



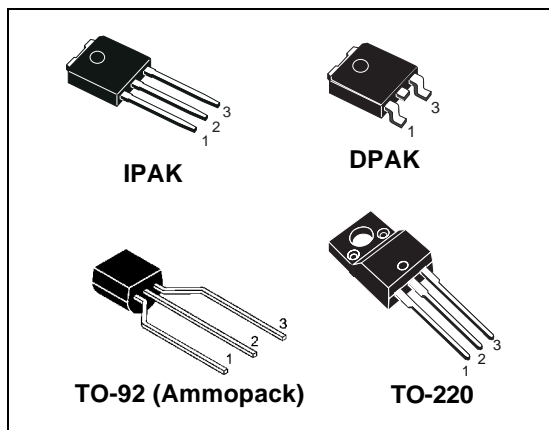
# STD2HNK60Z - STD2HNK60Z-1 STF2HNK60Z - STQ2HNK60ZR-AP

N-channel 600V - 4.4Ω - 2A - TO-92/TO-220FP/DPAK/IPAK  
Zener-protected SuperMESH™ Power MOSFET

## General features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>TOT</sub>
STD2HNK60Z	600V	<4.8Ω	2A	45W
STD2HNK60Z-1	600V	<4.8Ω	2A	45W
STF2HNK60Z	600V	<4.8Ω	2A	20W
STQ2HNK60ZR-AP	600V	<4.8Ω	0.5A	3W

- Gate charge minimized
- 100% avalanche tested
- Extremely high dv/dt capability
- ESD improved capability
- New high voltage benchmark



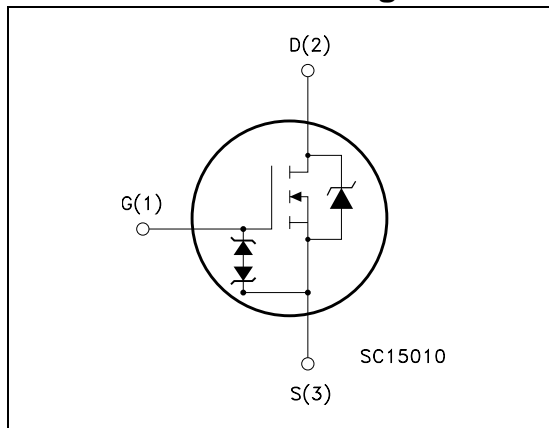
## Description

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 application. Such series complements ST full range of high voltage Power MOSFETs including revolutionary MDmesh™ products.

## Applications

- Switching application

## Internal schematic diagram



## Order codes

Sales Type	Marking	Package	Packaging
STD2HNK60Z	D2HNK60Z	DPAK	Tape & reel
STD2HNK60Z-1	D2HNK60Z	IPAK	Tube
STF2HNK60Z	F2HNK60Z	TO-220FP	Tube
STQ2HNK60ZR-AP	Q2HNK60ZR	TO-92	Ammopak

**Contents:**

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		IPAK/DPAK	TO-220FP	TO-92	
$V_{DS}$	Drain-Source Voltage ( $V_{GS} = 0$ )	600			V
$V_{DGR}$	Drain-gate Voltage ( $R_{GS} = 20k\Omega$ )	600			V
$V_{GS}$	Gate-Source Voltage	$\pm 30$			V
$I_D$	Drain Current (continuous) at $T_C = 25^\circ\text{C}$	2.0	2.0	0.5	A
$I_D$	Drain Current (continuous) at $T_C = 100^\circ\text{C}$	1.26	1.26	0.32	A
$I_{DM}^{(1)}$	Drain Current (pulsed)	8	8	2	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	45	20	3	W
	Derating Factor	0.36	0.16	0.025	W/ $^\circ\text{C}$
$V_{ESD(G-S)}$	Gate Source ESD (HBM-C=100pF, R=1.5k $\Omega$ )	2000			V
$V_{ISO}$	Insulation withstand voltage (DC)	--	2500	--	V
$dv/dt^{(2)}$	Peak Diode Recovery voltage slope	4.5			V/ns
$T_J$ $T_{stg}$	Operating Junction Temperature Storage Temperature	-55 to 150			$^\circ\text{C}$
$T_l$	Maximum lead temperature for soldering purpose	300		260	$^\circ\text{C}$

