



# STGP19NC60SD

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

## Features

Type	V <sub>CE(S)</sub>	V <sub>CE(sat)</sub> (typ)@150°C	I <sub>C</sub> @100°C
STGP19NC60SD	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.

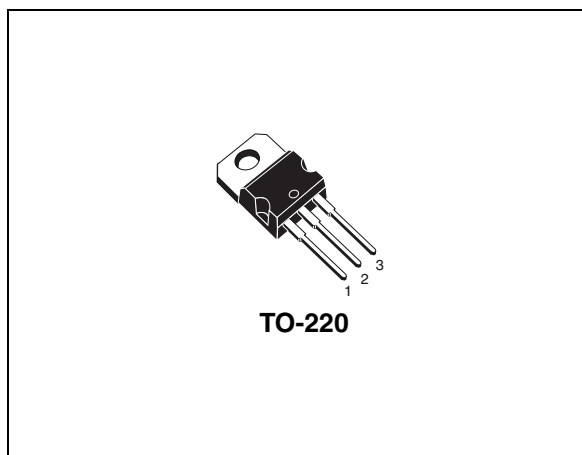


Figure 1. Internal schematic diagram

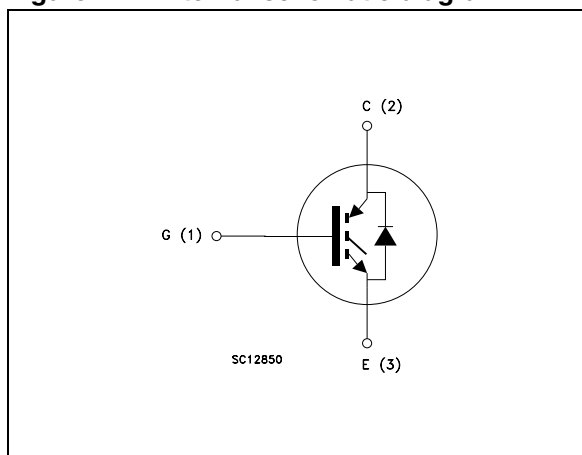


Table 1. Device summary

Order code	Marking	Package	Packaging
STGP19NC60SD	GP19NC60SD	TO-220	Tube

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# 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	A
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 100°C	20	A
I <sub>CP</sub> <sup>(2)</sup>	Pulsed collector current	80	A
I <sub>F</sub>	Diode RMS forward current at T <sub>C</sub> = 25°C	20	A
I <sub>FSM</sub>	Surge non repetitive forward current tp = 10ms sinusoidal	50	A
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

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. Pulsed: width limited by max junction temperature allowed

**Table 2. Thermal resistance**

Symbol	Parameter	Value	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case max IGBT	1	°C/W
	Thermal resistance junction-case max DIODE	3.0	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5	°C/W

## 2 Electrical characteristics

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

**Table 3. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-emitter breakdown voltage	$I_C = 1mA, V_{GE} = 0$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15V, I_C = 12A$ $V_{GE} = 15V, I_C = 12A, T_C = 150^{\circ}C$		1.55 1.35	1.9	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250 \mu A$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max rating}, T_C = 25^{\circ}C$ $V_{CE} = \text{Max rating}, T_C = 150^{\circ}C$			150 1	$\mu A$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20V, V_{CE} = 0$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15V, I_C = 12A$		10		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25V, f = 1MHz,$ $V_{GE} = 0$		1190		pF
$C_{oes}$	Output capacitance			135		pF
$C_{res}$	Reverse transfer capacitance			28.5		pF
$Q_g$	Total gate charge	$V_{CE} = 480V, I_C = 12A,$		54.5		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15V,$		8.7		nC
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 18</a>		25.8		nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 480V, I_C = 12A$		17.5		ns
$t_r$	Current rise time	$R_G = 10\Omega, V_{GE} = 15V,$		6.2		ns
$(di/dt)_{on}$	Turn-on current slope	<i>Figure 19</i>		1870		A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 480V, I_C = 12A$		17		ns
$t_r$	Current rise time	$R_G = 10\Omega, V_{GE} = 15V,$		6.5		ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 125^\circ C$ <i>Figure 19</i>		1700		A/ $\mu$ s
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 480V, I_C = 12A$		90		ns
$t_{d(Voff)}$	Turn-off delay time	$R_G = 10\Omega, V_{GE} = 15V,$		175		ns
$t_f$	Current fall time	<i>Figure 19</i>		215		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 480V, I_C = 12A$		155		ns
$t_{d(Voff)}$	Turn-off delay time	$R_G = 10\Omega, V_{GE} = 15V,$		245		ns
$t_f$	Current fall time	$T_j = 125^\circ C$ <i>Figure 19</i>		290		ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}$	Turn-on switching losses	$V_{CC} = 480V, I_C = 12A$		135		$\mu$ J
$E_{off}^{(1)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$		815		$\mu$ J
$E_{ts}$	Total switching losses	<i>Figure 17</i>		995		$\mu$ J
$E_{on}$	Turn-on switching losses	$V_{CC} = 480V, I_C = 12A$		200		$\mu$ J
$E_{off}^{(1)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$		1175		$\mu$ J
$E_{ts}$	Total switching losses	$T_j = 125^\circ C$ <i>Figure 17</i>		1375		$\mu$ J

