STD5NK52ZD, STB5NK52ZD-1
STF5NK52ZD,STP5NK52ZD

N-channel 520 V,1.22 Ω,4.4 A,TO-220,IPAK,I²PAK,DPAK,TO-220FP Zener-protected SuperMESH™ Power MOSFET

Features

Type	V_{DSS}	$R_{DS(on)}$ max	I_D	Pw
STB5NK52ZD-1	520 V	< 1.5 Ω	4.4 A	70 W
STD5NK52ZD-1	520 V	< 1.5 Ω	4.4 A	70 W
STD5NK52ZD	520 V	< 1.5 Ω	4.4 A	70 W
STF5NK52ZD	520 V	< 1.5 Ω	4.4 A	25 W
STP5NK52ZD	520 V	< 1.5 Ω	4.4 A	70 W

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

Application

- Switching applications

Description

The SuperFREDMesh™ series associates all advantages of reduced on-resistance, zener gate protection and very high dv/dt capability with a fast body-drain recovery diode. Such series complements the “FDmesh™” advanced technology.

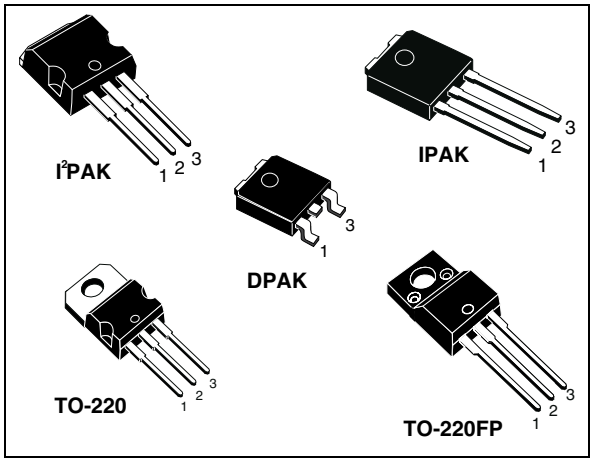


Figure 1. Internal schematic diagram

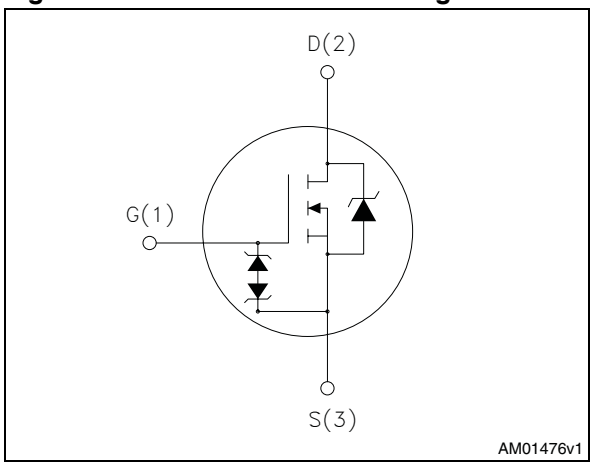


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB5NK52ZD-1	B5NK52ZD	I²PAK	Tube
STD5NK52ZD-1	D5NK52ZD	IPAK	Tube
STD5NK52ZD	D5NK52ZD	DPAK	Tape and reel
STF5NK52ZD	F5NK52ZD	TO-220FP	Tube
STP5NK52ZD	P5NK52ZD	TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220 I²PAK	IPAK DPAK	TO-220FP	
V_{DS}	Drain-source voltage (V_{GS} = 0)	520			V
V_{GS}	Gate- source voltage	± 30			V
I_D	Drain current (continuous) at T_C = 25 °C	4.4		4.4 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	2.7		2.7 (1)	A
I_{DM} (2)	Drain current (pulsed)	17.6		17.6 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	70		25	W
	Derating factor	0.56		0.2	W/°C
$V_{ESD(G-S)}$	Gate source ESD(HBM-C=100pF, R=1.5 kΩ)	2800			V
dv/dt (3)	Peak diode recovery voltage slope	15			V/ns
T_j T_{stg}	Operating junction temperature Storage temperature	-55 to 150			°C

1. Limited only by max temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 4.4$ A, di/dt $\leq$ 200 A/µs, V_{DD} = 80% $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220 I²PAK	IPAK DPAK	TO-220FP	
Rthj-case	Thermal resistance junction-case max	1.78		5	°C/W
Rthj-amb	Thermal resistance junction-ambient max	62.5	100	62.5	°C/W
T_l	Maximum lead temperature for soldering purpose	300			°C

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	4.4	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, $I_D = I_{AR}$, V_{DD} = 50 V)	170	mJ

2 Electrical characteristics

(Tcase =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	520			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 = 50 µA	2.5	3.75	4.5	V
$R_{DS(on}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 2.2 A		1.22	1.5	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs}	Forward transconductance	V_{DS} = 15 V, I_D = 2.2 A		3.1		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0		529 71 13.4		pF pF pF
$C_{OSS\ eq}$ (1)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 416 V		11		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 416 V, I_D = 4.4 A, V_{GS} = 10 V (see *Figure 19*)		16.9 4.2 8.4		nC nC nC

