



# STGB10NC60KD, STGD10NC60KD STGF10NC60KD, STGP10NC60KD

10 A, 600 V short-circuit rugged IGBT

## Features

- Lower on voltage drop ( $V_{CE(sat)}$ )
- Lower  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- Short-circuit withstand time 10 $\mu$ s

## Description

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

## Applications

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

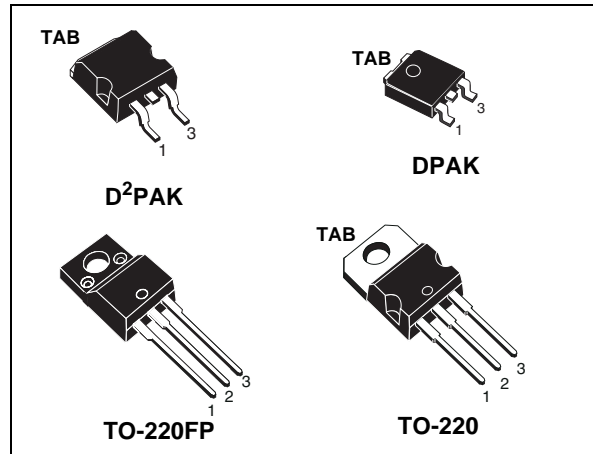


Figure 1. Internal schematic diagram

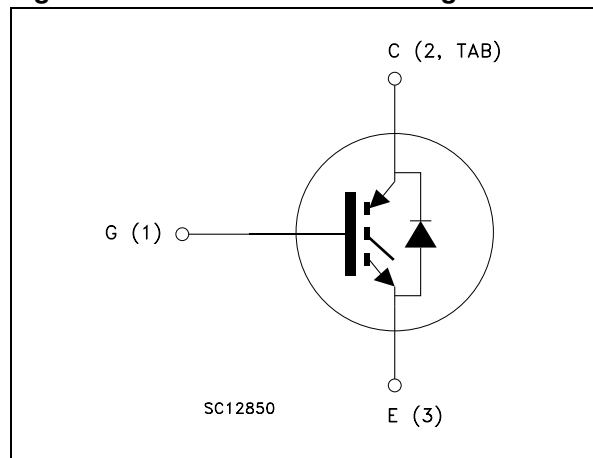


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGB10NC60KDT4	GB10NC60KD	D <sup>2</sup> PAK	Tape and reel
STGD10NC60KDT4	GD10NC60KD	DPAK	
STGF10NC60KD	GF10NC60KD	TO-220FP	Tube
STGP10NC60KD	GP10NC60KD	TO-220	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK TO-220	DPAK	TO-220FP	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	600			V
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 25°C	20		9	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100°C	10		6	A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	30			A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	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
I <sub>FSM</sub>	Surge non repetitive forward current T <sub>p</sub> = 10 ms sinusoidal	20			A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25°C	65	62	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	V
t <sub>scw</sub>	Short-circuit withstand time V <sub>CE</sub> = 0.5 V <sub>CES</sub> , T <sub>J</sub> = 125 °C, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 12 V	10			μs
T <sub>stg</sub>	Storage temperature	- 55 to 150			°C
T <sub>J</sub>	Operating junction temperature				

1. Calculated according to the iterative formula

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. V<sub>clamp</sub> = 80 % V<sub>CES</sub>, V<sub>GE</sub> = 15 V, R<sub>G</sub> = 10 Ω, T<sub>J</sub> = 150 °C

3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220 D <sup>2</sup> PAK	DPAK	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case IGBT	1.9	2	5	°C/W
$R_{thj-case}$	Thermal resistance junction-case diode	4	4.5	7	
$R_{thj-amb}$	Thermal resistance junction-ambient	62.5	100	62.5	

## 2 Electrical characteristics

( $T_j = 25^\circ\text{C}$  unless otherwise specified)

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 1\text{mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{V}$ , $I_C = 5\text{A}$ $V_{GE} = 15\text{V}$ , $I_C = 5\text{A}$ , $T_j = 125^\circ\text{C}$		2.2 1.8	2.5	V 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 ( $V_{GE} = 0$ )	$V_{CE} = 600\text{V}$ $V_{CE} = 600\text{V}$ , $T_j = 125^\circ\text{C}$			150 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{V}$			$\pm 100$	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15\text{V}$ , $I_C = 5\text{A}$		15		S

