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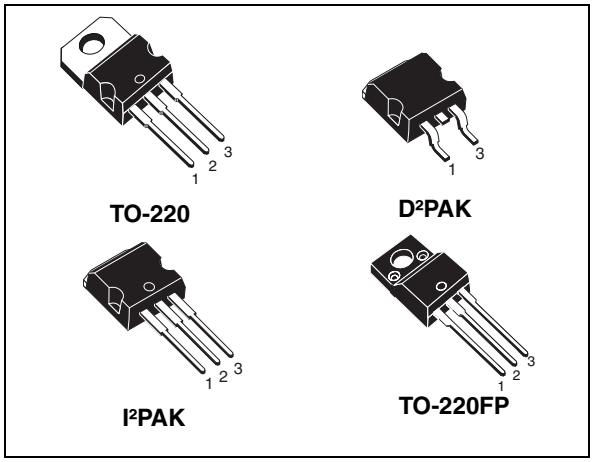
STB6NK60Z - STB6NK60Z-1
STP6NK60ZFP - STP6NK60Z

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

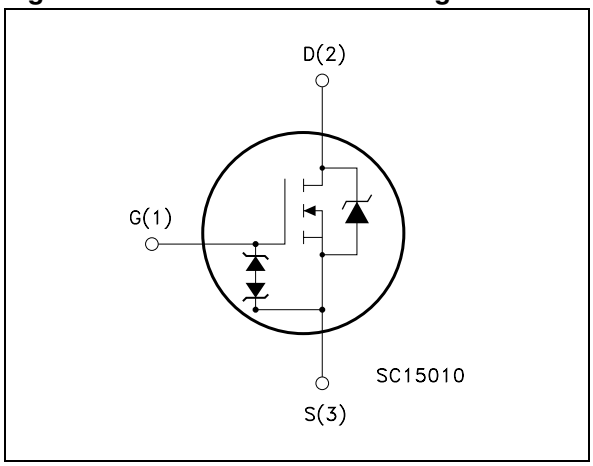


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB6NK60Z	B6NK60Z	D²PAK	Tape & reel
STB6NK60Z-1	B6NK60Z	I²PAK	Tube
STP6NK60ZFP	P6NK60ZFP	TO-220FP	Tube
STP6NK60Z	P6NK60Z	TO-220	Tube

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2.1 Electrical characteristics (curves) 6

3 Test circuit 9

4 Package mechanical data 10

5 Packing mechanical data 15

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/D²/I²PAK	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

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 6 A, di/dt ≤ 200 A/µs, V_{DD} = 80% $V_{(BR)DSS}$

Table 3. Thermal data

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Symbol	Parameter	Value		Unit
		TO-220/D²/I²PAK	TO-220FP	
Rthj-case	Thermal resistance junction-case max	1.14	4.2	°C/W
Rthj-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 Tj max)	6	A
E_{AS}	Single pulse avalanche energy (starting T_J= 25 °C, I_D= I_{AR}, V_{DD}= 50 V)	210	mJ

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2 Electrical characteristics

(T_{CASE}=25°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 mA, V_{GS} = 0	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0) V_{DS} = Max rating V_{DS} = Max rating, T_C = 125 °C				1 50	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 100 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 3 A		1	1.2	Ω

Table 6. Dynamic

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

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1. Pulsed: pulse duration=300µs, 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}

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Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 3 A		14		ns
t_r	Rise time	R_G = 4.7 Ω V_{GS} = 10 V		14		ns
$t_{d(off)}$	Turn-off delay time	*(see Figure 17)*		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 A, V_{GS} = 0			1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 6 A, di/dt = 100 A/µs		445		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 50 V, T_j = 150 °C		2.7		µC
I_{RRM}	Reverse recovery current	*(see Figure 19)*		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	Eggs± 1 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.

