

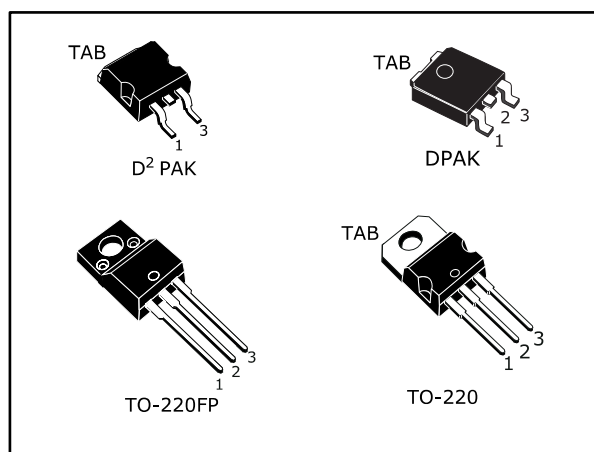


Figure 1: Internal schematic diagram

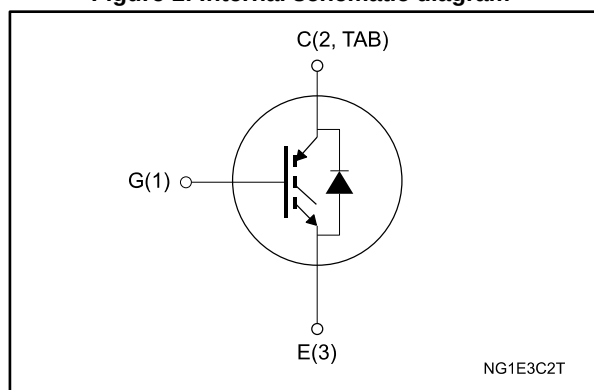


Table 1: Device summary

Order code	Marking	Package	Packing
STGB10NC60KDT4	GB10NC60KD	D²PAK	Tape and reel
STGD10NC60KDT4	GD10NC60KD	DPAK	
STGF10NC60KD	GF10NC60KD	TO-220FP	Tube
STGP10NC60KD	GP10NC60KD	TO-220	

Features

- Lower on voltage drop ($V_{CE(sat)}$)
- Lower C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- Short-circuit withstand time 10 μ s

Applications

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

Description

These devices are very fast IGBTs developed using advanced PowerMESH™ technology. This process guarantees an excellent trade-off between switching performance and low on-state behavior. These devices are well-suited for resonant or soft-switching applications.

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
	2.1 Electrical characteristics (curves)	7
3	Test circuits	10
4	Package information	11
	4.1 D ² PAK (TO-263) type A package information	11
	4.2 D ² PAK (TO-263) type B package information	14
	4.3 DPAK (TO-252) type A package information.....	17
	4.4 TO-220FP package information	20
	4.5 TO-220 type A package information.....	22
	4.6 D ² PAK (TO-263) type A packing information	24
	4.7 D ² PAK (TO-263) type B packing information	26
	4.8 DPAK (TO-252) type A tape packing information.....	27
5	Revision history	29

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value			Unit
		D ² PAK, TO-220	DPAK	TO-220FP	
V _{CES}	Collector-emitter voltage (V _{GE} = 0 V)	600			V
I _C ⁽¹⁾	Continuous collector current at T _C = 25 °C	20		9	A
	Continuous collector current at T _C = 100 °C	10		6	A
I _{CL} ⁽²⁾	Turn-off latching current	30			A
I _{CP} ⁽³⁾	Pulsed collector current	30			A
V _{GE}	Gate-emitter voltage	±20			V
I _F	Diode RMS forward current at T _C =25°C	10			A
I _{FSM}	Surge non repetitive forward current t _p = 10 ms sinusoidal	20			A
P _{TOT}	Total dissipation at T _C = 25 °C	65	62	25	W
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C)	2500			V
t _{scw}	Short-circuit withstand time V _{CE} = 0.5 V _{CES} , T _J = 125 °C, R _G = 10 Ω, V _{GE} = 12 V	10			µs
T _{stg}	Storage temperature range	- 55 to 150			°C
T _J	Operating junction temperature range				

Notes:

(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}, V_{GE} = 15 V, R_G = 10 Ω, T_J = 150 °C.

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

Table 3: Thermal data

Symbol	Parameter	Value			Unit
		TO-220, D ² PAK	DPAK	TO-220FP	
R _{thj-case}	Thermal resistance junction-case IGBT	1.9	2	5	°C/W
R _{thj-case}	Thermal resistance junction-case diode	4	4.5	7	
R _{thj-amb}	Thermal resistance junction-ambient	62.5	100	62.5	

2 Electrical characteristics

$T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Table 4: Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$I_C = 1\text{ mA}$, $V_{GE} = 0\text{ V}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 5\text{ A}$		2.2	2.5	V
		$V_{GE} = 15\text{ V}$, $I_C = 5\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$		1.8		
$V_{GE(th)}$	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	$V_{CE} = 600\text{ V}$, $V_{GE} = 0\text{ V}$			150	μA
		$V_{CE} = 600\text{ V}$, $V_{GE} = 0\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾			1	mA
I_{GES}	Gate-emitter leakage current	$V_{GE} = \pm 20\text{ V}$			± 100	nA
g_{fs} ⁽²⁾	Forward transconductance	$V_{CE} = 15\text{ V}$, $I_C = 5\text{ A}$		15		S

Notes:

⁽¹⁾Defined by design, not subject to production test.