1. Pulse test: pulse duration < 300  $\mu\text{s}$ , duty cycle < 2 %

**Table 5. Dynamic**

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

**Table 6. 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	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V$ <i>(see Figure 20)</i>	-	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	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>(see Figure 20)</i>	-	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	$V_{CC} = 390V, I_C = 5A,$ $R_{GE} = 10\Omega, V_{GE} = 15V$ <i>(see Figure 20)</i>	-	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	$V_{CC} = 390V, I_C = 5A,$ $R_{GE} = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>(see Figure 20)</i>	-	60 106 136	-	ns ns ns

**Table 7. 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	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V$ <i>(see Figure 20)</i>	-	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	$V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>(see Figure 20)</i>	-	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 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F=5\text{ A}$	-	2	-	V
		$I_F=5\text{ A}, T_J=125\text{ °C}$	-	1.6	-	V
$t_{rr}$	Reverse recovery time	$I_F=5\text{ A}, V_R=40\text{ V},$ $di/dt=100\text{ A}/\mu\text{s}$	-	22	-	ns
$Q_{rr}$	Reverse recovery charge	(see <a href="#">Figure 5</a> )	-	14	-	nC
$I_{rrm}$	Reverse recovery current		-	1.3	-	A
$t_{rr}$	Reverse recovery time	$I_F=5\text{ A}, V_R=40\text{ V},$ $T_J=125\text{ °C}, di/dt=100\text{ A}/\mu\text{s}$	-	35	-	ns
$Q_{rr}$	Reverse recovery charge	(see <a href="#">Figure 5</a> )	-	40	-	nC
$I_{rrm}$	Reverse recovery current		-	2.2	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

