STF2NK60Z - STQ2NK60ZR-AP
STP2NK60Z - STD2NK60Z-1

N-CHANNEL 600V - 7.2Ω - 1.4A TO-220/TO-220FP/TO-92/IPAK
Zener-Protected SuperMESH™ MOSFET

Table 1: General Features

TYPE	V_{DSS}	$R_{DS(on)}$	I_D	Pw
STF2NK60Z	600 V	< 8 Ω	1.4 A	20
STQ2NK60ZR-AP	600 V	< 8 Ω	0.4 A	3 W
STP2NK60Z	600 V	< 8 Ω	1.4 A	45 W
STD2NK60Z-1	600 V	< 8 Ω	1.4 A	45 W

- TYPICAL R_{DS}(on) = 7.2 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
- SWITH MODE LOW POWER SUPPLIES(SMPS)
- LOW POWER, BALLAST, CFL (COMPACT FLUORESCENT LAMPS)

Figure 1: Package

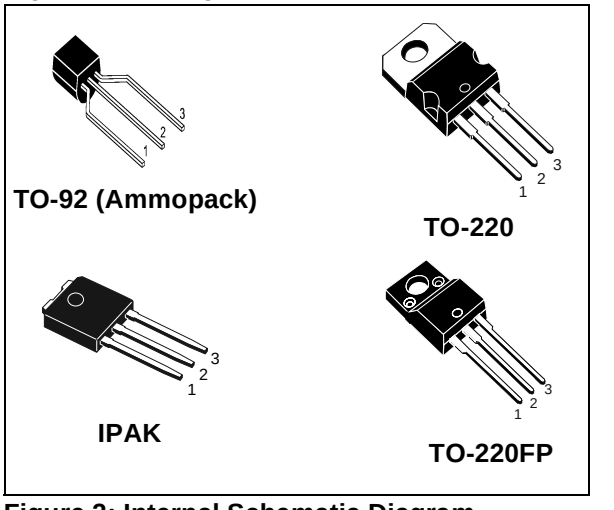


Figure 2: Internal Schematic Diagram

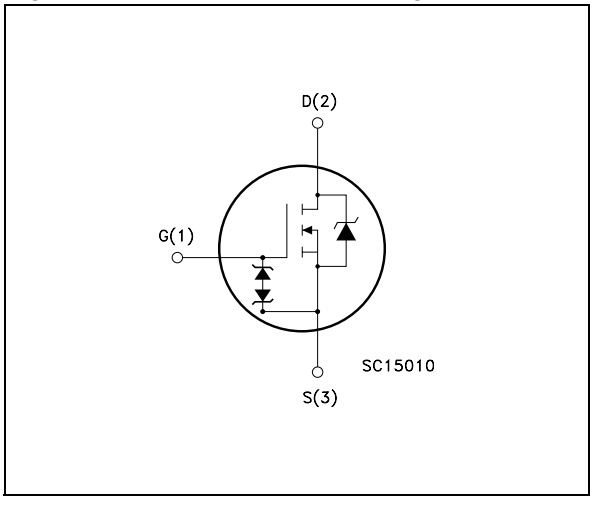


Table 2: Order Codes

Part Number	Marking	Package	Packaging
STQ2NK60ZR-AP	Q2NK60ZR	TO-92	AMMOPAK
STP2NK60Z	P2NK60Z	TO-220	TUBE
STD2NK60Z-1	D2NK60Z	IPAK	TUBE
STF2NK60Z	F2NK60Z	TO-220FP	TUBE

Table 3: Absolute Maximum ratings

Symbol	Parameter	Value			Unit
		TO-220 / IPAK	TO-92	TO-220FP	
V_{DS}	Drain-source Voltage (V_{GS} = 0)	600			V
V_{DGR}	Drain-gate Voltage (R_{GS} = 20 kΩ)	600			V
V_{GS}	Gate- source Voltage	± 30			V
I_D	Drain Current (continuous) at T_C = 25°C	1.4	0.4	1.4 (*)	A
I_D	Drain Current (continuous) at T_C = 100°C	0.77	0.25	0.77 (*)	A
I_{DM} (•)	Drain Current (pulsed)	5.6	1.6	5.6 (*)	A
P_{TOT}	Total Dissipation at T_C = 25°C	45	3	20	W
	Derating Factor	0.36	0.025	0.16	W/°C
$V_{ESD(G-S)}$	Gate source ESD (HBM-C= 100pF, R=1.5kΩ)	1500			V
V_{ISO}	Insulation Withstand Voltage (DC)			2500	V
dv/dt (1)	Peak Diode Recovery voltage slope	4.5			V/ns
T_j T_{stg}	Operating Junction Temperature Storage Temperature	-55 to 150			°C

(•) Pulse width limited by safe operating area
(1) $I_{SD} \leq 1.4A$, $di/dt \leq 200A/\mu s$, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX.}$
(*) Limited only by maximum temperature allowed

