

Figure 1: Internal schematic diagram

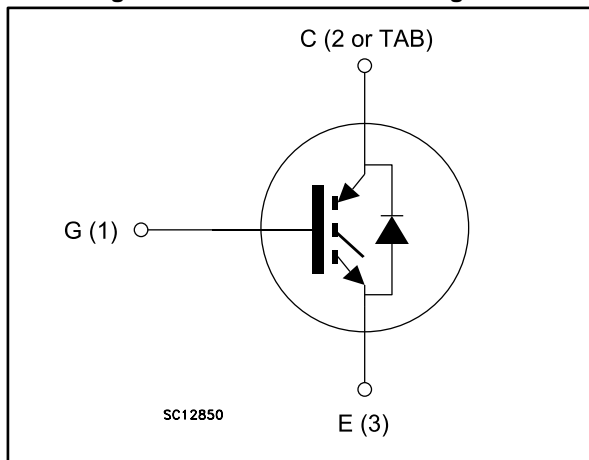


Table 1: Device summary

Order code	Marking	Package	Packing
STGB3HF60HD	GB3HF60HD	D <sup>2</sup> PAK	Tape and reel
STGD3HF60HDT4	GD3HF60HD	DPAK	Tape and reel
STGF3HF60HD	GF3HF60HD	TO-220FP	Tube
STGP3HF60HD	GP3HF60HD	TO-220	Tube

### Features

- Minimal tail current
- Low conduction and switching losses
- Ultrafast soft recovery antiparallel diode

### Applications

- Motor drive

### Description

These devices are based on a new advanced planar technology concept to yield an IGBT with more stable switching performance ( $E_{off}$ ) versus temperature, as well as lower conduction losses.

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## 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) .....	7
<b>3</b>	<b>Test circuits .....</b>	<b>10</b>
<b>4</b>	<b>Package information .....</b>	<b>11</b>
	4.1 D <sup>2</sup> PAK (TO-263) package information .....	11
	4.2 D <sup>2</sup> PAK (TO-263) packing information.....	14
	4.3 DPAK (TO-252) type A package information.....	16
	4.4 DPAK (TO-252) packing information.....	19
	4.5 TO-220FP package information .....	21
	4.6 TO-220 type A package information.....	23
<b>5</b>	<b>Revision history .....</b>	<b>25</b>

# 1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK	D <sup>2</sup> PAK TO-220	TO-220FP	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	600			V
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 25 °C	7.5			A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100 °C	4.5			A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	18			A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	18			A
V <sub>GE</sub>	Gate-emitter voltage	± 20			V
I <sub>F</sub>	Diode RMS forward current at T <sub>C</sub> = 25 °C	10			A
I <sub>FSM</sub>	Surge non repetitive forward current t <sub>p</sub> = 10 ms sinusoidal	25			A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	38		18	W
T <sub>STG</sub>	Storage temperature range	- 55 to 150			°C
T <sub>j</sub>	Operating junction temperature range				

**Notes:**

<sup>(1)</sup>Calculated according to the iterative formula:

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

<sup>(2)</sup>V<sub>clamp</sub> = 80 %, (V<sub>CES</sub>), T<sub>j</sub> = 150 °C, R<sub>G</sub> = 10 Ω, V<sub>GE</sub> = 15 V.

<sup>(3)</sup>Pulse width limited by maximum junction temperature range.

Table 3: Thermal data

Symbol	Parameter	Value			Unit
		DPAK	D <sup>2</sup> PAK TO-220	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case IGBT	3.3		6.9	°C/W
	Thermal resistance junction-case diode	5		8	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	100	62.5		°C/W

## 2 Electrical characteristics

( $T_j=25\text{ °C}$  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	$V_{GE} = 15\text{ V}$ , $I_C = 0.5\text{ A}$ , $T_j = 125\text{ °C}$		1.4		V
		$V_{GE} = 15\text{ V}$ , $I_C = 1.5\text{ A}$		2.45	2.95	
		$V_{GE} = 15\text{ V}$ , $I_C = 1.5\text{ A}$ , $T_j = 125\text{ °C}$		1.85		
$V_{GE(th)}$	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 ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			250	$\mu\text{A}$
		$V_{CE} = 600\text{ V}$ , $T_j = 125\text{ °C}$			1	mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{ V}$ , $I_C = 1.5\text{ A}$		1.5		S

**Table 5: Dynamic electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$	-	152	-	pF
$C_{oes}$	Output capacitance		-	14	-	pF
$C_{res}$	Reverse transfer capacitance		-	3	-	pF
$Q_g$	Total gate charge	$V_{CE} = 480\text{ V}$ , $I_C = 1.5\text{ A}$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 18: "Gate charge test circuit"</a> )	-	12	-	nC
$Q_{ge}$	Gate-emitter charge		-	2	-	nC
$Q_{gc}$	Gate-collector charge		-	6	-	nC

Table 6: Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $I_C = 1.5\text{ A}$ $R_G = 100\ \Omega$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> <a href="#">Figure 19: "Switching waveform"</a> )	-	11	-	ns
$t_r$	Current rise time		-	4	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	285	-	A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $I_C = 1.5\text{ A}$ $R_G = 100\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_j = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> <a href="#">Figure 19: "Switching waveform"</a> )	-	10	-	ns
$t_r$	Current rise time		-	5	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	265	-	A/ $\mu$ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}$ , $I_C = 1.5\text{ A}$ , $R_{GE} = 100\ \Omega$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> <a href="#">Figure 19: "Switching waveform"</a> )	-	26	-	ns
$t_d(off)$	Turn-off delay time		-	60	-	ns
$t_f$	Current fall time		-	50	-	ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}$ , $I_C = 1.5\text{ A}$ , $R_{GE} = 100\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_j = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> <a href="#">Figure 19: "Switching waveform"</a> )	-	64	-	ns
$t_d(off)$	Turn-off delay time		-	69	-	ns
$t_f$	Current fall time		-	71	-	ns

Table 7: Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CC} = 400\text{ V}$ , $I_C = 1.5\text{ A}$ $R_G = 100\ \Omega$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> <a href="#">Figure 19: "Switching waveform"</a> )	-	19	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	12	-	$\mu$ J
$E_{ts}$	Total switching energy		-	31	-	$\mu$ J
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CC} = 400\text{ V}$ , $I_C = 1.5\text{ A}$ $R_G = 100\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_j = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 17: "Test circuit for inductive load switching"</a> <a href="#">Figure 19: "Switching waveform"</a> )	-	38	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	35	-	$\mu$ J
$E_{ts}$	Total switching energy		-	73	-	$\mu$ J

