



# STGB8NC60KD - STGD8NC60KD STGF8NC60KD - STGP8NC60KD

600 V - 8 A - 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

## Applications

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

## Description

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

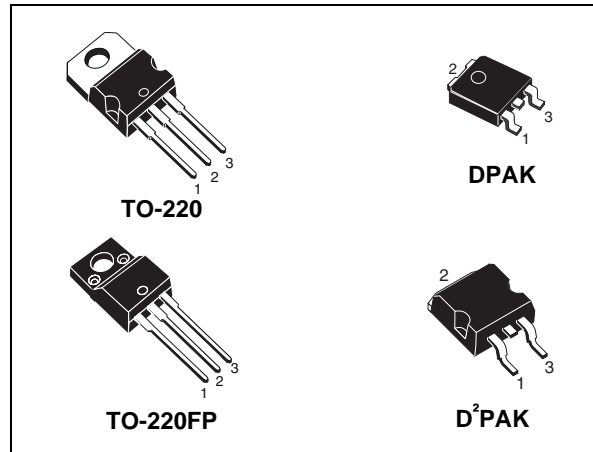


Figure 1. Internal schematic diagram



Table 1. Device summary

Order codes	Marking	Package	Packaging
STGB8NC60KDT4	GB8NC60KD	D <sup>2</sup> PAK	Tape and reel
STGD8NC60KDT4	GD8NC60KD	DPAK	Tape and reel
STGF8NC60KD	GF8NC60KD	TO-220FP	Tube
STGP8NC60KD	GP8NC60KD	TO-220	Tube

## Contents

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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>	Collector current (continuous) at T <sub>C</sub> = 25 °C	15		7	A
I <sub>C</sub> <sup>(1)</sup>	Collector current (continuous) at T <sub>C</sub> = 100 °C	8		4	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	7			A
I <sub>FSM</sub>	Surge not repetitive forward current t <sub>p</sub> = 10 ms sinusoidal	20			A
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C)	--	--	2500	V
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	65	62	24	W
T <sub>j</sub>	Operating junction temperature	- 55 to 150			°C
T <sub>scw</sub>	Short circuit withstand time (V <sub>CE</sub> = 0.5 V <sub>BR(CES)</sub> , T <sub>C</sub> = 125 °C, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 12 V)	10			μs

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C) \cdot I_C}$$

- 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
- Pulse width limited by max junction temperature allowed

**Table 3. Thermal resistance**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK TO-220	DPAK	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max IGBT	1.9	2.0	5.1	°C/W
R <sub>thj-case</sub>	Thermal resistance junction-case max diode	4	4.5	7	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5			°C/W

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  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	$V_{GE}=15\text{ V}, I_C=3\text{ A}$ $V_{GE}=15\text{ V}, I_C=3\text{ A}, T_C=125^{\circ}\text{C}$		2.2 1.8	2.75	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE}=V_{GE}, I_C=250\text{ }\mu\text{A}$	4.5		6.5	V
$I_{CES}$	Collector cut-off current ( $V_{GE}=0$ )	$V_{CE}=600\text{ V}$ $V_{CE}=600\text{ V}, T_C=125^{\circ}\text{C}$			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	$V_{CE}=15\text{ V}, I_C=3\text{ A}$		1.9		S

1. Pulse duration = 300 us, duty cycle 1.5 %

**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	$V_{CE}=390\text{ V}, I_C=3\text{ A},$		19		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE}=15\text{ V},$		5		nC
$Q_{gc}$	Gate-collector charge	(see Figure 20)		9		nC

**Table 6. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}, I_C=3\text{ A}$		17		ns
$t_r$	Current rise time	$R_G=10\text{ }\Omega, V_{GE}=15\text{ V}$		6		ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 21)		655		A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}, I_C=3\text{ A}$		16.5		ns
$t_r$	Current rise time	$R_G=10\text{ }\Omega, V_{GE}=15\text{ V},$ $T_C=125^{\circ}\text{C}$		6.5		ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 21)		575		A/ $\mu\text{s}$

**Table 6. Switching on/off (inductive load) (continued)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}, I_C = 3\text{ A},$		33		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega, V_{GE} = 15\text{ V}$		72		ns
$t_f$	Current fall time	(see Figure 21)		82		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}, I_C = 3\text{ A},$		60		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega, V_{GE} = 15\text{ V},$		106		ns
$t_f$	Current fall time	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 21)		136		ns

**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}, I_C = 3\text{ A}$		55		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V}$		85		$\mu\text{J}$
$E_{ts}$	Total switching losses	(see Figure 21)		140		$\mu\text{J}$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}, I_C = 3\text{ A}$		87		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		162		$\mu\text{J}$
$E_{ts}$	Total switching losses	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 21)		249		$\mu\text{J}$

