



# STB12NK80Z STP12NK80Z - STW12NK80Z

N-channel 800V - 0.65Ω - 10.5A - TO-220 - D<sup>2</sup>PAK - TO-247  
Zener - Protected SuperMESH™ Power MOSFET

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STB12NK80Z	800V	<0.75Ω	10.5 A	190W
STP12NK80Z	800V	<0.75Ω	10.5 A	190W
STW12NK80Z	800V	<0.75Ω	10.5 A	190W

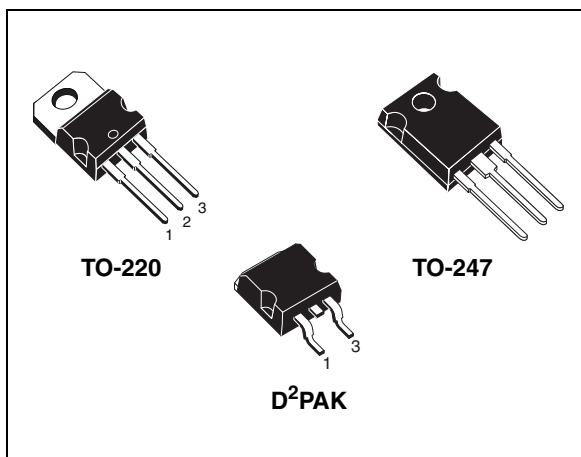
- Extremely high dv/dt capability
- Improved esd capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing reliability

## Description

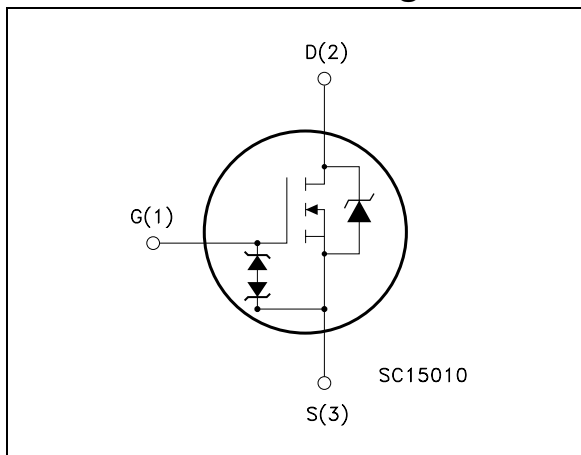
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications.

## Application

- Switching application



## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STB12NK80Z	B12NK80Z	D <sup>2</sup> PAK	Tape & reel
STP12NK80Z	P12NK80Z	TO-220	Tube
STW12NK80Z	W12NK80Z	TO-247	Tube

# Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	800	V
$V_{DGR}$	Drain-gate voltage ( $R_{GS} = 20K\Omega$ )	800	V
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25^\circ C$	10.5	A
$I_D$	Drain current (continuous) at $T_C = 100^\circ C$	6.6	A
$I_{DM}^{(1)}$	Drain current (pulsed)	42	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ C$	190	W
	Derating Factor	1.51	W/ $^\circ C$
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 150	$^\circ C$

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 10.5$  A,  $di/dt \leq 200$  A/ $\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq T_{JMAX}$

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220/ D <sup>2</sup> PAK	TO-247	
$R_{thj-case}$	Thermal resistance junction-case Max	0.66		$^\circ C/W$
$R_{thj-a}$	Thermal resistance junction-ambient Max	62.5	50	$^\circ C/W$
$T_l$	Maximum lead temperature for soldering purpose	300		$^\circ C$

