



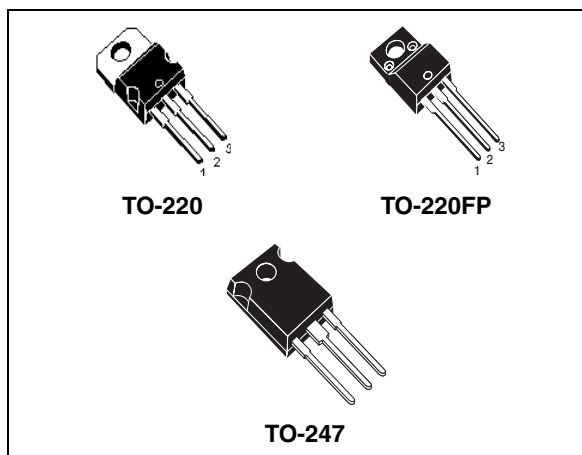
# STP5NK100Z - STF5NK100Z STW5NK100Z

N-channel 1000V - 2.7Ω - 3.5A - TO-220/TO-220FP/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>
STF5NK100Z	1000 V	< 3.7 Ω	3.5 A
STP5NK100Z	1000 V	< 3.7 Ω	3.5 A
STW5NK100Z	1000 V	< 3.7 Ω	3.5 A

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



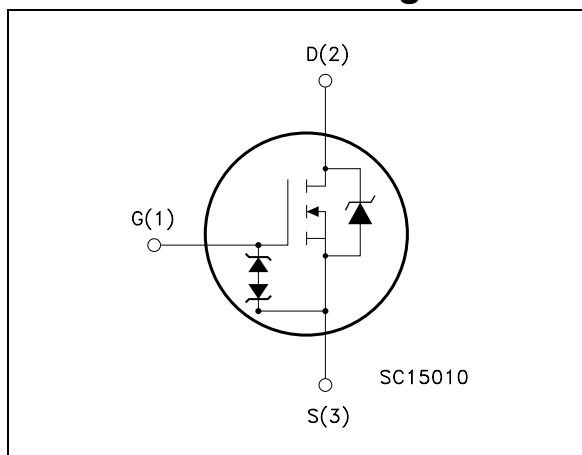
## Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established stripbased 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
STF5NK100Z	F5NK100Z	TO-220FP	Tube
STP5NK100Z	P5NK100Z	TO-220	Tube
STW5NK100Z	W5NK100Z	TO-247	Tube

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# 1 Electrical ratings

**Table 1. 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=1.5K $\Omega$ )	4000		V
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	4.5		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; Tc= 25°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
- $I_{SD} \leq 3.5\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 2. 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 3. Avalanche characteristics**

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

**Table 4. 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

## 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	$I_D = 1mA, V_{GS} = 0$	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	$\mu A$ $\mu A$
$I_{GSS}$	Gate body leakage current ( $V_{GS} = 0$ )	$V_{GS} = \pm 20V$			$\pm 10$	$\mu A$
$V_{GS(th)}$	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	$V_{GS} = 10V, I_D = 1.75 A$		2.7	3.7	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15V, I_D = 1.75A$		4		S
$C_{iss}$	Input capacitance	$V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$		1154		pF
$C_{oss}$	Output capacitance			106		pF
$C_{rss}$	Reverse transfer capacitance			21.3		pF
$C_{osseq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0V \text{ to } 800V$		46.8		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 500V, I_D = 1.75A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see <a href="#">Figure 20</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	$V_{DD} = 800V, I_D = 3.5A$ $V_{GS} = 10V$ (see <a href="#">Figure 21</a> )		42		nC
$Q_{gs}$	Gate-source charge			7.3	59	nC
$Q_{gd}$	Gate-drain charge			21.7		nC

