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

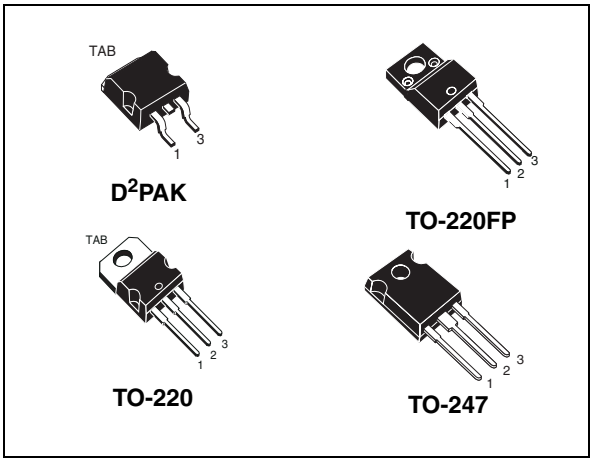
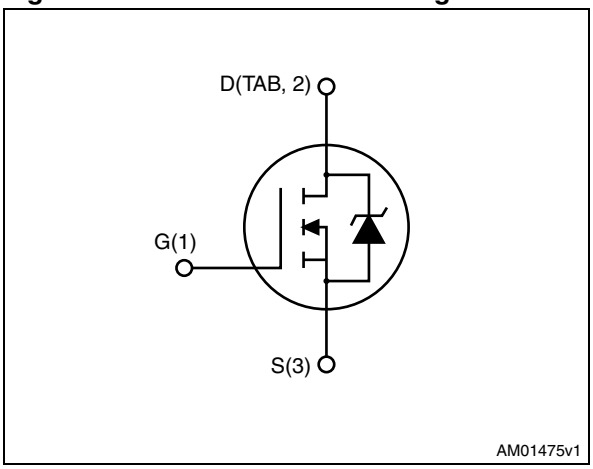


Figure 1. Internal schematic diagram



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.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB25NM60ND	25NM60ND	D²PAK	Tape and reel
STF25NM60ND	25NM60ND	TO-220FP	Tube
STP25NM60ND	25NM60ND	TO-220	Tube
STW25NM60ND	25NM60ND	TO-247	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D^2PAK, 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
Viso	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	D²PAK	TO-220FP	TO-220	TO-247	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case max	0.78	3.1	0.78		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max		62.5		50	°C/W
$R_{thj\text{-}pcb}$(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 °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 mA, V_{GS} = 0	600			V
dv/dt(1)	Drain source voltage slope	V_{DD}= 480 V, I_D= 21 A, V_{GS}= 10 V		48		V/ns
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V V_{DS} = 600 V @T_C= 125 °C			1 100	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 10.5 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 V, I_D = 10.5 A	-	17	-	S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0	-	2400 150 15	-	pF pF pF
$C_{oss\ eq.}$ (2)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 480 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 V, I_D = 10.5 A R_G = 4.7 Ω V_{GS} = 10 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 V, I_D = 21 A, V_{GS} = 10 V, *(see Figure 19)*	-	80 15 40	-	nC nC nC
R_g	Gate input resistance	f=1 MHz gate DC bias=0 Test signal level = 20 mV open drain	-	1.6	-	Ω

1. Pulsed: pulse duration=300µs, duty cycle 1.5%
2. $C_{oss\ eq.}$ 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)		-		21 84	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 21 A, V_{GS} = 0	-		1.3	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 21 A, V_{DD} = 60 V di/dt=100 A/µs *(see Figure 20)*	-	160 1 15		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 21 A,V_{DD} = 60 V di/dt=100 A/µs, T_J = 150 °C *(see Figure 20)*	-	230 2 19		ns µC 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

