



# STGF19NC60HD

N-channel 600V - 9A - TO-220FP  
Very fast PowerMESH™ IGBT

## General features

Type	V <sub>CES</sub>	V <sub>CE(sat)</sub> (max)@25°C	I <sub>C</sub> @100°C
STGF19NC60HD	600V	< 2.5V	9A

- Low on-voltage drop (V<sub>cesat</sub>)
- Low C<sub>RES</sub> / C<sub>IES</sub> ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode

## Description

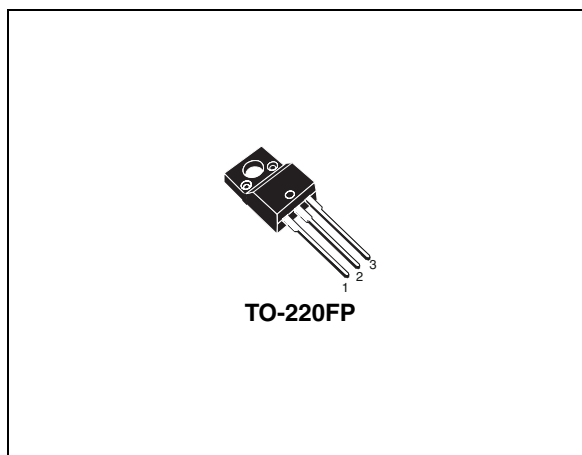
Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix "H" identifies a family optimized for high frequency applications in order to achieve very high switching performances (reduced t<sub>fall</sub>) maintaining a low voltage drop.

## Applications

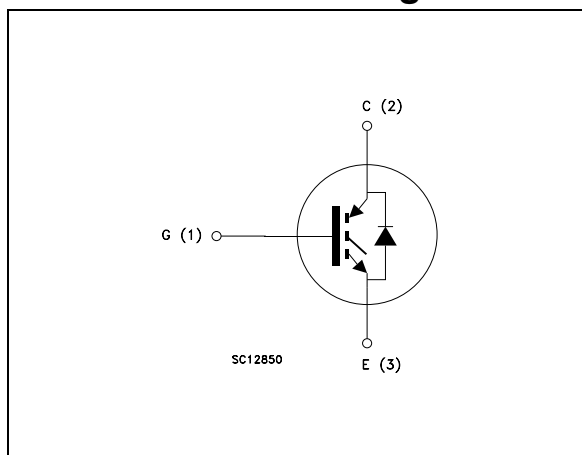
- High frequency motor controls
- SMPS and PFC in both hard switch and resonant topologies
- Motor drivers

## Order codes

Part number	Marking	Package	Packaging
STGF19NC60HD	GF19NC60HD	TO-220FP	Tube



## Internal schematic diagram



## Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GS} = 0$ )	600	V
$I_C^{(1)}$	Collector current (continuous) at $T_C = 25^\circ\text{C}$	16	A
$I_C^{(1)}$	Collector current (continuous) at $T_C = 100^\circ\text{C}$	9	A
$I_{CL}^{(2)}$	Turn-off minimum current	40	A
$I_F$	Diode RMS forward current at $T_C = 25^\circ\text{C}$	20	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	35	W
$T_j$	Operating junction temperature	- 55 to 150	$^\circ\text{C}$

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

2.  $V_{clamp}=480\text{V}$ ,  $T_j=150^\circ\text{C}$ ,  $R_G=10\Omega$ ,  $V_{GE}=15\text{V}$

**Table 2. Thermal resistance**

Symbol	Parameter	Value	Unit
Rthj-case	Thermal resistance junction-case max IGBT	3.9	$^\circ\text{C/W}$
	Thermal resistance junction-case max DIODE	5.5	$^\circ\text{C/W}$
Rthj-amb	Thermal resistance junction-ambient max	62.5	$^\circ\text{C/W}$

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  unless otherwise specified)

