

### 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.

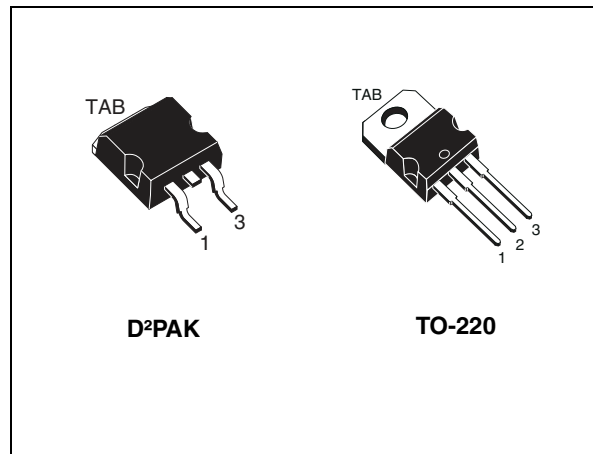


Figure 1. Internal schematic diagram

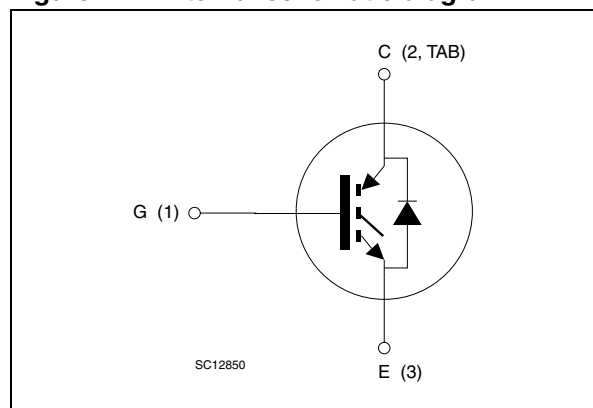


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGBL6NC60DT4	GBL6NC60D	D <sup>2</sup> PAK	Tape and reel
STGPL6NC60D	GPL6NC60D	TO-220	Tube

# Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>4</b>
2.1	Electrical characteristics (curves) .....	6
<b>3</b>	<b>Test circuit</b> .....	<b>9</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>10</b>
<b>5</b>	<b>Packaging mechanical data</b> .....	<b>14</b>
<b>6</b>	<b>Revision history</b> .....	<b>16</b>



# 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 $T_C = 25\text{ °C}$	14	A
$I_C^{(1)}$	Collector current (continuous) at $T_C = 100\text{ °C}$	6	A
$I_{CL}^{(2)}$	Turn-off latching current	18	A
$I_{CP}^{(3)}$	Pulsed collector current	18	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Diode RMS forward current at $T_C = 25\text{ °C}$	7	A
$I_{FSM}$	Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	20	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	56	W
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ ; $T_C = 25\text{ °C}$ )	--	V
$T_j$	Operating junction temperature	- 55 to 150	$^{\circ}\text{C}$

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(\max)} - T_C}{R_{thj-c} \times V_{CE(\text{sat})}(\max)(T_{j(\max)}, I_C(T_C))}$$

2.  $V_{\text{clamp}} = 80\%, (V_{CES}), T_j = 150^{\circ}\text{C}, R_G = 10\ \Omega, V_{GE} = 15\text{ V}$
3. Pulse width limited by max junction temperature allowed

**Table 3. Thermal resistance**

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

## 2 Electrical characteristics

$T_{CASE} = 25\text{ °C}$  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	$V_{GE} = 15\text{ V}, I_C = 1.5\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 3\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 3\text{ A}, T_C = 125\text{ °C}$		1.9 2.2 2	2.9	V 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 ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_C = 125\text{ °C}$			50 5	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	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	$V_{CE} = 390\text{ V}, I_C = 3\text{ A},$		12		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{ V}$		2.6		nC
$Q_{gc}$	Gate-collector charge	(see Figure 17)		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/ $\mu$ 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	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 18)		820		A/ $\mu$ 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	$T_C = 125\text{ }^\circ\text{C}$ (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	$V_{CC} = 390\text{ V}, I_C = 3\text{ A}$		46.5		$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V}$		23.5		$\mu$ J
$E_{ts}$	Total switching losses	(see Figure 18)		70		$\mu$ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}, I_C = 3\text{ A}$		67.5		$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$		46		$\mu$ J
$E_{ts}$	Total switching losses	$T_C = 125\text{ }^\circ\text{C}$ (see Figure 18)		113.5		$\mu$ 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 & 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
$t_f$	Current fall time	$V_{CC} = 200\text{ V}, I_C = 1.5\text{ A}$		16		ns
$E_{off}^{(1)}$	Turn-off switching losses	$R_G = 22\ \Omega, V_{clamp} = 400\text{ V},$ $L = 1\text{ mH}, C\text{-snubber} = 2.7\text{ nF}$ (see Figure 18)		1.6		$\mu$ J
$t_f$	Current fall time	$V_{CC} = 200\text{ V}, I_C = 1.5\text{ A}$		19		ns
$E_{off}^{(1)}$	Turn-off switching losses	$R_G = 22\ \Omega, V_{clamp} = 400\text{ V},$ $L = 1\text{ mH}, C\text{-snubber} = 2.7\text{ nF},$ $T_C = 100\text{ }^\circ\text{C}$ (see Figure 18)		3.5		$\mu$ J

