



STD10NM60N, STF10NM60N, STI10NM60N, STP10NM60N, STU10NM60N

N-channel 600 V, 0.53 Ω typ., 10 A MDmesh™ II Power MOSFET
in DPAK, TO-220FP, I²PAK, TO-220 and IPAK packages

Datasheet — production data

Features

Order codes	V _{DSS} @T _{Jmax}	R _{DS(on)} max.	I _D	P _w
STD10NM60N	650 V	< 0.55 Ω	10 A	70 W
STF10NM60N				25 W
STI10NM60N				70 W
STP10NM60N				
STU10NM60N				

- 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.

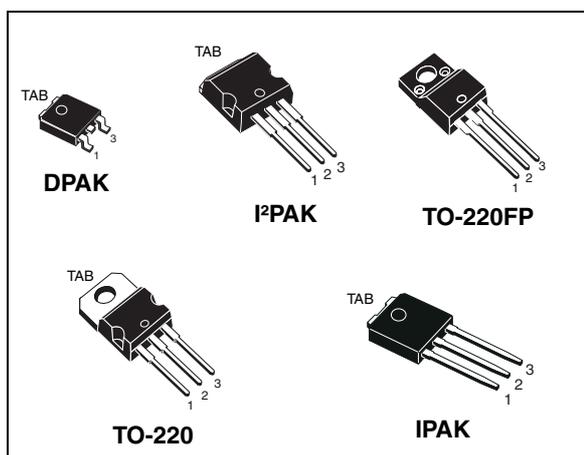
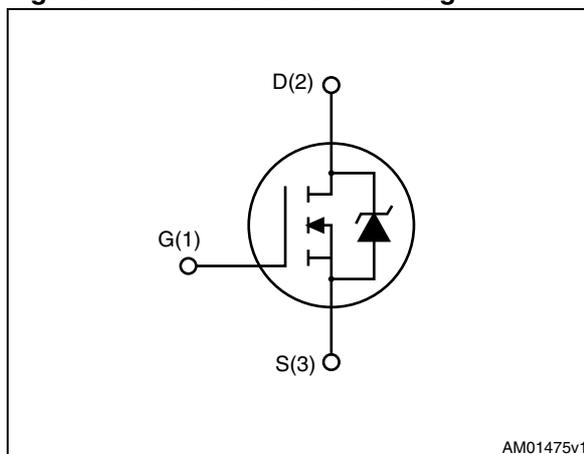


Figure 1. Internal schematic diagram



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Table 1. Device summary

Order codes	Marking	Package	Packaging
STD10NM60N	10NM60N	DPAK	Tape and reel
STF10NM60N	10NM60N	TO-220FP	Tube
STI10NM60N	10NM60N	I ² PAK	Tube
STP10NM60N	10NM60N	TO-220	Tube
STU10NM60N	10NM60N	IPAK	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value				Unit
		TO-220 I ² PAK	TO-220FP	IPAK	DPAK	
V _{GS}	Gate- source voltage	± 25				V
I _D	Drain current (continuous) at T _C = 25 °C	10	10 ⁽¹⁾	10		A
I _D	Drain current (continuous) at T _C = 100 °C	5	5 ⁽¹⁾	5		A
I _{DM} ⁽²⁾	Drain current (pulsed)	32	32 ⁽¹⁾	32		A
P _{TOT}	Total dissipation at T _C = 25 °C	70	25	70		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

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- I_{SD} ≤ 10 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
		TO-220 I ² PAK	TO-220FP	IPAK	DPAK	
R _{thj-case}	Thermal resistance junction-case max	1.79	5	1.79		°C/W
R _{thj-amb}	Thermal resistance junction-ambient max	62.50		100		°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max				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)	4	A
E _{AS}	Single pulse avalanche energy (starting T _J =25 °C, I _D =I _{AS} , V _{DD} =50 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	I _D = 1 mA, V _{GS} = 0 I _D = 1 mA, V _{GS} = 0, T _C = 150 °C	600	650		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			± 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 = 4 A		0.53	0.55	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C _{iss}	Input capacitance	V _{DS} = 50 V, f = 1 MHz, V _{GS} = 0	-	540	-	pF
C _{oss}	Output capacitance			44		pF
C _{rss}	Reverse transfer capacitance			1.2		pF
C _{oss eq} ⁽¹⁾	Equivalent capacitance time related	V _{DS} = 0 to 480 V, V _{GS} = 0	-	110	-	pF
R _g	Gate input resistance	f = 1 MHz open drain	-	6	-	Ω
Q _g	Total gate charge	V _{DD} = 480 V, I _D = 8 A,	-	19	-	nC
Q _{gs}	Gate-source charge	V _{GS} = 10 V		3		nC
Q _{gd}	Gate-drain charge	(see Figure 17)		10		nC

1. C_{oss eq} time related 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. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 4\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 16)	-	10	-	ns
t_r	Rise time			12		ns
$t_{d(off)}$	Turn-off-delay time			32		ns
t_f	Fall time			15		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
I_{SD}	Source-drain current		-		8	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				32	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 8\text{ A}$, $V_{GS} = 0$	-		1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 8\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 18)	-	250		ns
Q_{rr}	Reverse recovery charge			2.12		μC
I_{RRM}	Reverse recovery current			17		A
t_{rr}	Reverse recovery time	$I_{SD} = 8\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 18)	-	315		ns
Q_{rr}	Reverse recovery charge			2.6		μC
I_{RRM}	Reverse recovery current			16.5		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 and I²PAK

