

## 5 A - 1200 V - low drop internally clamped IGBT

### Features

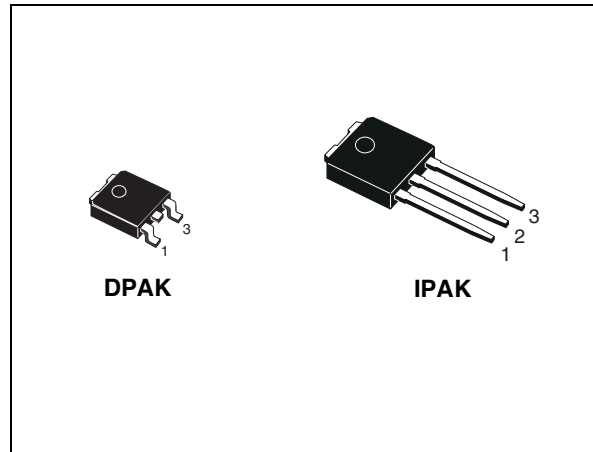
- Low on-voltage drop ( $V_{CE(sat)}$ )
- High current capability
- Off losses include tail current
- High voltage clamping

### Applications

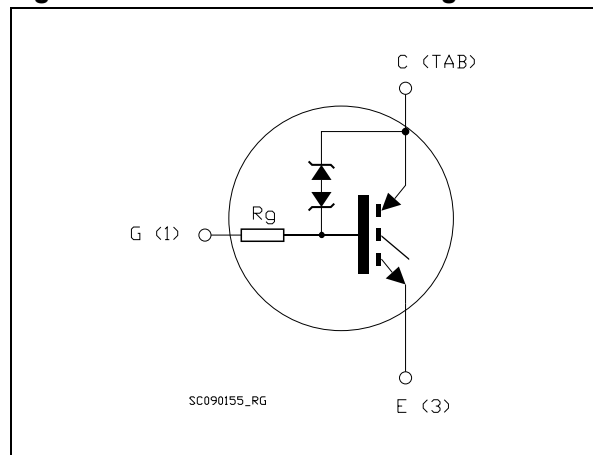
- Light dimmer
- Inrush current limitation
- Pre-heating for electronic lamp ballast

### Description

This IGBT utilizes the advanced Power MESH™ 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
STGD5NB120SZ-1	GD5NB120SZ	IPAK	Tube
STGD5NB120SZT4	GD5NB120SZ	DPAK	Tape and reel

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	1200	V
$I_C^{(1)}$	Collector current (continuous) at $T_C = 25\text{ °C}$	10	A
$I_C^{(1)}$	Collector current (continuous) at $T_C = 100\text{ °C}$	5	A
$I_{CP}^{(2)}$	Pulsed collector current	10	A
$I_{CL}^{(3)}$	Turn-off latching current	10	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$V_{ECR}$	Emitter-collector voltage	20	V
$E_{AS}^{(4)}$	Single pulse avalanche energy at $T_C = 25\text{ °C}$	10	mJ
	Single pulse avalanche energy at $T_C = 100\text{ °C}$	7	mJ
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	75	W
$T_j$	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. Pulse width limited by max. temperature allowed
3.  $V_{CLAMP} = 80\% (V_{CES})$ ,  $V_{GE} = 15\text{ V}$ ,  $R_G = 10\ \Omega$ ,  $T_J = 150\text{ °C}$
4.  $V_{CE} = 50\text{ V}$ ,  $I_{AV} = 3.3\text{ A}$

**Table 3. Thermal resistance**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT max	1.67	$^{\circ}\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	100	$^{\circ}\text{C/W}$

## 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 ( $V_{GE} = 0$ )	$I_C = 10\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ $V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ , $T_C = 125\text{ °C}$		1.3 1.2	2.0	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$	2		5	V
$V_{GE}$	Gate emitter voltage	$V_{CE} = 2.5\text{ V}$ , $I_C = 2\text{ A}$ , $T_C = 25 \div 125\text{ °C}$			6.5	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 900\text{ V}$ $V_{CE} = 900\text{ V}$ , $T_C = 125\text{ °C}$			50 250	$\mu\text{A}$ $\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{ V}$ , $I_C = 5\text{ A}$		5		S
$R_G$	Gate resistance			4		k $\Omega$