**Table 3. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-emitter breakdown voltage	$I_C = 1\text{mA}$ , $V_{GE} = 0$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{V}$ , $I_C = 12\text{A}$		1.8	2.5	V
		$V_{GE} = 15\text{V}$ , $I_C = 12\text{A}$ , $T_C = 125^{\circ}\text{C}$		1.6		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 250\ \mu\text{A}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max rating}$ , $T_C = 25^{\circ}\text{C}$			150	$\mu\text{A}$
		$V_{CE} = \text{Max rating}$ , $T_C = 125^{\circ}\text{C}$			1	mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{V}$ , $V_{CE} = 0$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{V}$ , $I_C = 12\text{A}$		5		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$ $C_{oes}$ $C_{res}$	Input capacitance	$V_{CE} = 25\text{V}$ , $f = 1\text{MHz}$ , $V_{GE} = 0$		1180		pF
	Output capacitance			130		pF
	Reverse transfer capacitance			36		pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total gate charge	$V_{CE} = 390\text{V}$ , $I_C = 5\text{A}$ ,		53		nC
	Gate-emitter charge	$V_{GE} = 15\text{V}$ ,		10		nC
	Gate-collector charge	<a href="#">Figure 17</a>		23		nC

**Table 5. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390V, I_C = 12A$		25		ns
$t_r$	Current rise time	$R_G = 10\Omega, V_{GE} = 15V,$		7		ns
$(di/dt)_{on}$	Turn-on current slope	<i>Figure 18</i>		1600		A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390V, I_C = 12A$		24		ns
$t_r$	Current rise time	$R_G = 10\Omega, V_{GE} = 15V,$		8		ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 125^\circ C$ <i>Figure 18</i>		1400		A/ $\mu$ s
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 390V, I_C = 12A$		27		ns
$t_{d(Voff)}$	Turn-off delay time	$R_G = 10\Omega, V_{GE} = 15V,$		97		ns
$t_f$	Current fall time	<i>Figure 18</i>		73		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 390V, I_C = 12A$		58		ns
$t_{d(Voff)}$	Turn-off delay time	$R_G = 10\Omega, V_{GE} = 15V,$		144		ns
$t_f$	Current fall time	$T_j = 125^\circ C$ <i>Figure 18</i>		128		ns

**Table 6. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 12A$		85		$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$		189		$\mu$ J
$E_{ts}$	Total switching losses	<i>Figure 16</i>		274		$\mu$ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 12A$		187		$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$		407		$\mu$ J
$E_{ts}$	Total switching losses	$T_j = 125^\circ C$ <i>Figure 16</i>		594		$\mu$ J

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in *Figure 19* If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs & Diode are at the same temperature (25°C and 125°C)
2. Turn-off losses include also the tail of the collector current

Table 7. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_f$	Forward on-voltage	$I_f = 12A$		1.9	2.5	V
		$I_f = 12A, T_j = 125^\circ C$		1.5		V
$t_{rr}$	Reverse recovery time	$I_f = 12A, V_R = 40V,$		31		ns
$Q_{rr}$	Reverse recovery charge	$T_j = 25^\circ C, di/dt = 100 A/\mu s$		30		nC
$I_{rrm}$	Reverse recovery current	<a href="#">Figure 19</a>		2		A
$t_{rr}$	Reverse recovery time	$I_f = 12A, V_R = 40V,$		59		ns
$Q_{rr}$	Reverse recovery charge	$T_j = 125^\circ C, di/dt = 100A/\mu s$		102		nC
$I_{rrm}$	Reverse recovery current	<a href="#">Figure 19</a>		4		A

