



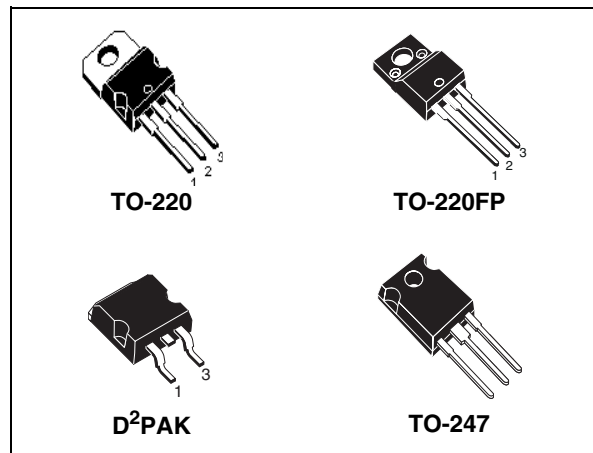
# STP6NK90Z - STP6NK90ZFP STB6NK90Z - STW7NK90Z

N-channel 900V - 1.56Ω - 5.8A - TO-220/TO-220FP/D<sup>2</sup>PAK/TO-247  
Zener-protected SuperMESH™ Power MOSFET

## General features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub>	I <sub>D</sub>
STP6NK90Z	900 V	< 2 Ω	5.8 A
STP6NK90ZFP	900 V	< 2 Ω	5.8 A
STB6NK90Z	900 V	< 2 Ω	5.8 A
STW7NK90Z	900 V	< 2 Ω	5.8 A

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



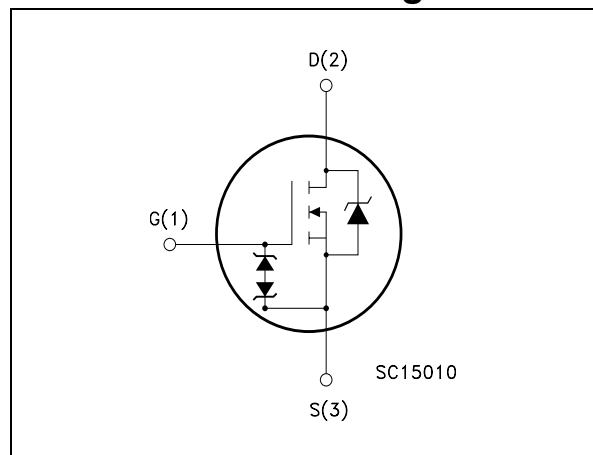
## Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

## Applications

- Switching application

## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STP6NK90Z	P6NK90Z	TO-220	Tube
STP6NK90ZFP	P6NK90ZFP	TO-220FP	Tube
STB6NK90ZT4	B6NK90Z	D <sup>2</sup> PAK	Tape e reel
STW7NK90Z	W7NK90Z	TO-247	Tube

# Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
1.1	Protection features of gate-to-source zener diodes .....	4
<b>2</b>	<b>Electrical characteristics</b> .....	<b>5</b>
2.1	Electrical characteristics (curves) .....	7
<b>3</b>	<b>Test circuit</b> .....	<b>10</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>11</b>
<b>5</b>	<b>Packaging mechanical data</b> .....	<b>16</b>
<b>6</b>	<b>Revision history</b> .....	<b>17</b>

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220/ D <sup>2</sup> PAK/TO247	TO220FP	
V <sub>DS</sub>	Drain-source voltage (V <sub>GS</sub> = 0)	900		V
V <sub>GS</sub>	Gate-source voltage	± 30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25°C	5.8	5.8 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100°C	3.65	3.65 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	23.2	23.2 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25°C	140	30	W
	Derating factor	1.12	0.24	W/°C
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	4.5		V/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; T <sub>c</sub> = 25°C)	-	2500	V
T <sub>j</sub> T <sub>stg</sub>	Max operating junction temperature Storage temperature	-55 to 150		°C °C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 5.8 A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>.