**Table 5. Dynamic electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$		430		pF
$C_{oes}$	Output capacitance			40		pF
$C_{res}$	Reverse transfer capacitance			7		pF

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960 \text{ V}, I_C = 5 \text{ A}$		690		ns
$t_r$	Current rise time	$R_{drive} = 1 \text{ k}\Omega, V_{GE} = 15 \text{ V},$ <i>(see Figure 18)</i>		170		ns
$(di/dt)_{on}$	Turn-on current slope			39.6		A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960 \text{ V}, I_C = 5 \text{ A}$		600		ns
$t_r$	Current rise time	$R_{drive} = 1 \text{ k}\Omega, V_{GE} = 15 \text{ V}$		185		ns
$(di/dt)_{on}$	Turn-on current slope	$T_C = 125 \text{ }^\circ\text{C}$ <i>(see Figure 18)</i>		39		A/ $\mu$ s
$t_c$	Cross-over time	$V_{CC} = 960 \text{ V}, I_C = 5 \text{ A}$		4		$\mu$ s
$t_r(V_{off})$	Off voltage rise time	$R_{drive} = 1 \text{ k}\Omega, V_{GE} = 15 \text{ V}$		2.2		$\mu$ s
$t_{d(off)}$	Turn-off delay time	<i>(see Figure 18)</i>		12.1		$\mu$ s
$t_f$	Current fall time			1.13		$\mu$ s
$t_c$	Cross-over time	$V_{CC} = 960 \text{ V}, I_C = 5 \text{ A}$		5		$\mu$ s
$t_r(V_{off})$	Off voltage rise time	$R_{drive} = 1 \text{ k}\Omega, V_{GE} = 15 \text{ V},$		2.2		$\mu$ s
$t_{d(off)}$	Turn-off delay time	$T_C = 125 \text{ }^\circ\text{C}$ <i>(see Figure 18)</i>		12.1		$\mu$ s
$t_f$	Current fall time			2		$\mu$ s

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960 \text{ V}, I_C = 5 \text{ A}$		2.59		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_{drive} = 1 \text{ k}\Omega, V_{GE} = 15 \text{ V}$		9		mJ
$E_{ts}$	Total switching losses	<i>(see Figure 18)</i>		11.59		mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960 \text{ V}, I_C = 5 \text{ A}$		2.64		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_{drive} = 1 \text{ k}\Omega, V_{GE} = 15 \text{ V},$		10.2		mJ
$E_{ts}$	Total switching losses	$T_C = 125 \text{ }^\circ\text{C}$ <i>(see Figure 18)</i>		12.68		mJ

- $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in *(see Figure 18)*. 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)
- Turn-off losses include also the tail of the collector current

**Table 8. Functional test**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{AS}$	Unclamped inductive switching current	$V_{CC} = 50 \text{ V}, L = 1.8 \text{ mH}$ $T_{start} = 25 \text{ }^\circ\text{C}, R_{drive} = 1 \text{ k}\Omega$	3.3			A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