**Notes:**

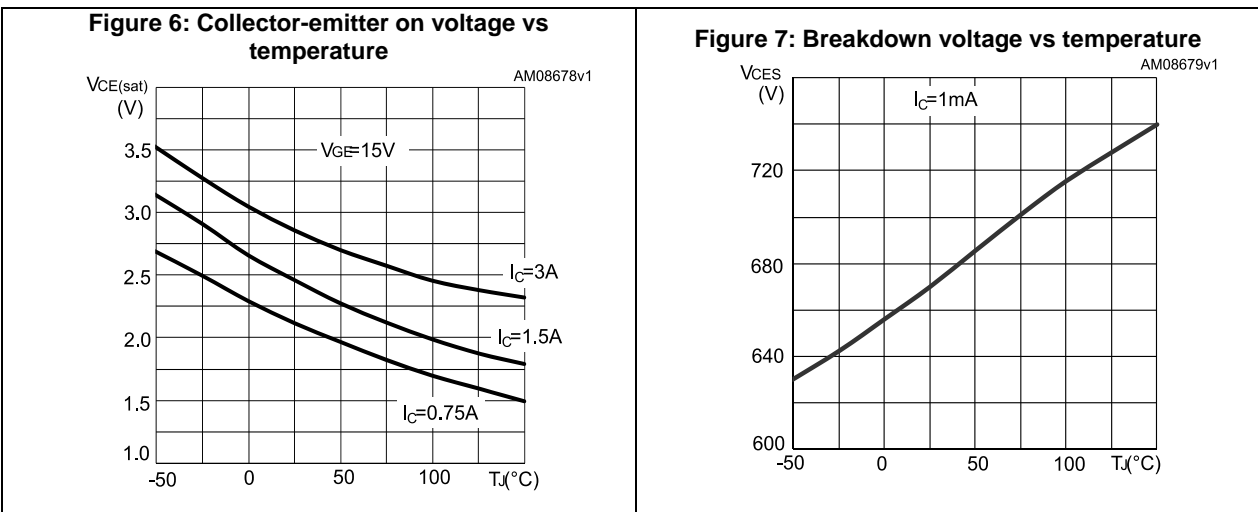
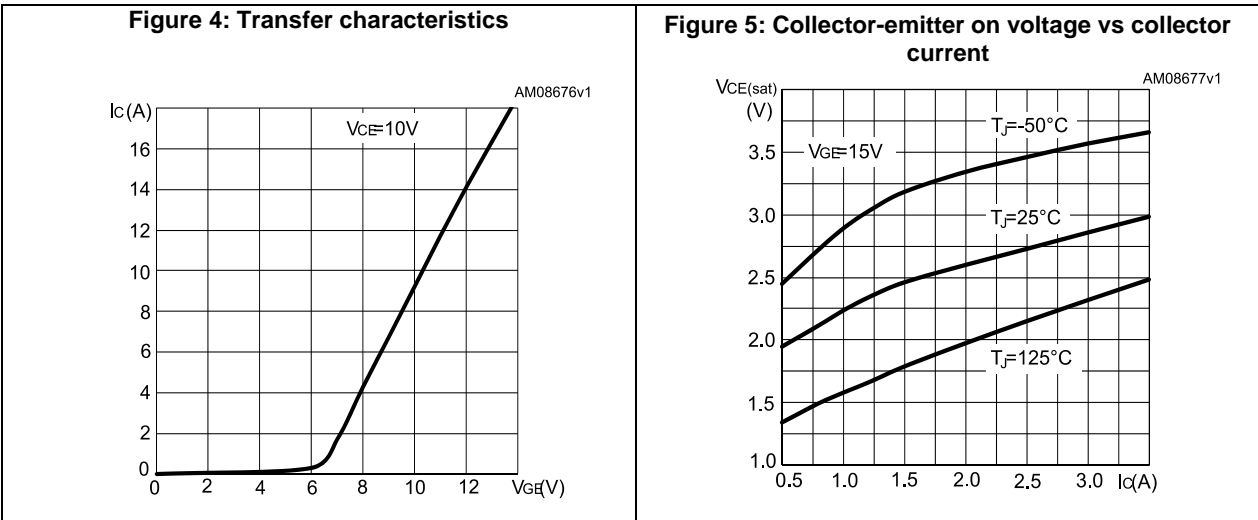
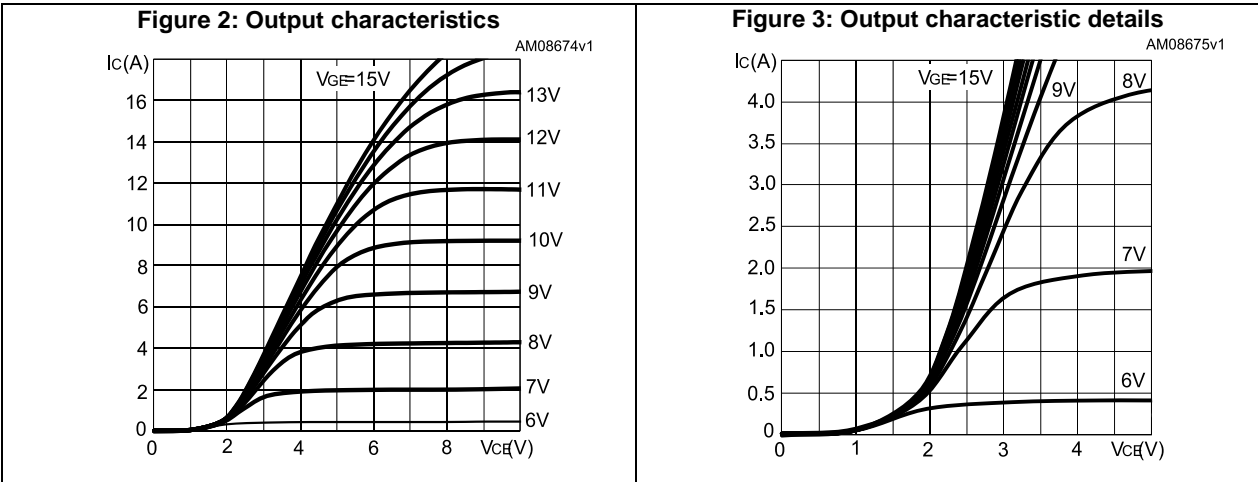
<sup>(1)</sup> $E_{on}$  is the turn-on energy when a typical diode is used in the test circuit in [Figure 17: "Test circuit for inductive load switching"](#). If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs and diode are at the same temperature (25 °C and 125 °C).

<sup>(2)</sup>Turn-off energy include also the tail of the collector current.

Table 8: Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 1.5 \text{ A}$	-	1.4	1.8	V
		$I_F = 1.5 \text{ A}, T_j = 125 \text{ }^\circ\text{C}$	-	1.15		
$t_{rr}$	Reverse recovery time	$I_F = 1.5 \text{ A}, V_R = 40 \text{ V},$ $di/dt = 100 \text{ A}/\mu\text{s}$ (see <a href="#">Figure 20: "Diode reverse recovery waveform"</a> )	-	85		ns
$Q_{rr}$	Reverse recovery charge		-	124		nC
$I_{rrm}$	Reverse recovery current		-	3		A
$t_{rr}$	Reverse recovery time	$I_F = 1.5 \text{ A}, V_R = 40 \text{ V},$ $T_j = 125 \text{ }^\circ\text{C}, di/dt = 100 \text{ A}/\mu\text{s}$ (see <a href="#">Figure 20: "Diode reverse recovery waveform"</a> )	-	114		ns
$Q_{rr}$	Reverse recovery charge		-	194		nC
$I_{rrm}$	Reverse recovery current		-	3.5		A

