



STGD10NC60SD STGF10NC60SD

10 A, 600 V fast IGBT

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.

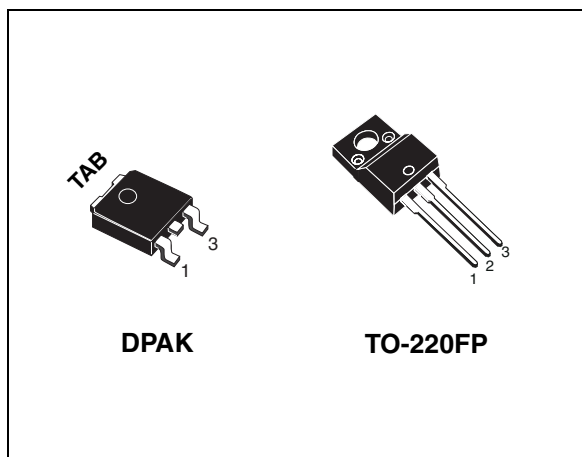


Figure 1. Internal schematic diagram

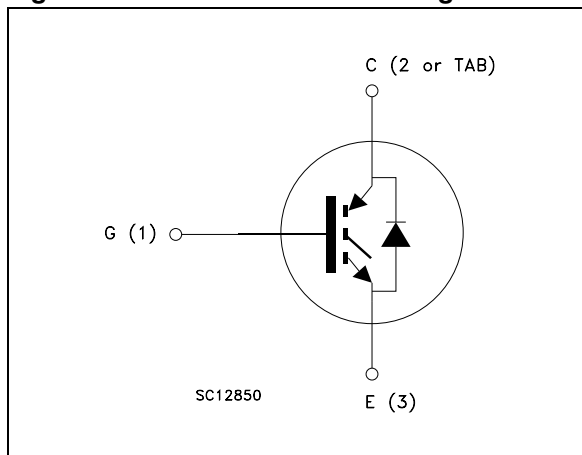


Table 1. Device summary

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

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		DPAK	TO-220FP	
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	600		V
$I_C^{(1)}$	Continuous collector current at $T_C = 25^\circ\text{C}$	18	10	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100^\circ\text{C}$	10	5	A
$I_{CL}^{(2)}$	Turn-off latching current	14		A
$I_{CP}^{(3)}$	Pulsed collector current	25		A
I_F	Diode RMS forward current at $T_C = 25^\circ\text{C}$	10		A
I_{FSM}	Surge non repetitive forward current $t_p = 10$ ms sinusoidal	20		A
V_{GE}	Gate-emitter voltage	± 20		V
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	60	25	W
V_{ISO}	Isolation withstand voltage (RMS) from all three leads to external heat sink ($t = 1$ sec; $T_C = 25^\circ\text{C}$)		2500	V
T_j	Operating junction temperature	-55 to 150		$^\circ\text{C}$

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. $V_{clamp} = 80\%(V_{CES})$, $T_j = 150^\circ\text{C}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$.

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

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		DPAK	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case IGBT	2.08	5	$^\circ\text{C/W}$
	Thermal resistance junction-case diode	4.5		$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	100	62.5	$^\circ\text{C/W}$

