



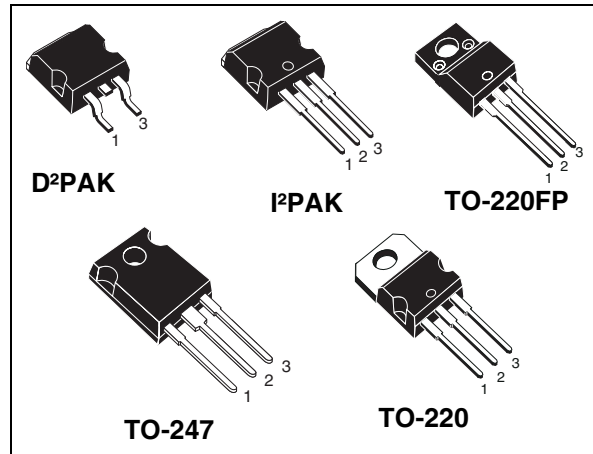
# STB22NM60N, STF22NM60N, STI22NM60N STP22NM60N, STW22NM60N

N-channel 600 V, 0.2  $\Omega$ , 16 A MDmesh™ II Power MOSFET  
in D<sup>2</sup>PAK, TO-220FP, I<sup>2</sup>PAK, TO-220 and TO-247

## Features

Order codes	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STB22NM60N	650 V	< 0.22 $\Omega$	16 A
STF22NM60N	650 V	< 0.22 $\Omega$	16 A
STI22NM60N	650 V	< 0.22 $\Omega$	16 A
STP22NM60N	650 V	< 0.22 $\Omega$	16 A
STW22NM60N	650 V	< 0.22 $\Omega$	16 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

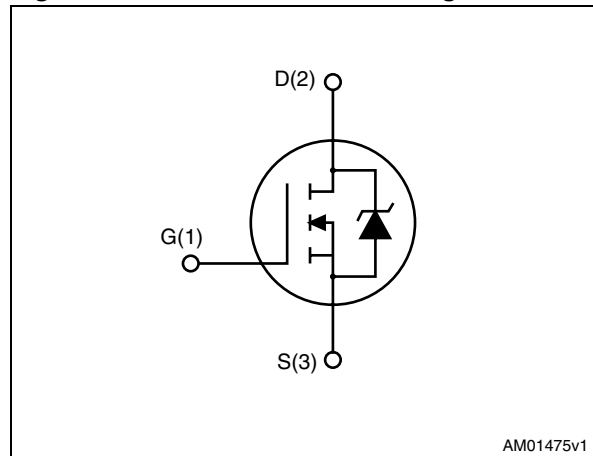


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB22NM60N	22NM60N	D <sup>2</sup> PAK	Tape and reel
STF22NM60N		TO-220FP	Tube
STI22NM60N		I <sup>2</sup> PAK	
STP22NM60N		TO-220	
STW22NM60N		TO-247	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK I <sup>2</sup> PAK	TO-220 TO-247	TO-220FP	
V <sub>GS</sub>	Gate- source voltage	± 30			V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	16		16 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	10		10 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	64		64 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	125		30	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15			V/ns
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
T <sub>J</sub> T <sub>stg</sub>	Operating junction temperature Storage temperature	-55 to 150			°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 16 A, di/dt ≤ 100 A/μs, peak V<sub>DS</sub> ≤ V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	Value					Unit
		D <sup>2</sup> PAK	I <sup>2</sup> PAK	TO-220	TO-247	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max.	1				4.17	°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>J</sub>	Maximum lead temperature for soldering purpose				300		°C/W

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

**Table 4. Thermal data**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	6	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	300	mJ

## 2 Electrical characteristics

(T<sub>case</sub> = 25 °C unless otherwise specified)

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	600			V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max rating V <sub>DS</sub> = Max rating, T <sub>C</sub> =125 °C			1 10	μA μA
I <sub>GSS</sub>	Gate-body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ± 25 V			100	μA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 100 μA	2	3	4	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 8 A		0.2	0.22	Ω

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 50 V, f = 1 MHz, V <sub>GS</sub> = 0	-	1330	-	pF
C <sub>oss</sub>	Output capacitance			84		pF
C <sub>rss</sub>	Reverse transfer capacitance			4.6		pF
C <sub>oss eq.</sub> <sup>(1)</sup>	Output equivalent capacitance	V <sub>DS</sub> = 0 to 480 V, V <sub>GS</sub> = 0	-	181	-	pF
R <sub>g</sub>	Gate input resistance	f=1 MHz open drain	-	4.7	-	Ω
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 16 A,	-	44	-	nC
Q <sub>gs</sub>	Gate-source charge	V <sub>GS</sub> = 10 V		6		nC
Q <sub>gd</sub>	Gate-drain charge	(see Figure 18)		25		nC

1. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DS</sub>.