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2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220/ I²PAK/ D²PAK

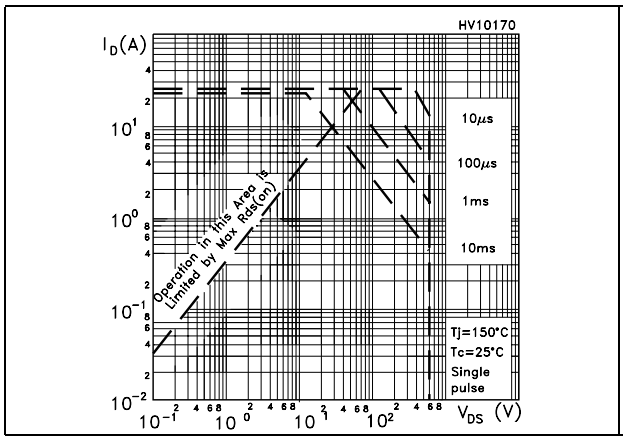


Figure 3. Thermal impedance for TO-220/ I²PAK/ D²PAK

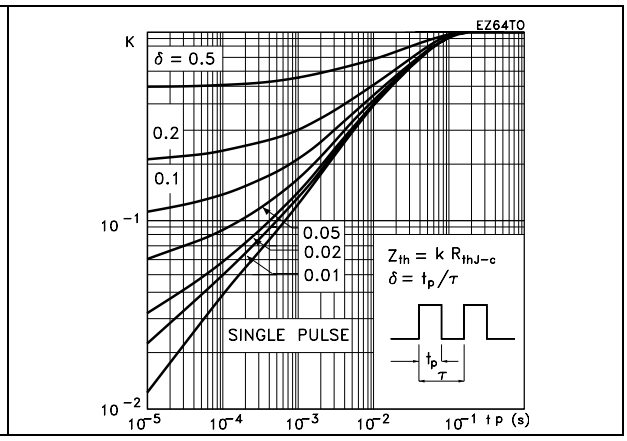


Figure 4. Safe operating area for TO-220FP

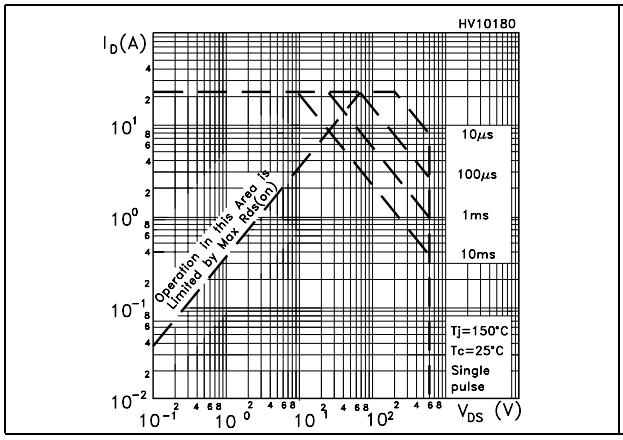
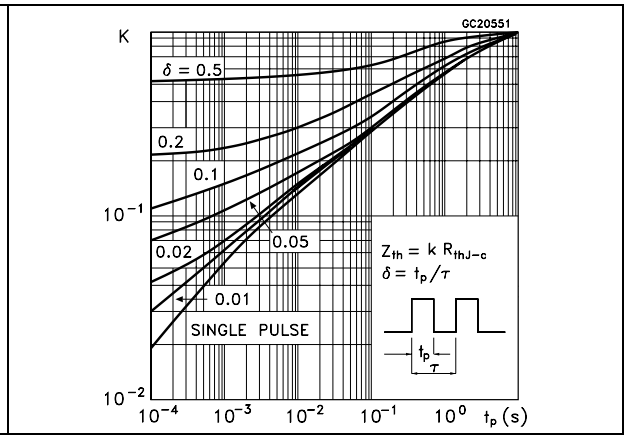


Figure 5. Thermal impedance for TO-220FP



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Figure 6. Output characteristics

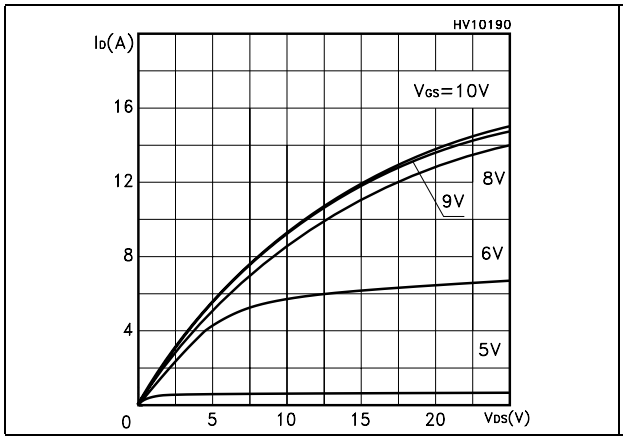
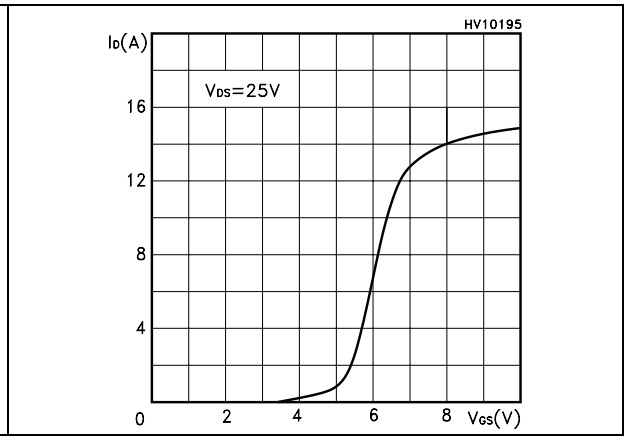


