

# STGF20NB60S

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

**Table 1: General Features** 

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

- LOW ON-VOLTAGE DROP (V<sub>cesat</sub>)
- **HIGHT 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<sup>™</sup> 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

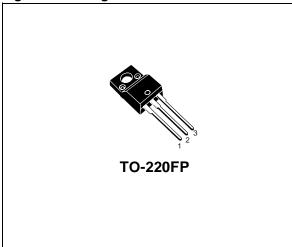


Figure 2: Internal Schematic Diagram

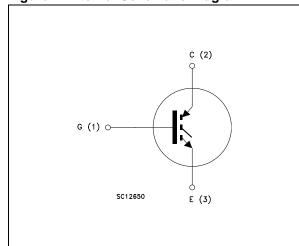


Table 2: Order Code

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

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**Table 3: Absolute Maximum ratings** 

Symbol	Parameter	Value	Unit	
V <sub>CES</sub>	Collector-Emitter Voltage (V <sub>GS</sub> = 0)	600	V	
V <sub>ECR</sub>	Emitter-Collector Voltage	20	V	
V <sub>GE</sub>	Gate-Emitter Voltage	±20	V	
I <sub>C</sub>	Collector Current (continuous) at T <sub>C</sub> = 25°C (#)	24	А	
I <sub>C</sub>	Collector Current (continuous) at T <sub>C</sub> = 100°C (#)	13	А	
I <sub>CM</sub> (■)	) Collector Current (pulsed) 70		Α	
Ртот	Total Dissipation at T <sub>C</sub> = 25°C	40		
	Derating Factor	0.32	W/°C	
V <sub>ISO</sub>	Insulation withstand voltage AC (t=1sec, Tc=25°C)	2500		
T <sub>stg</sub>	Storage Temperature			
Tj	Operating Junction Temperature range	-55 to 150		

<sup>( )</sup> Pulse width limited by safe operating area

### **Table 4: Thermal Data**

		Min.	Тур.	Max.	
Rthj-case	Thermal Resistance Junction-case			3.15	°C/W
Rthj-amb	Thermal Resistance Junction-ambient			62.5	°C/W
TL	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)		300		°C

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

Table 5: On/Off

Symbol	Parameter Test Conditions Min		Min.	Тур.	Max.	Unit
V <sub>BR(CES)</sub>	Collector-Emitter Breakdown Voltage	$I_C = 250 \mu A, V_{GE} = 0$	600			V
I <sub>CES</sub>	Collector cut-off Current (V <sub>GE</sub> = 0)	$V_{CE}$ = Max Rating, $T_{C}$ = 25 °C $V_{CE}$ = Max Rating, $T_{C}$ = 125 °C			10 100	μA μA
I <sub>GES</sub>	Gate-Emitter Leakage Current (V <sub>CE</sub> = 0)	V <sub>GE</sub> = ± 20V , V <sub>CE</sub> = 0			±100	nA
V <sub>GE(th)</sub>	Gate Threshold Voltage	$V_{CE} = V_{GE}$ , $I_C = 250 \mu A$	2.5		5	V
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	V <sub>GE</sub> = 15V, I <sub>C</sub> = 20 A, Tj= 25°C V <sub>GE</sub> = 15V, I <sub>C</sub> = 20A, Tj=150°C		1.25 1.2	1.7	V V

<sup>(#)</sup> Calculated according to the iterative formula:

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

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## **ELECTRICAL CHARACTERISTICS** (CONTINUED)

Table 6: Dynamic

Symbol	Parameter Test Conditions		Min.	Тур.	Max.	Unit
g <sub>fs</sub> (1)	Forward Transconductance	V <sub>CE</sub> = 10 V , I <sub>C</sub> = 8 A		20		S
C <sub>ies</sub>	Input Capacitance	$V_{CE} = 25 \text{ V, f} = 1 \text{ MHz, } V_{GE} = 0$		1820		pF
C <sub>oes</sub>	Output Capacitance			167		pF
C <sub>res</sub>	Reverse Transfer Capacitance			27		pF
Q <sub>g</sub> Q <sub>ge</sub> Q <sub>gc</sub>	Total Gate Charge Gate-Emitter Charge Gate-Collector Charge	$V_{CC} = 480 \text{ V}, I_{C} = 20 \text{ A},$ $V_{GE} = 15 \text{ V}$ (see Figure 19)		83 10 27	115	nC nC nC
I <sub>CL</sub>	Turn-off SOA minimum current	$V_{clamp} = 480 \text{ V}$ , $Tj = 125^{\circ}C$ $R_G = 100 \Omega$	80			Α

