



STD5N52U STF5N52U, STI5N52U

N-channel 525 V, 1.28 Ω , 4.4 A, DPAK, TO-220FP, I²PAK
UltraFASTmesh™ Power MOSFET

Features

Type	V _{DSS}	R _{DS(on)} max	I _D	P _w
STD5N52U	525 V	< 1.5 Ω	4.4 A	70 W
STF5N52U				25 W
STI5N52U				70 W

- 100% avalanche tested
- Outstanding dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Very low R_{DS(on)}
- Extremely low t_{rr}

Applications

- Switching applications
 - High voltage inverters specific fo LCD TV
 - Lighting full bridge topology
 - Motor control

Description

These devices are N-channel Power MOSFETs developed using UltraFASTmesh™ technology, which combines the advantages of reduced on-resistance, Zener gate protection and very high dv/dt capability with an enhanced fast body-drain recovery diode.

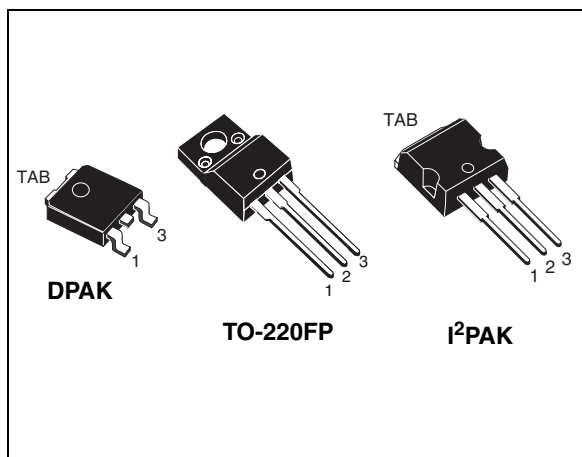


Figure 1. Internal schematic diagram

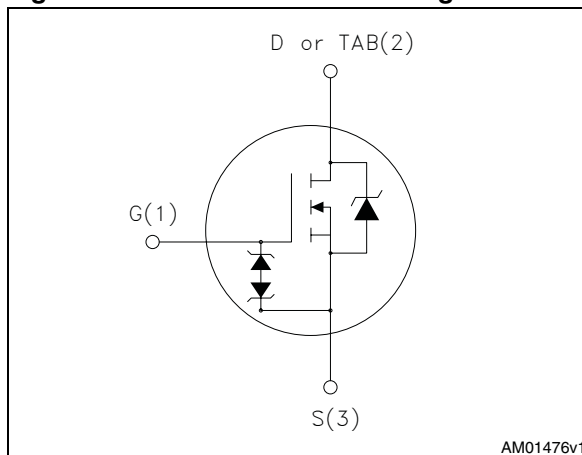


Table 1. Device summary

Order code	Marking	Package	Packaging
STD5N52U	5N52U	DPAK	Tape and reel
STF5N52U	5N52U	TO-220FP	Tube
STI5N52U	5N52U	I ² PAK	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK	TO-220FP	I ² PAK	
V _{GS}	Gate- source voltage	± 30			V
I _D	Drain current (continuous) at T _C = 25 °C	4.4			A
I _D	Drain current (continuous) at T _C = 100 °C	2.8			A
I _{DM} ⁽¹⁾	Drain current (pulsed)	17.6			A
P _{TOT}	Total dissipation at T _C = 25 °C	70	25	70	W
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _J max)	4.4			A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	170			mJ
dv/dt ⁽²⁾	Peak diode recovery voltage slope	20			V/ns
V _{ESD(G-S)}	G-S ESD (HBM C=100 pF; R=1.5 kΩ)	2800			V
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. Pulse width limited by safe operating area.

2. I_{SD} ≤ 4.4 A, di/dt ≤ 400 A/μs, peak V_{DS} ≤ V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		DPAK	TO-220FP	I ² PAK	
R _{thj-case}	Thermal resistance junction-case max	1.78	5	1.78	°C/W
R _{thj-amb}	Thermal resistance junction-ambient max		62.5	100	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb	50			°C/W

2 Electrical characteristics

(T_{case} = 25 °C unless otherwise specified)

Table 4. On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage ($V_{GS} = 0$)	$I_D = 1 \text{ mA}$	525			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = 525 \text{ V}$ $V_{DS} = 525 \text{ V}, T_C = 125 \text{ °C}$			10 500	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20 \text{ V}$			10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 50 \text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}, I_D = 2.2 \text{ A}$		1.28	1.5	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 25 \text{ V}, f = 1 \text{ MHz},$ $V_{GS} = 0$	-	529 71 13.4	-	pF pF pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0 \text{ to } 420 \text{ V}, V_{GS} = 0$	-	11	-	pF
R_g	Gate input resistance	$f = 1 \text{ MHz}$ open drain	-	6	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 416 \text{ V}, I_D = 4.4 \text{ A},$ $V_{GS} = 10 \text{ V}$ (see Figure 17)	-	16.9 4.2 8.4	-	nC nC 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 6. 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	$V_{DD} = 260 \text{ V}, I_D = 2.2 \text{ A},$ $R_G = 4.7 \text{ }\Omega, V_{GS} = 10 \text{ V}$ (see Figure 16)	-	11.4 13.6 23.1 15	-	ns ns ns ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		4.4	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		17.6	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 4.4 \text{ A}$, $V_{GS} = 0$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 4.4 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$	-	55		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 60 \text{ V}$	-	95		μC
I_{RRM}	Reverse recovery current	(see Figure 18)	-	3.5		A
t_{rr}	Reverse recovery time	$I_{SD} = 4.4 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$	-	120		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 60 \text{ V}$, $T_J = 150 \text{ }^\circ\text{C}$	-	266		μC
I_{RRM}	Reverse recovery current	(see Figure 18)	-	4.5		A