1. 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	$I_f = 12A$ $I_f = 12A, T_j = 125^\circ C$		2.3 2.0		V V
$t_{rr}$	Reverse recovery time	$I_f = 12A, V_R = 40V,$		31		ns
$Q_{rr}$	Reverse recovery charge	$T_j = 25^\circ C, di/dt = 100 A/\mu s$		29.5		nC
$I_{rrm}$	Reverse recovery current	<i>Figure 20</i>		1.9		A
$t_{rr}$	Reverse recovery time	$I_f = 12A, V_R = 40V,$		48.5		ns
$Q_{rr}$	Reverse recovery charge	$T_j = 125^\circ C, di/dt = 100A/\mu s$		70.5		nC
$I_{rrm}$	Reverse recovery current	<i>Figure 20</i>		3		A

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

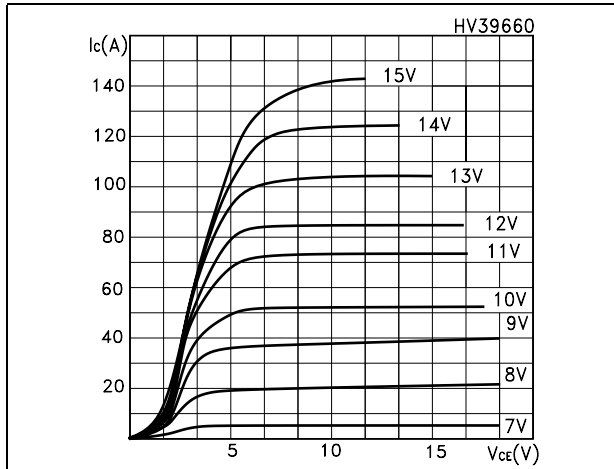


