



# STF20NK50Z, STP20NK50Z

N-channel 500 V, 0.23  $\Omega$ , 17 A SuperMESH™ Power MOSFET  
Zener-protected in TO-220FP and TO-220 packages

Datasheet — production data

## Features

Order codes	V <sub>DSS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>	P <sub>TOT</sub>
STF20NK50Z	500 V	< 0.27 $\Omega$	17 A	40 W
STP20NK50Z	500 V	< 0.27 $\Omega$	17 A	190 W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance

## Applications

- Switching applications

## Description

These devices are N-channel Zener-protected Power MOSFETs developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

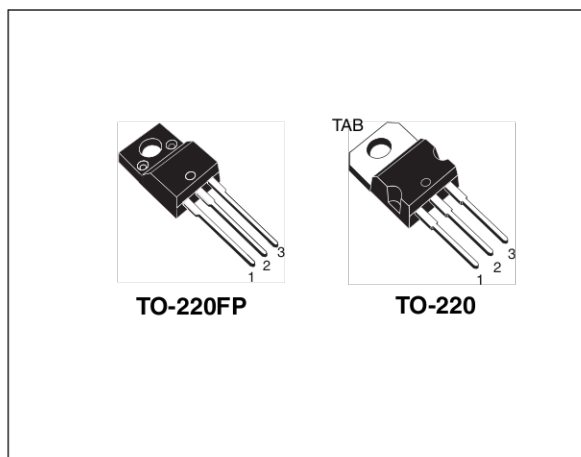


Figure 1. Internal schematic diagram

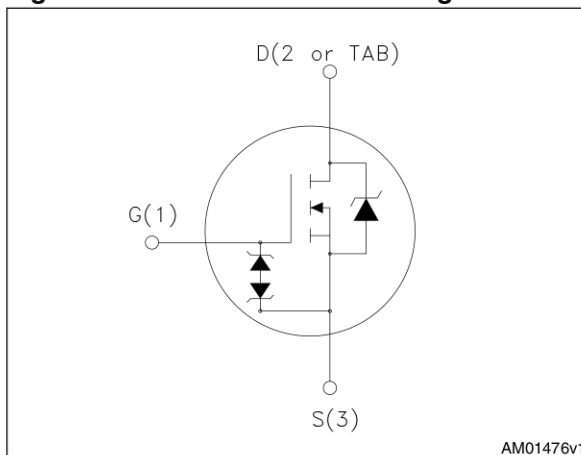


Table 1. Device summary

Order codes	Marking	Package	Packaging
STF20NK50Z	F20NK50Z	TO-220FP	Tube
STP20NK50Z	P20NK50Z	TO-220	

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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	500		V
$V_{GS}$	Gate-source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$	17	17 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	10.71	10.71 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	68	68	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	190	40	W
	Derating factor	1.52	0.32	W/ $^{\circ}\text{C}$
$V_{ISO}$	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
ESD	Gate-source human body model ( $R=1.5\text{ k}\Omega$ , $C=100\text{ pF}$ )	6		kV
$dv/dt^{(3)}$	Peak diode recovery voltage slope	4.5		V/ns
$T_{stg}$	Storage temperature	-55 to 150		$^{\circ}\text{C}$
$T_j$	Max operating junction temperature	150		$^{\circ}\text{C}$

1. Limited by maximum junction temperature.

2. Pulse width limited by safe operating area.

3.  $I_{SD} \leq 17\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	0.66	3.1	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	62.5	$^{\circ}\text{C}/\text{W}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)	17	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J=25\text{ }^{\circ}\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50\text{ V}$ )	850	mJ

