



# STD2NC45-1 STQ1NC45R-AP

N-channel 450V - 4.1Ω - 1.5A - IPAK - TO-92  
SuperMESH™ Power MOSFET

## General features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STD2NC45-1	450V	<4.5Ω	1.5A	30W
STQ1NC45R-AP	450V	<4.5Ω	0.5A	3.1W

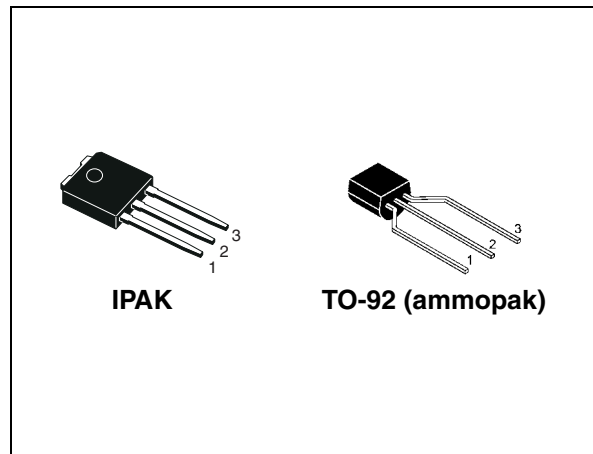
- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- New high voltage benchmark

## Description

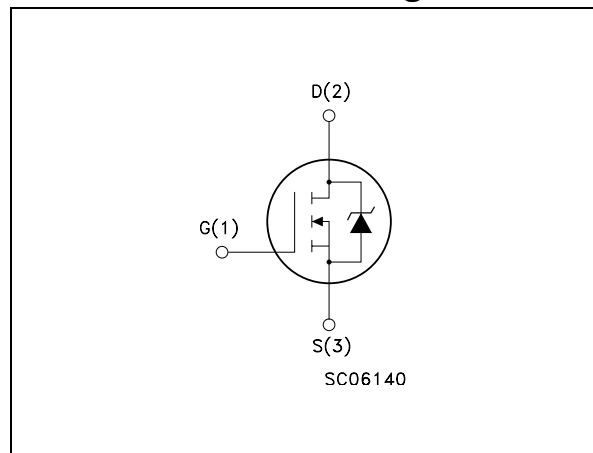
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements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

## Applications

- Switching application
  - Switch mode low power supplies (SMPS)
  - Low power, low cost CFL (compact fluorescent lamps)
  - Low power battery chargers



## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STD2NC45-1	D2NC45	IPAK	Tube
STQ1NC45R-AP	Q1NC45R	TO-92	Ammopak

# Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		IPAK	TO-92	
V <sub>DS</sub>	Drain-source voltage (V <sub>GS</sub> = 0)	450		V
V <sub>GS</sub>	Gate- source voltage	±30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25°C	1.5	0.5	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100°C	0.95	0.315	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	6	2	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25°C	30	3.1	W
	Derating factor	0.24	0.025	W/°C
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	3		V/ns
T <sub>stg</sub>	Storage temperature	-65 to 150		°C
T <sub>j</sub>	Max. operating junction temperature			°C

1. Pulse width limited by safe operating area
2. I<sub>SD</sub> ≤ 0.5A, di/dt ≤ 100 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		IPAK	TO-92	
R <sub>thj-case</sub>	Thermal resistance junction-case max	4.1	--	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	100	120	°C/W
R <sub>thj-lead</sub>	Thermal resistance junction-lead max	--	40	°C/W
T <sub>l</sub>	Maximum lead temperature for soldering purpose	275	260	°C

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> Max)	1.5	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>j</sub> =25°C, I <sub>D</sub> =I <sub>AS</sub> , V <sub>DD</sub> =50V)	25	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 250\mu\text{A}$ , $V_{GS} = 0$	450			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	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 30\text{V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\mu\text{A}$	2.3	3	3.7	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{V}$ , $I_D = 0.5\text{A}$		4.1	4.5	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} > I_{D(on)} \times R_{DS(on)max}$ , $I_D = 0.5\text{A}$		1.1		S
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$		160		pF
$C_{oss}$	Output capacitance			27.5		pF
$C_{rss}$	Reverse transfer capacitance			4.7		pF
$Q_g$	Total gate charge	$V_{DD} = 360\text{V}$ , $I_D = 1.5\text{A}$ ,		7		nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10\text{V}$ , $R_G = 4.7\Omega$		1.3	10	nC
$Q_{gd}$	Gate-drain charge	(see Figure 18)		3.2		nC

1. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$	Turn-on delay time Rise time	$V_{DD} = 225V$ , $I_D = 0.5A$ $R_G = 4.7\Omega$ , $V_{GS} = 10V$ (see Figure 17)		6.7 4		ns ns
$t_{r(Voff)}$ $t_f$ $t_c$	Off-voltage rise time Fall time Cross-over time	$V_{DD} = 360V$ , $I_D = 1.5A$ , $R_G = 4.7\Omega$ , $V_{GS} = 10V$ (see Figure 17)		8.5 12 18		ns ns ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$ $I_{SDM}^{(1)}$	Source-drain current Source-drain current (pulsed)				1.5 6.0	A A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 1.5A$ , $V_{GS} = 0$			1.6	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 1.5A$ , $di/dt = 100A/\mu s$ $V_{DD} = 100V$ , $T_j = 150^\circ C$ (see Figure 22)		225 530 4.7		ns $\mu C$ A

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

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for IPAK

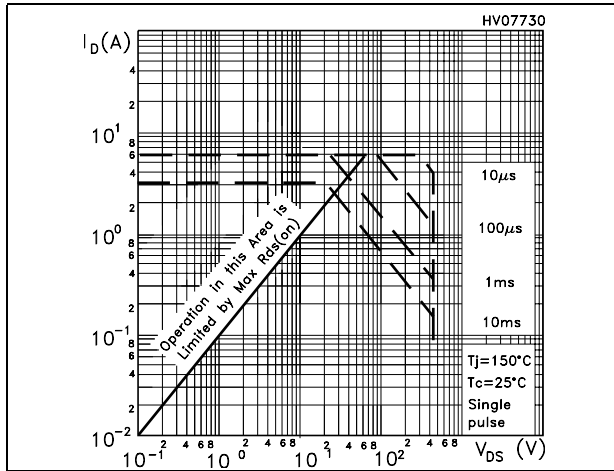


Figure 2. Thermal impedance for IPAK

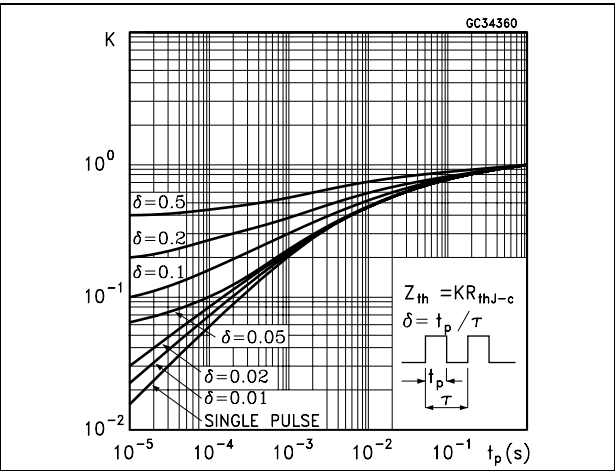


Figure 3. Safe operating area for TO-92

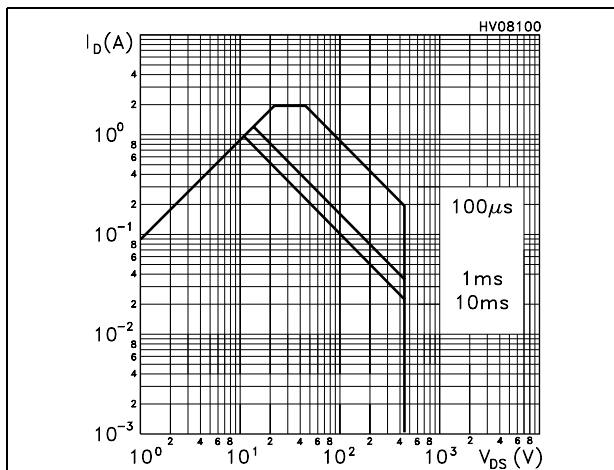