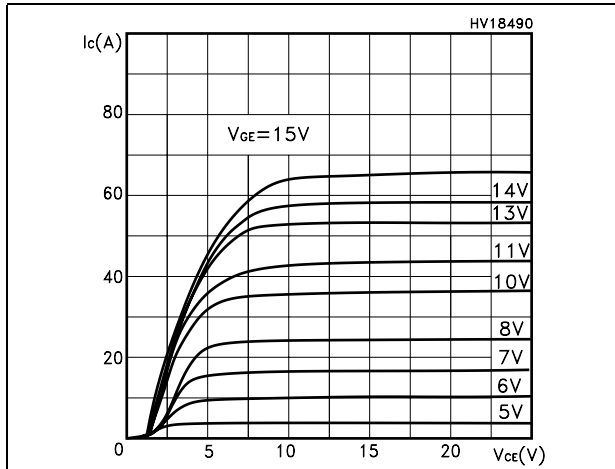


Figure 3. Transfer characteristics

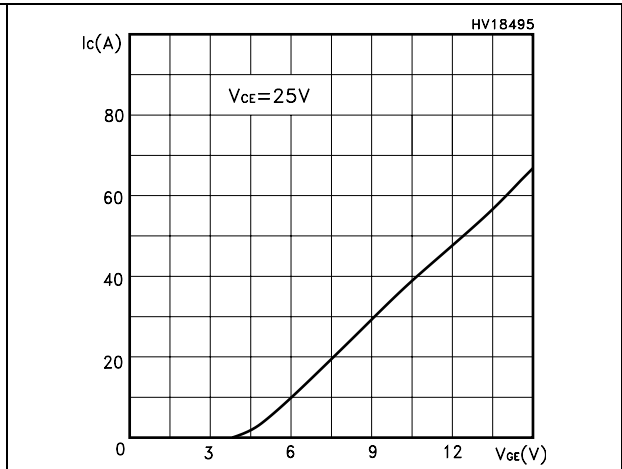


Figure 4. Transconductance

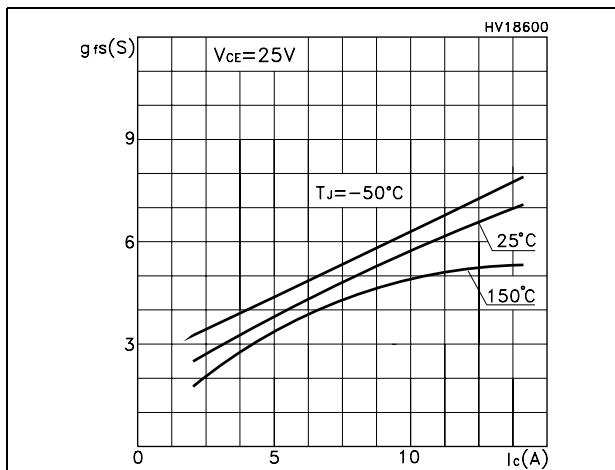


Figure 5. Collector-emitter on voltage vs temperature

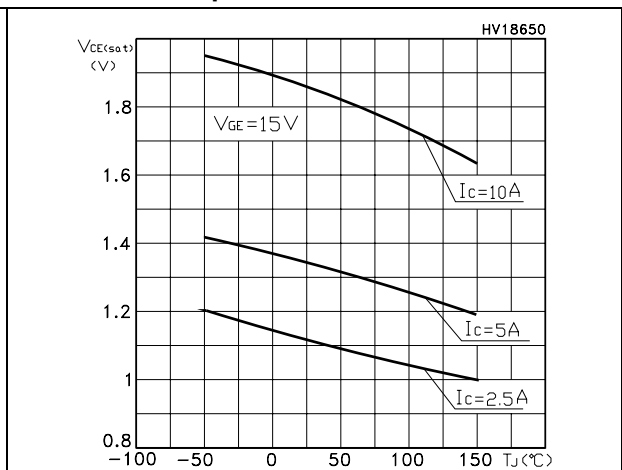


Figure 6. Gate charge vs gate-source voltage

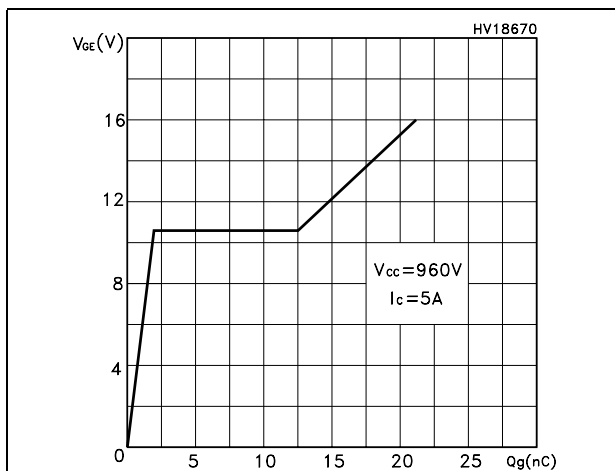


