



# STD1NK60 - STD1NK60-1 STQ1HNK60R - STN1HNK60

N-CHANNEL 600V - 8Ω - 1A DPAK/TO-92/IPAK/SOT-223  
SuperMESH™ MOSFET

**Table 1: General Features**

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STD1NK60	600 V	< 8.5 Ω	1 A	30 W
STD1NK60-1	600 V	< 8.5 Ω	1 A	30 W
STQ1HNK60R	600 V	< 8.5 Ω	0.4 A	3 W
STN1HNK60	600 V	< 8.5 Ω	0.4 A	3.3 W

- TYPICAL R<sub>DS(on)</sub> = 8 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- ESD IMPROVED CAPABILITY
- 100% AVALANCHE TESTED
- NEW HIGH VOLTAGE BENCHMARK
- GATE CHARGE MINIMIZED

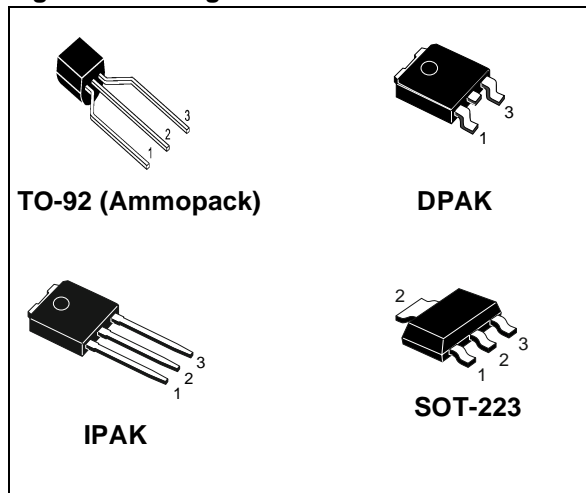
## DESCRIPTION

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.

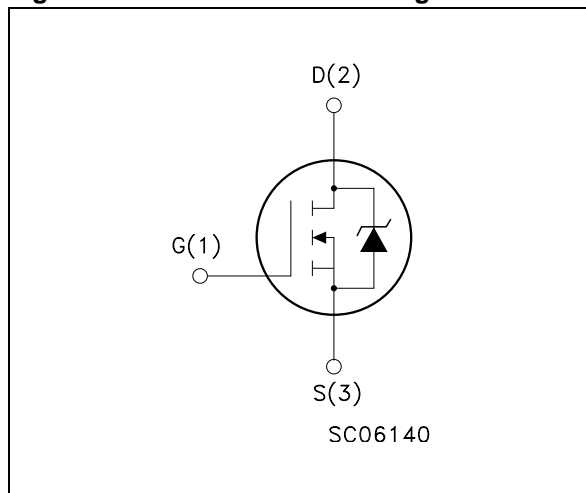
## APPLICATIONS

- LOW POWER BATTERY CHARGERS
- SWITCH MODE LOW POWER SUPPLIES(SMPS)
- LOW POWER, BALLAST, CFL (COMPACT FLUORESCENT LAMPS)

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



**Table 2: Order Codes**

Part Number	Marking	Package	Packaging
STD1NK60T4	D1NK60	DPAK	TAPE & REEL
STD1NK60-1	D1NK60	IPAK	TUBE
STQ1HNK60R	1HNK60R	TO-92	BULK
STQ1HNK60R-AP	1HNK60R	TO-92	AMMOPAK
STN1HNK60	1HNK60	SOT-223	TAPE & REEL

Rev. 2

**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value			Unit
		DPAK / IPAK	TO-92	SOT-223	
$V_{DS}$	Drain-source Voltage ( $V_{GS} = 0$ )	600			V
$V_{DGR}$	Drain-gate Voltage ( $R_{GS} = 20\text{ k}\Omega$ )	600			V
$V_{GS}$	Gate- source Voltage	$\pm 30$			V
$I_D$	Drain Current (continuous) at $T_C = 25^\circ\text{C}$	1.0	0.4	0.4	A
$I_D$	Drain Current (continuous) at $T_C = 100^\circ\text{C}$	0.63	0.25	0.25	A
$I_{DM}(\bullet)$	Drain Current (pulsed)	4	1.6	1.6	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	30	3	3.3	W
	Derating Factor	0.24	0.025	0.025	W/ $^\circ\text{C}$
$dv/dt(1)$	Peak Diode Recovery voltage slope	3			V/ns
$T_j$ $T_{stg}$	Operating Junction Temperature Storage Temperature	-55 to 150			$^\circ\text{C}$

( $\bullet$ ) Pulse width limited by safe operating area

(1)  $I_{SD} \leq 1.0\text{A}$ ,  $di/dt \leq 100\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 4: Thermal Data**

		DPAK/IPAK	TO-92	SOT-223	Unit
Rthj-case	Thermal Resistance Junction-case Max	4.16	--	--	$^\circ\text{C}/\text{W}$
Rthj-amb	Thermal Resistance Junction-ambient Max	100	120	37.87 (#)	$^\circ\text{C}/\text{W}$
Rthj-lead	Thermal Resistance Junction-lead Max	--	40	--	$^\circ\text{C}/\text{W}$
$T_l$	Maximum Lead Temperature For Soldering Purpose	275	260		$^\circ\text{C}$