⁽²⁾Pulse test: pulse duration < 300 μs , duty cycle < 2 %.

Table 5: Dynamic characteristics

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

Table 6: Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 18: "Test circuit for inductive load switching" and Figure 20: "Switching waveform")	-	17	-	ns
t_r	Current rise time		-	6	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	655	-	A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125^\circ\text{C}$ (see Figure 18: "Test circuit for inductive load switching" and Figure 20: "Switching waveform")	-	16.5	-	ns
t_r	Current rise time		-	6.5	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	575	-	A/ μ s
$t_{r(voff)}$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 18: "Test circuit for inductive load switching" and Figure 20: "Switching waveform")	-	33	-	ns
$t_{d(off)}$	Turn-off delay time		-	72	-	ns
t_f	Current fall time		-	82	-	ns
$t_{r(voff)}$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125^\circ\text{C}$ (see Figure 18: "Test circuit for inductive load switching" and Figure 20: "Switching waveform")	-	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 energy	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 18: "Test circuit for inductive load switching")	-	55	-	μ J
$E_{off(2)}$	Turn-off switching energy		-	85	-	μ J
E_{ts}	Total switching energy		-	140	-	μ J
$E_{on(1)}$	Turn-on switching energy	$V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125^\circ\text{C}$ (see Figure 18: "Test circuit for inductive load switching")	-	87	-	μ J
$E_{off(2)}$	Turn-off switching energy		-	162	-	μ J
E_{ts}	Total switching energy		-	249	-	μ J

Notes:

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

Table 8: Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	$I_F=5\text{ A}$	-	2	-	V
		$I_F=5\text{ A}$, $T_J=125\text{ °C}$	-	1.6	-	V
t_{rr}	Reverse recovery time	$I_F=5\text{ A}$, $V_R=40\text{ V}$, $di/dt=100\text{ A}/\mu\text{s}$ (see Figure 21: "Diode reverse recovery waveform")	-	22	-	ns
Q_{rr}	Reverse recovery charge		-	14	-	nC
I_{rrm}	Reverse recovery current		-	1.3	-	A
t_{rr}	Reverse recovery time	$I_F=5\text{ A}$, $V_R=40\text{ V}$, $T_J=125\text{ °C}$, $di/dt=100\text{ A}/\mu\text{s}$ (see Figure 21: "Diode reverse recovery waveform")	-	35	-	ns
Q_{rr}	Reverse recovery charge		-	40	-	nC
I_{rrm}	Reverse recovery current		-	2.2	-	A