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

Table 8. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
BV_{GSO}	Gate-source breakdown voltage	$I_{GS} = \pm 1 \text{ mA}$ (open drain)	30	-	-	V

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK and i²PAK

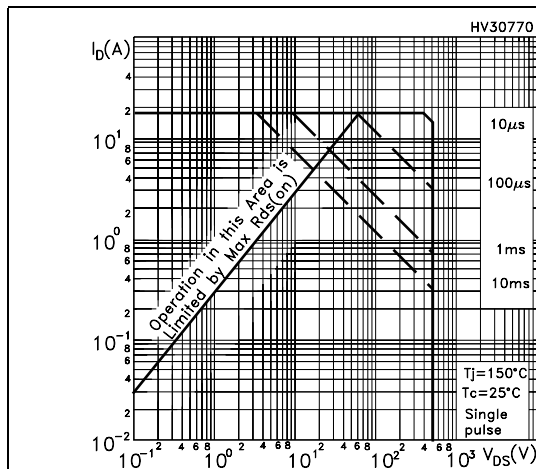


Figure 3. Thermal impedance for DPAK and i²PAK

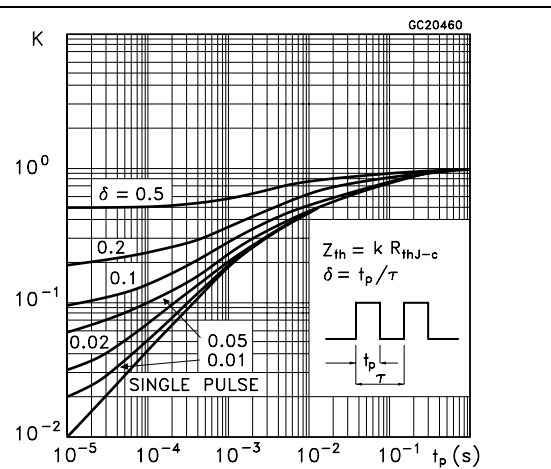


Figure 4. Safe operating area for TO-220FP

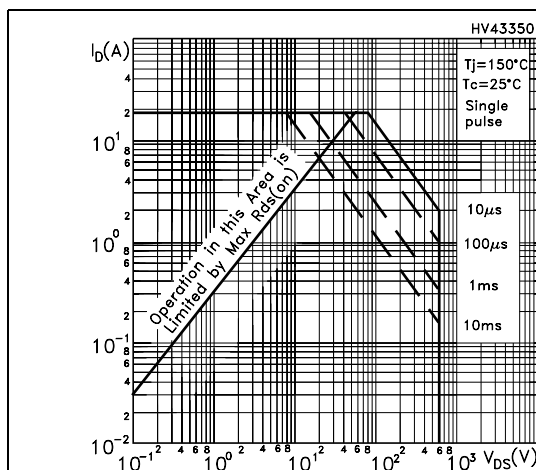


Figure 5. Thermal impedance for TO-220FP

