STGBL6NC60D
STGPL6NC60D

600 V - 6 A hyper fast IGBT

Datasheet — production data

Features

- Low C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode

Applications

- Very high frequency operation
- High frequency lamp ballast
- SMPS and PFC (including hard switching)

Description

This series of hyper fast IGBT is based on PowerMESH technology and exhibits very low turn-off energy, thanks to a new lifetime control system. This results in an optimized trade-off between on-state voltage and switching losses, allowing very high operating frequencies.

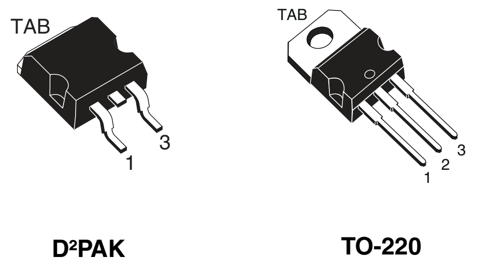

Figure 1. Internal schematic diagram

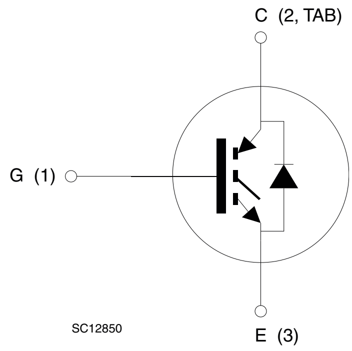

Table 1. Device summary

Order codes	Marking	Package	Packaging
STGBL6NC60DT4	GBL6NC60D	D²PAK	Tape and reel
STGPL6NC60D	GPL6NC60D	TO-220	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600	V
I_C(1)	Collector current (continuous) at T_C = 25 °C	14	A
I_C(1)	Collector current (continuous) at T_C = 100 °C	6	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	7	A
I_{FSM}	Surge non repetitive forward current t_p = 10 ms sinusoidal	20	A
P_{TOT}	Total dissipation at T_C = 25 °C	56	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T_C = 25 °C)	--	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. Vclamp = 80%,(V_{CES}), Tj =150°C, R_G = 10 Ω, V_{GE} = 15 V
3. Pulse width limited by max junction temperature allowed

Table 3. Thermal resistance

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT max.	2.2	°C/W
	Thermal resistance junction-case diode max.	4	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max.	62.5	°C/W

2 Electrical characteristics

T_{CASE} = 25 °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 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C= 1.5 A V_{GE} = 15 V, I_C= 3 A V_{GE}= 15 V, I_C= 3 A,T_C=125°C		1.9 2.2 2	2.9	V V V
$V_{GE(th)}$	Gate threshold voltage	V_{CE}= V_{GE}, I_C= 250 µA	3.75		5.75	V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 600 V V_{CE} = 600 V, T_C = 125 °C			50 5	µA mA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ±20 V			±100	nA
g_{fs}	Forward transconductance	V_{CE} = 15 V, I_C = 3 A		3		S

Table 5. Dynamic electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0		208 32.5 5.4		pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 390 V, I_C = 3 A, V_{GE} = 15 V *(see Figure 17)*		12 2.6 4.9		nC nC 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} = 390 V, I_C = 3 A R_G= 10 Ω, V_{GE} = 15 V *(see Figure 18)*		6.7 3.7 930		ns ns A/µs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CC} = 390 V, I_C = 3 A R_G = 10 Ω, V_{GE} = 15 V, T_C =125 °C *(see Figure 18)*		6.5 4 820		ns ns A/µs
$t_r(V_{off})$ $t_d(_{off})$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 390 V, I_C = 3 A, R_{GE} = 10 Ω, V_{GE} = 15 V *(see Figure 18)*		17 46 47		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 V, I_C = 3 A, R_{GE} = 10 Ω, V_{GE} =15 V, T_C = 125 °C *(see Figure 18)*		35 67 55		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} = 390 V, I_C = 3 A R_G = 10 Ω, V_{GE}=15 V *(see Figure 18)*		46.5 23.5 70		µJ µJ µJ
E_{on} (1) E_{off}(2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 390 V, I_C = 3 A R_G = 10 Ω, V_{GE} = 15 V, T_C = 125 °C *(see Figure 18)*		67.5 46 113.5		µJ µJ µJ

1. Eon 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-pack 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. Turn-off with snubber

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_f E_{off}(1)	Current fall time Turn-off switching losses	V_{CC} = 200 V, I_C = 1.5 A R_G = 22 Ω, V_{clamp}=400 V, L=1 mH, C-snubber = 2.7 nF *(see Figure 18)*		16 1.6		ns µJ
t_f E_{off} (1)	Current fall time Turn-off switching losses	V_{CC} = 200 V, I_C = 1.5 A R_G = 22 Ω, V_{clamp}= 400 V, L=1 mH, C-snubber= 2.7 nF, T_C= 100 °C *(see Figure 18)*		19 3.5		ns µJ

