



# STP5NK100Z, STF5NK100Z STW5NK100Z

N-channel 1000 V, 2.7  $\Omega$ , 3.5 A, TO-220, TO-220FP, TO-247  
SuperMESH3™ Power MOSFET

## Features

Type	V <sub>DSS</sub> (@T <sub>JMAX</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STF5NK100Z	1000 V	< 3.7 $\Omega$	3.5 A
STP5NK100Z	1000 V	< 3.7 $\Omega$	3.5 A
STW5NK100Z	1000 V	< 3.7 $\Omega$	3.5 A

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability

## Applications

- Switching application

## Description

The new SuperMESH™ series of Power MOSFETS is the result of further design improvements on ST's well-established strip-based PowerMESH™ layout. In addition to significantly lower on-resistance, the device offers superior dv/dt capability to ensure optimal performance even in the most demanding applications. The SuperMESH™ devices further complement an already broad range of innovative high voltage MOSFETs, which includes the revolutionary MDmesh™ products.

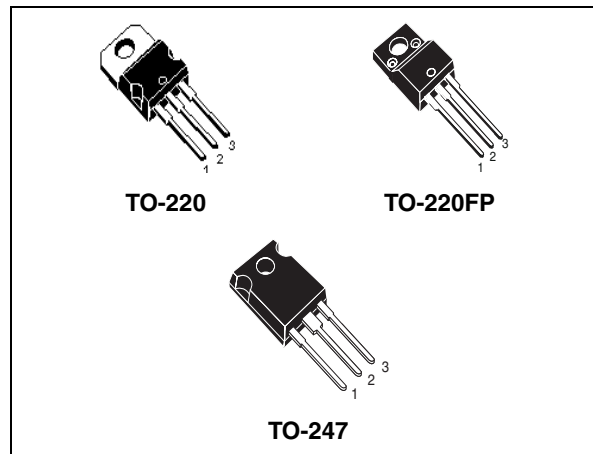


Figure 1. Internal schematic diagram

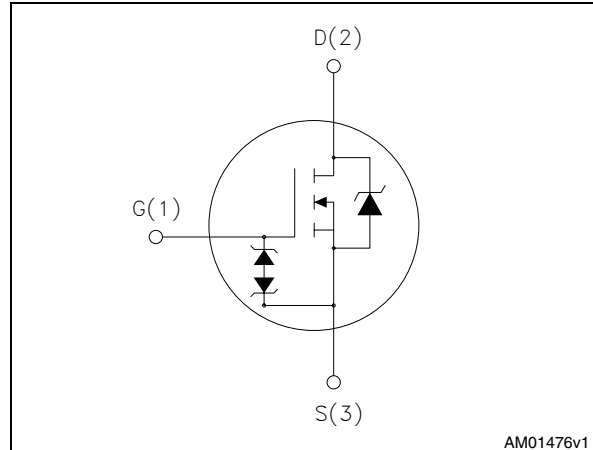


Table 1. Device summary

Order code	Marking	Package	Packaging
STF5NK100Z	F5NK100Z	TO-220FP	Tube
STP5NK100Z	P5NK100Z	TO-220	Tube
STW5NK100Z	W5NK100Z	TO-247	Tube

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220, TO-247	TO-220FP	
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	1000		V
$V_{GS}$	Gate-source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25^\circ\text{C}$	3.5	3.5 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C=100^\circ\text{C}$	2.2	2.2 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	14	14 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	125	30	W
	Derating factor	1	0.24	W/°C
$V_{ESD(G-S)}$	Gate source ESD (HBM-C=100pF, R=1.5 k $\Omega$ )	4000		V
$dv/dt^{(3)}$	Peak diode recovery voltage slope	4.5		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t=1$ s; $T_C= 25^\circ\text{C}$ )		2500	V
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 150		°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- $I_{SD} \leq 3.5$  A,  $di/dt \leq 200$  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-247	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	1	4.2	°C/W
$R_{thj-a}$	Thermal resistance junction-ambient max	62.5		°C/W
$T_l$	Maximum lead temperature for soldering purpose	300		°C

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{JMAX}$ )	3.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J=25^\circ\text{C}$ , $I_d=I_{AR}$ , $V_{dd}=50$ V)	250	mJ

