



STGBL6NC60DI, STGDL6NC60DI STGFL6NC60DI, STGPL6NC60DI

6 A, 600 V hyper fast IGBT

Features

- Low C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very high frequency operation
- Very soft ultrafast recovery antiparallel diode

Applications

- High frequency inverters
- SMPS and PFC (hard switching too)
- High frequency motor drive

Description

Thanks to a new lifetime control system, this new PowerMESH™ technology-based series of devices exhibits very low turn-off energy, representing the best trade-off between on-state voltage and switching losses and thus allowing very high operating frequencies.

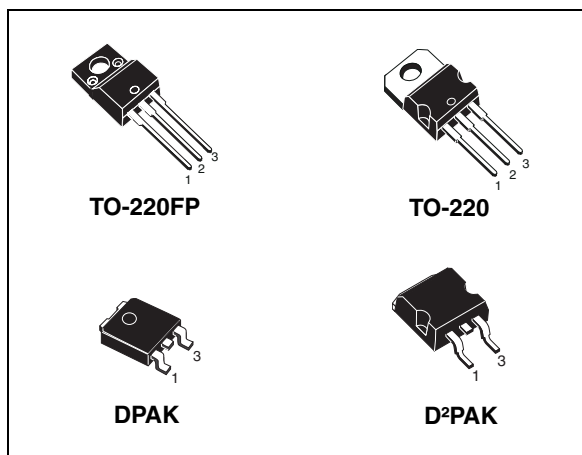


Figure 1. Internal schematic diagram

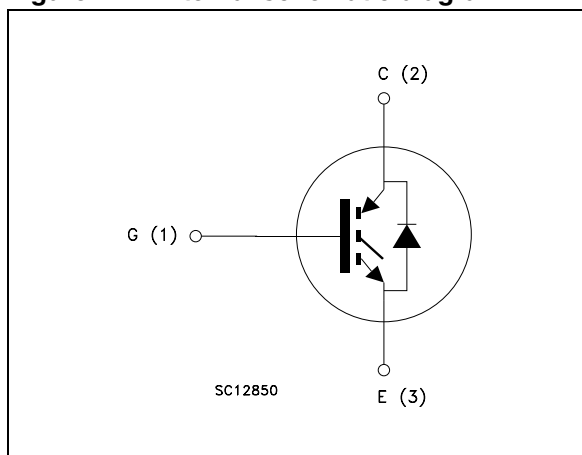


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGBL6NC60DIT4	GBL6NC60DI	D ² PAK	Tape and reel
STGDL6NC60DIT4	GDL6NC60DI	DPAK	Tape and reel
STGPL6NC60DI	GPL6NC60DI	TO-220	Tube
STGFL6NC60DI	GFL6NC60DI	TO-220FP	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK	TO-220 D ² PAK	TO-220FP	
V _{CES}	Collector-emitter voltage (V _{GE} = 0)	600			V
I _C ⁽¹⁾	Collector current (continuous) at T _C = 25 °C	13	14	7	A
I _C ⁽¹⁾	Collector current (continuous) at T _C = 100 °C	5	6	3	A
I _{CL} ⁽²⁾	Turn-off latching current	18			A
I _{CP} ⁽³⁾	Pulsed collector current	18			A
V _{GE}	Gate-emitter voltage	±20			V
I _F	Diode RMS forward current at T _C = 25 °C	10			A
I _{FSM}	Surge non repetitive forward current t _p =10ms sinusoidal	25			A
P _{TOT}	Total dissipation at T _C = 25 °C	50	56	22	W
V _{ISO}	Isolation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C)	--	--	2500	V
T _j	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_{clamp} = 80% (V_{CES}), T_j = 150 °C, R_G = 10 Ω, V_{GE} = 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-220 D ² PAK	TO-220FP	
R _{thj-case}	Thermal resistance junction-case IGBT max.	2.5	2.2	5.6	°C/W
	Thermal resistance junction-case diode max.	4.5	4	7	°C/W
R _{thj-amb}	Thermal resistance junction-ambient max.	100	62.5		°C/W

2 Electrical characteristics

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

Table 4. Static electrical characteristics

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	$V_{GE} = 15\text{ V}, I_C = 1.5\text{ A}$		1.9		V
		$V_{GE} = 15\text{ V}, I_C = 3\text{ A}$		2.2	2.9	V
		$V_{GE} = 15\text{ V}, I_C = 3\text{ A}, T_j = 125\text{ °C}$		2		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 ($V_{GE} = 0$)	$V_{CE} = 600\text{ V}$			50	μA
		$V_{CE} = 600\text{ V}, T_j = 125\text{ °C}$			5	mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 100	nA
g_{fs}	Forward transconductance	$V_{CE} = 15\text{ V}, I_C = 3\text{ A}$		3		S

Table 5. Dynamic electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0$	-	208	-	pF
C_{oes}	Output capacitance			32.5		pF
C_{res}	Reverse transfer capacitance			5.4		pF
Q_g	Total gate charge	$V_{CE} = 390\text{ V}, I_C = 3\text{ A}, V_{GE} = 15\text{ V}$ (see Figure 17)	-	12	-	nC
Q_{ge}	Gate-emitter charge			2.6		nC
Q_{gc}	Gate-collector charge			4.9		nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		6.7		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	3.7	-	ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 18)		930		A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		6.5		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	4	-	ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)		820		A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$,		17		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	46	-	ns
t_f	Current fall time	(see Figure 18)		47		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$,		35		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	67	-	ns
t_f	Current fall time	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)		55		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		32		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	24	-	μ J
E_{ts}	Total switching losses	(see Figure 18)		56		μ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		51		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	46	-	μ J
E_{ts}	Total switching losses	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)		97		μ J