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	$I_F = 1\text{ A}$			1.3	V
		$I_F = 3\text{ A}$		1.35		V
		$I_F = 3\text{ A}, T_C = 125\text{ }^\circ\text{C}$		1.15		V
$t_{rr}$	Reverse recovery time	$I_F = 3\text{ A}, V_R = 40\text{ V},$ $di/dt = 100\text{ A}/\mu\text{s}$		50		ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$		55		nC
$I_{rrm}$	Reverse recovery current	(see Figure 19)		2.2		A
$t_{rr}$	Reverse recovery time	$I_F = 3\text{ A}, V_R = 40\text{ V},$ $T_C = 125\text{ }^\circ\text{C}, di/dt = 100$ $\text{A}/\mu\text{s}$		80		ns
				105		nC
		(see Figure 19)		2.7		A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

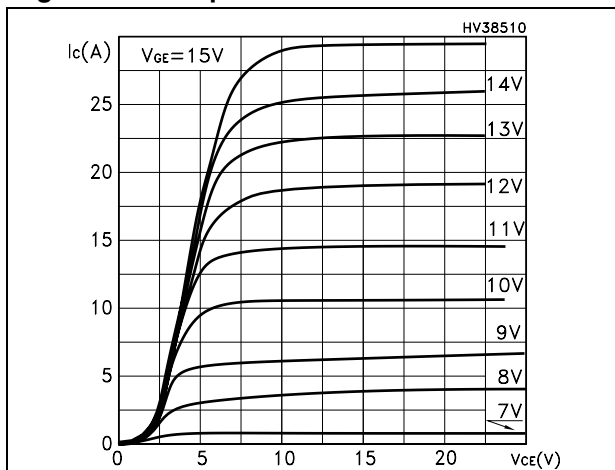


Figure 3. Transfer characteristics

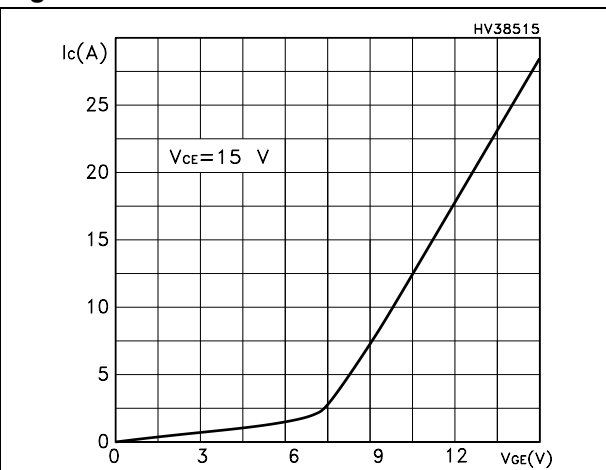


Figure 4. Transconductance

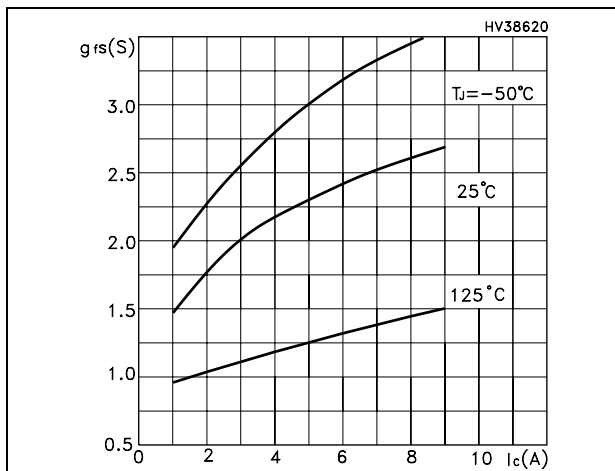
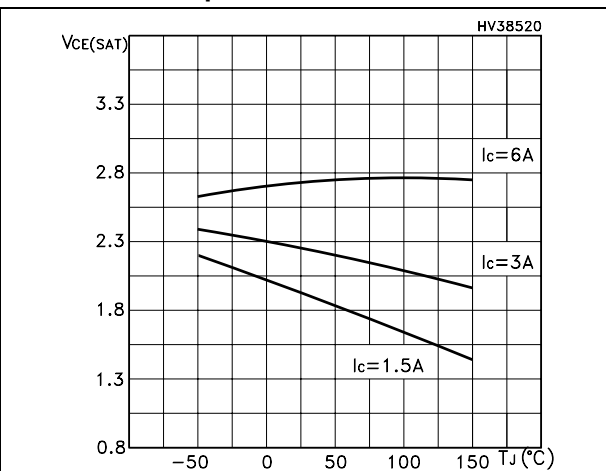
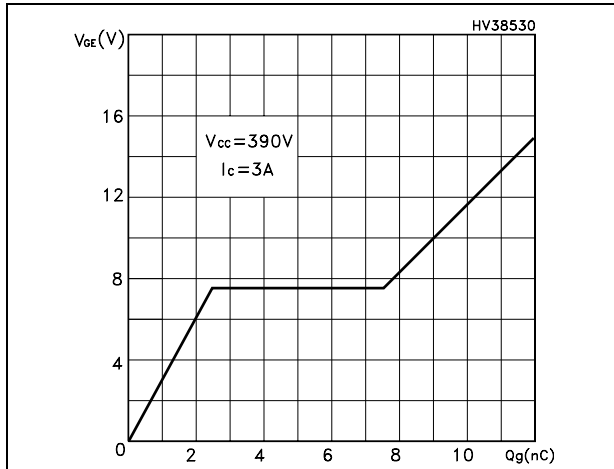


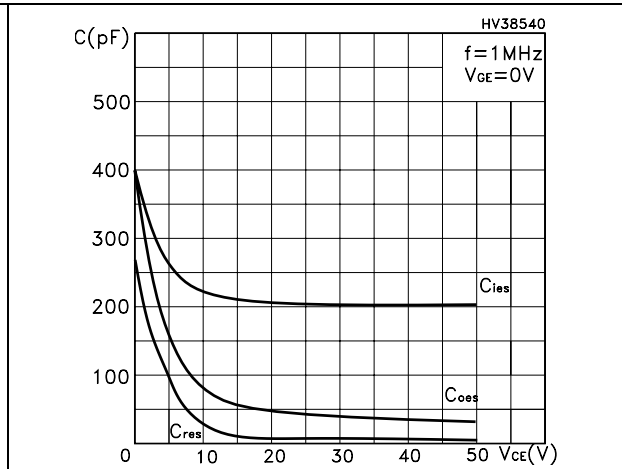
Figure 5. Collector-emitter on voltage vs. temperature



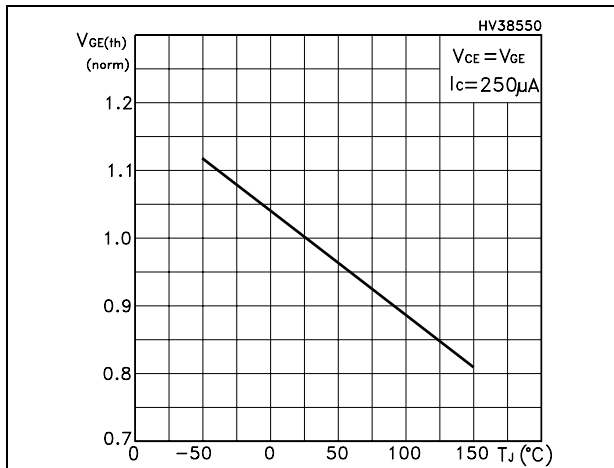
**Figure 6. Gate charge vs. gate-source voltage**



