



## STGF20NB60S

N-CHANNEL 13A - 600V TO-220FP  
PowerMESH™ IGBT

**Table 1: General Features**

TYPE	V <sub>CES</sub>	V <sub>CES(sat)</sub> (Max) @25°C	I <sub>C</sub> @100°C
STGF20NB60S	600 V	< 1.7 V	13 A

- LOW ON-VOLTAGE DROP (V<sub>CESsat</sub>)
- HIGH CURRENT CAPABILITY
- OFF LOSSES INCLUDE TAIL CURRENT
- HIGH INPUT IMPEDANCE (VOLTAGE DRIVEN)

### 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 "S" identifies a family optimized to achieve minimum on-voltage drop for low frequency to applications (<1kHz).

### APPLICATIONS

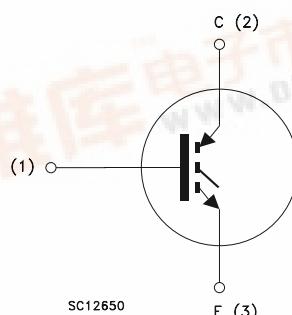
- LIGHT DIMMER
- STATIC RELAYS
- MOTOR CONTROL

**Figure 1: Package**



TO-220FP

**Figure 2: Internal Schematic Diagram**



**Table 2: Order Code**

PART NUMBER	MARKING	PACKAGE	PACKAGING
STGF20NB60S	GF20NB60S	TO-220FP	TUBE

## STGF20NB60S

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**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-Emitter Voltage ( $V_{GS} = 0$ )	600	V
$V_{ECR}$	Emitter-Collector Voltage	20	V
$V_{GE}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current (continuous) at $T_C = 25^\circ\text{C}$ (#)	24	A
$I_C$	Collector Current (continuous) at $T_C = 100^\circ\text{C}$ (#)	13	A
$I_{CM} (\blacksquare)$	Collector Current (pulsed)	70	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	40	W
	Derating Factor	0.32	W/ $^\circ\text{C}$
$V_{ISO}$	Insulation withstand voltage AC ( $t=1\text{sec}$ , $T_c=25^\circ\text{C}$ )	2500	V
$T_{stg}$	Storage Temperature	$-55 \text{ to } 150$	$^\circ\text{C}$
$T_j$	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			3.15	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal Resistance Junction-ambient			62.5	$^\circ\text{C/W}$
$T_L$	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)		300		$^\circ\text{C}$

## 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	$I_C = 250 \mu\text{A}$ , $V_{GE} = 0$	600			V
$V_{BR(ECS)}$	Emitter-Collector Breakdown Voltage	$I_C = 1\text{mA}$ , $V_{GE} = 0$	20			V
$I_{CES}$	Collector cut-off Current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max Rating}$ , $T_C = 25^\circ\text{C}$ $V_{CE} = \text{Max Rating}$ , $T_C = 125^\circ\text{C}$			10 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GES}$	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		5	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE} = 15\text{V}$ , $I_C = 20 \text{ A}$ , $T_j = 25^\circ\text{C}$ $V_{GE} = 15\text{V}$ , $I_C = 20\text{A}$ , $T_j = 150^\circ\text{C}$		1.25 1.2	1.7	V V

(#) Calculated according to the iterative formula:

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

**ELECTRICAL CHARACTERISTICS (CONTINUED)**
**Table 6: Dynamic**

<b>Symbol</b>	<b>Parameter</b>	<b>Test Conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Unit</b>
$g_{fs}$ (1)	Forward Transconductance	$V_{CE} = 10 \text{ V}$ , $I_C = 8 \text{ A}$		20		S
$C_{ies}$	Input Capacitance	$V_{CE} = 25 \text{ V}$ , $f = 1 \text{ MHz}$ , $V_{GE} = 0$		1820		pF
$C_{oes}$	Output Capacitance			167		pF
$C_{res}$	Reverse Transfer Capacitance			27		pF
$Q_g$	Total Gate Charge	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$ ,		83		nC
$Q_{ge}$	Gate-Emitter Charge	$V_{GE} = 15 \text{ V}$		10		nC
$Q_{gc}$	Gate-Collector Charge	(see Figure 19)		27		nC
$I_{CL}$	Turn-off SOA minimum current	$V_{clamp} = 480 \text{ V}$ , $T_j = 125^\circ\text{C}$ $R_G = 100 \Omega$	80			A