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ Max)	10.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25^\circ C$ , $I_d = I_{ar}$ , $V_{dd} = 50V$ )	400	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	$I_D = 1mA, V_{GS} = 0$	800			V
$I_{DSS}$	Peak diode recovery voltage slope	$V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating},$ $T_C = 125^{\circ}C$			1 50	$\mu A$ $\mu A$
$I_{GSS}$	Gate body leakage current ( $V_{GS} = 0$ )	$V_{GS} = \pm 20V$			$\pm 10$	$\mu A$
$V_{GS(th)}$	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	$V_{GS} = 10V, I_D = 5.25A$		0.65	0.75	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15V, I_D = 5.25A$		12		S
$C_{iss}$	Input capacitance	$V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$		2620		pF
$C_{oss}$	Output capacitance			250		pF
$C_{rss}$	Reverse transfer capacitance			53		pF
$C_{osseq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0V \text{ to } 640V$		100		pF
$Q_g$	Total gate charge	$V_{DD} = 640V, I_D = 10.5A$		87		nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10V$		14		nC
$Q_{gd}$	Gate-drain charge	(see <a href="#">Figure 18</a> )		44		nC
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400V, I_D = 5.25A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see <a href="#">Figure 19</a> )		30		ns
$t_r$	Rise time			18		ns
$t_{d(off)}$	Off-voltage rise time			70		ns
$t_f$	Fall time			20		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{DD} = 640V, I_D = 10.5A,$		16		ns
$t_f$	Fall time	$R_G = 4.7\Omega, V_{GS} = 10V$		15		ns
$t_c$	Cross-over time	(see <a href="#">Figure 19</a> )		28		ns

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. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				10.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				42	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}=10.5A, V_{GS}=0$			1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD}=10.5A,$ $di/dt = 100A/\mu s,$ $V_{DD}=100V, T_j=150^\circ C$		635		ns
$Q_{rr}$	Reverse recovery charge			5.9		$\mu C$
$I_{RRM}$	Reverse recovery current			18.5		A

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

**Table 7. Gate-source zener diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$BV_{GSO}^{(1)}$	Gate-Source breakdown voltage	$I_{gs}=\pm 1mA$ (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 1. Safe operating area for TO-220/ D<sup>2</sup>PAK