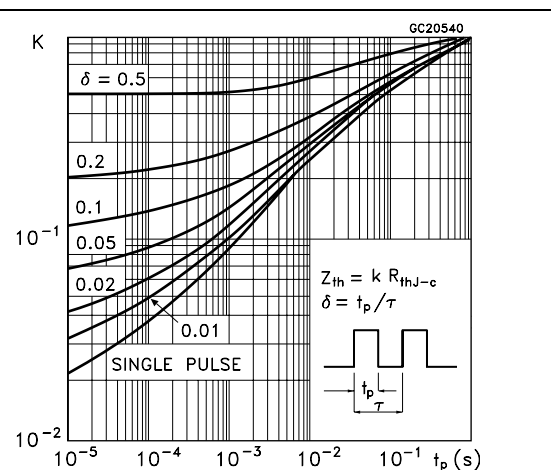


Figure 6. Output characteristics

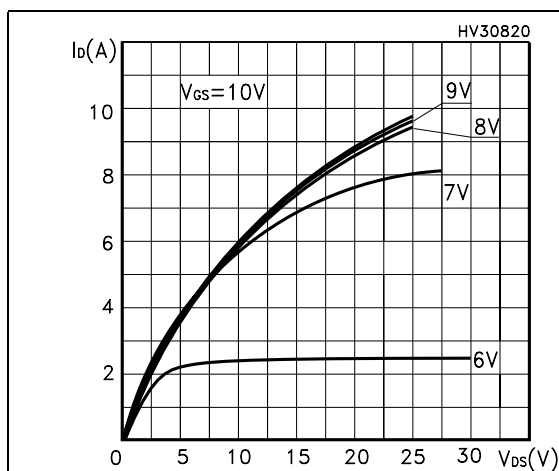


Figure 7. Transfer characteristics

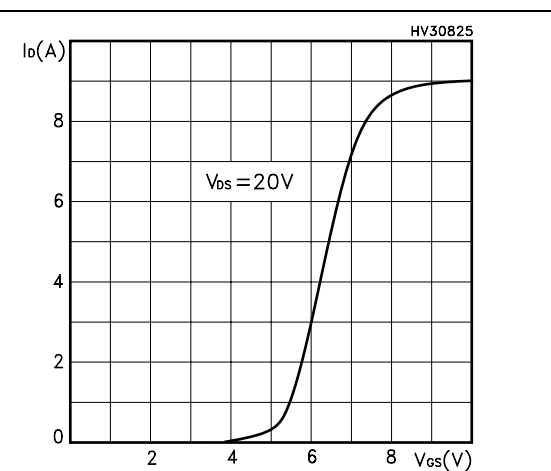


Figure 8. Normalized BV_{DSS} vs temperature Figure 9. Static drain-source on resistance

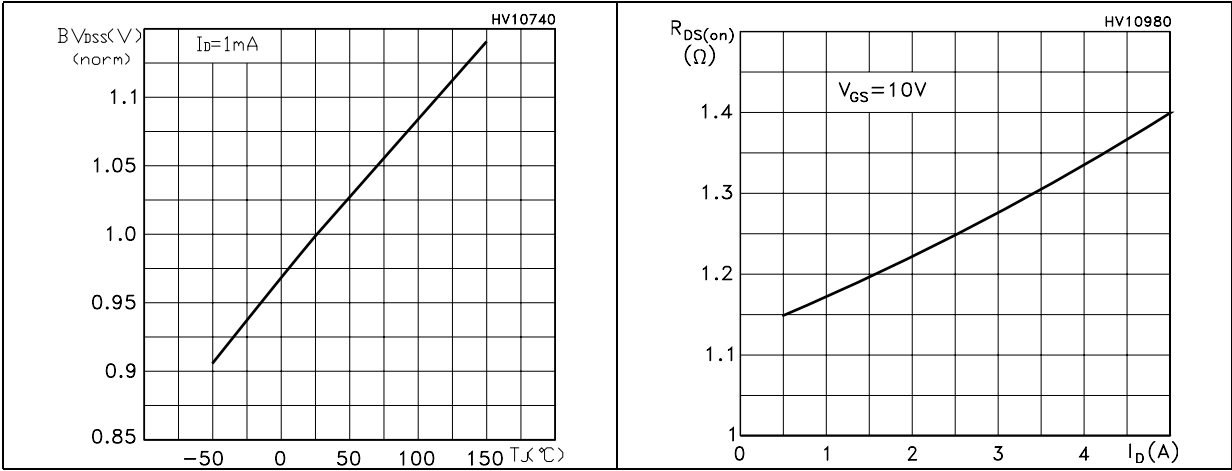


Figure 10. Gate charge vs gate-source voltage Figure 11. Capacitance variations

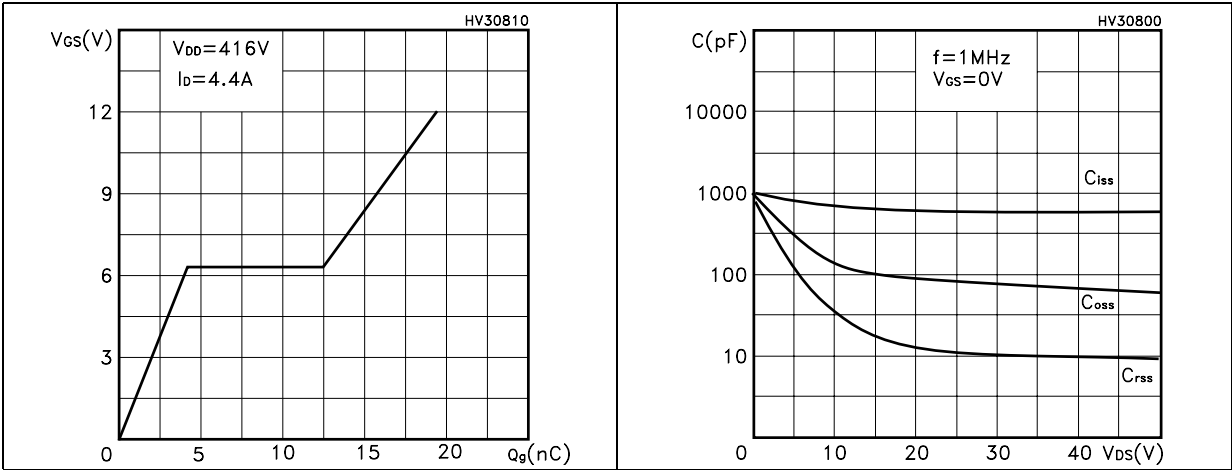


Figure 12. Normalized gate threshold voltage vs temperature Figure 13. Normalized on resistance vs temperature