(#) When mounted on FR-4 board of  $1\text{ in}^2$ , 2oz Cu,  $t < 10\text{ sec}$

**Table 5: Avalanche Characteristics**

Symbol	Parameter	Max Value	Unit
$I_{AR}$	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max)	1	A
$E_{AS}$	Single Pulse Avalanche Energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	25	mJ

**ELECTRICAL CHARACTERISTICS ( $T_{CASE} = 25^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)**
**Table 6: On/Off**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	$I_D = 1\text{mA}$ , $V_{GS} = 0$	600			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	$V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$	2.25	3	3.7	V
$R_{DS(on)}$	Static Drain-source On Resistance	$V_{GS} = 10\text{V}$ , $I_D = 0.5\text{ A}$		8	8.5	$\Omega$

**ELECTRICAL CHARACTERISTICS (CONTINUED)**

**Table 7: Dynamic**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}$ (1)	Forward Transconductance	$V_{DS} = 15\text{ V}, I_D = 0.5\text{ A}$		1		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$		156 23.5 3.8		pF pF pF
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	$V_{DD} = 300\text{ V}, I_D = 0.5\text{ A},$ $R_G = 4.7\ \Omega, V_{GS} = 10\text{ V}$ (Resistive Load see, Figure 21)		6.5 5 19 25		ns ns ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total Gate Charge Gate-Source Charge Gate-Drain Charge	$V_{DD} = 480\text{ V}, I_D = 1\text{ A},$ $V_{GS} = 10\text{ V}, R_G = 4.7\ \Omega$ (see, Figure 23)		7 1.1 3.7	10	nC nC nC

**Table 8: Source Drain Diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}$ (2)	Source-drain Current Source-drain Current (pulsed)				1 4	A A
$V_{SD}$ (1)	Forward On Voltage	$I_{SD} = 1.0\text{ A}, V_{GS} = 0$			1.6	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 1.0\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 25\text{ V}, T_j = 25^\circ\text{C}$ (see test circuit, Figure 22)		140 240 3.3		ns $\mu\text{C}$ A
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 1.0\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 25\text{ V}, T_j = 150^\circ\text{C}$ (see test circuit, Figure 22)		229 377 3.3		ns $\mu\text{C}$ A

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

(2) Pulse width limited by safe operating area.