2.1 Electrical characteristics (curves)

Figure 2: Output characteristics

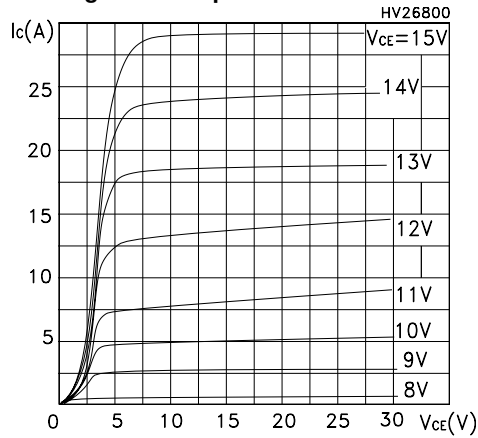


Figure 3: Transfer characteristics

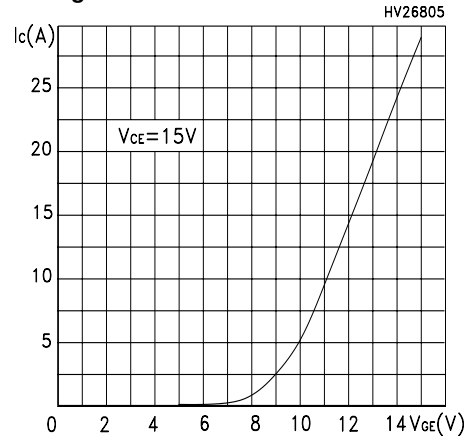


Figure 4: Transconductance

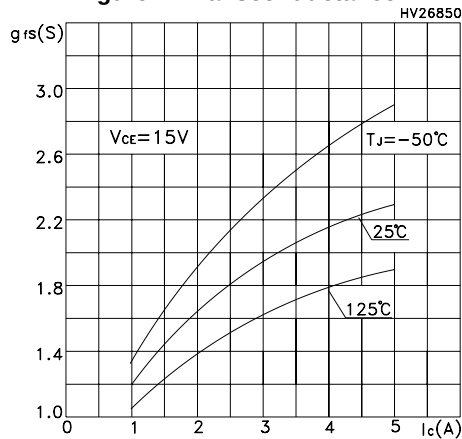


Figure 5: Collector-emitter on voltage vs temperature

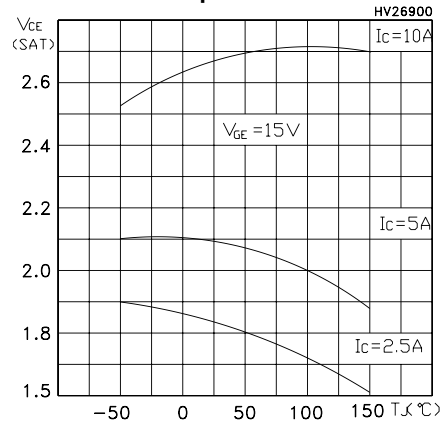


Figure 6: Collector-emitter on voltage vs temperature

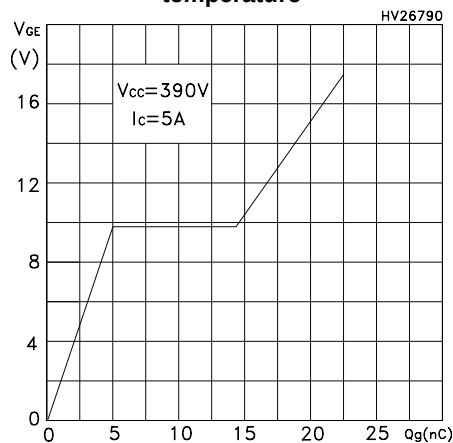


Figure 7: Capacitance variations

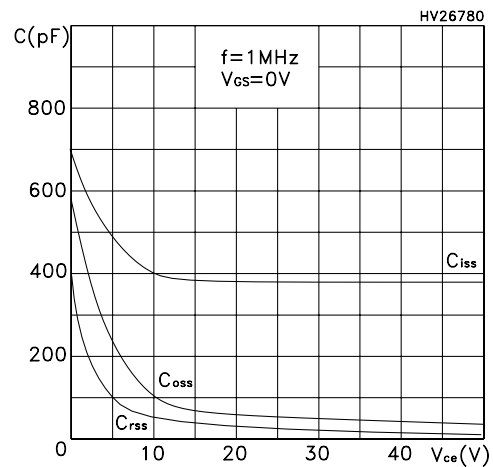


Figure 8: Normalized gate threshold voltage vs temperature

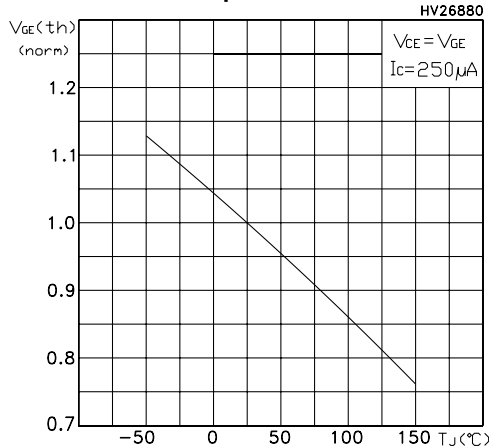


Figure 9: Collector-emitter on voltage vs collector current

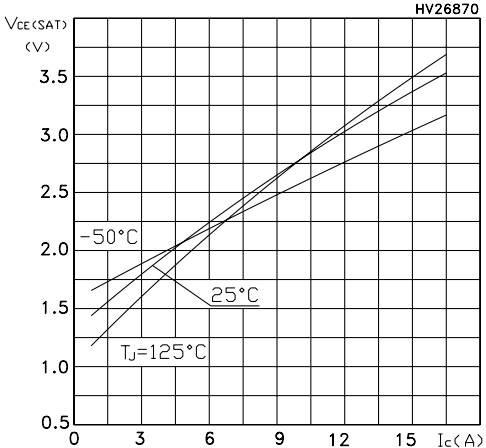