## 2.1 Electrical characteristics (curves)



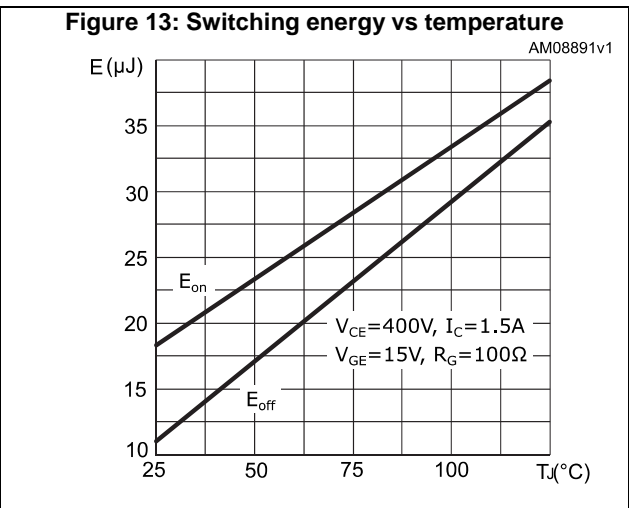
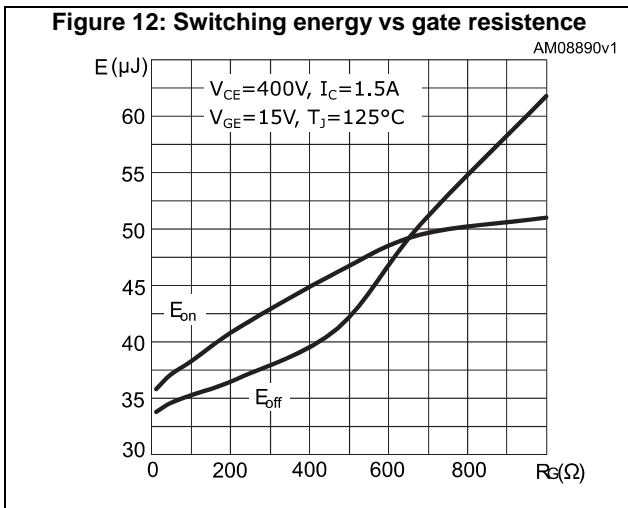
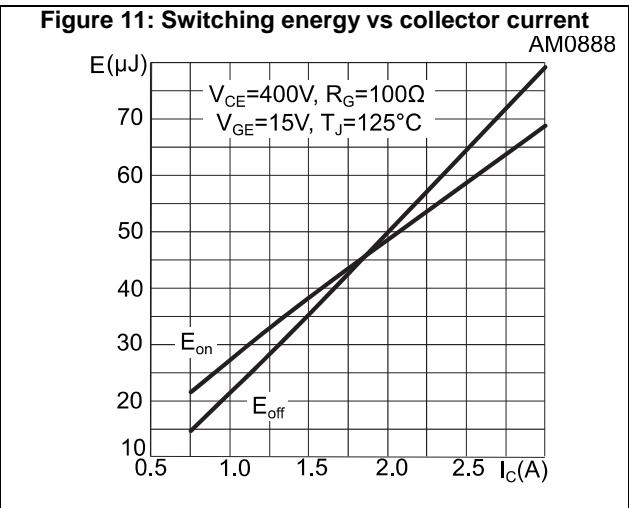
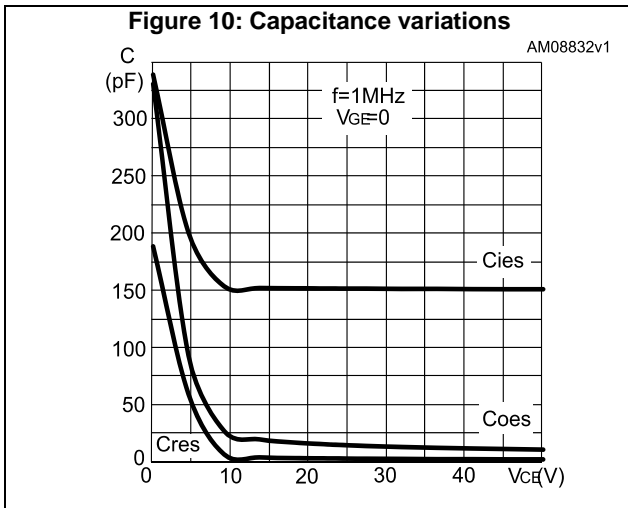
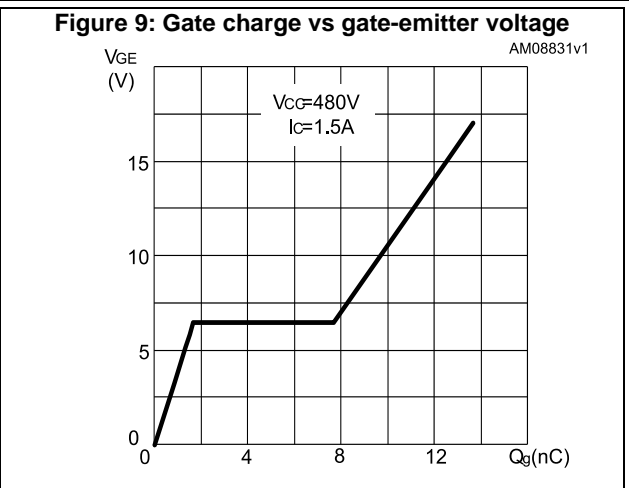
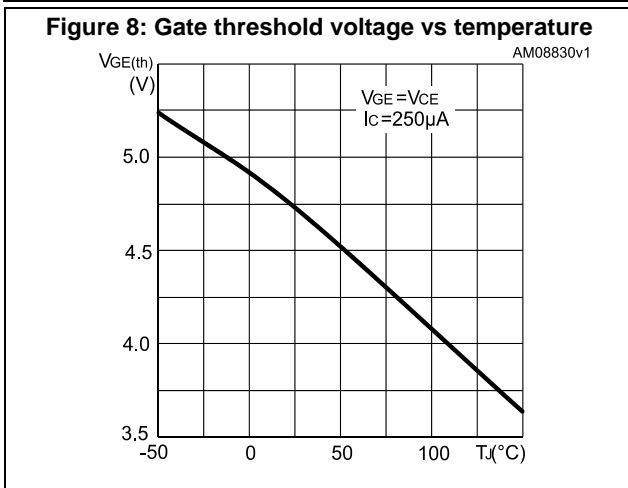




Figure 14: Turn-off SOA

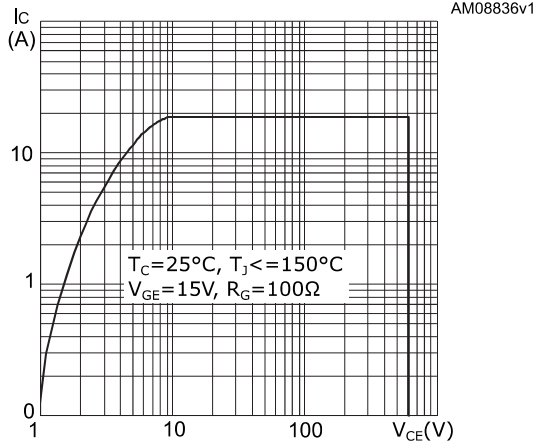


Figure 15: Diode forward on voltage

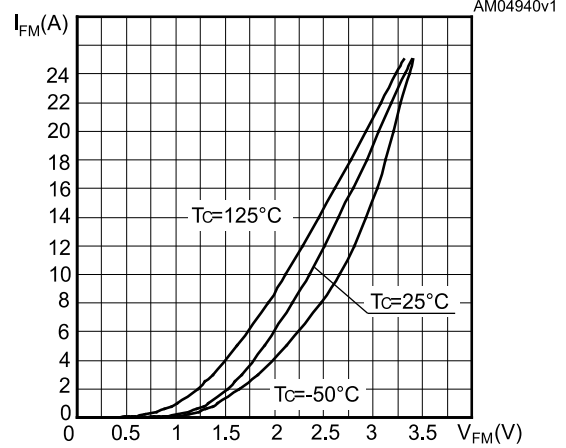
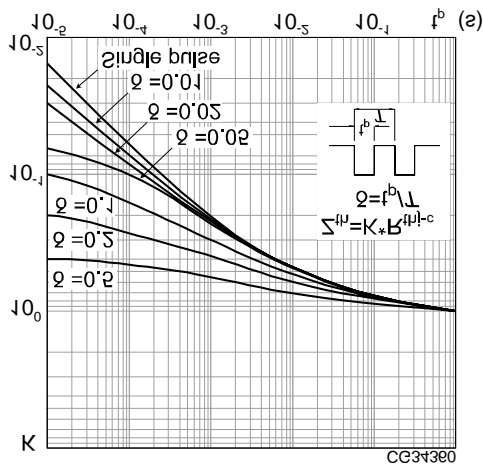
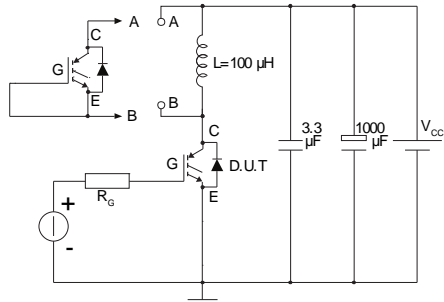


