



STP4NK80Z - STP4NK80ZFP STD4NK80Z - STD4NK80Z-1

N-channel 800V - 3Ω - 3A - TO-220/TO-220FP/DPAK/IPAK
Zener - Protected SuperMESH™ MOSFET

General features

Type	V _{DSS} (@T _{jmax})	R _{DS(on)}	I _D
STP4NK80Z	800 V	< 3.5 Ω	3 A
STP4NK80ZFP	800 V	< 3.5 Ω	3 A
STD4NK80Z	800 V	< 3.5 Ω	3 A
STD4NK80Z-1	800 V	< 3.5 Ω	3 A

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

Description

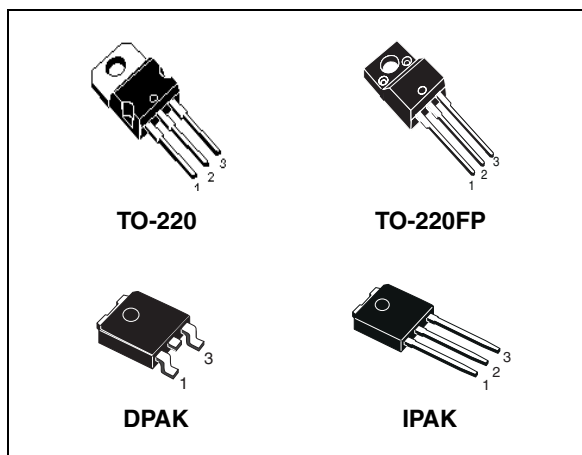
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements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

Applications

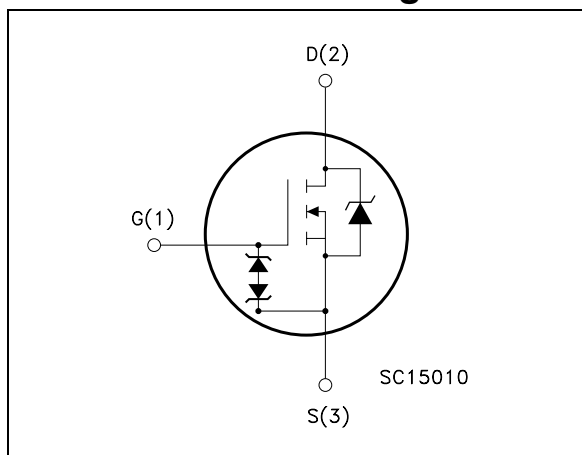
- Switching application

Order codes

Part number	Marking	Package	Packaging
STP4NK80Z	P4NK80Z	TO-220	Tube
STP4NK80ZFP	P4NK80ZFP	TO-220FP	Tube
STD4NK80ZT4	D4NK80Z	DPAK	Tape & reel
STD4NK80Z-1	D4NK80Z	IPAK	Tube



Internal schematic diagram



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1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/DPAK/ IPAK	TO-220FP	
V_{DS}	Drain-source voltage ($V_{GS} = 0$)	800		V
V_{GS}	Gate-source voltage	± 30		V
I_D	Drain current (continuous) at $T_C = 25^\circ\text{C}$	3	3 ⁽¹⁾	A
I_D	Drain current (continuous) at $T_C = 100^\circ\text{C}$	1.89	1.89 ⁽¹⁾	A
$I_{DM}^{(2)}$	Drain current (pulsed)	12	12 ⁽¹⁾	A
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	80	25	W
	Derating factor	0.64	0.21	W/°C
$V_{ESD(G-S)}$	Gate source ESD (HBM-C=100pF, R=1.5K Ω)	3000		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 ($t=1\text{s}$; $T_C = 25^\circ\text{C}$)	-	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. $I_{SD} \leq 4\text{A}$, $di/dt \leq 200\text{A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq T_{JMAX}$.

