



# STP5NK100Z - STF5NK100Z STW5NK100Z

N-CHANNEL 1000V - 2.7Ω - 3.5A TO-220/TO-220FP/TO-247  
Zener-Protected SuperMESH™ MOSFET

**Table 1: General Features**

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STF5NK100Z	1000 V	< 3.7 Ω	3.5 A (*)	30 W
STP5NK100Z	1000 V	< 3.7 Ω	3.5 A	125 W
STW5NK100Z	1000 V	< 3.7 Ω	3.5 A	125 W

- TYPICAL R<sub>DS(on)</sub> = 2.7 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- IMPROVED ESD CAPABILITY
- 100% AVALANCHE RATED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY

## DESCRIPTION

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strippbased 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.

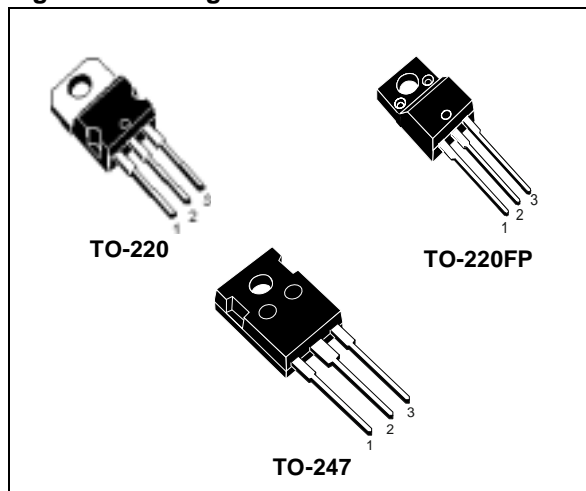
## APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES

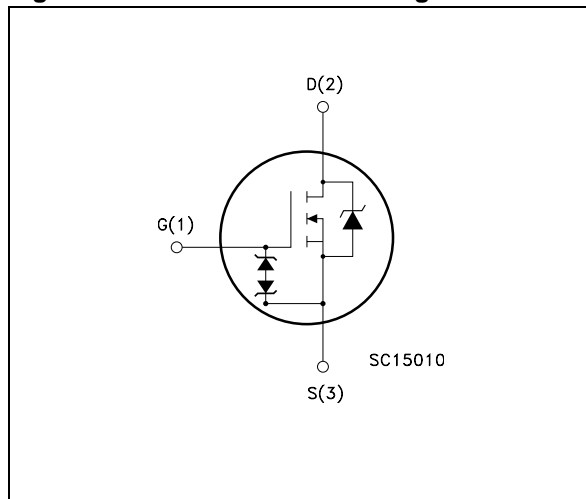
**Table 2: Order Codes**

SALES TYPE	MARKING	PACKAGE	PACKAGING
STF5NK100Z	F5NK100Z	TO-220FP	TUBE
STP5NK100Z	P5NK100Z	TO-220	TUBE
STW5NK100Z	W15NK100Z	TO-247	TUBE

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value		Unit
		STP5NK100Z STW5NK100Z	STF5NK100Z	
V <sub>DS</sub>	Drain-source Voltage (V <sub>GS</sub> = 0)	1000		V
V <sub>DGR</sub>	Drain-gate Voltage (R <sub>GS</sub> = 20 kΩ)	1000		V
V <sub>GS</sub>	Gate- source Voltage	± 30		V
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 25°C	3.5	3.5 (*)	A
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 100°C	2.2	2.2 (*)	A
I <sub>DM</sub> (•)	Drain Current (pulsed)	14	14 (*)	A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	125	30	W
	Derating Factor	1	0.24	W/°C
V <sub>ESD(G-S)</sub>	Gate source ESD(HBM-C=100pF, R=1.5KΩ)	4000		V
dv/dt (1)	Peak Diode Recovery voltage slope	4.5		V/ns
V <sub>ISO</sub>	Insulation Withstand Voltage (DC)	-	2500	V
T <sub>j</sub> T <sub>stg</sub>	Operating Junction Temperature Storage Temperature	-55 to 150 -55 to 150		°C °C

(•) Pulse width limited by safe operating area

(1) I<sub>SD</sub> ≤ 3.5A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>.

