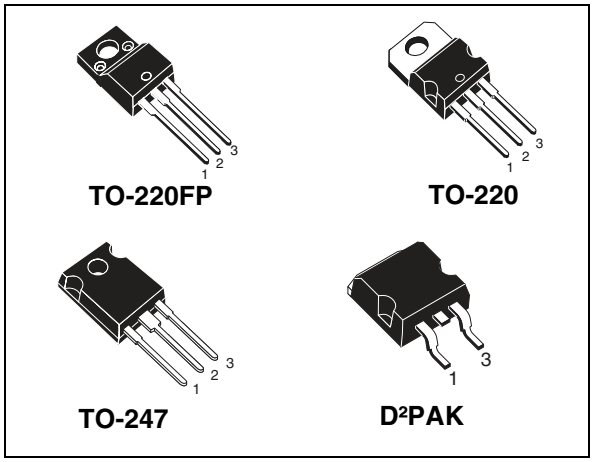
STB23NM50N, STF23NM50N STP23NM50N, STW23NM50N

N-channel 500 V, 0.162 Ω, 17 A TO-220, TO-220FP, TO-247, D²PAK MDmesh™ II Power MOSFET

Features

Order codes	V_{DSS} (@Tjmax)	$R_{DS(on)}$ max.	I_D
STB23NM50N	550 V	< 0.19 Ω	17 A
STF23NM50N			
STP23NM50N			
STW23NM50N			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance



Application

Switching applications

Description

These devices are made using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Figure 1. Internal schematic diagram

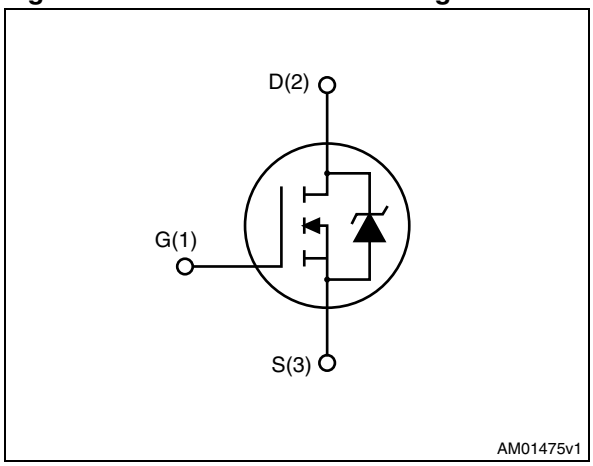


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB23NM50N	23NM50N	D²PAK	Tape and reel
STF23NM50N		TO-220FP	Tube
STP23NM50N		TO-220	
STW23NM50N		TO-247	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220, D²PAK	TO-247	TO-220FP	
V_{DS}	Drain-source voltage (V_{GS} = 0)	500			V
V_{GS}	Gate- source voltage	± 25			V
I_D	Drain current (continuous) at T_C = 25 °C	17		17 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	11		11 (1)	A
I_{DM} (2)	Drain current (pulsed)	68		68 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	125		30	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s;T_C=25 °C)			2500	V
dv/dt (3)	Peak diode recovery voltage slope	15			V/ns
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. $I_{SD} \leq 17$ A, di/dt ≤ 400 A/µs, V_{DS} peak $\leq V_{(BR)DSS}$, V_{DD} = 80% $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D²PAK	TO-247	TO-220	TO-220FP	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	1			4.17	°C/W
$R_{thj\text{-}pcb}$ (1)	Thermal resistance junction-pcb minimum footprint	30				°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max		62.5	50	62.5	°C/W
T_l	Maximum lead temperature for soldering purpose		300			°C

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

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max)	6	A
E_{AS}	Single pulse avalanche energy (starting Tj = 25 °C, $I_D = I_{AR}$, V_{DD} = 50 V)	254	mJ

2 Electrical characteristics

(T_{CASE}=25 °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 mA, V_{GS} = 0	500			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0) V_{DS} = max rating V_{DS} = max rating, @125 °C				1 100	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 25 V			100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 8.5 A		0.162	0.19	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0	-	1330 84 4.8	-	pF pF pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 400 V	-	210	-	pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 400 V, I_D = 17 A, V_{GS} = 10 V, *(see Figure 18)*	-	45 7 24	-	nC nC nC
R_g	Gate input resistance	f=1 MHz Gate DC Bias=0 Test signal level=20 mV open drain	-	4.6	-	Ω

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

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off-delay time Fall time	V_{DD} = 250 V, I_D = 17 A R_G = 4.7 Ω V_{GS} = 10 V *(see Figure 17)*	-	6.6 19 71 29	-	ns ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)		-		17 68	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 17 A, V_{GS} = 0	-		1.5	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 17 A, di/dt = 100 A/µs V_{DD} = 60 V *(see Figure 22)*	-	286 3700 26		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 17 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C *(see Figure 22)*	-	350 4800 27		ns nC 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 TO-220, D²PAK