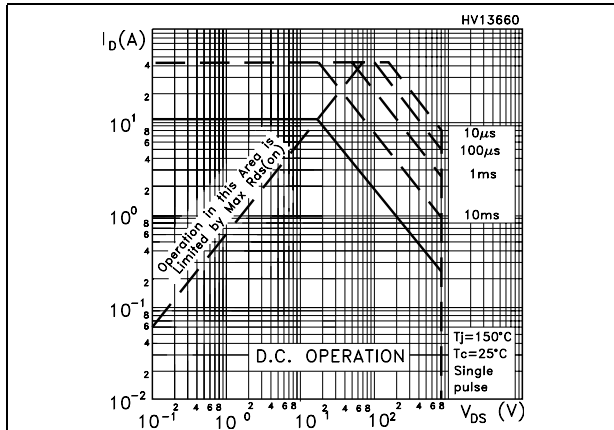


Figure 2. Thermal impedance for TO-220/ D<sup>2</sup>PAK

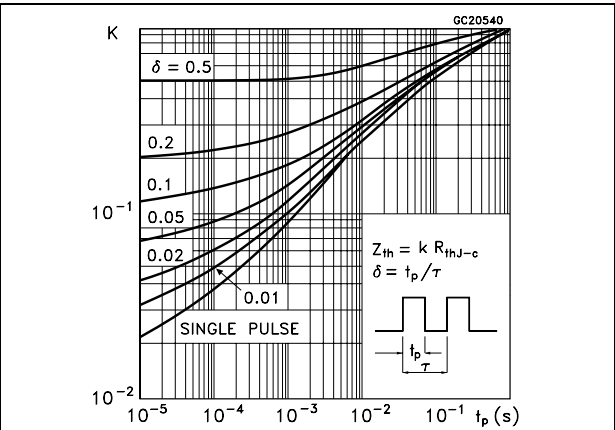


Figure 3. Safe operating area for TO-247

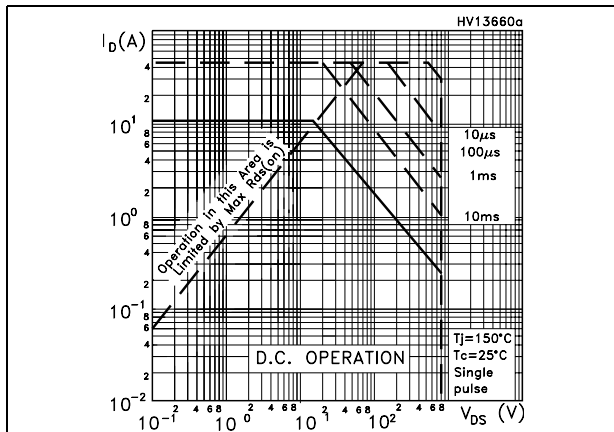


Figure 4. Thermal impedance for TO-247

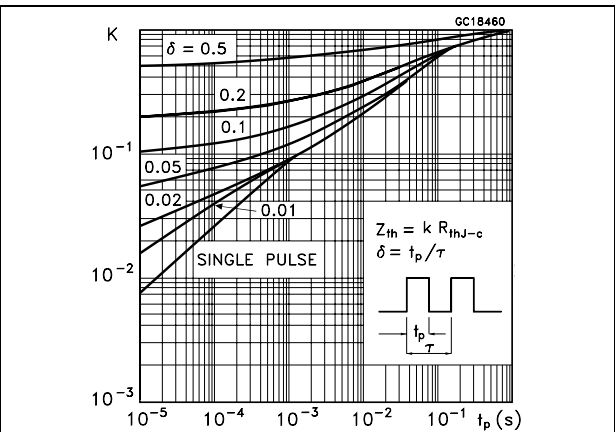


Figure 5. Output characteristics

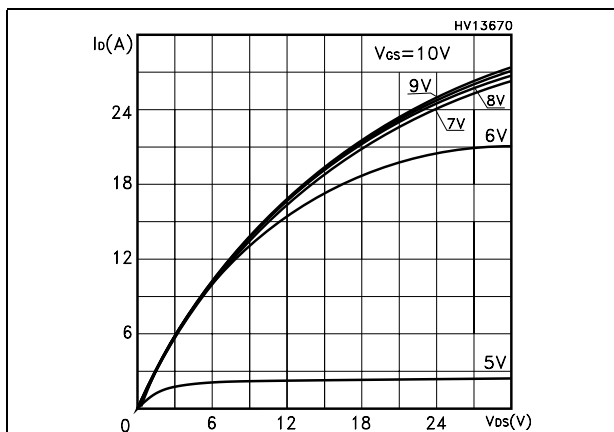


Figure 6. Transfer characteristics

