

16 A, 600 V, low drop IGBT

## Features

- Low on-voltage drop ( $V_{CE(sat)}$ )
- High current capability

## Applications

- Light dimmer
- Static relays
- Motor drive

## Description

This IGBT utilizes the advanced PowerMESH™ process featuring extremely low on-state voltage drop in low-frequency working conditions (up to 1 kHz).

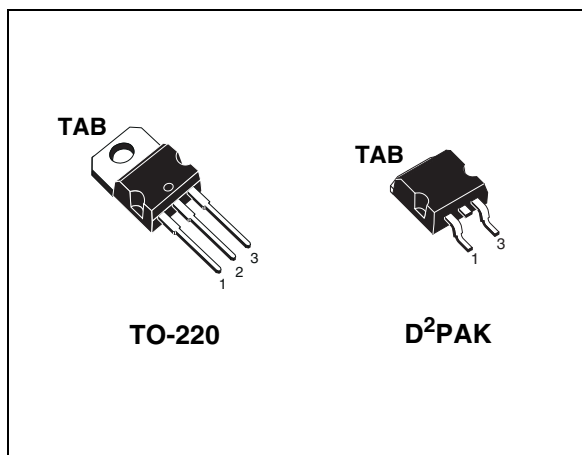


Figure 1. Internal schematic diagram

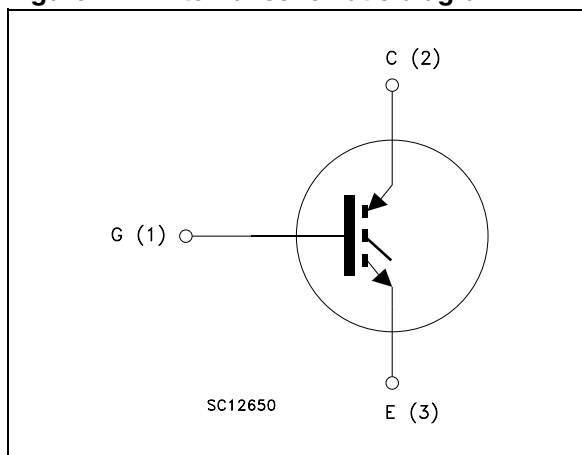


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGB10NB60ST4	GB10NB60S	D <sup>2</sup> PAK	Tape and reel
STGP10NB60S	GP10NB60S	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 circuits</b> .....	<b>9</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>10</b>
<b>5</b>	<b>Packaging mechanical data</b> .....	<b>15</b>
<b>6</b>	<b>Revision history</b> .....	<b>18</b>

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	29	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	16	A
$I_{CL}^{(2)}$	Turn-off latching current	20	A
$I_{CP}^{(3)}$	Pulsed collector current	80	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	80	W
$T_j$	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.  $V_{clamp} = 80\%$  of  $V_{CES}$ ,  $T_j = 150\text{ °C}$ ,  $R_G = 1k\Omega$ ,  $V_{GE} = 15\text{ V}$   
 3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	1.56	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient	62.5	°C/W

## 2 Electrical characteristics

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

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 250\ \mu\text{A}$	600			V
$V_{(BR)ECS}$	Emitter-collector breakdown voltage ( $V_{GE} = 0$ )	$I_C = 1\ \text{mA}$	20			V
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\ \text{V}$			$\pm 100$	nA
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\ \text{V}$ $V_{CE} = 600\ \text{V}, T_j = 125\text{ °C}$			10 100	$\mu\text{A}$ $\mu\text{A}$
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\ \mu\text{A}$	2.5		5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\ \text{V}, I_C = 5\ \text{A}$ $V_{GE} = 15\ \text{V}, I_C = 10\ \text{A}$ $V_{GE} = 15\ \text{V}, I_C = 10\ \text{A}, T_j = 125\text{ °C}$		1.15 1.35 1.25	1.75	V
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15\ \text{V}, I_C = 10\ \text{A}$	5			S

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\ \text{V}, f = 1\ \text{MHz}, V_{GE} = 0$		610		pF
$C_{oes}$	Output capacitance		-	65	-	pF
$C_{res}$	Reverse transfer capacitance				12	
$Q_g$	Total gate charge	$V_{CE} = 400\ \text{V}, I_C = 10\ \text{A},$ $V_{GE} = 15\ \text{V}$ (see Figure 17)	-	33	-	nC