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 2\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} = 80\%V_{(BR)DSS}$

**Table 2. Thermal data**

		IPAK/DPAK	TO-220FP	TO-92	
$R_{thj-case}$	Thermal resistance junction-case Max	2.77	6.25	--	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient Max	100	62.5	120	$^\circ\text{C}/\text{W}$
$R_{thj-lead}$	Thermal resistance junction-lead Max	--	--	40	$^\circ\text{C}/\text{W}$

**Table 3. Avalanche data**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	2	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{V}$ )	120	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	$I_D = 1mA, V_{GS} = 0$	600			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 ( $V_{DS} = 0$ )	$V_{GS} = \pm 20V$			$\pm 10$	nA
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 50\mu A$	3	3.75	4.5	V
$R_{DS(on)}$	Static Drain-Source On Resistance	$V_{GS} = 10V, I_D = 1.0A$		4.4	4.8	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward Transconductance	$V_{DS} = 15V, I_D = 1.0A$		1.5		S
$C_{iss}$	Input Capacitance	$V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$		280		pF
$C_{oss}$	Output Capacitance			38		pF
$C_{rss}$	Reverse Transfer Capacitance			7		pF
$C_{oss \text{ eq}}^{(2)}$	Equivalent Output Capacitance	$V_{GS} = 0, V_{DS} = 0V \text{ to } 480V$		30		pF
$Q_g$	Total Gate Charge	$V_{DD} = 480V, I_D = 2.0A$ $V_{GS} = 10V$ (see Figure 18)		11	15	nC
$Q_{gs}$	Gate-Source Charge			2.25		nC
$Q_{gd}$	Gate-Drain Charge			6		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 6. Switching times**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$	Turn-on Delay Time Rise Time	$V_{DD}=300V, I_D=1.0A,$ $R_G=4.7\Omega, V_{GS}=10V$ (see Figure 17)		10 30		ns ns
$t_{d(off)}$ $t_f$	Turn-off Delay Time Fall Time	$V_{DD}=300V, I_D=1.0A,$ $R_G=4.7\Omega, V_{GS}=10V$ (see Figure 17)		23 50		ns ns

**Table 7. Source drain diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}^{(1)}$	Source-drain Current Source-drain Current (pulsed)				2.0 8.0	A A
$V_{SD}^{(2)}$	Forward on Voltage	$I_{SD}=2.0A, V_{GS}=0$			1.3	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD}=2.0A, di/dt = 100A/\mu s,$ $V_{DD}=20 V, T_j=25^\circ C$		178 445 5		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD}=2.0A, di/dt = 100A/\mu s,$ $V_{DD}=20 V, T_j=150^\circ C$		200 500 5		ns nC A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration=300μs, duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-92

Figure 2. Thermal impedance for TO-92

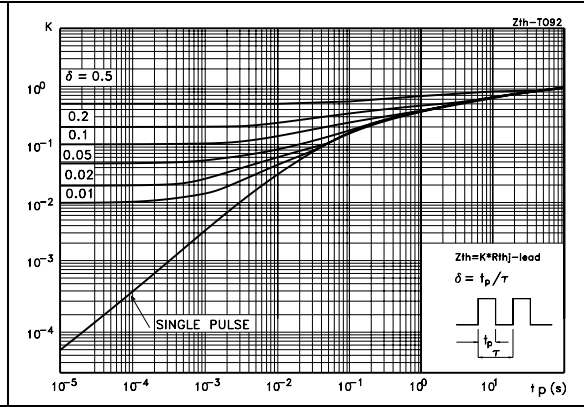
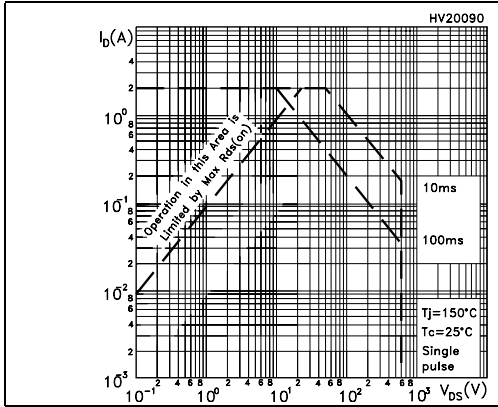


Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

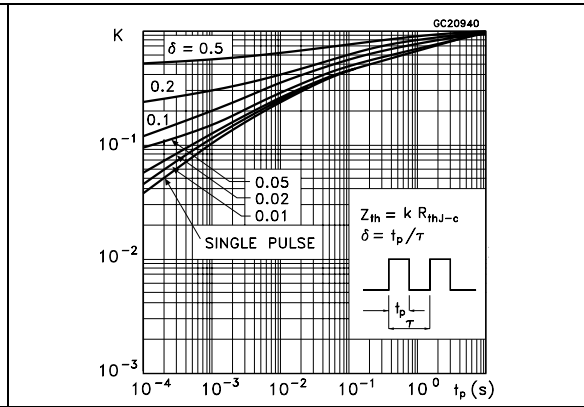
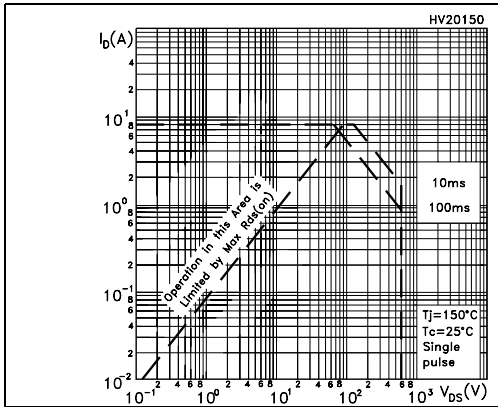


Figure 5. Safe operating area for IPAK/DPAK

Figure 6. Thermal impedance for IPAK/DPAK

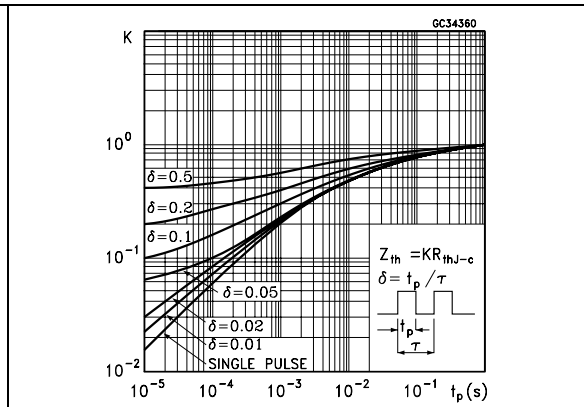
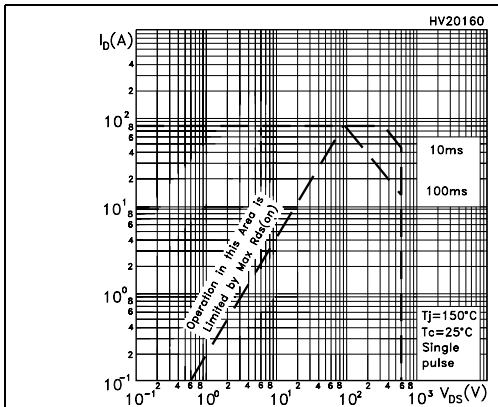


