



STx13NM60N

N-channel 600 V, 0.28 Ω , 11 A MDmesh™ II Power MOSFET
in D²PAK, DPAK, TO-220FP, I²PAK, TO-220, IPAK, TO-247

Features

Order codes	V _{DSS} (@T _{jmax})	R _{DS(on)} max	I _D
STB13NM60N STD13NM60N STF13NM60N STI13NM60N STP13NM60N STU13NM60N STW13NM60N	650 V	< 0.36 Ω	11 A

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

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a 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.

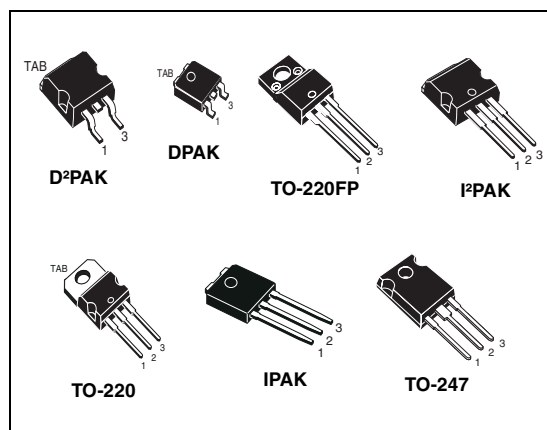
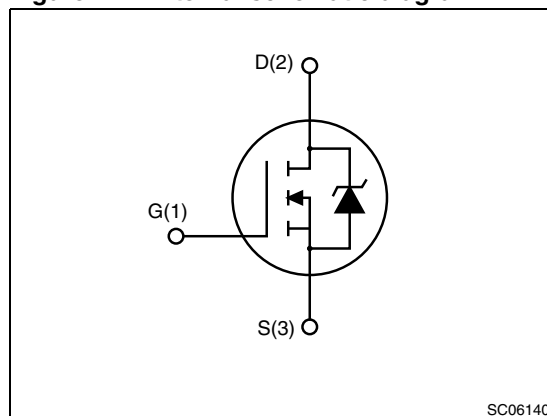


Figure 1. Internal schematic diagram



SC06140

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STB13NM60N STD13NM60N STF13NM60N STI13NM60N STP13NM60N STU13NM60N STW13NM60N	13NM60N	D ² PAK DPAK TO-220FP I ² PAK TO-220 IPAK TO-247	Tape and reel Tape and reel Tube Tube Tube Tube Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		D ² PAK DPAK	TO-220FP	I ² PAK, TO-220, IPAK, TO-247	
V _{DS}	Drain-source voltage (V _{GS} = 0)	600			V
V _{GS}	Gate-source voltage	± 25			V
I _D	Drain current (continuous) at T _C = 25 °C	11	11 ⁽¹⁾	11	A
I _D	Drain current (continuous) at T _C = 100 °C	6.93	6.93 ⁽¹⁾	6.93	A
I _{DM} ⁽²⁾	Drain current (pulsed)	44	44 ⁽¹⁾	44	A
P _{TOT}	Total dissipation at T _C = 25 °C	90	25	90	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 _{stg}	Storage temperature	- 55 to 150			°C
T _j	Max. operating junction temperature	150			°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 11 A, di/dt ≤ 400 A/μs, V_{DS peak} ≤ V_{(BR)DSS}, V_{DD} = 80% V_{(BR)DSS}.

Table 3. Thermal data

Symbol	Parameter	Value							Unit
		D ² PAK	DPAK	TO-220FP	I ² PAK	TO-220	IPAK	TO-247	
R _{thj-case}	Thermal resistance junction-case max	1.39		5	1.39				°C/W
R _{thj-amb}	Thermal resistance junction-ambient max			62.5	62.5		100	50	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max	30	50						°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max)	3.5	A
E_{AS}	Single pulse avalanche energy (starting $T_J=25\text{ }^{\circ}\text{C}$, $I_D=I_{AS}$, $V_{DD}=50\text{ V}$)	200	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 (V _{GS} = 0)	I _D = 1 mA	600			V
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} = ± 25 V			0.1	μA
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 = 5.5 A		0.28	0.36	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	-	790 60 3.6	-	pF pF pF
C _{oss eq.} ⁽¹⁾	Equivalent output capacitance	V _{GS} = 0, V _{DS} = 0 to 480 V	-	135	-	pF
Q _g Q _{gs} Q _{gd}	Total gate charge Gate-source charge Gate-drain charge	V _{DD} = 480 V, I _D = 11 A, V _{GS} = 10 V, (see Figure 19)	-	30 4 15	-	nC nC nC
R _G	Gate input resistance	f = 1 MHz open drain	-	4.7	-	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
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 5.5\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ <i>(see Figure 18)</i>	-	3	-	ns
t_r	Rise time			8		ns
$t_{d(off)}$	Turn-off delay time			30		ns
t_f	Fall time			10		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD}	Source-drain current		-		11	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				44	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 11\text{ A}$, $V_{GS} = 0$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ <i>(see Figure 20)</i>	-	230		ns
Q_{rr}	Reverse recovery charge			2		μC
I_{RRM}	Reverse recovery current			18		A
t_{rr}	Reverse recovery time	$I_{SD} = 11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ <i>(see Figure 20)</i>	-	290		ns
Q_{rr}	Reverse recovery charge			190		μC
I_{RRM}	Reverse recovery current			17		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, I²PAK and TO-220