**Table 6. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 480\text{ V}, I_C = 10\text{ A}$		0.7		$\mu\text{s}$
$t_r$	Current rise time	$R_G = 1\text{ k}\Omega, V_{GE} = 15\text{ V}$	-	0.46	-	$\mu\text{s}$
$(di/dt)_{on}$	Turn-on current slope	(see Figure 16)		8		$\text{A}/\mu\text{s}$
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 480\text{ V}, I_C = 10\text{ A}$		2.2		
$t_{d(off)}$	Turn-off delay time	$R_G = 1\text{ k}\Omega, V_{GE} = 15\text{ V}$	-	1.2	-	$\mu\text{s}$
$t_f$	Current fall time	(see Figure 16)		1.2		
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 480\text{ V}, I_C = 10\text{ A}$		3.8		
$t_{d(off)}$	Turn-off delay time	$R_G = 1\text{ k}\Omega, V_{GE} = 15\text{ V},$ $T_j = 125\text{ }^\circ\text{C}$	-	1.2	-	$\mu\text{s}$
$t_f$	Current fall time	(see Figure 16)		1.9		

**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 480\text{ V}, I_C = 10\text{ A}$		0.6		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 1\text{ k}\Omega, V_{GE} = 15\text{ V}$	-	5	-	mJ
$E_{ts}$	Total switching losses	(see Figure 16)		5.6		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$V_{CC} = 480\text{ V}, I_C = 10\text{ A}$ $R_G = 1\text{ k}\Omega, V_{GE} = 15\text{ V},$ $T_j = 125\text{ }^\circ\text{C}$ (see Figure 16)	-	8	-	mJ

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit. 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 (25°C and 125°C).
2. Turn-off losses include also the tail of the collector current.

