



STB6NK60Z - STB6NK60Z-1 STP6NK60ZFP - STP6NK60Z

N-channel 600 V - 1 Ω - 6 A - TO-220/TO-220FP/D²PAK/I²PAK
Zener-Protected SuperMESH™ Power MOSFET

Features

Type	V _{DSS}	R _{DS(on)}	I _D	P _W
STB6NK60Z	600 V	< 1.2 Ω	6 A	110 W
STB6NK60Z-1	600 V	< 1.2 Ω	6 A	110 W
STP6NK60ZFP	600 V	< 1.2 Ω	6 A	30 W
STP6NK60Z	600 V	< 1.2 Ω	6 A	110 W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized

Application

- Switching applications

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.

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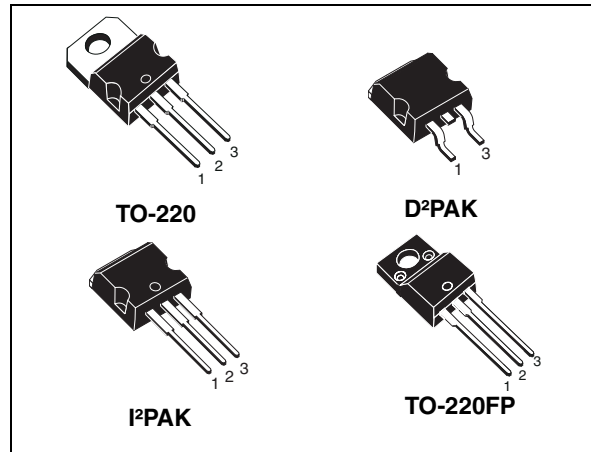


Figure 1. Internal schematic diagram

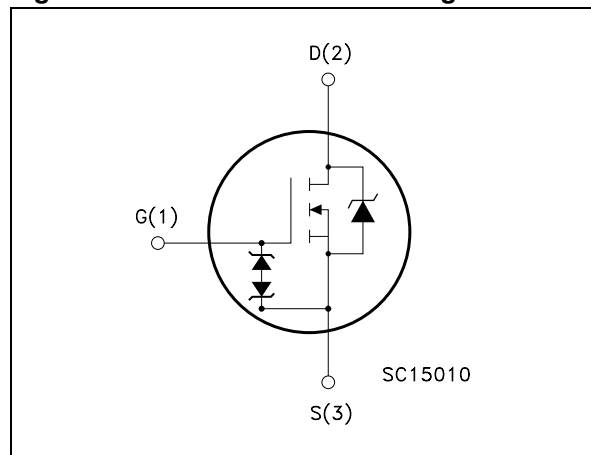


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB6NK60Z	B6NK60Z	D ² PAK	Tape & reel
STB6NK60Z-1	B6NK60Z	I ² PAK	Tube
STP6NK60ZFP	P6NK60ZFP	TO-220FP	Tube
STP6NK60Z	P6NK60Z	TO-220	Tube

Contents

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/D ² /I ² PAK	TO-220FP	
V _{DS}	Drain-source voltage (V _{GS} = 0)	600		V
V _{GS}	Gate-source voltage	± 30		V
I _D	Drain current (continuous) at T _C = 25 °C	6	6 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	3.8	3.8 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	24	24 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	110	30	W
	Derating factor	0.88	0.24	W/°C
V _{ESD(G-S)}	G-S ESD (HBM C=100 pF, R=1.5 kΩ)	3500		V
dv/dt ⁽³⁾	Peak diode recovery voltage slope	4.5		V/ns
V _{ISO}	Insulation withstand voltage (DC)	--	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} ≤ 6 A, di/dt ≤ 200 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-220/D ² /I ² PAK	TO-220FP	
R _{thj-case}	Thermal resistance junction-case max	1.14	4.2	°C/W
R _{thj-amb}	Thermal resistance junction-amb 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 _j max)	6	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	210	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	$I_D = 1 \text{ mA}$, $V_{GS} = 0$	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	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20 \text{ V}$			± 10	μA
$V_{GS(th)}$	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	$V_{GS} = 10 \text{ V}$, $I_D = 3 \text{ A}$		1	1.2	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 8 \text{ V}$, $I_D = 3 \text{ A}$		5		S
C_{iss}	Input capacitance	$V_{DS} = 25 \text{ V}$, $f = 1 \text{ MHz}$, $V_{GS} = 0$		905		pF
C_{oss}	Output capacitance			115		pF
C_{riss}	Reverse transfer capacitance			25		pF
$C_{oss \text{ eq}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$, $V_{DS} = 0 \text{ to } 480 \text{ V}$		56		pF
Q_g	Total gate charge	$V_{DD} = 480 \text{ V}$, $I_D = 6 \text{ A}$, $V_{GS} = 10 \text{ V}$ <i>(see Figure 18)</i>		33	46	nC
Q_{gs}	Gate-source charge			6		nC
Q_{gd}	Gate-drain charge			17		nC

