



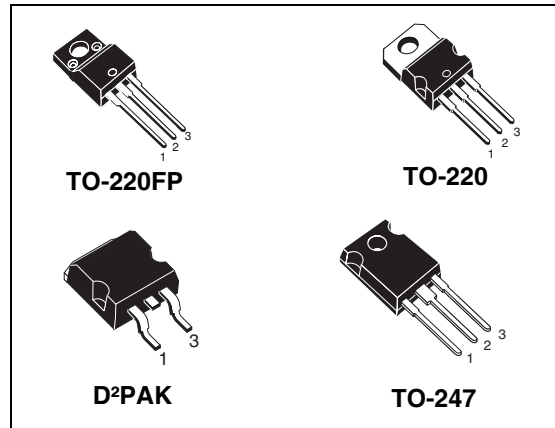
# STB28NM50N, STF28NM50N STP28NM50N, STW28NM50N

N-channel 500 V, 0.135  $\Omega$ , 21 A D<sup>2</sup>PAK, TO-220, TO-220FP, TO-247  
MDmesh™ II Power MOSFET

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB28NM50N	550 V	< 0.158 $\Omega$	21 A
STF28NM50N			
STP28NM50N			
STW28NM50N			

- 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

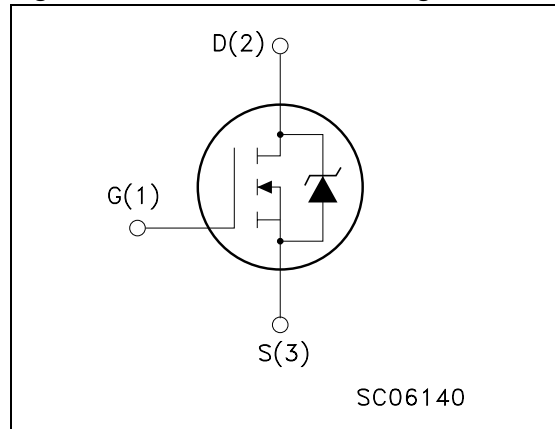


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB28NM50N	28NM50N	D <sup>2</sup> PAK	Tape and reel
STF28NM50N		TO-220FP	Tube
STP28NM50N		TO-220	
STW28NM50N		TO-247	

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value				Unit
		TO-220	D <sup>2</sup> PAK	TO-220FP	TO-247	
V <sub>DS</sub>	Drain-source voltage (V <sub>GS</sub> = 0)	500				V
V <sub>GS</sub>	Gate- source voltage	± 25				V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	21		21 <sup>(1)</sup>	21	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	13		13 <sup>(1)</sup>	13	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	84		84 <sup>(1)</sup>	84	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	90		25	150	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)			2500		V
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	21				V/ns
T <sub>stg</sub>	Storage temperature	- 55 to 150				°C
T <sub>j</sub>	Max. operating junction temperature	150				°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 21 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		TO-220	D <sup>2</sup> PAK	TO-247	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max	1.39		0.83	5	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5		50	62.5	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb max		30			°C/W
T <sub>l</sub>	Maximum lead temperature for soldering purpose	300		300		°C

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

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ Max)	8.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	430	mJ

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  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 ( $V_{GS} = 0$ )	$V_{DS} = \text{max rating}$ $V_{DS} = \text{max rating}, @125^{\circ}\text{C}$			1 10	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20 \text{ V}$			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	$V_{GS} = 10 \text{ V}, I_D = 10.5 \text{ A}$		0.135	0.158	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25 \text{ V}, f = 1 \text{ MHz},$ $V_{GS} = 0$	-	1735	-	pF
$C_{oss}$	Output capacitance			122		
$C_{rss}$	Reverse transfer capacitance			4.3		
$C_{oss(tr)}^{(1)}$	Equivalent output capacitance time related	$V_{GS} = 0, V_{DS} = 0 \text{ to } 50 \text{ V}$	-	122	-	pF
$C_{oss(er)}^{(2)}$	Equivalent output capacitance energy related			86		
$Q_g$	Total gate charge	$V_{DD} = 400 \text{ V}, I_D = 21 \text{ A},$ $V_{GS} = 10 \text{ V},$ (see <a href="#">Figure 18</a> )	-	50	-	nC
$Q_{gs}$	Gate-source charge			9.5		
$Q_{gd}$	Gate-drain charge			25		
$R_g$	Gate input resistance	$f=1 \text{ MHz}$ Gate DC Bias=0 Test signal level=20 mV open drain	-	2.7	-	$\Omega$