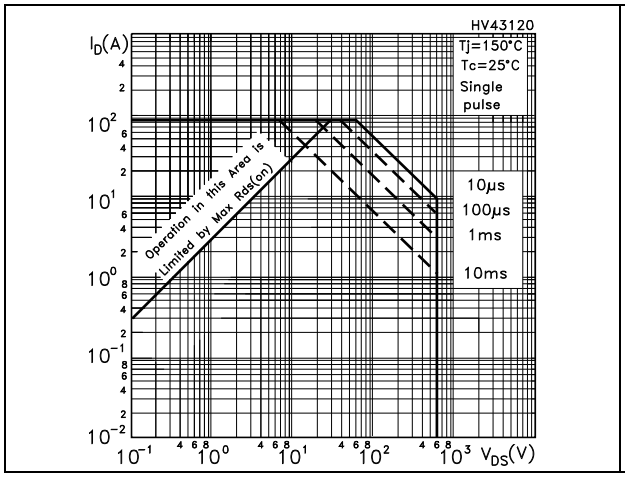


Figure 3. Thermal impedance for D²PAK and TO-220

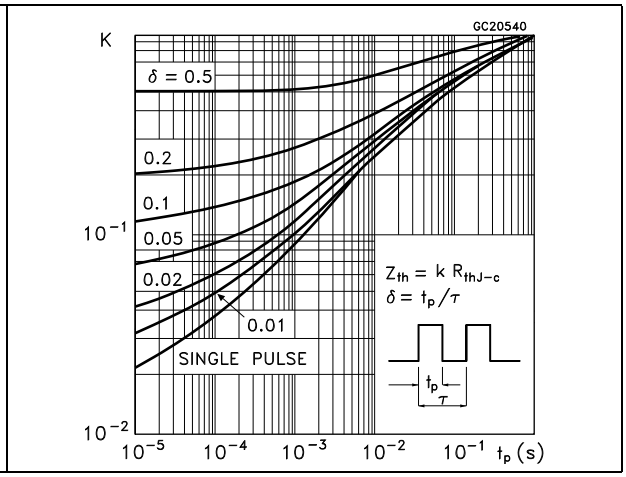


Figure 4. Safe operating area for TO-220FP

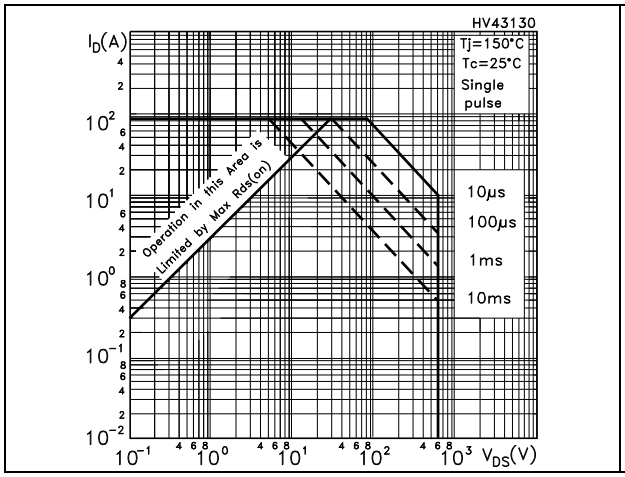


Figure 5. Thermal impedance for TO-220FP

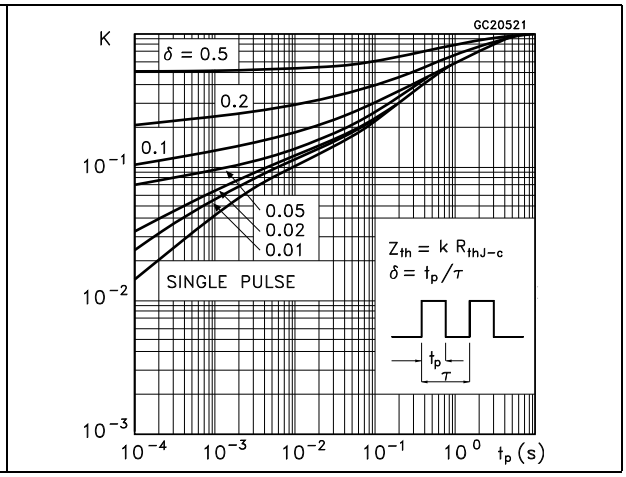


Figure 6. Safe operating area for TO-247

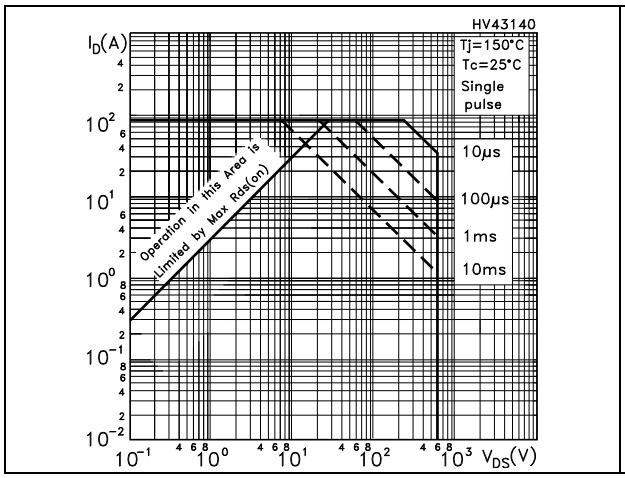


Figure 7. Thermal impedance for TO-247