Figure 7. Transfer characteristics



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Figure 8. Transconductance

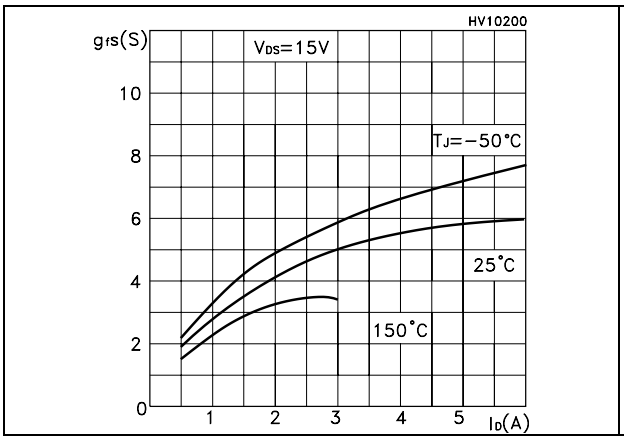


Figure 9. Static drain-source on resistance

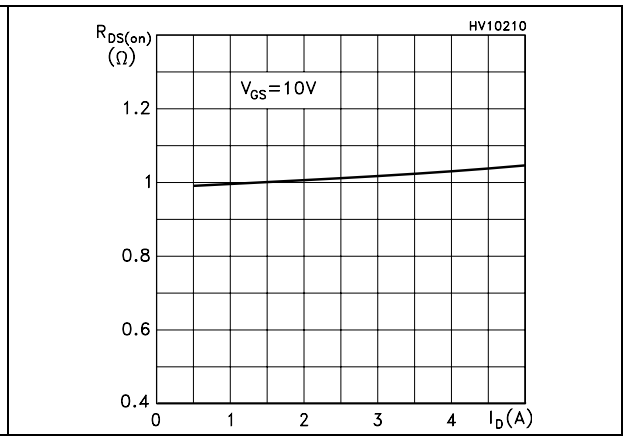


Figure 10. Gate charge vs gate-source voltage

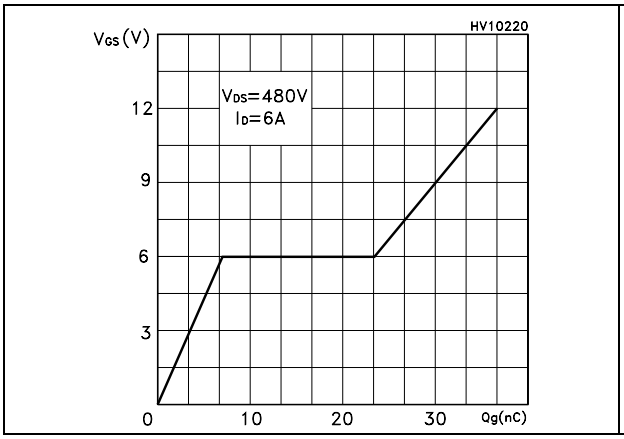


Figure 11. Capacitance variations

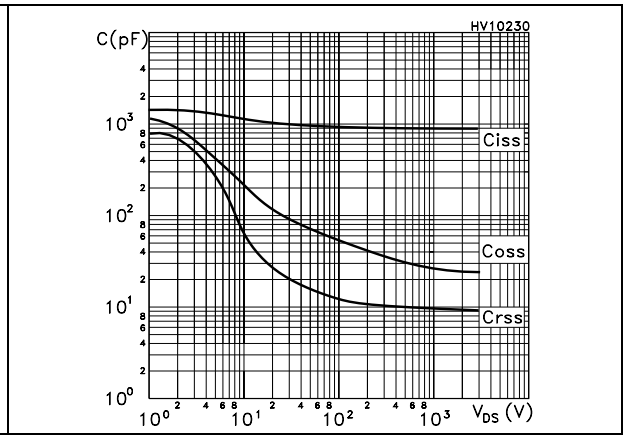


Figure 12. Normalized gate threshold voltage vs temperature

