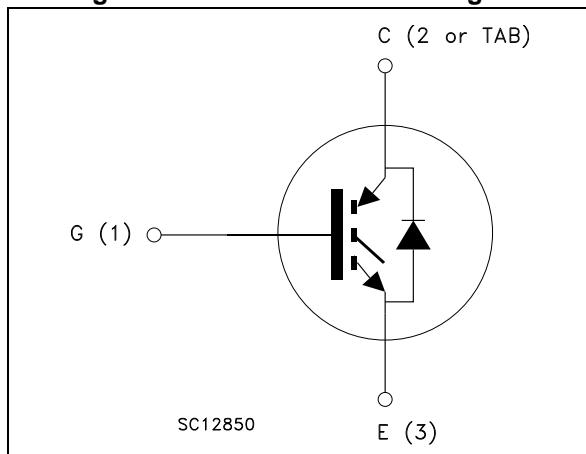


**Figure 1. Internal schematic diagram**



## Features

- Low on-voltage drop ( $V_{CE(sat)}$ )
- Very soft ultrafast recovery anti-parallel diode

## Applications

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

## Description

These devices are ultrafast IGBT. They utilize the advanced Power MESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

**Table 1. Device summary**

Part numbers	Marking	Package	Packing
STGB19NC60HDT4	GB19NC60HD	D <sup>2</sup> PAK	Tape and reel
STGF19NC60HD	GF19NC60HD	TO-220FP	Tube
STGP19NC60HD	GP19NC60HD	TO-220	Tube
STGW19NC60HD	GW19NC60HD	TO-247	Tube

## Contents

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# 1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220 D <sup>2</sup> PAK	TO-220FP	TO-247	
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600			V
$I_C^{(1)}$	Continuous collector current at $T_C = 25^\circ\text{C}$	40	16	42	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100^\circ\text{C}$	19	10	21	A
$I_{CL}^{(2)}$	Turn-off latching current	40			A
$I_{CP}^{(3)}$	Pulsed collector current	60			A
$I_F$	Diode RMS forward current at $T_C = 25^\circ\text{C}$	20			A
$I_{FSM}$	Surge not repetitive forward current $t_p=10\text{ ms sinusoidal}$	50			A
$V_{GE}$	Gate-emitter voltage	$\pm 20$			V
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	130	32	140	W
$V_{ISO}$	Isolation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}; T_C = 25^\circ\text{C}$ )	2500			V
$T_{STG}$	Storage temperature range	- 55 to 150			$^\circ\text{C}$
$T_j$	Operating junction temperature range				

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.  $V_{clamp} = 80\%V_{CES}, T_J = 150^\circ\text{C}, R_G = 1\Omega, V_{GE} = 15\text{ V}$

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

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220 D <sup>2</sup> PAK	TO-220FP	TO-247	
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.95	3.9	0.9	$^\circ\text{C/W}$
	Thermal resistance junction-case diode	3	5.5	3	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	62.5		50	$^\circ\text{C/W}$

## 2 Electrical characteristics

( $T_J = 25^\circ\text{C}$  unless otherwise specified)

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{CES}}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 1 \text{ mA}$	600			V
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage	$V_{GE} = 15 \text{ V}, I_C = 12 \text{ A}$		1.8	2.5	V
		$V_{GE} = 15 \text{ V}, I_C = 15 \text{ A}$		2		
		$V_{GE} = 15 \text{ V}, I_C = 30 \text{ A}, T_J = 100^\circ\text{C}$		2.5		
		$V_{GE} = 15 \text{ V}, I_C = 12 \text{ A}, T_J = 125^\circ\text{C}$		1.6		
$V_{GE(\text{th})}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250 \mu\text{A}$	3.75		5.75	
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600 \text{ V}$			150	$\mu\text{A}$
		$V_{CE} = 600 \text{ V}, T_J = 125^\circ\text{C}$			1	mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20 \text{ V}$			$\pm 100$	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15 \text{ V}, I_C = 12 \text{ A}$		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	$V_{CE} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GE} = 0$	-	1180	-	pF
$C_{oes}$	Output capacitance		-	130	-	
$C_{res}$	Reverse transfer capacitance		-	36	-	
$Q_g$	Total gate charge	$V_{CE} = 390 \text{ V}, I_C = 5 \text{ A}, V_{GE} = 15 \text{ V}$ (see <a href="#">Figure 20</a> )	-	53	-	nC
$Q_{ge}$	Gate-emitter charge		-	10	-	
$Q_{gc}$	Gate-collector charge		-	23	-	

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390 \text{ V}, I_C = 12 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V}$ (see <a href="#">Figure 21</a> )	-	25	-	ns
$t_r$	Current rise time		-	7	-	
$(di/dt)_{on}$	Turn-on current slope		-	1600	-	A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390 \text{ V}, I_C = 12 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V},$ $T_J = 125^\circ\text{C}$ (see <a href="#">Figure 21</a> )	-	24	-	ns
$t_r$	Current rise time		-	8	-	
$(di/dt)_{on}$	Turn-on current slope		-	1400	-	A/ $\mu\text{s}$
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 390 \text{ V}, I_C = 12 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V},$ (see <a href="#">Figure 21</a> )	-	27	-	ns
$t_{d(Voff)}$	Turn-off delay time		-	97	-	
$t_f$	Current fall time		-	73	-	
$t_{r(Voff)}$	Off voltage rise time	$V_{CC} = 390 \text{ V}, I_C = 12 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V},$ $T_J = 125^\circ\text{C}$ (see <a href="#">Figure 21</a> )	-	58	-	ns
$t_{d(Voff)}$	Turn-off delay time		-	144	-	
$t_f$	Current fall time		-	128	-	

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}$	Turn-on switching energy	$V_{CC} = 390 \text{ V}, I_C = 12 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V},$ (see <a href="#">Figure 21</a> )	-	85	-	$\mu\text{J}$
$E_{off}^{(1)}$	Turn-off switching energy		-	189	-	
$E_{ts}$	Total switching energy		-	274	-	
$E_{on}$	Turn-on switching energy	$V_{CC} = 390 \text{ V}, I_C = 12 \text{ A}$ $R_G = 10 \Omega, V_{GE} = 15 \text{ V},$ $T_J = 125^\circ\text{C}$ (see <a href="#">Figure 21</a> )	-	187	-	$\mu\text{J}$
$E_{off}^{(1)}$	Turn-off switching energy		-	407	-	
$E_{ts}$	Total switching energy		-	594	-	