Table 4: Thermal Data

		TO-220/IPAK	TO-220FP	TO-92	Unit
Rthj-case	Thermal Resistance Junction-case Max	2.77	6.25	--	°C/W
Rthj-amb	Thermal Resistance Junction-ambient Max	100	100	120	°C/W
Rthj-lead	Thermal Resistance Junction-lead Max	--	--	40	°C/W
T_l	Maximum Lead Temperature For Soldering Purpose	300		260	°C

Table 5: Avalanche Characteristics

Symbol	Parameter	Max Value	Unit
I_{AR}	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T_j max)	1.4	A
E_{AS}	Single Pulse Avalanche Energy (starting T_j = 25 °C, $I_D = I_{AR}$, V_{DD} = 50 V)	90	mJ

Table 6: Gate-Source Zener Diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV_{GSO}	Gate source Breakdown Voltage	I_{gs}= ± 1 mA (Open Drain)	30			V

PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES

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.

ELECTRICAL CHARACTERISTICS (T_{CASE} =25°C UNLESS OTHERWISE SPECIFIED)

Table 7: On/Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	I_D = 1mA, V_{GS} = 0	600			V
I_{DSS}	Zero Gate Voltage Drain Current (V_{GS} = 0) 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} = ± 20V			±10	µA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 50 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static Drain-source On Resistance	V_{GS} = 10V, I_D = 0.7 A		7.2	8	Ω

Table 8: Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward Transconductance	V_{DS} = 15 V, I_D= 0.7 A		1		S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{DS} = 25V, f = 1 MHz, V_{GS} = 0		170 27 5		pF pF pF
$C_{oss\ eq.}$ (3)	Equivalent Output Capacitance	V_{GS} = 0V, V_{DS} = 0V to 480V		30		pF
$t_{d(on)}$ t_r $t_{d(off)}$ t_r	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	V_{DD} = 300 V, I_D = 0.65 A, R_G= 4.7 Ω, V_{GS} = 10 V (Resistive Load see, Figure 22)		8 30 22 55		ns ns ns ns
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V_{DD} = 480V, I_D = 1.5 A, V_{GS} = 10V (see, Figure 24)		7.7 1.7 4	10	nC nC nC

Table 9: Source Drain Diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (2)	Source-drain Current Source-drain Current (pulsed)				1.5 6	A A
V_{SD} (1)	Forward On Voltage	I_{SD} = 1.5 A, V_{GS} = 0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 1.3 A, di/dt = 100 A/µs V_{DD} = 25V, T_j = 25°C (see test circuit, Figure 23)		250 550 4.4		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 1.3 A, di/dt = 100 A/µs V_{DD} = 25V, T_j = 150°C (see test circuit, Figure 23)		300 690 4.6		ns µC A

(1) Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %.
(2) Pulse width limited by safe operating area.
(3) $C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as Coss when VDS increases from 0 to 80% VDSS