1. Turn-off losses include also the tail of the collector current

Table 9. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	I_F = 1 A I_F=3 A I_F=3 A,Tc=125 °C		 1.35 1.15	1.3	V V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 3 A, V_R = 40 V, di/dt = 100 A/µs *(see Figure 19)*		50 55 2.2		ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 3 A,V_R = 40 V, T_C =125 °C, di/dt = 100 A/µs *(see Figure 19)*		80 105 2.7		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

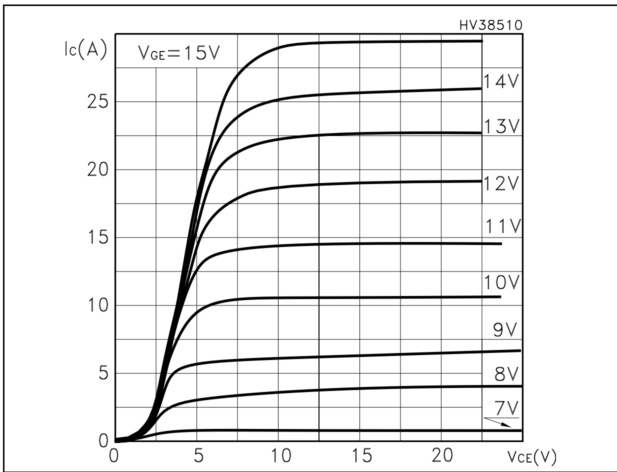