Figure 3: Safe Operating Area For SOT-223

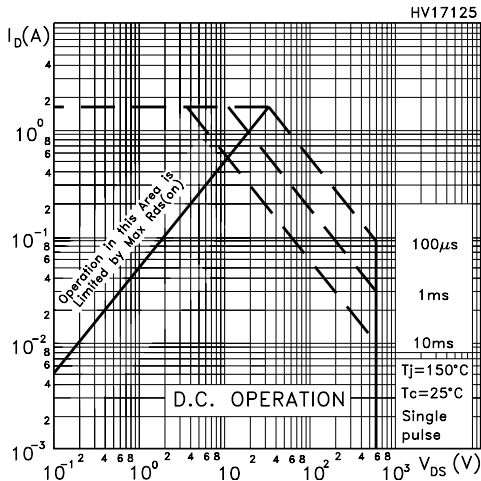


Figure 4: Safe Operating Area For DPAK/IPAK

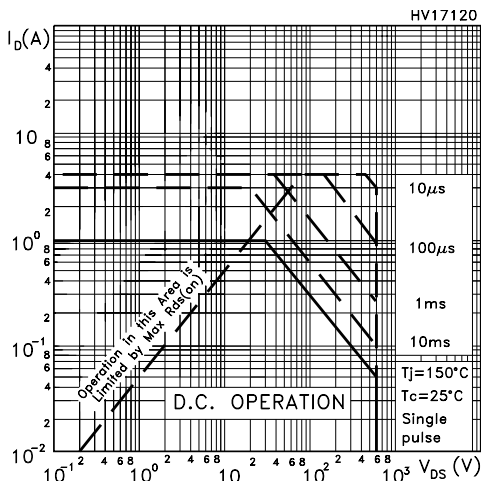


Figure 5: Safe Operating Area For TO-92

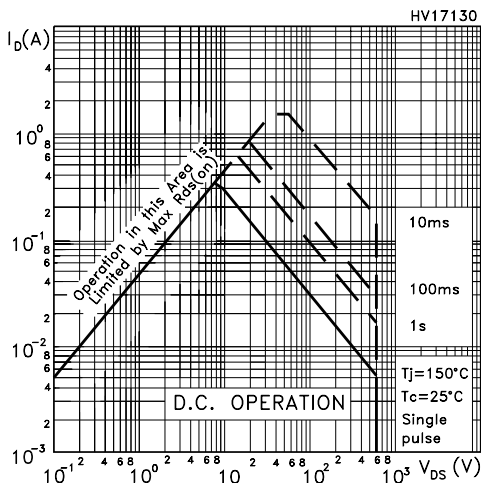


Figure 6: Thermal Impedance For SOT-223

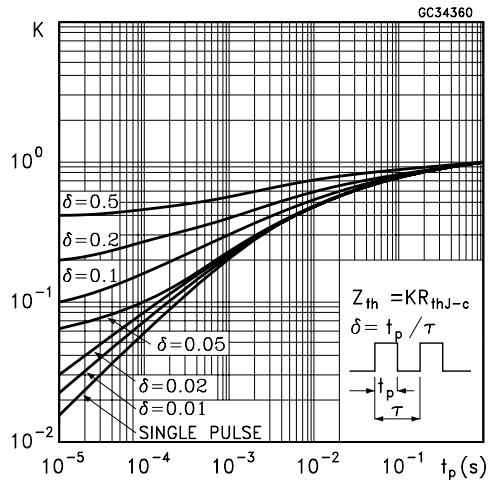


Figure 7: Thermal Impedance For DPAK/IPAK

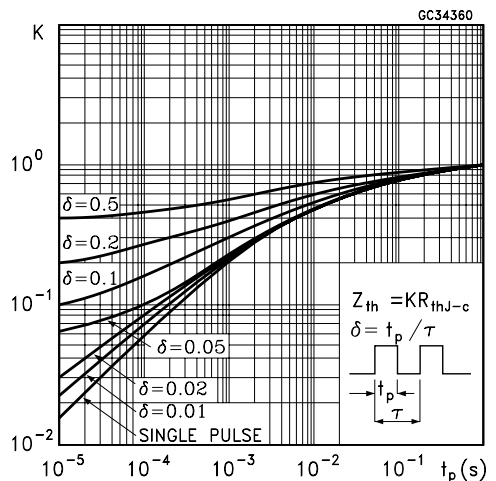


Figure 8: Thermal Impedance For TO-92

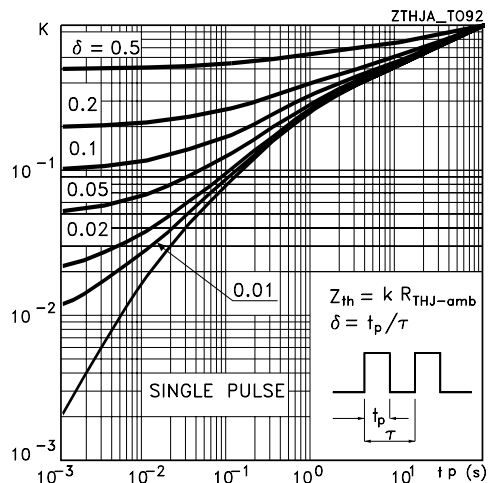


Figure 9: Output Characteristics

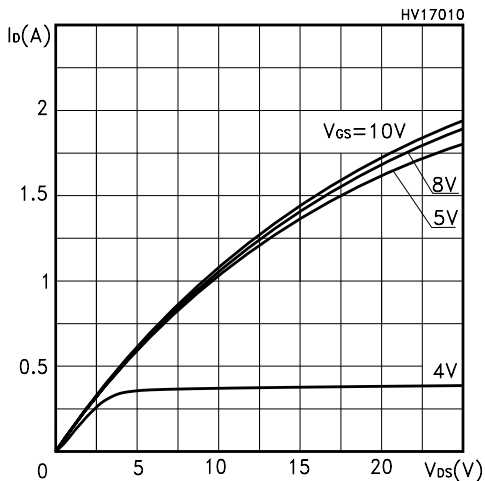