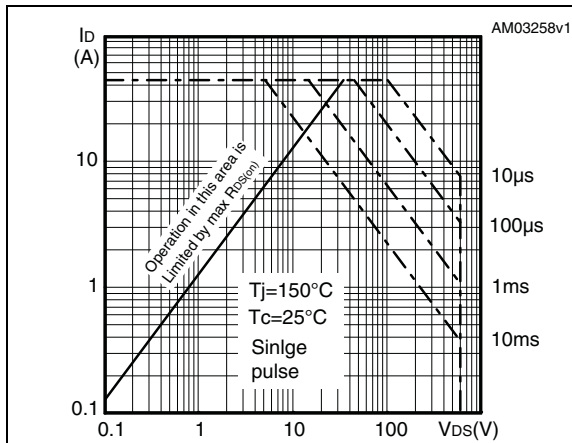


Figure 3. Thermal impedance for D²PAK, I²PAK and TO-220

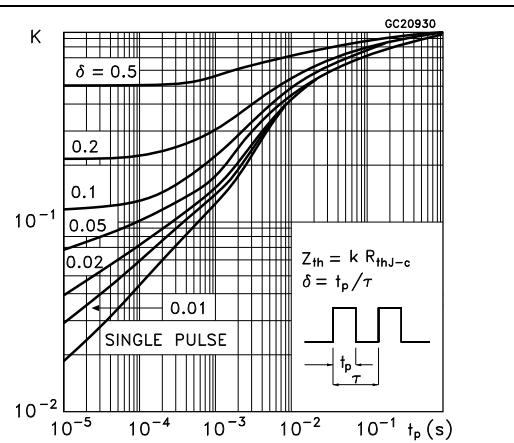


Figure 4. Safe operating area for TO-220FP

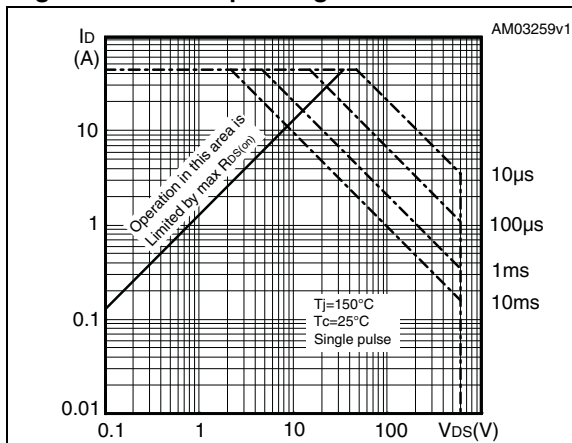


Figure 5. Thermal impedance for TO-220FP

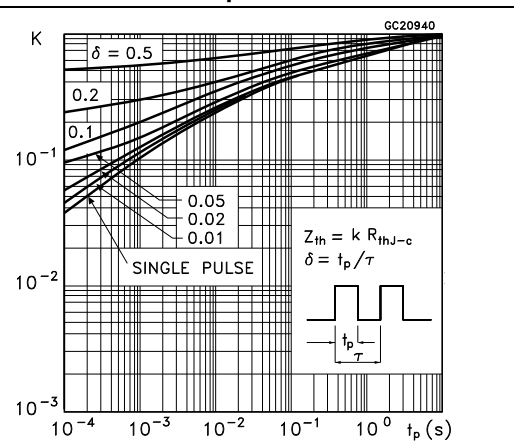


Figure 6. Safe operating area for TO-247

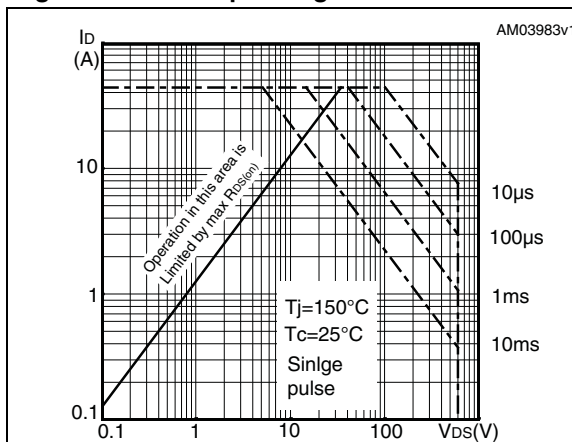


Figure 7. Thermal impedance for TO-247

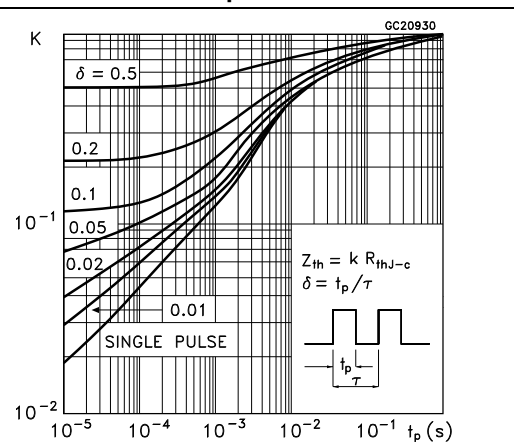


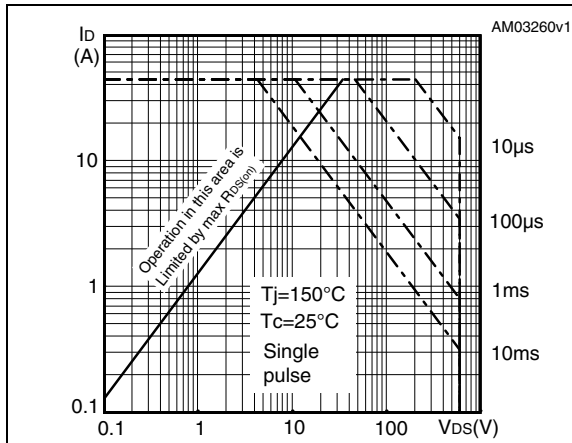
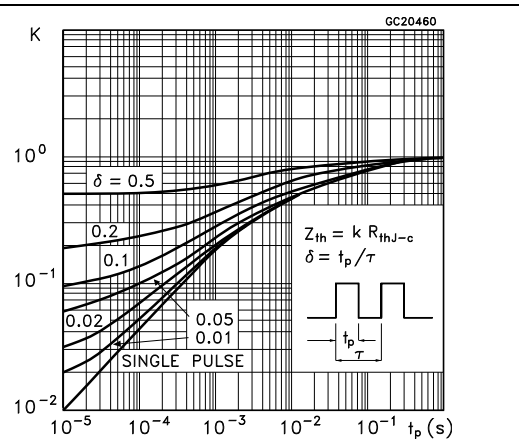
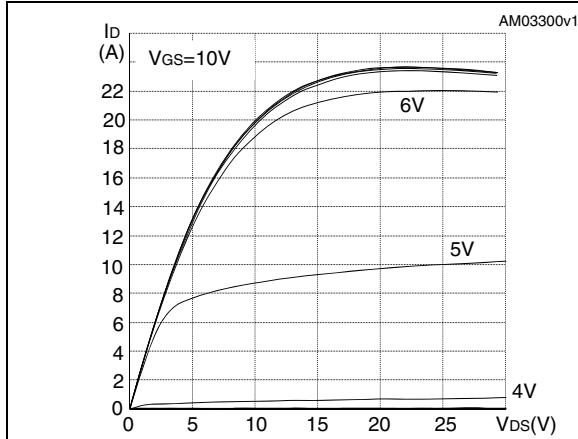
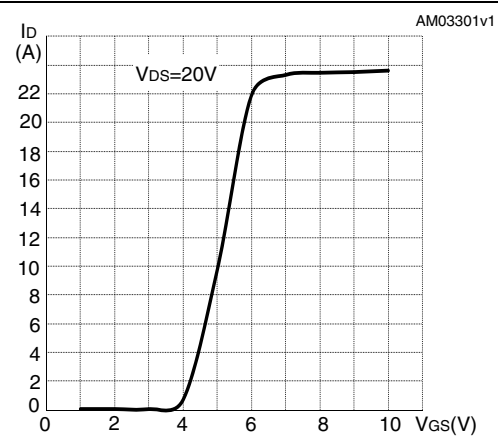
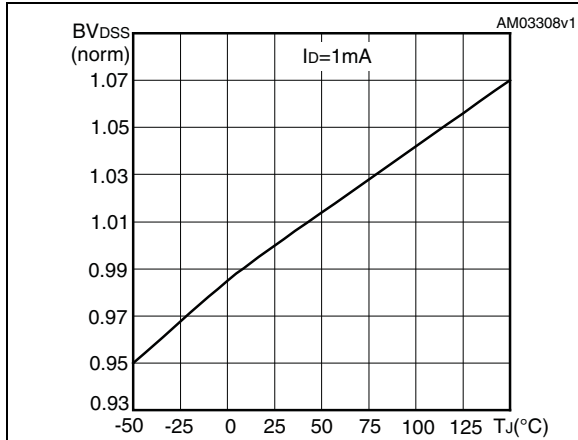
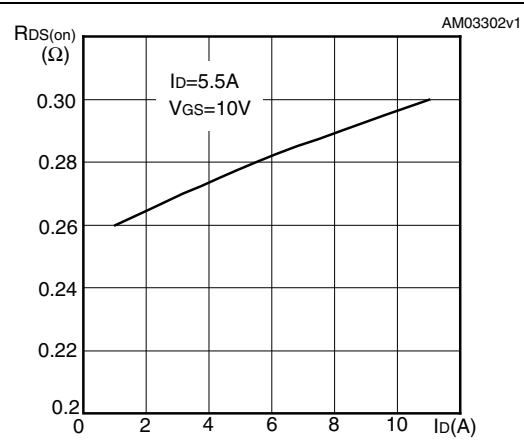
Figure 8. Safe operating area for DPAK and IPAK**Figure 9. Thermal impedance for DPAK and IPAK****Figure 10. Output characteristics****Figure 11. Transfer characteristics****Figure 12. Normalized BVDS vs temperature****Figure 13. Static drain-source on resistance**

