



# STP6NK70Z STF6NK70Z - STW6NK70Z

N-channel 700V - 1.5Ω - 5A - TO-220/TO-220FP  
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>
STP6NK70Z	700 V	< 1.8 Ω	5 A
STF6NK70Z	700 V	< 1.8 Ω	5 A <sup>(1)</sup>
STW6NK70Z	700 V	< 1.8 Ω	5 A

1. Limited only by maximum temperature allowed

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

## Description

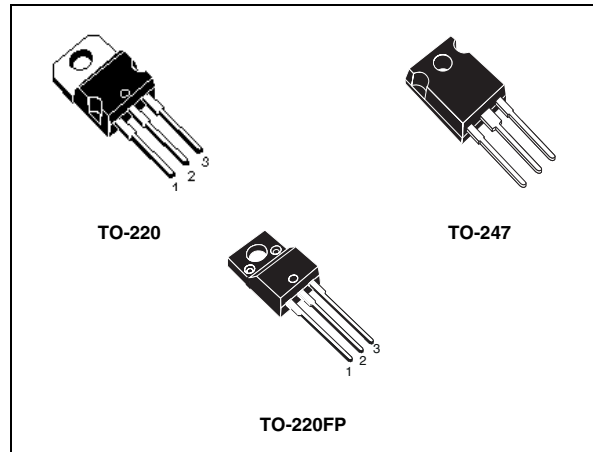
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strippbased PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements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

## Applications

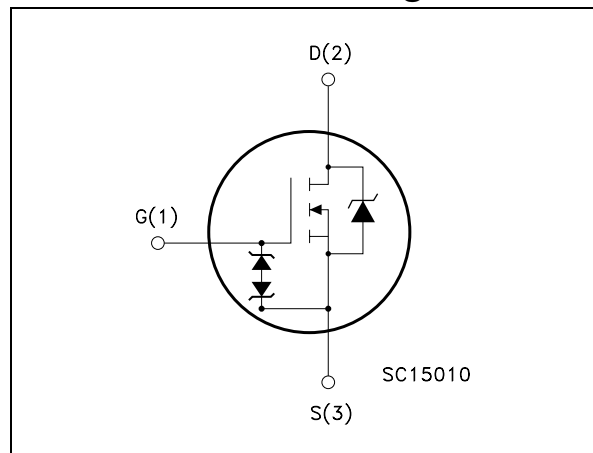
- Switching application

## Order codes

Part number	Marking	Package	Packaging
STP6NK70Z	P6NK70Z	TO-220	Tube
STF6NK70Z	F6NK70Z	TO-220FP	Tube
STW6NK70Z	W5NK90Z	TO-247	Tube



## Internal schematic diagram



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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 ( $V_{GS} = 0$ )	700		V
$V_{GS}$	Gate-source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25^\circ\text{C}$	5	5 <sup>(2)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100^\circ\text{C}$	3.15	3.15 <sup>(2)</sup>	A
$I_{DM}^{(1)}$	Drain current (pulsed)	20	20 <sup>(2)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	110	30	W
	Derating factor	0.87	0.24	W/°C
$V_{ESD(G-S)}$	Gate source ESD (HBM-C=100pF, R=1.5K $\Omega$ )	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=1s; $T_C = 25^\circ\text{C}$ )	-	2500	V
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 150		°C

1. Pulse width limited by safe operation area
2. Limited only by maximum temperature allowed
3.  $I_{SD} \leq 5$  A,  $di/dt \leq 100$  A/ $\mu$ 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	1.14	4.2	°C/W
$R_{thj-a}$	Thermal resistance junction-ambient max	62.5		°C/W
$T_I$	Maximum lead temperature for soldering purpose	300		°C