1. Including the tail of the collector current.

**Table 8. Collector-emitter diode**

<b>Symbol</b>	<b>Parameter</b>	<b>Test conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Unit</b>
$V_F$	Forward on-voltage	$I_F = 12 \text{ A}$	-	2.6	-	V
		$I_F = 12 \text{ A}, T_J = 125 \text{ }^\circ\text{C}$	-	2.1	-	
$t_{rr}$	Reverse recovery time	$I_F = 12 \text{ A}, V_R = 40 \text{ V},$ $di/dt = 100 \text{ A}/\mu\text{s}$ (see <i>Figure 22</i> )	-	31	-	ns
$Q_{rr}$	Reverse recovery charge		-	30	-	nC
$I_{rrm}$	Reverse recovery current		-	2	-	A
$t_{rr}$	Reverse recovery time	$I_F = 12 \text{ A}, V_R = 40 \text{ V},$ $T_J = 125 \text{ }^\circ\text{C}, di/dt = 100 \text{ A}/\mu\text{s}$ ((see <i>Figure 22</i> ))	-	59	-	ns
$Q_{rr}$	Reverse recovery charge		-	102	-	nC
$I_{rrm}$	Reverse recovery current		-	4	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

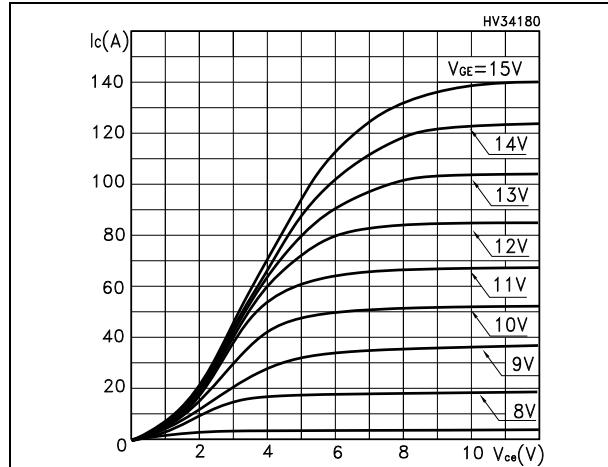


Figure 3. Transfer characteristics

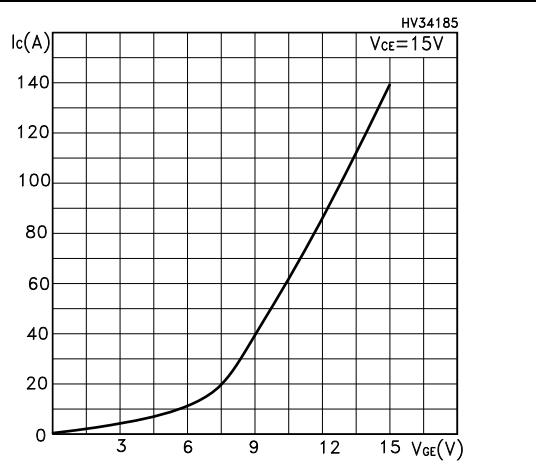


Figure 4. Transconductance

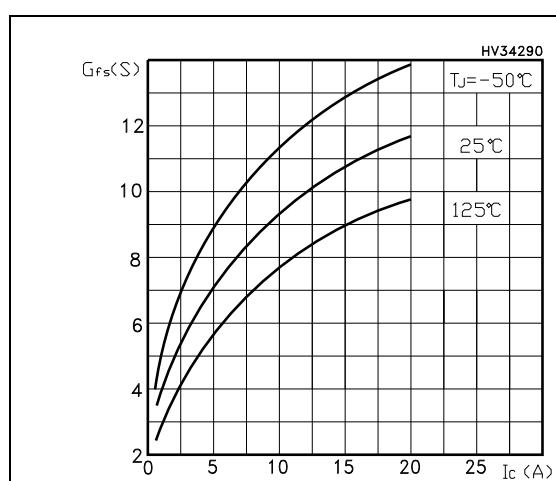


Figure 5. Collector-emitter on voltage vs. temperature

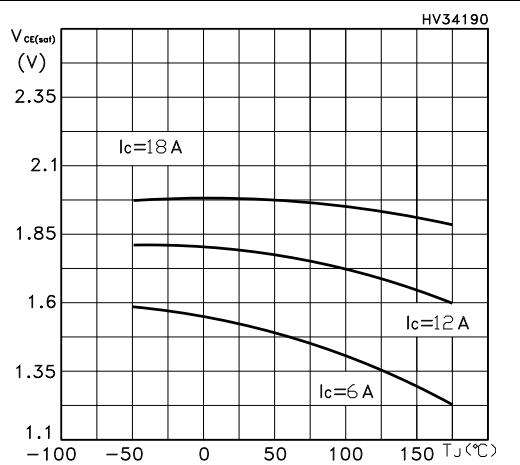


Figure 6. Gate charge vs. gate-source voltage

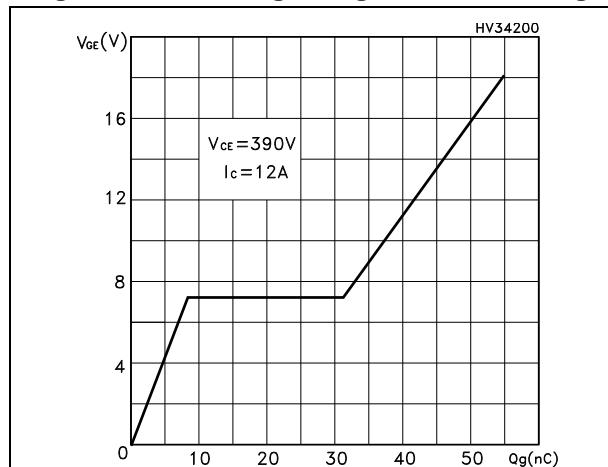
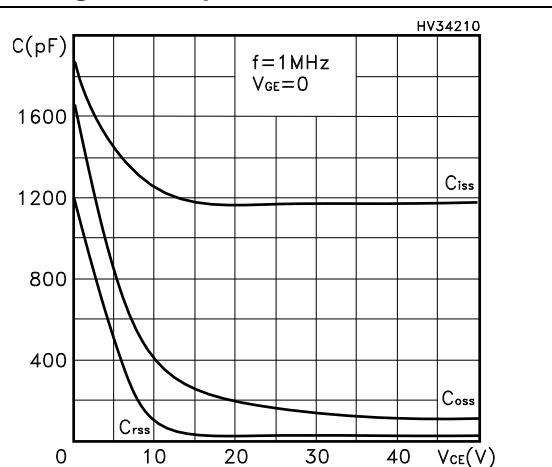
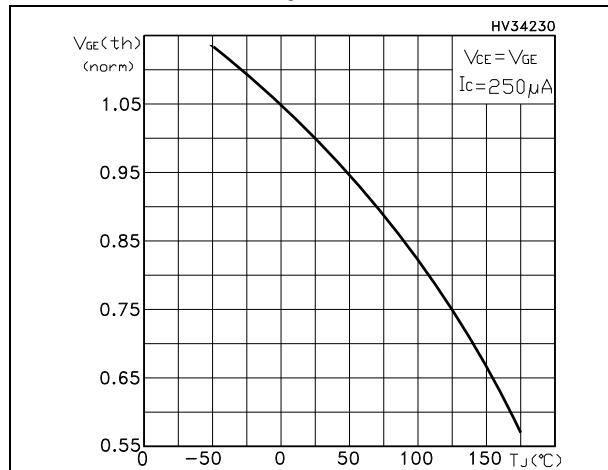