**Table 2. Thermal data**

Symbol	Parameter	Value				Unit
		TO-220	D <sup>2</sup> PAK	TO-220FP	TO-247	
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.39		4.2	0.89	°C/W
R <sub>thj-pcb</sub>	Thermal resistance junction-case max		60			°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5			50	°C/W
T <sub>l</sub>	Maximum lead temperature for soldering purpose	300				°C

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max)	5.8	A
$E_{AS}$	Single pulse avalanche energy (starting Tj=25°C, Id=Iar, Vdd=50V)	300	mJ

**Table 4. Gate-source zener diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-source breakdown voltage	Igs=± 1mA (Open Drain)	30			V

## 1.1 Protection features of gate-to-source zener diodes

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 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	$I_D = 1mA, V_{GS} = 0$	900			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	$\mu A$ $\mu A$
$I_{GSS}$	Gate-body leakage Current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20 V$			$\pm 10$	$\mu A$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 100 \mu A$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 V, I_D = 2.9 A$		1.56	2	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15V, I_D = 2.9 A$		5		S
$C_{iss}$	Input capacitance	$V_{DS} = 25 V, f = 1 \text{ MHz},$ $V_{GS} = 0$		1350		pF
$C_{oss}$	Output capacitance			130		pF
$C_{rss}$	Reverse transfer capacitance			26		pF
$C_{oss \text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{DS} = 0V, V_{DS} = 0V \text{ to } 720V$		70		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 450 V, I_D = 3 A,$ $R_G = 4.7 \Omega, V_{GS} = 10 V$ (see <a href="#">Figure 20</a> )		17		ns
$t_r$	Rise time			45		ns
$t_{r(off)}$	Turn-off delay time			20		ns
$t_f$	Fall time			20		ns
$Q_g$	Total gate charge	$V_{DD} = 720 V, I_D = 5.8 A,$ $V_{GS} = 10 V$		46.5	60.5	nC
$Q_{gs}$	Gate-source charge			8.5		nC
$Q_{gd}$	Gate-drain charge			25		nC
$T_{r(Voff)}$	Off-voltage rise time	$V_{DD} = 720 V, I_D = 5.8 A,$ $R_G = 4.7 \Omega, V_{GS} = 10 V$ (see <a href="#">Figure 22</a> )		11		ns
$T_r$	Fall time			12		ns
$T_c$	Cross-over time			20		ns

1. Pulsed: pulse duration=300 $\mu s$ , 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				5.8	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				23.2	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 5.8 \text{ A}, V_{GS} = 0$			1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 5.8 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 36 \text{ V}, T_J = 150^\circ\text{C}$ (see <a href="#">Figure 22</a> )		840		ns
$Q_{rr}$	Reverse recovery charge			5880		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			14		A