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		TO-220	TO-220FP	DPAK IPAK	
$R_{thj-case}$	Thermal resistance junction- case max	1.56	5	1.56	°C/W
R_{thj-a}	Thermal resistance junction- ambient max	62.5		100	°C/W
T_I	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	A
E_{AS}	Single pulse avalanche energy (starting $T_j=25^{\circ}\text{C}$, $I_d=I_{AR}$, $V_{dd}=50\text{V}$)	190	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

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

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{mA}$, $V_{GS} = 0$	800			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = \text{Max rating}$, $V_{DS} = \text{Max rating}$, $T_c = 125^{\circ}\text{C}$			1 50	μA μA
I_{GSS}	Gate body leakage current ($V_{GS} = 0$)	$V_{GS} = \pm 20\text{V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 50\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{V}$, $I_D = 1.5\text{A}$		3	3.5	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{V}$, $I_D = 1.5\text{A}$		2.9		S
C_{iss}	Input capacitance	$V_{DS} = 25\text{V}$, $f = 1\text{MHz}$, $V_{GS} = 0$		575		pF
C_{oss}	Output capacitance			67		pF
C_{rss}	Reverse transfer capacitance			13		pF
$C_{osseq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$, $V_{DS} = 0\text{V}$ to 400V		60		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400\text{V}$, $I_D = 1.5\text{A}$, $R_G = 4.7\Omega$, $V_{GS} = 10\text{V}$ (see Figure 18)		13		ns
t_r	Rise time			12		ns
$t_{d(off)}$	Off-voltage rise time			35		ns
t_f	Fall time			32		ns
$t_{r(Voff)}$	Off-voltage rise time	$V_{DD} = 640\text{V}$, $I_D = 3\text{A}$, $R_G = 4.7\Omega$, $V_{GS} = 10\text{V}$ (see Figure 16)		18		ns
t_r	Fall time			7.5		ns
t_c	Cross-over time			25		ns
Q_g	Total gate charge	$V_{DD} = 640\text{V}$, $I_D = 3\text{A}$		22.5		nC
Q_{gs}	Gate-source charge	$V_{GS} = 10\text{V}$		4.2		nC
Q_{gd}	Gate-drain charge	(see Figure 19)		11.3		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. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD}	Source-drain current				3	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				12	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 3\text{ A}$, $V_{GS} = 0$			1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 3\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 80\text{ V}$, $T_j = 150^\circ\text{C}$ (see Figure 20)		400		ns
Q_{rr}	Reverse recovery charge			1520		μC
I_{RRM}	Reverse recovery current			7.6		A

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration=300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220/DPAK/IPAK

