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1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		IPAK	TO-92	
V_{DS}	Drain-source voltage ($V_{GS} = 0$)	450		V
V_{GS}	Gate- source voltage	± 30		V
I_D	Drain current (continuous) at $T_C = 25^\circ\text{C}$	1.5	0.5	A
I_D	Drain current (continuous) at $T_C = 100^\circ\text{C}$	0.95	0.315	A
$I_{DM}^{(1)}$	Drain current (pulsed)	6	2	A
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	30	3.1	W
	Derating factor	0.24	0.025	W/ $^\circ\text{C}$
$dv/dt^{(2)}$	Peak diode recovery voltage slope	3		V/ns
T_{stg}	Storage temperature	-65 to 150		$^\circ\text{C}$
T_j	Max. operating junction temperature			$^\circ\text{C}$

1. Pulse width limited by safe operating area

2. $I_{SD} \leq 0.5\text{A}$, $di/dt \leq 100\text{ A}/\mu\text{s}$, $V_{DD} = 80\% V_{(BR)DSS}$

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		IPAK	TO-92	
$R_{thj-case}$	Thermal resistance junction-case max	4.1	--	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	100	120	$^\circ\text{C}/\text{W}$
$R_{thj-lead}$	Thermal resistance junction-lead max	--	40	$^\circ\text{C}/\text{W}$
T_l	Maximum lead temperature for soldering purpose	275	260	$^\circ\text{C}$

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j Max)	1.5	A
E_{AS}	Single pulse avalanche energy (starting $T_j = 25^\circ\text{C}$, $I_D = I_{AS}$, $V_{DD} = 50\text{V}$)	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	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 30\text{V}$			± 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	Ω

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} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 25\text{V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$		160 27.5 4.7		pF pF pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 360\text{V}$, $I_D = 1.5\text{A}$, $V_{GS} = 10\text{V}$, $R_G = 4.7\Omega$ (see Figure 18)		7 1.3 3.2	10	nC nC nC

1. Pulsed: pulse duration = 300 μs , 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 μC 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 IPAK