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

2. Pulse width limited by safe operating area

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220/  
D<sup>2</sup>PAK

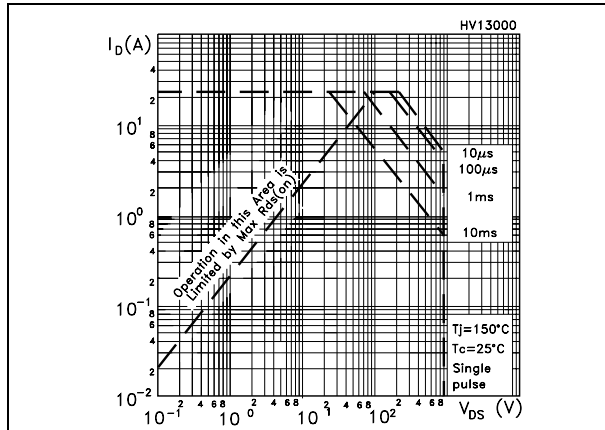


Figure 2. Thermal impedance for TO-220/  
D<sup>2</sup>PAK

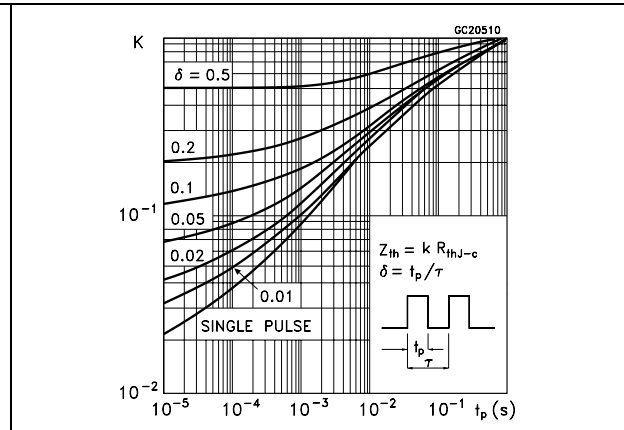


Figure 3. Safe operating area for TO-220FP

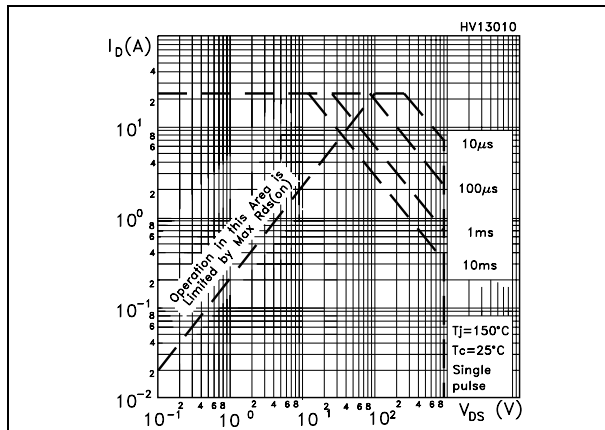


Figure 4. Thermal impedance for TO-220FP

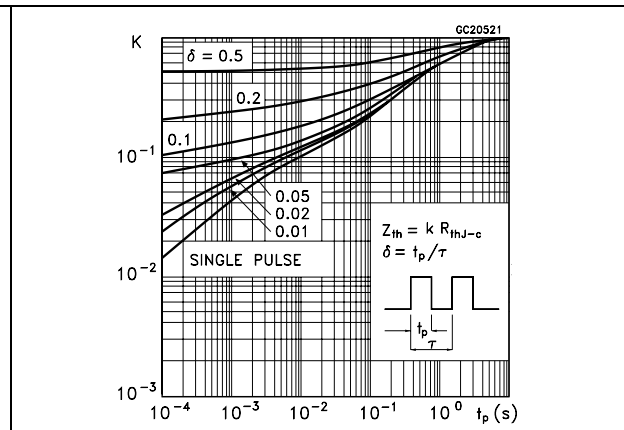


Figure 5. Safe operating area for TO-247

