



# STGP7NC60HD STGF7NC60HD - STGB7NC60HD

N-CHANNEL 14A - 600V - TO-220/TO-220FP/D<sup>2</sup>PAK  
Very Fast PowerMESH™ IGBT

**Table 1: General Features**

TYPE	V <sub>CES</sub>	V <sub>CE(sat)</sub> (Max) @25°C	I <sub>C</sub> @100°C
STGP7NC60HD	600 V	< 2.5 V	14 A
STGF7NC60HD	600 V	< 2.5 V	6 A
STGB7NC60HD	600 V	< 2.5 V	14 A

- LOWER ON-VOLTAGE DROP (V<sub>cesat</sub>)
- OFF LOSSES INCLUDE TAIL CURRENT
- LOSSES INCLUDE DIODE RECOVERY ENERGY
- LOWER C<sub>RES</sub>/C<sub>IES</sub> RATIO
- HIGH FREQUENCY OPERATION UP TO 70 KHz
- VERY SOFT ULTRA FAST RECOVERY ANTI PARALLEL DIODE
- NEW GENERATION PRODUCTS WITH TIGHTER PARAMETER DISTRIBUTION

## 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.

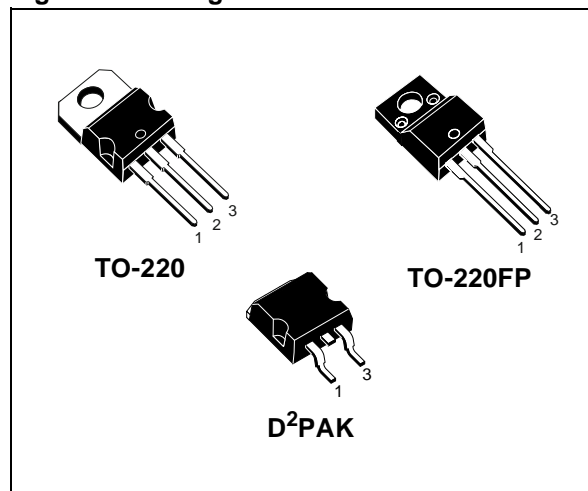
## APPLICATIONS

- HIGH FREQUENCY INVERTERS
- SMPS AND PFC IN BOTH HARD SWITCH AND RESONANT TOPOLOGIES
- MOTOR DRIVERS

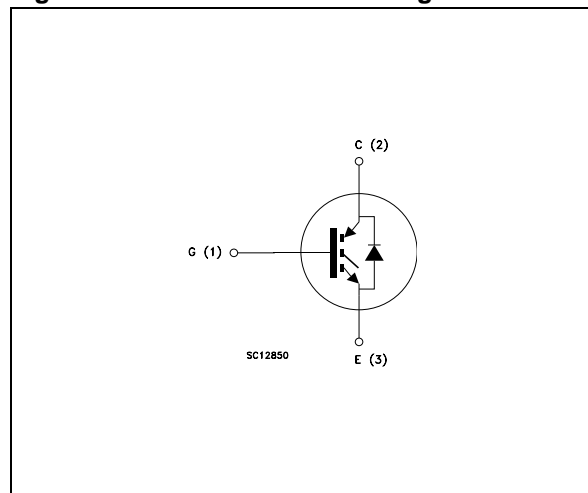
**Table 2: Order Code**

PART NUMBER	MARKING	PACKAGE	PACKAGING
STGP7NC60HD	GP7NC60HD	TO-220	TUBE
STGF7NC60HD	GF7NC60HD	TO-220FP	TUBE
STGB7NC60HDT4	GB7NC60HD	D <sup>2</sup> PAK	TAPE & REEL

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value		Unit
		STGP7NC60HD STGB7NC60HD	STGF7NC60HD	
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 (#)	25	10	A
I <sub>C</sub>	Collector Current (continuous) at T <sub>C</sub> = 100°C (#)	14	6	A
I <sub>CM</sub> (☐)	Collector Current (pulsed)	50		A
I <sub>F</sub>	Diode RMS Forward Current at T <sub>C</sub> = 25°C	20		A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	80	25	W
	Derating Factor	0.64	0.20	W/°C
V <sub>ISO</sub>	Insulation Withstand Voltage A.C.(t = 1 sec; T <sub>c</sub> = 25°C)	--	2500	V
T <sub>stg</sub>	Storage Temperature	- 55 to 150		°C
T <sub>j</sub>	Operating Junction Temperature			

(☐) Pulse width limited by max. junction temperature.

