

## 10 A, 600 V short-circuit rugged IGBT

### Features

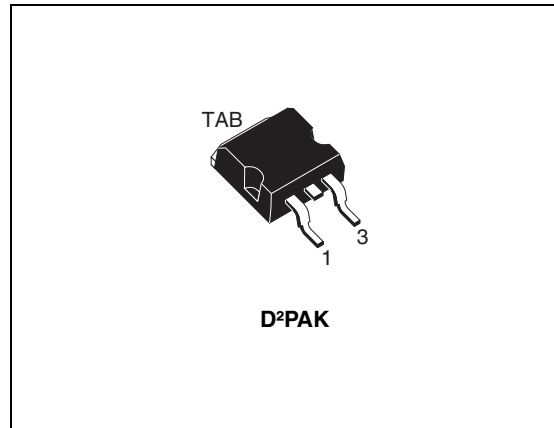
- Low on voltage drop ( $V_{CESAT}$ )
- Short-circuit withstand time 10  $\mu$ s

### Applications

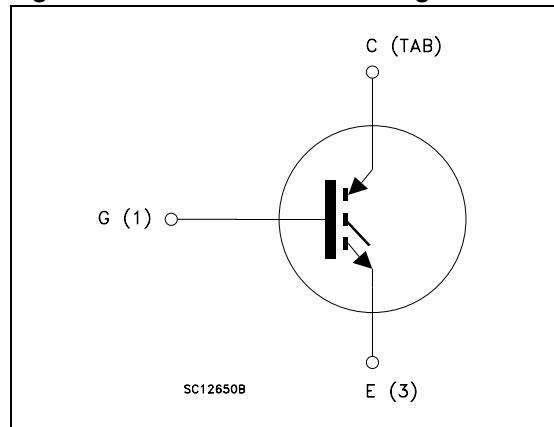
- High frequency motor controls
- SMPS and PFC in both hard switch and resonant topologies
- Motor drives

### Description

This device 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**

Part number	Marking	Package	Packaging
STGB10NC60KT4	GB10NC60K	D²PAK	Tape and reel

# 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 $T_C = 25^\circ\text{C}$	20	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100^\circ\text{C}$	10	A
$I_{CL}^{(2)}$	Turn-off latching current	30	A
$I_{CP}^{(3)}$	Pulsed collector current	30	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	65	W
$T_{STG}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_J$	Operating junction temperature		
$t_{SCW}$	Short-circuit withstand time ( $V_{CE} = 0.5 V_{CES}$ , $T_J = 125^\circ\text{C}$ , $R_G = 10 \Omega$ , $V_{GE} = 12 \text{ V}$ )	10	$\mu\text{s}$

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.  $V_{\text{clamp}} = 80 \% V_{CES}$ ,  $V_{GE} = 15 \text{ V}$ ,  $R_G = 10 \Omega$ ,  $T_J = 150^\circ\text{C}$

3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case	1.9	$^\circ\text{C/W}$
$R_{thJA}$	Thermal resistance junction-ambient	62.5	$^\circ\text{C/W}$

## 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 ( $V_{GE} = 0$ )	$I_C = 1\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 5\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 5\text{ A}, T_J = 125\text{ °C}$		2.2 1.8	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4.5		6.5	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$			150 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15\text{ V}, I_C = 5\text{ A}$		15		S