Figure 2. Transfer characteristics

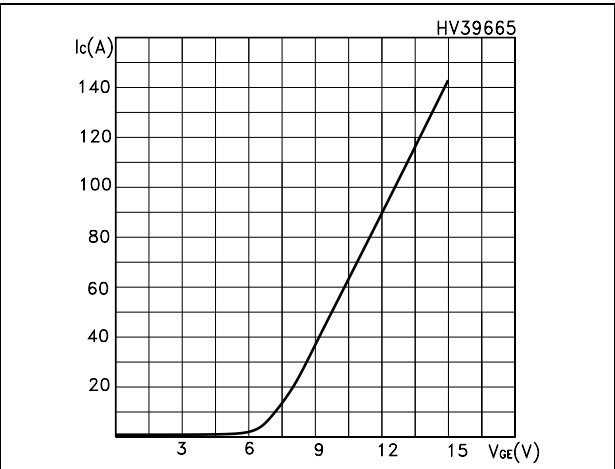


Figure 3. Transconductance

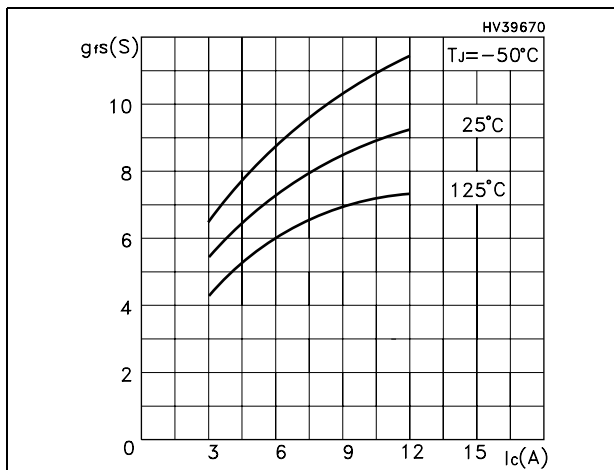


Figure 4. Collector-emitter on voltage vs temperature

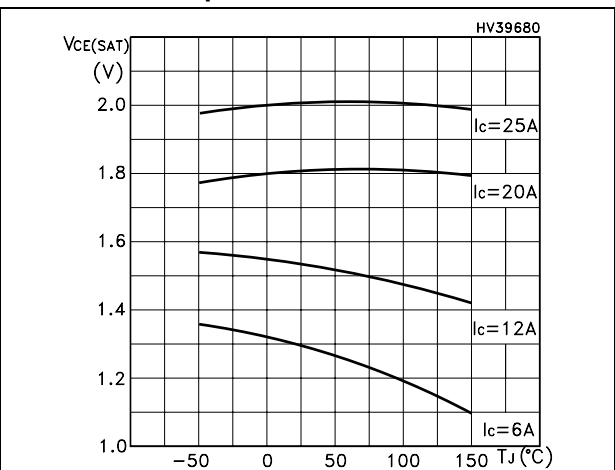


Figure 5. Gate charge vs gate-source voltage

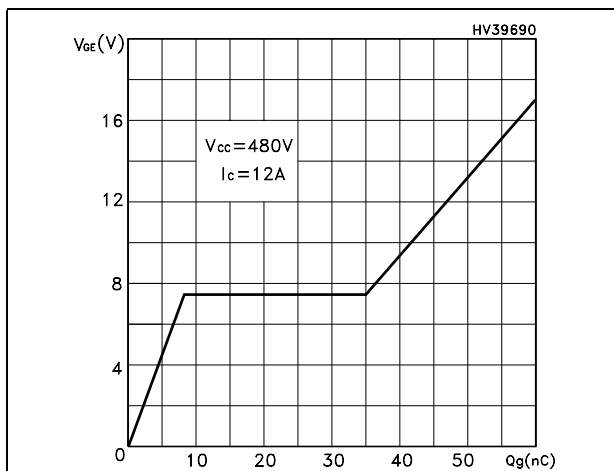


Figure 6. Capacitance variations

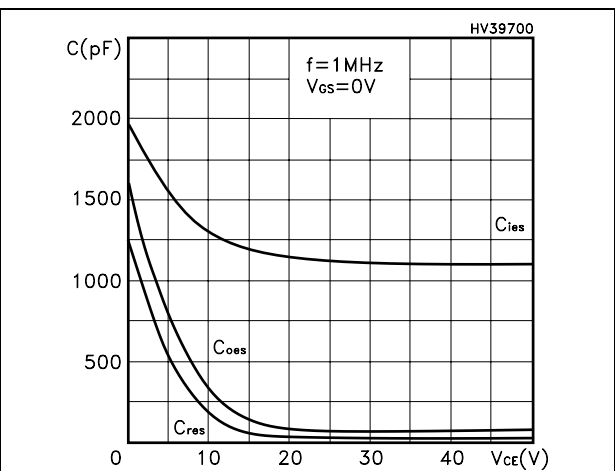


Figure 7. Normalized gate threshold voltage vs temperature

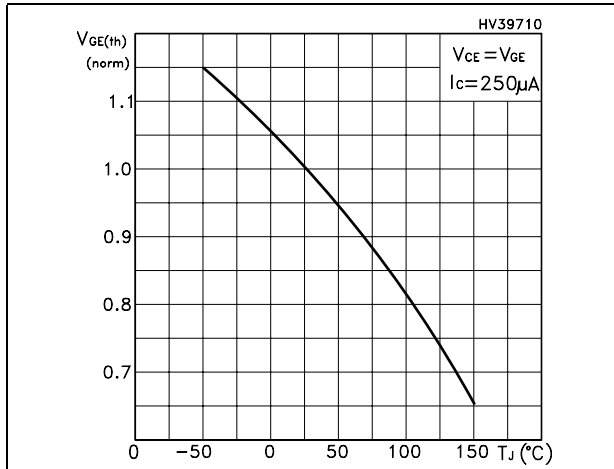


Figure 8. Collector-emitter on voltage vs collector current

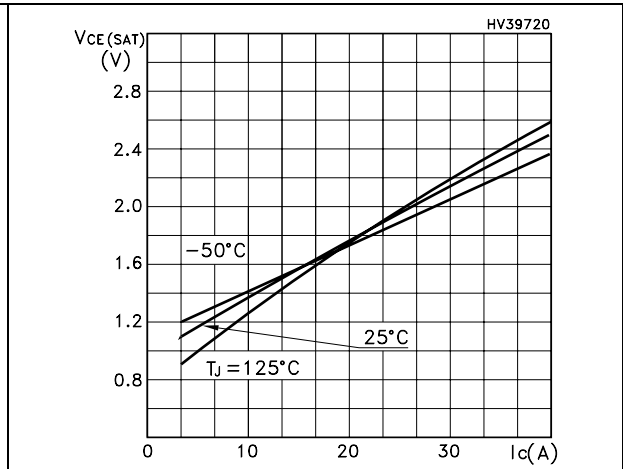