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
t <sub>c(off)</sub>	Turn-off crossing time	V <sub>DD</sub> = 300 V, I <sub>D</sub> = 8 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V (see Figure 17)	-	13	-	ns
t <sub>r(v)</sub>	Voltage rise time			18		ns
t <sub>d(off)</sub>	Turn-off-delay time			74		ns
t <sub>f(i)</sub>	Fall time			38		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$I_{SD}$	Source-drain current		-		16	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		64	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 16 \text{ A}, V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 16 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	-	296		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}$	-	4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 19)		26.8		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 16 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	-	350		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V } T_J = 150 \text{ }^\circ\text{C}$	-	4.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 19)		27		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, I<sup>2</sup>PAK

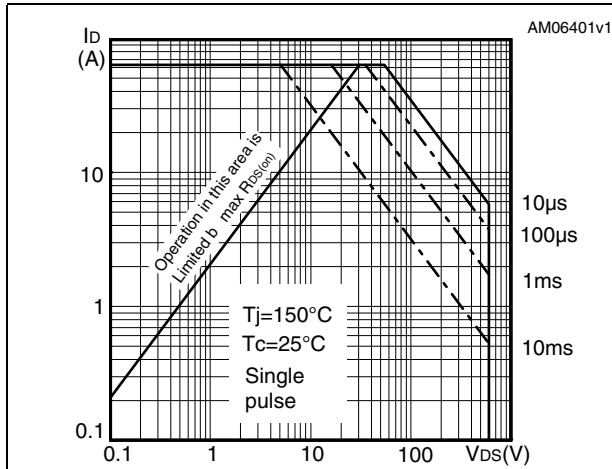


Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK

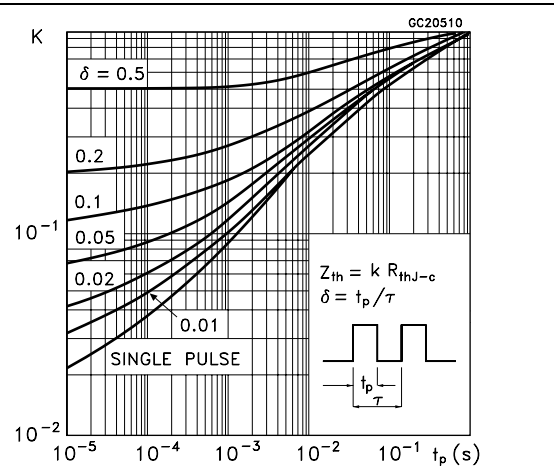


Figure 4. Safe operating area for TO-220FP

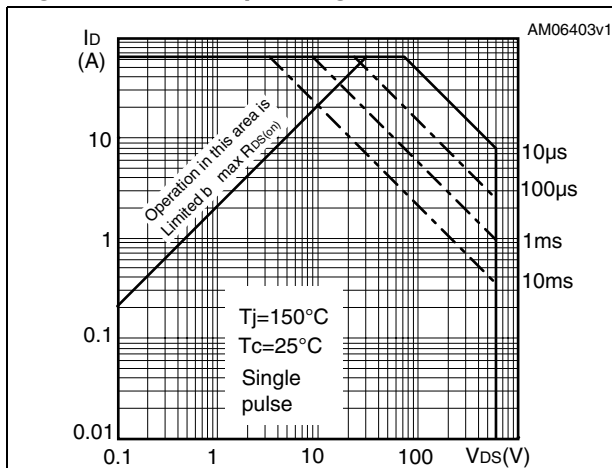


Figure 5. Thermal impedance for TO-220FP

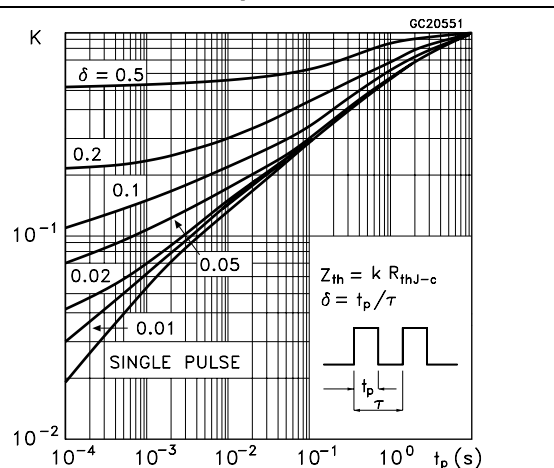


Figure 6. Safe operating area for TO-247

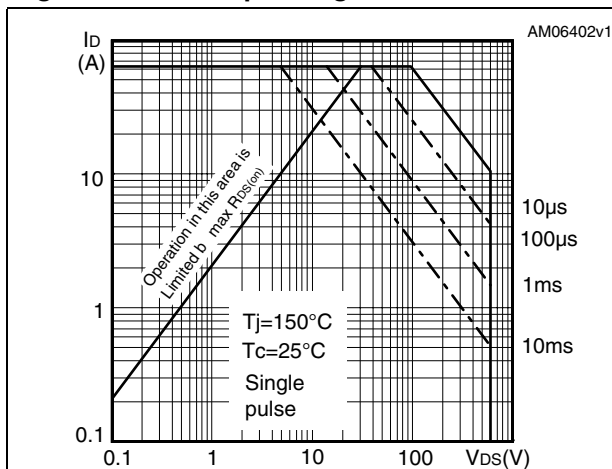


Figure 7. Thermal impedance for TO-247

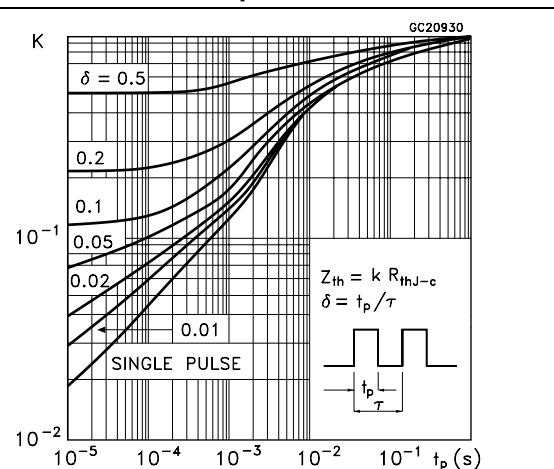


Figure 8. Output characteristics

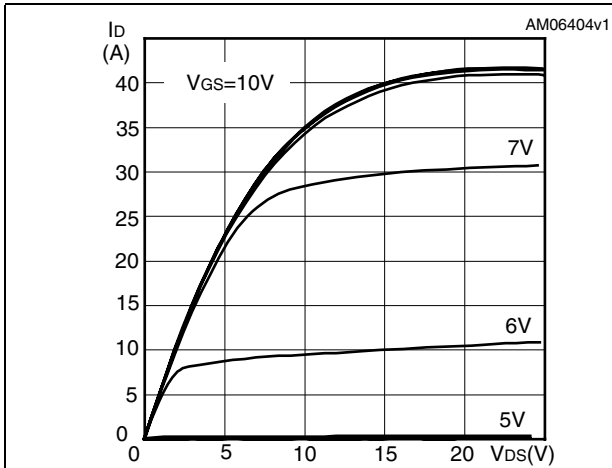


Figure 9. Transfer characteristics

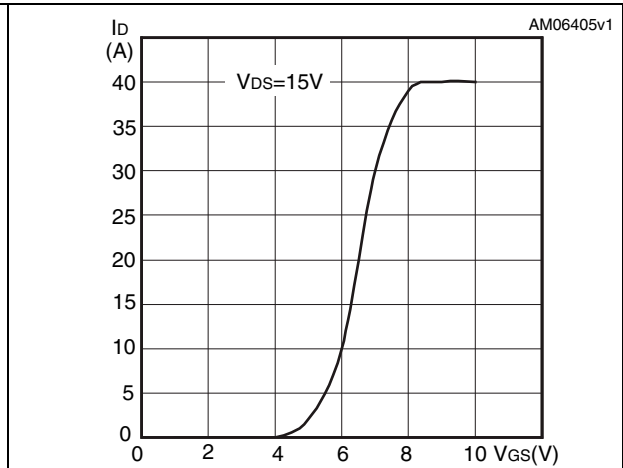


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on resistance

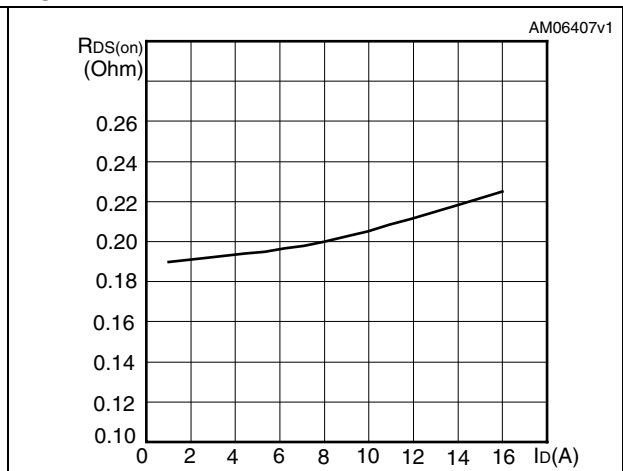
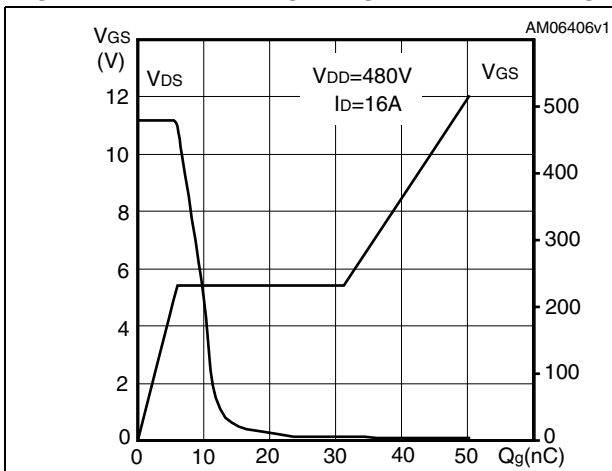