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

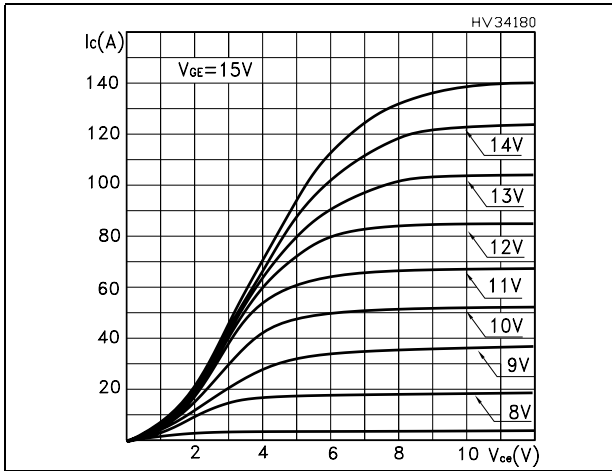


Figure 2. Transfer characteristics

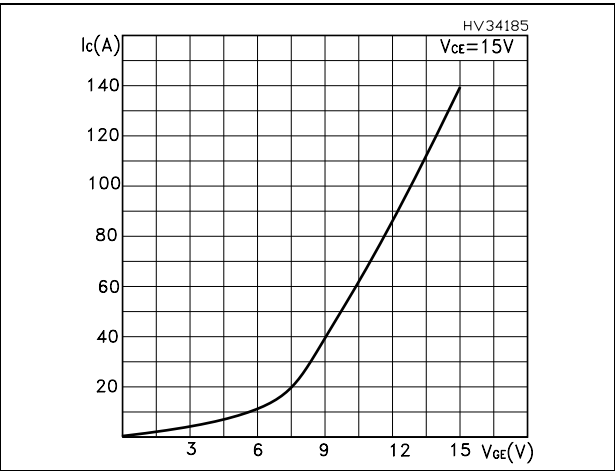


Figure 3. Transconductance

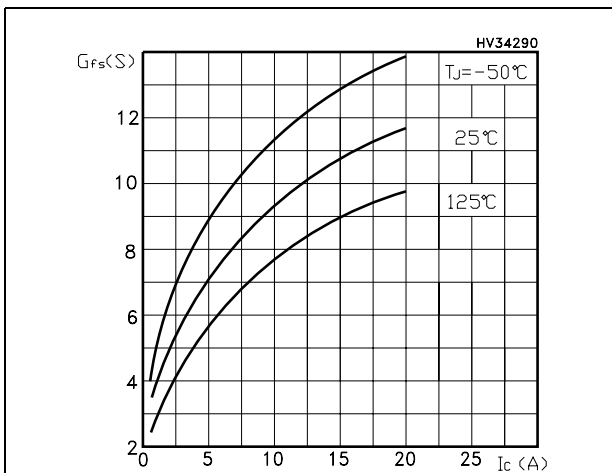


Figure 4. Collector-emitter on voltage vs temperature