Figure 14. Gate charge vs gate-source voltage Figure 15. Capacitance variations

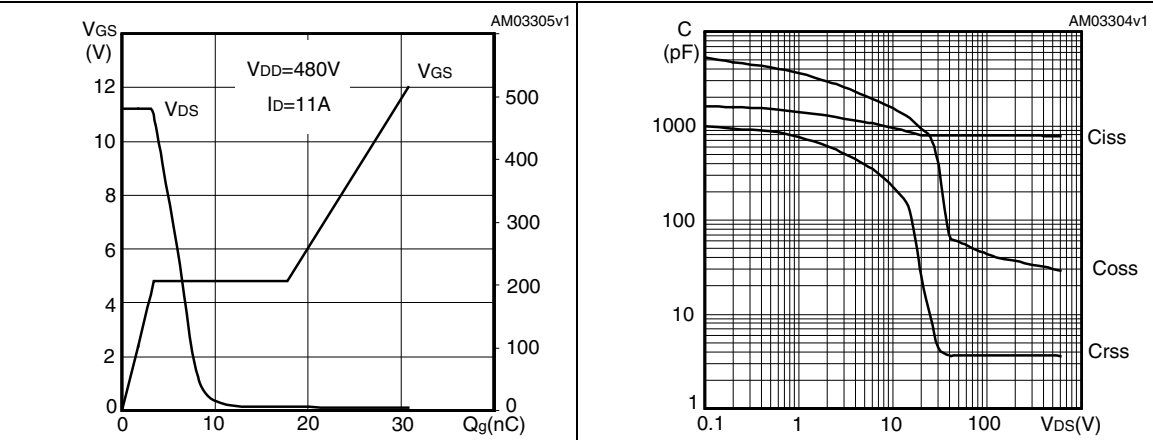
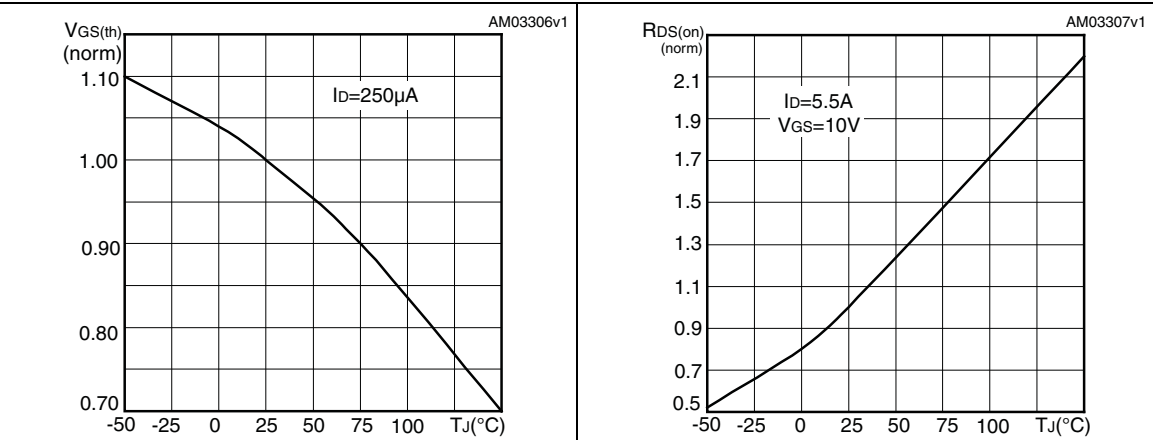


Figure 16. Normalized gate threshold voltage vs temperature Figure 17. Normalized on resistance vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