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

**Table 7: Switching On**

<b>Symbol</b>	<b>Parameter</b>	<b>Test Conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Unit</b>
$t_{d(on)}$	Turn-on Delay Time	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$		92		ns
$t_r$	Current Rise Time	$R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$		70		ns
$(di/dt)_{on}$	Turn-on Current Slope	(see Figure 17)		340		A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on Delay Time	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$		80		ns
$t_r$	Current Rise Time	$R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$		73		ns
$(di/dt)_{on}$	Turn-on Delay Time	$T_j = 125^\circ\text{C}$ (see Figure 17)		320		A/ $\mu\text{s}$

**Table 8: Switching Off**

<b>Symbol</b>	<b>Parameter</b>	<b>Test Conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Unit</b>
$t_c$	Cross-over Time	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$ ,		1.6		$\mu\text{s}$
$t_r(V_{off})$	Off Voltage Rise Time	$R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$		0.78		$\mu\text{s}$
$t_d(off)$	Turn-off Delay Time	$T_j = 25^\circ\text{C}$		1.1		$\mu\text{s}$
$t_f$	Current Fall Time	(see Figure 17)		0.79		$\mu\text{s}$
$t_c$	Cross-over Time	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$ ,		2.4		$\mu\text{s}$
$t_r(V_{off})$	Off Voltage Rise Time	$R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$		1.1		$\mu\text{s}$
$t_d(off)$	Turn-off Delay Time	$T_j = 125^\circ\text{C}$		2.4		$\mu\text{s}$
$t_f$	Current Fall Time	(see Figure 17)		1.2		$\mu\text{s}$

**Table 9: Switching Energy**

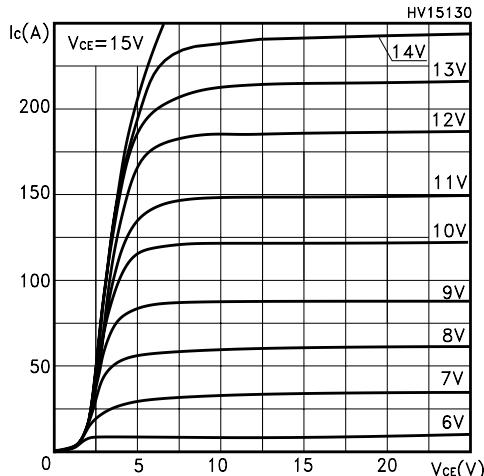
<b>Symbol</b>	<b>Parameter</b>	<b>Test Conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max</b>	<b>Unit</b>
$E_{on}$ (2) $E_{off}$ (3) $E_{ts}$	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$ $R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$ , (see Figure 18)		0.84 7.4 8.24		mJ mJ mJ
$E_{on}$ (2) $E_{off}$ (3) $E_{ts}$	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 480 \text{ V}$ , $I_C = 20 \text{ A}$ $R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ (see Figure 18)		0.86 11.5 12.4		mJ mJ mJ

(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.

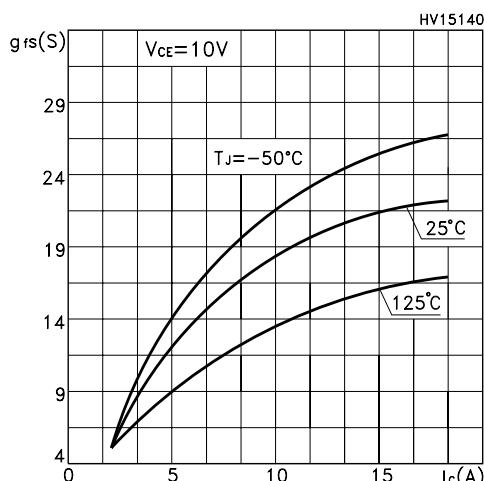
(3) Turn-off losses include also the tail of the collector current.