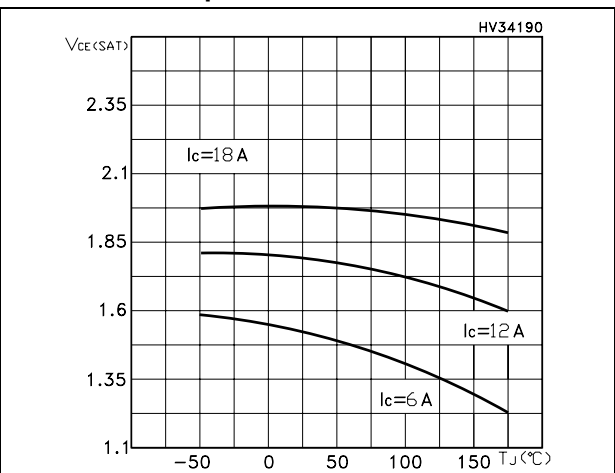


Figure 5. Gate charge vs gate-source voltage

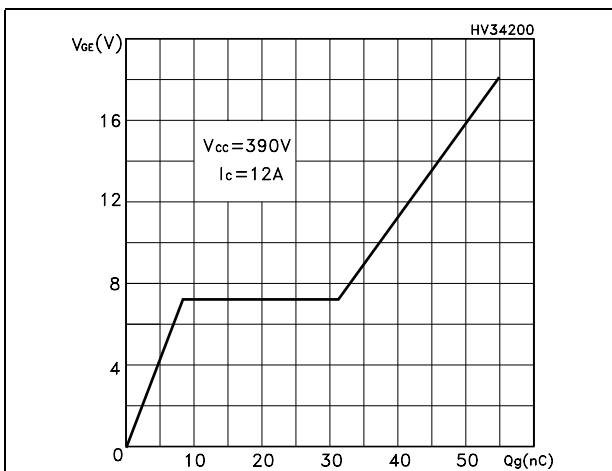


Figure 6. Capacitance variations

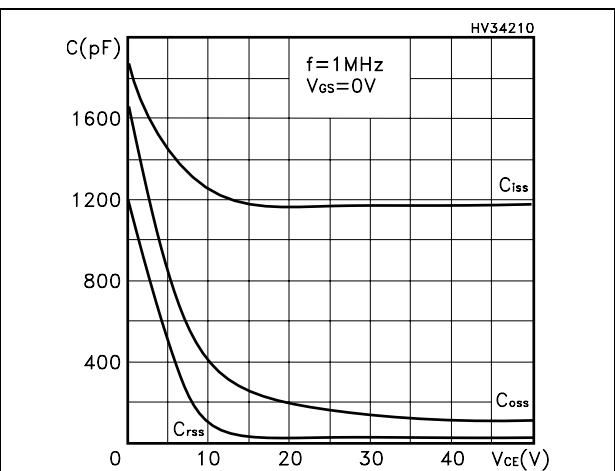


Figure 7. Normalized gate threshold voltage vs temperature

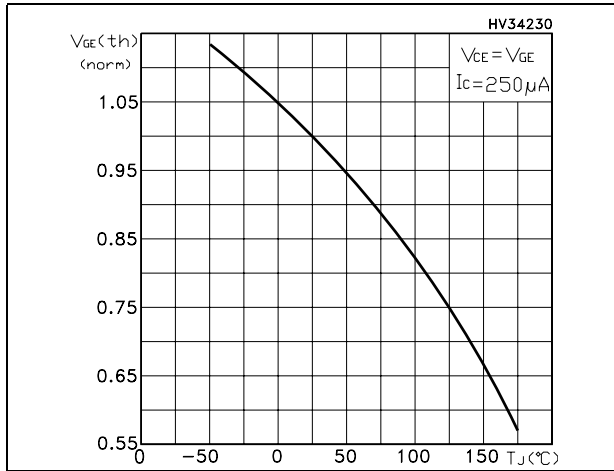


Figure 8. Collector-emitter on voltage vs collector current

