



# STGB6NC60HD - STGB6NC60HD-1 STGF6NC60HD - STGP6NC60HD

N-channel 600V - 7A - I<sup>2</sup>PAK / D<sup>2</sup>PAK / TO-220 / TO-220FP  
Very fast PowerMESH™ IGBT

## Features

Type	V <sub>CE</sub>	V <sub>CE(sat)</sub> max @25°C	I <sub>C</sub> @100°C
STGB6NC60HD	600V	<2.5V	7A
STGB6NC60HD-1	600V	<2.5V	7A
STGP6NC60HD	600V	<2.5V	7A
STGF6NC60HD	600V	<2.5V	3A

- Low on voltage drop (V<sub>cesat</sub>)
- Low C<sub>RES</sub> / C<sub>IES</sub> ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- High frequency operation

## Description

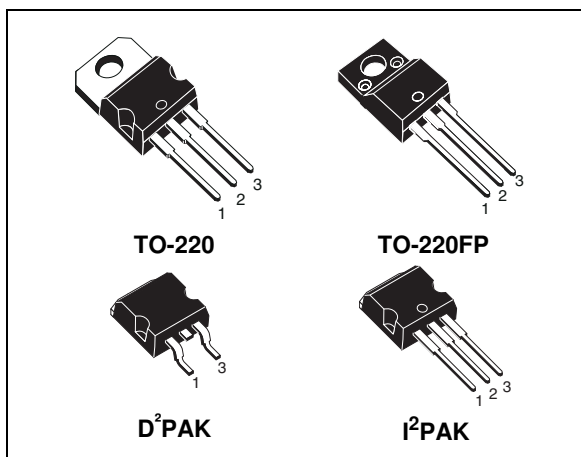
Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix “H” identifies a family optimized for high frequency application in order to achieve very high switching performances (reduced t<sub>fall</sub>) maintaining a low voltage drop.

## Applications

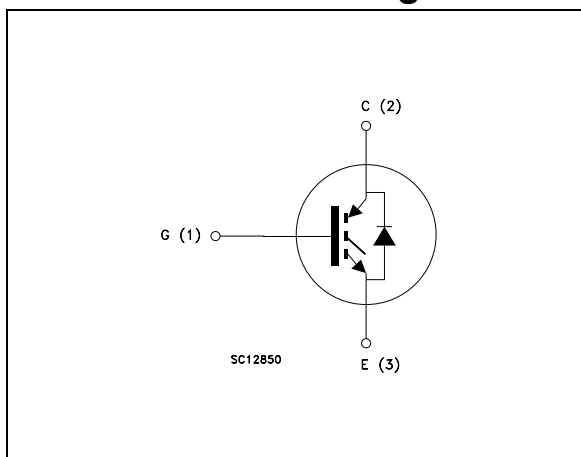
- High frequency inverters
- SMPS and PFC in both hard switch and resonant topologies
- Motor drivers

## Order codes

Part number	Marking	Package	Packaging
STGB6NC60HDT4	GB6NC60HD	D <sup>2</sup> PAK	Tape & reel
STGB6NC60HD-1	GB6NC60HD	I <sup>2</sup> PAK	Tube
STGP6NC60HD	GP6NC60HD	TO-220	Tube
STGF6NC60HD	GF6NC60HD	TO-220FP	Tube



## Internal schematic diagram



# Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK/I <sup>2</sup> PAK/ TO-220	TO-220FP	
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	15	6	A
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 100°C	7	3	A
I <sub>CM</sub> <sup>(2)</sup>	Collector current (pulsed)	21		A
V <sub>GE</sub>	Gate-emitter voltage	±20		V
I <sub>F</sub>	Diode RMS forward current at T <sub>c</sub> =25°C	10		A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25°C	56	20	W
V <sub>ISO</sub>	Insulation withstand voltage A.C.(t=1sec;Tc=25°C)	--	2500	
T <sub>stg</sub>	Storage temperature	- 55 to 150		°C
T <sub>j</sub>	Operating junction temperature			
T <sub>l</sub>	Maximum lead temperature for soldering purpose (for 10sec. 1.6 mm from case)	300		°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. Pulse width limited by max junction temperature