Figure 3: .Safe Operating Area For TO-220

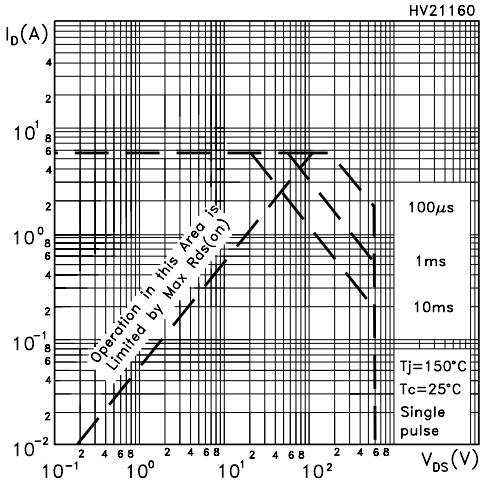


Figure 4: Safe Operating Area For IPAK

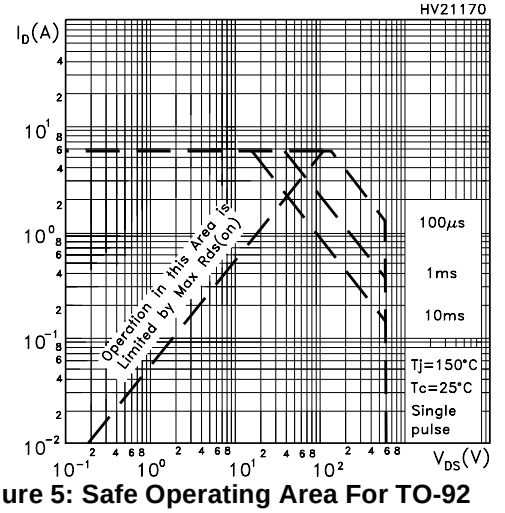


Figure 5: Safe Operating Area For TO-92

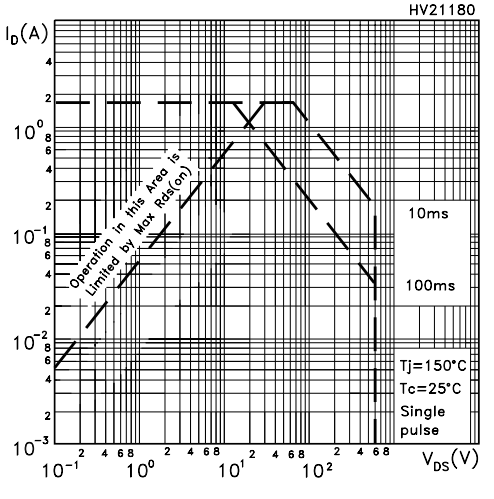


Figure 6: Thermal Impedance For TO-220

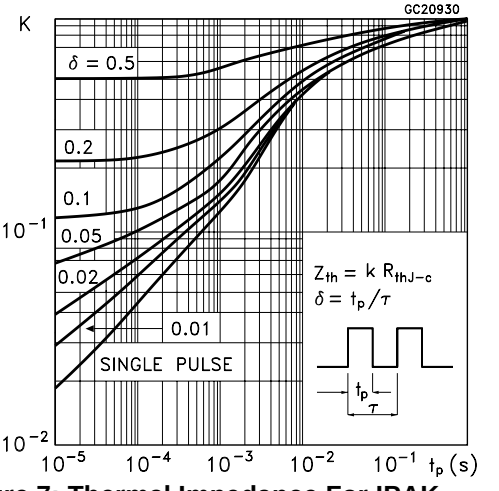


Figure 7: Thermal Impedance For IPAK

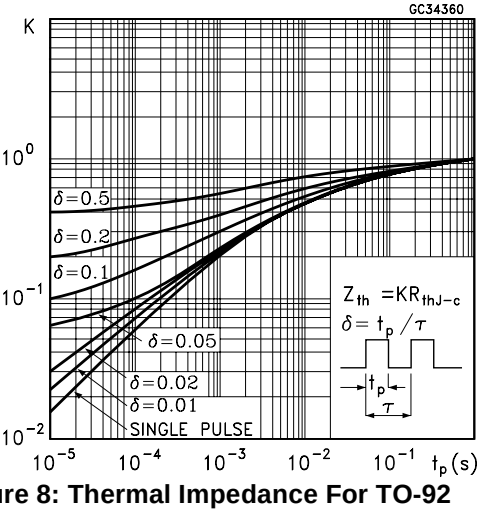


Figure 8: Thermal Impedance For TO-92