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	1000			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating},$ $T_c = 125^{\circ}C$			1 50	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{GS} = 0$ )	$V_{GS} = \pm 20 \text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 100 \mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}, I_D = 1.75 \text{ A}$		2.7	3.7	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15 \text{ V}, I_D = 1.75 \text{ A}$	-	4		S
$C_{iss}$	Input capacitance	$V_{DS} = 25 \text{ V}, f = 1 \text{ MHz},$ $V_{GS} = 0$	-	1154		pF
$C_{oss}$	Output capacitance			106		pF
$C_{rss}$	Reverse transfer capacitance			21.3		pF
$C_{osseq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0 \text{ V to } 800 \text{ V}$	-	46.8		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 500 \text{ V}, I_D = 1.75 \text{ A},$ $R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 21</a> )	-	22.5		ns
$t_r$	Rise time			7.7		ns
$t_{d(off)}$	Off-voltage rise time			51.5		ns
$t_f$	Fall time			19		ns
$Q_g$	Total gate charge	$V_{DD} = 800 \text{ V}, I_D = 3.5 \text{ A}$	-	42	59	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10 \text{ V}$		7.3		nC
$Q_{gd}$	Gate-drain charge	(see <a href="#">Figure 22</a> )		21.7		nC

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

2.  $C_{oss \text{ eq}}$  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		-		3.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		14	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}=3.5\text{ A}$ , $V_{GS}=0$	-		1.6	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD}=3.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD}=30\text{ V}$ (see <a href="#">Figure 23</a> )	-	605 3.09 10.5		ns $\mu\text{C}$ A
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD}=3.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD}=35\text{ V}$ , $T_j=150\text{ }^\circ\text{C}$ (see <a href="#">Figure 23</a> )	-	742 4.2 11.2		ns $\mu\text{C}$ A