Figure 4. Thermal impedance for TO-92

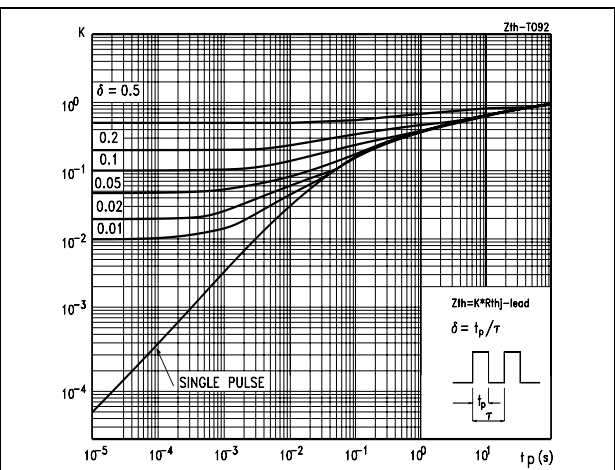


Figure 5. Output characteristics

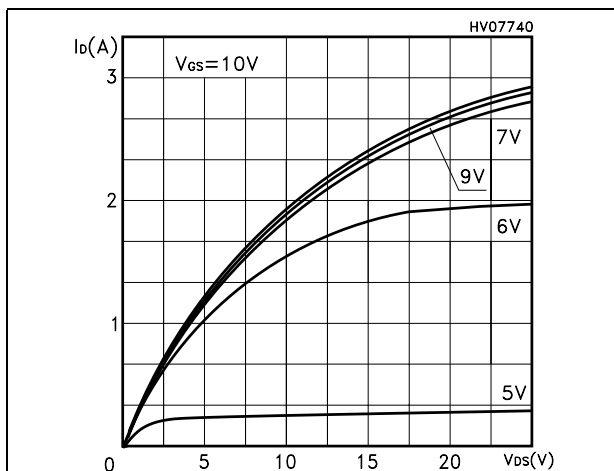


Figure 6. Transfer characteristics

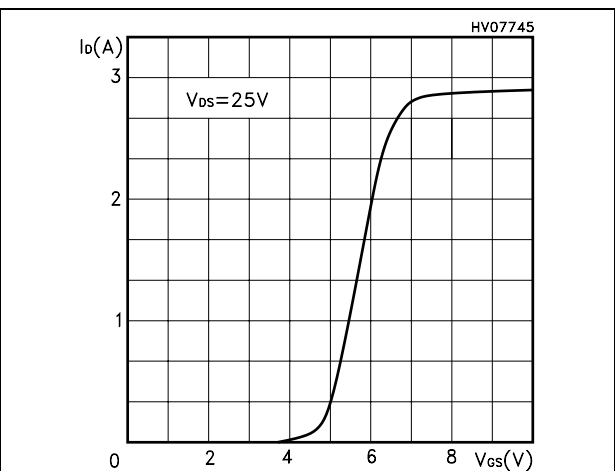


Figure 7. Transconductance

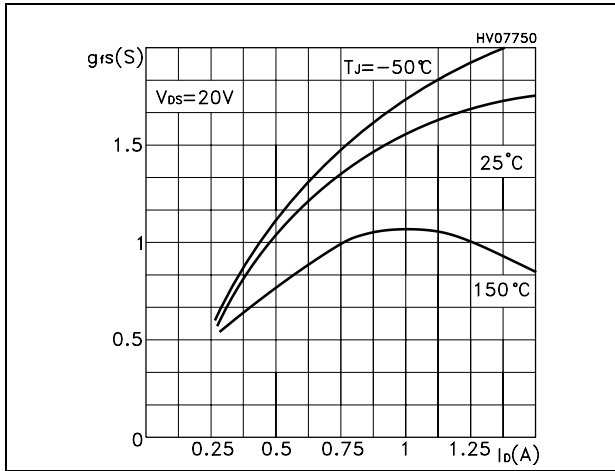


Figure 8. Static drain-source on resistance

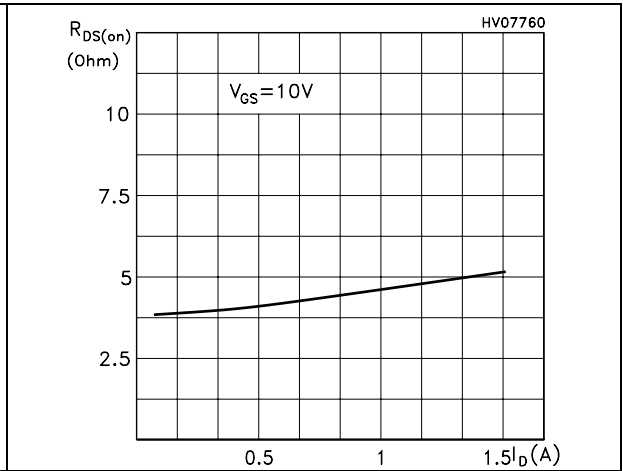


Figure 9. Gate charge vs gate-source voltage

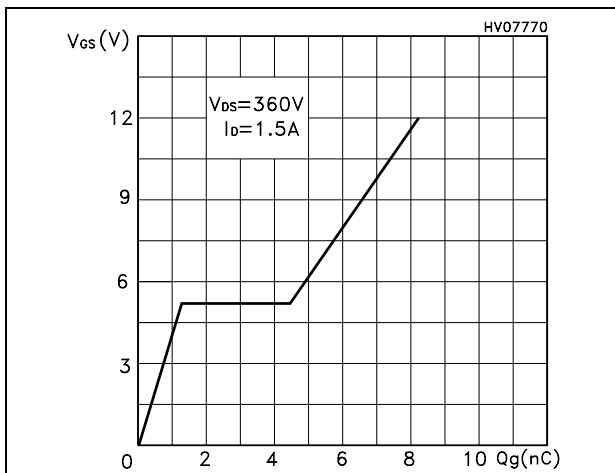


Figure 10. Capacitance variations

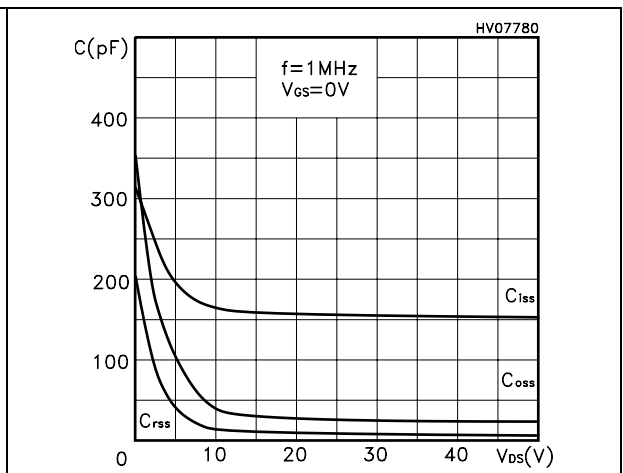