(\*) Limited only by maximum temperature allowed

**Table 4: Thermal Data**

		TO-220 TO-247	TO-220FP	
R <sub>thj-case</sub>	Thermal Resistance Junction-case Max	1	4.2	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient Max	62.5		°C/W
T <sub>l</sub>	Maximum Lead Temperature For Soldering Purpose	300		°C

**Table 5: Avalanche Characteristics**

Symbol	Parameter	Max Value	Unit
I <sub>AR</sub>	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)	3.5	A
E <sub>AS</sub>	Single Pulse Avalanche Energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	250	mJ

**Table 6: Gate-Source Zener Diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV <sub>GSO</sub>	Gate-Source Breakdown Voltage	I <sub>gs</sub> =± 1mA (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** ( $T_{CASE} = 25^{\circ}C$  UNLESS OTHERWISE SPECIFIED)**Table 7: On /Off**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	1000			V
$I_{DSS}$	Zero Gate Voltage Drain Current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating},$ $T_C = 125^{\circ}C$			1 50	$\mu A$ $\mu A$
$I_{GSS}$	Gate-body Leakage Current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20 \text{ V}$			$\pm 10$	$\mu A$
$V_{GS(th)}$	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	$V_{GS} = 10 \text{ V}, I_D = 1.75 \text{ A}$		2.7	3.7	$\Omega$

**Table 8: Dynamic**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs} (1)$	Forward Transconductance	$V_{DS} = 15 \text{ V}, I_D = 1.75 \text{ A}$		4		S
$C_{iss}$	Input Capacitance	$V_{DS} = 25 \text{ V}, f = 1 \text{ MHz},$ $V_{GS} = 0$		1154		pF
$C_{oss}$	Output Capacitance			106		pF
$C_{rss}$	Reverse Transfer Capacitance			21.3		pF
$C_{oss \text{ eq}} (3)$	Equivalent Output Capacitance	$V_{GS} = 0 \text{ V}, V_{DS} = 0 \text{ to } 800 \text{ V}$		46.8		pF
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 500 \text{ V}, I_D = 1.75 \text{ A},$ $R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see Figure 21)		22.5		ns
$t_r$	Rise Time			7.7		ns
$t_{d(off)}$	Turn-off-Delay Time			51.5		ns
$t_f$	Fall Time			19		ns
$Q_g$	Total Gate Charge	$V_{DD} = 800 \text{ V}, I_D = 3.5 \text{ A},$ $V_{GS} = 10 \text{ V}$ (see Figure 24)		42	59	nC
$Q_{gs}$	Gate-Source Charge			7.3		nC
$Q_{gd}$	Gate-Drain Charge			21.7		nC

**Table 9: Source Drain Diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain Current				3.5	A
$I_{SDM} (2)$	Source-drain Current (pulsed)				14	A
$V_{SD} (1)$	Forward On Voltage	$I_{SD} = 3.5 \text{ A}, V_{GS} = 0$			1.6	V
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 3.5 \text{ A}, di/dt = 100 \text{ A}/\mu s$ $V_{DD} = 35 \text{ V}$ (see Figure 22)		605		ns
$Q_{rr}$	Reverse Recovery Charge			3.09		$\mu C$
$I_{RRM}$	Reverse Recovery Current			10.5		A
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 3.5 \text{ A}, di/dt = 100 \text{ A}/\mu s$ $V_{DD} = 35 \text{ V}, T_j = 150^{\circ}C$ (see Figure 22)		742		ns
$Q_{rr}$	Reverse Recovery Charge			4.2		$\mu C$
$I_{RRM}$	Reverse Recovery Current			11.2		A

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

(2) Pulse width limited by safe operating area.

(3)  $C_{oss \text{ eq}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$ .