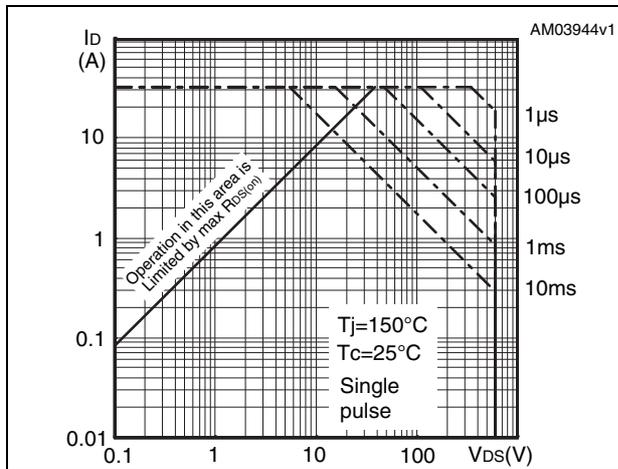


Figure 3. Thermal impedance for TO-220 and I²PAK

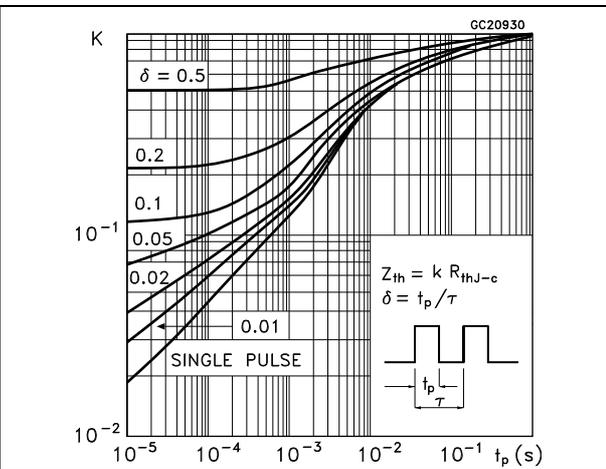


Figure 4. Safe operating area for TO-220FP

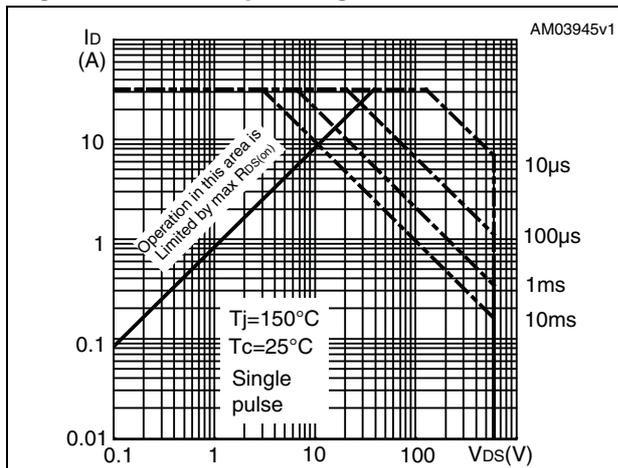


Figure 5. Thermal impedance for TO-220FP

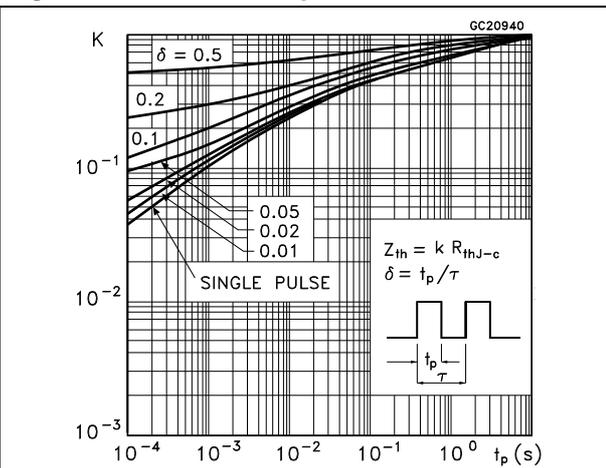


Figure 6. Safe operating area for DPAK, IPAK

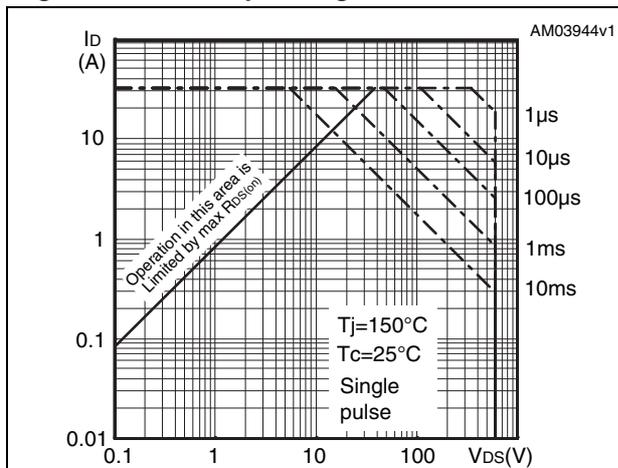


Figure 7. Thermal impedance for DPAK, IPAK

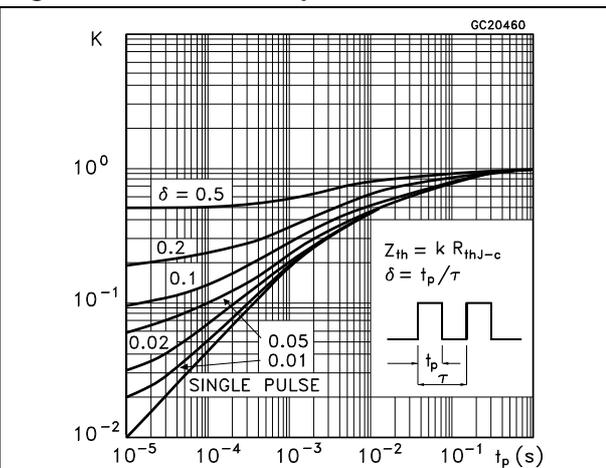


Figure 8. Output characteristics