Figure 11. Normalized gate threshold voltage vs temperature

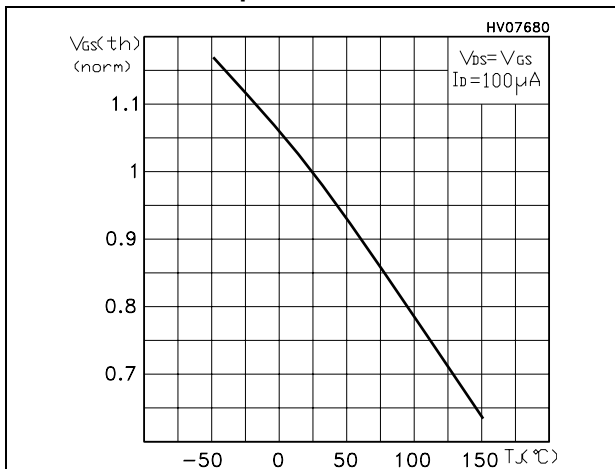


Figure 12. Normalized on resistance vs temperature

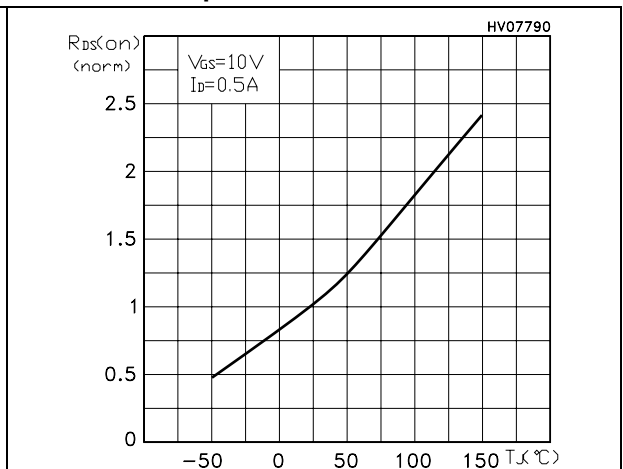


Figure 13. Source-drain diode forward characteristics

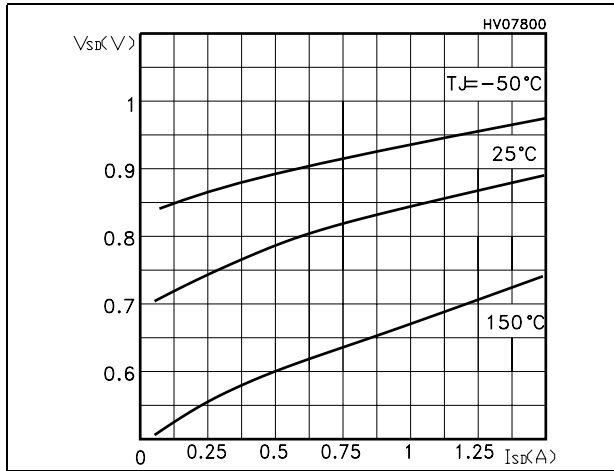


Figure 14. Normalized  $B_{VDSS}$  vs temperature

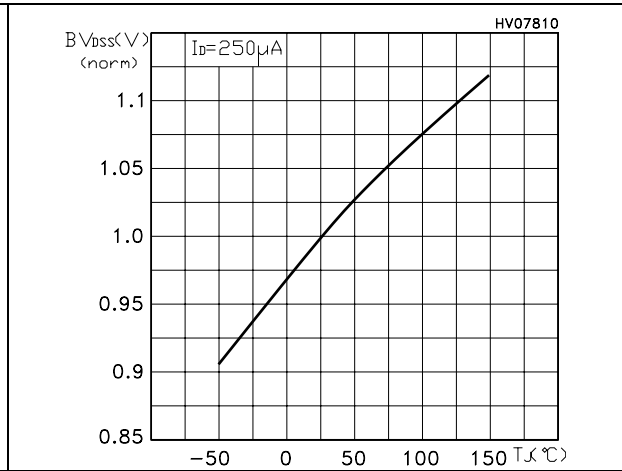


Figure 15. Max  $I_d$  current vs Temperature

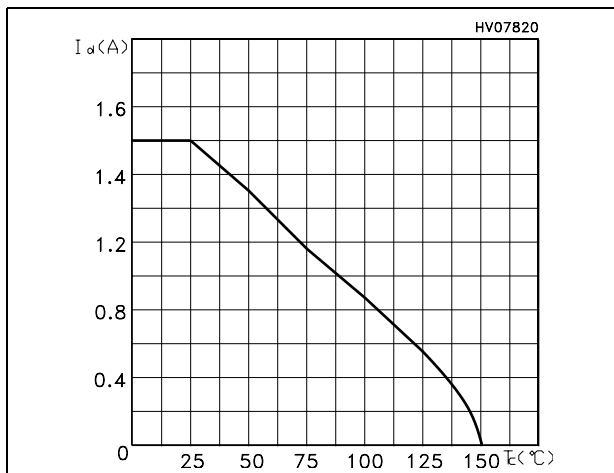
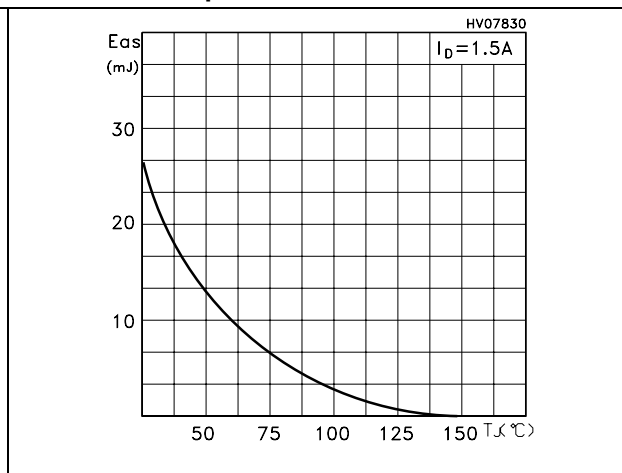