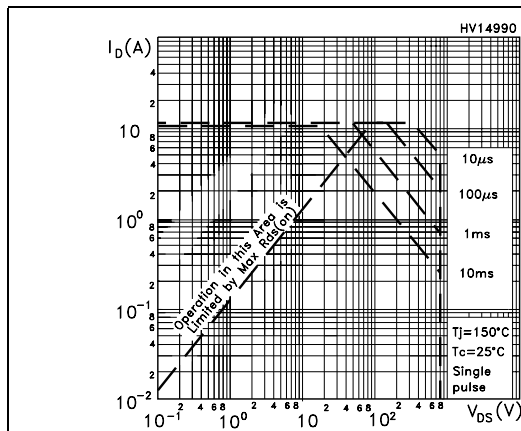


Figure 2. Thermal impedance for TO-220/DPAK/IPAK

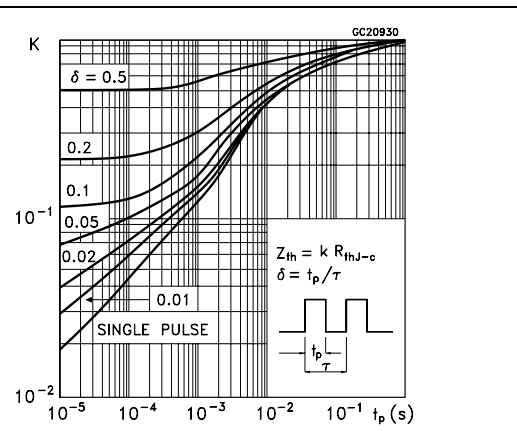


Figure 3. Safe operating area for TO-220FP

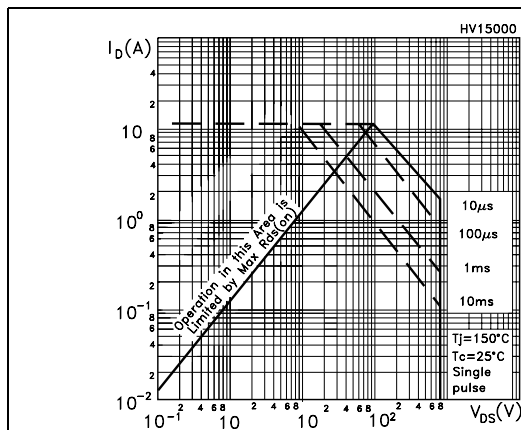


Figure 4. Thermal impedance for TO-220FP

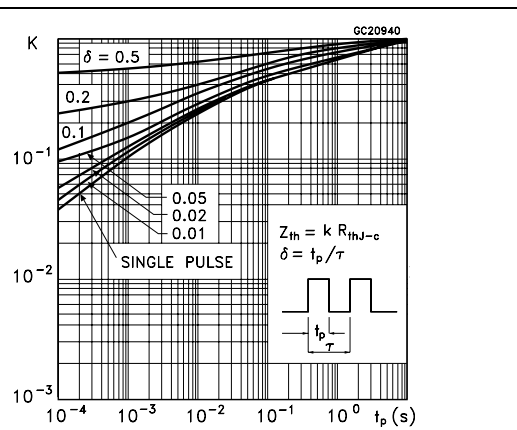


Figure 5. Output characteristics

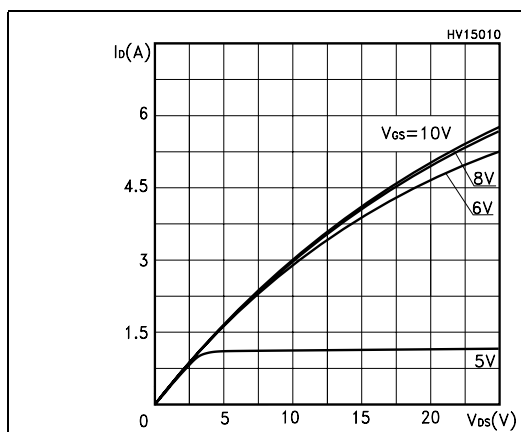