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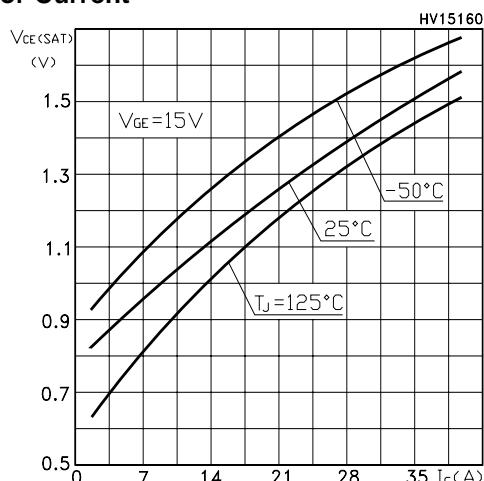
**Figure 3: Output Characteristics**



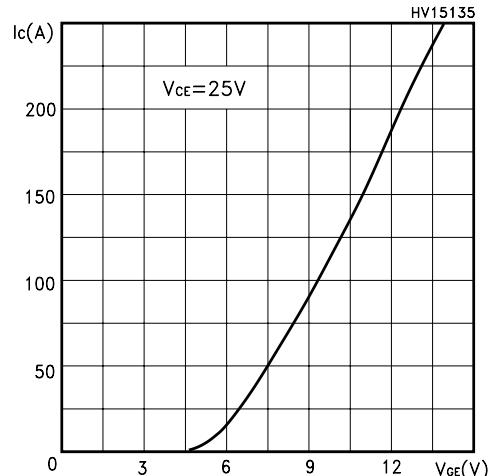
**Figure 4: Transconductance**



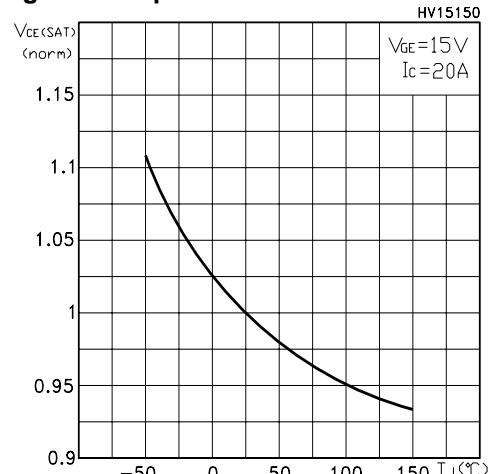
**Figure 5: Collector-Emitter On Voltage vs Collector Current**



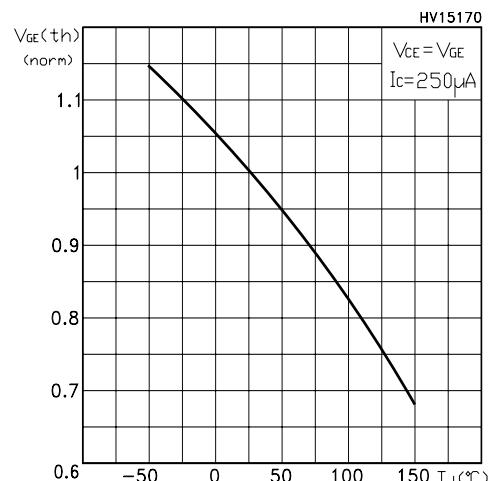
**Figure 6: Transfer Characteristics**



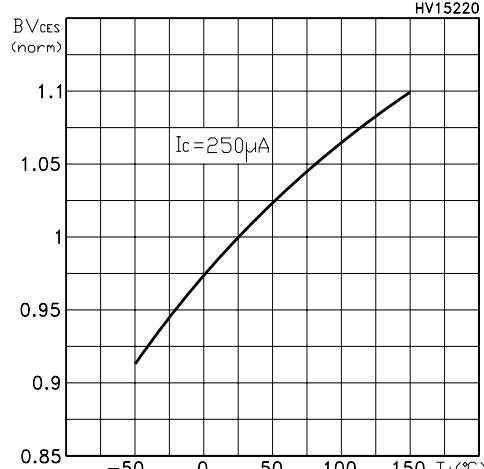
**Figure 7: Normalized Collector-Emitter On Voltage vs Temperature**