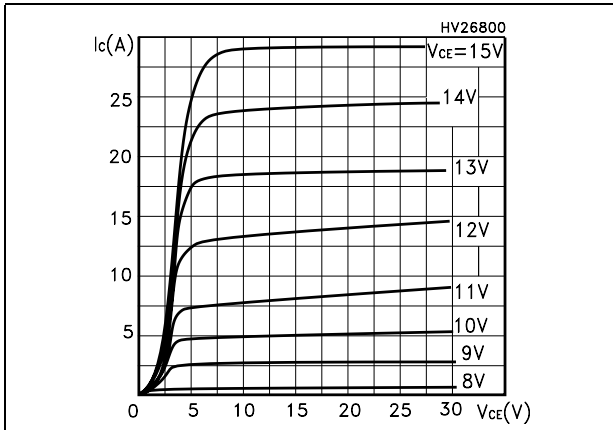


Figure 3. Transfer characteristics

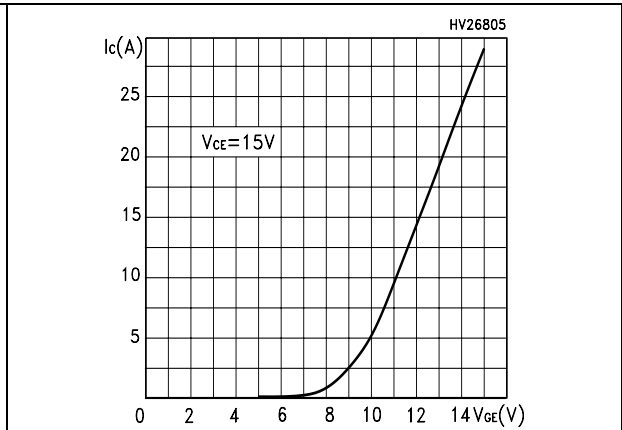


Figure 4. Transconductance

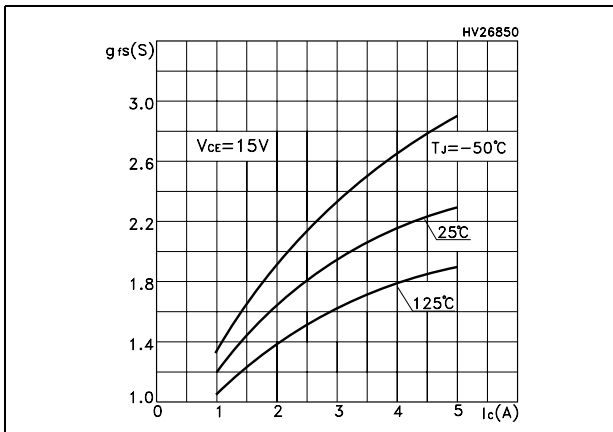


Figure 5. Collector-emitter on voltage vs temperature

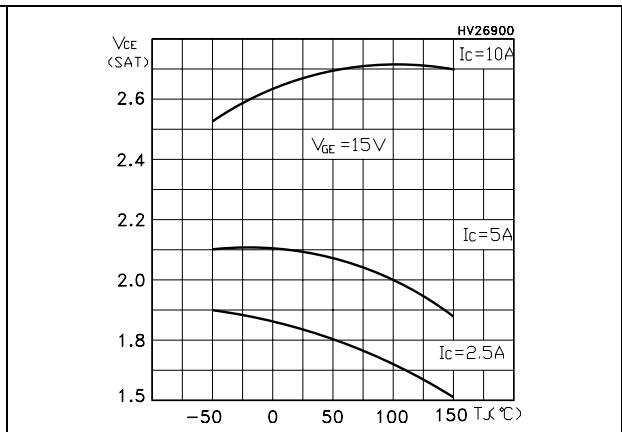


Figure 6. Gate charge vs gate-source voltage Figure 7. Capacitance variations

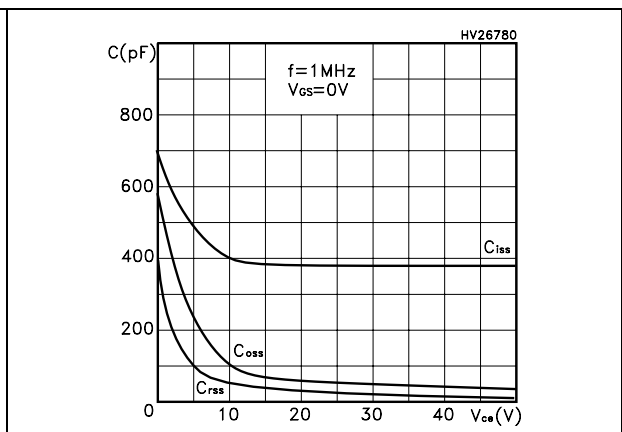
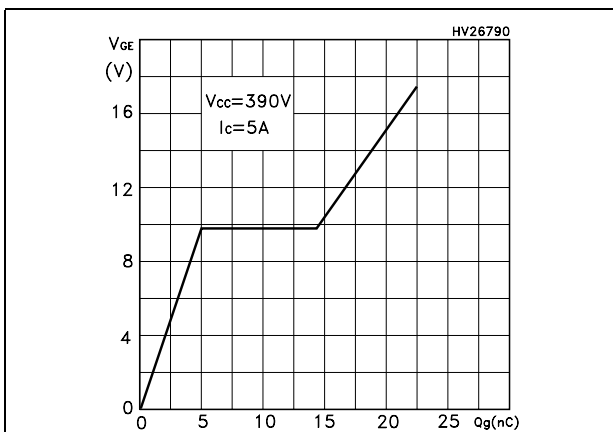




