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### Features

- Optimized performance for medium operating frequencies up to 5 kHz in hard switching
- Low on-voltage drop ( $V_{CE(sat)}$ )
- Very soft ultra fast antiparallel diode

### Application

- Motor drive

### Description

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

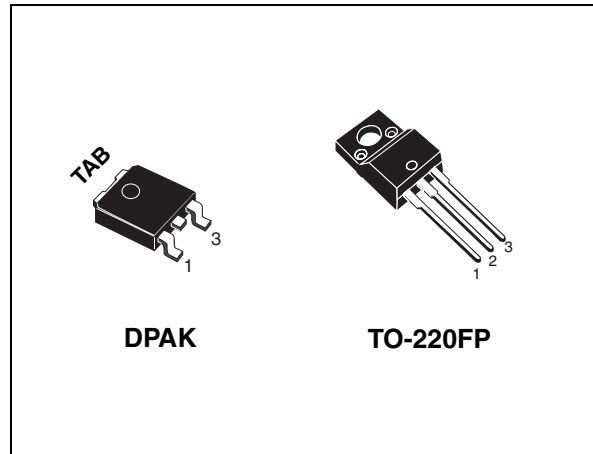


Figure 1. Internal schematic diagram

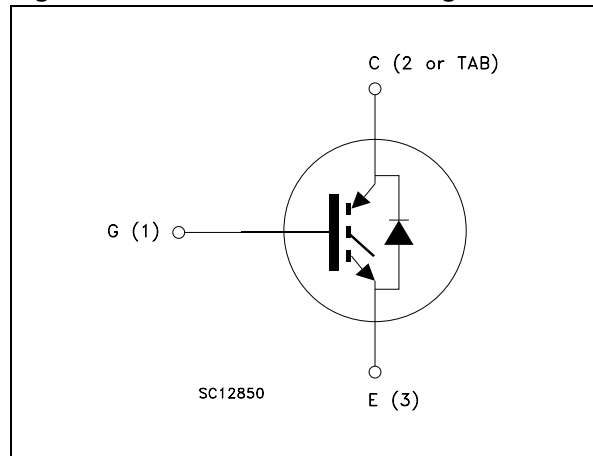


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGD10NC60SDT4	GD10NC60SD	DPAK	Tape and reel
STGF10NC60SD	GF10NC60SD	TO-220FP	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		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	18	10	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100 °C	10	5	A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	14		A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	25		A
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
V <sub>GE</sub>	Gate-emitter voltage	±20		V
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	60	25	W
V <sub>ISO</sub>	Isolation withstand voltage (RMS) from all three leads to external heat sink (t = 1 sec; T <sub>C</sub> = 25 °C)	2500		V
T <sub>j</sub>	Operating junction temperature	-55 to 150		°C

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>), T<sub>j</sub> = 150 °C, R<sub>G</sub> = 10 Ω, V<sub>GE</sub> = 15 V.

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

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		DPAK	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case IGBT	2.08	5	°C/W
	Thermal resistance junction-case diode	4.5		°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	100	62.5	°C/W

## 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	$V_{GE}=15\text{ V}, I_C=5\text{ A}$ $V_{GE}=15\text{ V}, I_C=5\text{ A}, T_J=125^\circ\text{C}$		1.45 1.45	1.65	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE}=V_{GE}, I_C=250\text{ }\mu\text{A}$	3.75		5.75	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 ( $V_{CE}=0$ )	$V_{GE}=\pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE}=15\text{ V}, I_C=5\text{ A}$		3.5		S

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE}=25\text{ V}, f=1\text{ MHz}, V_{GE}=0$	-	365	-	pF
$C_{oes}$	Output capacitance			44		
$C_{res}$	Reverse transfer capacitance			8		
$Q_g$	Total gate charge	$V_{CE}=480\text{ V}, I_C=5\text{ A},$	-	18	-	nC
$Q_{ge}$	Gate-emitter charge	$V_{GE}=15\text{ V}$		8		
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 18</a>		3.5		