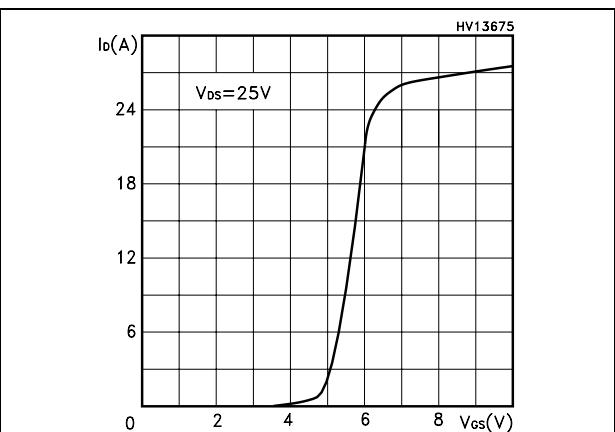


Figure 7. Transconductance

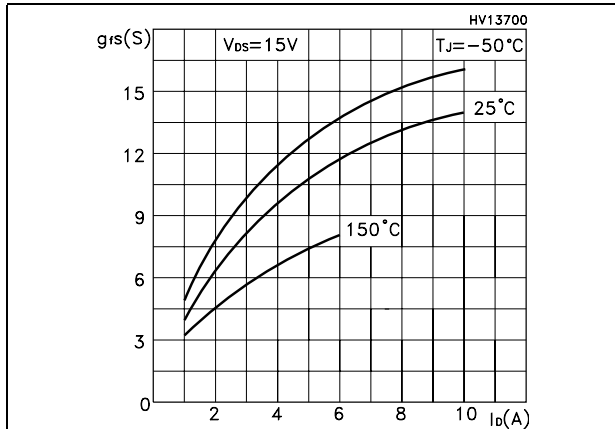


Figure 8. Static drain-source on resistance

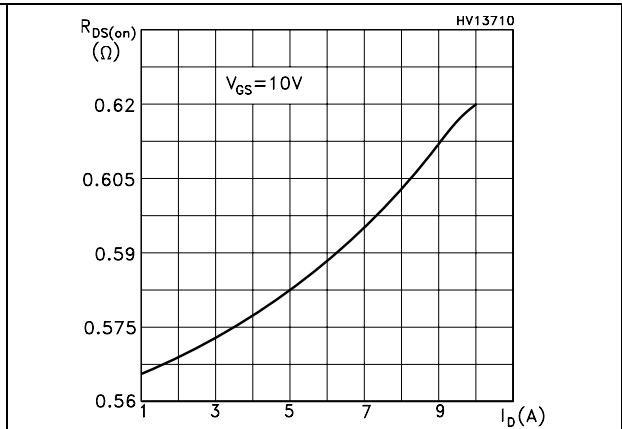


Figure 9. Gate charge vs gate-source voltage

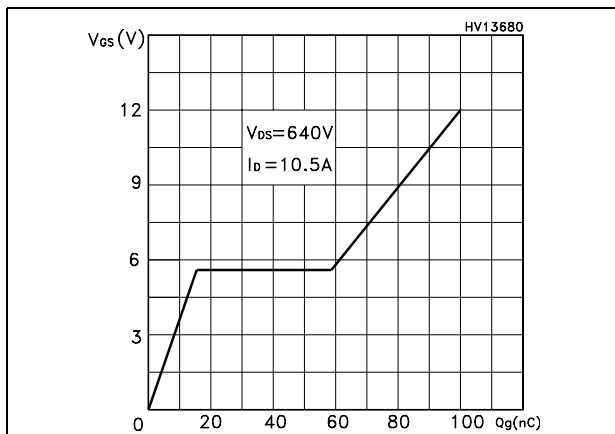


Figure 10. Capacitance variations

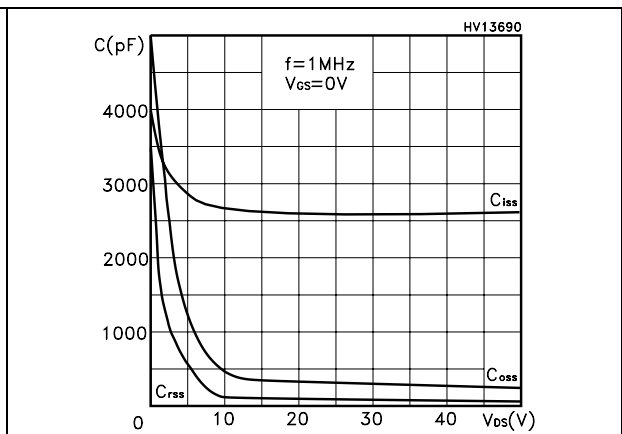