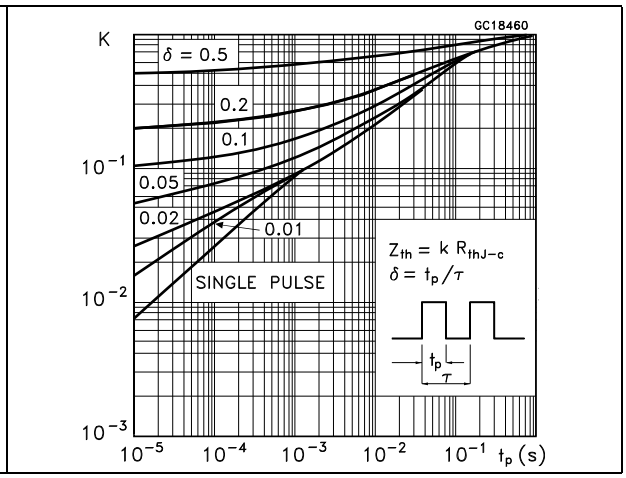


Figure 8. Output characteristics

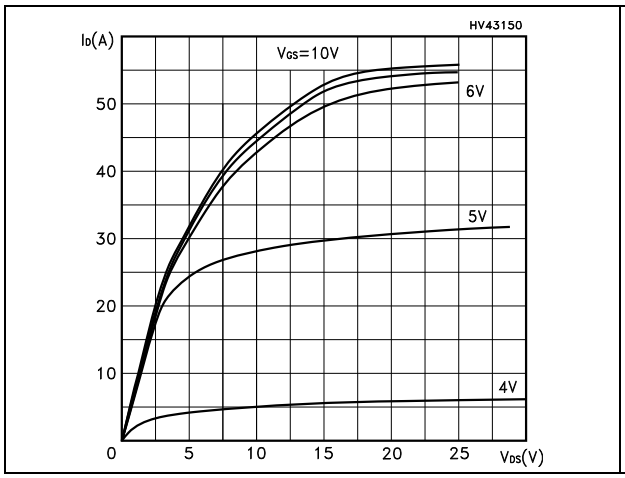


Figure 9. Transfer characteristics

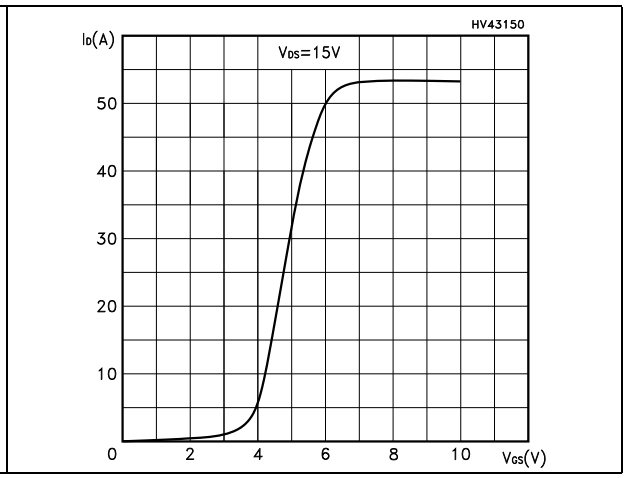


Figure 10. Transconductance

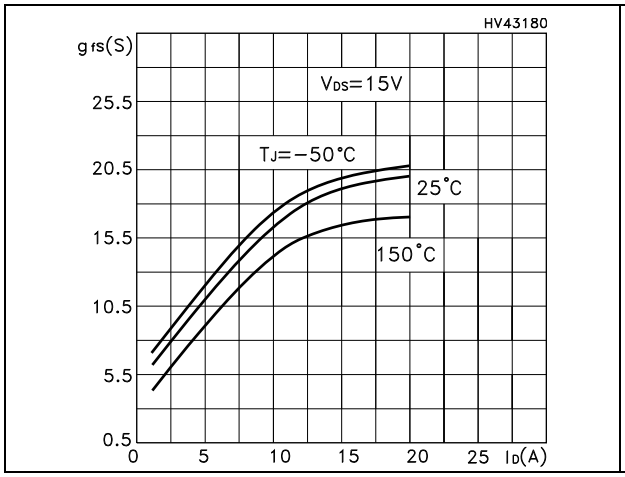


Figure 11. Static drain-source on resistance

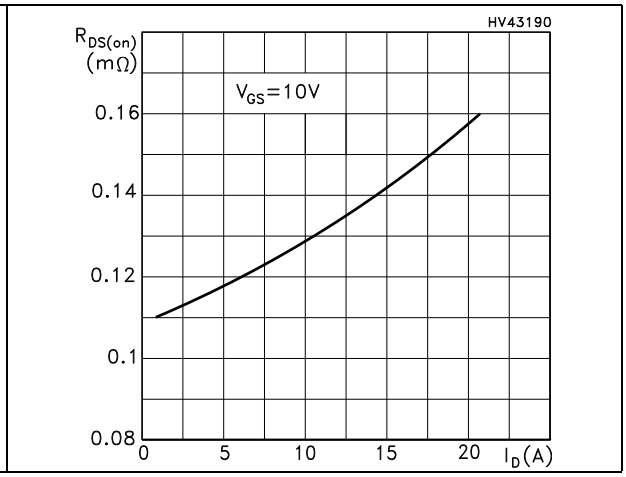


Figure 12. Gate charge vs gate-source voltage

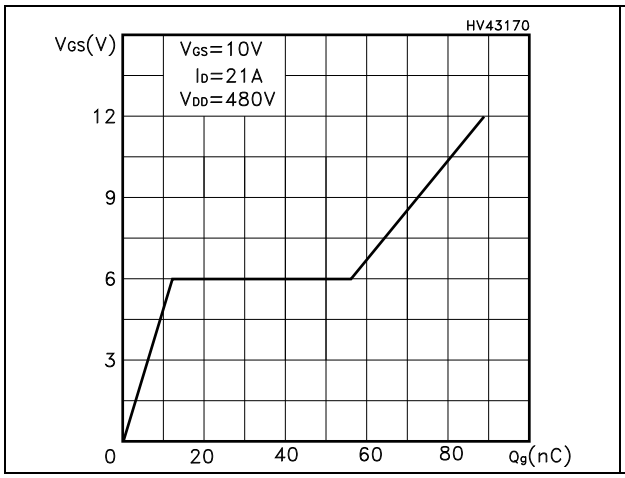


