



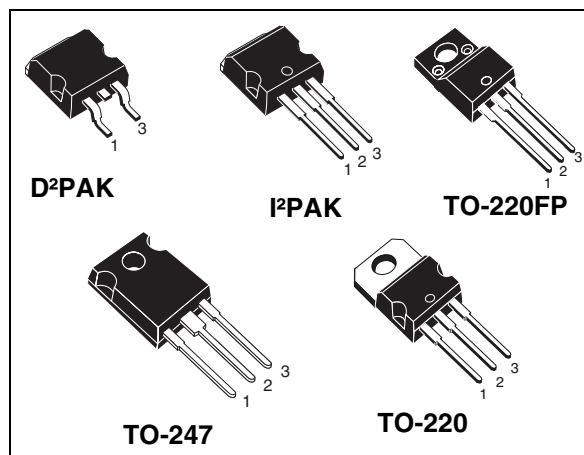
STB22NM60N, STF22NM60N, STI22NM60N STP22NM60N, STW22NM60N

N-channel 600 V, 0.2 Ω , 16 A MDmesh™ II Power MOSFET
in D²PAK, TO-220FP, I²PAK, TO-220 and TO-247

Features

Order codes	V _{DSS} (@T _{jmax})	R _{DS(on)} max.	I _D
STB22NM60N	650 V	< 0.22 Ω	16 A
STF22NM60N	650 V	< 0.22 Ω	16 A
STI22NM60N	650 V	< 0.22 Ω	16 A
STP22NM60N	650 V	< 0.22 Ω	16 A
STW22NM60N	650 V	< 0.22 Ω	16 A

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



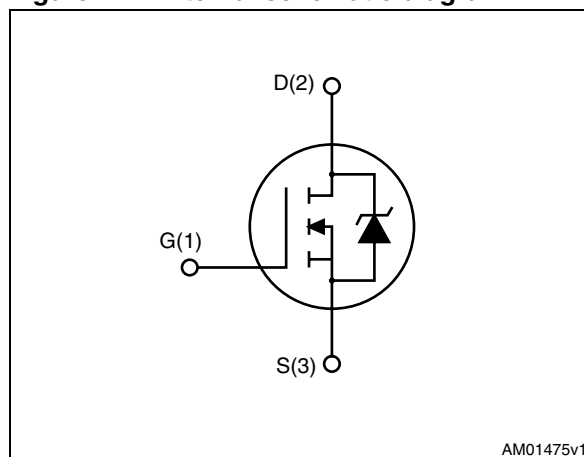
Application

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



AM01475v1

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB22NM60N	22NM60N	D ² PAK	Tape and reel
STF22NM60N		TO-220FP	Tube
STI22NM60N		I ² PAK	
STP22NM60N		TO-220	
STW22NM60N		TO-247	

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		D ² PAK I ² PAK	TO-220 TO-247	TO-220FP	
V _{GS}	Gate- source voltage	± 30			V
I _D	Drain current (continuous) at T _C = 25 °C	16		16 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	10		10 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	64		64 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	125		30	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	15			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 _J T _{stg}	Operating junction temperature Storage temperature	-55 to 150			°C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 16 \text{ A}$, $di/dt \leq 400 \text{ A}/\mu\text{s}$, $V_{DSpeak} \leq V_{(BR)DSS}$, $V_{DD} = 80\% V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value					Unit
		D ² PAK	I ² PAK	TO-220	TO-247	TO-220FP	
R _{thj-case}	Thermal resistance junction-case max.	1				4.17	°C/W
R _{thj-amb}	Thermal resistance junction-ambient max.		62.5		50	62.5	°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb max.	30					°C/W
T _J	Maximum lead temperature for soldering purpose		300				°C/W

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

Table 4. Thermal data

Symbol	Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _J max)	6	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	300	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	$I_D = 1 \text{ mA}$, $V_{GS} = 0$	600			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$, $T_C = 125 \text{ °C}$			1 100	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 25 \text{ V}$			100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250 \mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}$, $I_D = 8 \text{ A}$		0.2	0.22	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	$V_{DS} = 50 \text{ V}$, $f = 1 \text{ MHz}$, $V_{GS} = 0$	-	1330 84 4.6	-	pF pF pF
$C_{oss \text{ eq.}}^{(1)}$	Output equivalent capacitance	$V_{DS} = 0 \text{ to } 480 \text{ V}$, $V_{GS} = 0$	-	181	-	pF
R_g	Gate input resistance	$f = 1 \text{ MHz}$ open drain	-	4.7	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 480 \text{ V}$, $I_D = 16 \text{ A}$, $V_{GS} = 10 \text{ V}$ (see Figure 18)	-	44 6 25	-	nC nC nC

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_{DS} .

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 8\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 17)	-	11	-	ns
$t_{r(v)}$	Voltage rise time			18		ns
$t_{d(off)}$	Turn-off delay time			74		ns
$t_{f(i)}$	Fall time			38		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
I_{SD}	Source-drain current		-		16	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				64	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 16\text{ A}$, $V_{GS} = 0$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 16\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 19)	-	296		ns
Q_{rr}	Reverse recovery charge			4		μC
I_{RRM}	Reverse recovery current			26.8		A
t_{rr}	Reverse recovery time	$I_{SD} = 16\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 19)	-	350		ns
Q_{rr}	Reverse recovery charge			4.7		μC
I_{RRM}	Reverse recovery current			27		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, I²PAK