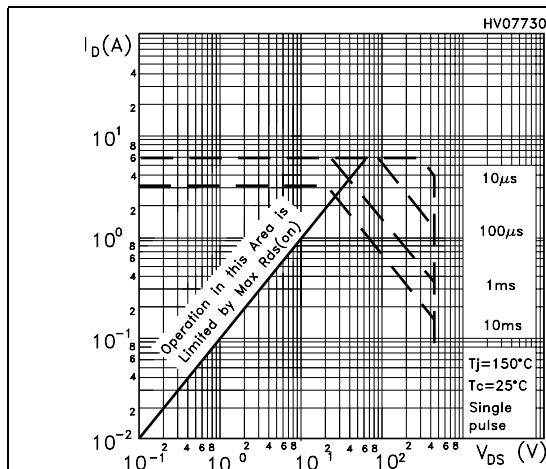


Figure 2. Thermal impedance for IPAK

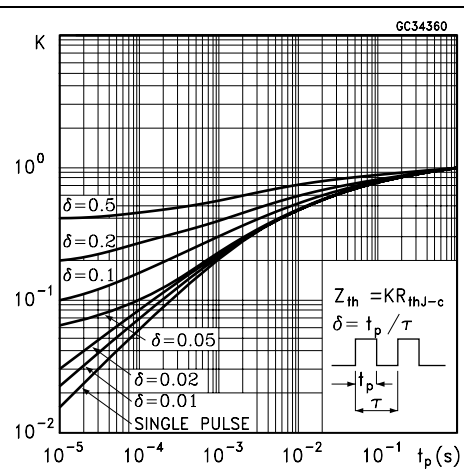


Figure 3. Safe operating area for TO-92

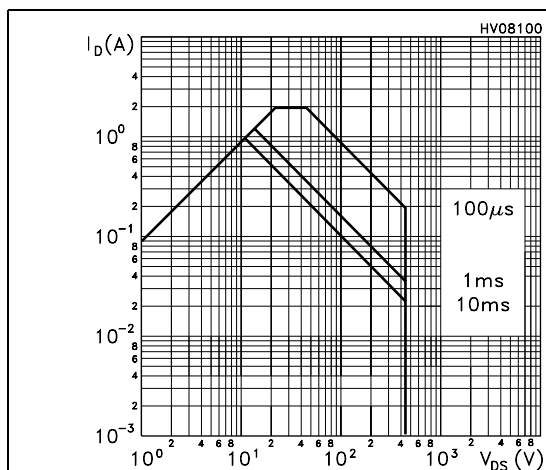


Figure 4. Thermal impedance for TO-92

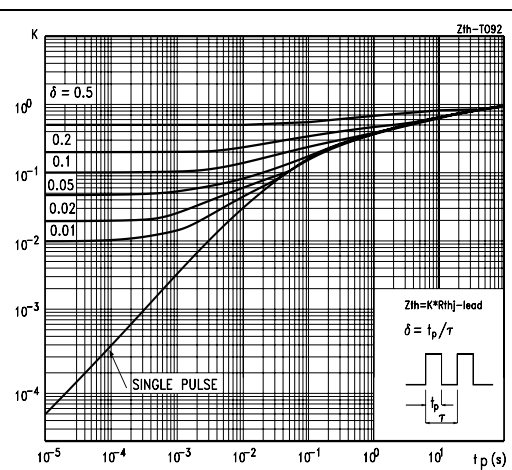


Figure 5. Output characteristics