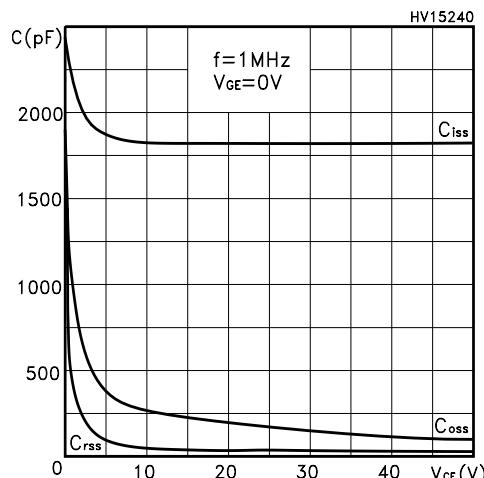
**Figure 8: Gate Threshold vs Temperature**



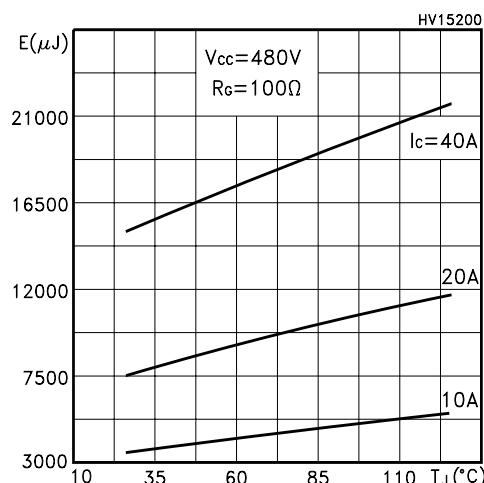
**Figure 9: Normalized Breakdown Voltage vs Temperature**



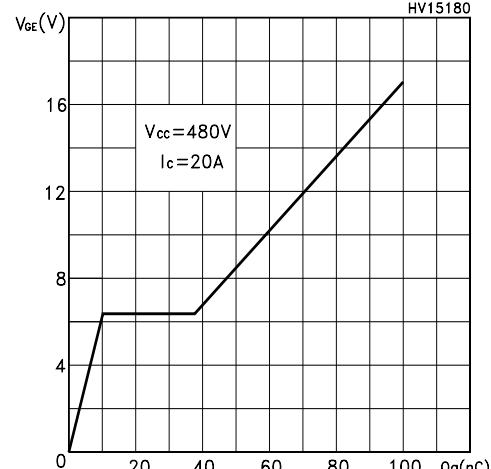
**Figure 10: Capacitance Variations**



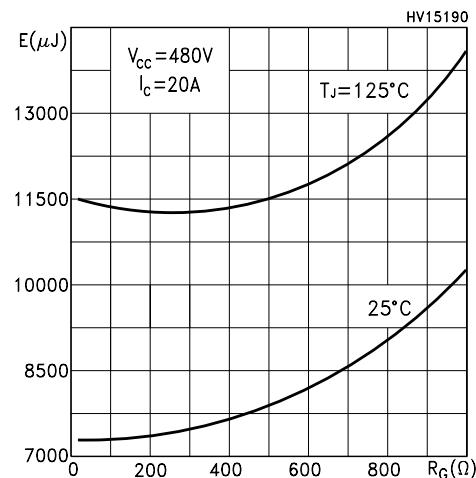
**Figure 11: Switching Losses vs Temperature**