Figure 3: Safe Operating Area For TO-220

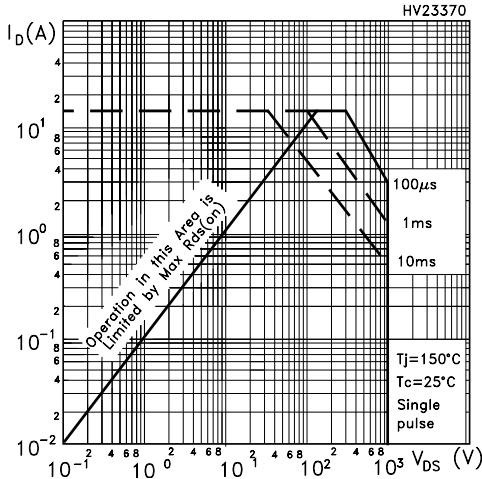


Figure 4: Safe Operating Area For TO-220FP

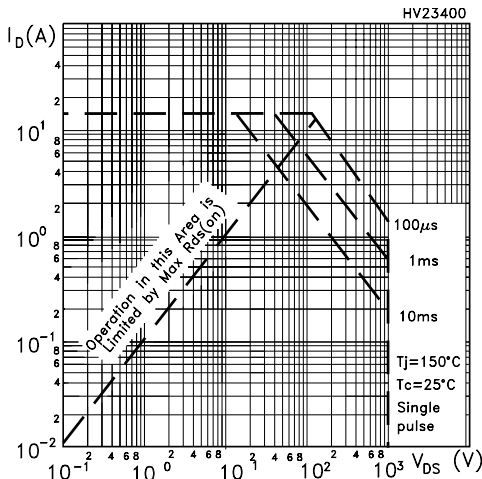


Figure 5: Safe Operating Area For TO-247

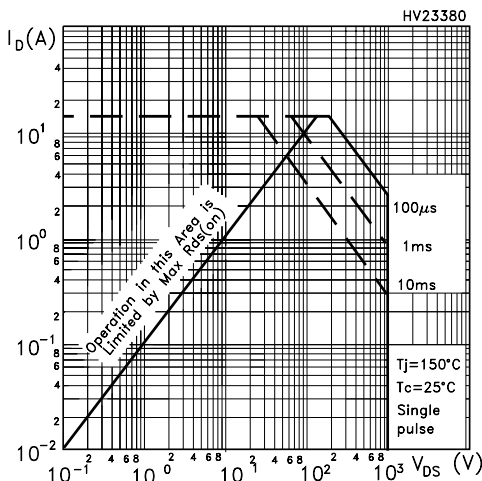


Figure 6: Thermal Impedance TO-220

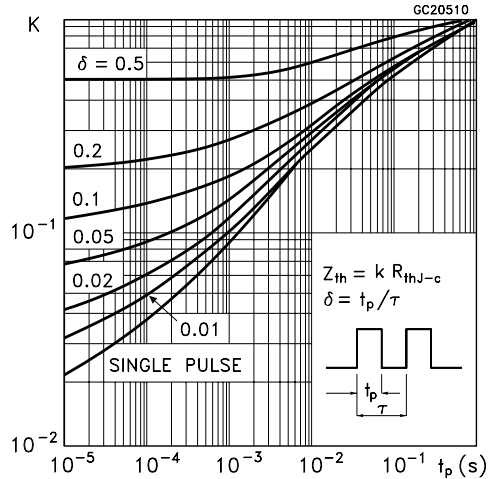


Figure 7: Thermal Impedance For TO-220FP