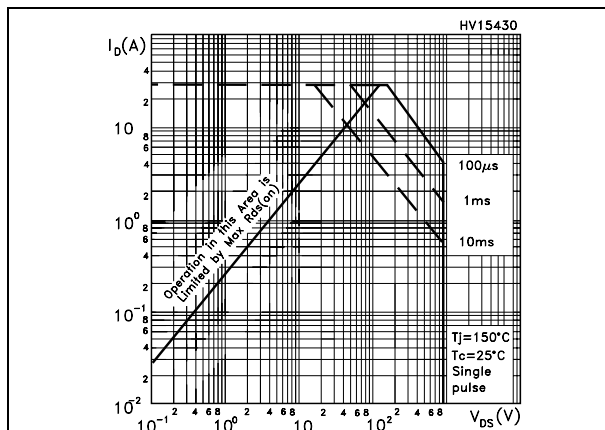


Figure 6. Thermal impedance for TO-247

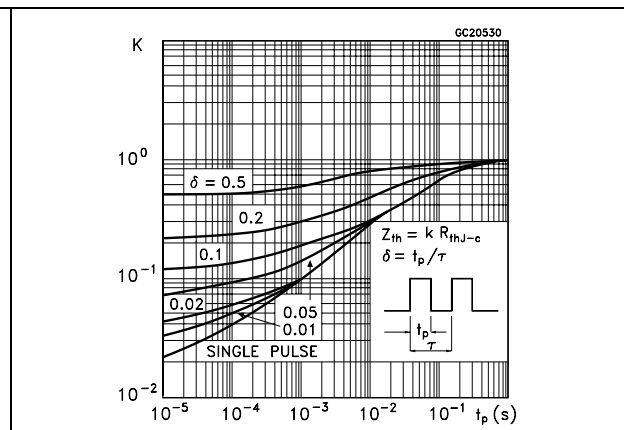


Figure 7. Output characteristics

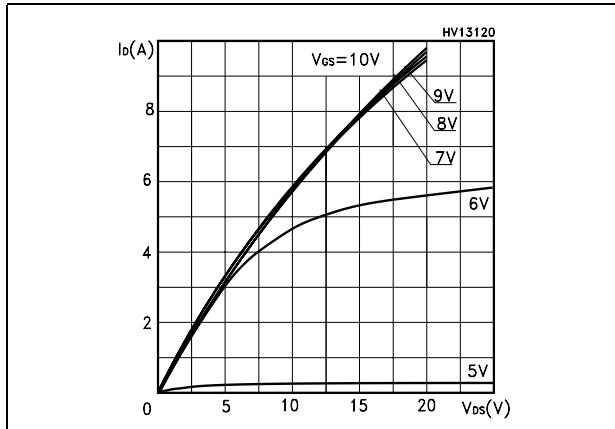


Figure 8. Transfer characteristics

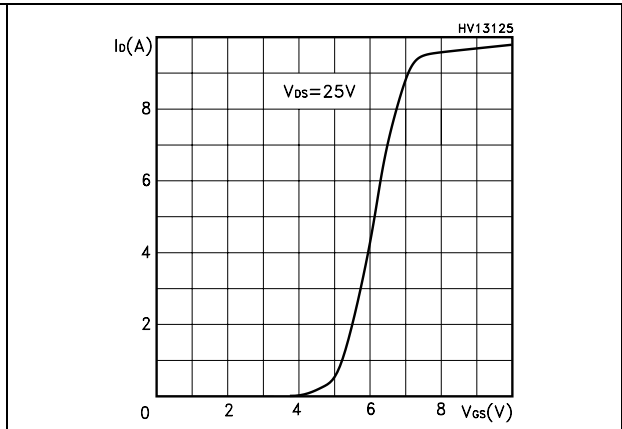


Figure 9. Transconductance

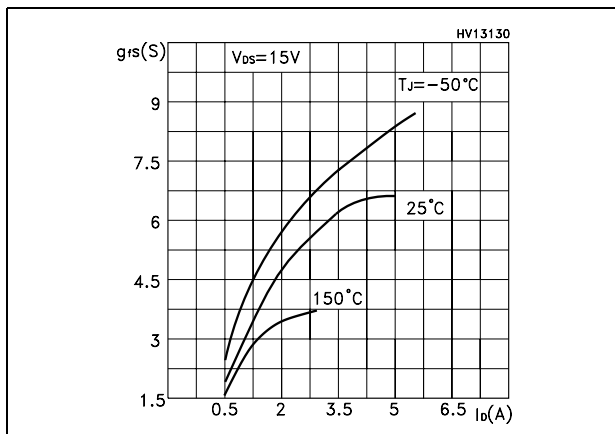


Figure 10. Static drain-source on resistance

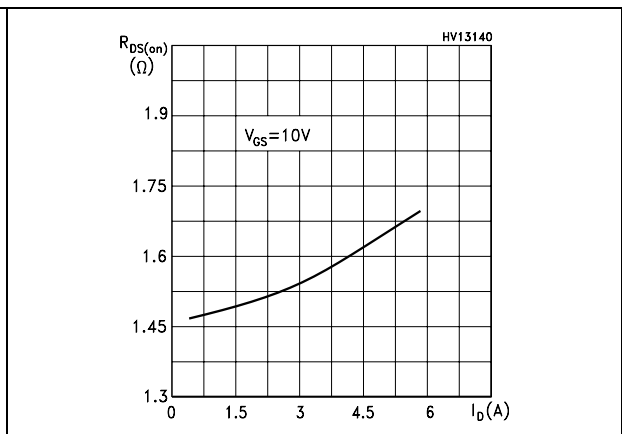


Figure 11. Gate charge vs gate-source voltage

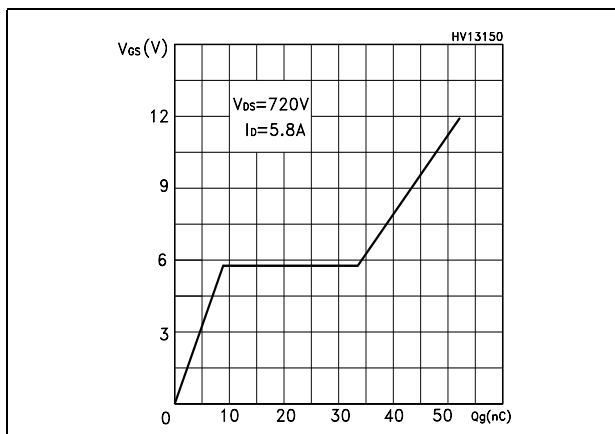