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	$I_F = 3\text{ A}$ $I_F = 3\text{ A}, T_C = 125\text{ }^\circ\text{C}$		1.6 1.3	2.1	V V
$t_{rr}$	Reverse recovery time	$I_F = 3\text{ A}, V_R = 30\text{ V},$		23.5		ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$		16.5		nC
$I_{rrm}$	Reverse recovery current	(see Figure 22)		1.4		A
$t_{rr}$	Reverse recovery time	$I_F = 3\text{ A}, V_R = 30\text{ V},$		39		ns
$Q_{rr}$	Reverse recovery charge	$T_C = 125\text{ }^\circ\text{C}, di/dt = 100\text{ A}/\mu\text{s}$		39		nC
$I_{rrm}$	Reverse recovery current	(see Figure 22)		2		A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

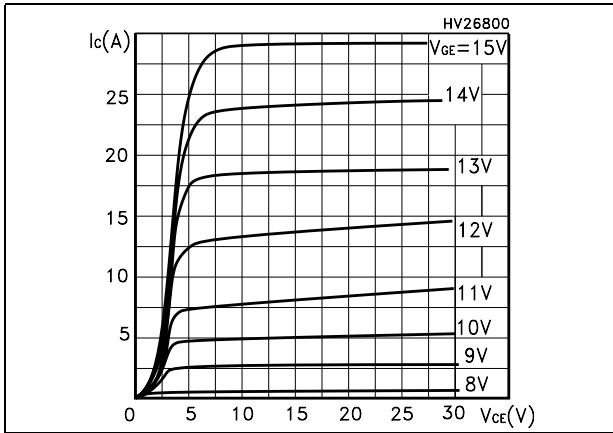


Figure 3. Transfer characteristics

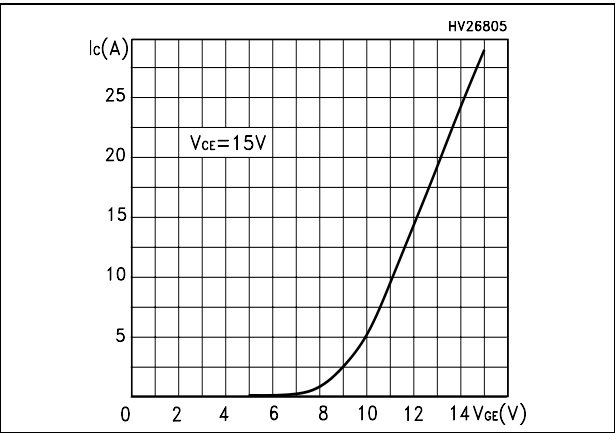


Figure 4. Transconductance

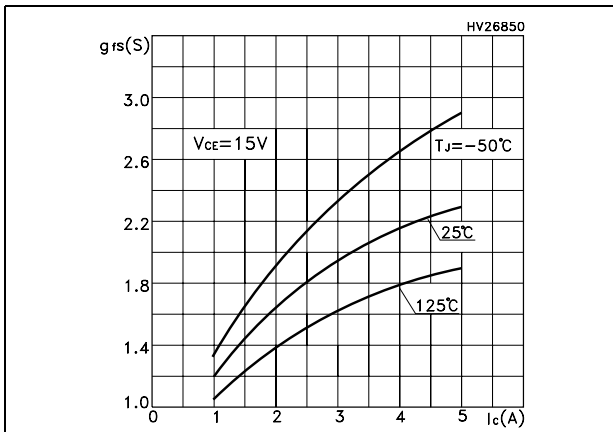


Figure 5. Collector-emitter on voltage vs temperature

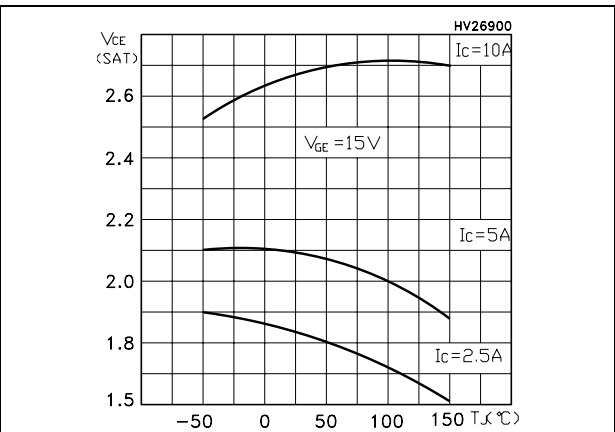


Figure 6. Gate charge vs gate-source voltage

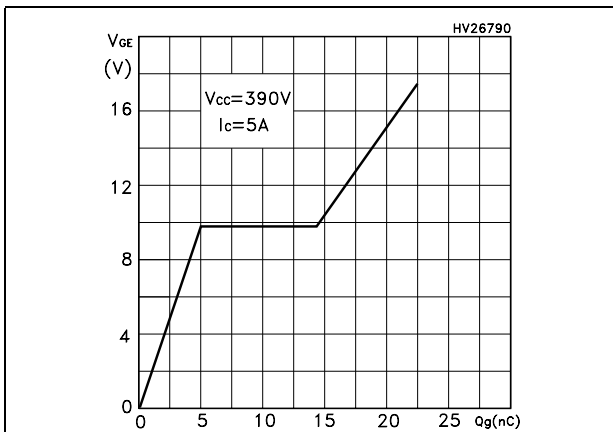