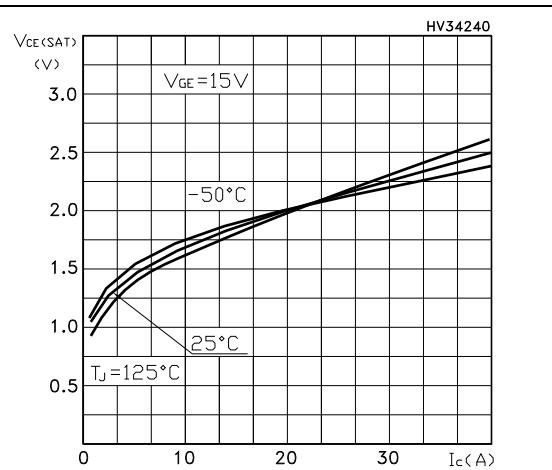
Figure 7. Capacitance variations



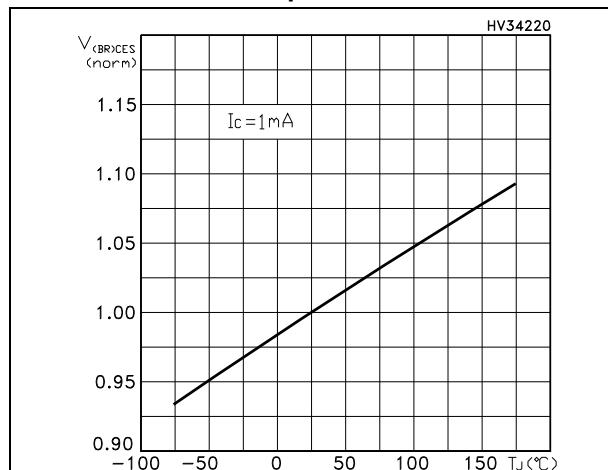
**Figure 8. Normalized gate threshold voltage vs. temperature**



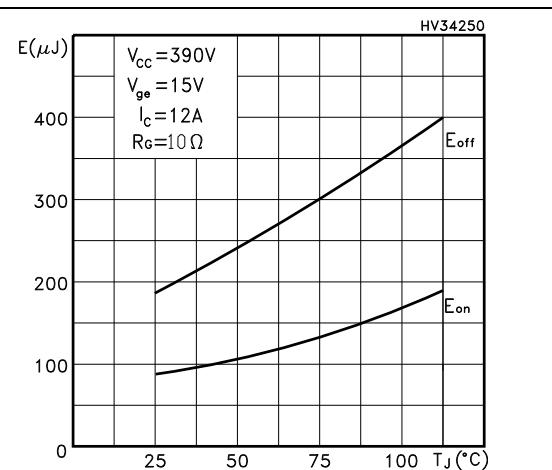
**Figure 9. Collector-emitter on voltage vs. collector current**



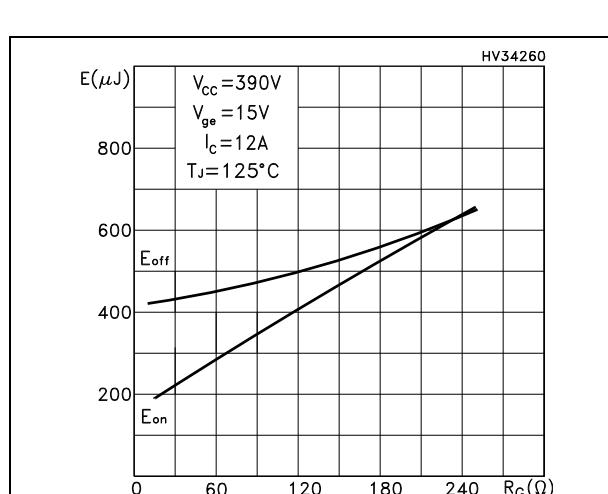
**Figure 10. Normalized breakdown voltage vs. temperature**