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

**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-220FP

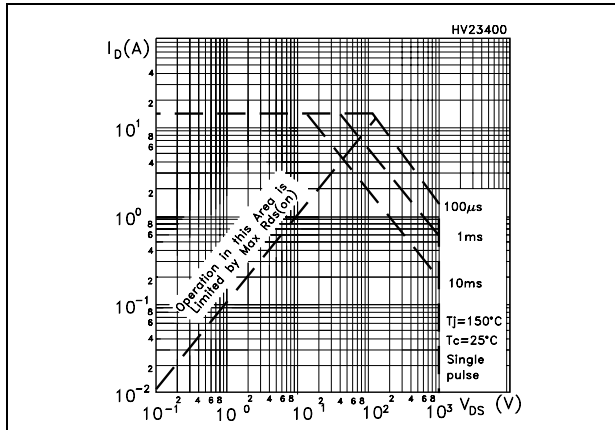


Figure 3. Thermal impedance for TO-220FP

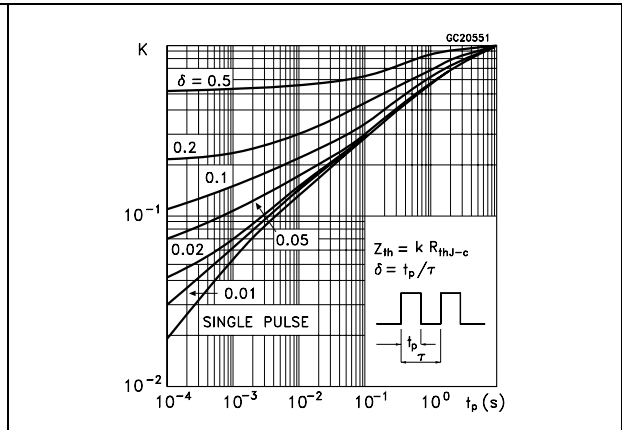


Figure 4. Safe operating area for TO-220

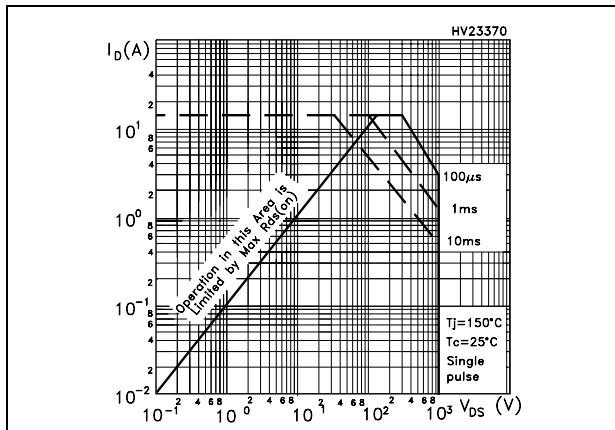


Figure 5. Thermal impedance for TO-220

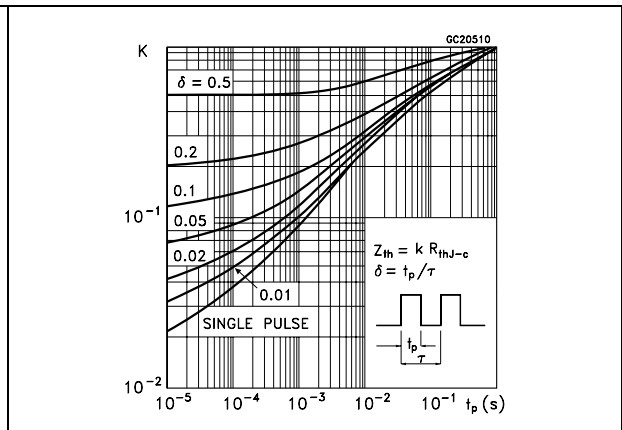


Figure 6. Safe operating area for TO-247

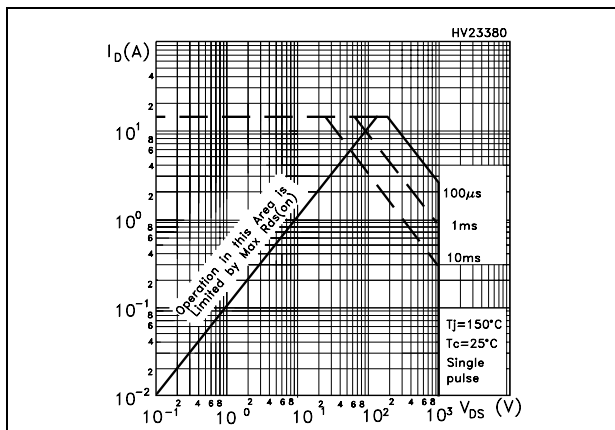


Figure 7. Thermal impedance for TO-247