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

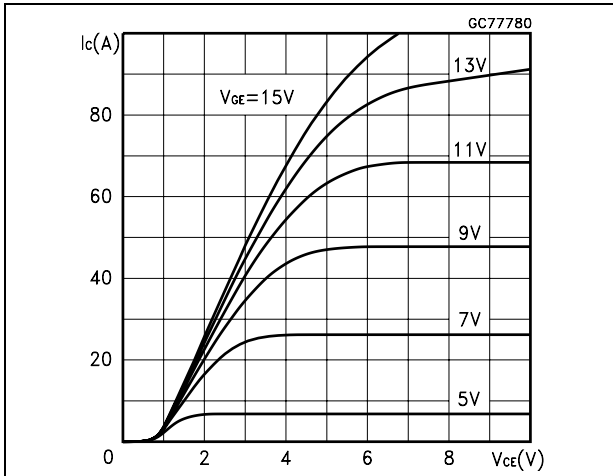


Figure 3. Transfer characteristics

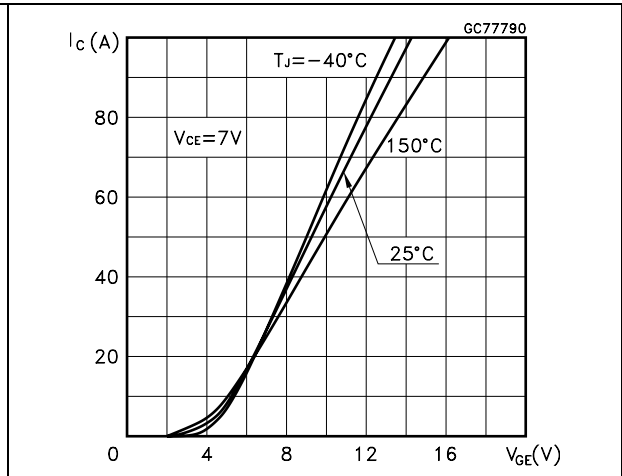


Figure 4. Transconductance

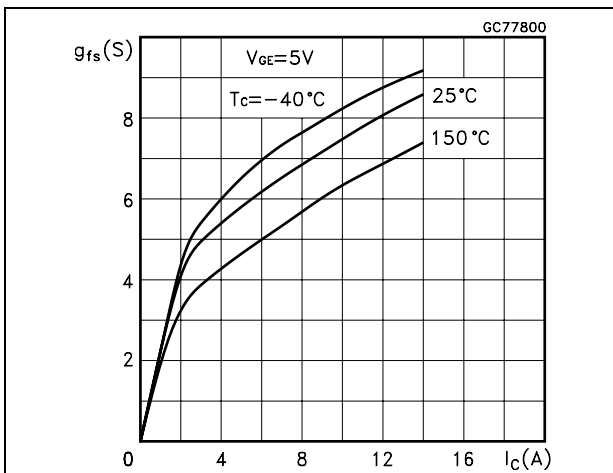


Figure 5. Collector-emitter on voltage vs. temperature

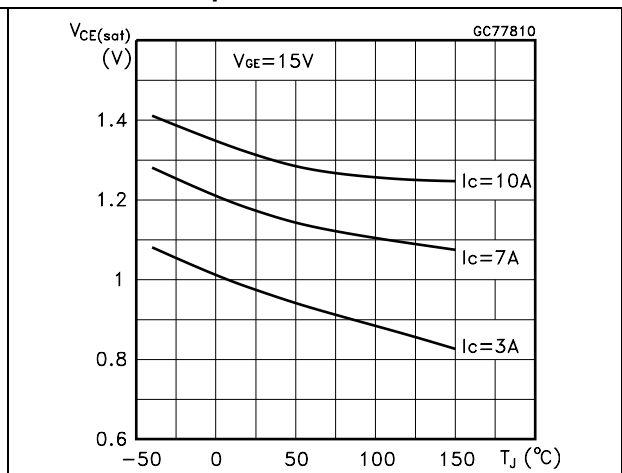


Figure 6. Collector-emitter on voltage vs. collector current

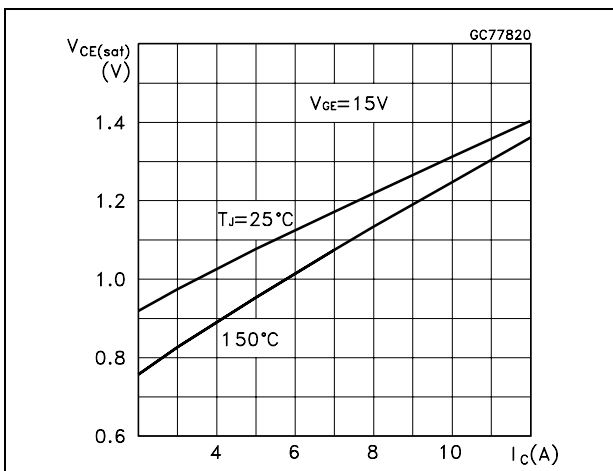


Figure 7. Normalized gate threshold vs. temperature

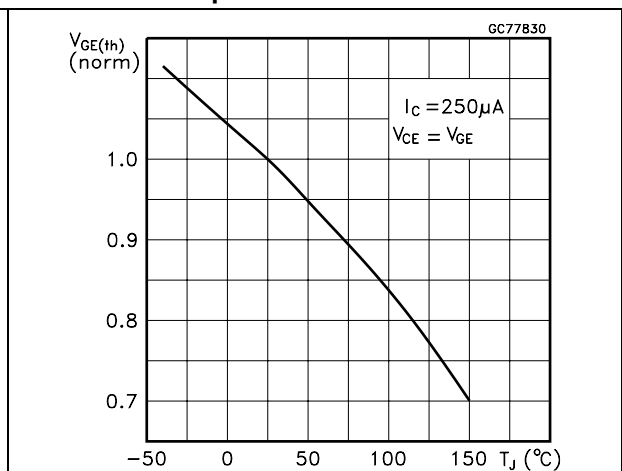