Figure 10: Transconductance

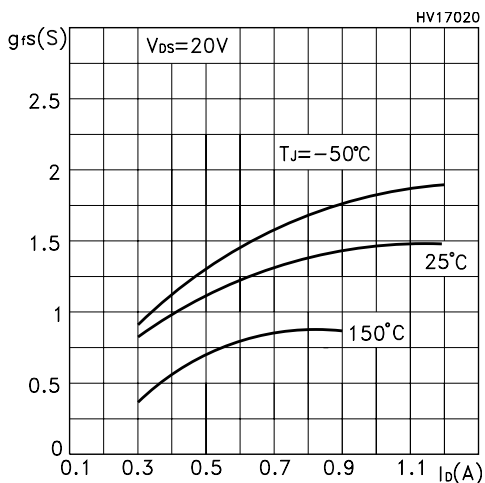


Figure 11: Capacitance Variations

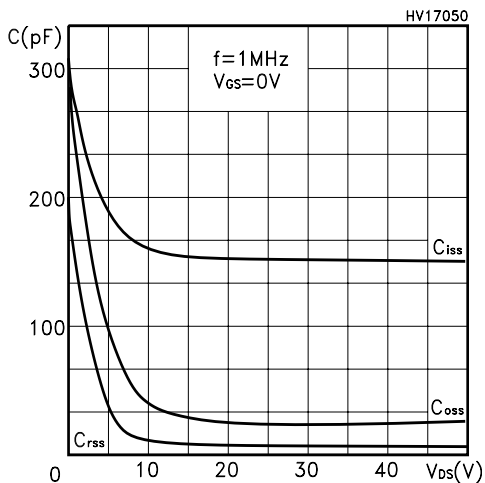


Figure 12: Transfer Characteristics

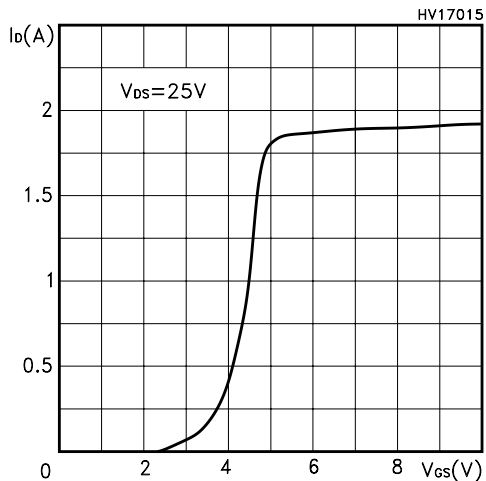


Figure 13: Gate Charge vs Gate-source Voltage

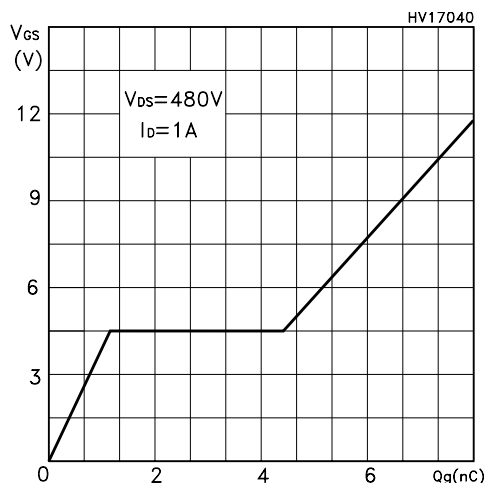
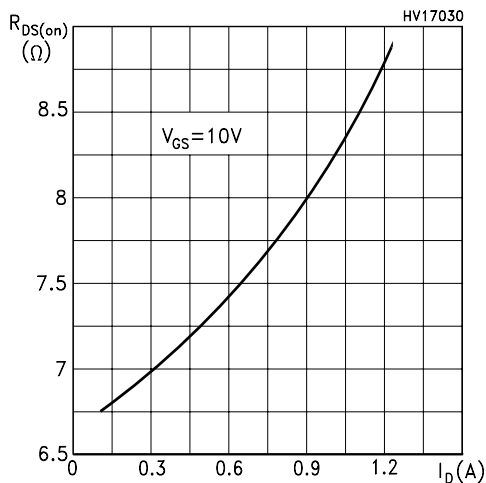
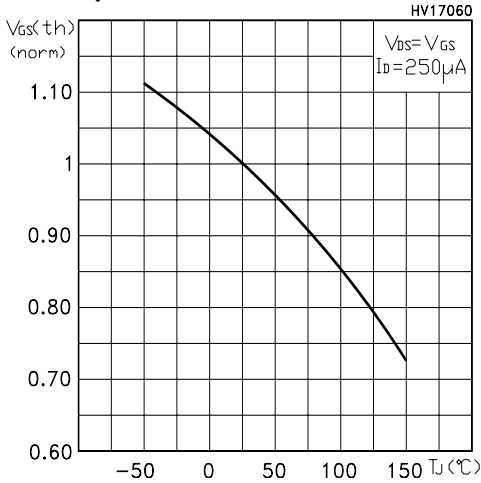


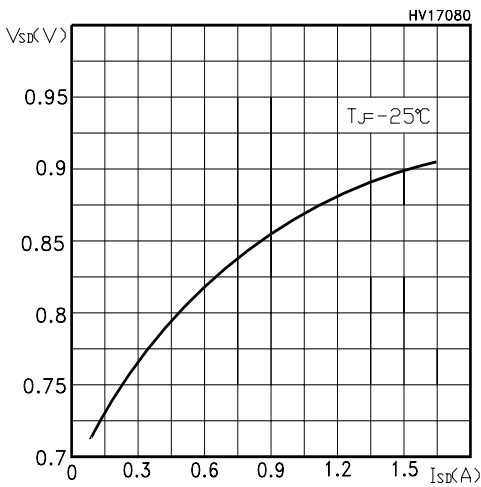
Figure 14: Static Drain-source On Resistance



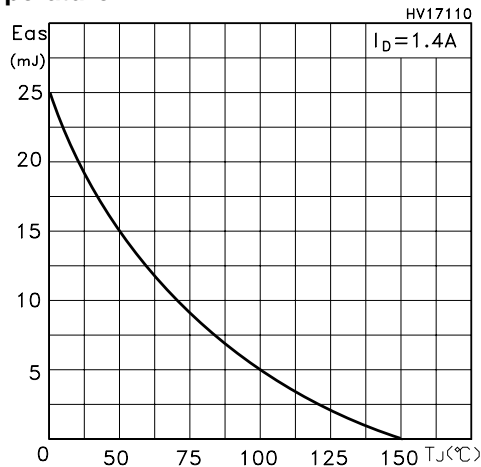
**Figure 15: Normalized Gate Threshold Voltage vs Temperature**