1. $C_{oss\ eq}$. 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. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off-delay time Fall time	V_{DD} = 260 V, I_D = 2.2 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 18*)		11.4 13.6 23.1 15		ns ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)				4.4 17.6	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 4.4 A, V_{GS} = 0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 4.4 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 23*)		97.7 300 5.9		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 4.4 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 23*)		139 500 7.2		ns nC 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	Igs=± 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

2.1 Electrical characteristics (curves)

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

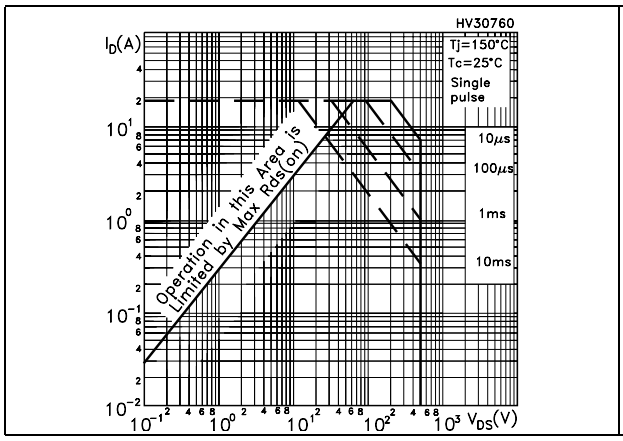


Figure 3. Thermal impedance for TO-220 / I²PAK

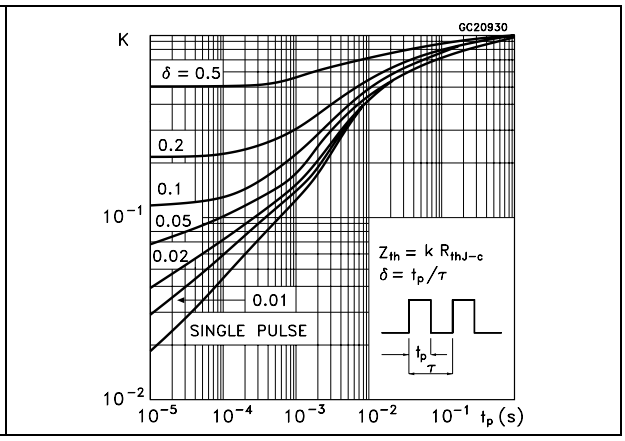


Figure 4. Safe operating area for TO-220FP

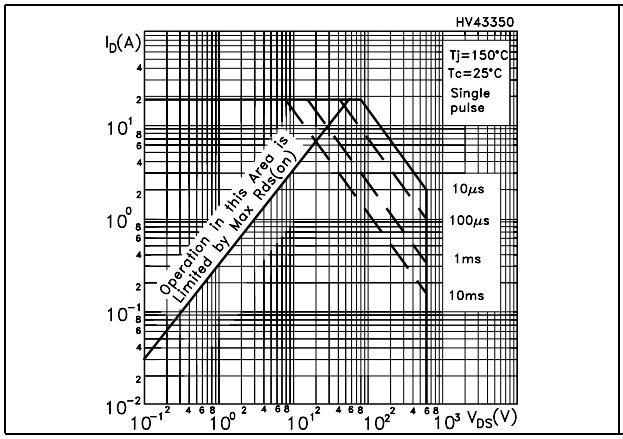


Figure 5. Thermal impedance for TO-220FP

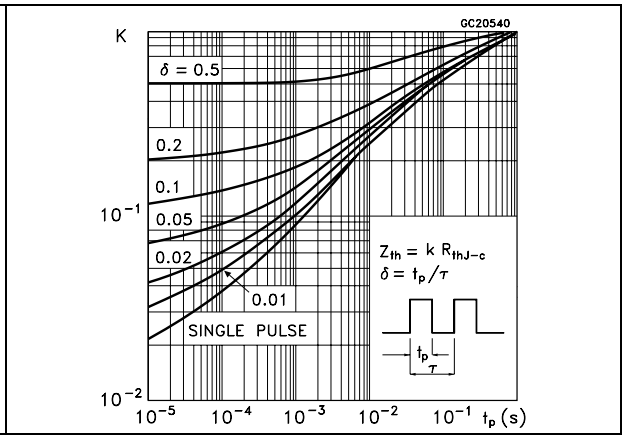


Figure 6. Safe operating area for IPAK/DPAK

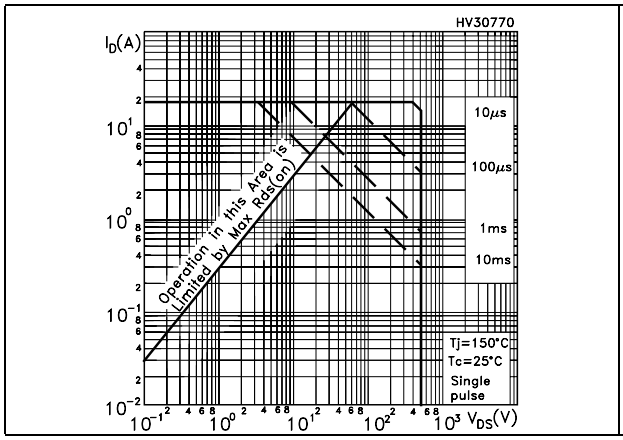


Figure 7. Thermal impedance for IPAK/DPAK

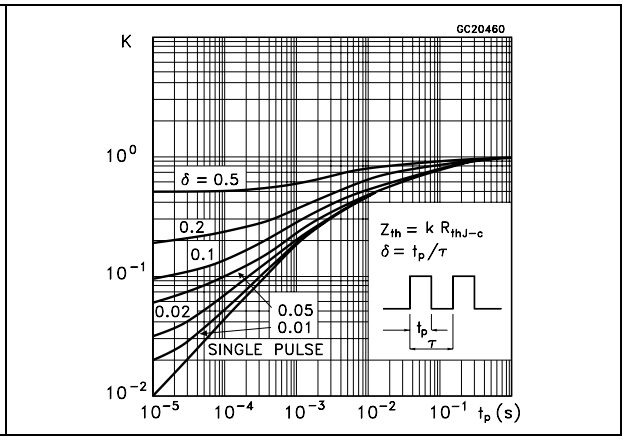


Figure 8. Output characteristics

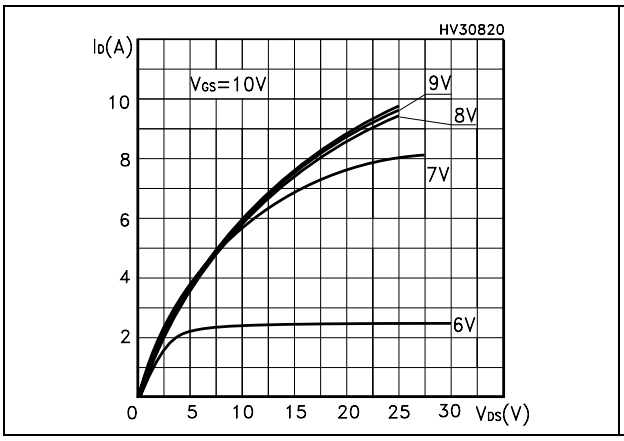


Figure 9. Transfer characteristics

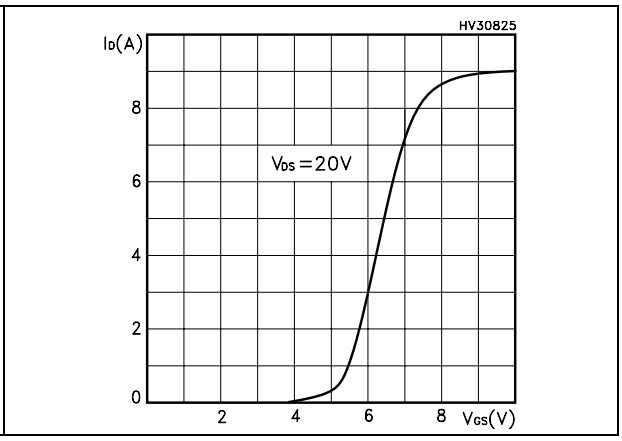