Figure 12. Capacitance variations

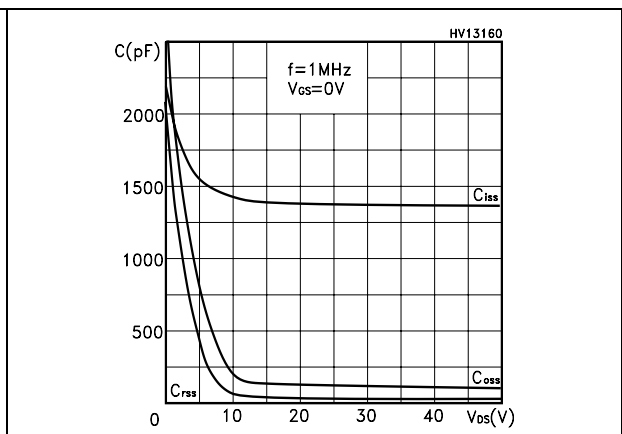




Figure 13. Normalized gate threshold voltage vs temperature

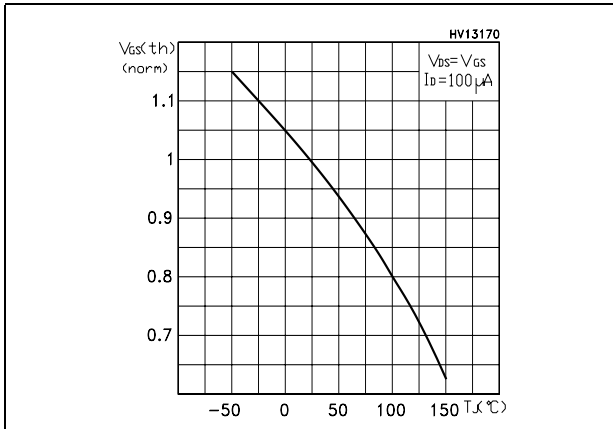


Figure 14. Normalized on resistance vs temperature

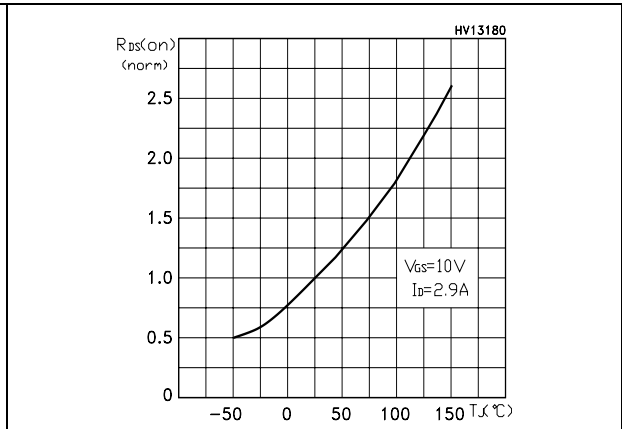


Figure 15. Source-drain diode forward characteristic

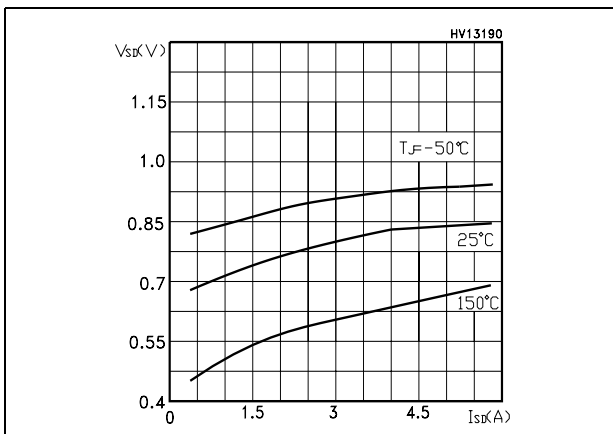


Figure 16. Normalized BVDSS vs temperature

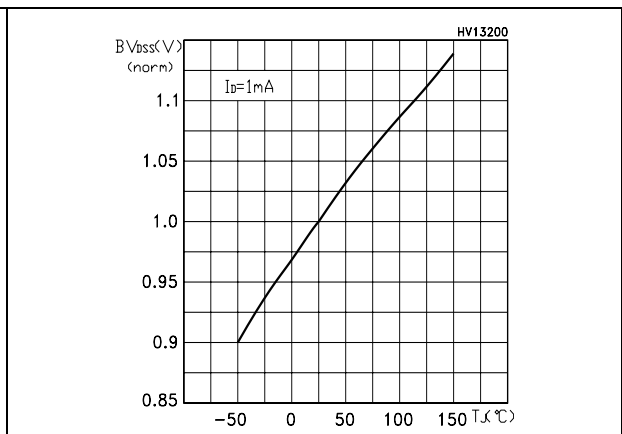
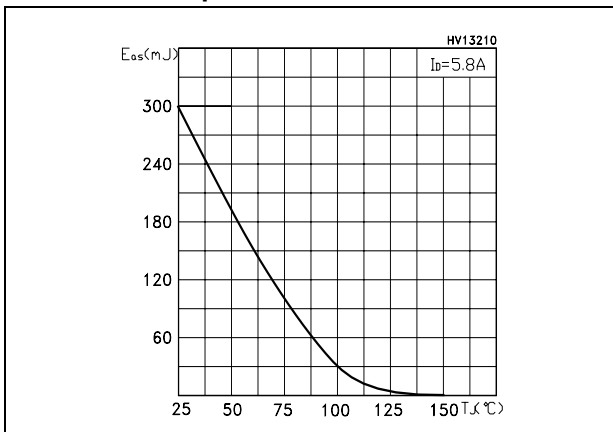