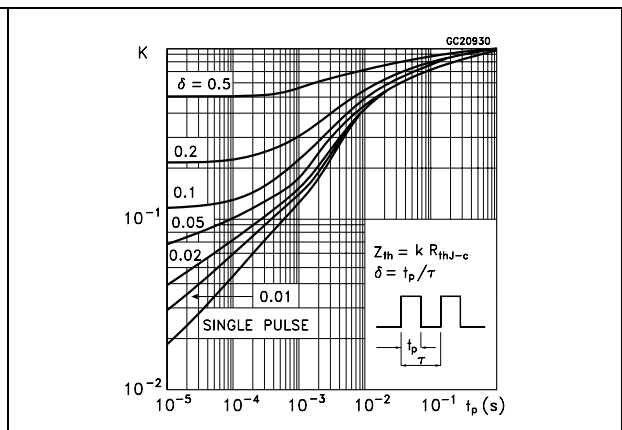


Figure 8. Output characteristics

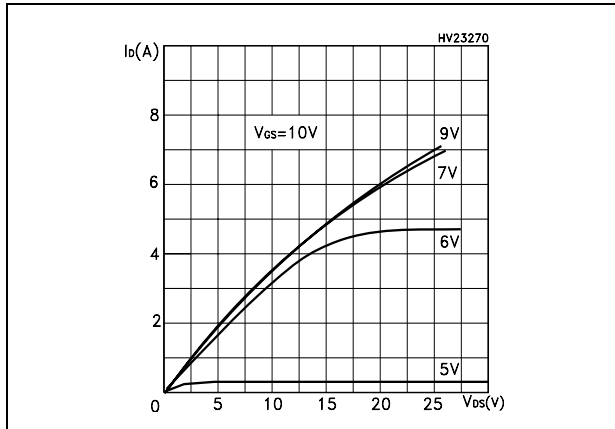


Figure 9. Transfer characteristics

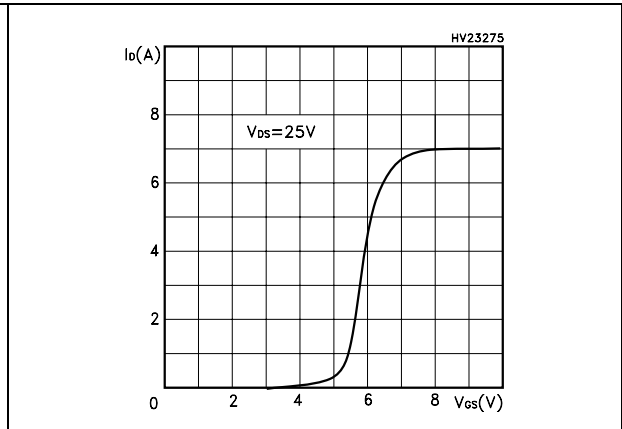


Figure 10. Transconductance

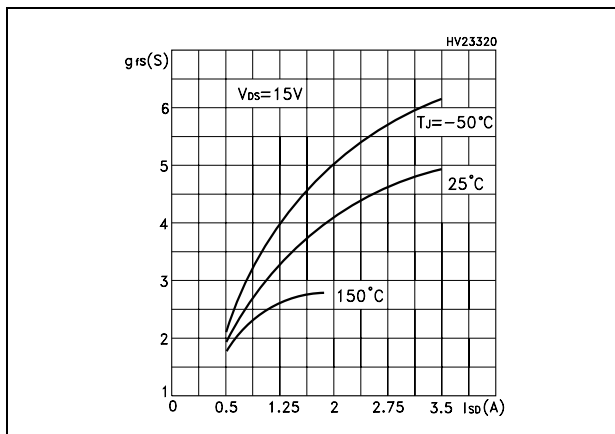


Figure 11. Static drain-source on resistance

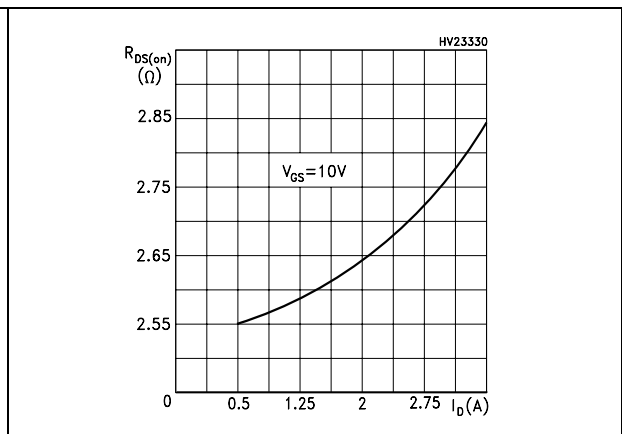


Figure 12. Gate charge vs gate-source voltage Figure 13. Capacitance variations

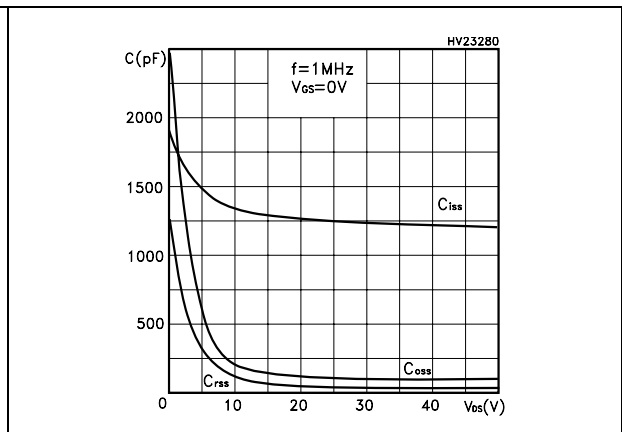
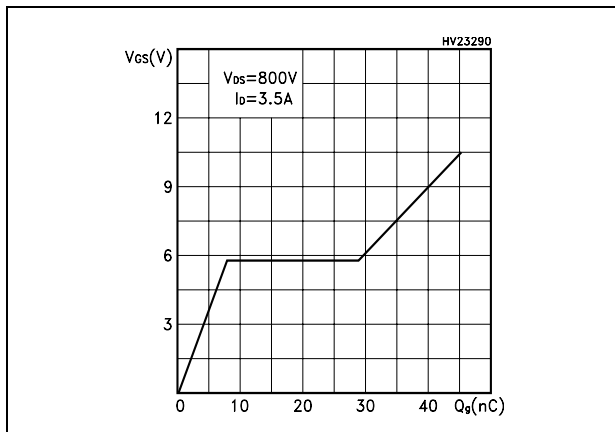