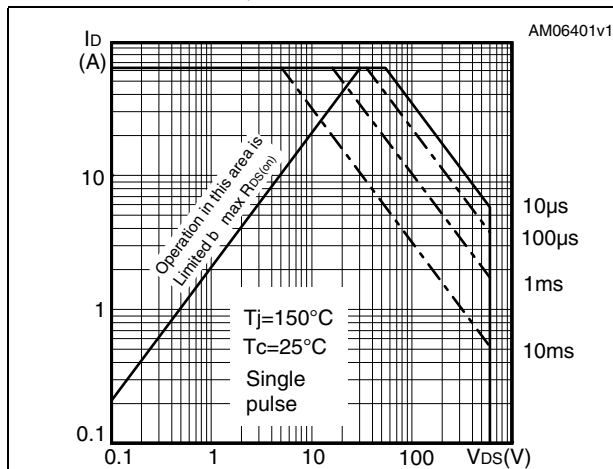


Figure 3. Thermal impedance for TO-220, D²PAK, I²PAK

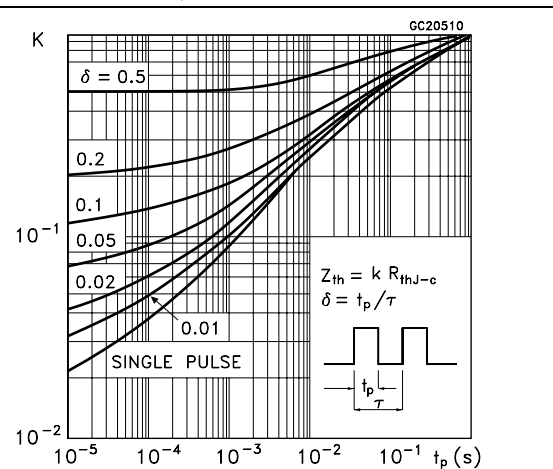


Figure 4. Safe operating area for TO-220FP

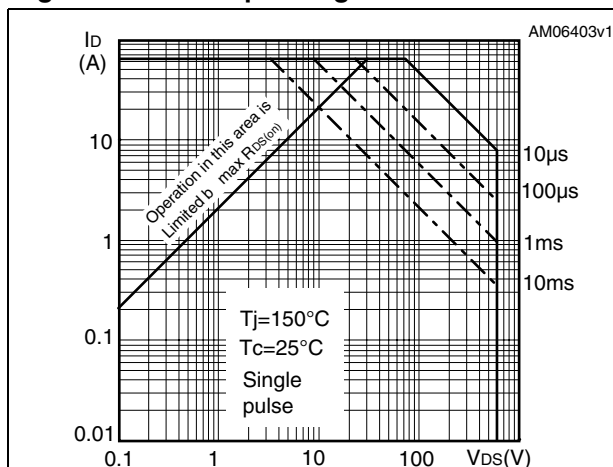


Figure 5. Thermal impedance for TO-220FP

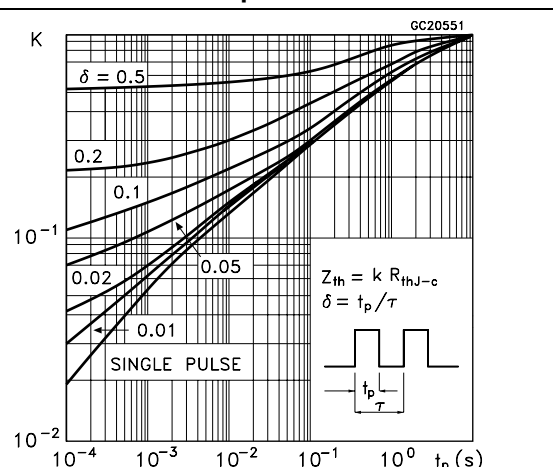


Figure 6. Safe operating area for TO-247

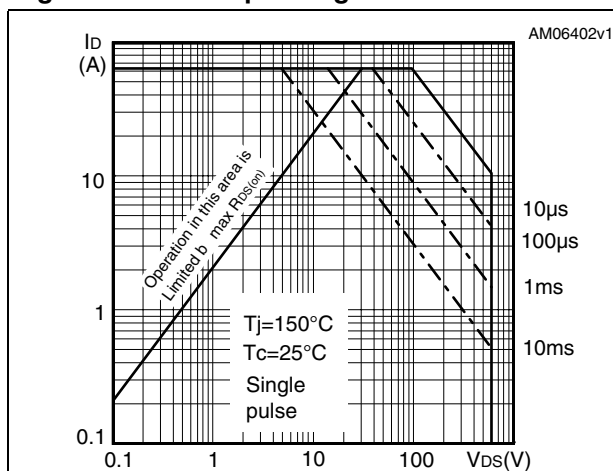


Figure 7. Thermal impedance for TO-247

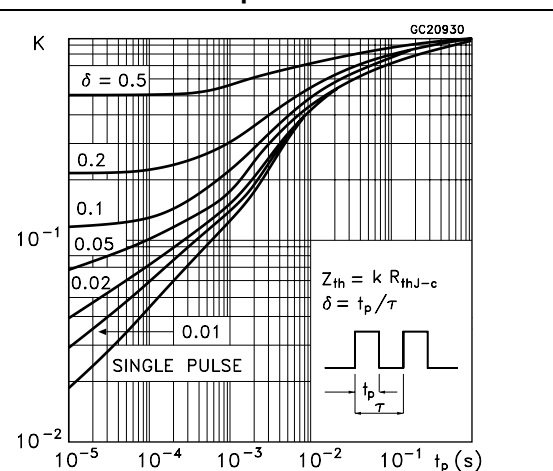


Figure 8. Output characteristics

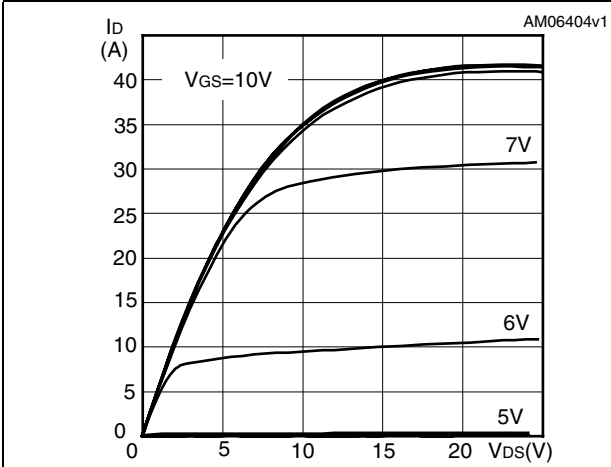


Figure 9. Transfer characteristics