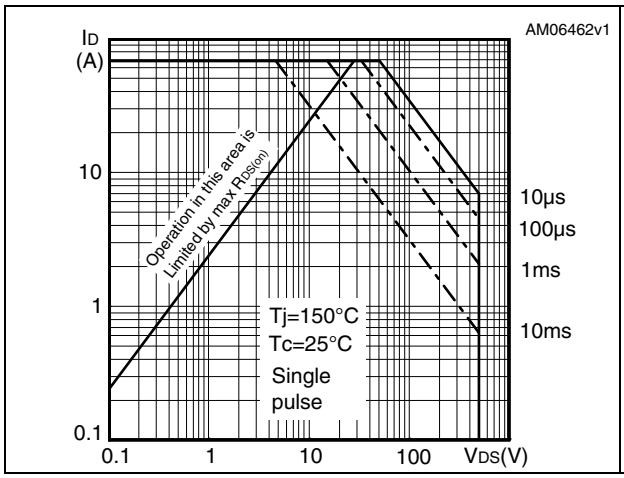


Figure 3. Thermal impedance for TO-220, D²PAK

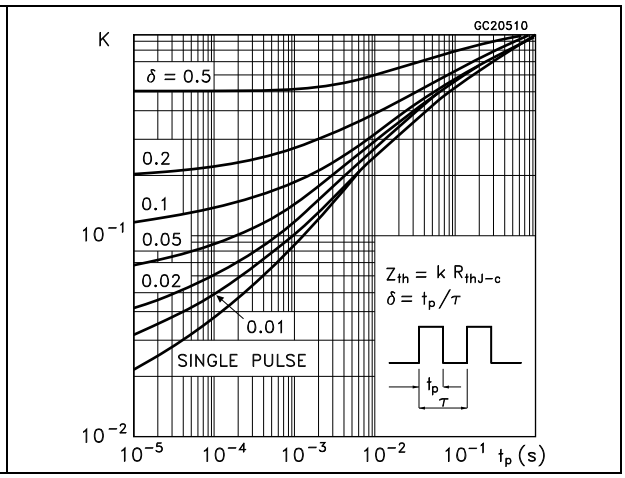


Figure 4. Safe operating area for TO-220FP

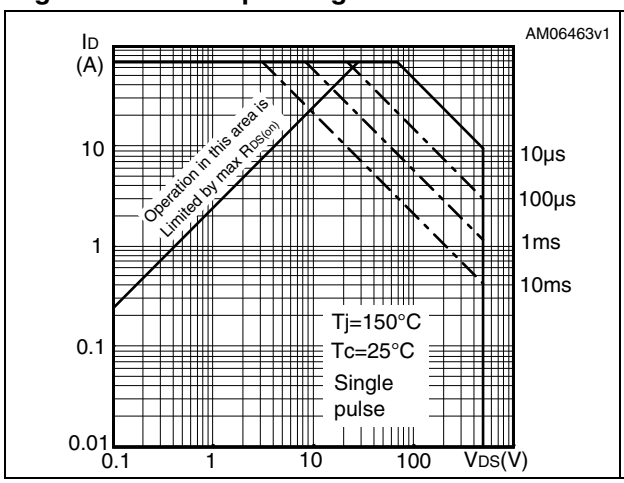


Figure 5. Thermal impedance for TO-220FP

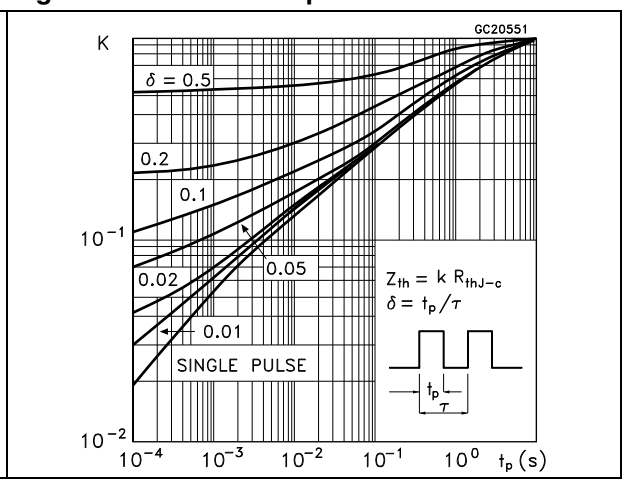


Figure 6. Safe operating area for TO-247

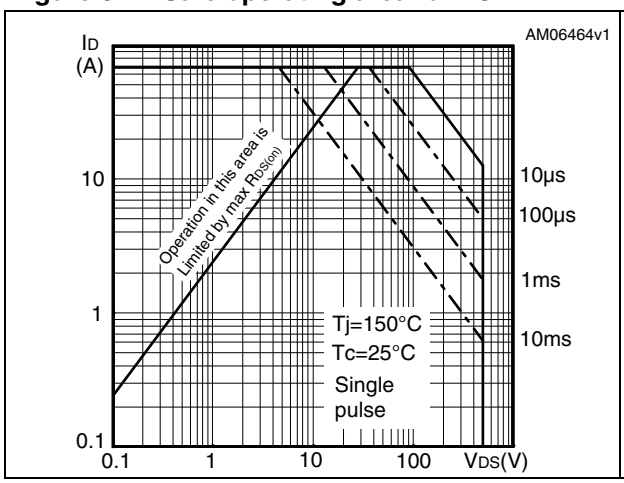


Figure 7. Thermal impedance for TO-247

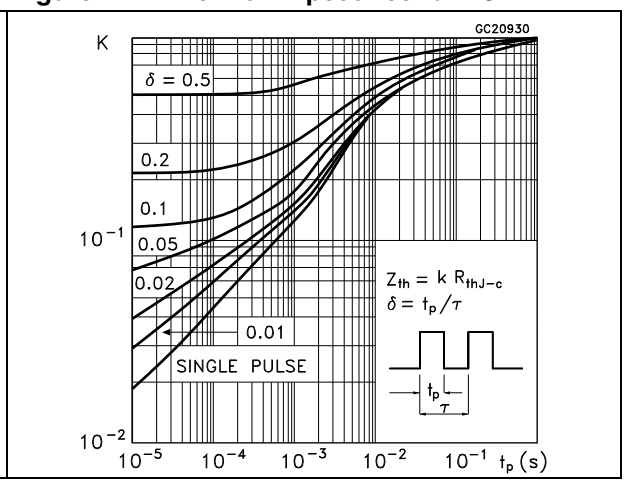


Figure 8. Output characteristics

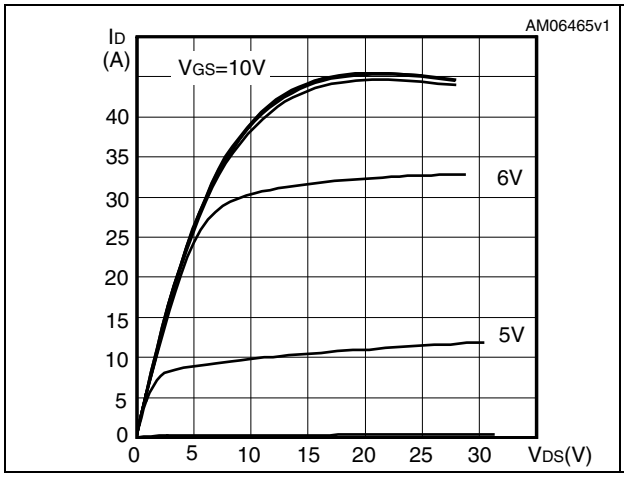


Figure 9. Transfer characteristics

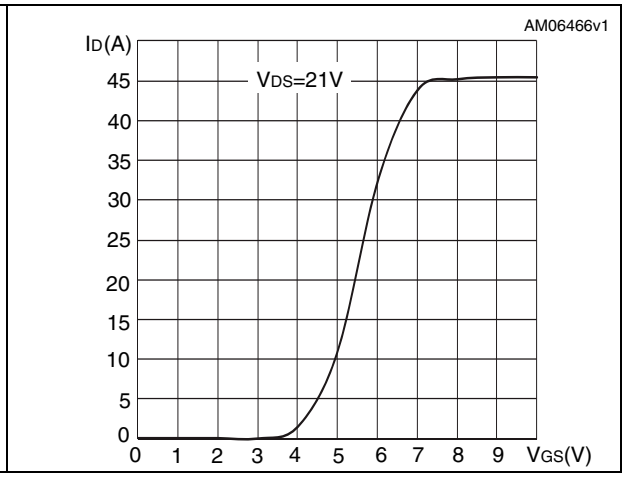