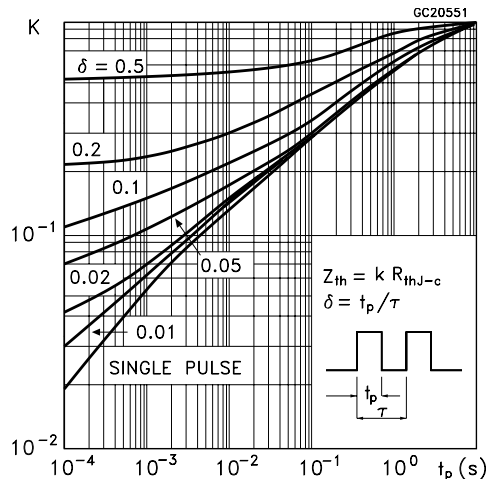


Figure 8: Thermal Impedance For TO-247

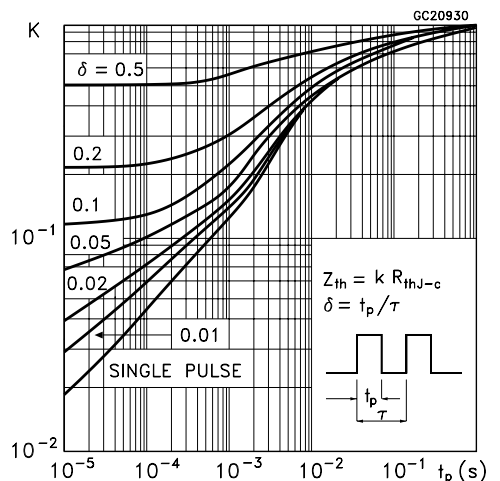


Figure 9: Output Characteristics

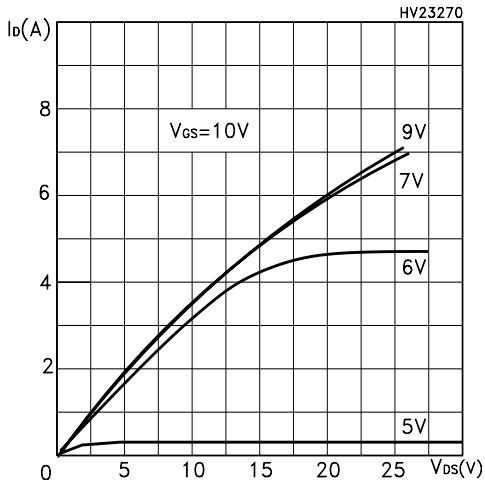


Figure 10: Transconductance

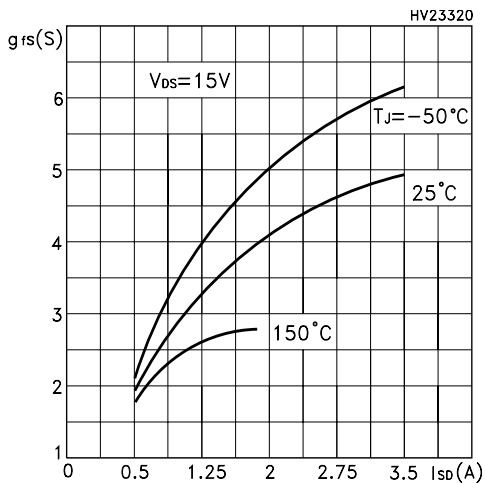


Figure 11: Gate Charge vs Gate-source Voltage

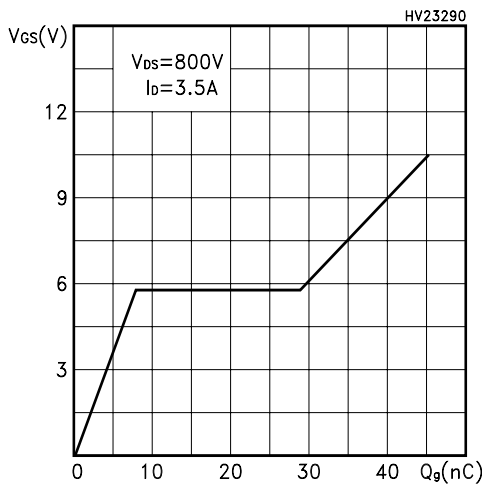


Figure 12: Transfer Characteristics

