



# STGF3NC120HD

N-CHANNEL 3A - 1200V TO-220FP

FAST PowerMESH™ IGBT with Integral Damper Diode

Table 1: General Features

TYPE	V <sub>CES</sub>	V <sub>CE(sat)</sub> (Max) @25°C	I <sub>C</sub> @100°C
STGF3NC120HD	1200 V	< 2.8 V	3 A

- LOW ON-VOLTAGE DROP (V<sub>cesat</sub>)
- HIGH CURRENT CAPABILITY
- OFF LOSSES INCLUDE TAIL CURRENT
- HIGH SPEED

## DESCRIPTION

This PowerMESH™ IGBT is designed using the latest high voltage technology based on a patented strip layout. A new lifetime control allows good switching performance and low voltage drop. This IGBT featuring a co-packaged diode is optimized for horizontal deflection applications in small and medium sets.

## APPLICATIONS

- HORIZONTAL DEFLECTION
- HOME APPLIANCE
- LIGHTING

Table 2: Order Code

PART NUMBER	MARKING	PACKAGE	PACKAGING
STGF3NC120HD	GF3NC120HD	TO-220FP	TUBE

Figure 1: Package

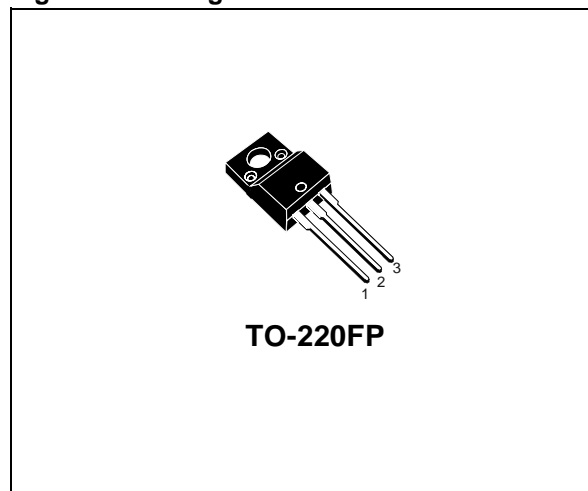
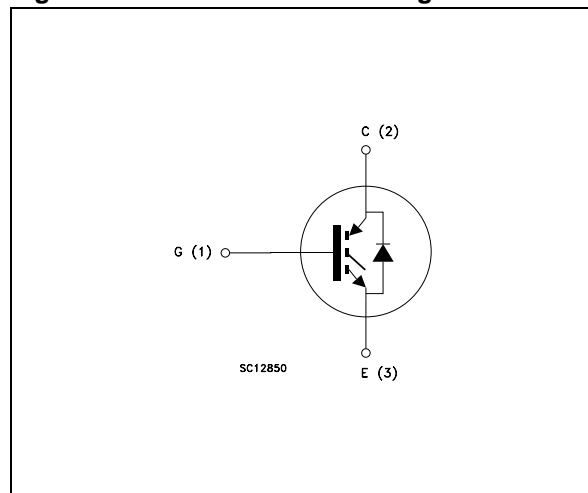


Figure 2: Internal Schematic Diagram



**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-Emitter Voltage ( $V_{GS} = 0$ )	1200	V
$V_{ECR}$	Emitter-Collector Voltage	20	V
$V_{GE}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current (continuous) at $T_C = 25^\circ\text{C}$	6	A
$I_C$	Collector Current (continuous) at $T_C = 100^\circ\text{C}$	3	A
$I_{CM}$ (■)	Collector Current (pulsed)	10	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	25	W
	Derating Factor	0.20	W/°C
$V_{ISO}$	Insulation withstand voltage AC ( $t=1\text{sec}$ , $T_c=25^\circ\text{C}$ )	2500	V
$T_{stg}$	Storage Temperature	-55 to 150	°C
$T_j$	Operating Junction Temperature range		

(■) Pulse width limited by safe operating area

**Table 4: Thermal Data**

		Min.	Typ.	Max.	
$R_{thj-case}$	Thermal Resistance Junction-case			5.0	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient			62.5	°C/W
$T_L$	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)		300		°C