**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	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <a href="#">Figure 19</a>	-	19 4 1330	-	ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125^\circ\text{C}$ <a href="#">Figure 19</a>	-	18 4.5 1000	-	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	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <a href="#">Figure 19</a>	-	100 160 205	-	ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125^\circ\text{C}$ <a href="#">Figure 19</a>	-	165 250 310	-	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	$V_{CC} = 480\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <a href="#">Figure 17</a>	-	60 340 400	-	$\mu$ J $\mu$ J $\mu$ J
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 480\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125^\circ\text{C}$ <a href="#">Figure 17</a>	-	90 540 630	-	$\mu$ 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 17](#). If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature.
2. Turn-off losses included also 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	$I_F = 5\text{ A}$ $I_F = 5\text{ A}$ , $T_J = 125^\circ\text{C}$	-	2 1.65	2.45	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 5\text{ A}$ , $V_R = 40\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ <a href="#">Figure 20</a>	-	22 14 1.3		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 5\text{ A}$ , $V_R = 40\text{ V}$ , $T_J = 125^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ <a href="#">Figure 20</a>	-	34 35 2.1		ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

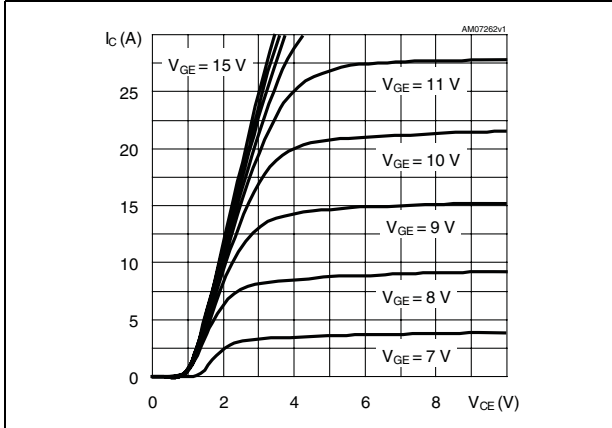


Figure 3. Transfer characteristics

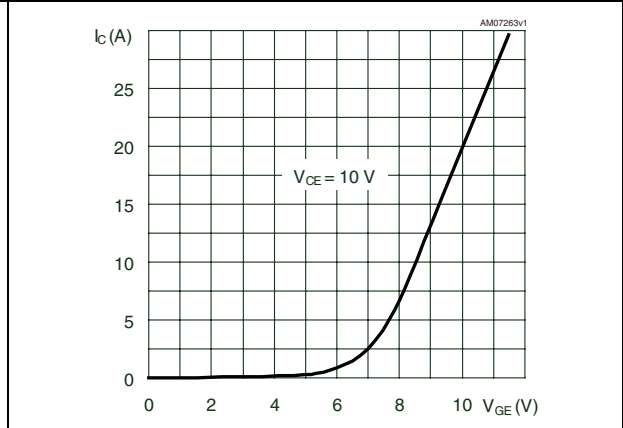


Figure 4. Collector-emitter on voltage vs collector current

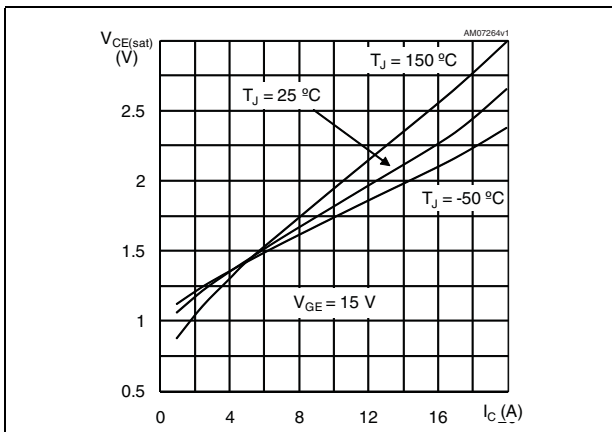


Figure 5. Collector-emitter on voltage vs temperature

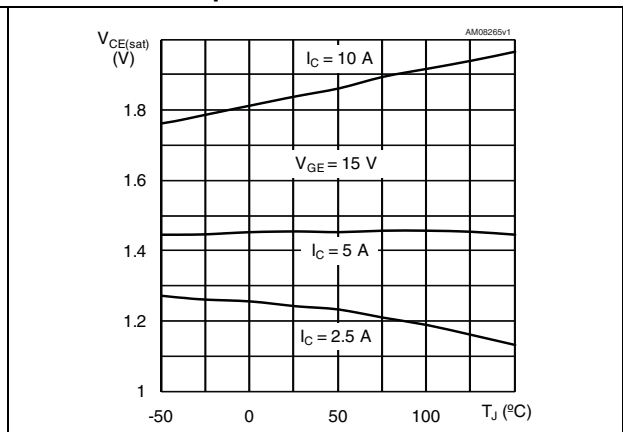


Figure 6. Normalized breakdown voltage vs temperature

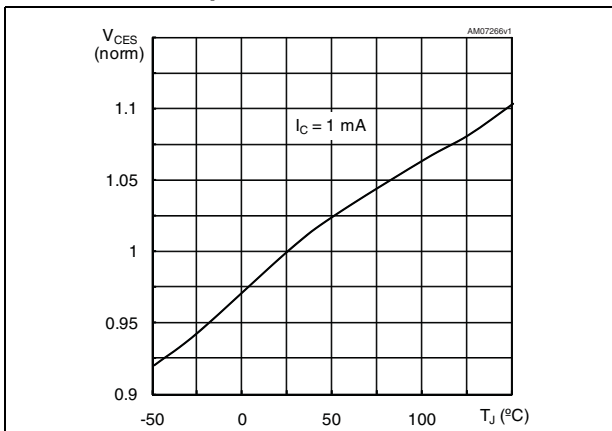


Figure 7. Normalized gate threshold vs temperature

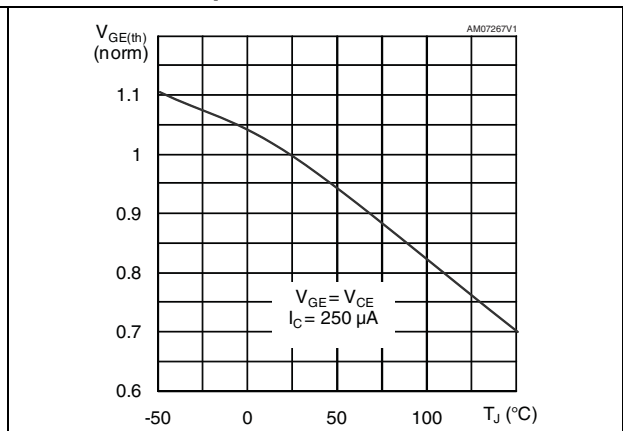