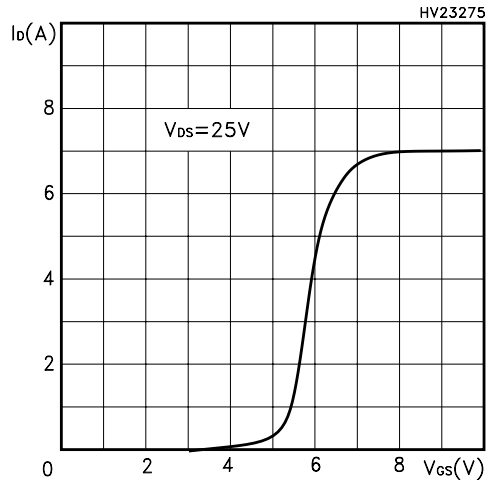


Figure 13: Static Drain-Source On Resistance

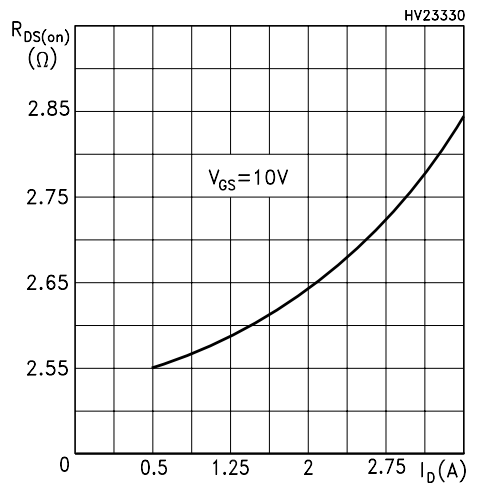


Figure 14: Capacitance Variations

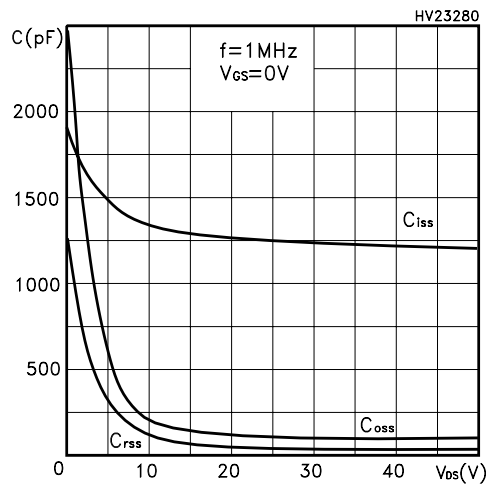


Figure 15: Normalized Gate Threshold Voltage vs Temperature

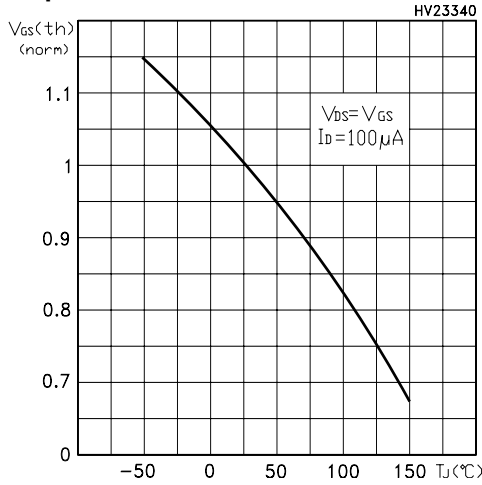


Figure 16: Source-Drain Forward Characteristics

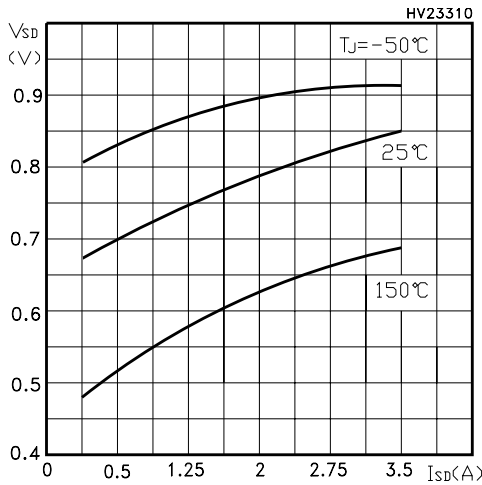


