



# STD11NM50N STF11NM50N, STP11NM50N

N-channel 500 V, 0.4  $\Omega$ , 8.5 A MDmesh™ II Power MOSFET  
in DPAK, TO-220FP and TO-220

## Features

Order codes	V <sub>DSS</sub> @T <sub>Jmax</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STD11NM50N STF11NM50N STP11NM50N	550 V	< 0.47 $\Omega$	8.5 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.

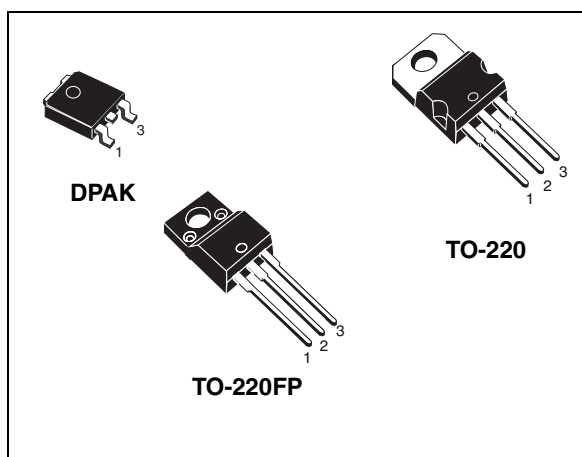


Figure 1. Internal schematic diagram

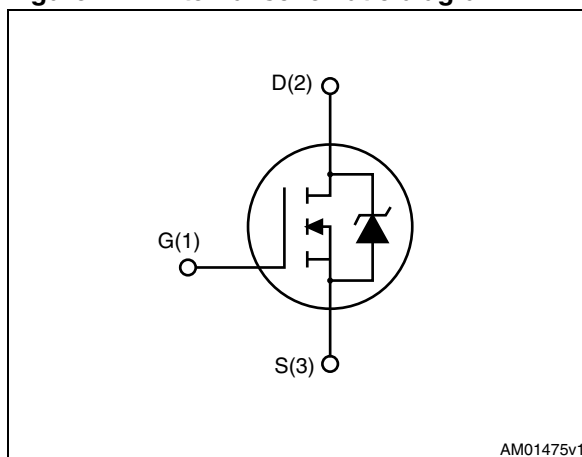


Table 1. Device summary

Order codes	Marking	Package	Packaging
STD11NM50N	11NM50N	DPAK	Tape and reel
STF11NM50N	11NM50N	TO-220FP	Tube
STP11NM50N	11NM50N	TO-220	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		TO-220	DPAK	TO-220FP	
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	500			V
$V_{GS}$	Gate-source voltage	$\pm 25$			V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	8.5		8.5 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	6		6 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	34		34 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	70	70	25	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 ( $t = 1\text{ s}$ ; $T_C = 25\text{ }^\circ\text{C}$ )	2500			V
$T_{stg}$	Storage temperature	- 55 to 150			$^\circ\text{C}$
$T_j$	Max. operating junction temperature	150			$^\circ\text{C}$

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 8.5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{Peak} < V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		TO-220	DPAK	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	1.79		5	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5		62.5	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max <sup>(1)</sup>		50		$^\circ\text{C}/\text{W}$
$T_l$	Maximum lead temperature for soldering purpose	300		300	$^\circ\text{C}$

1. When mounted on 1inch<sup>2</sup> FR-4 board, 2 oz Cu

**Table 4. Thermal data**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive <sup>(1)</sup>	3	A
$E_{AS}$	Single pulse avalanche energy <sup>(2)</sup>	150	mJ

1. Pulse width limited by  $T_{JMAX}$ .
2. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified)

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	500			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	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 4.5\text{ A}$		0.4	0.47	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	547	-	pF
$C_{oss}$	Output capacitance			42		
$C_{rss}$	Reverse transfer capacitance			2		
$C_{oss\text{ eq.}}^{(1)}$	Output equivalent capacitance	$V_{DS} = 0\text{ to }400\text{ V}$ , $V_{GS} = 0$	-	210	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	5.8	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}$ , $I_D = 8.5\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	19	-	nC
$Q_{gs}$	Gate-source charge			3.7		
$Q_{gd}$	Gate-drain charge			10		