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in (see Figure 19). If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs and 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	$I_F = 1\text{ A}$			1.7	V
		$I_F = 3\text{ A}$	-	1.8		V
		$I_F = 3\text{ A}$, $T_j = 125\text{ }^\circ\text{C}$		1.3		V
t_{rr}	Reverse recovery time	$I_F = 3\text{ A}$, $V_R = 40\text{ V}$,		23		ns
Q_{rr}	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	21		nC
I_{rrm}	Reverse recovery current	(see Figure 19)		1.5		A
t_{rr}	Reverse recovery time	$I_F = 3\text{ A}$, $V_R = 40\text{ V}$,		47		ns
Q_{rr}	Reverse recovery charge	$T_j = 125\text{ }^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	51		nC
I_{rrm}	Reverse recovery current	(see Figure 19)		2		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

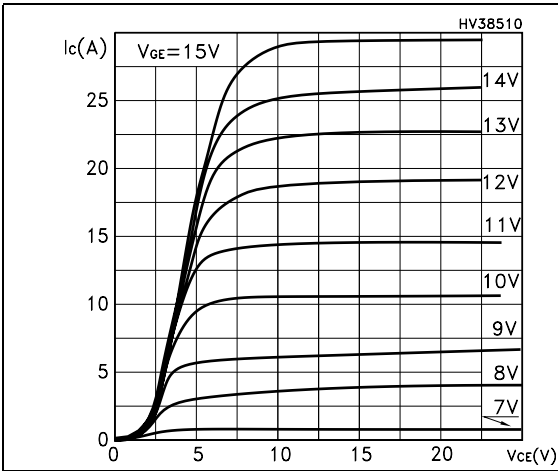


Figure 3. Transfer characteristics

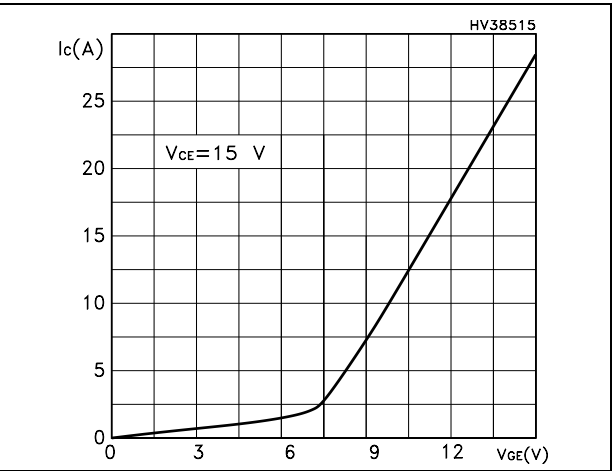