**Table 4: Thermal Data**

			Min.	Typ.	Max.	
R <sub>thj-case</sub>	Thermal Resistance Junction-case	TO-220 D <sup>2</sup> PAK			1.56	°C/W
		TO-220FP			5.0	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient				62.5	°C/W
T <sub>L</sub>	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: Main Parameters**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>BR(CES)</sub>	Collector-Emitter Breakdown Voltage	I <sub>C</sub> = 1 mA, V <sub>GE</sub> = 0	600			V
I <sub>CES</sub>	Collector cut-off Current (V <sub>GE</sub> = 0)	V <sub>CE</sub> = Max Rating, T <sub>C</sub> = 25 °C V <sub>CE</sub> = Max Rating, T <sub>C</sub> = 125 °C			10 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
V <sub>GE(th)</sub>	Gate Threshold Voltage	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250 μA	3.75		5.75	V
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	V <sub>GE</sub> = 15V, I <sub>C</sub> = 7 A		1.85	2.5	V
		V <sub>GE</sub> = 15V, I <sub>C</sub> = 7 A, T <sub>c</sub> = 125°C		1.7		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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}$ (1)	Forward Transconductance	$V_{CE} = 15 \text{ V}$ , $I_C = 7 \text{ A}$		4.30		S
$C_{ies}$	Input Capacitance	$V_{CE} = 25 \text{ V}$ , $f = 1 \text{ MHz}$ , $V_{GE} = 0$		720		pF
$C_{oes}$	Output Capacitance			81		pF
$C_{res}$	Reverse Transfer Capacitance			17		pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total Gate Charge Gate-Emitter Charge Gate-Collector Charge	$V_{CE} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ , $V_{GE} = 15 \text{ V}$ (see Figure 22)		35 7 16	48	nC nC nC
$I_{CL}$	Turn-Off SOA Minimum Current	$V_{clamp} = 480 \text{ V}$ , $T_j = 150^\circ\text{C}$ $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$	50			A

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

Table 7: Switching On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15\text{V}$ , $T_j = 25^\circ\text{C}$ (see Figure 19)		18.5 8.5 1060		ns ns A/ $\mu\text{s}$
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15\text{V}$ , $T_j = 125^\circ\text{C}$ (see Figure 20)		18.5 7 1000		ns ns A/ $\mu\text{s}$

Table 8: Switching Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time	$V_{CC} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ , $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ $T_j = 25^\circ\text{C}$ (see Figure 20)		27 72 60		ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time	$V_{CC} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ , $R_G = 10 \Omega$ , $V_{GE} = 15 \text{ V}$ $T_j = 125^\circ\text{C}$ (see Figure 20)		56 116 105		ns ns ns

Table 9: Switching Energy

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$E_{on}$ (2) $E_{off}$ (3) $E_{ts}$	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15\text{V}$ , $T_j = 25^\circ\text{C}$ (see Figure 19)		95 115 210	125 150 275	$\mu\text{J}$ $\mu\text{J}$ $\mu\text{J}$
$E_{on}$ (2) $E_{off}$ (3) $E_{ts}$	Turn-on Switching Losses Turn-off Switching Loss Total Switching Loss	$V_{CC} = 390 \text{ V}$ , $I_C = 7 \text{ A}$ $R_G = 10 \Omega$ , $V_{GE} = 15\text{V}$ , $T_j = 125^\circ\text{C}$ (see Figure 20)		140 215 355		$\mu\text{J}$ $\mu\text{J}$ $\mu\text{J}$

(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. IGBTs & DIODE are at the same temperature (25°C and 125°C)

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

Table 10: Collector-Emitter Diode

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	
$V_f$	Forward On-Voltage	$I_f = 3.5 \text{ A}$		1.3	1.9	V	
		$I_f = 3.5 \text{ A}, T_j = 125 \text{ }^\circ\text{C}$		1.1		V	
$t_{rr}$	Reverse Recovery Time	$I_f = 7 \text{ A}, V_R = 40 \text{ V},$ $T_j = 25 \text{ }^\circ\text{C}, di/dt = 100 \text{ A}/\mu\text{s}$		37		ns	
$t_a$	Reverse Recovery Charge			22		ns	
$Q_{rr}$				40		nC	
$I_{rrm}$			Reverse Recovery Current		2.1		A
S			Softness factor of the diode		0.68		
$t_{rr}$	Reverse Recovery Time	$I_f = 7 \text{ A}, V_R = 40 \text{ V},$ $T_j = 125 \text{ }^\circ\text{C}, di/dt = 100 \text{ A}/\mu\text{s}$		61		ns	
$t_a$	Reverse Recovery Charge			34		ns	
$Q_{rr}$				98		nC	
$I_{rrm}$			Reverse Recovery Current		3.2		A
S			Softness factor of the diode		0.79		