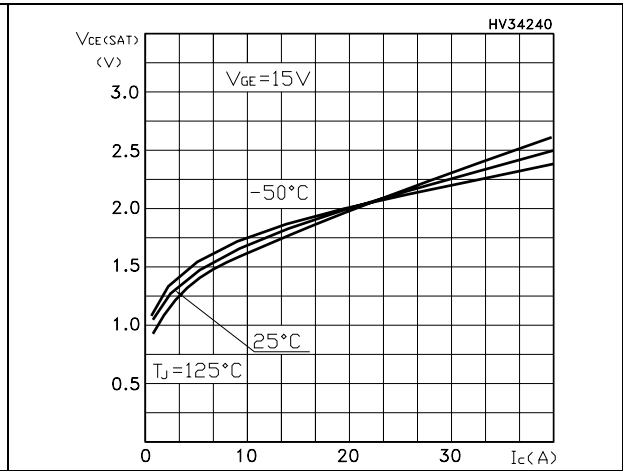


Figure 9. Normalized breakdown voltage vs temperature

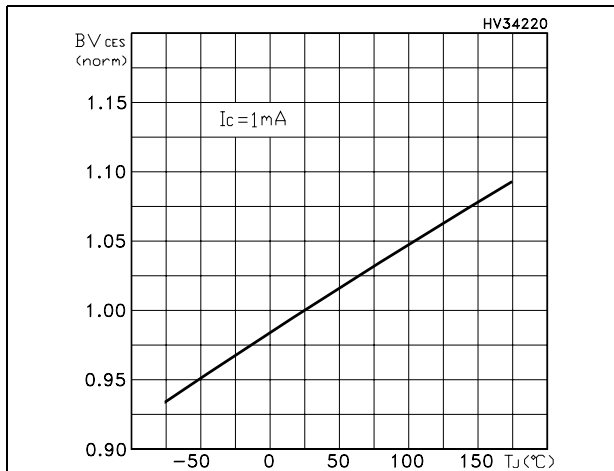


Figure 10. Switching losses vs temperature

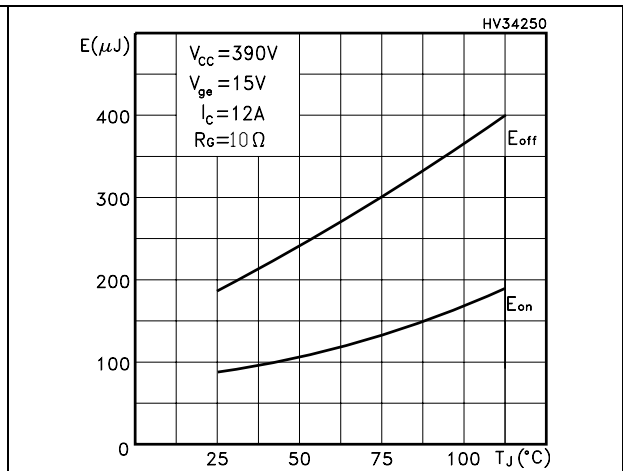


Figure 11. Switching losses vs gate resistance