Figure 13. Capacitance variations

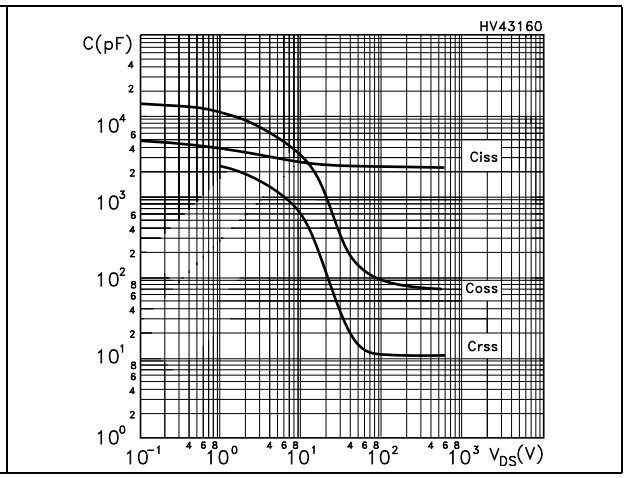


Figure 14. Normalized gate threshold voltage vs temperature

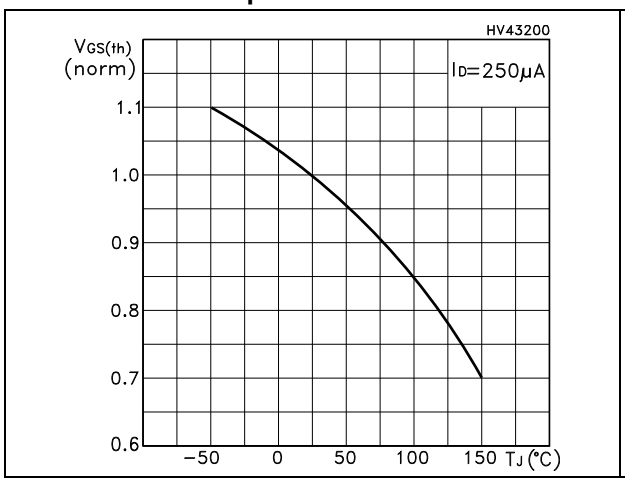


Figure 15. Normalized on resistance vs temperature

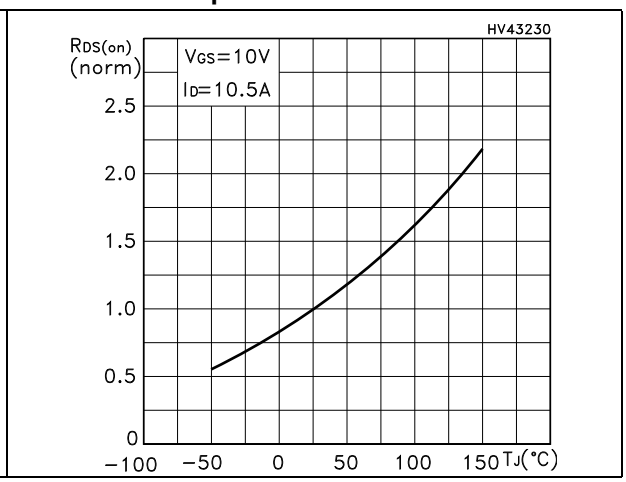


Figure 16. Source-drain diode forward characteristics

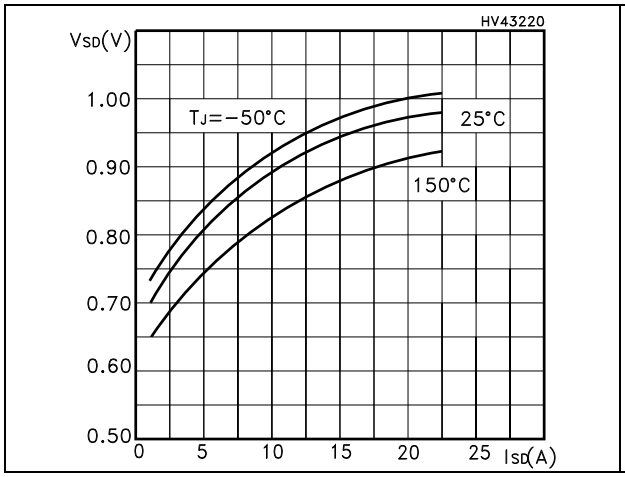
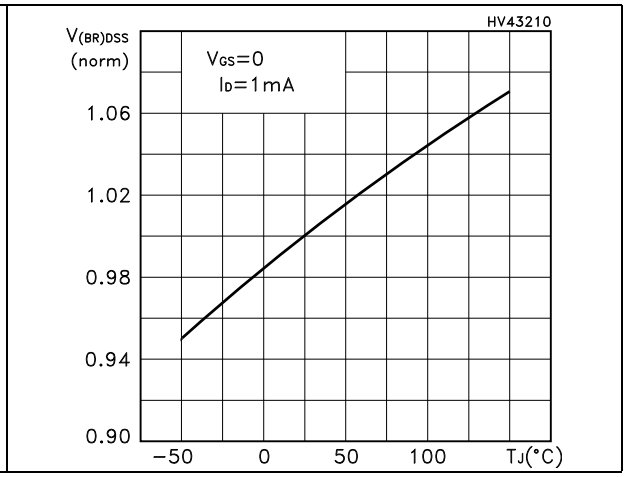


