



# STP20NM65N STF20NM65N

N-channel 650 V, 0.250  $\Omega$ , 15 A TO-220, TO-220FP  
second generation MDmesh™ Power MOSFET

## Features

Order codes	V <sub>DSS</sub> @T <sub>jmax</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STP20NM65N	710 V	0.270 $\Omega$	15 A
STF20NM65N			

- 100 % avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Application

- Switching applications

## Description

These devices are N-channel Power MOSFETs realized using the second generation 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.

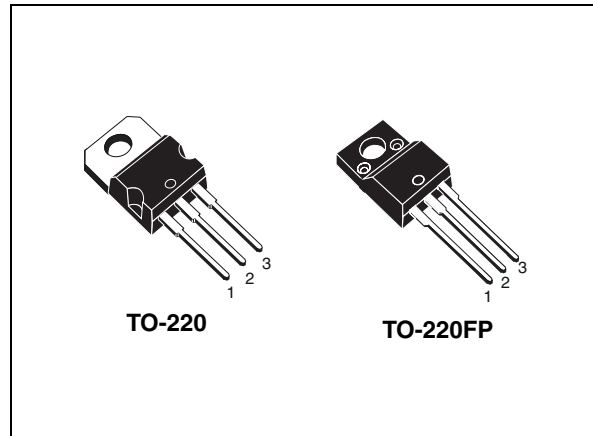


Figure 1. Internal schematic diagram

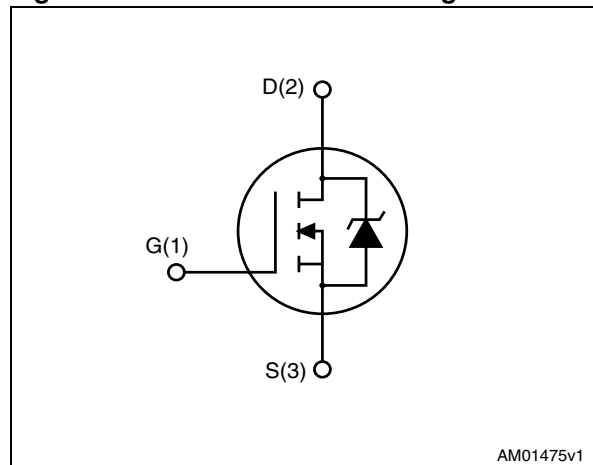


Table 1. Device summary

Order codes	Marking	Package	Packaging
STP20NM65N	20NM65N	TO-220	Tubes
STF20NM65N	20NM65N	TO-220FP	Tubes

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
$V_{DS}$	Drain source voltage	650		V
$V_{GS}$	Gate source voltage	± 25		V
$I_D$	Drain current continuous $T_C = 25\text{ °C}$	15	15 <sup>(1)</sup>	A
$I_D$	Drain current continuous $T_C = 100\text{ °C}$	9.45		A
$I_{DM}^{(2)}$	Drain current pulsed	60		A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	125	30	W
$dv/dt^{(3)}$	Peak diode recovery voltage slope	15		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heatsink ( $t=1\text{ s}$ ; $T_C = 25\text{ °C}$ )	2500		V
$T_{stg}$ $T_J$	Storage temperature Max. operating junction temperature	-55 to 150 150		°C

1. Limited only by maximum temperature allowed.
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 15\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

**Table 3. Thermal data**

Symbol	Parameters	Value		Unit
		TO-220	TO-220FP	
$R_{thjc}$	Thermal resistance junction-case max.	1	4.17	°C/W
$R_{thja}$	Thermal resistance junction-ambient max.	62.50		°C/W
$T_J$	Max. lead temperature for soldering purposes	300		°C

**Table 4. Avalanche characteristics**

Symbol	Parameters	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 $T_J = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	115	mJ

## 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	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	650			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS}=0$ )	$V_{DS} = \text{max rating}$ $V_{DS} = \text{max rating @ } 125\text{ °C}$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage ( $V_{DS}=0$ )	$V_{GS} = \pm 25\text{ V}$ , $V_{DS}=0$			100	nA
$V_{GS(th)}$	Gate threshold voltage	$I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = V_{DS}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$I_D=7.5\text{ A}$ , $V_{GS}=10\text{ V}$		0.250	0.270	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ISS}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	1280	-	pF
$C_{OSS}$	Output capacitance			110		pF
$C_{RSS}$	Reverse capacitance			10		pF
$C_{OSS\text{ eq}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0$ to $V_{GS} = 0$	-	260	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	4.8	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> )	-	44	-	nC
$Q_{gs}$	Gate source charge			8		nC
$Q_{gd}$	Gate-drain charge			22		nC