Figure 3. Transfer characteristics

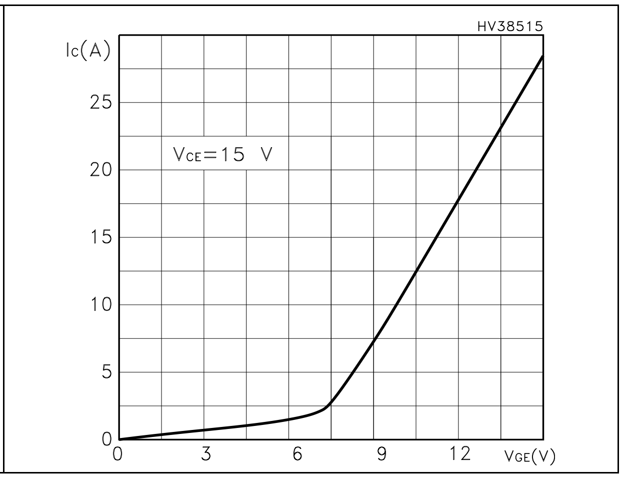


Figure 4. Transconductance

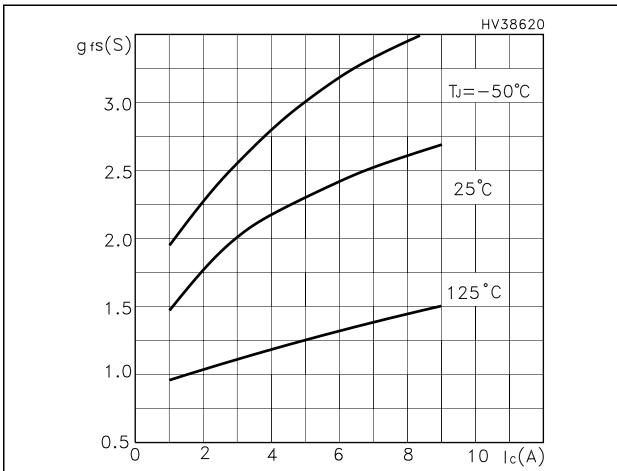


Figure 5. Collector-emitter on voltage vs. temperature

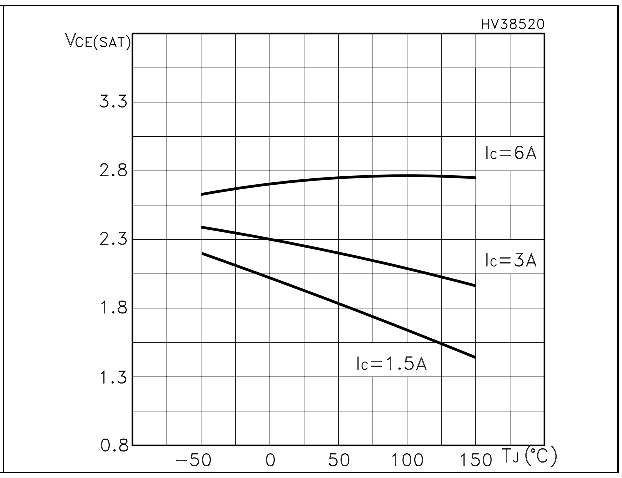


Figure 6. Gate charge vs. gate-source voltage

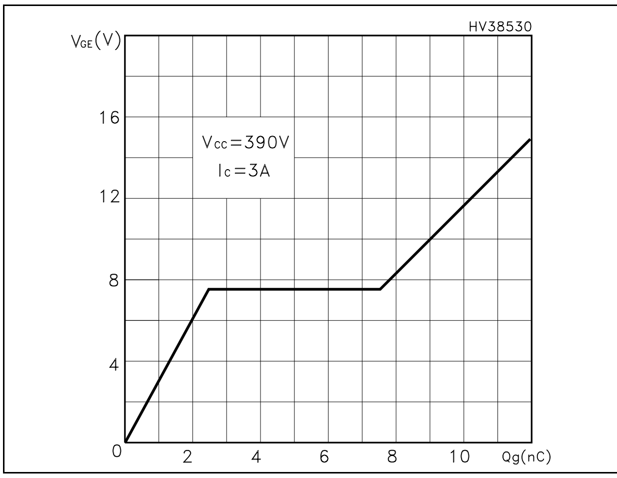


Figure 7. Capacitance variations

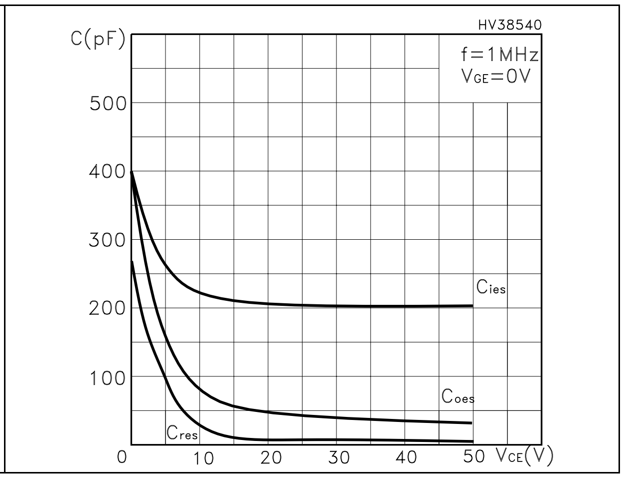


Figure 8. Normalized gate threshold voltage vs. temperature

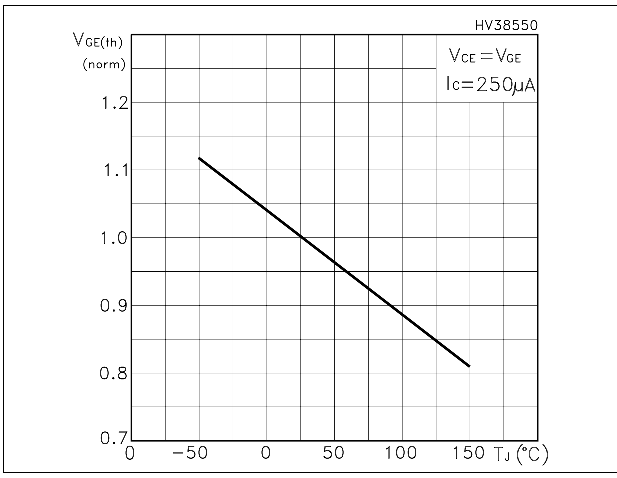


Figure 9. Collector-emitter on voltage vs. collector current