Figure 8. Capacitance variations

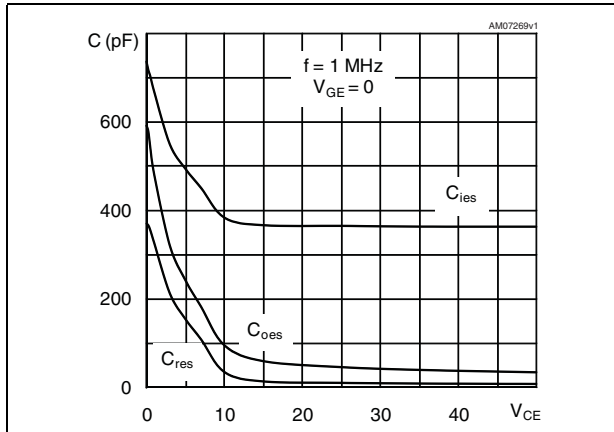


Figure 9. Gate charge vs gate-emitter voltage

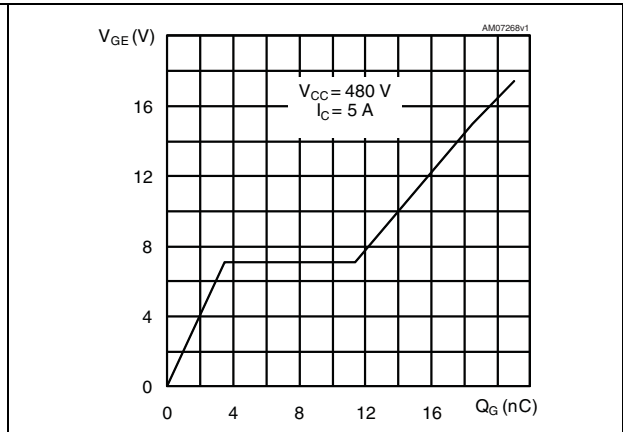


Figure 10. Switching losses vs temperature

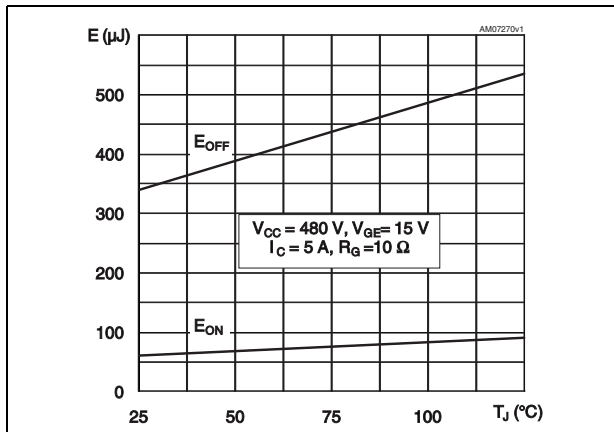


Figure 11. Switching losses vs gate resistance

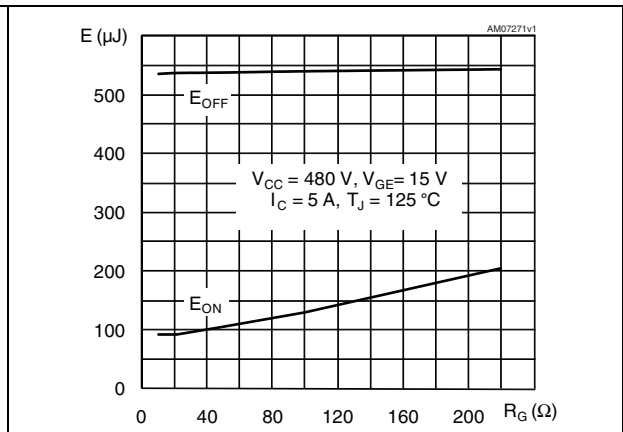


Figure 12. Switching losses vs collector current

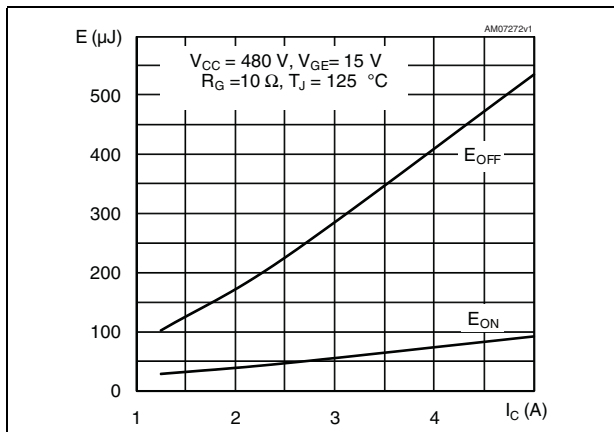


Figure 13. Diode forward on voltage

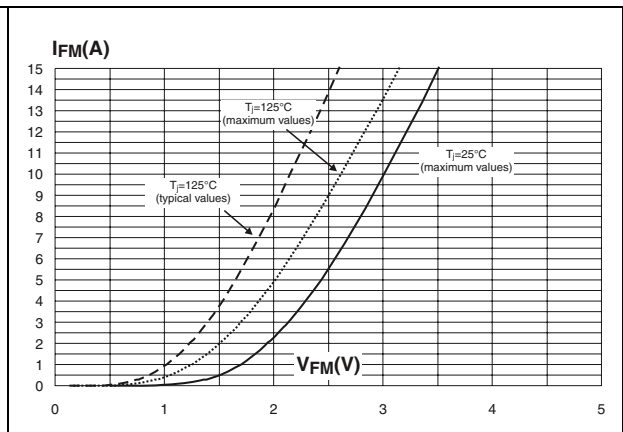




Figure 14. Thermal impedance for DPAK

Figure 15. Thermal impedance for TO-220FP

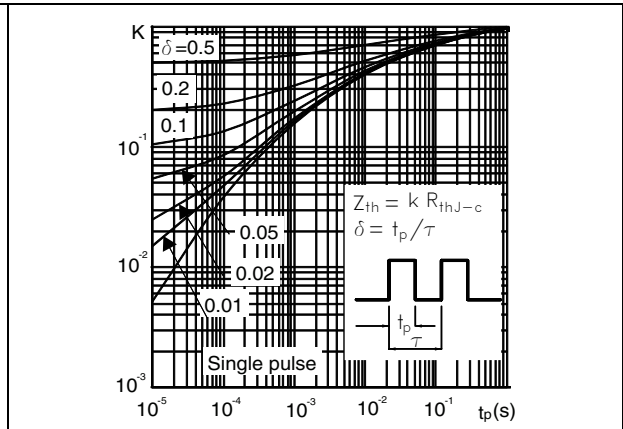
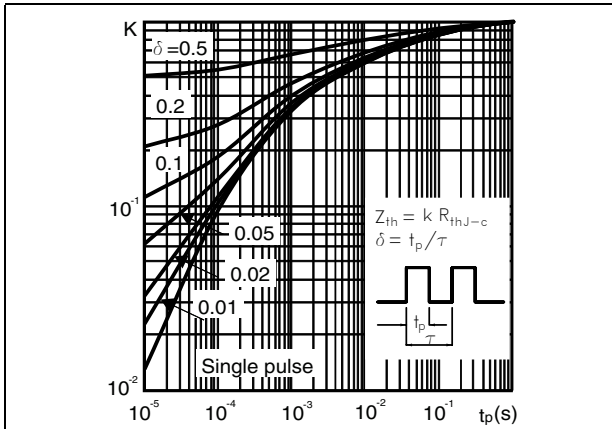
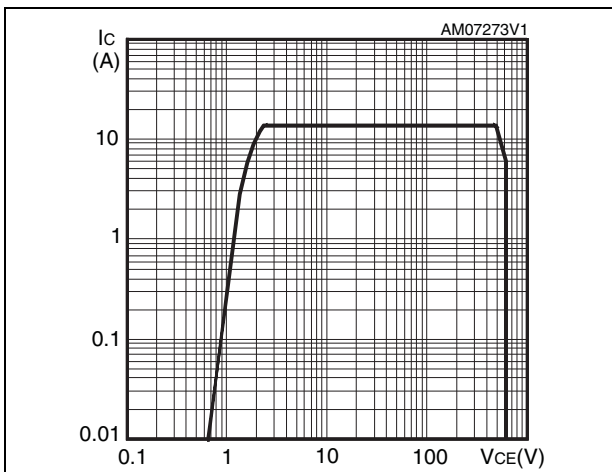