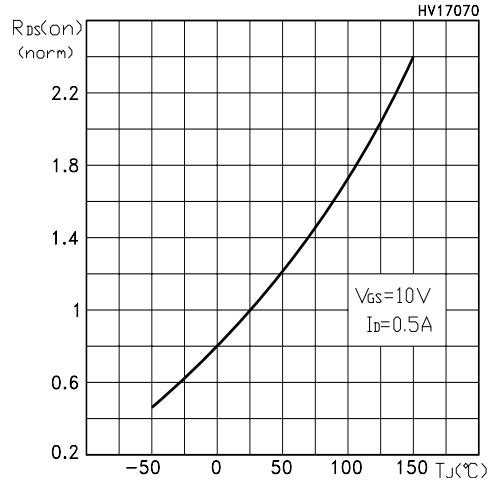
**Figure 16: Source-Drain Forward Characteristics**



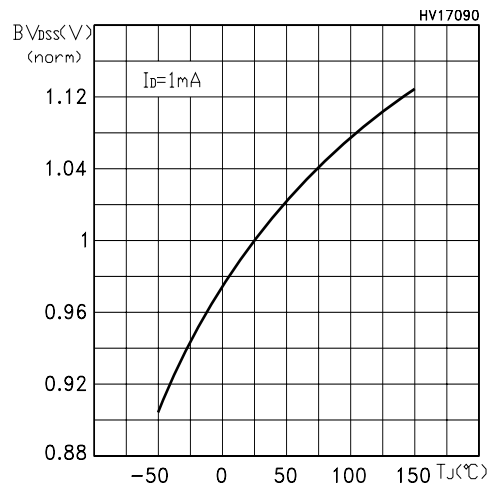
**Figure 17: Maximum Avalanche Energy vs Temperature**