Figure 7. Capacitance variations

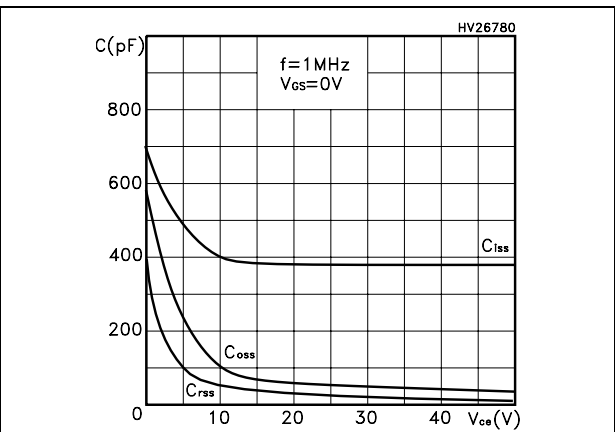


Figure 8. Normalized gate threshold voltage vs temperature

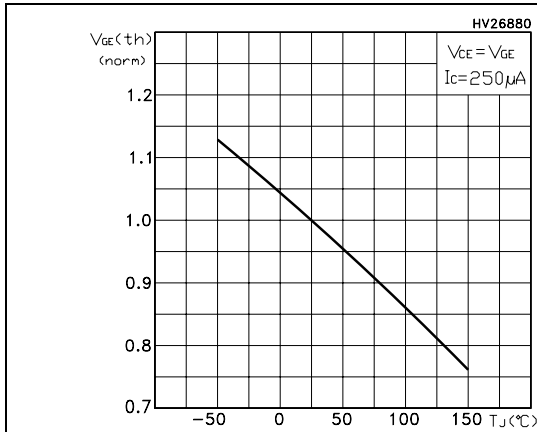


Figure 9. Collector-emitter on voltage vs collector current

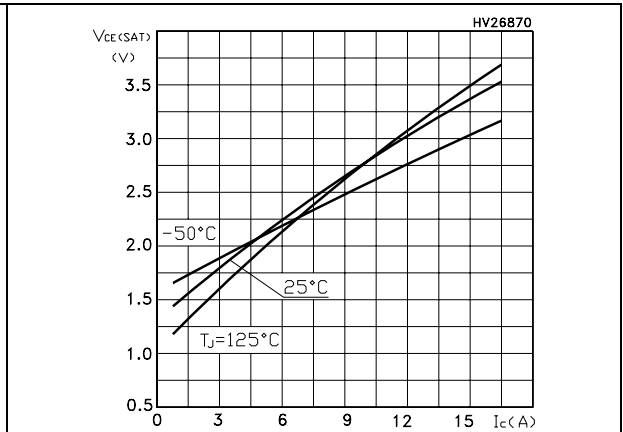


Figure 10. Normalized breakdown voltage vs temperature

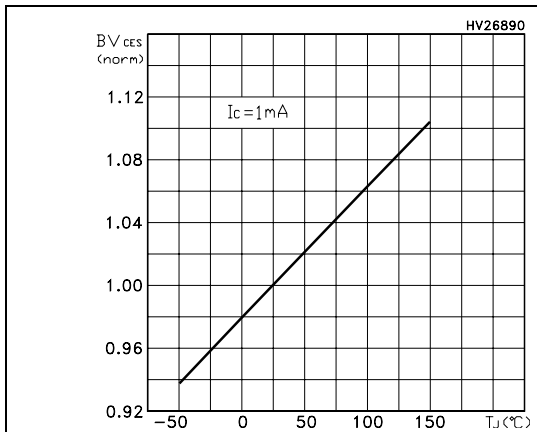


Figure 11. Switching losses vs temperature

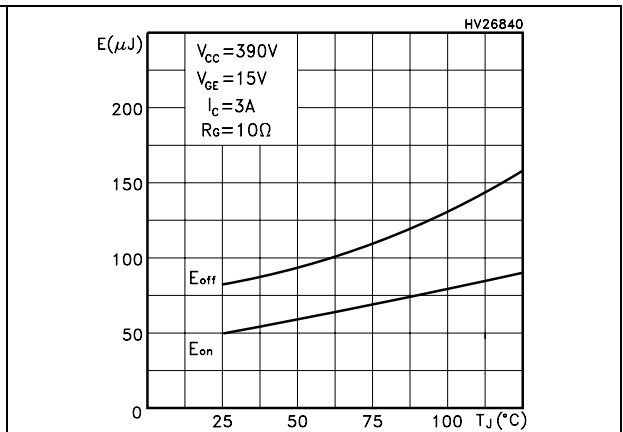


Figure 12. Switching losses vs gate resistance