1.  $C_{oss(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

2.  $C_{oss(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising 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	$V_{DD} = 250\text{ V}$ , $I_D = 10.5\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17</a> )	-	13.6	-	ns
$t_r$	Rise time			19		ns
$t_{d(off)}$	Turn-off delay time			62		ns
$t_f$	Fall time			52		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		21	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				84	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 21\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 21\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 400\text{ V}$ (see <a href="#">Figure 22</a> )	-	326		ns
$Q_{rr}$	Reverse recovery charge			5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			30		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 21\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 400\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 22</a> )	-	376		ns
$Q_{rr}$	Reverse recovery charge			6.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			33.2		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, D<sup>2</sup>PAK

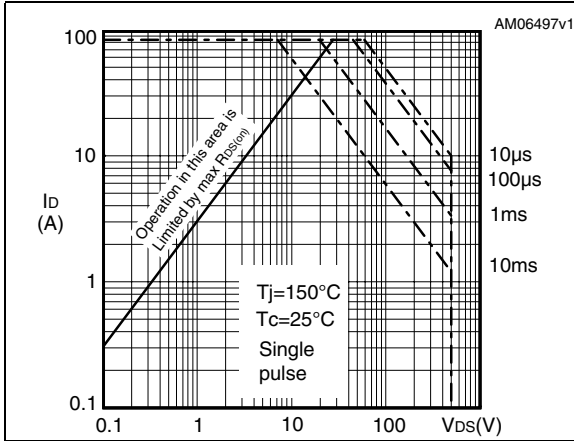


Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK

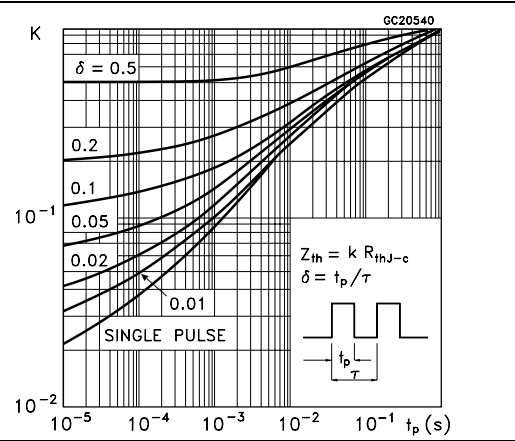


Figure 4. Safe operating area for TO-220FP

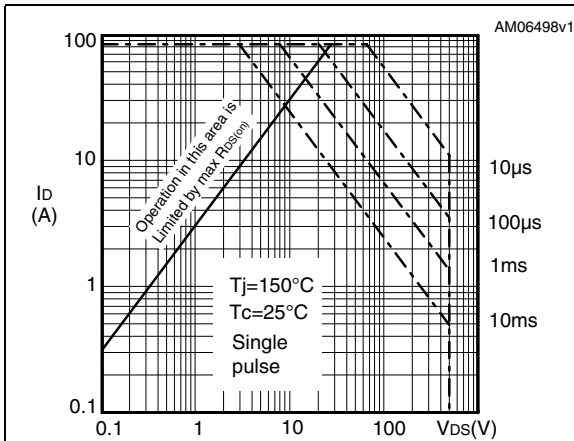


Figure 5. Thermal impedance for TO-220FP

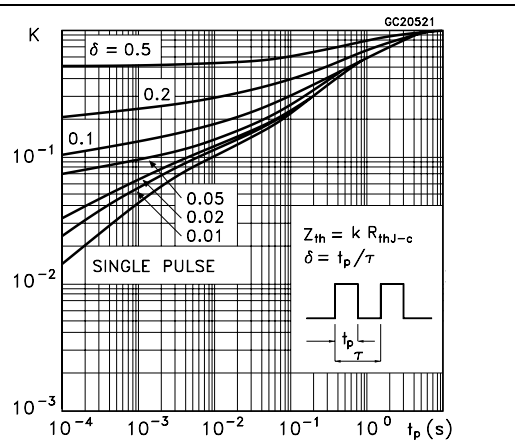


Figure 6. Safe operating area for TO-247

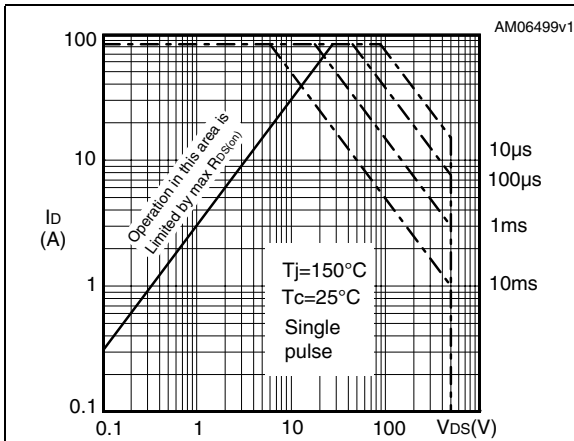


Figure 7. Thermal impedance for TO-247

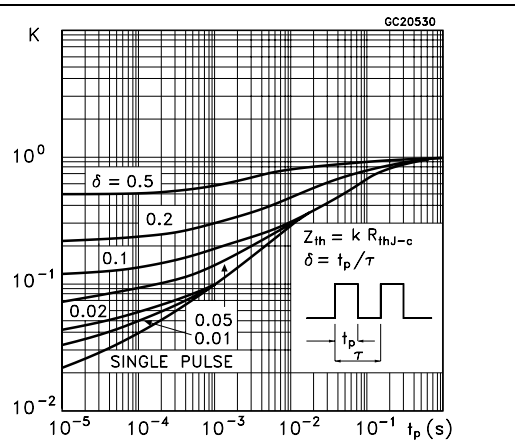


Figure 8. Output characteristics

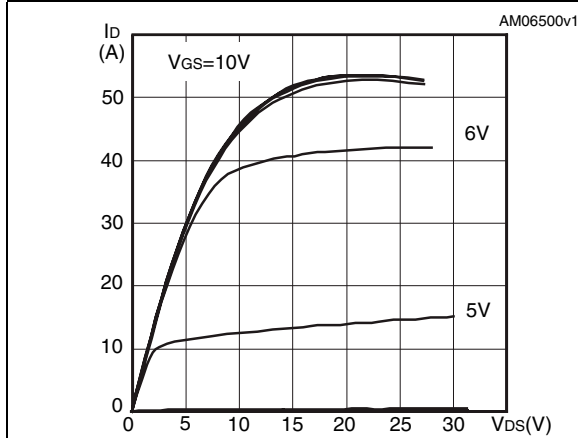


Figure 9. Transfer characteristics

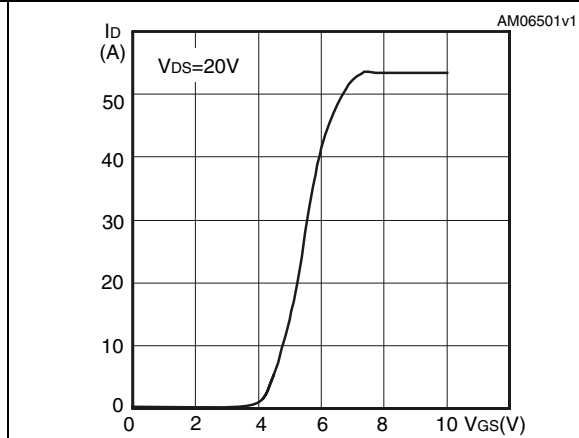


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on resistance

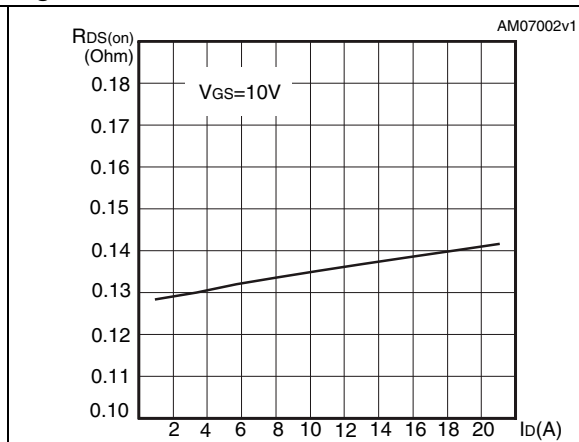
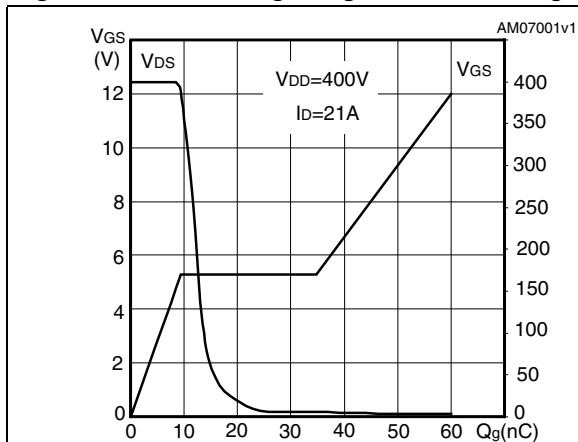