**Table 2. Thermal resistance**

Symbol	Parameter		Value	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case max	TO-220 D <sup>2</sup> PAK I <sup>2</sup> PAK	2	°C/W
		TO-220FP	5	°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	$I_C = 1\text{mA}, V_{GE} = 0$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{V}, I_C = 3\text{A}$ $V_{GE} = 15\text{V}, I_C = 3\text{A}, T_C = 125^{\circ}C$		1.9 1.7	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\ \mu\text{A}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max rating}, T_C = 25^{\circ}C$ $V_{CE} = \text{Max rating}, T_C = 125^{\circ}C$			10 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{V}, V_{CE} = 0$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{V}, I_C = 3\text{A}$		3		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{V}, f = 1\text{MHz},$ $V_{GE} = 0$		205		pF
$C_{oes}$	Output capacitance			32		pF
$C_{res}$	Reverse transfer capacitance			5.5		pF
$Q_g$	Total gate charge	$V_{CE} = 390\text{V}, I_C = 3\text{A},$ $V_{GE} = 15\text{V},$ <i>(see Figure 18)</i>		13.6		nC
$Q_{ge}$	Gate-emitter charge			3.4		nC
$Q_{gc}$	Gate-collector charge			5.1		nC
$I_{CL}$	Turn-off SOA minimum current	$V_{clamp} = 390\text{V}, T_J = 150^{\circ}C,$ $R_G = 10\ \Omega, V_{GE} = 15\text{V}$		19		A

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390V, I_C = 3A$		12		ns
$t_r$	Current rise time	$R_G = 10\Omega, V_{GE} = 15V,$		5		ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 25^\circ C$ (see Figure 19)		612		A/ $\mu s$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390V, I_C = 3A$		13		ns
$t_r$	Current rise time	$R_G = 10\Omega, V_{GE} = 15V,$		4.3		ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 125^\circ C$ (see Figure 19)		560		A/ $\mu s$
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390V, I_C = 3A,$		40		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\Omega, V_{GE} = 15V,$		76		ns
$t_f$	Current fall time	$T_j = 25^\circ C$ (see Figure 19)		100		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390V, I_C = 3A,$		60		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\Omega, V_{GE} = 15V,$		98		ns
$t_f$	Current fall time	$T_j = 125^\circ C$ (see Figure 19)		124		ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 3A$		20		$\mu J$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$		68		$\mu J$
$E_{ts}$	Total switching losses	$T_j = 25^\circ C$ (see Figure 19)		88		$\mu J$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 3A$		37		$\mu J$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$		93		$\mu J$
$E_{ts}$	Total switching losses	$T_j = 125^\circ C$ (see Figure 19)		130		$\mu J$

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 17. 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)
2. 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	$I_f = 1.5A$ $I_f = 1.5A, T_j = 125^\circ C$		1.6	2.1	V
				1.3		V
$t_{rr}$	Reverse recovery time	$I_f = 3A, V_R = 40V,$ $T_j = 25^\circ C, di/dt = 100 A/\mu s$ <i>(see Figure 20)</i>		21		ns
$Q_{rr}$	Reverse recovery charge			14		nC
$I_{rrm}$	Reverse recovery current			1.36		A
$t_{rr}$	Reverse recovery time	$I_f = 3A, V_R = 40V,$ $T_j = 125^\circ C, di/dt = 100A/\mu s$ <i>(see Figure 20)</i>		34		ns
$Q_{rr}$	Reverse recovery charge			32		nC
$I_{rrm}$	Reverse recovery current			1.88		A