Figure 12. Capacitance variations

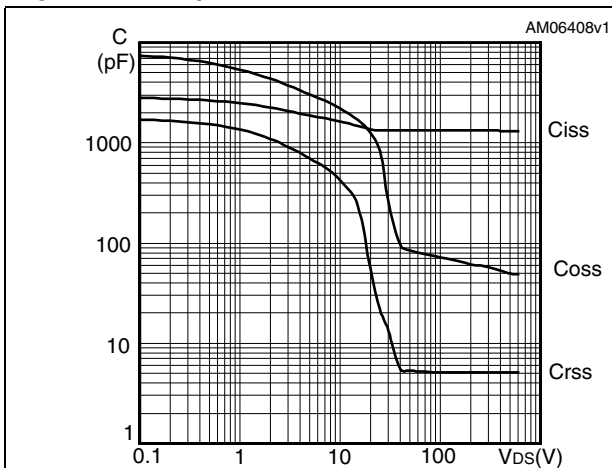
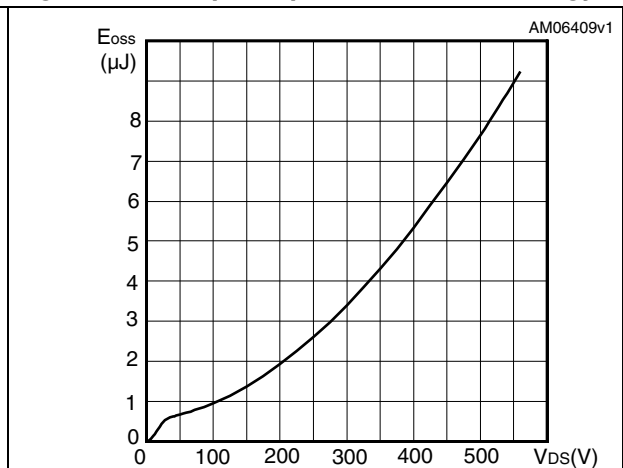
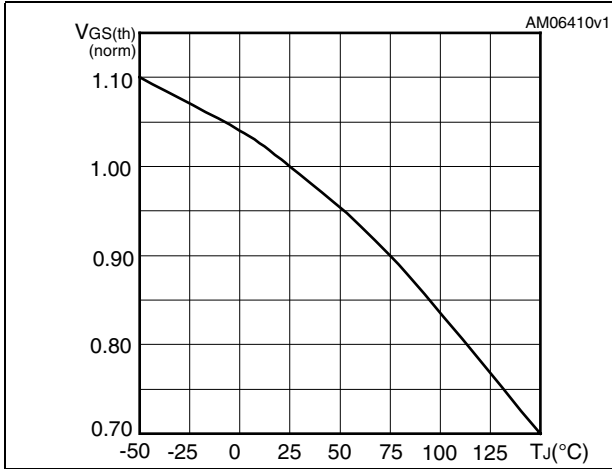


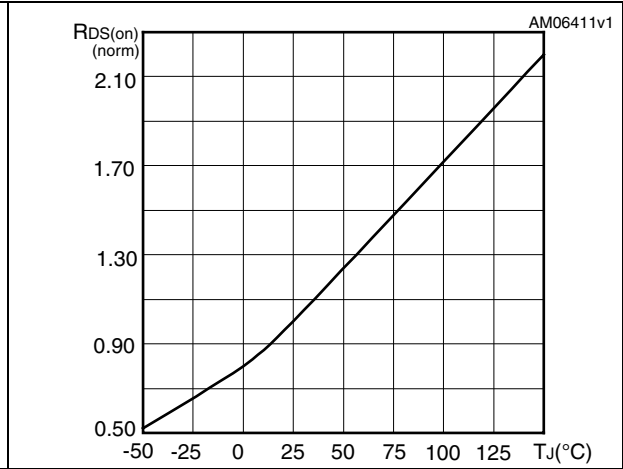
Figure 13. Output capacitance stored energy



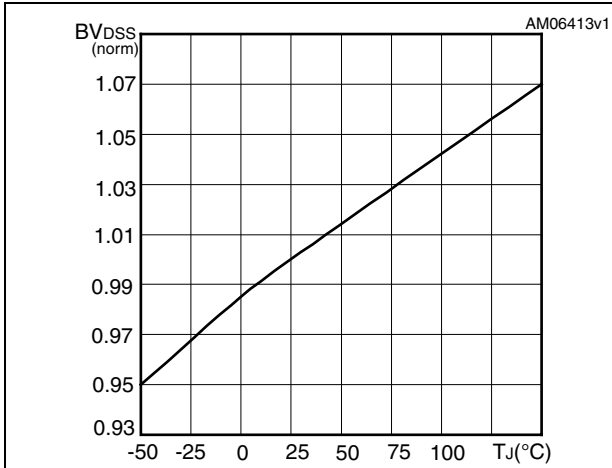
**Figure 14. Normalized gate threshold voltage vs temperature**