Figure 7. Capacitance variations

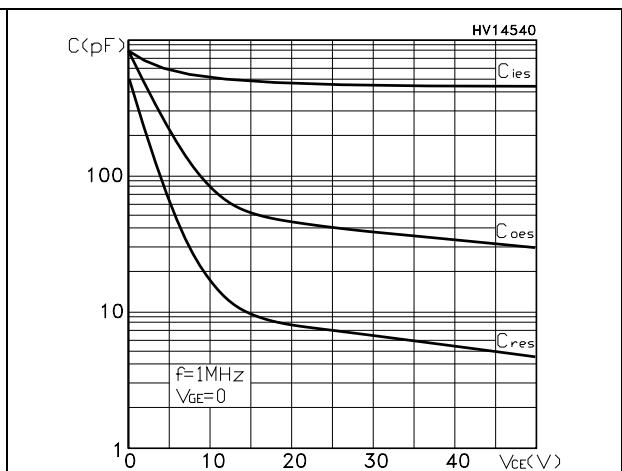


Figure 8. Normalized gate threshold voltage vs temperature

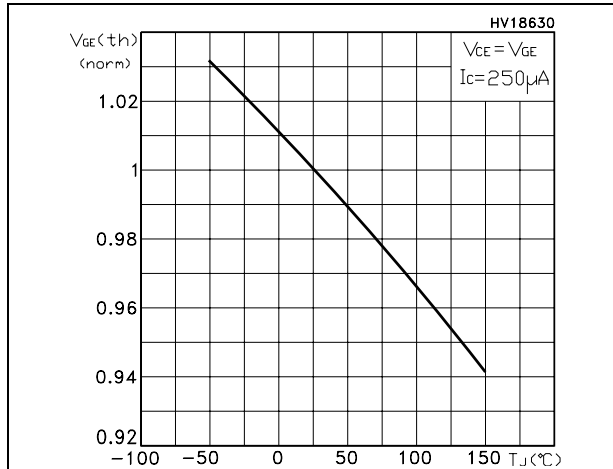


Figure 9. Collector-emitter on voltage vs collector current

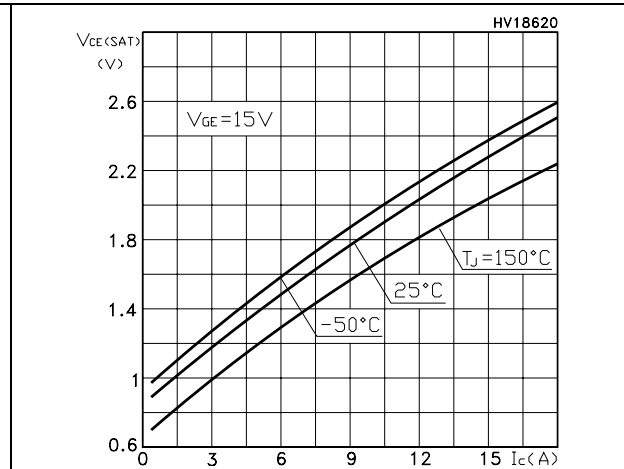


Figure 10. Breakdown voltage vs temperature

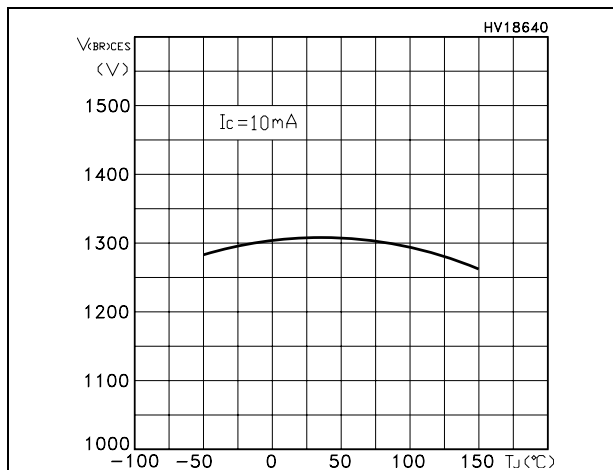