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				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
$t_{rr}$	Reverse recovery time	$I_{SD}=3.5\text{ A}$ , $di/dt = 100\text{A}/\mu\text{s}$ , $V_{DD}=30\text{ V}$ (see <a href="#">Figure 22</a> )		605		ns
$Q_{rr}$	Reverse recovery charge			3.09		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			10.5		A
$t_{rr}$	Reverse recovery time	$I_{SD}=3.5\text{ A}$ , $di/dt = 100\text{A}/\mu\text{s}$ , $V_{DD}=35\text{ V}$ , $T_j=150^\circ\text{C}$ (see <a href="#">Figure 22</a> )		742		ns
$Q_{rr}$	Reverse recovery charge			4.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			11.2		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 1. Safe operating area for TO-220FP

Figure 2. Thermal impedance for TO-220FP

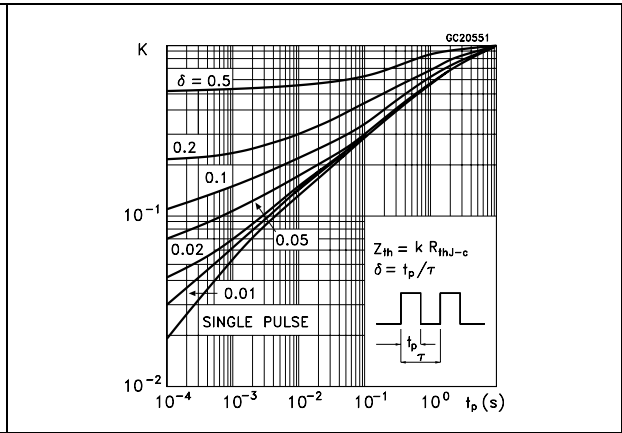
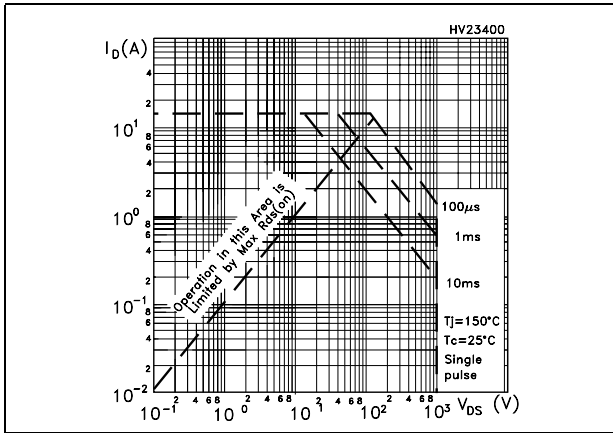


Figure 3. Safe operating area for TO-220

Figure 4. Thermal impedance for TO-220

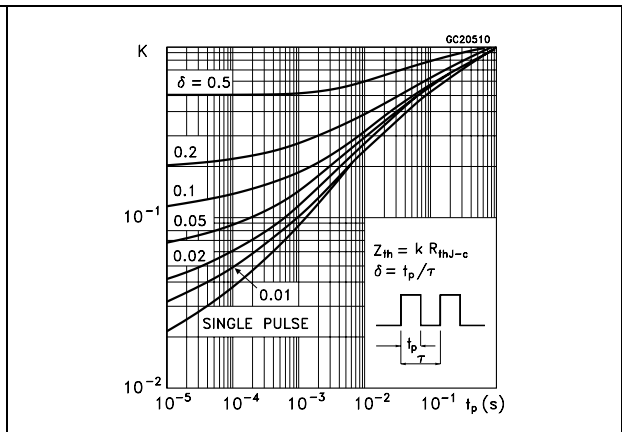
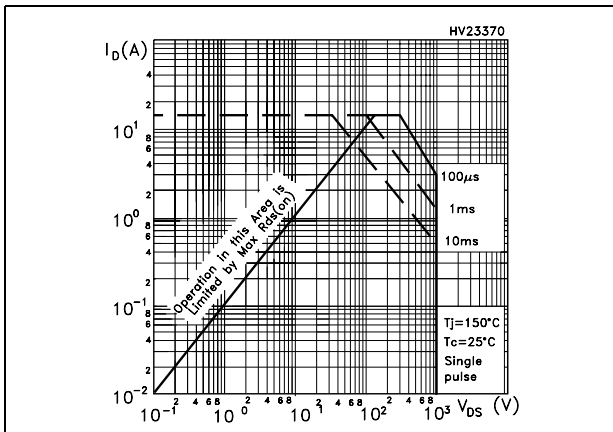