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	μA mA
I_{GES}	Gate-emitter leakage ($V_{CE}=0$)	$V_{GE}=\pm 20\text{ V}$			± 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} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{CE}=25\text{ V}$, $f=1\text{ MHz}$, $V_{GE}=0$	-	365 44 8	-	pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	$V_{CE}=480\text{ V}$, $I_C=5\text{ A}$, $V_{GE}=15\text{ V}$ Figure 18	-	18 8 3.5	-	nC nC nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$		19		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	4	-	ns
$(di/dt)_{on}$	Turn-on current slope	Figure 19		1330		A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$		18		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	4.5	-	ns
$(di/dt)_{on}$	Turn-on current slope	$T_J = 125^\circ\text{C}$ Figure 19		1000		A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$,		100		ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	160	-	ns
t_f	Current fall time	Figure 19		205		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$,		165		ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	250	-	ns
t_f	Current fall time	$T_J = 125^\circ\text{C}$ Figure 19		310		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 480\text{ V}$, $I_C = 5\text{ A}$		60		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	340	-	μ J
E_{ts}	Total switching losses	Figure 17		400		μ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 480\text{ V}$, $I_C = 5\text{ A}$		90		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	540	-	μ J
E_{ts}	Total switching losses	$T_J = 125^\circ\text{C}$ Figure 17		630		μ 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}	Reverse recovery time	$I_F = 5\text{ A}$, $V_R = 40\text{ V}$,		22		ns
Q_{rr}	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	14		nC
I_{rrm}	Reverse recovery current	Figure 20		1.3		A
t_{rr}	Reverse recovery time	$I_F = 5\text{ A}$, $V_R = 40\text{ V}$,		34		ns
Q_{rr}	Reverse recovery charge	$T_J = 125^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	35		nC
I_{rrm}	Reverse recovery current	Figure 20		2.1		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