**ELECTRICAL CHARACTERISTICS ( $T_{CASE} = 25^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)**
**Table 5: On/Off**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-Emitter Breakdown Voltage	$I_C = 1\text{ mA}$ , $V_{GE} = 0$	1200			V
$I_{CES}$	Collector cut-off Current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max Rating}$ , $T_C = 25^\circ\text{C}$ $V_{CE} = \text{Max Rating}$ , $T_C = 125^\circ\text{C}$			50 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-Emitter Leakage Current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{V}$ , $V_{CE} = 0$			$\pm 100$	nA
$V_{GE(th)}$	Gate Threshold Voltage	$V_{CE} = V_{GE}$ , $I_C = 250\ \mu\text{A}$	2		5	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE} = 15\text{V}$ , $I_C = 3\text{ A}$ $V_{GE} = 15\text{V}$ , $I_C = 3\text{ A}$ , $T_c = 125^\circ\text{C}$		2.3 2.2	2.8	V V

## ELECTRICAL CHARACTERISTICS (CONTINUED)

Table 6: Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}$ (1)	Forward Transconductance	$V_{CE} = 25 \text{ V}$ , $I_C = 3 \text{ A}$		4		S
$C_{ies}$	Input Capacitance	$V_{CE} = 25 \text{ V}$ , $f = 1 \text{ MHz}$ , $V_{GE} = 0$		470		pF
$C_{oes}$	Output Capacitance			45		pF
$C_{res}$	Reverse Transfer Capacitance			6		pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total Gate Charge Gate-Emitter Charge Gate-Collector Charge	$V_{CC} = 960 \text{ V}$ , $I_C = 3 \text{ A}$ , $V_{GE} = 15 \text{ V}$ (see Figure 22)		24 3 10	32	nC nC nC
$I_{CL}$	Turn-off SOA minimum current	$V_{clamp} = 960 \text{ V}$ , $T_j = 150^\circ\text{C}$ $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$	10			A

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

Table 7: Switching On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 800 \text{ V}$ , $I_C = 3 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 25^\circ\text{C}$ (see Figure 20)		15 3.5 880		ns ns A/ $\mu\text{s}$
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 480 \text{ V}$ , $I_C = 3 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ (see Figure 20)		14.5 4 770		ns ns A/ $\mu\text{s}$

Table 8: Switching Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time	$V_{CC} = 800 \text{ V}$ , $I_C = 3 \text{ A}$ , $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ $T_j = 25^\circ\text{C}$ (see Figure 20)		72 118 250		ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time	$V_{CC} = 800 \text{ V}$ , $I_C = 3 \text{ A}$ , $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ $T_j = 125^\circ\text{C}$ (see Figure 20)		132 210 470		ns ns ns

Table 9: Switching Energy

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$E_{on}$ (2) $E_{off}$ (3) $E_{ts}$	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 800 \text{ V}$ , $I_C = 3 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 25^\circ\text{C}$ (see Figure 21)		236 290 526		$\mu\text{J}$ $\mu\text{J}$ $\mu\text{J}$
$E_{on}$ (2) $E_{off}$ (3) $E_{ts}$	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 800 \text{ V}$ , $I_C = 3 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ (see Figure 21)		360 620 980		$\mu\text{J}$ $\mu\text{J}$ $\mu\text{J}$

(2)  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 2. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs & DIODE are at the same temperature ( $25^\circ\text{C}$  and  $125^\circ\text{C}$ )

(3) Turn-off losses include also the tail of the collector current.

Table 10: Collector-Emitter Diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit
$I_f$ $I_{fm}$	Forward Current Forward Current pulsed				3 12	A A
$V_f$	Forward On-Voltage	$I_f = 1.5\text{ A}$ $I_f = 1.5\text{ A}, T_j = 125^\circ\text{C}$		1.6 1.3	2.0	V V
$t_{rr}$ $Q_{rr}$ $I_{rm}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_f = 3\text{ A}, V_R = 40\text{ V}$ $T_j = 25^\circ\text{C}, di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 23)		51 85 3.3		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rm}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_f = 3\text{ A}, V_R = 40\text{ V}$ $T_j = 125^\circ\text{C}, di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 23)		64 133 4.2		ns nC A