Figure 5. Safe operating area for TO-247

Figure 6. Thermal impedance for TO-247

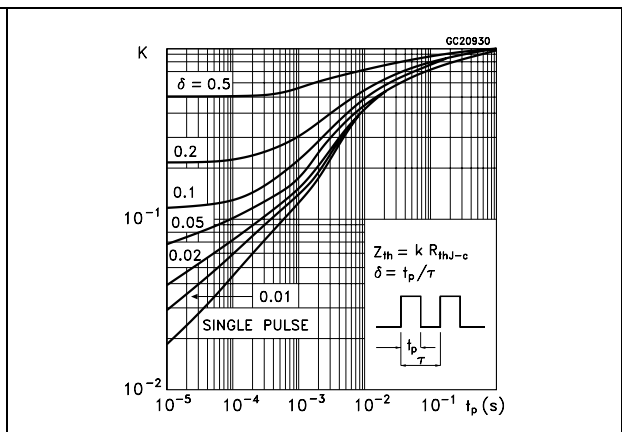
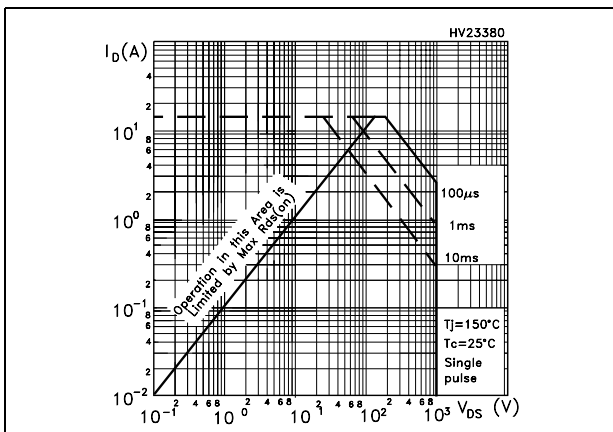


Figure 7. Output characteristics

Figure 8. Transfer characteristics

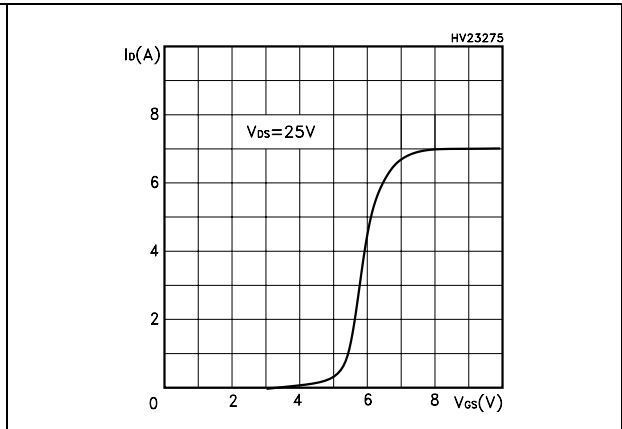
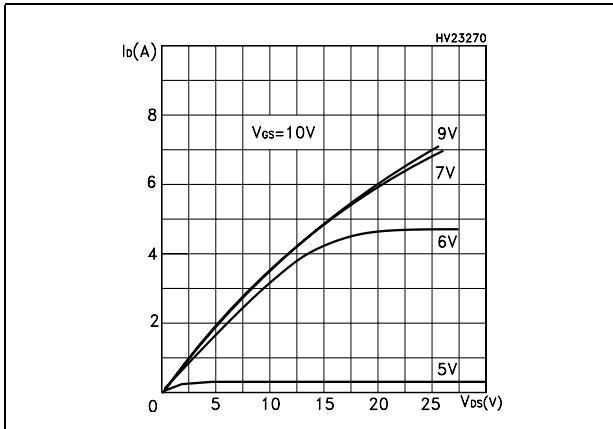