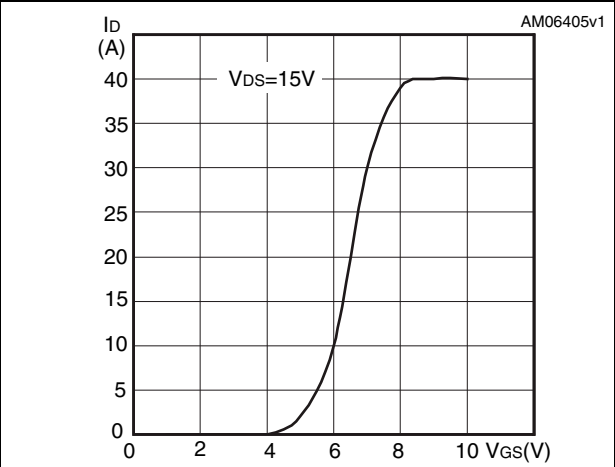


Figure 10. Gate charge vs gate-source voltage

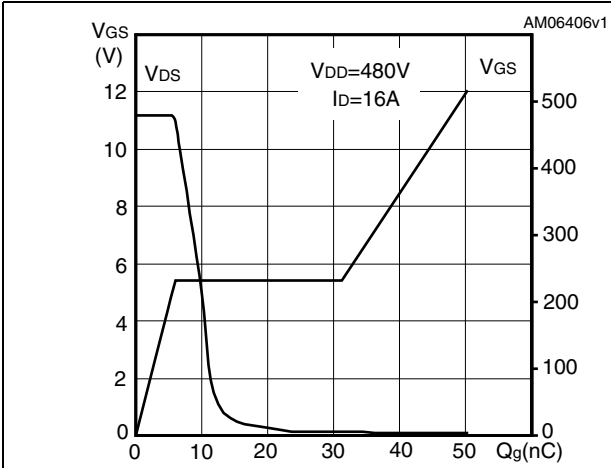


Figure 11. Static drain-source on resistance

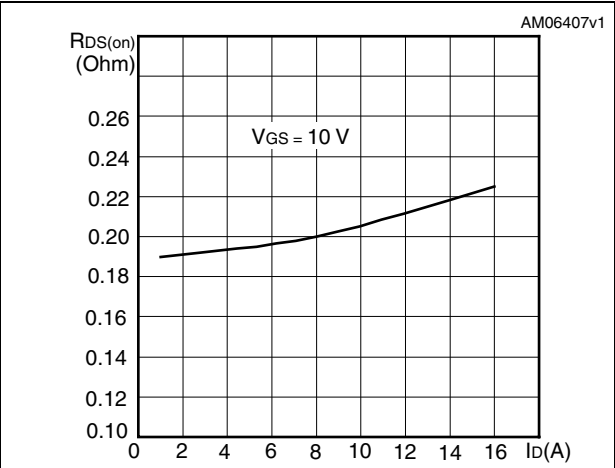


Figure 12. Capacitance variations

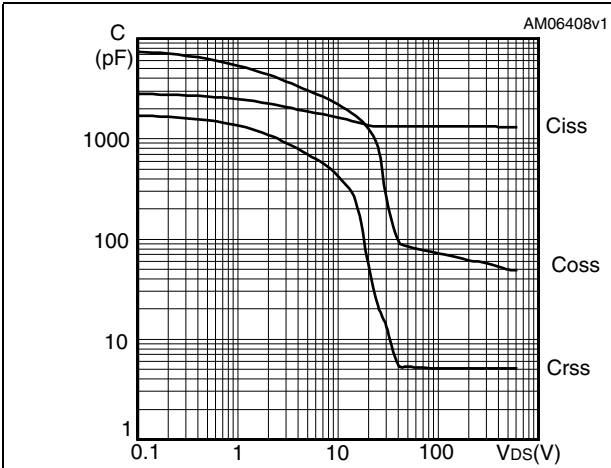


Figure 13. Output capacitance stored energy

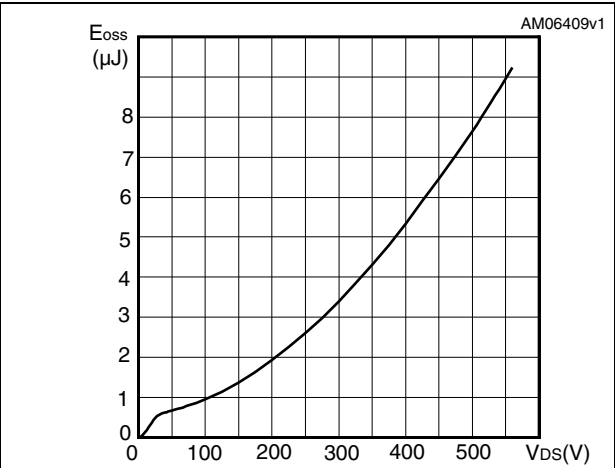


Figure 14. Normalized gate threshold voltage vs temperature

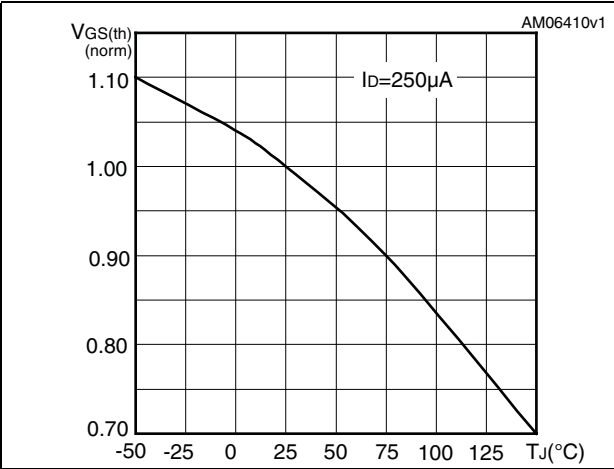


Figure 15. Normalized on resistance vs temperature

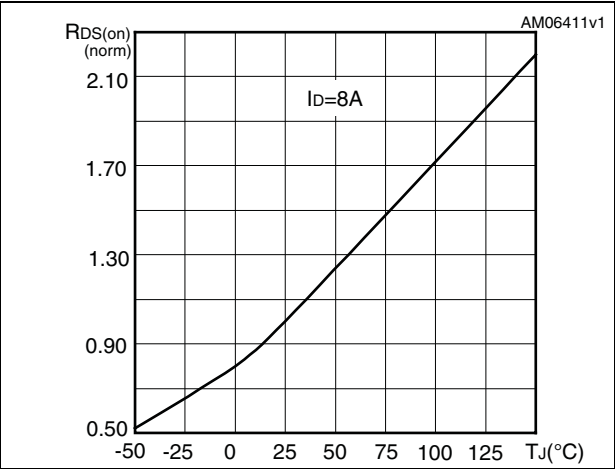
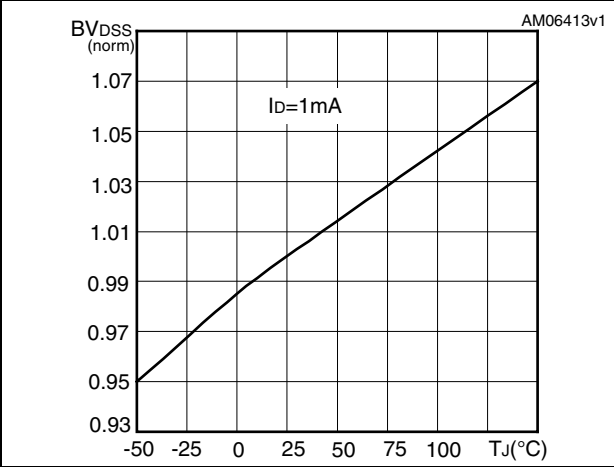