1. Pulse test: pulse duration < 300  $\mu\text{s}$ , duty cycle < 2 %.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$		380		pF
$C_{oes}$	Output capacitance			46		pF
$C_{res}$	Reverse transfer capacitance			8.5		pF
$Q_g$	Total gate charge	$V_{CE} = 390\text{ V}, I_C = 5\text{ A},$ $V_{GE} = 15\text{ V},$ <i>(see Figure 17)</i>		19		nC
$Q_{ge}$	Gate-emitter charge			5		nC
$Q_{gc}$	Gate-collector charge			9		nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}, I_C = 5\text{ A}$ $R_G = 10\Omega, V_{GE} = 15\text{ V},$ <i>(see Figure 18)</i>		17		ns
$t_r$	Current rise time			6		ns
$(di/dt)_{on}$	Turn-on current slope			655		A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}, I_C = 5\text{ A}$ $R_G = 10\Omega, V_{GE} = 15\text{ V}, T_J = 125\text{ °C}$ <i>(see Figure 18)</i>		16.5		ns
$t_r$	Current rise time			6.5		ns
$(di/dt)_{on}$	Turn-on current slope			575		A/ $\mu\text{s}$
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}, I_C = 5\text{ A},$ $R_{GE} = 10\Omega, V_{GE} = 15\text{ V},$ <i>(see Figure 18)</i>		33		ns
$t_{d(off)}$	Turn-off delay time			72		ns
$t_f$	Current fall time			82		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}, I_C = 5\text{ A},$ $R_{GE} = 10\Omega, V_{GE} = 15\text{ V}, T_J = 125\text{ °C}$ <i>(see Figure 18)</i>		60		ns
$t_{d(off)}$	Turn-off delay time			106		ns
$t_f$	Current fall time			136		ns

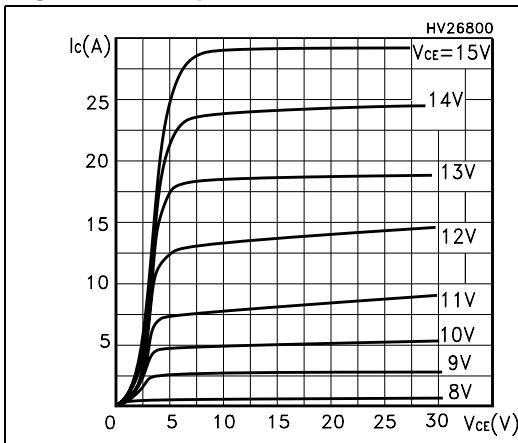
**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 5A$		55		$\mu J$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$ <i>(see Figure 18)</i>		85		$\mu J$
$E_{ts}$	Total switching losses			140		$\mu J$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390V, I_C = 5A$		87		$\mu J$
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$		162		$\mu J$
$E_{ts}$	Total switching losses	<i>(see Figure 18)</i>		249		$\mu J$

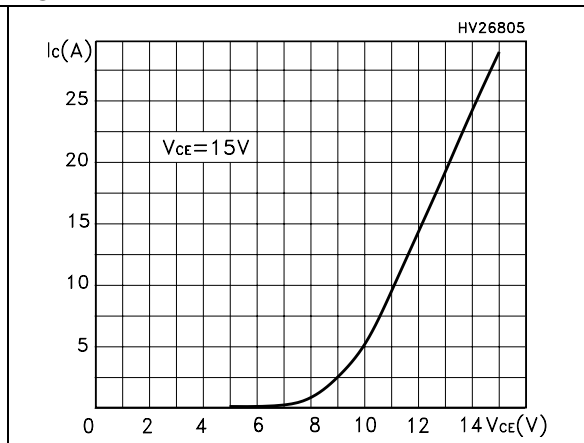
1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 2. If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs & Diode are at the same temperature ( $25^\circ C$  and  $125^\circ C$ )
2. Turn-off losses include also the tail of the collector current