Figure 7. Output characteristics

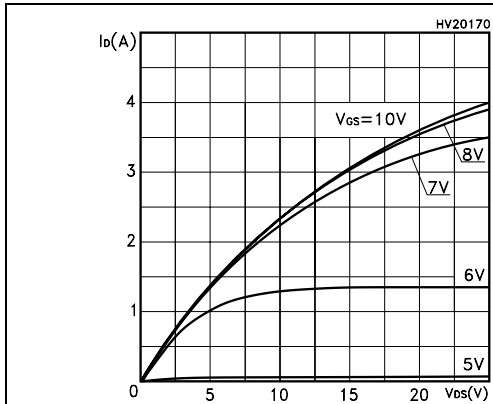


Figure 8. Transfer characteristics

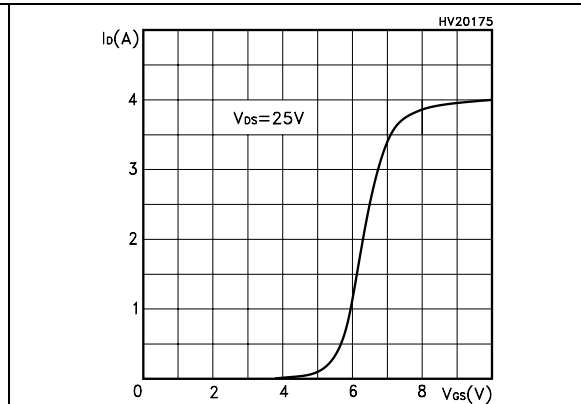


Figure 9. Normalized  $B_{V_{DS}}$  vs temperature

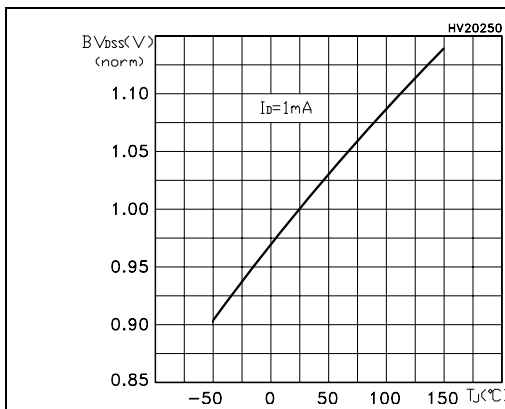


Figure 10. Static drain-source on resistance

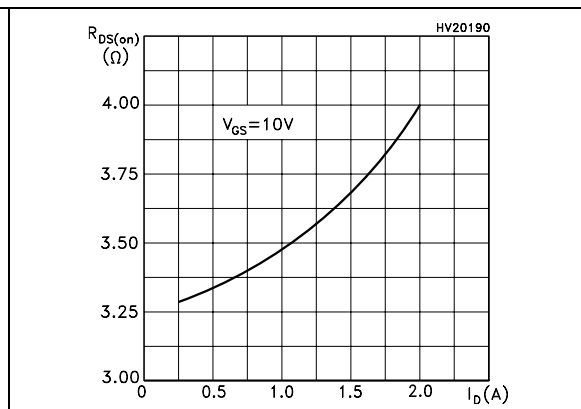


Figure 11. Gate charge vs gate-source voltage

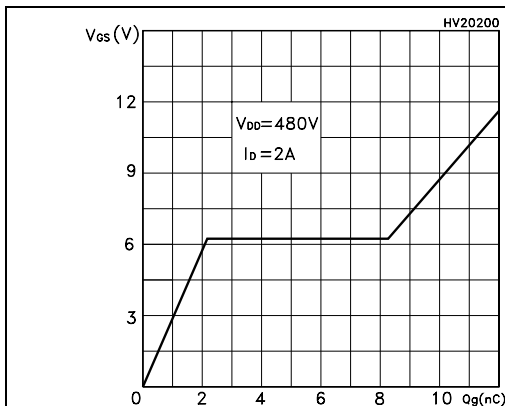