**Figure 11. Switching energy vs. temperature**



**Figure 12. Switching energy vs. gate resistance**



**Figure 13. Switching energy vs. collector current**

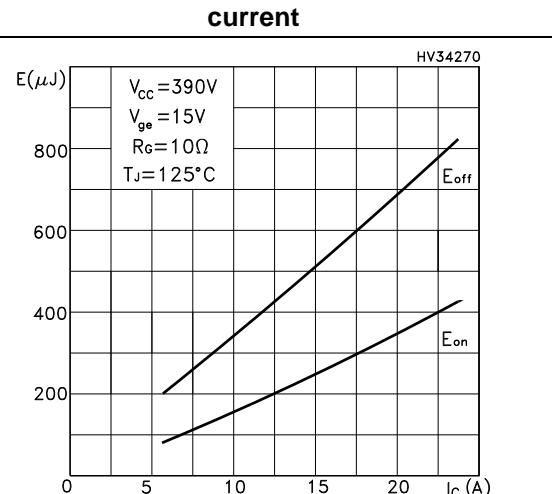


Figure 14. Turn-off SOA

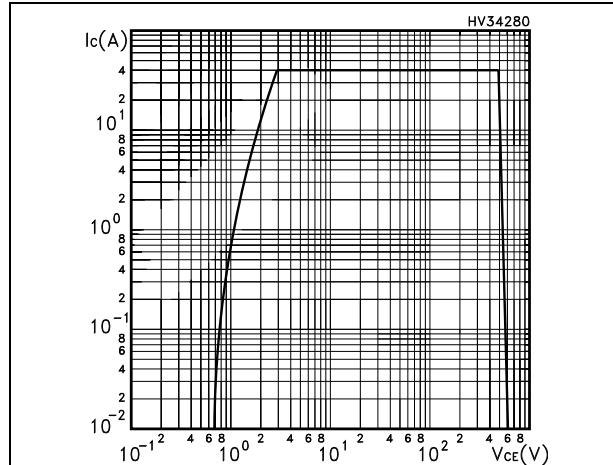


Figure 15. Thermal impedance for TO-247

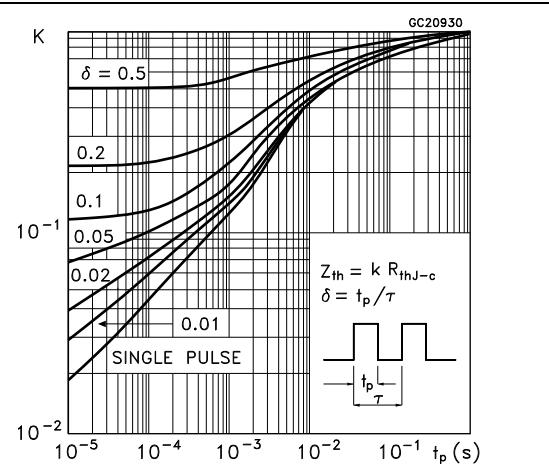


Figure 16. Thermal impedance for TO-220, D<sup>2</sup>PAK

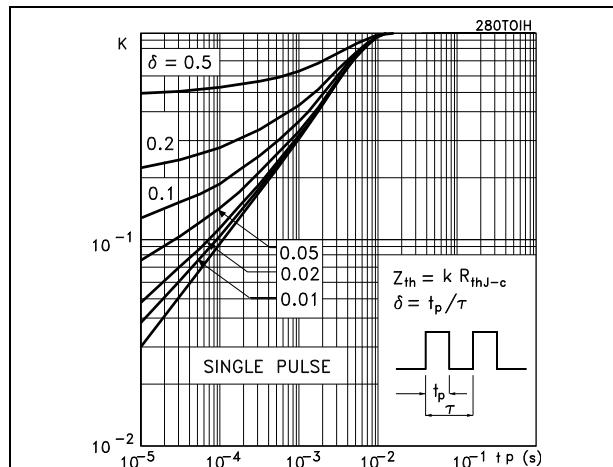


Figure 17. Thermal impedance for TO-220FP

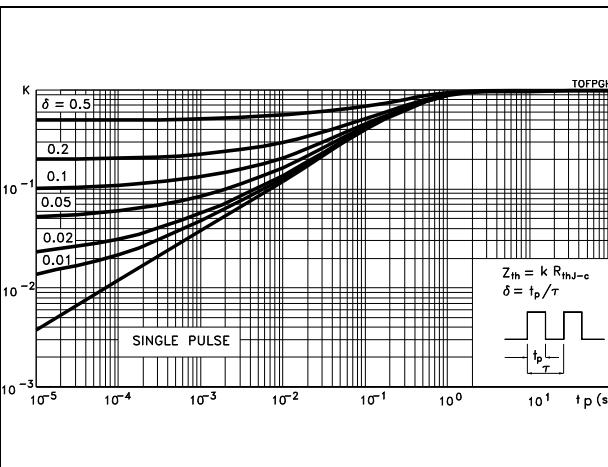
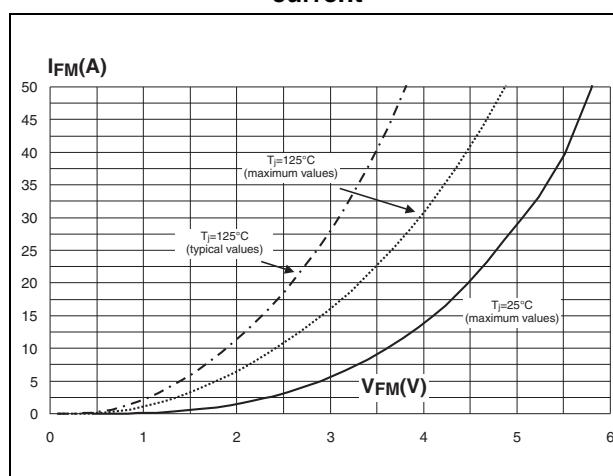
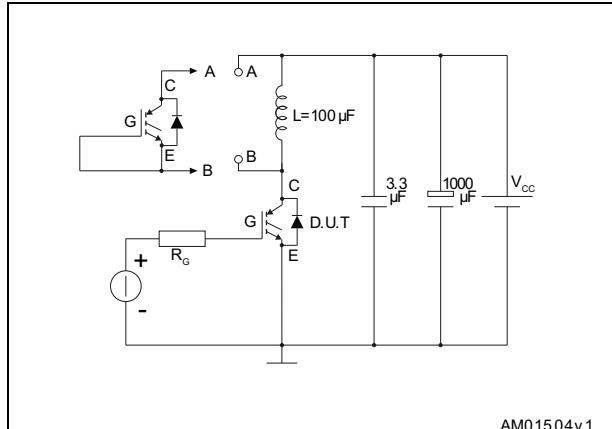


Figure 18. Forward voltage drop vs. forward current

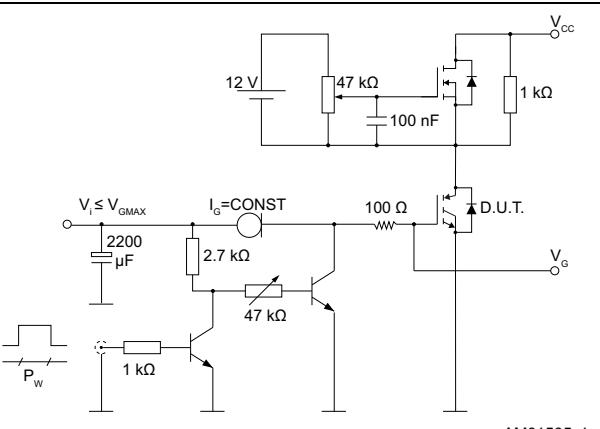


### 3 Test circuits

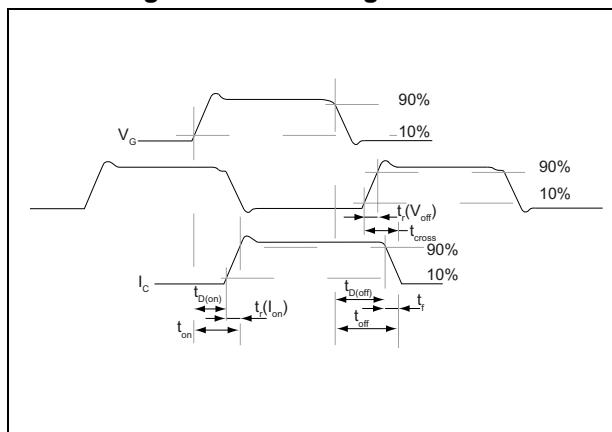
**Figure 19. Test circuit for inductive load switching**