Figure 10. Normalized B_{VDSS} vs temperature

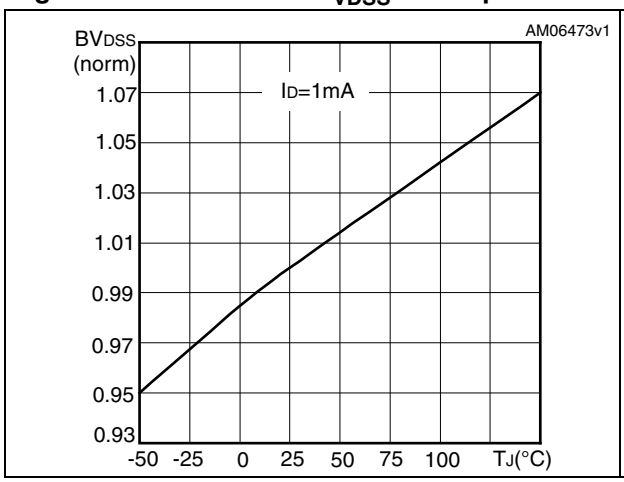


Figure 11. Static drain-source on resistance

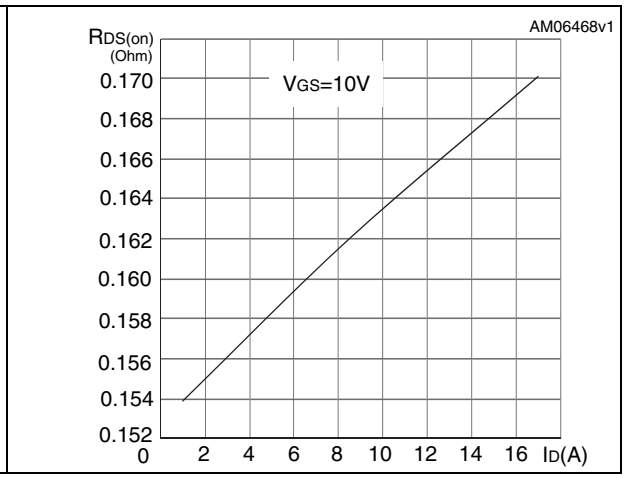


Figure 12. Gate charge vs gate-source voltage

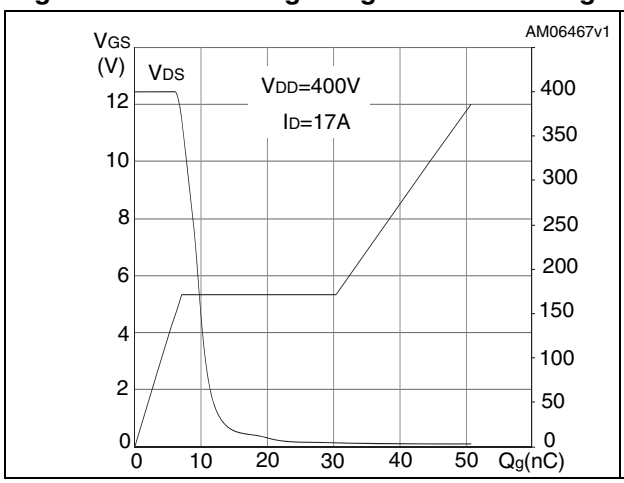


Figure 13. Capacitance variations

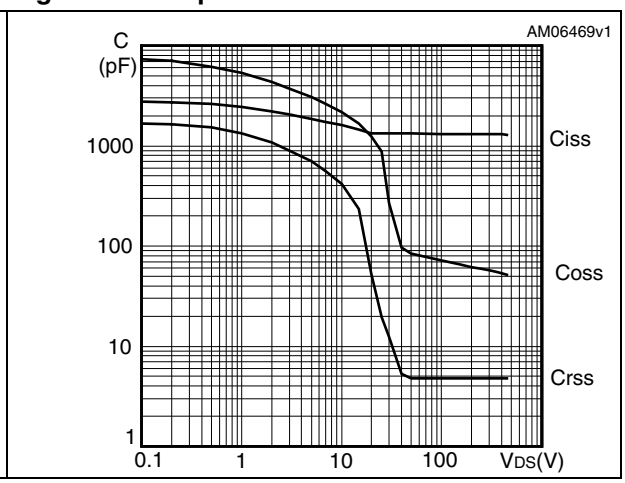


Figure 14. Normalized gate threshold voltage vs temperature

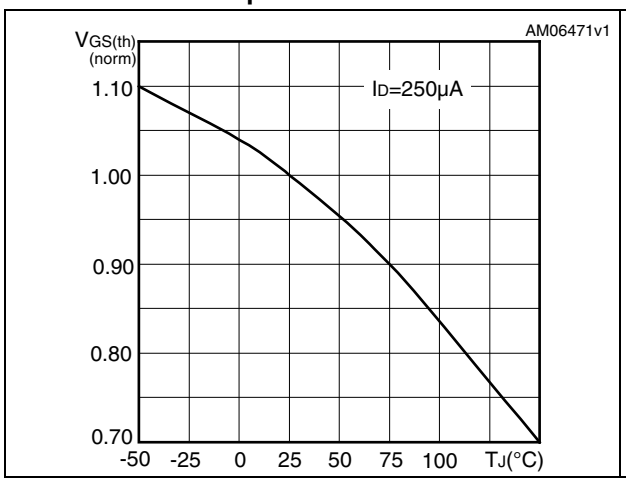


Figure 15. Normalized on resistance vs temperature

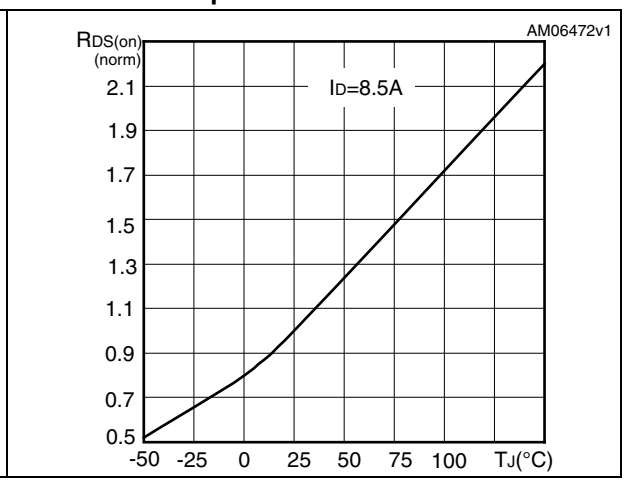
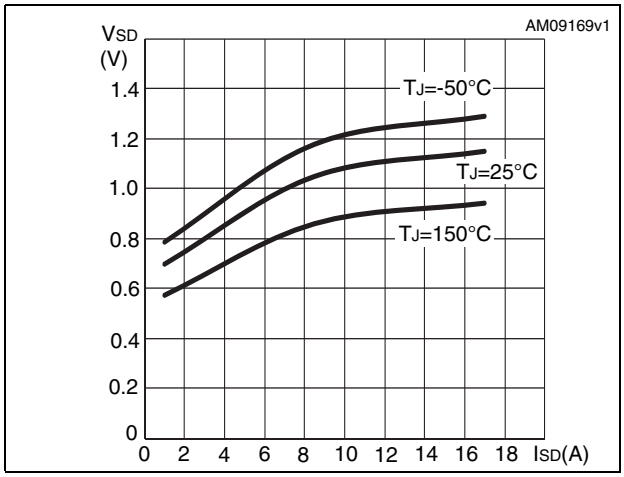