Figure 4. Transconductance

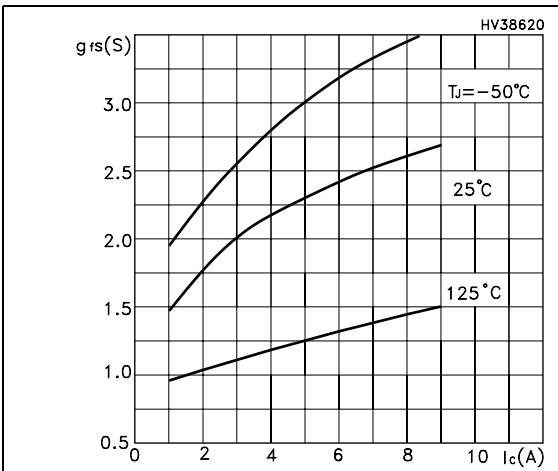


Figure 5. Collector-emitter on voltage vs temperature

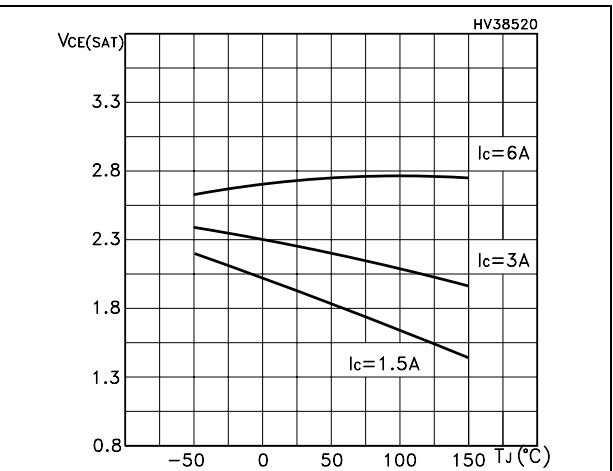


Figure 6. Gate charge vs gate-source voltage

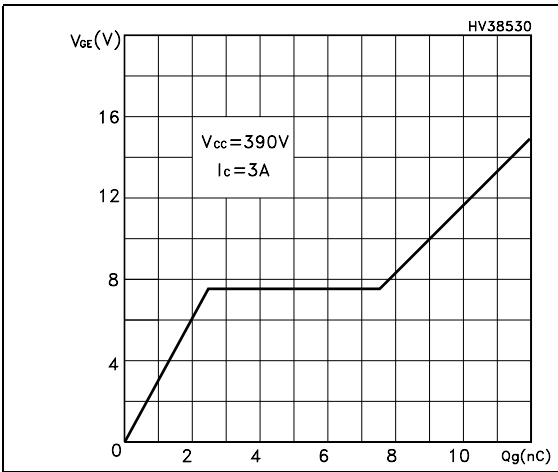


Figure 7. Capacitance variations

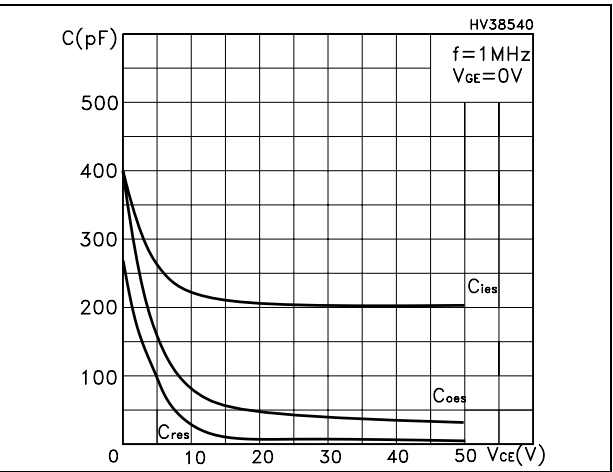


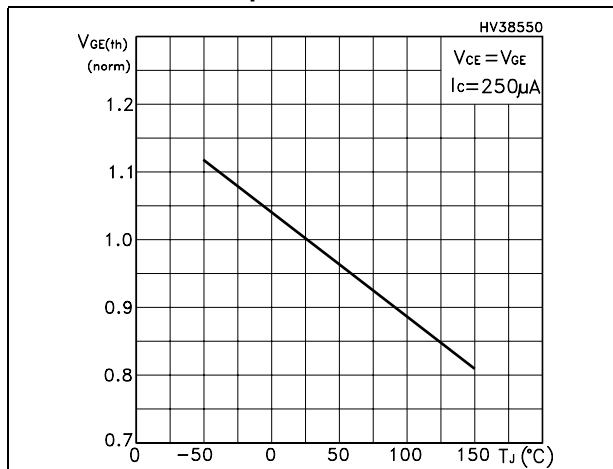
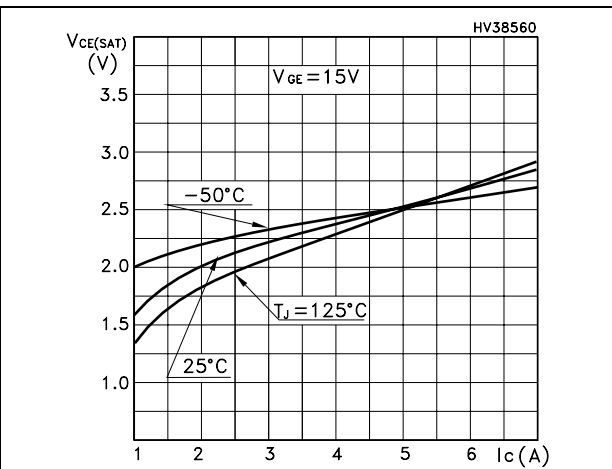
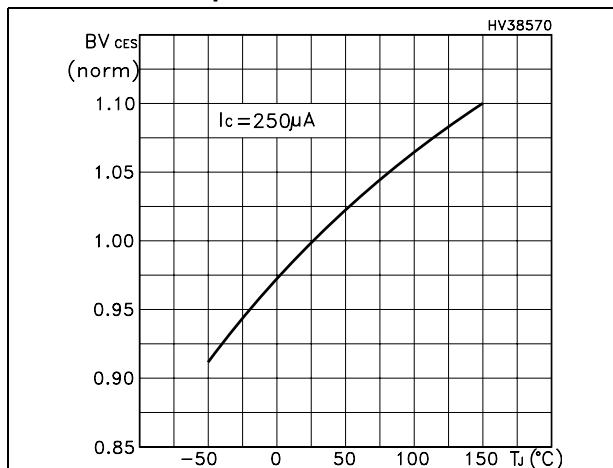
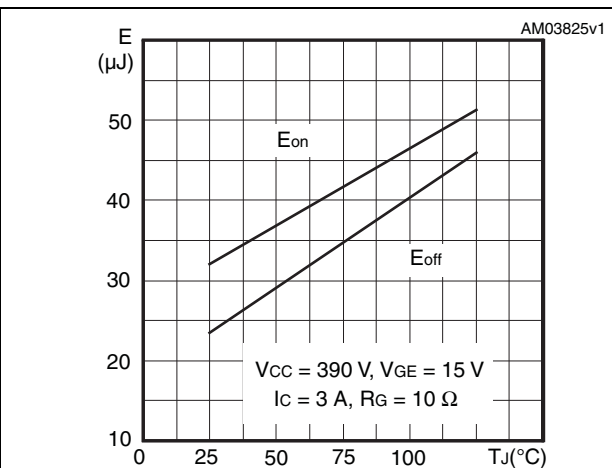
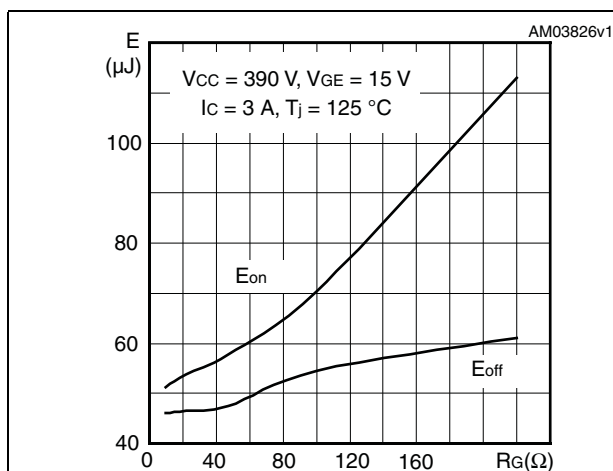
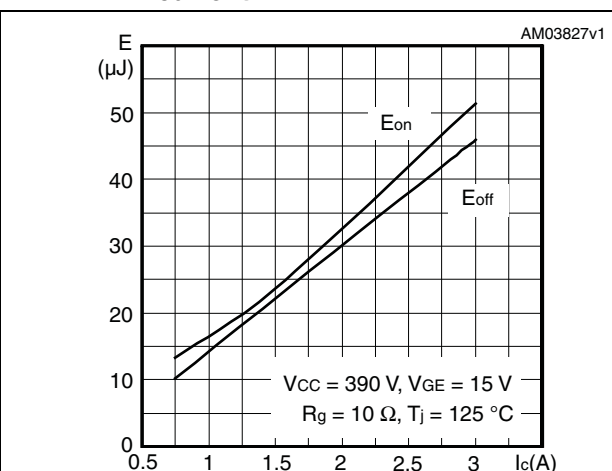
Figure 8. Normalized gate threshold voltage vs temperature**Figure 9. Collector-emitter on voltage vs collector current****Figure 10. Normalized breakdown voltage vs temperature****Figure 11. Switching losses vs temperature****Figure 12. Switching losses vs gate resistance****Figure 13. Switching losses vs collector current**