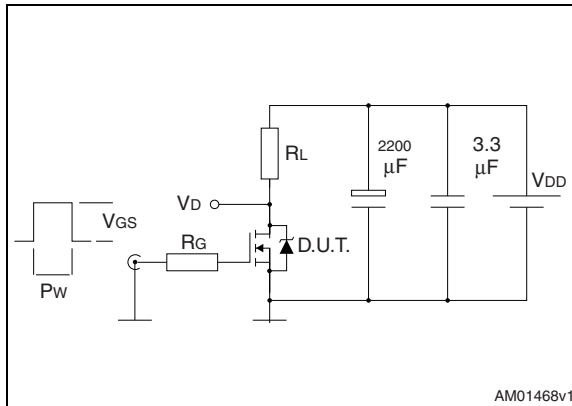


Figure 19. Gate charge test circuit

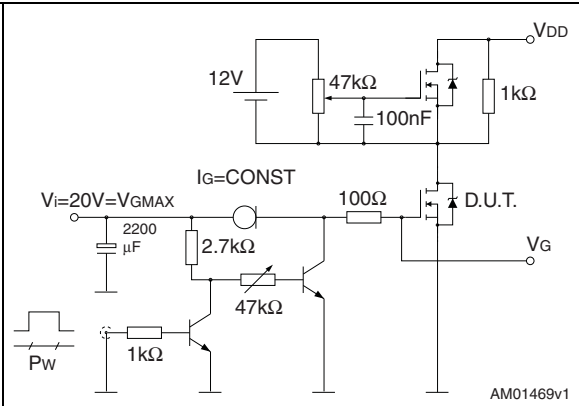


Figure 20. Test circuit for inductive load switching and diode recovery times

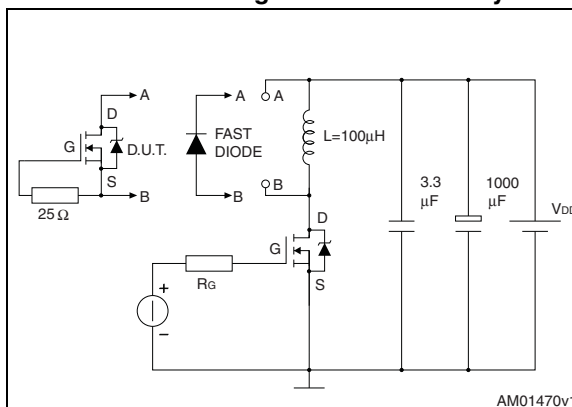


Figure 21. Unclamped inductive load test circuit

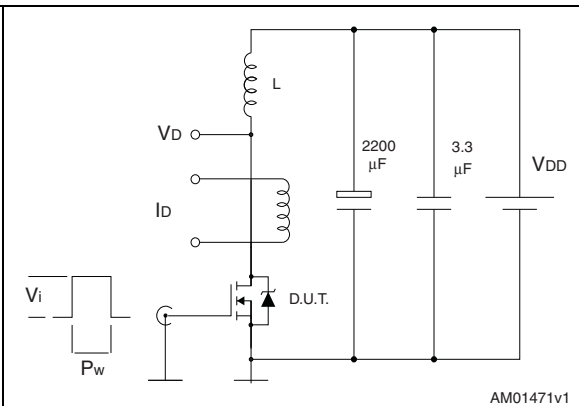


Figure 22. Unclamped inductive waveform

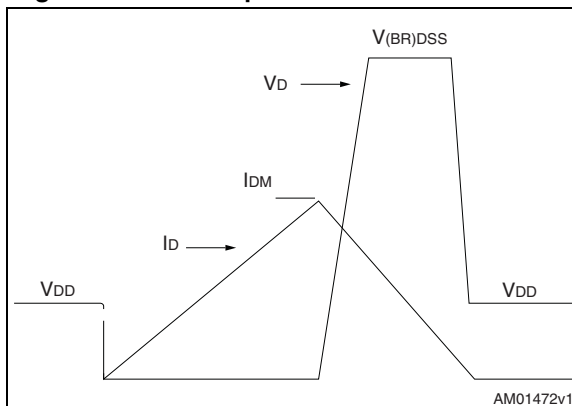
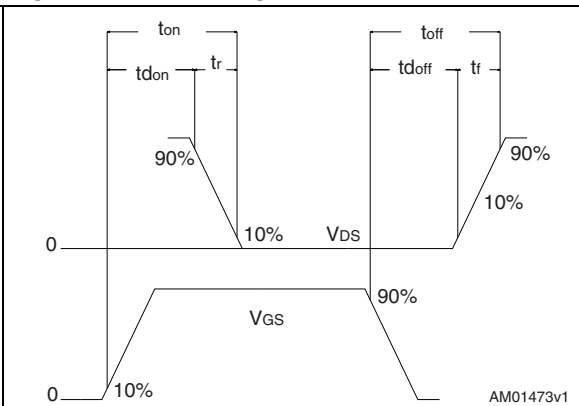


Figure 23. Switching time waveform



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 9. 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°

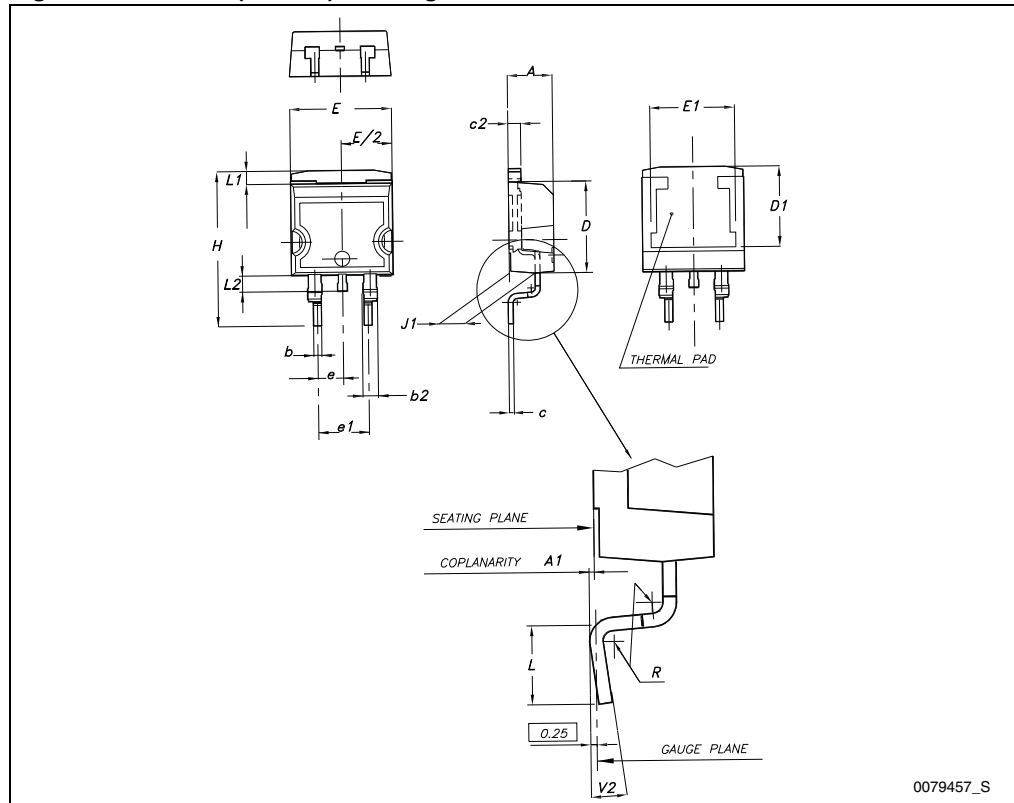
Figure 24. D²PAK (TO-263) drawing

Table 10. DPAK (TO-252) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		1.50
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 25. DPAK (TO-252) drawing