Figure 16: Thermal impedance



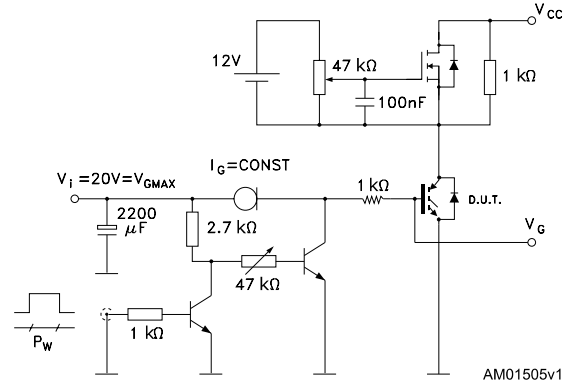
### 3 Test circuits

Figure 17: Test circuit for inductive load switching



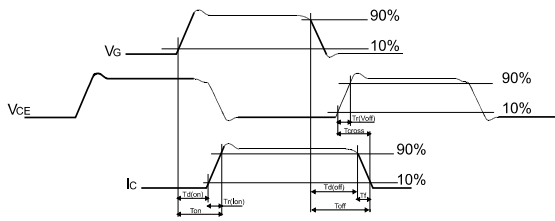
AM01504v1

Figure 18: Gate charge test circuit



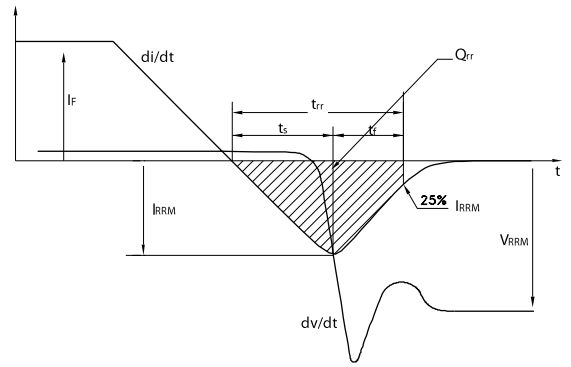
AM01505v1

Figure 19: Switching waveform



AM01506v1

Figure 20: Diode reverse recovery waveform



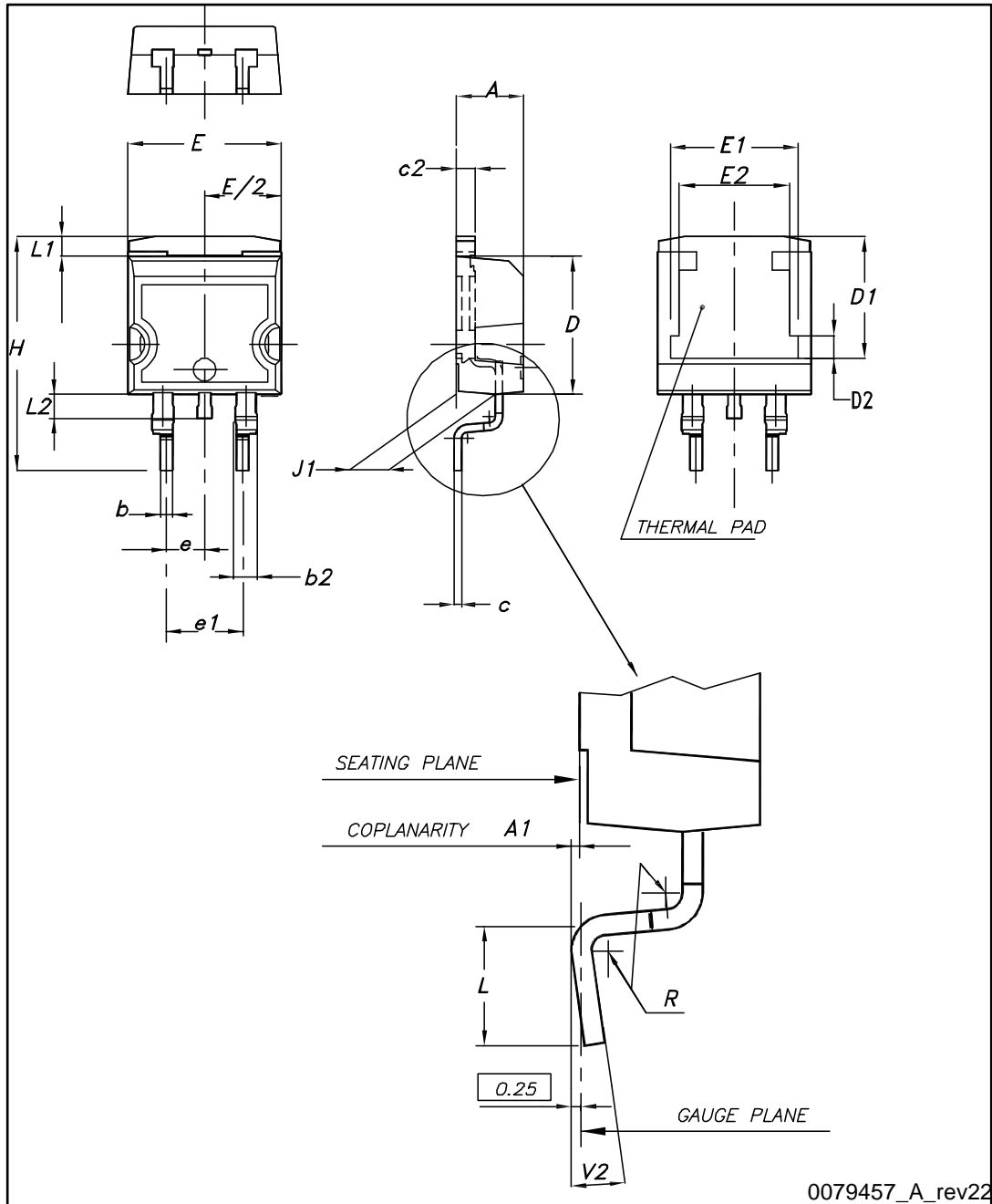
AM01507v1

## 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 21: D<sup>2</sup>PAK (TO-263) type A package outline

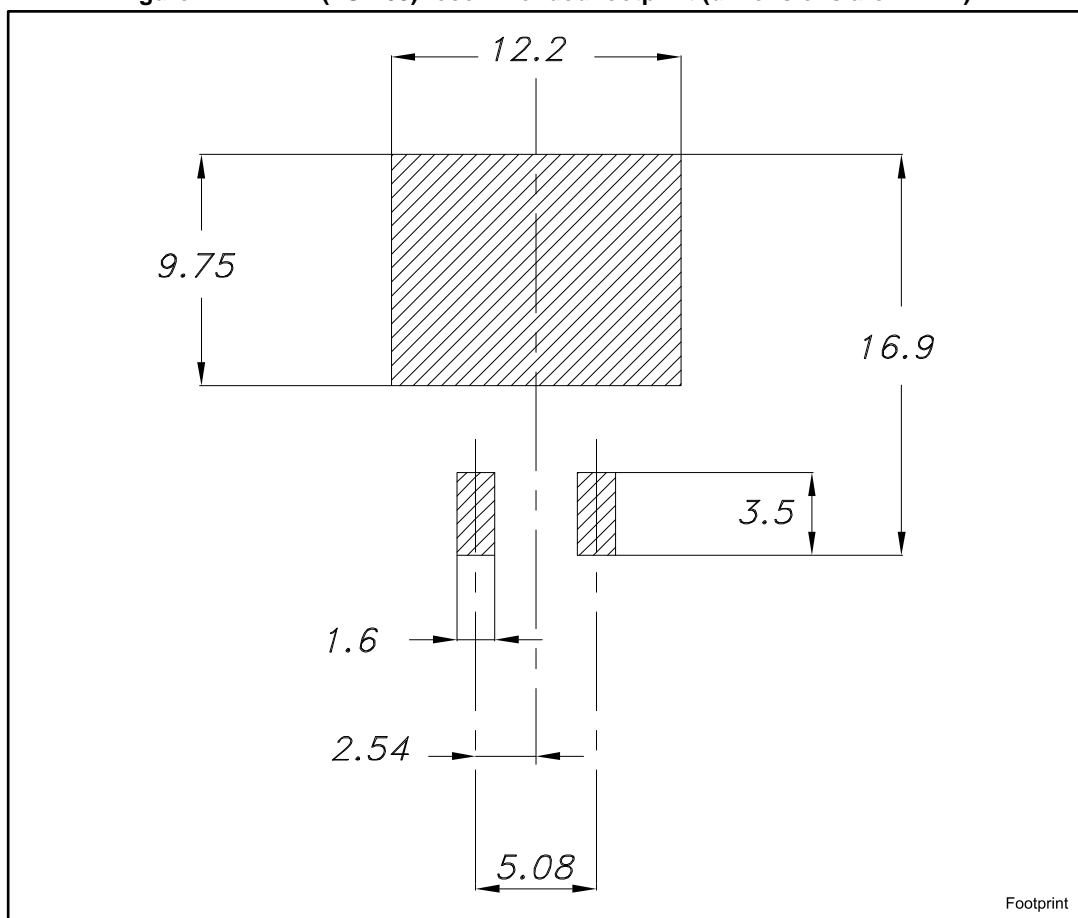


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Table 9: D<sup>2</sup>PAK (TO-263) type A package mechanical data

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		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		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 22: D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