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

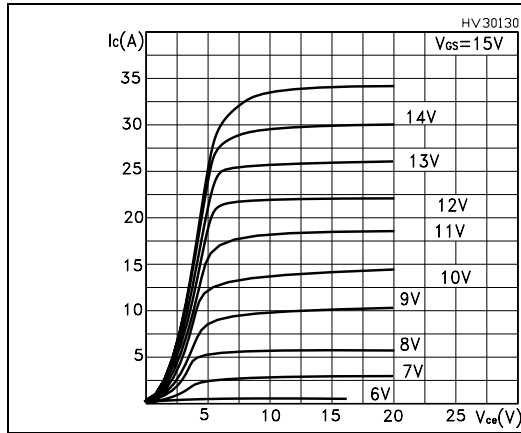


Figure 2. Transfer characteristics

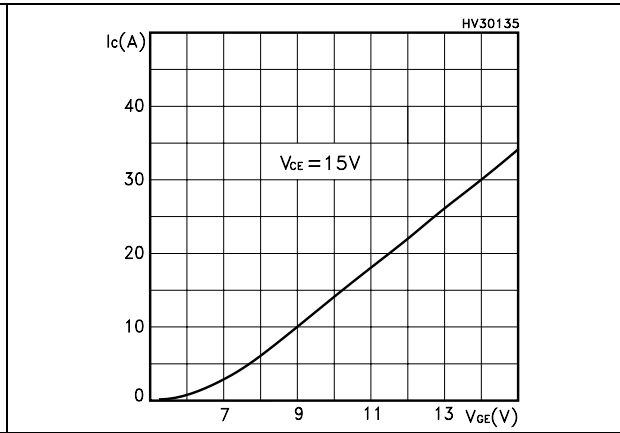


Figure 3. Transconductance

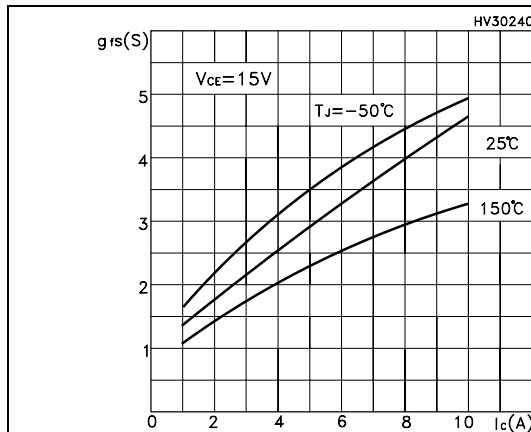


Figure 4. Collector-emitter on voltage vs temperature

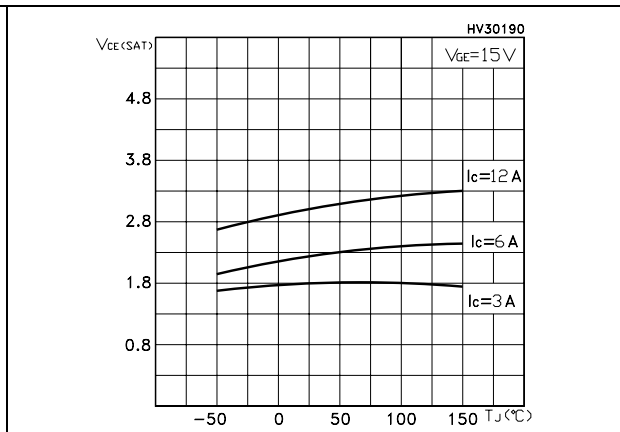


Figure 5. Gate charge vs gate-source voltage

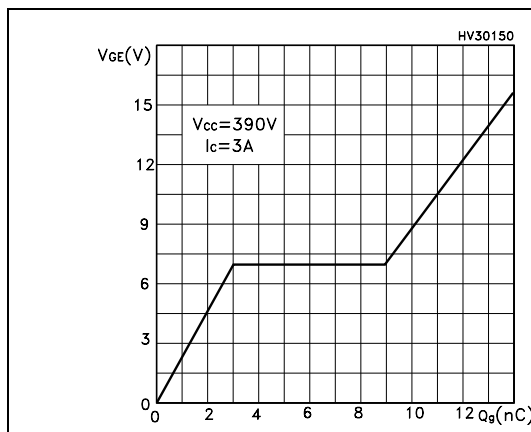


Figure 6. Capacitance variations