Figure 17. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

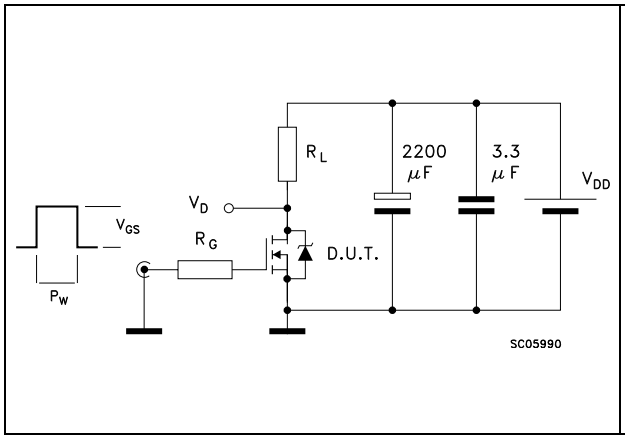


Figure 19. Gate charge test circuit

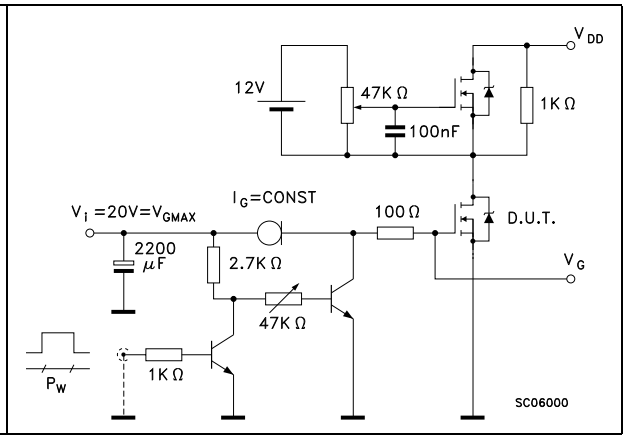


Figure 20. Test circuit for inductive load switching and diode recovery times

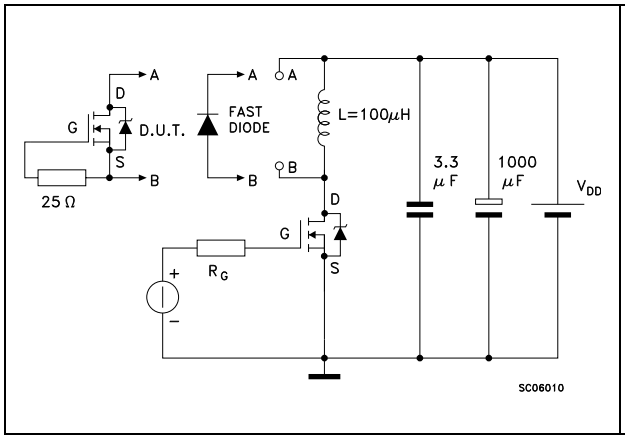


Figure 21. Unclamped inductive load test circuit

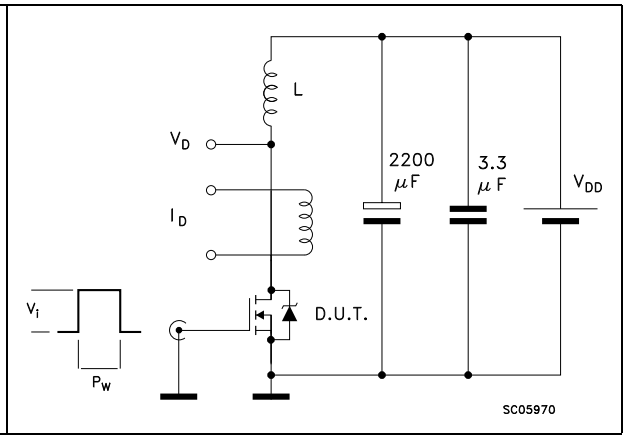


Figure 22. Unclamped inductive waveform

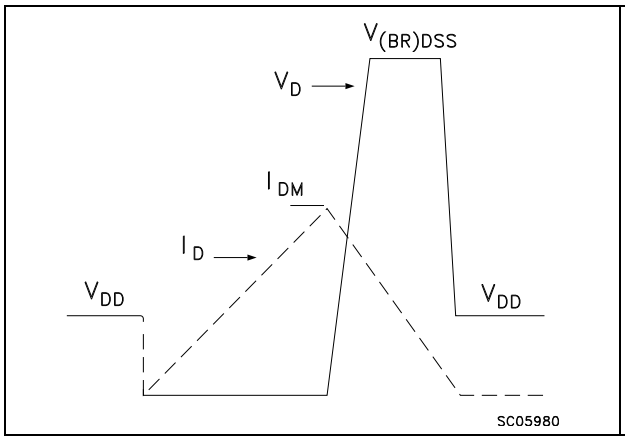
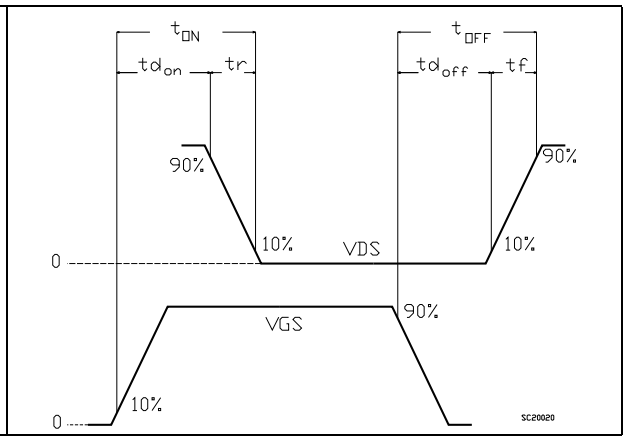


Figure 23. Switching time waveform



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

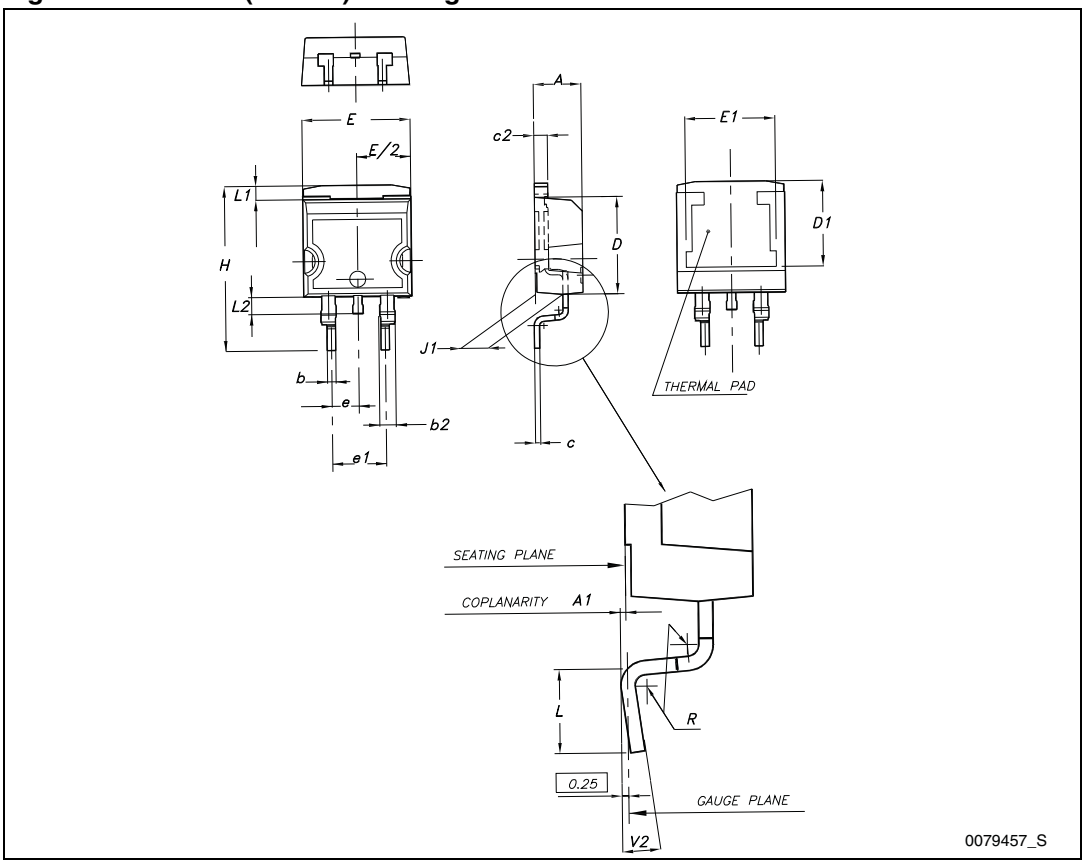
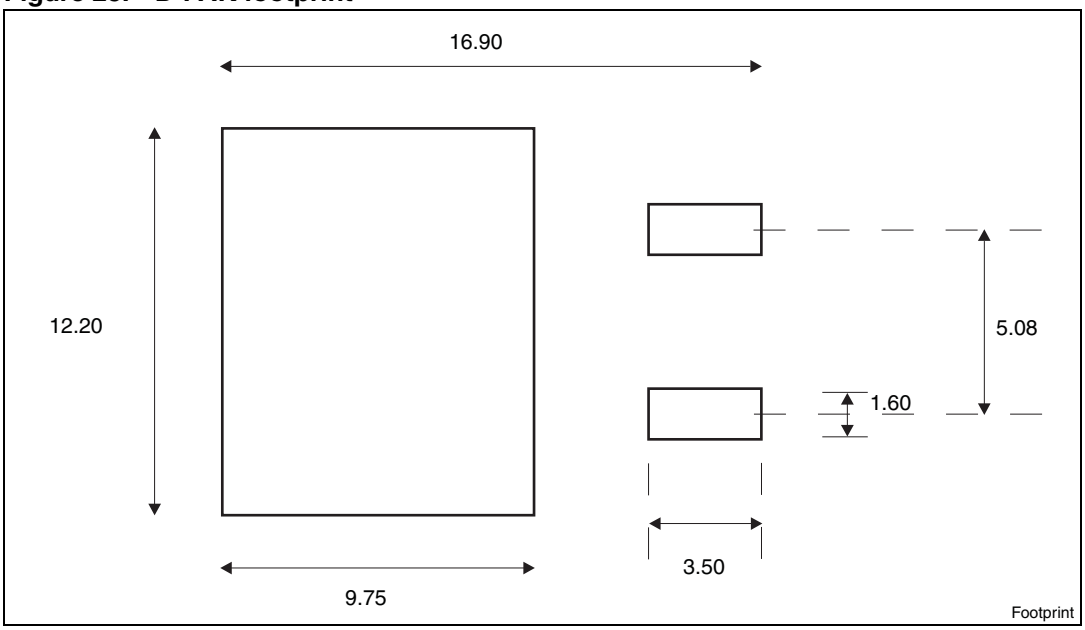