Figure 3: Output Characteristics

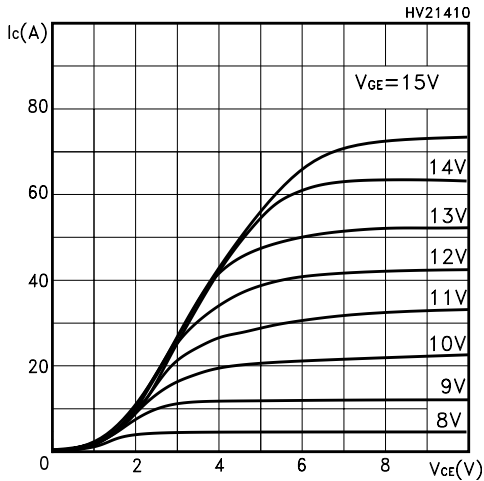


Figure 4: Transconductance

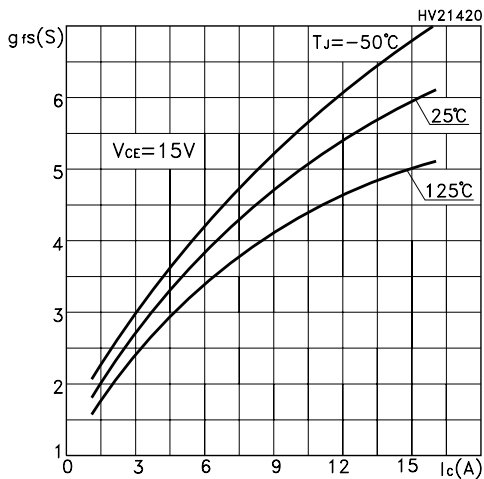


Figure 5: Collector-Emitter On Voltage vs Collector Current

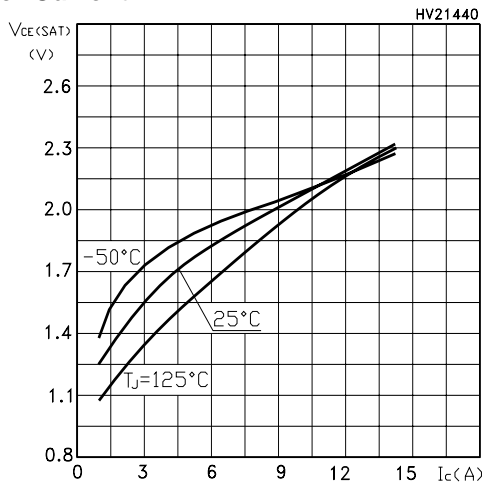


Figure 6: Transfer Characteristics

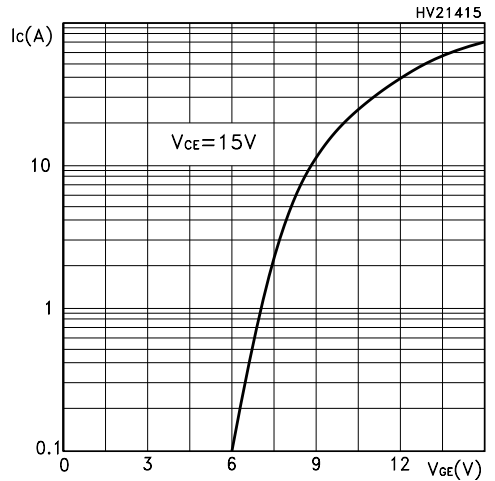


Figure 7: Collector-Emitter On Voltage vs Temperature

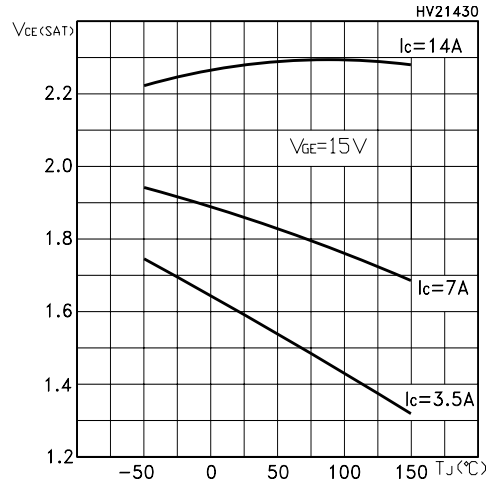


Figure 8: Normalized Gate Threshold vs Temperature