### 4.2 D<sup>2</sup>PAK (TO-263) packing information

Figure 23: Tape outline

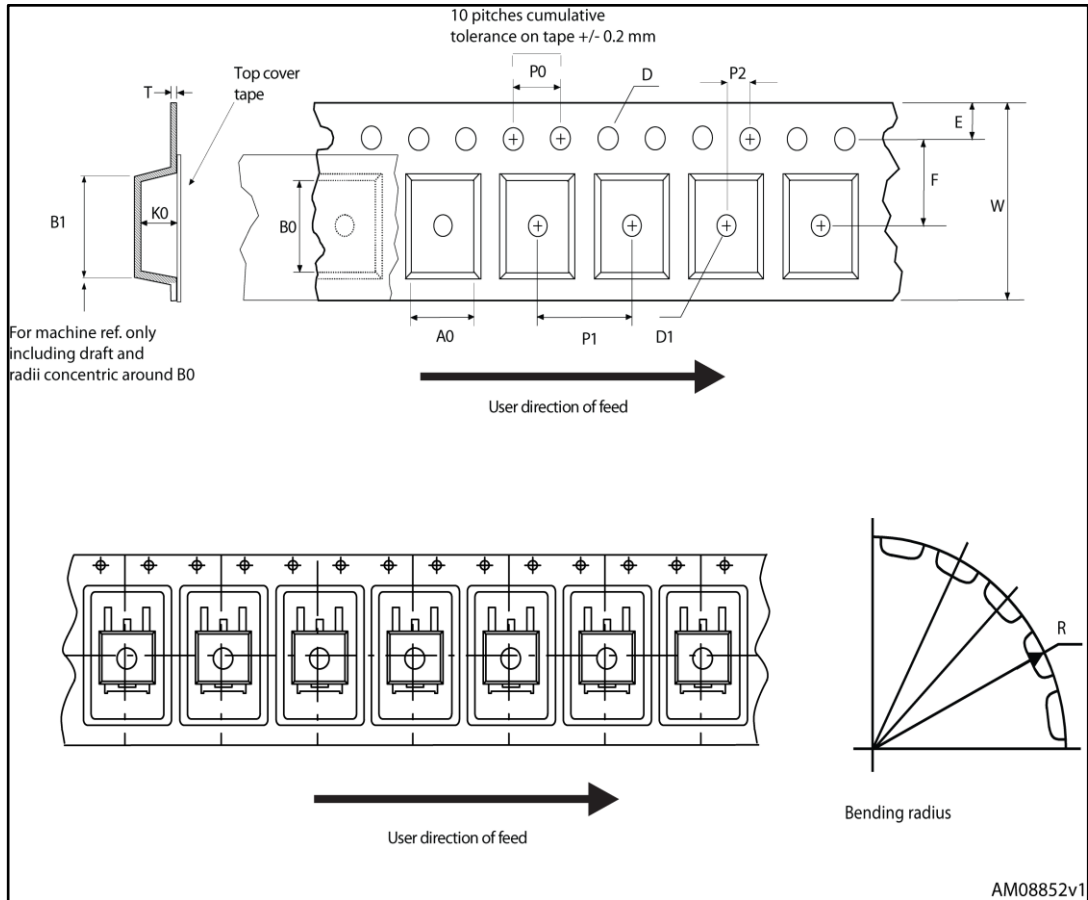


Figure 24: Reel outline

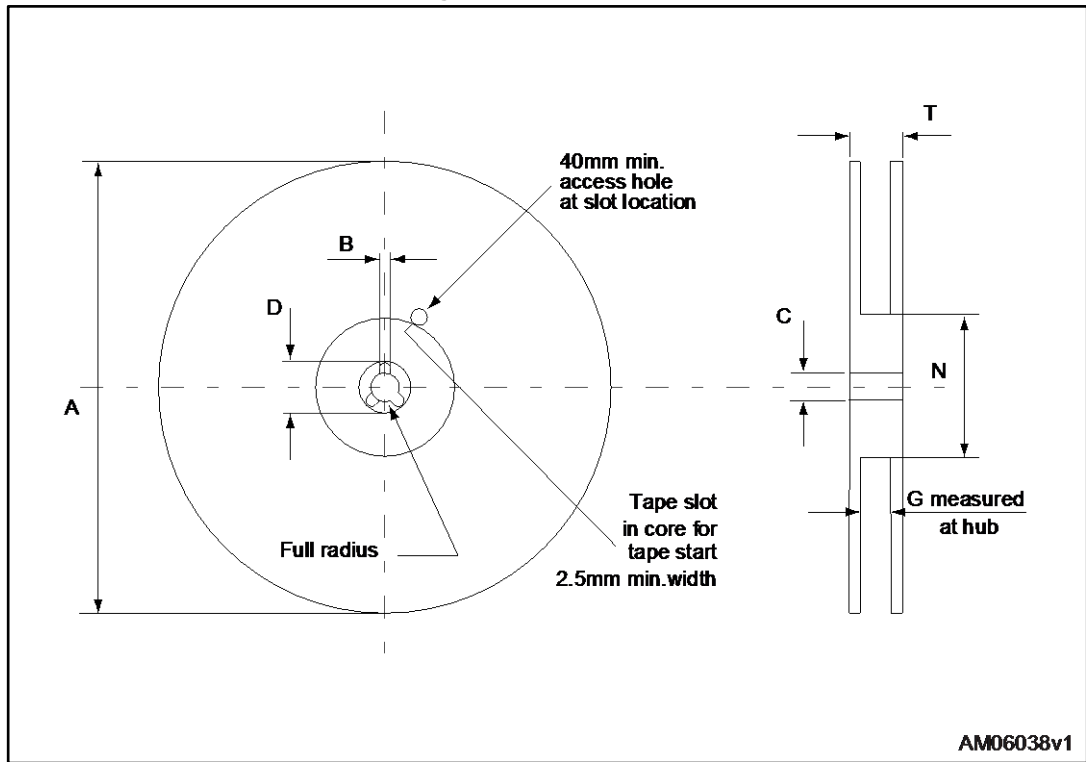


Table 10: D<sup>2</sup>PAK tape and reel mechanical data