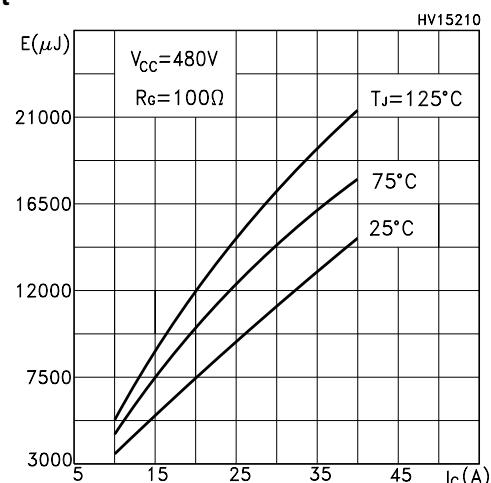
**Figure 12: Gate Charge vs Gate-Emitter Voltage**



**Figure 13: Switching Losses vs Gate Charge**



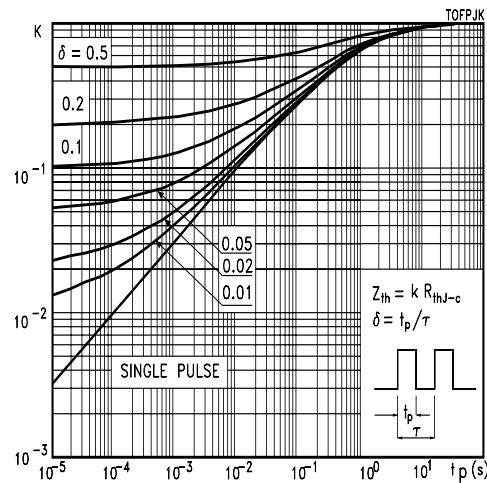
**Figure 14: Switching Losses vs Collector Current**



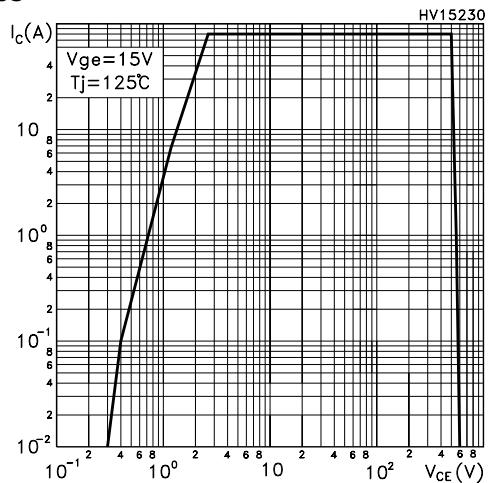
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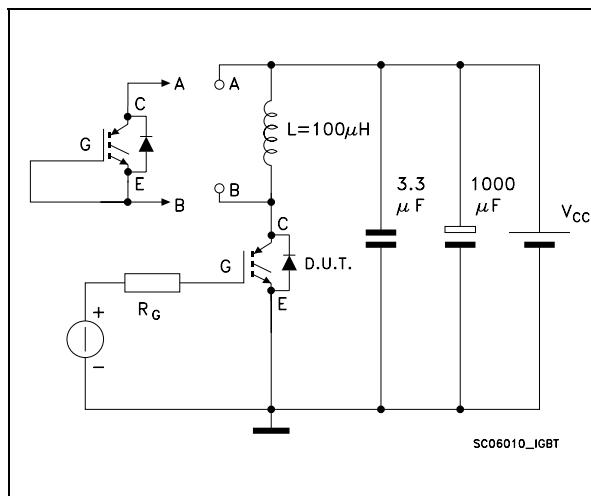
**Figure 15: Thermal Impedance**