Figure 6. Transfer characteristics

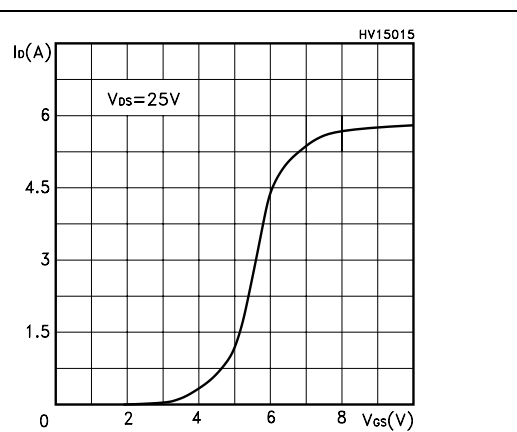


Figure 7. Transconductance

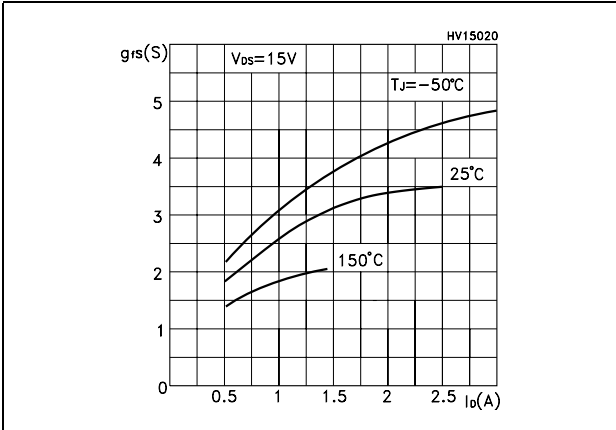


Figure 8. Static drain-source on resistance

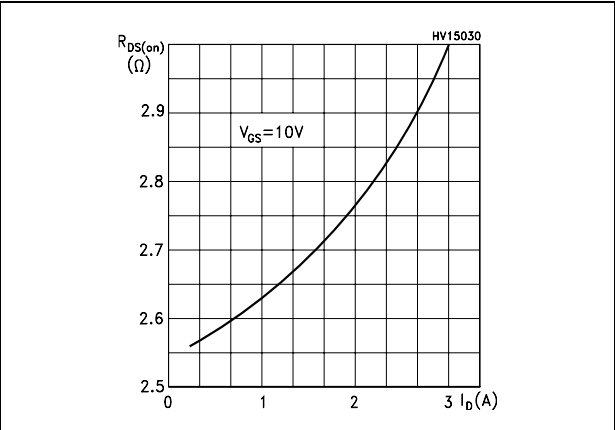


Figure 9. Gate charge vs gate-source voltage

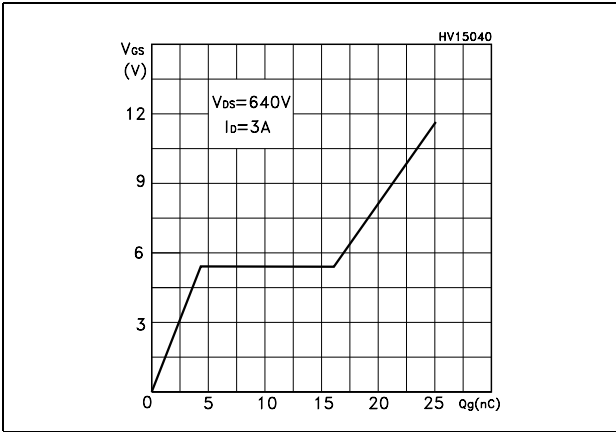


Figure 10. Capacitance variations

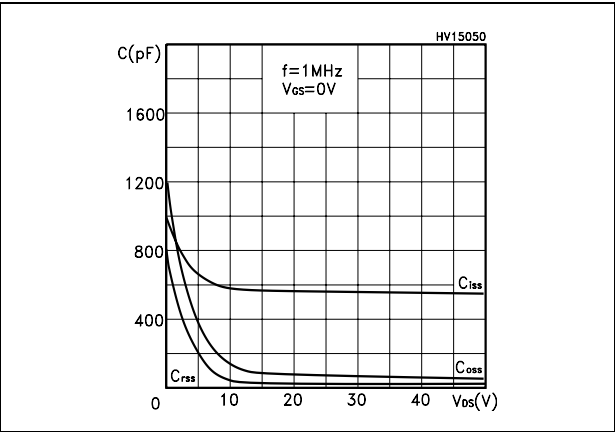


