



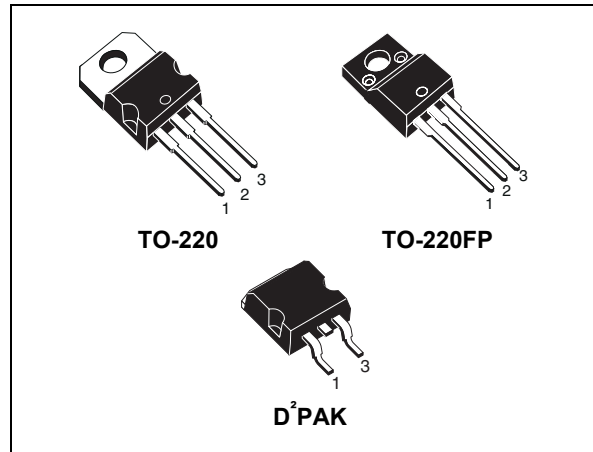
# STGB10NC60KD STGF10NC60KD - STGP10NC60KD

N-channel 600V - 10A - D<sup>2</sup>PAK / TO-220 / TO-220FP  
Short circuit rated PowerMESH™ IGBT

## General features

Type	V <sub>CE</sub>	V <sub>CE(sat)</sub> Max @25°C	I <sub>C</sub> @100°C
STGB10NC60KD	600V	<2.5V	10A
STGP10NC60KD	600V	<2.5V	10A
STGF10NC60KD	600V	<2.5V	6A

- Lower on voltage drop (V<sub>cesat</sub>)
- Lower C<sub>RES</sub> / C<sub>IES</sub> ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- Short circuit withstand time 10μs



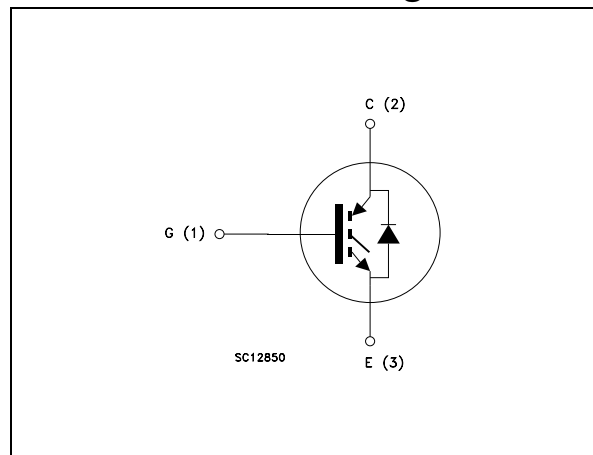
## Description

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 “K” identifies a family optimized for high frequency motor control applications with short circuit withstand capability.

## Applications

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

## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STGB10NC60KDT4	GB10NC60KD	D <sup>2</sup> PAK	Tape & reel
STGP10NC60KD	GP10NC60KD	TO-220	Tube
STGF10NC60KD	GF10NC60KD	TO-220FP	Tube

## Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		D <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	20	9	A
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 100°C	10	6	A
I <sub>CM</sub> <sup>(2)</sup>	Collector current (pulsed)	30		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	60	25	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s;T <sub>C</sub> =25°C)	--	2500	
T <sub>stg</sub>	Storage temperature	- 55 to 150		°C
T <sub>j</sub>	Operating junction temperature			
T <sub>scw</sub>	Short circuit withstand time	10		µs
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	2.08	°C/W
		TO-220FP	5.0	°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	$I_C = 1\text{mA}, V_{GE} = 0$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{V}, I_C = 5\text{A}$		2.2	2.5	V
		$V_{GE} = 15\text{V}, I_C = 5\text{A}, T_C = 125^{\circ}C$		1.8		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\ \mu\text{A}$	4.5		6.5	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max rating}, T_C = 25^{\circ}C$			150	$\mu\text{A}$
		$V_{CE} = \text{Max rating}, T_C = 125^{\circ}C$			1	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	$V_{CE} = 15\text{V}, I_C = 5\text{A}$		15		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$ $C_{oes}$ $C_{res}$	Input capacitance	$V_{CE} = 25\text{V}, f = 1\text{MHz},$ $V_{GE} = 0$		380		pF
	Output capacitance			46		pF
	Reverse transfer capacitance			8.5		pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total gate charge	$V_{CE} = 390\text{V}, I_C = 5\text{A},$		19		nC
	Gate-emitter charge	$V_{GE} = 15\text{V},$		5		nC
	Gate-collector charge	(see Figure 18)		9		nC