1.  $C_{OSS\text{ eq}}$ : 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	$V_{DD} = 325\text{ V}$ , $I_D=7.5\text{ A}$ $R_g=4.7\text{ }\Omega$ , $V_{GS}=10\text{ V}$ (see <a href="#">Figure 15</a> )	-	15	-	ns
$t_r$	Rise time			13.5		ns
$t_{d(off)}$	Turn-off-delay time	(see <a href="#">Figure 20</a> )	-	75	-	ns
$t_f$	Fall time			21		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}^{(1)}$	Source drain current Source drain current (pulsed)		-		15 60	A A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 15 \text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 15 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 17</a> )	-	455		ns
$Q_{rr}$	Reverse recovery charge			5.5		nC
$I_{RRM}$	Reverse recovery current			24.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 15 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 17</a> )	-	710		ns
$Q_{rr}$	Reverse recovery charge			8		nC
$I_{RRM}$	Reverse recovery current			24		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

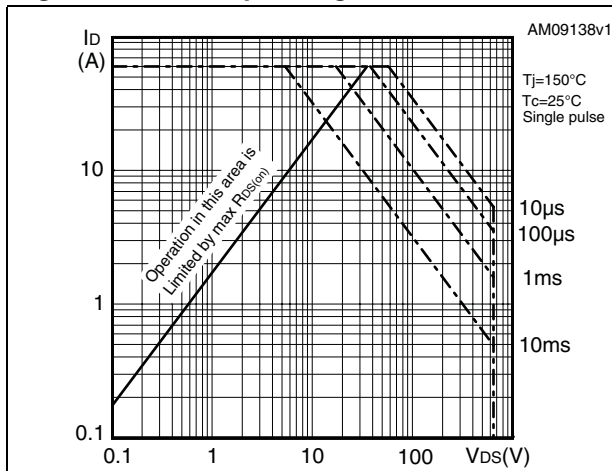


Figure 3. Thermal impedance for TO-220

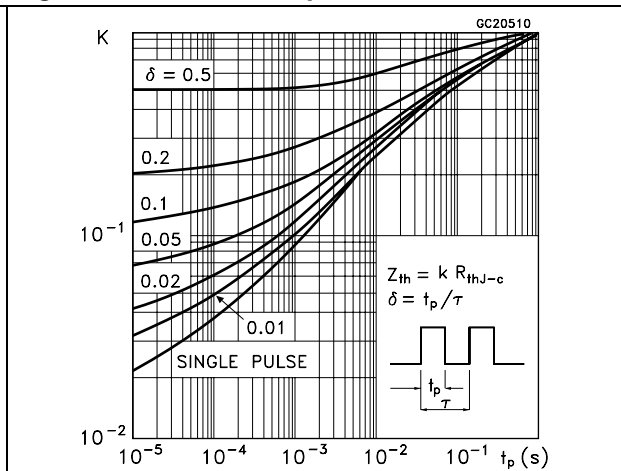


Figure 4. Safe operating area for TO-220FP

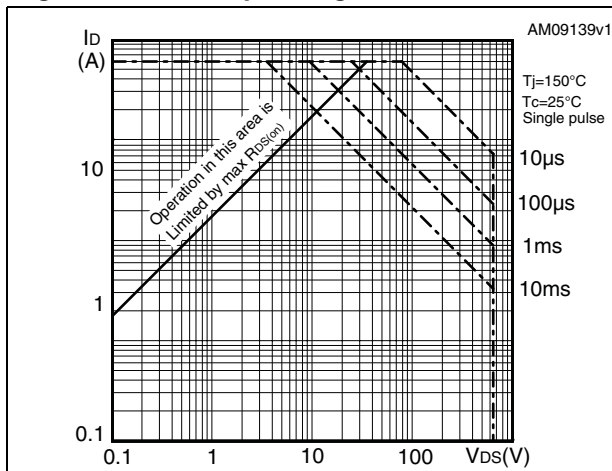


Figure 5. Thermal impedance for TO-220FP