Figure 11. Normalized gate threshold voltage vs temperature

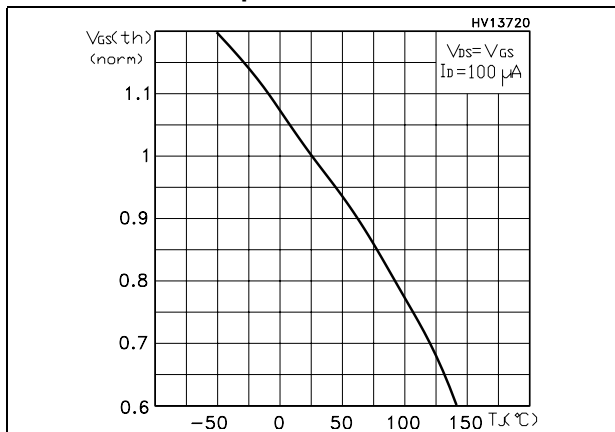


Figure 12. Normalized on resistance vs temperature

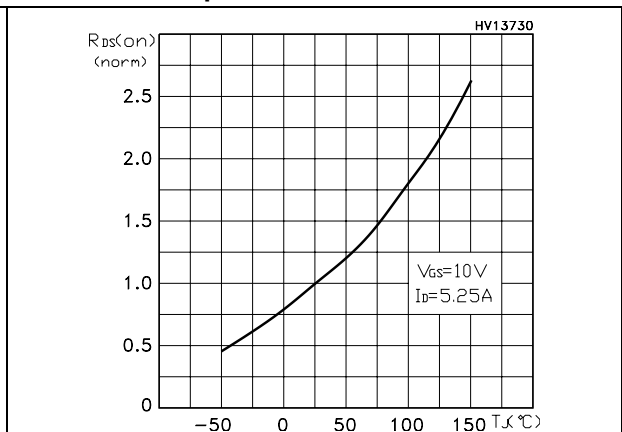


Figure 13. Source-drain diode forward characteristics

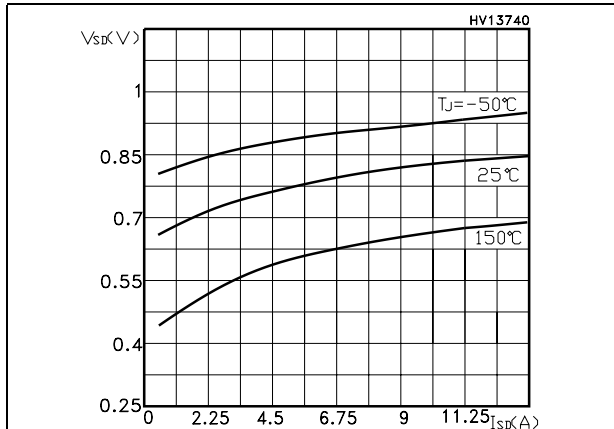


Figure 14. Normalized  $B_{V_{DSS}}$  vs temperature

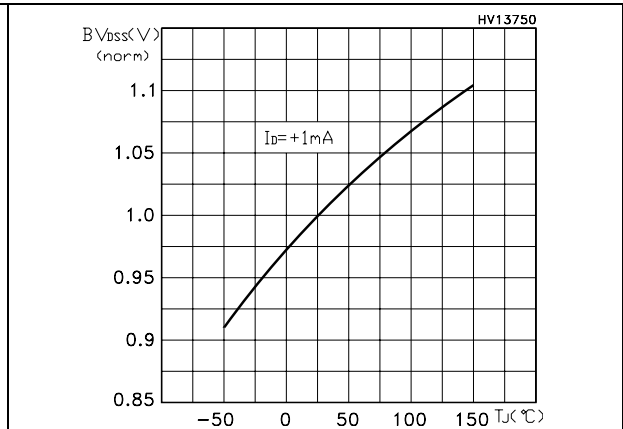
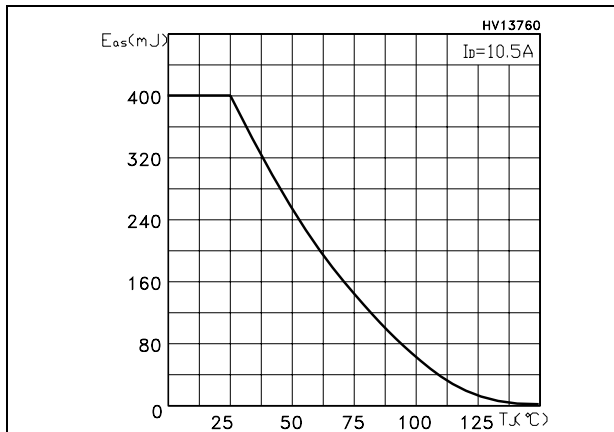