Figure 14. RBSOA

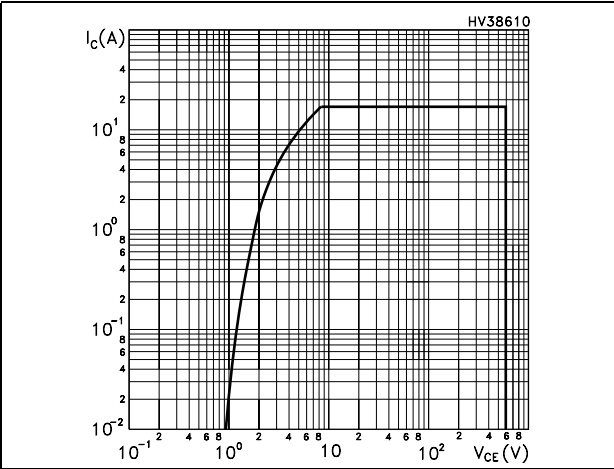
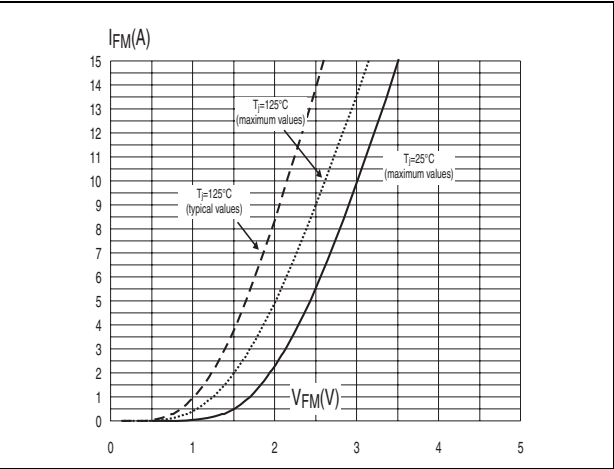