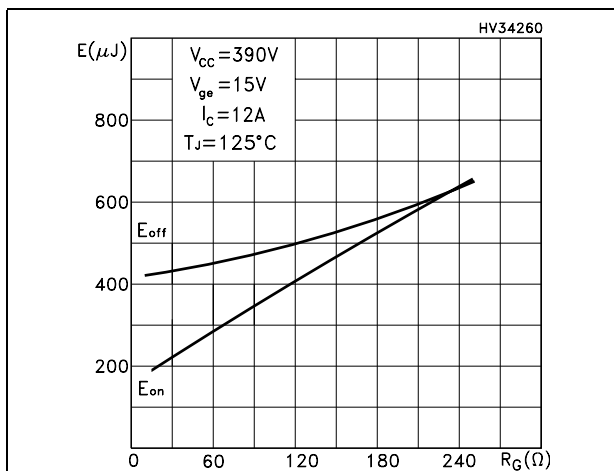


Figure 12. Switching losses vs collector current

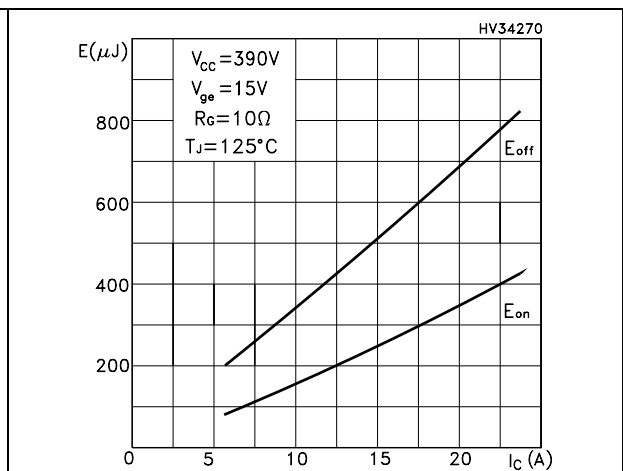




Figure 13. Turn-off SOA

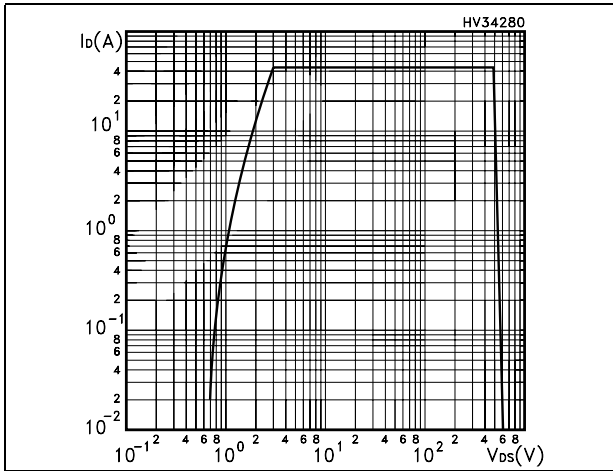


Figure 14. Emitter-collector diode characteristics

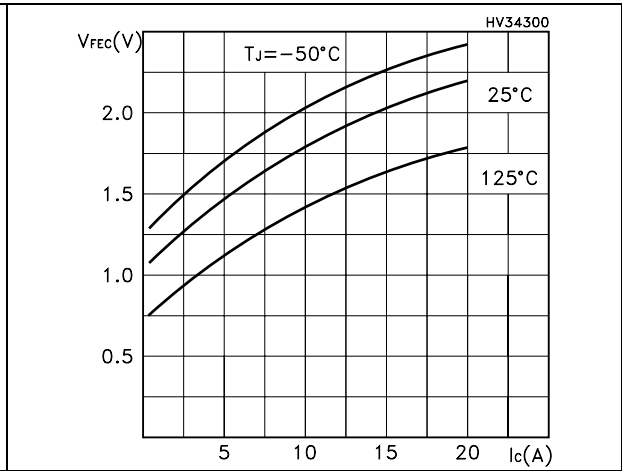
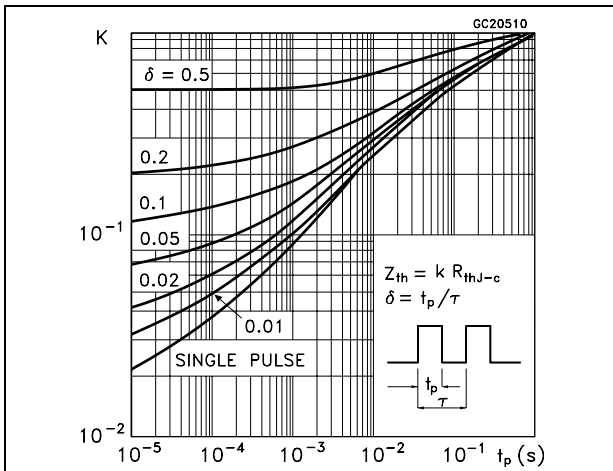