Figure 25. D²PAK footprint[a]



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

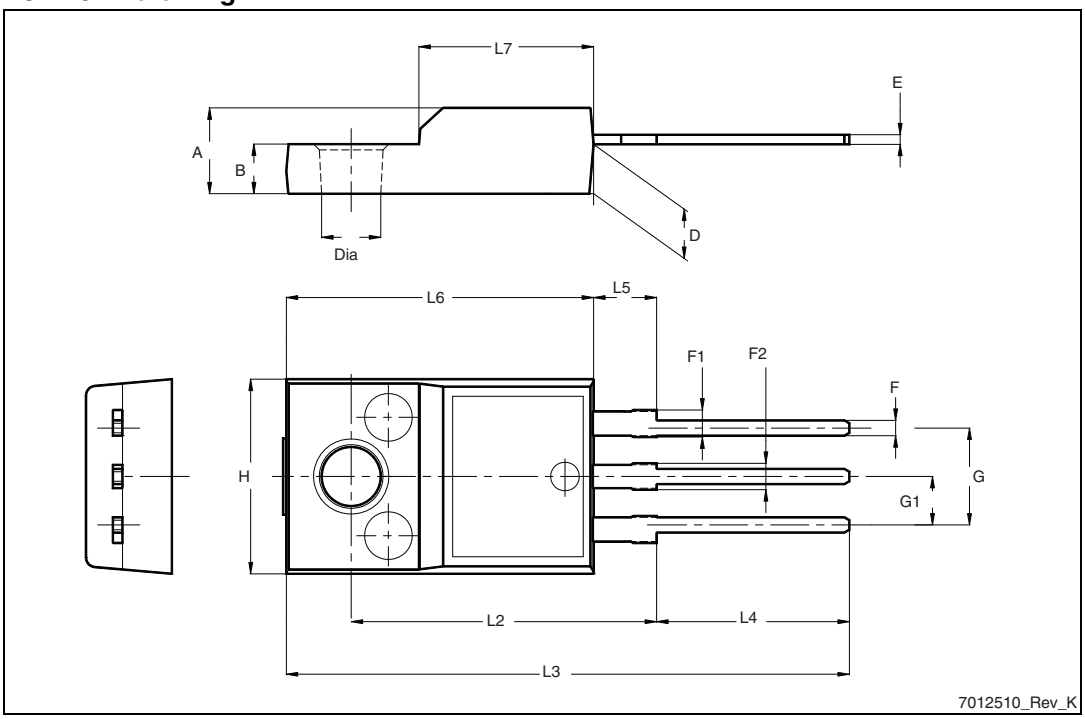


Table 10. TO-220 type A mechanical data

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	
∅P	3.75		3.85
Q	2.65		2.95