Figure 16. Maximum avalanche energy vs temperature





### 3 Test circuit

Figure 17. Switching times test circuit for resistive load

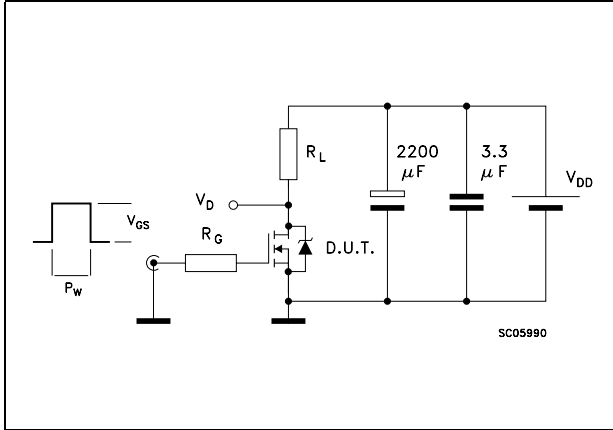


Figure 18. Gate charge test circuit

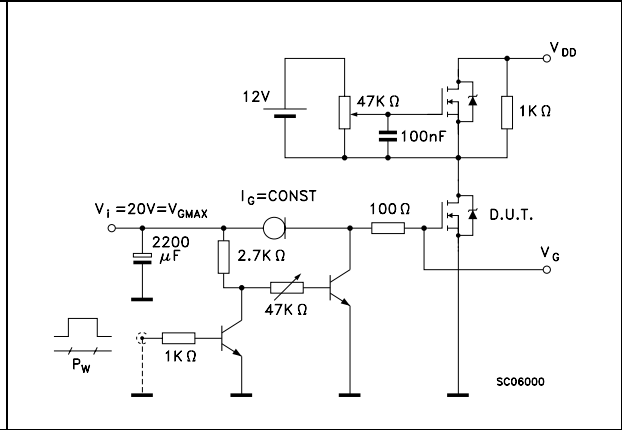


Figure 19. Test circuit for inductive load switching and diode recovery times

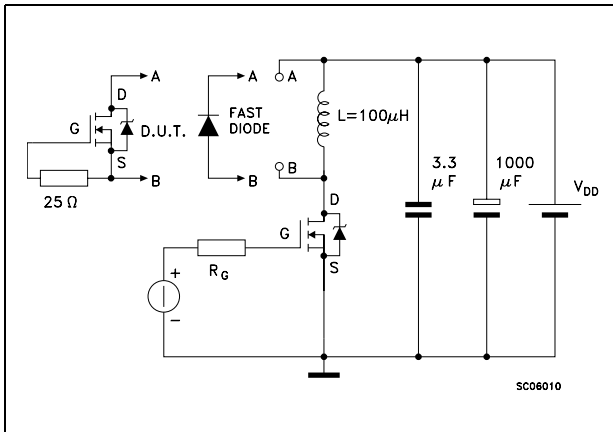


Figure 20. Unclamped Inductive load test circuit

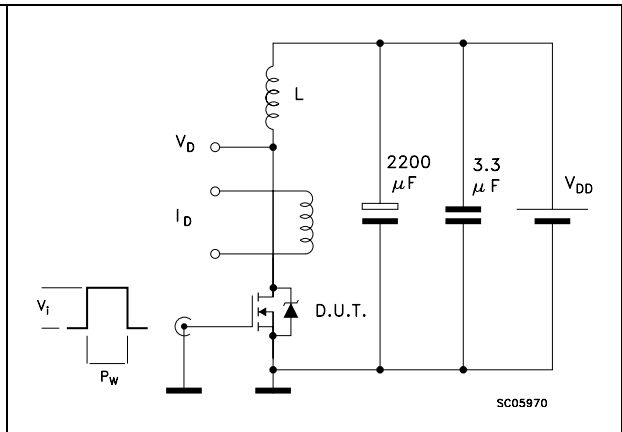


Figure 21. Unclamped inductive waveform

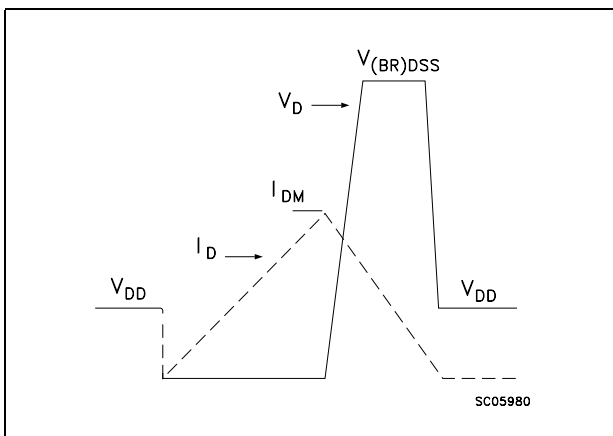
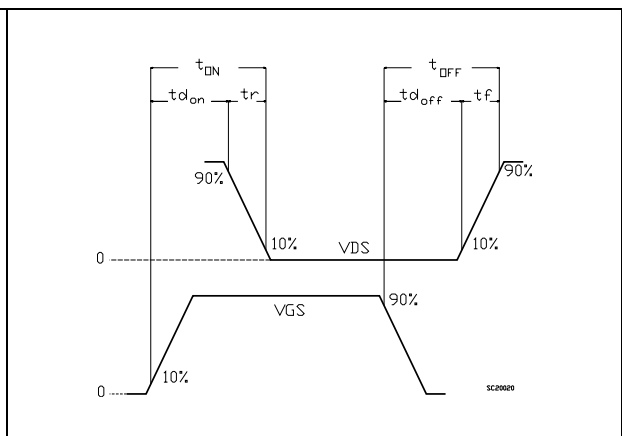