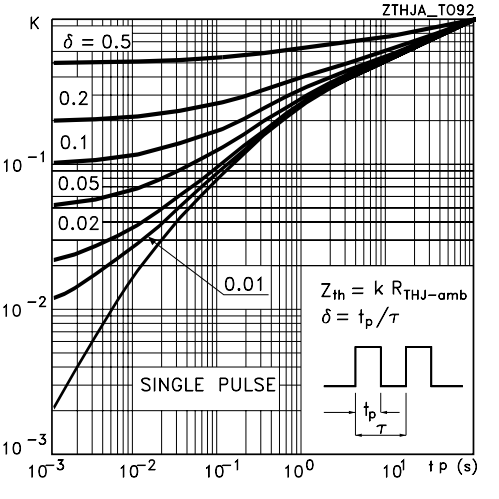


Figure 9: Safe Operating Area For TO-220FP

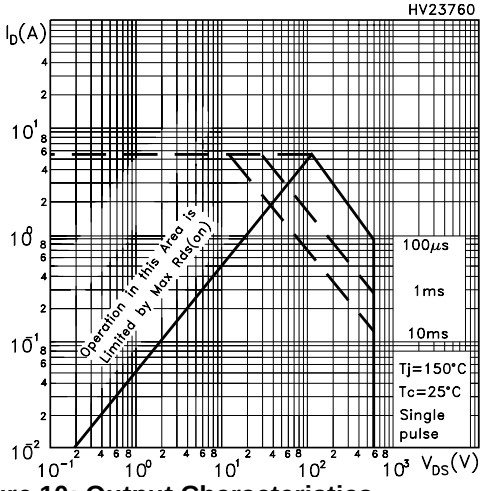


Figure 10: Output Characteristics

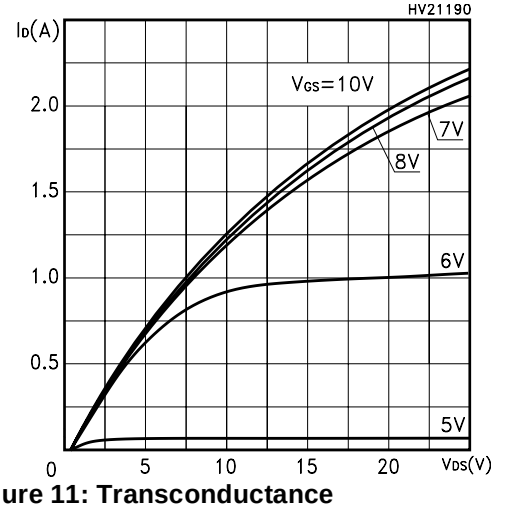


Figure 11: Transconductance

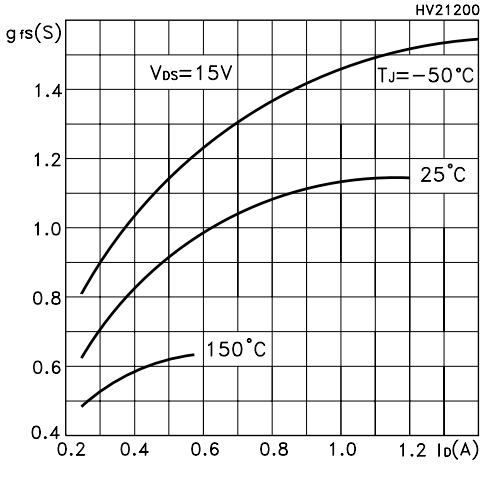


Figure 12: Thermal Impedance For TO-220FP

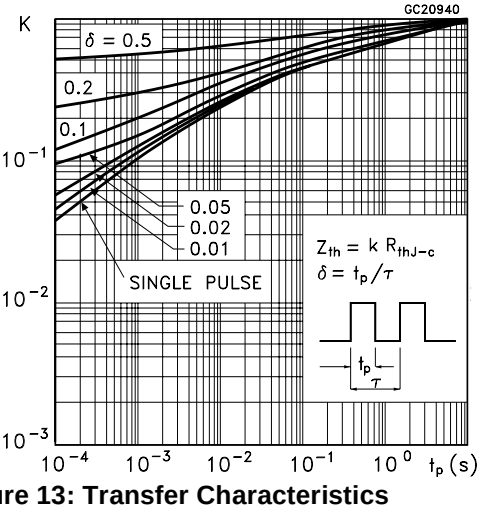


Figure 13: Transfer Characteristics

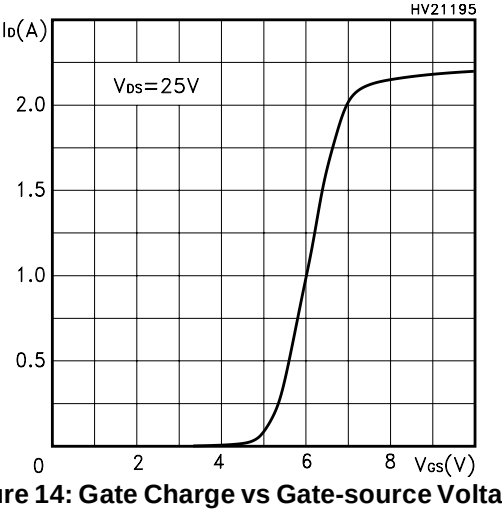


Figure 14: Gate Charge vs Gate-source Voltage

