

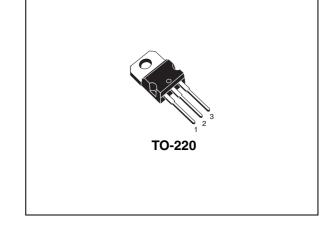
## STGP19NC60S

## N-channel 600V - 20A - TO-220 Medium frequency PowerMESH™ IGBT

#### **Features**

Туре	V <sub>CES</sub>	V <sub>CE(sat)</sub> (typ)@150°C	I <sub>C</sub> @100°C
STGP19NC60S	600V	< 1.35V	20A

- Very low on-voltage drop (V<sub>CE(sat)</sub>)
- High input impedance (voltage driven)
- IGBT co-packaged with ultrafast freewheeling diode.
- Minimum power losses at 5 kHz in hard switching
- Optimized performance for medium operating frequencies.



### **Application**

■ Medium frequency motor control

### **Description**

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

Figure 1. Internal schematic diagram

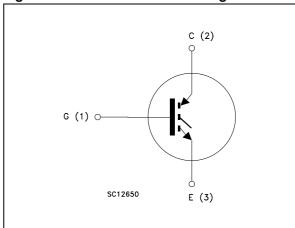


Table 1. Device summary

Order code	Marking	Package	Packaging	
STGP19NC60S	GP19NC60S	TO-220	Tube	

Contents STGP19NC60S

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STGP19NC60S Electrical ratings

## 1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GS</sub> = 0)	600	V
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 25°C	50	Α
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 100°C	20	Α
I <sub>CP</sub> <sup>(2)</sup>	Pulsed collector current	80	Α
V <sub>GE</sub>	Gate-emitter voltage	±20	V
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25°C	125	W
T <sub>j</sub>	Operating junction temperature	- 55 to 150	°C

<sup>1.</sup> Calculated according to the iterative formula:

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

2. Pulsed: width limited by max junction temperature allowed

Table 2. Thermal resistance

Symbol	Parameter	Value	Unit
Rthj-case	Thermal resistance junction-case max IGBT	1	°C/W
Rthj -amb	Thermal resistance junction-ambient max	62.5	°C/W

Electrical characteristics STGP19NC60S

## 2 Electrical characteristics

( $T_{CASE}$ =25°C unless otherwise specified)

Table 3. Static

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V <sub>BR(CES)</sub>	Collector-emitter breakdown voltage	I <sub>C</sub> = 1mA, V <sub>GE</sub> = 0	600			٧
V <sub>CE(sat)</sub>	Collector-emitter saturation voltage	V <sub>GE</sub> = 15V, I <sub>C</sub> = 12A V <sub>GE</sub> = 15V, I <sub>C</sub> =12A,Tc=150°C		1.55 1.35	1.9	V V
V <sub>GE(th)</sub>	Gate threshold voltage	$V_{CE} = V_{GE}, I_{C} = 250 \mu A$	3.75		5.75	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, $T_{C}$ = 150°C			150 1	μA mA
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
9 <sub>fs</sub>	Forward transconductance	$V_{CE} = 15V_{,} I_{C} = 12A$		10		S

Table 4. Dynamic

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C <sub>ies</sub> C <sub>oes</sub> C <sub>res</sub>	Input capacitance Output capacitance Reverse transfer capacitance	$V_{CE} = 25V, f = 1MHz,$ $V_{GE} = 0$		1190 135 28.5		pF pF pF
Q <sub>g</sub> Q <sub>ge</sub> Q <sub>gc</sub>	Total gate charge Gate-emitter charge Gate-collector charge	$V_{CE}$ = 480V, $I_{C}$ = 12A, $V_{GE}$ = 15V, Figure 17		54.5 8.7 25.8		nC nC nC

Table 5. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub> t <sub>r</sub> (di/dt)on	Turn-on delay time Current rise time Turn-on current slope	$V_{CC}$ = 480V, $I_{C}$ = 12A $R_{G}$ = 10 $\Omega$ , $V_{GE}$ = 15V, Figure 18		17.5 6.2 1870		ns ns A/µs
t <sub>d(on)</sub> t <sub>r</sub> (di/dt)on	Turn-on delay time Current rise time Turn-on current slope	$V_{CC}$ = 480V, $I_{C}$ = 12A $R_{G}$ = 10 $\Omega$ $V_{GE}$ = 15V, $T_{j}$ = 125°C Figure 18		17 6.5 1700		ns ns A/µs
$\begin{matrix} t_{r(Voff)} \\ t_{d(Voff)} \\ t_{f} \end{matrix}$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC}$ = 480V, $I_{C}$ = 12A $R_{G}$ = 10 $\Omega$ , $V_{GE}$ = 15V, Figure 18		90 175 215		ns ns ns
t <sub>r(Voff)</sub> t <sub>d(Voff)</sub> t <sub>f</sub>	Off voltage rise time Turn-off delay time Current fall time	$V_{CC}$ = 480V, $I_{C}$ = 12A $R_{G}$ = 10 $\Omega$ $V_{GE}$ = 15V, $T_{j}$ = 125°C Figure 18		155 245 290		ns ns ns