Figure 11. Normalized collector-emitter on voltage vs temperature

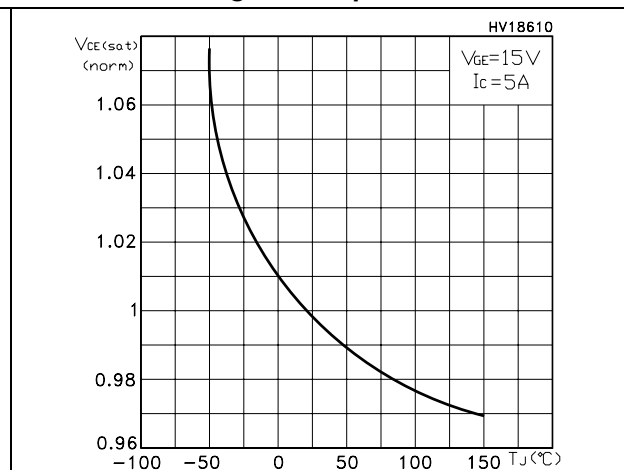


Figure 12. Switching losses vs gate resistance

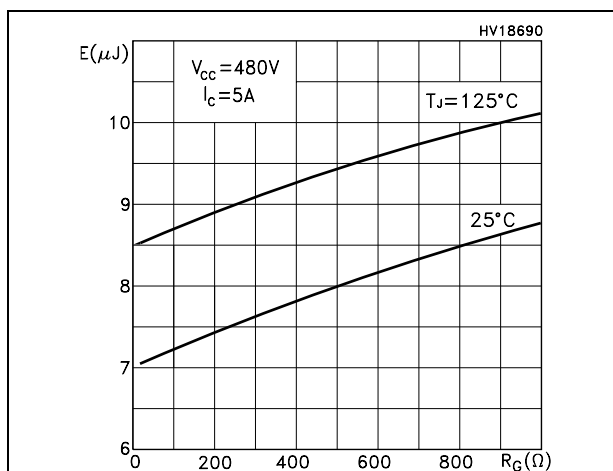


Figure 13. Switching losses vs collector current

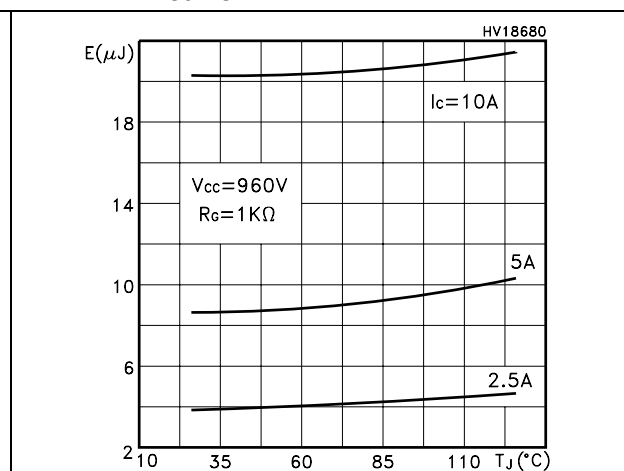


Figure 14. Turn-off SOA

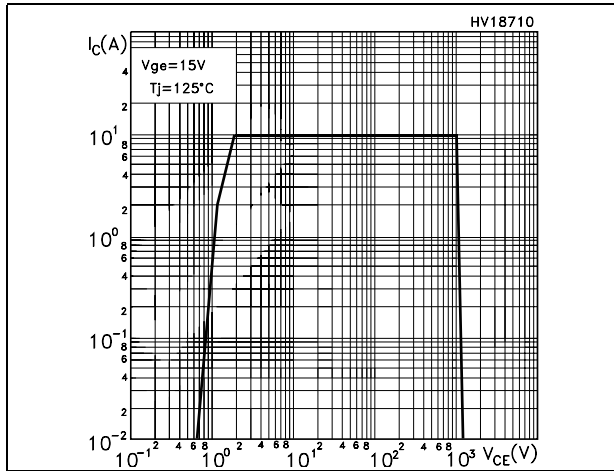
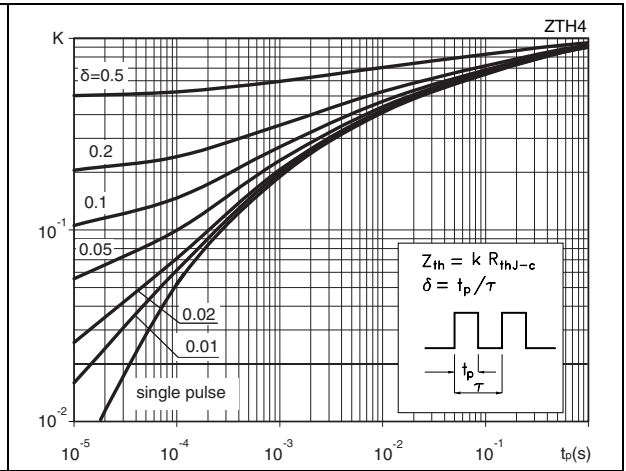