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

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	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V, T_j = 25^\circ C$ (see Figure 19)		17 6 655		ns ns A/ $\mu s$
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ (see Figure 19)		16.5 6.5 575		ns ns A/ $\mu s$
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390V, I_C = 5A,$ $R_{GE} = 10\Omega, V_{GE} = 15V, T_j = 25^\circ C$ (see Figure 19)		33 72 82		ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390V, I_C = 5A,$ $R_{GE} = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ (see Figure 19)		60 106 136		ns ns ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V, T_j = 25^\circ C$ (see Figure 19)		55 85 140		$\mu J$ $\mu J$ $\mu J$
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ (see Figure 19)		87 162 249		$\mu J$ $\mu J$ $\mu J$

1.  $E_{on}$  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-pak diode, the co-pak 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	$I_f = 2.5A$		1.6	2.1	V
		$I_f = 2.5A, T_j = 125^\circ C$		1.3		V
$t_{rr}$	Reverse recovery time	$I_f = 5A, V_R = 30V,$		23.5		ns
$Q_{rr}$	Reverse recovery charge	$T_j = 25^\circ C, di/dt = 100 A/\mu s$		16.5		nC
$I_{rrm}$	Reverse recovery current	(see Figure 20)		1.4		A
$t_{rr}$	Reverse recovery time	$I_f = 5A, V_R = 30V,$		39		ns
$Q_{rr}$	Reverse recovery charge	$T_j = 125^\circ C, di/dt = 100A/\mu s$		39		nC
$I_{rrm}$	Reverse recovery current	(see Figure 20)		2		A