Figure 14. Normalized gate threshold voltage vs temperature

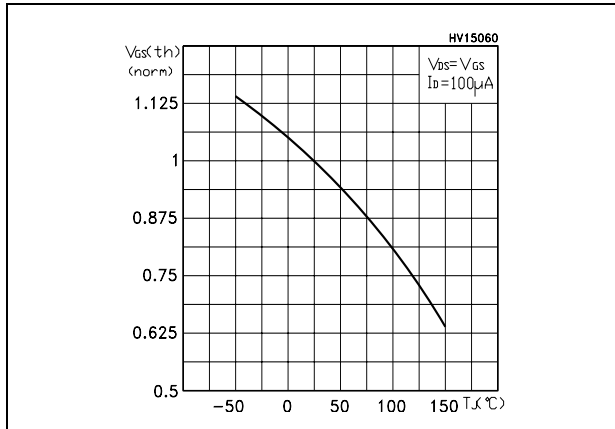


Figure 15. Normalized on resistance vs temperature

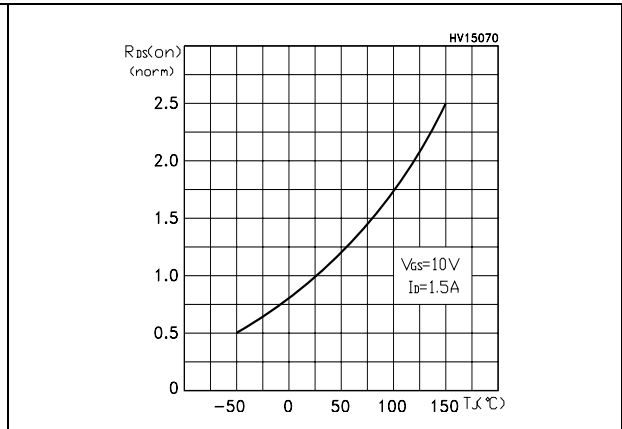


Figure 16. Source-drain diode forward characteristics

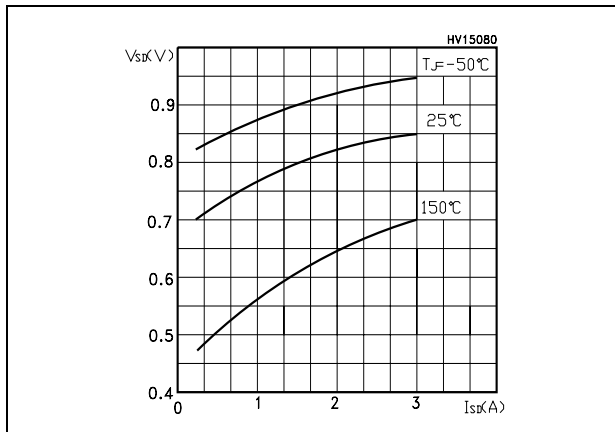


Figure 17. Normalized BVdss vs temperature

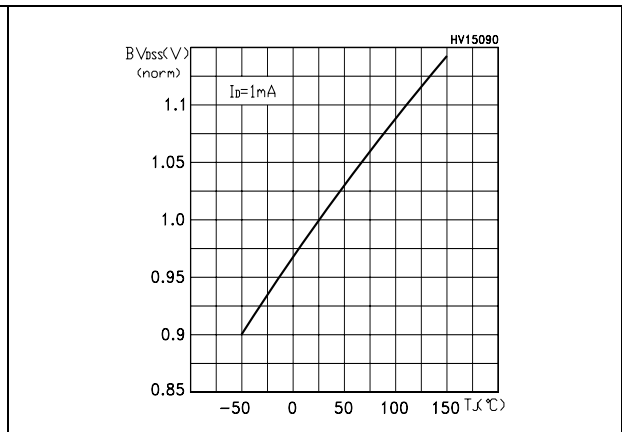
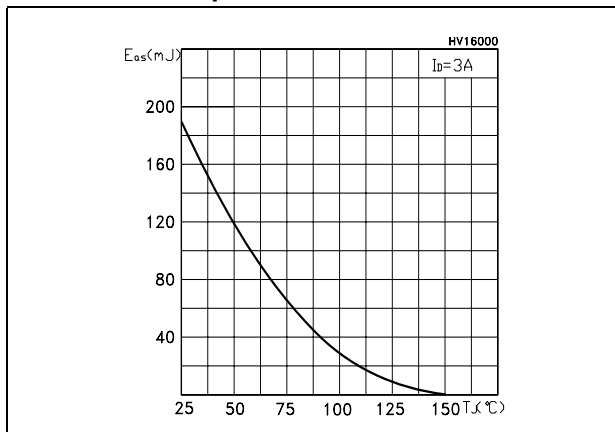