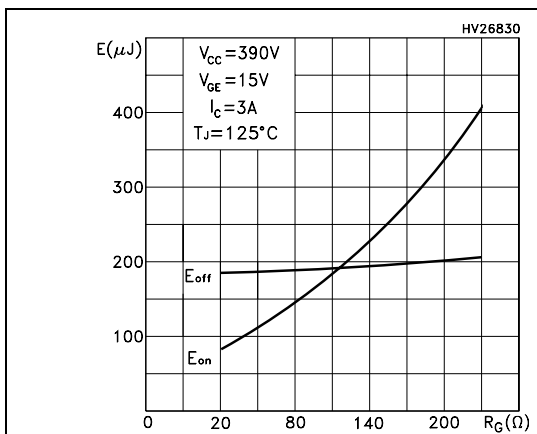


Figure 13. Switching losses vs collector current

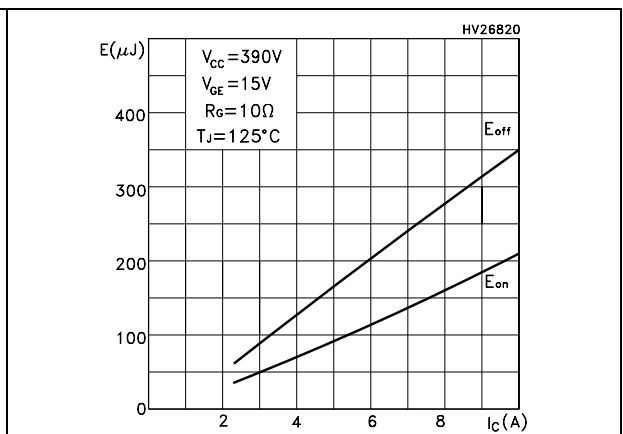


Figure 14. Thermal impedance for TO-220/D<sup>2</sup>PAK

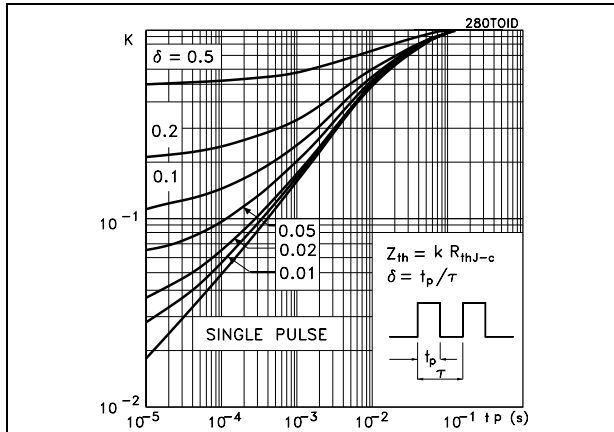


Figure 15. Turn-off SOA

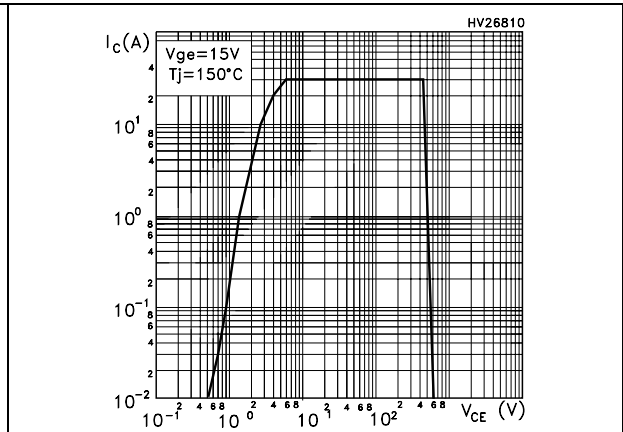


Figure 16. Forward voltage drop versus forward current

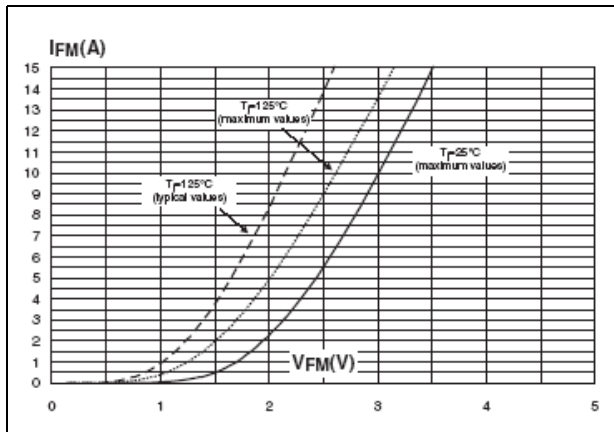


Figure 17. Thermal impedance for DPAK

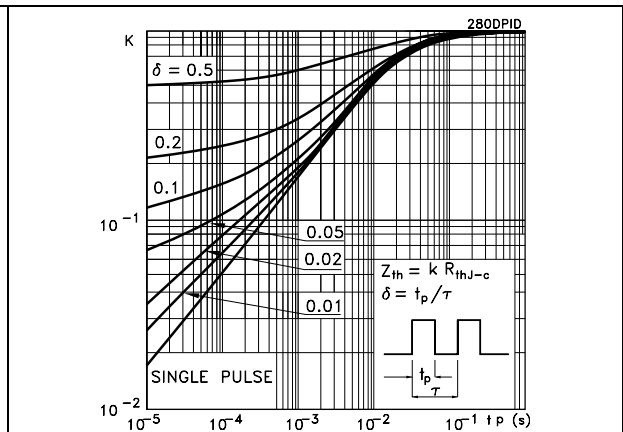
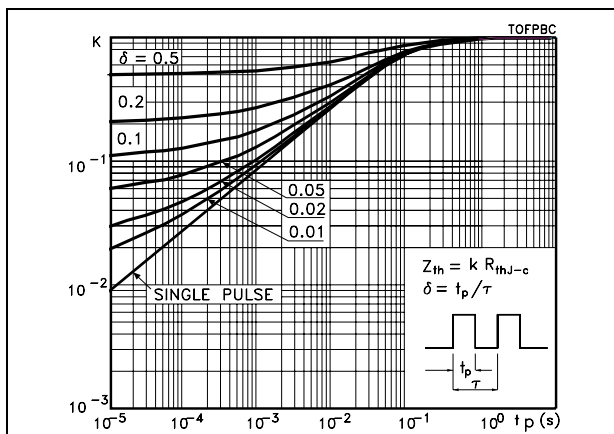