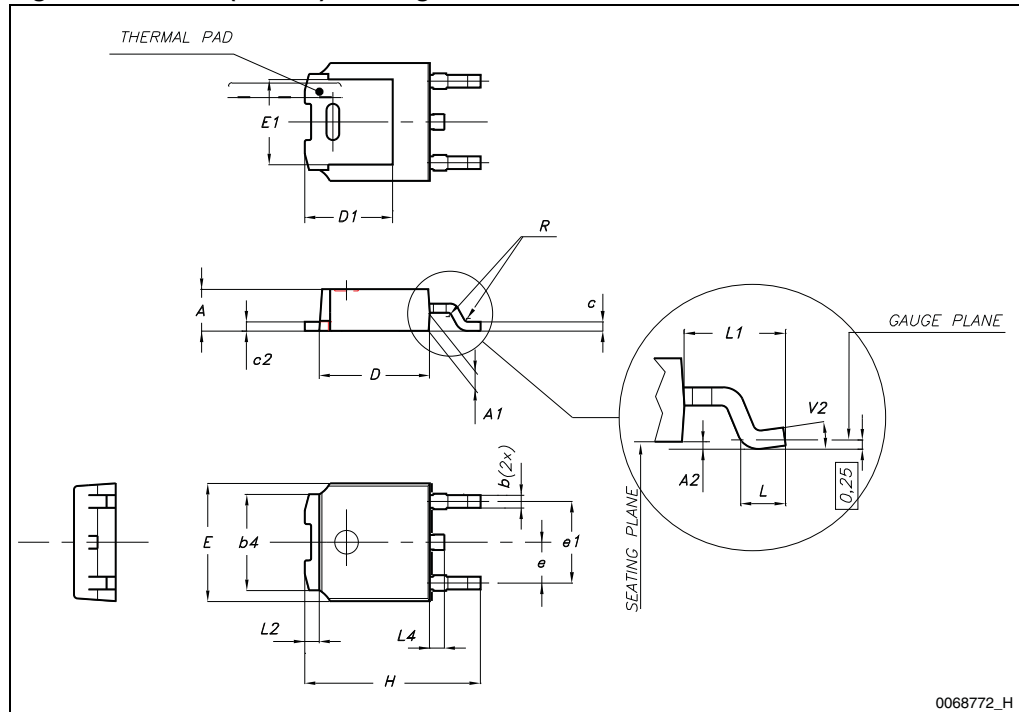


Table 11. TO-220FP mechanical data

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

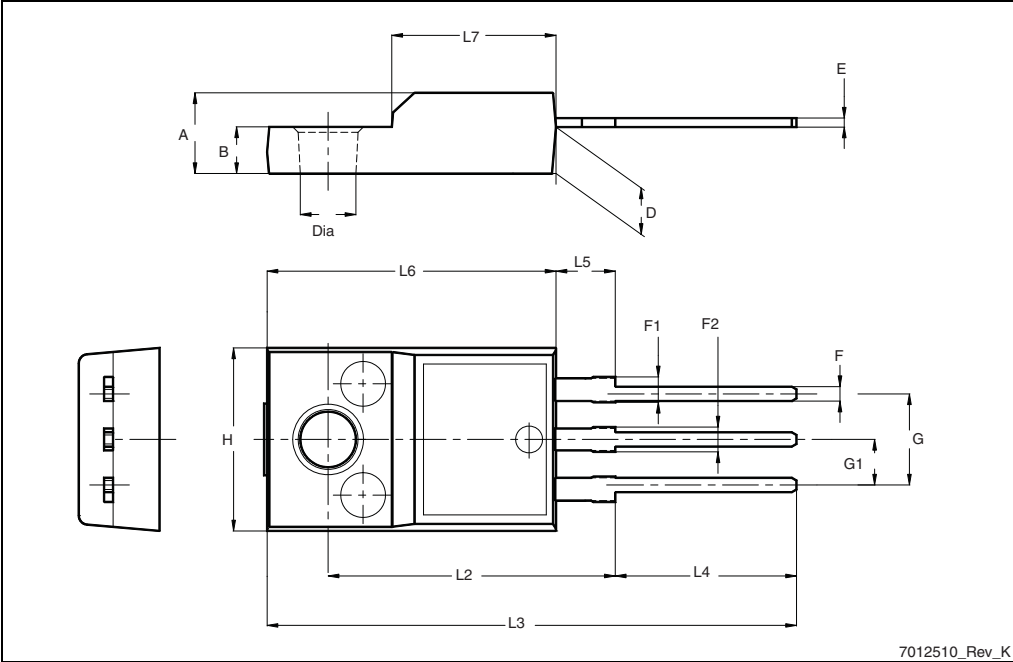


Table 12. I²PAK (TO-262) mechanical data

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

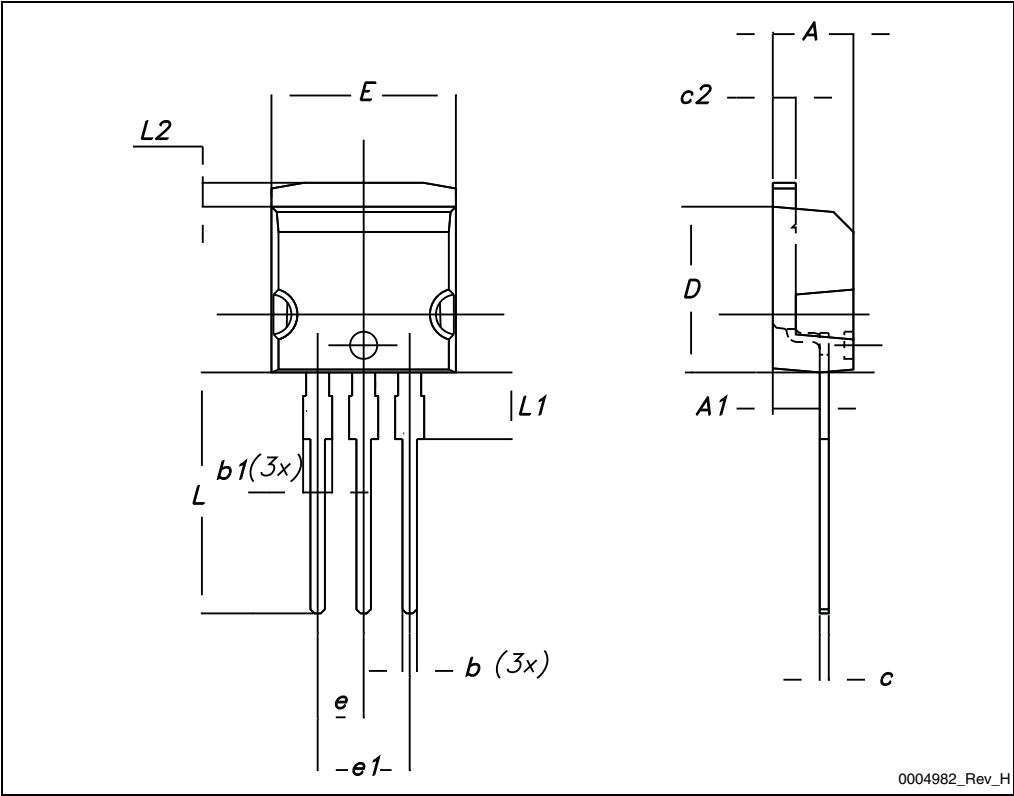


Table 13. TO-220 type A mechanical data