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

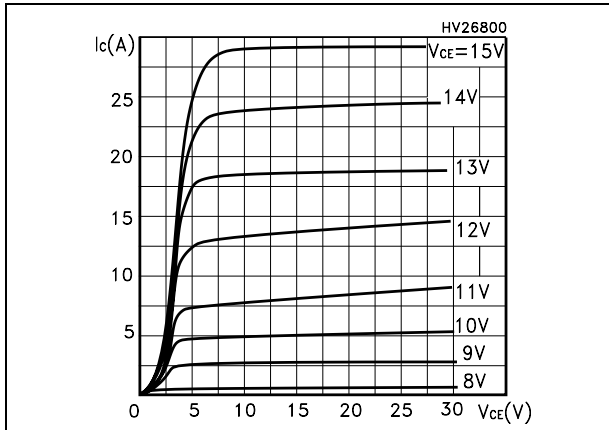


Figure 2. Transfer characteristics

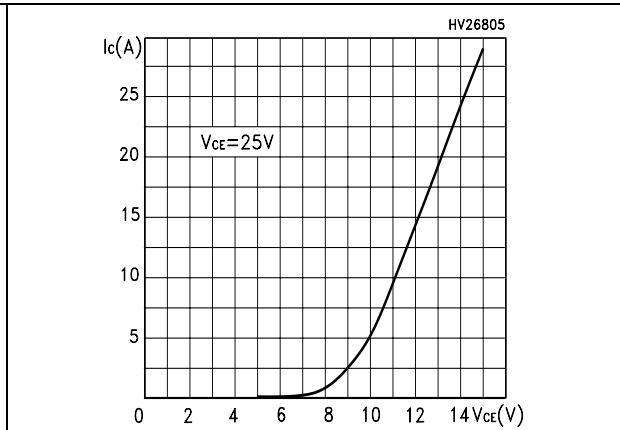


Figure 3. Transconductance

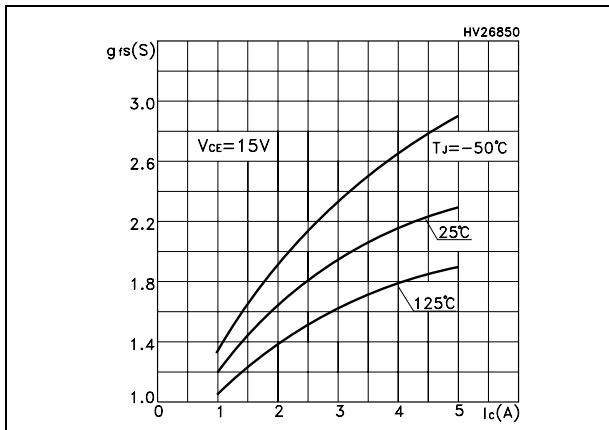


Figure 4. Collector-emitter on voltage vs temperature

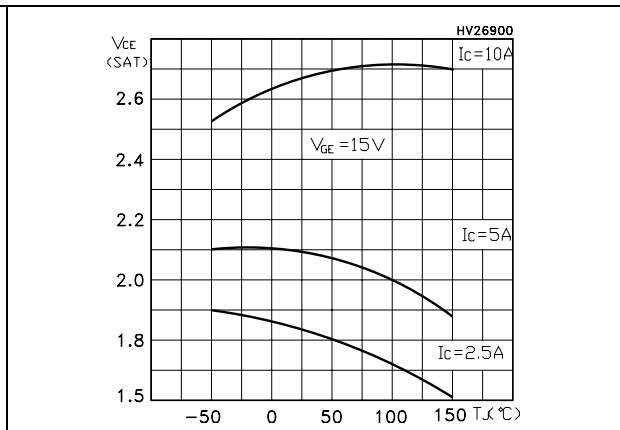


Figure 5. Gate charge vs gate-source voltage Figure 6. Capacitance variations

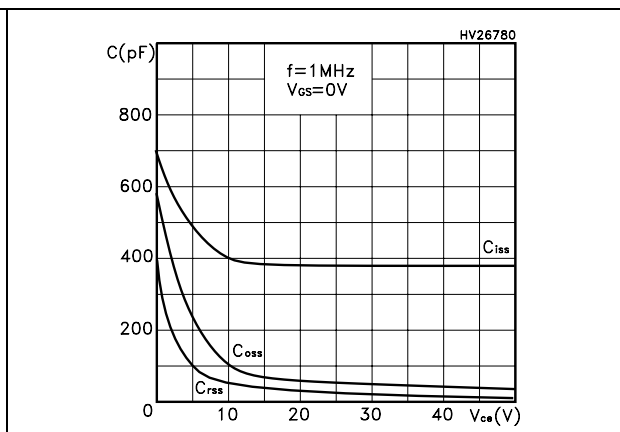
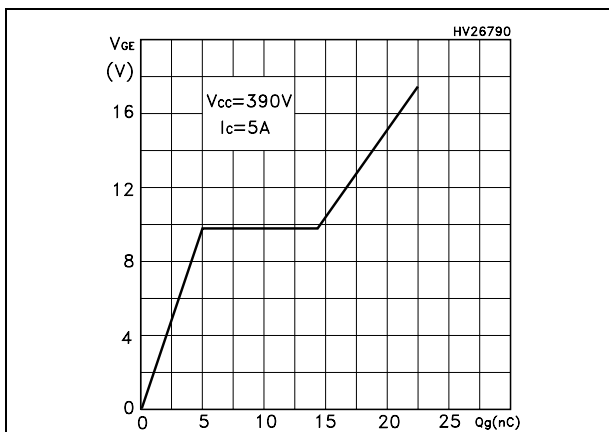