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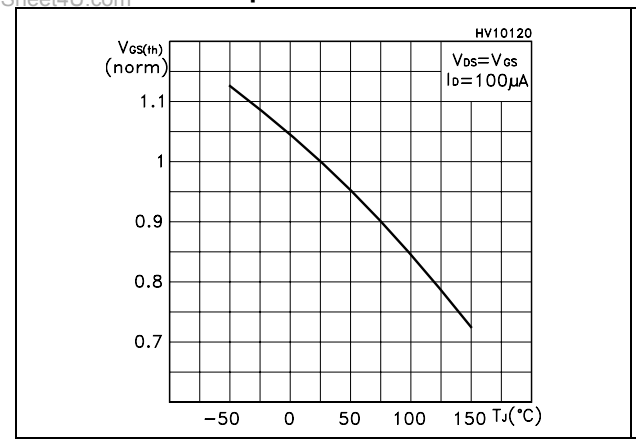
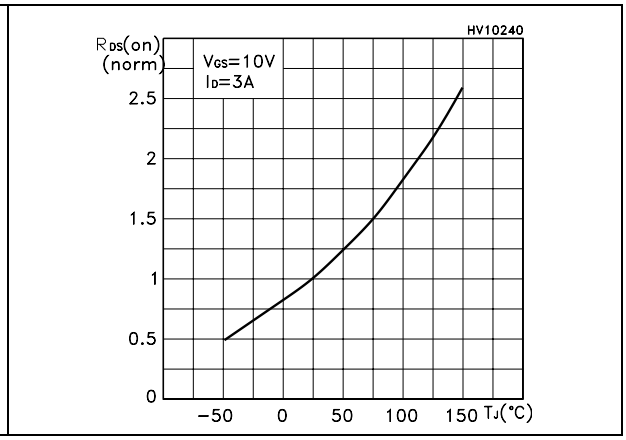


Figure 13. Normalized on resistance vs temperature



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Figure 14. Source-drain diode forward characteristics

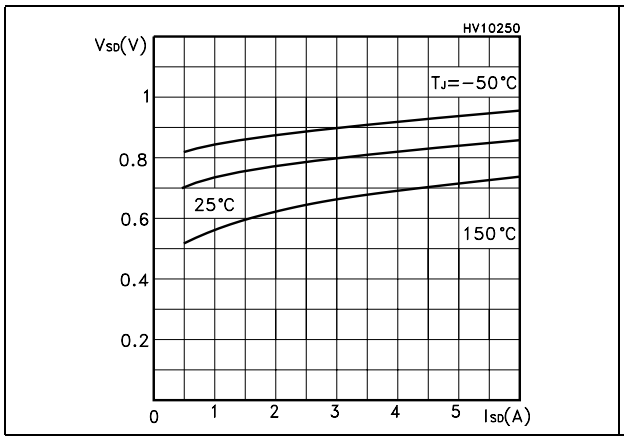


Figure 15. Normalized B_{VDSS} vs temperature

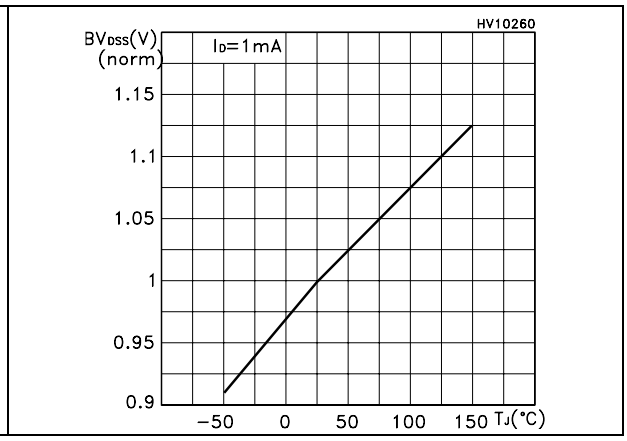
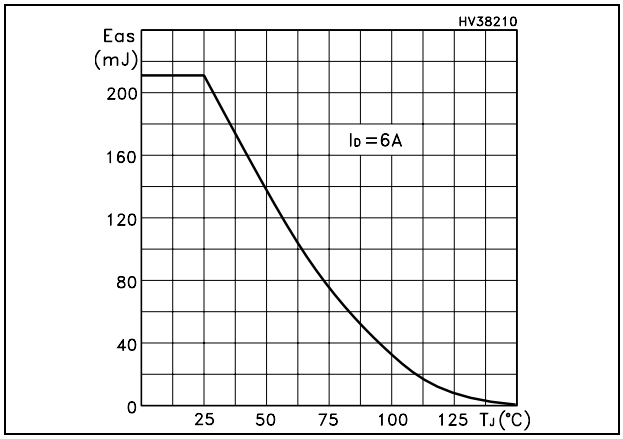