1. Pulsed: pulse duration=300 μs , 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. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 3\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ <i>(see Figure 17)</i>		14		ns
t_r	Rise time			14		ns
$t_{d(off)}$	Turn-off delay time			47		ns
t_f	Fall time			19		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD}	Source-drain current				6	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				24	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 6\text{ A}$, $V_{GS} = 0$			1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 6\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 50\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ <i>(see Figure 19)</i>		445		ns
Q_{rr}	Reverse recovery charge			2.7		μC
I_{RRM}	Reverse recovery current			12		A

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

Table 9. Gate-source zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}^{(1)}$	Gate-source breakdown voltage	$E_{ggs} \pm 1\text{ mA}$ (open drain)	30			V

1. 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-220/ I²PAK/ D²PAK

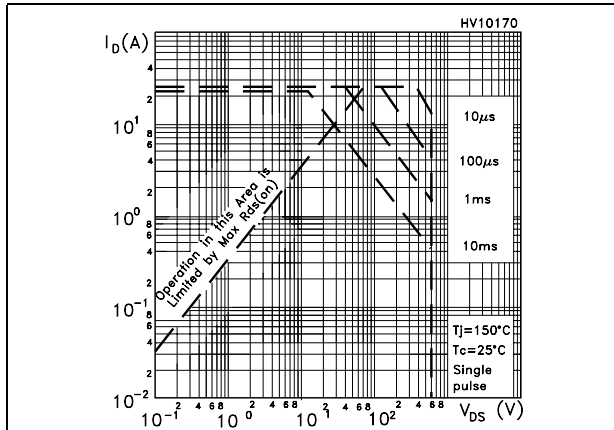