**Table 3. Avalanche characteristics**

Symbol	Parameter	Max Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ Max)	5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$ , $I_d=I_{ar}$ , $V_{dd}=50\text{V}$ )	200	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	$I_D = 1mA, V_{GS} = 0$	700			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	$V_{GS} = 10 V, I_D = 2.5 A$		1.5	1.8	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15V, I_D = 2.5A$		4.4		S
$C_{iss}$	Input capacitance	$V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$		930		pF
$C_{oss}$	Output capacitance			105		pF
$C_{rss}$	Reverse transfer capacitance			22		pF
$C_{osseq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0V \text{ to } 560V$		70		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 350 V, I_D = 2.5 A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see <a href="#">Figure 18</a> )		17		ns
$t_r$	Rise time			18		ns
$t_{d(off)}$	Off-voltage rise time			45		ns
$t_f$	Fall time			30		ns
$Q_g$	Total gate charge	$V_{DD} = 560V, I_D = 5A$		34	47	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10V$		6.5		nC
$Q_{gd}$	Gate-drain charge	(see <a href="#">Figure 19</a> )		17		nC

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

2.  $C_{oss eq.}$  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	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				20	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 5 \text{ A}$ , $V_{GS} = 0$			1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 35 \text{ V}$ (see <a href="#">Figure 20</a> )		432		ns
$Q_{rr}$	Reverse recovery charge			2.37		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			11		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 35 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 20</a> )		588		ns
$Q_{rr}$	Reverse recovery charge			3.38		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			11.5		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