Figure 17: Maximum Avalanche Energy vs Temperature

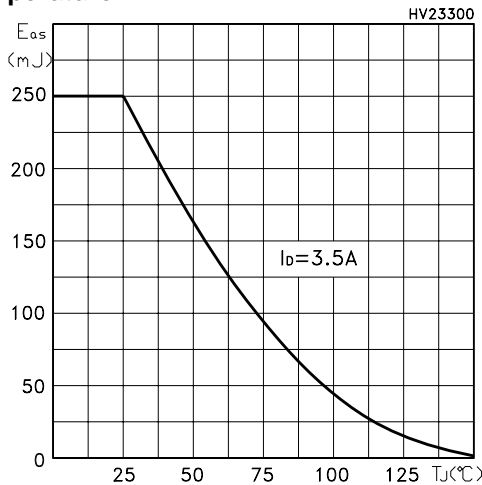


Figure 18: Normalized On Resistance vs Temperature

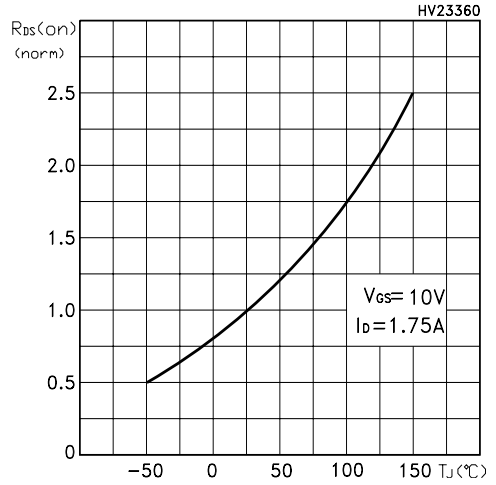


Figure 19: Normalized BV<sub>DSS</sub> vs Temperature

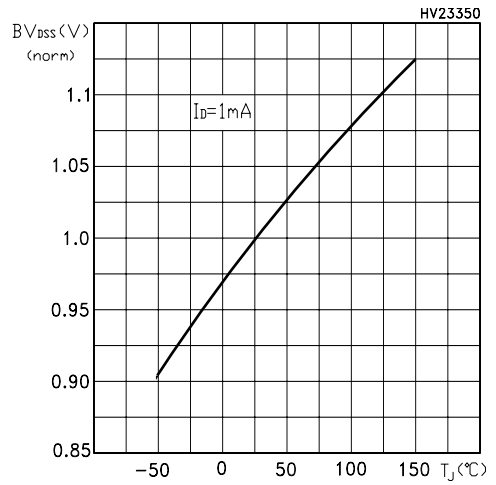


Figure 20: Unclamped Inductive Load Test Circuit

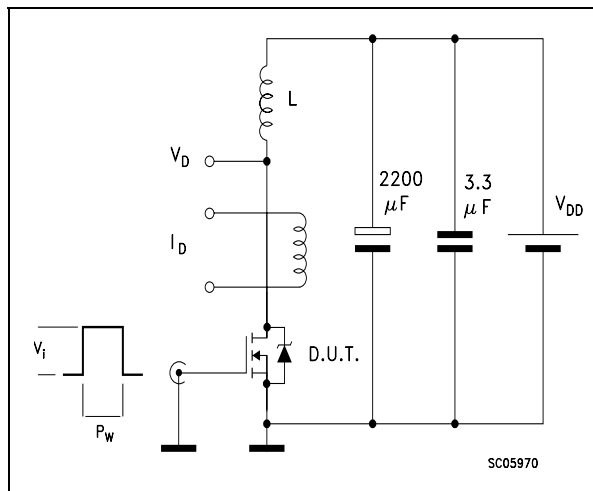