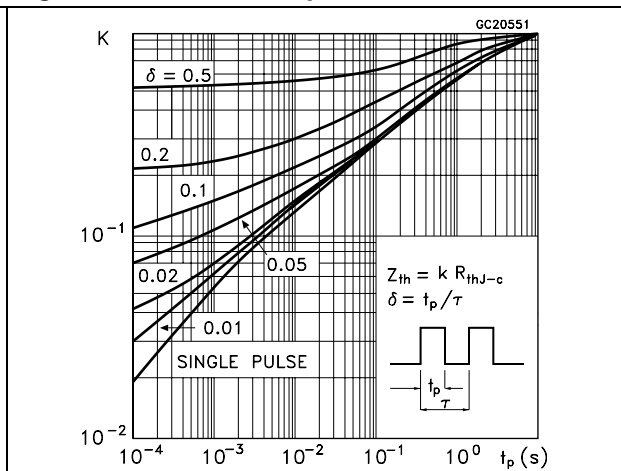


Figure 6. Output characteristics

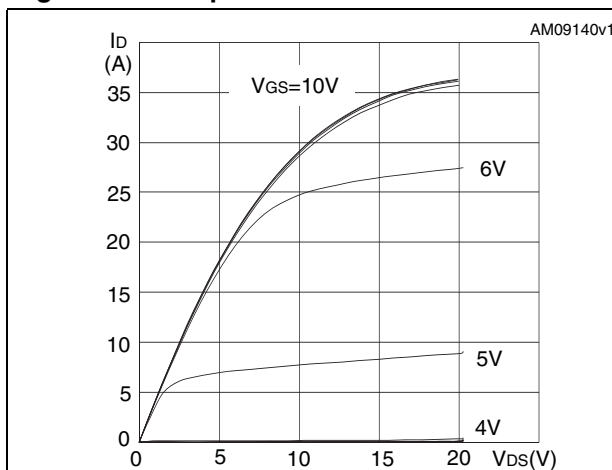


Figure 7. Transfer characteristics

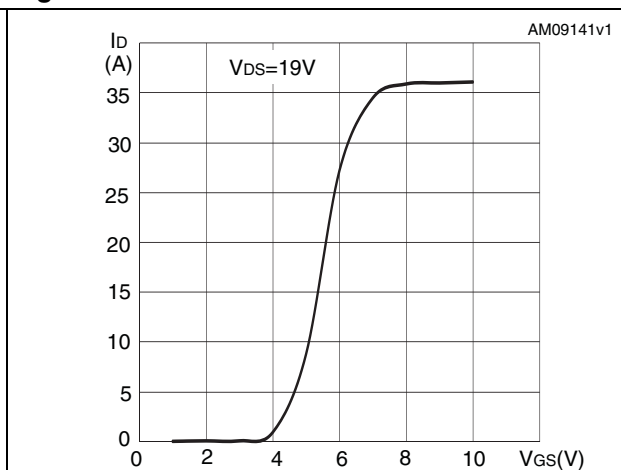


Figure 8. Normalized  $B_{V_{DSS}}$  vs temperature

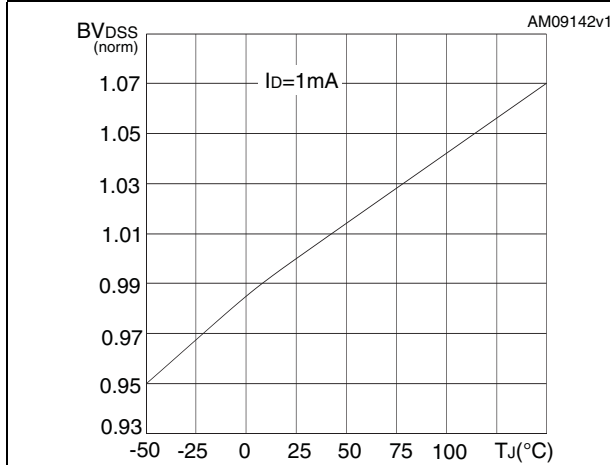


Figure 9. Static drain-source on resistance

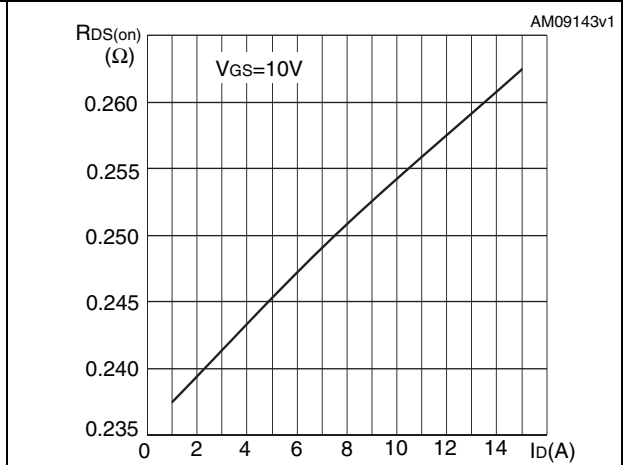


Figure 10. Gate charge vs gate-source voltage

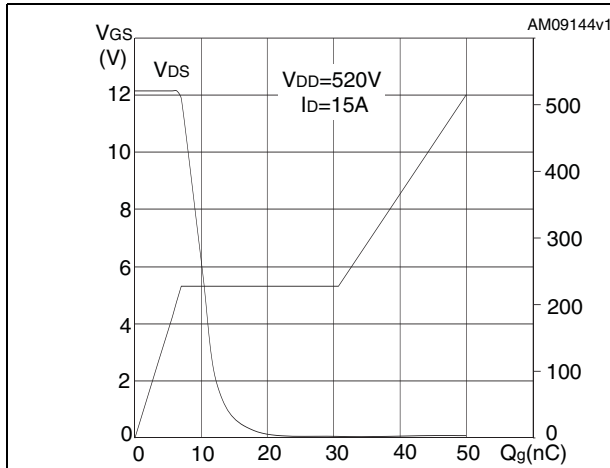


Figure 11. Capacitance variations

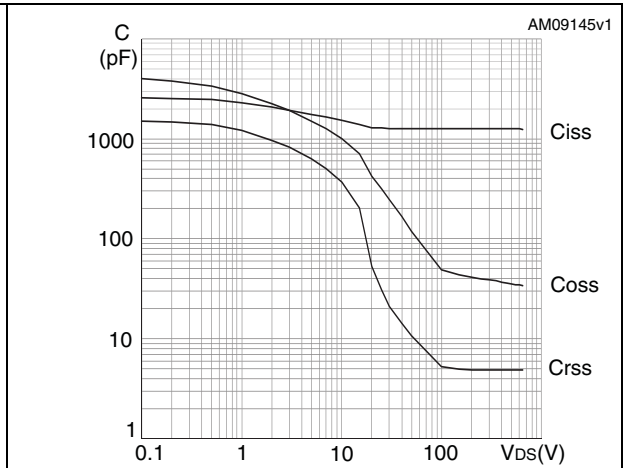


Figure 12. Normalized gate threshold voltage vs temperature

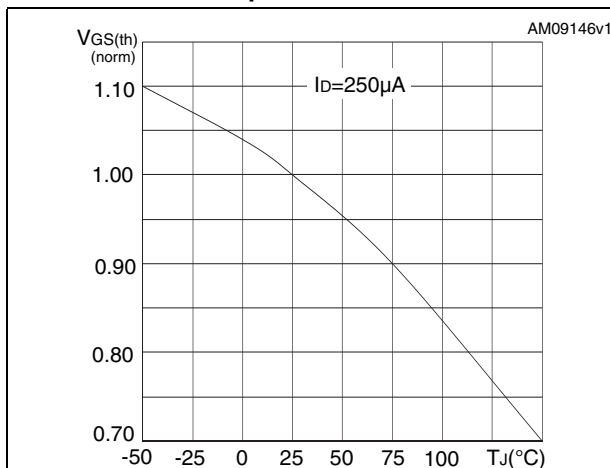