Figure 16. Source-drain diode forward characteristics



3 Test circuits

Figure 17. Switching times test circuit for resistive load

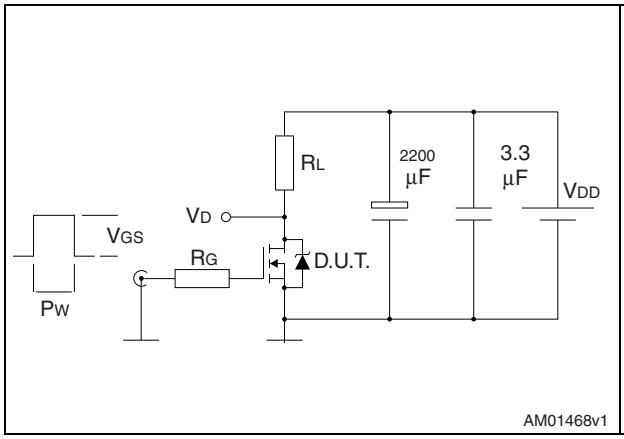


Figure 18. Gate charge test circuit

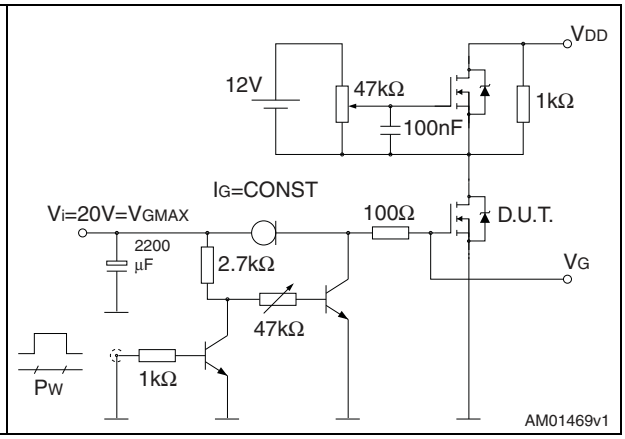


Figure 19. Test circuit for inductive load switching and diode recovery times

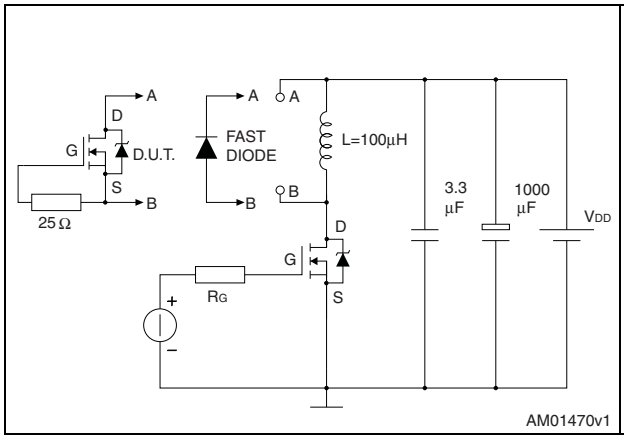


Figure 20. Unclamped inductive load test circuit

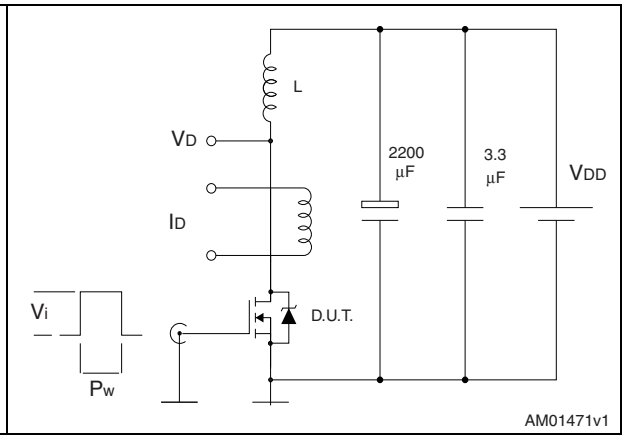


Figure 21. Unclamped inductive waveform

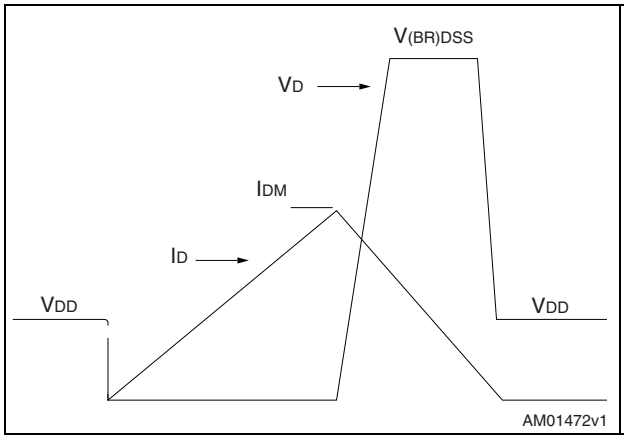
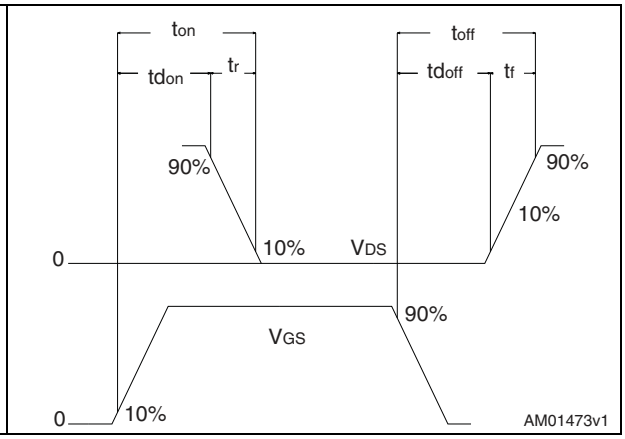


Figure 22. Switching time waveform



4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® 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 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 23. TO-220FP drawing