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	$V_{DD} = 250\text{ V}$ , $I_D = 4.25\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 19</a> )		8		ns
$t_r$	Rise time			10		ns
$t_{d(off)}$	Turn-off delay time			33		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				8.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		34	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 8.5\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 8.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see <a href="#">Figure 22</a> )		230		ns
$Q_{rr}$	Reverse recovery charge			2.1		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			18		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 8.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 22</a> )		275		ns
$Q_{rr}$	Reverse recovery charge			2.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			18		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

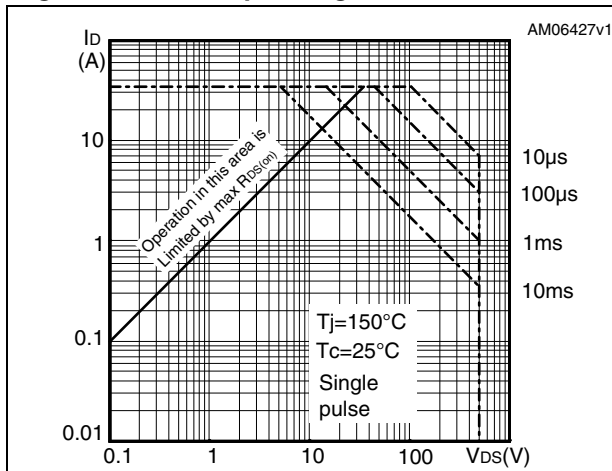


Figure 3. Thermal impedance for TO-220

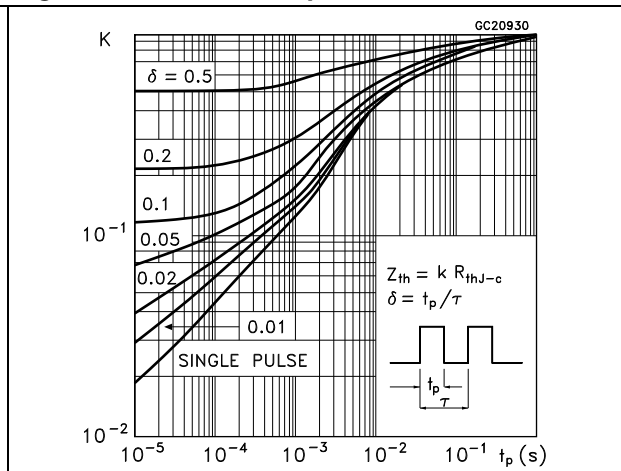


Figure 4. Safe operating area for TO-220FP

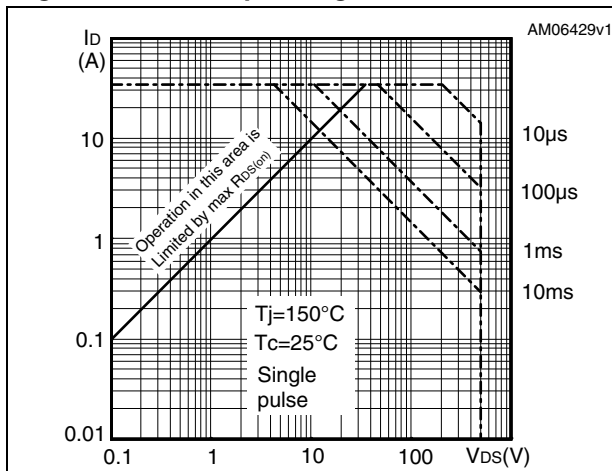


Figure 5. Thermal impedance for TO-220FP

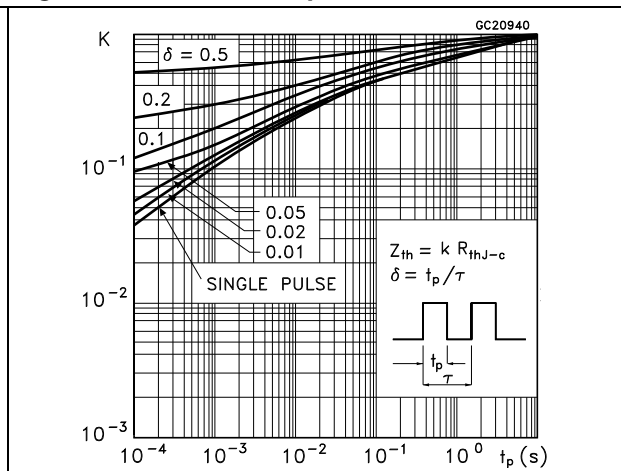


Figure 6. Safe operating area for DPAK