Figure 9. Transconductance

Figure 10. Static drain-source on resistance

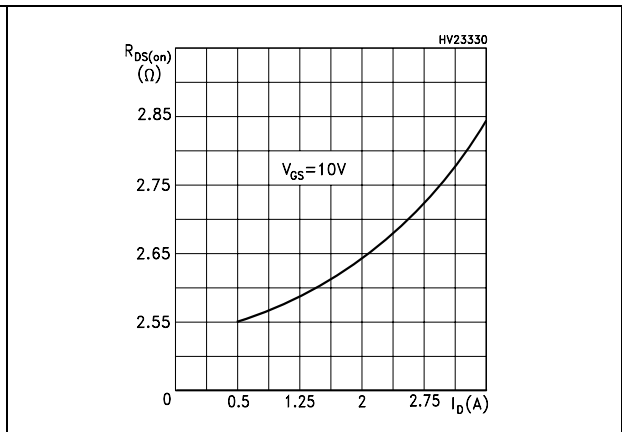
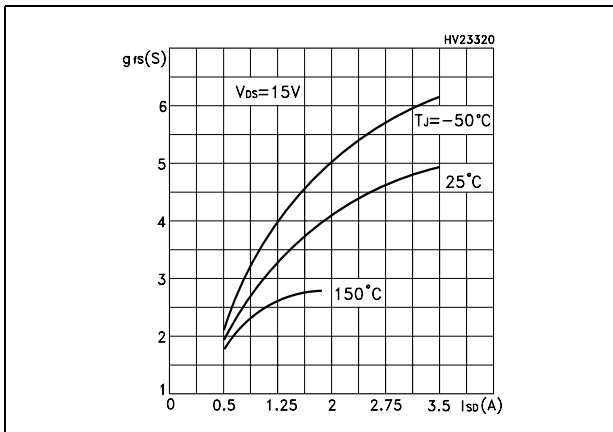


Figure 11. Gate charge vs gate-source voltage

Figure 12. Capacitance variations

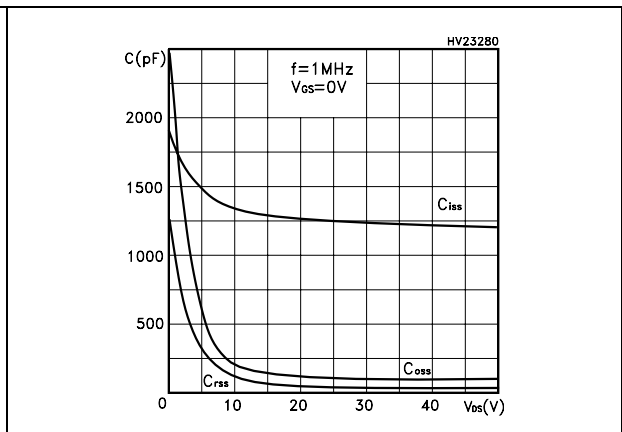
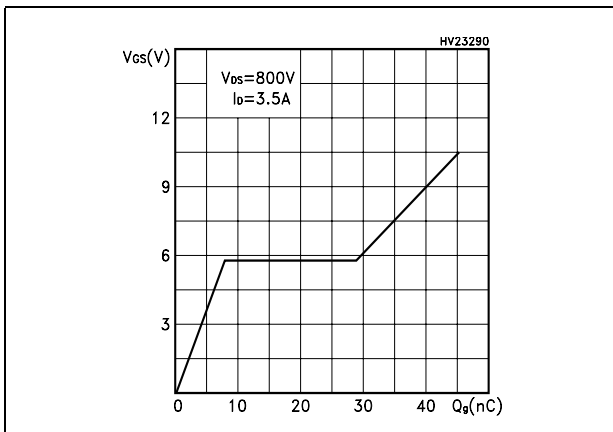