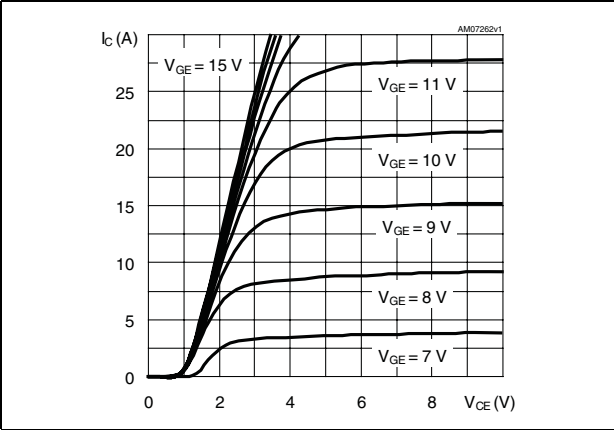


Figure 3. Transfer characteristics

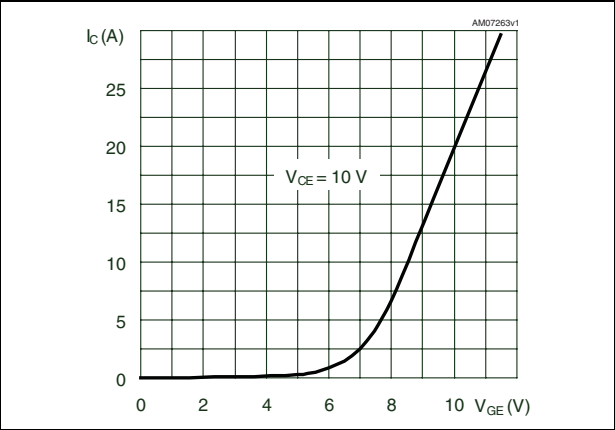


Figure 4. Collector-emitter on voltage vs collector current

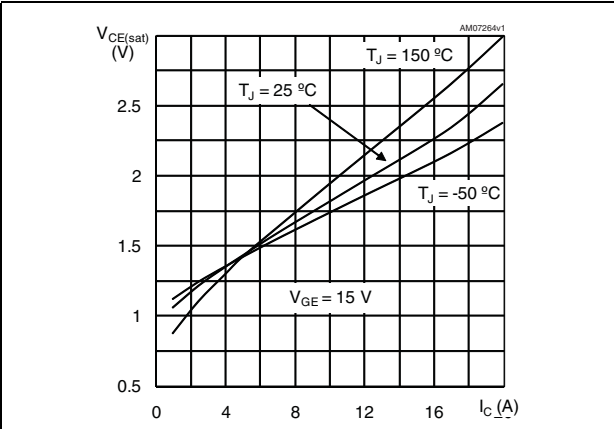


Figure 5. Collector-emitter on voltage vs temperature

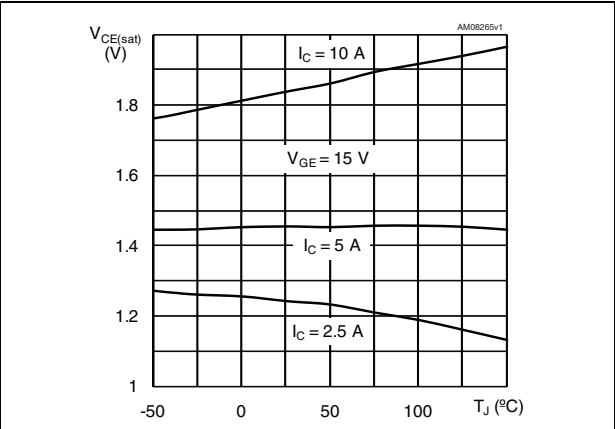


Figure 6. Normalized breakdown voltage vs temperature

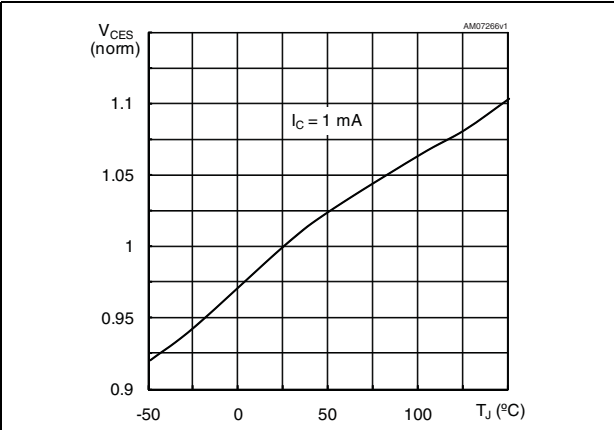