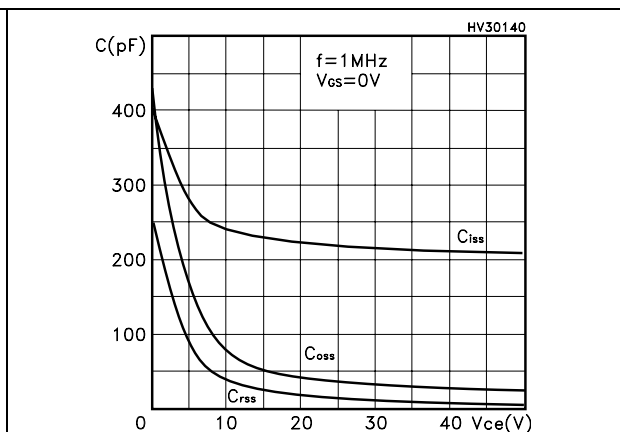


Figure 7. Normalized gate threshold voltage vs temperature

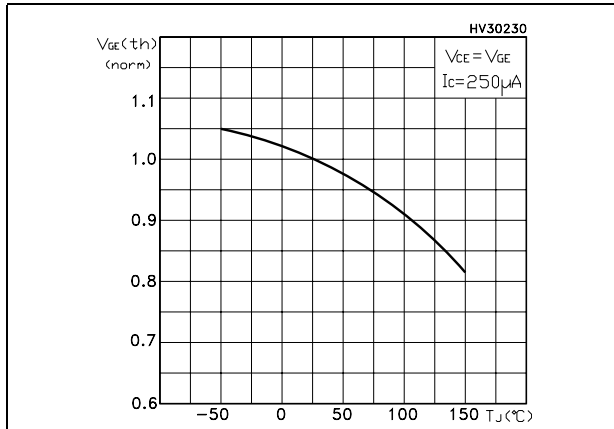


Figure 8. Collector-emitter on voltage vs collector current

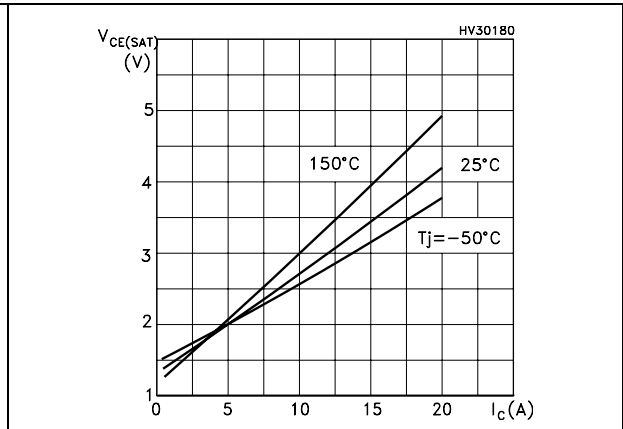


Figure 9. Normalized breakdown voltage vs temperature

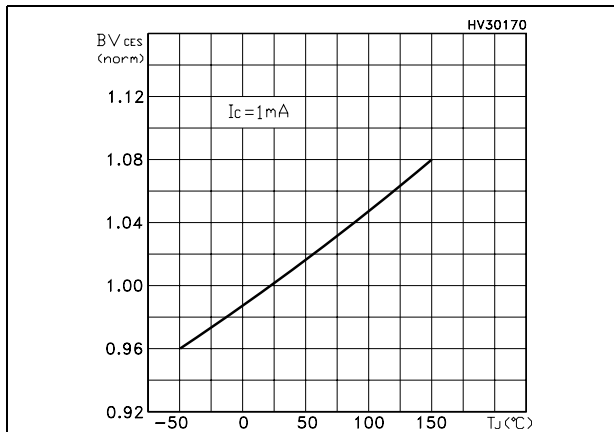


Figure 10. Switching losses vs temperature

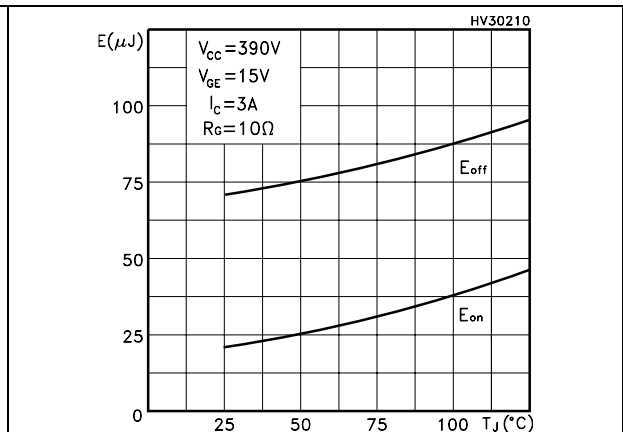


Figure 11. Switching losses vs gate resistance