Table 6. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
E <sub>on</sub> E <sub>off</sub> <sup>(1)</sup> E <sub>ts</sub>	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC}$ = 480V, $I_{C}$ = 12A $R_{G}$ = 10 $\Omega$ , $V_{GE}$ = 15V, Figure 16		135 815 995		ր Մպ Մպ
E <sub>on</sub> E <sub>off</sub> <sup>(1)</sup> E <sub>ts</sub>	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC}$ = 480V, $I_{C}$ = 12A $R_{G}$ = 10 $\Omega$ , $V_{GE}$ = 15V, $T_{j}$ = 125°C Figure 16		200 1175 1375		μJ μJ μJ

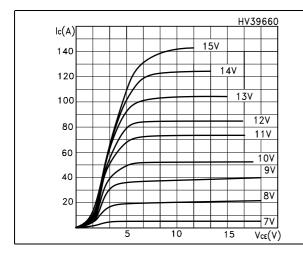
<sup>1.</sup> Turn-off losses include also the tail of the collector current

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### 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

Figure 2. Transfer characteristics



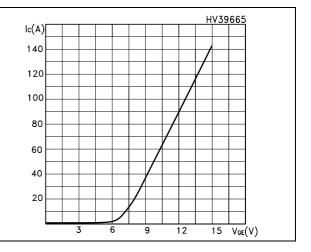
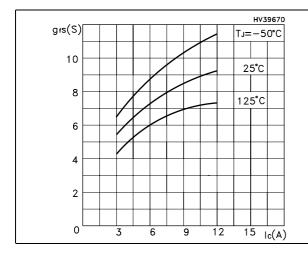


Figure 3. Transconductance

Figure 4. Collector-emitter on voltage vs temperature



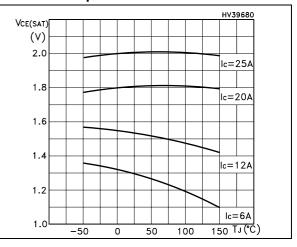
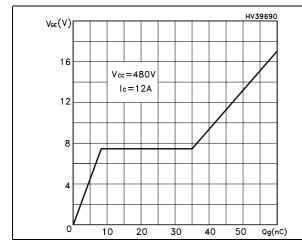


Figure 5. Gate charge vs gate-source voltage Figure 6. Capacitance variations



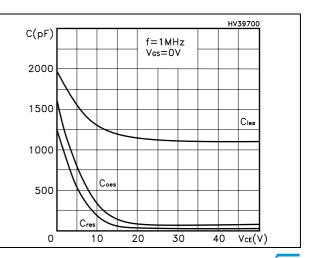


Figure 7. Normalized gate threshold voltage Figure 8. Collector-emitter on voltage vs vs temperature collector current

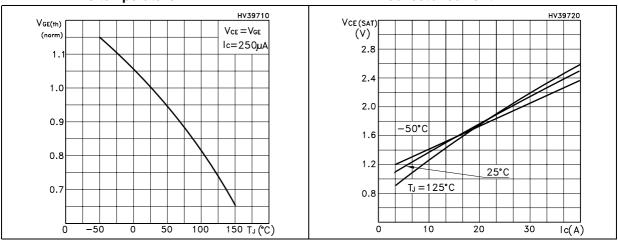


Figure 9. Normalized breakdown voltage vs Figure 10. Switching losses vs temperature temperature

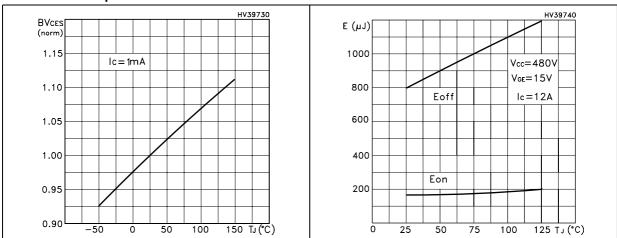
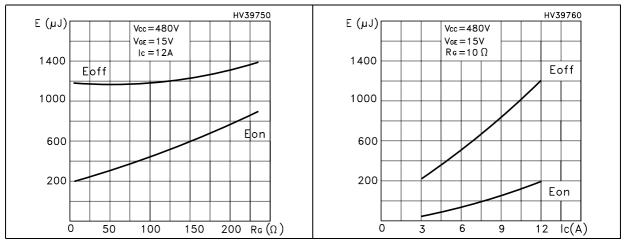


Figure 11. Switching losses vs gate resistance Figure 12. Switching losses vs collector current



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Electrical characteristics STGP19NC60S