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  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 ( $V_{GS} = 0$ )	$V_{DS} = 500\text{ V}$ $V_{DS} = 500\text{ V}$ , $T_C = 125\text{ °C}$			1 50	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 8.5\text{ A}$		0.23	0.27	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	2600		pF
$C_{oss}$	Output capacitance			328		pF
$C_{rss}$	Reverse transfer capacitance			72		pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0$ , $V_{DS} = 0\text{ to }640\text{ V}$	-	187		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250\text{ V}$ , $I_D = 8.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> )	-	28		ns
$t_r$	Rise time			20		ns
$t_{d(off)}$	Turn-off delay time			70		ns
$t_f$	Fall time			15		ns
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}$ , $I_D = 17\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17</a> )	-	85	119	nC
$Q_{gs}$	Gate-source charge			15.5		nC
$Q_{gd}$	Gate-drain charge			42		nC

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%  $V_{DSS}$ .

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		17	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		68	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 17\text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 17\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_R = 100\text{ V}$ (see <a href="#">Figure 18</a> )	-	355		ns
$Q_{rr}$	Reverse recovery charge			3.90		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			22		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 17\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_R = 100\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 18</a> )	-	440		ns
$Q_{rr}$	Reverse recovery charge			5.72		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			26		A

1. Pulsed: pulse duration=300 $\mu\text{s}$ , duty cycle 1.5%

2. Pulse width limited by safe operating area

**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 TO-220

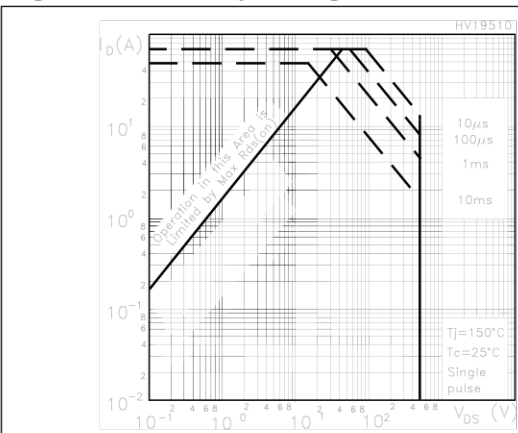


Figure 3. Thermal impedance for TO-220

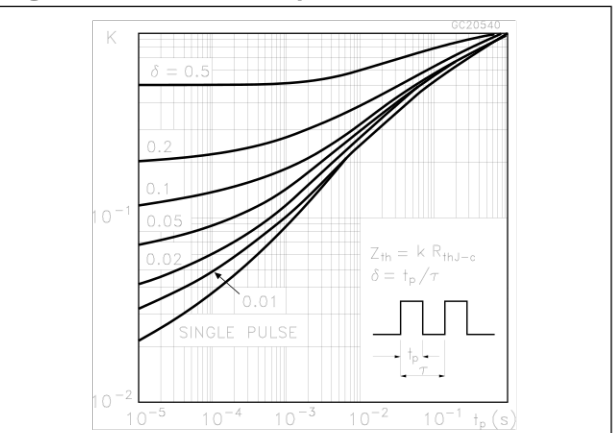


Figure 4. Safe operating area for TO-220FP

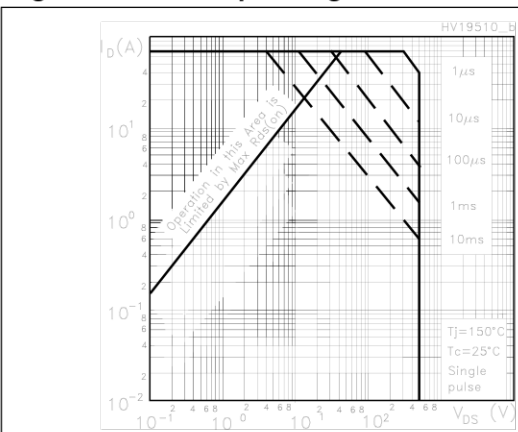


Figure 5. Thermal impedance for TO-220FP

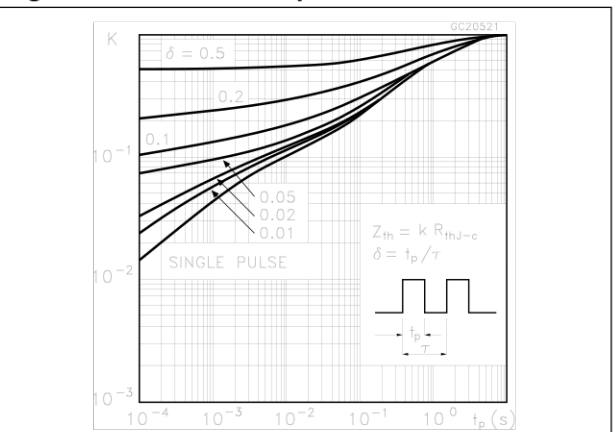


Figure 6. Output characteristics

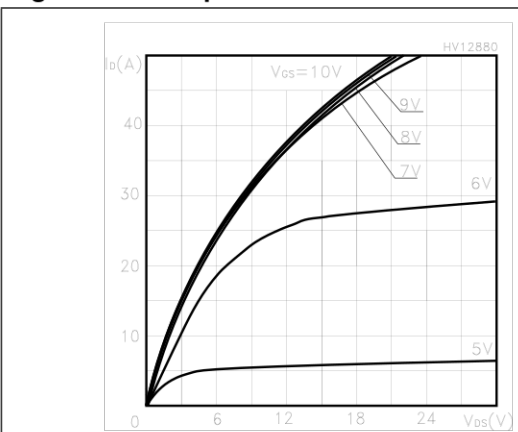


Figure 7. Transfer characteristics

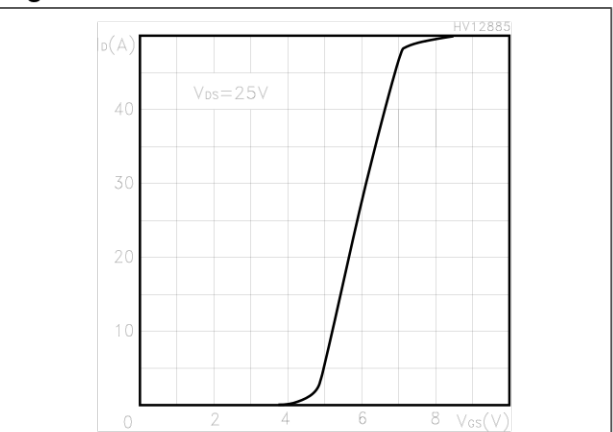


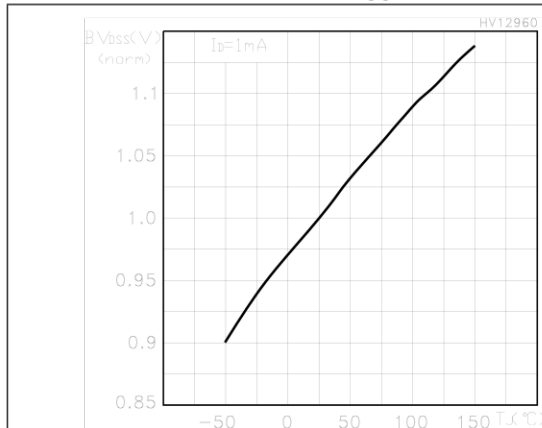
Figure 8. Normalized  $B_{V_{DS}}$  vs temperature