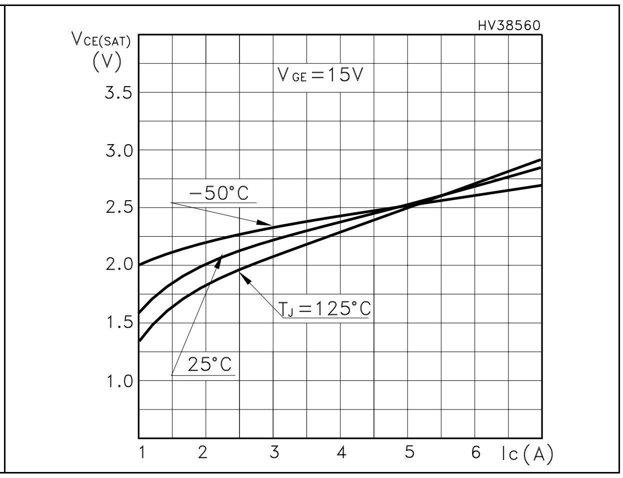


Figure 10. Normalized breakdown voltage vs. temperature

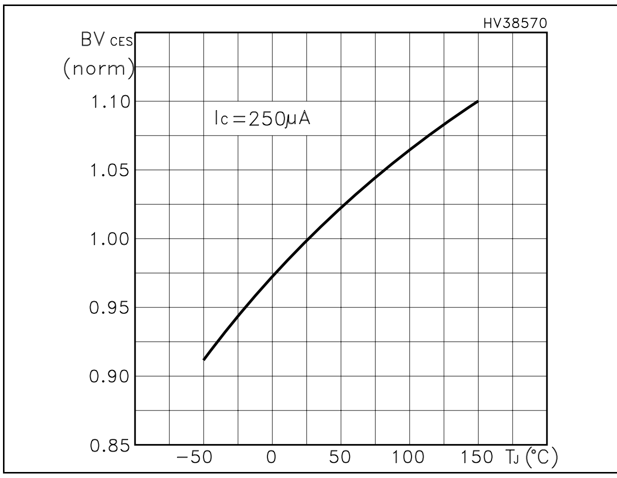


Figure 11. Switching losses vs. temperature

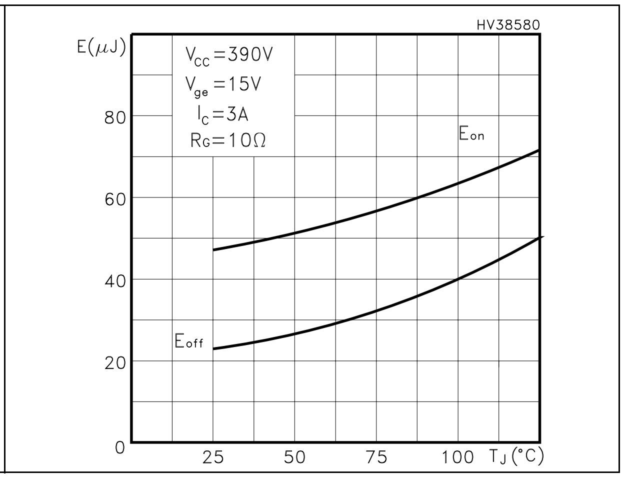


Figure 12. Switching losses vs. gate resistance

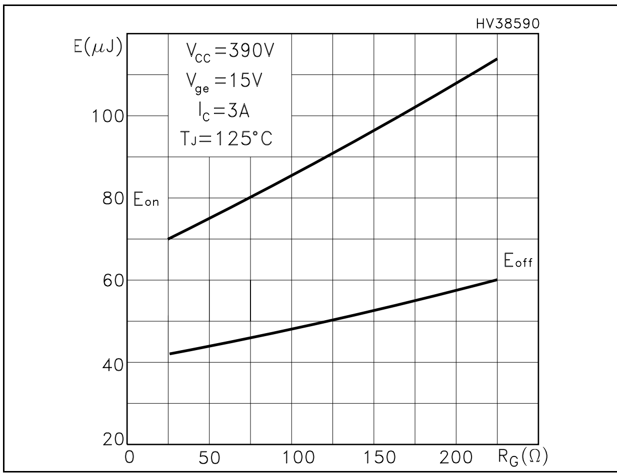


Figure 13. Switching losses vs. collector current

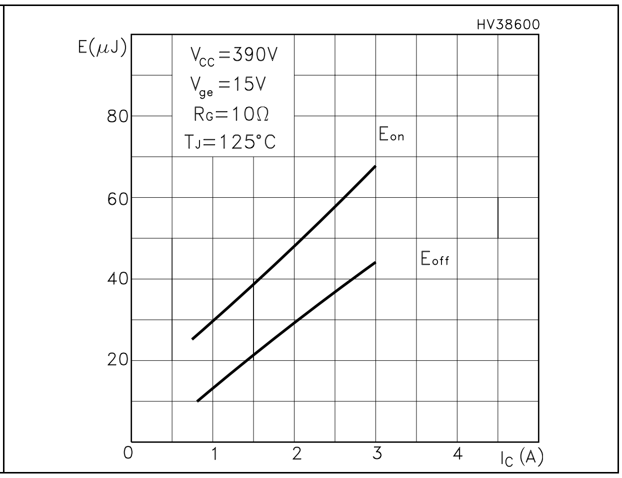


Figure 14. Turn-off SOA

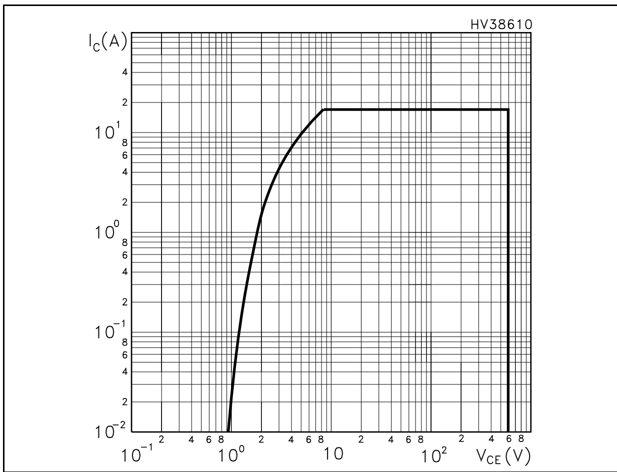
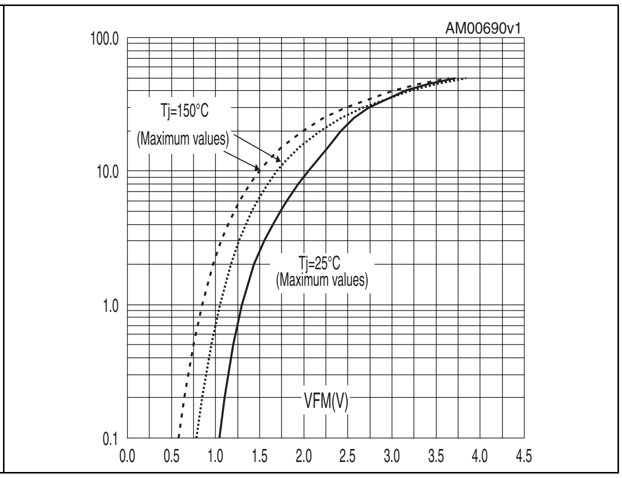