**Figure 18: Normalized On Resistance vs Temperature**



**Figure 19: Normalized  $BV_{DSS}$  vs Temperature**



**Figure 20: Max Id Current vs Tc**

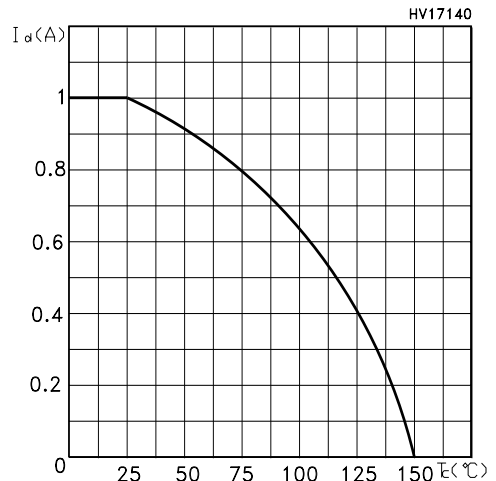


Figure 21: Switching Times Test Circuit For Resistive Load

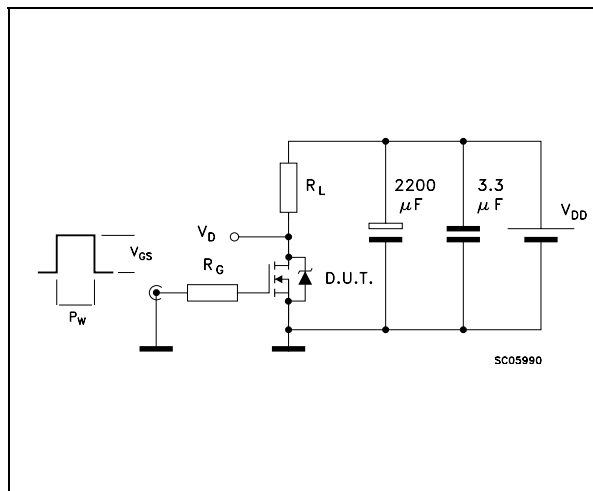


Figure 22: Test Circuit For Inductive Load Switching and Diode Recovery Times

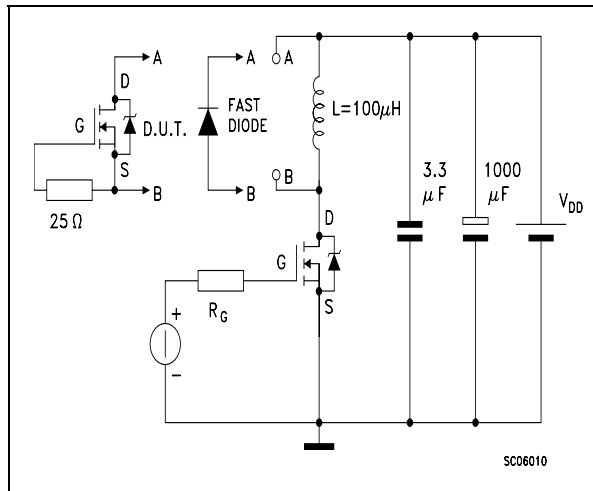
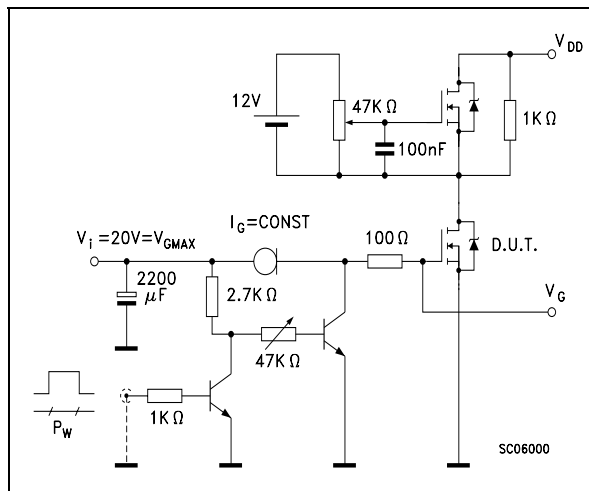
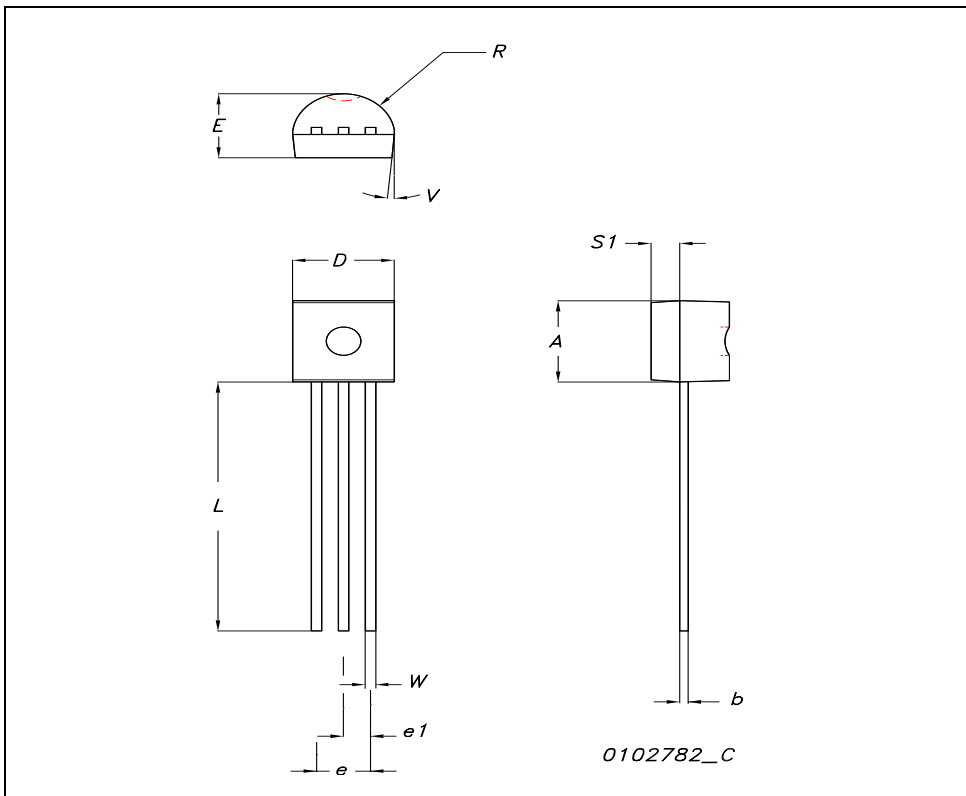


Figure 23: Gate Charge Test Circuit



**TO-92 MECHANICAL DATA**

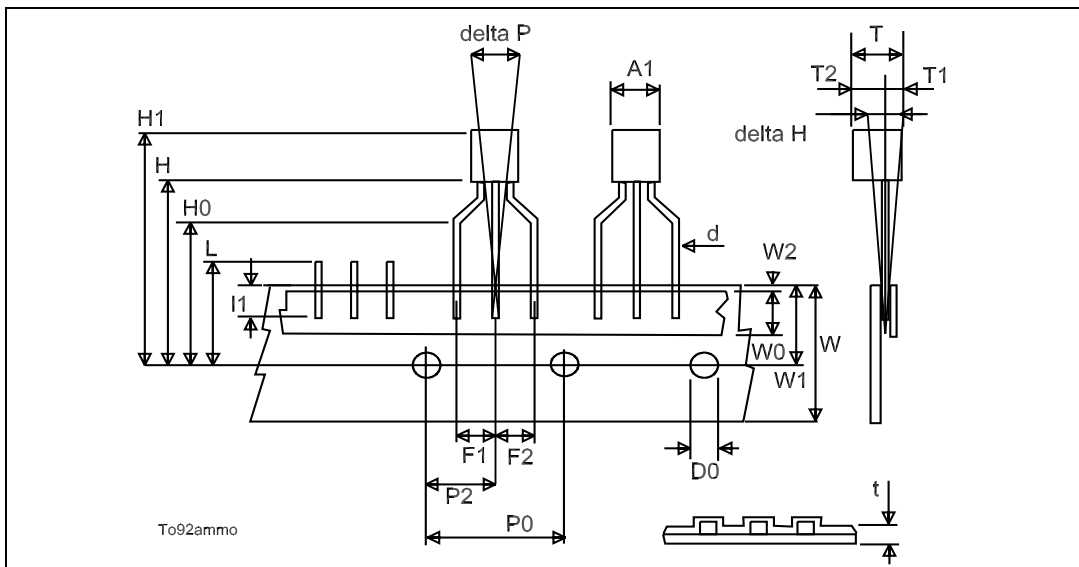
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.32		4.95	0.170		0.194
b	0.36		0.51	0.014		0.020
D	4.45		4.95	0.175		0.194
E	3.30		3.94	0.130		0.155
e	2.41		2.67	0.094		0.105
e1	1.14		1.40	0.044		0.055
L	12.70		15.49	0.50		0.610
R	2.16		2.41	0.085		0.094
S1	0.92		1.52	0.036		0.060
W	0.41		0.56	0.016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