Figure 11. Source-drain diode forward characteristics

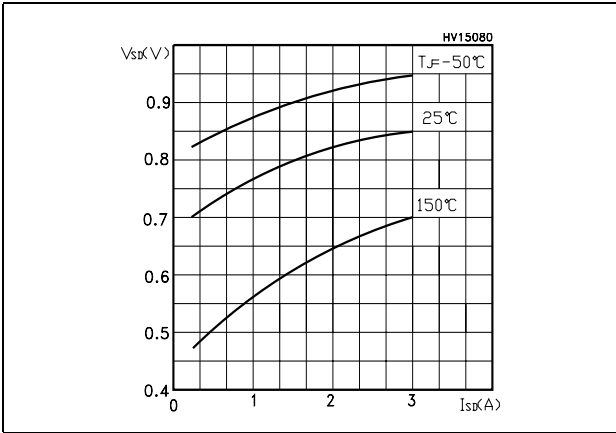


Figure 12. Normalized BVdss vs temperature

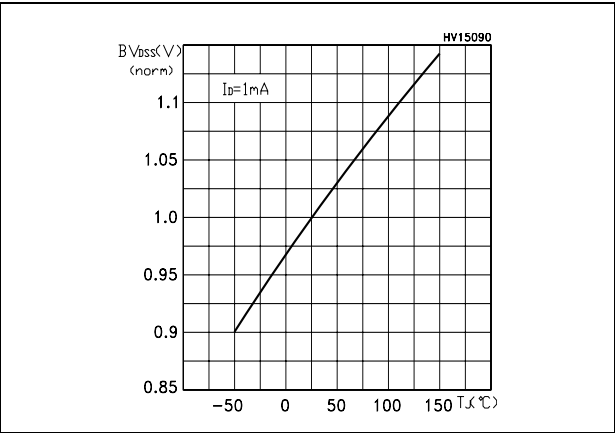


Figure 13. Normalized gate threshold voltage vs temperature

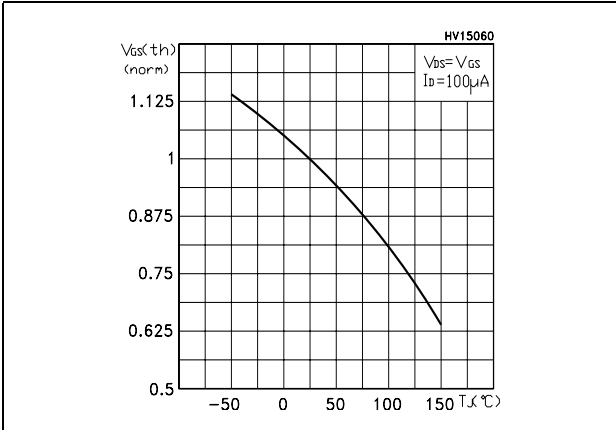


Figure 14. Avalanche energy vs temperature

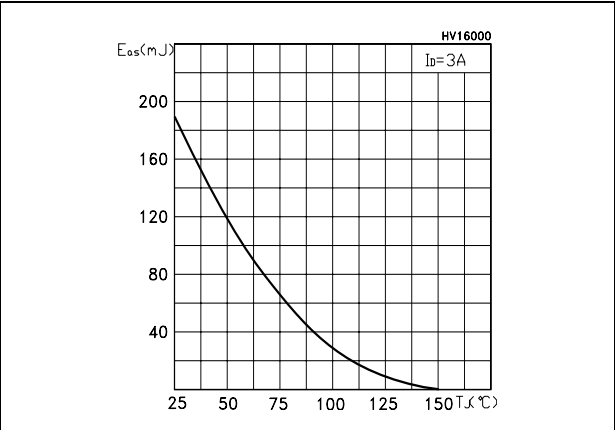
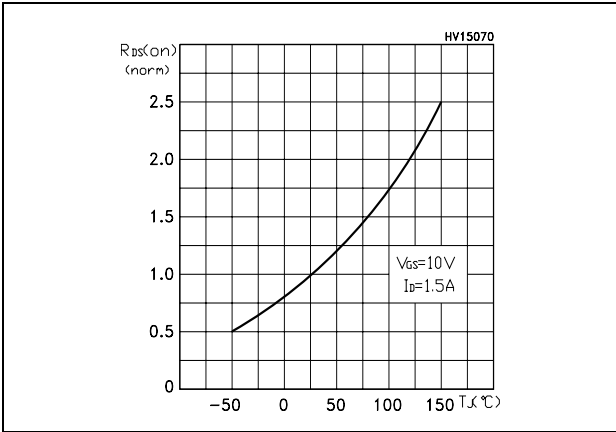