Figure 8. Normalized gate threshold voltage vs temperature

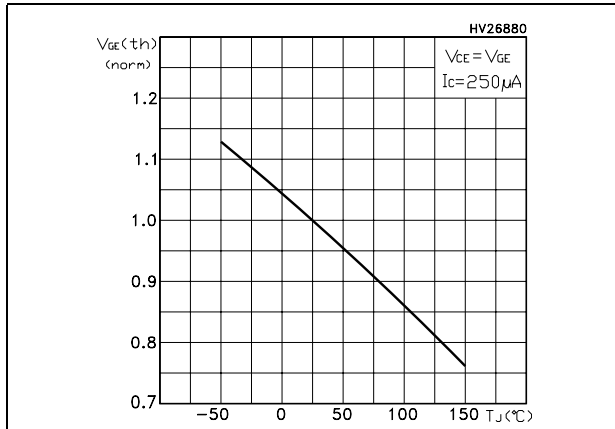


Figure 9. Collector-emitter on voltage vs collector current

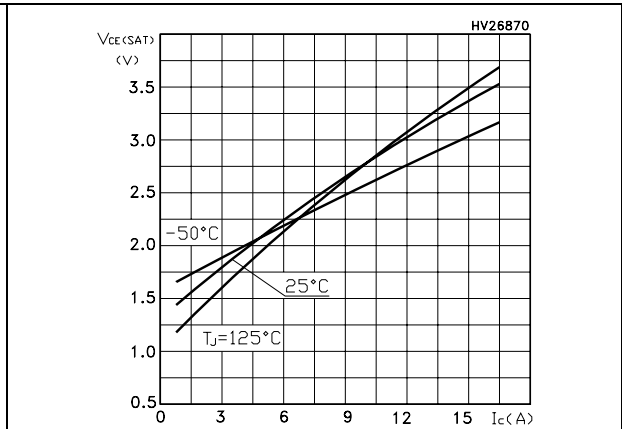


Figure 10. Normalized breakdown voltage vs temperature

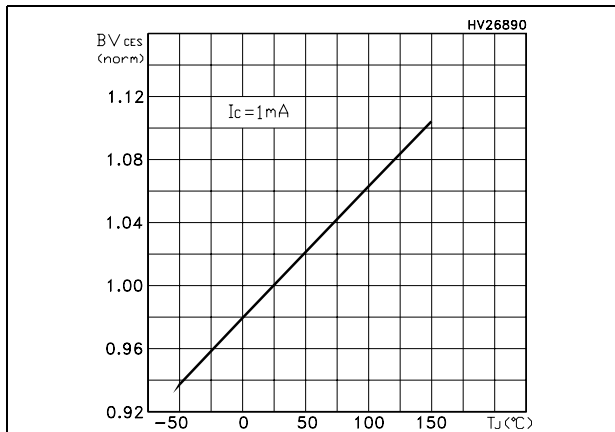


Figure 11. Switching losses vs temperature

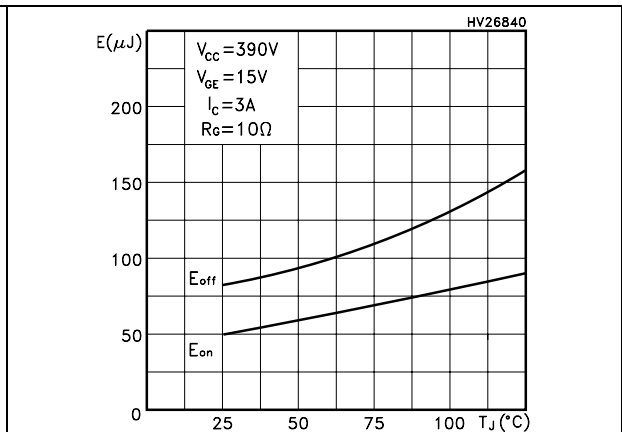


Figure 12. Switching losses vs gate resistance