Figure 3. Thermal impedance for TO-220/ I²PAK/ D²PAK

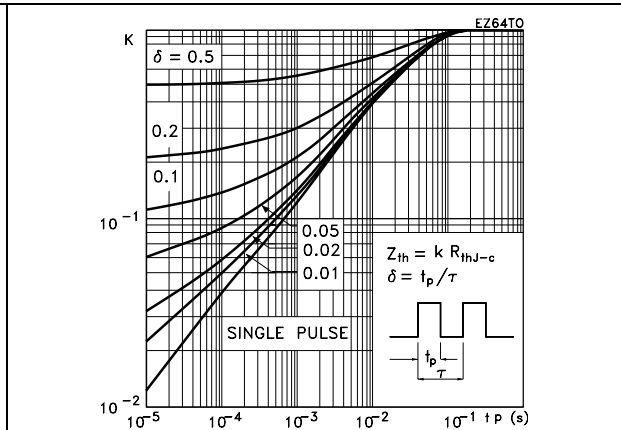


Figure 4. Safe operating area for TO-220FP

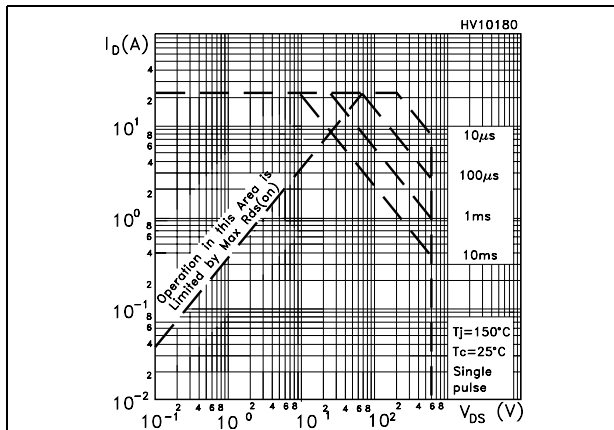


Figure 5. Thermal impedance for TO-220FP

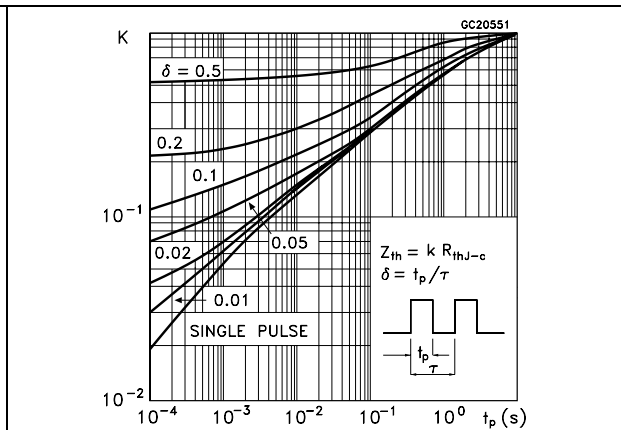


Figure 6. Output characteristics

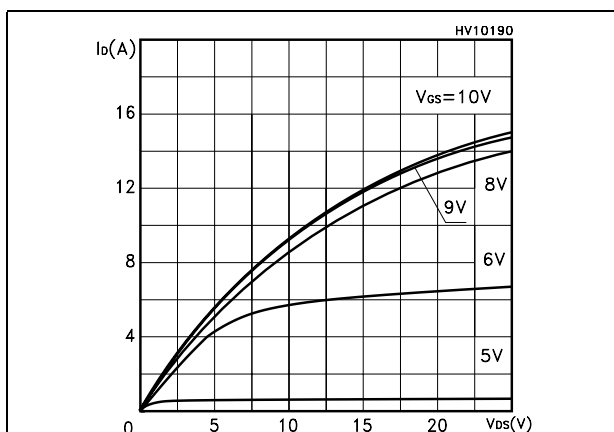


Figure 7. Transfer characteristics

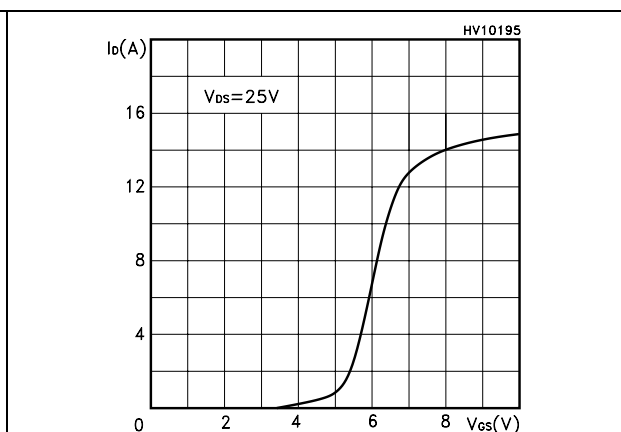


Figure 8. Transconductance

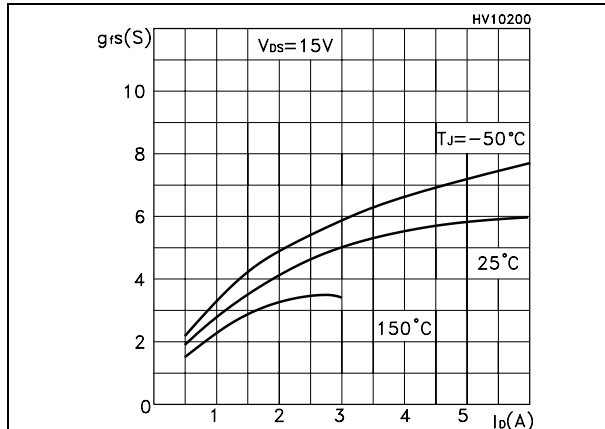


Figure 9. Static drain-source on resistance

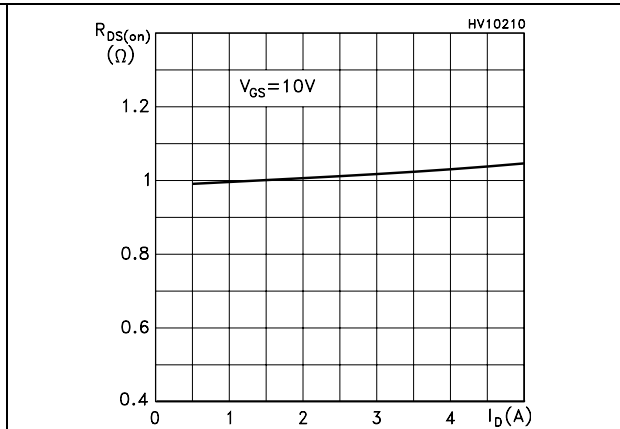


Figure 10. Gate charge vs gate-source voltage Figure 11. Capacitance variations

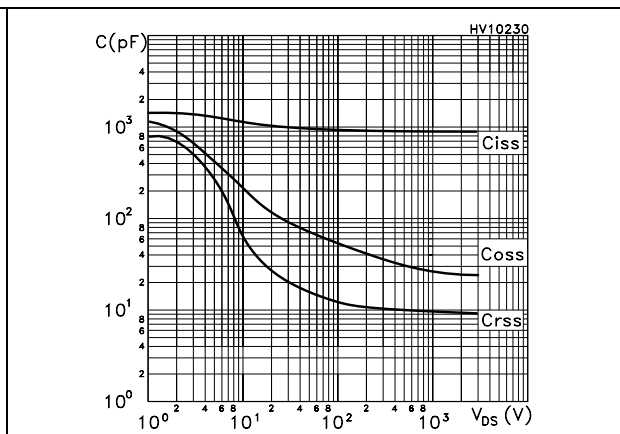
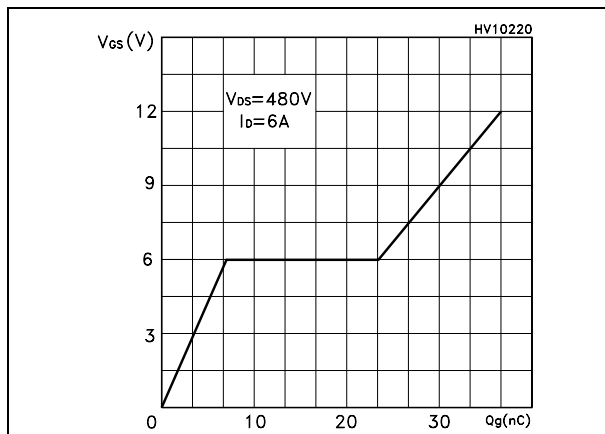


Figure 12. Normalized gate threshold voltage vs temperature

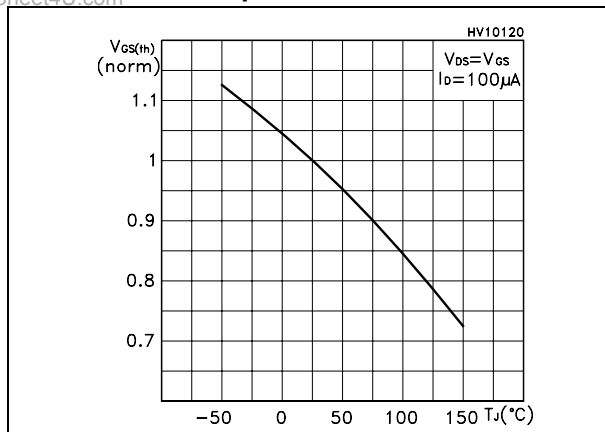
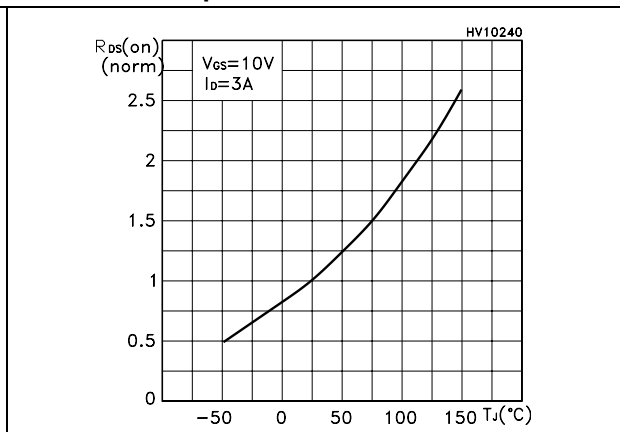


Figure 13. Normalized on resistance vs temperature



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Electrical characteristics

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Figure 14. Source-drain diode forward characteristics