Figure 13. Normalized gate threshold voltage vs temperature

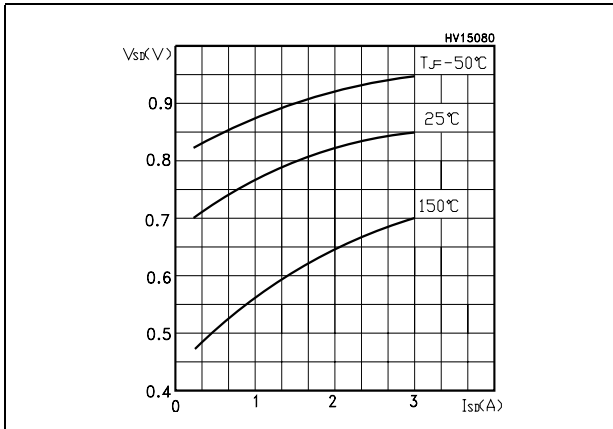


Figure 14. Normalized on resistance vs temperature

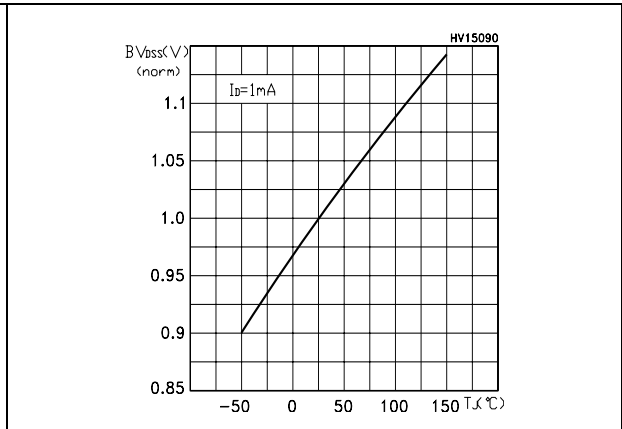


Figure 15. Source-drain diode forward characteristics

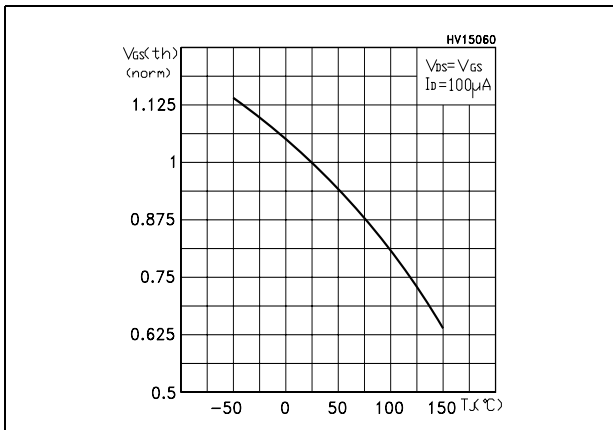


Figure 16. Normalized BVdss vs temperature

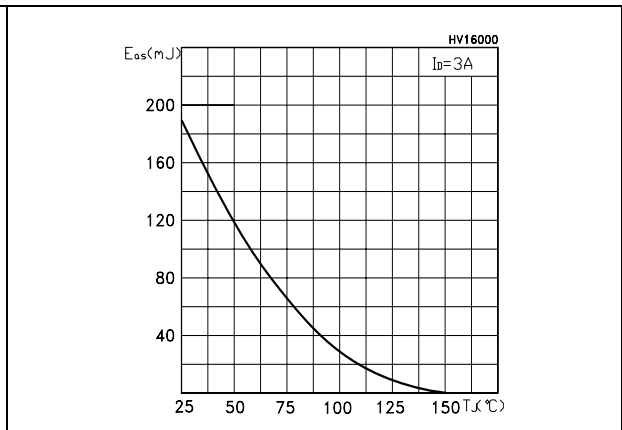
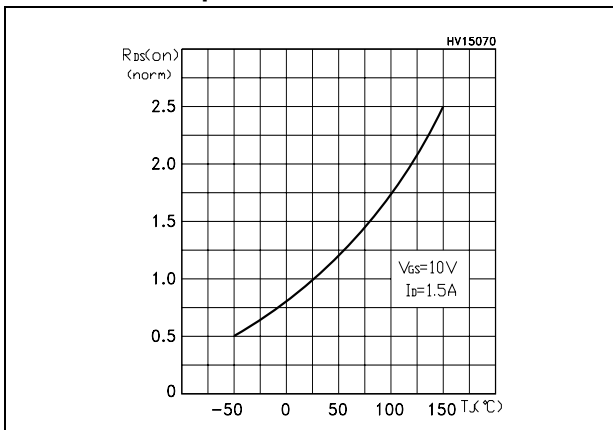