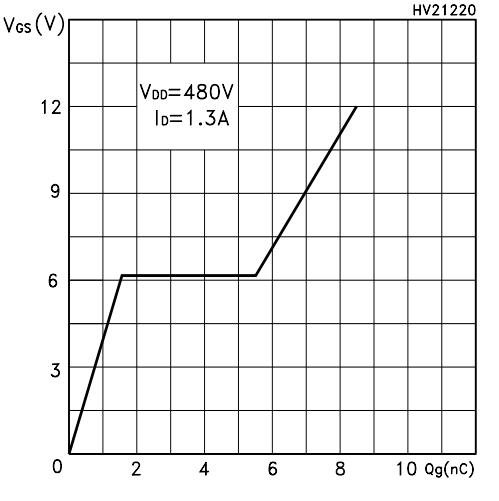


Figure 15: Static Drain-source On Resistance

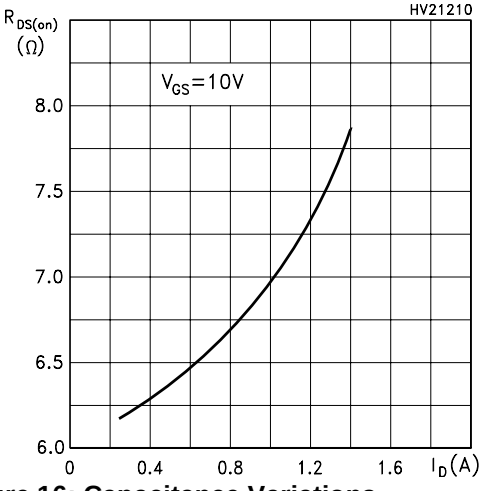


Figure 16: Capacitance Variations

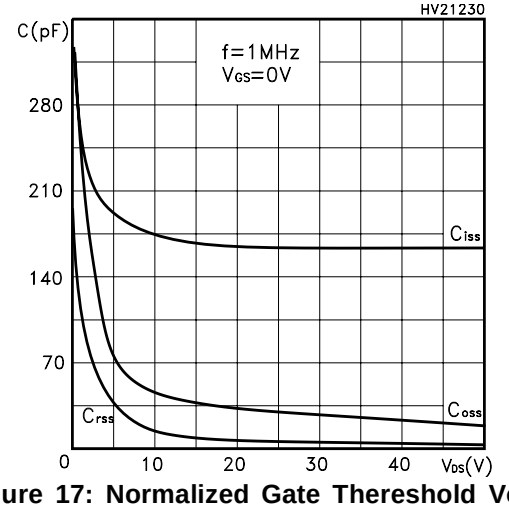


Figure 17: Normalized Gate Thereshold Voltage vs Temperature

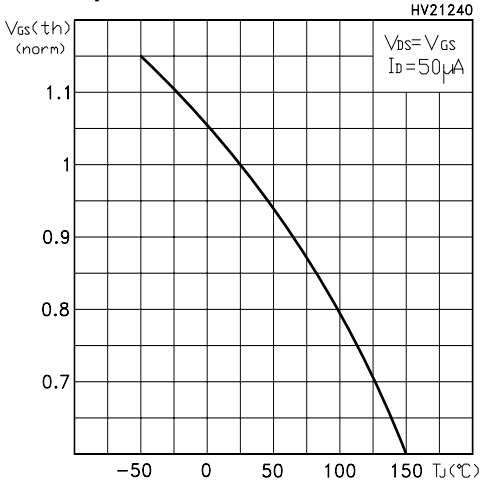


Figure 18: Source-Drain Forward Characteristics

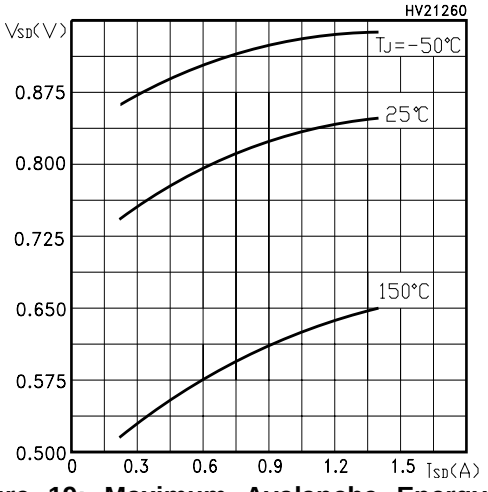


Figure 19: Maximum Avalanche Energy vs Temperature