Figure 7. Normalized gate threshold vs temperature

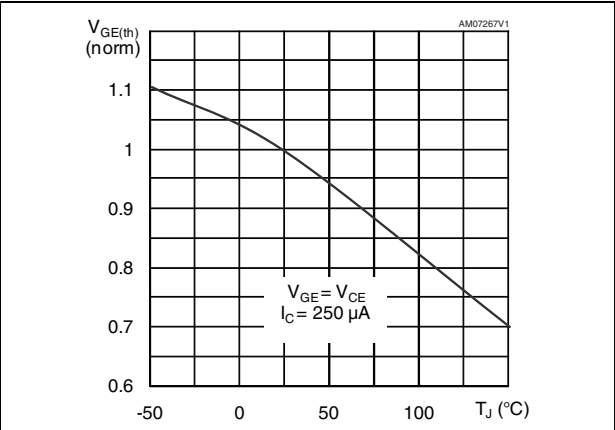


Figure 8. Capacitance variations

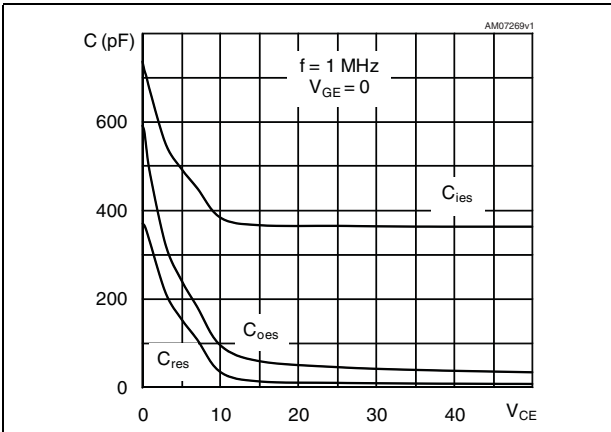


Figure 9. Gate charge vs gate-emitter voltage

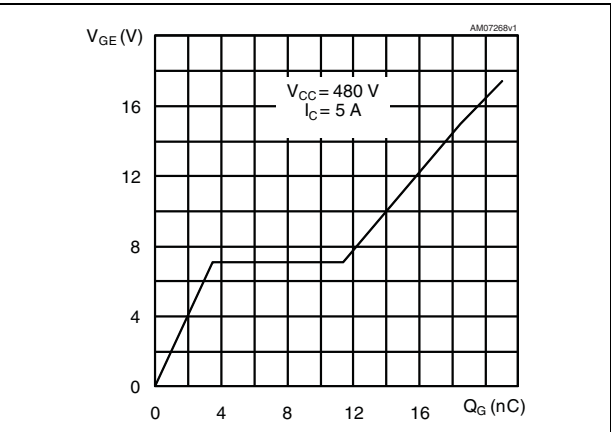


Figure 10. Switching losses vs temperature

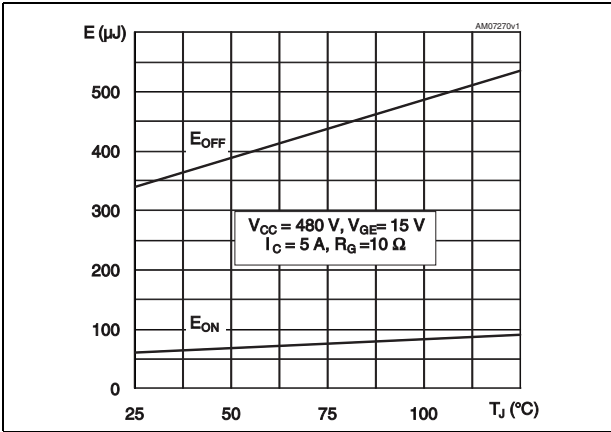


Figure 11. Switching losses vs gate resistance