Figure 17. Maximum avalanche energy vs temperature



### 3 Test circuit

Figure 18. Unclamped Inductive load test circuit

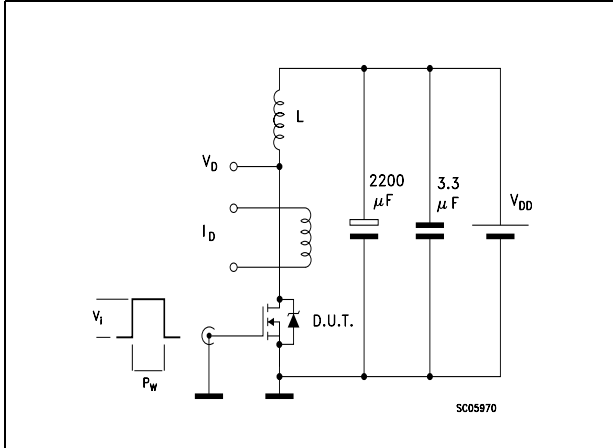


Figure 19. Unclamped Inductive waveform

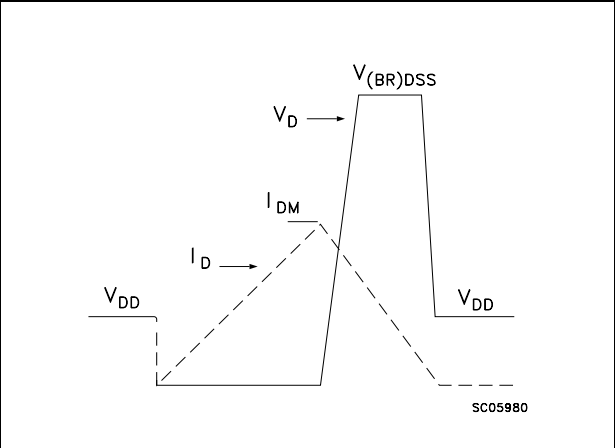


Figure 20. Switching times test circuit for resistive load

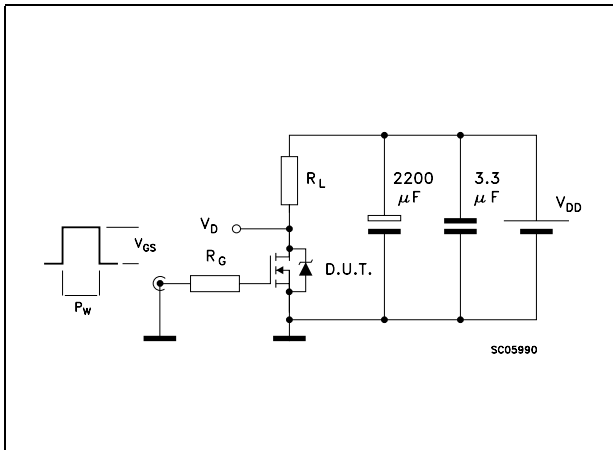