Figure 8. Normalized breakdown voltage vs. temperature

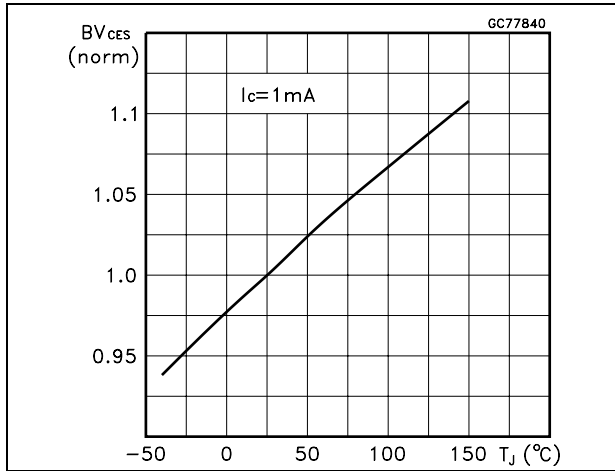


Figure 9. Gate charge vs. gate-emitter voltage

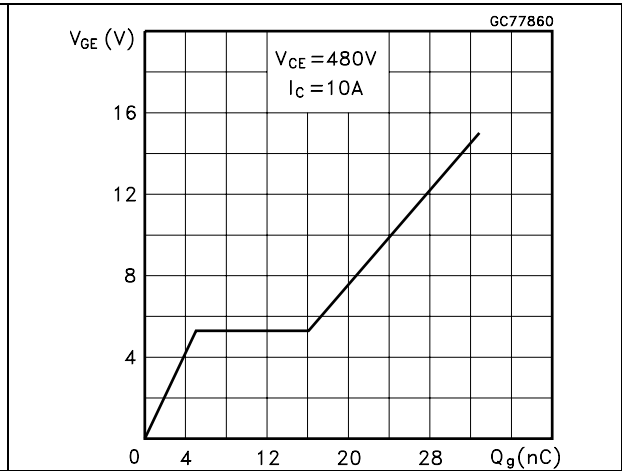


Figure 10. Capacitance variations

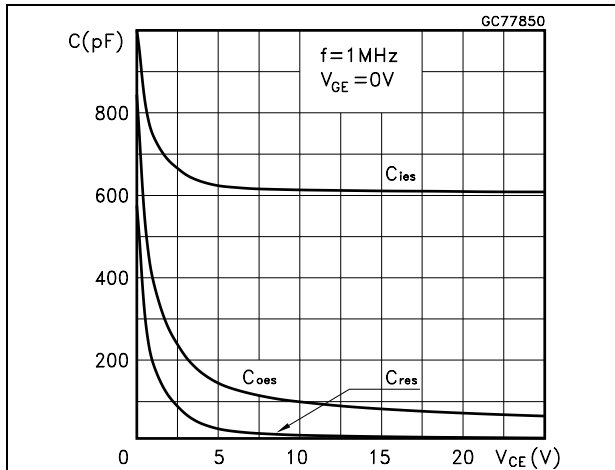


Figure 11. Switching losses vs. temperature

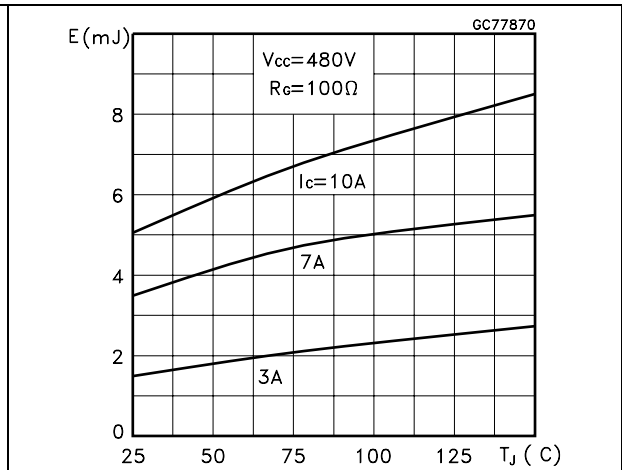


Figure 12. Switching losses vs. gate resistance

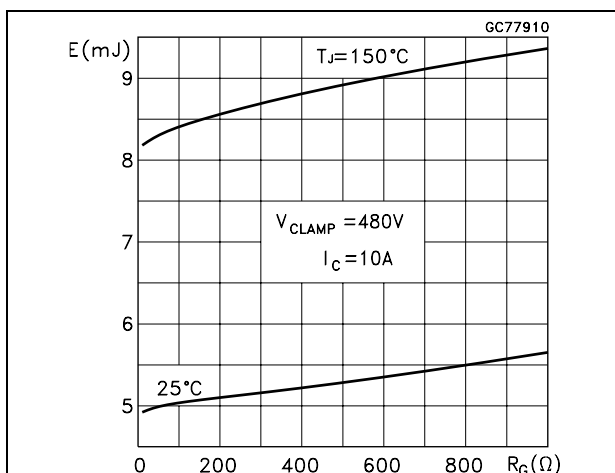


Figure 13. Switching losses vs. collector current

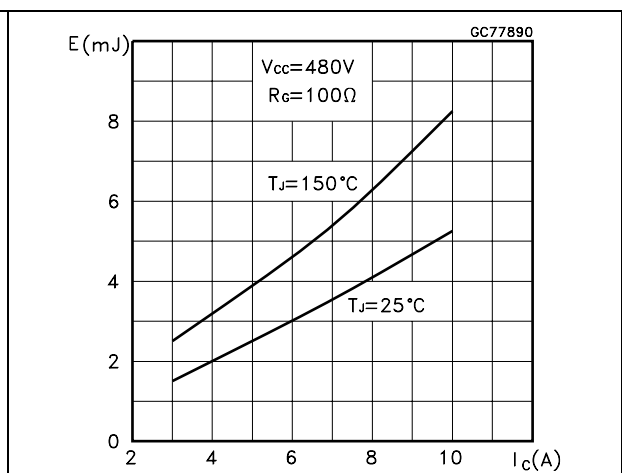
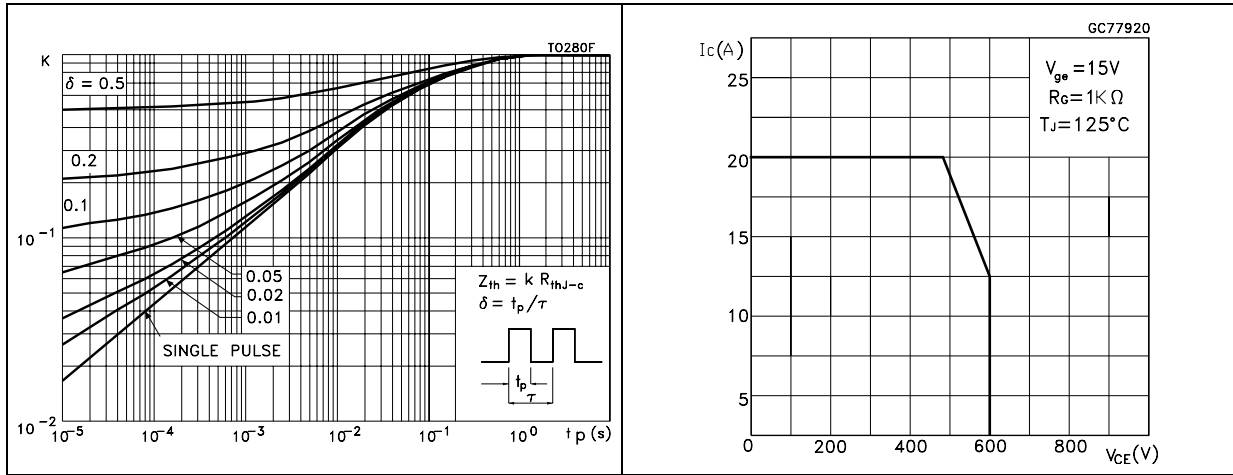