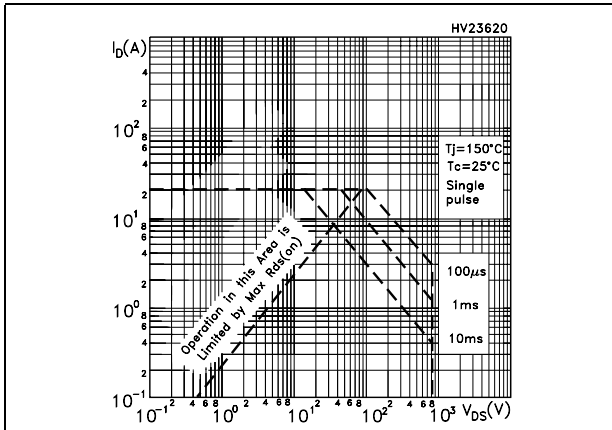


Figure 2. Thermal impedance

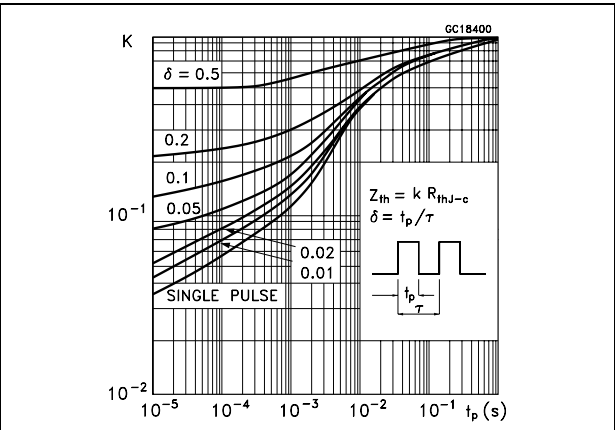


Figure 3. Safe operating area for TO-220FP

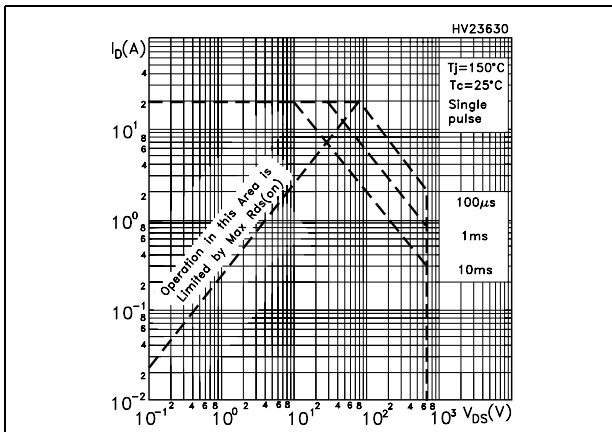


Figure 4. Thermal impedance for TO-220FP

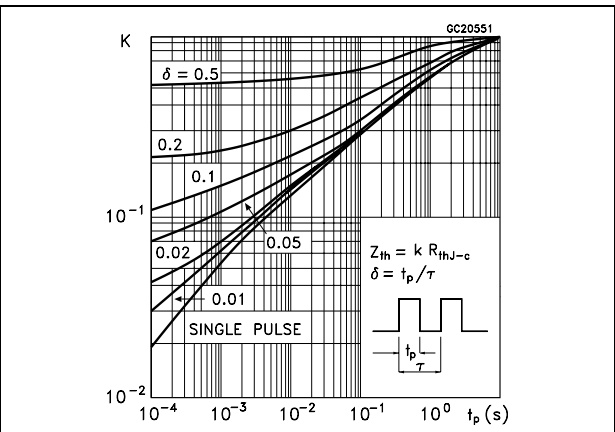


Figure 5. Safe operating area for TO-247

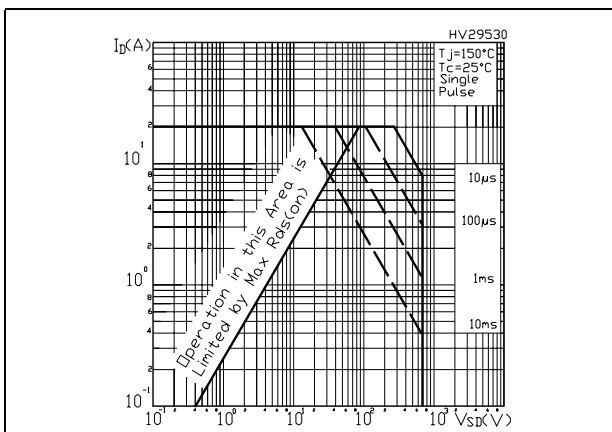


Figure 6. Thermal impedance for TO-247