Figure 21. Gate charge test circuit

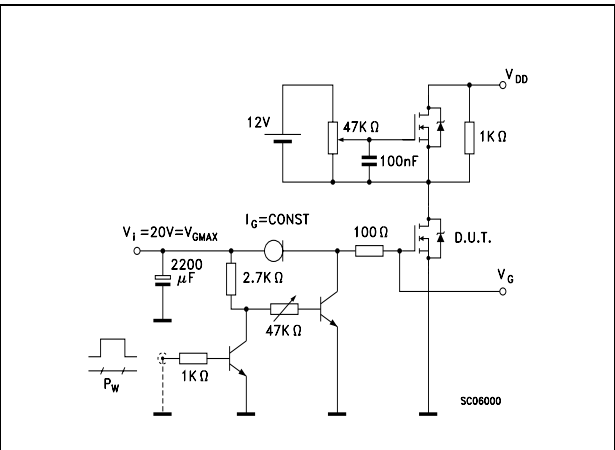
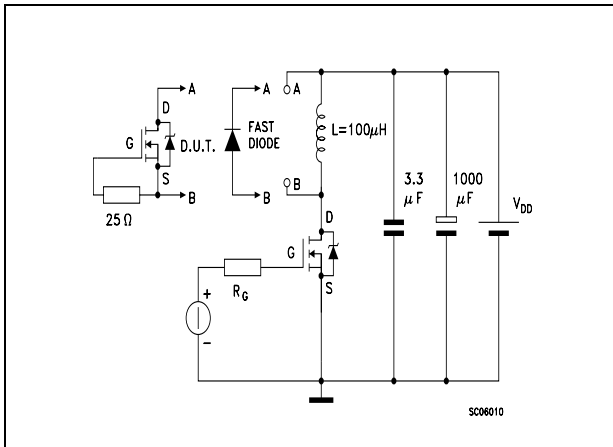


Figure 22. Test circuit for inductive load switching and diode recovery times

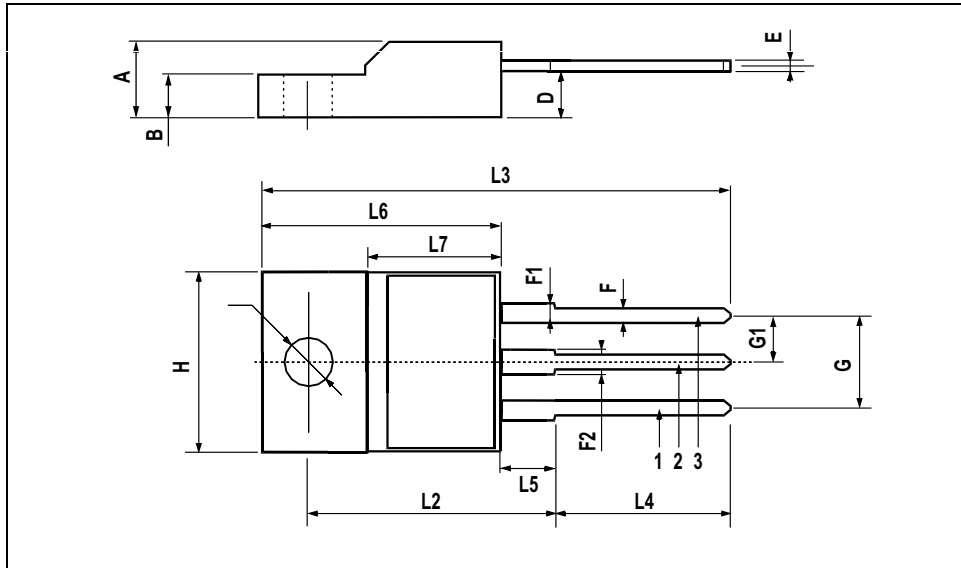


## 4 Package mechanical data

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)