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



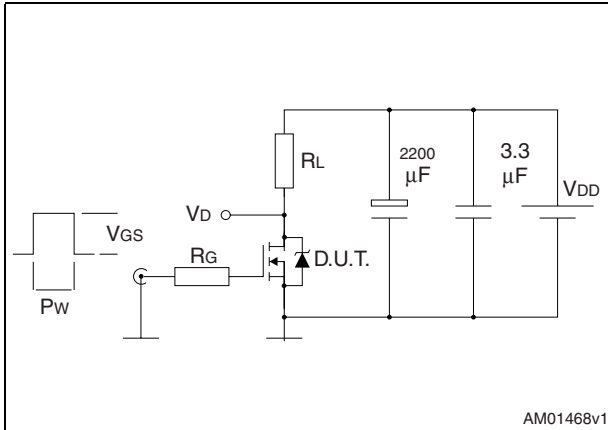
**Figure 16. Normalized B<sub>V</sub>DSS vs temperature**



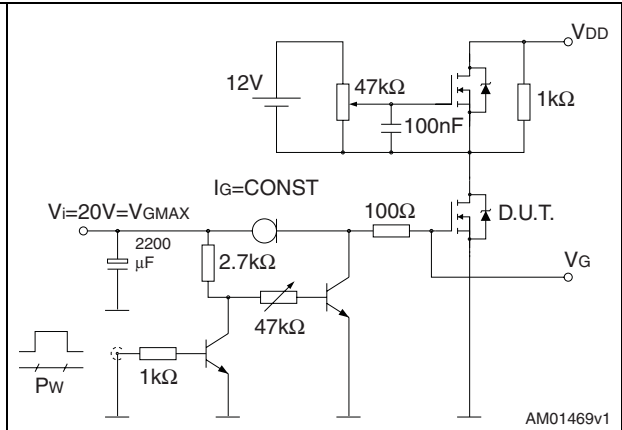


### 3 Test circuits

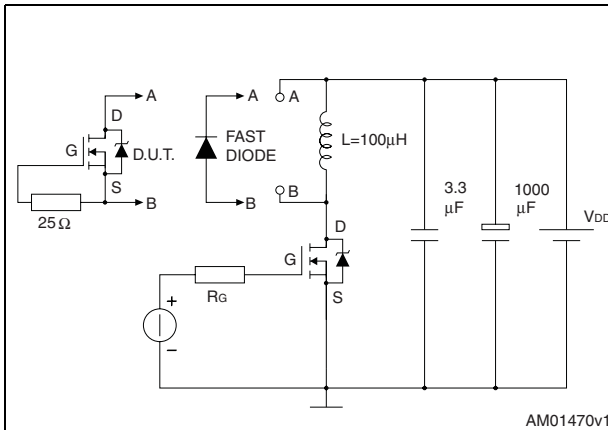
**Figure 17. Switching times test circuit for resistive load**



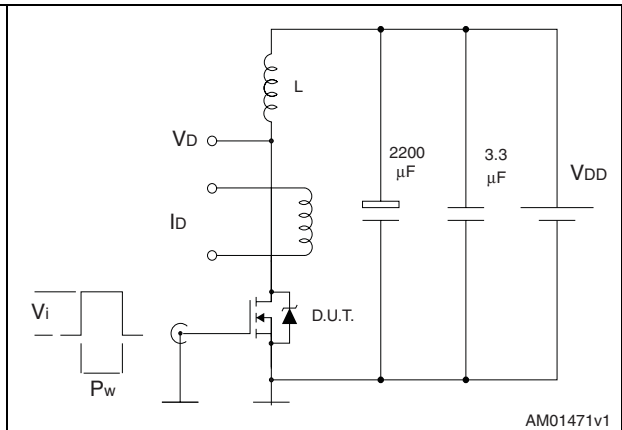
**Figure 18. Gate charge test circuit**



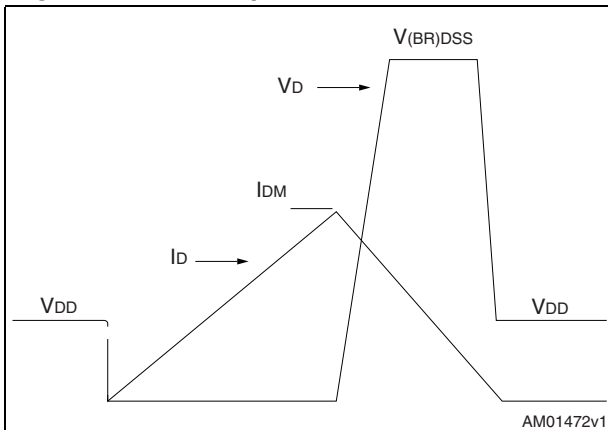
**Figure 19. Test circuit for inductive load switching and diode recovery times**