Figure 7. Normalized gate threshold voltage vs temperature

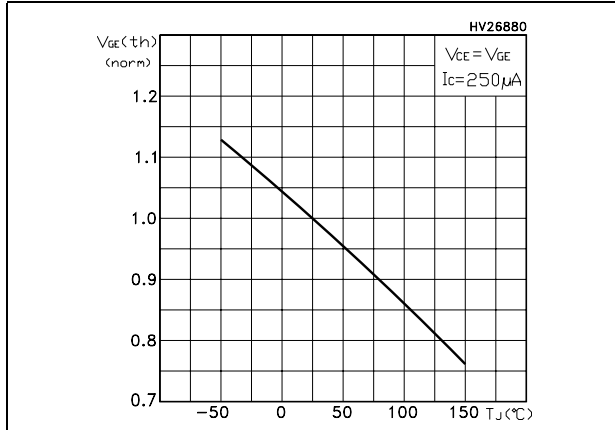


Figure 8. Collector-emitter on voltage vs collector current

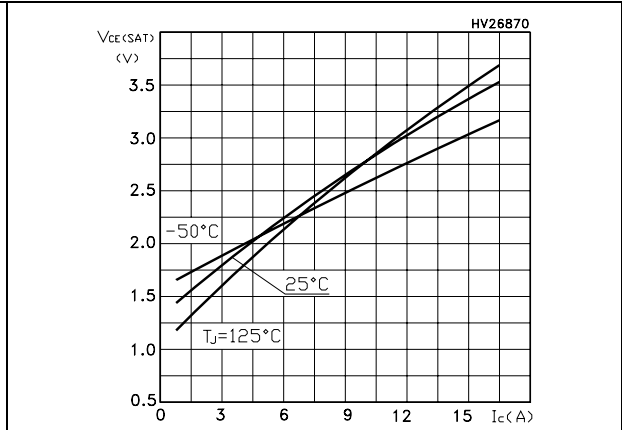


Figure 9. Normalized breakdown voltage vs temperature

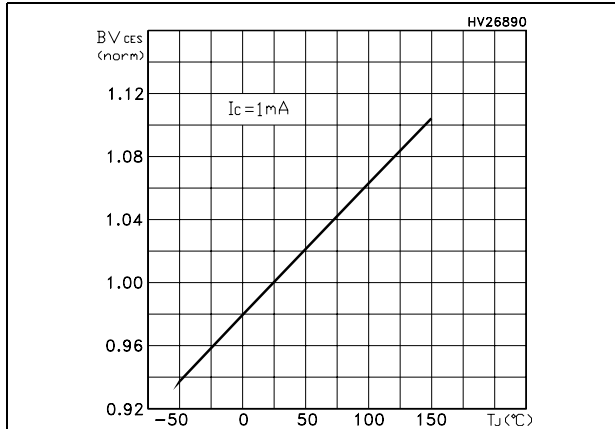


Figure 10. Switching losses vs temperature

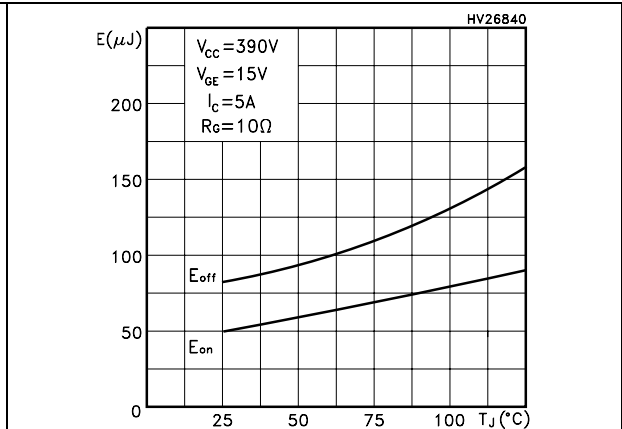


Figure 11. Switching losses vs gate resistance