Figure 13. Normalized on resistance vs temperature

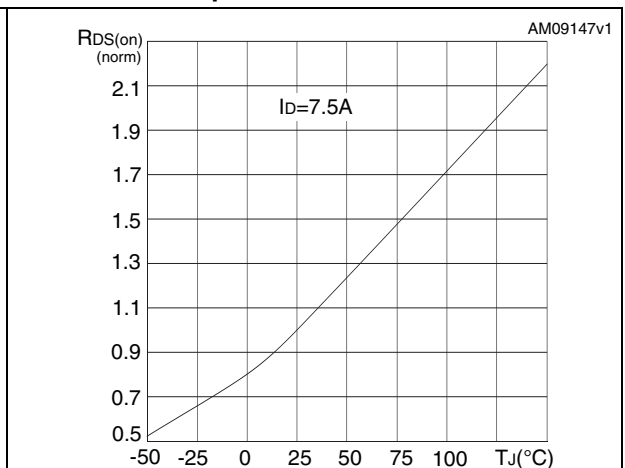
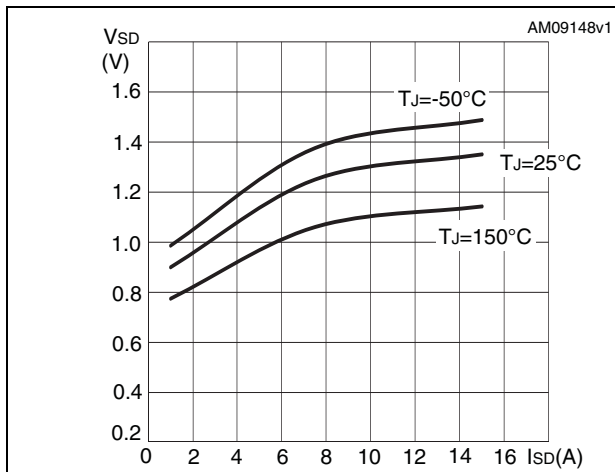


Figure 14. Source-drain diode forward characteristics





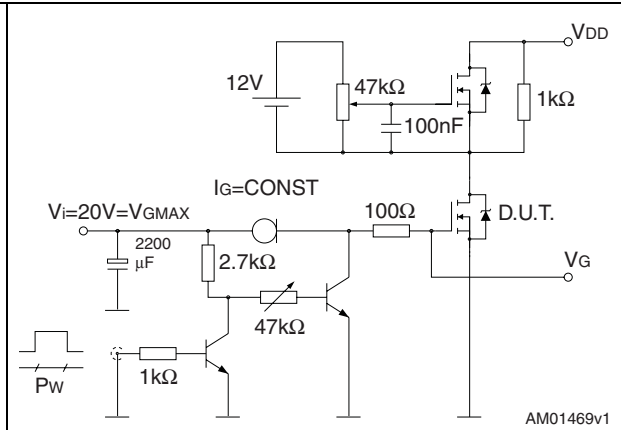
### 3 Test circuits

**Figure 15. Switching times test circuit for resistive load**



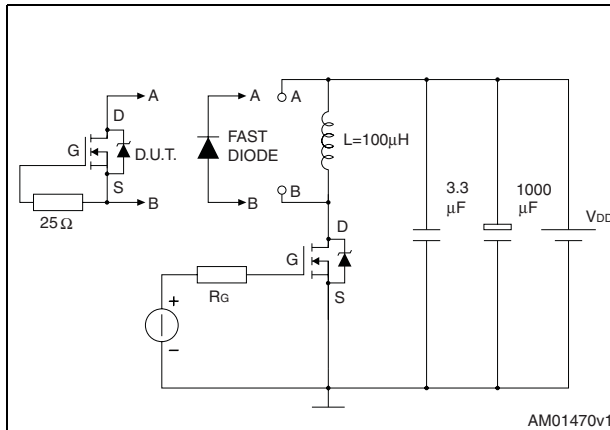
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**Figure 16. Gate charge test circuit**



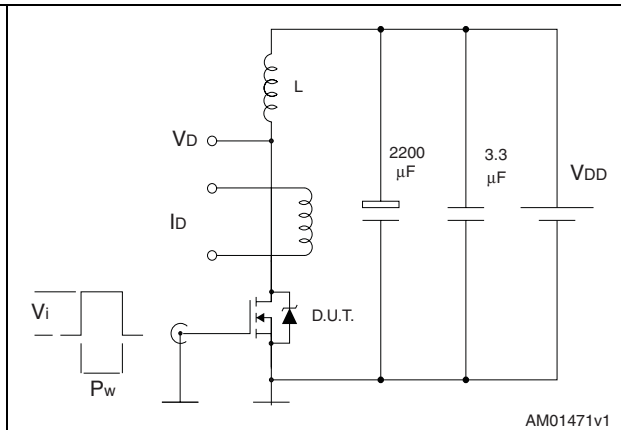
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**Figure 17. Test circuit for inductive load switching and diode recovery times**