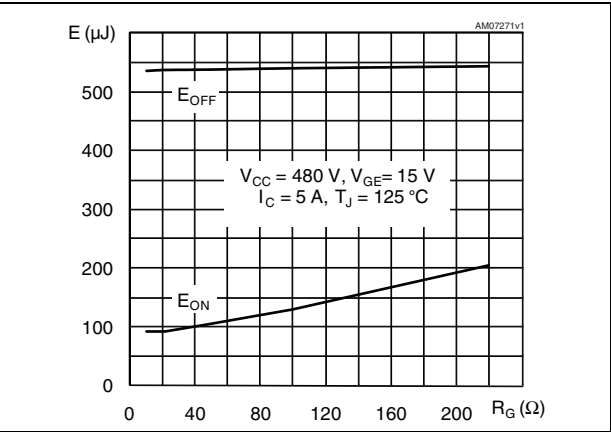


Figure 12. Switching losses vs collector current

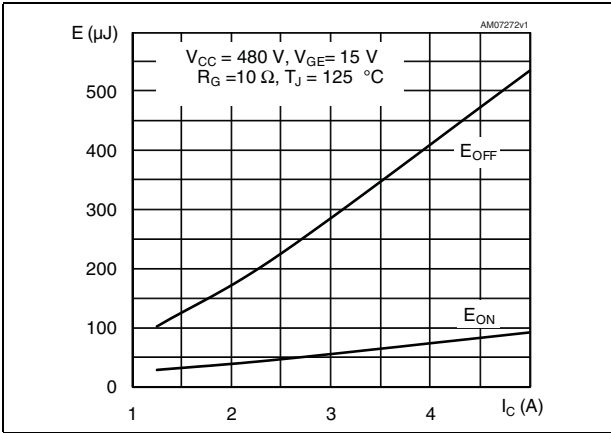


Figure 13. Diode forward on voltage

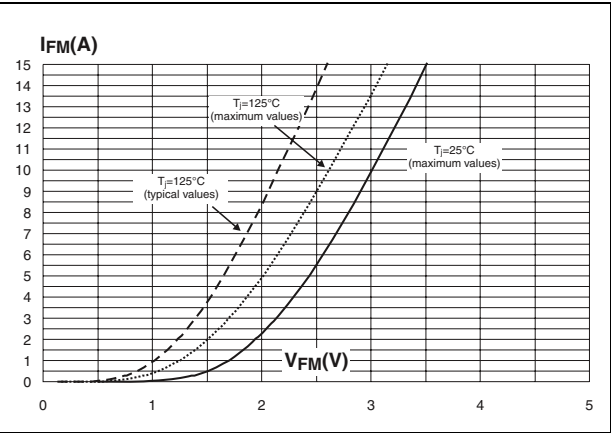


Figure 14. Thermal impedance for DPAK

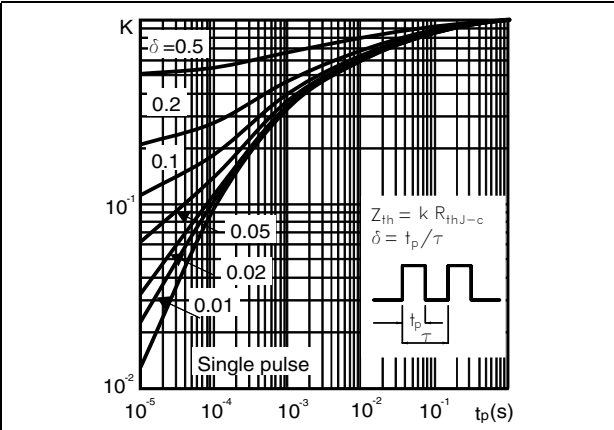


Figure 15. Thermal impedance for TO-220FP

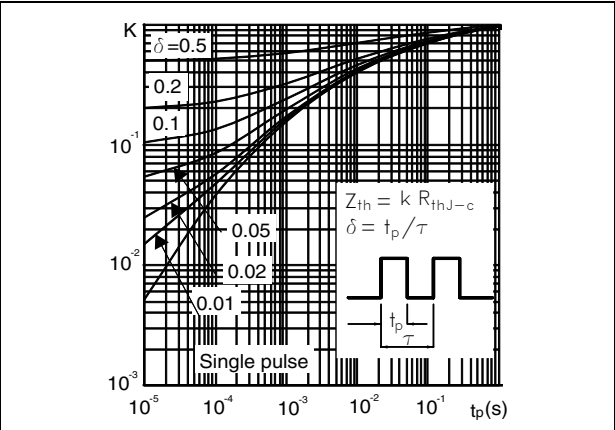
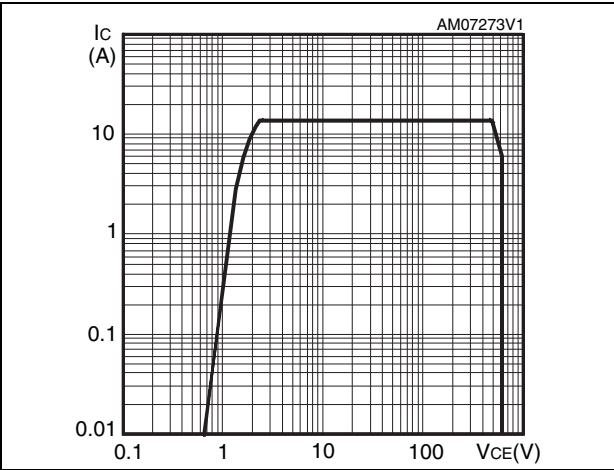