Figure 3: Output Characteristics

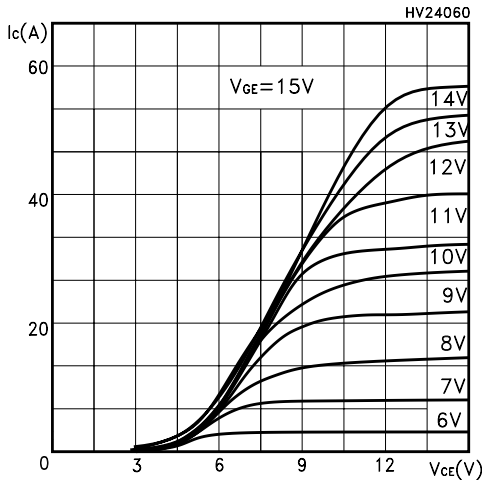


Figure 4: Transconductance

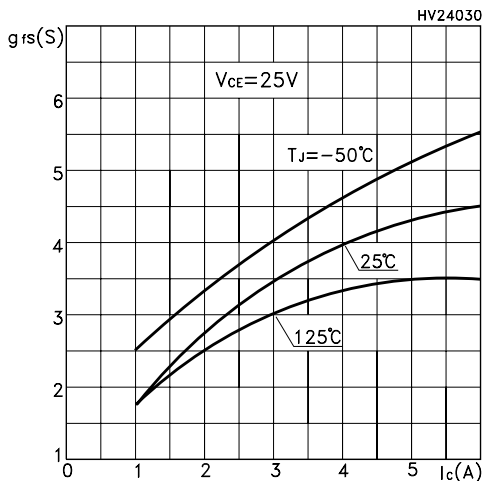


Figure 5: Collector-Emitter On Voltage vs Collector Current

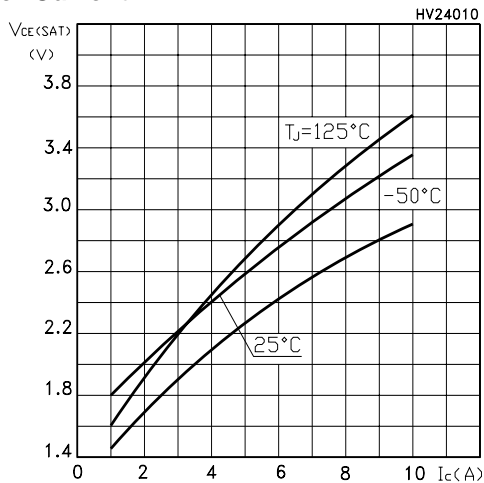


Figure 6: Transfer Characteristics

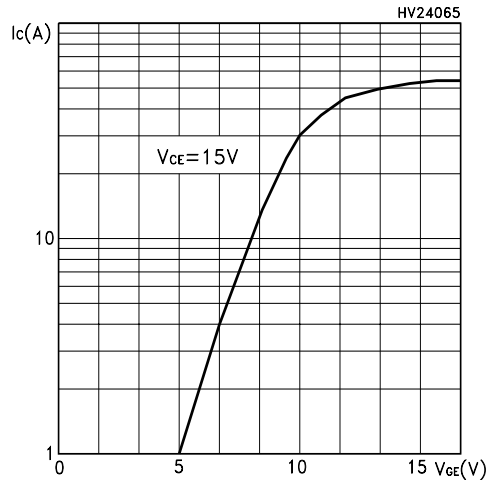


Figure 7: Collector-Emitter On Voltage vs Temperature

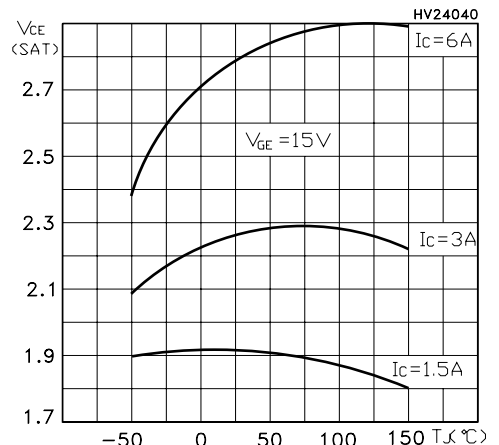