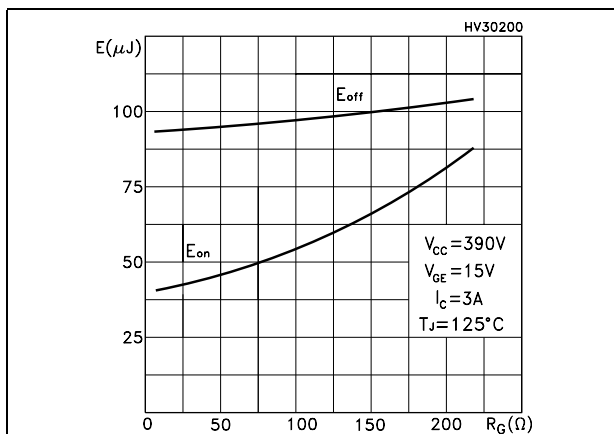


Figure 12. Switching losses vs collector current

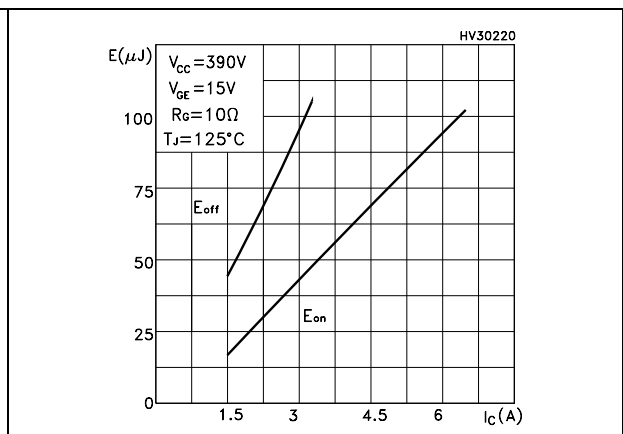




Figure 13. Thermal impedance for TO-220 / D<sup>2</sup>PAK / I<sup>2</sup>PAK

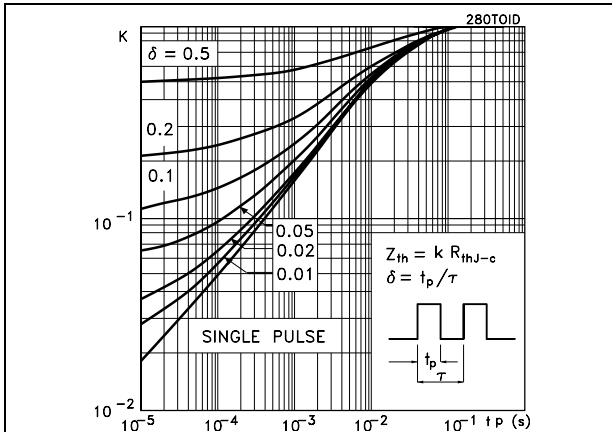


Figure 14. Turn-off SOA

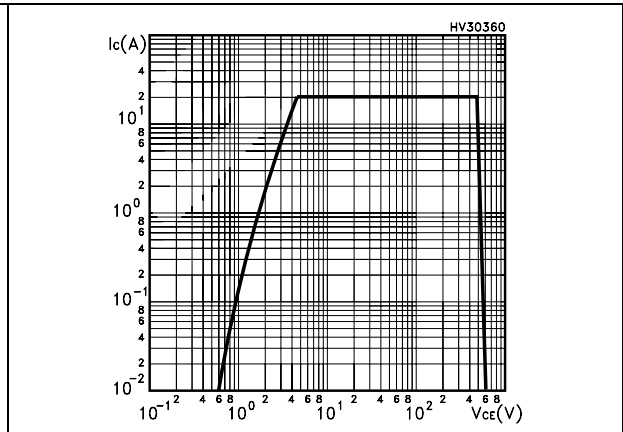


Figure 15. Thermal impedance for TO-220FP

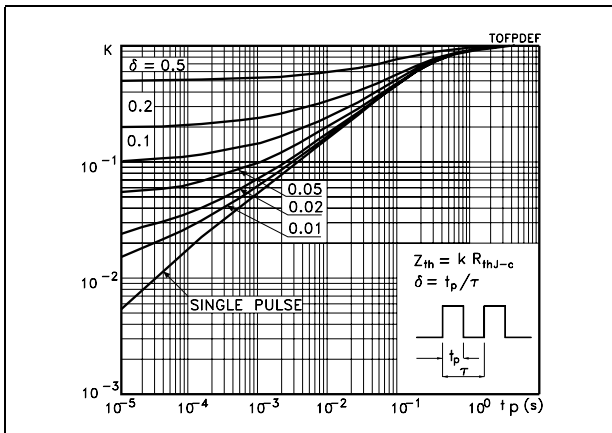
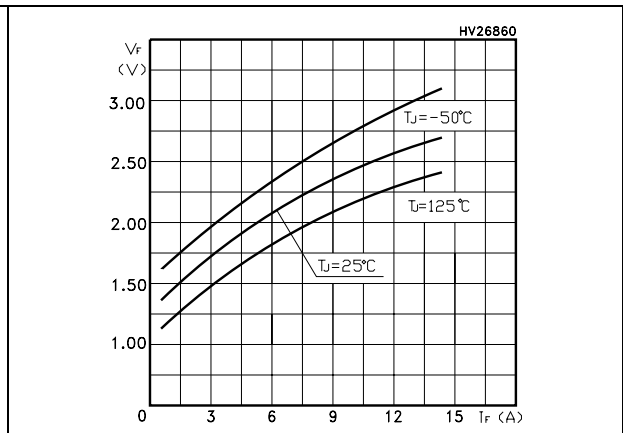