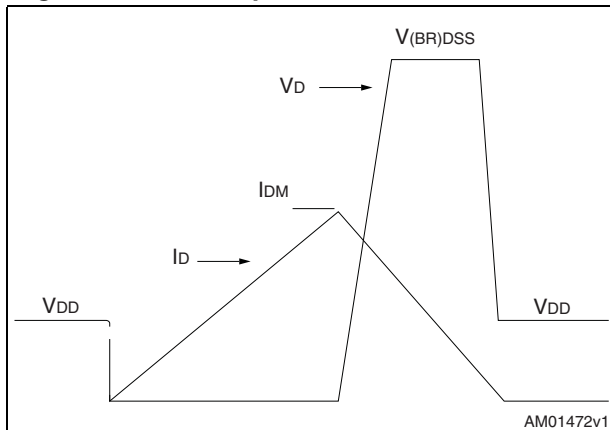
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**Figure 18. Unclamped inductive load test circuit**



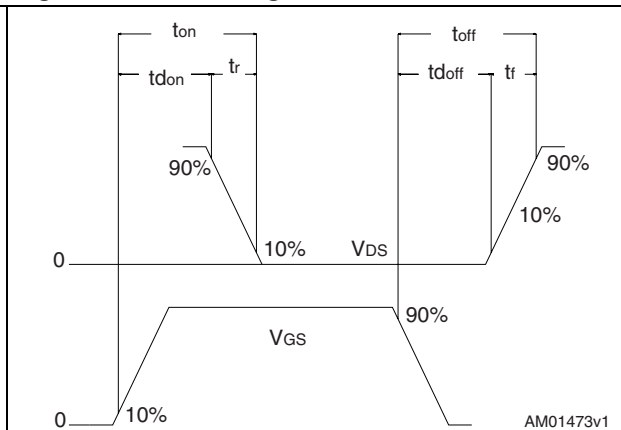
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**Figure 19. Unclamped inductive waveform**



AM01472v1

**Figure 20. 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 specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Table 9. 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 21. TO-220 type A drawing