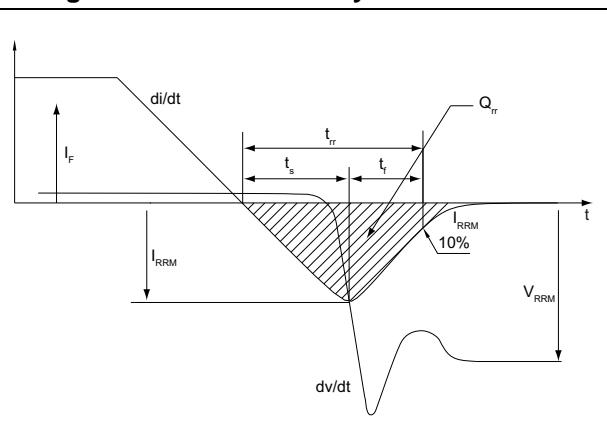
**Figure 20. Gate charge test circuit**



**Figure 21. Switching waveform**



**Figure 22. Diode recovery time waveform**

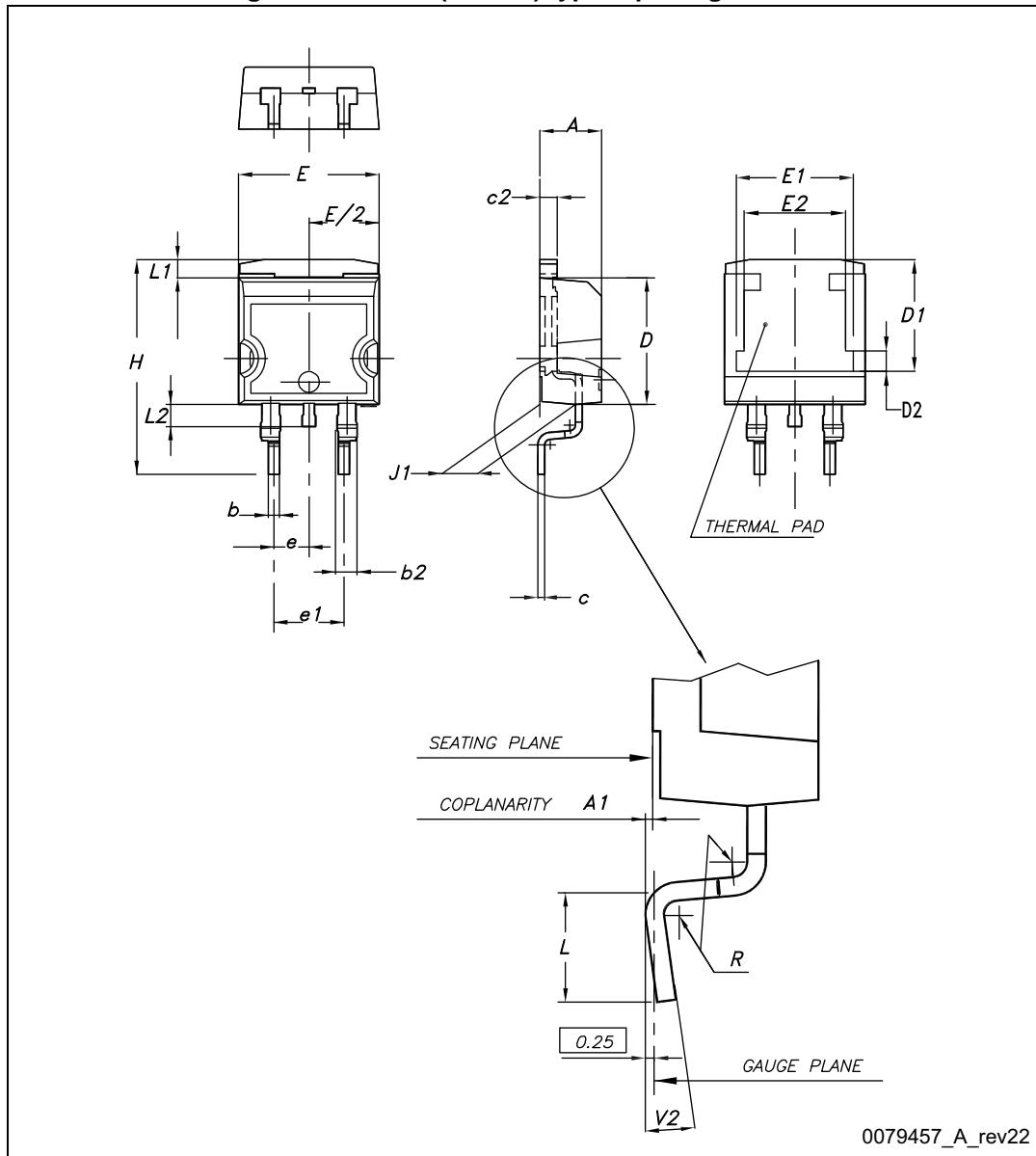


## 4 Package information

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](http://www.st.com).  
ECOPACK is an ST trademark.

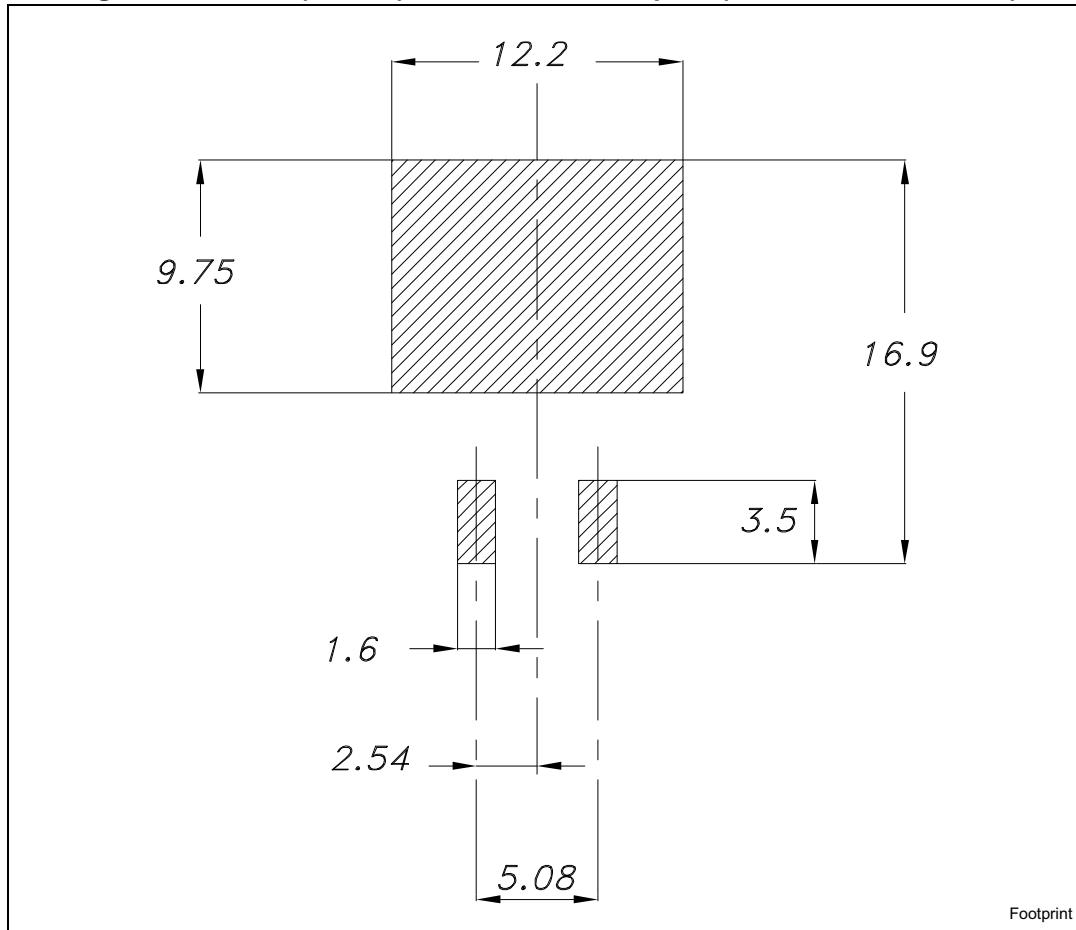
### 4.1 D<sup>2</sup>PAK (TO-263) package information