Figure 15. Forward voltage drop versus forward current



3 Test circuits

Figure 16. Test circuit for inductive load switching

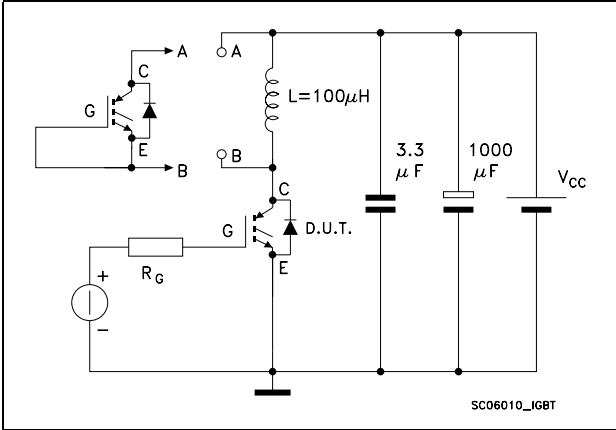


Figure 17. Gate charge test circuit

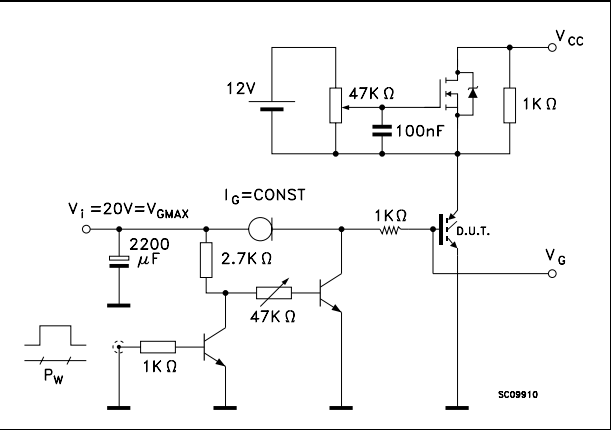


Figure 18. Switching waveform

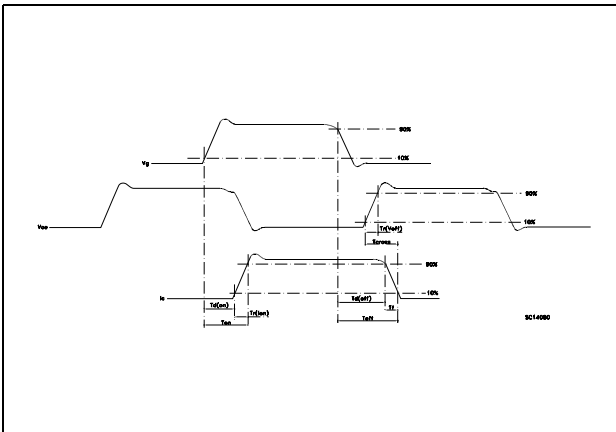
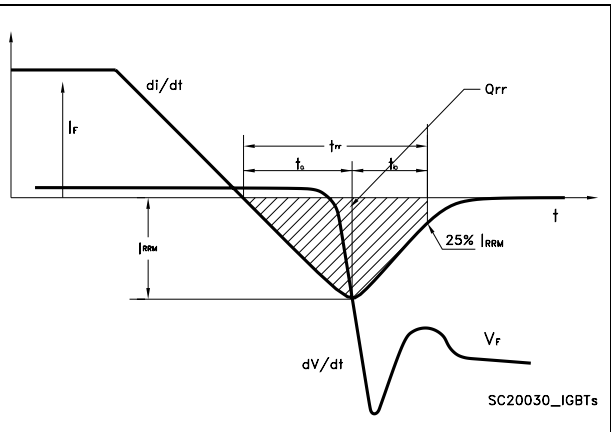