Figure 10. Normalized B_{VDSS} vs temperature

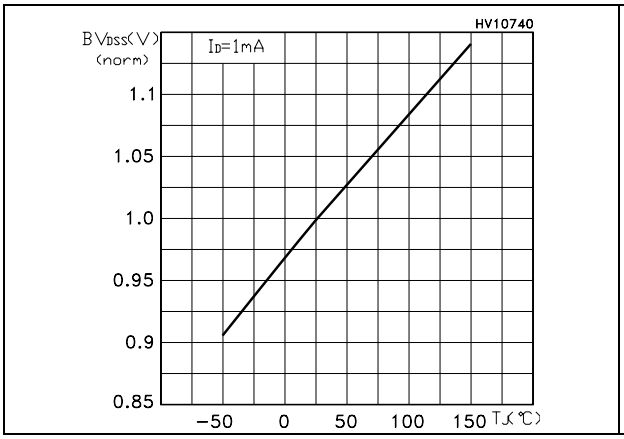


Figure 11. Static drain-source on resistance

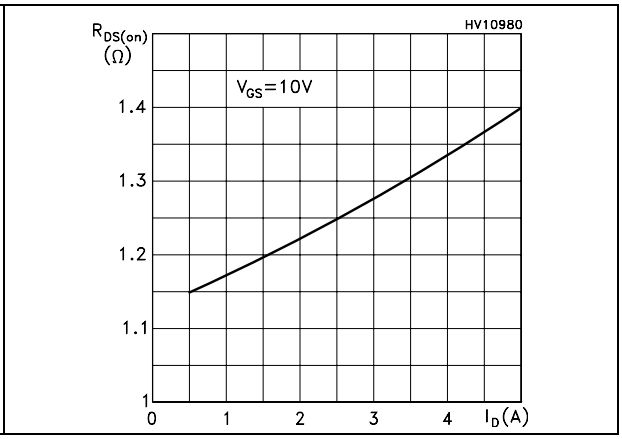


Figure 12. Gate charge vs gate-source voltage

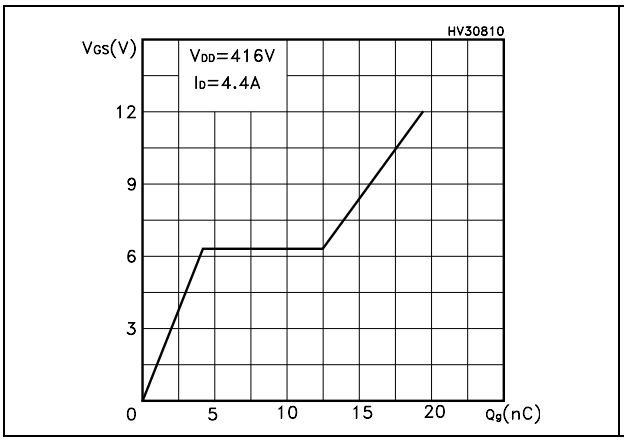


Figure 13. Capacitance variations

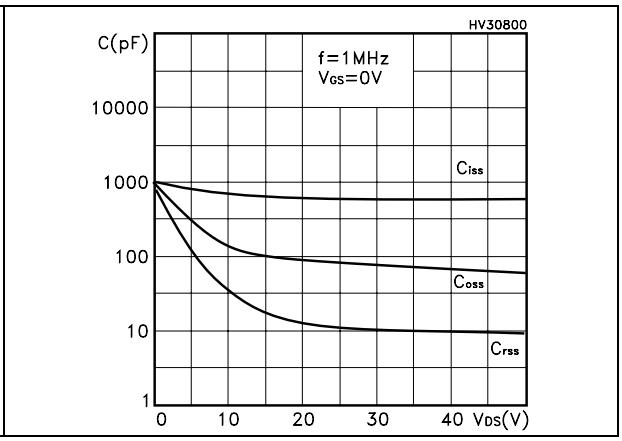


Figure 14. Normalized gate threshold voltage vs temperature

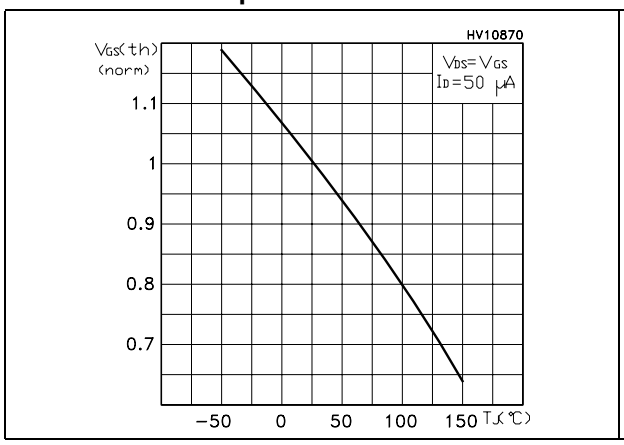


Figure 15. Normalized on resistance vs temperature

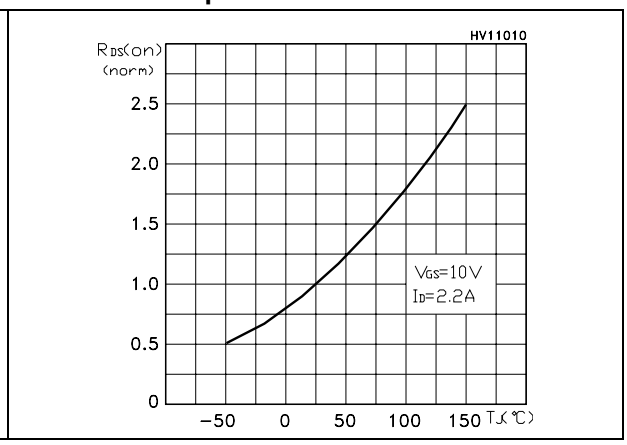


Figure 16. Source-drain diode forward characteristics

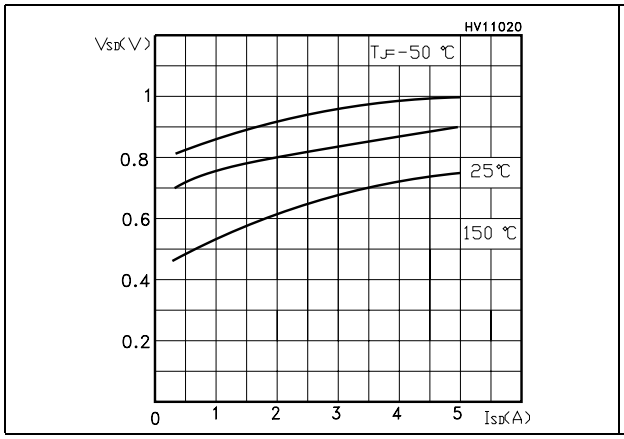
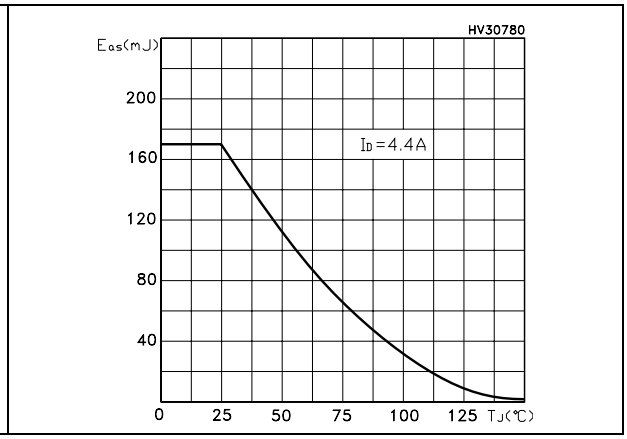


Figure 17. Maximum avalanche energy vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