Figure 23. D<sup>2</sup>PAK (TO-263) type A package outline



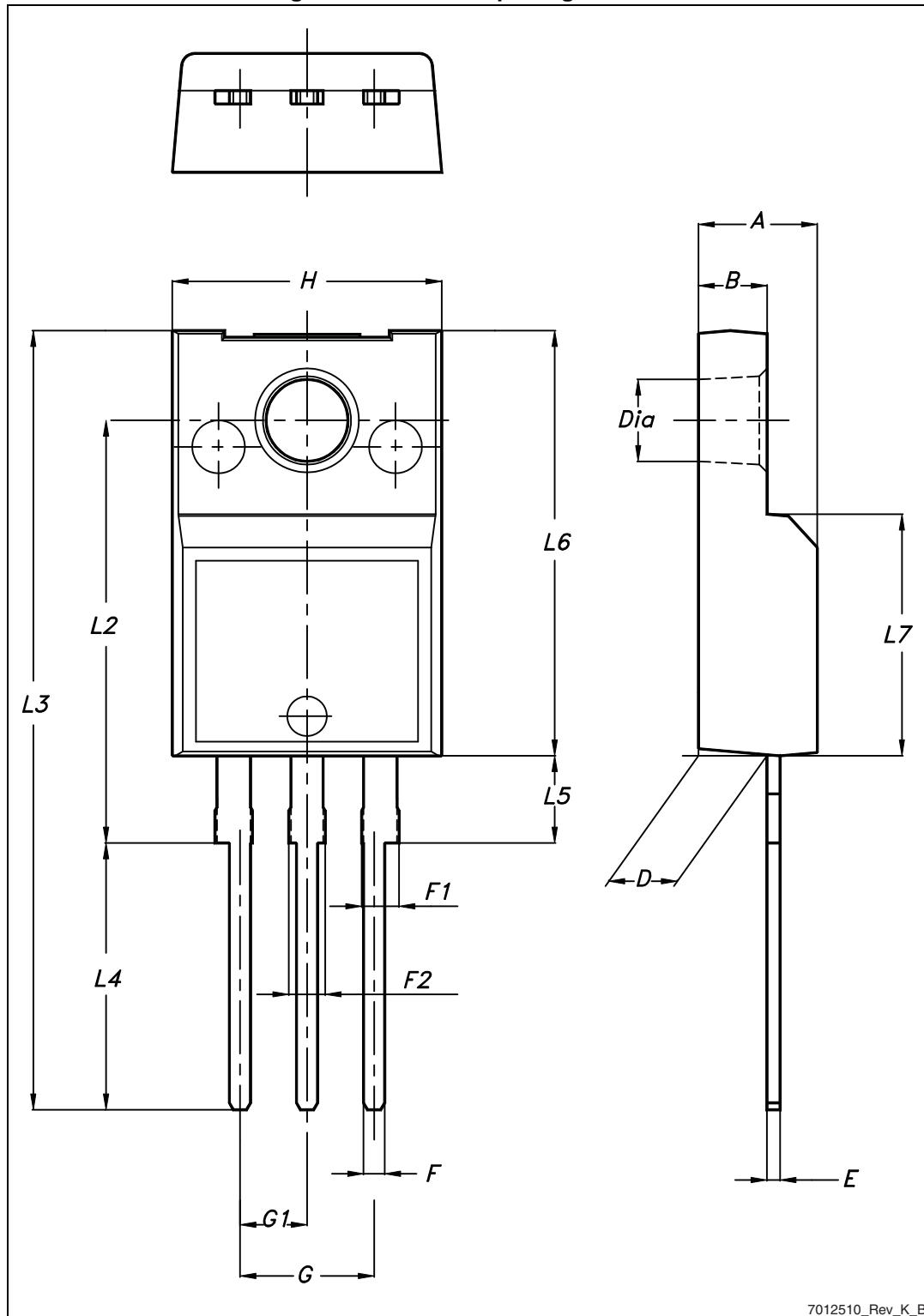
**Table 9. D<sup>2</sup>PAK (TO-263) type A mechanical data**

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	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		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 24. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**