Figure 12. Capacitance variations

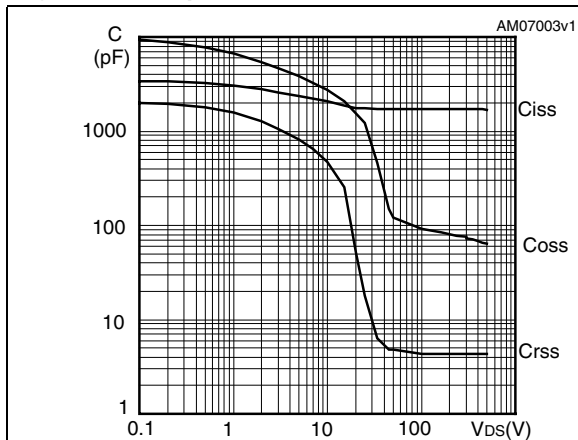


Figure 13. Output capacitance stored energy

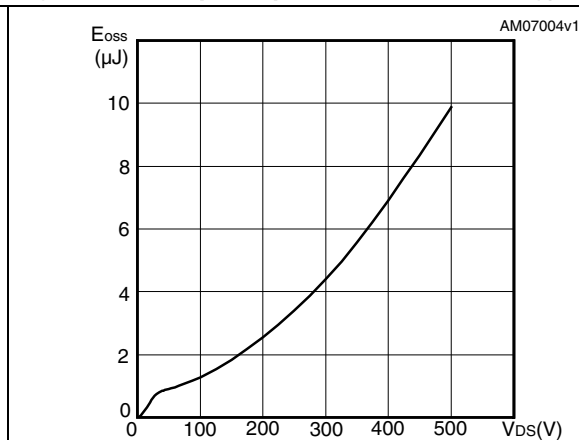




Figure 14. Normalized gate threshold voltage vs temperature

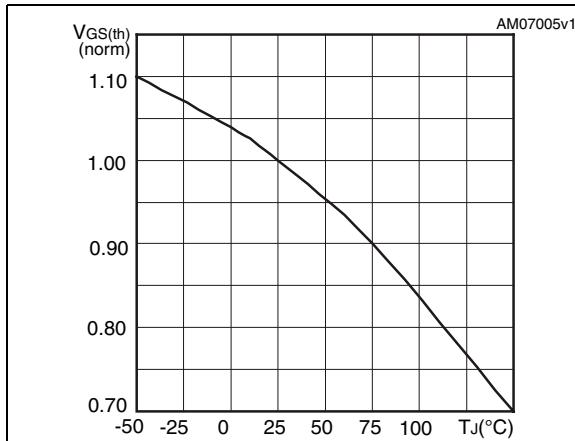
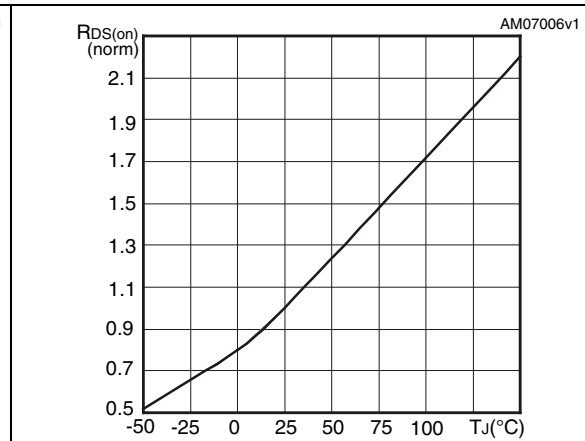
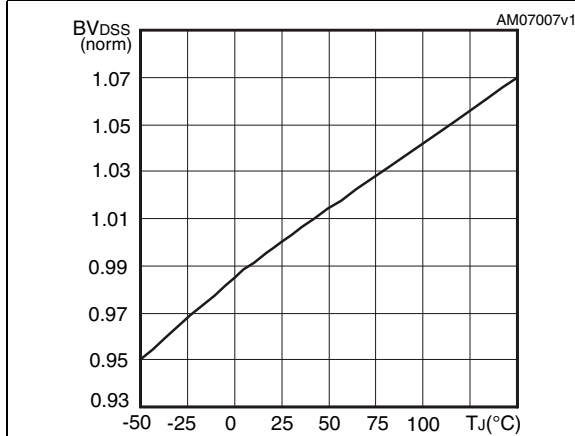