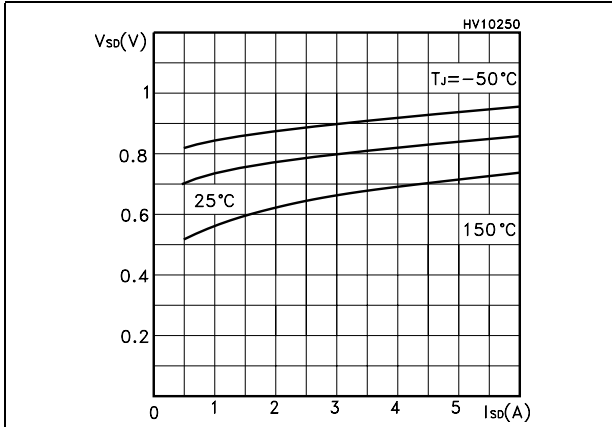


Figure 15. Normalized B_{VDSS} vs temperature

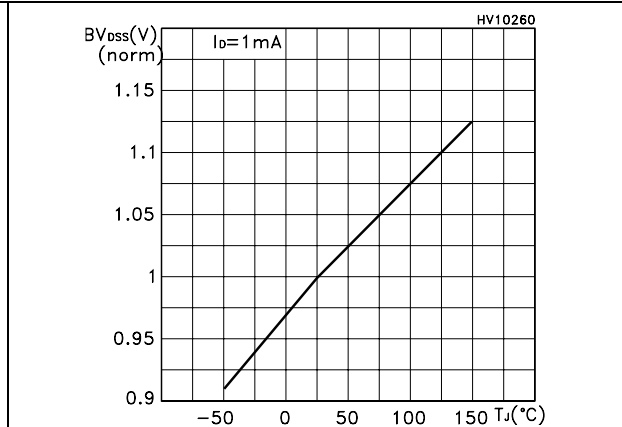
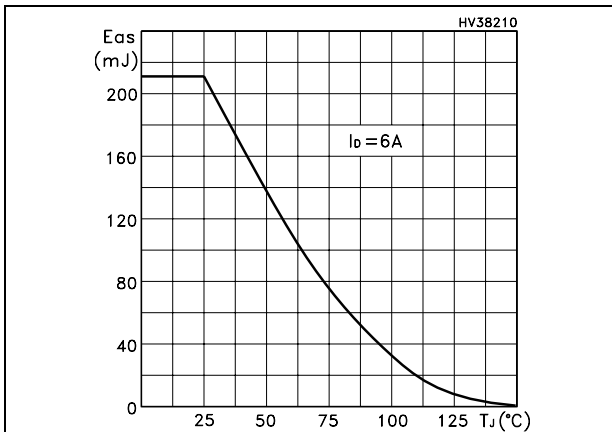