Figure 18. Thermal impedance for TO-220FP





### 3 Test circuit

Figure 19. Test circuit for inductive load switching

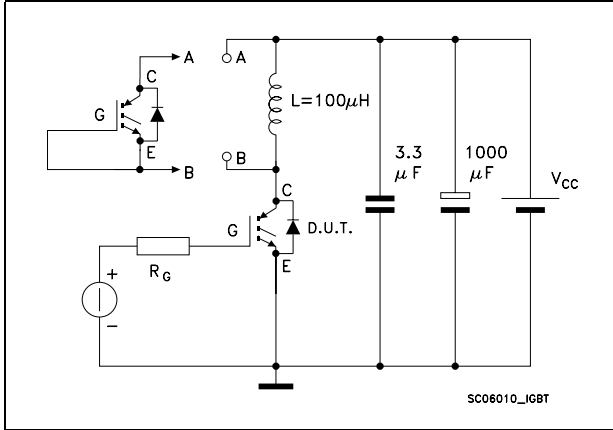


Figure 20. Gate charge test circuit

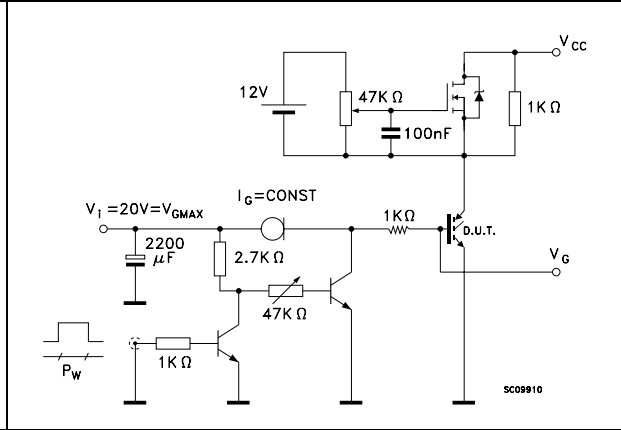


Figure 21. Switching waveform

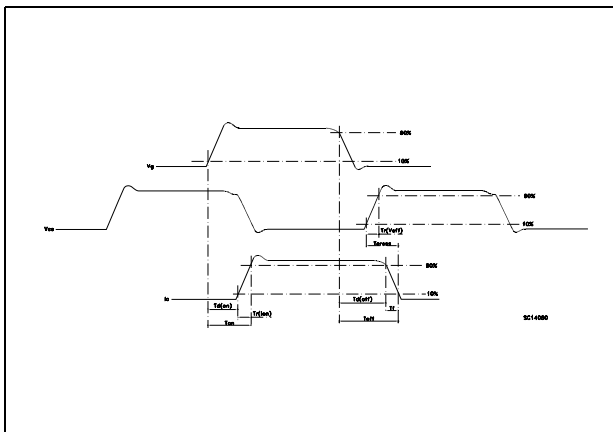
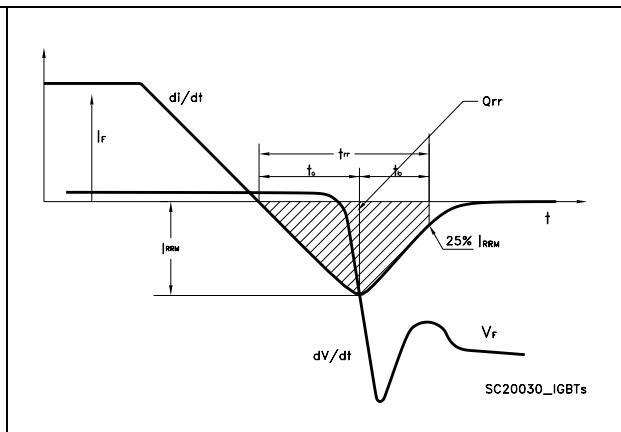


Figure 22. Diode recovery time waveform

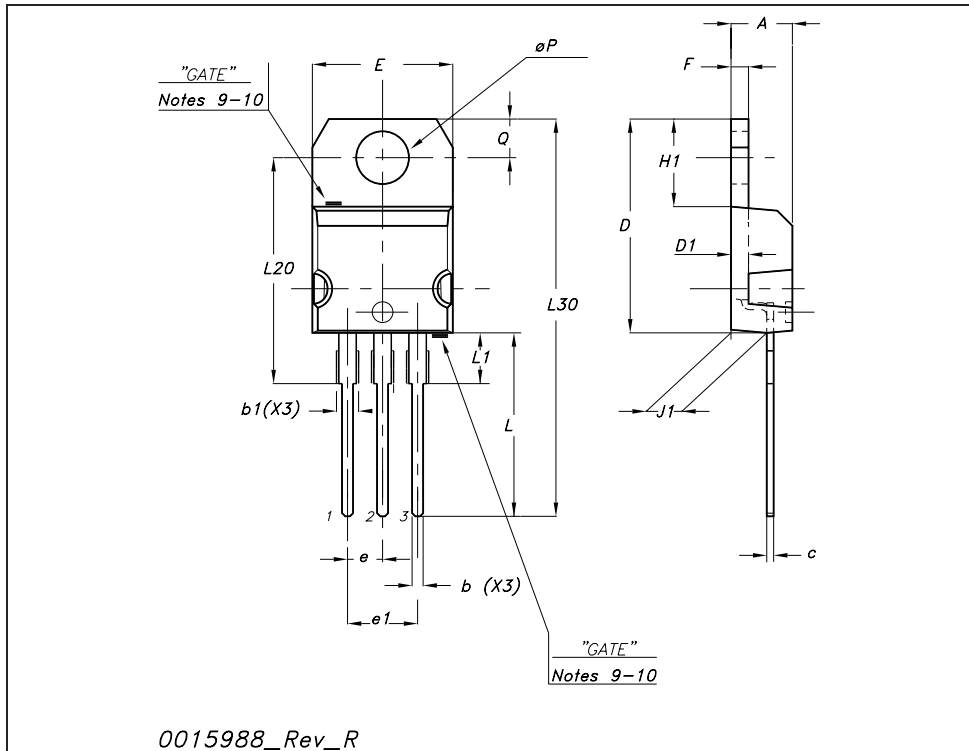


## 4      **Package mechanical data**

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)