Figure 9. Normalized breakdown voltage vs temperature

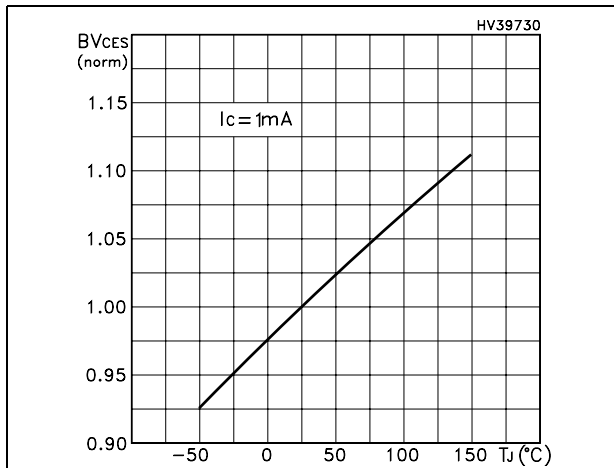


Figure 10. Switching losses vs temperature

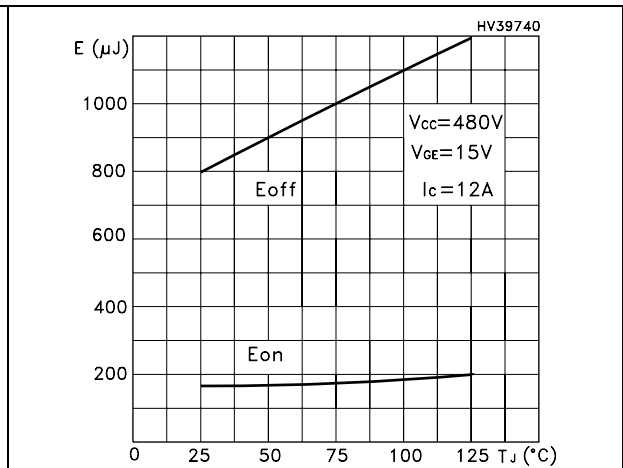


Figure 11. Switching losses vs gate resistance

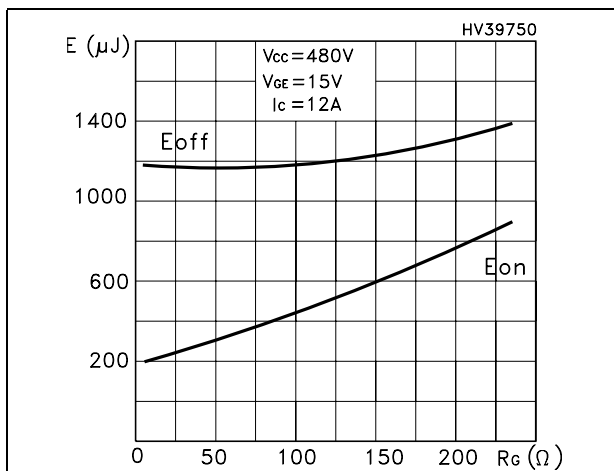


Figure 12. Switching losses vs collector current

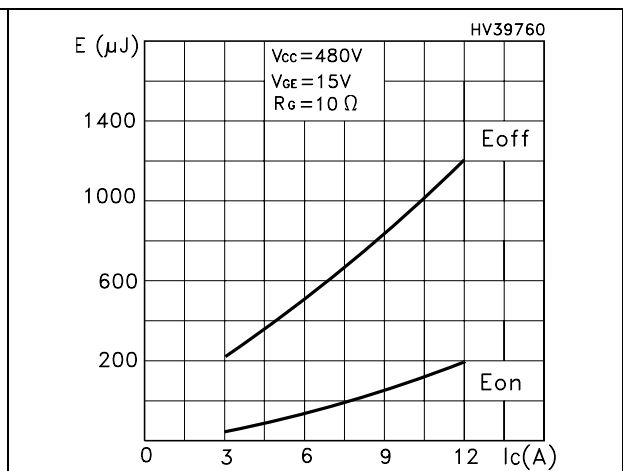


Figure 13. Turn-off SOA

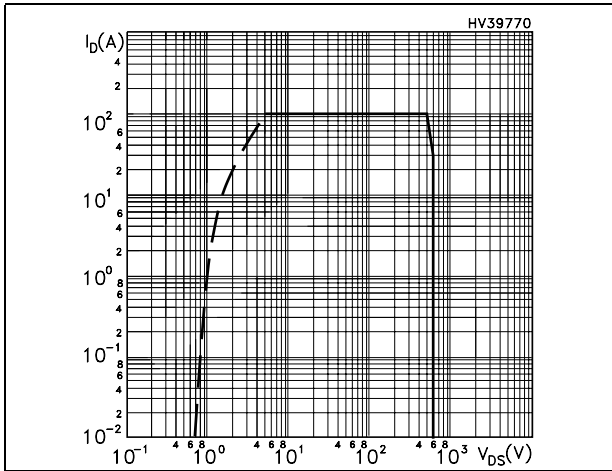


Figure 14. Forward voltage drop versus forward current

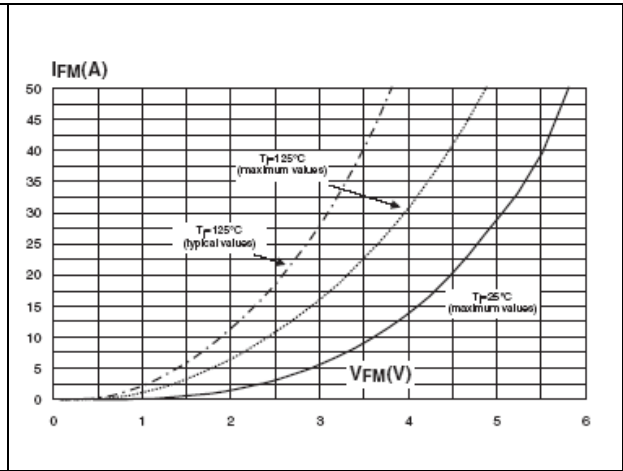


Figure 15. Thermal impedance

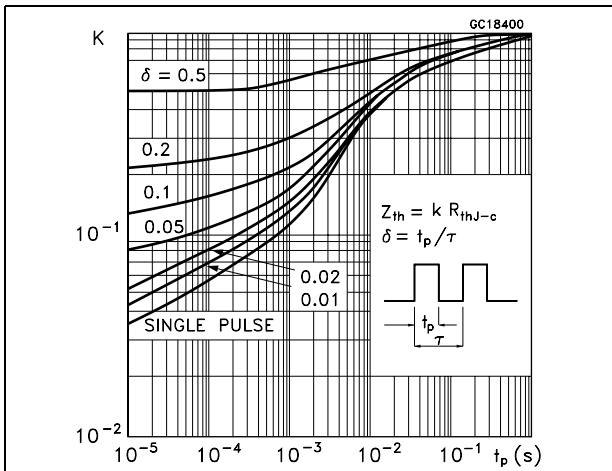