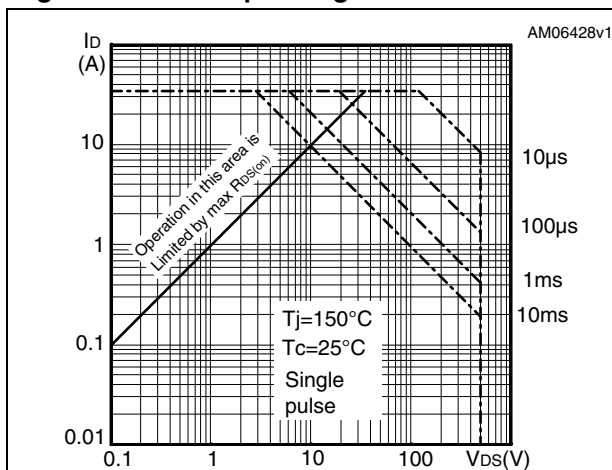


Figure 7. Thermal impedance for DPAK

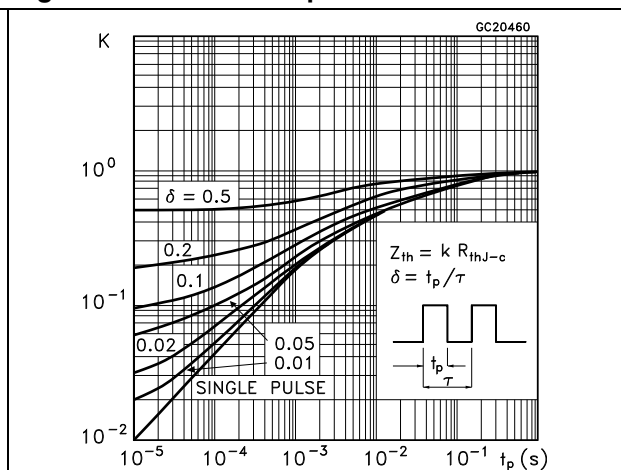


Figure 8. Output characteristics

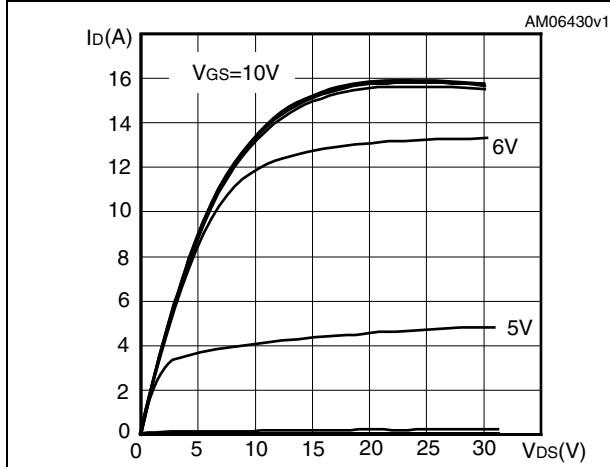


Figure 9. Transfer characteristics

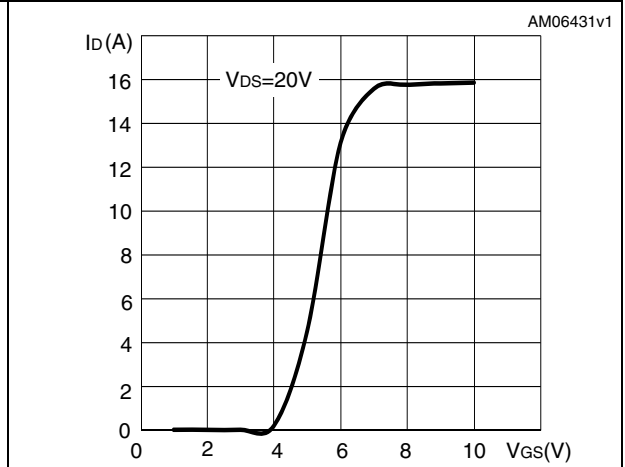


Figure 10. Gate charge vs gate-source voltage

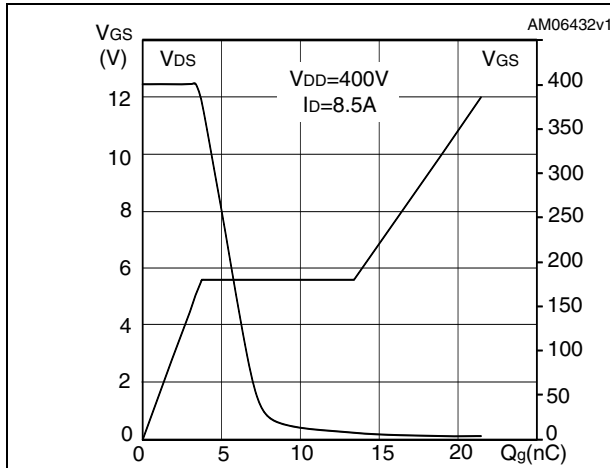


Figure 11. Static drain-source on resistance

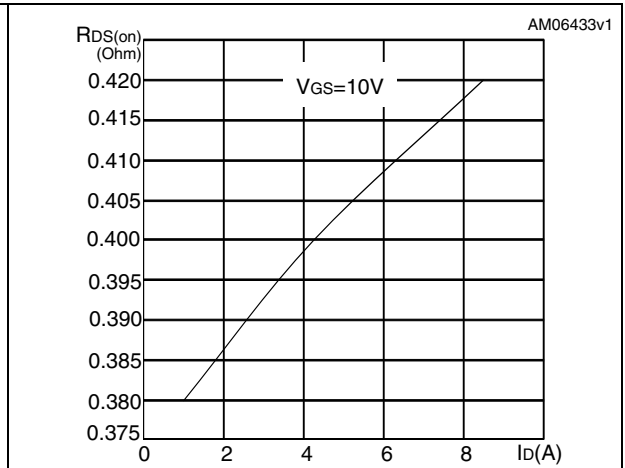


Figure 12. Capacitance variations

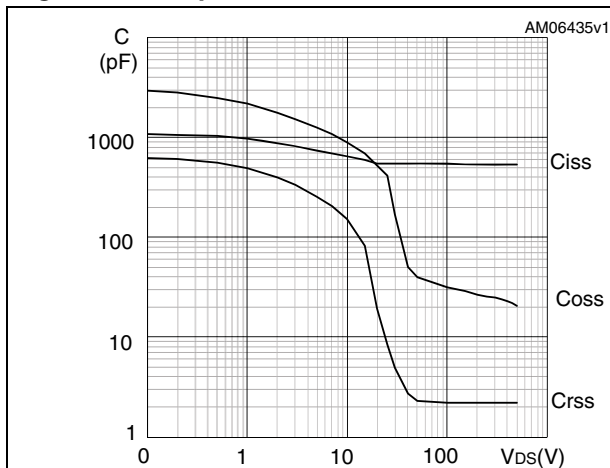
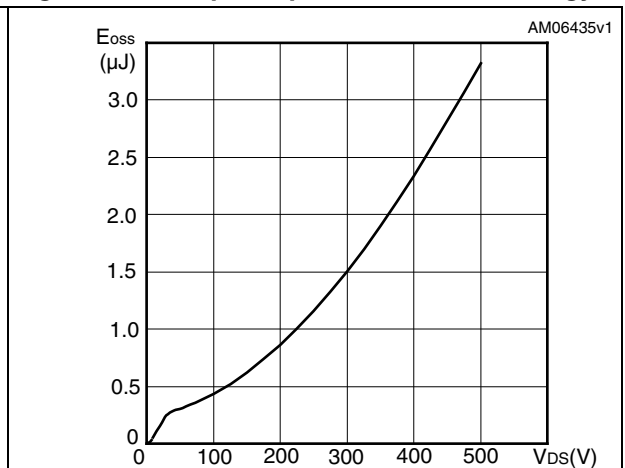
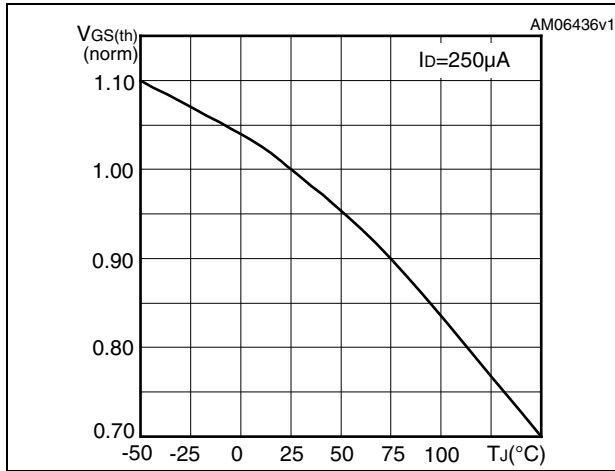