Figure 16. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 17. Switching times test circuit for resistive load

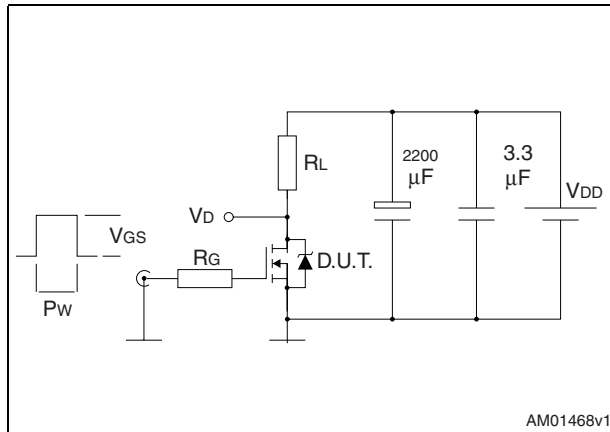


Figure 18. Gate charge test circuit

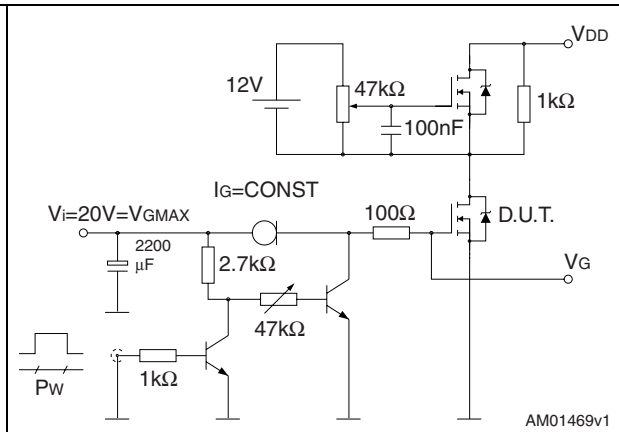


Figure 19. Test circuit for inductive load switching and diode recovery times

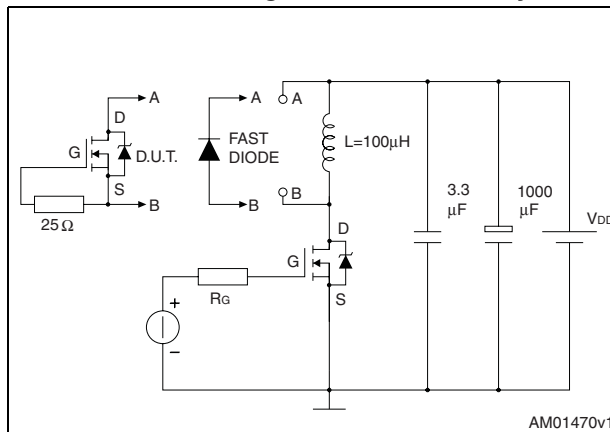


Figure 20. Unclamped inductive load test circuit

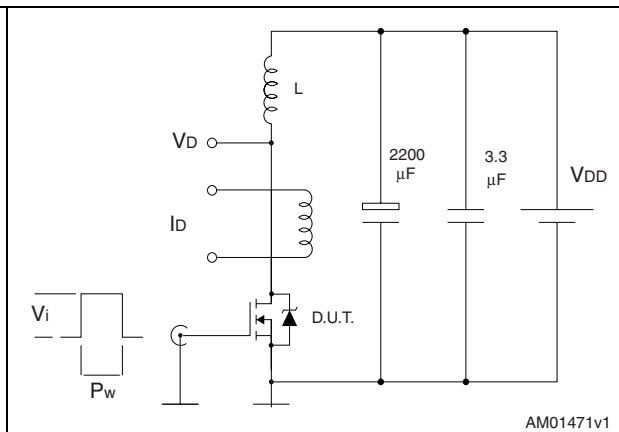


Figure 21. Unclamped inductive waveform

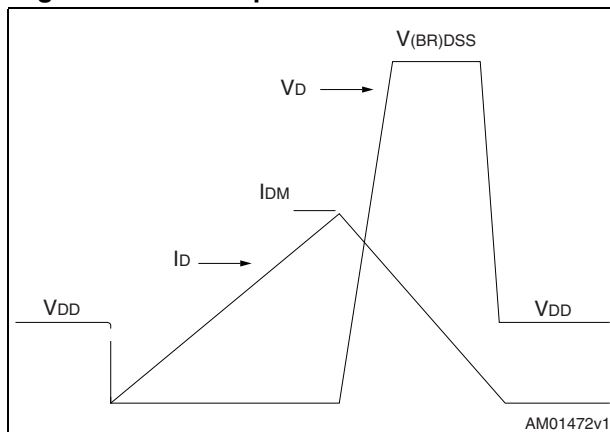
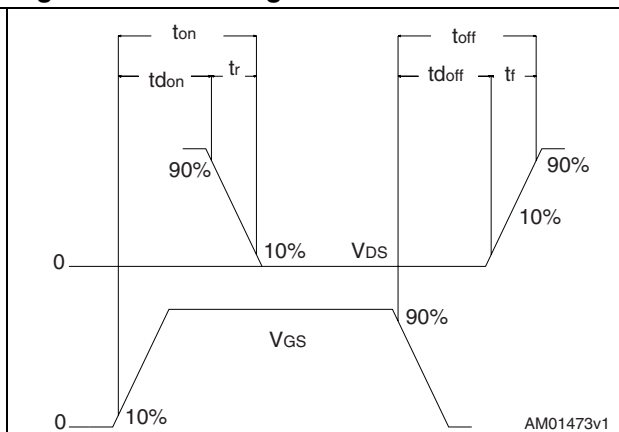