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 28. TO-220 type A drawing

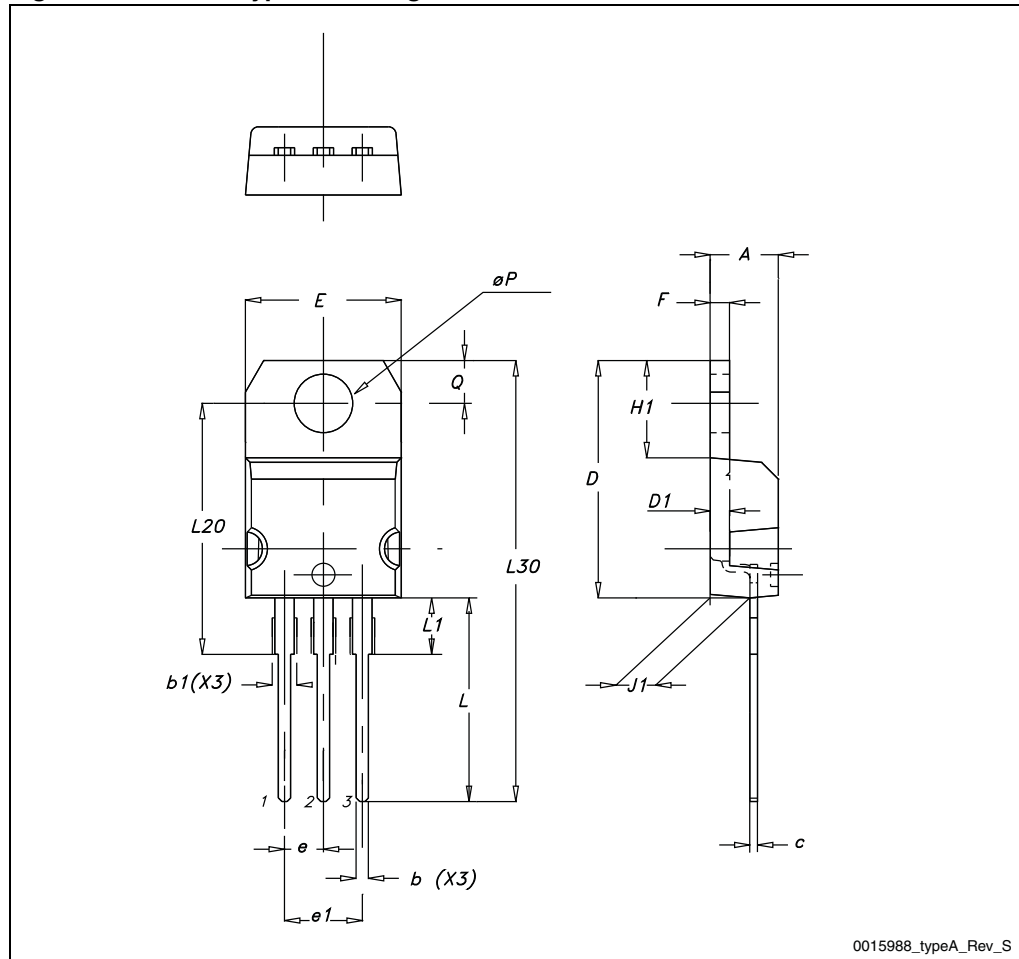


Table 14. IPAK (TO-251) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.3	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10 °	

Figure 29. IPAK (TO-251) drawing

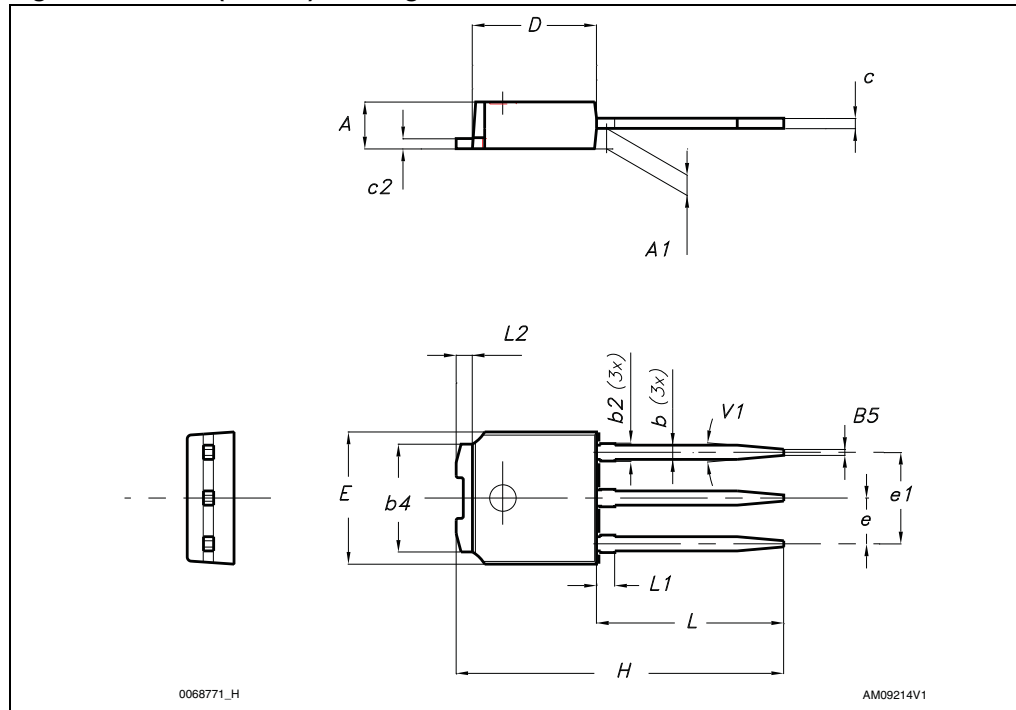
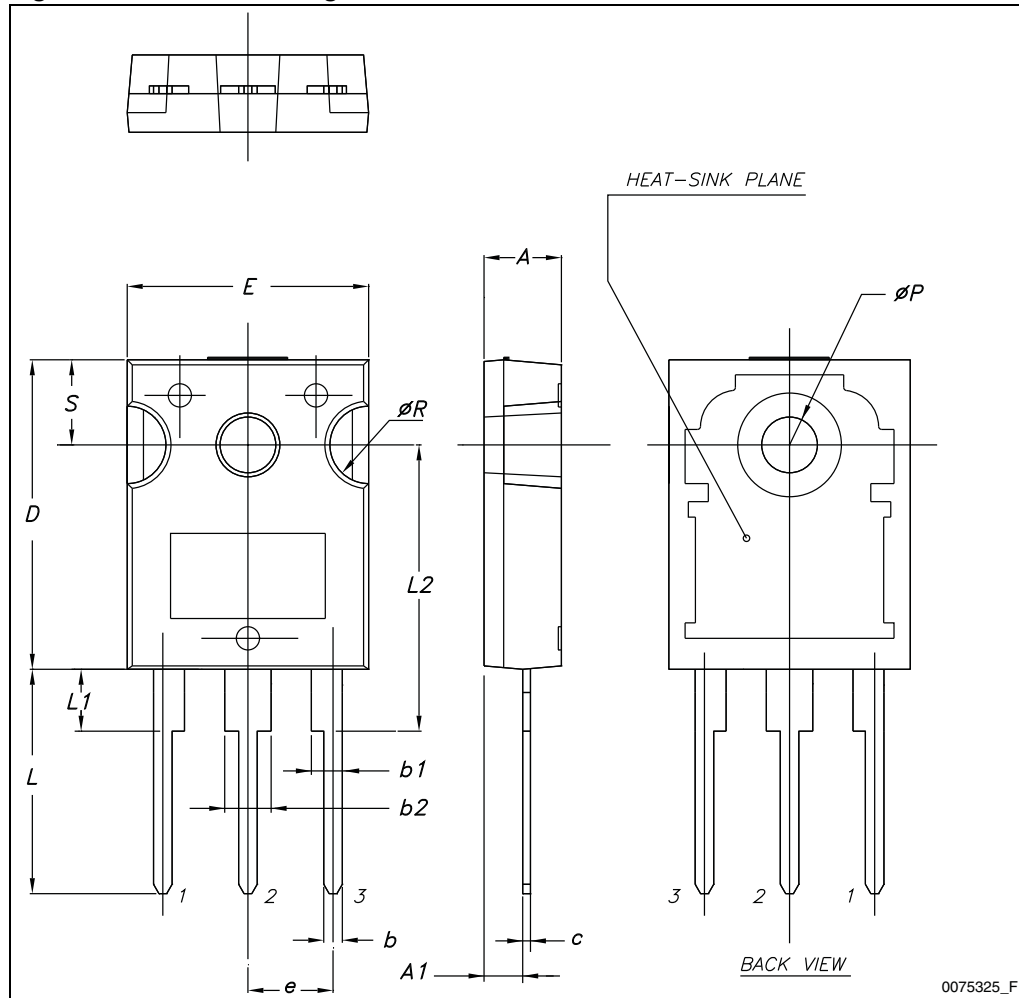