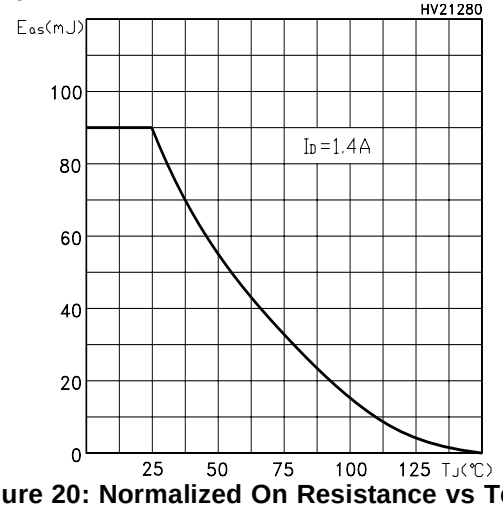


Figure 20: Normalized On Resistance vs Temperature

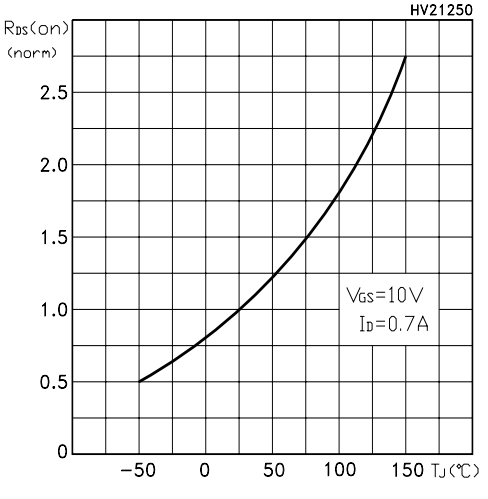


Figure 21: Normalized BV_{DSS} vs Temperature

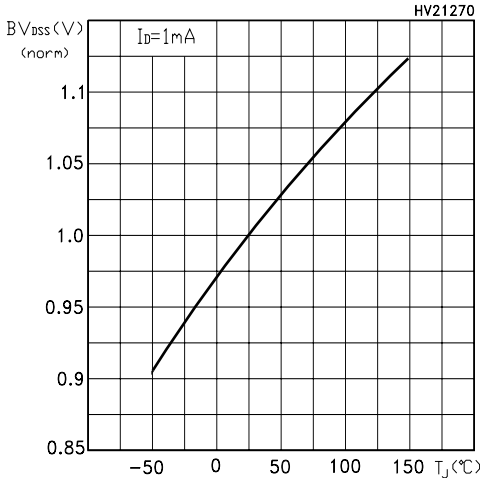


Figure 22: Switching Times Test Circuit For Resistive Load

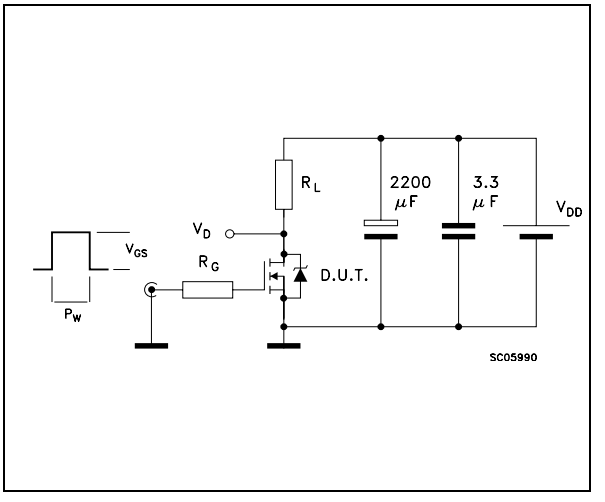


Figure 23: Test Circuit For Inductive Load Switching and Diode Recovery Times

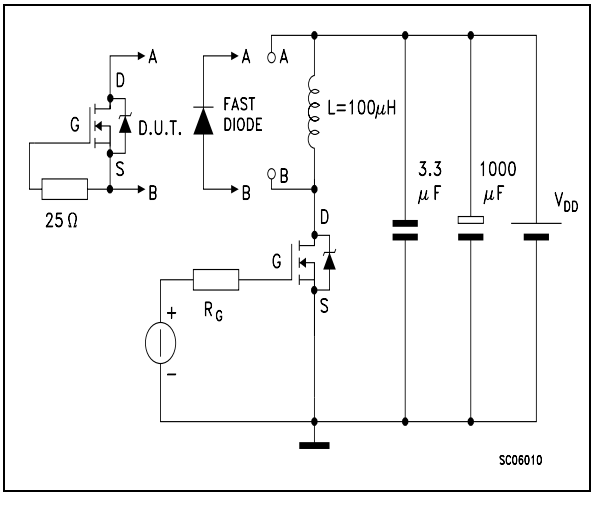
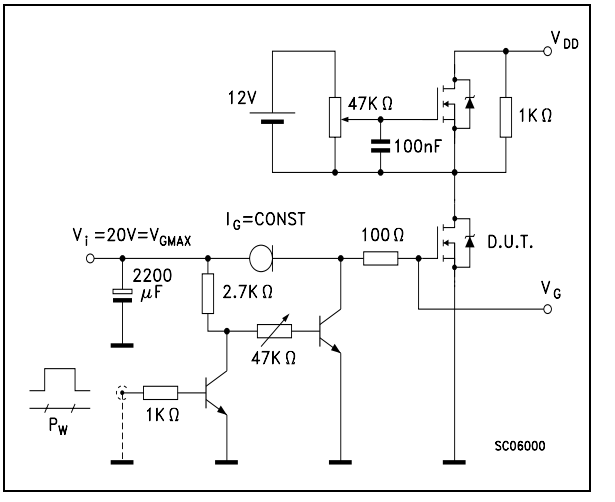