Figure 15. Thermal impedance





### 3 Test circuit

Figure 16. Test circuit for inductive load switching

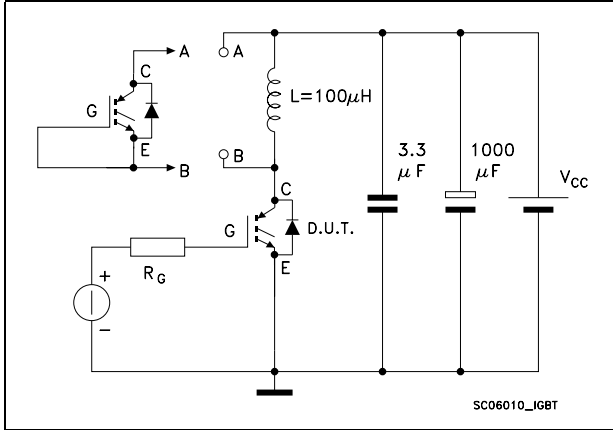


Figure 17. Gate charge test circuit

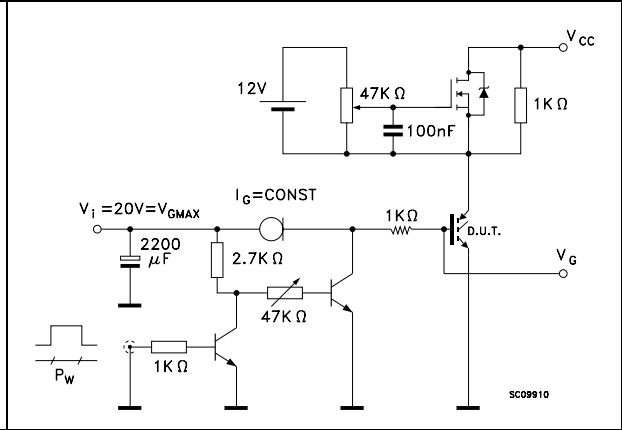
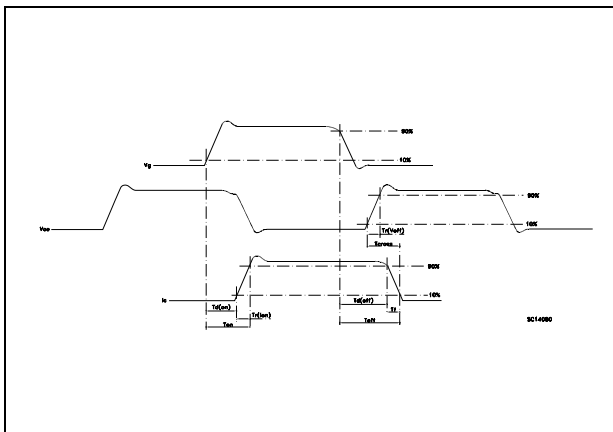