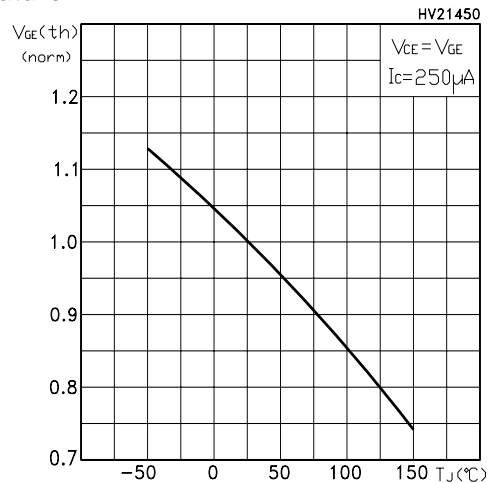


Figure 9: Normalized Breakdown Voltage vs Temperature

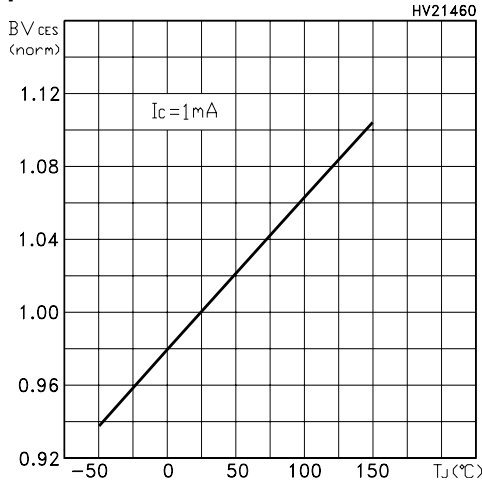


Figure 10: Capacitance Variations

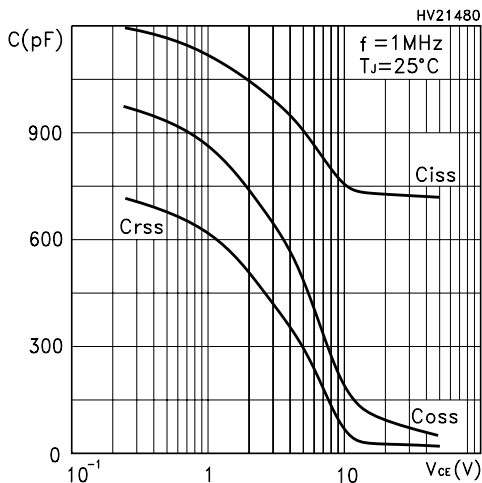


Figure 11: Total Switching Losses vs Gate Resistance

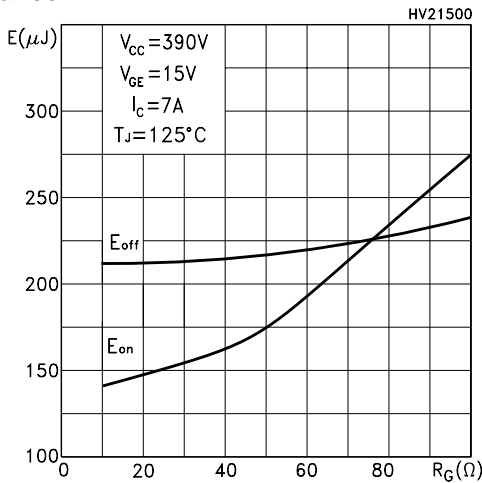


Figure 12: Gate Charge vs Gate-Emitter Voltage

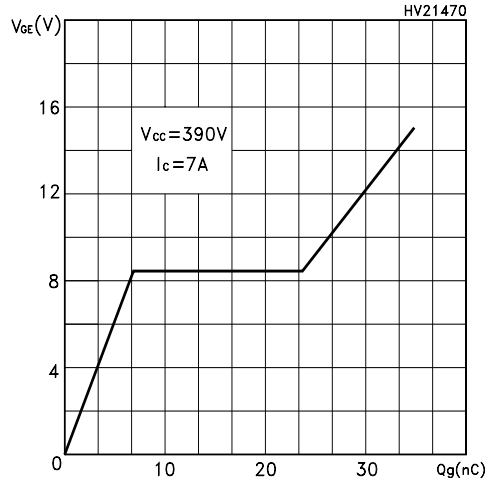


Figure 13: Total Switching Losses vs Temperature

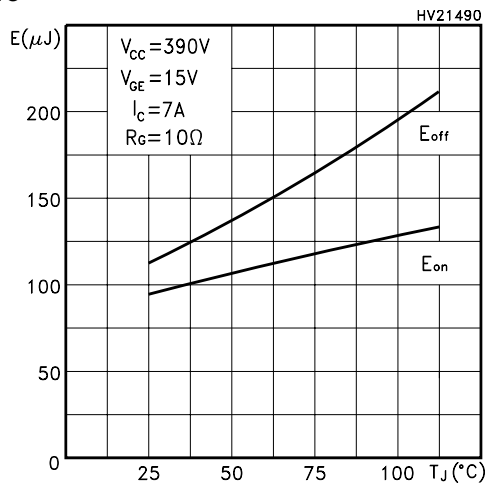