Figure 9. Static drain-source on-resistance

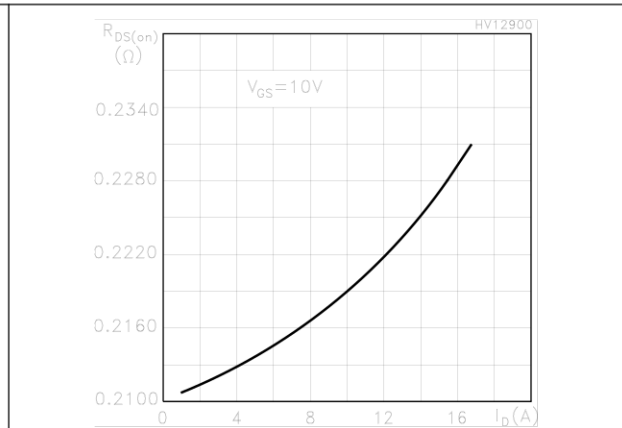


Figure 10. Gate charge vs gate-source voltage

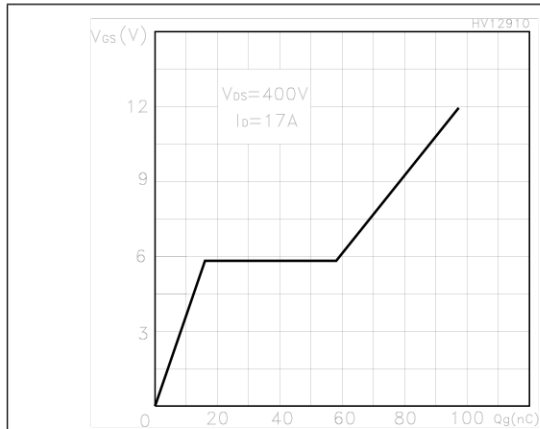


Figure 11. Capacitance variations

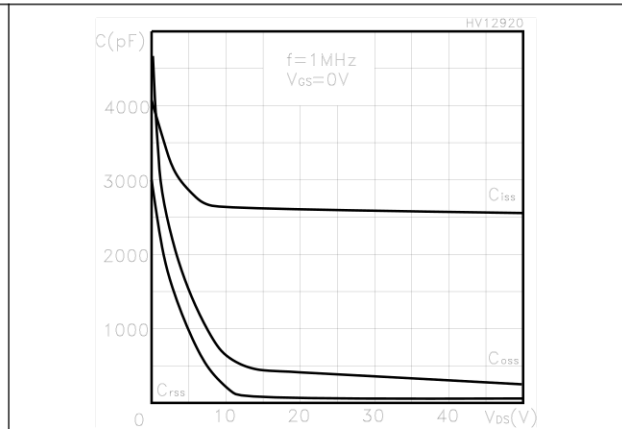


Figure 12. Normalized gate threshold voltage vs temperature

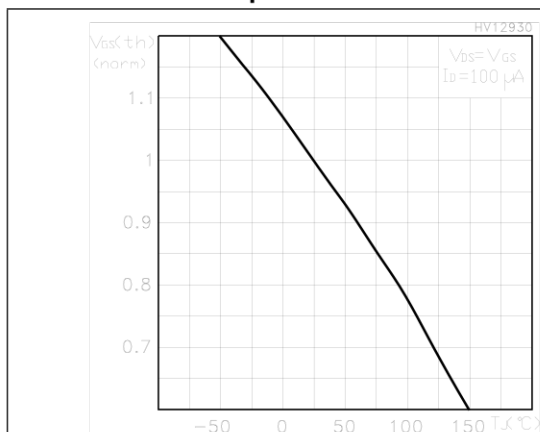