Figure 26. TO-220 type A drawing

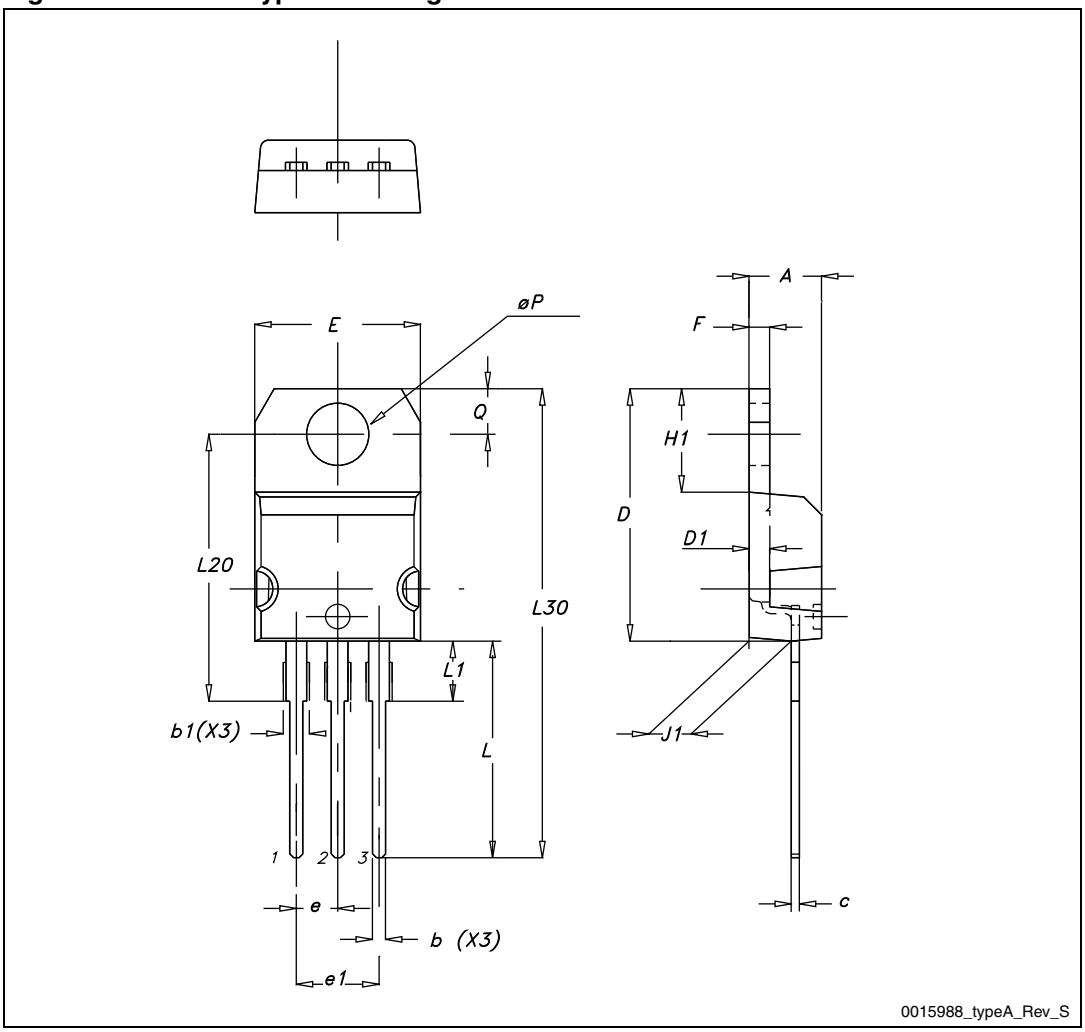
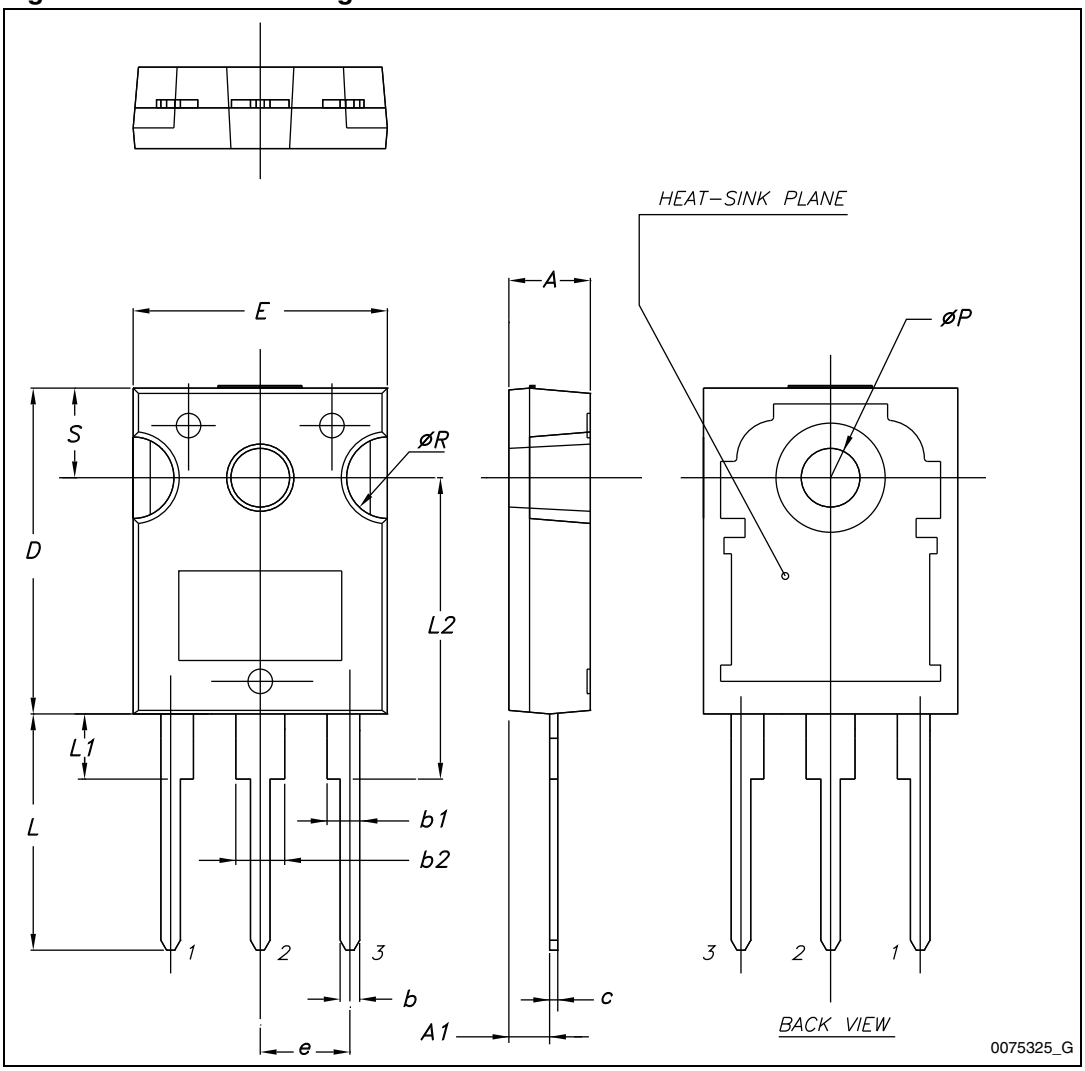