<sup>(1)</sup> Pulsed: Pulse duration= 300 µs, duty cycle 1.5%

#### Table 7: Switching On

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub> t <sub>r</sub> (di/dt) <sub>on</sub>	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 480 \text{ V}, I_{C} = 20 \text{ A}$ $R_{G} = 100 \Omega, V_{GE} = 15 \text{V}$ (see Figure 17)		92 70 340		ns ns A/µs
t <sub>d(on)</sub> t <sub>r</sub> (di/dt) <sub>on</sub>	Turn-on Delay Time Current Rise Time Turn-on Delay Time	$V_{CC} = 480 \text{ V}, I_{C} = 20 \text{ A}$ $R_{G} = 100 \Omega, V_{GE} = 15 \text{ V},$ $Tj = 125 ^{\circ}\text{C} \text{ (see Figure 17)}$		80 73 320		ns ns A/µs

### **Table 8: Switching Off**

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
t <sub>c</sub>	Cross-over Time	$V_{CC} = 480 \text{ V}, I_{C} = 20 \text{ A},$		1.6		μs
$t_{r}(V_{Off})$	Off Voltage Rise Time	$R_G = 100 \Omega$ , $V_{GE} = 15 V$ $T_J = 25 °C$		0.78		μs
$t_{d(off)}$	Turn-off Delay Time	(see Figure 17)		1.1		μs
t <sub>f</sub>	Current Fall Time			0.79		μs
t <sub>c</sub>	Cross-over Time	$V_{CC} = 480 \text{ V}, I_{C} = 20 \text{ A},$		2.4		μs
$t_{r}(V_{\text{off}}) \\$	Off Voltage Rise Time	$R_G = 100 \Omega$ , $V_{GE} = 15 V$ $T_I = 125 °C$		1.1		μs
$t_{d(off)}$	Turn-off Delay Time	(see Figure 17)		2.4		μs
t <sub>f</sub>	Current Fall Time			1.2		μs

### **Table 9: Switching Energy**

Symbol	Parameterr	Test Conditions	Min.	Тур.	Max	Unit
Eon (2) E <sub>off</sub> (3) E <sub>ts</sub>	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
Eon (2) E <sub>off</sub> (3) E <sub>ts</sub>	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 480 \text{ V, } I_{C} = 20 \text{ A}$ $R_{G} = 100 \Omega$ , $V_{GE} = 15 \text{ V,Tj} = 125 ^{\circ}\text{C}$ (see Figure 18)		0.86 11.5 12.4		mJ mJ mJ

<sup>(2)</sup> Eon 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.



<sup>(3)</sup> Turn-off losses include also the tail of the collector current.

**Figure 3: Output Characteristics** 

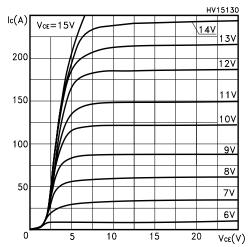


Figure 4: Transconductance

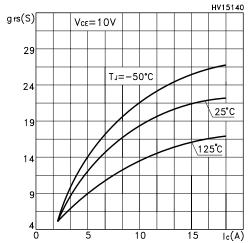


Figure 5: Collector-Emitter On Voltage vs Collector Current

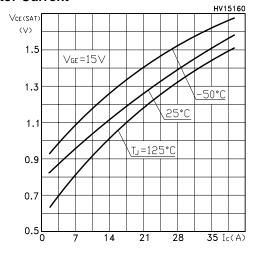


Figure 6: Transfer Characteristics

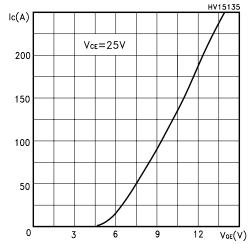


Figure 7: Normalized Collector-Emitter On Voltage vs Temperature

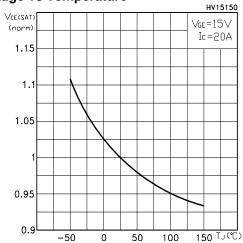
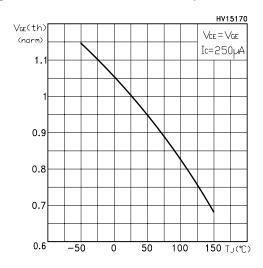


Figure 8: Gate Threshold vs Temperature



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Figure 9: Normalized Breakdown Voltage vs Temperature