Figure 14. Thermal impedance for TO-220 and D<sup>2</sup>PAK

Figure 15. Turn-off SOA





### 3 Test circuits

Figure 16. Test circuit for inductive load switching

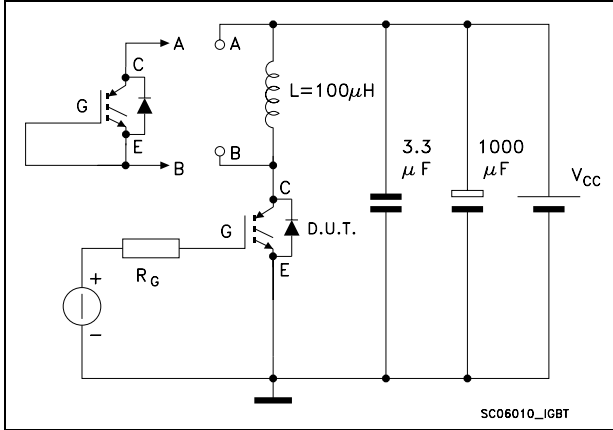


Figure 17. Gate charge test circuit

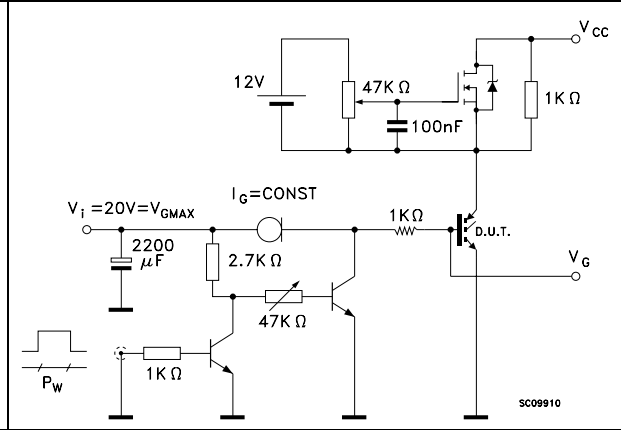
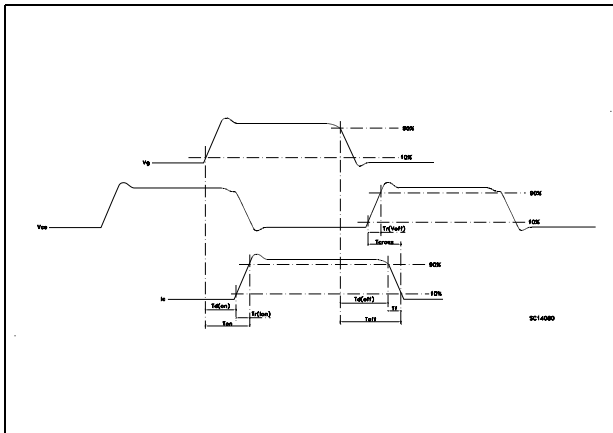


Figure 18. Switching waveforms



## 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.

Table 8. 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 19. D<sup>2</sup>PAK (TO-263) drawing

