

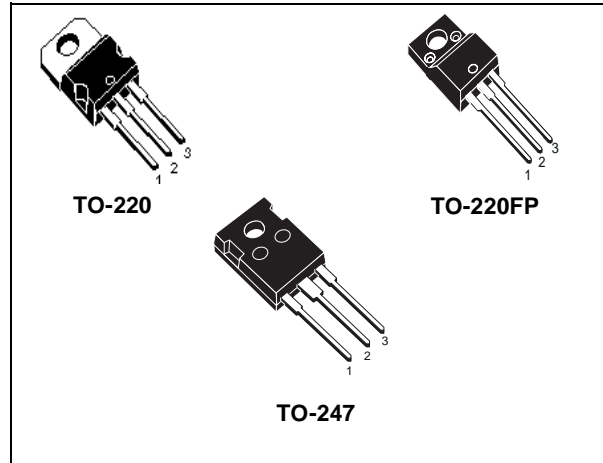


# STP20NM60FD - STF20NM60D STW20NM60FD

N-CHANNEL 600V - 0.26Ω - 20A TO-220/TO-220FP/TO-247  
FDmesh™ POWER MOSFET (with FAST DIODE)

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STP20NM60FD	600 V	< 0.29 Ω	20 A	192 W
STF20NM60D	600 V	< 0.29 Ω	20 A	45 W
STW20NM60FD	600 V	< 0.29 Ω	20 A	214 W

- TYPICAL R<sub>DS(on)</sub> = 0.26Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE
- TIGHT PROCESS CONTROL AND HIGH MANUFACTURING YIELDS



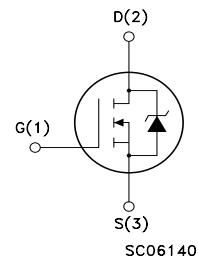
## DESCRIPTION

The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

## APPLICATIONS

- ZVS PHASE-SHIFT FULL BRIDGE CONVERTERS FOR SMPS AND WELDING EQUIPMENT

## INTERNAL SCHEMATIC DIAGRAM



## ORDERING INFORMATION

SALES TYPE	MARKING	PACKAGE	PACKAGING
STP20NM60FD	P20NM60FD	TO-220	TUBE
STF20NM60D	F20NM60D	TO-220FP	TUBE
STW20NM60FD	W20NM60FD	TO-247	TUBE

## STP20NM60FD - STF20NM60D - STW20NM60FD

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value			Unit
		STP20NM60FD	STF20NM60D	STW20NM60FD	
$V_{DS}$	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 $T_C = 25^\circ\text{C}$	20	20 (*)	20	A
$I_D$	Drain Current (continuous) at $T_C = 100^\circ\text{C}$	12.6	12.6 (*)	12.6	A
$I_{DM}(\bullet)$	Drain Current (pulsed)	80	80 (*)	80	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	192	45	214	W
	Derating Factor	1.20	0.36	1.42	W/ $^\circ\text{C}$
$dv/dt$ (1)	Peak Diode Recovery voltage slope	20			V/ns
$V_{ISO}$	Insulation Withstand Voltage (DC)	-	2500	-	V
$T_j$ $T_{stg}$	Operating Junction Temperature Storage Temperature	- 65 to 150			$^\circ\text{C}$ $^\circ\text{C}$

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

(1)  $I_{SD} \leq 20 \text{ A}$ ,  $di/dt \leq 400 \text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

(\*) Limited only by maximum temperature allowed

### THERMAL DATA

		TO-220	TO-220FP	TO-247	
Rthj-case	Thermal Resistance Junction-case Max	0.65	2.8	0.585	$^\circ\text{C}/\text{W}$
Rthj-amb	Thermal Resistance Junction-ambient Max	62.5		30	$^\circ\text{C}/\text{W}$
$T_l$	Maximum Lead Temperature For Soldering Purpose	300			$^\circ\text{C}$

### AVALANCHE CHARACTERISTICS

Symbol	Parameter	Max Value	Unit
$I_{AR}$	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max)	10	A
$E_{AS}$	Single Pulse Avalanche Energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 35 \text{ V}$ )	700	mJ