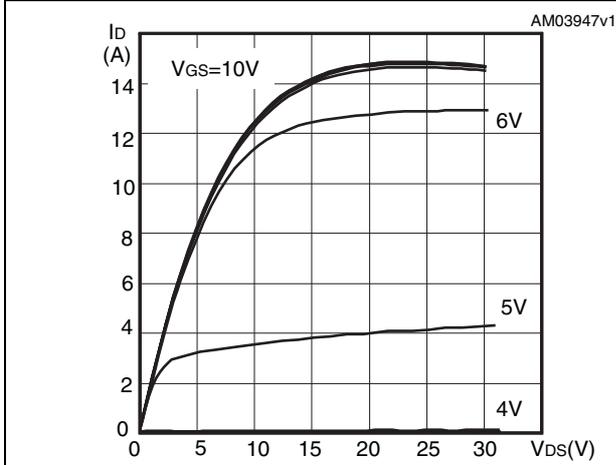


Figure 9. Transfer characteristics

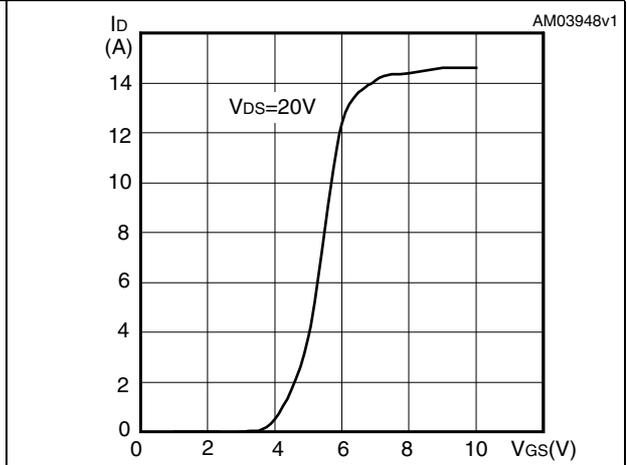


Figure 10. Normalized V_{DS} vs temperature

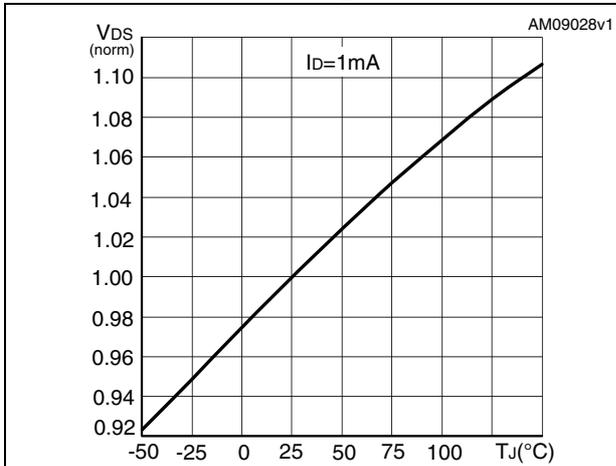


Figure 11. Static drain-source on-resistance

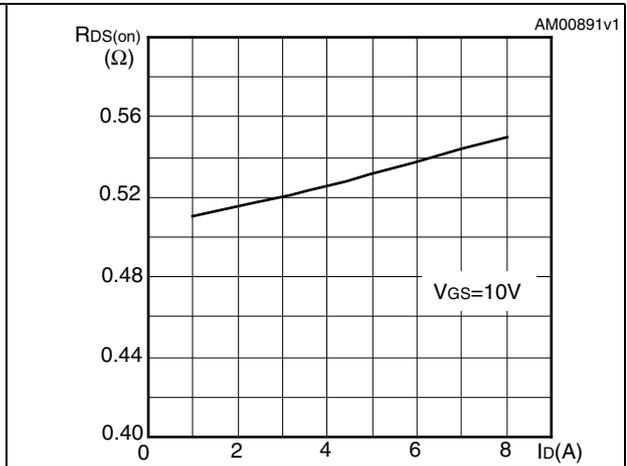


Figure 12. Gate charge vs gate-source voltage

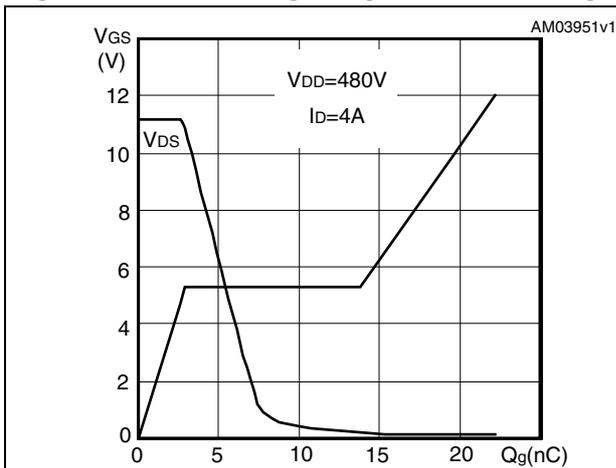


Figure 13. Capacitance variations

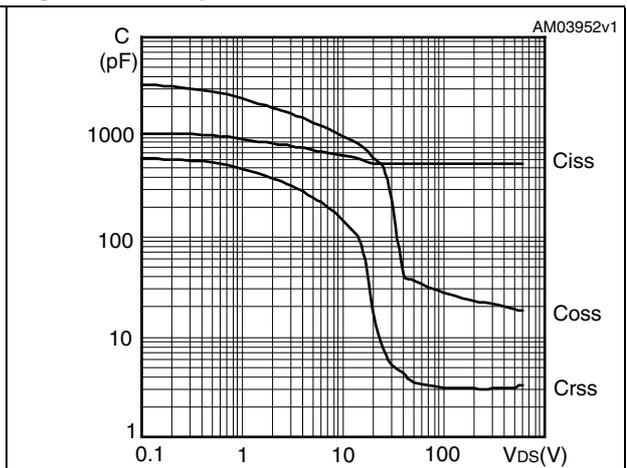
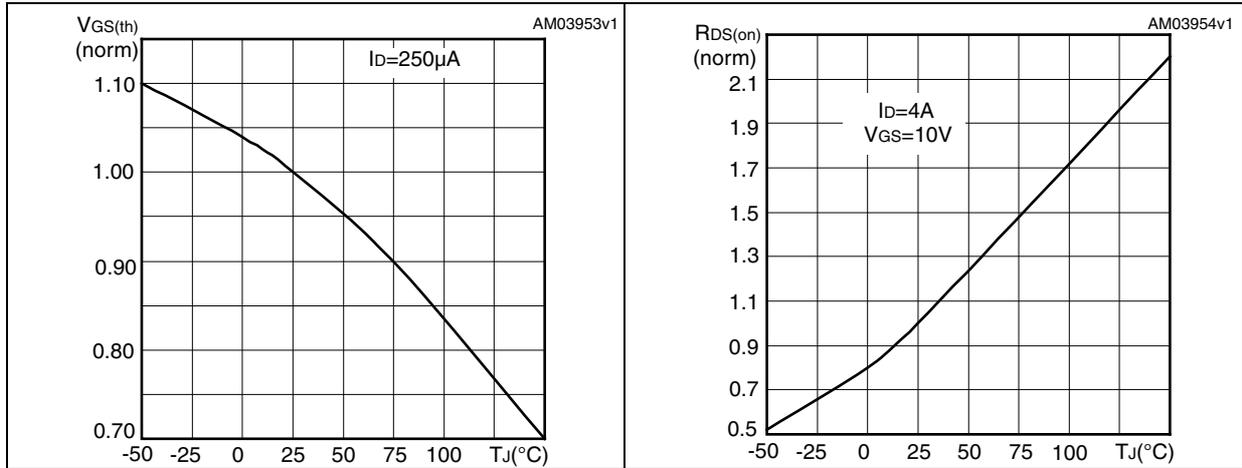