Figure 22. Switching time waveform



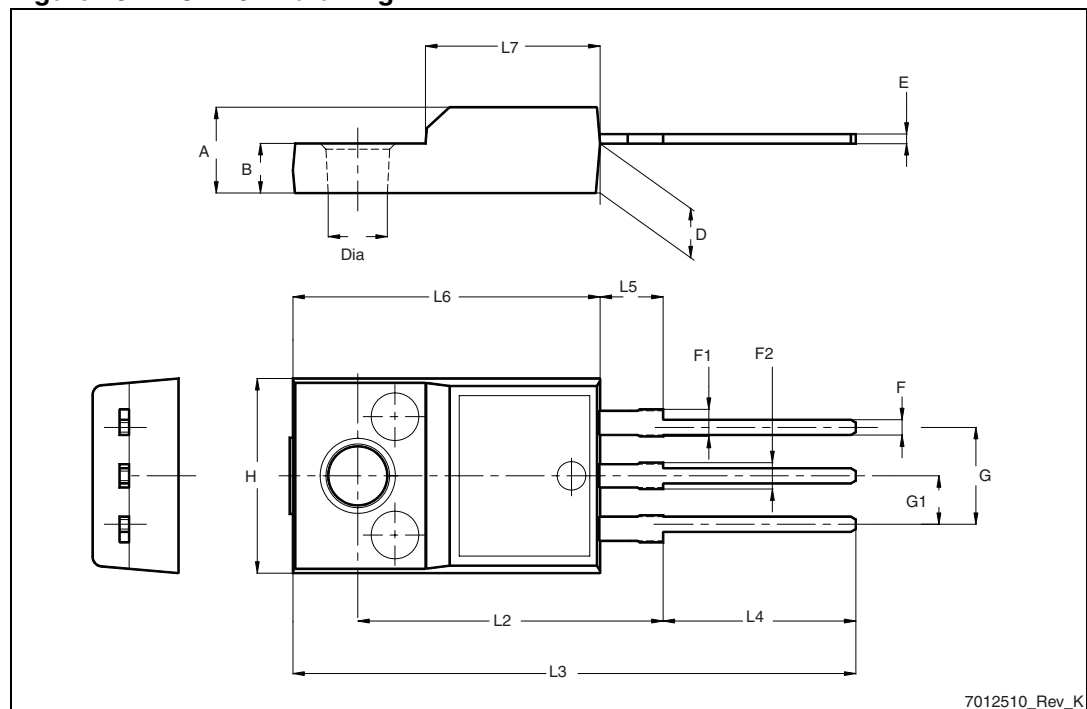
4 **Package mechanical data**

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

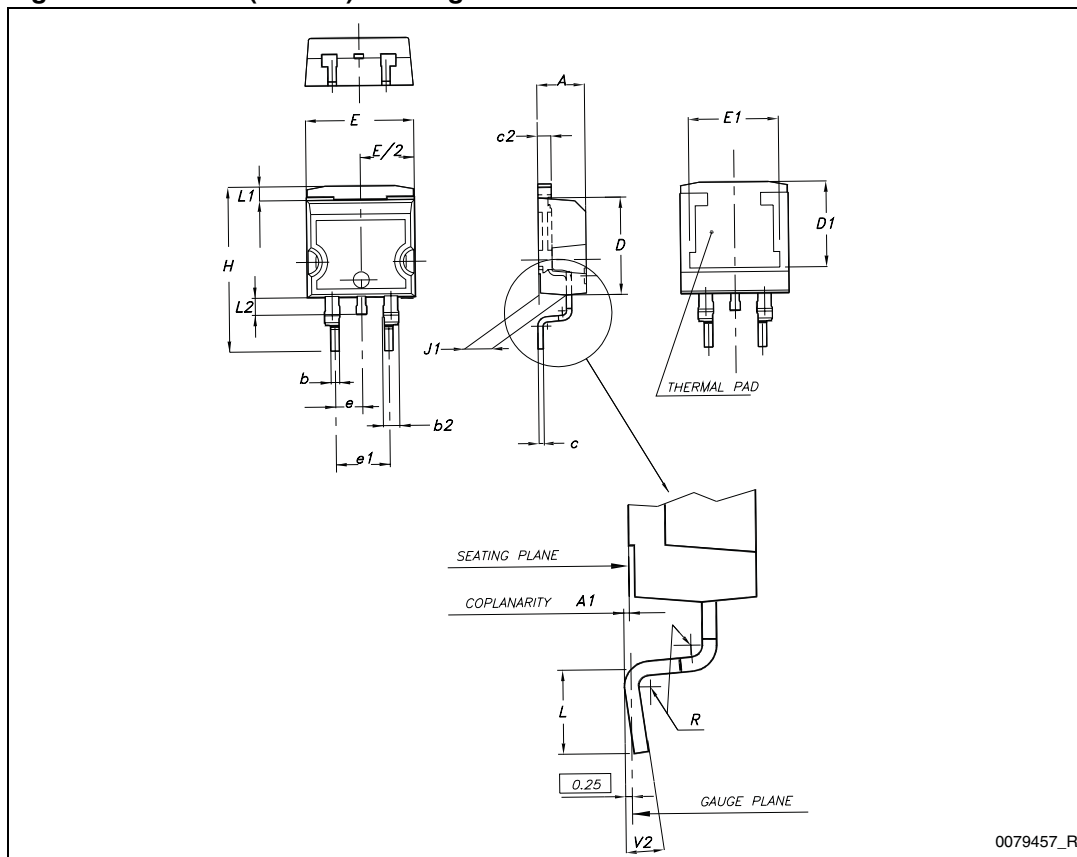
Figure 23. TO-220FP drawing



7012510_Rev_K

Table 10. 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

0079457_R

Table 11. 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 25. TO-220 type A drawing