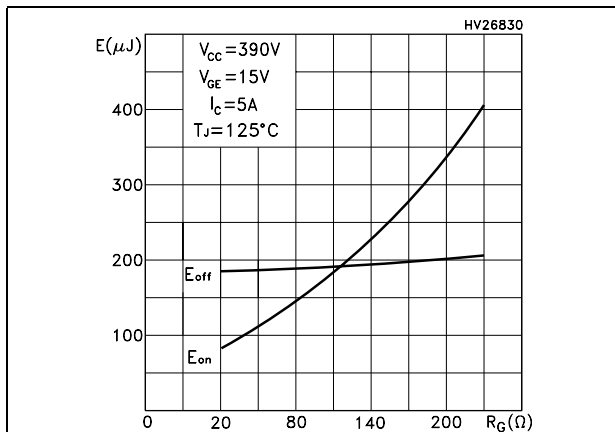


Figure 12. Switching losses vs collector current

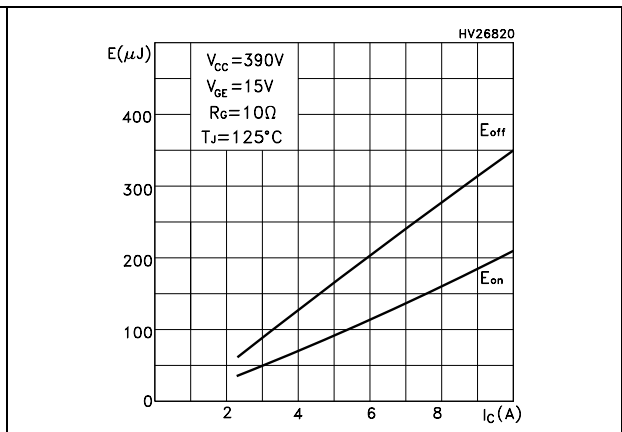




Figure 13. Thermal impedance for TO-220/  
D<sup>2</sup>PAK

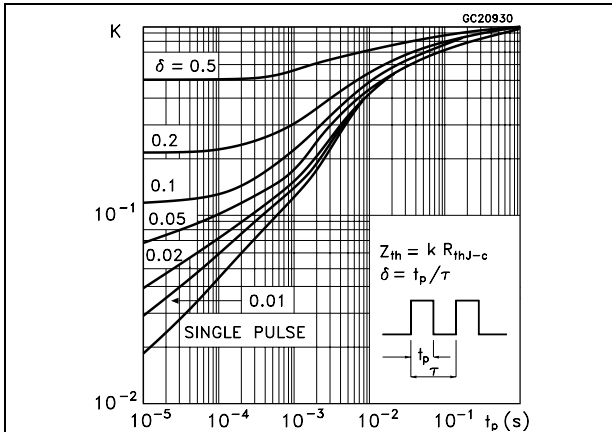


Figure 14. Turn-off SOA

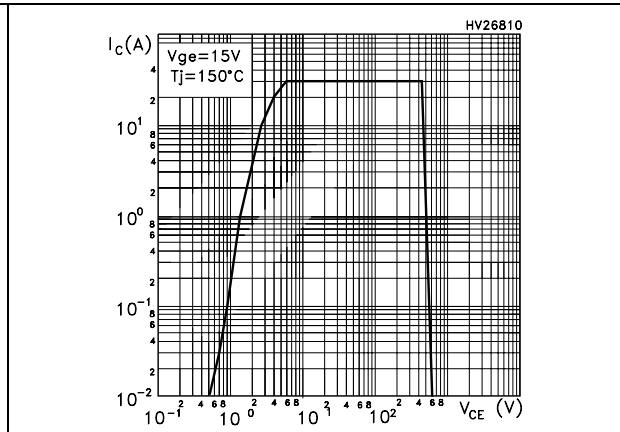


Figure 15. Emitter-collector diode  
characteristics

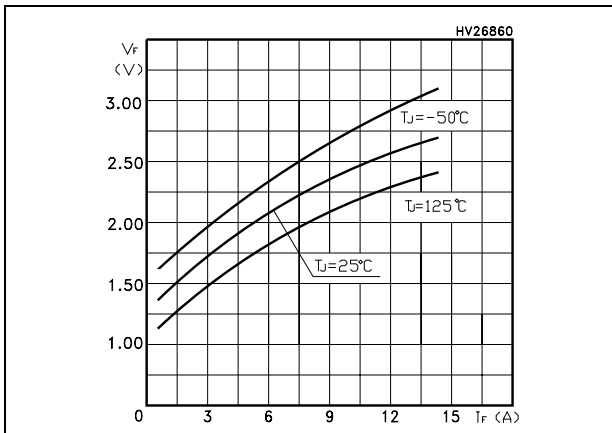
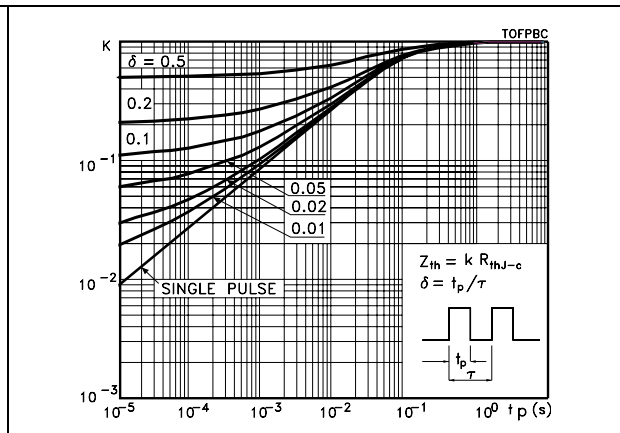