## 2.1 Electrical characteristics (curves)

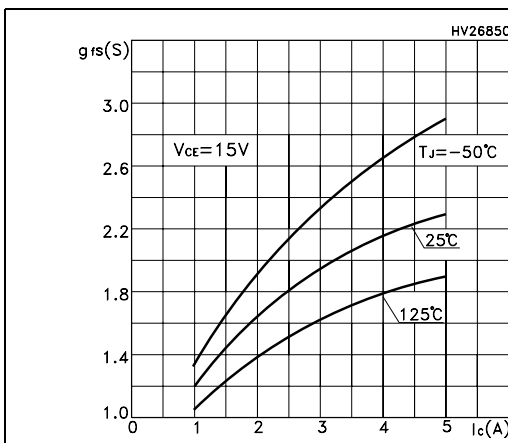
**Figure 2. Output characteristics**



**Figure 3. Transfer characteristics**



**Figure 4. Transconductance**



**Figure 5. Collector-emitter on voltage vs temperature**

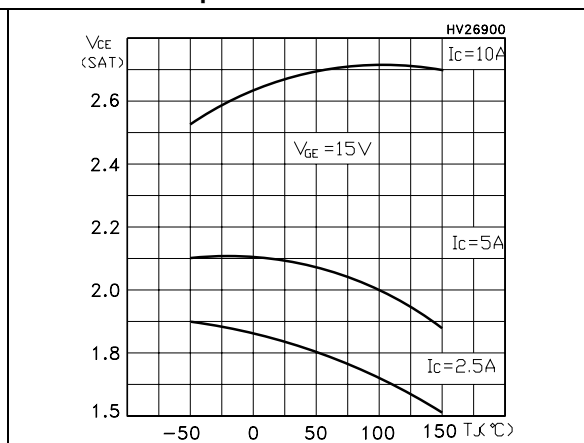


Figure 6. Gate charge vs. gate-source voltage

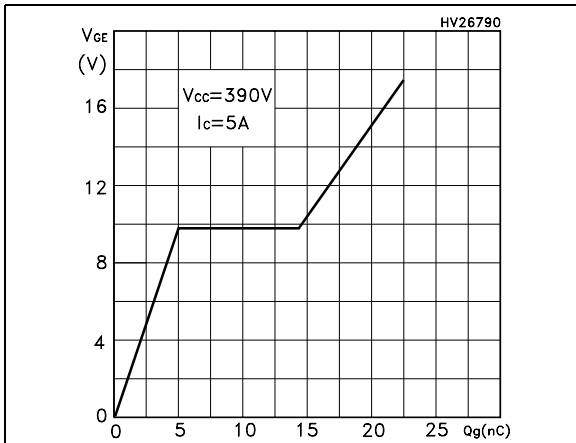


Figure 7. Capacitance variations

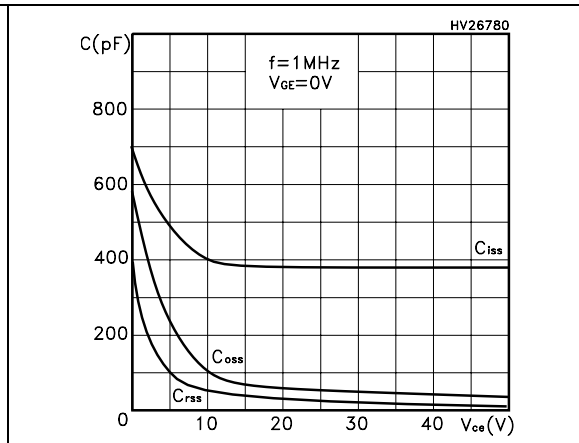