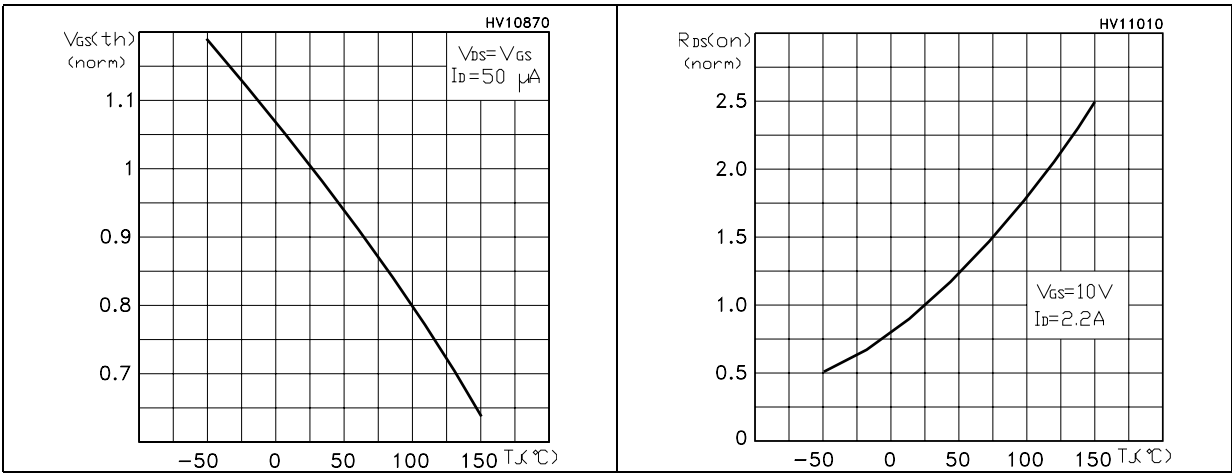


Figure 14. Source-drain diode forward characteristics

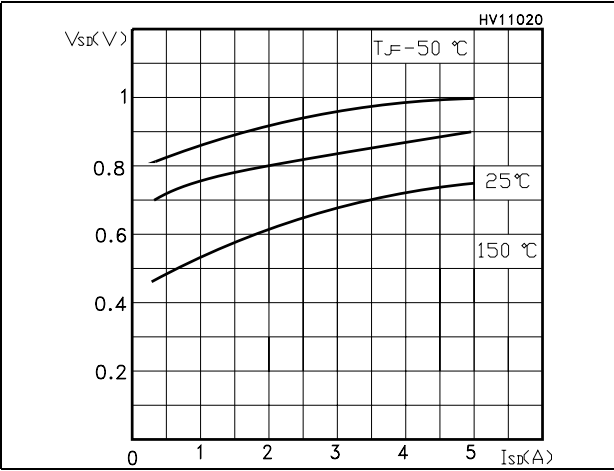
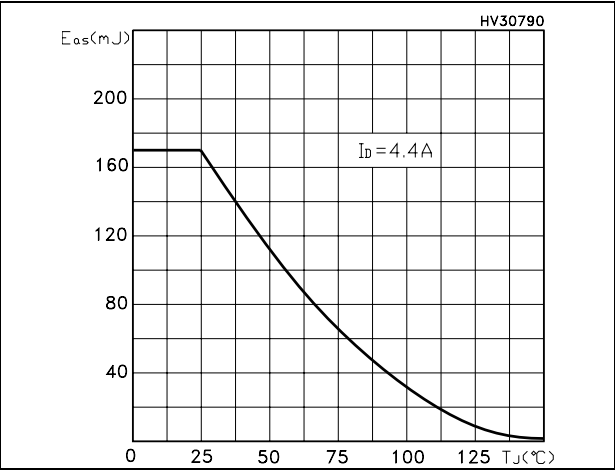