Figure 16. Thermal impedance for TO-220FP



### 3 Test circuit

Figure 17. Test circuit for inductive load switching

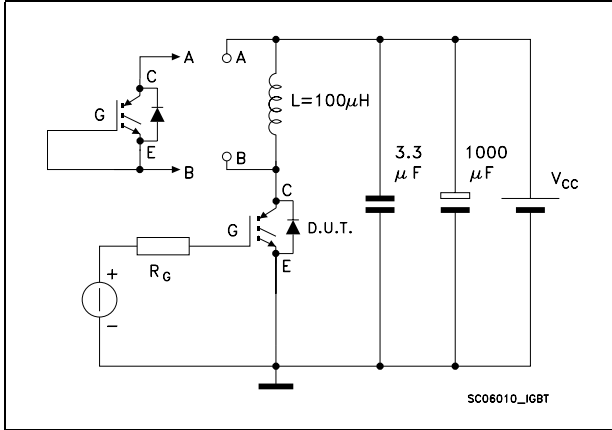


Figure 18. Gate charge test circuit

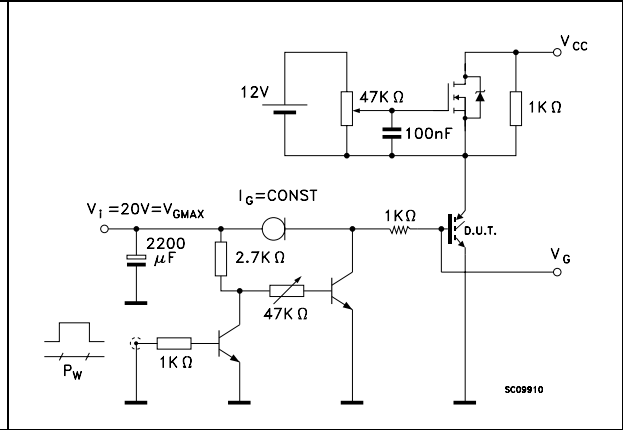


Figure 19. Switching waveform