Figure 21: Switching Times Test Circuit For Resistive Load

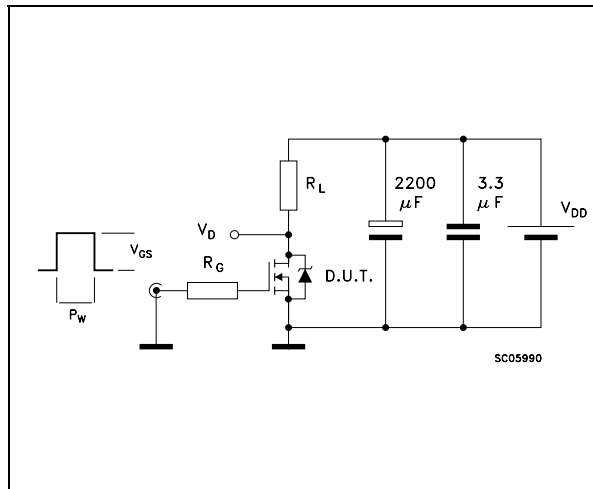


Figure 22: Test Circuit For Inductive Load Switching and Diode Recovery Times

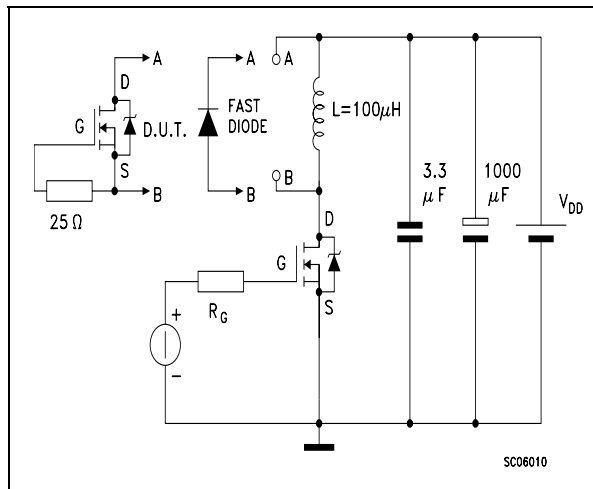


Figure 23: Unclamped Inductive Waferform

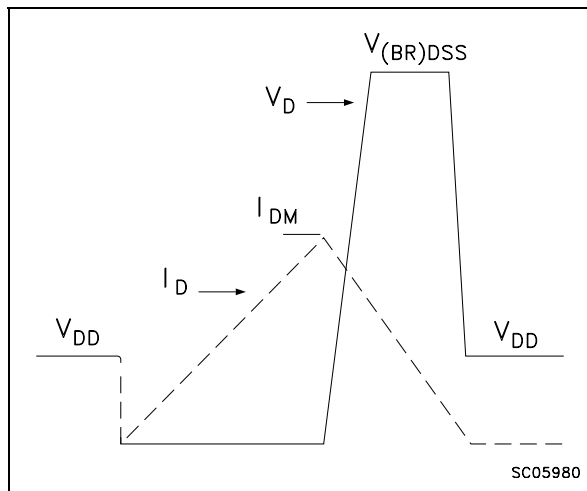
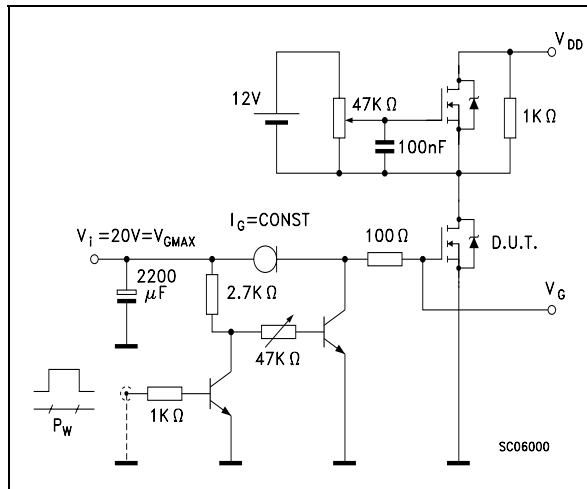
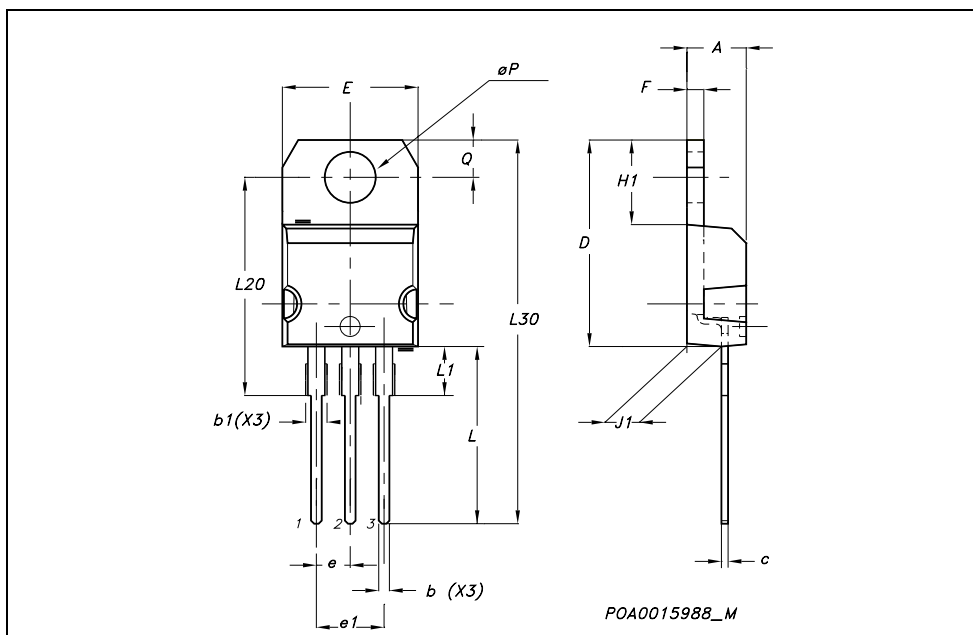