Figure 12. Capacitance variations

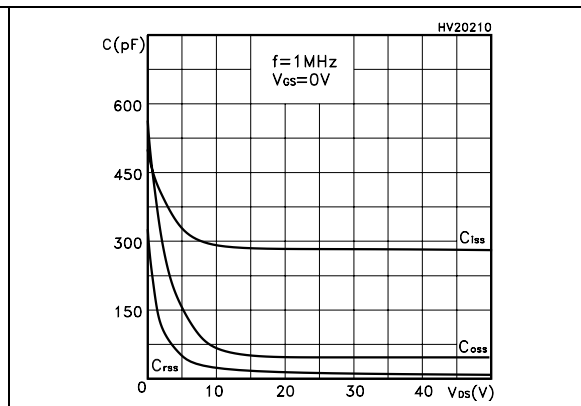


Figure 13. Normalized gate threshold voltage vs temperature

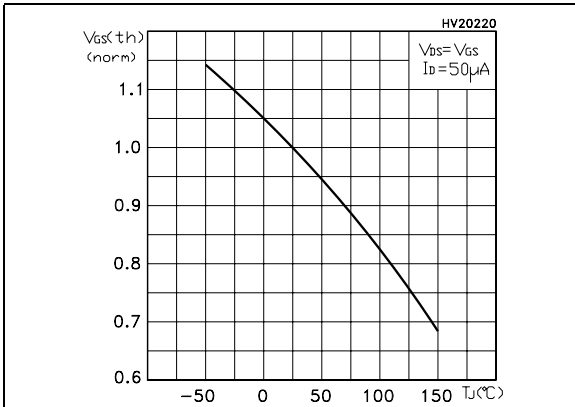


Figure 14. Normalized on resistance vs temperature

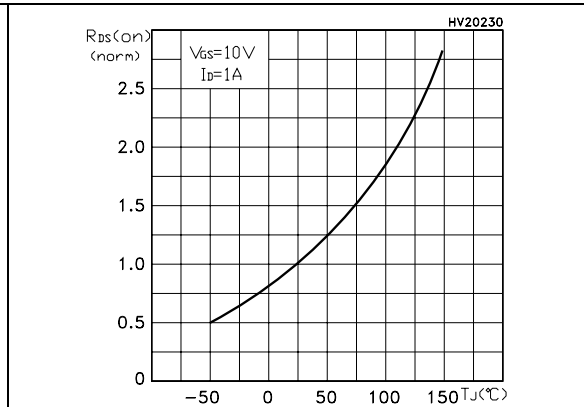


Figure 15. Source-drain diode forward characteristics

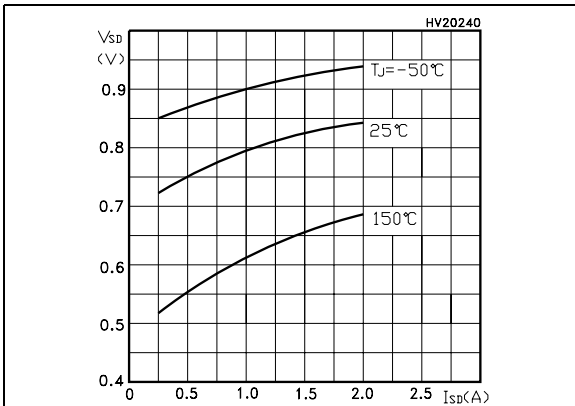
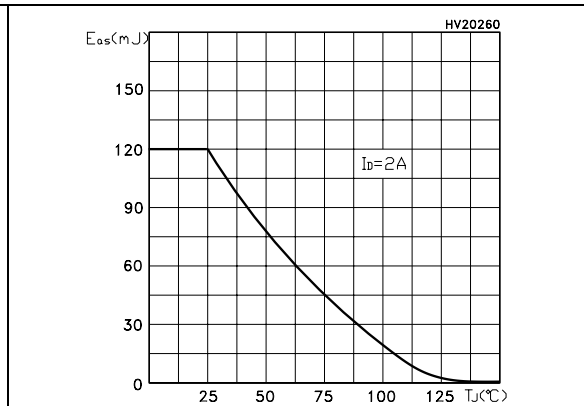