Figure 16. Maximum avalanche energy vs temperature



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3 Test circuit

Figure 17. Switching times test circuit for resistive load

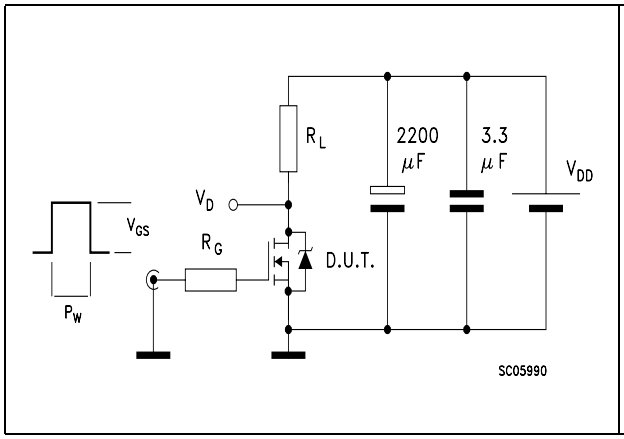


Figure 18. Gate charge test circuit

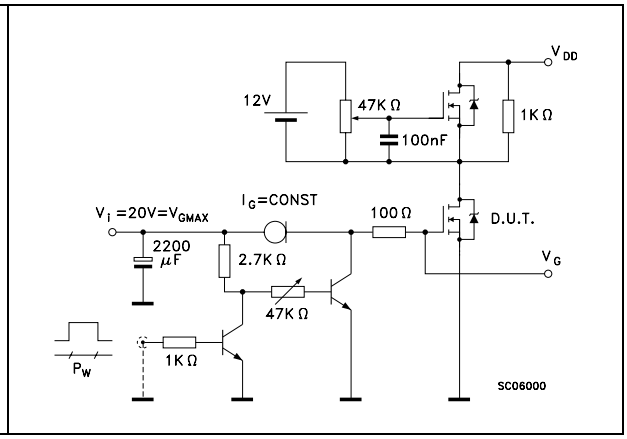


Figure 19. Test circuit for inductive load switching and diode recovery times

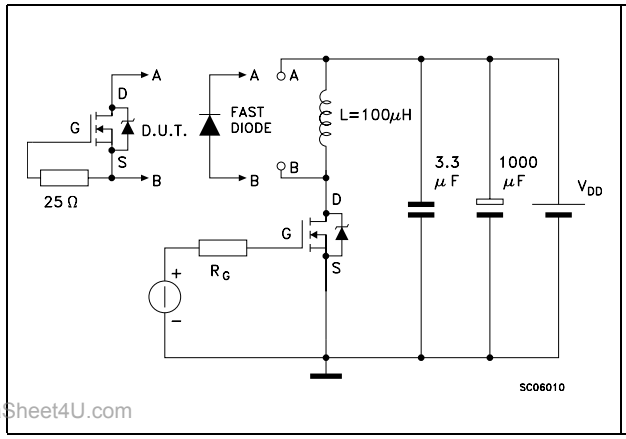
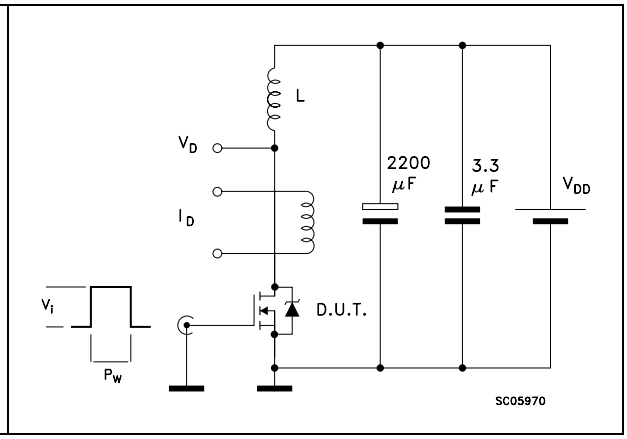