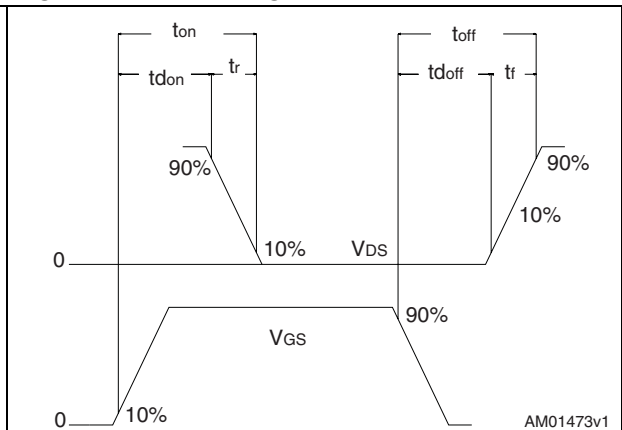
**Figure 20. Unclamped inductive load test circuit**



**Figure 21. Unclamped inductive waveform**



**Figure 22. Switching time waveform**



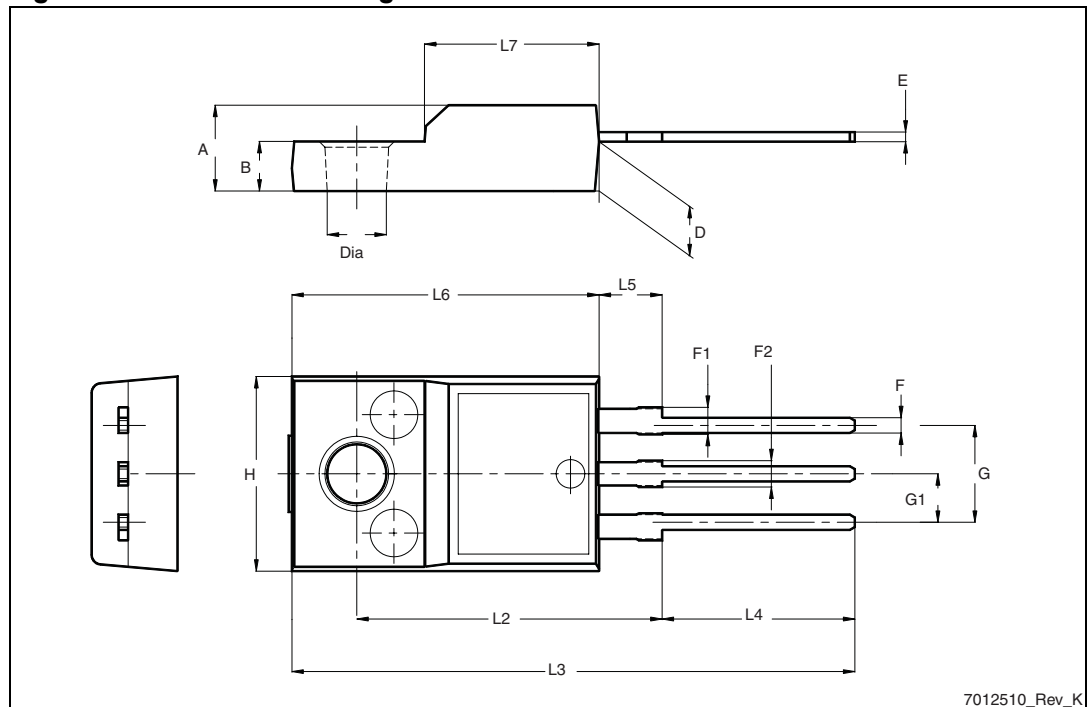
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® 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