Figure 15. Maximum avalanche energy vs temperature





### 3 Test circuit Package mechanical data

Figure 16. Switching times test circuit for resistive load

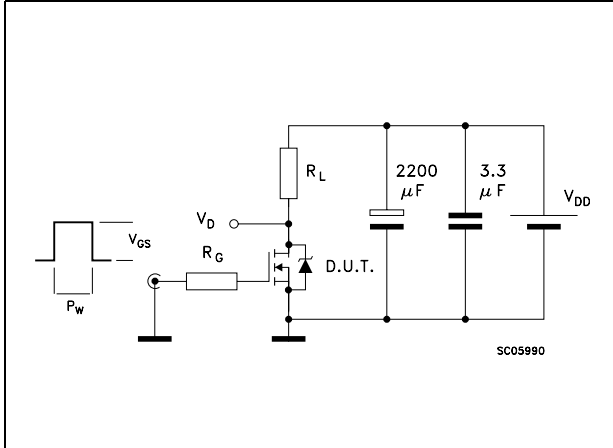


Figure 17. Gate charge test circuit

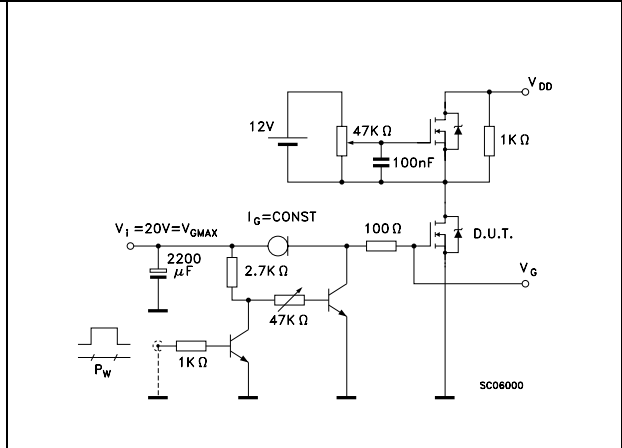


Figure 18. Test circuit for inductive load switching and diode recovery times

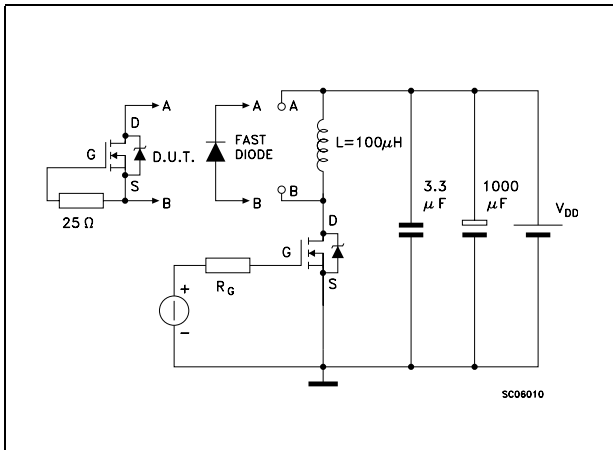


Figure 19. Unclamped Inductive load test circuit

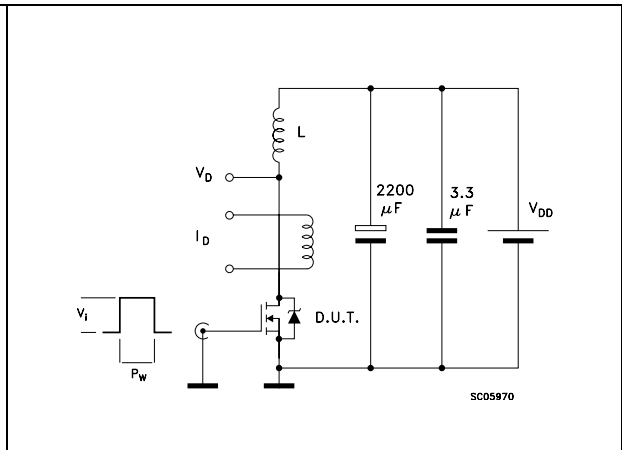
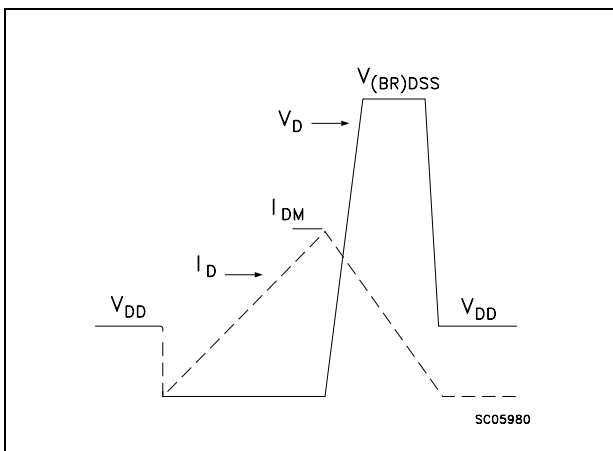