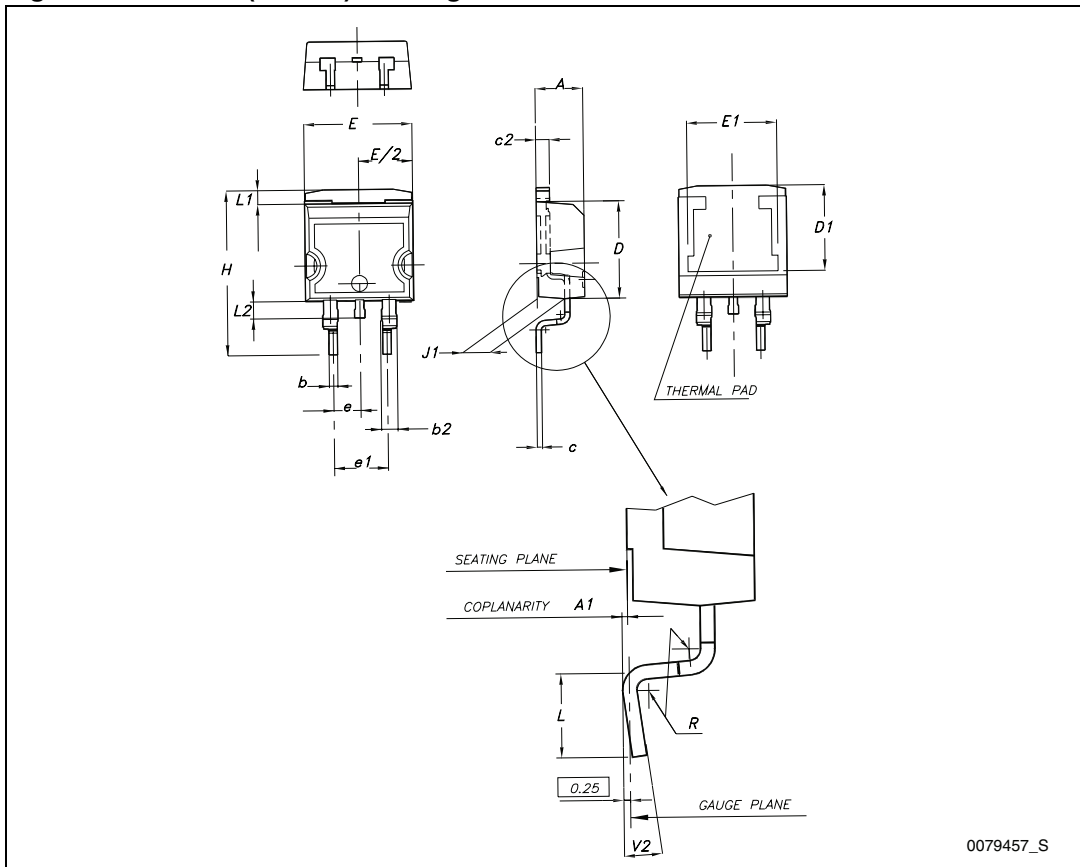
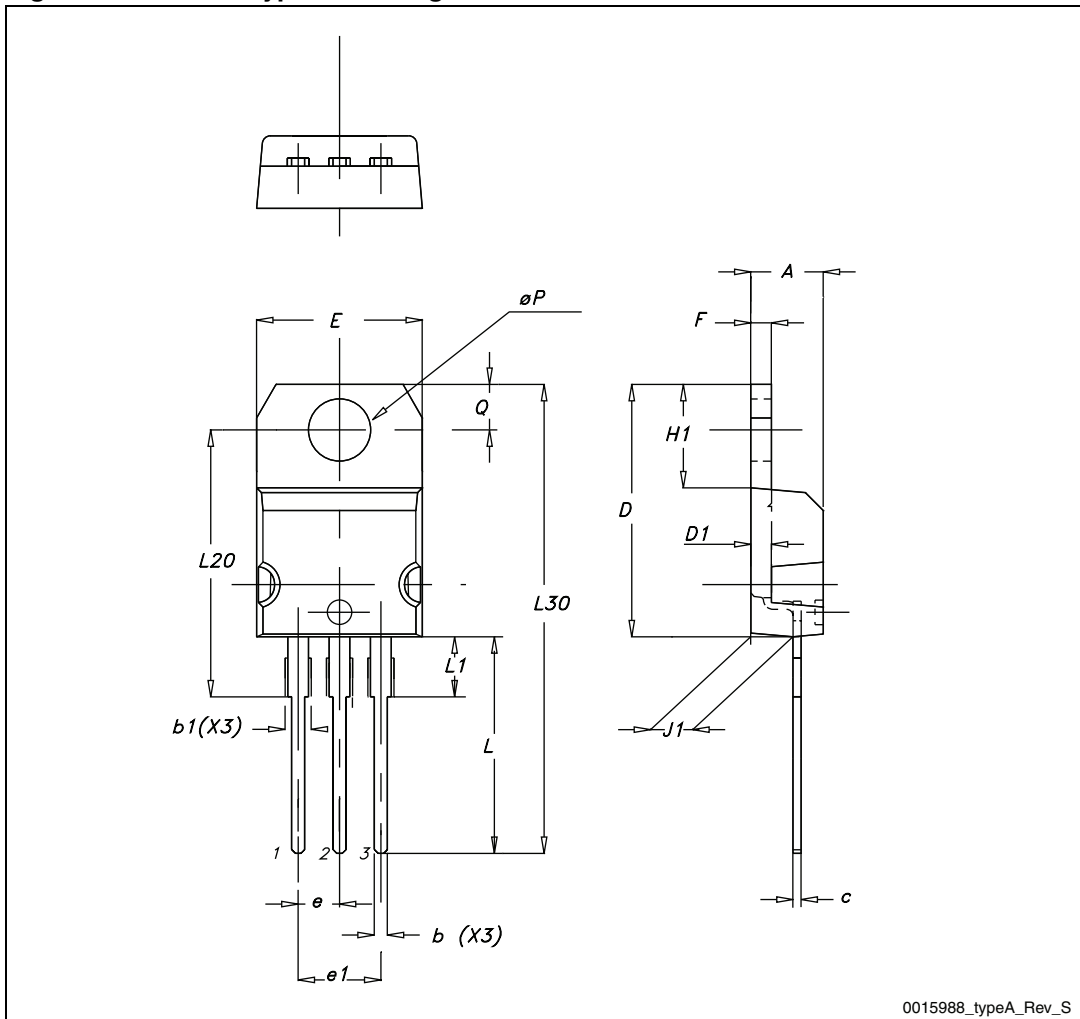