## STP20NM60FD - STF20NM60D - STW20NM60FD

### ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> = 25°C UNLESS OTHERWISE SPECIFIED) ON/OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source Breakdown Voltage	I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0	600			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max Rating V <sub>DS</sub> = Max Rating, T <sub>C</sub> = 125 °C			1 10	μA μA
I <sub>GSS</sub>	Gate-body Leakage Current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ±30V			±100	μA
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	3	4	5	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 10 A		0.26	0.29	Ω

### DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> (1)	Forward Transconductance	V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> , I <sub>D</sub> = 10A		9		S
C <sub>iss</sub> C <sub>oss</sub> C <sub>rss</sub>	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0		1310 580 30		pF pF pF
C <sub>oss</sub> eq. (3)	Equivalent Output Capacitance	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 480V		190		pF
R <sub>G</sub>	Gate Input Resistance	f=1 MHz Gate DC Bias = 0 Test Signal Level = 20mV Open Drain		2.7		Ω

### SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t <sub>d(on)</sub> t <sub>r</sub>	Turn-on Delay Time Rise Time	V <sub>DD</sub> = 300V, I <sub>D</sub> = 10A R <sub>G</sub> = 4.7Ω V <sub>GS</sub> = 10V (Resistive Load see, Figure 3)		25 12		ns ns
Q <sub>g</sub> Q <sub>gs</sub> Q <sub>gd</sub>	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V <sub>DD</sub> = 480V, I <sub>D</sub> = 20A, V <sub>GS</sub> = 10V		37 10 17	52	nC nC nC

### SWITCHING OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t <sub>r(Voff)</sub> t <sub>f</sub> t <sub>c</sub>	Off-voltage Rise Time Fall Time Cross-over Time	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 20A, R <sub>G</sub> = 4.7Ω, V <sub>GS</sub> = 10V (Inductive Load see, Figure 5)		8 22 30		ns ns ns

### SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I <sub>SD</sub> I <sub>SDM</sub> (2)	Source-drain Current Source-drain Current (pulsed)				20 80	A A
V <sub>SD</sub> (1)	Forward On Voltage	I <sub>SD</sub> = 20 A, V <sub>GS</sub> = 0			1.5	V
t <sub>rr</sub> Q <sub>rr</sub> I <sub>RRM</sub>	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I <sub>SD</sub> = 20 A, di/dt = 100A/μs, V <sub>DD</sub> = 60 V, T <sub>j</sub> = 150°C (see test circuit, Figure 5)		340 2.8 17		ns μC A

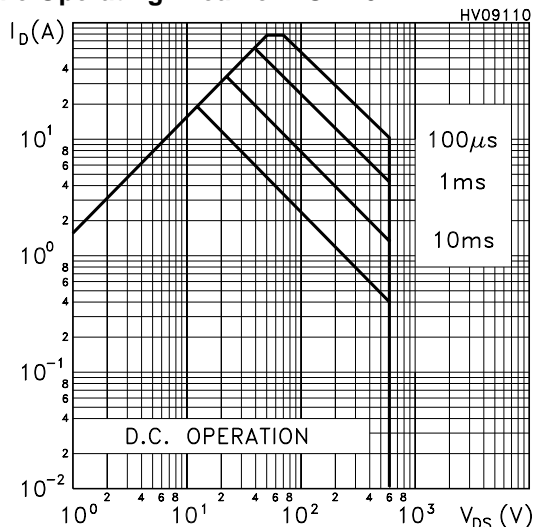
Note: 1. Pulsed: Pulse duration = 300 μs, duty cycle 1.5 %.