Figure 15. Thermal impedance



### 3 Test circuit

Figure 16. Test circuit for inductive load switching

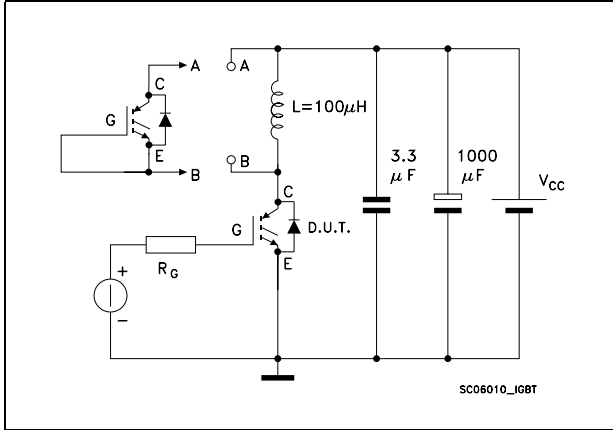


Figure 17. Gate charge test circuit

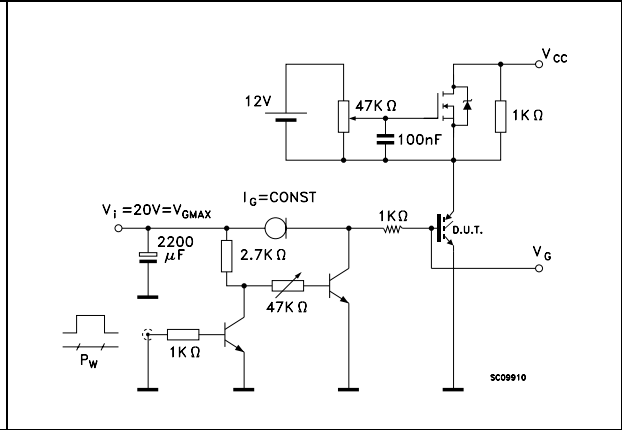


Figure 18. Switching waveform

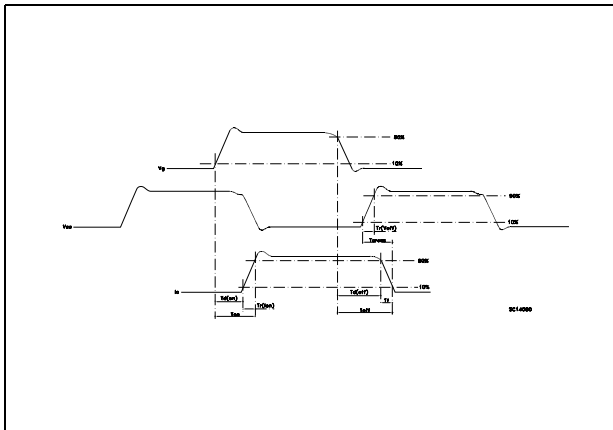
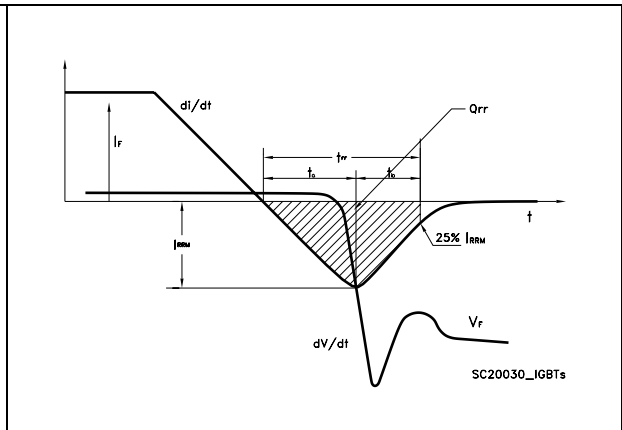


Figure 19. Diode recovery time waveform

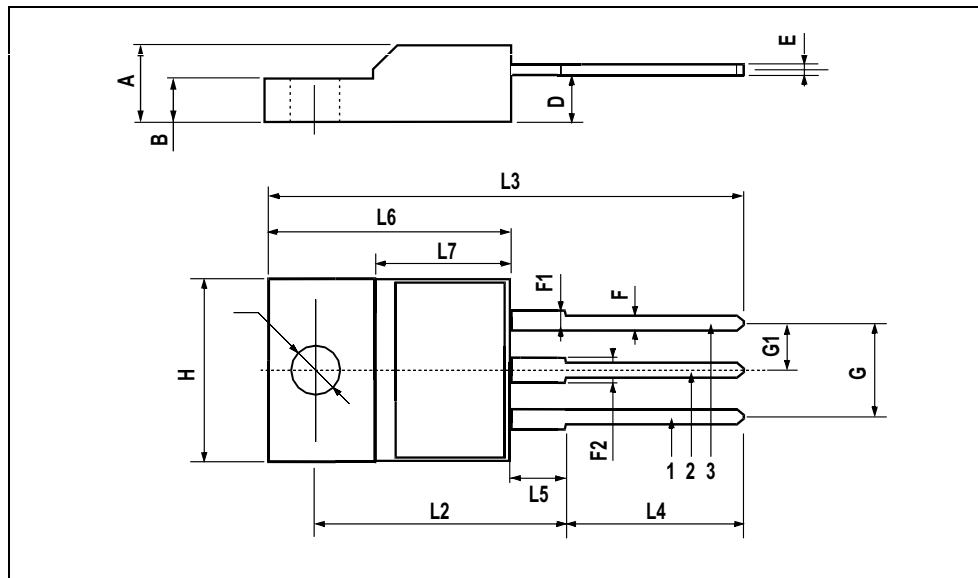


## 4 Package mechanical data

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](http://www.st.com)

**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



## 5 Revision history

**Table 8. Revision history**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
05-Aug-2006	1	Initial release.
27-Sep-2006	2	New value on <i>Absolute maximum ratings</i>
05-Jan-2007	3	Complete version

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