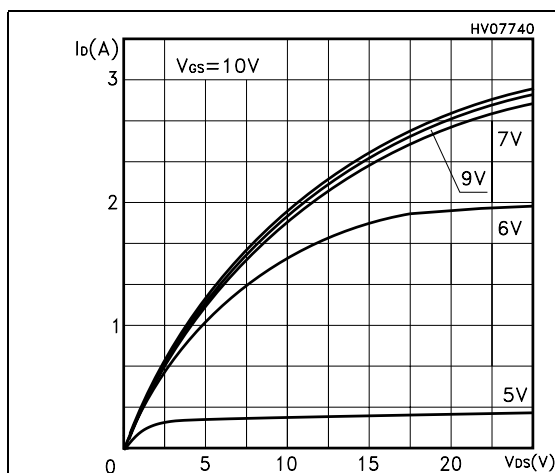


Figure 6. Transfer characteristics

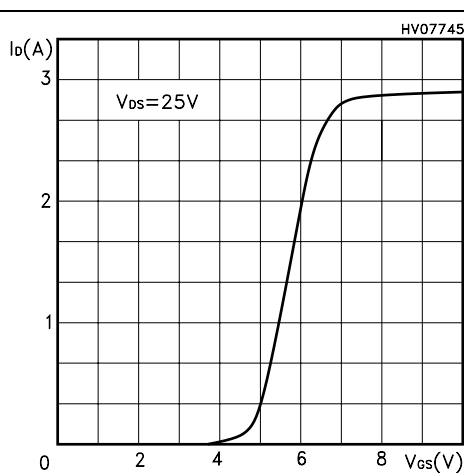


Figure 7. Transconductance

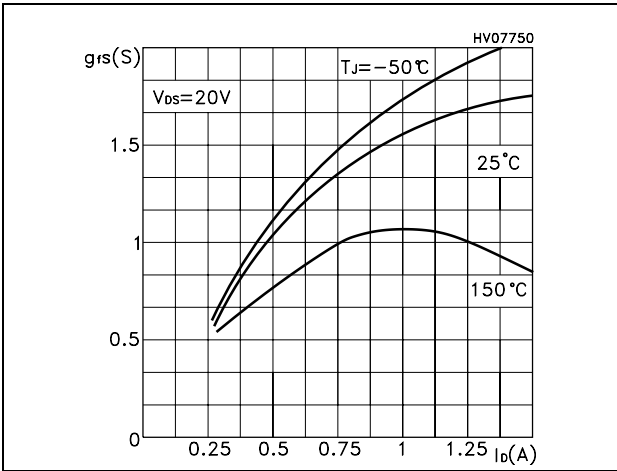


Figure 8. Static drain-source on resistance

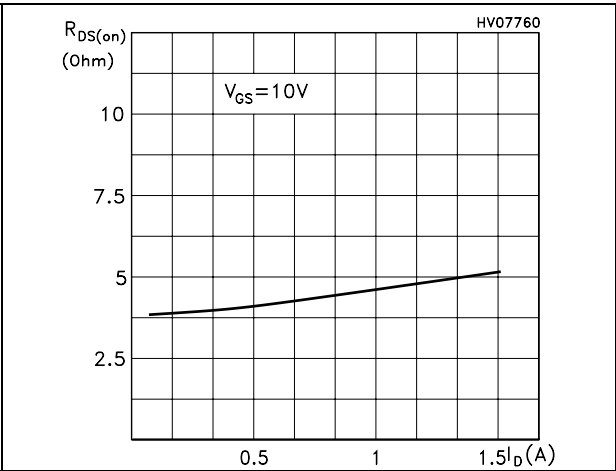


Figure 9. Gate charge vs gate-source voltage