Figure 8. Normalized gate threshold voltage vs. temperature

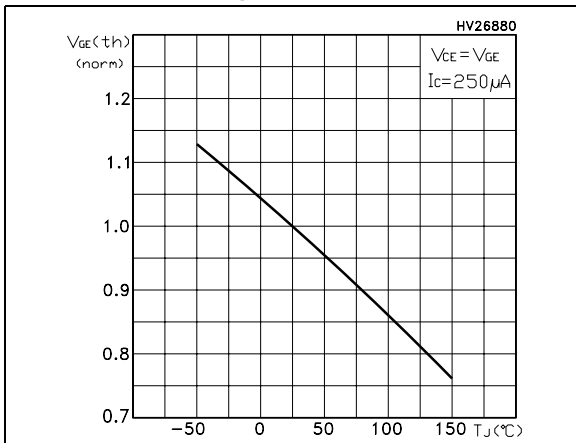


Figure 9. Collector-emitter on voltage vs collector current

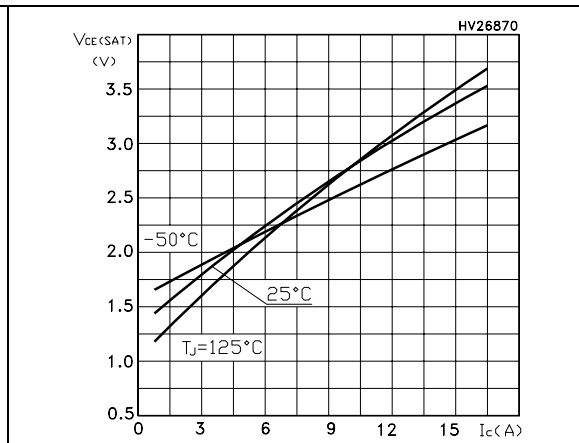


Figure 10. Normalized breakdown voltage vs temperature

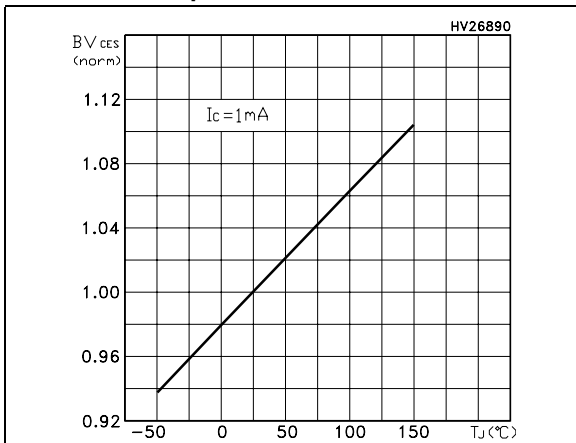


Figure 11. Switching losses vs temperature

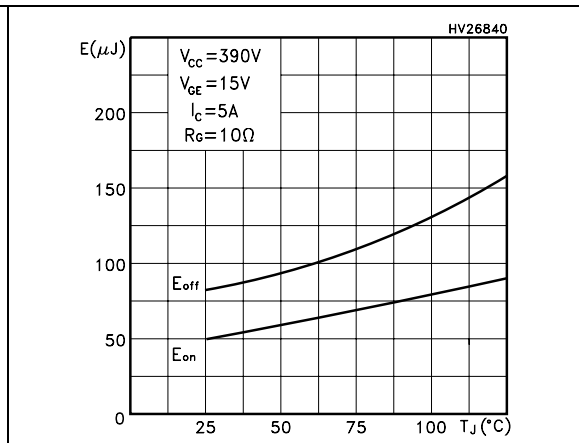


Figure 12. Switching losses vs. gate resistance

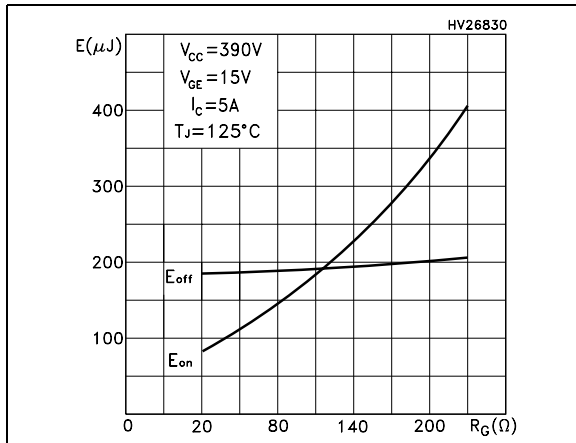