Figure 15. Normalized on resistance vs temperature

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

### 3 Test circuits

Figure 17. Switching times test circuit for resistive load

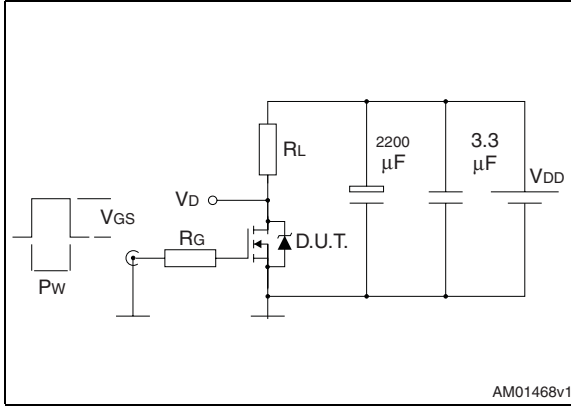


Figure 18. Gate charge test circuit

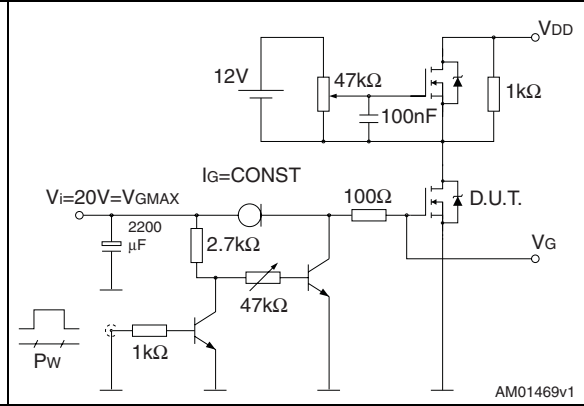


Figure 19. Test circuit for inductive load switching and diode recovery times

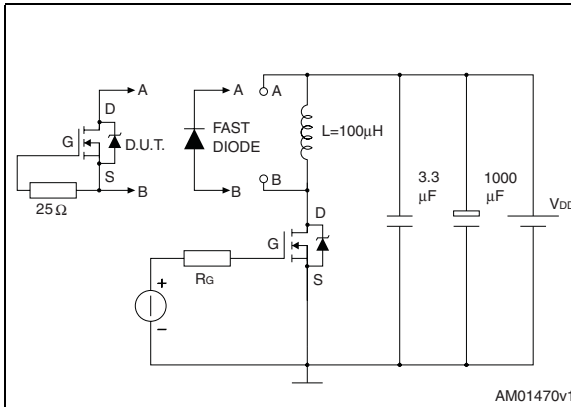