Figure 8: Normalized Gate Threshold vs Temperature

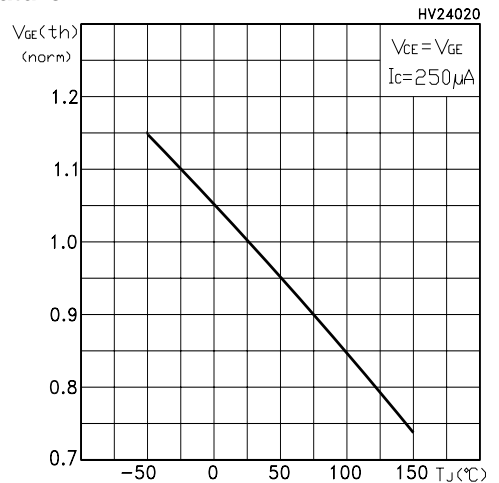


Figure 9: Normalized Breakdown Voltage vs Temperature

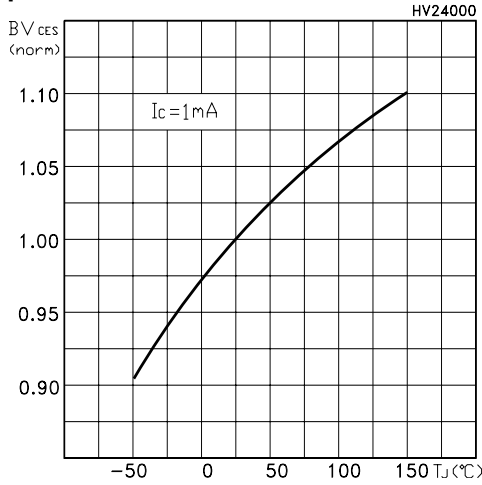


Figure 10: Capacitance Variations

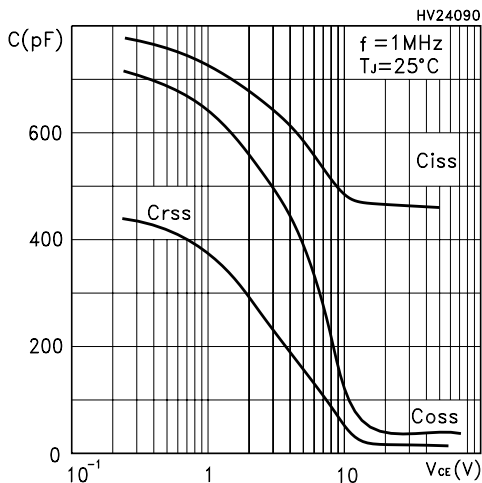


Figure 11: Switching Losses vs Gate Resistance

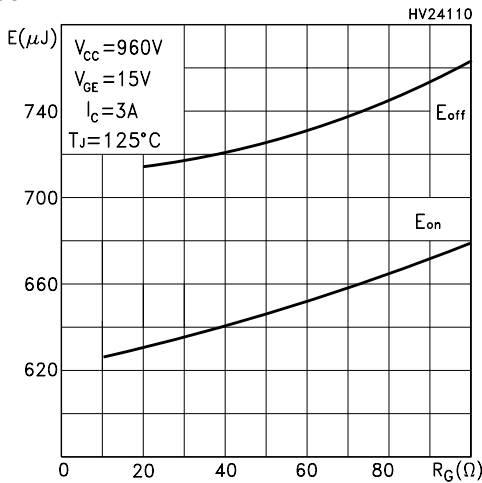


Figure 12: Gate Charge vs Gate-Emitter Voltage