Figure 13. Switching losses vs. collector current

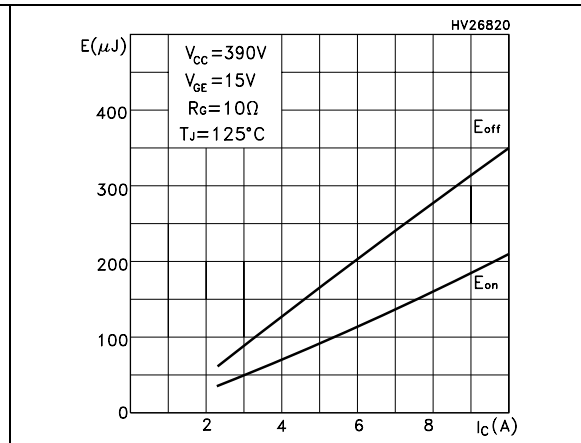


Figure 14. Thermal impedance

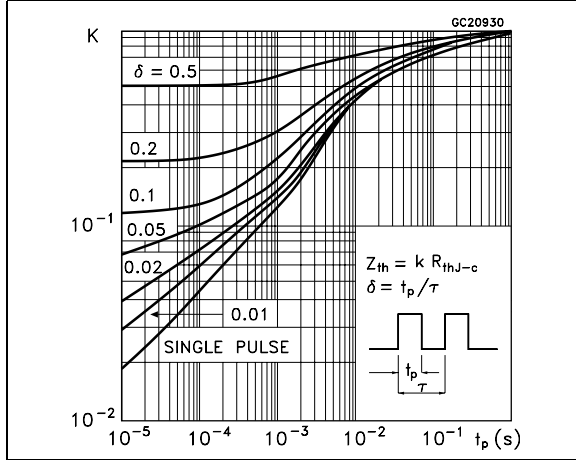
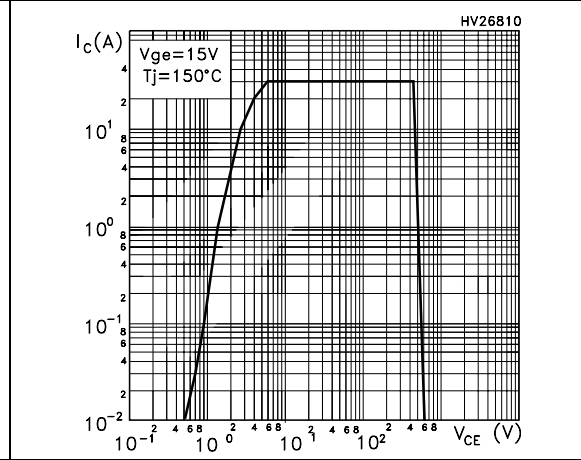


Figure 15. Turn-off SOA



### 3 Test circuits

Figure 16. Test circuit for inductive load switching

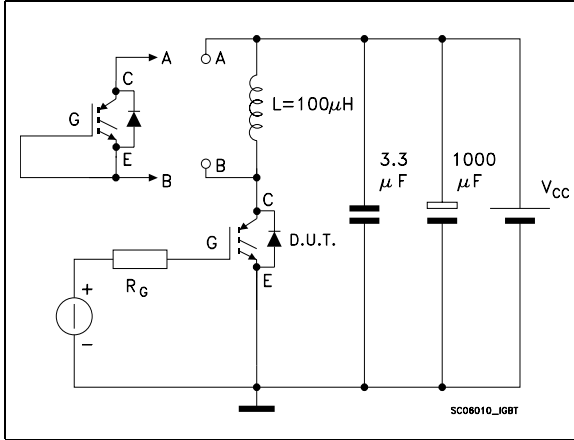


Figure 17. Gate charge test circuit

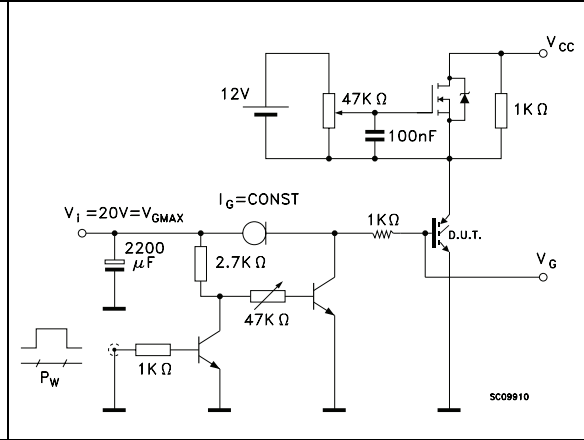
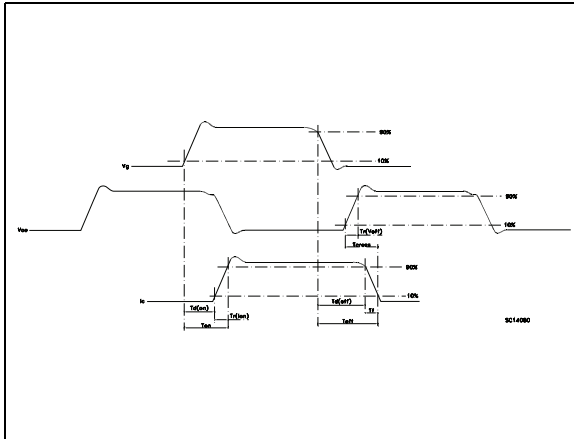