Figure 20. Unclamped inductive load test circuit

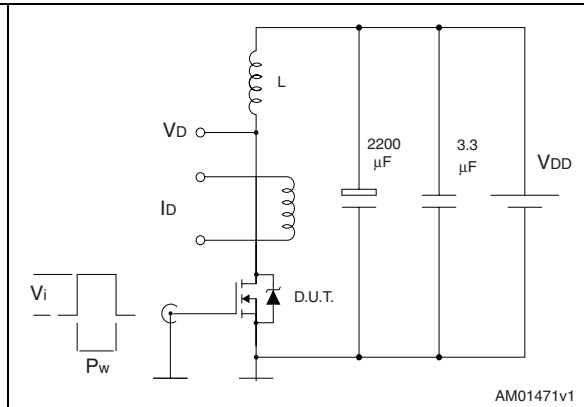
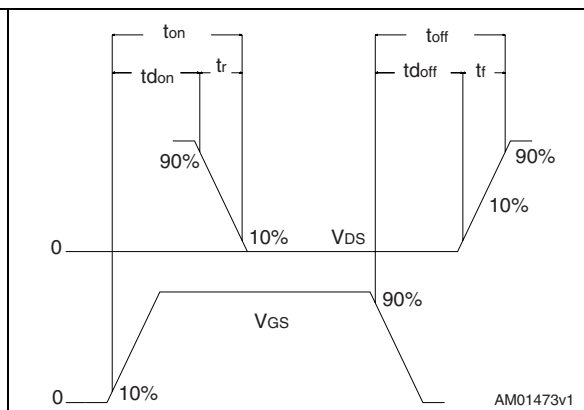
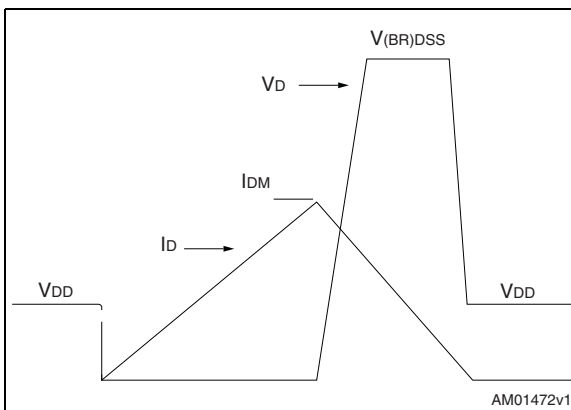


Figure 21. Unclamped inductive waveform

Figure 22. Switching time waveform



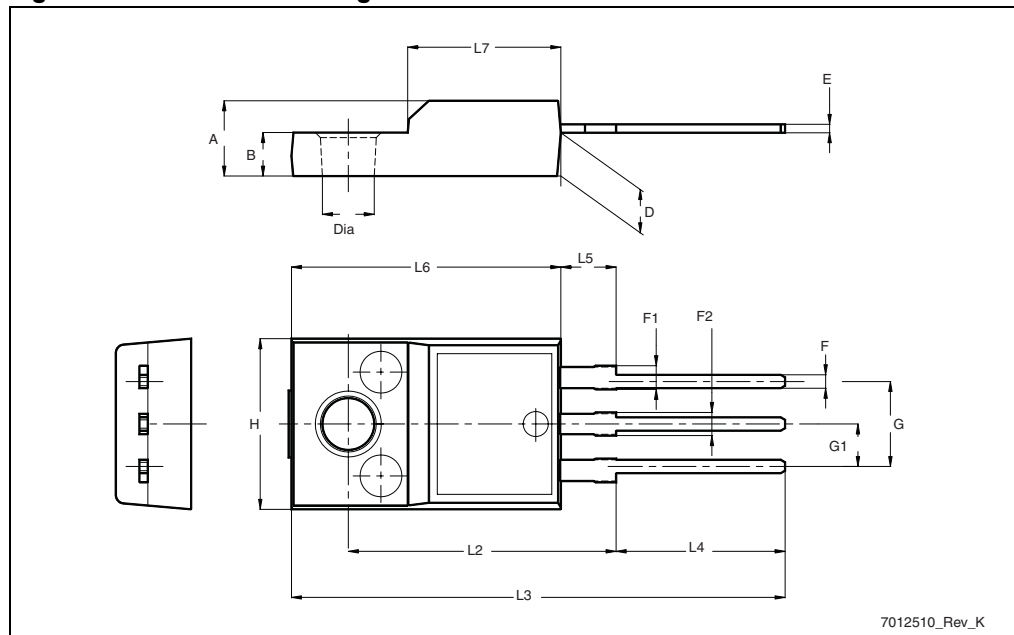
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<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