2. Pulse width limited by safe operating area.

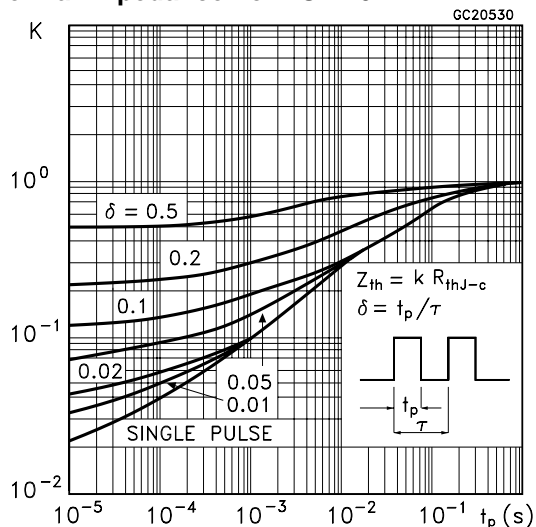
3. C<sub>oss</sub> eq. is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80%



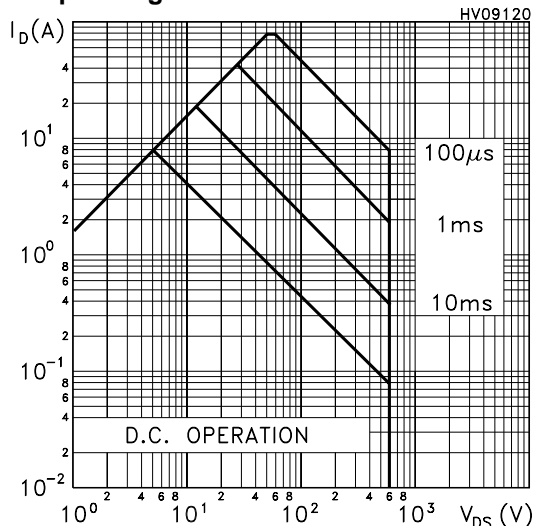
Safe Operating Area For TO-220



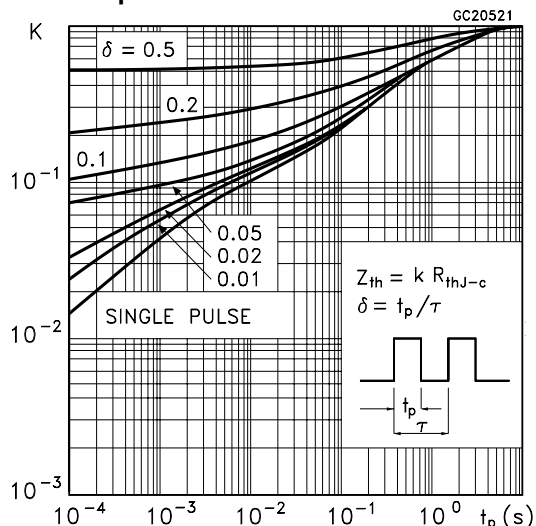
Thermal Impedance For TO-220



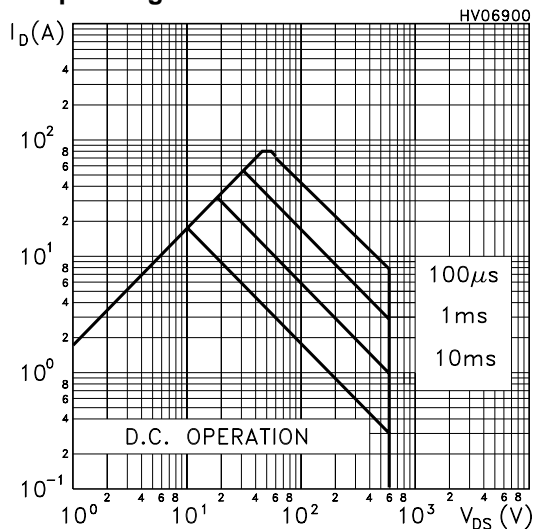
Safe Operating Area For TO-220FP