Figure 20. Unclamped inductive waveform

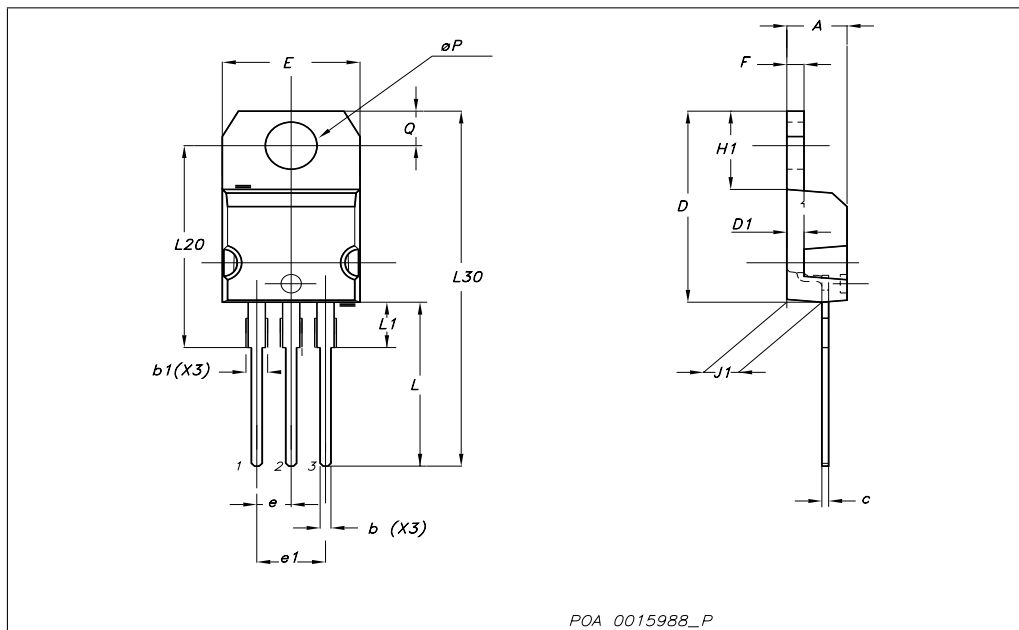


## 4 Package mechanical data

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)