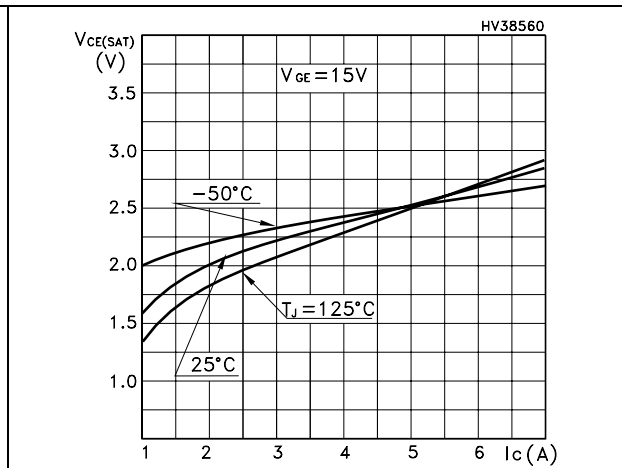
**Figure 7. Capacitance variations**



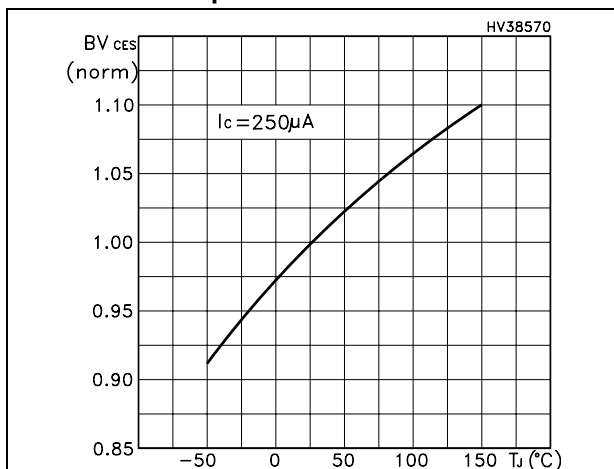
**Figure 8. Normalized gate threshold voltage vs. temperature**