Figure 20. Unclamped Inductive load test circuit



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Figure 21. Unclamped inductive waveform

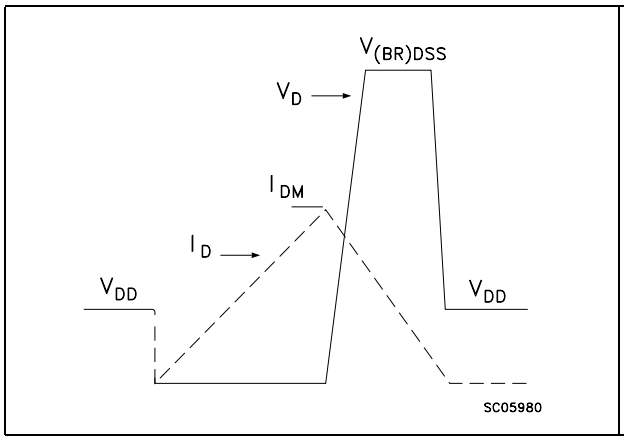
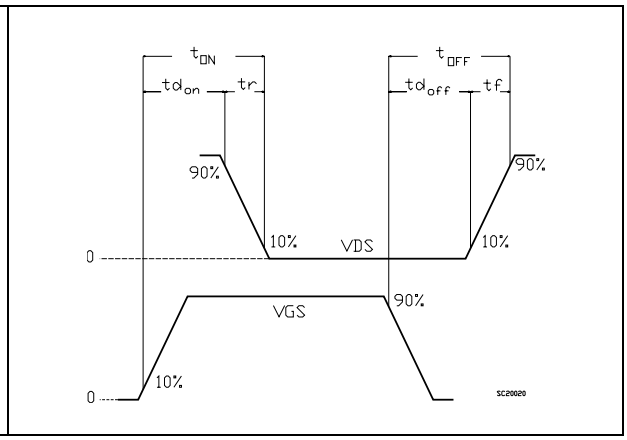


Figure 22. Switching time waveform



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4 Package mechanical data

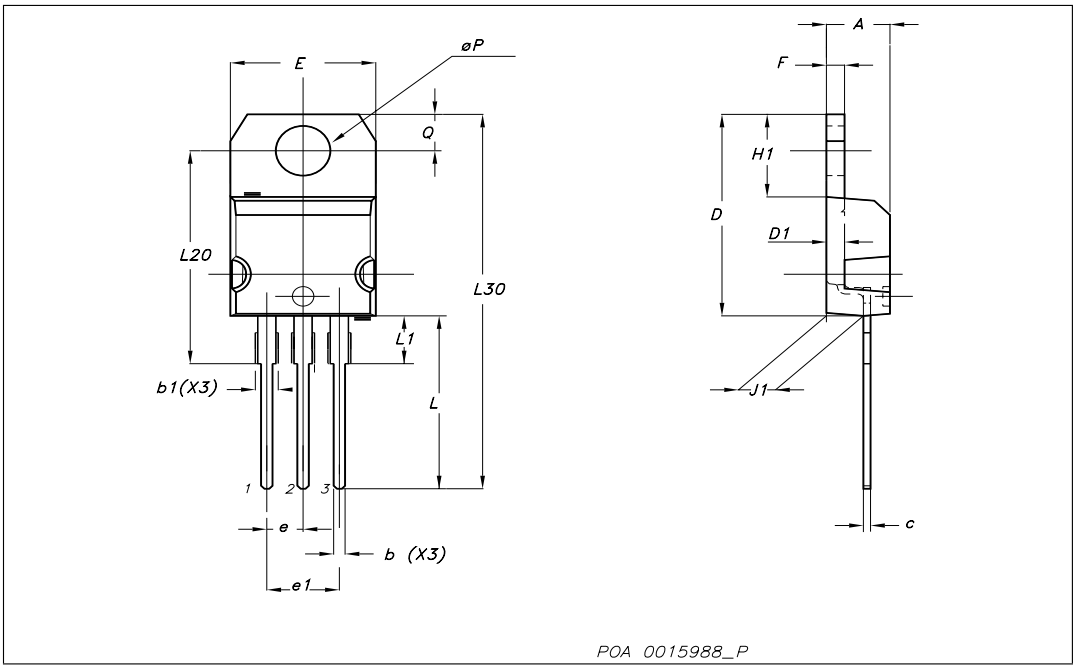
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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*