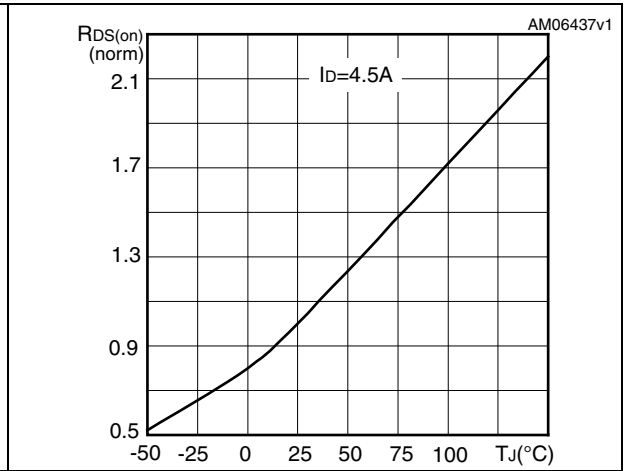
Figure 13. Output capacitance stored energy



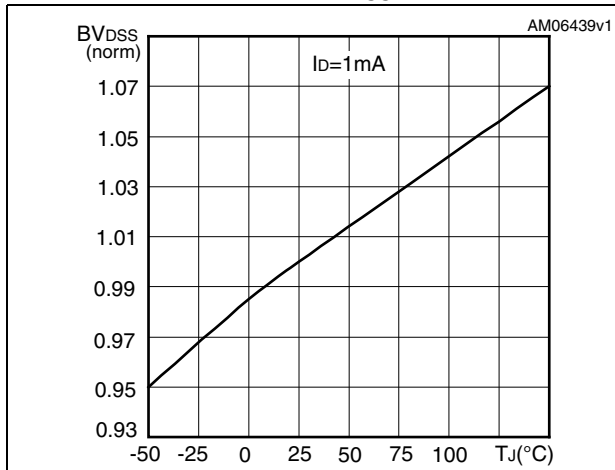
**Figure 14. Normalized gate threshold voltage vs temperature**



**Figure 15. Normalized on resistance vs temperature**



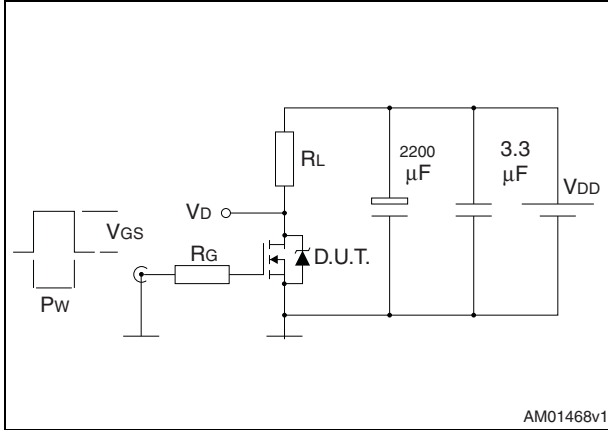
**Figure 16. Normalized  $B_{VDSS}$  vs temperature**