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



**Figure 10. Normalized breakdown voltage vs. temperature**



**Figure 11. Switching losses vs. temperature**

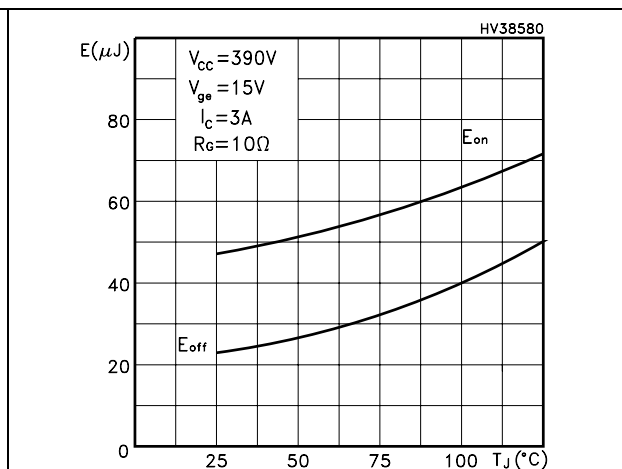


Figure 12. Switching losses vs. gate resistance

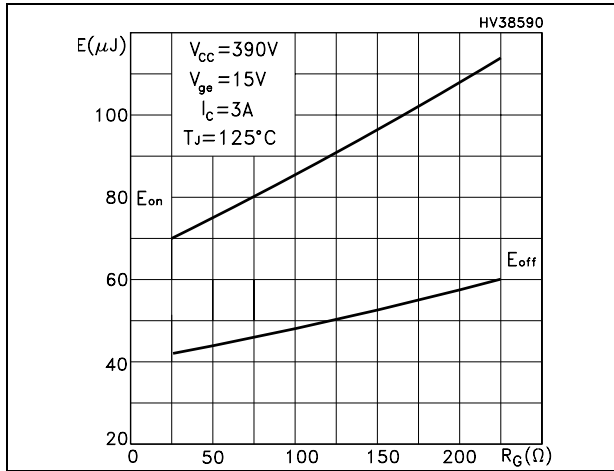


Figure 13. Switching losses vs. collector current

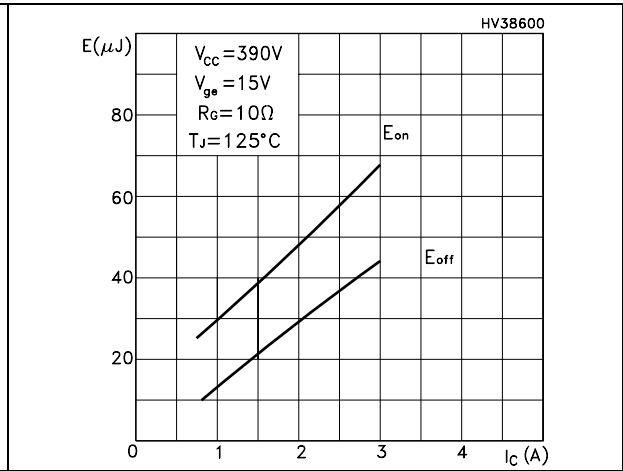


Figure 14. Turn-off SOA

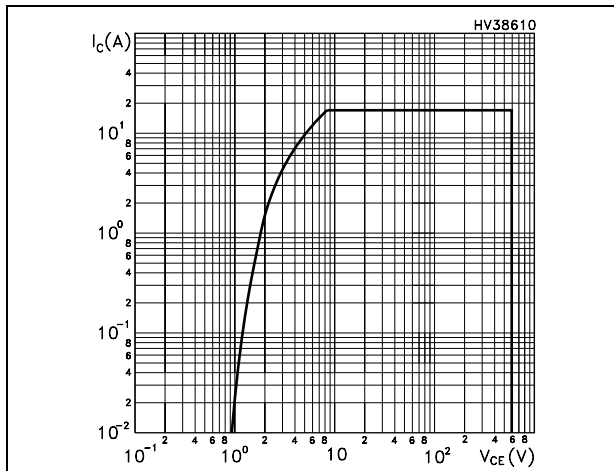
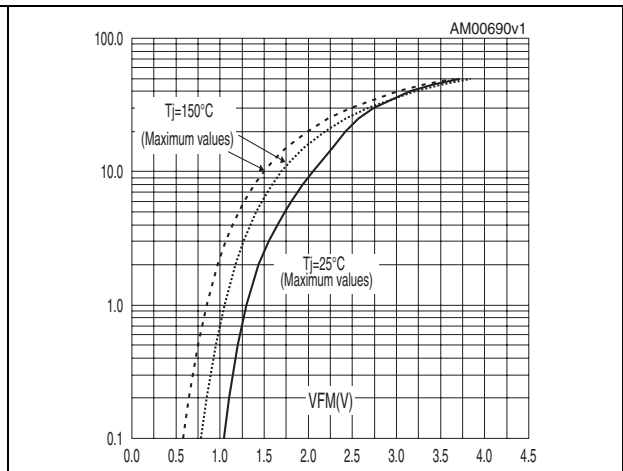


Figure 15. Forward voltage drop vs. forward current







## 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<sup>®</sup> 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