Figure 15. Forward voltage drop vs. forward current



3 Test circuit

Figure 16. Test circuit for inductive load switching

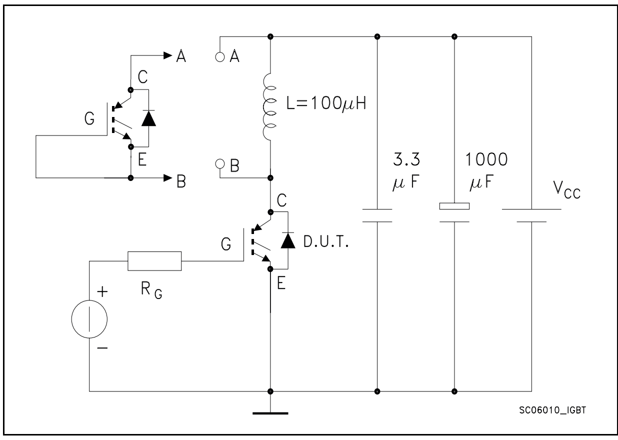


Figure 17. Gate charge test circuit

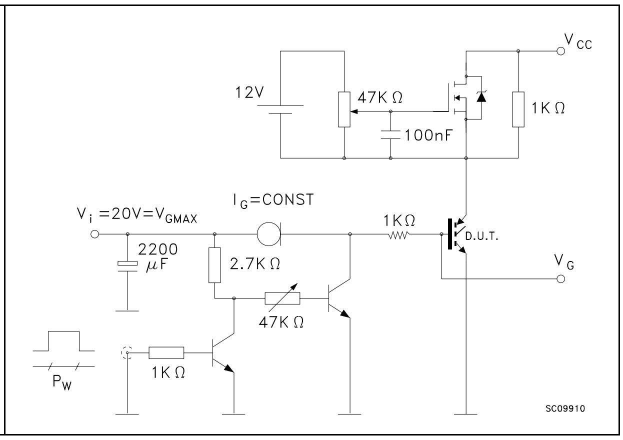


Figure 18. Switching waveform

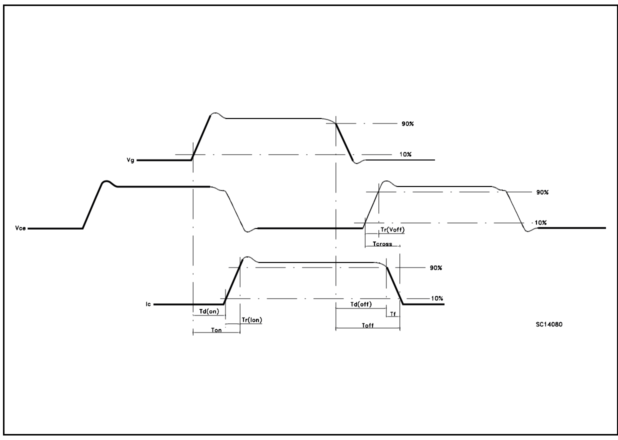
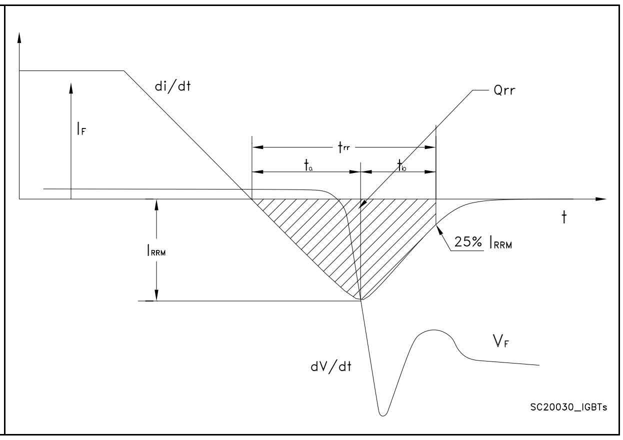


Figure 19. Diode recovery time waveform



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.