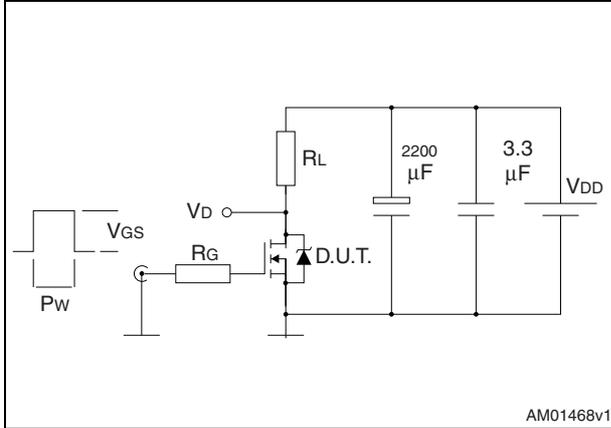
Figure 14. Normalized gate threshold voltage vs temperature

Figure 15. Normalized on-resistance vs temperature



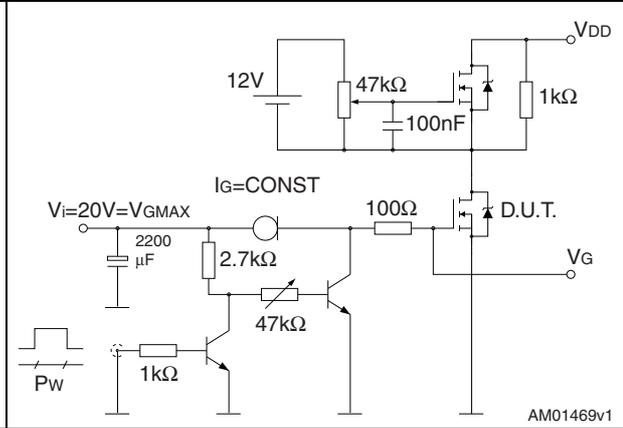
3 Test circuits

Figure 16. Switching times test circuit for resistive load



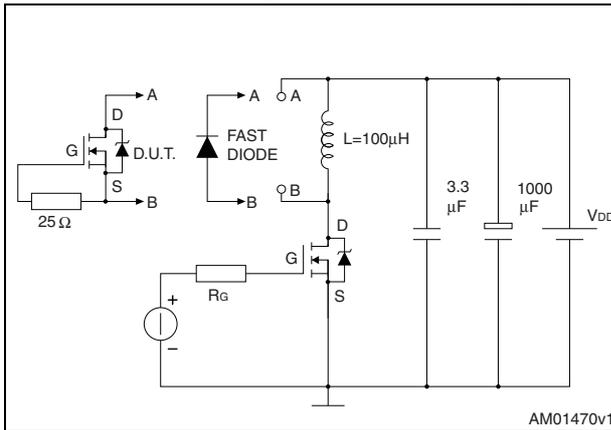
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Figure 17. Gate charge test circuit



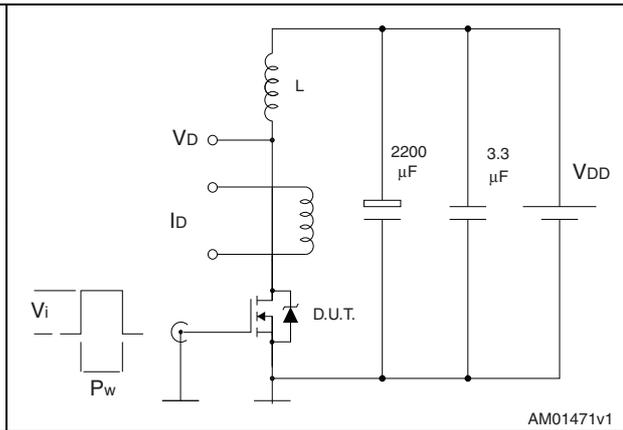
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Figure 18. Test circuit for inductive load switching and diode recovery times



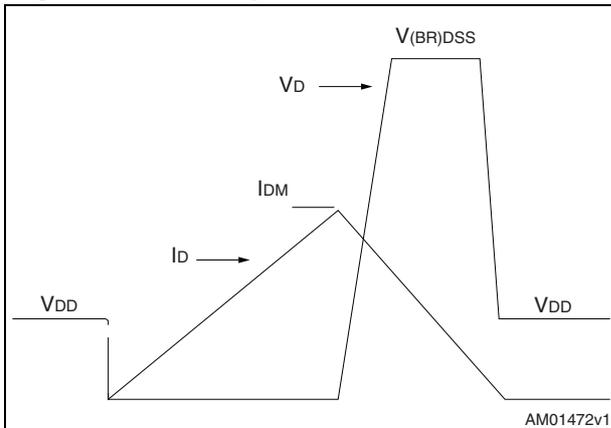
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Figure 19. Unclamped inductive load test circuit



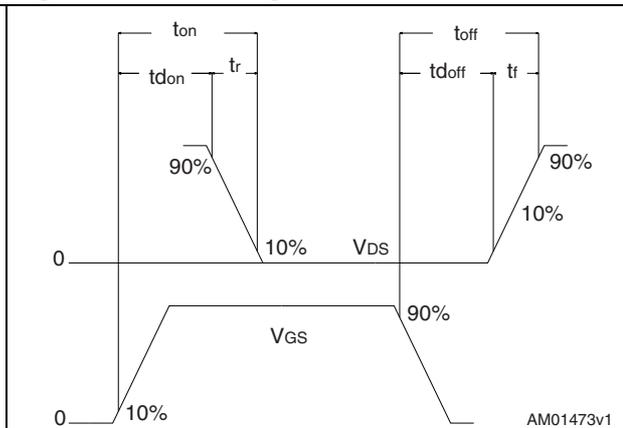
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Figure 20. Unclamped inductive waveform