Figure 18. Switching waveform



## 4 Package mechanical data

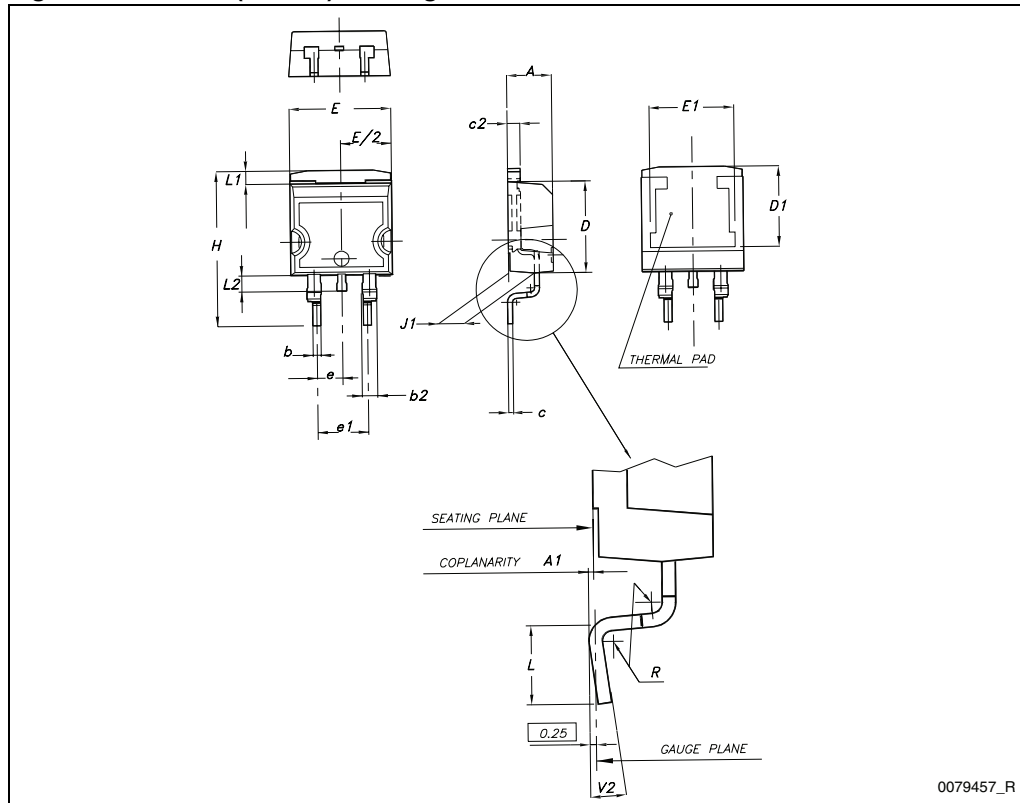
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**Table 8. D<sup>2</sup>PAK (TO-263) mechanical data**

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



## 5 Revision history

Table 9. Document revision history

Date	Revision	Changes
21-Nov-2005	1	New release
06-Dic-2005	2	Inserted row on <a href="#">Table 2: Absolute maximum ratings</a>
08-Feb-2007	3	Description has been updated
24-Feb-2011	4	Updated package mechanical data <a href="#">Table 8. on page 8</a> and <a href="#">Figure 19. on page 9</a>

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