Figure 10: Normalized breakdown voltage vs temperature

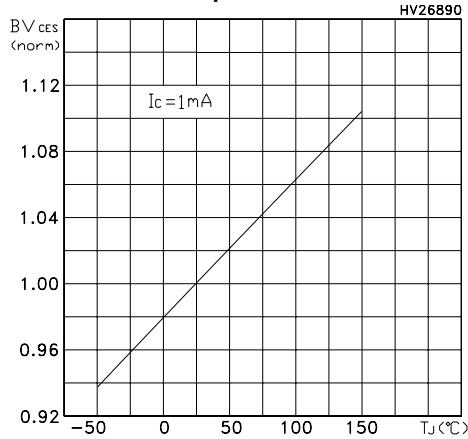


Figure 11: Switching energy vs temperature

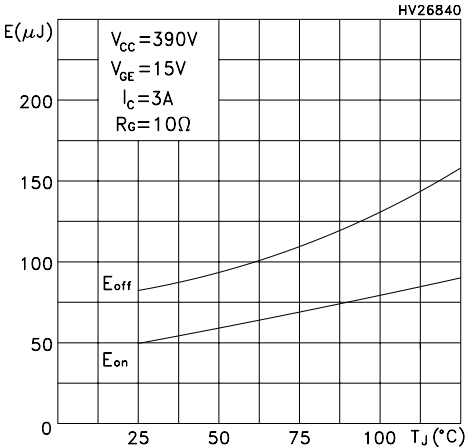


Figure 12: Switching energy vs gate resistance

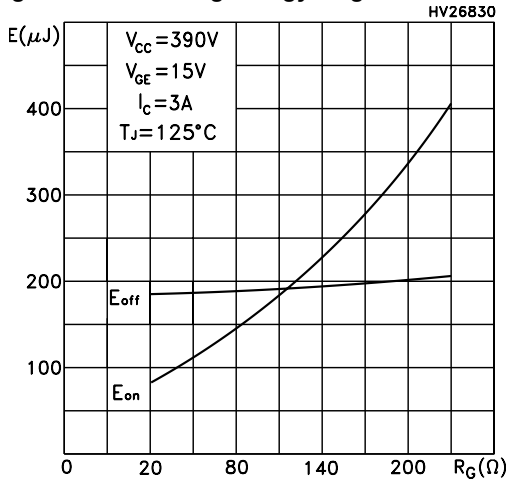


Figure 13: Switching energy vs collector current

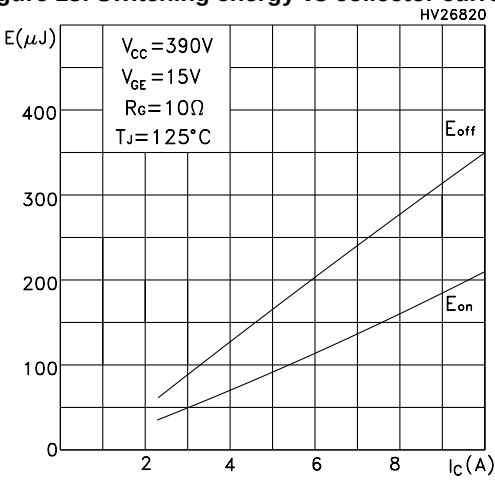


Figure 14: Thermal impedance for D²PAK, DPAK and TO-220

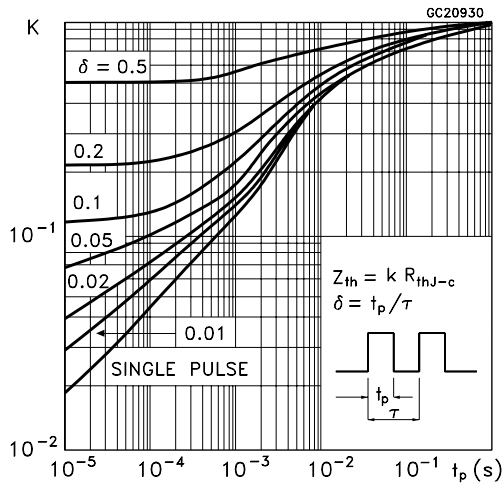


Figure 15: Turn-off SOA

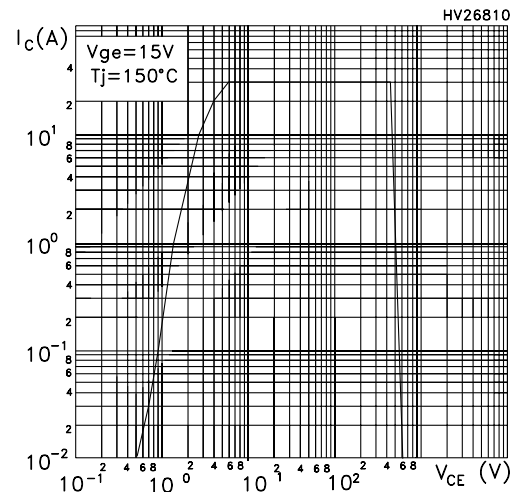


Figure 16: Emitter-collector diode characteristics

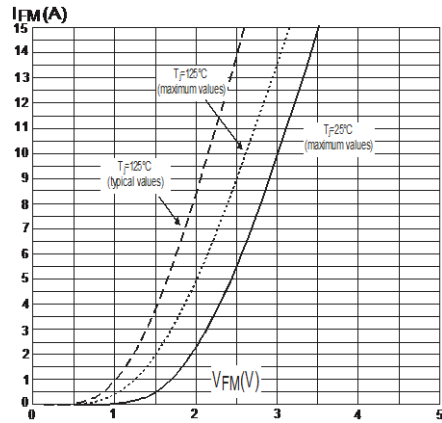
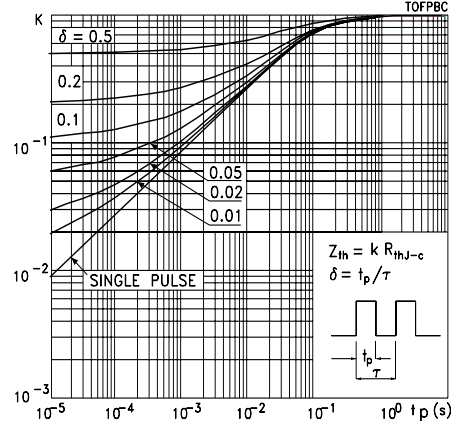
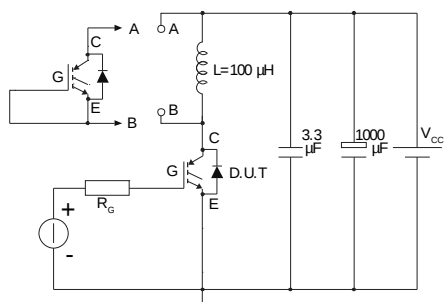