Figure 16. Maximum avalanche energy vs temperature



3 Test circuit

Figure 17. Switching times test circuit for resistive load

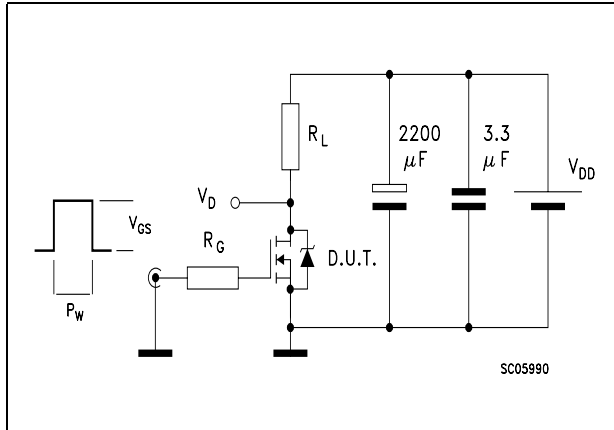


Figure 18. Gate charge test circuit

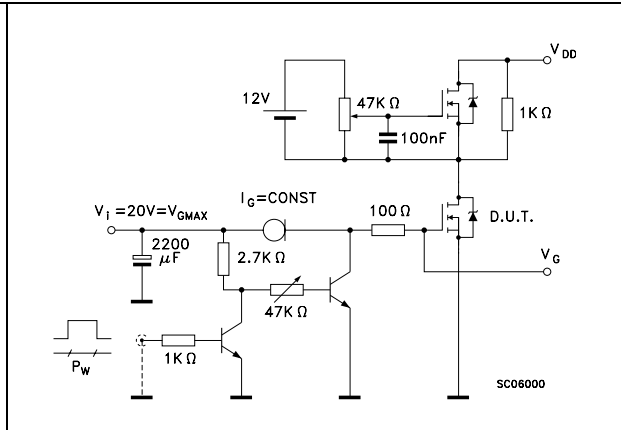


Figure 19. Test circuit for inductive load switching and diode recovery times

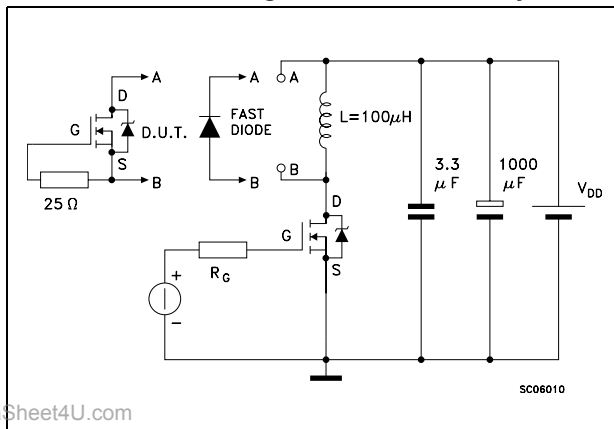