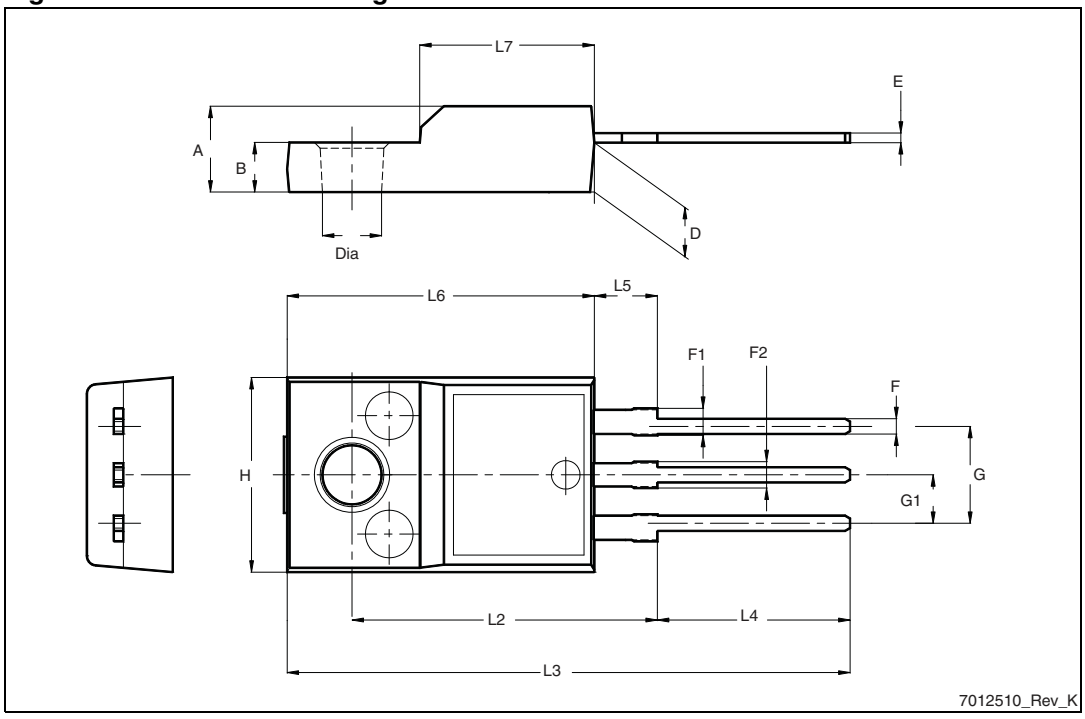


Table 10. TO-220 type A mechanical data

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 24. TO-220 type A drawing

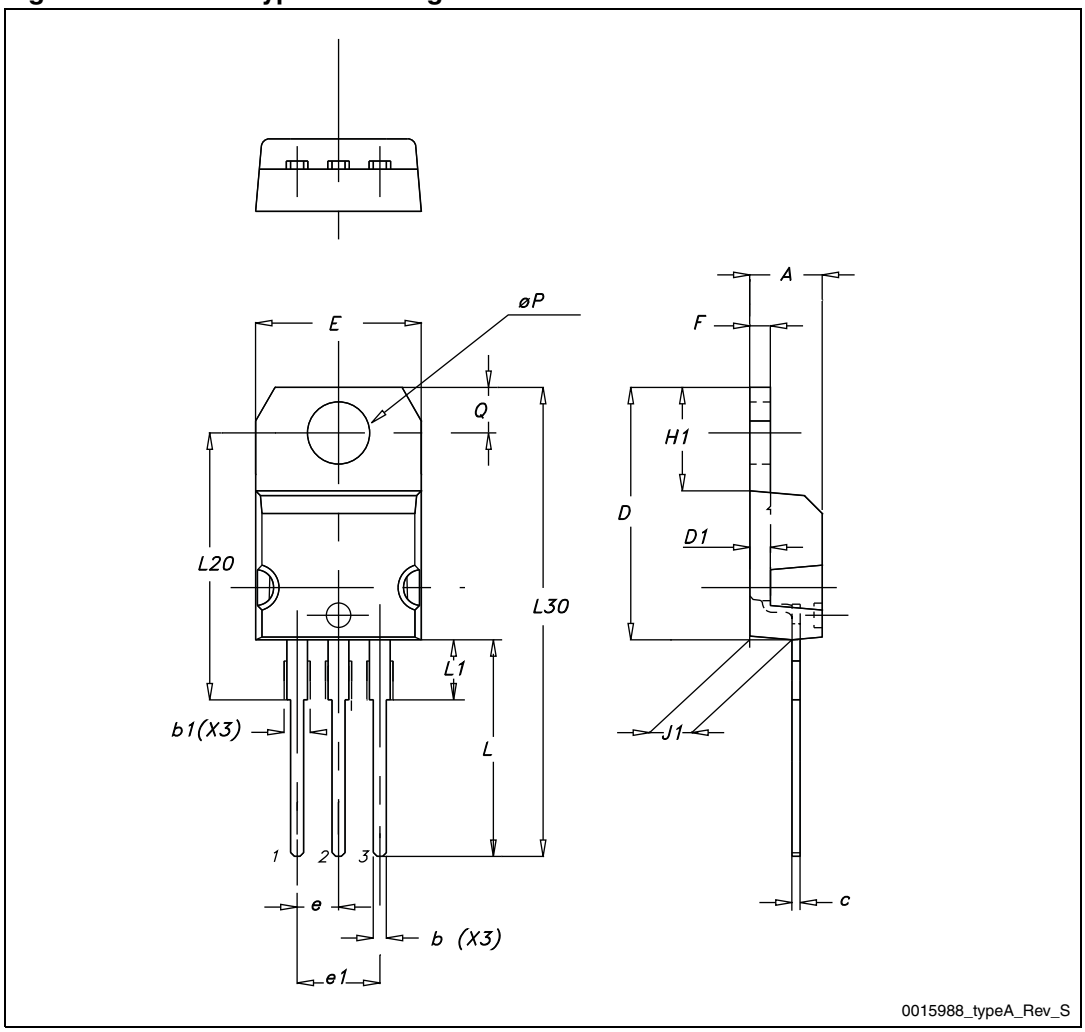


Table 11. TO-247 mechanical data

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		