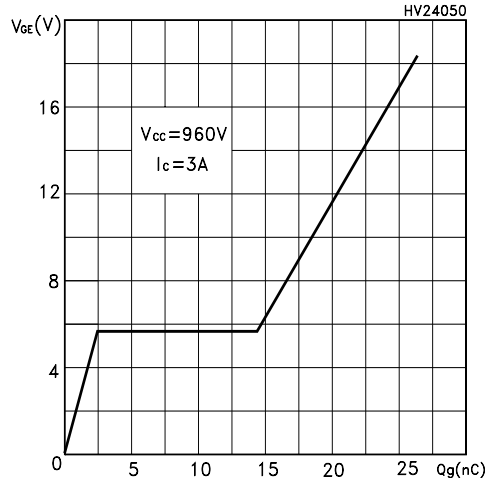


Figure 13: Switching Losses vs Temperature

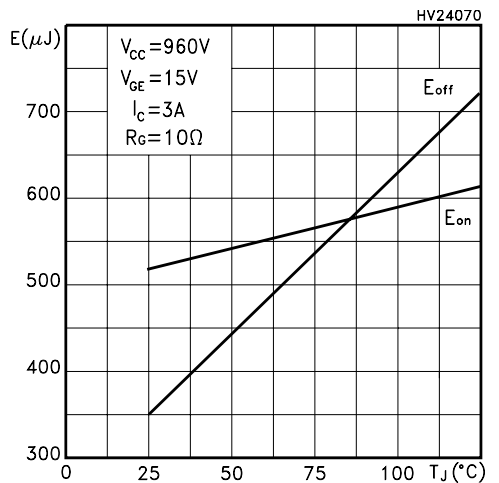


Figure 14: Switching Losses vs Collector Current

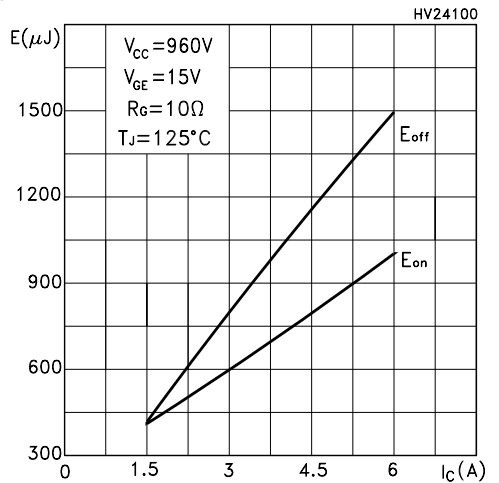


Figure 15: Thermal Impedance

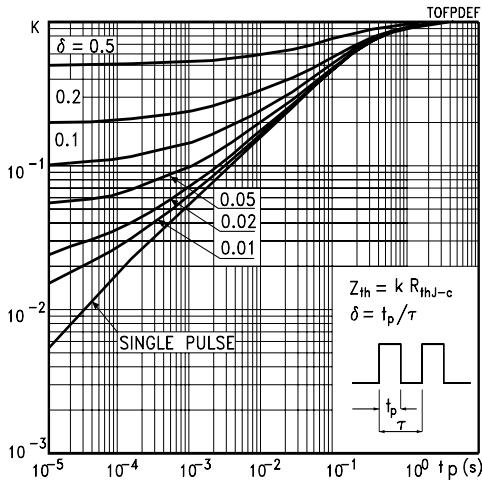


Figure 16: Collector-Emitter Diode Characteristics

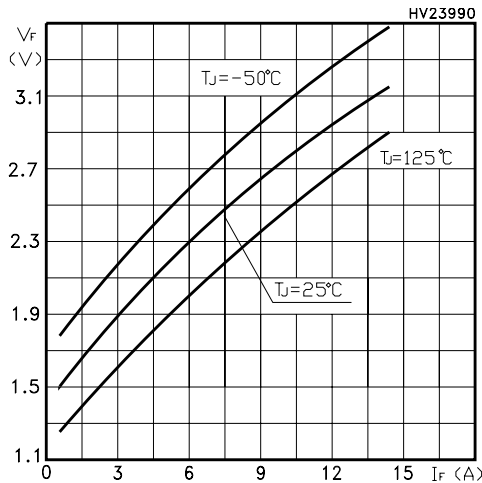