Figure 17. Maximum avalanche energy vs temperature



### 3 Test circuit

Figure 18. Unclamped inductive load test circuit

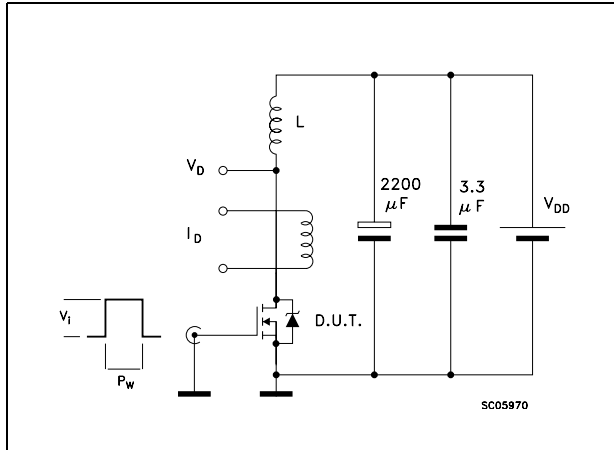


Figure 19. Unclamped inductive waveform

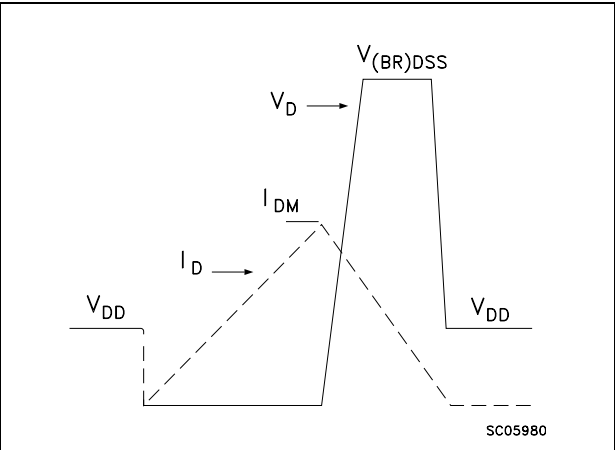


Figure 20. Switching times test circuit for resistive load

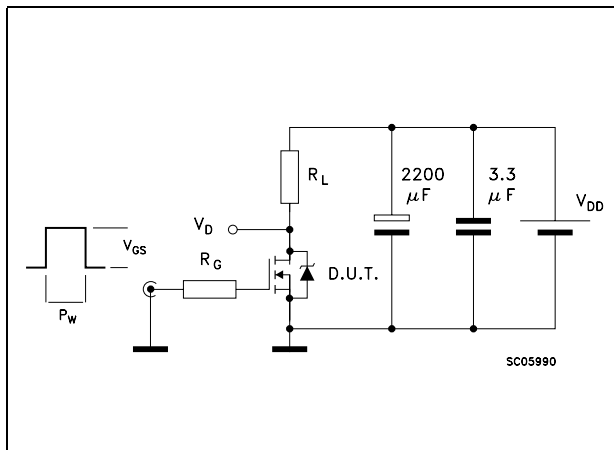


Figure 21. Gate charge test circuit

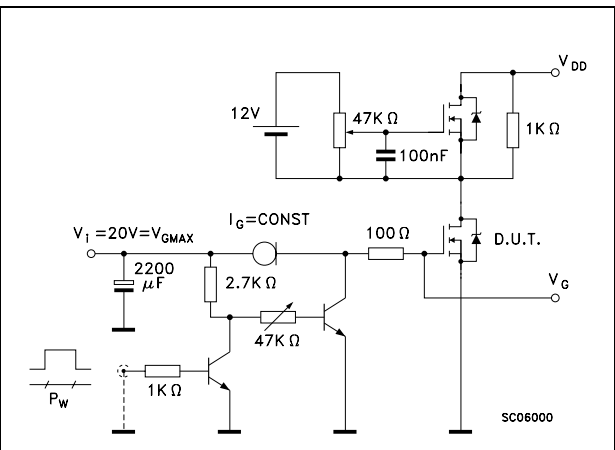
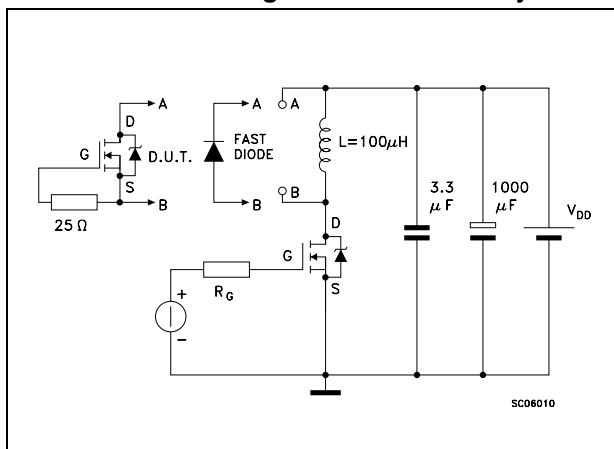