Figure 19. Diode recovery time waveform

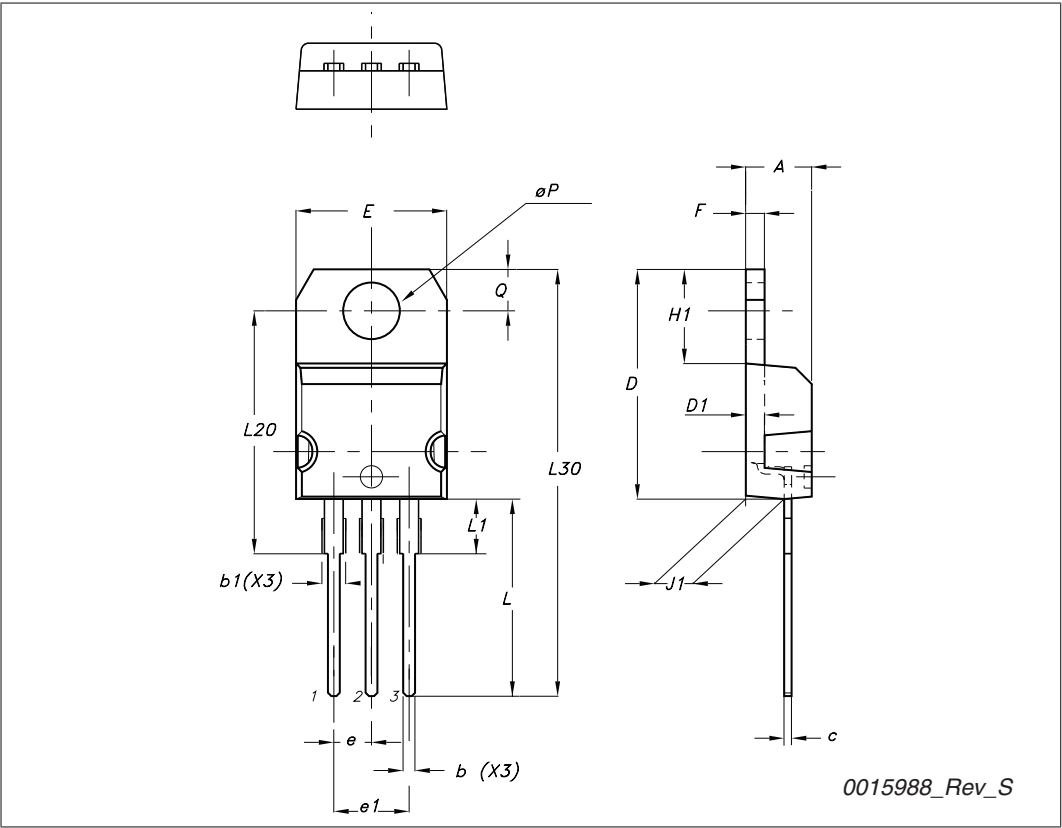


4 Package mechanical data

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-220 type A mechanical data

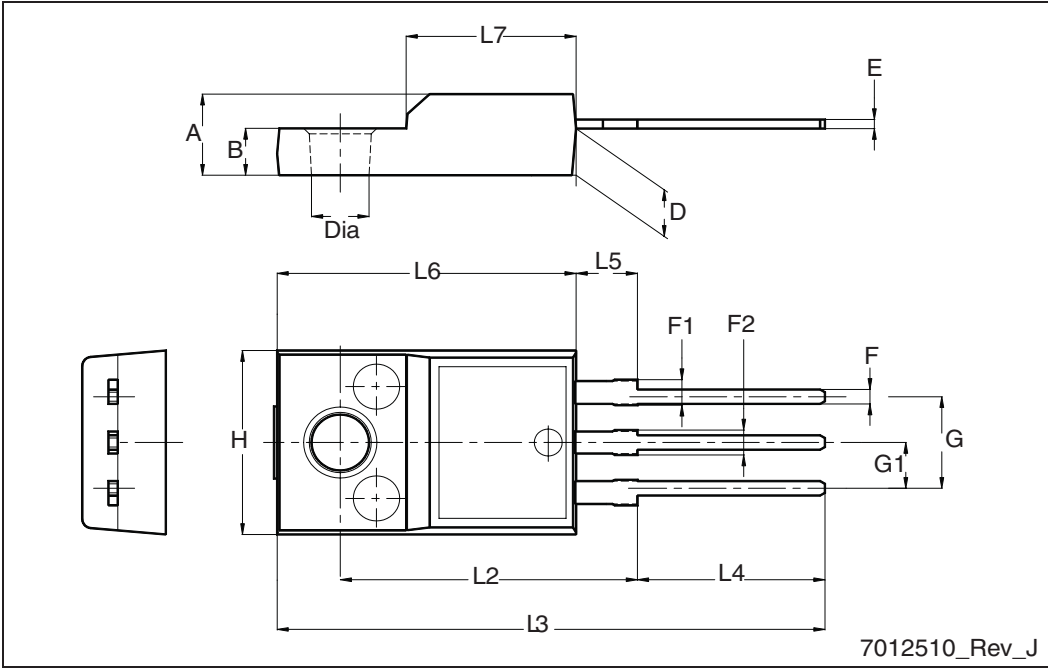
Dim	mm		
	Min	Typ	Max
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95



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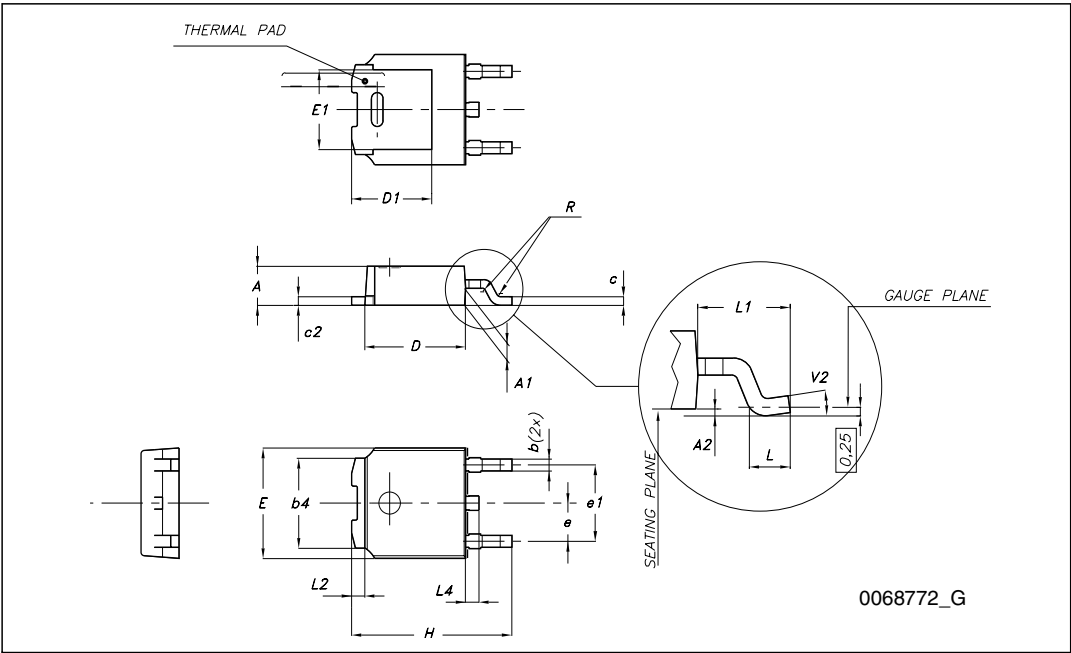
TO-220FP mechanical data

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		1.5
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