Table 15. TO-247 mechanical data

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 30. TO-247 drawing



5 Packaging mechanical data

Table 16. 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 31. D²PAK footprint^(a)

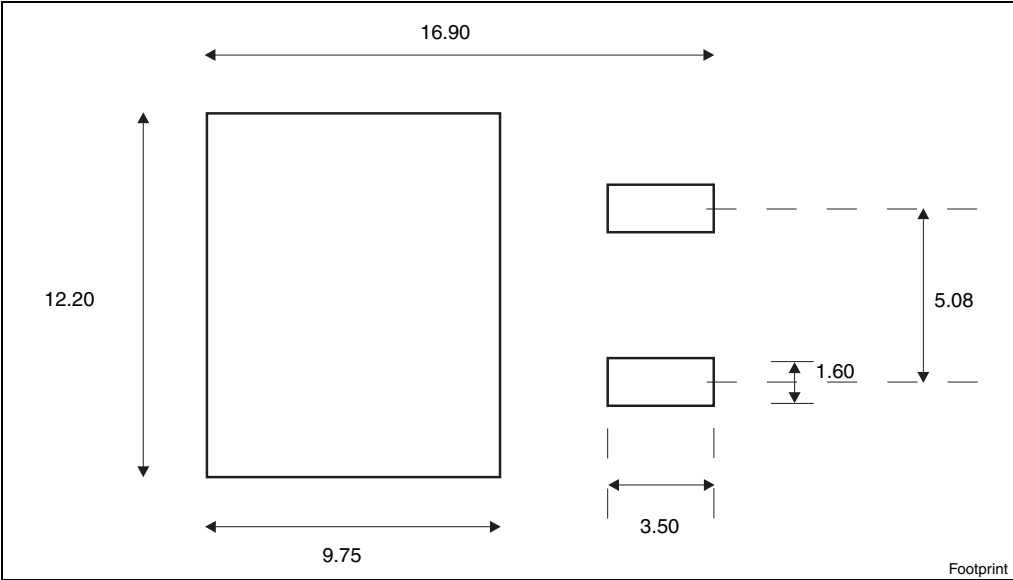
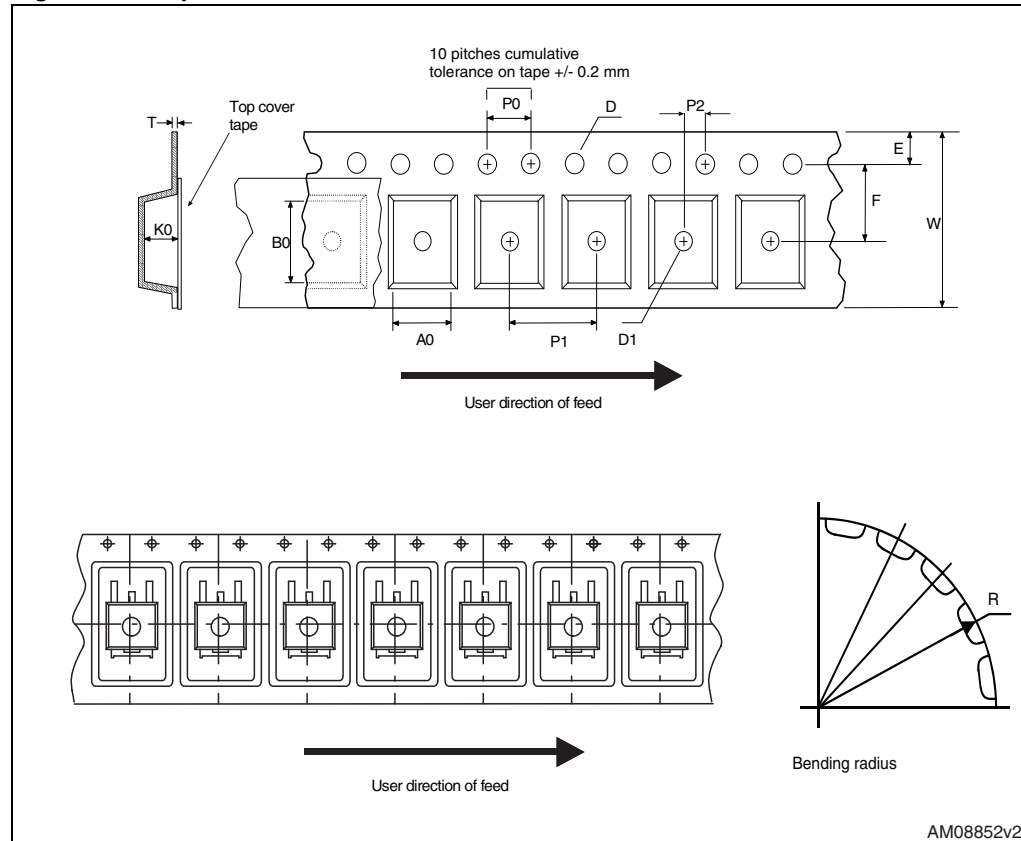