Figure 20. Unclamped Inductive load test circuit

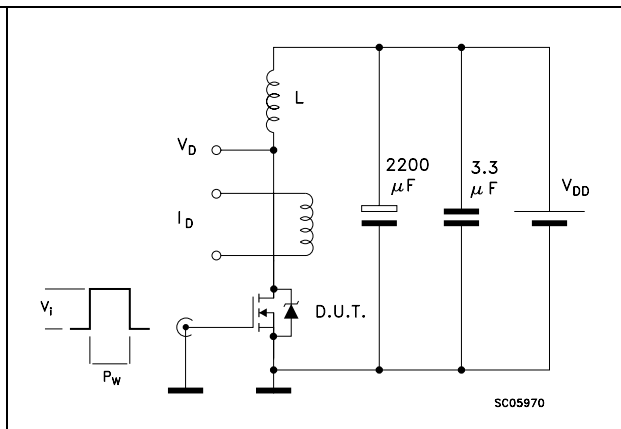


Figure 21. Unclamped inductive waveform

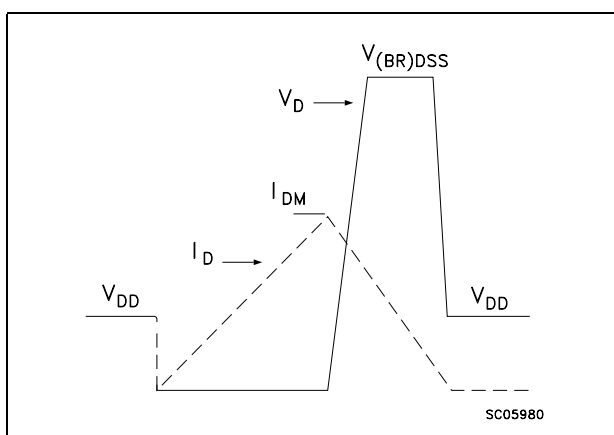
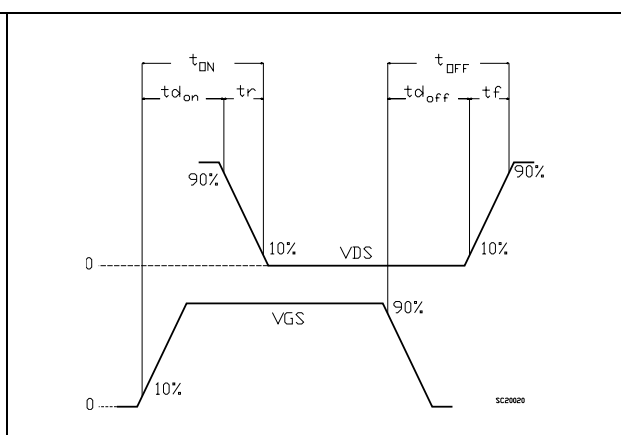


Figure 22. Switching time waveform



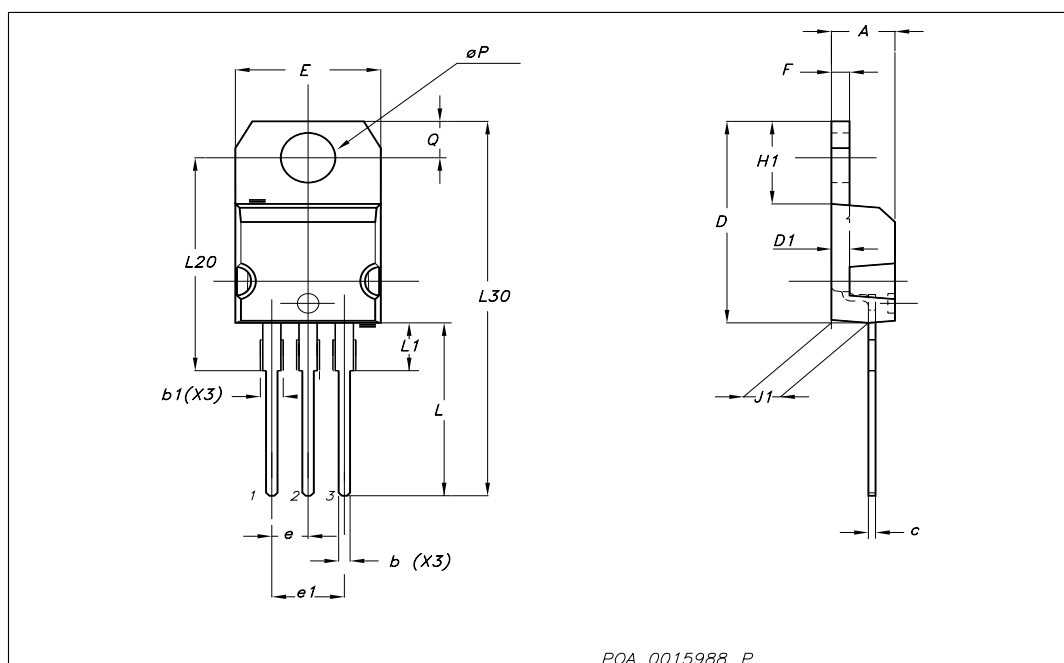
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4 Package mechanical data