Figure 18. Maximum avalanche energy vs temperature





### 3 Test circuits

Figure 19. Unclamped inductive load test circuit

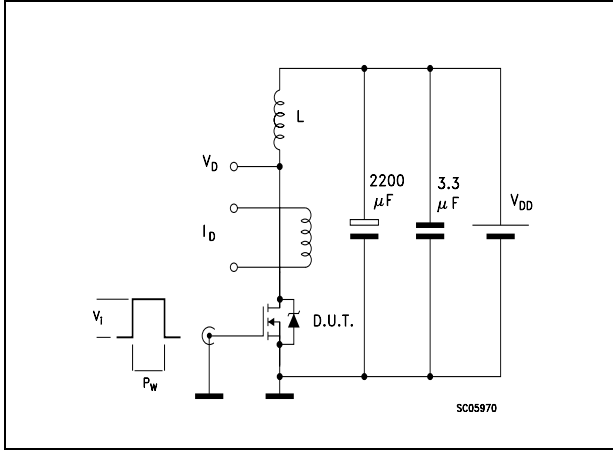


Figure 20. Unclamped inductive waveform

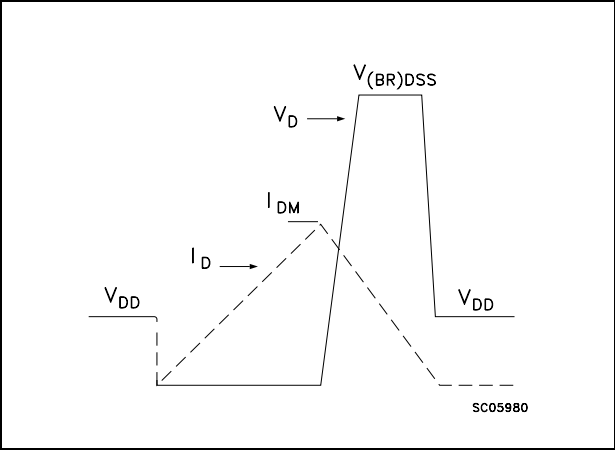


Figure 21. Switching times test circuit for resistive load

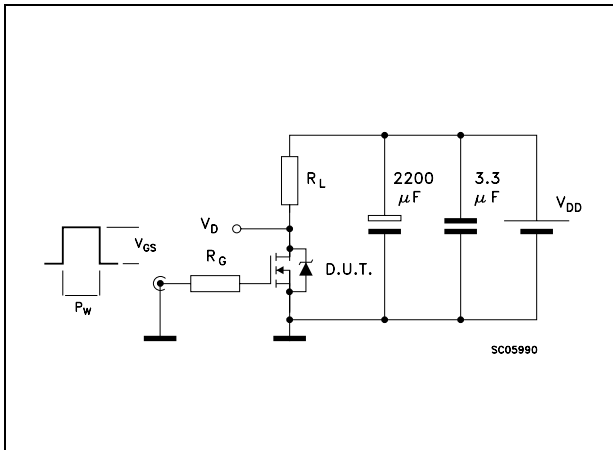


Figure 22. Gate charge test circuit

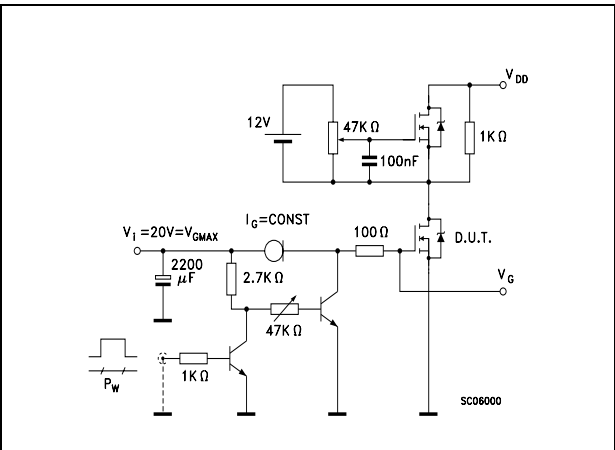
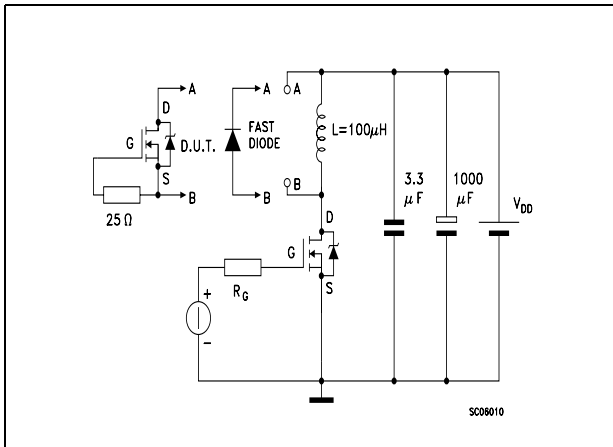