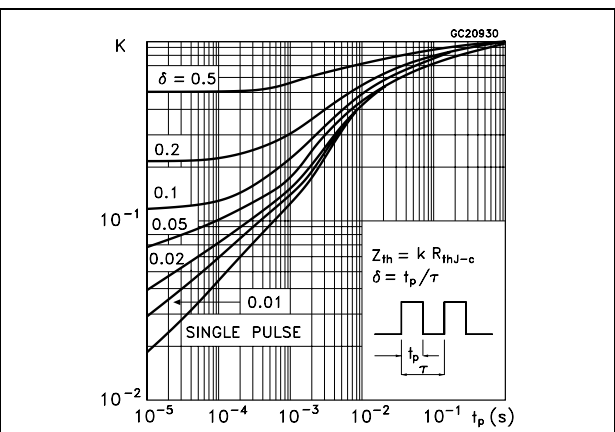


Figure 7. Output characteristics

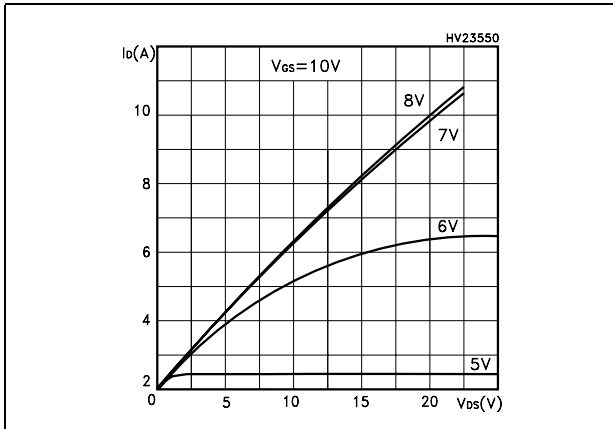


Figure 8. Transfer characteristics

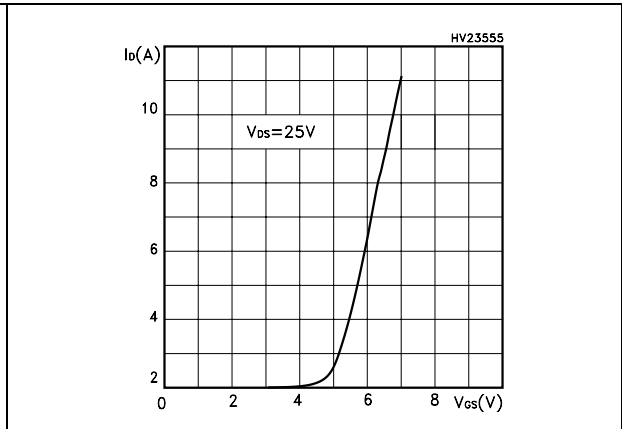


Figure 9. Transconductance

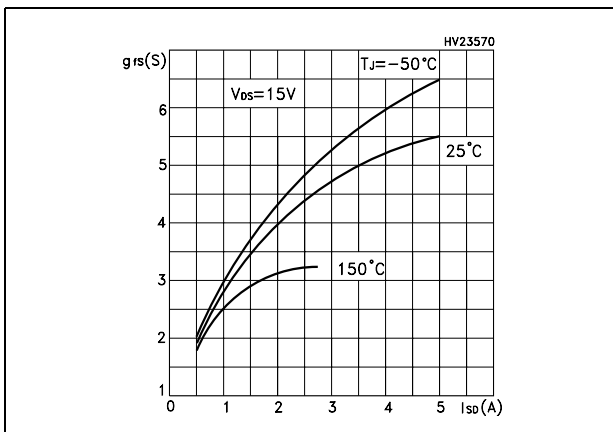


Figure 10. Static drain-source on resistance

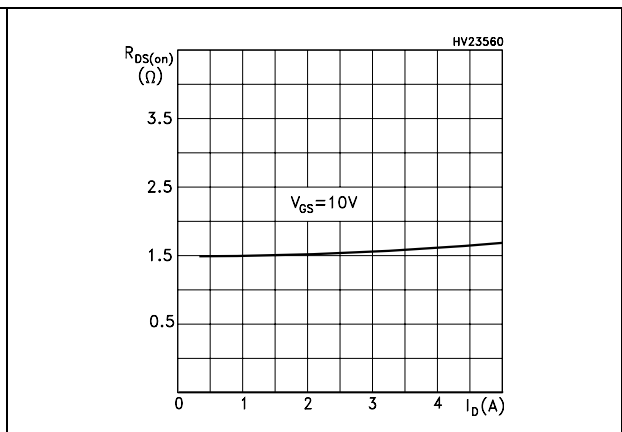