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 quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

### 4.3 DPAK (TO-252) type A package information

Figure 25: DPAK (TO-252) type A package outline

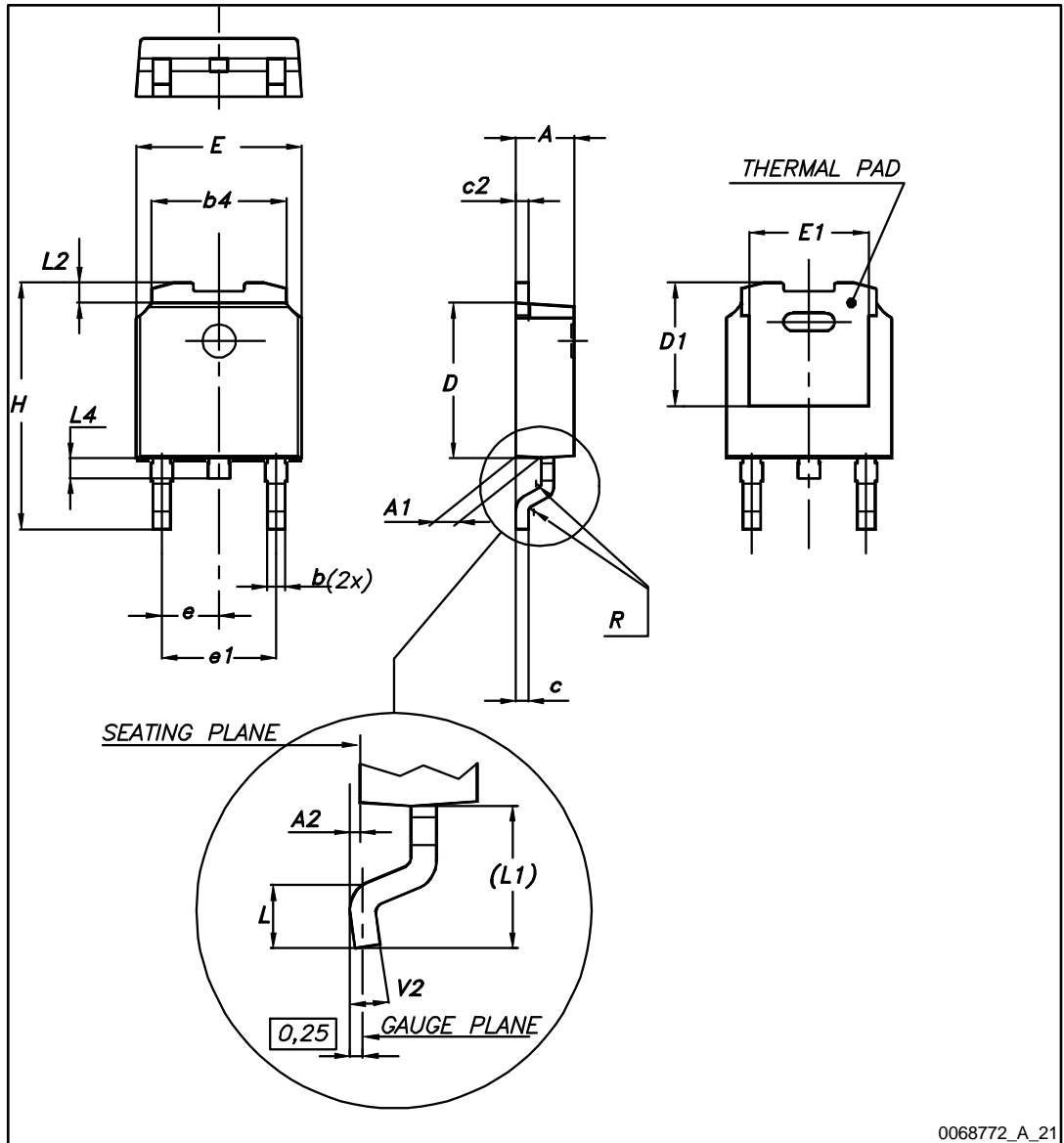
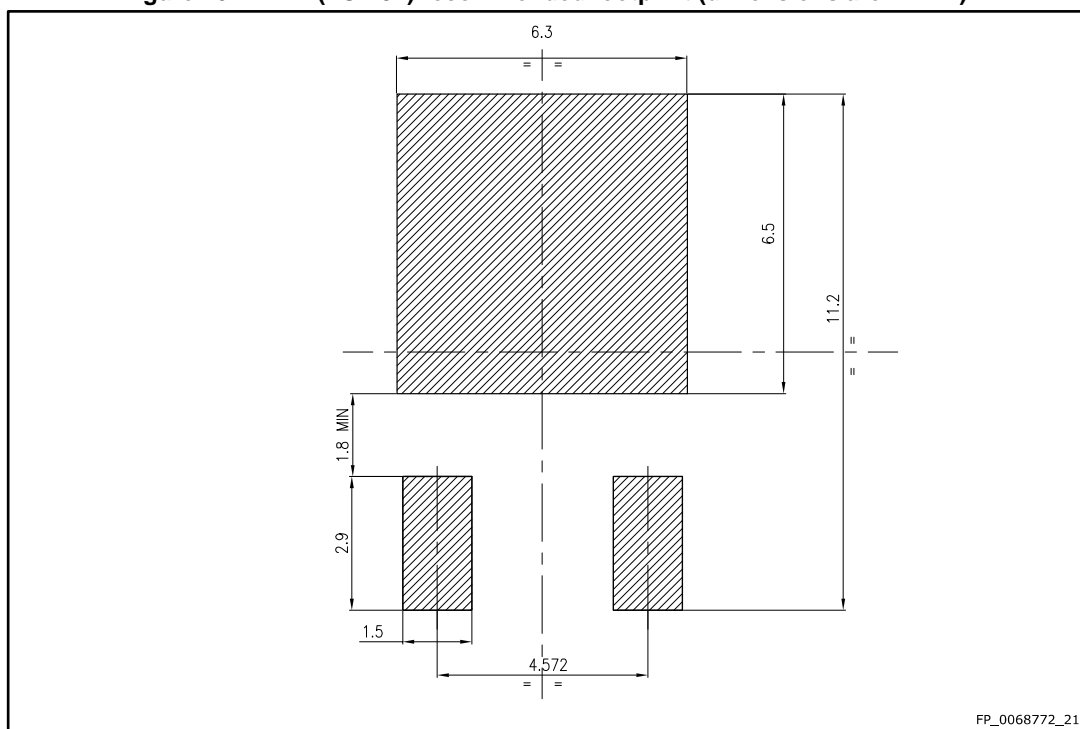