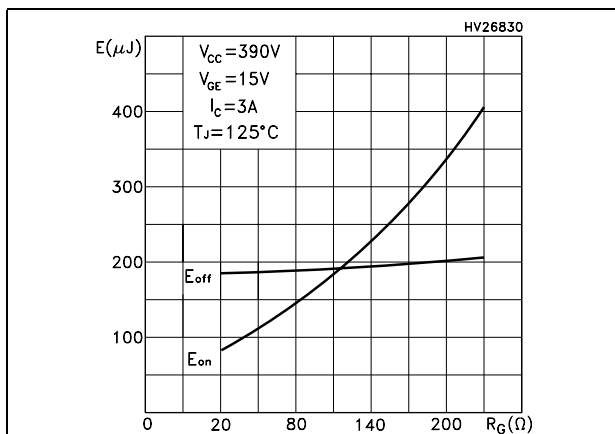


Figure 13. Switching losses vs collector current

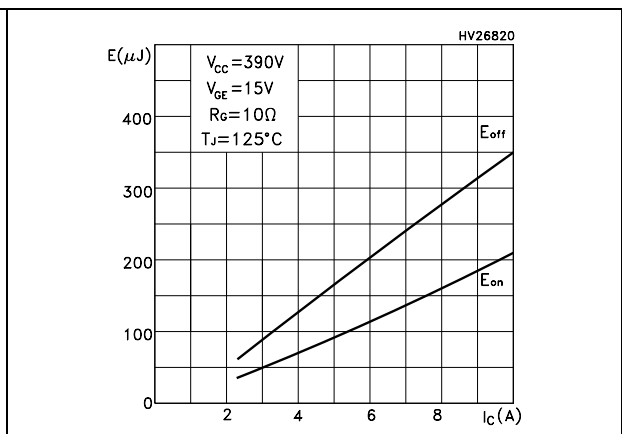


Figure 14. Thermal impedance for D<sup>2</sup>PAK, DPAK and TO-220

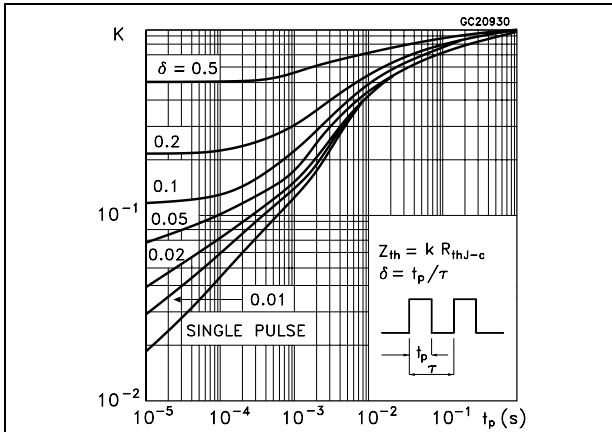


Figure 15. Turn-off SOA

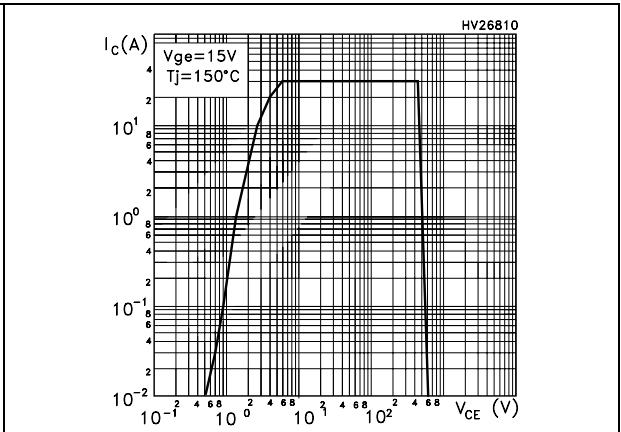


Figure 16. Emitter-collector diode characteristics

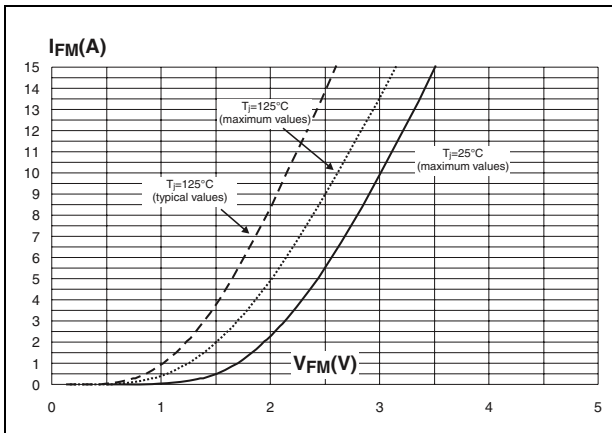
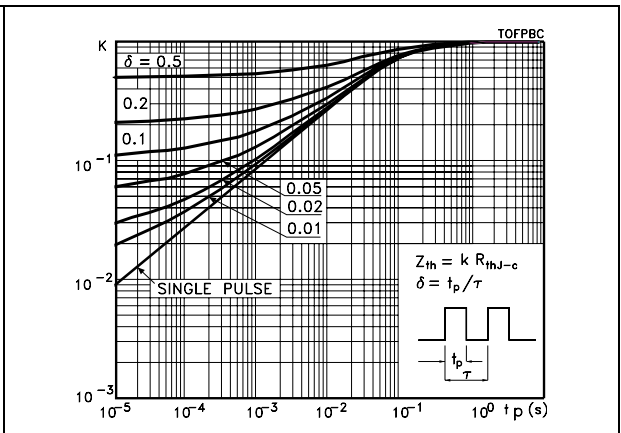