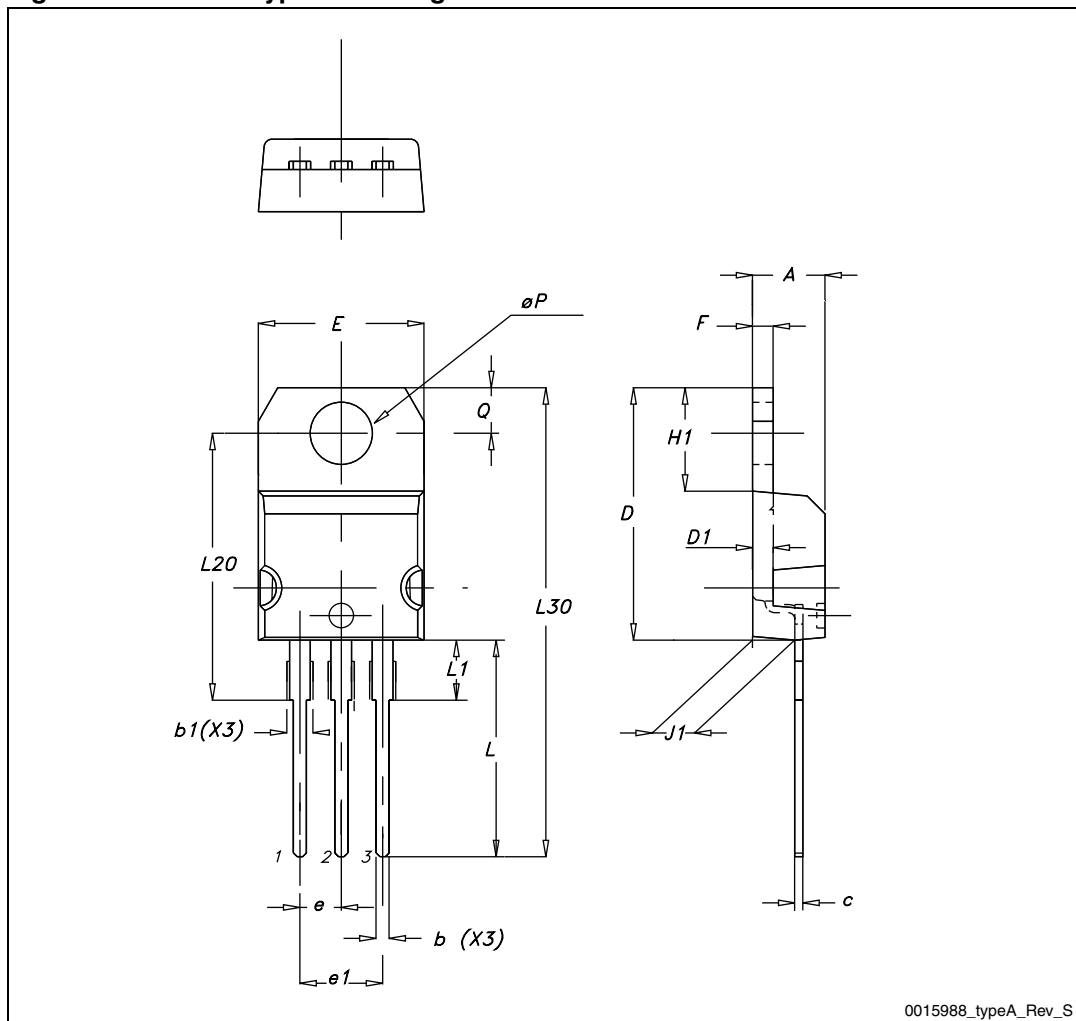


Table 12. TO-247 mechanical data

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	
ØP	3.55		3.65
ØR	4.50		5.50
S		5.50	