Figure 16. Turn-off SOA



3 Test circuits

Figure 17. Test circuit for inductive load switching

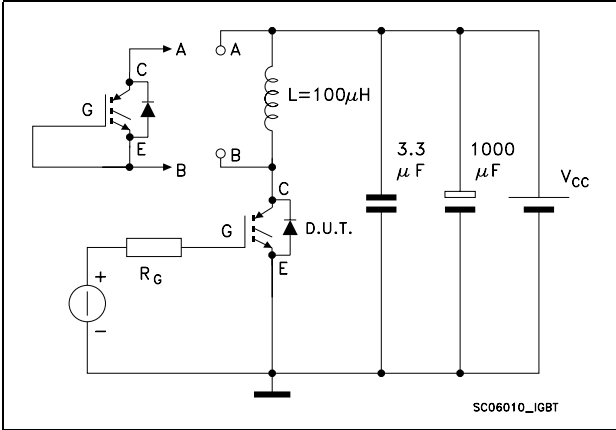


Figure 18. Gate charge test circuit

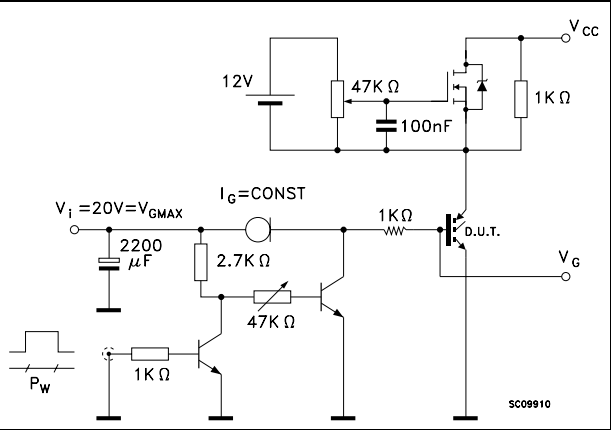


Figure 19. Switching waveforms

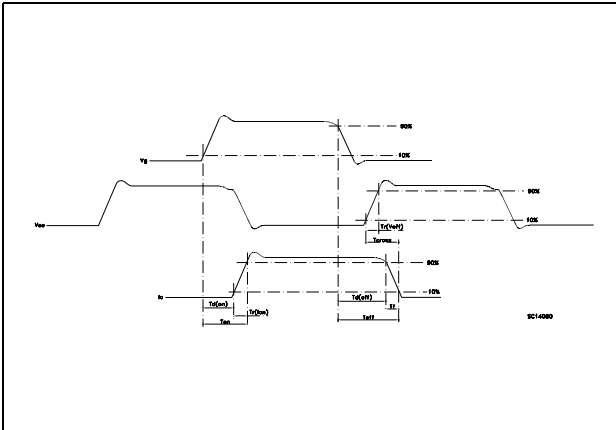
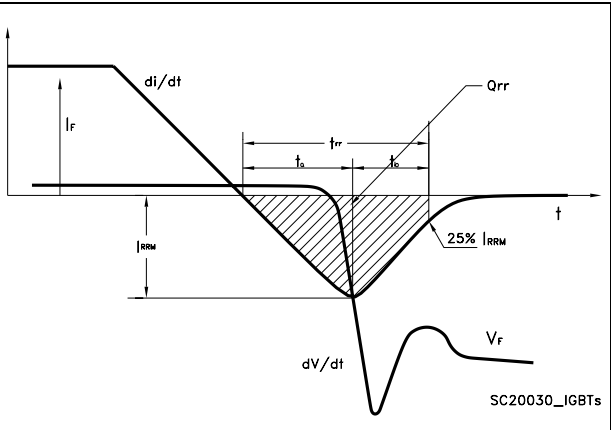


Figure 20. Diode recovery time waveform



4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK[®] packages, depending on their level of environmental compliance. ECOPACK[®] specifications, grade definitions and product status are available at: 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°