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Figure 21. Switching time waveform



AM01473v1

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. 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		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 22. DPAK (TO-252) drawing

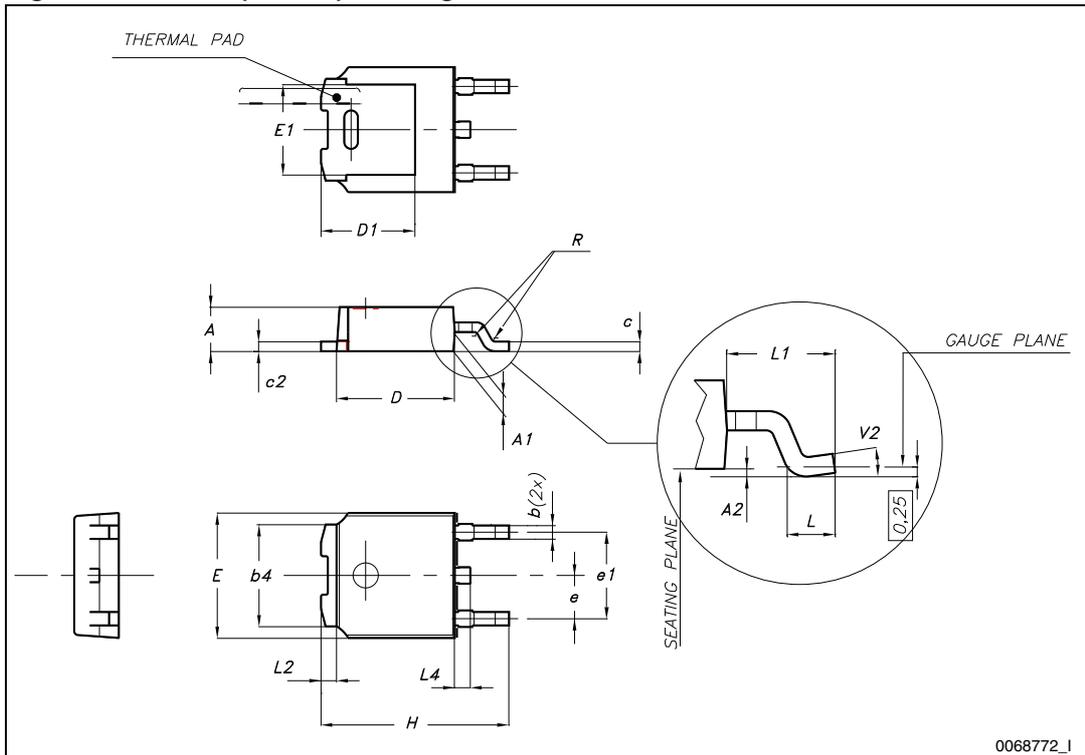
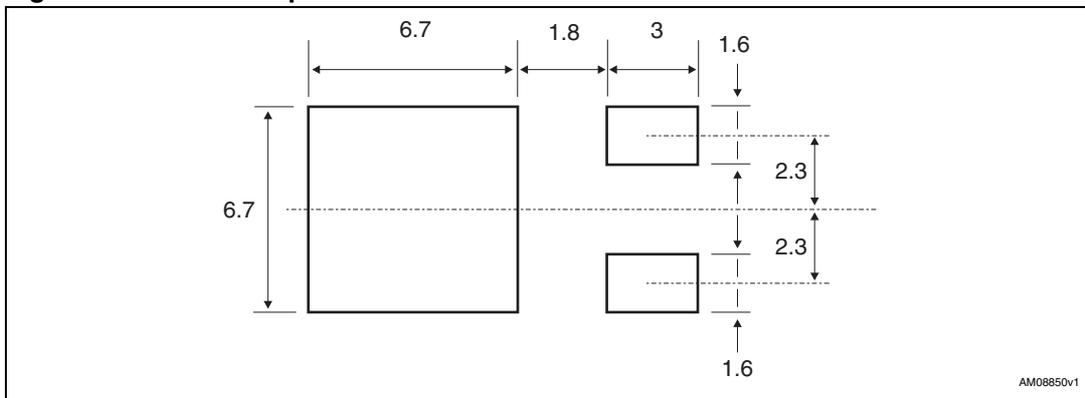


Figure 23. DPAK footprint^(a)