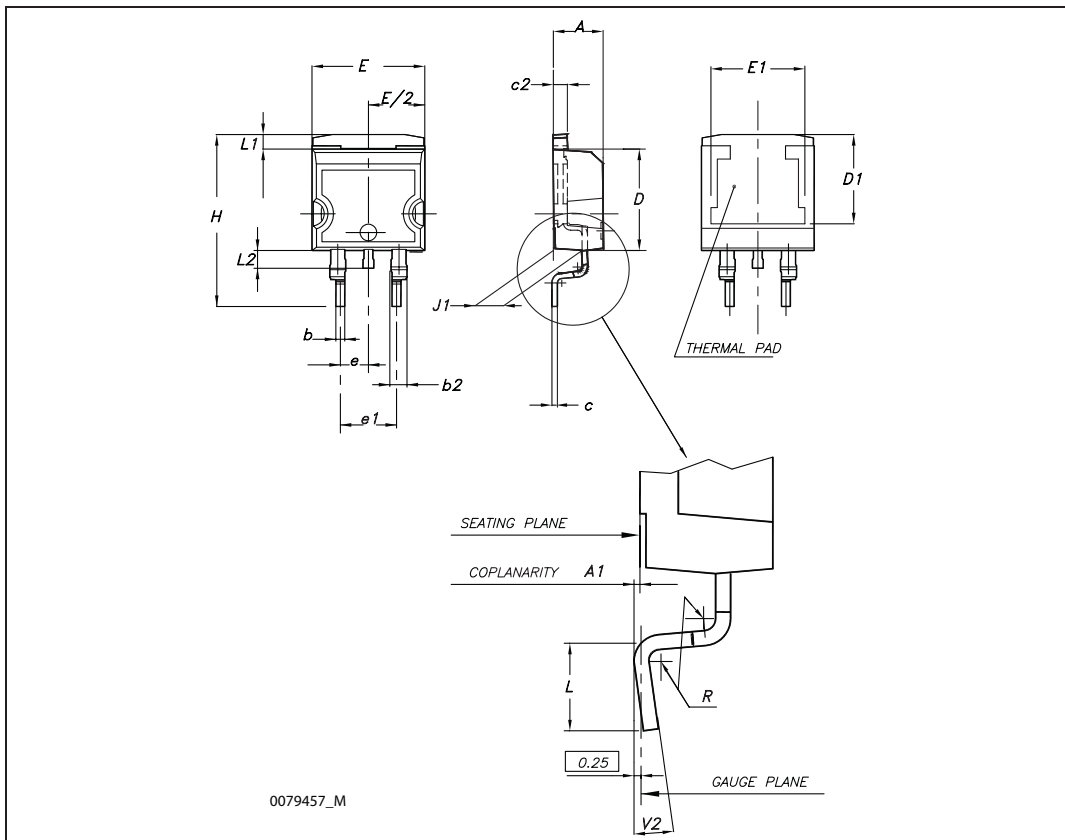
Figure 23. TO-220FP drawing



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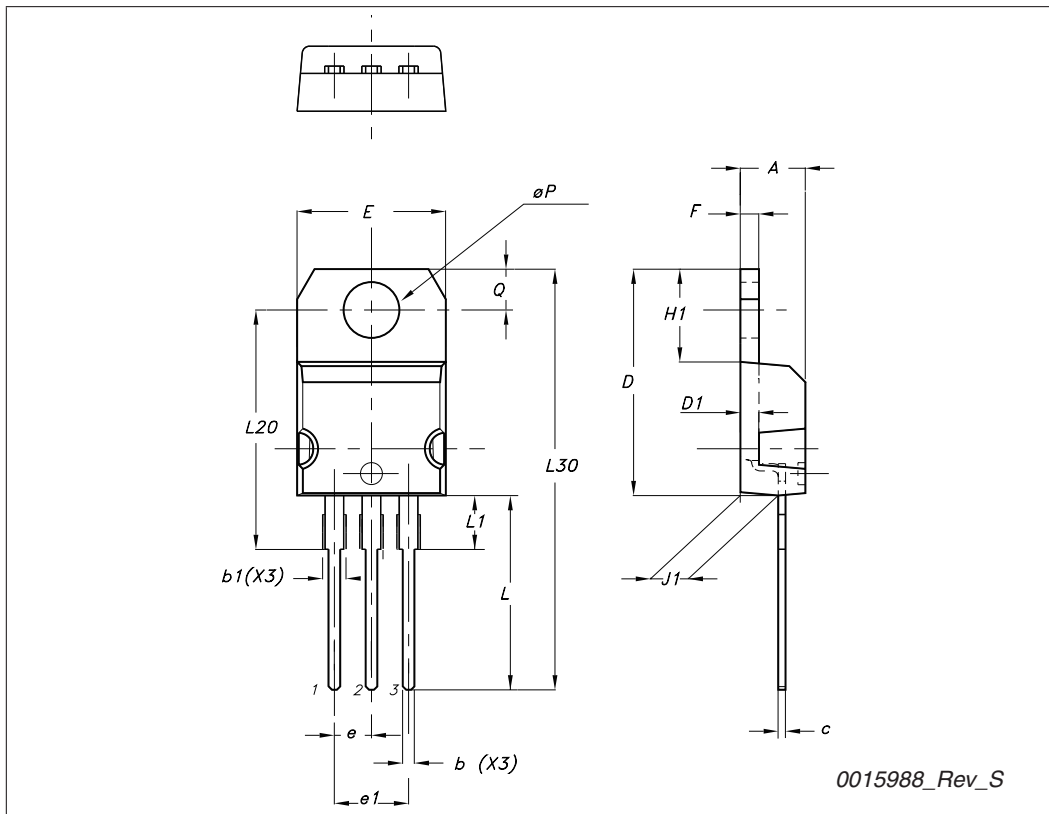
D<sup>2</sup>PAK (TO-263) mechanical data