Figure 13. Normalized on-resistance vs temperature

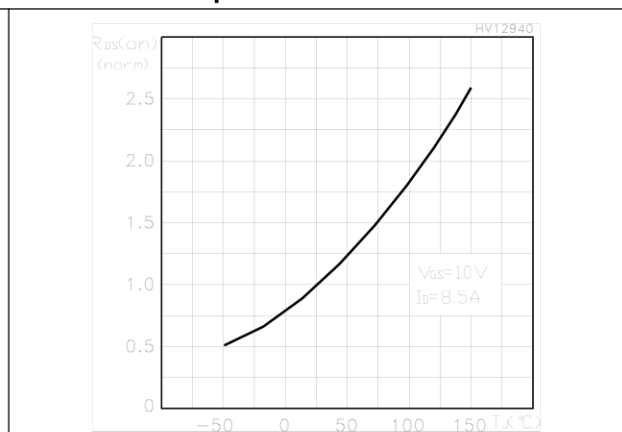


Figure 14. Maximum avalanche energy vs temperature

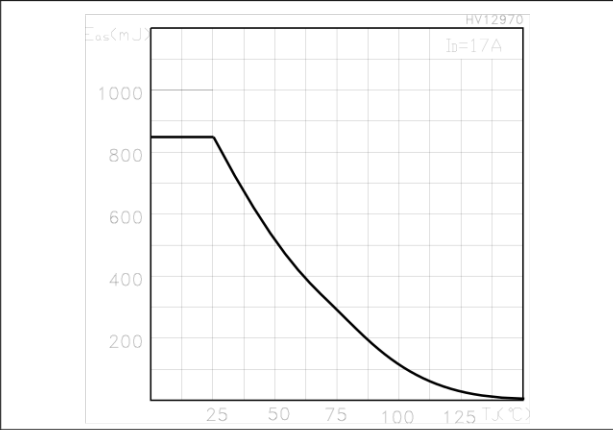
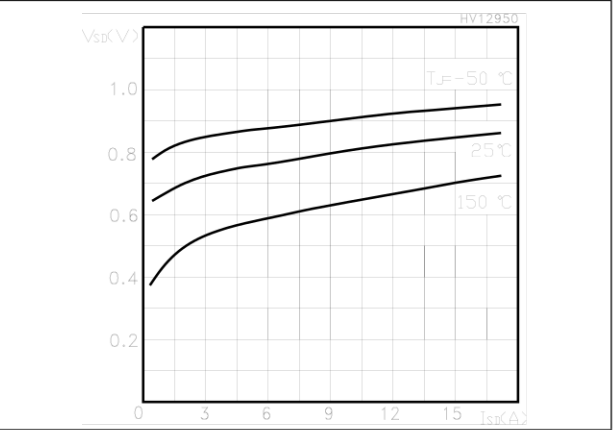


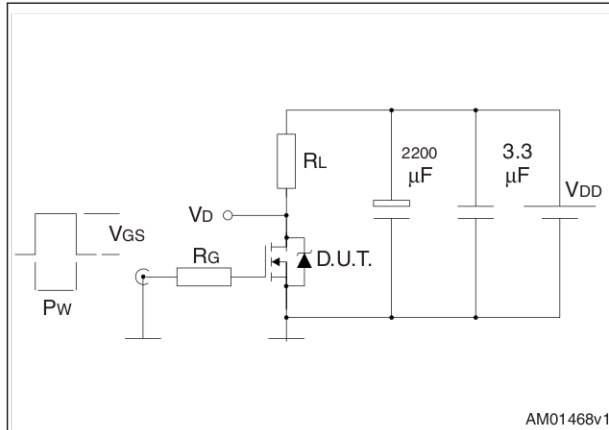
Figure 15. Source-drain diode forward characteristic