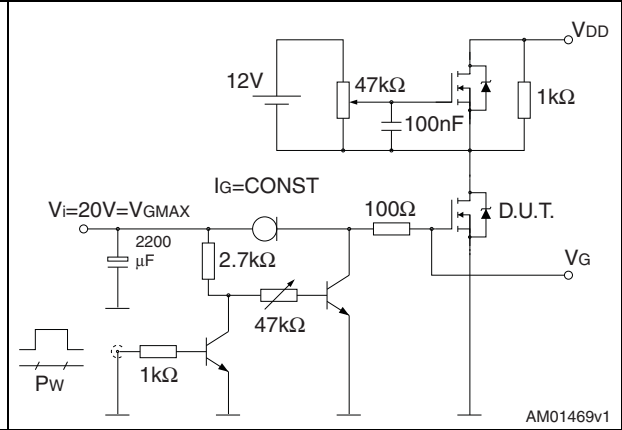
### 3 Test circuits

**Figure 17. Switching times test circuit for resistive load**



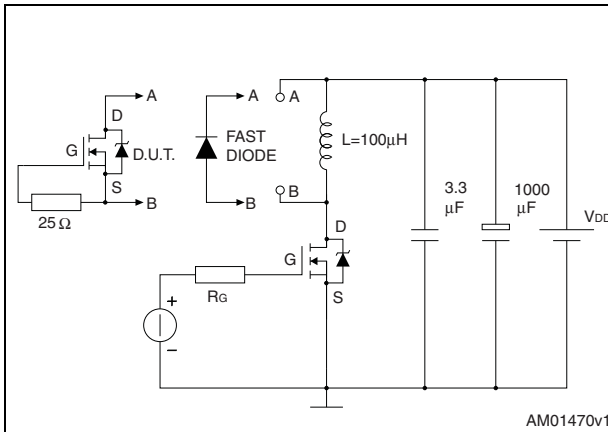
AM01468v1

**Figure 18. Gate charge test circuit**



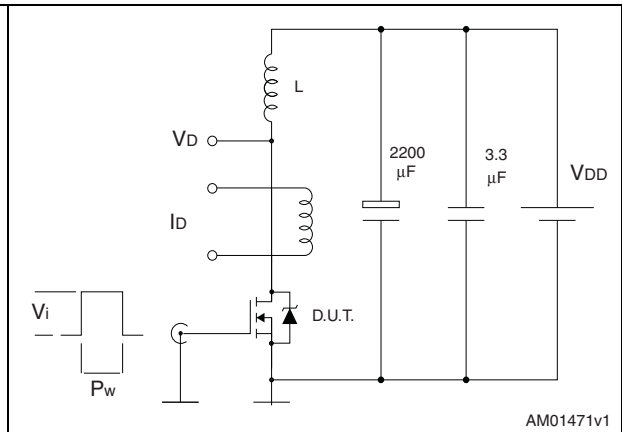
AM01469v1

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



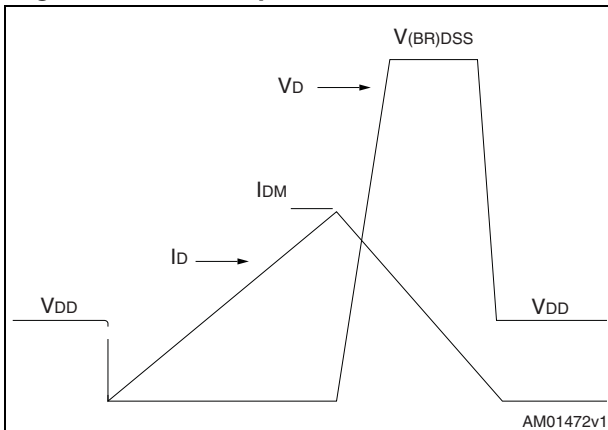
AM01470v1