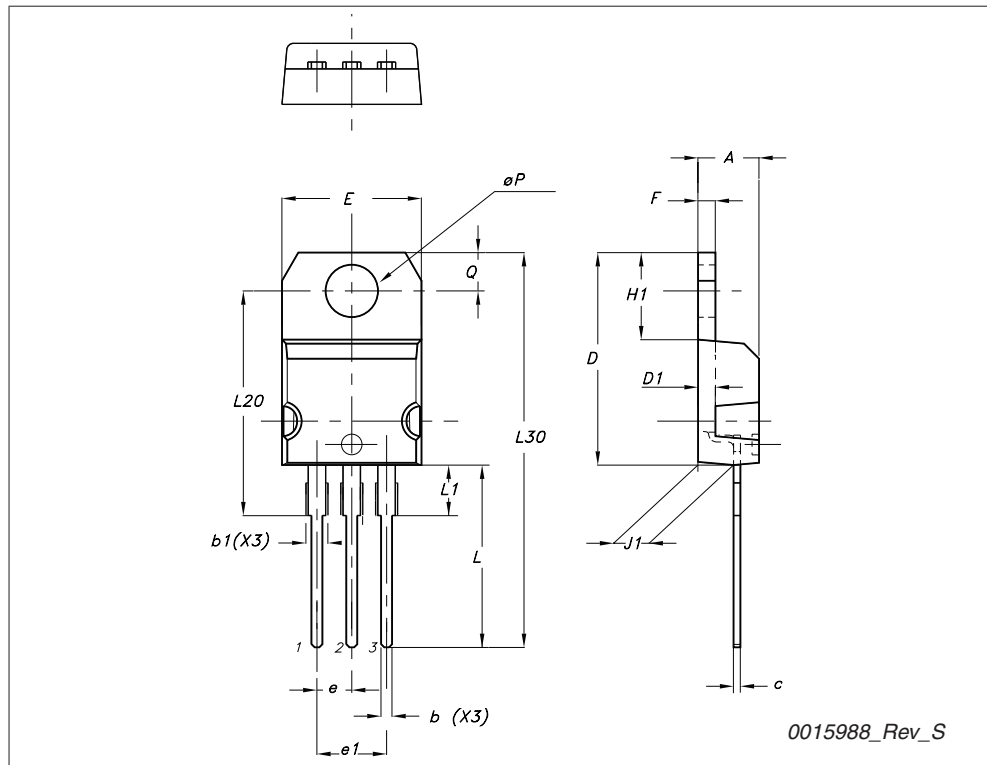
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 23. TO-220FP drawing