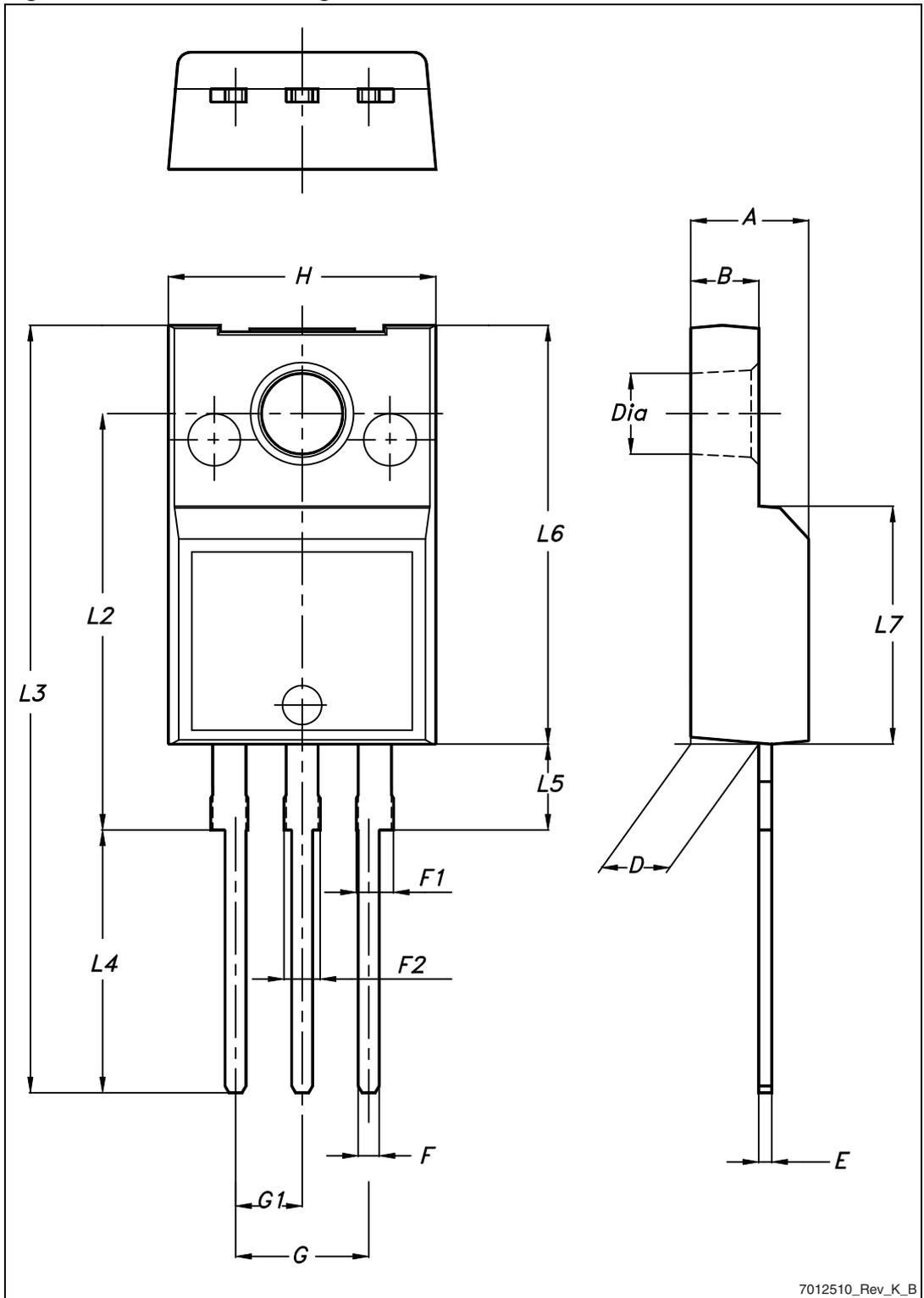


a. All dimensions are in millimeters

Table 10. 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 24. TO-220FP drawing



7012510_Rev_K_B

Table 11. 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 25. I²PAK (TO-262) drawing