Figure 17: Turn-Off SOA

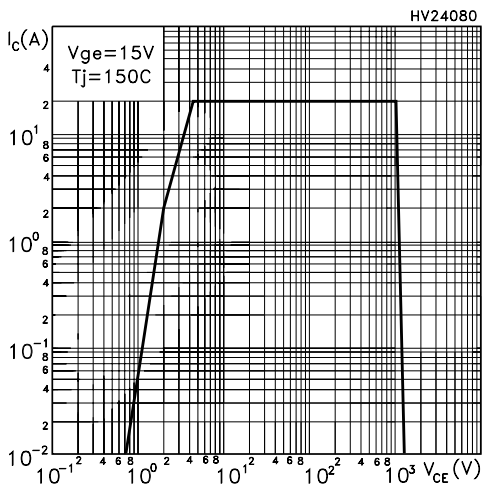


Figure 18: Power Losses

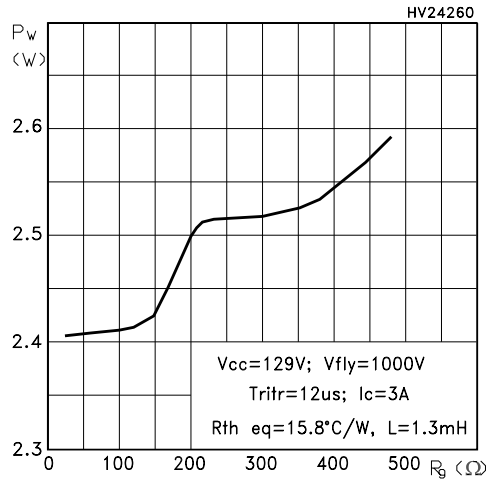


Figure 19: Power Losses

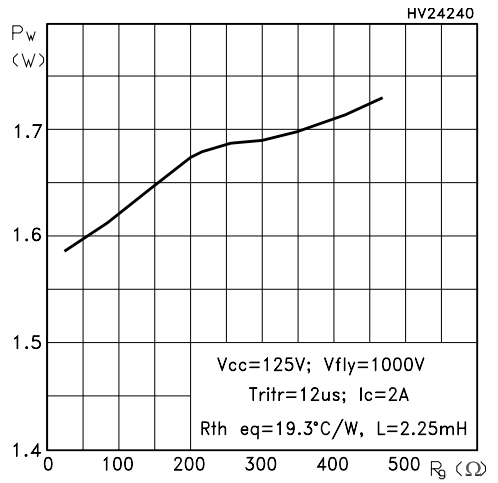


Figure 20: Test Circuit for Inductive Load Switching

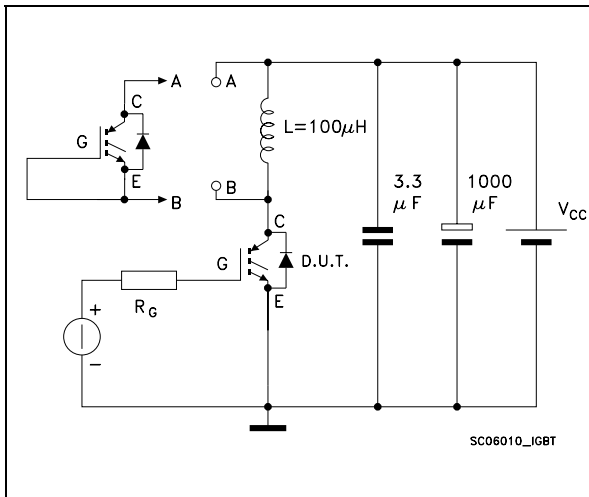


Figure 21: Switching Waveforms

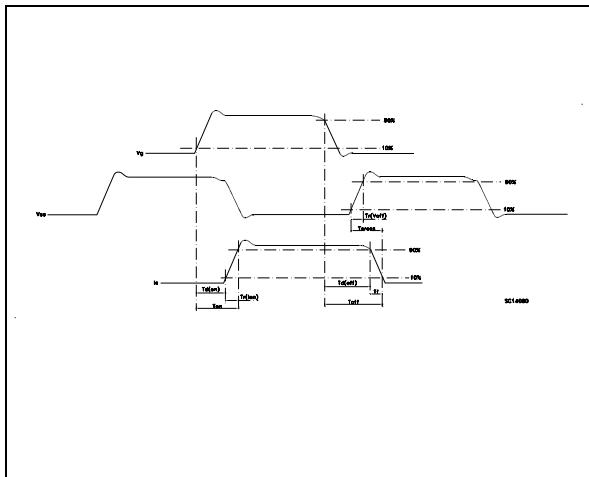


Figure 22: Gate Charge Test Circuit