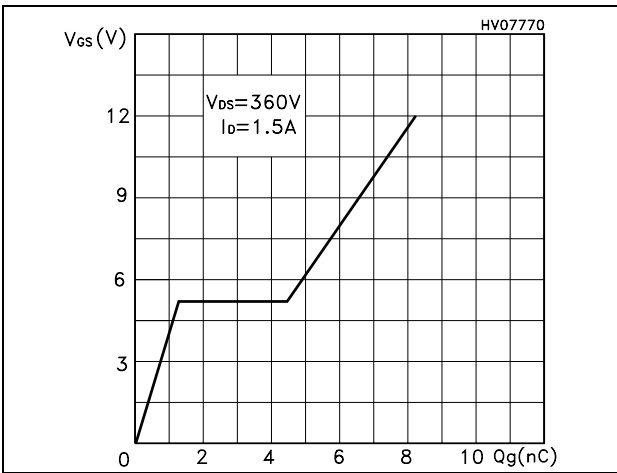


Figure 10. Capacitance variations

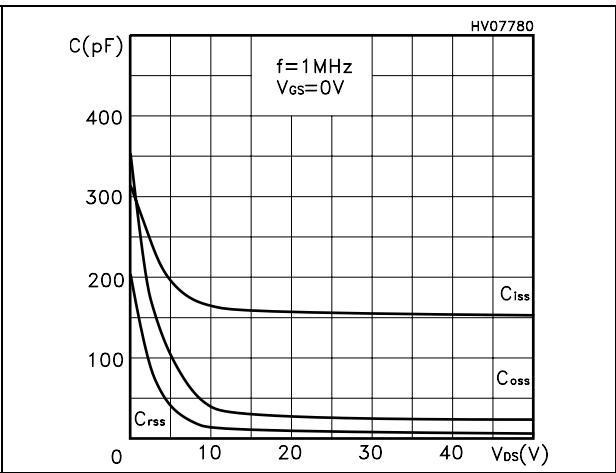


Figure 11. Normalized gate threshold voltage vs temperature

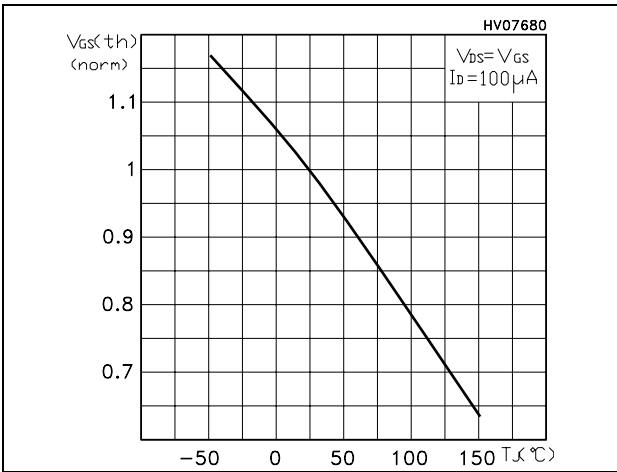


Figure 12. Normalized on resistance vs temperature

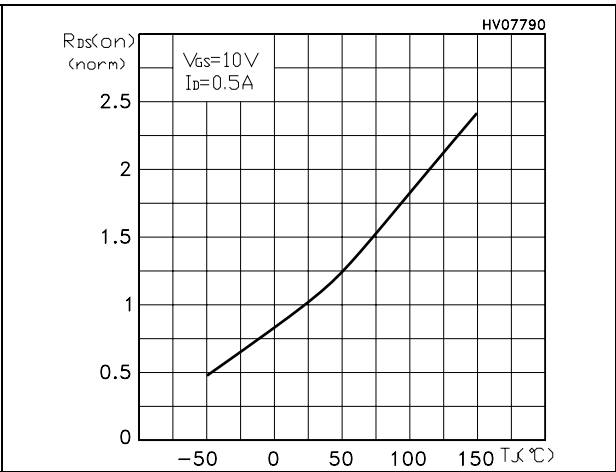