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°



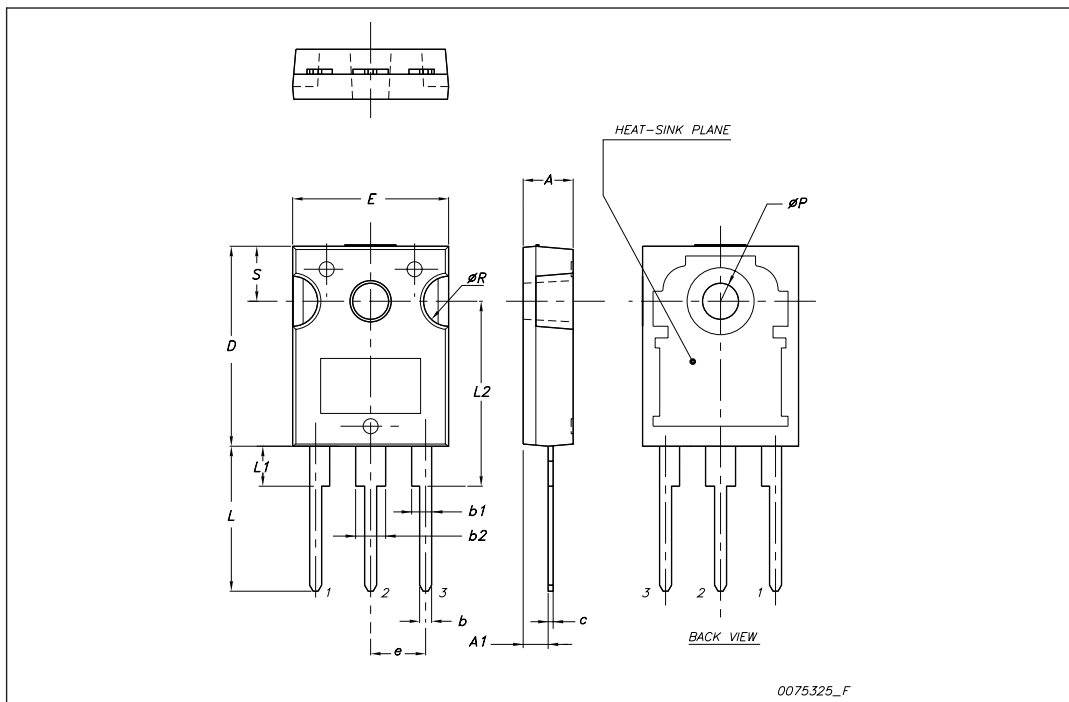
TO-220 type A mechanical data

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



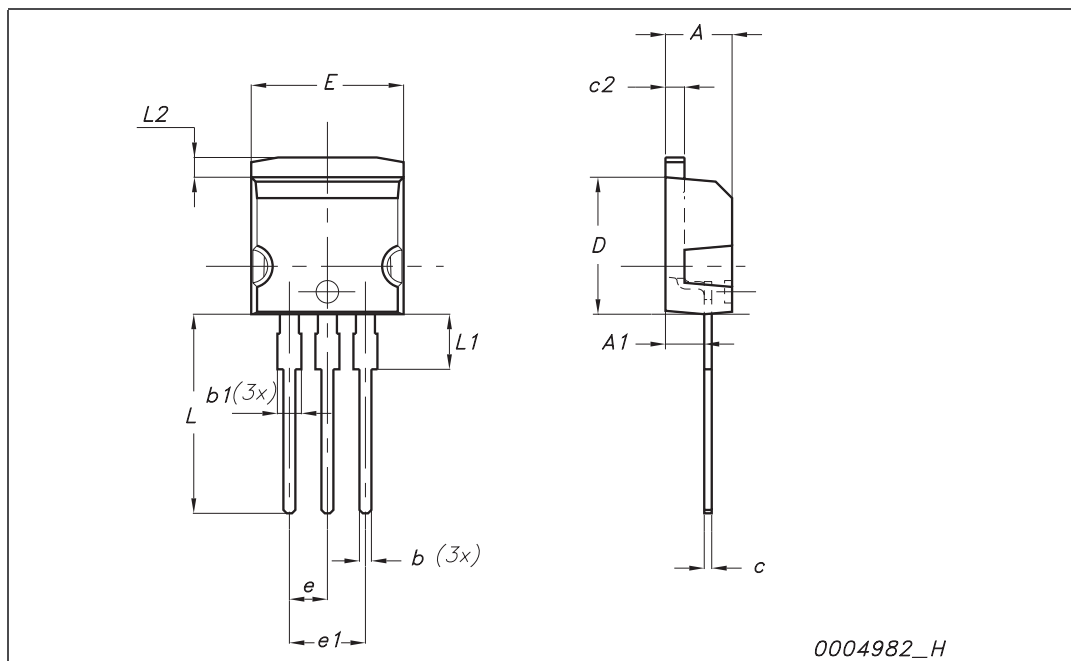
**TO-247 mechanical data**

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	



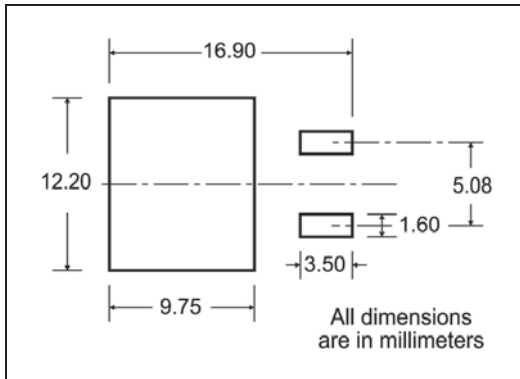
I<sup>2</sup>PAK (TO-262) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



# 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

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

Bending radius R min.



## 6 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
02-Jul-2009	1	First release.
18-Feb-2010	2	Document status promoted from preliminary data to datasheet.
27-Aug-2010	3	New package, mechanical data has been inserted: I <sup>2</sup> PAK

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