Figure 17: Thermal impedance for TO-220FP



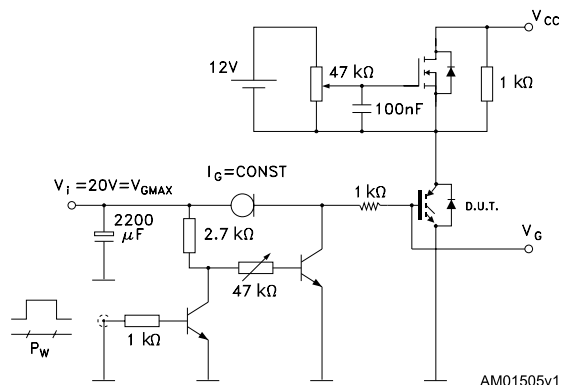
3 Test circuits

Figure 18: Test circuit for inductive load switching



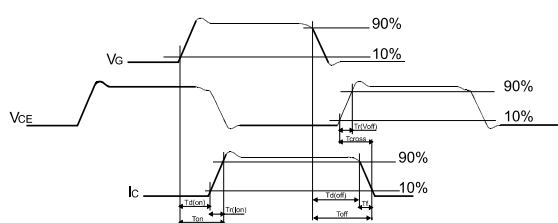
AM01504v1

Figure 19: Gate charge test circuit



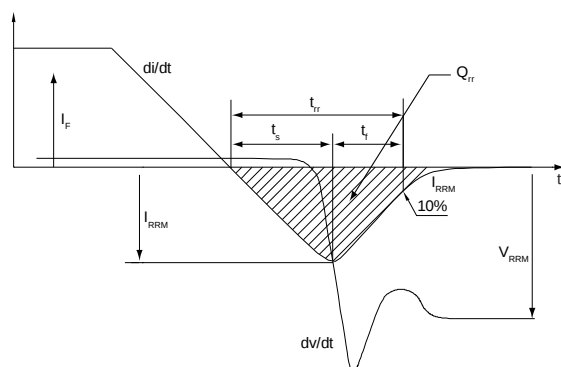
AM01505v1

Figure 20: Switching waveform



AM01506v1

Figure 21: 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. ECOPACK® is an ST trademark.