Figure 15. Maximum avalanche energy vs temperature



3 Test circuits

Figure 16. Switching times test circuit for resistive load

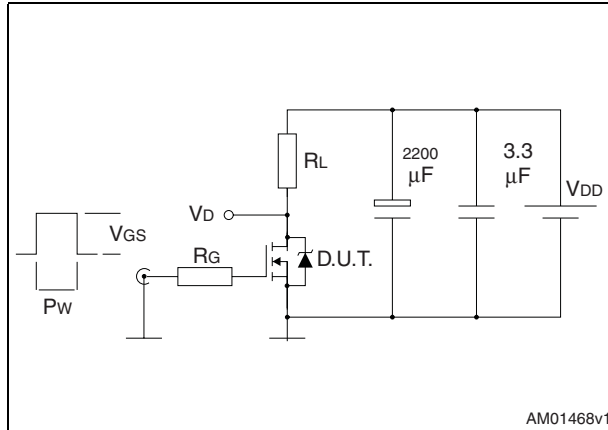


Figure 17. Gate charge test circuit

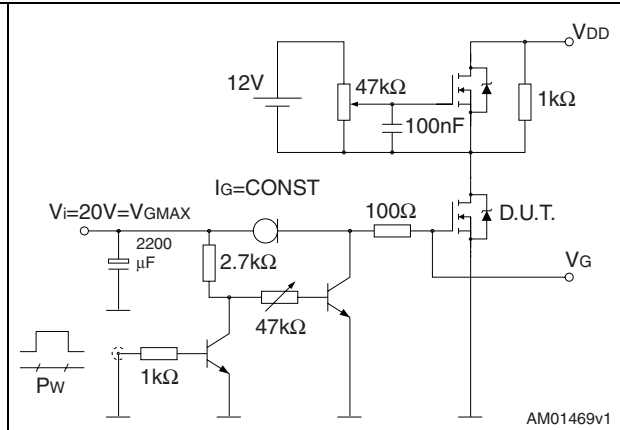


Figure 18. Test circuit for inductive load switching and diode recovery times

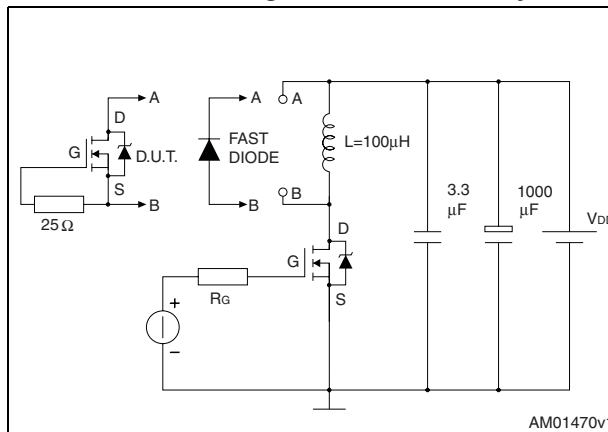


Figure 19. Unclamped inductive load test circuit

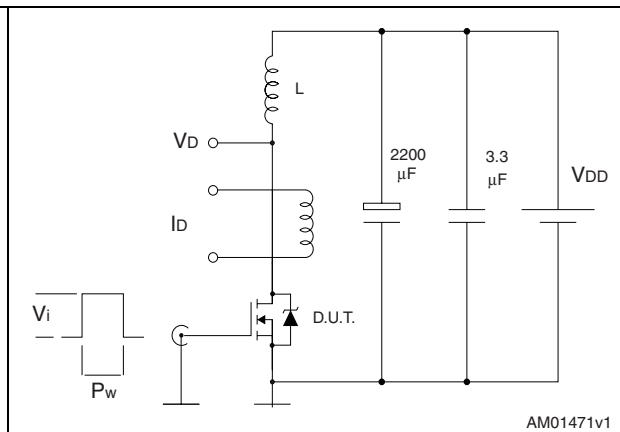


Figure 20. Unclamped inductive waveform

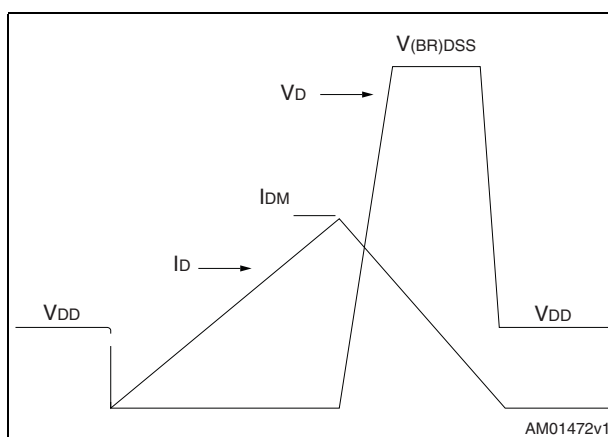
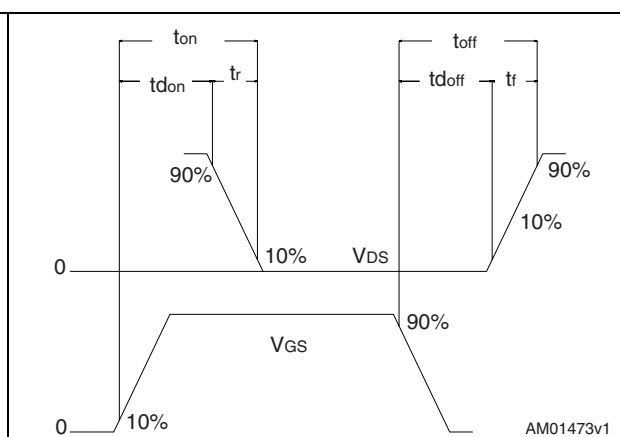


Figure 21. Switching time waveform



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. 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 22. DPAK (TO-252) drawing