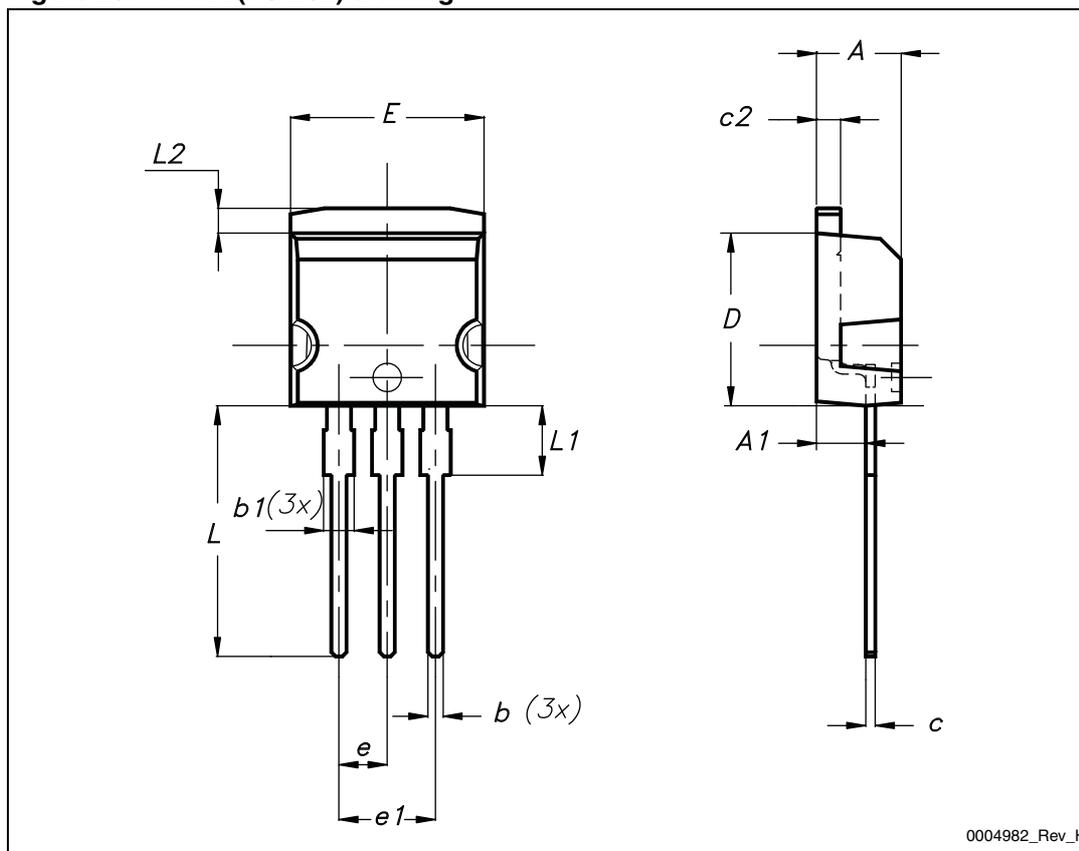


Table 12. TO-220 type A mechanical data

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

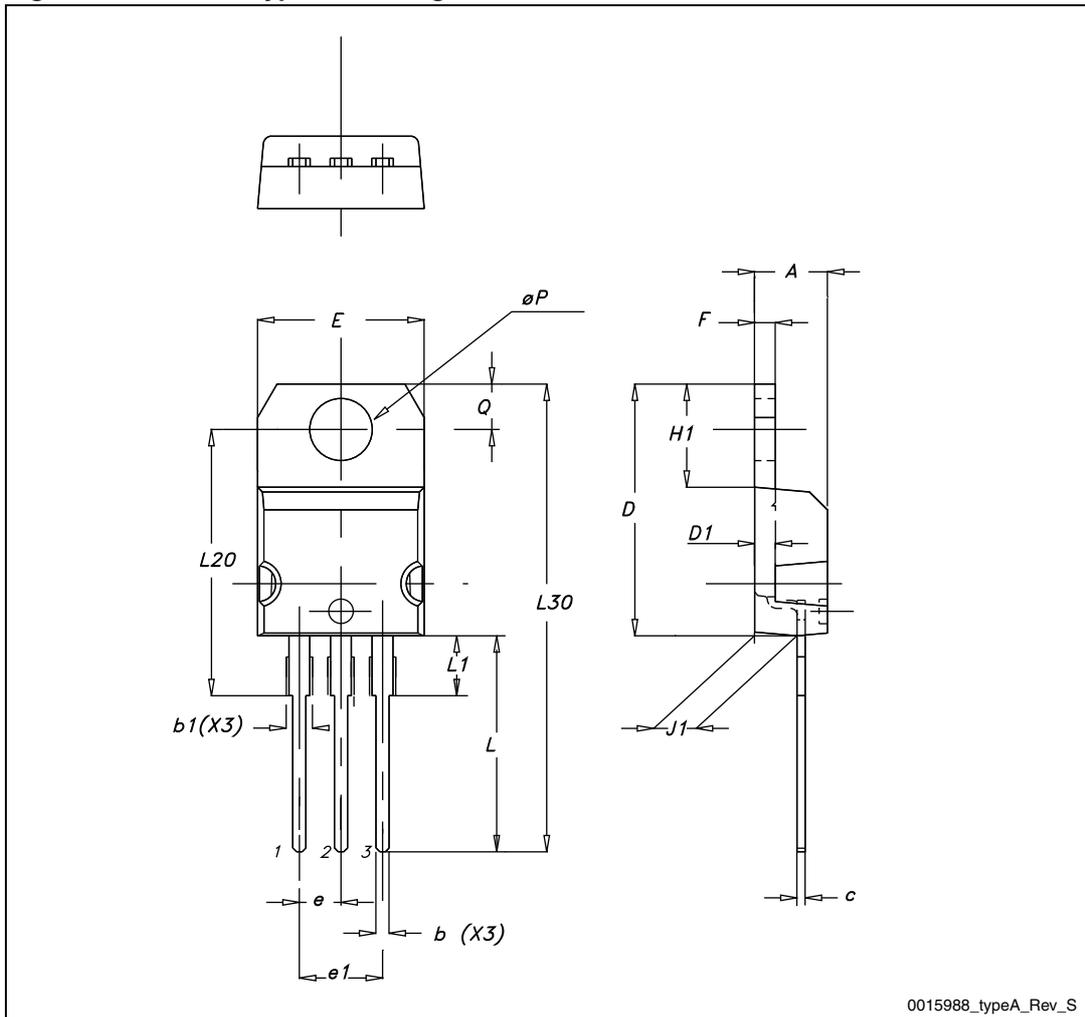
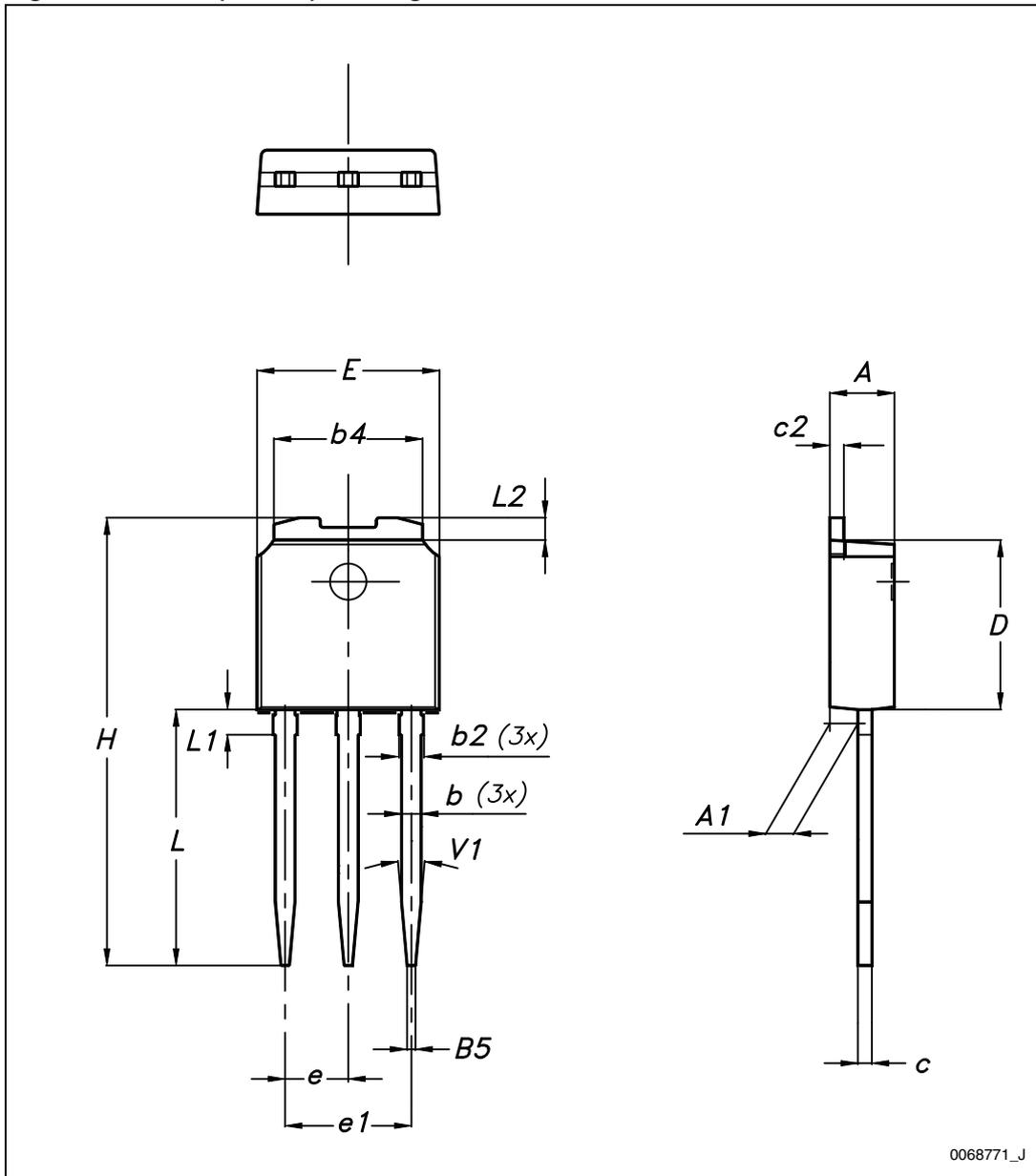