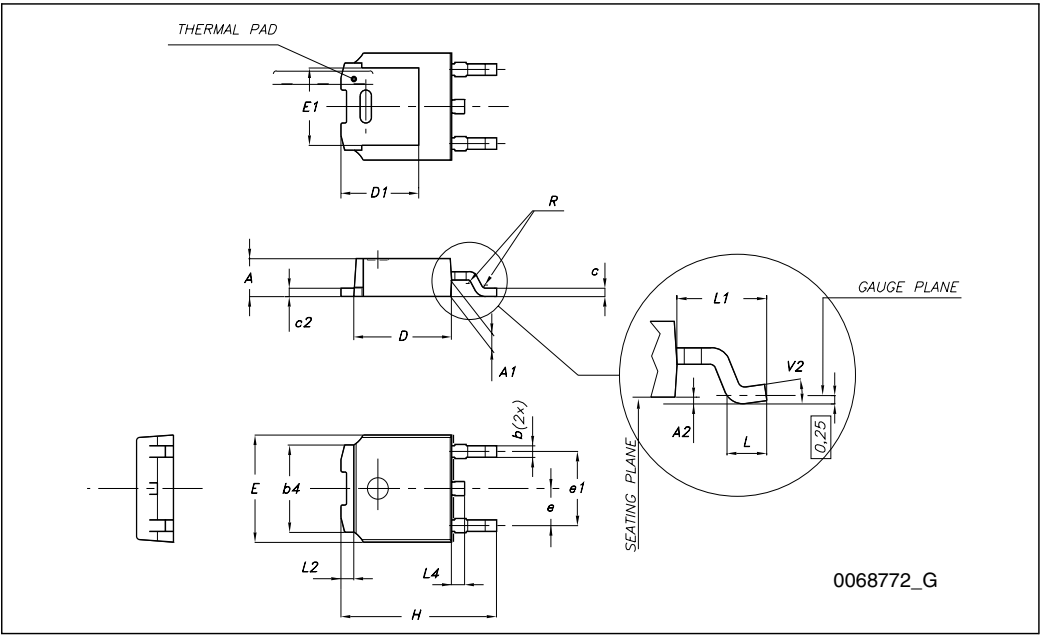
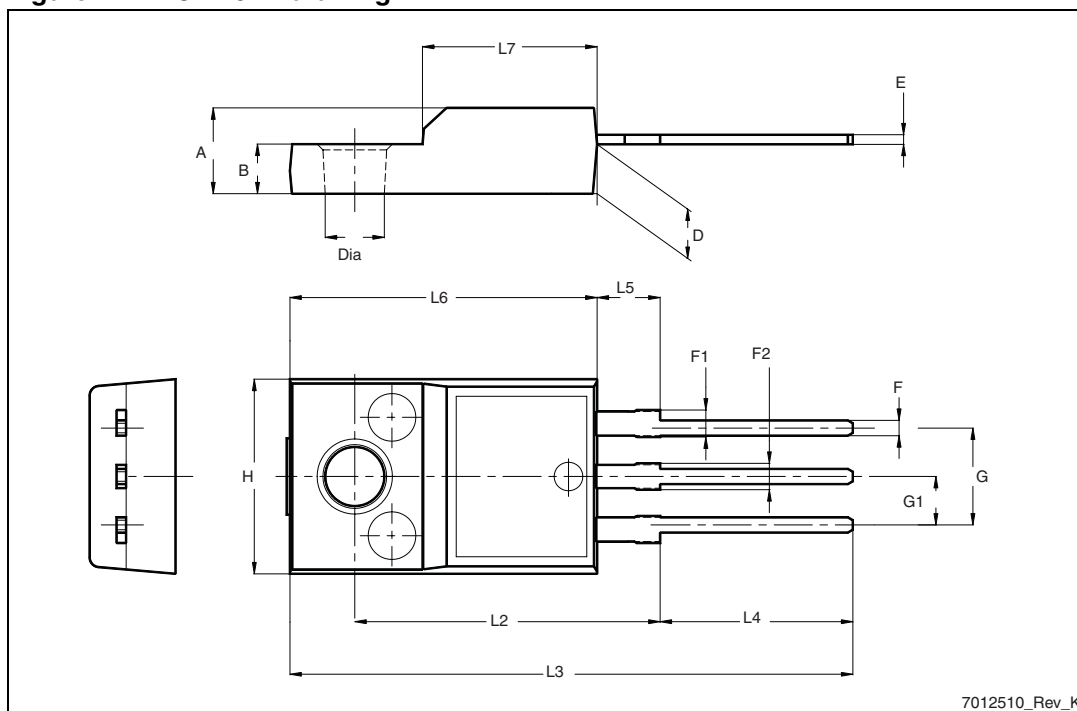