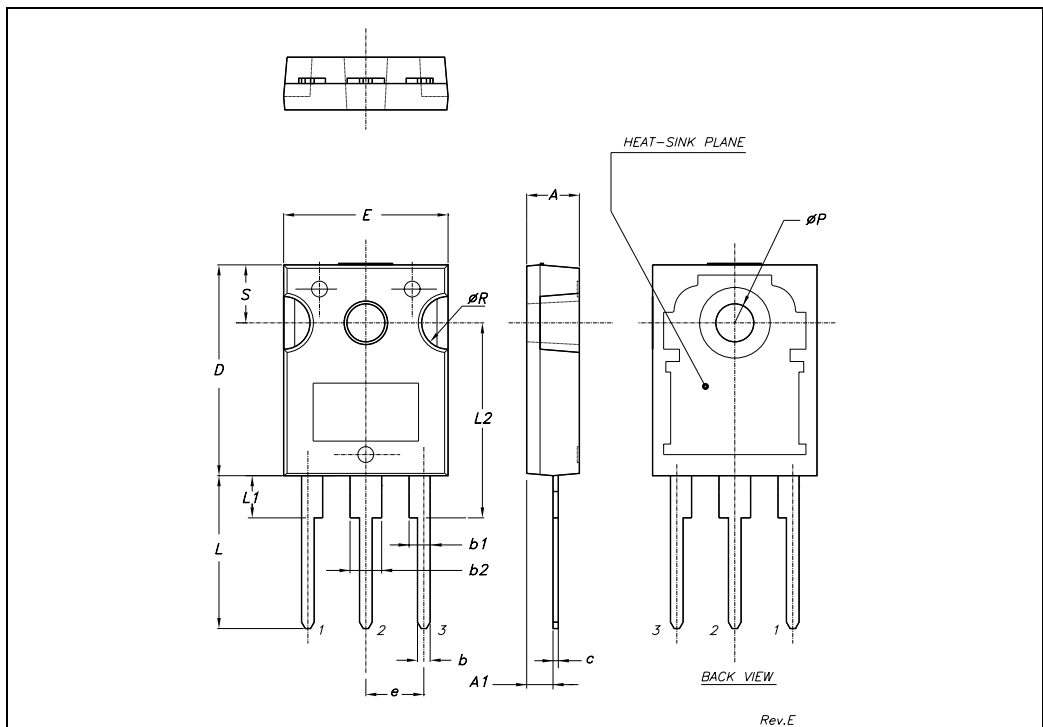
TO-220 mechanical data

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



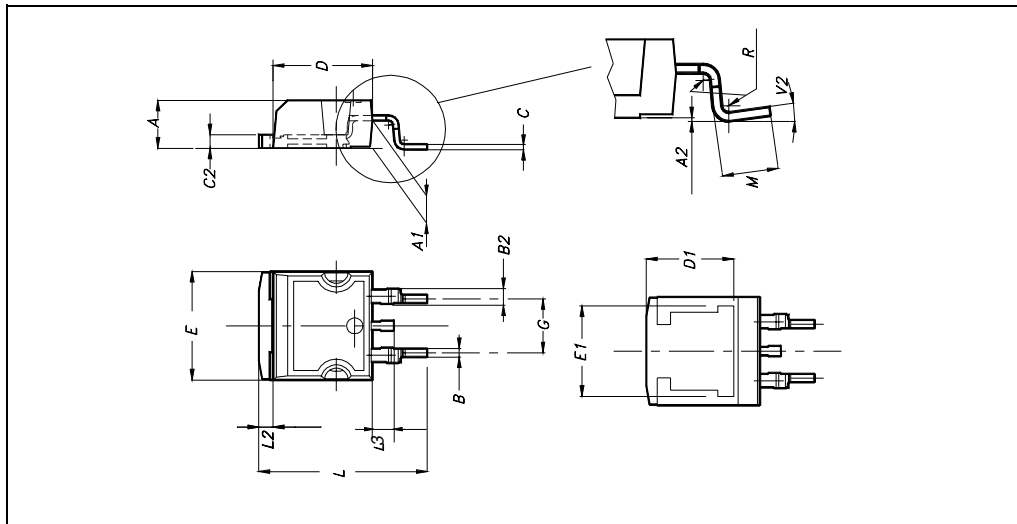
**TO-247 MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	



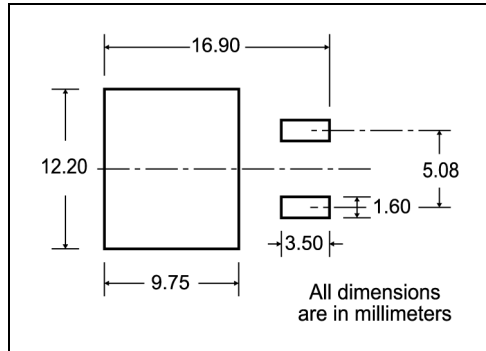
D<sup>2</sup>PAK MECHANICAL DATA

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

## D<sup>2</sup>PAK FOOTPRINT



## TAPE AND REEL SHIPMENT

**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

**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

\* on sales type

## 6 Revision history

**Table 8. Revision history**

Date	Revision	Changes
22-Jun-2004	2	Preliminary version
28-Jan-2005	3	Complete version
08-Sep-2005	4	<i>Figure 1</i> and <i>Figure 3</i> changed
31-Jul-2006	5	The document has been reformatted
27-Apr-2007	6	Modified Rds(on) value on <i>Table 4</i>

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