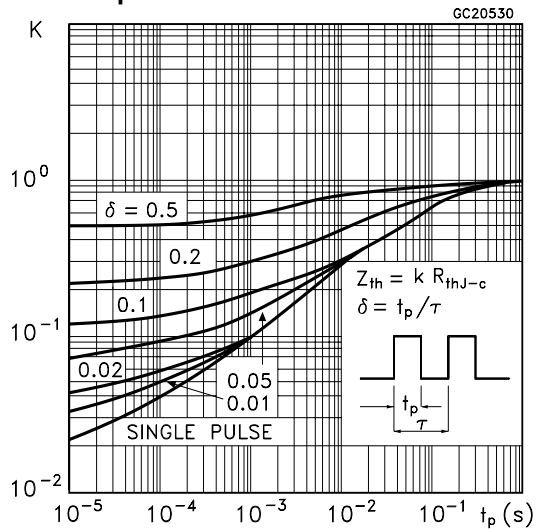
Thermal Impedance For TO-220FP



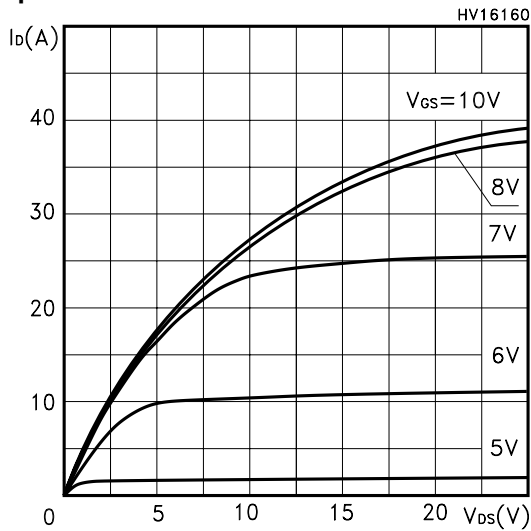
Safe Operating Area For TO-247



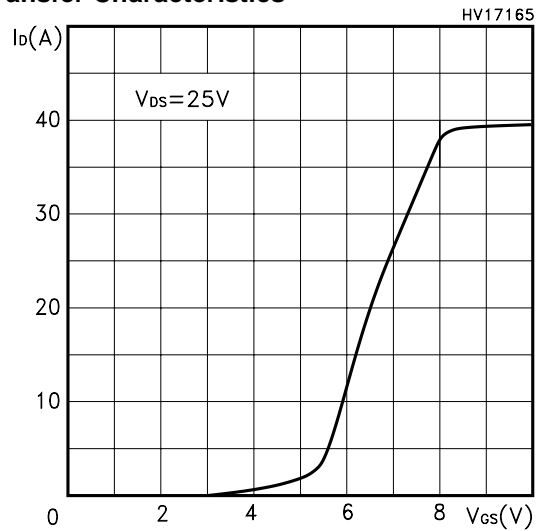
Thermal Impedance For TO-247



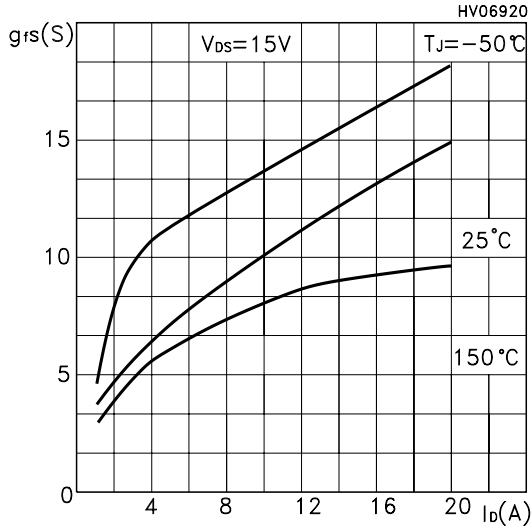
**Output Characteristics**



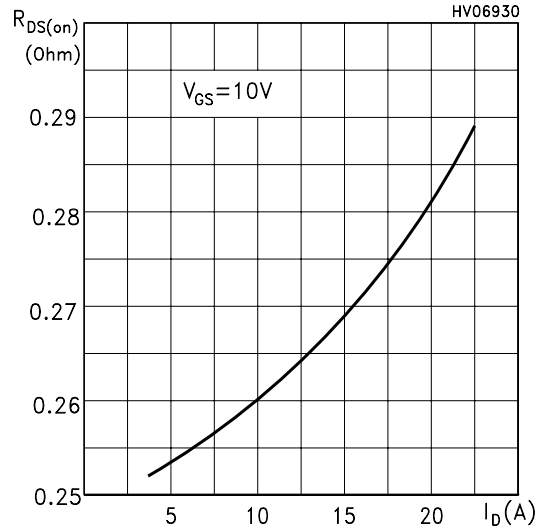
**Transfer Characteristics**



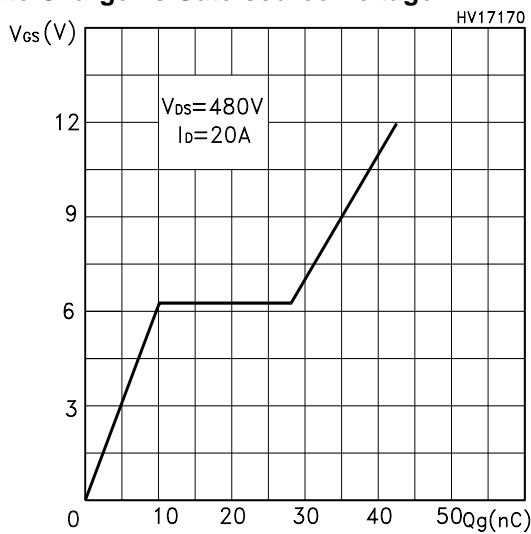