4.1 D²PAK (TO-263) type A package information

Figure 22: D²PAK (TO-263) type A package outline

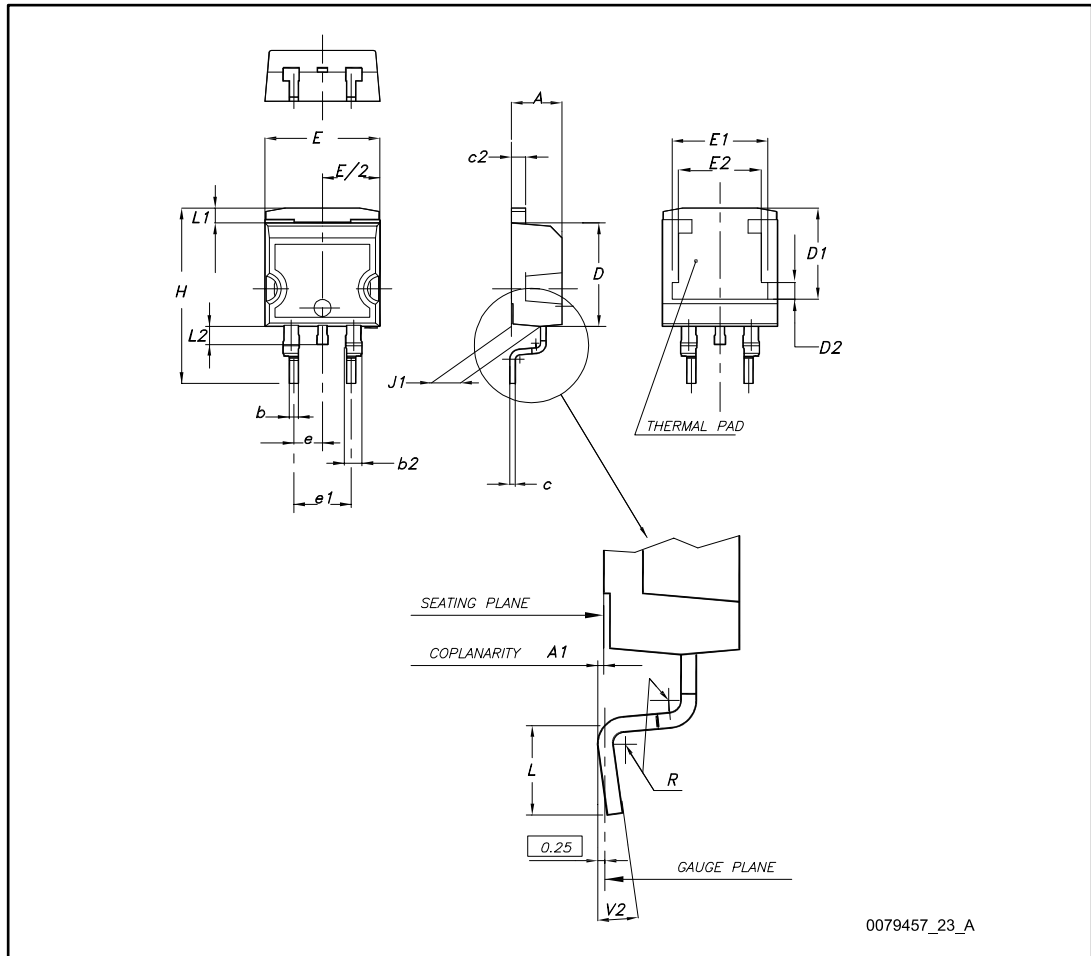
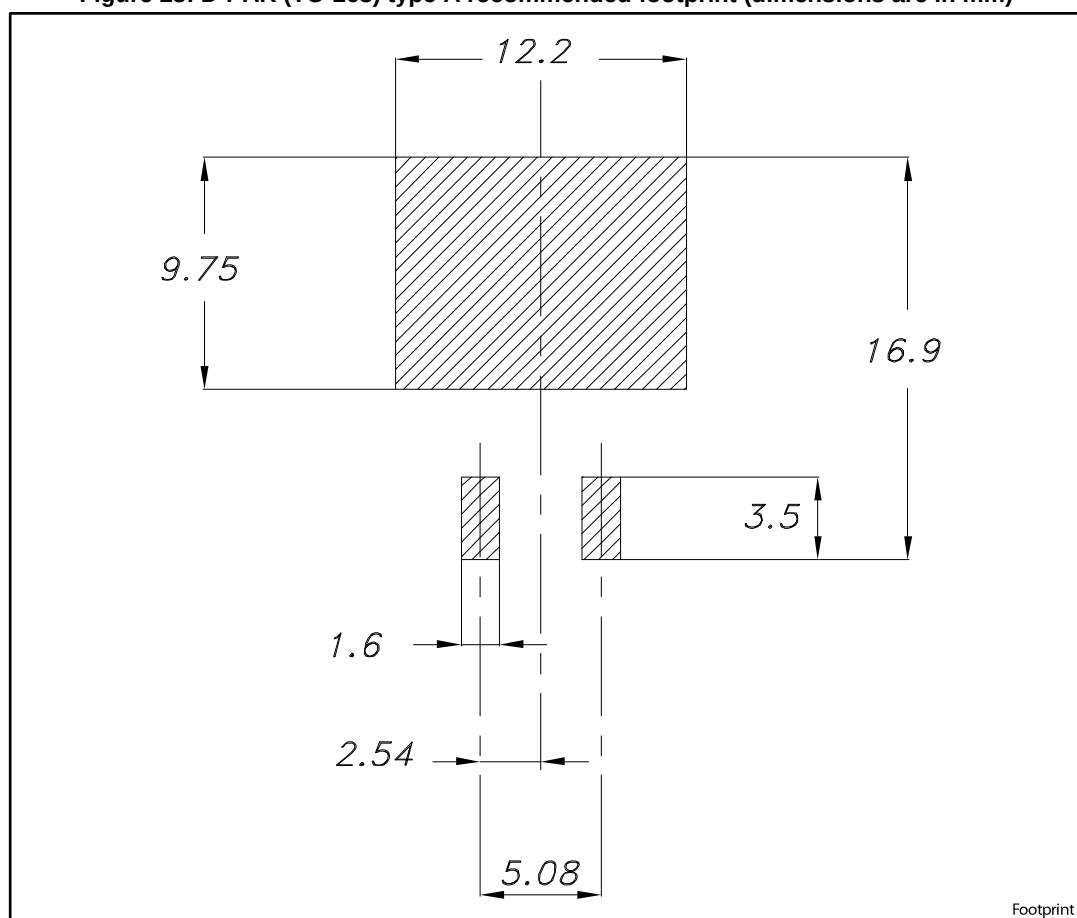


Table 9: D²PAK (TO-263) type A package mechanical data

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	10.00		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		0.40	
V2	0°		8°

Figure 23: D²PAK (TO-263) type A recommended footprint (dimensions are in mm)