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
∅P	3.55		3.65
∅R	4.50		5.50
S		5.50	

Figure 25. TO-247 drawing

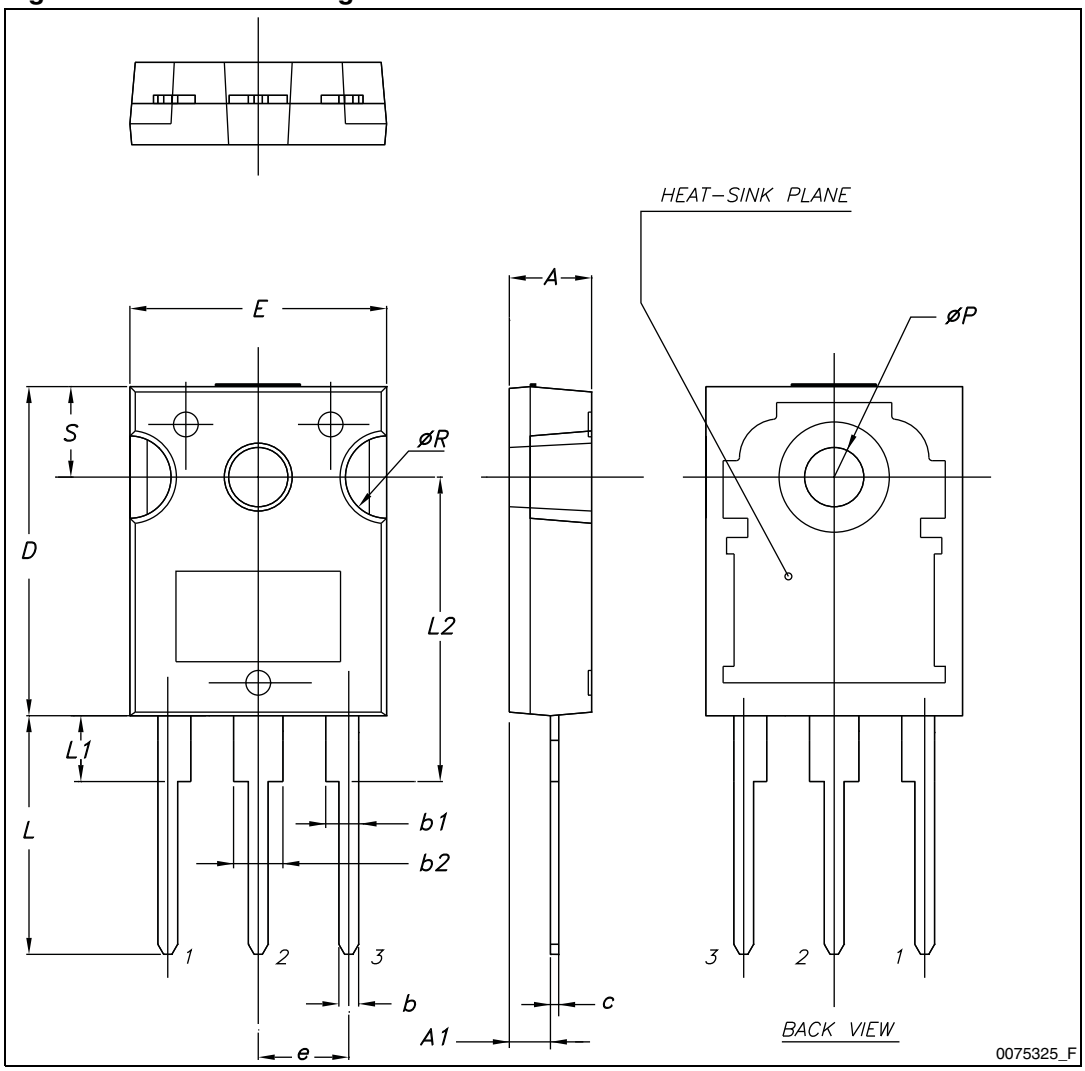


Table 12. D²PAK (TO-263) mechanical data

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 26. D²PAK footprint(a)