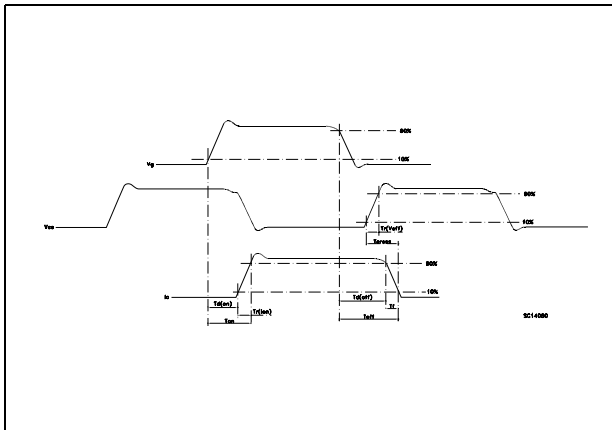
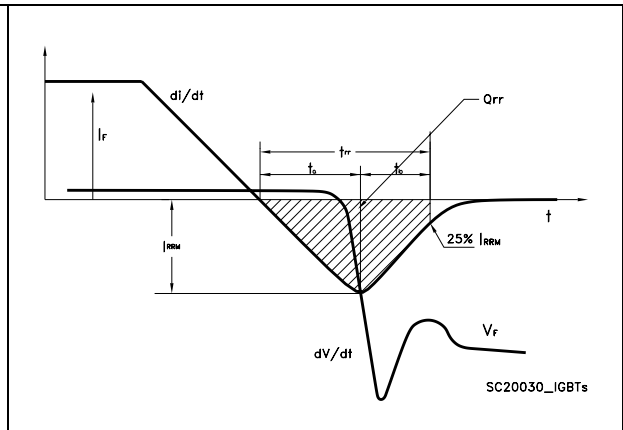


Figure 20. Diode recovery time waveform

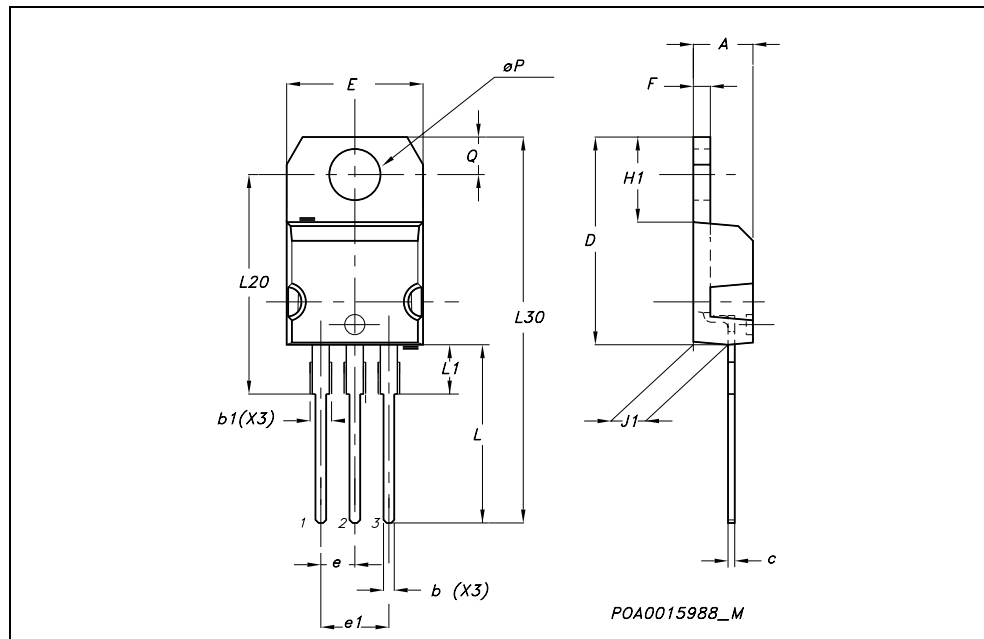


## 4 Package mechanical data

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)