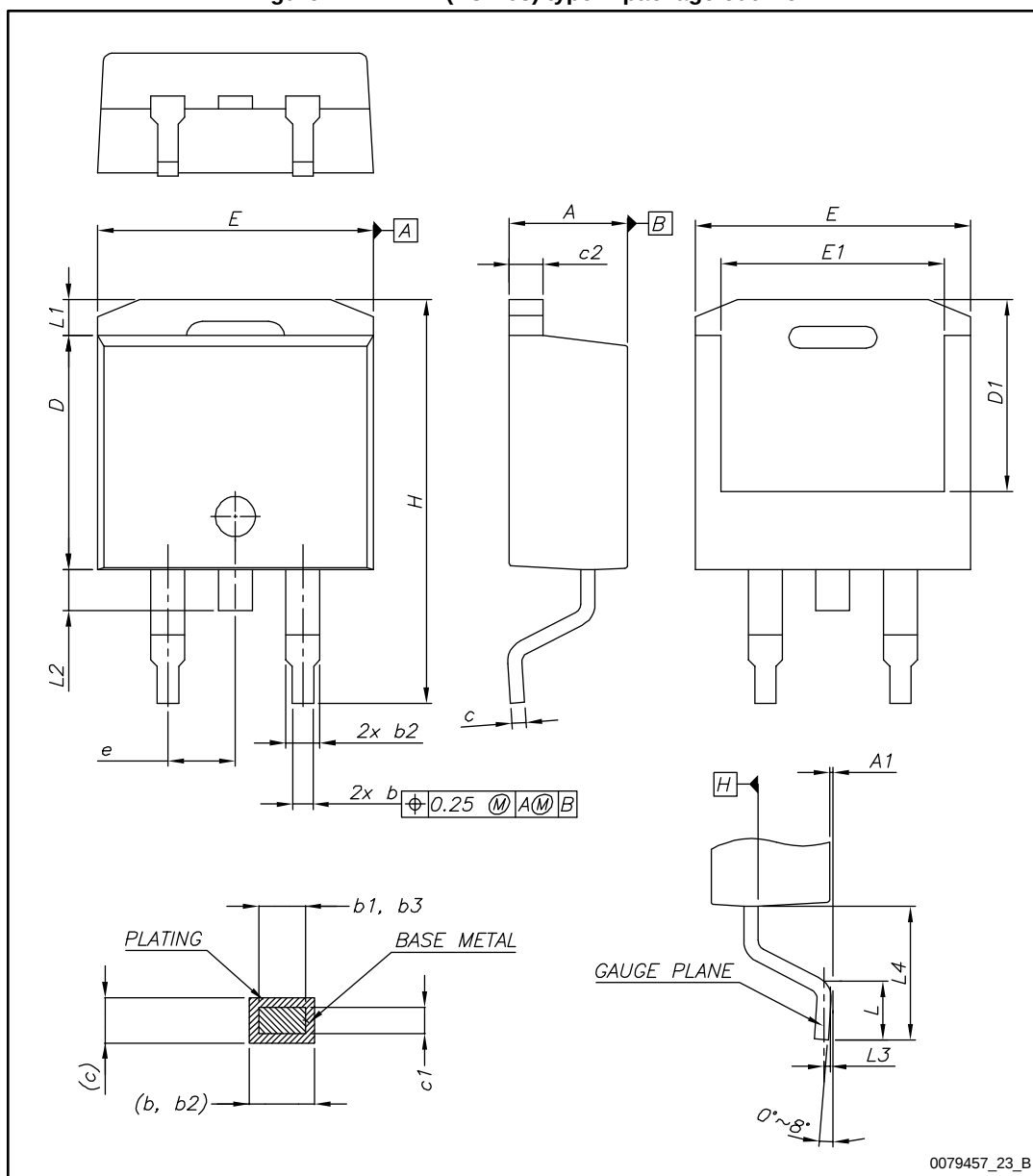
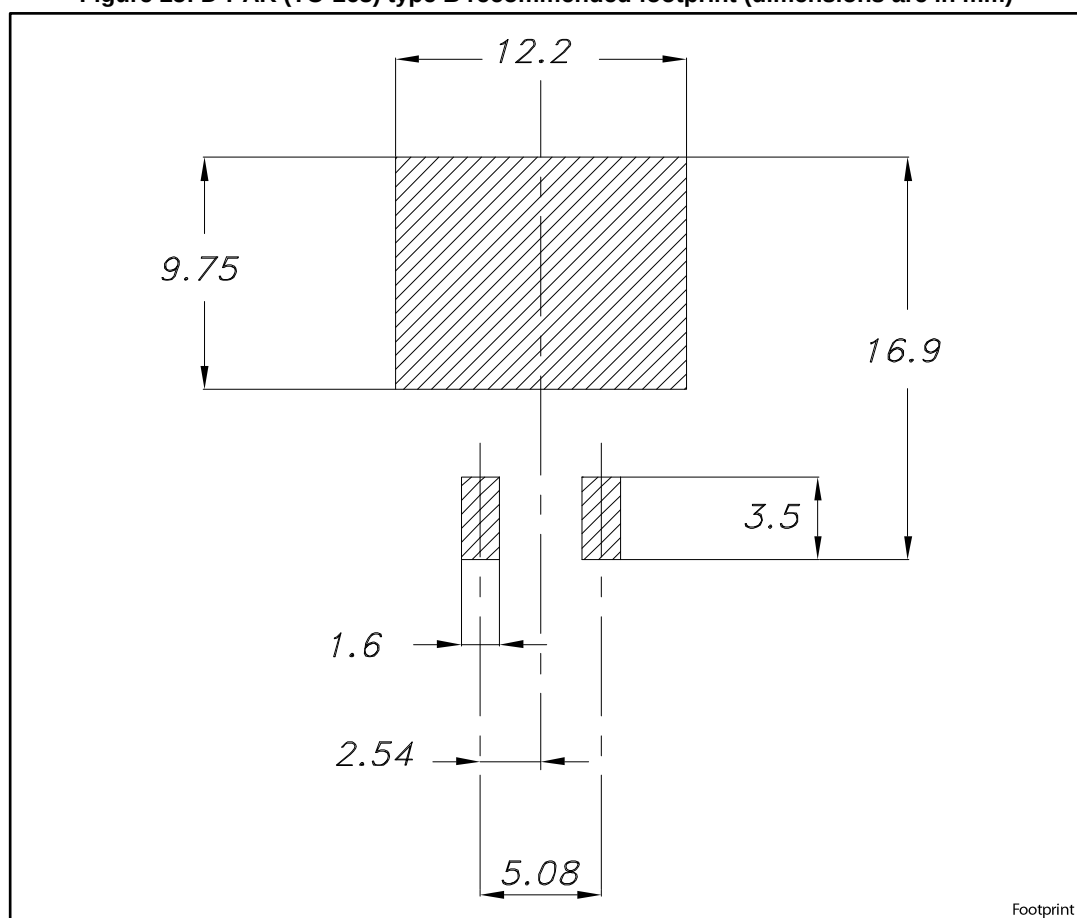
4.2 D²PAK (TO-263) type B package informationFigure 24: D²PAK (TO-263) type B package outline