Figure 17. Thermal impedance for TO-220FP



### 3 Test circuits

Figure 18. Test circuit for inductive load switching

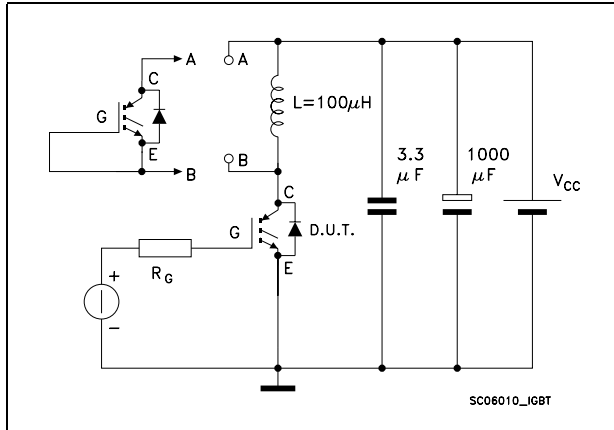


Figure 19. Gate charge test circuit

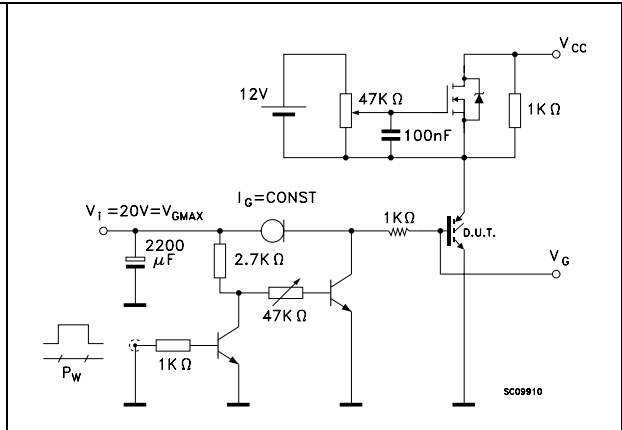


Figure 20. Switching waveform

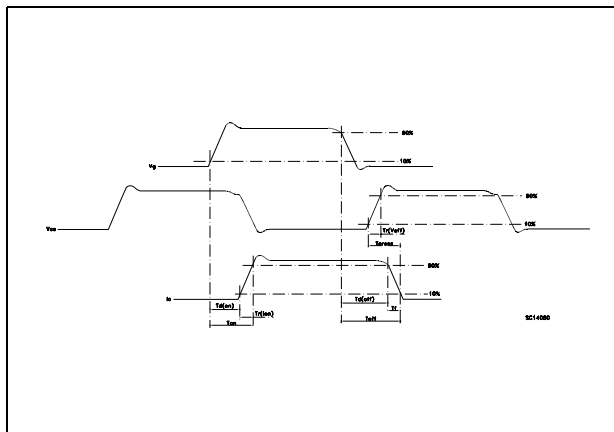
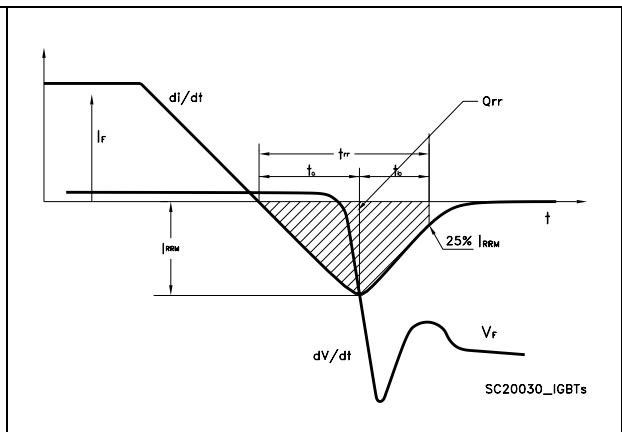


Figure 21. Diode recovery time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Table 9. D<sup>2</sup>PAK package mechanical data

Dim.	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°

Figure 22. D<sup>2</sup>PAK package drawing

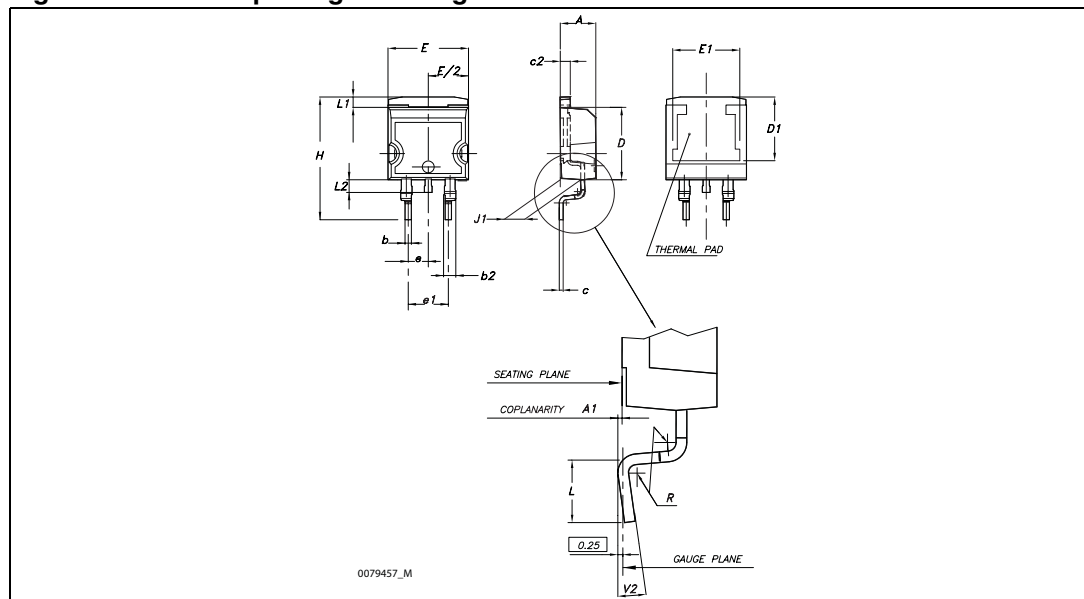


Table 10. DPAK package mechanical data

Dim.	mm		
	Min.	Typ	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 23. DPAK package drawing