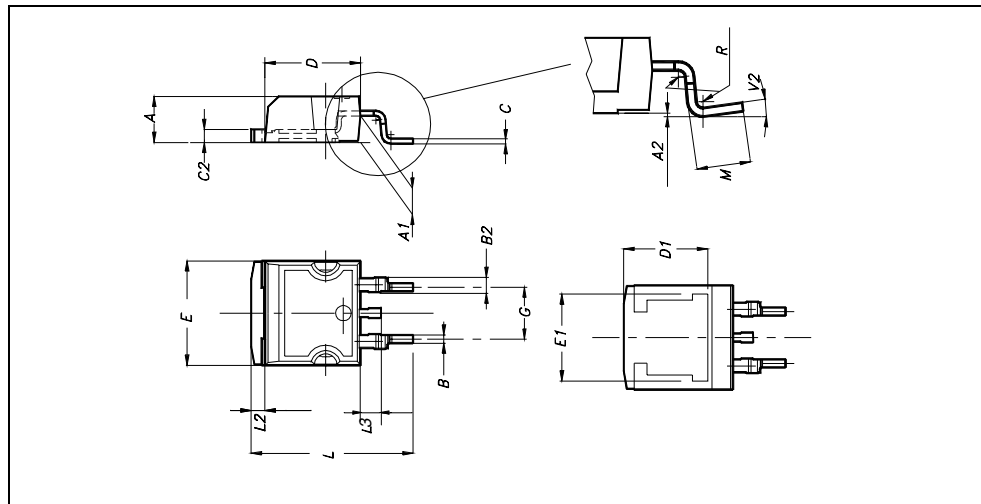
**TO-220 MECHANICAL DATA**

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



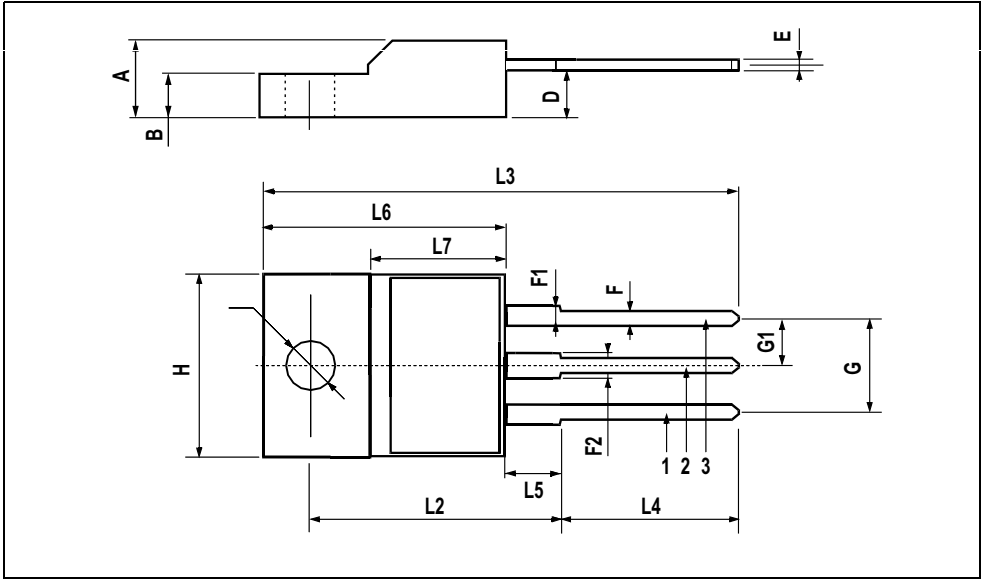
**D<sup>2</sup>PAK MECHANICAL DATA**

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

40 mm min. Access hole at slot location

Tape slot in core for tape start 2.5mm min. width

Full radius

G measured at hub

### 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

### 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

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

TRL

Bending radius R min.

\* on sales type

## 6 Revision history

**Table 8. Revision history**

Date	Revision	Changes
14-Jun-2005	1	New release
19-Jul-2005	2	Complete version
27-Jan-2006	3	Inserted ecopack indication
01-Mar-2006	4	The document has been reformatted
08-Feb-2007	5	Modified value on <a href="#">Table 5.: Switching on/off (inductive load)</a>



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