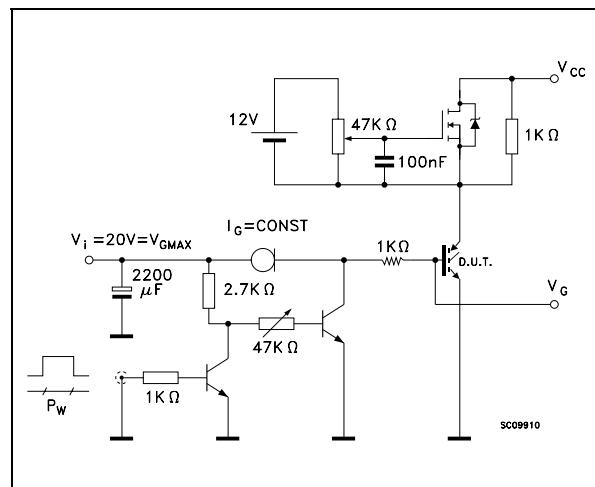
**Figure 16: Collector-Emitter Diode Characteristics**



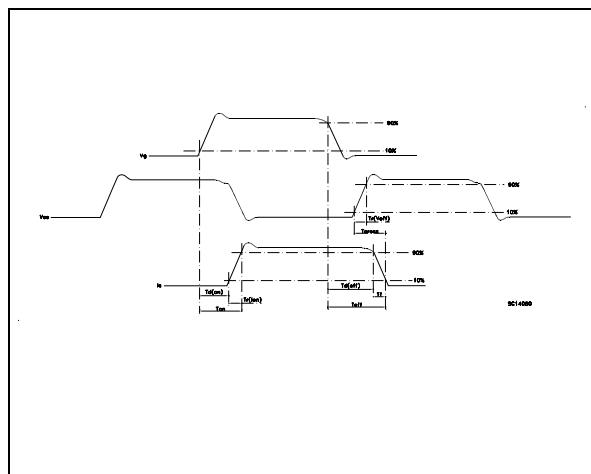
**Figure 17: Test Circuit for Inductive Load Switching**



**Figure 19: Gate Charge Test Circuit**

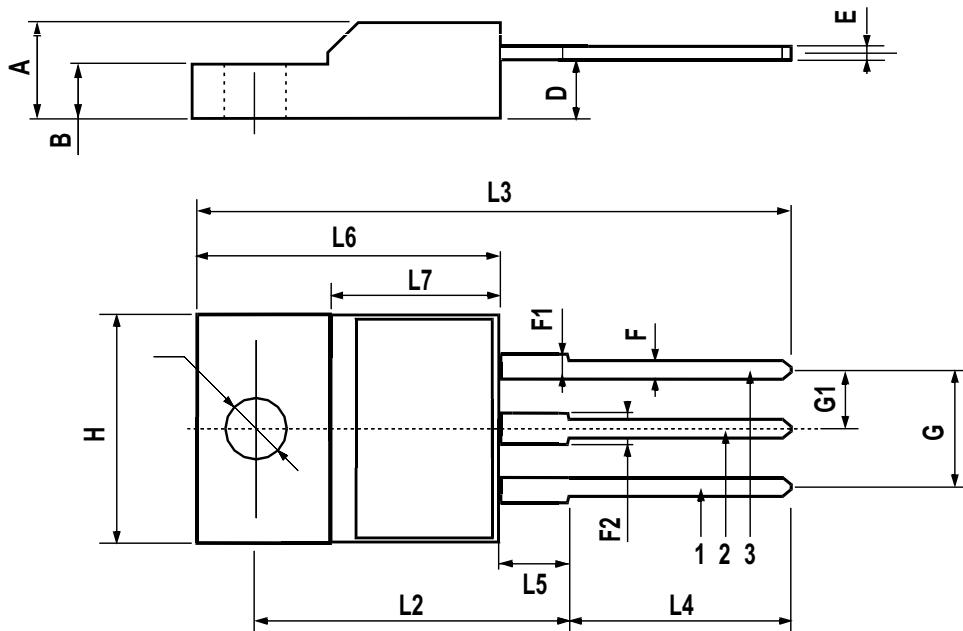


**Figure 18: Switching Waveforms**



**STGF20NB60S****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
17-Dec-2004	2	New template, no content change

## **STGF20NB60S**

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