Table 10. 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 20. TO-220 type A drawing

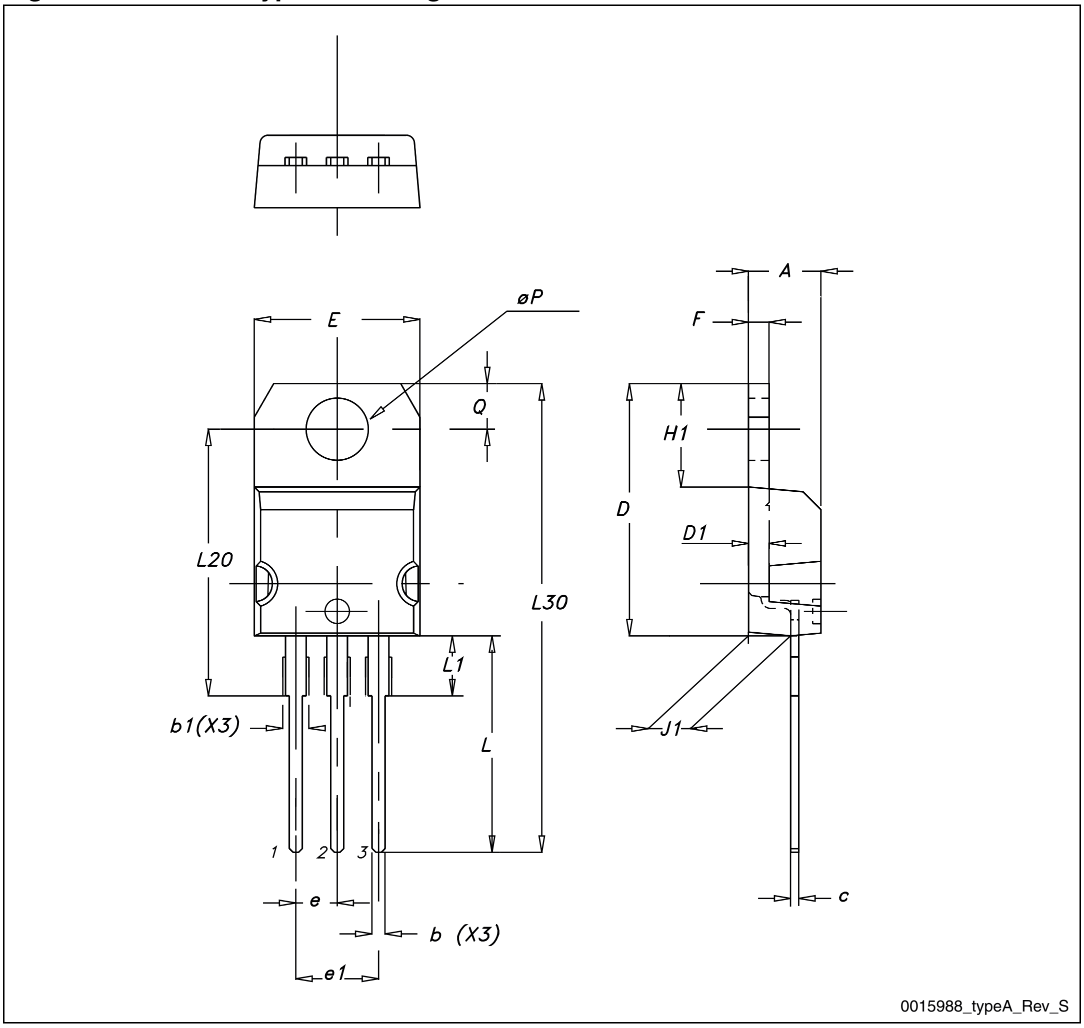


Table 11. D²PAK (TO-263) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 21. D²PAK (TO-263) drawing

