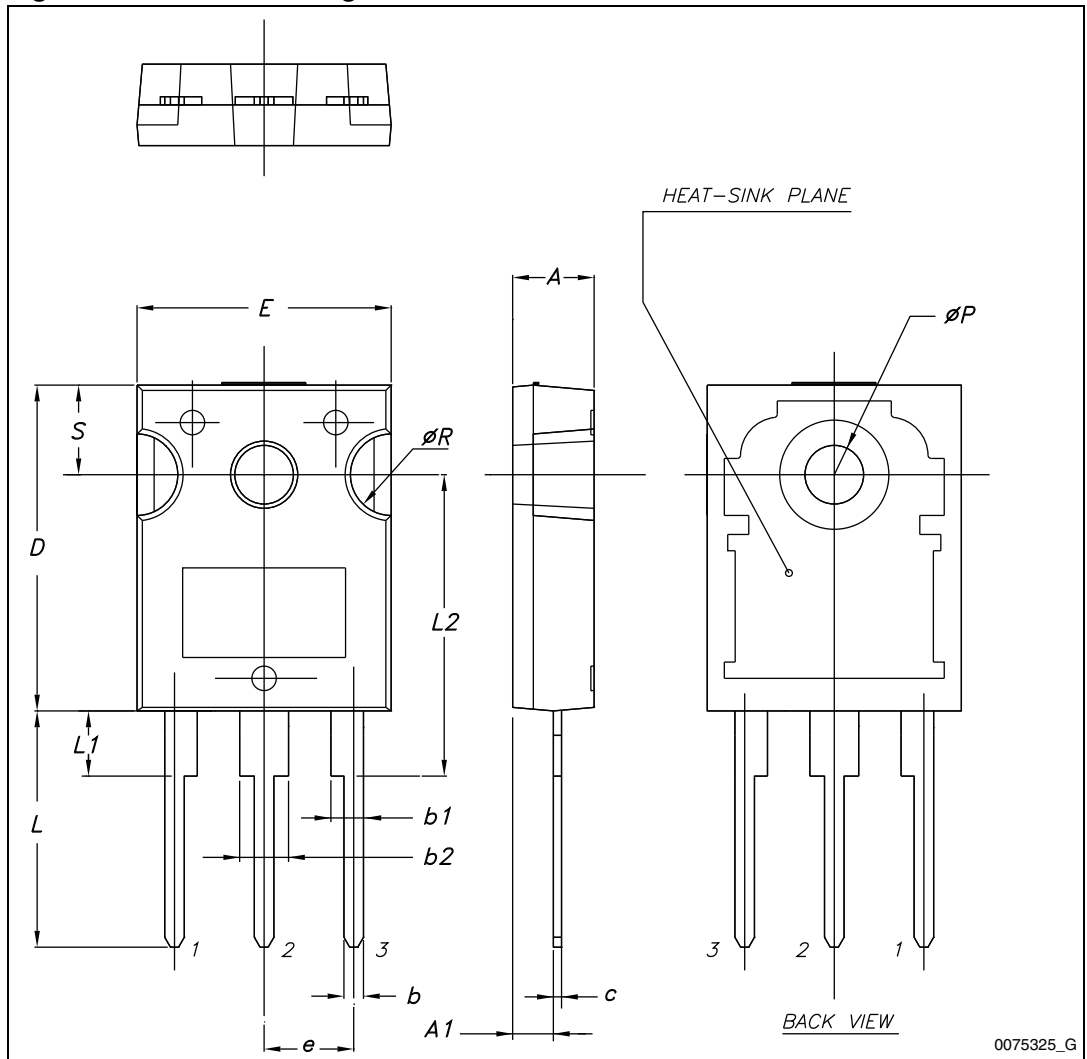


Table 11. TO-247 mechanical data

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 27. TO-247 drawing



5 Packing mechanical data

Table 12. D²PAK (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 28. Tape

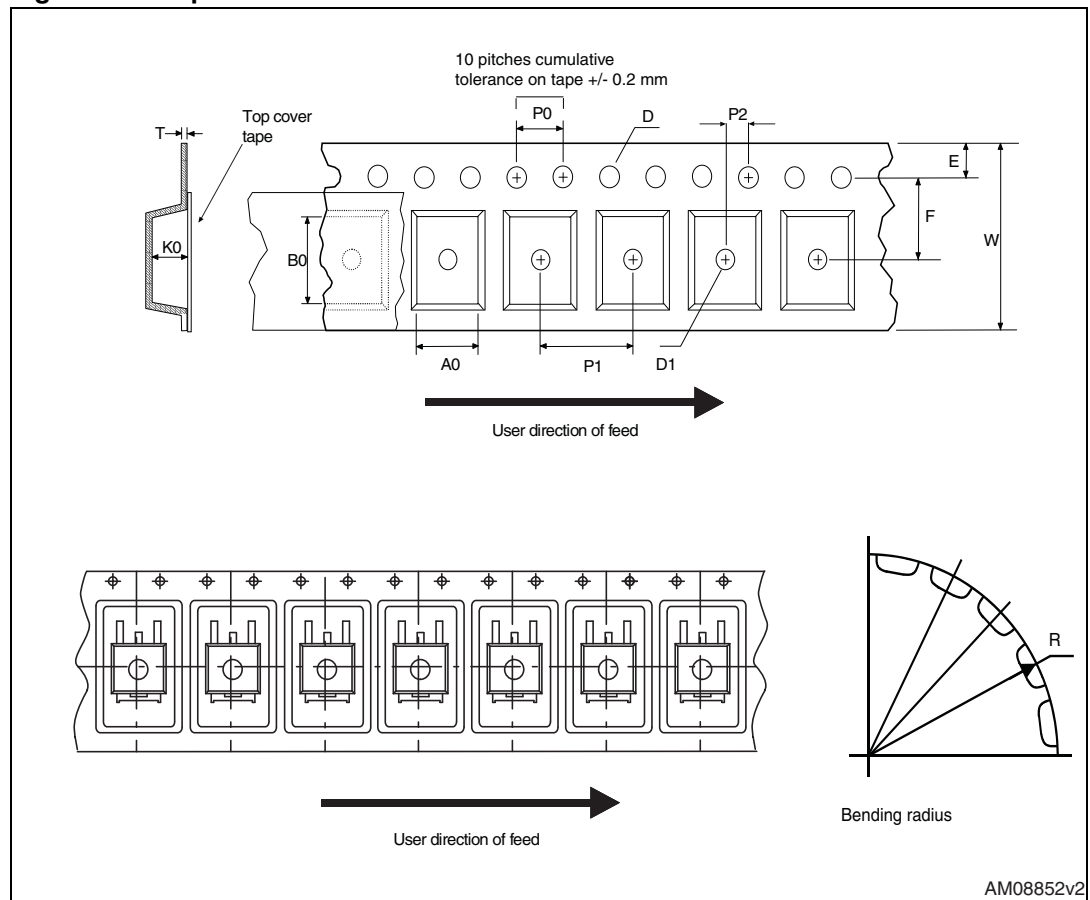
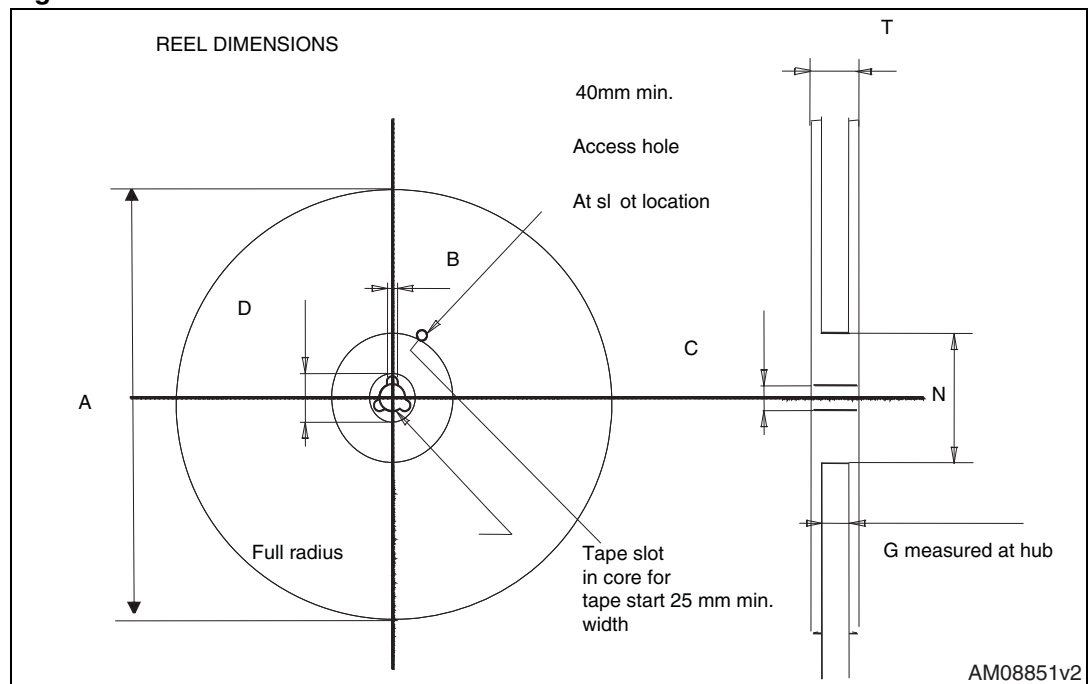


Figure 29. Reel



6 Revision history

Table 13. Document revision history

Date	Revision	Changes
15-Nov-2007	1	First release.
22-Jan-2008	2	Document status promoted from target specification to preliminary data.
08-Apr-2008	3	– Updated Table 3: Thermal data on page 3 ; – Document status promoted from preliminary data to datasheet.
03-Mar-2009	4	Q _g value has been updated.
28-Nov-2011	5	Updated Section 4: Package mechanical data and Section 5: Packing mechanical data . Minor text changes.

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.

UNLESS EXPRESSLY APPROVED IN WRITING BY TWO AUTHORIZED ST REPRESENTATIVES, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

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.

© 2011 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