Figure 22. Test circuit for inductive load switching and diode recovery times

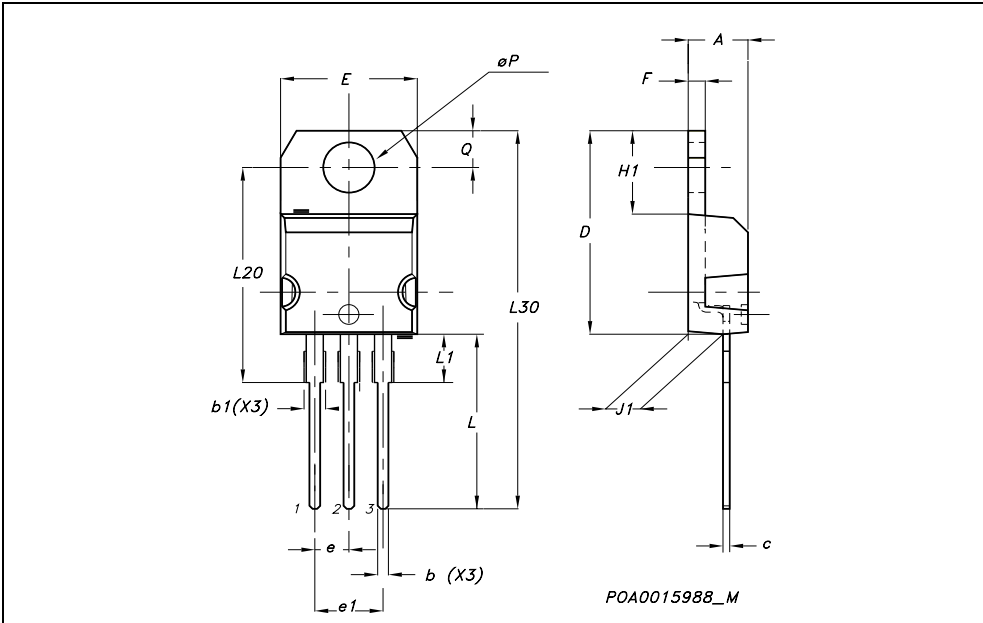


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

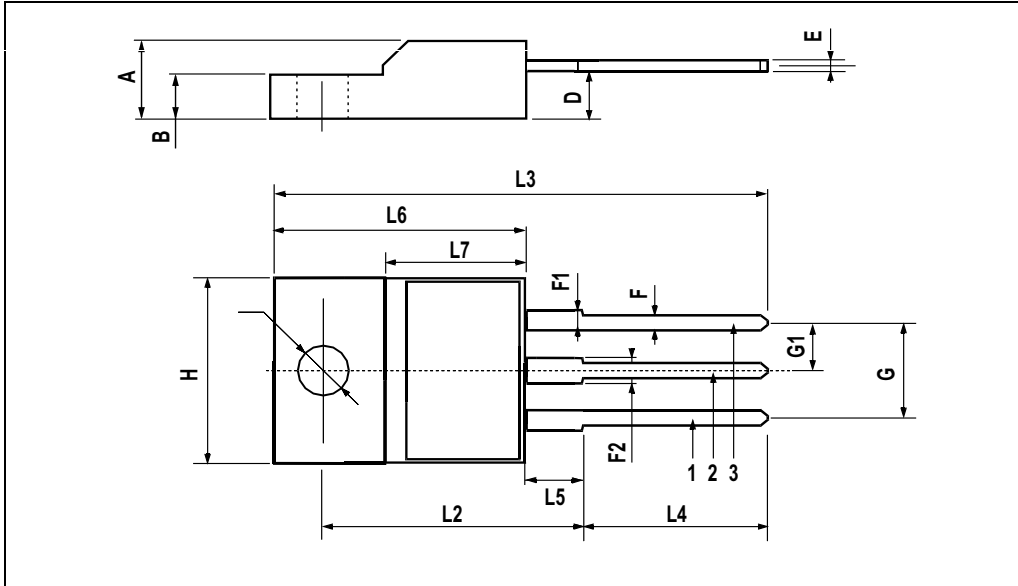
**TO-220 MECHANICAL DATA**

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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