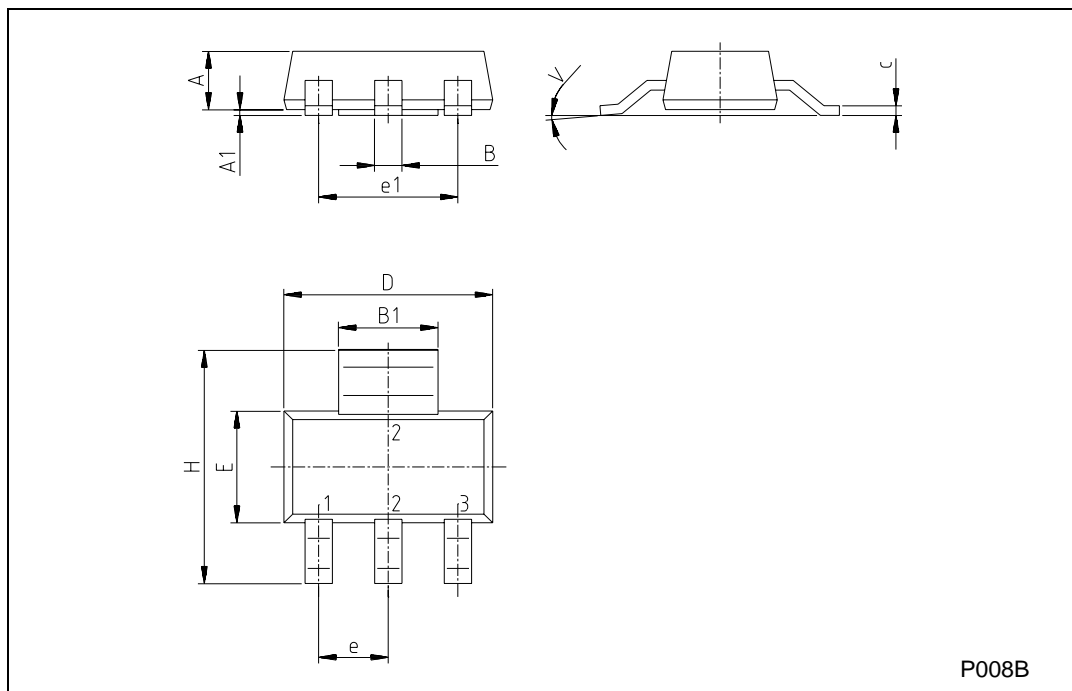
TO-92 AMMOPACK

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



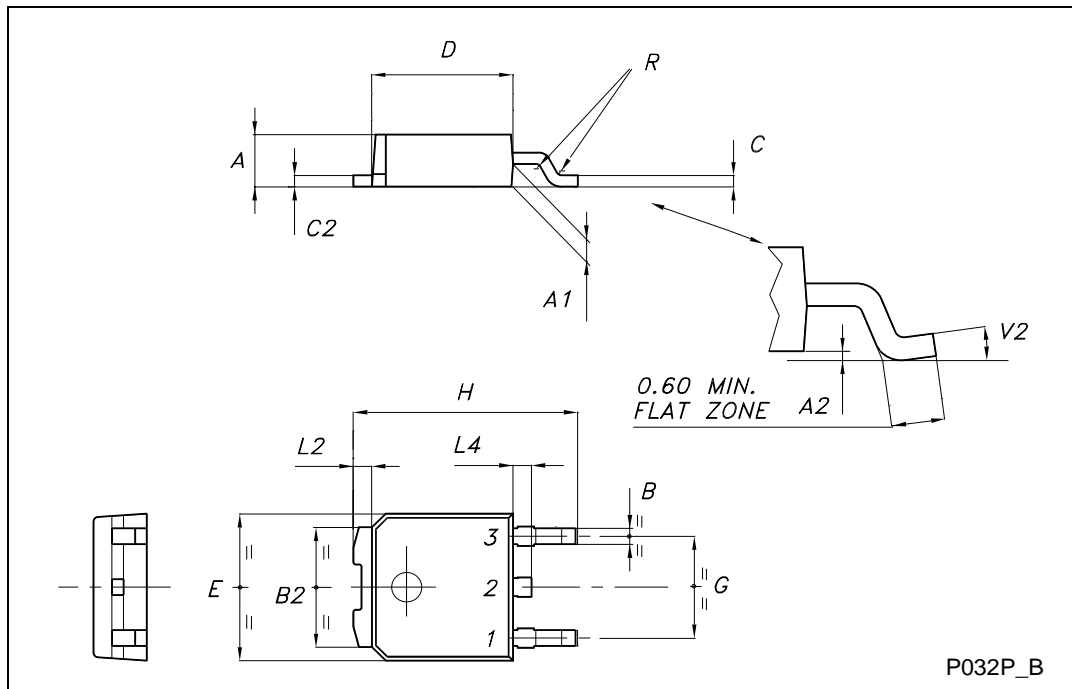
SOT-223 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.80			0.071
B	0.60	0.70	0.80	0.024	0.027	0.031
B1	2.90	3.00	3.10	0.114	0.118	0.122
c	0.24	0.26	0.32	0.009	0.010	0.013
D	6.30	6.50	6.70	0.248	0.256	0.264
e		2.30			0.090	
e1		4.60			0.181	
E	3.30	3.50	3.70	0.130	0.138	0.146
H	6.70	7.00	7.30	0.264	0.276	0.287
V			10°			10°
A1		0.02				