Figure 15. Normalized on resistance vs temperature



3 Test circuit

Figure 16. Unclamped Inductive load test circuit

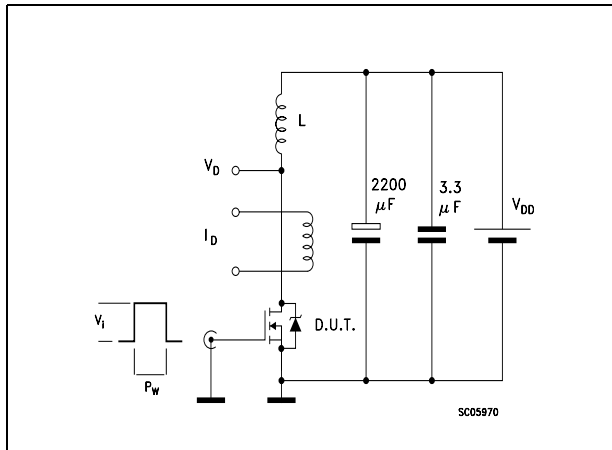


Figure 17. Unclamped Inductive waveform

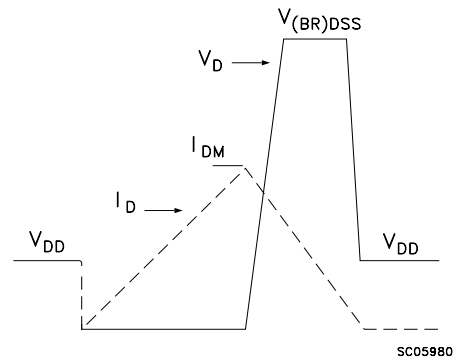


Figure 18. Switching times test circuit for resistive load

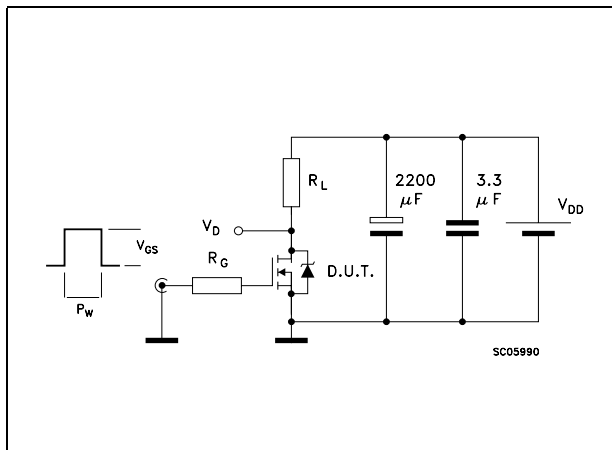


Figure 19. Gate charge test circuit

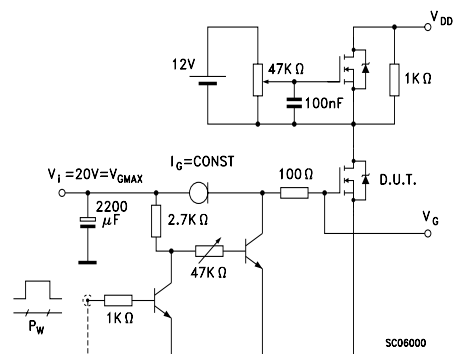


Figure 20. Test circuit for inductive load switching and diode recovery times

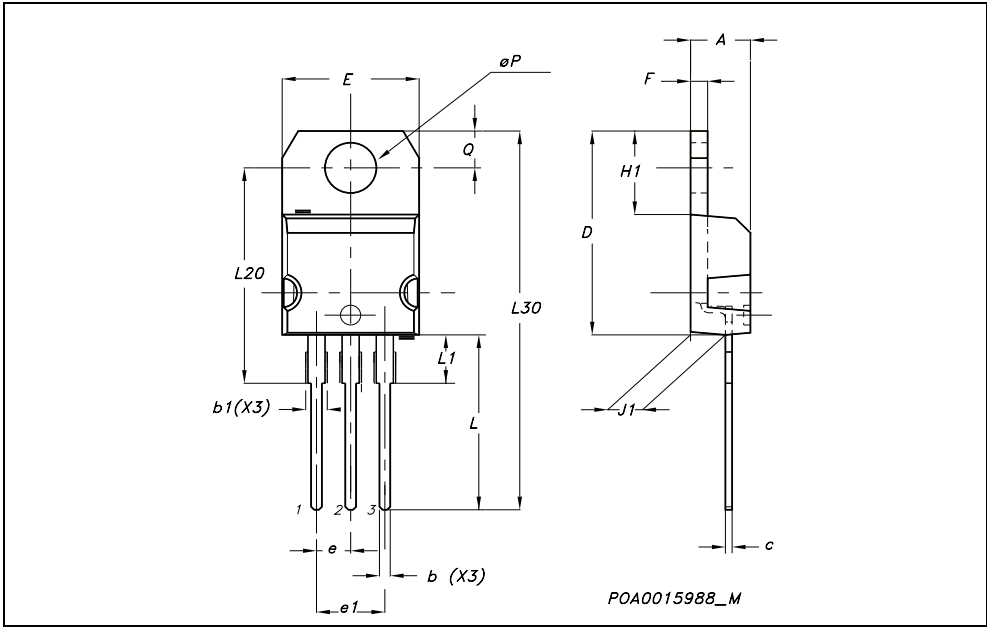


4 Package mechanical data

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

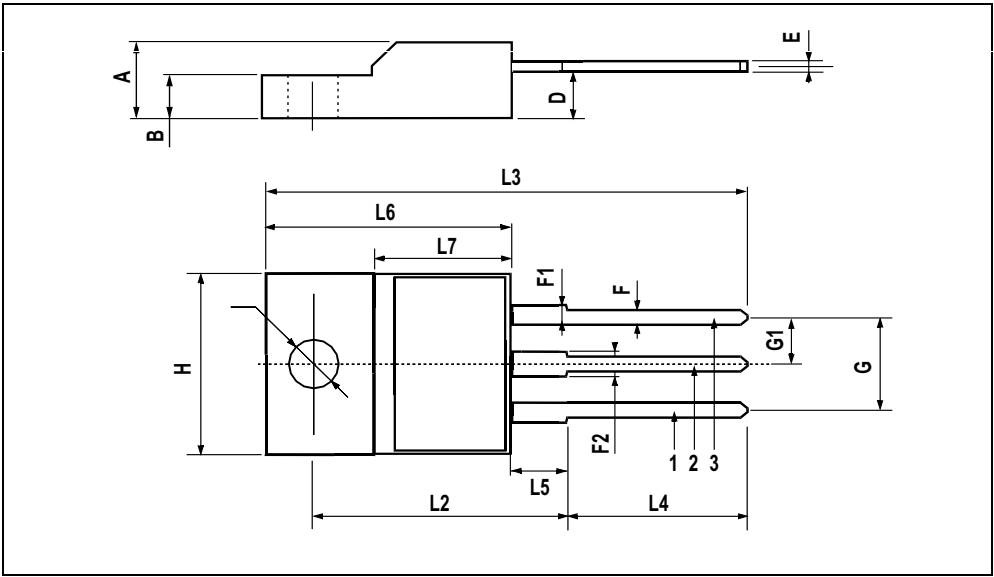
TO-220 MECHANICAL DATA

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



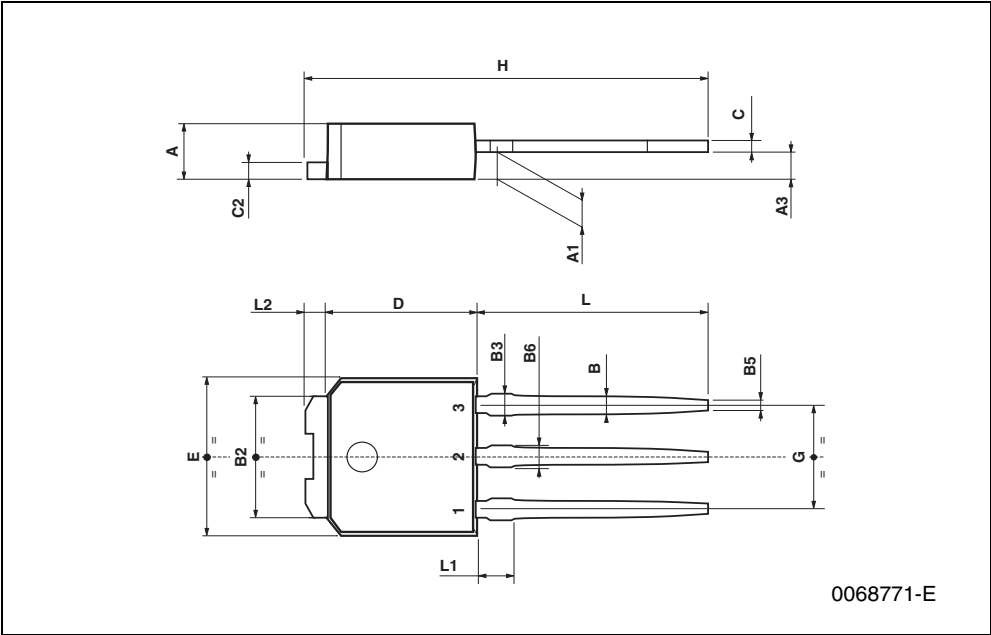
DPAK MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.9	0.025		0.035
b4	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
D1		5.1			0.200	
E	6.4		6.6	0.252		0.260
E1		4.7			0.185	
e		2.28			0.090	
e1	4.4		4.6	0.173		0.181
H	9.35		10.1	0.368		0.397
L	1			0.039		
(L1)		2.8			0.110	
L2		0.8			0.031	
L4	0.6		1	0.023		0.039
R		0.2			0.008	
V2	0°		8°	0°		8°

The mechanical drawing illustrates the DPAK package geometry. It includes a top view showing dimensions E, b4, and L2. A side view shows dimensions A, c2, D, and c. A detail view of the lead shows dimensions A1, R, and c. Another detail view shows the thermal pad with dimensions E1 and D1. A cross-sectional view shows the seating plane, gauge plane, and dimensions A2, L, L1, and V2. A dimension of 0.25 is also indicated for the lead thickness.