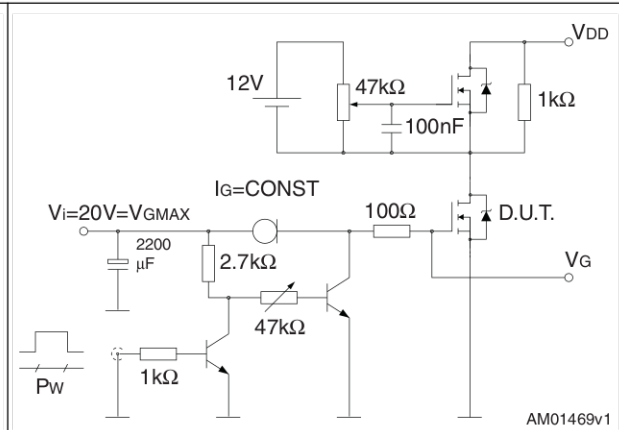


### 3 Test circuits

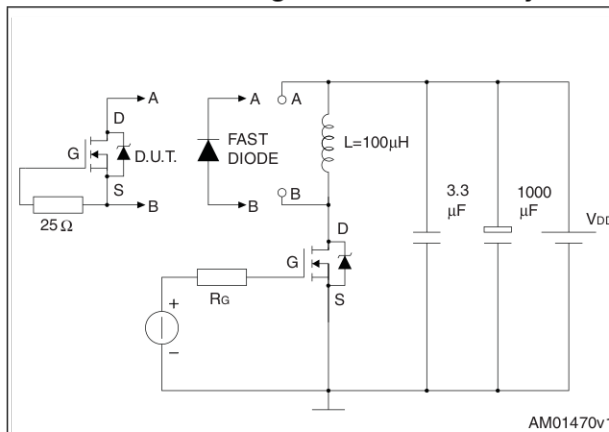
**Figure 16. Switching times test circuit for resistive load**



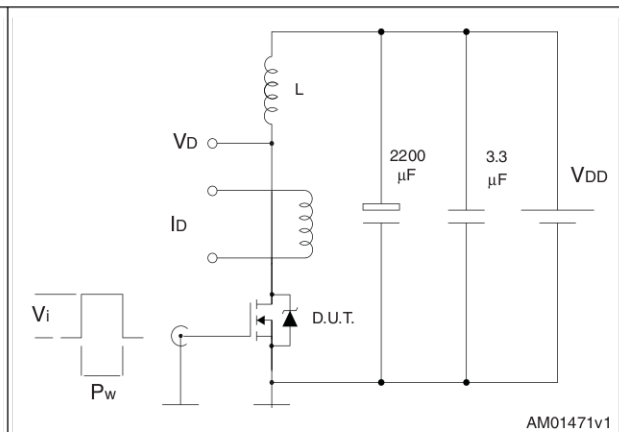
**Figure 17. Gate charge test circuit**



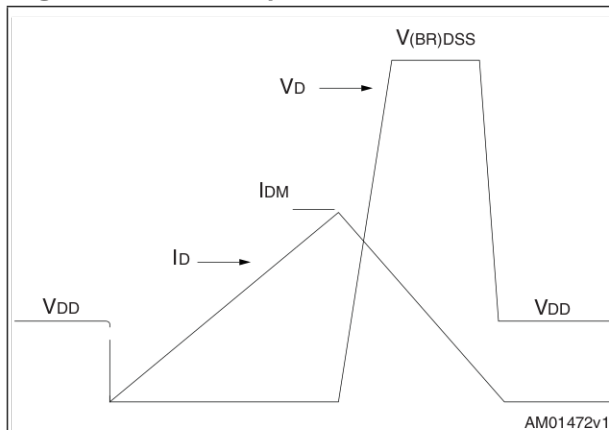
**Figure 18. Test circuit for inductive load switching and diode recovery times**



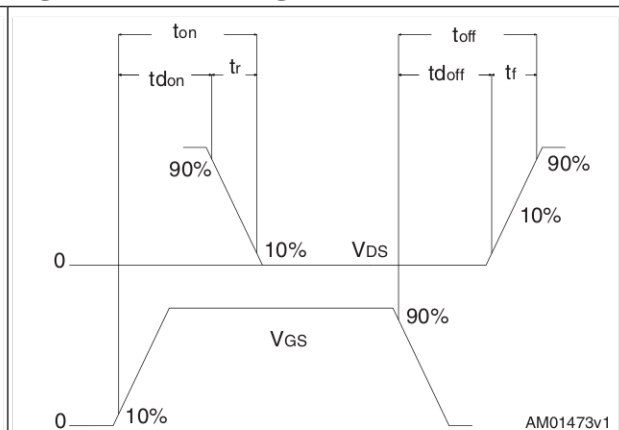
**Figure 19. Unclamped inductive load test circuit**