**Transconductance**



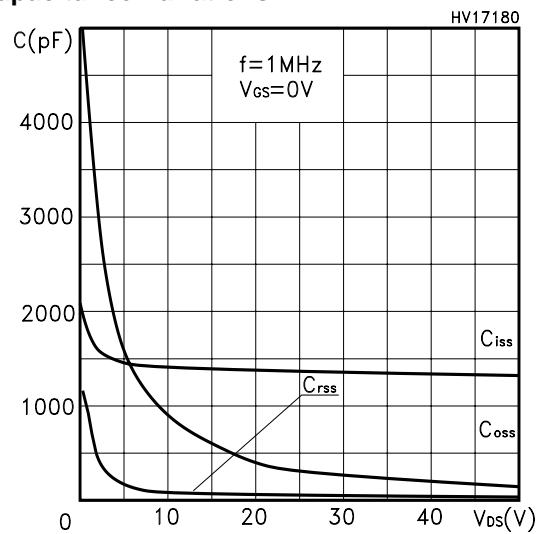
**Static Drain-source On Resistance**



**Gate Charge vs Gate-source Voltage**

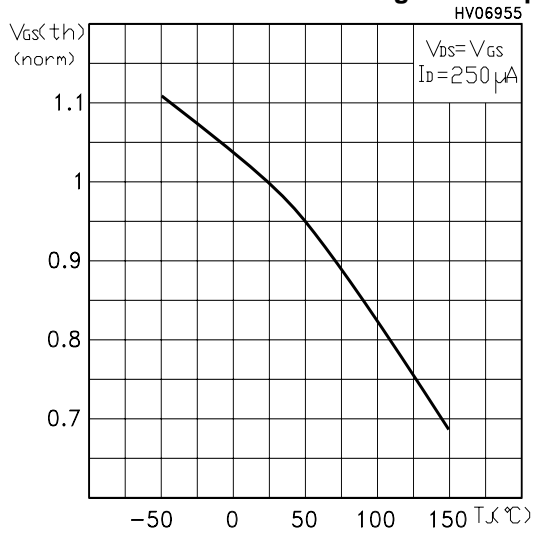


**Capacitance Variations**

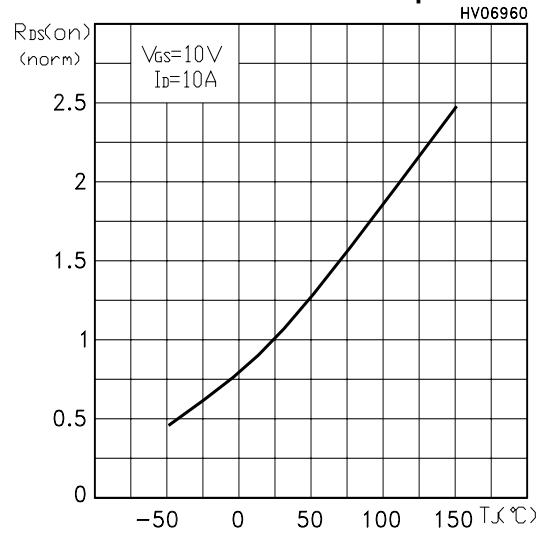


**STP20NM60FD - STF20NM60D - STW20NM60FD**

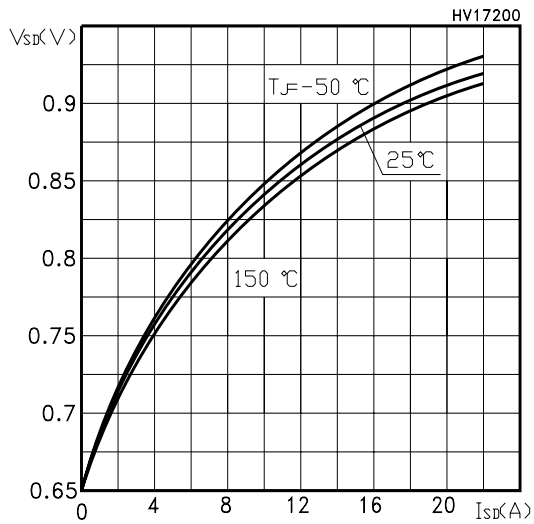