## 4.2 TO-220FP package information

Figure 25. TO-220FP package outline



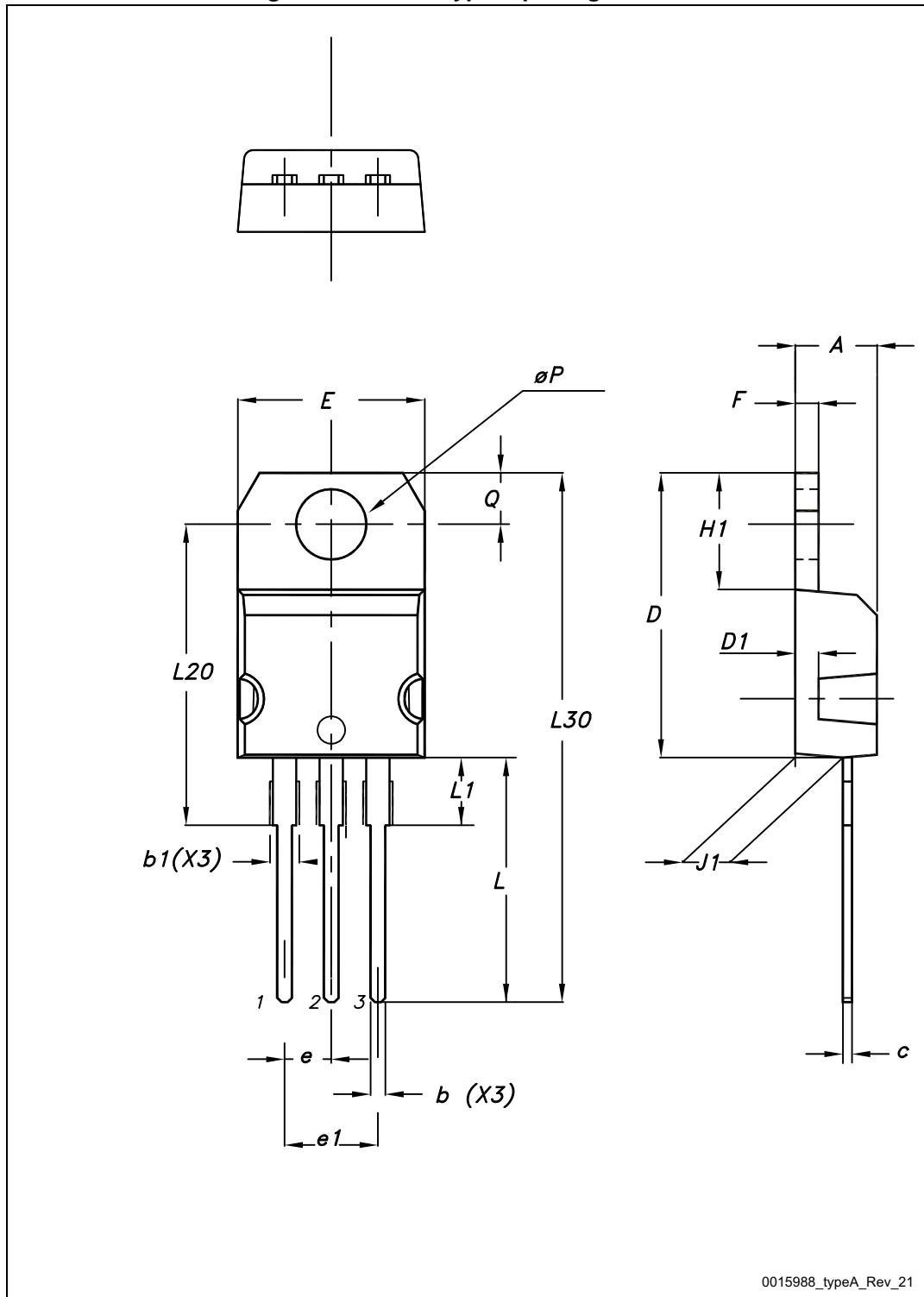
7012510\_Rev\_K\_B

**Table 10. TO-220FP package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

### 4.3 TO-220 package information

Figure 26. TO-220 type A package outline

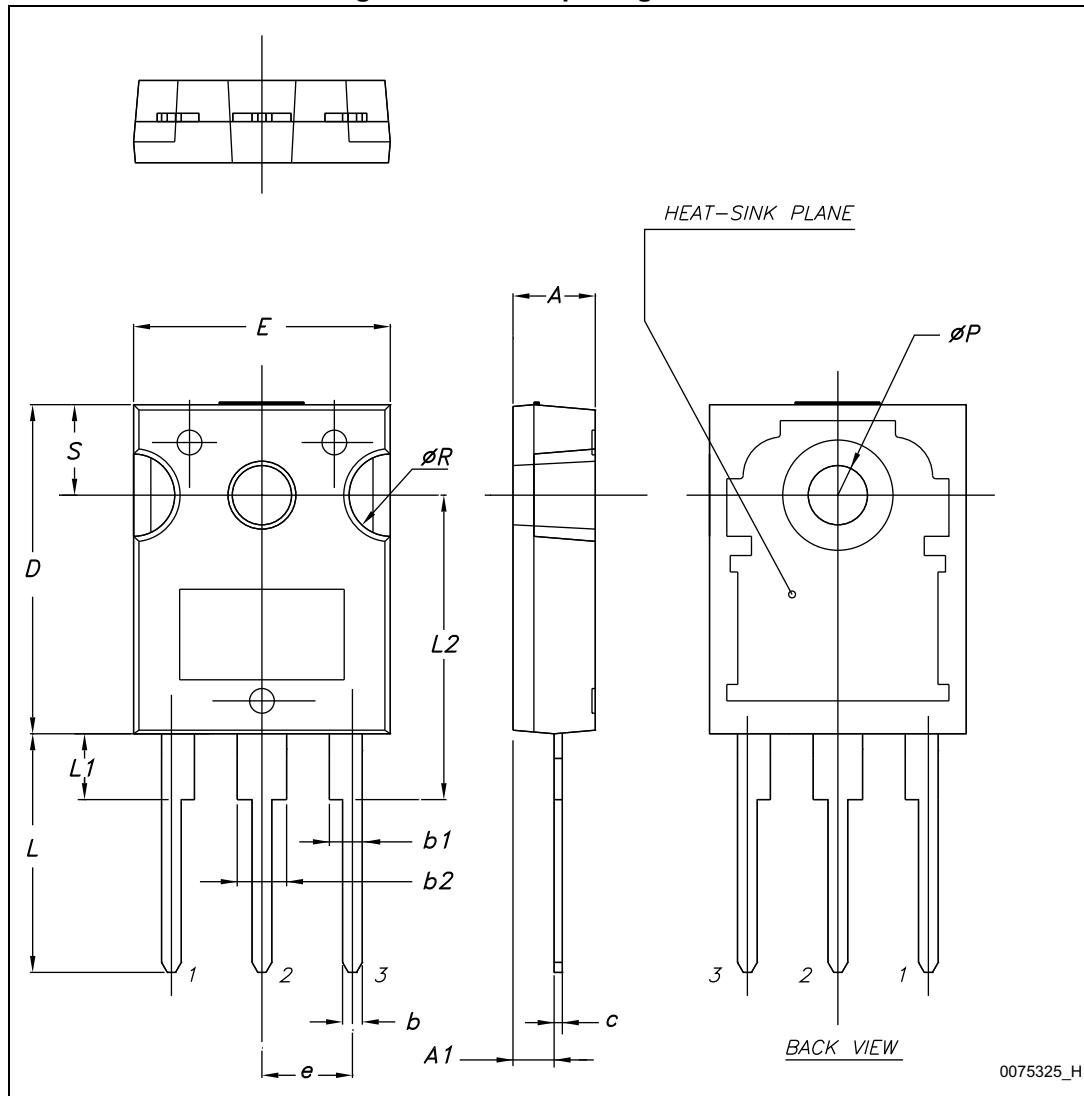


**Table 11. TO-220 type A mechanical data**

Dim.	mm.		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

## 4.4 TO-247 package information

Figure 27. TO-247 package outline



**Table 12. TO-247 package mechanical data**

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

## 5 Packing information

Figure 28. D<sup>2</sup>PAK (TO-263) tape outline

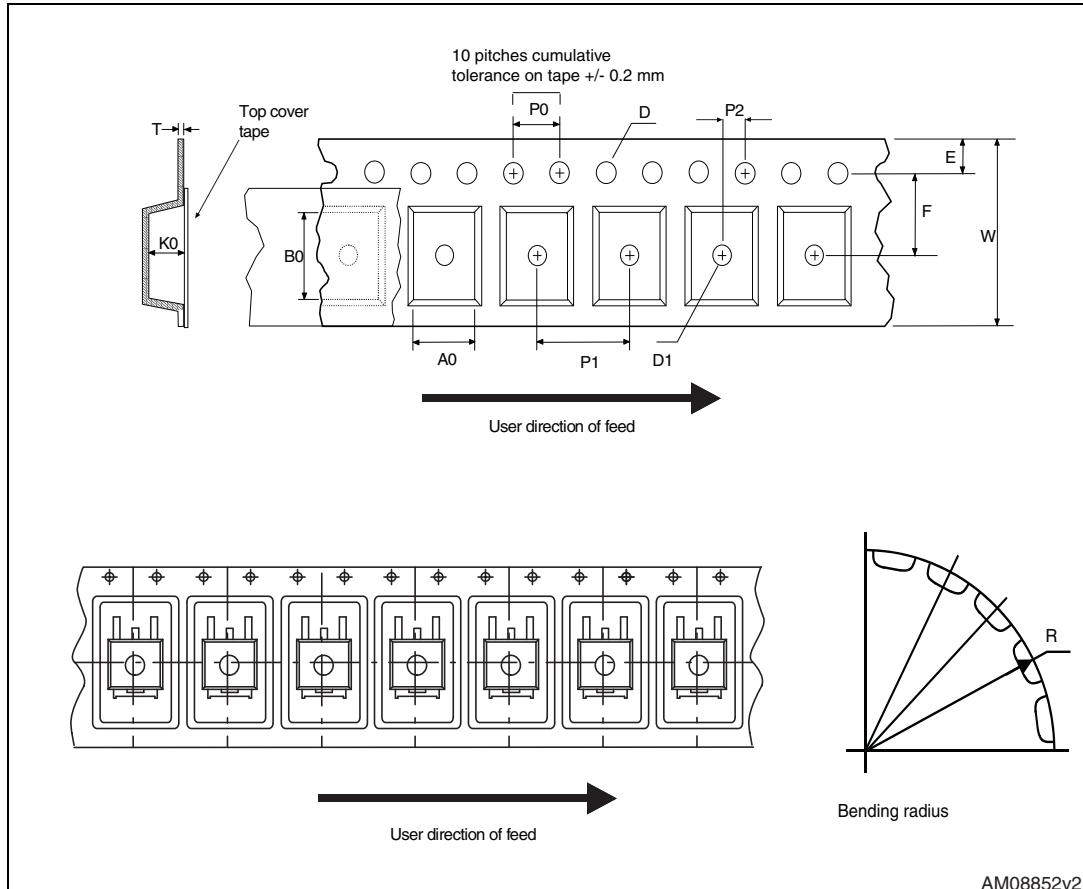
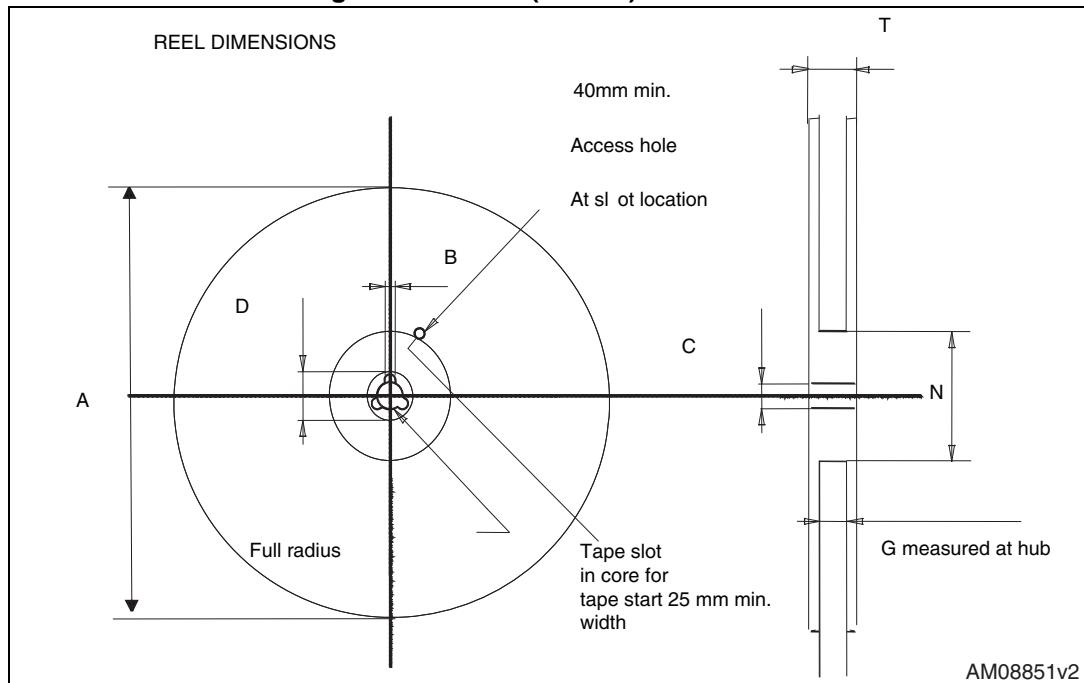


Figure 29. D<sup>2</sup>PAK (TO-263) reel outlineTable 13. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

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			

## 6 Revision history

Table 14. Document revision history

Date	Revision	Changes
02-Nov-2006	1	Initial release.
05-Jan-2007	2	Complete version.
01-Jul-2008	3	Modified: <i>Table 2: Absolute maximum ratings.</i> Inserted new packages, mechanical data: TO-220FP, TO-247.
13-Oct-2008	4	$V_{ISO}$ inserted in <i>Table 2</i> for TO-220FP.
15-May-2009	5	Updated $I_{CP}$ value.
19-May-2009	6	Updated: mechanical data for TO-220FP.
24-Nov-2010	7	Inserted new order code STGWA19NC60HD in TO-247 long leads package.
14-Dec-2010	8	Updated <i>Table 4: Static.</i>
02-Sep-2011	9	Removed order code STGWA19NC60HD in TO-247 long leads package.
06-Sep-2016	10	Added <a href="#">Section 5.2: TO-247 package information.</a> Minor text changes.

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