Figure 16. Emitter-collector diode characteristics



### 3 Test circuit

Figure 17. Test circuit for inductive load switching

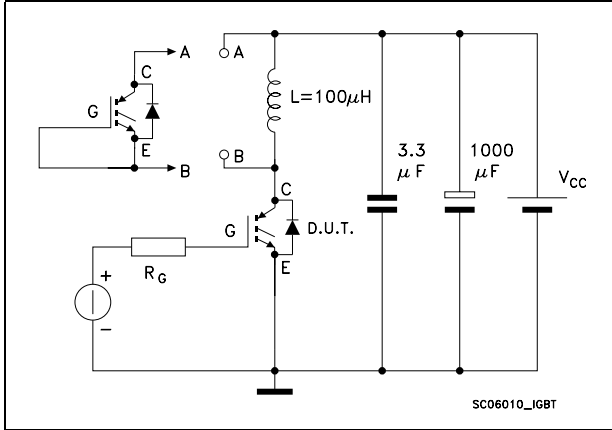


Figure 18. Gate charge test circuit

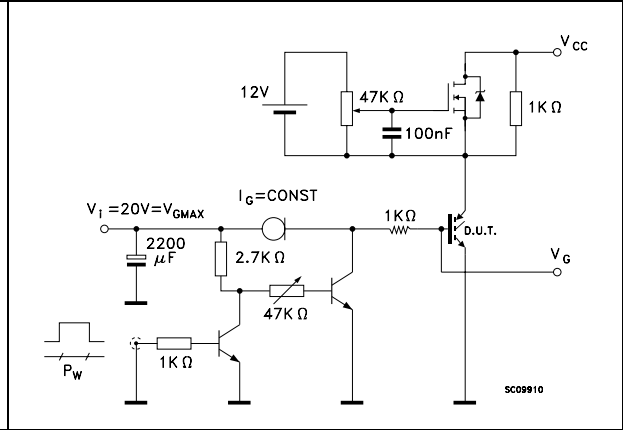


Figure 19. Switching waveform

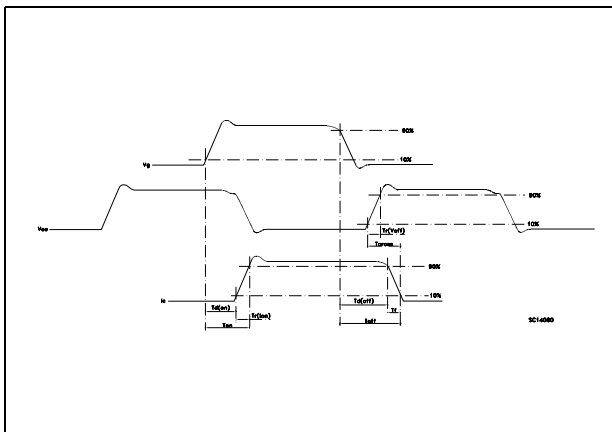
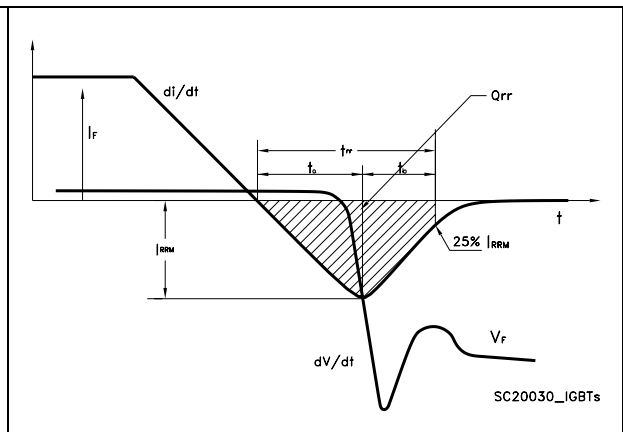