Table 13. IPAK (TO-251) mechanical data

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 27. IPAK (TO-251) drawing



0068771_J

5 Packaging mechanical data

Table 14. 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 28. Tape for DPAK (TO-252)

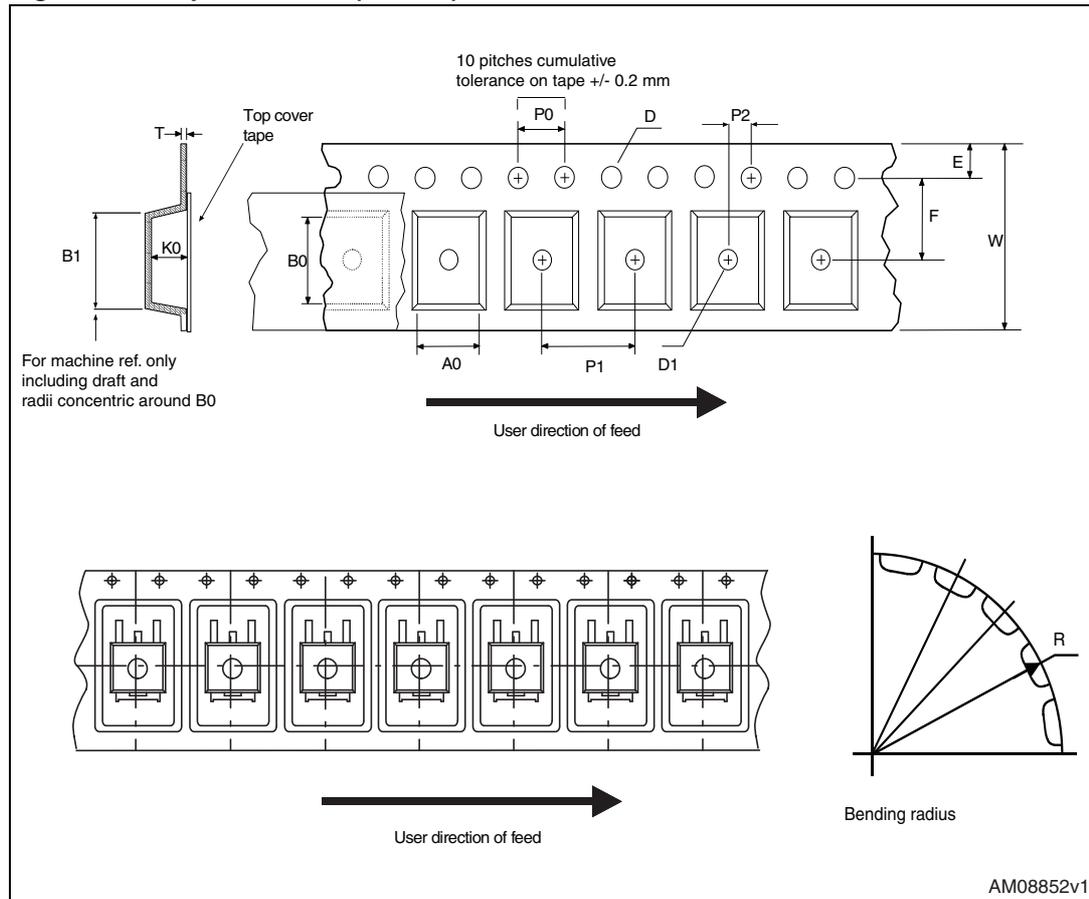
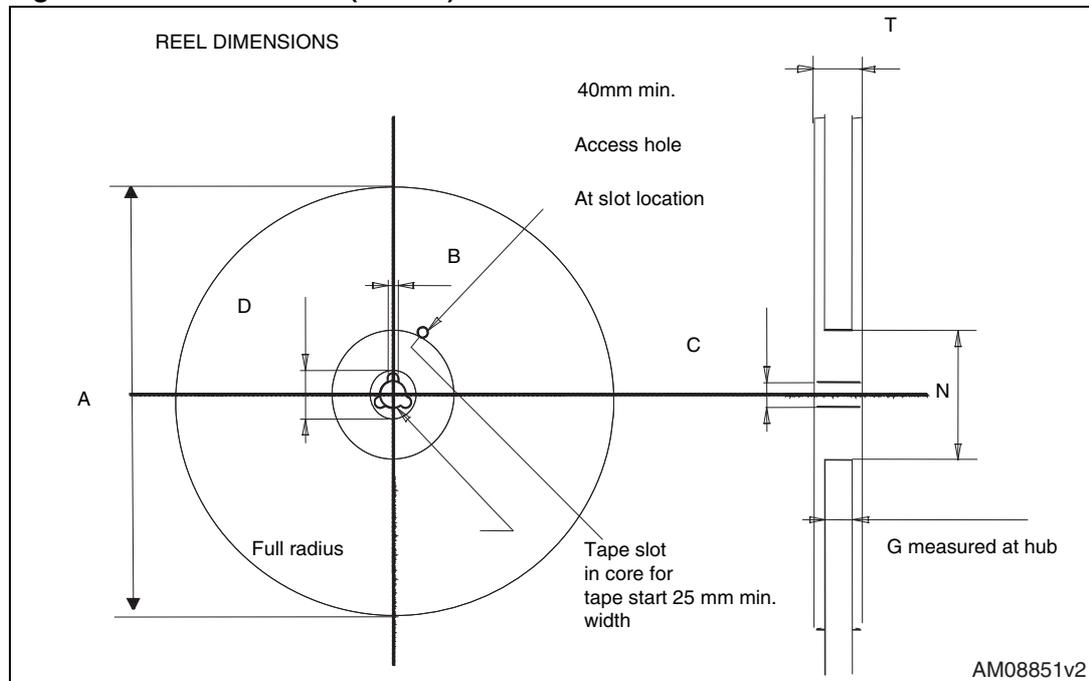


Figure 29. Reel for DPAK (TO-252)



6 Revision history

Table 15. Document revision history

Date	Revision	Changes
10-Jun-2009	1	First release
12-Jan-2010	2	<i>Figure 4: Safe operating area for TO-220FP</i> has been corrected
31-Mar-2010	3	<i>Features</i> have been corrected
17-Sep-2010	4	Content reworked to improve readability
24-Nov-2010	5	Corrected I_D value
16-Nov-2012	6	Inserted new package and mechanical data: I ² PAK

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