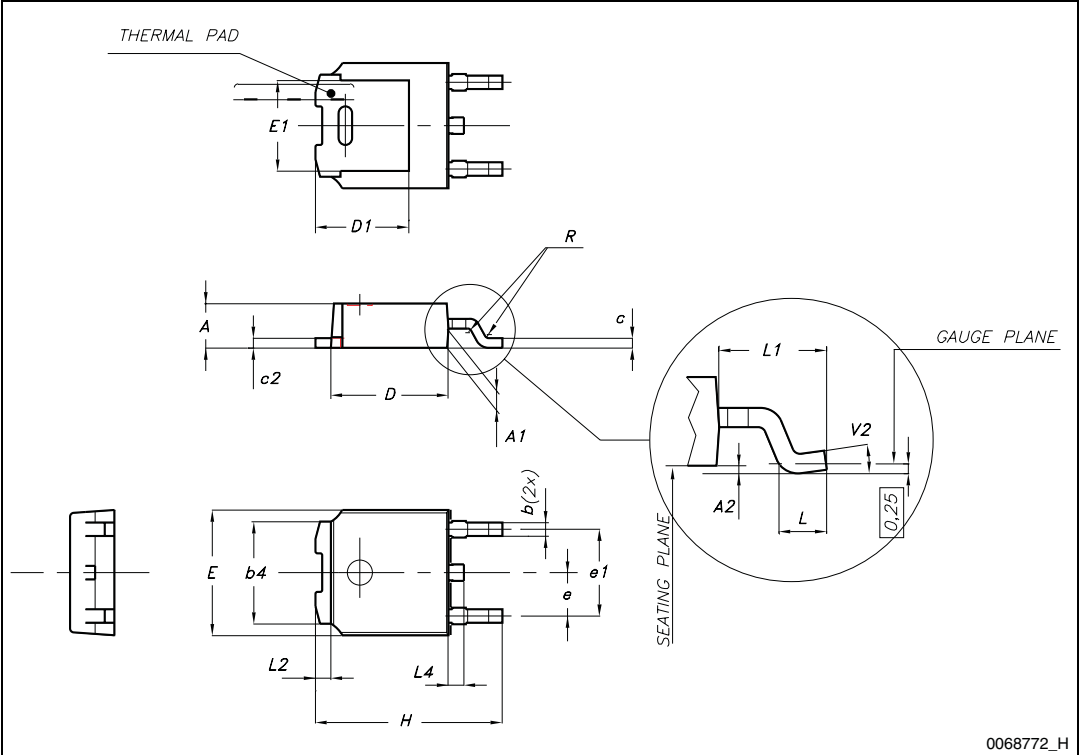
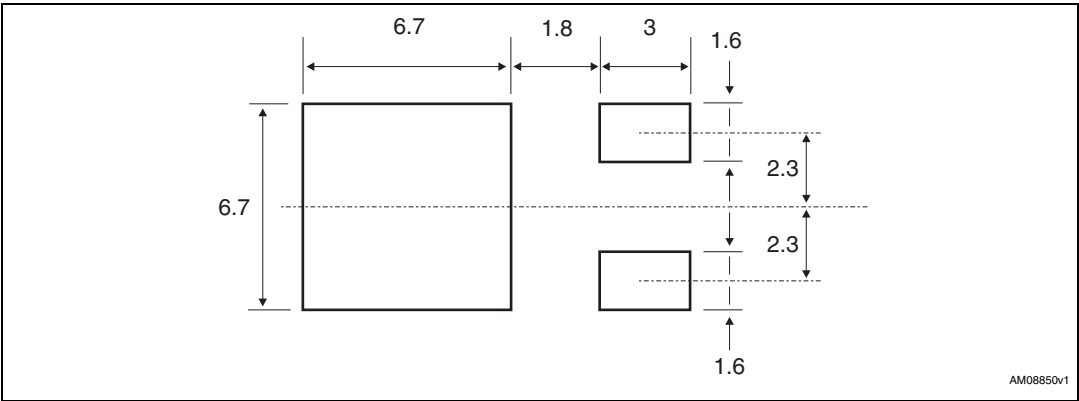


Figure 23. DPAK footprint^(a)