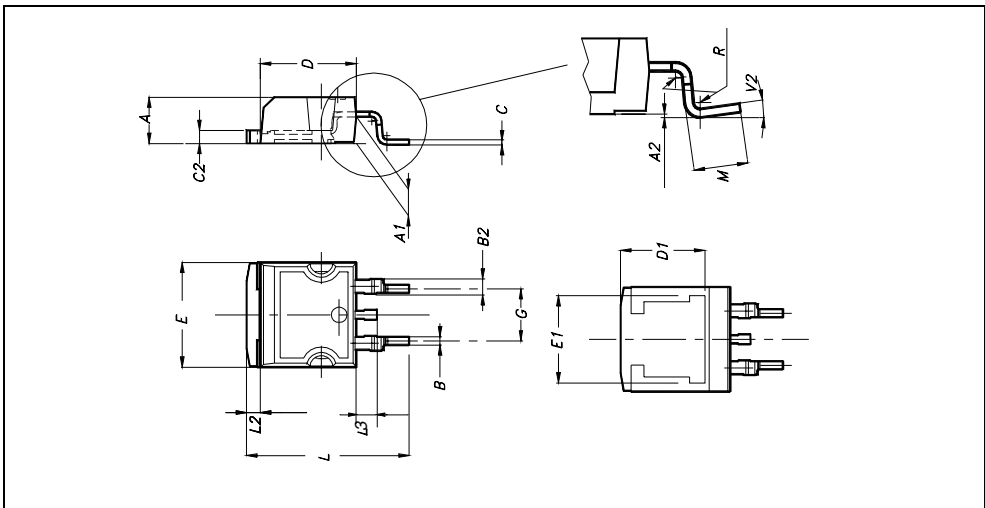
**TO-220FP MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
∅	3		3.2	0.118		0.126



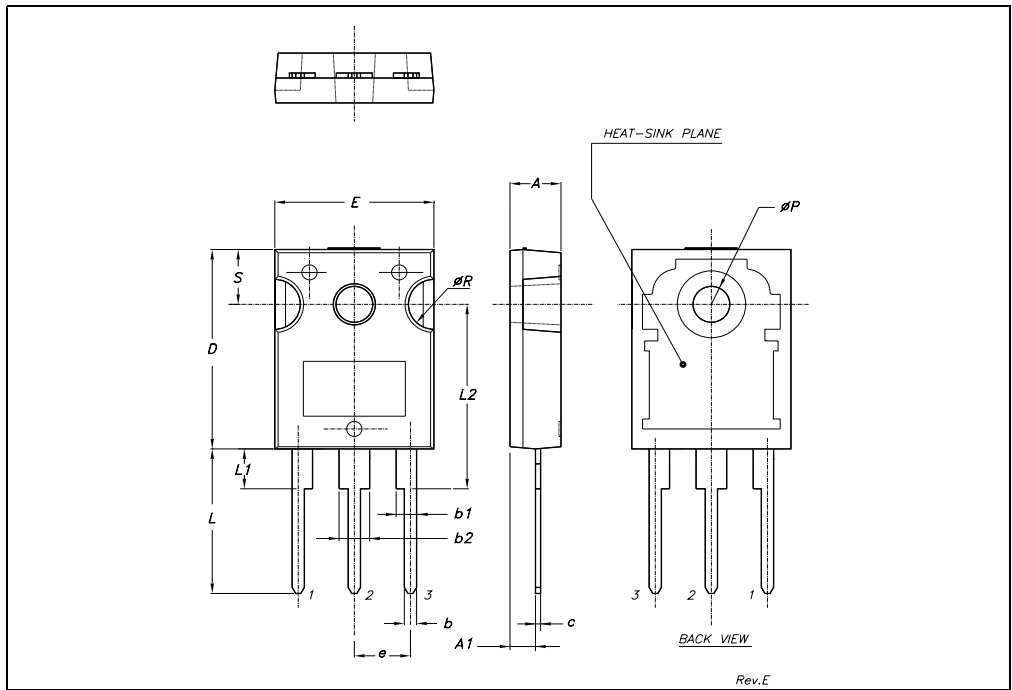
**D<sup>2</sup>PAK MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		4°			



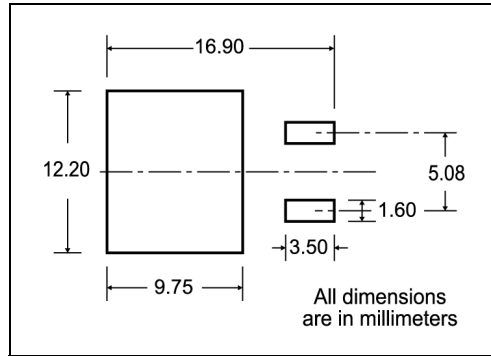
**TO-247 MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	



# 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

\* on sales type



## 6 Revision history

**Table 8. Revision history**

Date	Revision	Changes
29-Nov-2005	3	Complete version
16-Aug-2006	4	New template, no content change

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