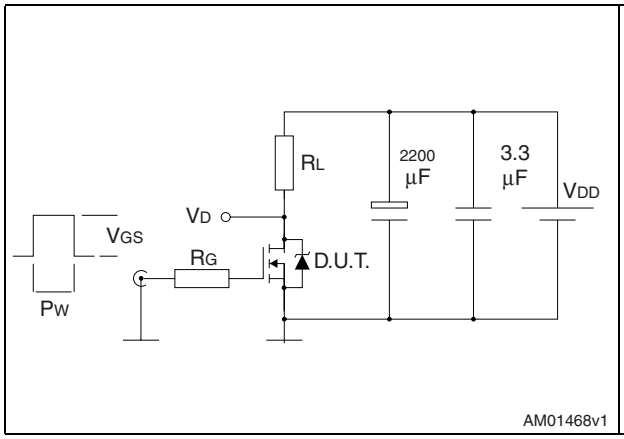


Figure 19. Gate charge test circuit

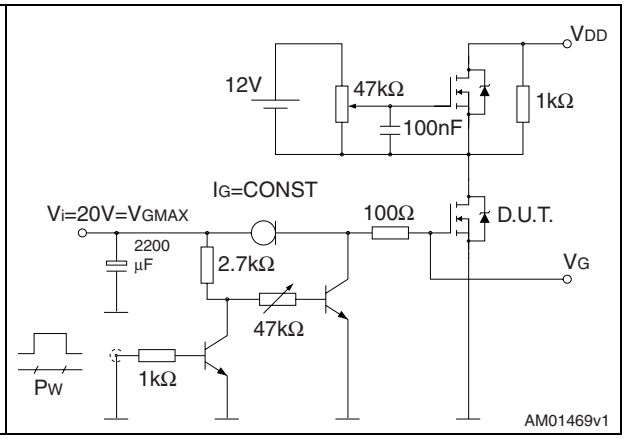


Figure 20. Test circuit for inductive load switching and diode recovery times

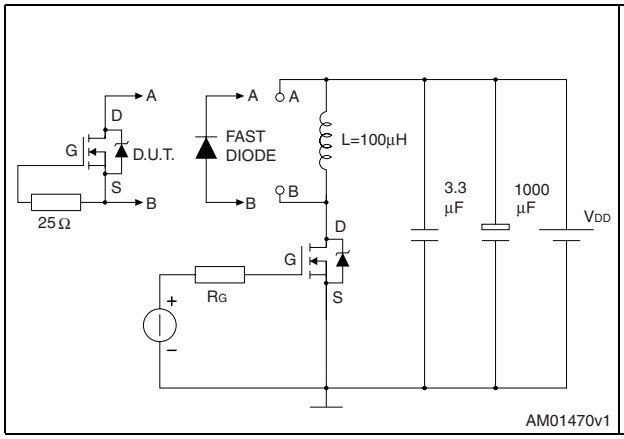


Figure 21. Unclamped Inductive load test circuit

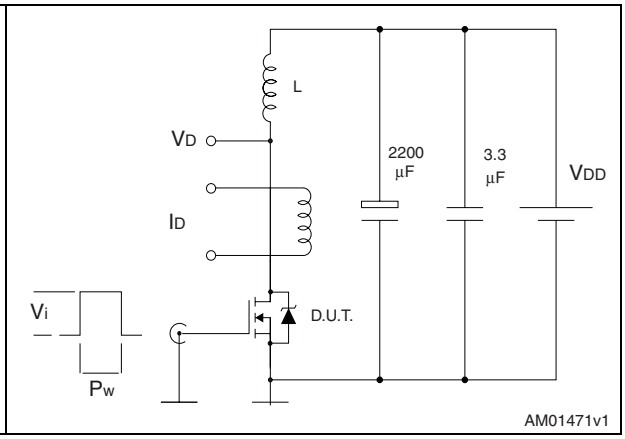


Figure 22. Unclamped inductive waveform

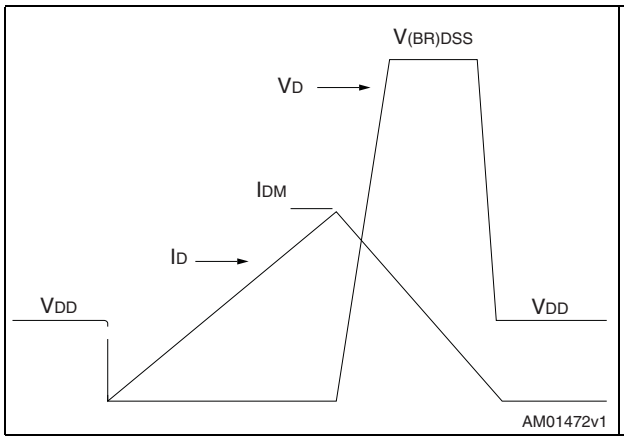
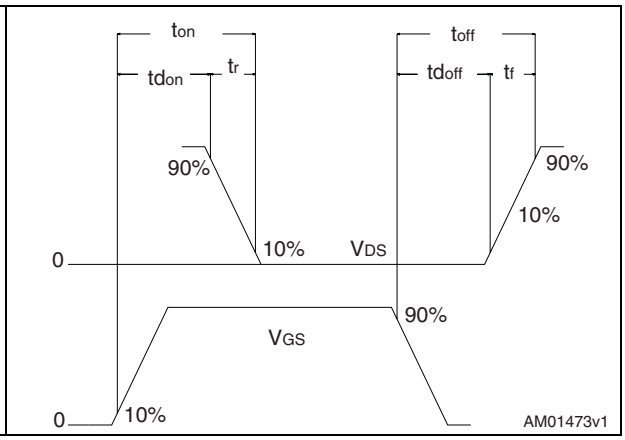