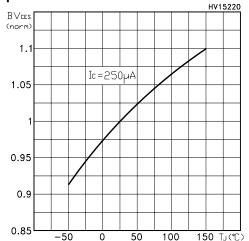


Figure 10: Capacitance Variations

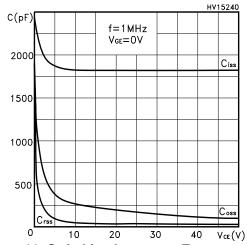


Figure 11: Switching Losses vs Temperature

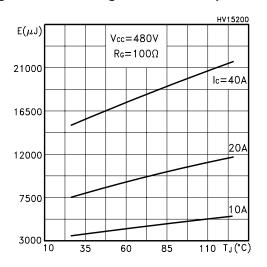


Figure 12: Gate Charge vs Gate-Emitter Voltage

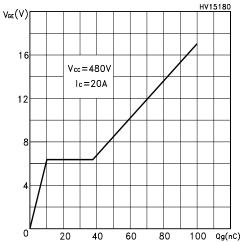


Figure 13: Switching Losses vs Gate Charge

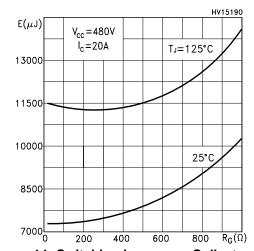


Figure 14: Switching Losses vs Collector Current

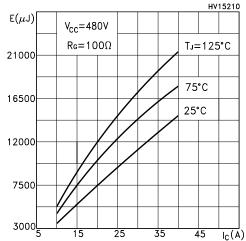


Figure 15: Thermal Impedance

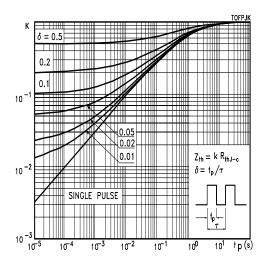


Figure 16: Collector-Emitter Diode Characteristics

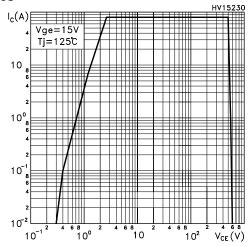


Figure 17: Test Circuit for Inductive Load Switching

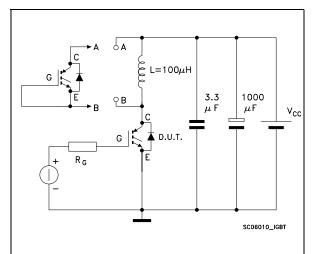


Figure 18: Switching Waveforms

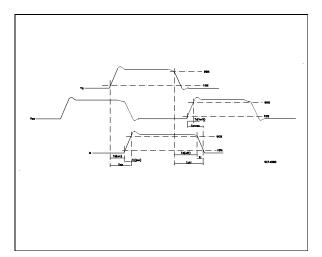
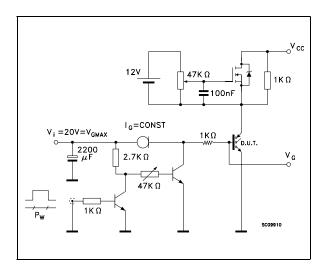


Figure 19: Gate Charge Test Circuit



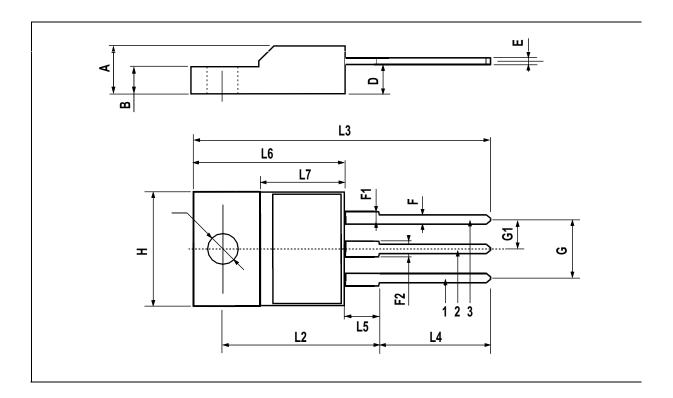
#### STGF20NB60S

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: <a href="https://www.st.com">www.st.com</a>

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## **TO-220FP MECHANICAL DATA**

DIM		mm.			inch	
DIM.	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
А	4.4		4.6	0.173		0.181
В	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
Е	0.45		0.7	0.017		0.027
F	0.75		1	0.030 0.03		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
Н	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



## STGF20NB60S

## **Table 10: Revision History**

Date	Revision Description of Changes	
17-Dec-2004	2	New template, no content change
05-Aug-2005	3	Some values changed in table 6

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