Figure 26. TO-247 drawing

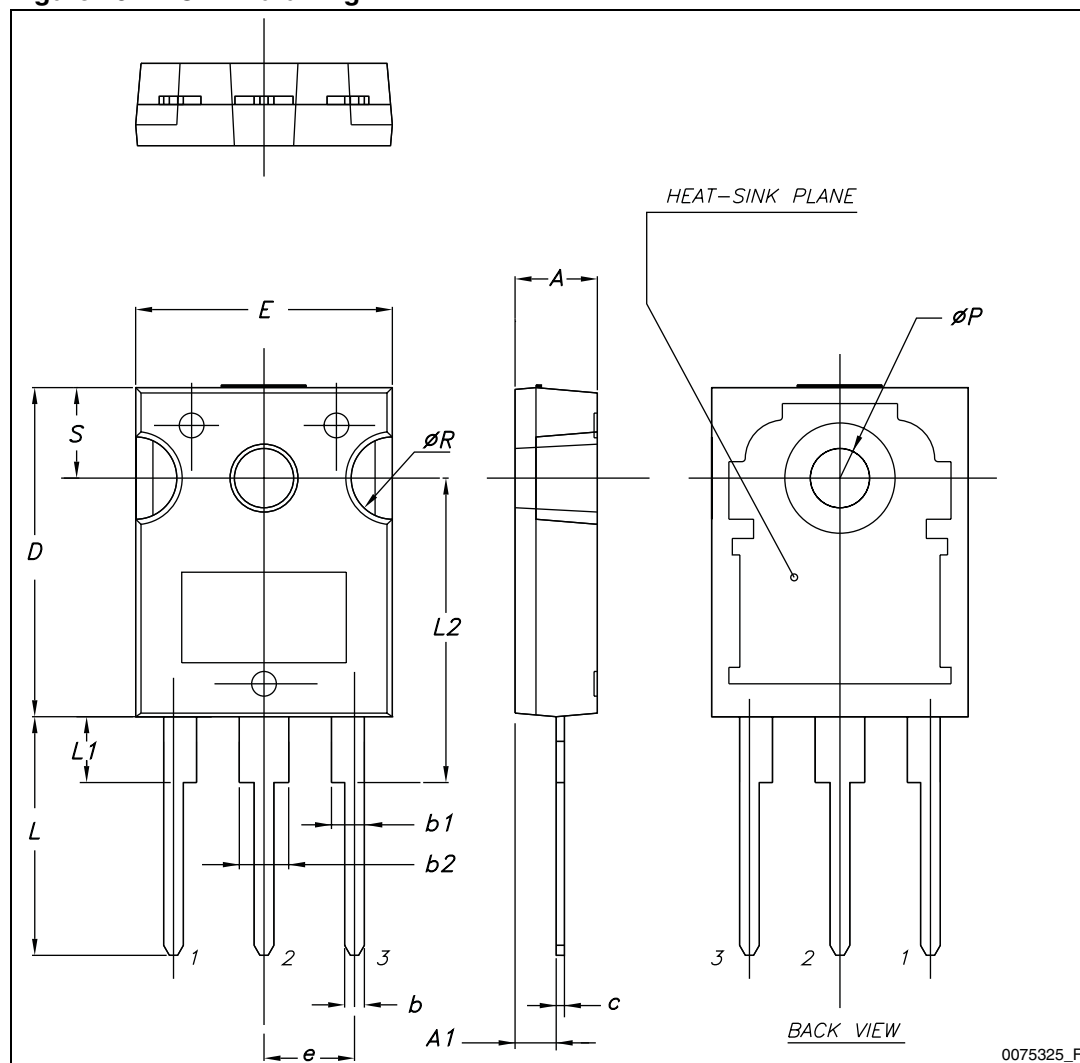
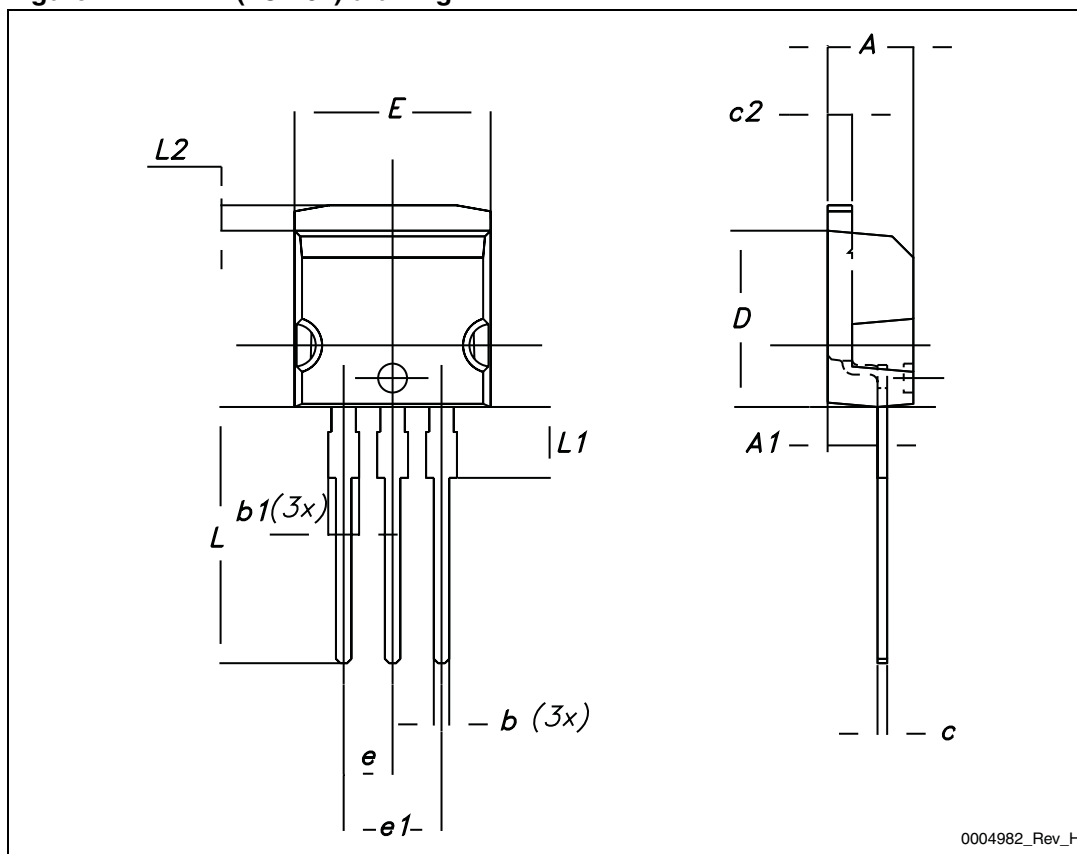


Table 13. I²PAK (TO-262) mechanical data

DIM.	mm.		
	min.	typ	max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

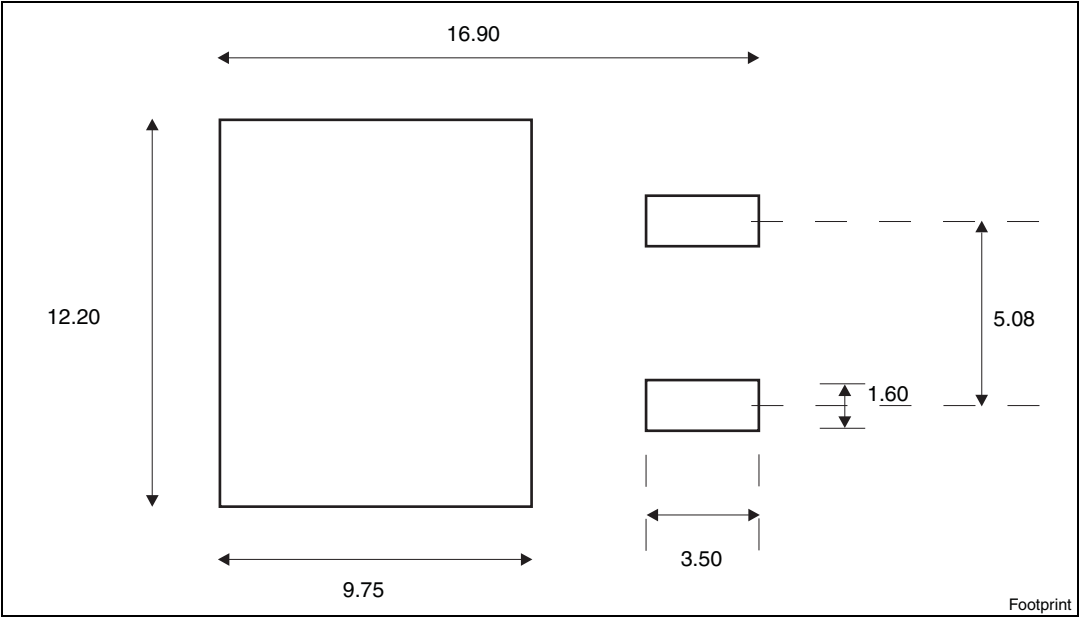
Figure 27. I²PAK (TO-262) drawing

5 Packaging mechanical data

Table 14. 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. D²PAK footprint^(a)