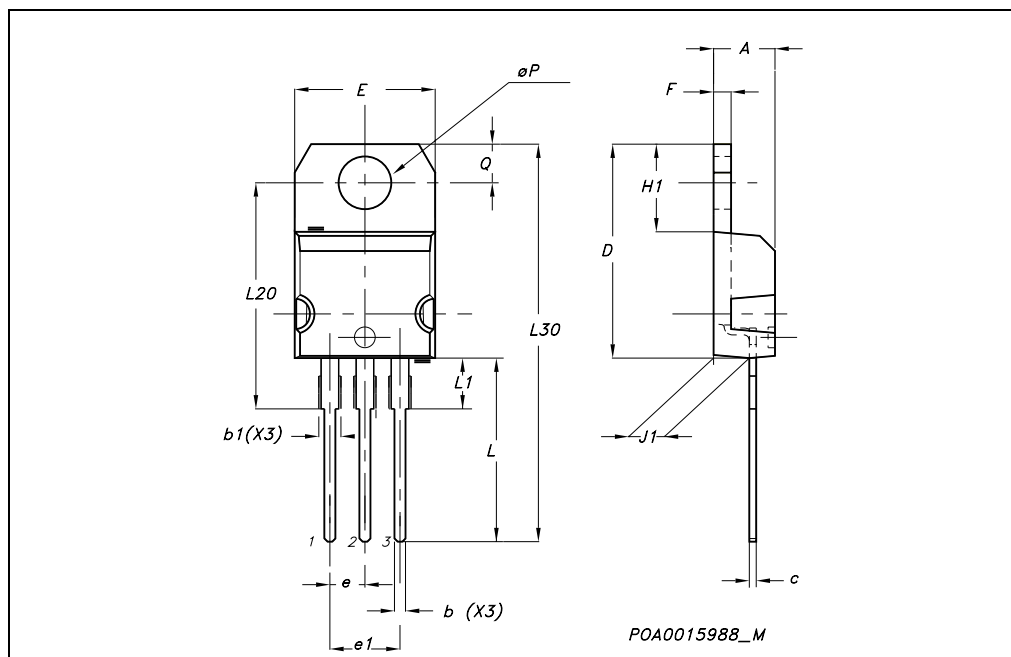
**TO-220FP MECHANICAL DATA**

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
Ø	3		3.2	0.118		0.126



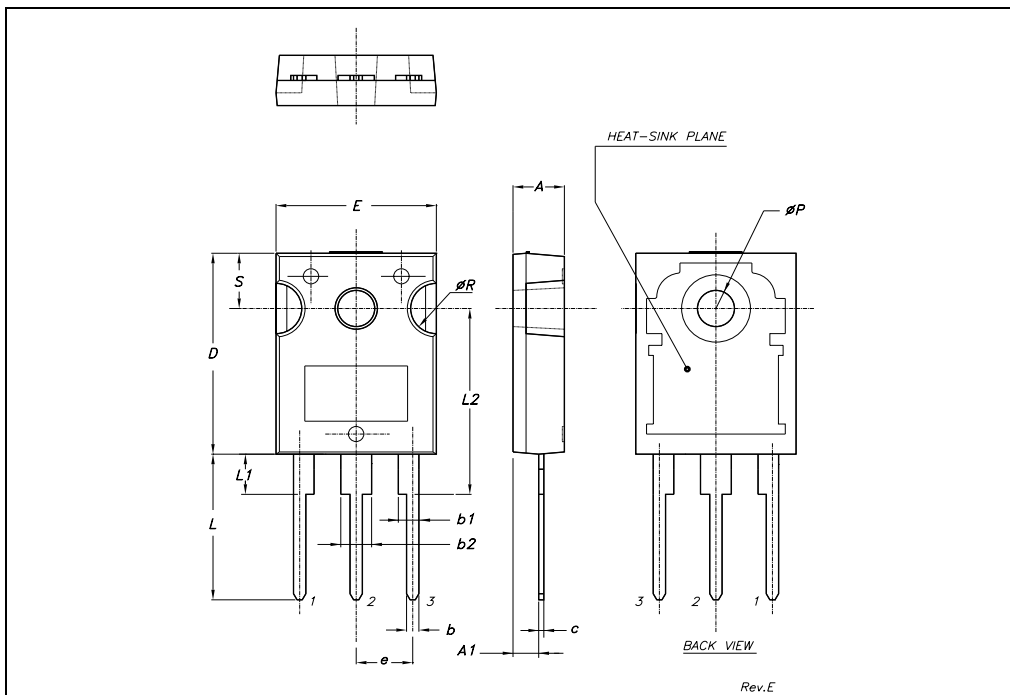
## TO-220 MECHANICAL DATA

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-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 Revision history

**Table 8. Revision history**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
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

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