Figure 13. Turn-off SOA

Figure 14. Thermal impedance

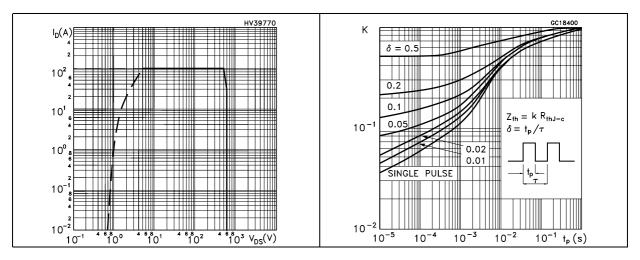
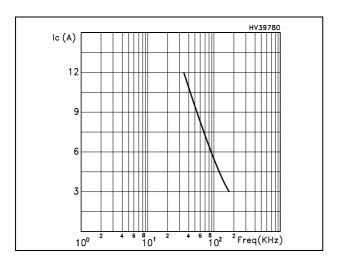


Figure 15. I<sub>C</sub> vs. frequency



### 2.2 Frequency applications

For a fast IGBT suitable for high frequency applications, the typical collector current vs. maximum operating frequency curve is reported. That frequency is defined as follows:

$$f_{MAX} = (P_D - P_C) / (E_{ON} + E_{OFF})$$

• The maximum power dissipation is limited by maximum junction to case thermal resistance:

#### **Equation 1**

$$P_D = \Delta T / R_{THJ-C}$$

considering 
$$\Delta T = T_J - T_C = 125 \,^{\circ}\text{C} - 75 \,^{\circ}\text{C} = 50 \,^{\circ}\text{C}$$

The conduction losses are:

#### **Equation 2**

$$P_C = I_C * V_{CE(SAT)} * \delta$$

with 50% of duty cycle, V<sub>CESAT</sub> typical value @125°C.

Power dissipation during ON & OFF commutations is due to the switching frequency:

#### **Equation 3**

$$P_{SW} = (E_{ON} + E_{OFF}) * freq.$$

Typical values @  $125^{\circ}$ C for switching losses are used (test conditions:  $V_{CE} = 480V$ ,  $V_{GE} = 15V$ ,  $R_{G} = 10$  Ohm). Furthermore, diode recovery energy is included in the  $E_{ON}$  (see *Note 1*), while the tail of the collector current is included in the  $E_{OFF}$  measurements.

Test circuit STGP19NC60S

## 3 Test circuit

Figure 16. Test circuit for inductive load switching

Figure 17. Gate charge test circuit

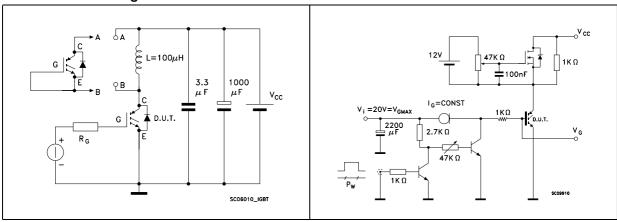
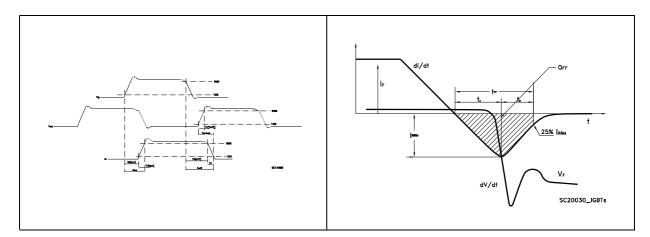


Figure 18. Switching waveform

Figure 19. Diode recovery time waveform



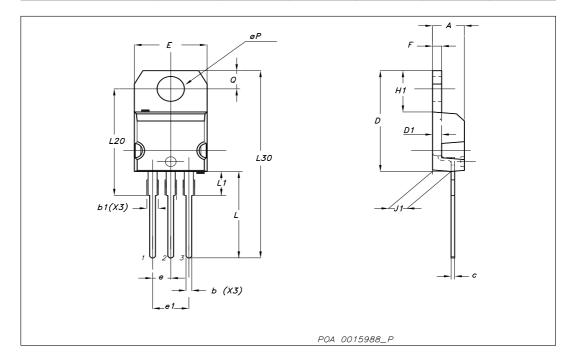
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## 4 Package mechanical data

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

### TO-220 mechanical data

Di		mm			inch	
Dim	Min	Тур	Max	Min	Тур	Max
Α	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
С	0.49		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
Е	10		10.40	0.393		0.409
е	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
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



STGP19NC60S Revision history

# 5 Revision history

Table 7. Document revision history

Date	Revision	Changes		
02-Jul-2007	1	First release		
13-Aug-2007 2 From target to preliminary version		From target to preliminary version		
18-Sep-2007	3	Added new section: Electrical characteristics (curves)		

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