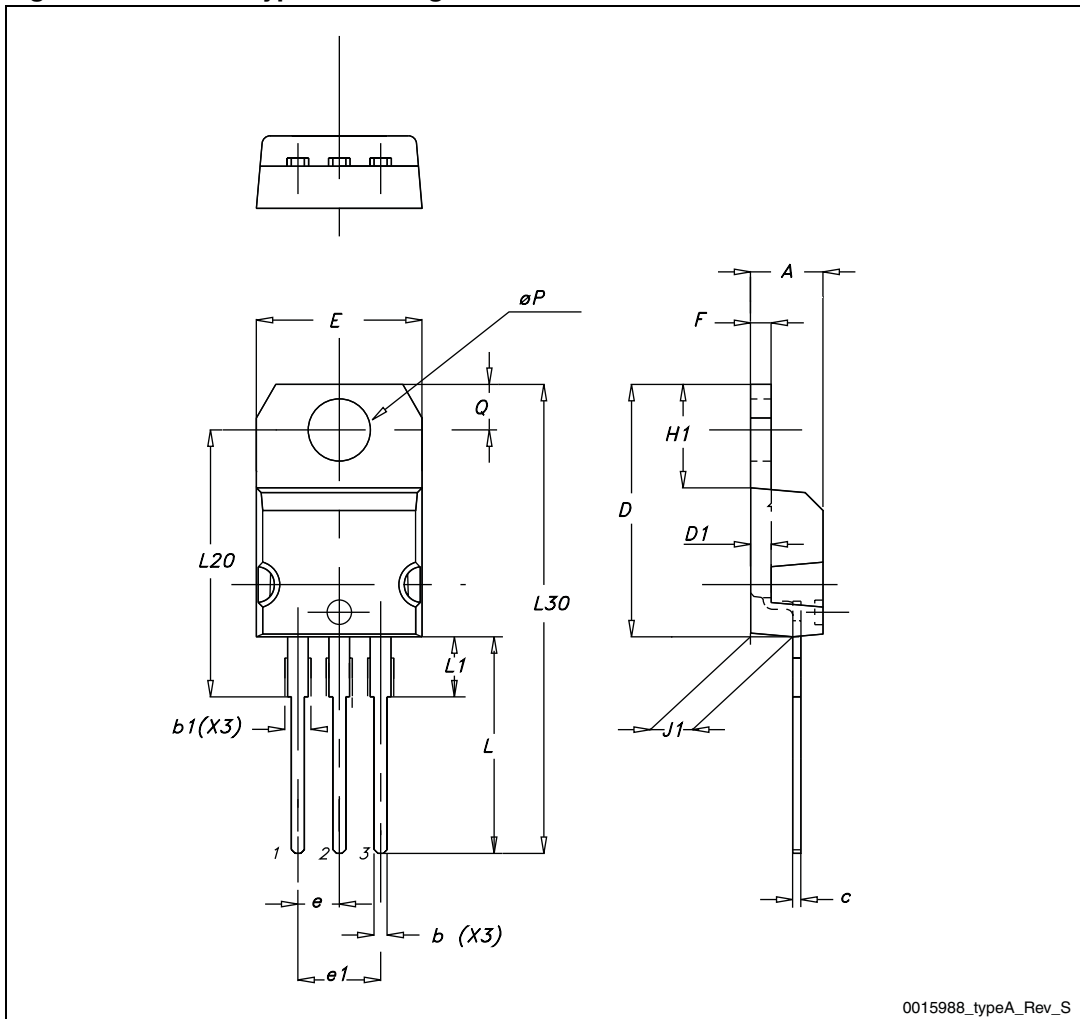
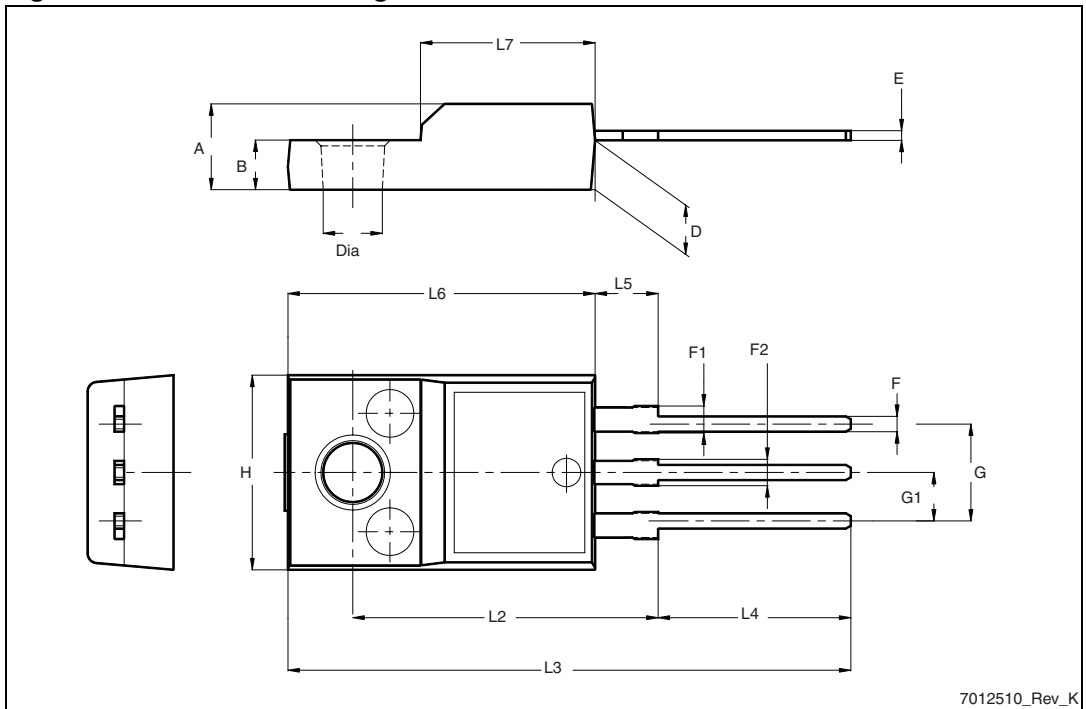


Table 10. TO-220FP mechanical data

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 22. TO-220FP drawing



## 5 Revision history

Table 11. Revision history

Date	Revision	Changes
12-Sep-2007	1	Initial release.
23-May-2011	2	Updated <a href="#">Chapter 4: Package mechanical data</a> .

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