Figure 18. Switching waveform

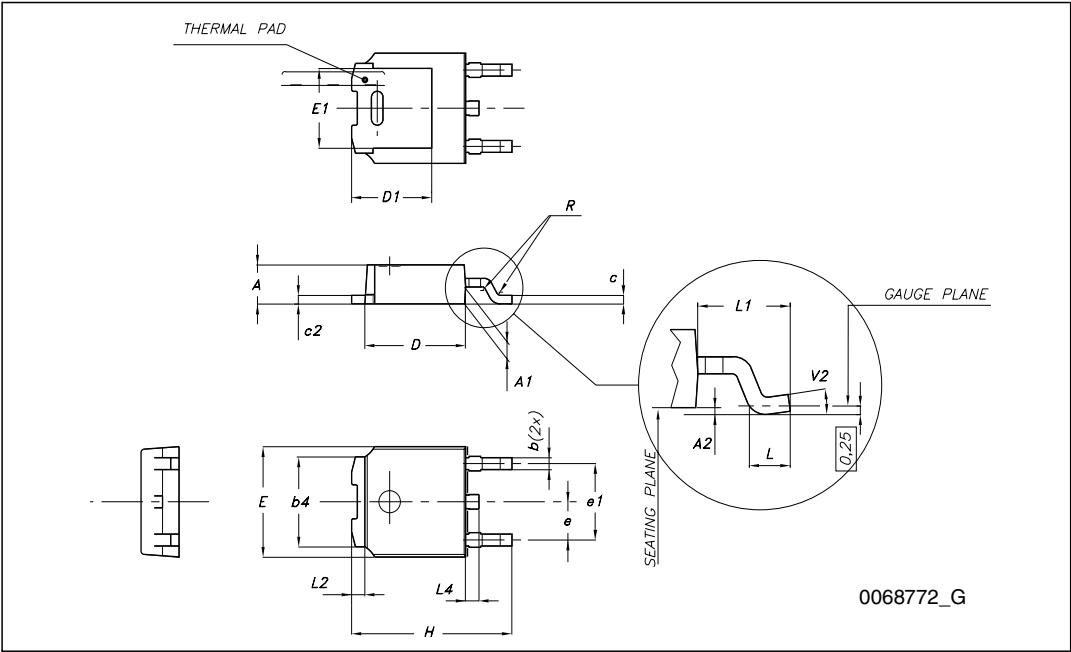


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

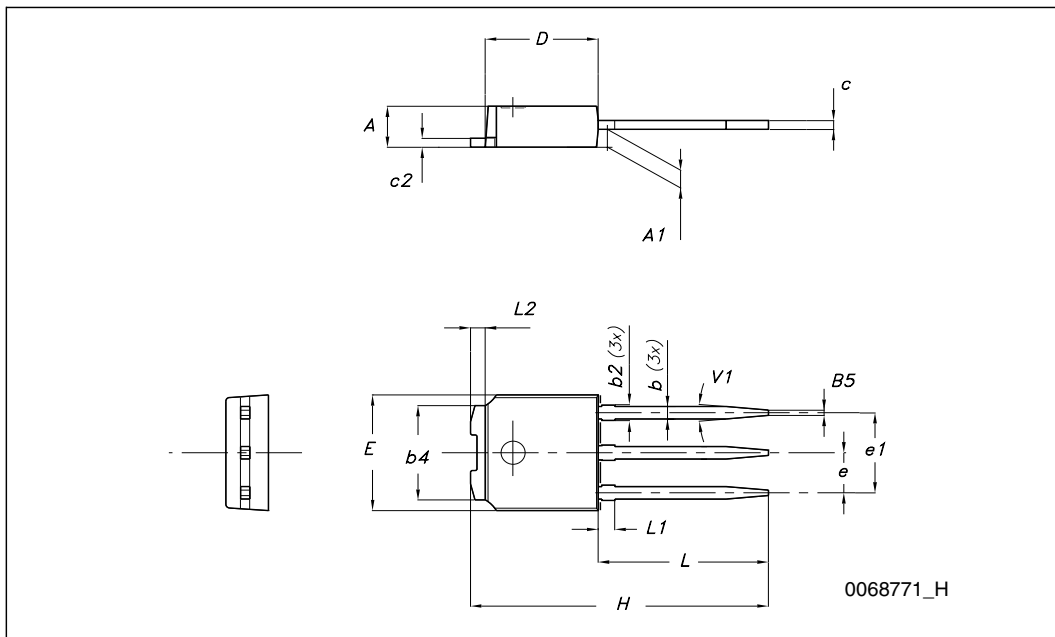
**TO-252 (DPAK) mechanical data**

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°



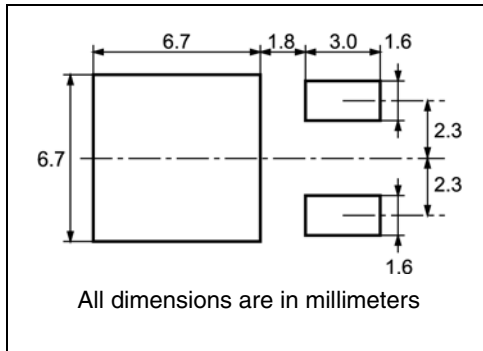
**TO-251 (IPAK) mechanical data**

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
(L1)	0.80		1.20
L2		0.80	
V1		10°	



# 5 Packaging mechanical data

## DPAK FOOTPRINT



## TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

BASE QTY	BULK QTY
2500	2500

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641

TOP COVER TAPE

User Direction of Feed

Center line of cavity

Bending radius R min.

FEED DIRECTION

For machine ref. only including draft and radii concentric around B0

10 pitches cumulative tolerance on tape +/- 0.2 mm

## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
06-Oct-2003	5	No history because migration
18-Jan-2005	6	Final datasheet
13-Nov-2008	7	Insert new value in <a href="#">Table 2: Absolute maximum ratings</a>

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