Figure 13. Source-drain diode forward characteristics

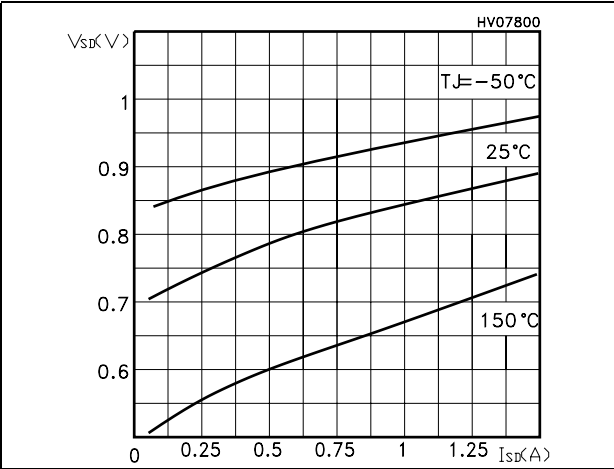


Figure 14. Normalized B_{VDSS} vs temperature

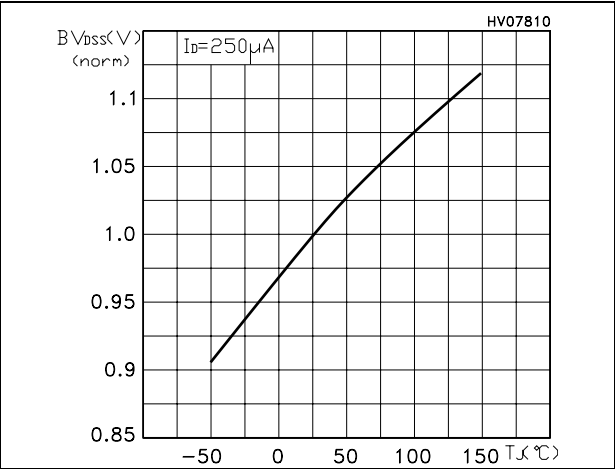


Figure 15. Max I_d current vs Temperature

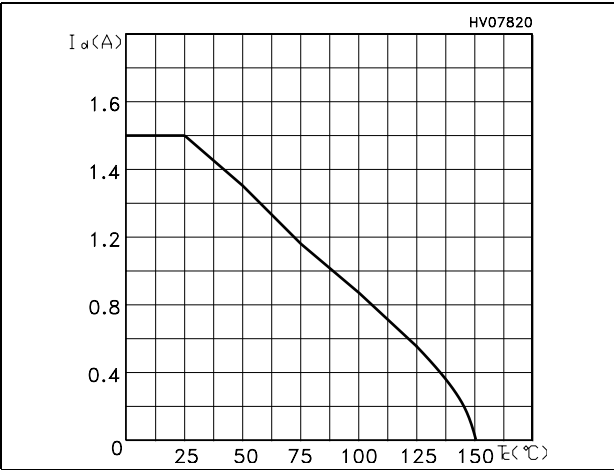
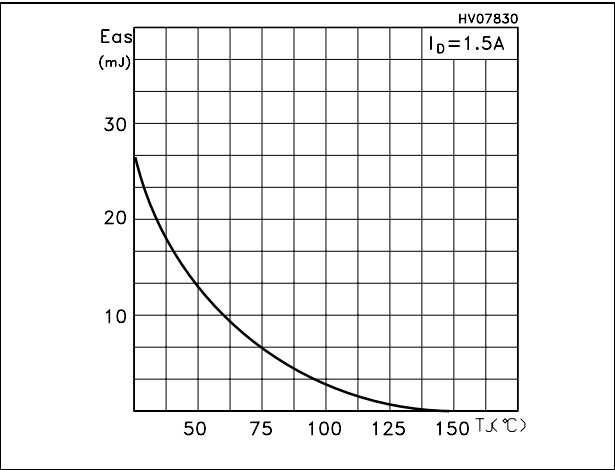