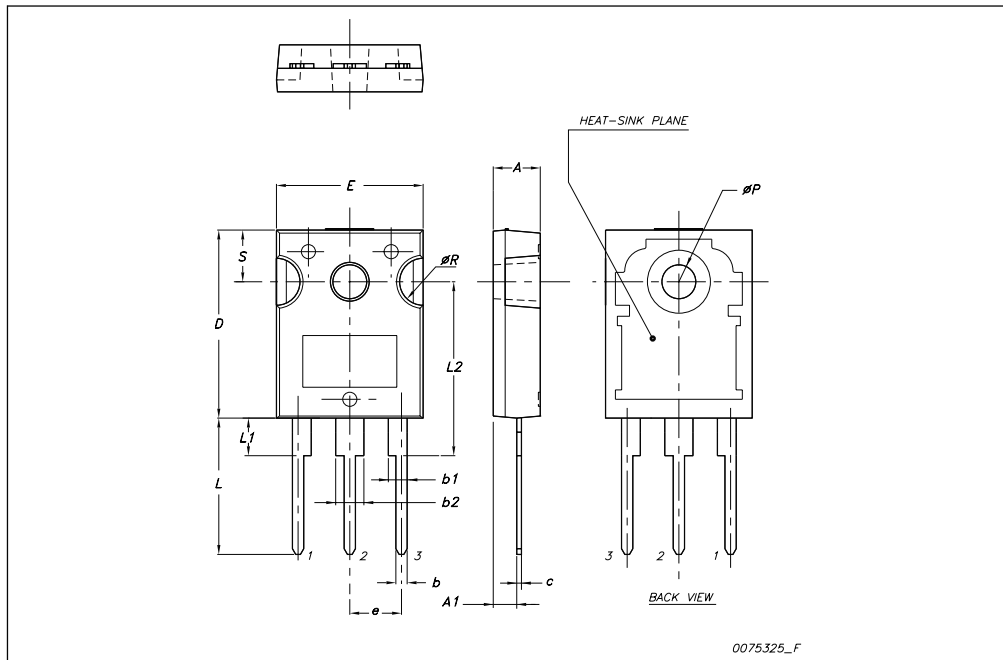
TO-220 type A mechanical data

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



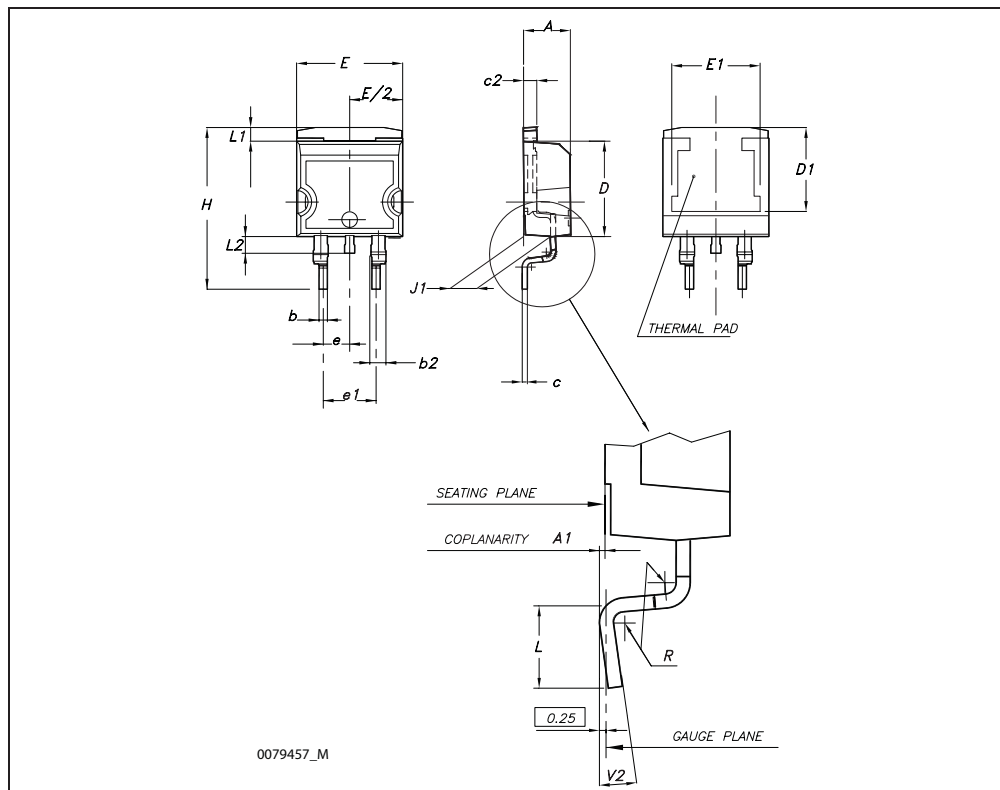
**TO-247 mechanical data**

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	



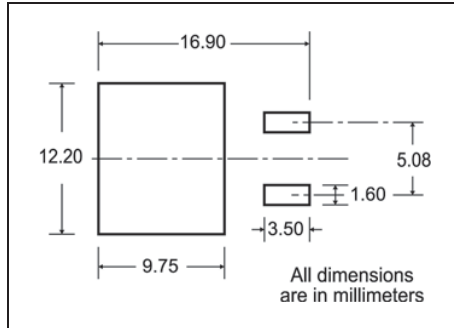
D<sup>2</sup>PAK (TO-263) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



## 5 Packaging mechanical data

D<sup>2</sup>PAK FOOTPRINT



TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

**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	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000



## 6 Revision history

Table 10. Document revision history

Date	Revision	Changes
19-Jul-2010	1	First release.

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