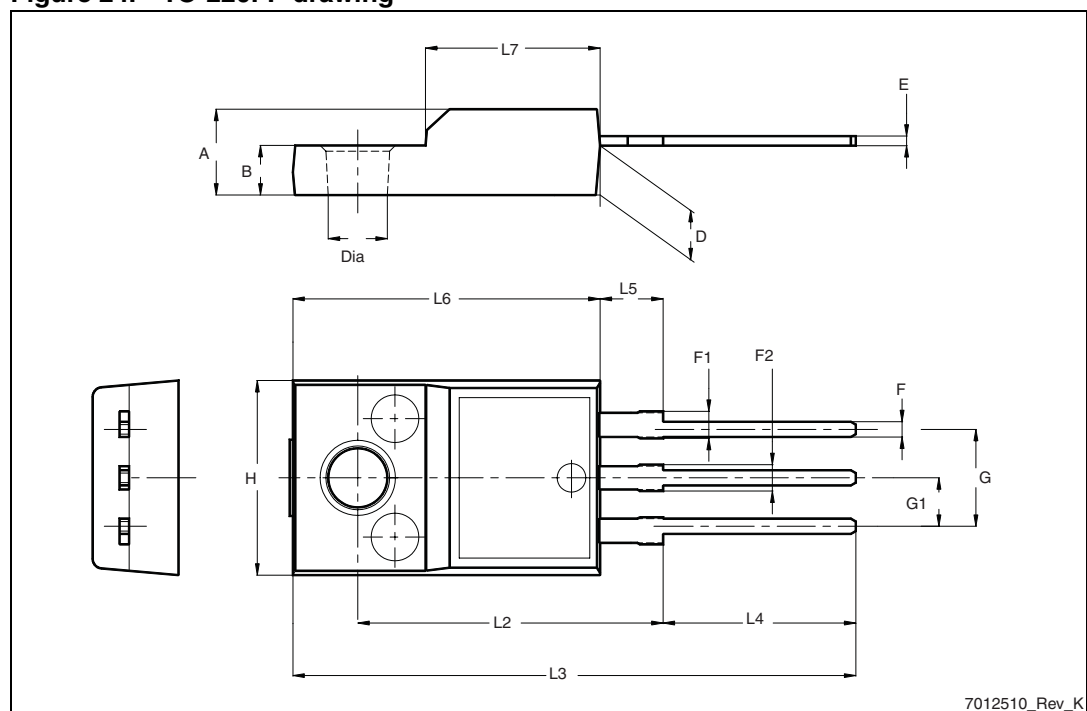


a. All dimension are in millimeters

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

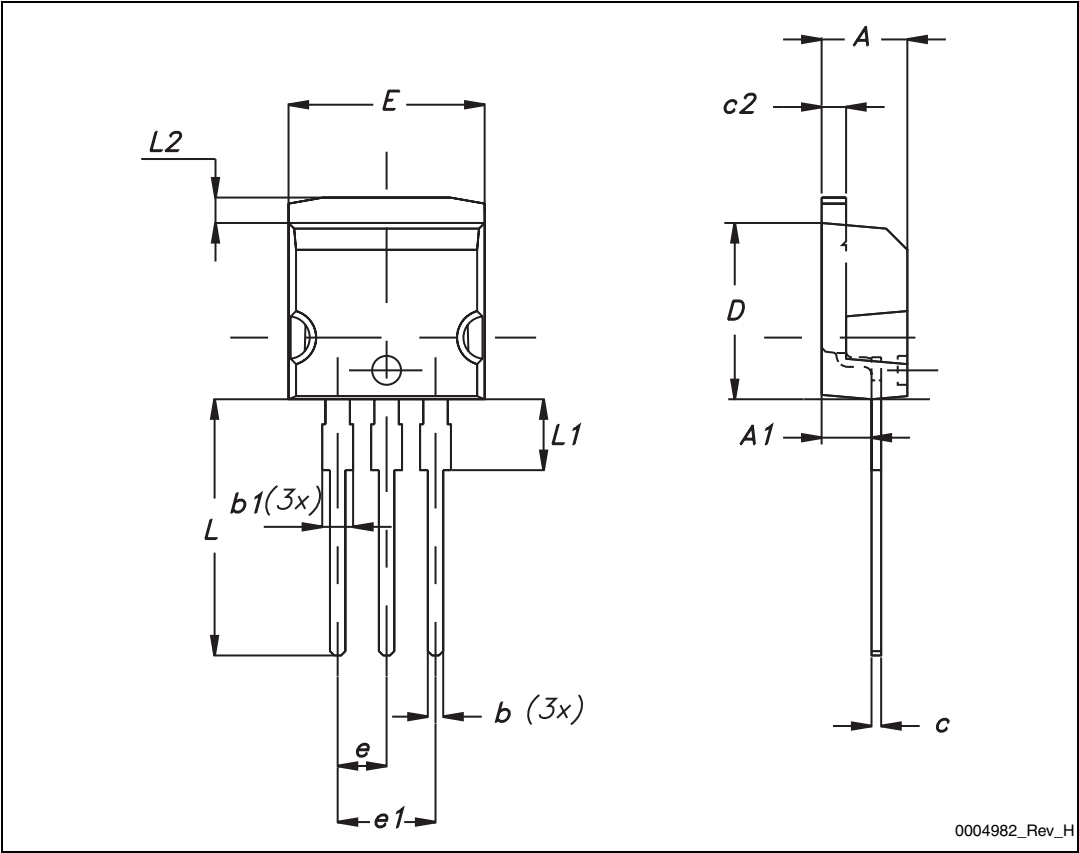


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Table 11. I²PAK (TO-262) mechanical data