Table 9. TO-220 type A mechanical data

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

Figure 20. TO-220 type A drawing



## 5 Packaging mechanical data

Table 10. 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 21. D<sup>2</sup>PAK footprint (a)

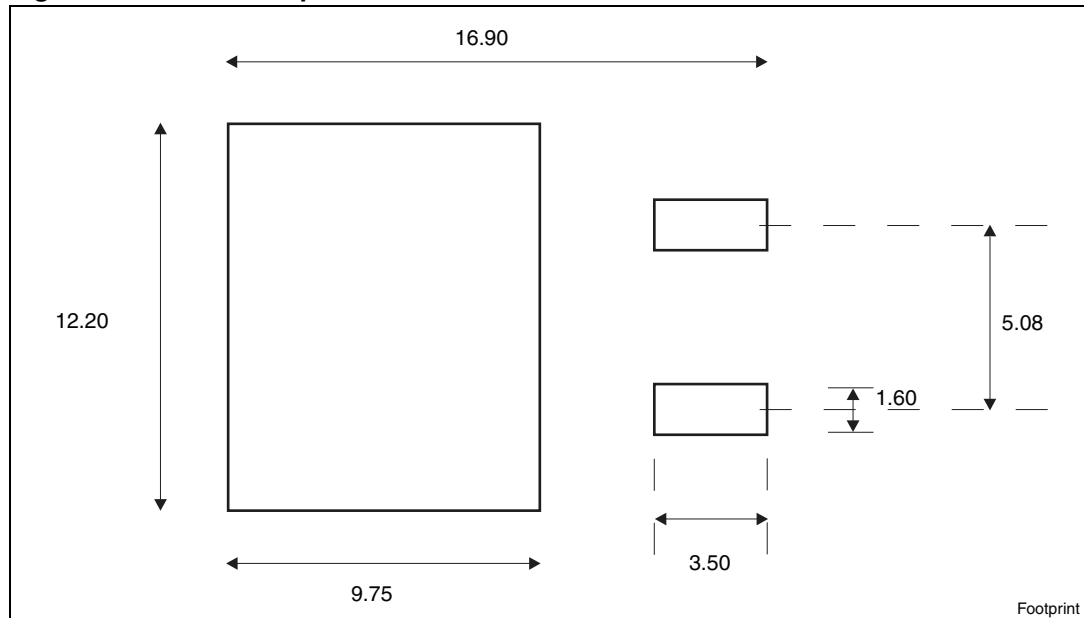
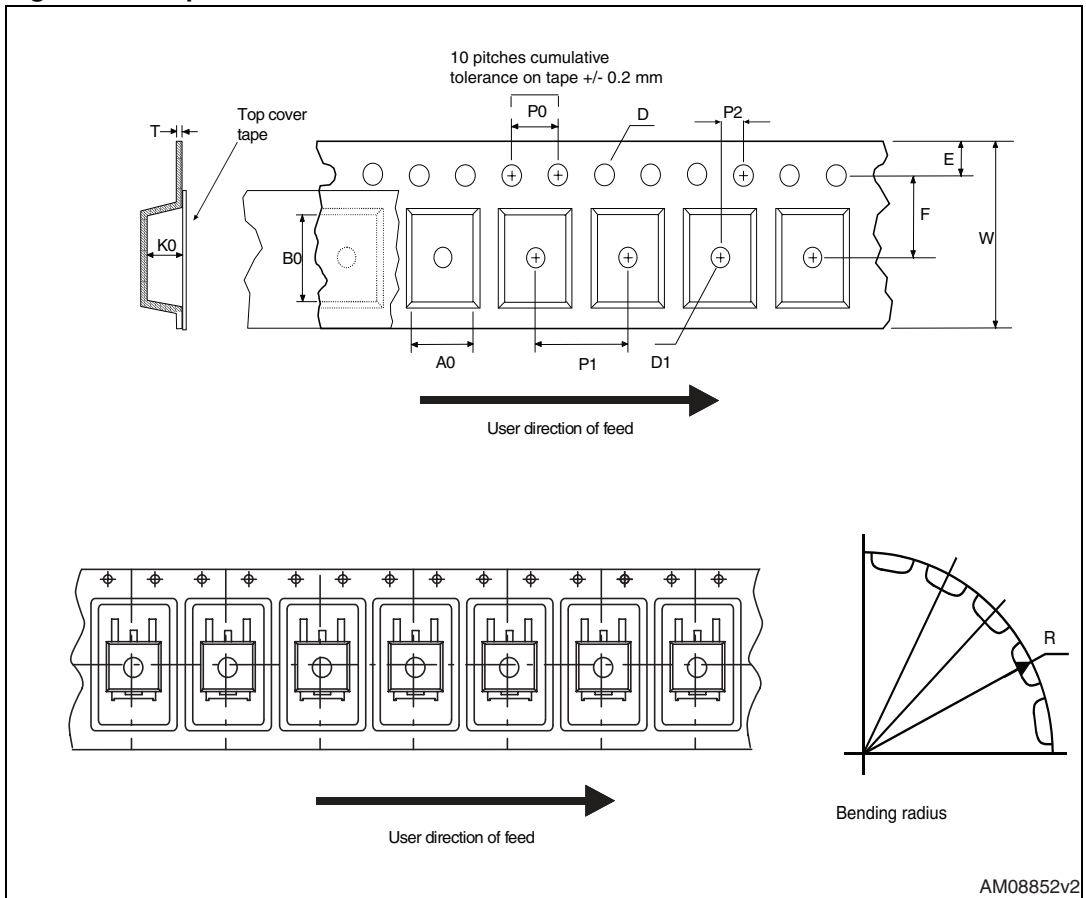