Figure 16. Maximum avalanche energy vs temperature



3 Test circuit

Figure 17. Switching times test circuit for resistive load

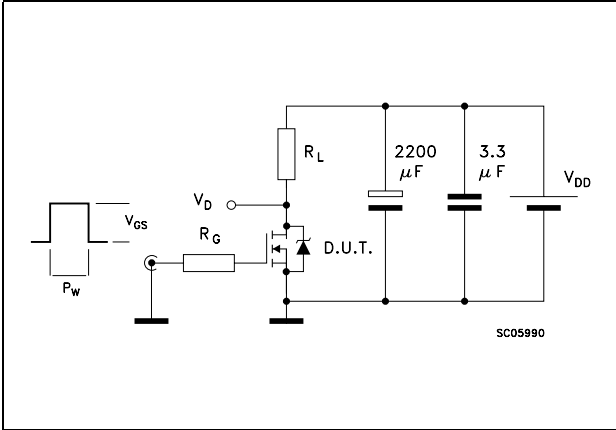


Figure 18. Gate charge test circuit

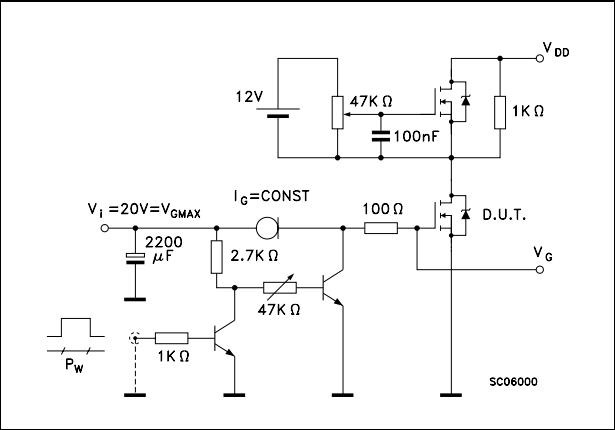


Figure 19. Test circuit for inductive load switching and diode recovery times

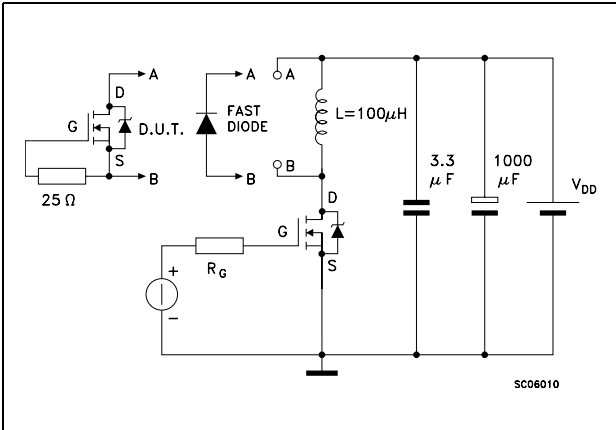


Figure 20. Unclamped Inductive load test circuit

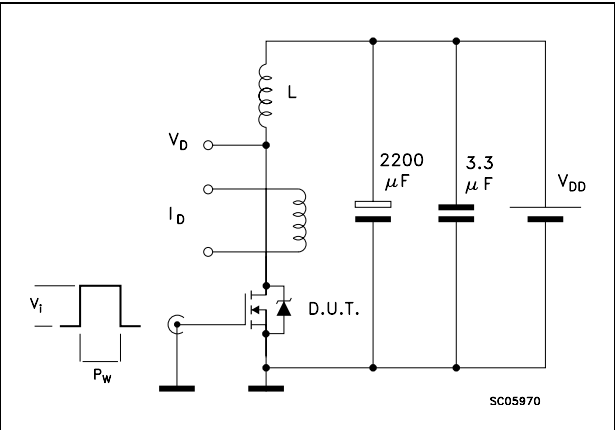


Figure 21. Unclamped inductive waveform

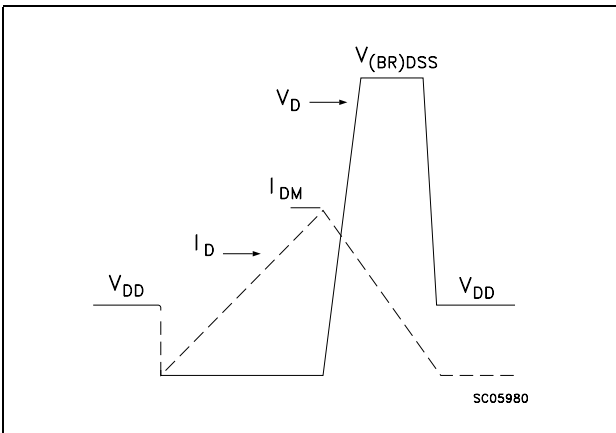
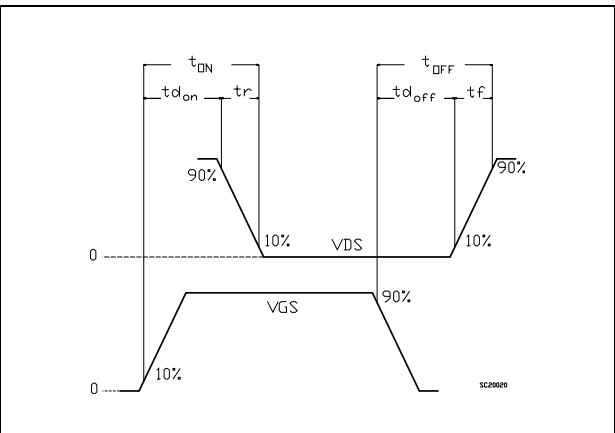