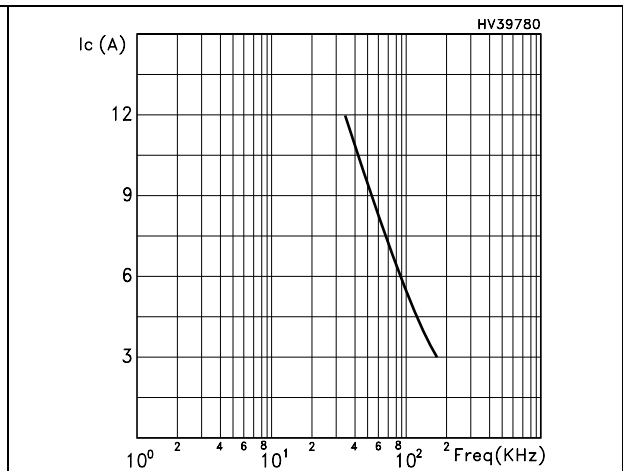


Figure 16. Ic vs. frequency





## 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  $\Delta T = T_J - T_C = 125\text{ °C} - 75\text{ °C} = 50\text{ °C}$

- The conduction losses are:

### Equation 2

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

with 50% of duty cycle,  $V_{CESAT}$  typical value @ 125°C.

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

### Equation 3

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

Typical values @ 125°C for switching losses are used (test conditions:  $V_{CE} = 480\text{V}$ ,  $V_{GE} = 15\text{V}$ ,  $R_G = 10\text{ Ohm}$ ). 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.