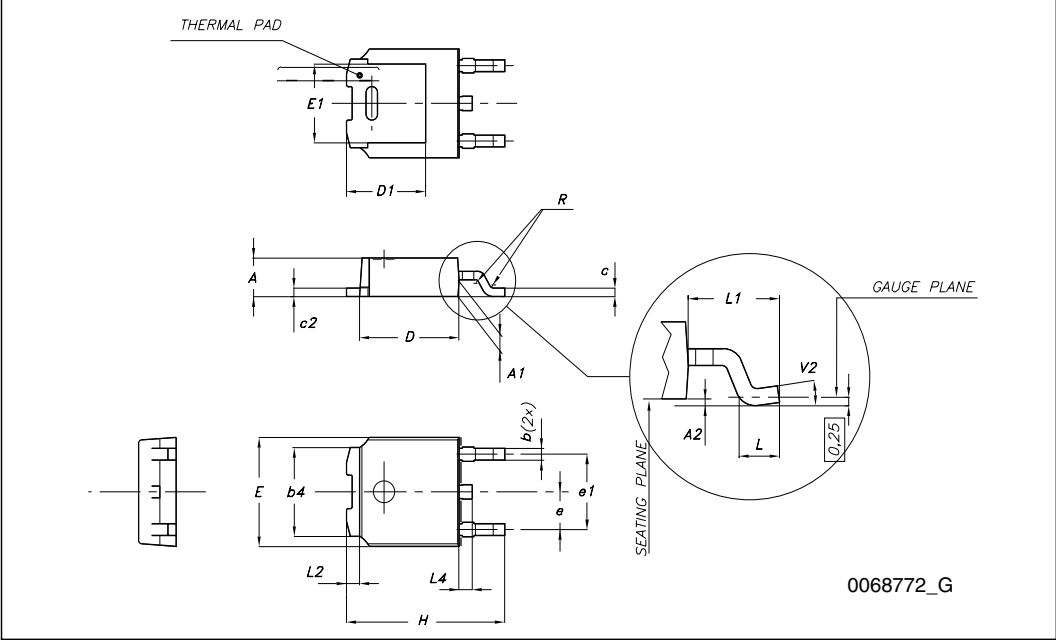
TO-220 mechanical data

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	1.14		1.70	0.044		0.066
c	0.48		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