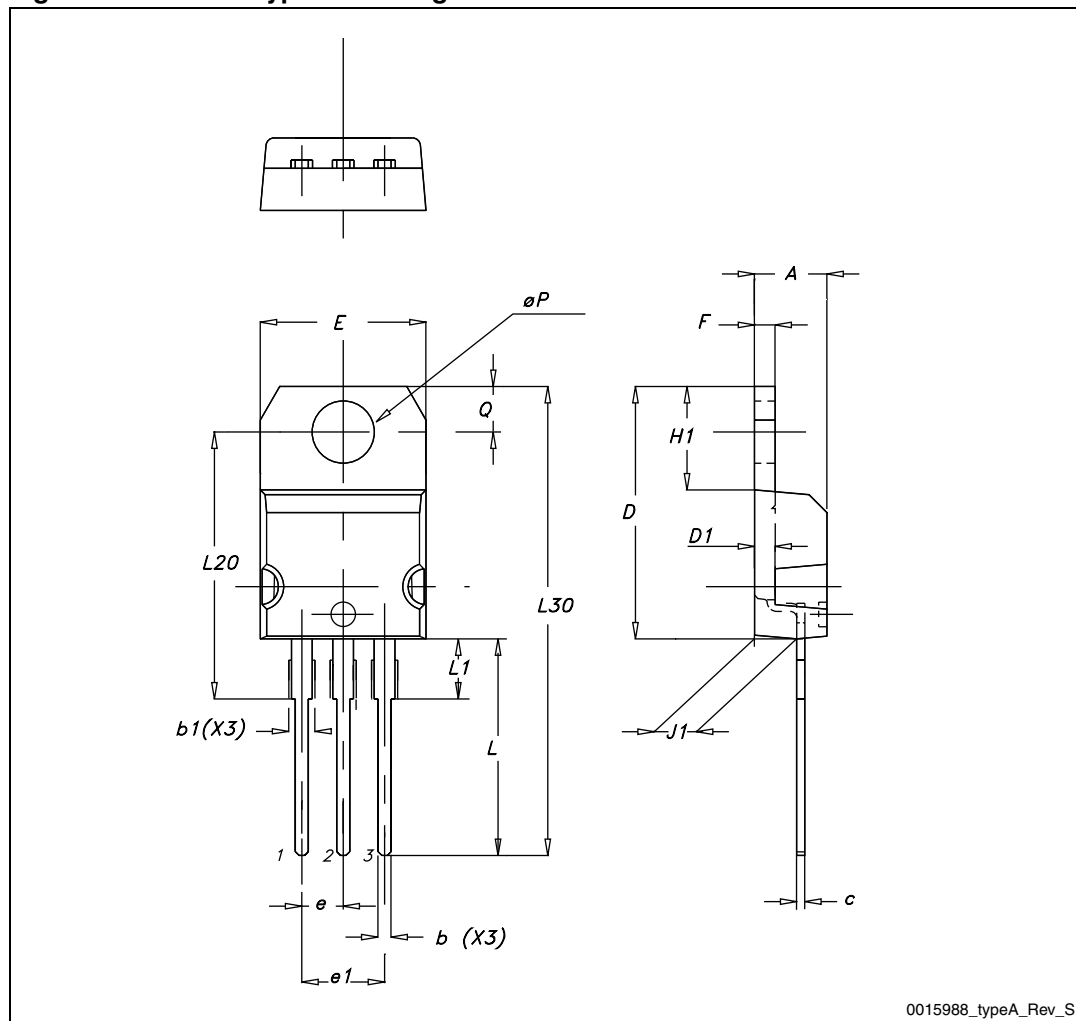
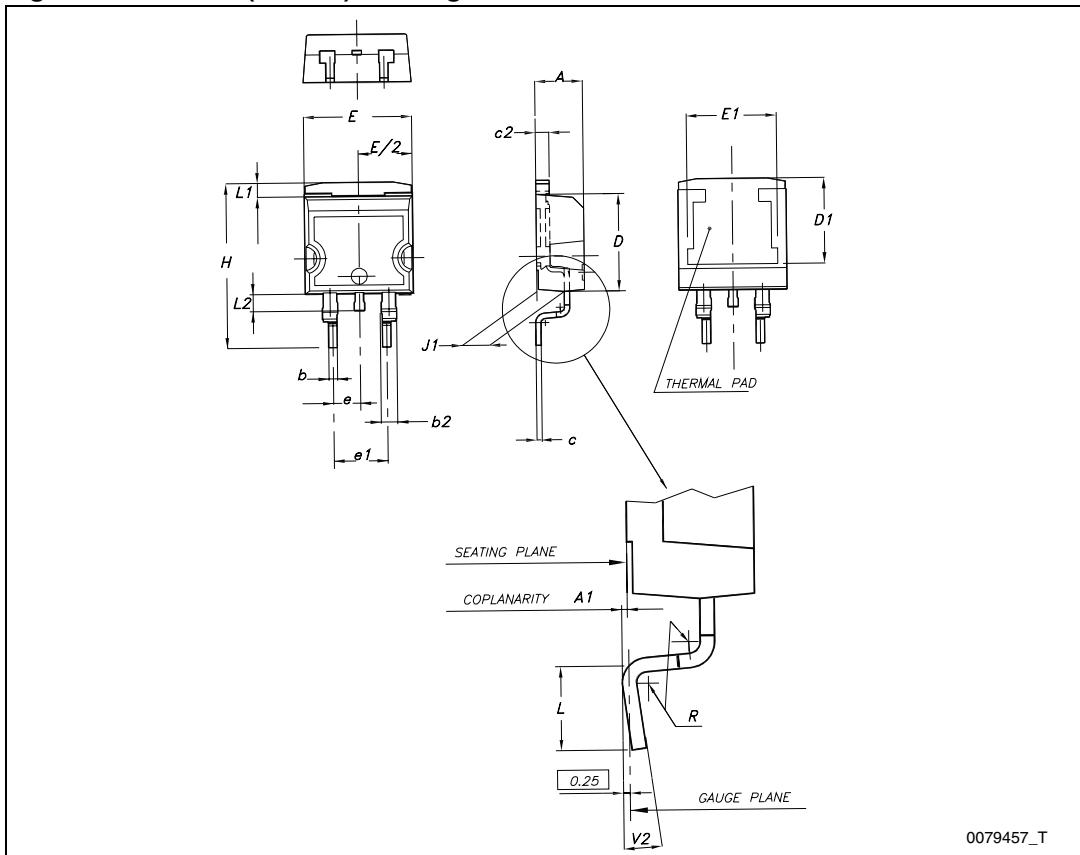