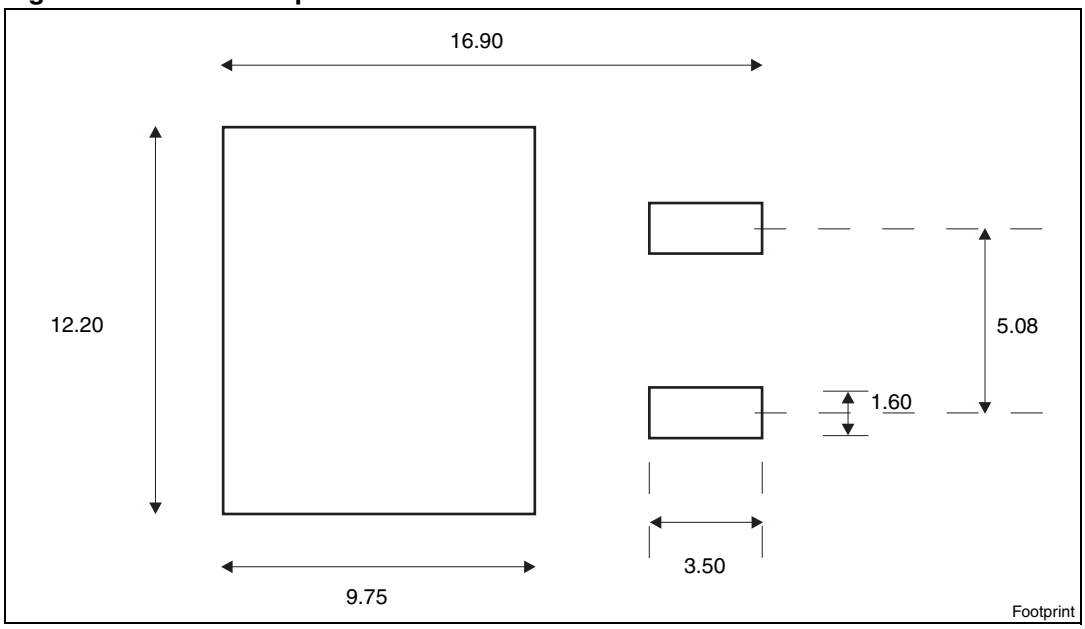
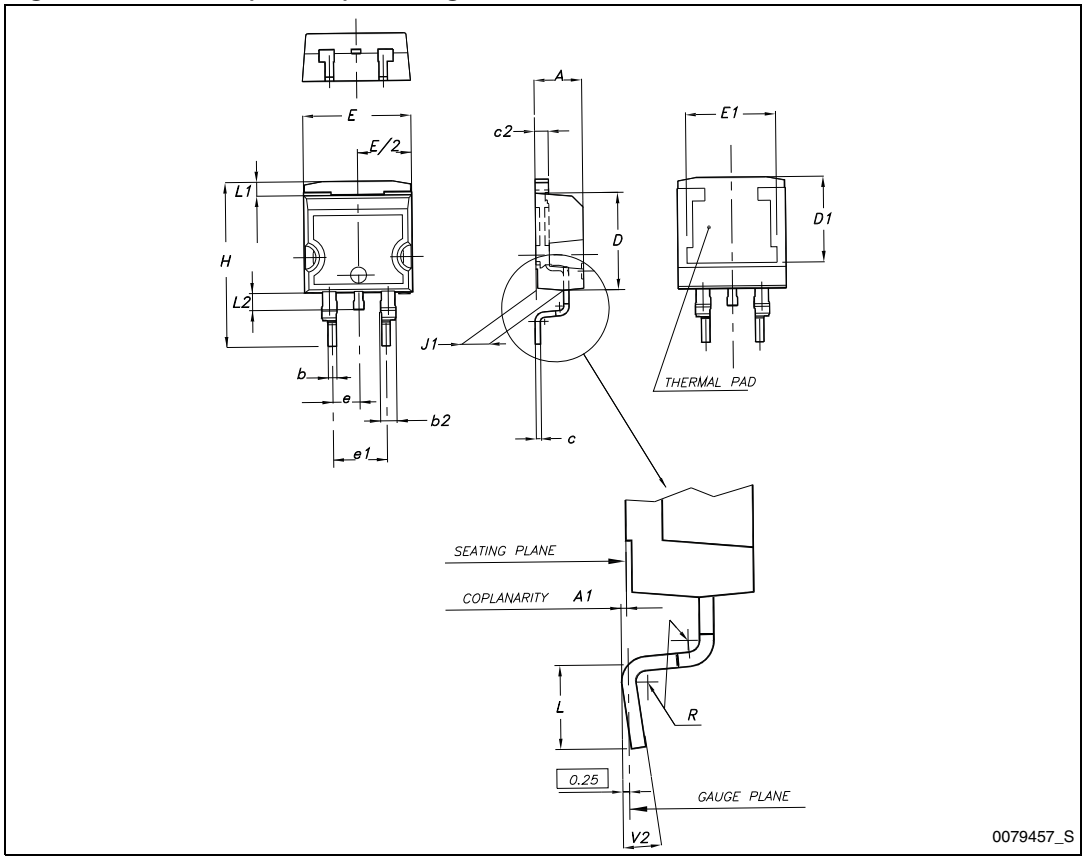