Figure 11. Gate charge vs gate-source voltage

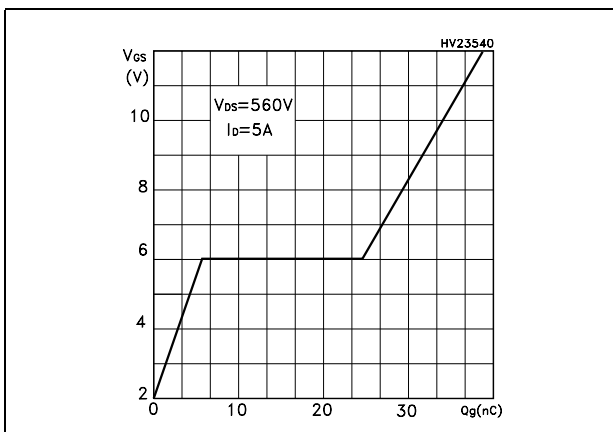


Figure 12. Capacitance variations

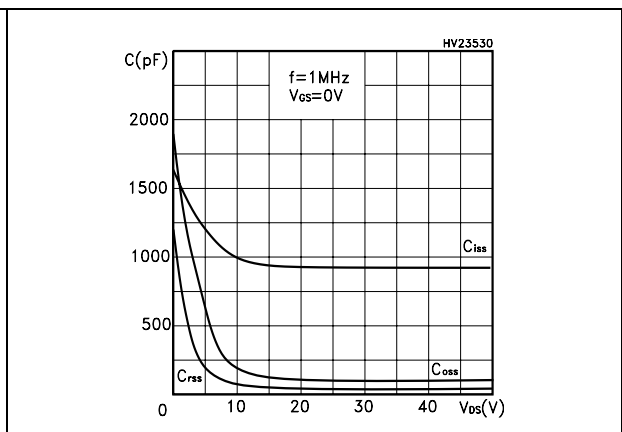




Figure 13. Source-drain diode forward characteristics

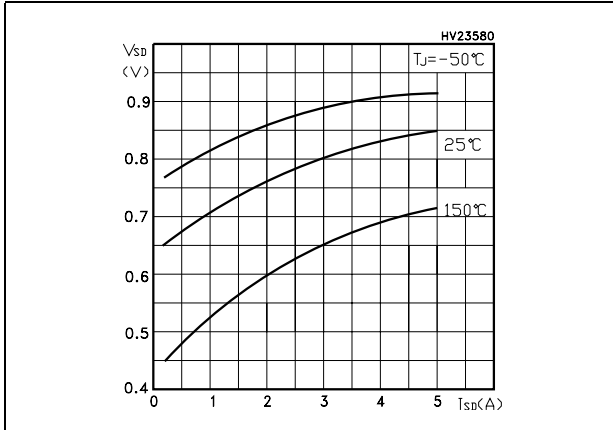


Figure 14. Normalized  $BV_{dss}$  vs temperature characteristics

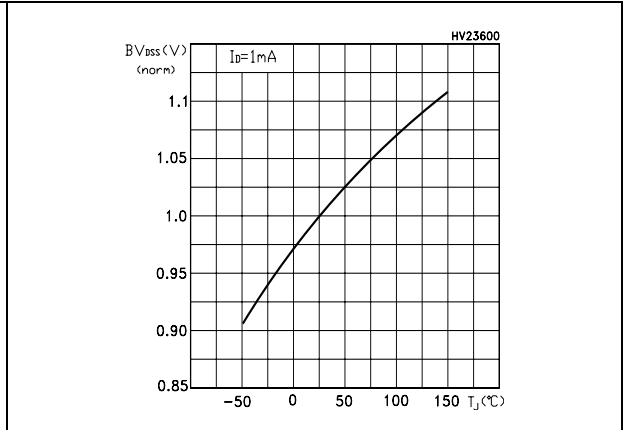
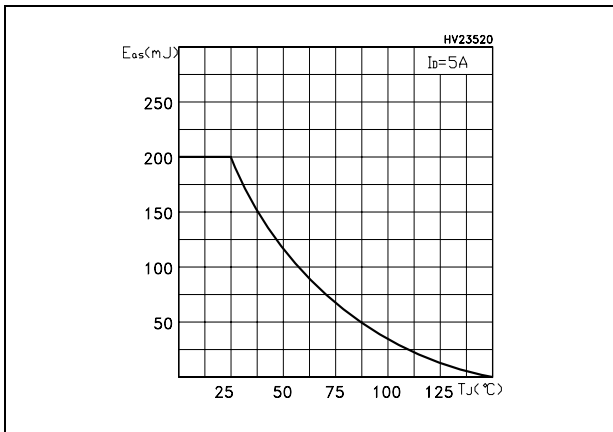