**Figure 20. Unclamped inductive load test circuit**



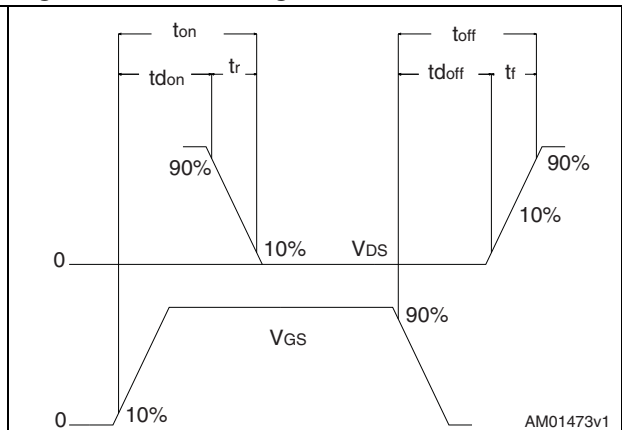
AM01471v1

**Figure 21. Unclamped inductive waveform**



AM01472v1

**Figure 22. Switching time waveform**



AM01473v1

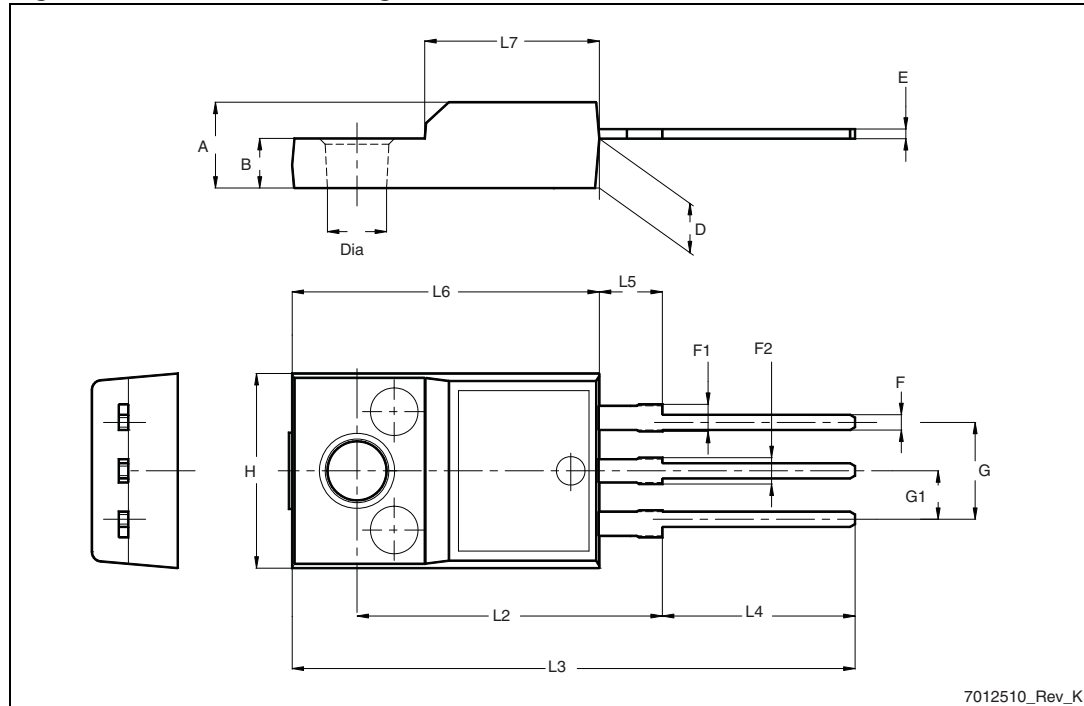
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Table 9. TO-220FP mechanical data

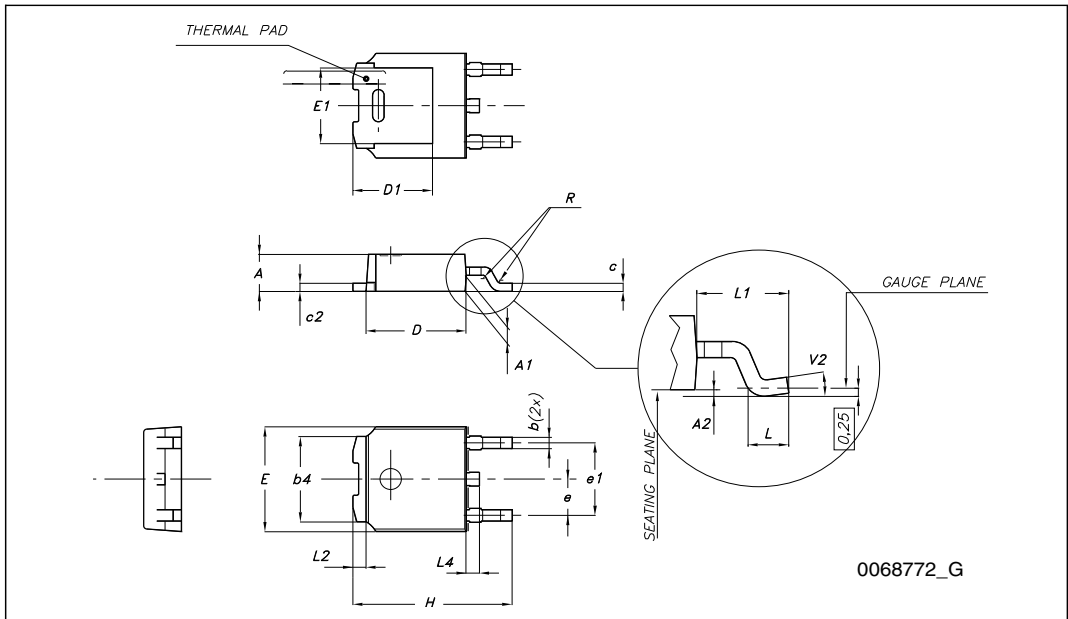
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 23. TO-220FP drawing