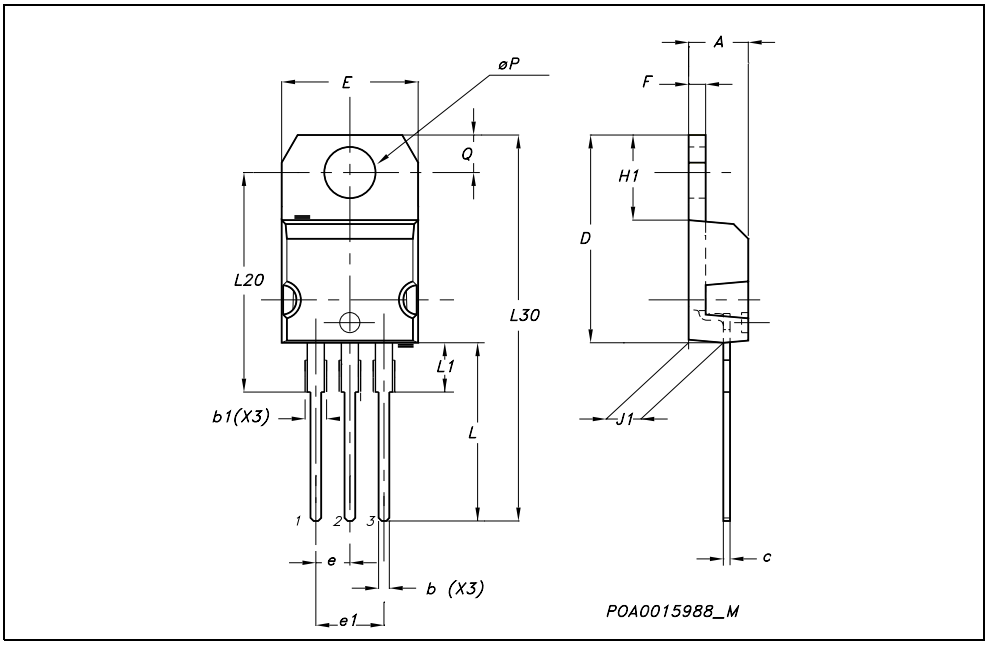
Figure 24: Gate Charge Test Circuit



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

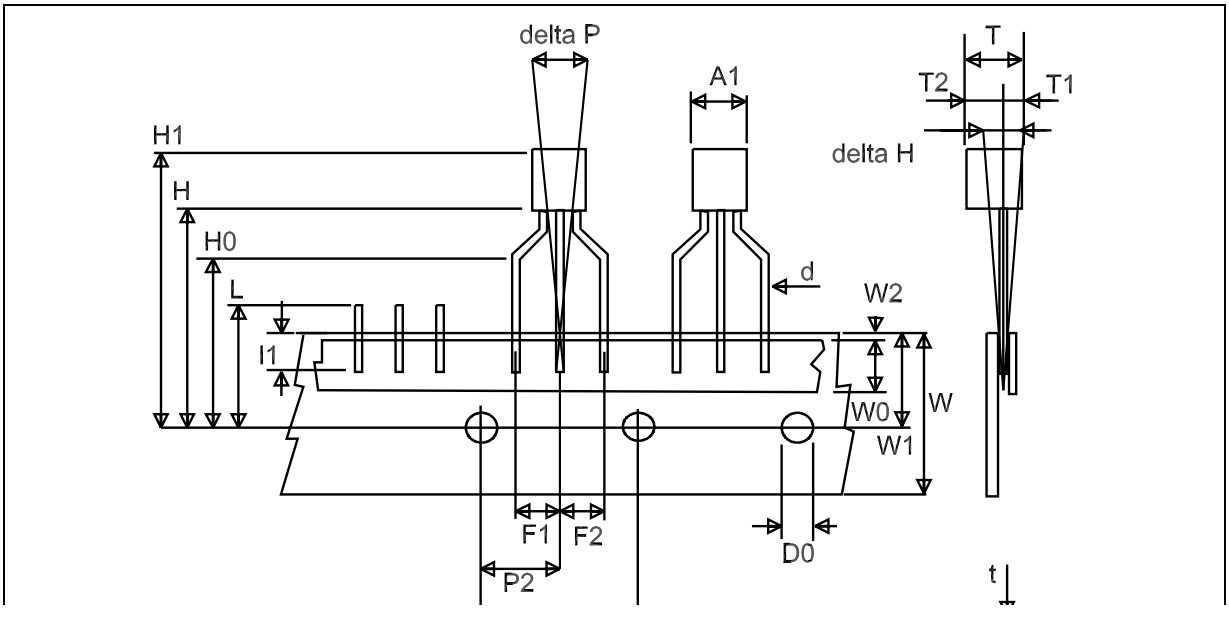
TO-220 MECHANICAL DATA

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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