Figure 15. Avalanche Energy vs starting  $T_j$



### 3 Test circuit

Figure 16. Unclamped inductive load test circuit

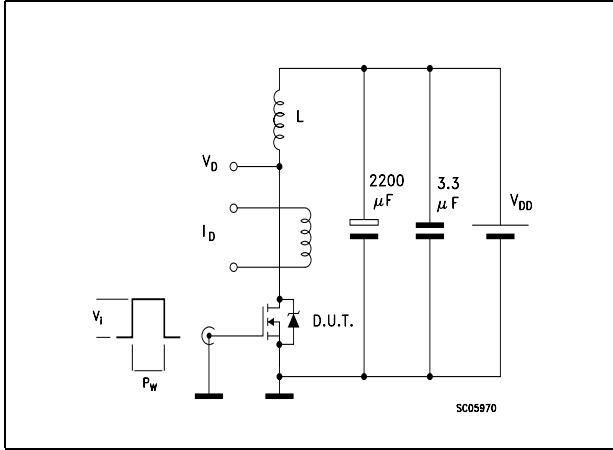


Figure 17. Unclamped inductive waveform

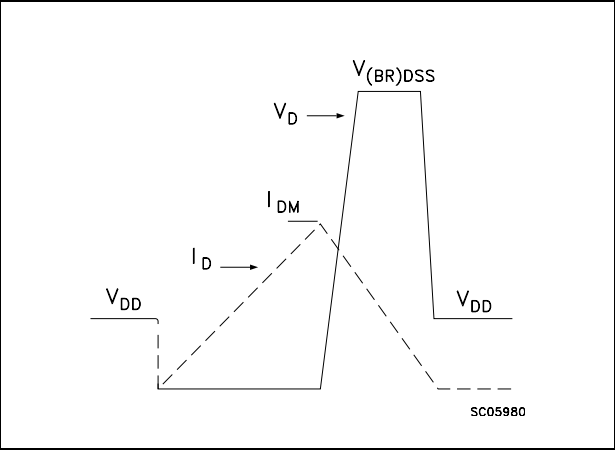


Figure 18. Switching times test circuit for resistive load

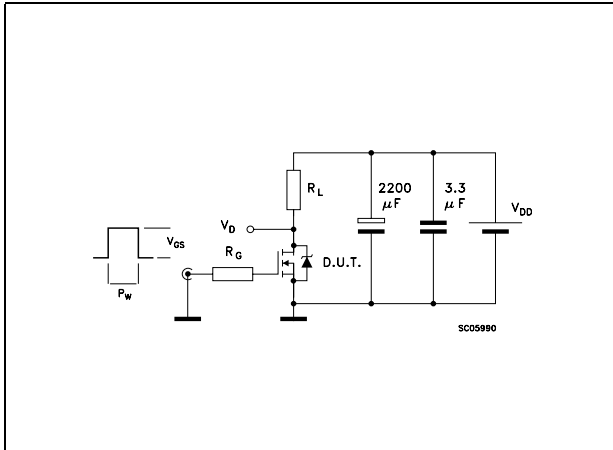