Figure 14: Total Switching Losses vs Collector Current

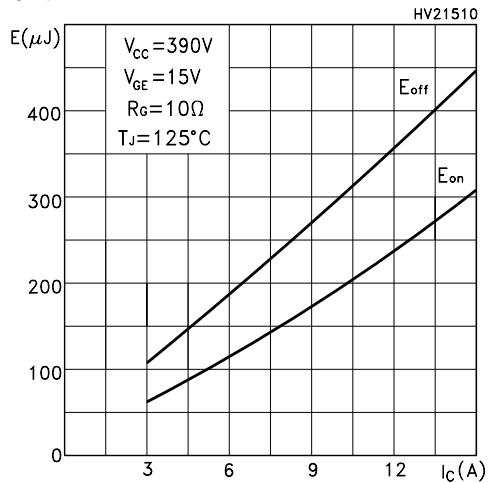


Figure 15: Thermal Impedance For TO-220/ D<sup>2</sup>PAK

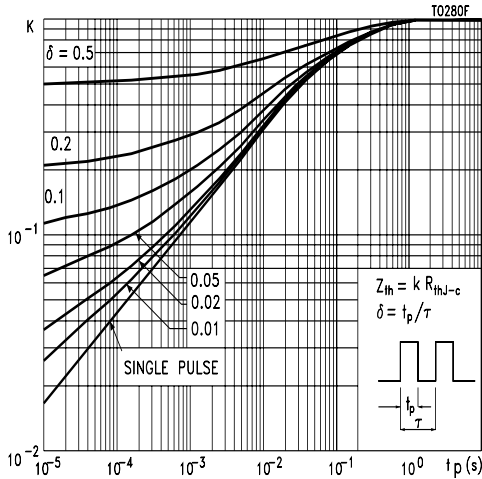


Figure 16: Thermal Impedance For TO-220FP

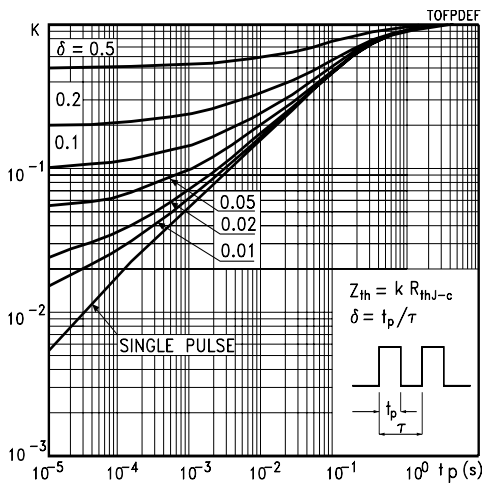


Figure 17: Turn-Off SOA

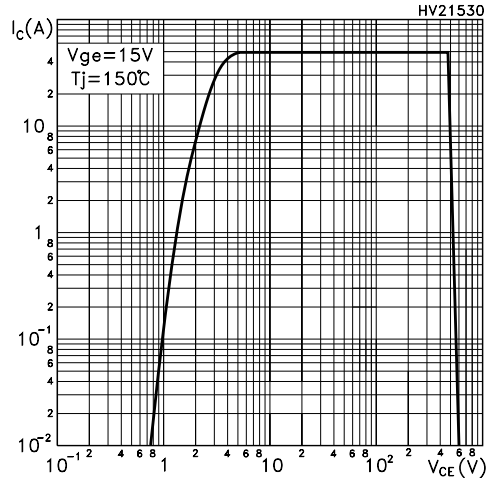


Figure 18: Emitter-Collector Diode Characteristics

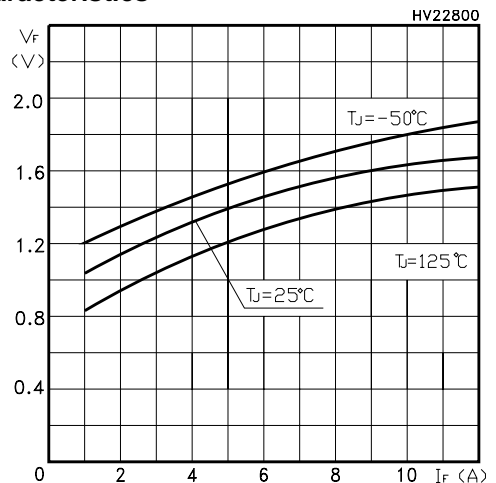
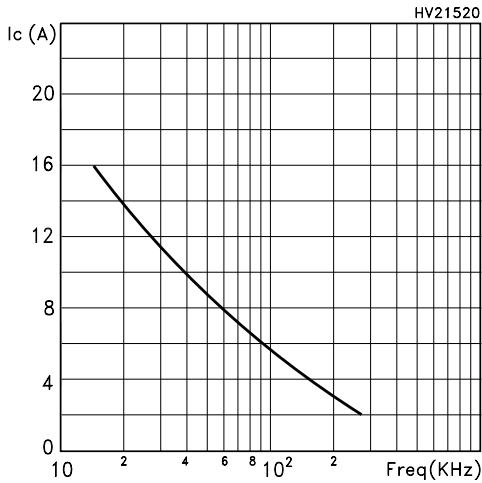