Figure 20. Diode recovery time waveform

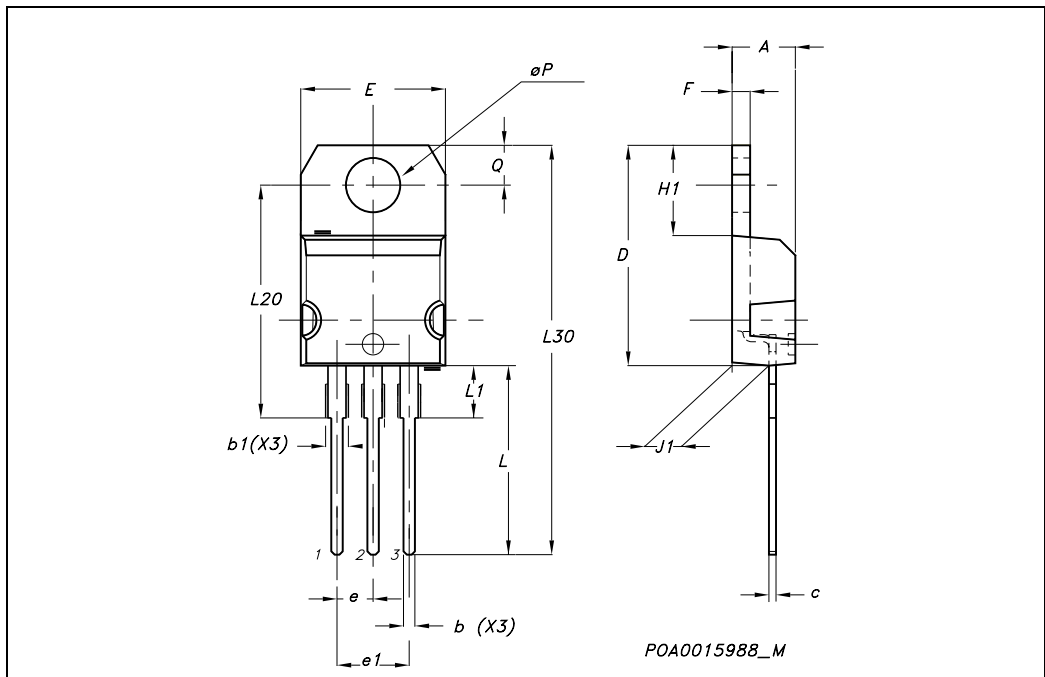


## 4 Package mechanical data

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)

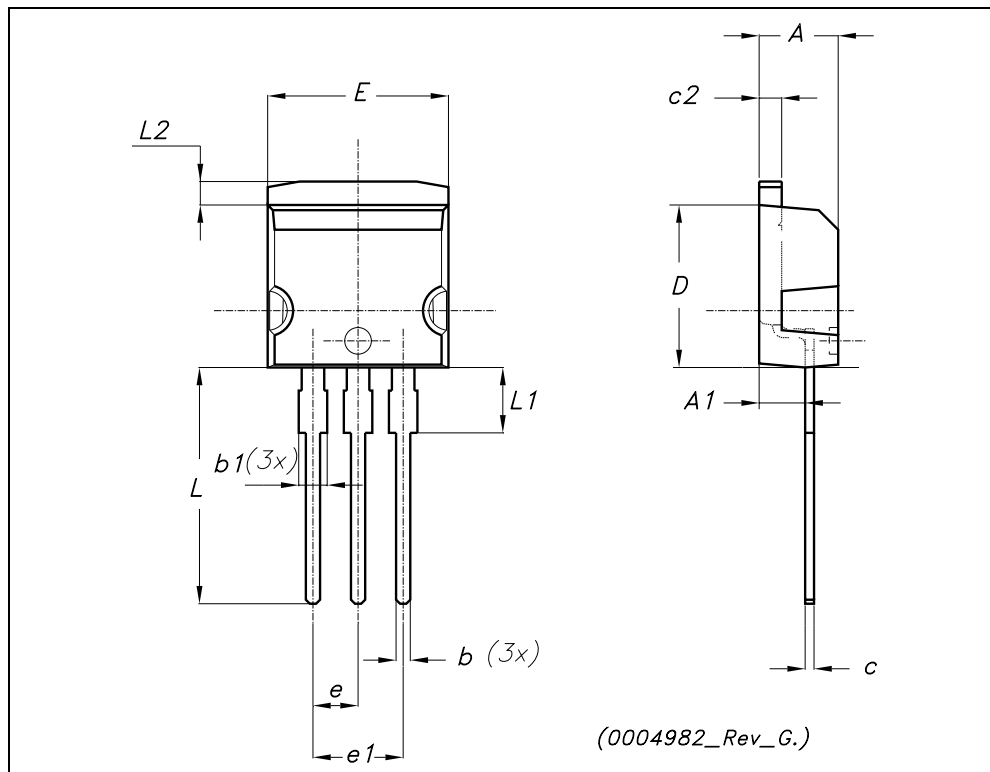
**TO-220 MECHANICAL DATA**

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	1.15		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