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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

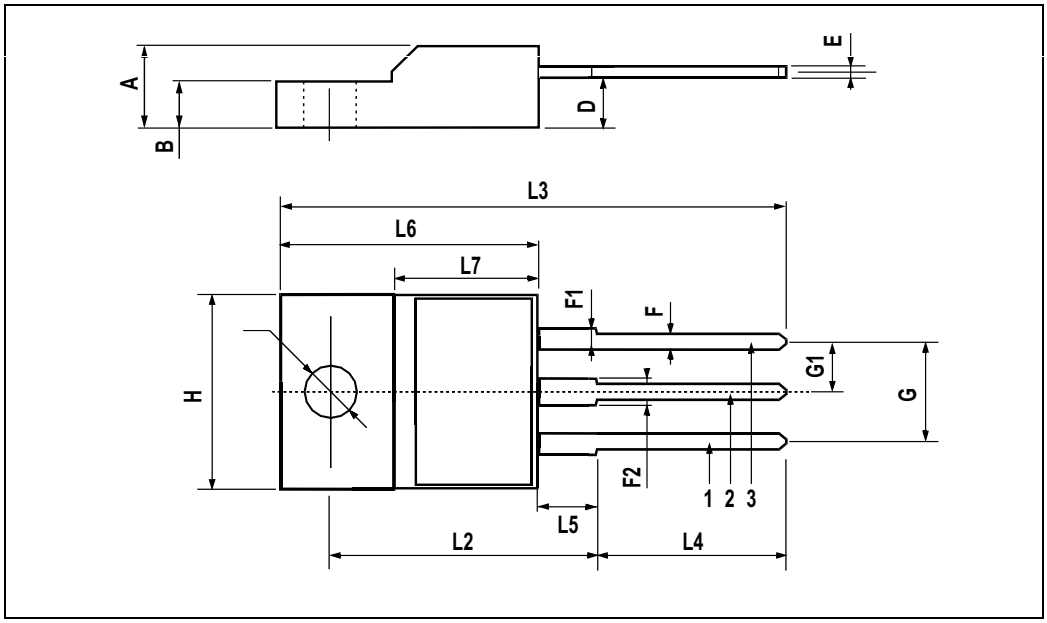


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TO-220FP MECHANICAL DATA

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

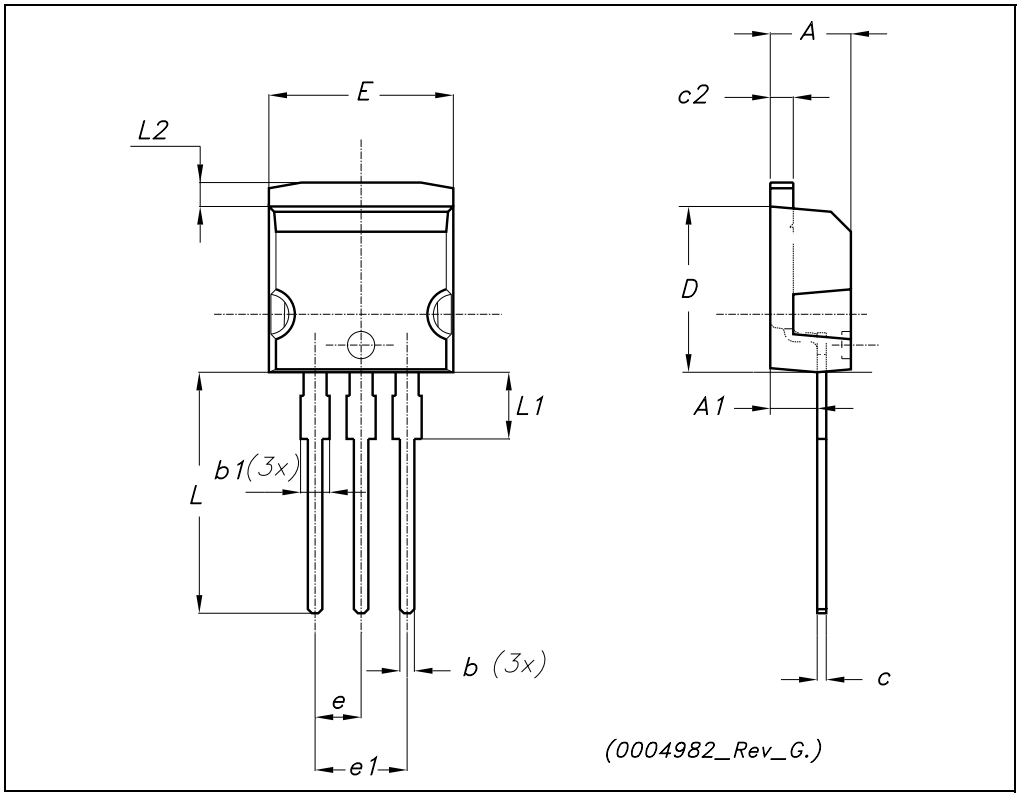


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TO-262 (I^2PAK) MECHANICAL DATA

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

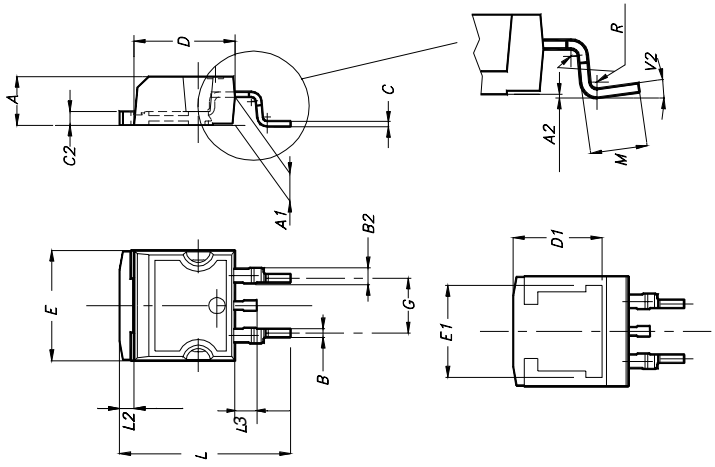


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D²PAK MECHANICAL DATA