Table 11. TO-247 mechanical data

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	
∅P	3.55		3.65
∅R	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

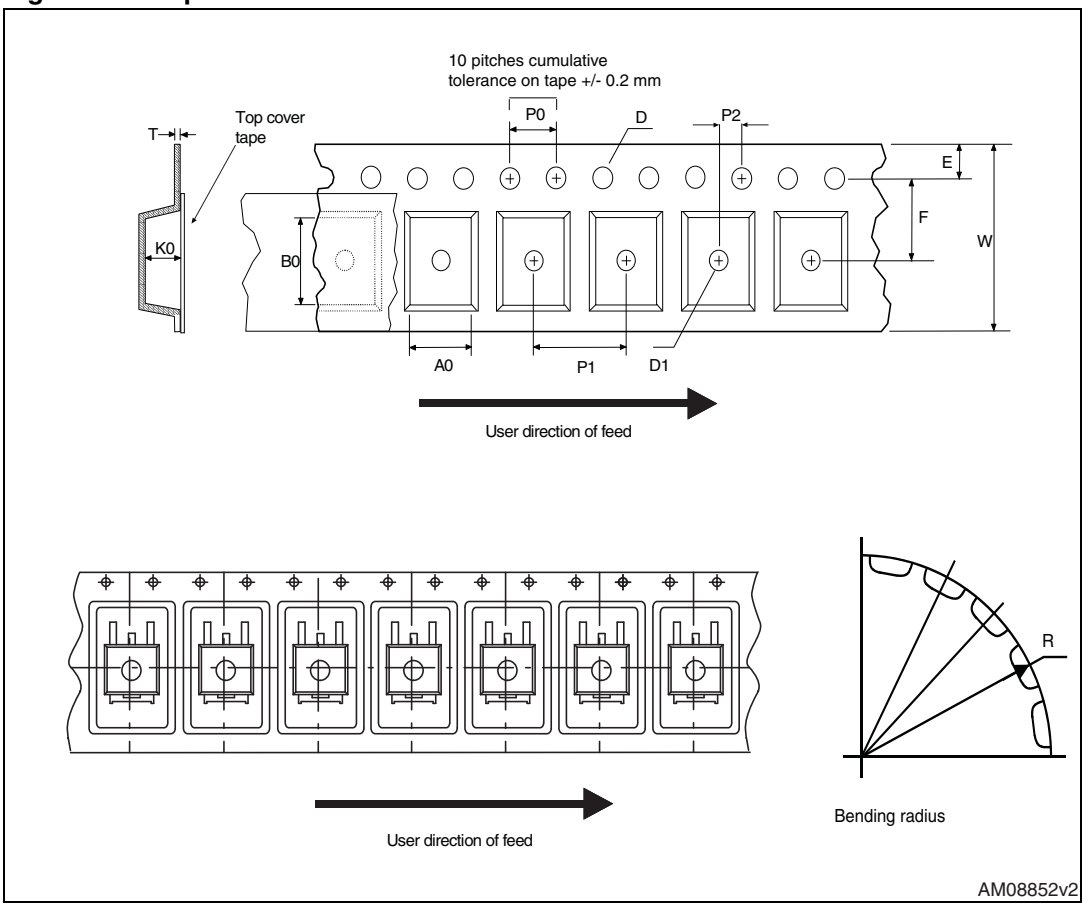
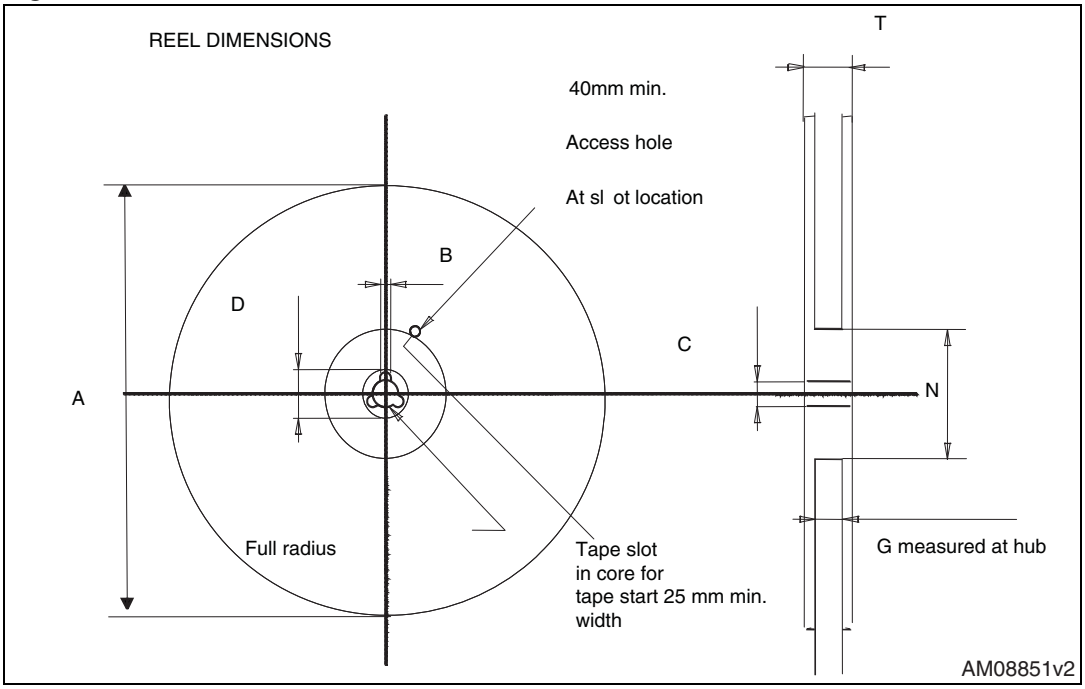


Figure 29. Reel



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.

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