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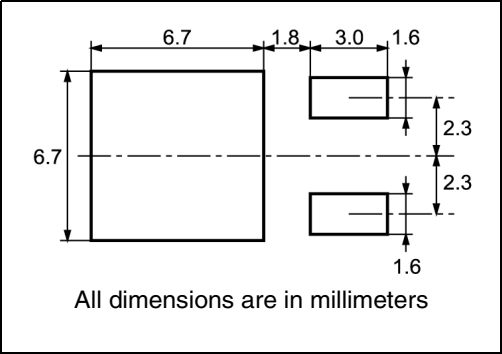
TO-251 (IPAK) MECHANICAL DATA

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

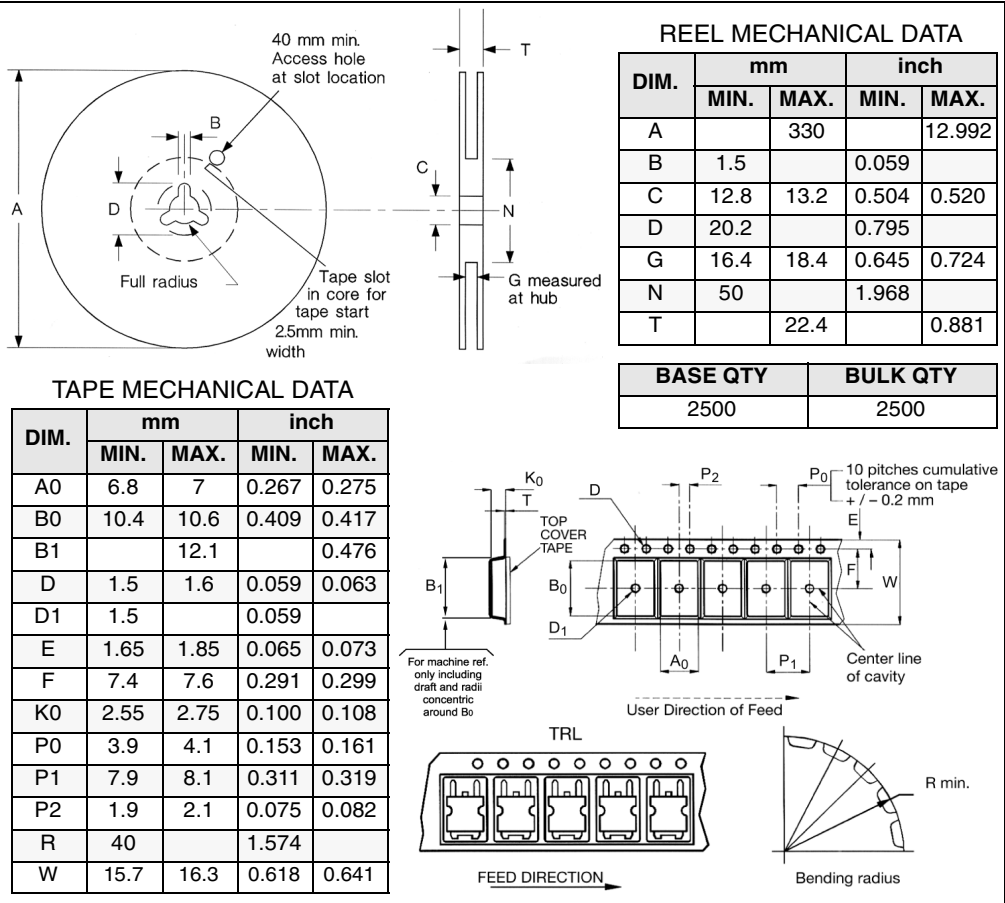


5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT



6 Revision history

Table 8. Revision history

Date	Revision	Changes
30-Mar-2005	5	Preliminary version
06-Sep-2005	6	Final version
21-Jan-2006	7	Inserted ecopack indication
16-Aug-2006	8	New template, no content change

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