**Normalized Gate Threshold Voltage vs Temp.**



**Normalized On Resistance vs Temperature**



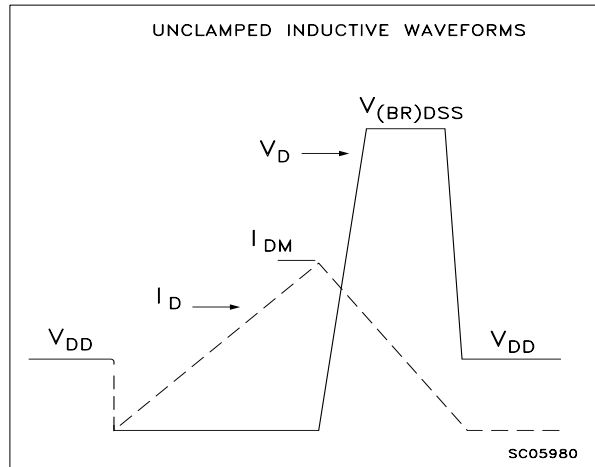
**Source-drain Diode Forward Characteristics**



**Fig. 1: Unclamped Inductive Load Test Circuit**



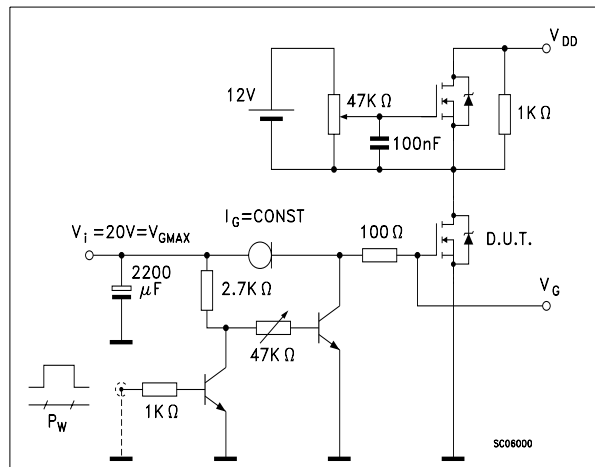
**Fig. 2: Unclamped Inductive Waveform**



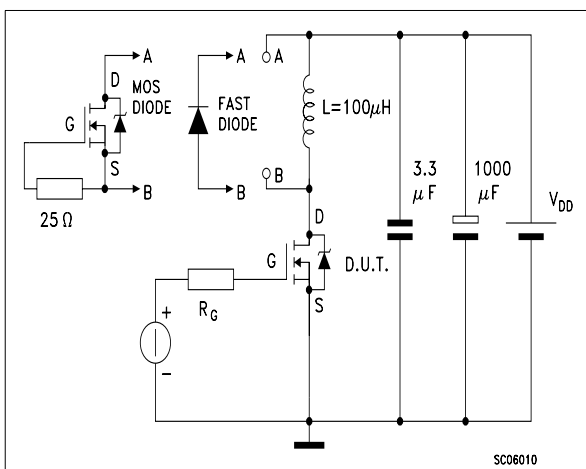
**Fig. 3: Switching Times Test Circuit For Resistive Load**