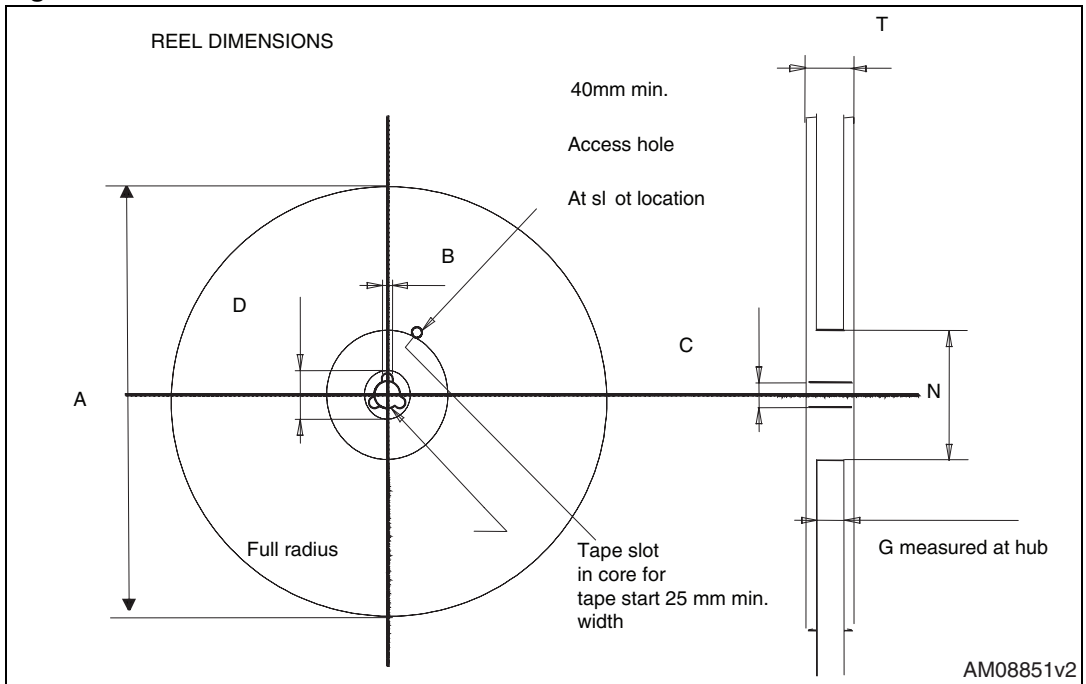
Figure 22. Tape



a. All dimension are in millimeters.



Figure 23. Reel



## 6 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
10-Nov-2004	1	New release.
28-Feb-2005	2	Some values changed in <a href="#">Table 4: Static</a> .
16-Dec-2010	3	Updated <a href="#">Table 2: Absolute maximum ratings</a> . Updated mechanical data <a href="#">Section 4: Package mechanical data</a> .
27-Sep-2011	4	Modified: unit value <a href="#">Table 7 on page 5</a> , <a href="#">Figure 2 on page 6</a> and <a href="#">Figure 3 on page 6</a> . Updated mechanical data D <sup>2</sup> PAK <a href="#">Table 8 on page 11</a> and <a href="#">Figure 19 on page 12</a> . Removed order code STGP10NB60SFP and TO-220FP package mechanical data.

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