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

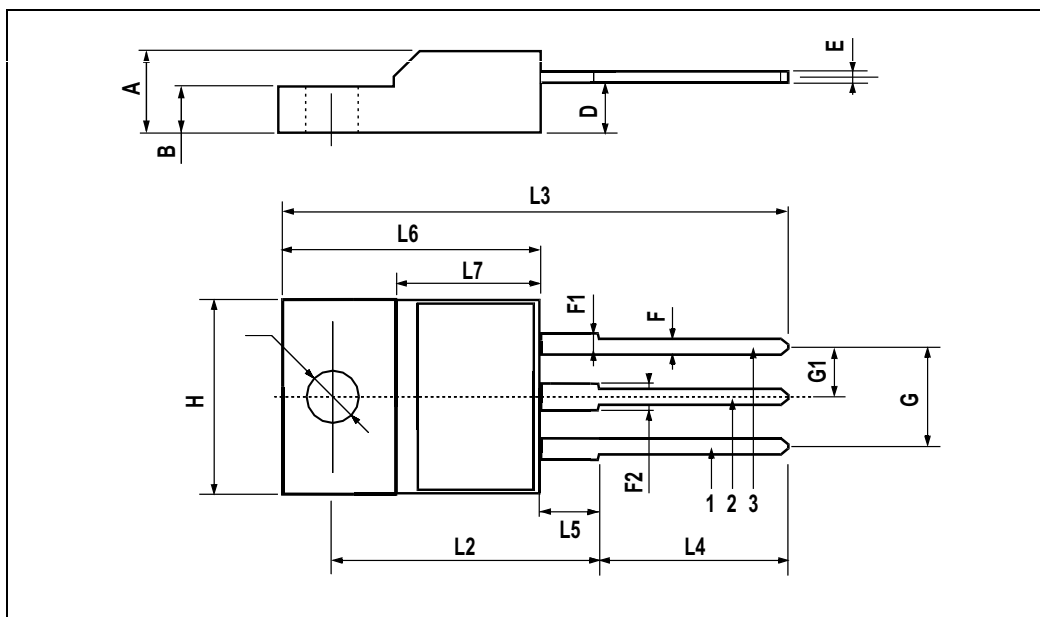
TO-220 mechanical data

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	0.49		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