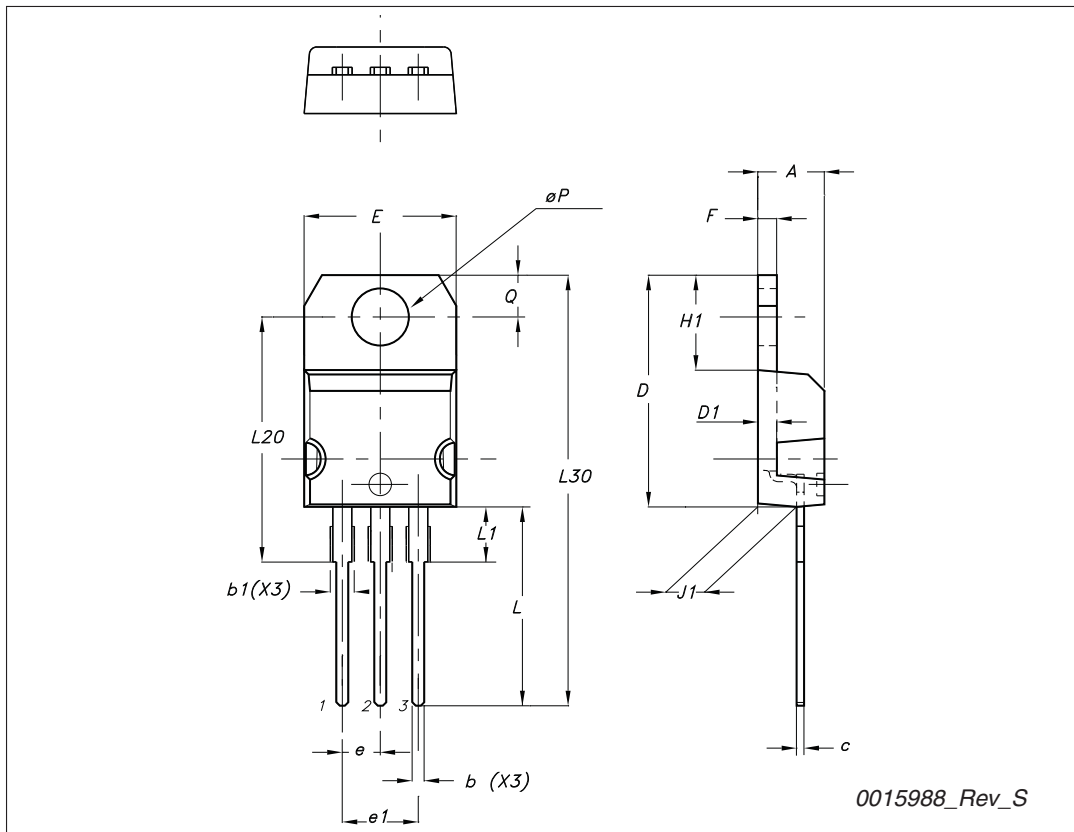
**TO-252 (DPAK) mechanical data**

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°



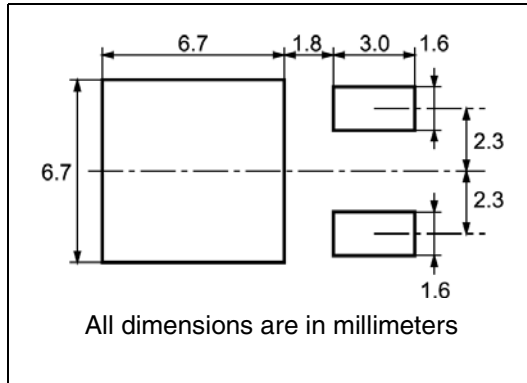
TO-220 type A mechanical data

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



## 5 Packaging mechanical data

### DPAK FOOTPRINT



### TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

#### REEL MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

#### TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

For machine ref. only including draft and radii concentric around B0

TRL

Bending radius R min.

## 6 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
22-Feb-2010	1	First release.
26-Apr-2010	2	Updated <a href="#">Table 8: Source drain diode</a> .
24-Nov-2010	3	New value inserted in <a href="#">Table 6: Dynamic</a> .

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