Figure 19: Ic vs Frequency



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:

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

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

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

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

2) The conduction losses are:

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

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

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

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

4) Typical values @ 125°C for switching losses are used (test conditions:  $V_{CE} = 390\text{V}$ ,  $V_{GE} = 15\text{V}$ ,  $R_G = 3.3\text{ Ohm}$ ). Furthermore, diode recovery energy is included in the  $E_{ON}$  (see note 2), while the tail of the collector current is included in the  $E_{OFF}$  measurements (see note 3).



Figure 20: Test Circuit for Inductive Load Switching

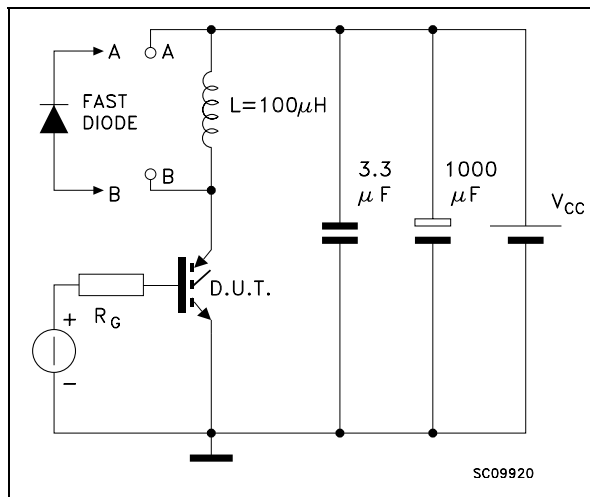


Figure 21: Switching Waveforms

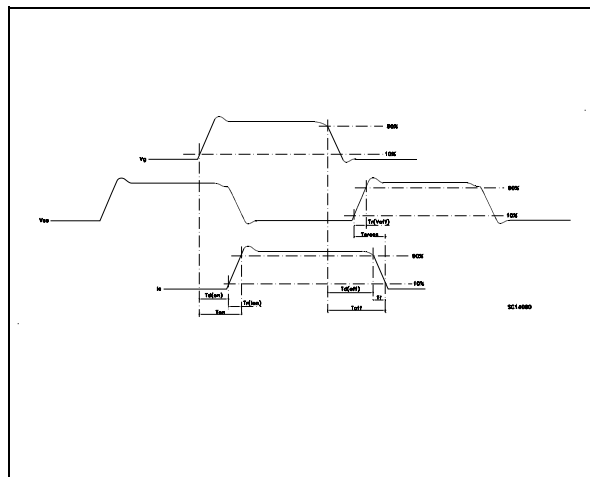


Figure 22: Gate Charge Test Circuit

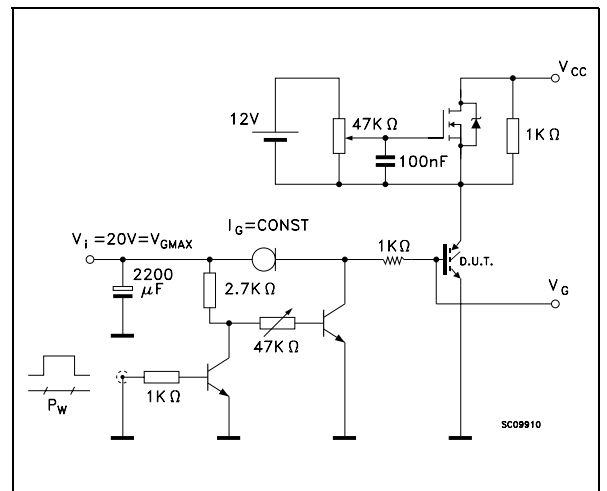
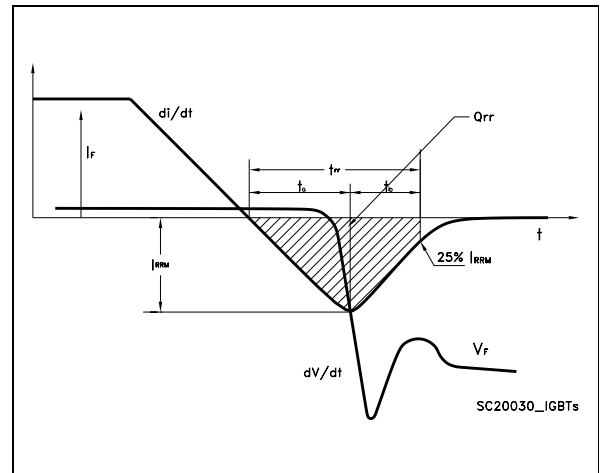
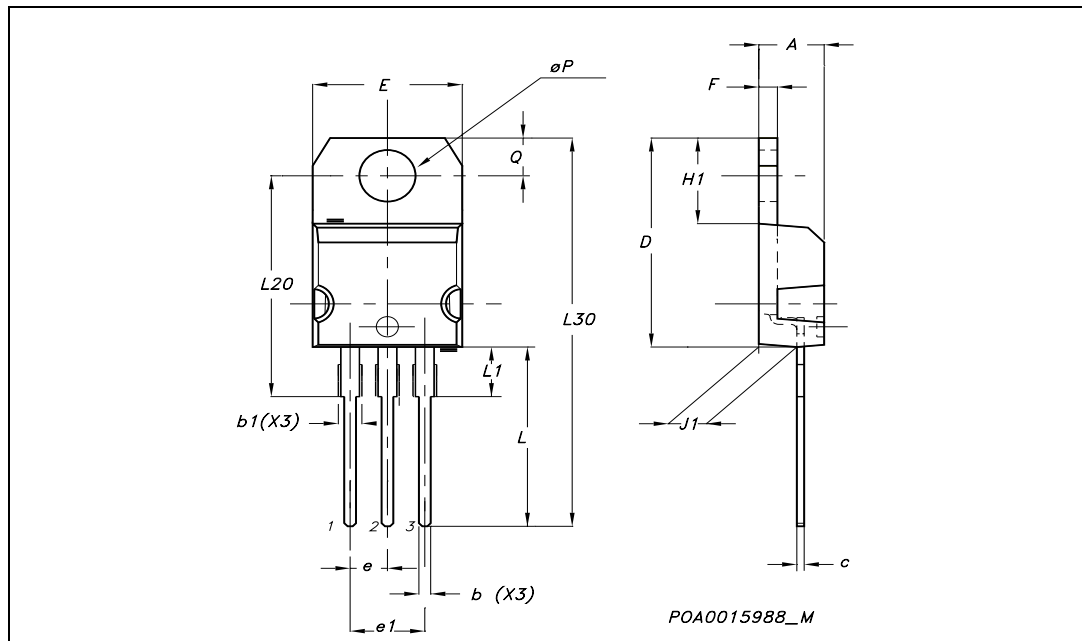


Figure 23: Diode Recovery Time Waveforms



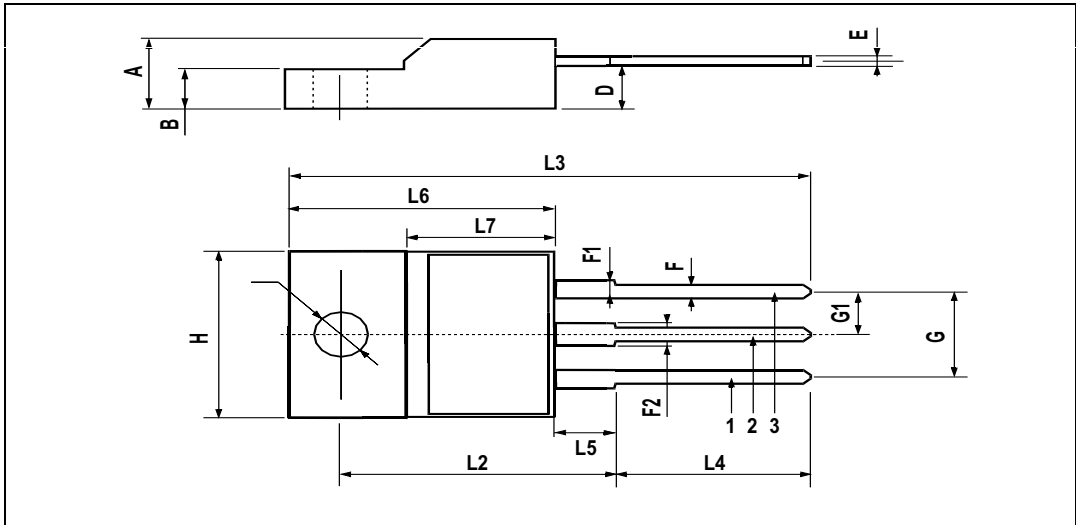
**TO-220 MECHANICAL DATA**

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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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