Figure 16. Turn-off SOA



### 3 Test circuits

Figure 17. Test circuit for inductive load switching

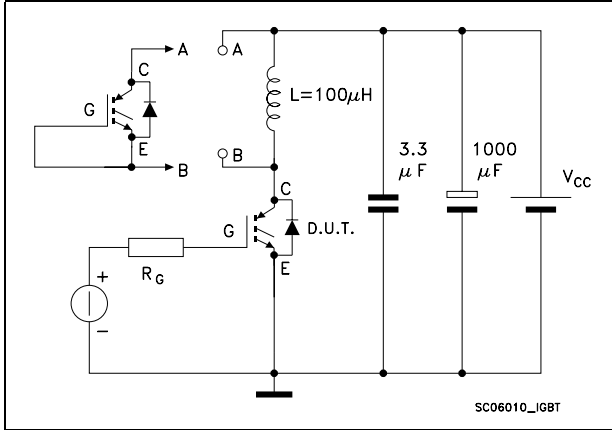


Figure 18. Gate charge test circuit

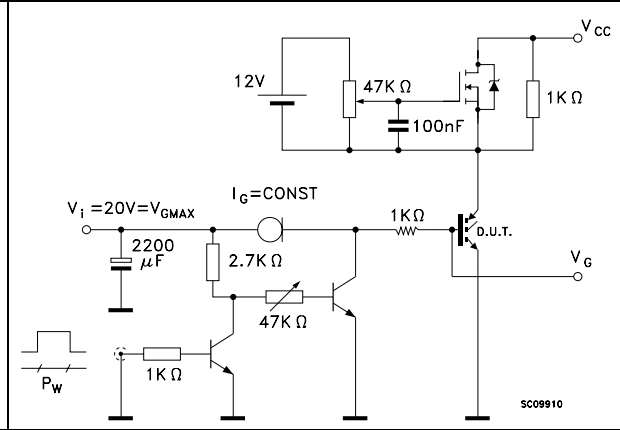


Figure 19. Switching waveforms

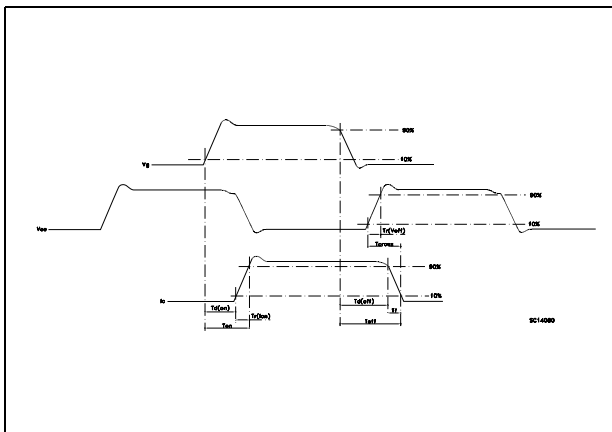
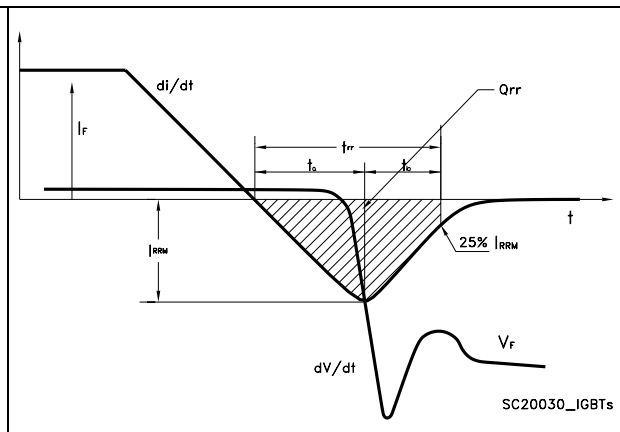