Figure 16. Maximum avalanche energy vs temperature





### 3 Test circuit

Figure 17. Switching times test circuit for resistive load

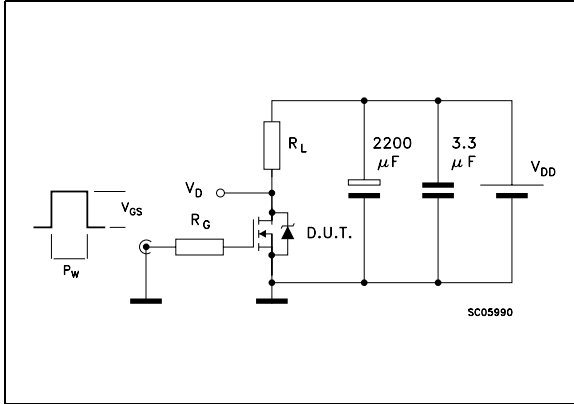


Figure 18. Gate charge test circuit

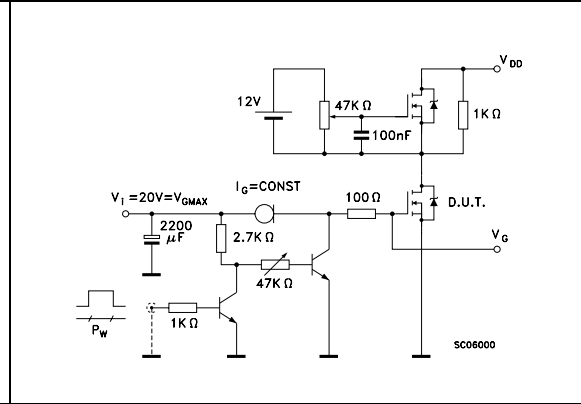


Figure 19. Test circuit for inductive load switching and diode recovery times

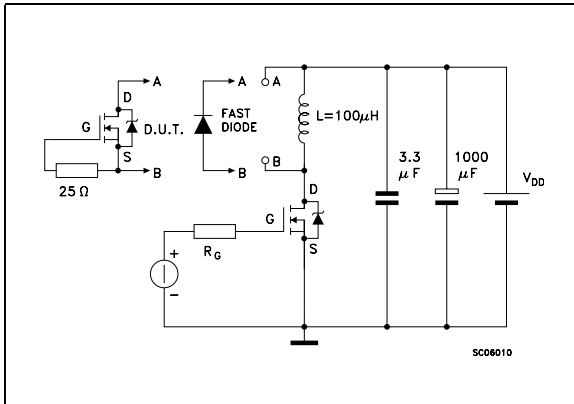


Figure 20. Unclamped inductive load test circuit

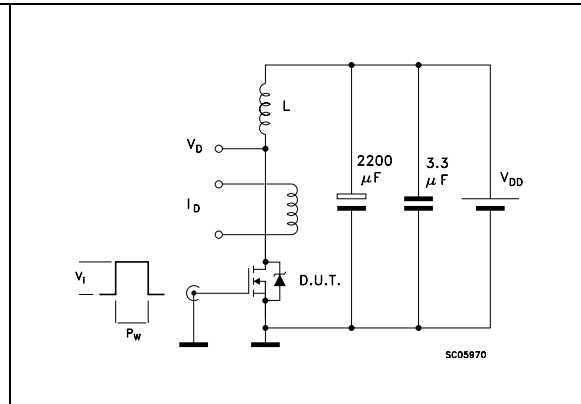


Figure 21. Unclamped inductive waveform

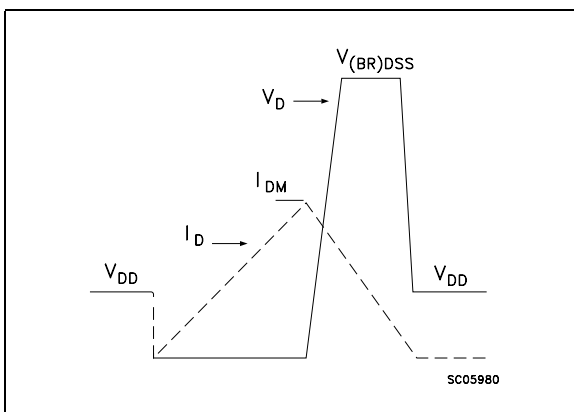
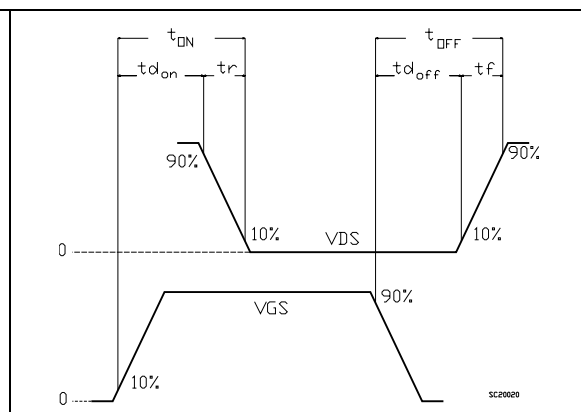