Figure 23. Test circuit for inductive load switching and diode recovery times

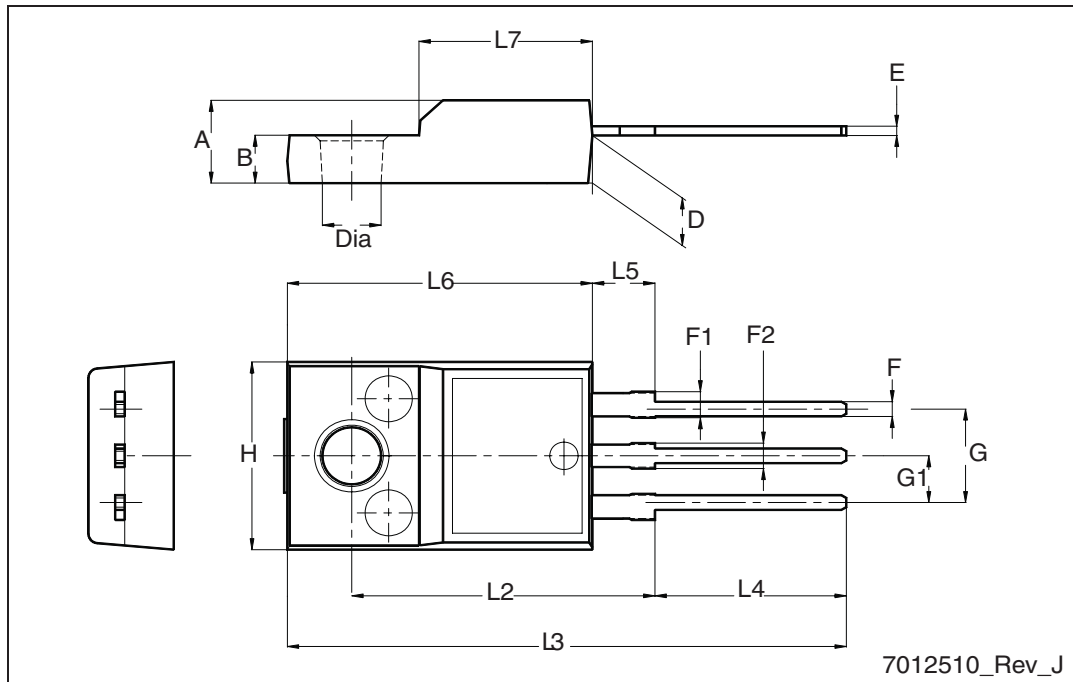


## 4 Package mechanical data

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.