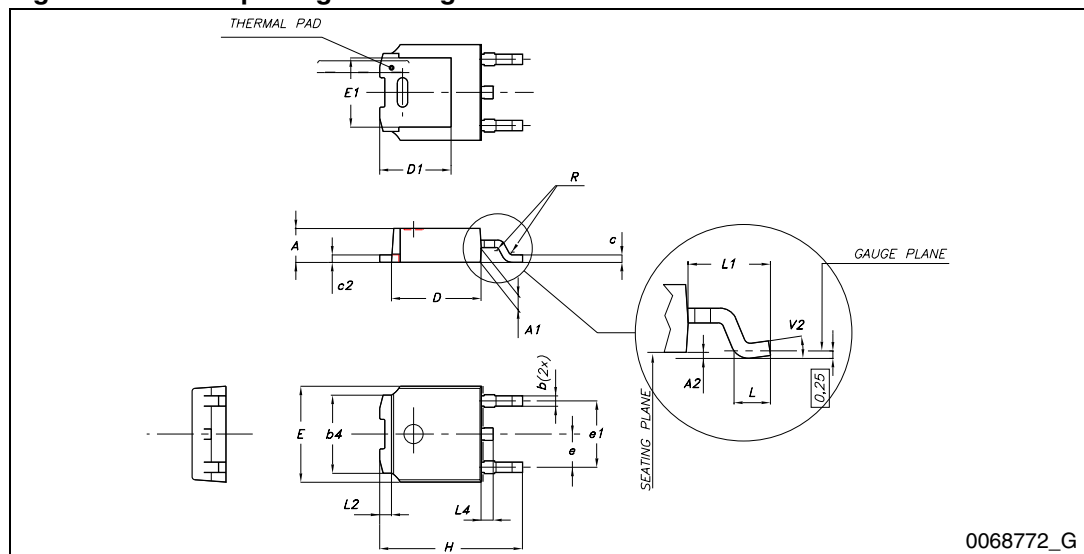


Table 11. TO-220FP package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 24. TO-220FP package drawing