Figure 22. Switching time waveform

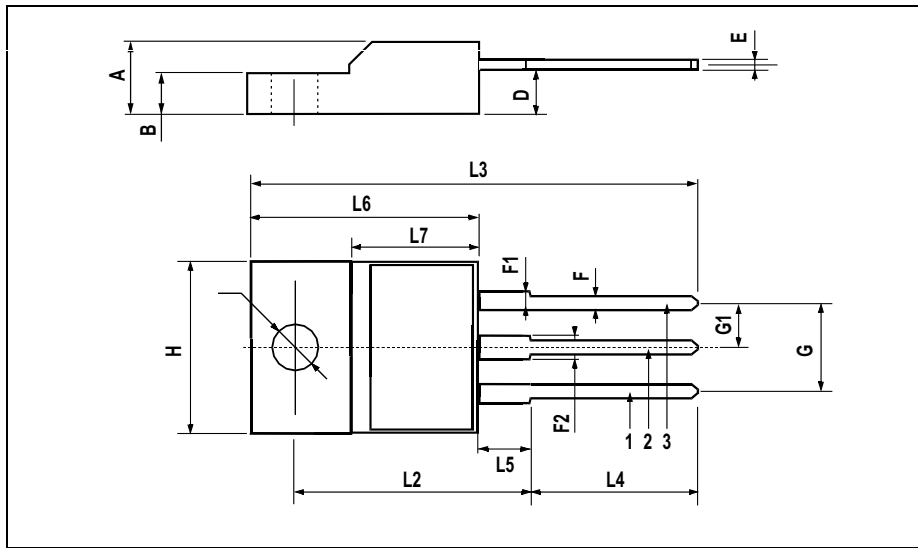


## 4 Package mechanical data

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)