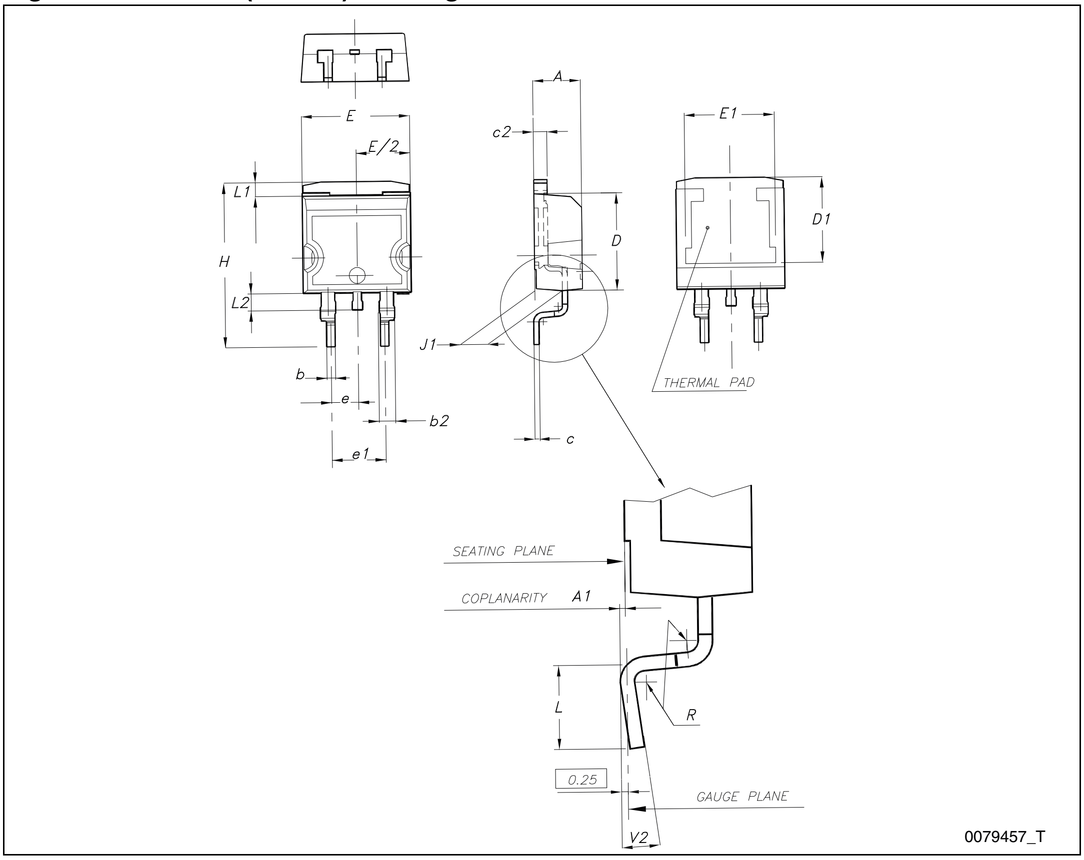
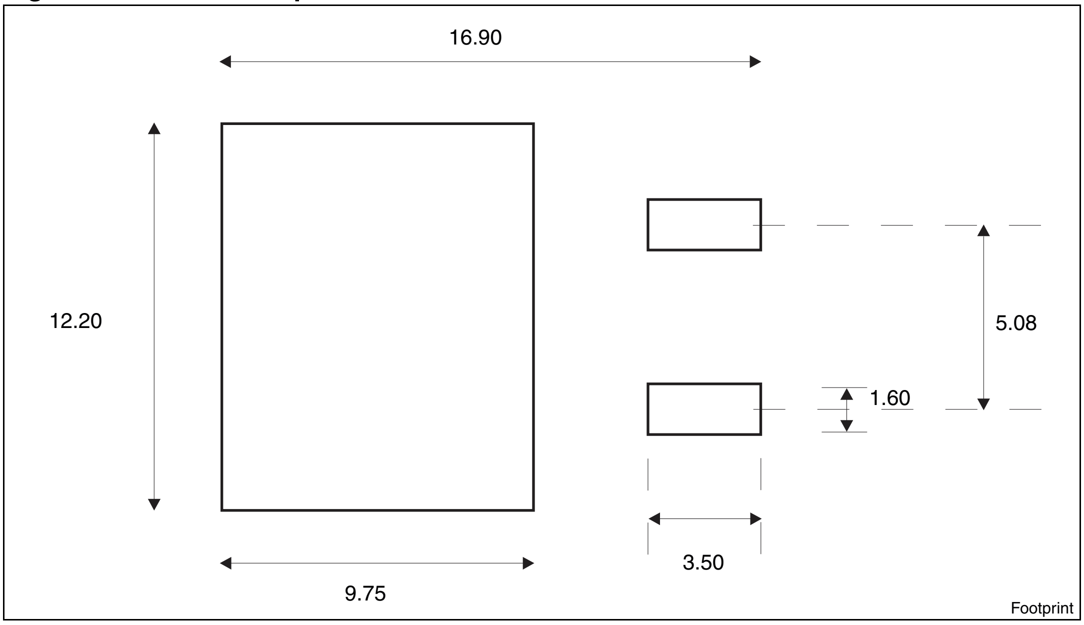


Figure 22. D²PAK footprint (a)



a. All dimension are in millimeters

5 Packaging mechanical data

Table 12. D²PAK (TO-263) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 23. Tape