Figure 22. Switching time waveform

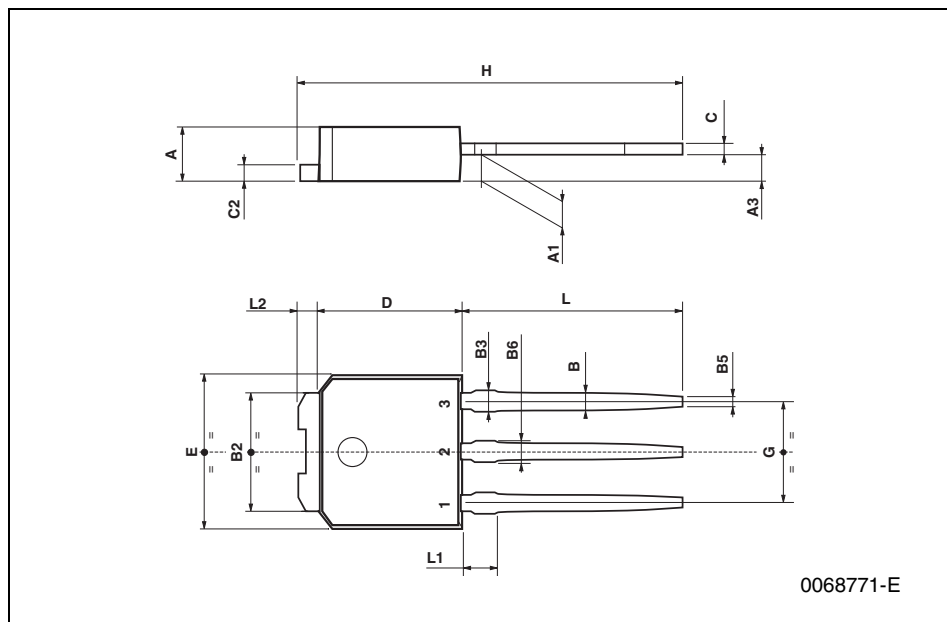


## 4 Package mechanical data

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)