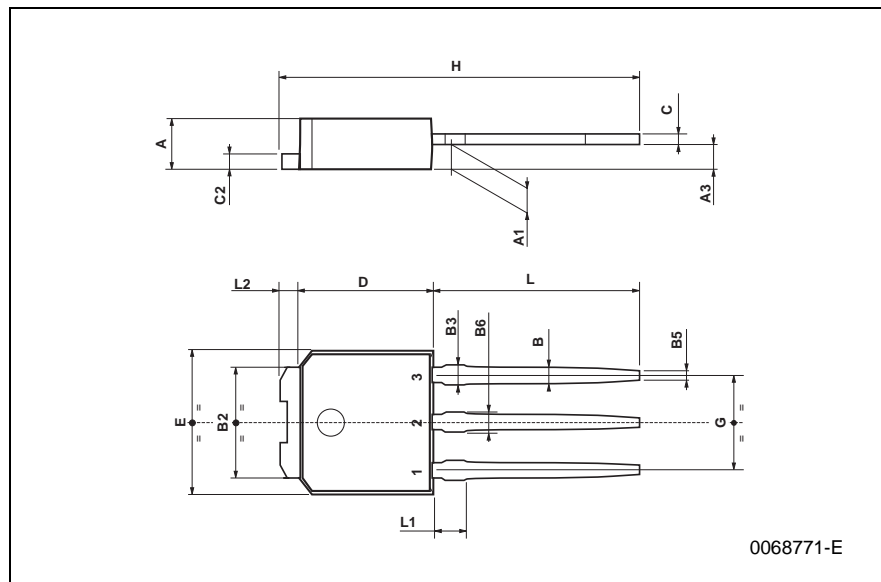
**TO-220FP MECHANICAL DATA**

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
∅	3		3.2	0.118		0.126



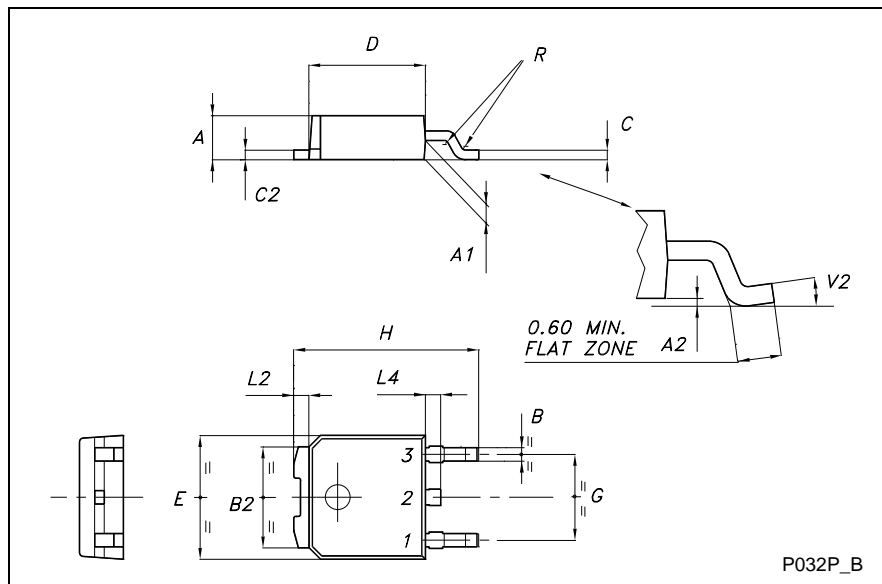
TO-251 (IPAK) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.031
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	15.9		16.3	0.626		0.641
L	9		9.4	0.354		0.370
L1	0.8		1.2	0.031		0.047
L2		0.8	1		0.031	0.039



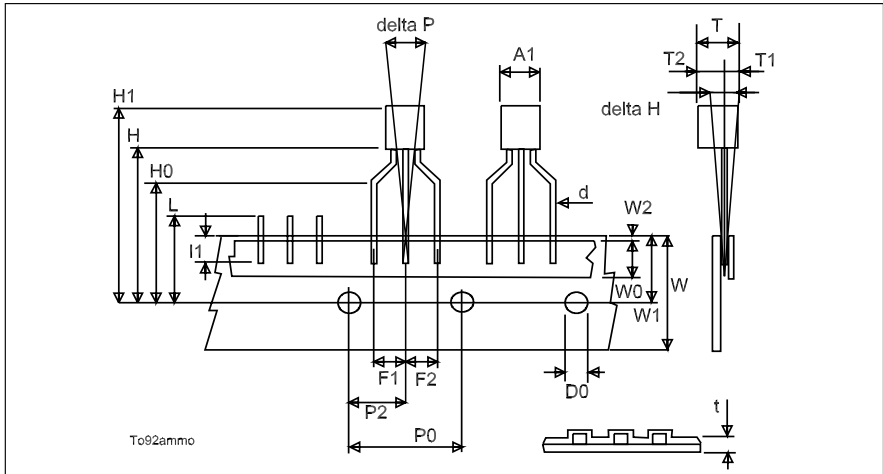
**TO-252 (DPAK) MECHANICAL DATA**

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.20		2.40	0.087		0.094
A1	0.90		1.10	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.90	0.025		0.035
B2	5.20		5.40	0.204		0.213
C	0.45		0.60	0.018		0.024
C2	0.48		0.60	0.019		0.024
D	6.00		6.20	0.236		0.244
E	6.40		6.60	0.252		0.260
G	4.40		4.60	0.173		0.181
H	9.35		10.10	0.368		0.398
L2		0.8			0.031	
L4	0.60		1.00	0.024		0.039
V2	0°		8°	0°		0°



**TO-92 AMMOPACK**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A1	4.45		4.95	0.170		0.194
T	3.30		3.94	0.130		0.155
T1			1.6			0.06
T2			2.3			0.09
d	0.41		0.56	0.016		0.022
P0	12.5	12.7	12.9	0.49	0.5	0.51
P2	5.65	6.35	7.05	0.22	0.25	0.27
F1, F2	2.44	2.54	2.94	0.09	0.1	0.11
delta H	-2		2	-0.08		0.08
W	17.5	18	19	0.69	0.71	0.74
W0	5.7	6	6.3	0.22	0.23	0.24
W1	8.5	9	9.25	0.33	0.35	0.36
W2			0.5			0.02
H	18.5		20.5	0.72		0.80
H0	15.5	16	16.5	0.61	0.63	0.65
H1			25			0.98
D0	3.8	4	4.2	0.15	0.157	0.16
t			0.9			0.035
L			11			0.43
l1	3			0.11		
delta P	-1		1	-0.04		0.04



## 5 Revision history

Table 8. Revision history

Date	Revision	Changes
09-Mar-2004	1	First release
23-Mar-2004	2	Modified title
02-Apr-2005	3	Complete version
06-Mar-2006	4	Inserted DPAK. New template

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