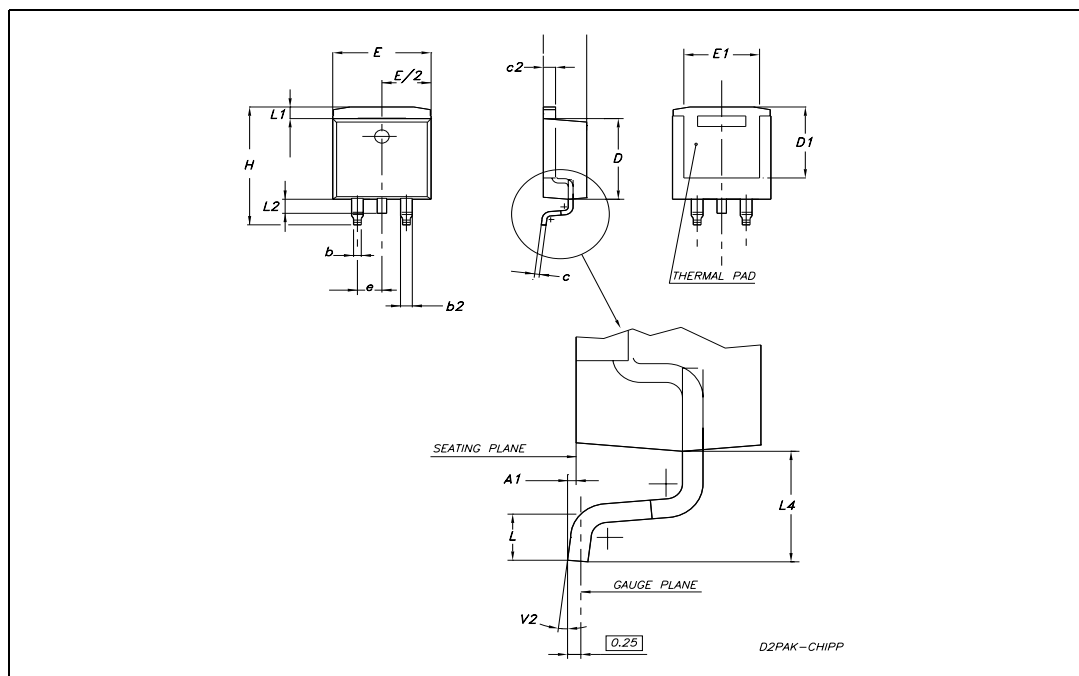
TO-220FP MECHANICAL DATA

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
∅	3		3.2	0.118		0.126

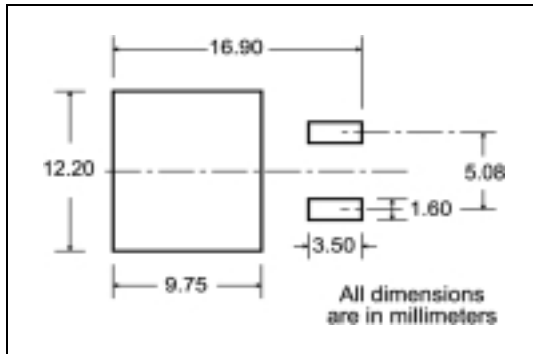


TO-263 (D<sup>2</sup>PAK) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.32		4.57	0.178		0.180
A1	0.00		0.25	0.00		0.009
b	0.71		0.91	0.028		0.350
b2	1.15		1.40	0.045		0.055
c	0.46		0.61	0.018		0.024
c2	1.22		1.40	0.048		0.055
D	8.89	9.02	9.40	0.350	0.355	0.370
D1	8.01			0.315		
E	10.04		10.28	0.395		0.404
e		2.54			0.010	
H	13.10		13.70	0.515		0.540
L	1.30		1.70	0.051		0.067
L1	1.15		1.39	0.045		0.054
L2	1.27		1.77	0.050		0.069
L4	2.70		3.10	0.106		0.122
V2	0°		8°	0°		8°



### D<sup>2</sup>PAK FOOTPRINT



### TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

**REEL MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

10 pitches cumulative tolerance on tape  $\pm 0.2$  mm

Center line of cavity

Bending radius R min.

\* on sales type

**Table 11: Revision History 9**

<b>Date</b>	<b>Revision</b>	<b>Description of Changes</b>
07-Jun-2004	4	Stylesheet update. No content change
19-Aug-2004	5	Complete Version
17-Sep-2004	6	Figure 18 has been added
09-Nov-2004	7	Final datasheet
19-Jan-2005	8	Datasheet updated
09-Jun-2005	9	Modified title

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