Figure 20. Diode recovery time waveform



## 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.

**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°

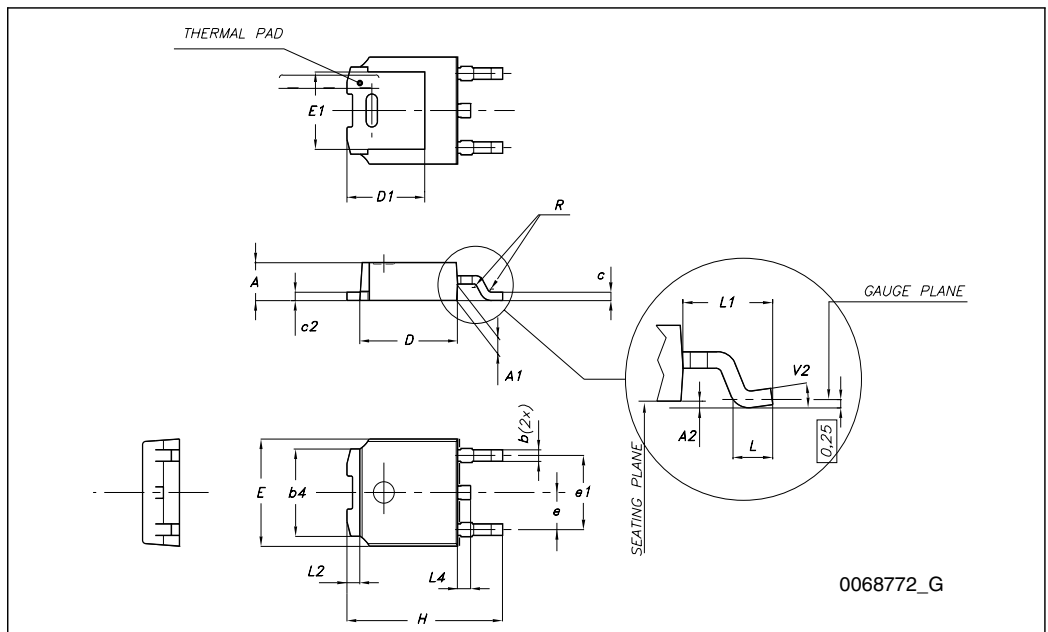
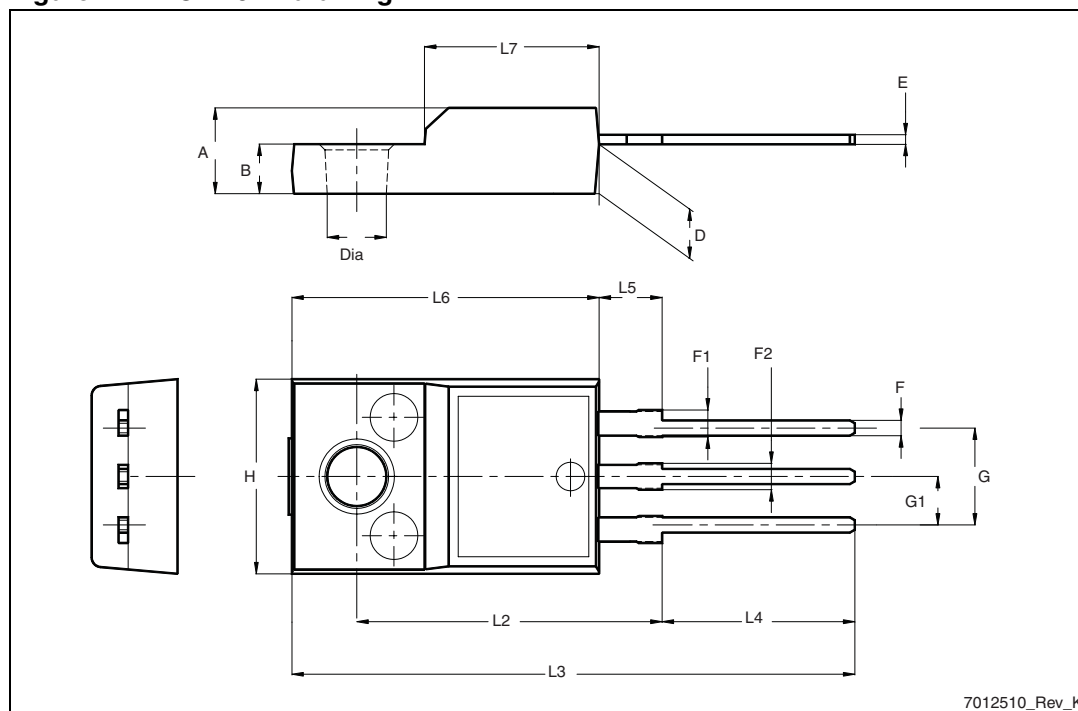


Table 9. TO-220FP mechanical data

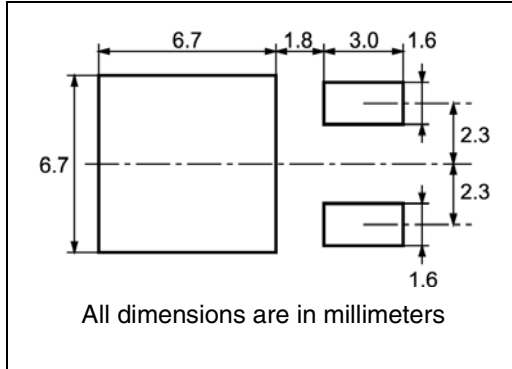
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 21. TO-220FP drawing



# 5 Packaging mechanical data

## 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

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

BASE QTY		BULK QTY	
2500		2500	

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

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

TRL

FEED DIRECTION

Bending radius R min.

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

## 6 Revision history

Table 10. Document revision history

Date	Revision	Changes
06-Jul-2009	1	Initial release
14-Jun-2010	2	Inserted <a href="#">Section 2.1: Electrical characteristics (curves)</a> .



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