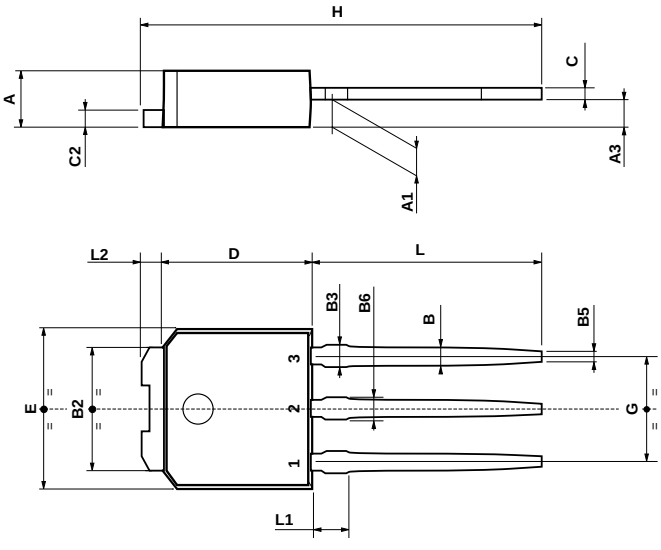
TO-92 AMMOPACK

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



TO-251 (IPAK) MECHANICAL DATA

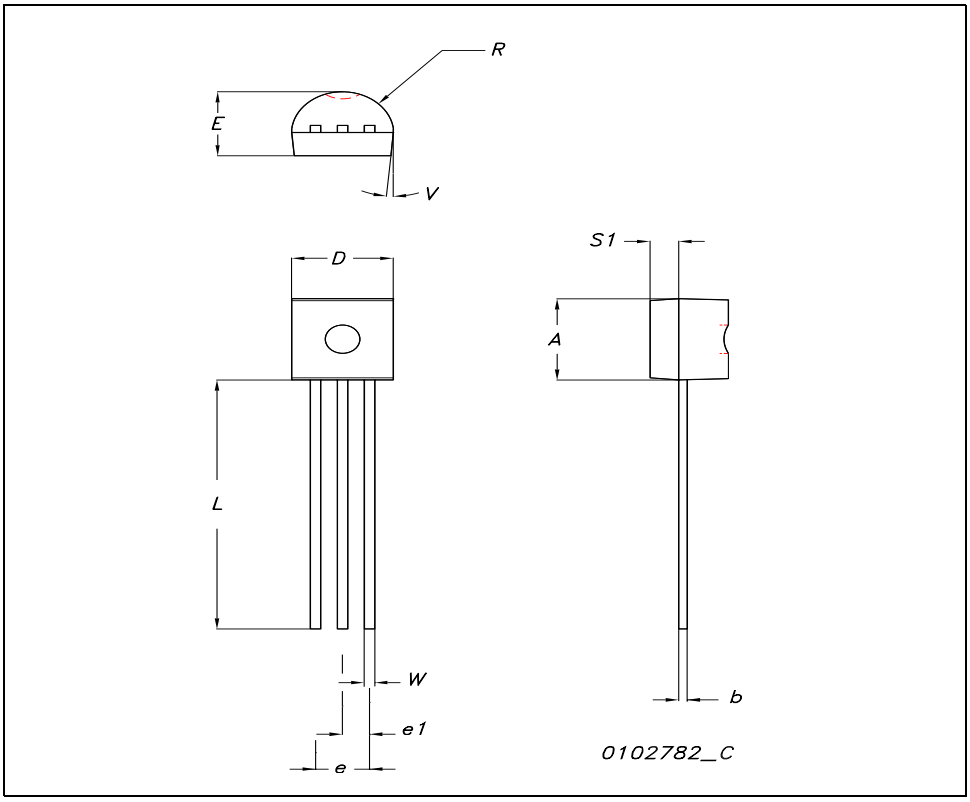
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.031
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		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-220FP MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	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		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126

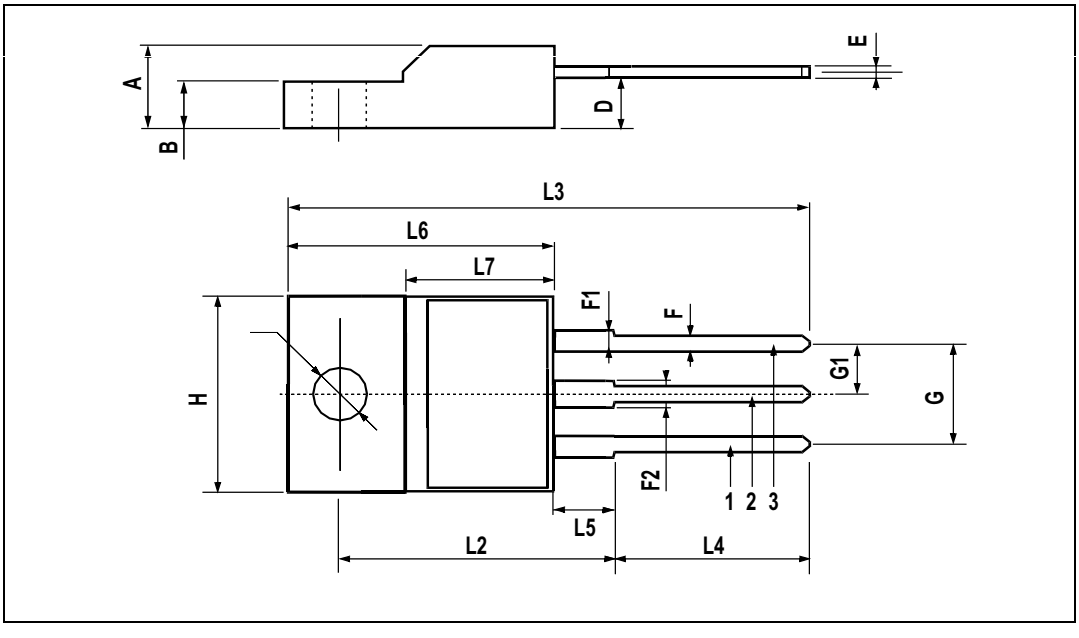


Table 10: Revision History

Date	Revision	Description of Changes
07-Jul-2004	3	The document change from “TARGET” to “COMPLETE” New stylesheet
11/Nov/2004	4	Added TO-220FP
05-Sep-2005	5	Inserted Ecopack indication