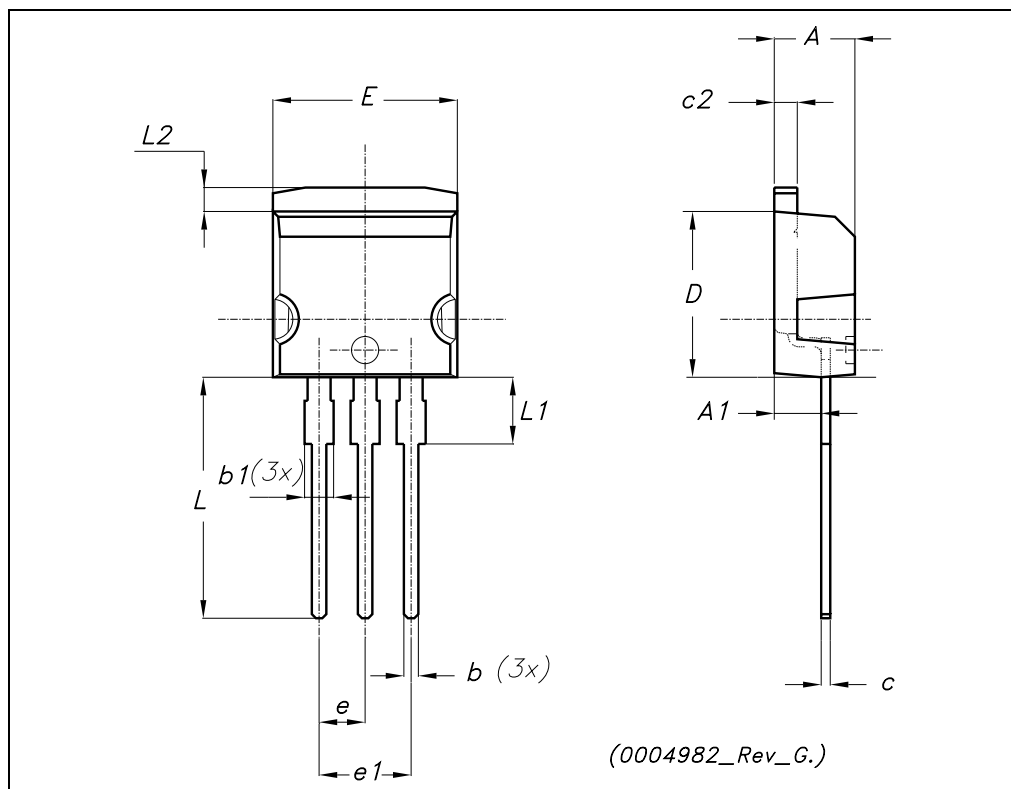
TO-220FP MECHANICAL DATA

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-262 (I²PAK) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055

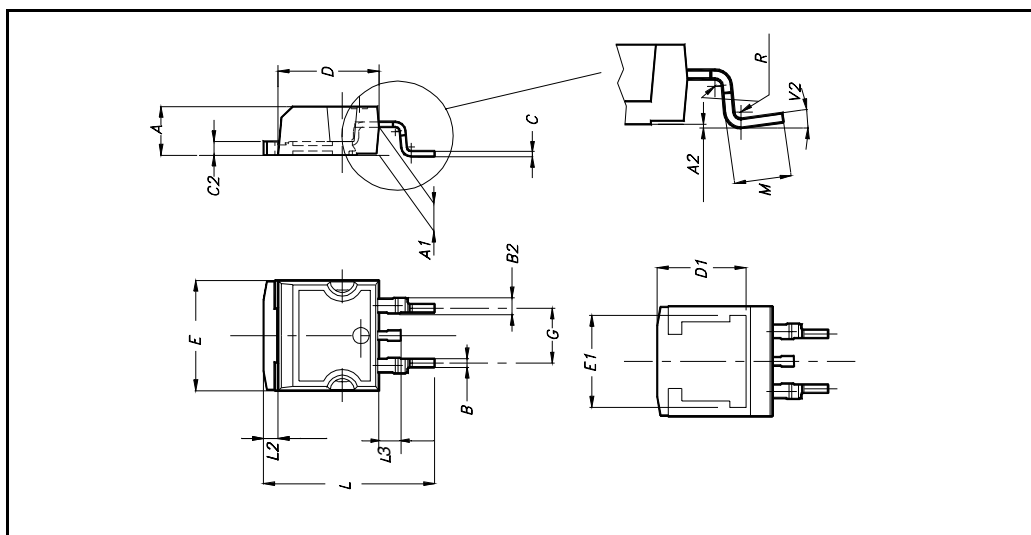


Package mechanical data

STB6NK60Z - STB6NK60Z-1 - STP6NK60ZFP - STP6NK60Z

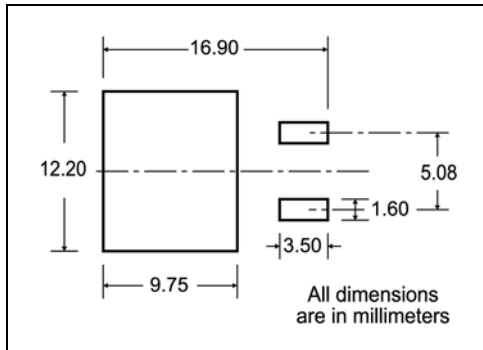
D²PAK MECHANICAL DATA

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°			



5 Packing mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

Full radius

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

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

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

* on sales type

6 Revision history

Table 10. Document revision history

Date	Revision	Changes
14-Jan-2004	4	Initial electronic version
23-Aug-2005	5	Inserted ecopack label
04-Oct-2005	6	Modified header
23-May-2007	7	Added Figure 16: Maximum avalanche energy vs temperature
22-Nov-2007	8	Figure 11: Capacitance variations has been updated

STB6NK60Z - STB6NK60Z-1 - STP6NK60ZFP - STP6NK60Z

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