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	0º		4º			

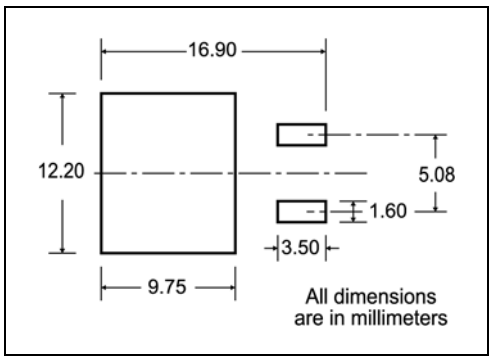


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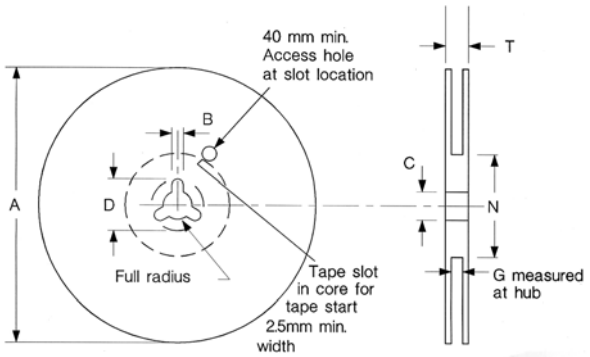
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5 Packing mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



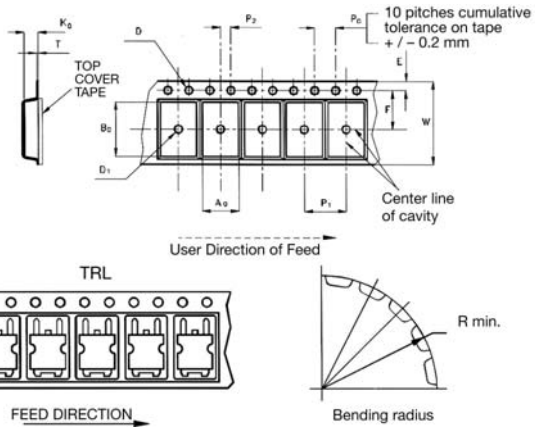
REEL MECHANICAL DATA

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		0795	
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



* on sales type

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