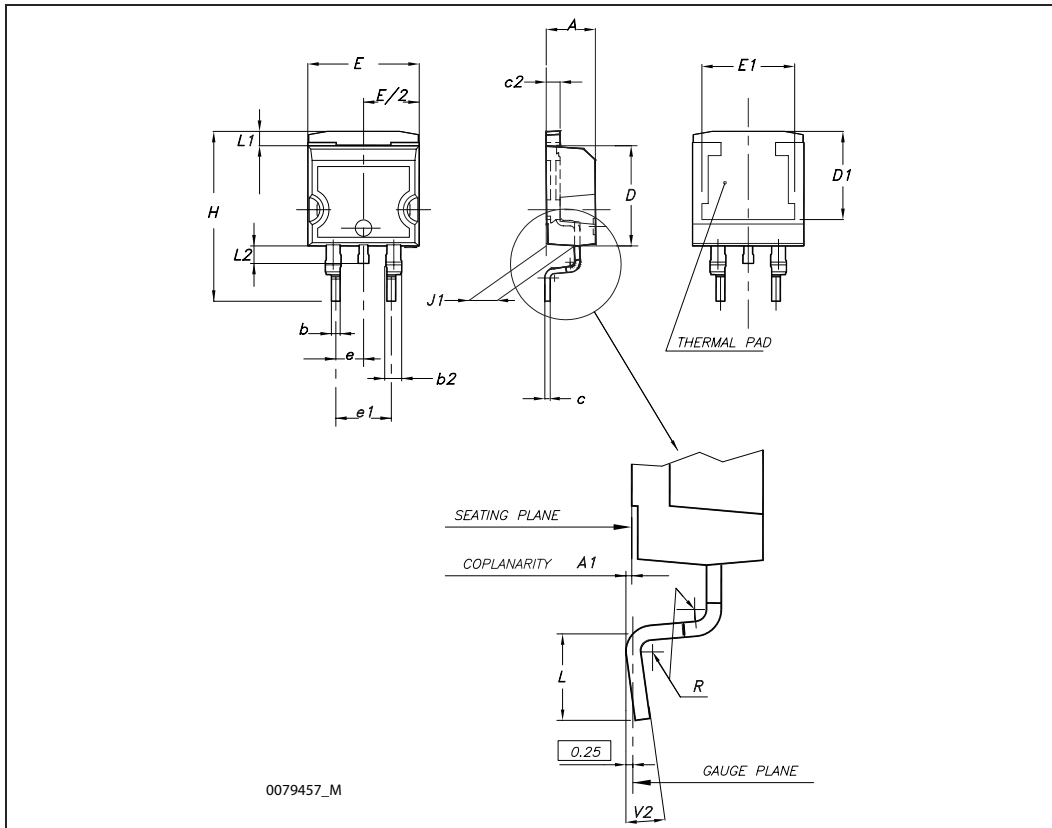
**TO-252 (DPAK) mechanical data**

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°



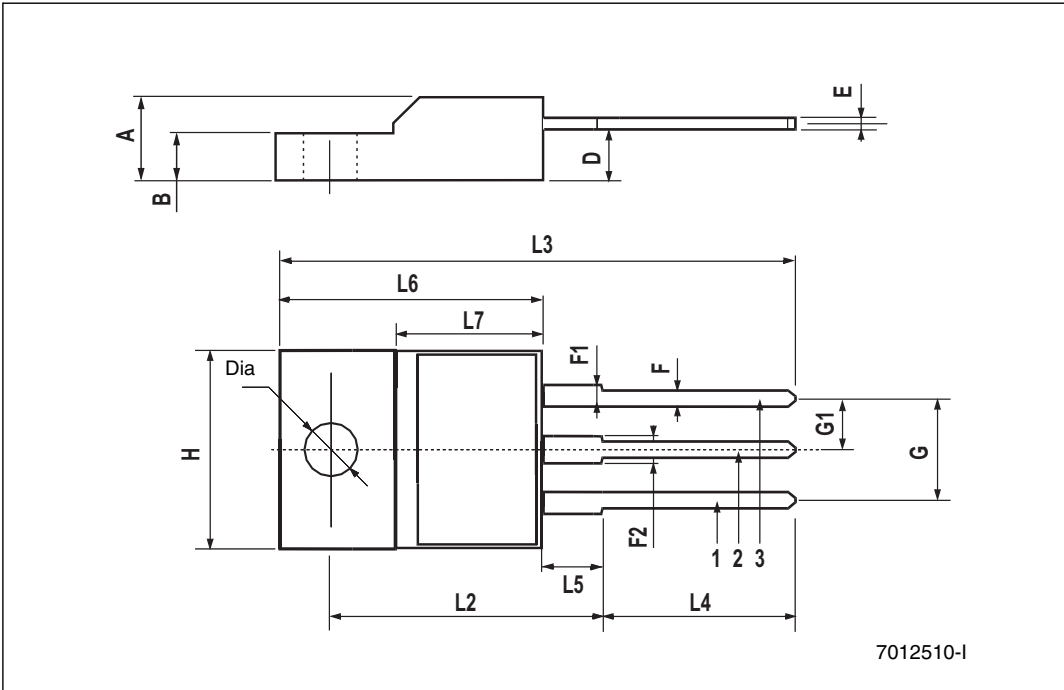
D<sup>2</sup>PAK (TO-263) mechanical data

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°



**TO-220FP mechanical data**

Dim.	mm.			inch		
	Min.	Typ	Max.	Min.	Typ.	Max.
A	4.40		4.60	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		0.70	0.017		0.027
F	0.75		1.00	0.030		0.039
F1	1.15		1.50	0.045		0.067
F2	1.15		1.50	0.045		0.067
G	4.95		5.20	0.195		0.204
G1	2.40		2.70	0.094		0.106
H	10		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.80		10.60	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.90		16.40	0.626		0.645
L7	9		9.30	0.354		0.366
Dia	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

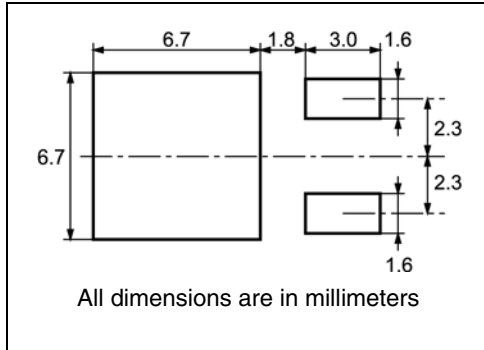
  

BASE QTY	BULK QTY
1000	1000

10 pitches cumulative tolerance on tape +/- 0.2 mm

\* on sales type

**DPAK FOOTPRINT**



**TAPE AND REEL SHIPMENT**

40 mm min. Access hole at slot location

Full radius

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

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	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** | **BULK QTY**

2500 | 2500

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

TRL

FEED DIRECTION

Bending radius R min.

For machine ref. only including draft and radii concentric around B0



## 6 Revision history

Table 9. Document revision history

Date	Revision	Changes
02-Oct-2007	1	First release
01-Apr-2008	2	Updated <a href="#">Figure 14</a> and <a href="#">Figure 17</a>

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