Figure 23. Switching time waveform

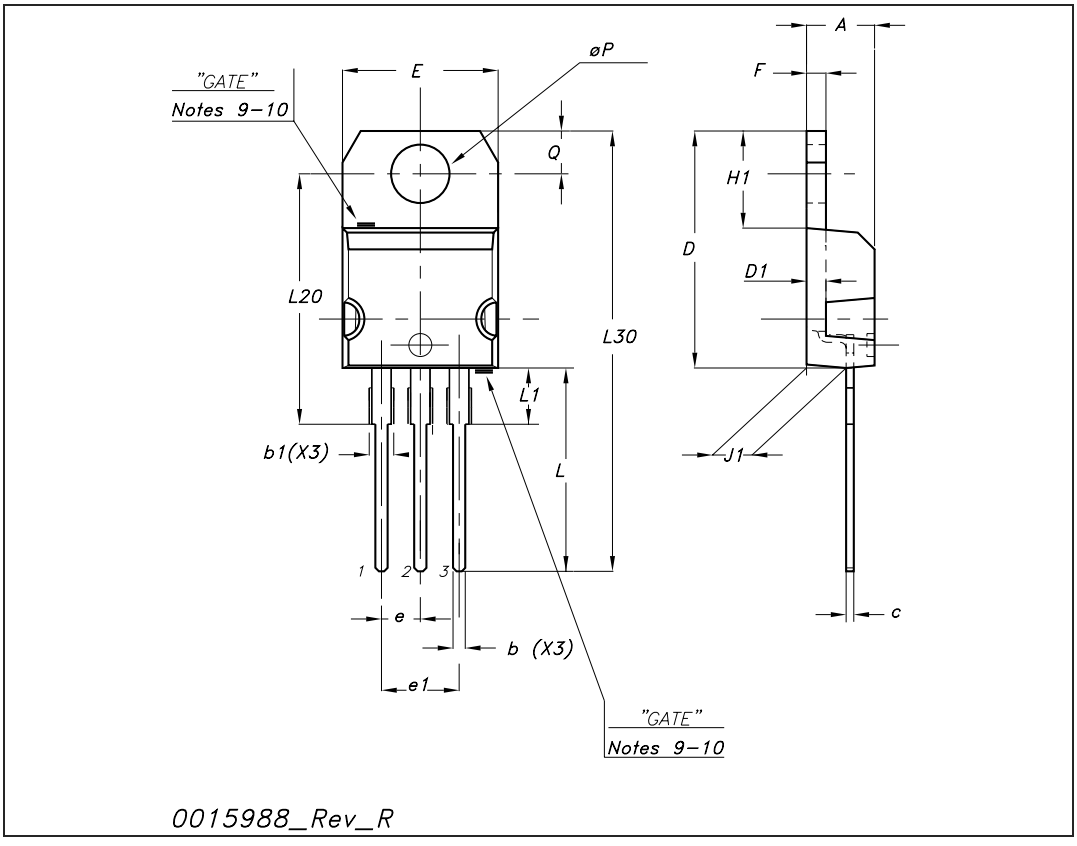


4 Package mechanical data

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

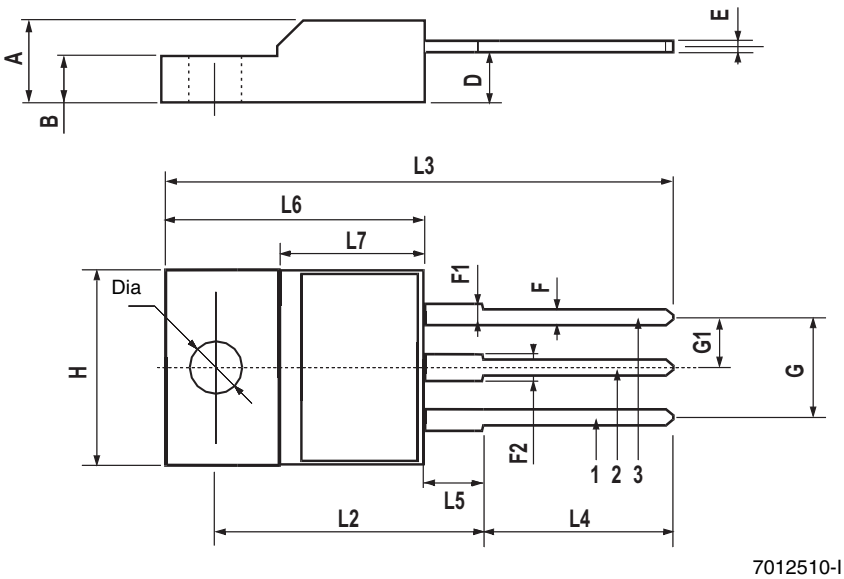
TO-220 mechanical data

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	0.48		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



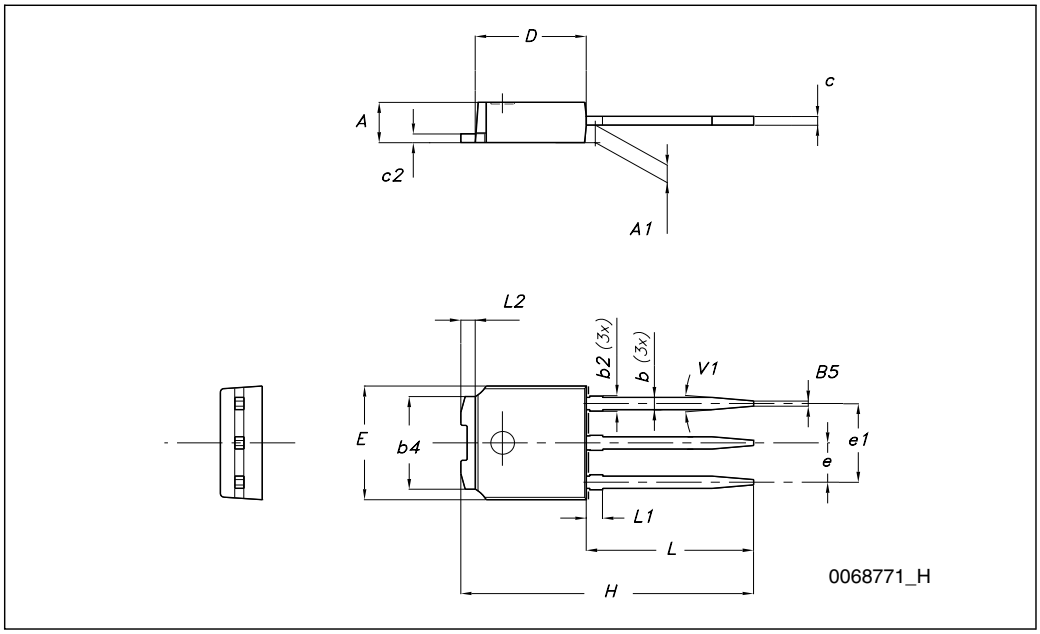
TO-220FP mechanical data

Dim.	mm.			inch		
	Min.	Typ	Max.	Min.	Typ.	Max.
A	4.40		4.60	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		0.70	0.017		0.027
F	0.75		1.00	0.030		0.039
F1	1.15		1.50	0.045		0.067
F2	1.15		1.50	0.045		0.067
G	4.95		5.20	0.195		0.204
G1	2.40		2.70	0.094		0.106
H	10		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.80		10.60	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.90		16.40	0.626		0.645
L7	9		9.30	0.354		0.366
Dia	3		3.2	0.118		0.126