Figure 24: Gate Charge Test Circuit



TO-220 MECHANICAL DATA

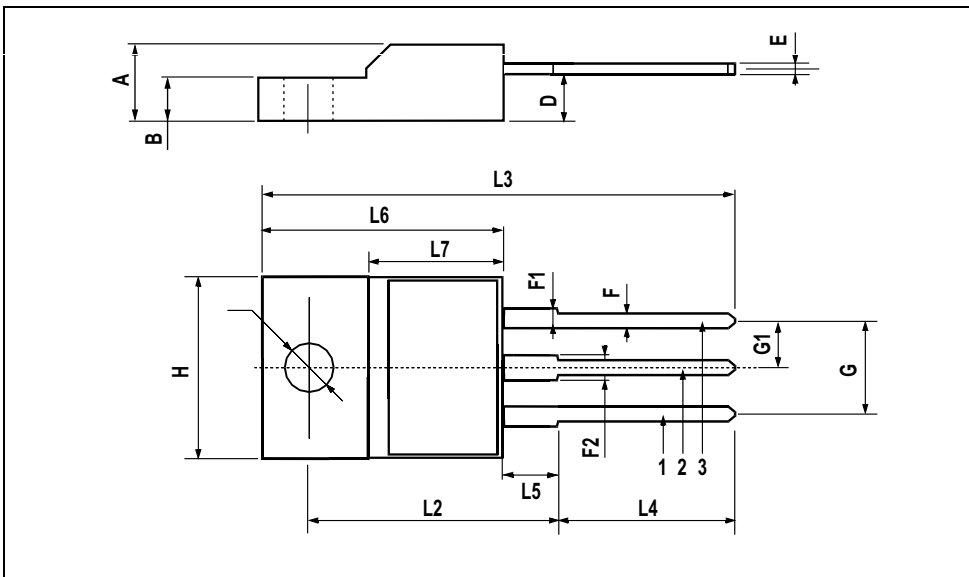
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.052
H1	6.20		6.60	0.244		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-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



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	

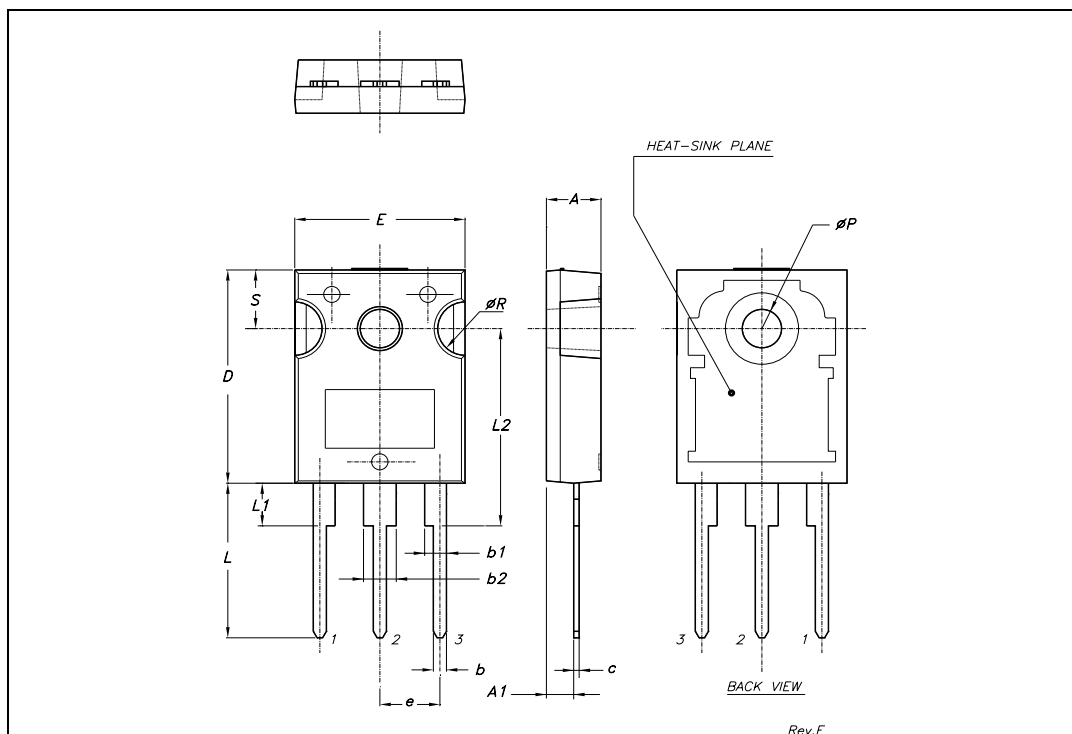


Table 10: Revision History

Date	Revision	Description of Changes
27-Sep-2004	1	First release.
08-Oct-2004	2	Final datasheet

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