a. All dimension are in millimeters

Figure 29. Tape

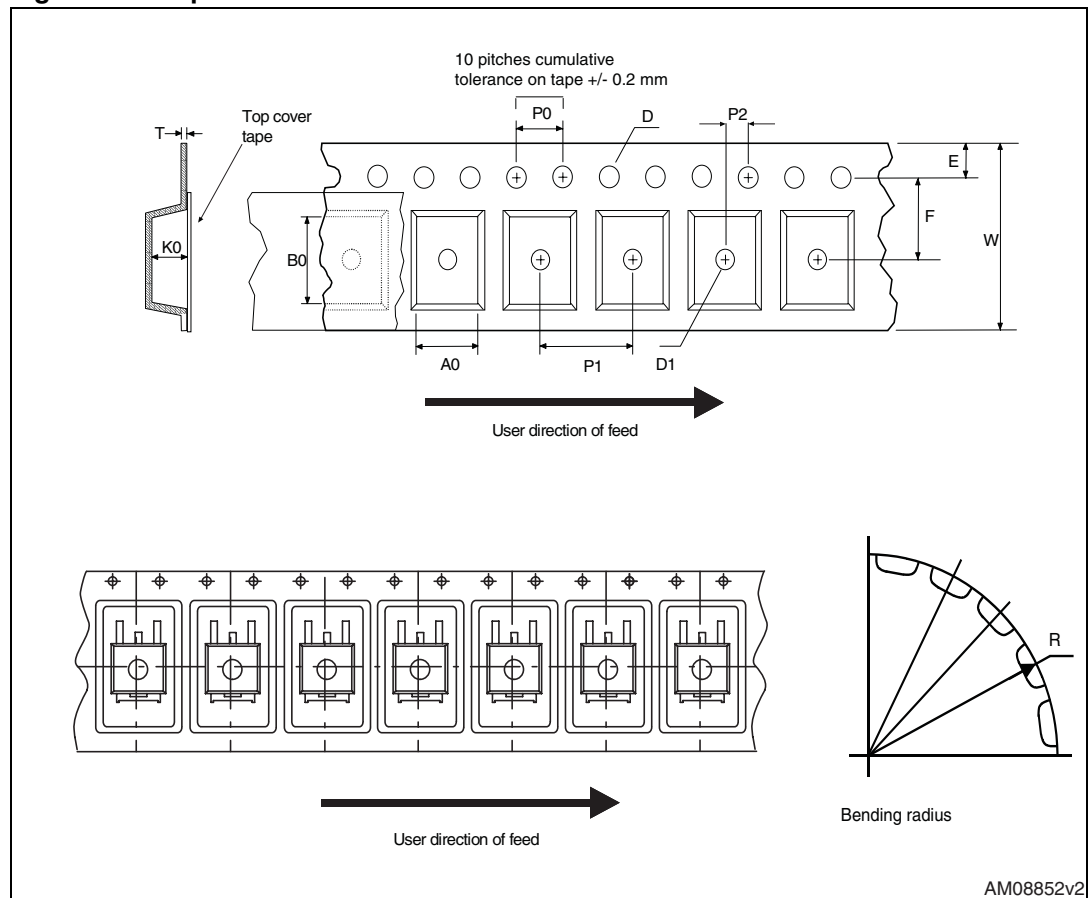
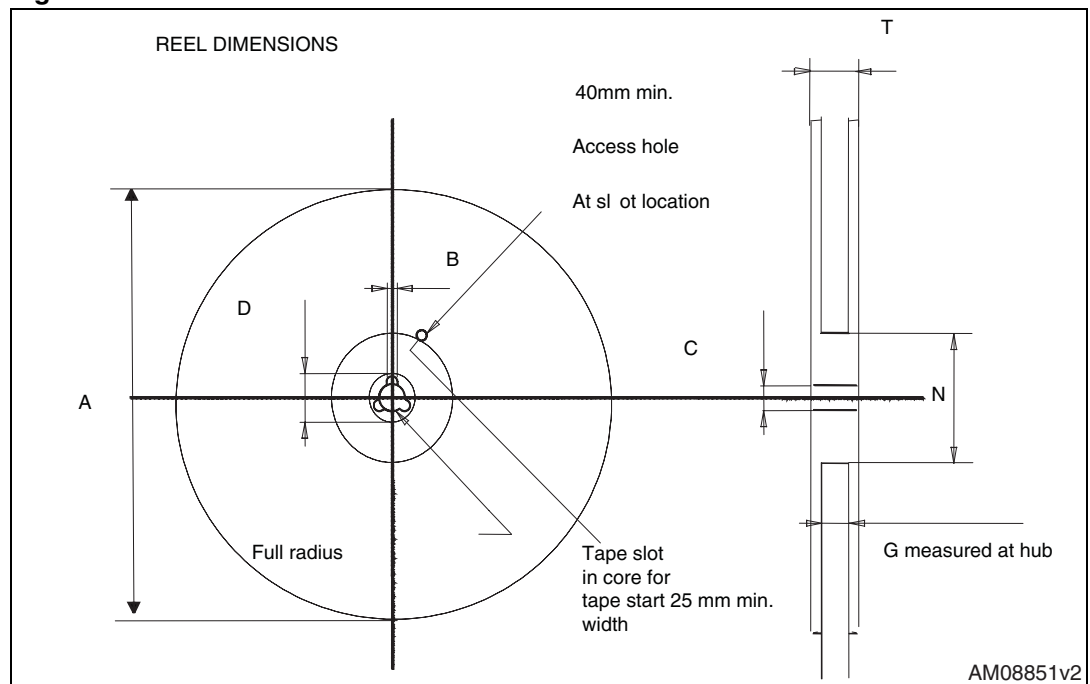


Figure 30. Reel



6 Revision history

Table 15. Document revision history

Date	Revision	Changes
02-Jul-2009	1	First release.
18-Feb-2010	2	Document status promoted from preliminary data to datasheet.
27-Aug-2010	3	New package, mechanical data has been inserted: I ² PAK.
05-Nov-2011	4	Some value changed in Table 5: On /off states .

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