Table 11. D<sup>2</sup>PAK (TO-263) mechanical data

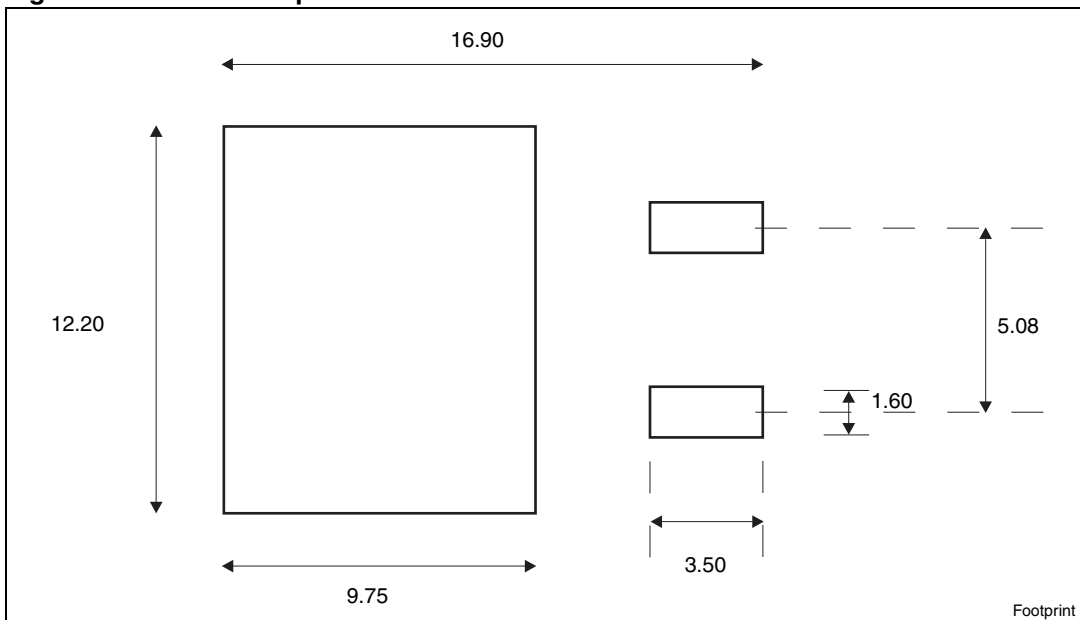
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 21. D<sup>2</sup>PAK (TO-263) drawing



0079457\_T

Figure 22. D<sup>2</sup>PAK footprint (a)



a. All dimension are in millimeters

## 5 Packaging mechanical data

Table 12. D<sup>2</sup>PAK (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