Table 11: DPAK (TO-252) type A mechanical data

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	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
e	2.16	2.28	2.40
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 26: DPAK (TO-252) recommended footprint (dimensions are in mm)



### 4.4 DPAK (TO-252) packing information

Figure 27: DPAK (TO-252) tape outline

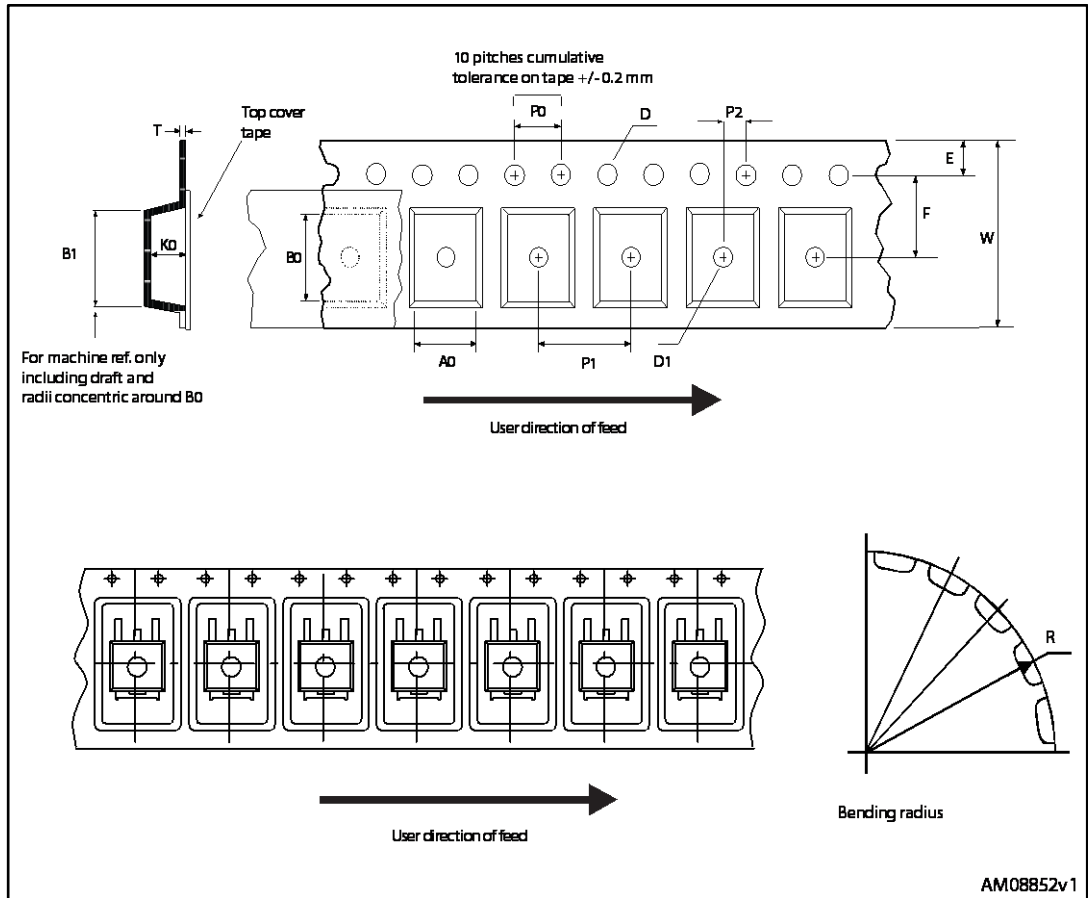


Figure 28: DPAK (TO-252) reel outline

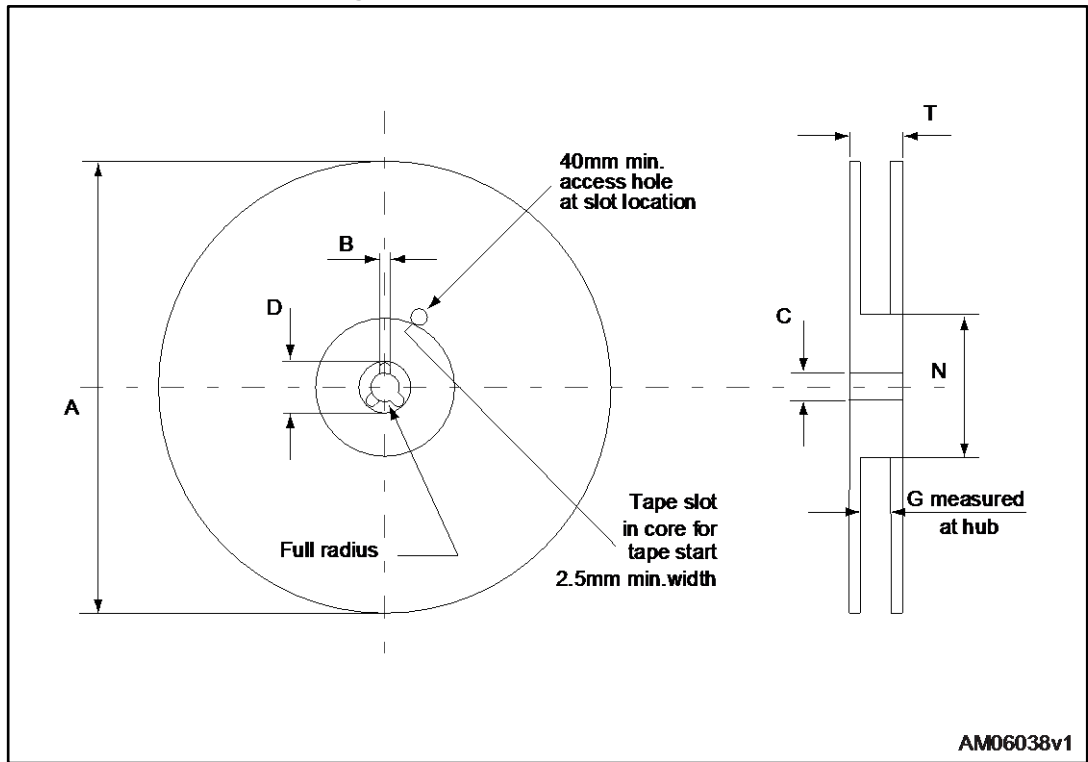
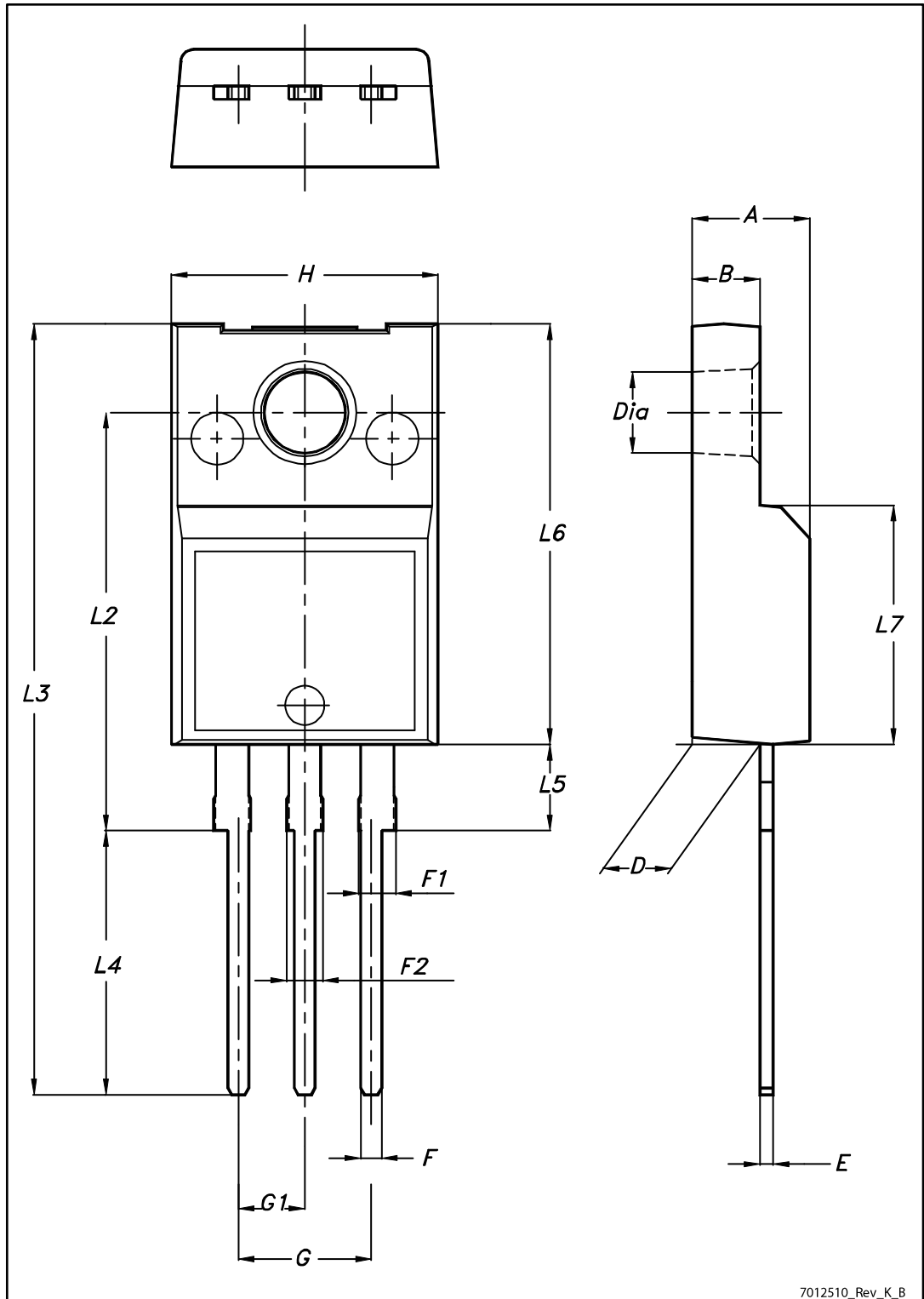