**Fig. 4: Gate Charge test Circuit**

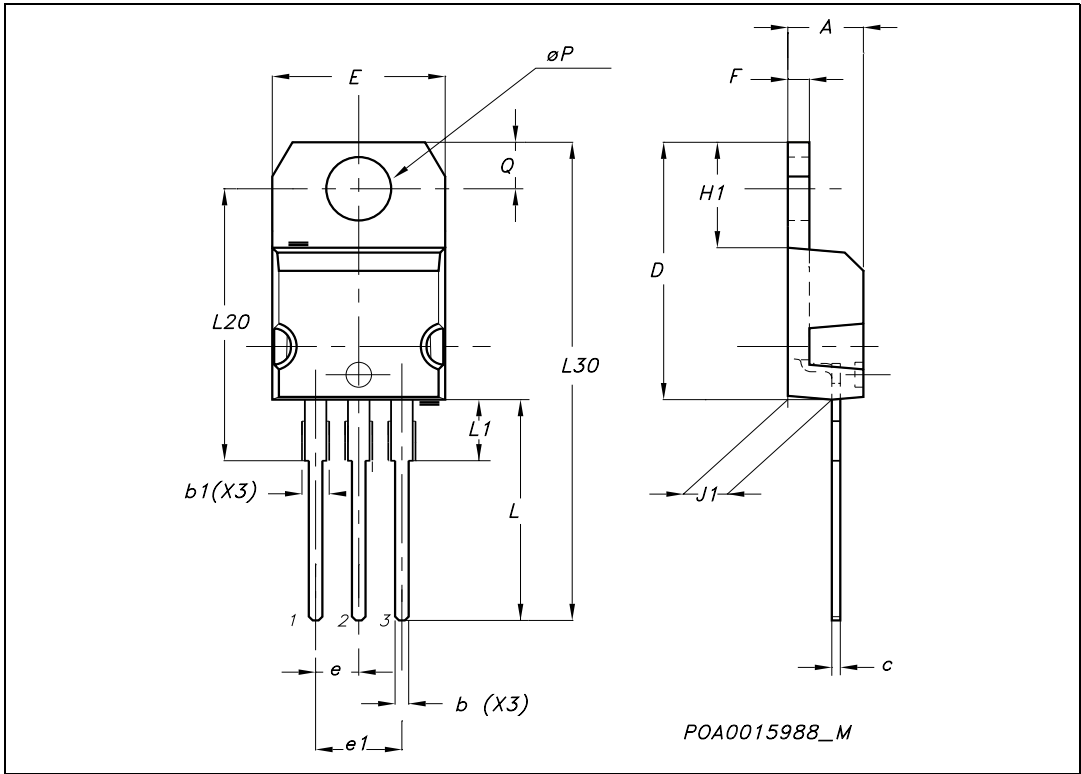


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



**TO-220 MECHANICAL DATA**

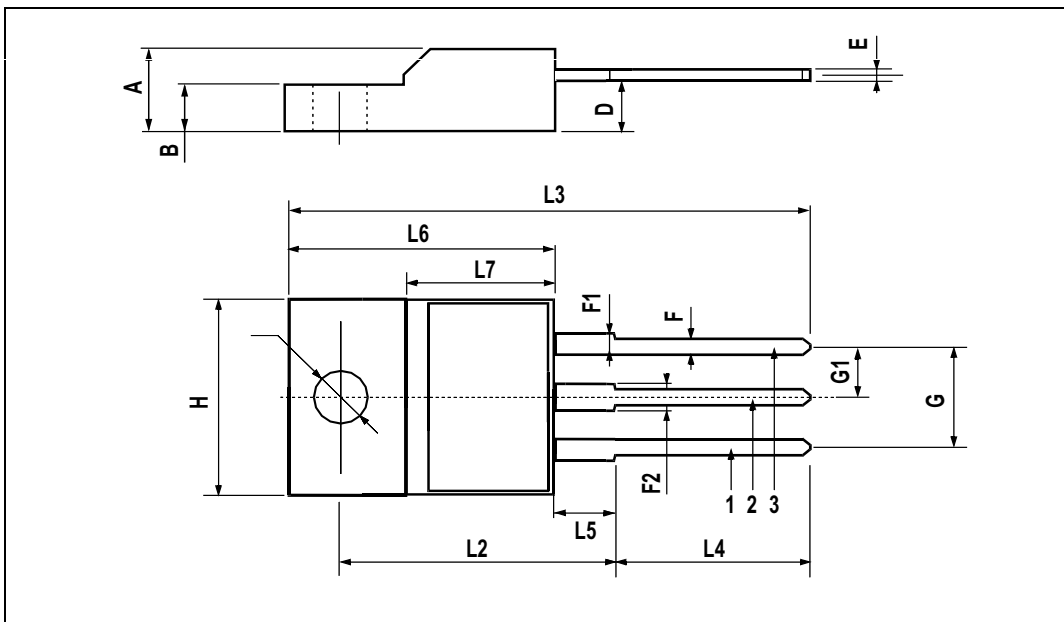
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.052