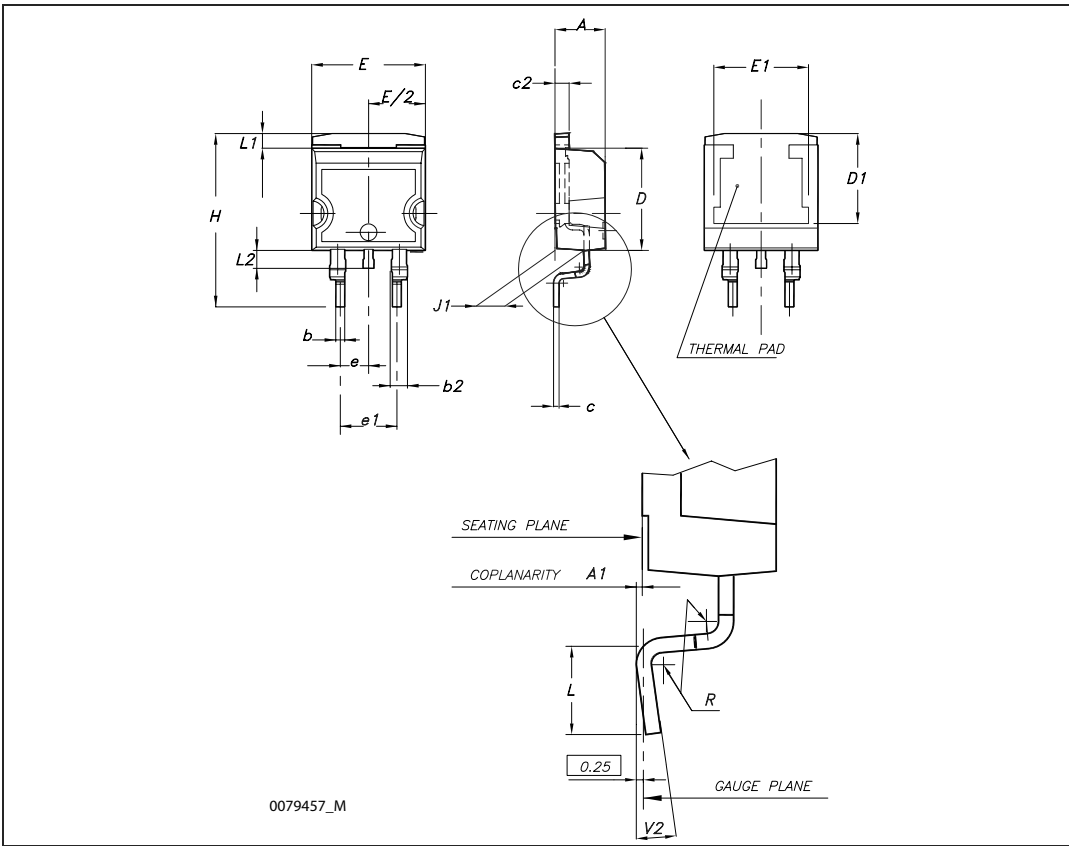
TO-252 (DPAK) mechanical data

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 °



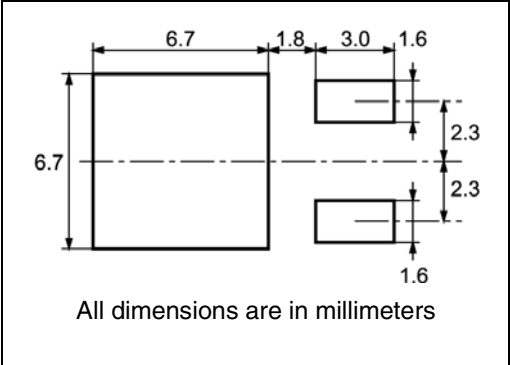
D²PAK (TO-263) mechanical data

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°

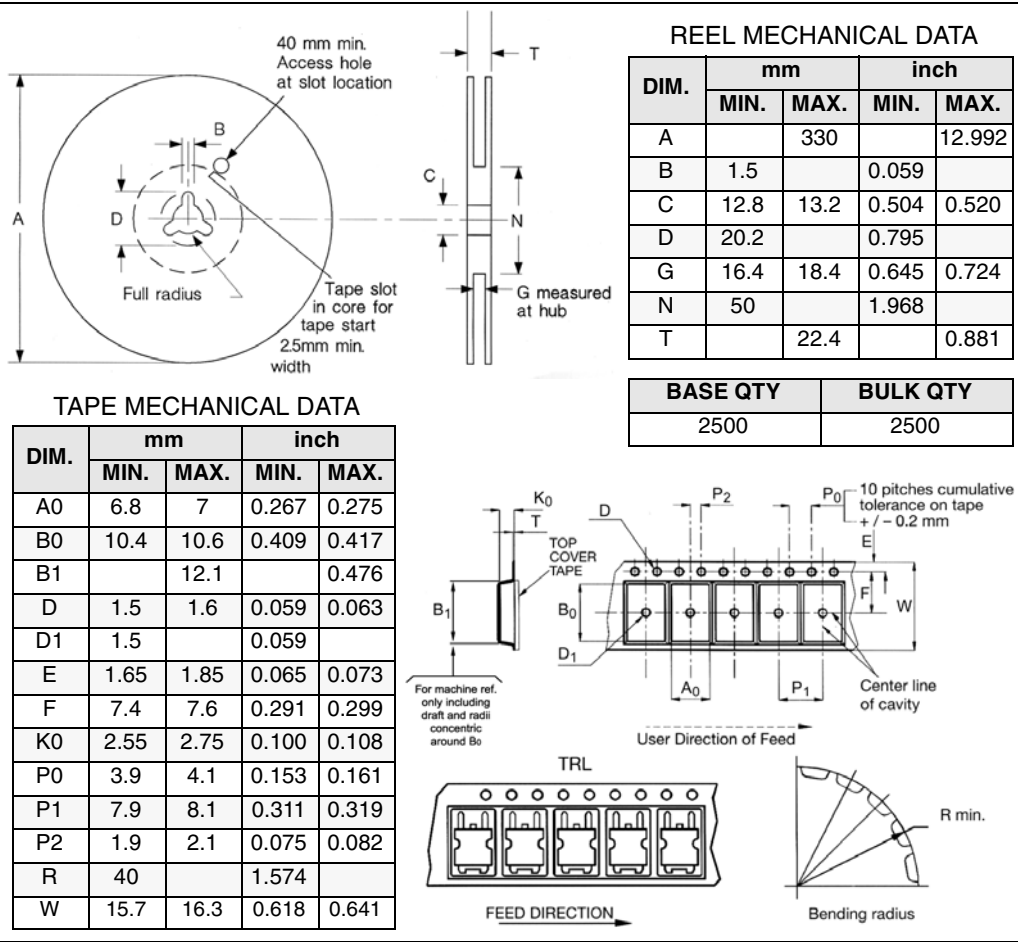


5 Packaging mechanical data

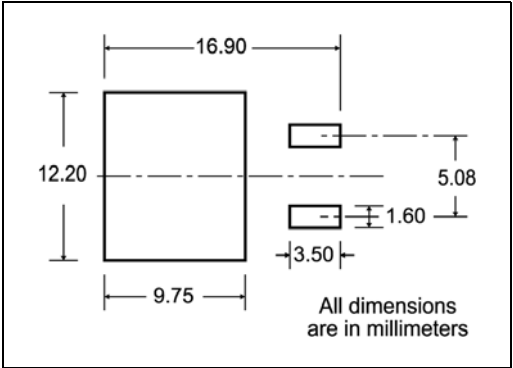
DPAK FOOTPRINT



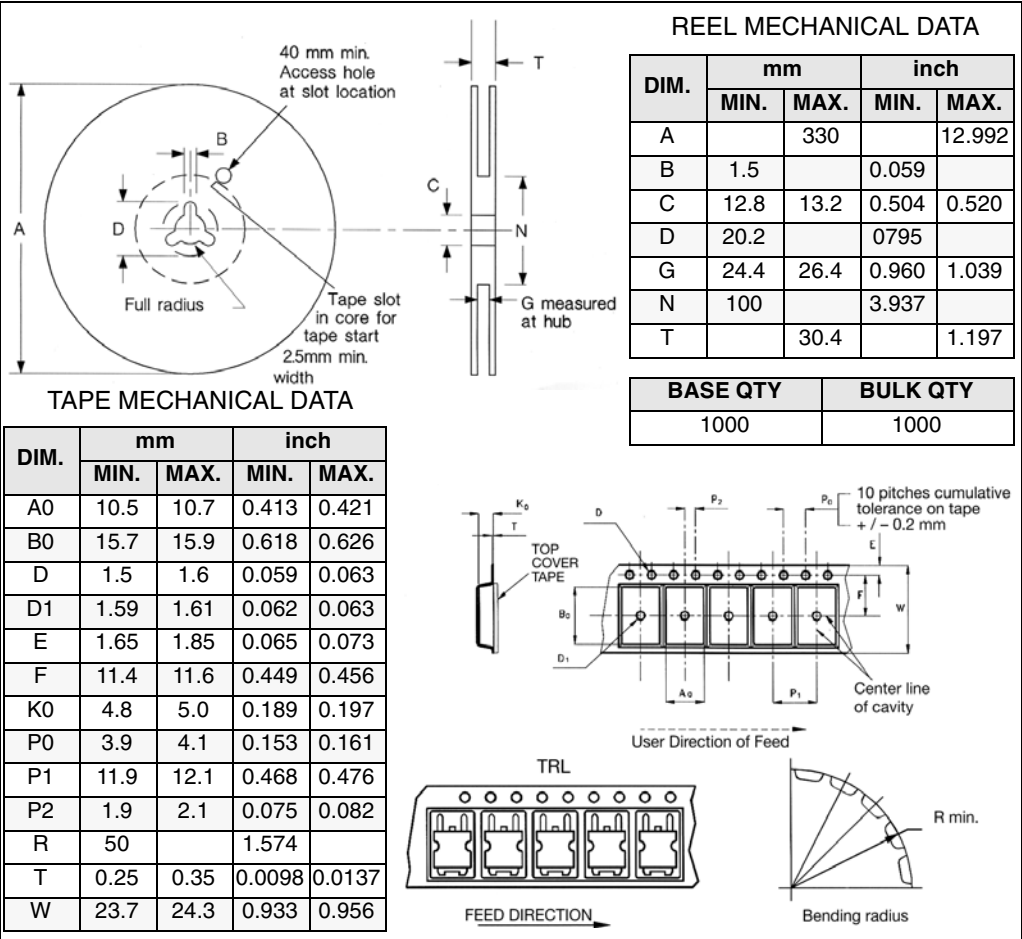
TAPE AND REEL SHIPMENT



D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



* on sales type

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
27-Mar-2009	1	First release
13-Aug-2009	2	Document status promoted from preliminary data to datasheet, inserted Section 2.1: Electrical characteristics (curves) , updated TO-220 and TO-220FP package mechanical data

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