Figure 32. Tape



a. All dimensions are in millimeters

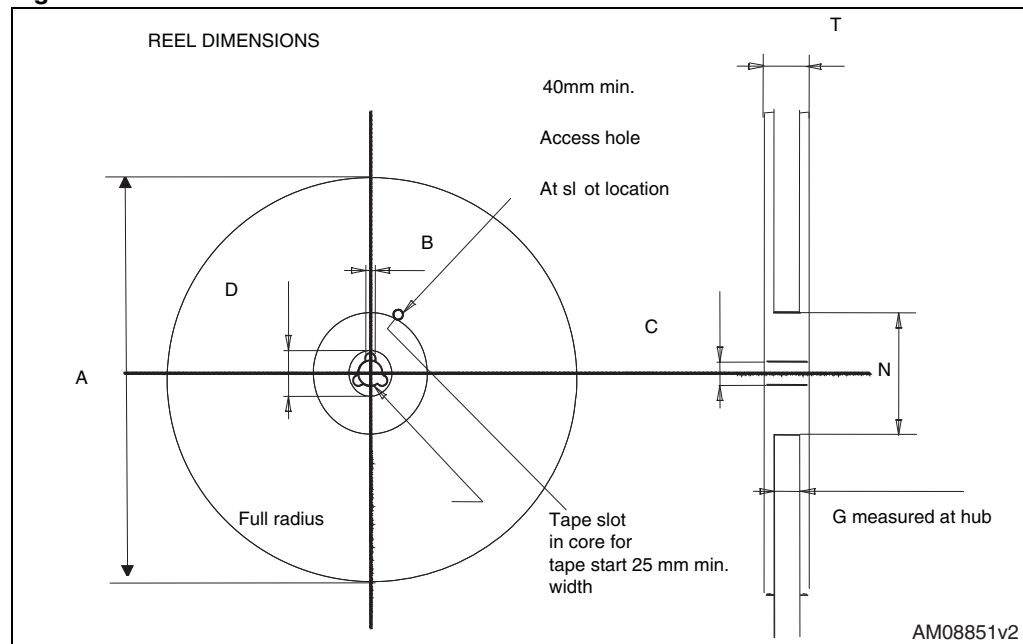
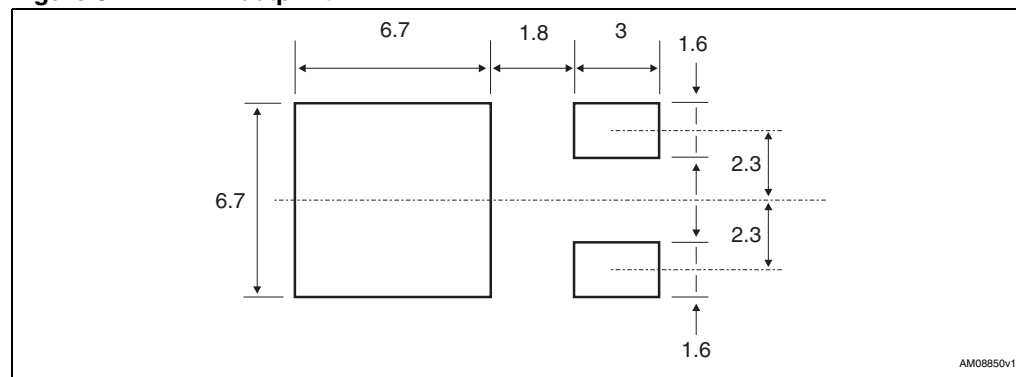
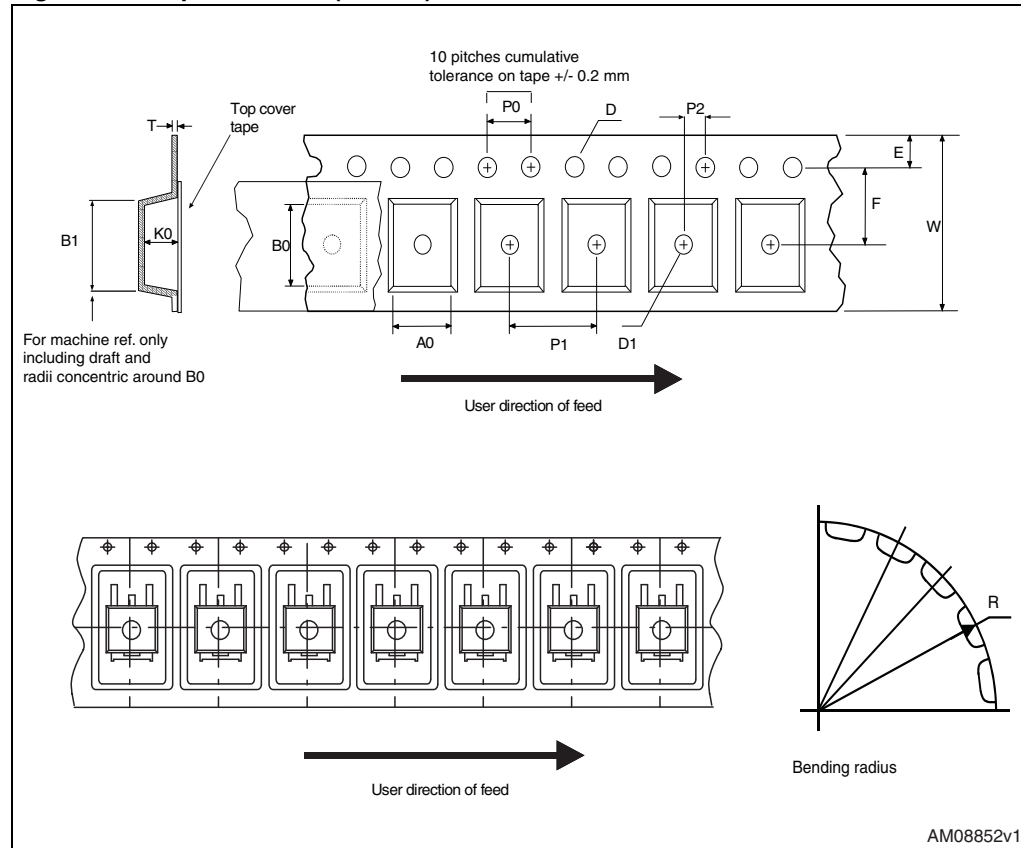
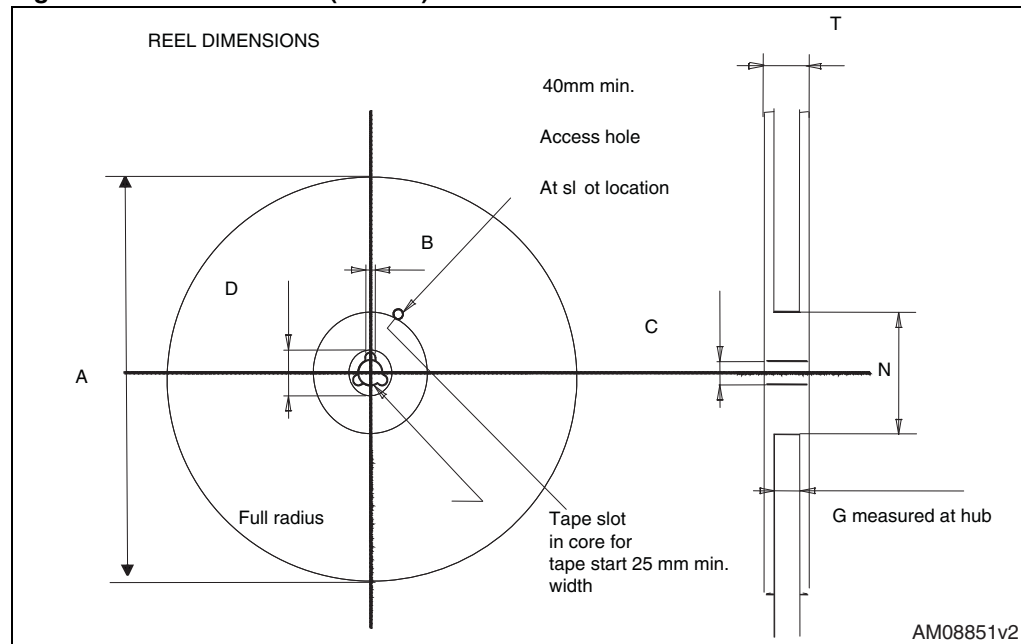
Figure 33. Reel

Table 17. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Figure 34. DPAK footprint^(b)

b. All dimensions are in millimeters

Figure 35. Tape for DPAK (TO-252)**Figure 36. Reel for DPAK (TO-252)**

6 Revision history

Table 18. Document revision history

Date	Revision	Changes
29-Feb-2009	1	First release
13-Jan-2010	2	– Added new package, mechanical data: TO-247 – Added new package, mechanical data: D ² PAK
08-Nov-2010	3	– Modified Figure 4 – Added new package, mechanical data: I ² PAK
18-Jan-2012	4	– Added new package, mechanical data: IPAK – Minor text changes

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