Figure 22. Switching time waveform



4 Package mechanical data

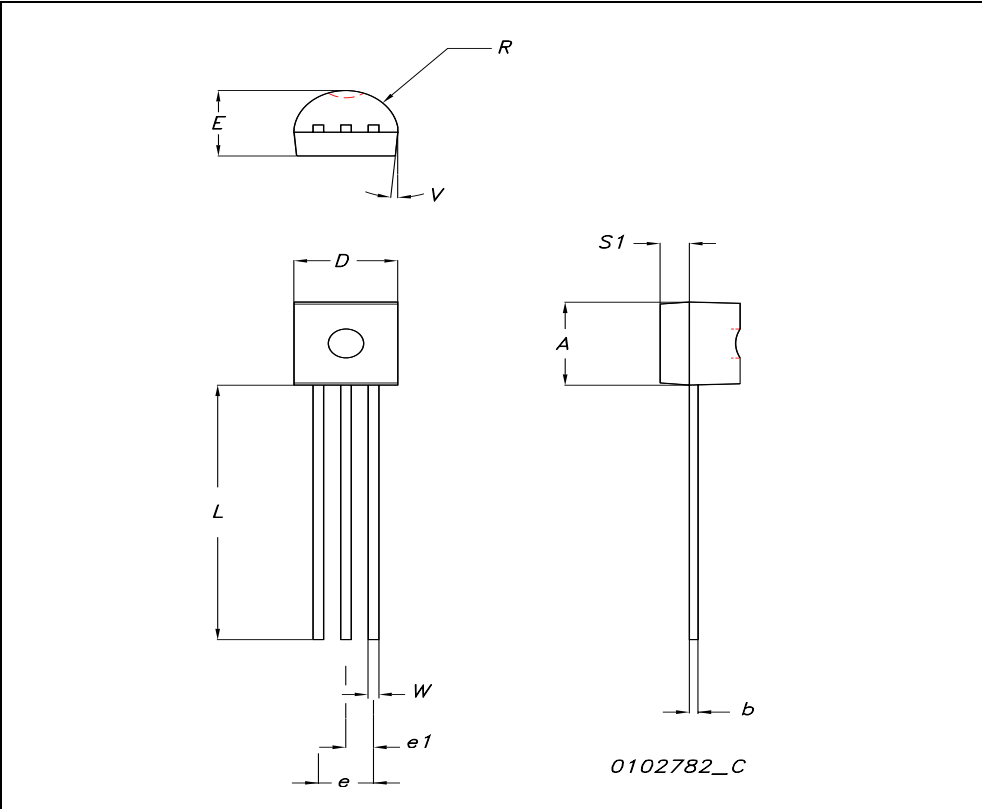
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings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

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

0068771-E

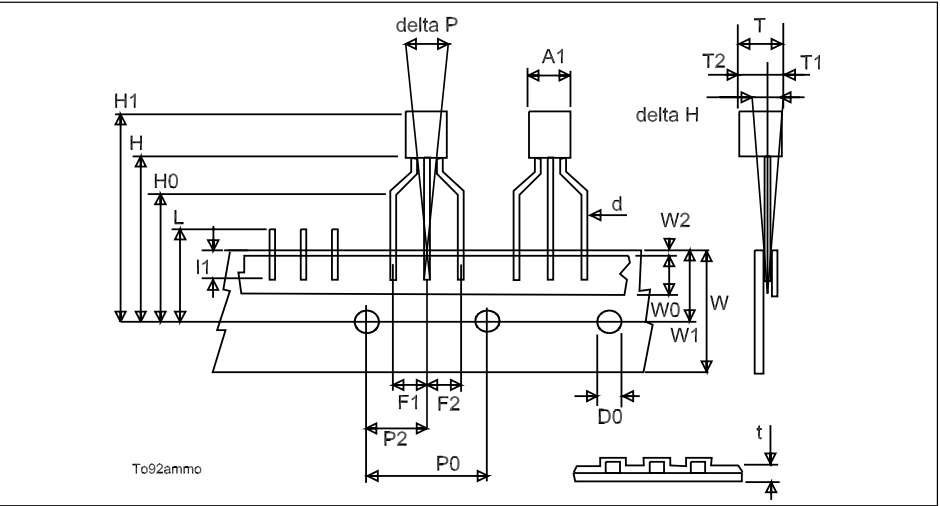
TO-92 MECHANICAL DATA

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
I1	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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