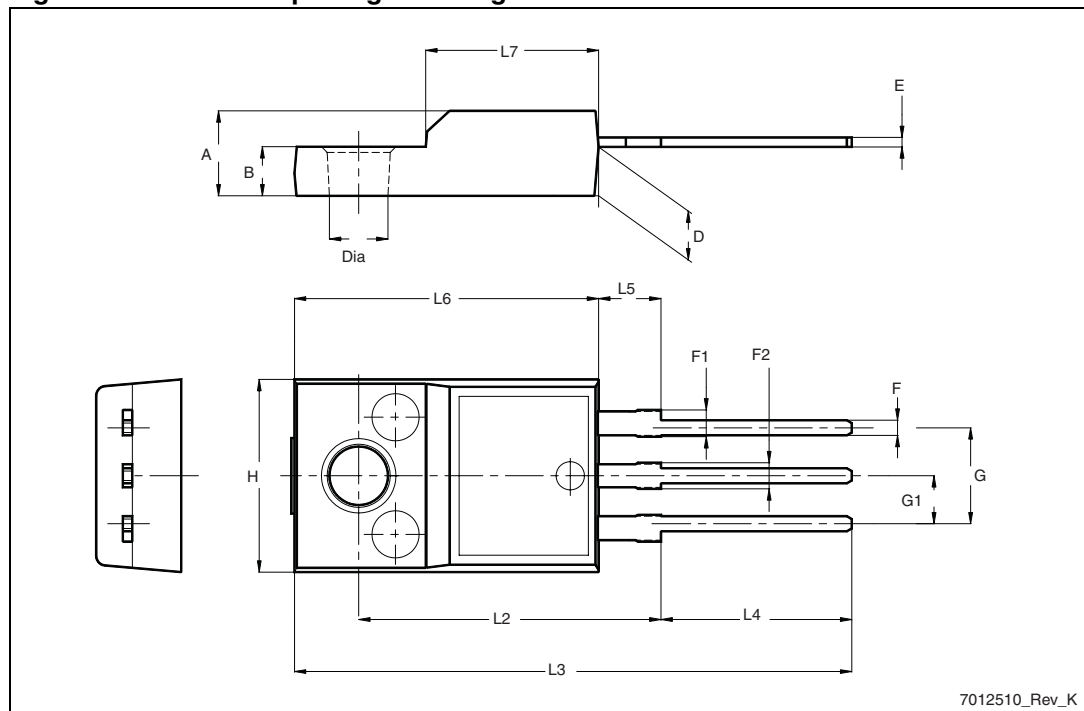
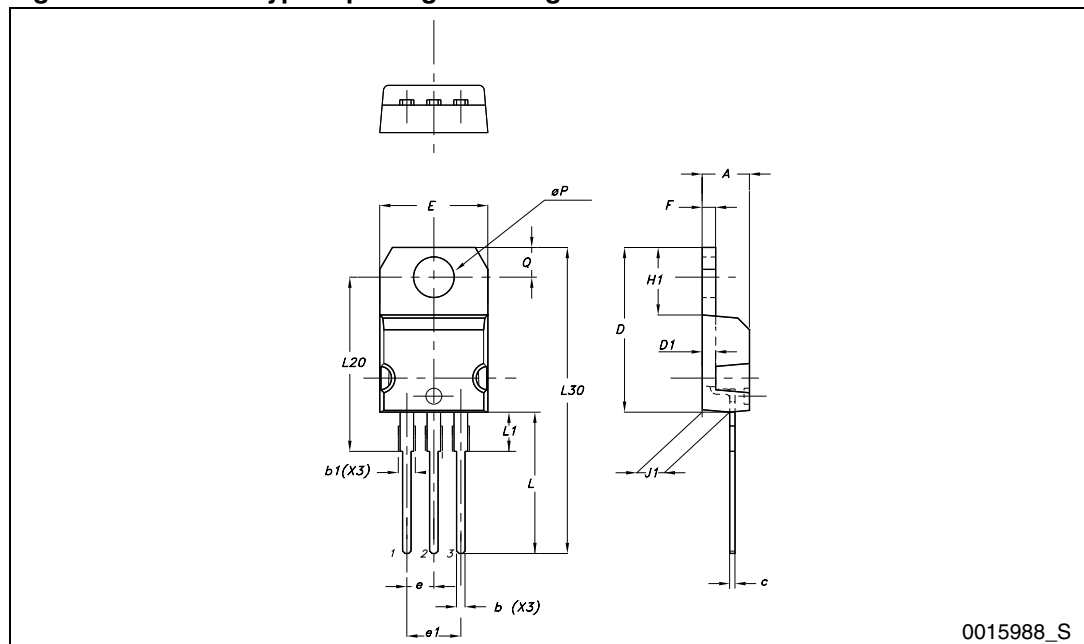


Table 12. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

Figure 25. TO-220 type A package drawing

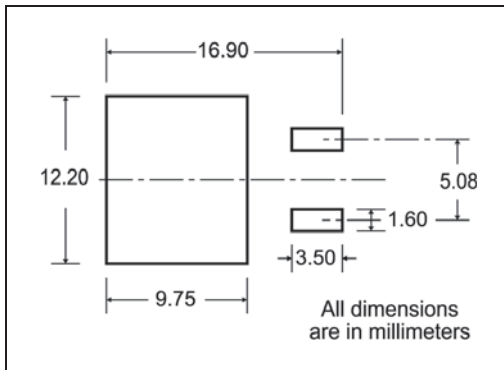


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# 5 Packaging mechanical data

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

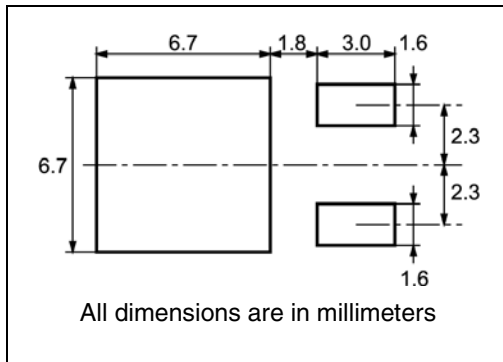
**REEL MECHANICAL DATA**

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

**DPAK FOOTPRINT**



**TAPE AND REEL SHIPMENT**

**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	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

**TAPE MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641

**BASE QTY** 2500      **BULK QTY** 2500

## 6 Revision history

**Table 13. Document 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 6.: Switching on/off (inductive load)</a> .
24-Nov-2009	6	Inserted DPAK package option.

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