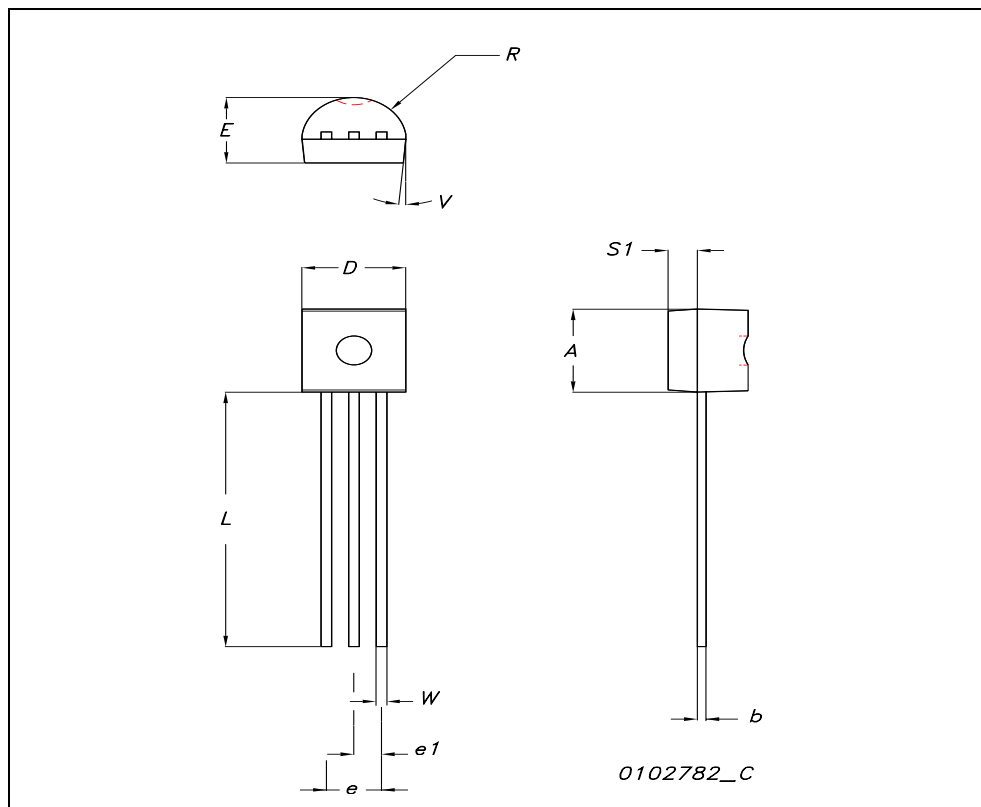
**TO-251 (IPAK) MECHANICAL DATA**

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



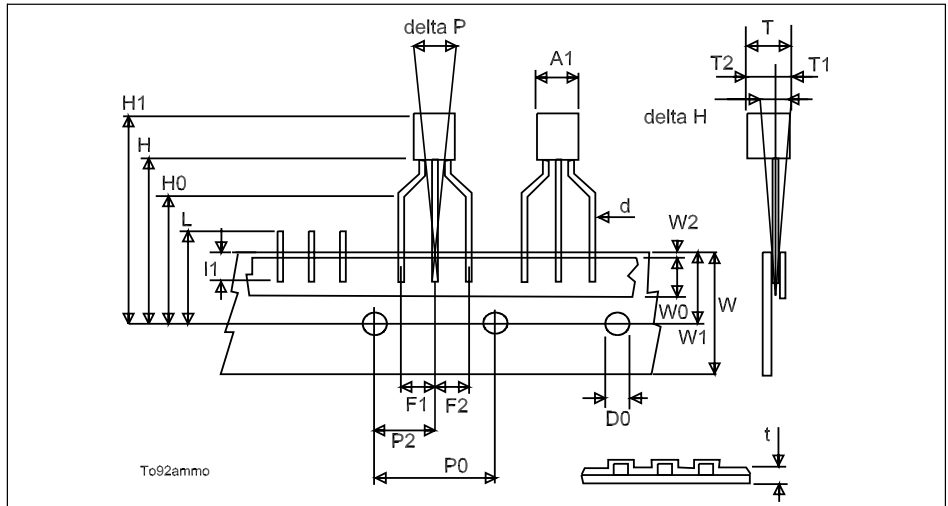
**TO-92 MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.32		4.95	0.170		0.194
b	0.36		0.51	0.014		0.020
D	4.45		4.95	0.175		0.194
E	3.30		3.94	0.130		0.155
e	2.41		2.67	0.094		0.105
e1	1.14		1.40	0.044		0.055
L	12.70		15.49	0.50		0.610
R	2.16		2.41	0.085		0.094
S1	0.92		1.52	0.036		0.060
W	0.41		0.56	0.016		0.022
V		5°			5°	



**TO-92 AMMOPACK**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A1	4.45		4.95	0.170		0.194
T	3.30		3.94	0.130		0.155
T1			1.6			0.06
T2			2.3			0.09
d	0.41		0.56	0.016		0.022
P0	12.5	12.7	12.9	0.49	0.5	0.51
P2	5.65	6.35	7.05	0.22	0.25	0.27
F1, F2	2.44	2.54	2.94	0.09	0.1	0.11
delta H	-2		2	-0.08		0.08
W	17.5	18	19	0.69	0.71	0.74
W0	5.7	6	6.3	0.22	0.23	0.24
W1	8.5	9	9.25	0.33	0.35	0.36
W2			0.5			0.02
H	18.5		20.5	0.72		0.80
H0	15.5	16	16.5	0.61	0.63	0.65
H1			25			0.98
D0	3.8	4	4.2	0.15	0.157	0.16
t			0.9			0.035
L			11			0.43
l1	3			0.11		
delta P	-1		1	-0.04		0.04



## 5 Revision history

**Table 8. Revision history**

Date	Revision	Changes
21-Jun-2004	2	Complete version
12-Jul-2006	3	New template

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