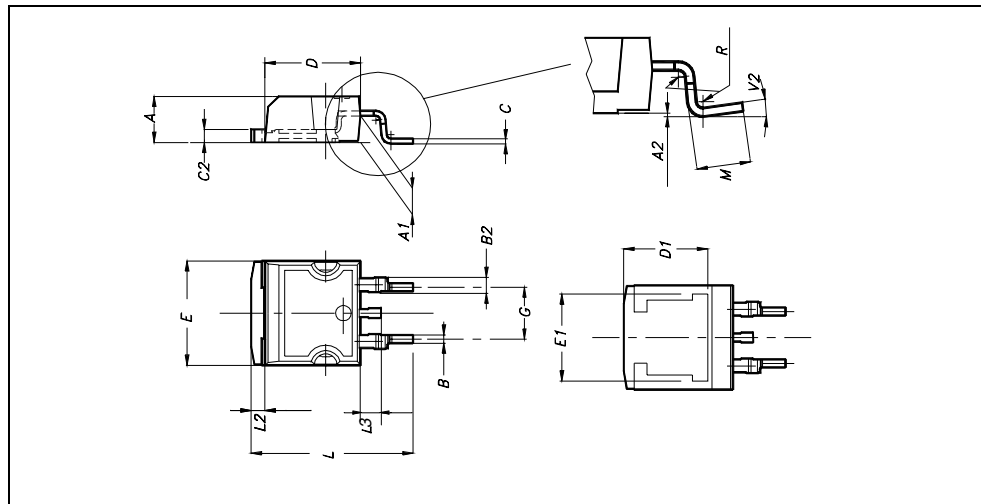
**TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
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
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



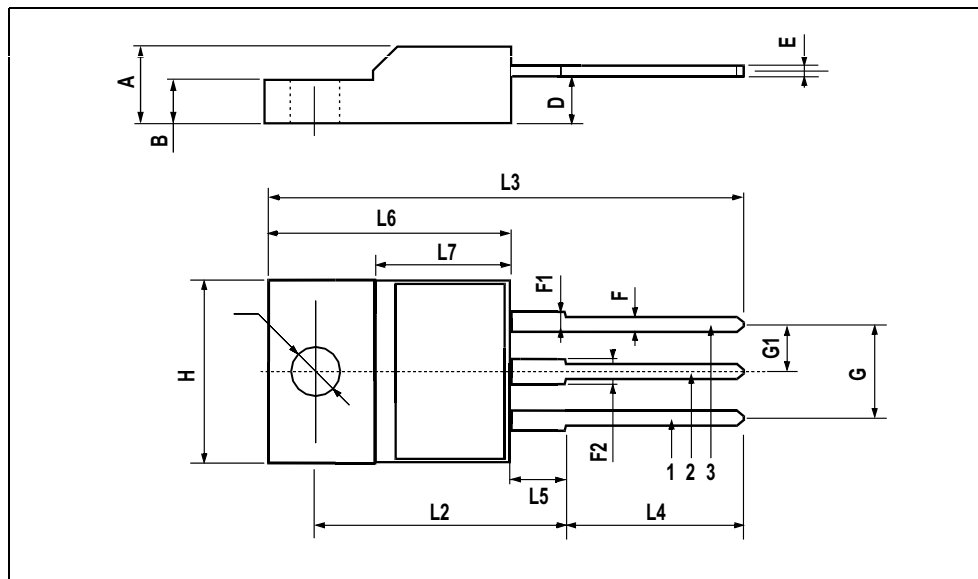
**D<sup>2</sup>PAK MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		4°			



**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



# 5 Packaging mechanical data

## 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 +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius

R min.

\* on sales type



## 6 Revision history

Table 8. Revision history

Date	Revision	Changes
28-Nov-2005	1	First Release
07-Mar-2006	2	Complete version
31-Jul-2006	3	Modified <a href="#">Figure 10</a> .
26-Apr-2007	4	Inserted package I <sup>2</sup> PAK

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