Figure 19. Gate charge test circuit

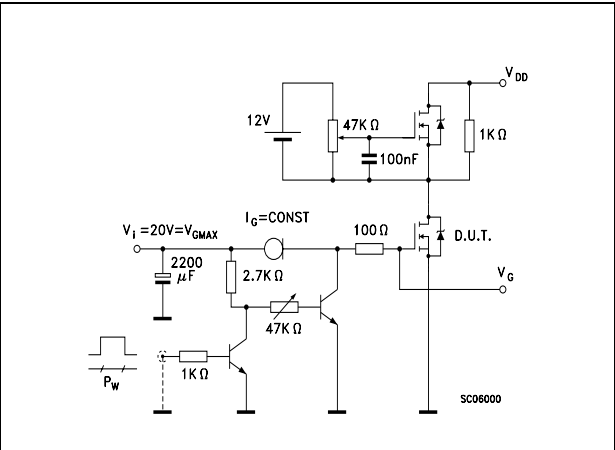
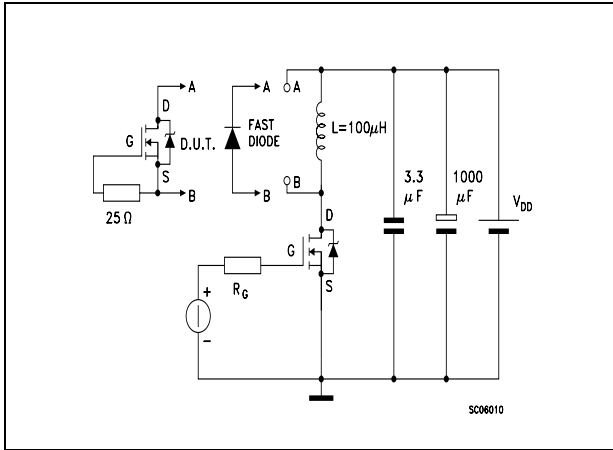


Figure 20. Test circuit for inductive load switching and diode recovery times

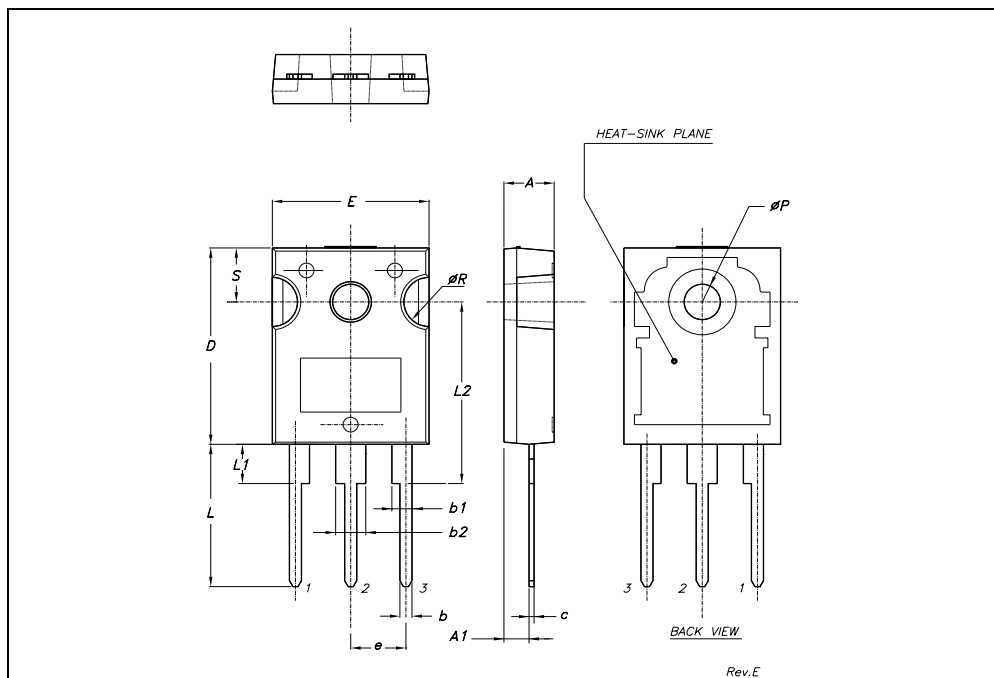


## 4 Package mechanical data

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)