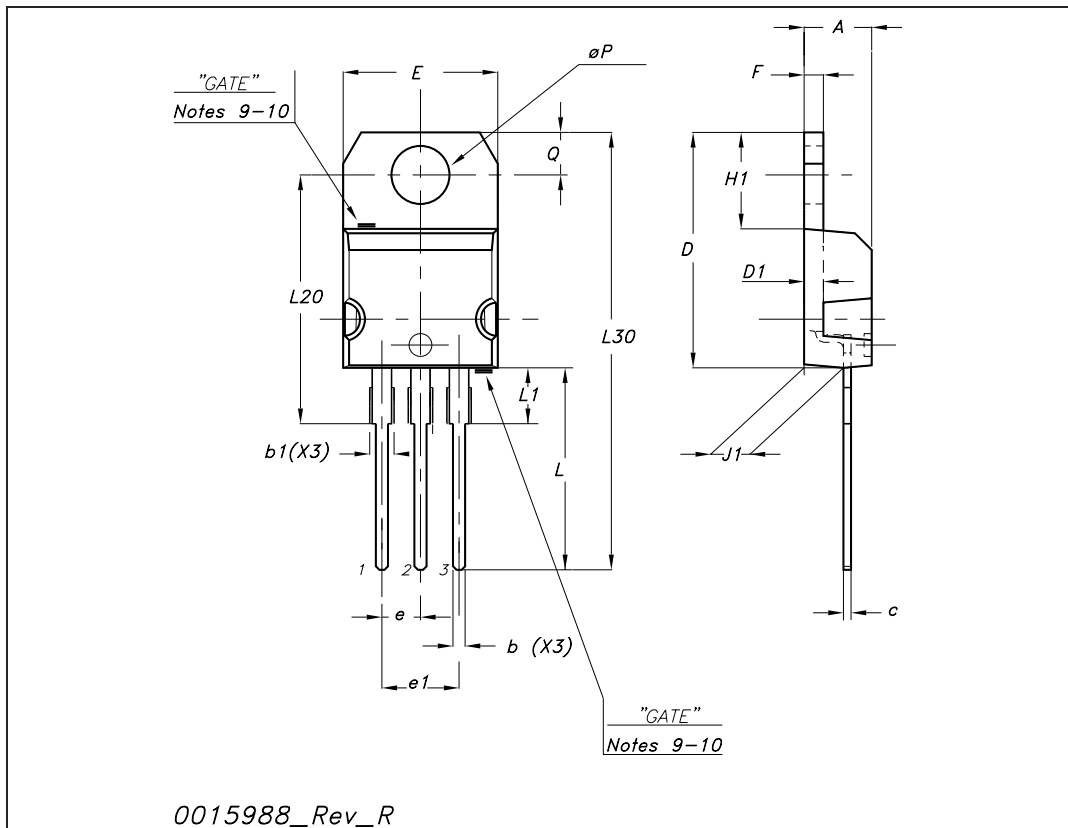
TO-220FP mechanical data

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		1.5
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



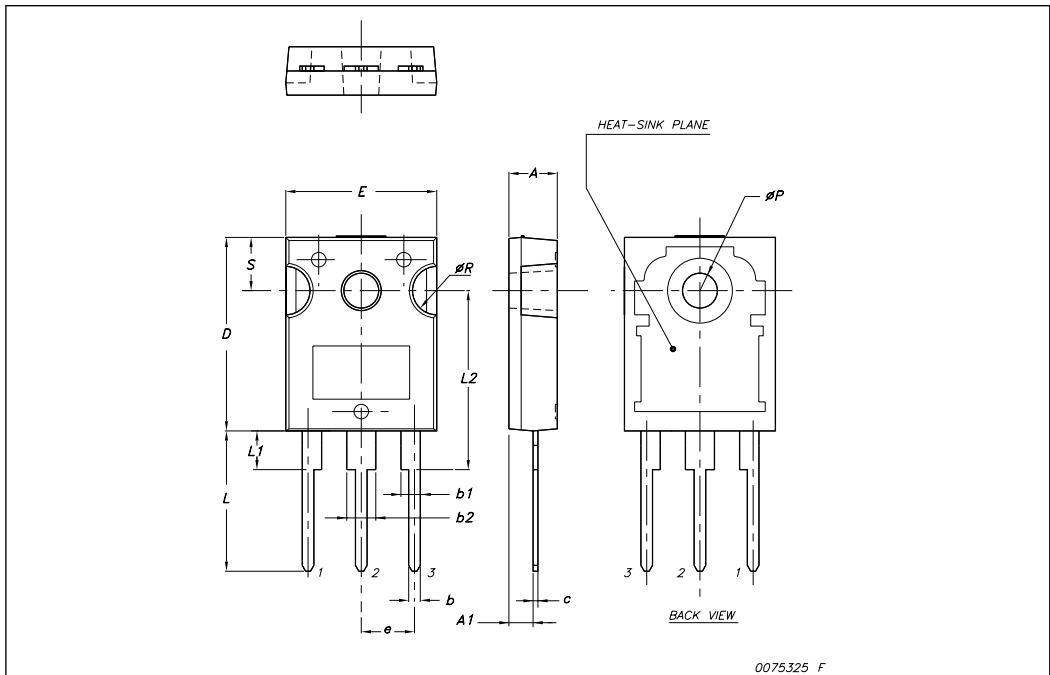
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



**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	



## 5 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
12-Oct-2004	1	First release
08-Sep-2005	2	Complete datasheet
16-Dec-2005	3	Inserted ecopack indication
16-Aug-2006	4	New template, no content change
15-May-2009	5	Modified: <a href="#">Section 2.1: Electrical characteristics (curves)</a>

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