H1	6.20		6.60	0.244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





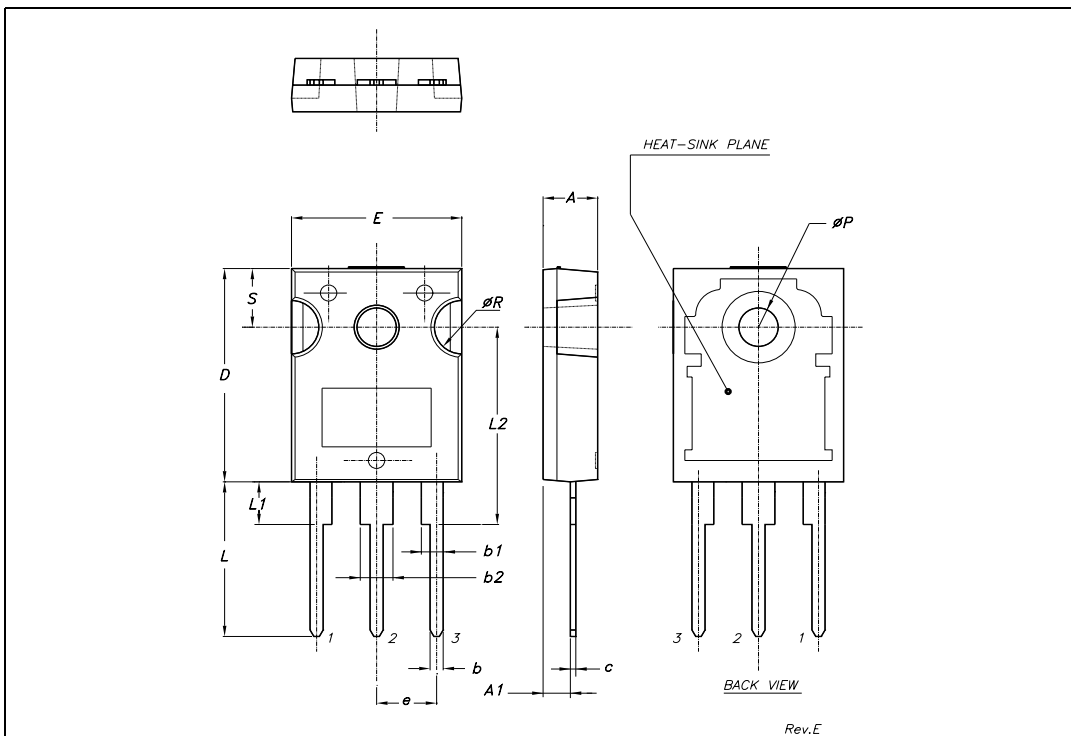
**TO-220FP MECHANICAL DATA**

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
∅	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	



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