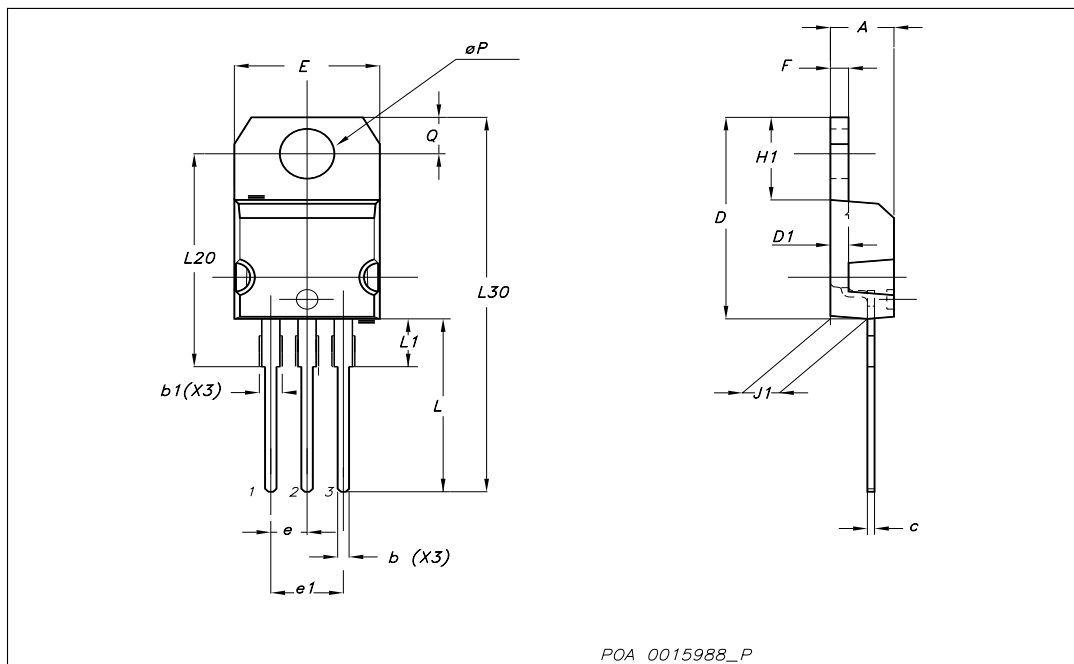


## 4 Package mechanical data

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-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	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
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	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	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



## 5 Revision history

**Table 8. Document revision history**

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

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