Table 12: DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

### 4.5 TO-220FP package information

Figure 29: TO-220FP package outline



7012510\_Rev\_K\_B

Table 13: 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

### 4.6 TO-220 type A package information

Figure 30: TO-220 type A package outline

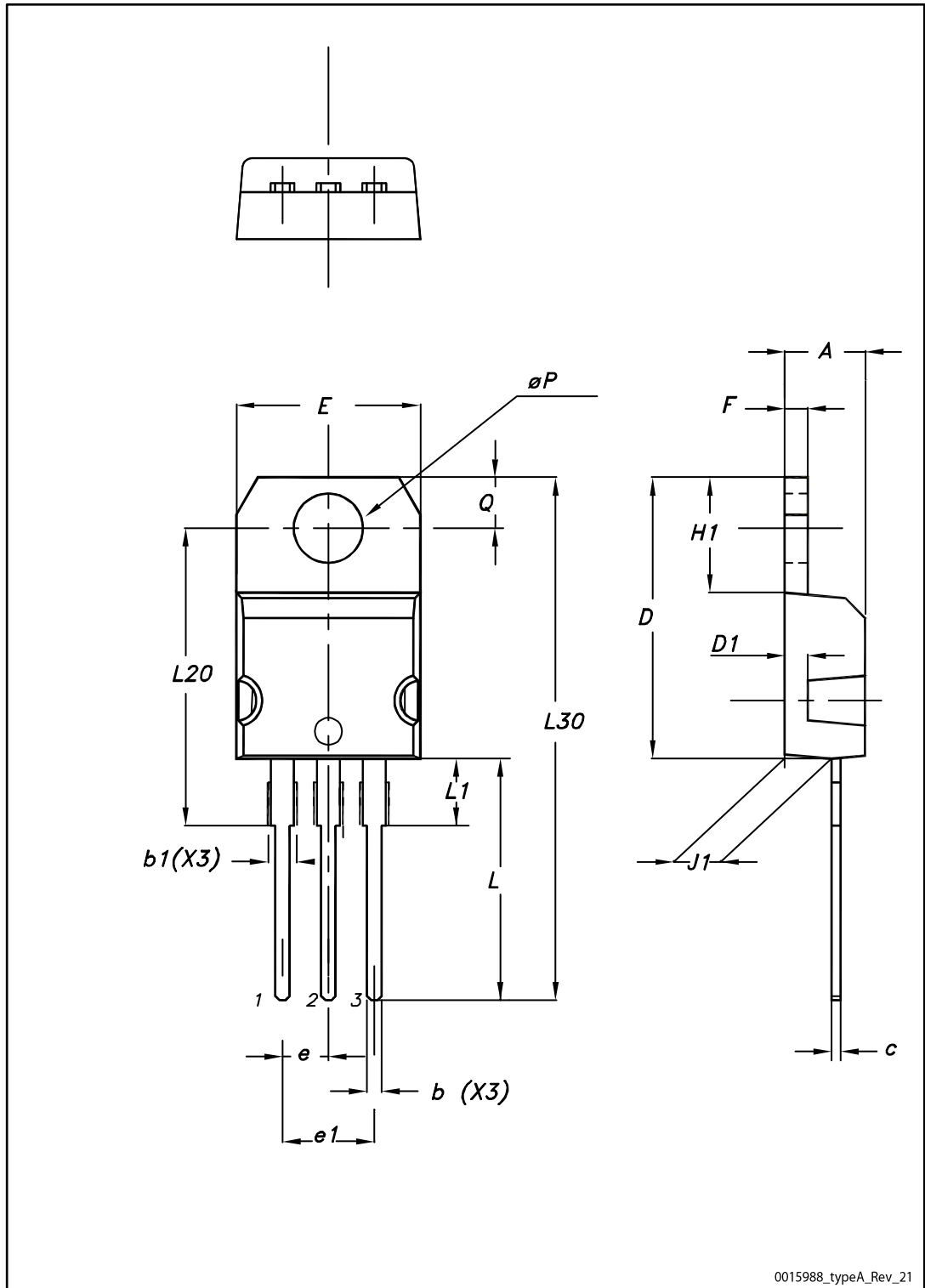


Table 14: TO-220 type A mechanical data

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



## 5 Revision history

Table 15: Document revision history

Date	Revision	Changes
29-Jun-2010	1	First release.
09-Sep-2010	2	Some values changed in <i>Table 2</i> .
22-Dec-2010	3	Document status promoted from preliminary data to datasheet.
24-Sep-2013	4	Added device in TO-220. Updated <i>Table 1: Device summary</i> , <i>Table 3: Thermal data</i> and <i>Section 4: Package mechanical data</i> accordingly.
19-Sep-2016	5	Added the order codes STGB3HF60HD and STGF3HF60HD. Added TO-220FP and D <sup>2</sup> PAK packages. Updated <i>Table 1: "Device summary"</i> , <i>Section 1: "Electrical ratings"</i> , <i>Section 4: "Package information"</i> . Minor text changes.

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