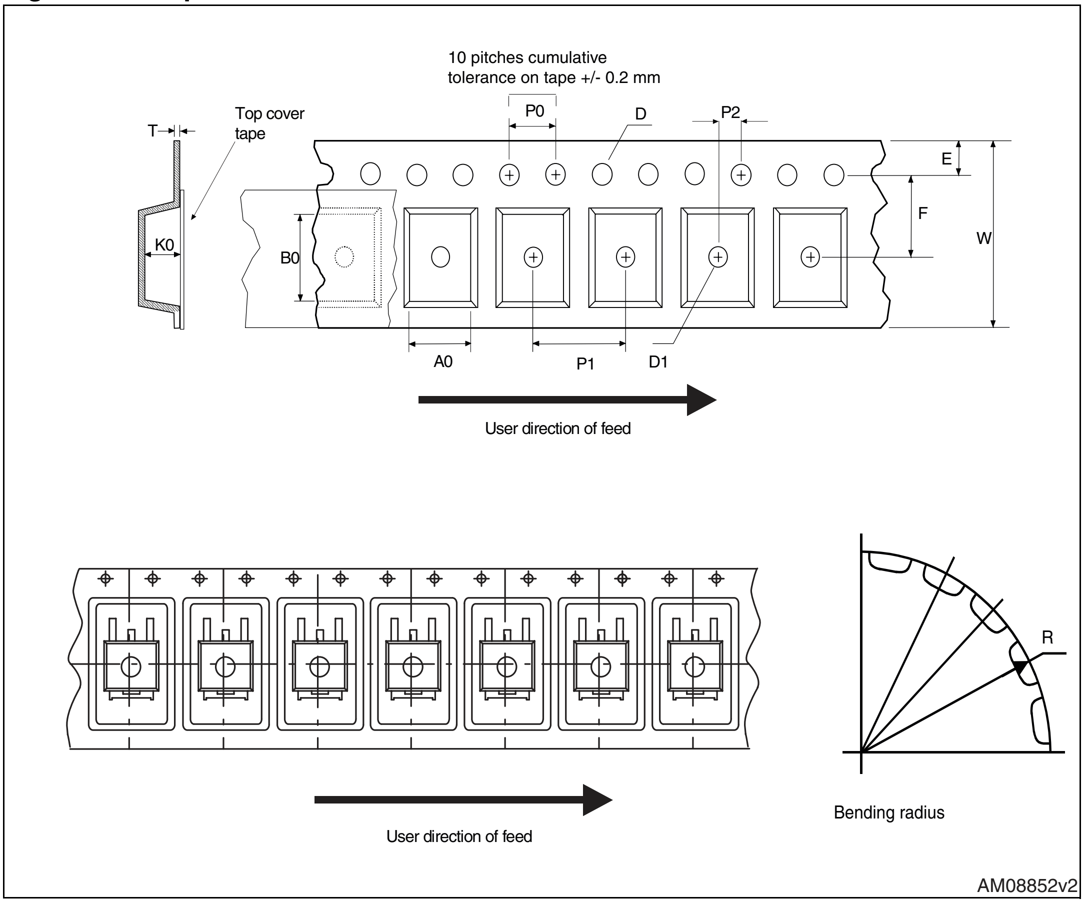
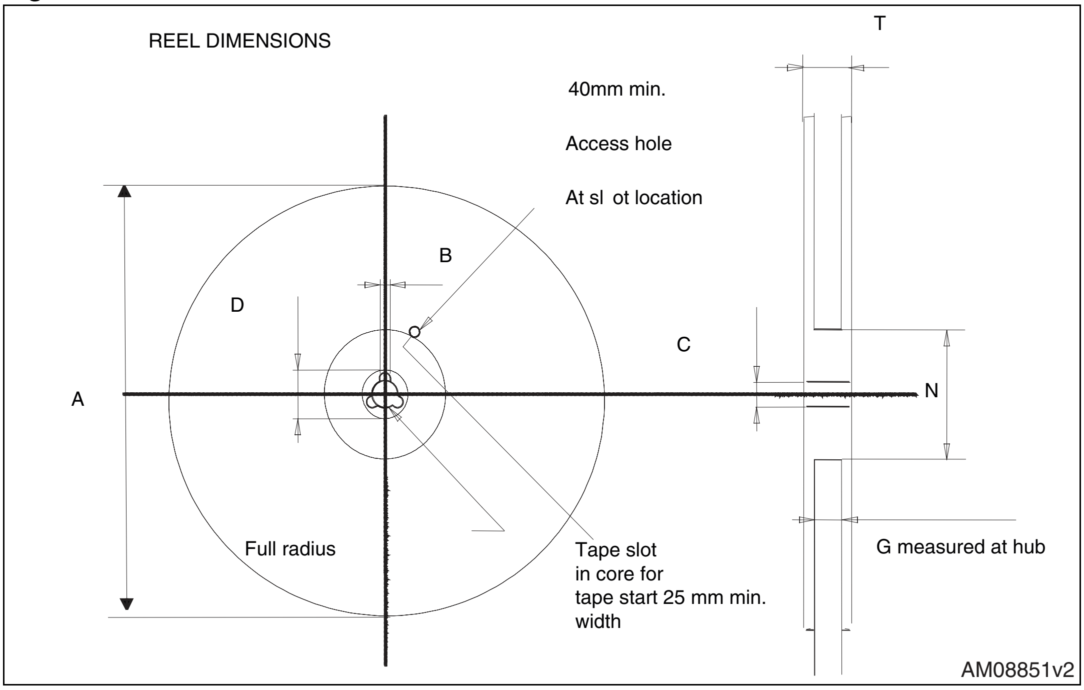


Figure 24. Reel



6 Revision history

Table 13. Document revision history

Date	Revision	Changes
27-Jul-2007	1	First release
09-Jul-2008	2	*4: Package mechanical data* has been updated.
21-Nov-2008	3	Updated *Table 9* and *Figure 15*
20-Sep-2012	4	Minor text changes in the Description. Updated: *Section 4: Package mechanical data on page 10* and *Section 5: Packaging mechanical data on page 14*.