Table 9. TO-220FP mechanical data

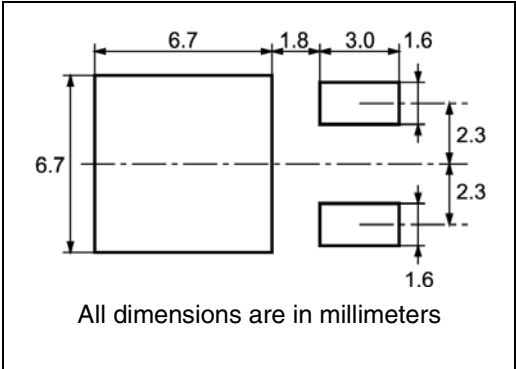
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 21. TO-220FP drawing

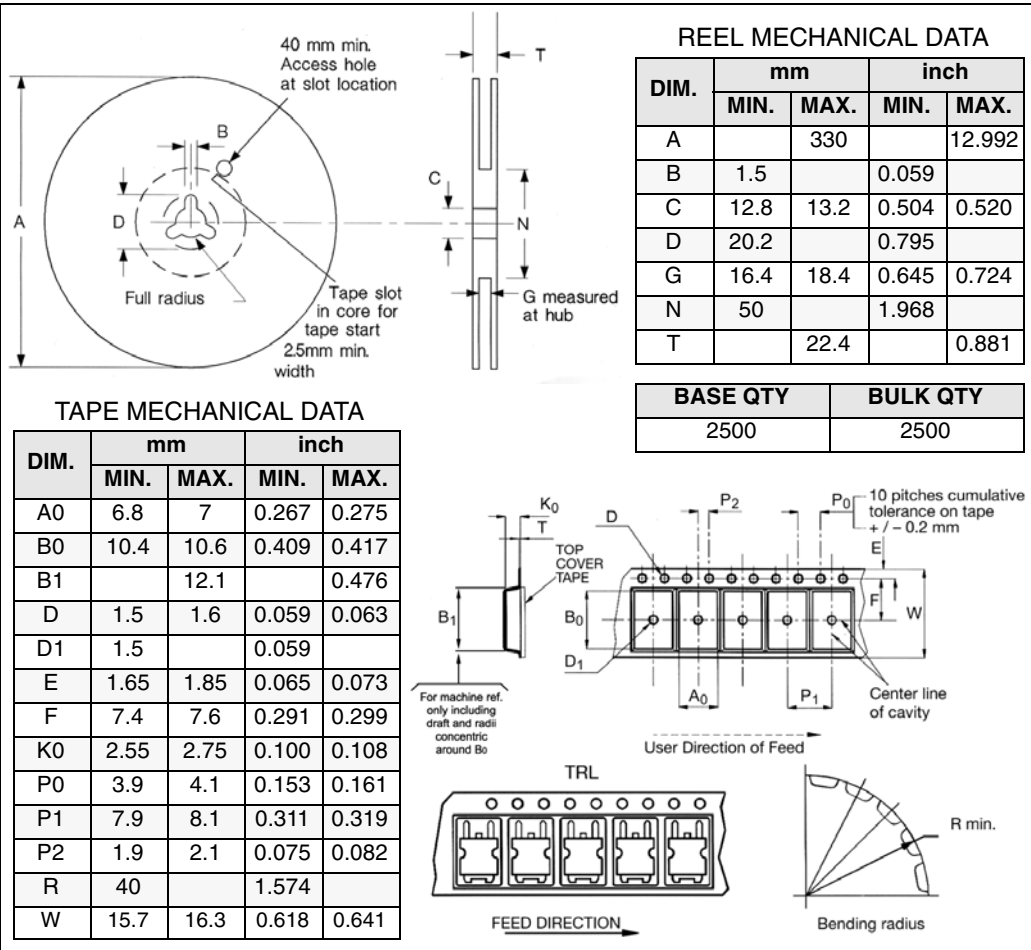


5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT



6 Revision history

Table 10. Document revision history

Date	Revision	Changes
06-Jul-2009	1	Initial release
14-Jun-2010	2	Inserted Section 2.1: Electrical characteristics (curves) .

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