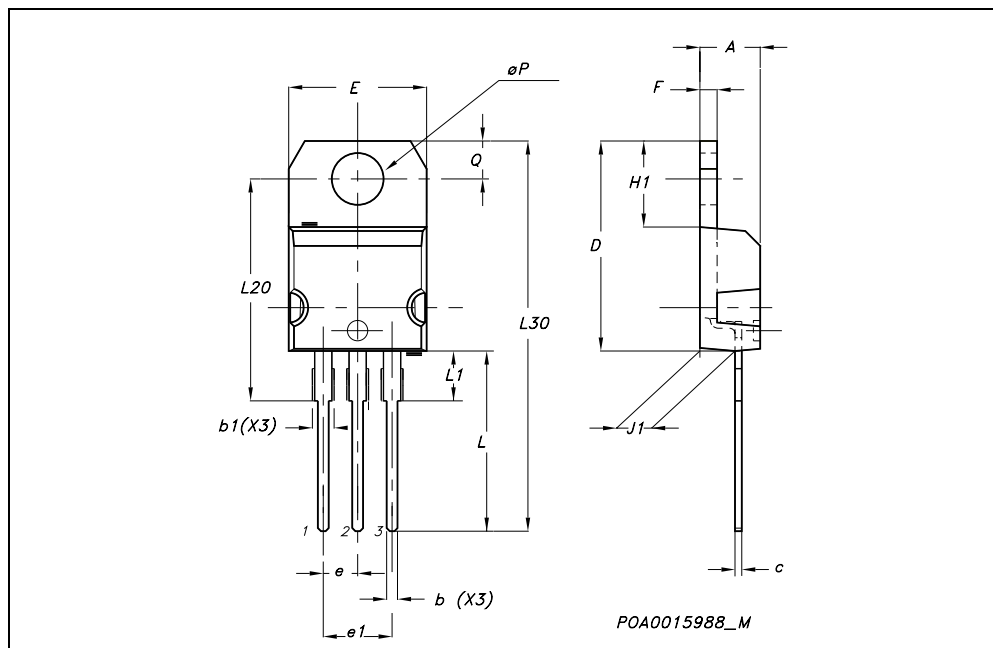
**TO-247 MECHANICAL DATA**

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	



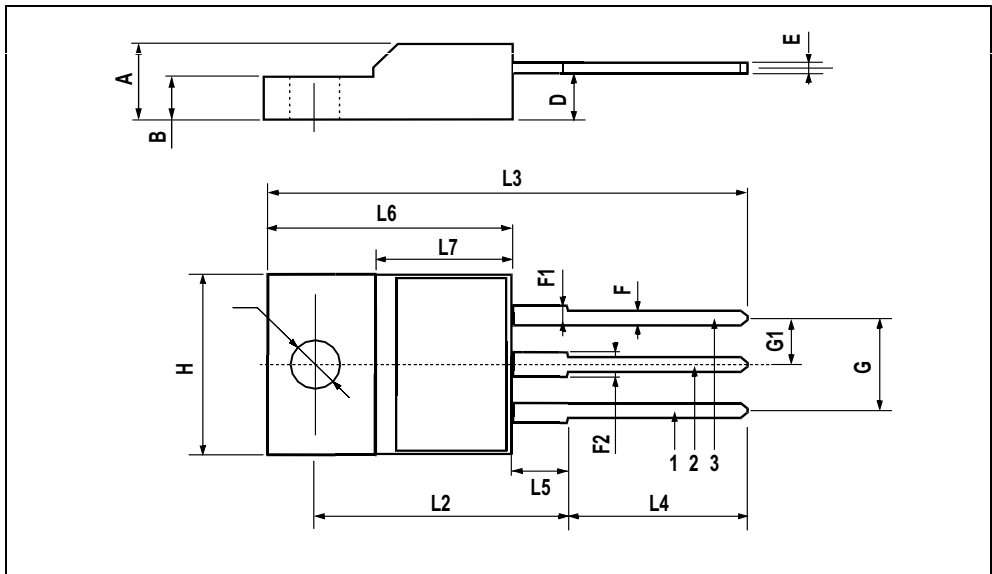
**TO-220 MECHANICAL DATA**

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
Ø	3		3.2	0.118		0.126



## 5 Revision history

**Table 8. Revision history**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
12-Nov-2004	1	First release
08-Sep-2004	2	Complete version with curves
06-Sep-2005	3	Inserted Ecopack indication
16-Aug-2006	4	New template, no content change

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