Figure 27. D²PAK (TO-263) drawing



a. All dimension are in millimeters

5 Package mechanical data

Table 13. 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

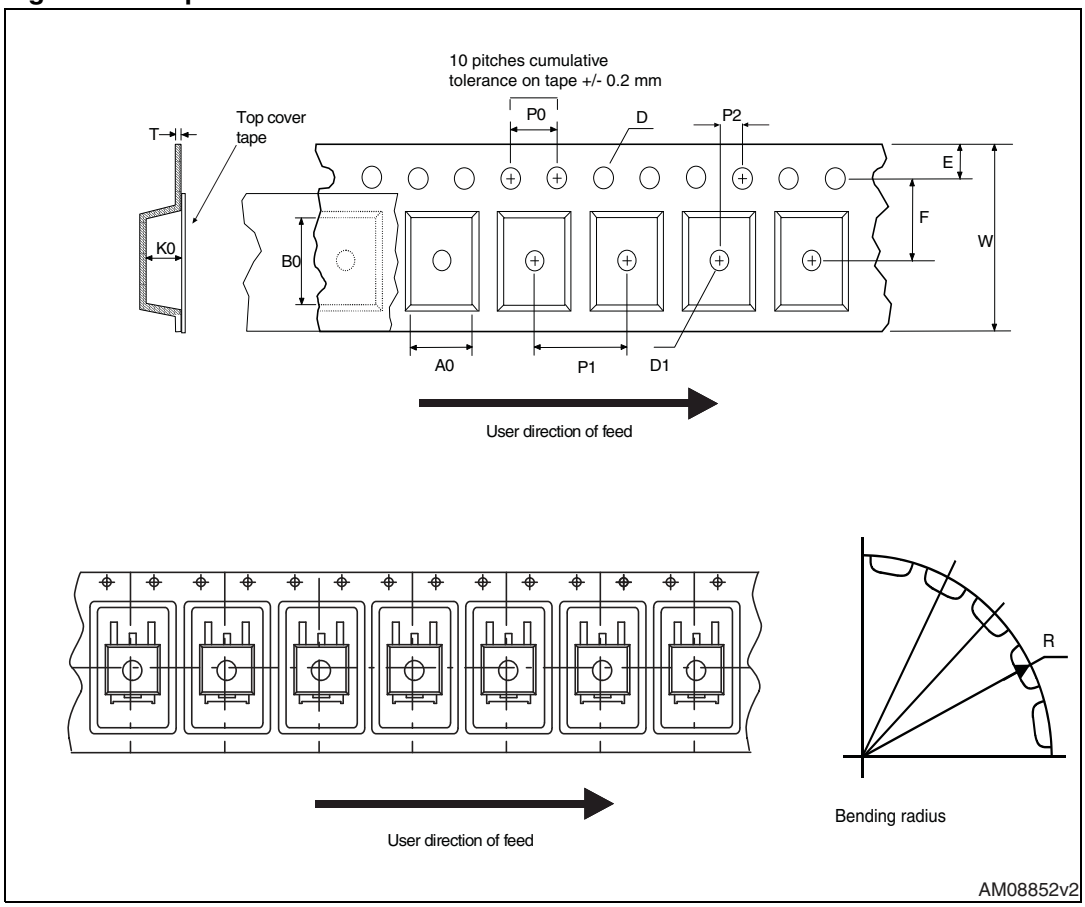
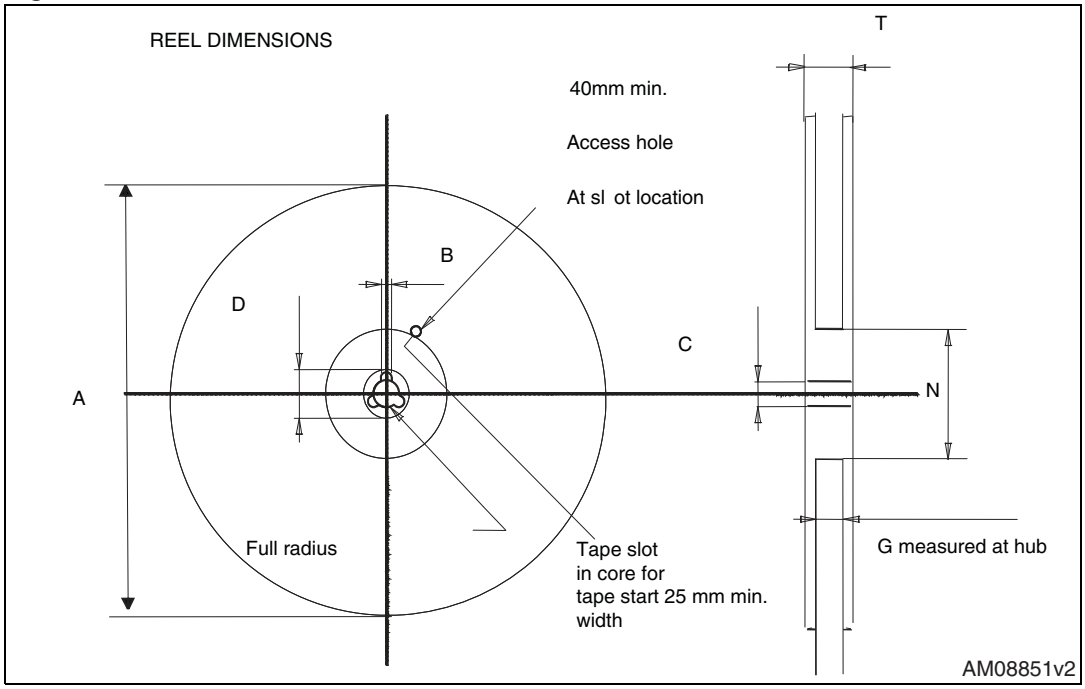


Figure 29. Reel



6 Revision history

Table 14. Document revision history

Date	Revision	Changes
11-Dec-2009	1	First release.
26-May-2010	2	Document status promoted from preliminary data to datasheet.
16-Sep-2010	3	Added new value in *Figure 14*, *Figure 15* and *Figure 10*.
23-May-2011	4	*Section 2.1: Electrical characteristics (curves)* has been updated.

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