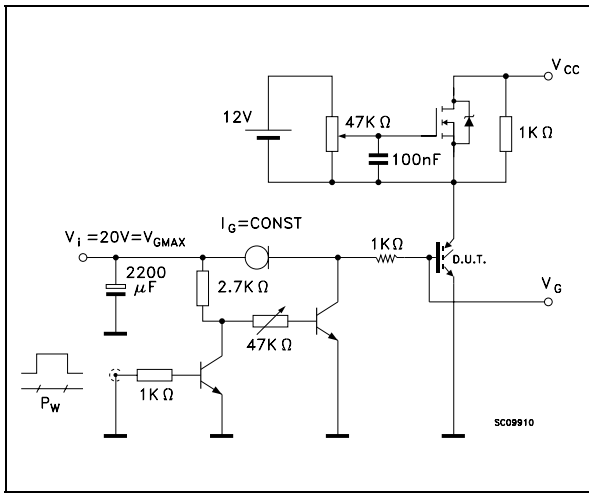
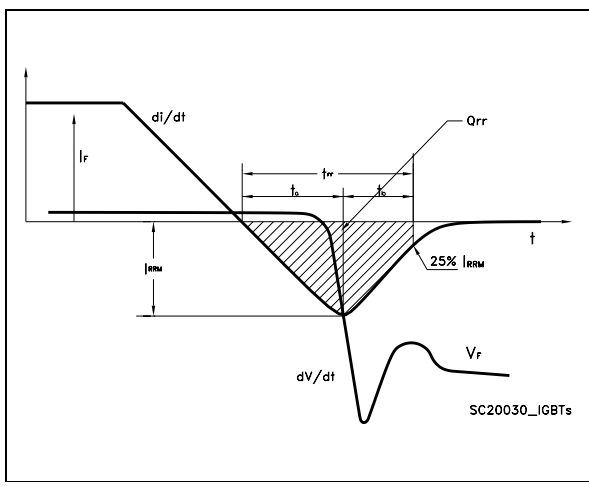


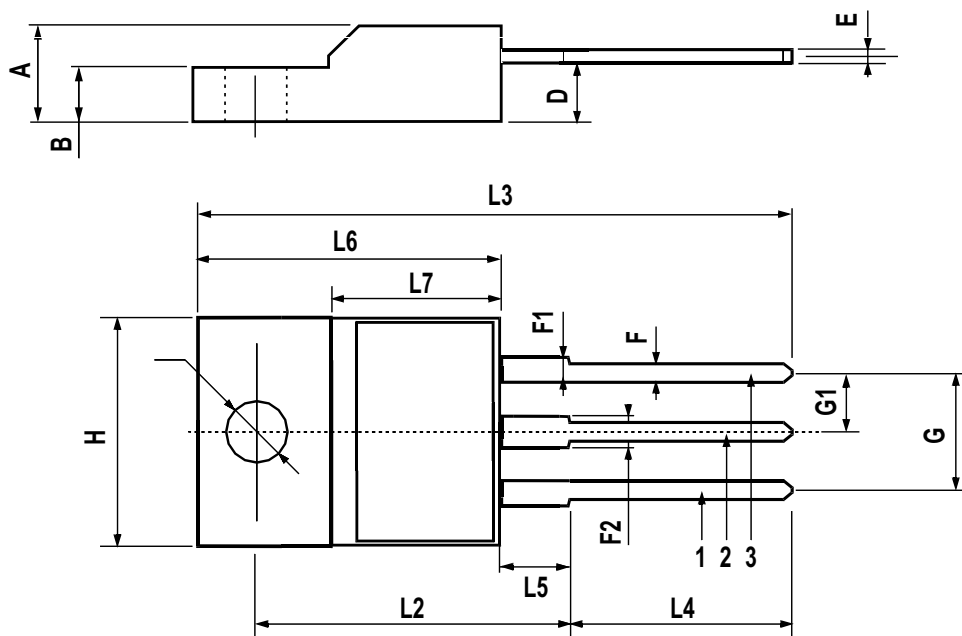
Figure 23: Diode Recovery Time Waveforms





## 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 11: Revision History**

<b>Date</b>	<b>Revision</b>	<b>Description of Changes</b>
13-Dec-2004	1	First release
21-Jan-2005	2	Modified Curve 17

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