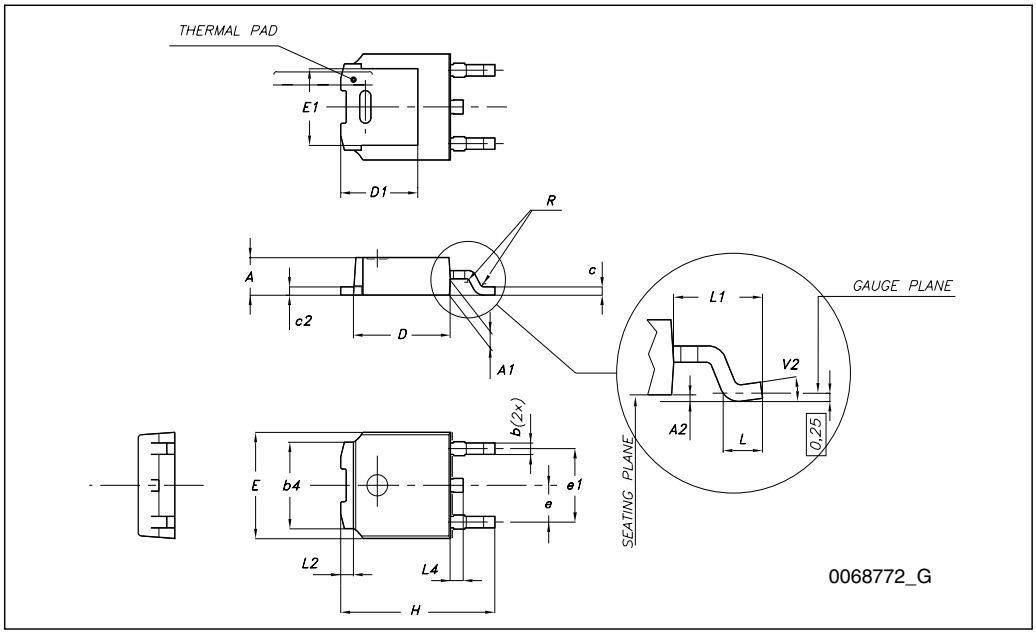
TO-251 (IPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
(L1)	0.80		1.20
L2		0.80	
V1		10 °	



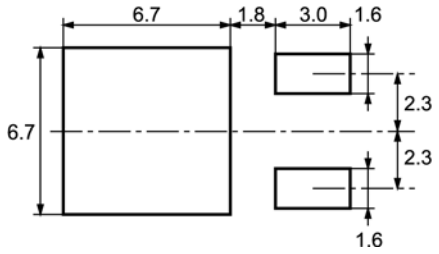
TO-252 (DPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0 °		8 °



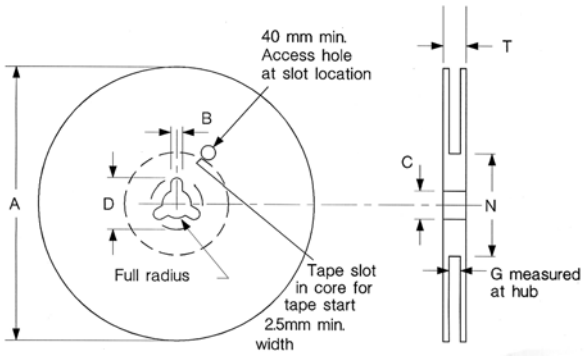
5 Packaging mechanical data

DPAK FOOTPRINT



All dimensions are in millimeters

TAPE AND REEL SHIPMENT



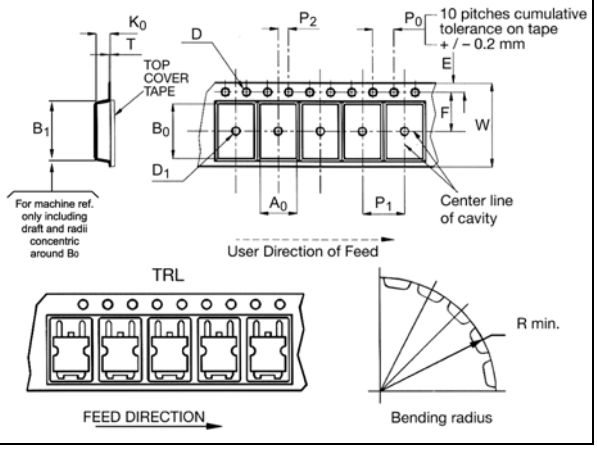
REEL MECHANICAL DATA

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		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

BASE QTY	BULK QTY
2500	2500

TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641



6 Revision history

Table 10. Document revision history

Date	Revision	Changes
16-Jun-2005	1	First release
06-Sep-2005	2	Inserted ecopack indication
03-Oct-2005	3	Corrected value on *Table 2*
23-Mar-2006	4	Complete version. New template
15-Sep-2008	5	Inserted new package: TO-220FP

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