**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](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 22. TO-220FP drawing

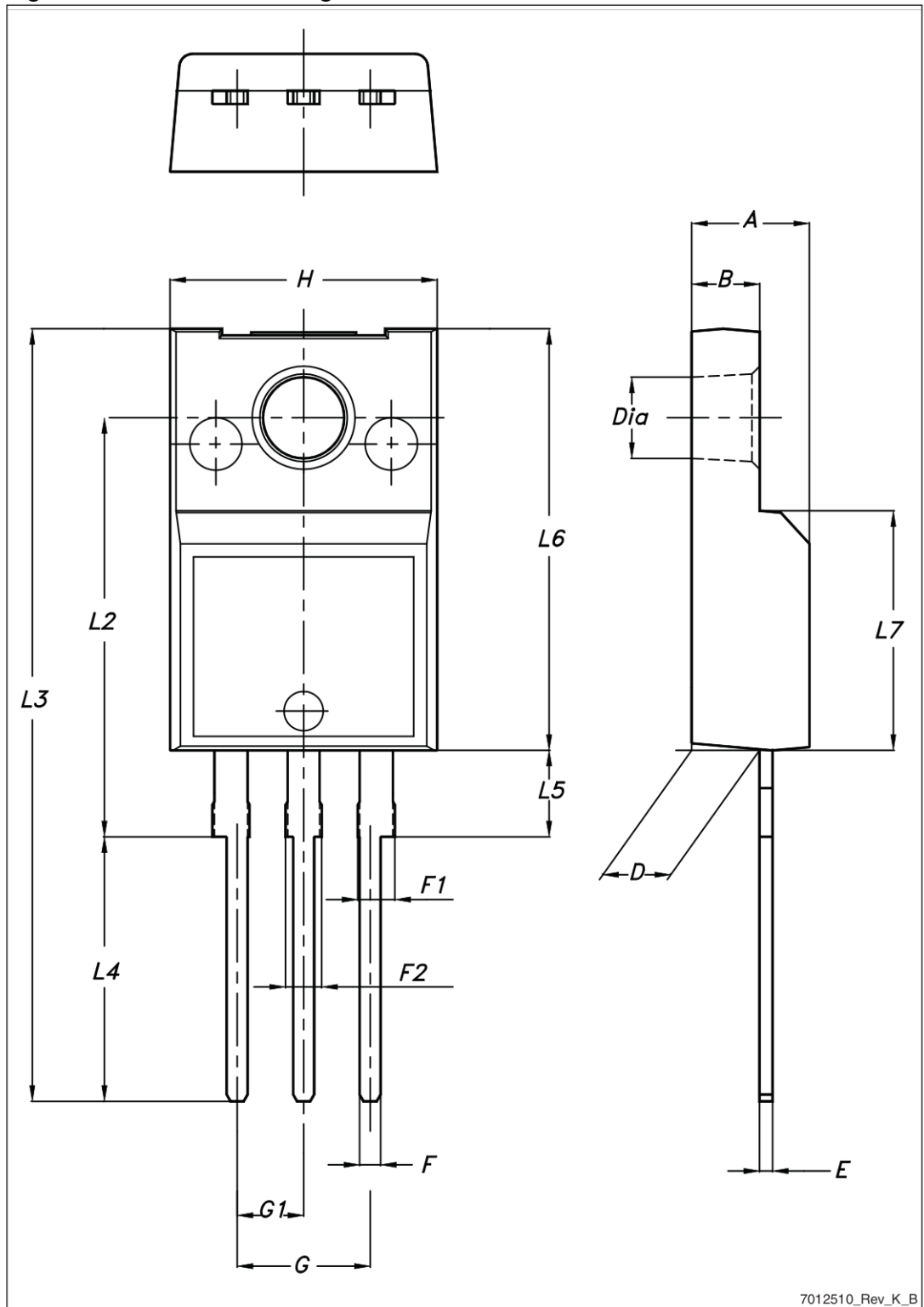
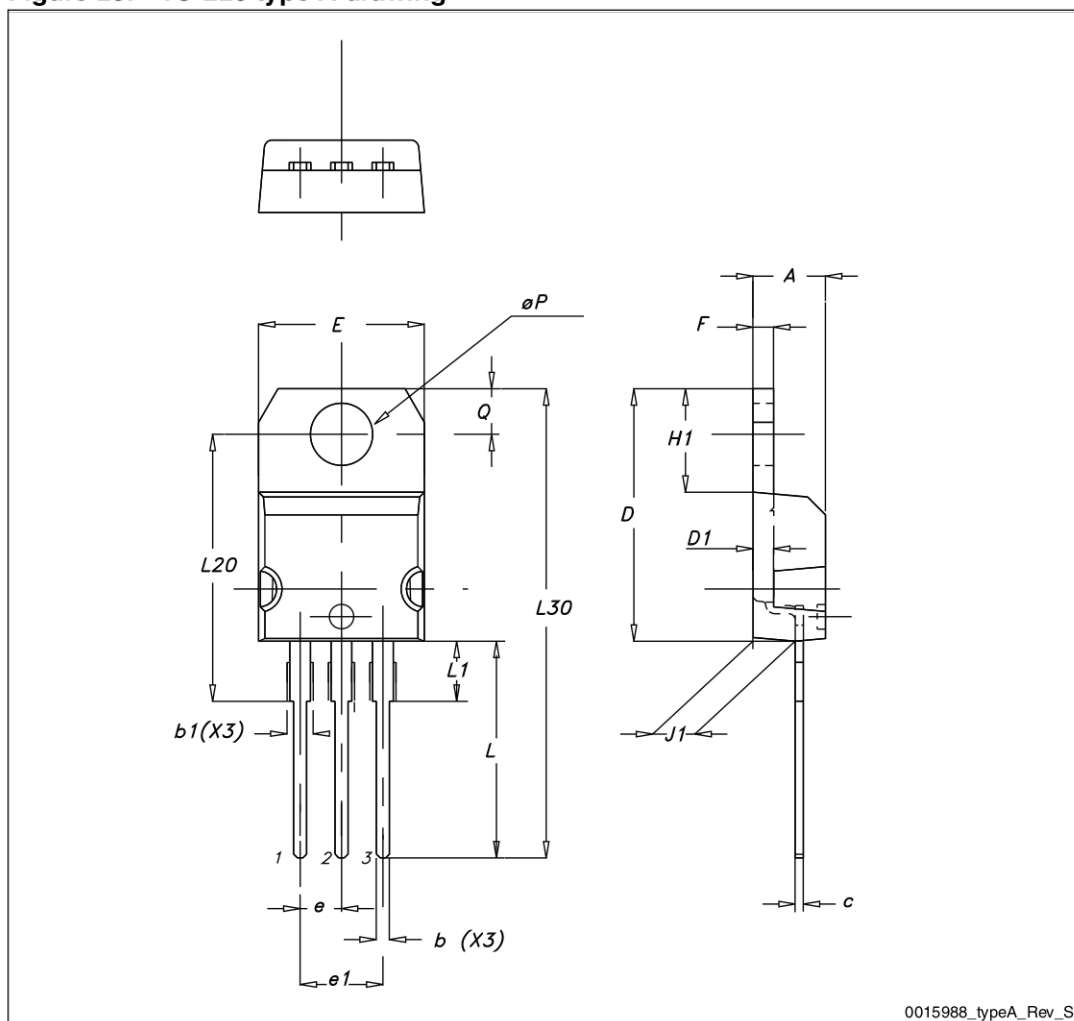


Table 10. TO-220 type A mechanical data

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 23. TO-220 type A drawing



## 5 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
05-Apr-2012	1	First release.

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