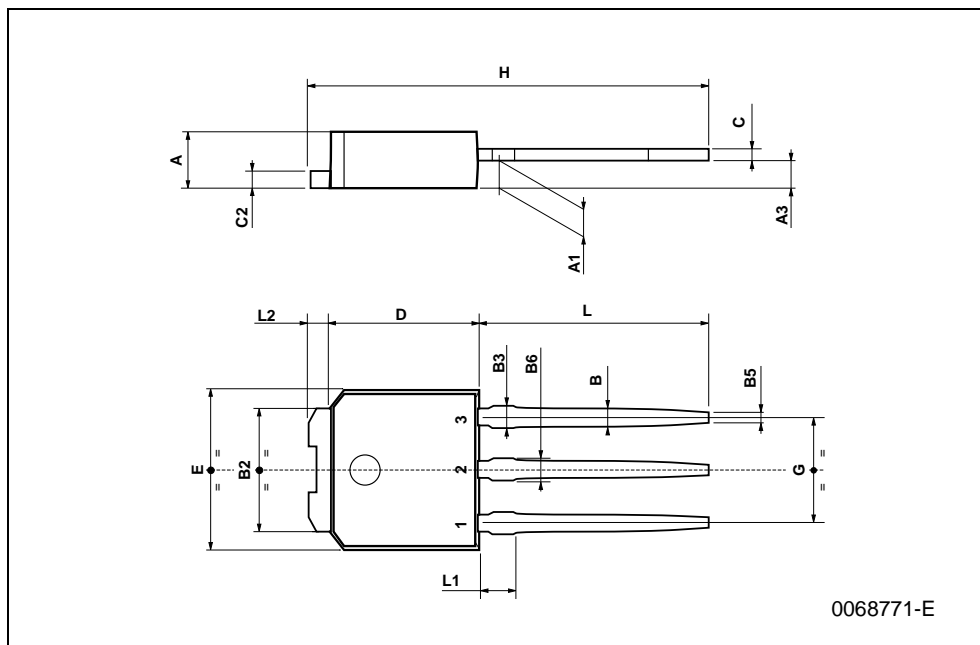
TO-252 (DPAK) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.20		2.40	0.087		0.094
A1	0.90		1.10	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.90	0.025		0.035
B2	5.20		5.40	0.204		0.213
C	0.45		0.60	0.018		0.024
C2	0.48		0.60	0.019		0.024
D	6.00		6.20	0.236		0.244
E	6.40		6.60	0.252		0.260
G	4.40		4.60	0.173		0.181
H	9.35		10.10	0.368		0.398
L2		0.8			0.031	
L4	0.60		1.00	0.024		0.039
V2	0°		8°	0°		0°

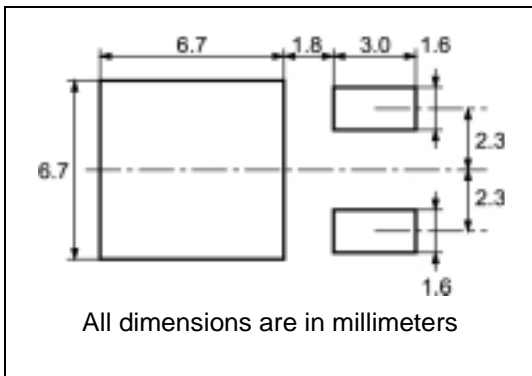


TO-251 (IPAK) MECHANICAL DATA

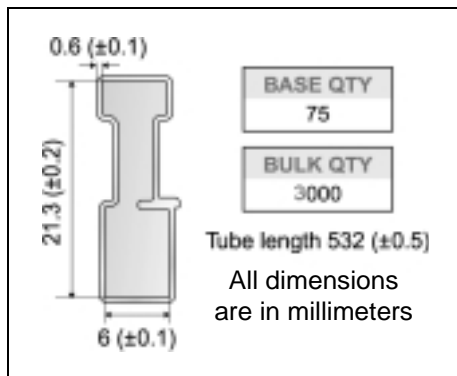
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.031
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		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



**DPAK FOOTPRINT**



**TUBE SHIPMENT (no suffix)\***



**TAPE AND REEL SHIPMENT (suffix "T4")\***

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

**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

For machine mt. only including draft and radii concentric around DR

10 pitches cumulative tolerance on tape + / - 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

\* on sales type

**Table 9: Revision History**

<b>Date</b>	<b>Revision</b>	<b>Description of Changes</b>
22-Nov-2004	2	Added SOT-223 Package and new stylesheet

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