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

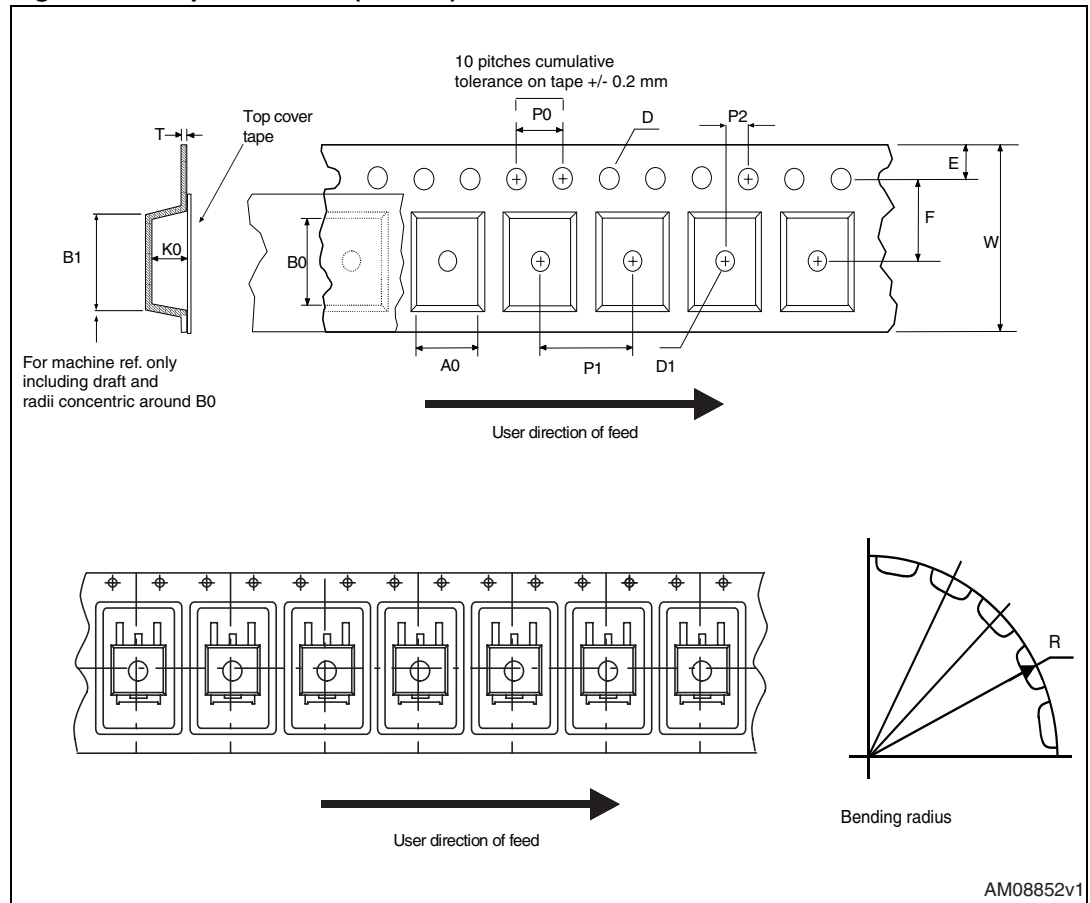
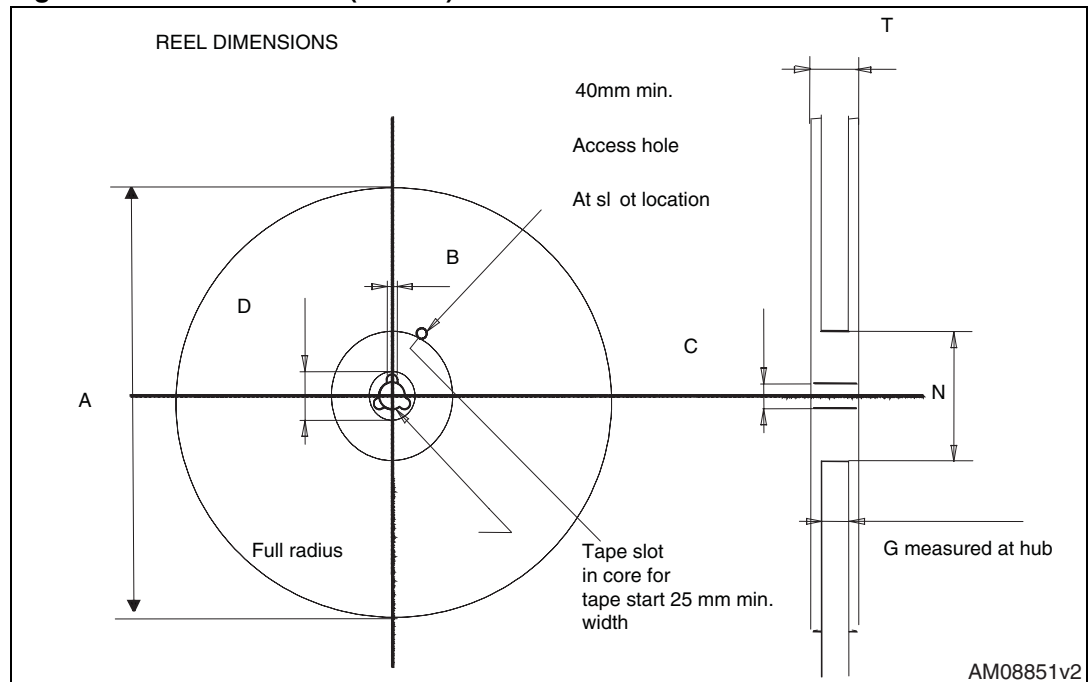
Figure 25. I²PAK (TO-262) drawing



5 Packaging mechanical data

Table 12. 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 26. Tape for DPAK (TO-252)**Figure 27. Reel for DPAK (TO-252)**

6 Revision history

Table 13. Document revision history

Date	Revision	Changes
06-May-2009	1	First release.
28-Sep-2011	2	Inserted new device in I ² PAK. Updated tables 1 , 2 and 3 with the new package. Updated Section 4: Package mechanical data with the new package and Section 5: Packaging mechanical data . Minor text changes.

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