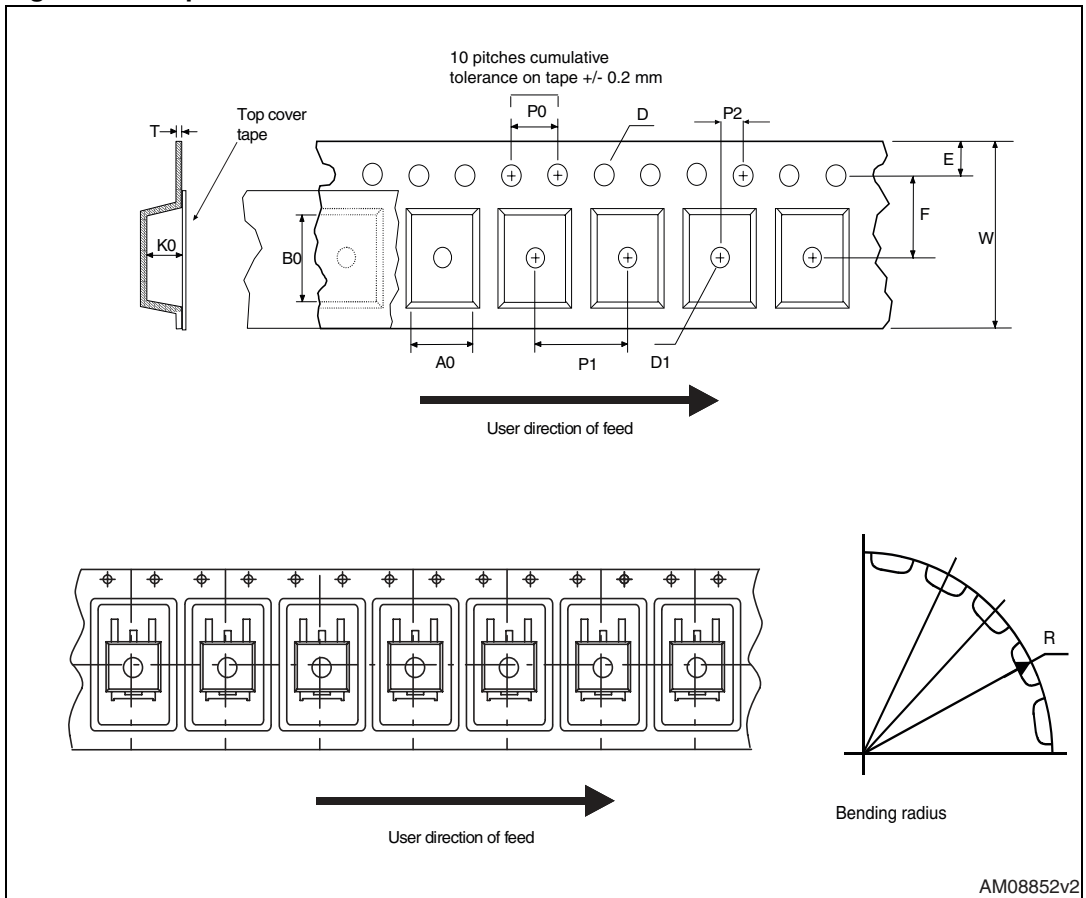
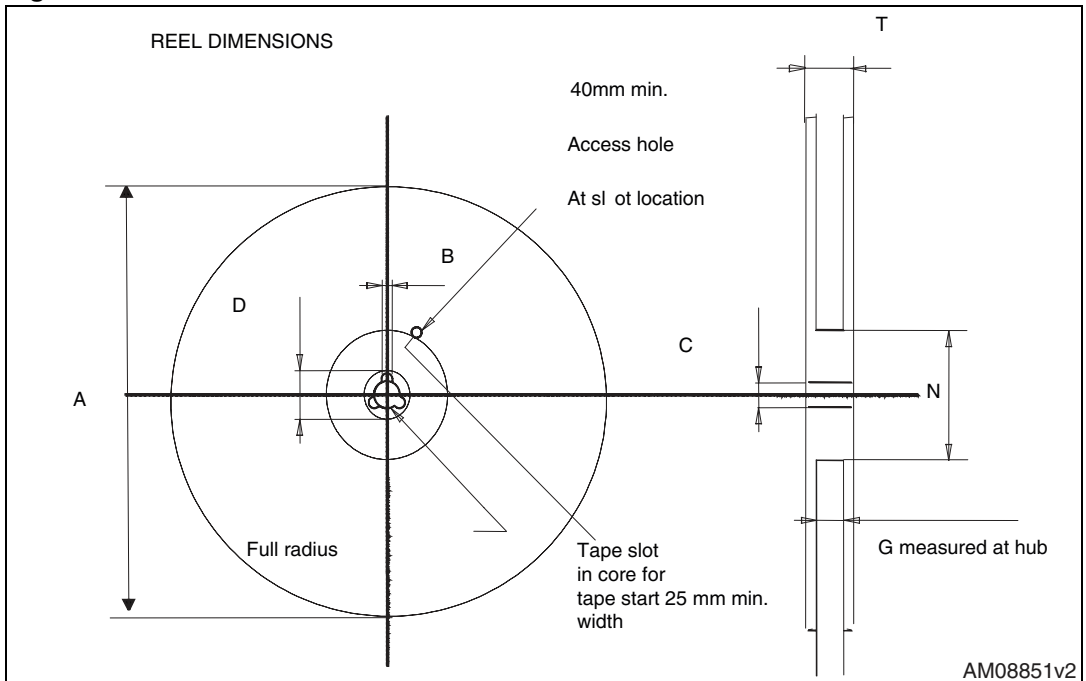


Figure 24. Reel



## 6 Revision history

**Table 13. Document revision history**

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



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