Table 10: D²PAK (TO-263) type B mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
b3	1.36		1.46
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e	2.54 BSC		
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 25: D²PAK (TO-263) type B recommended footprint (dimensions are in mm)

4.3 DPAK (TO-252) type A package information

Figure 26: DPAK (TO-252) type A package outline

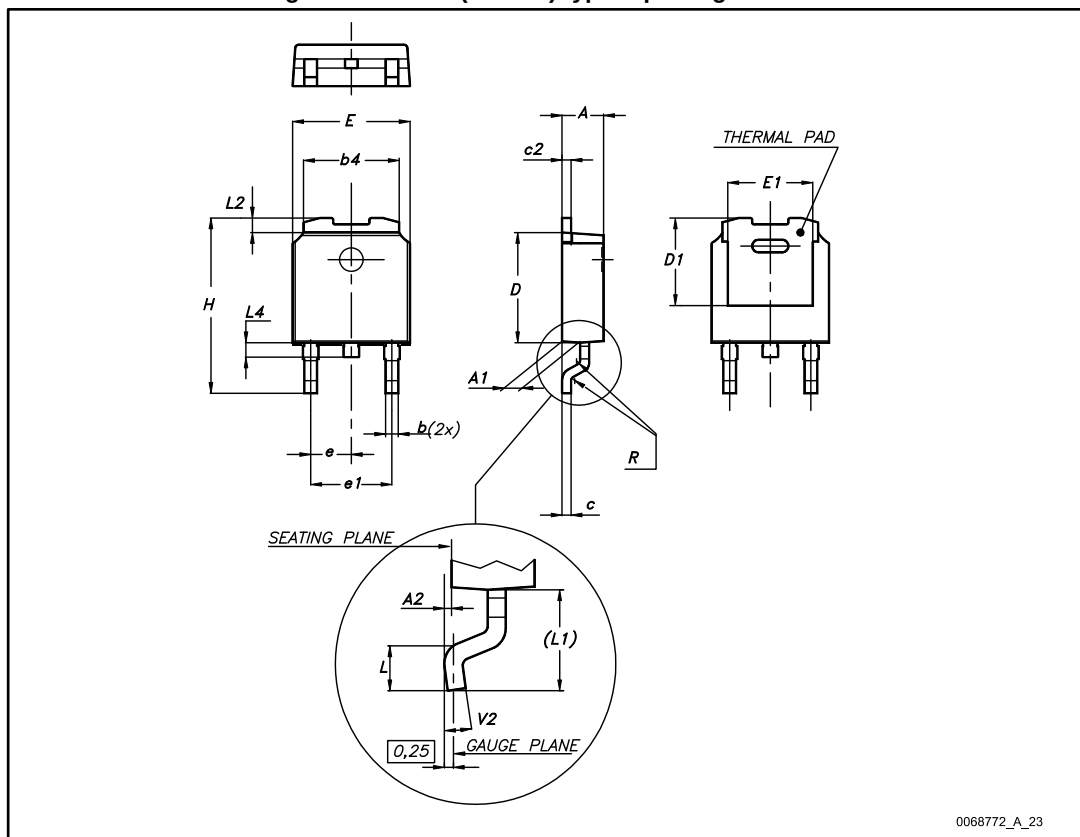
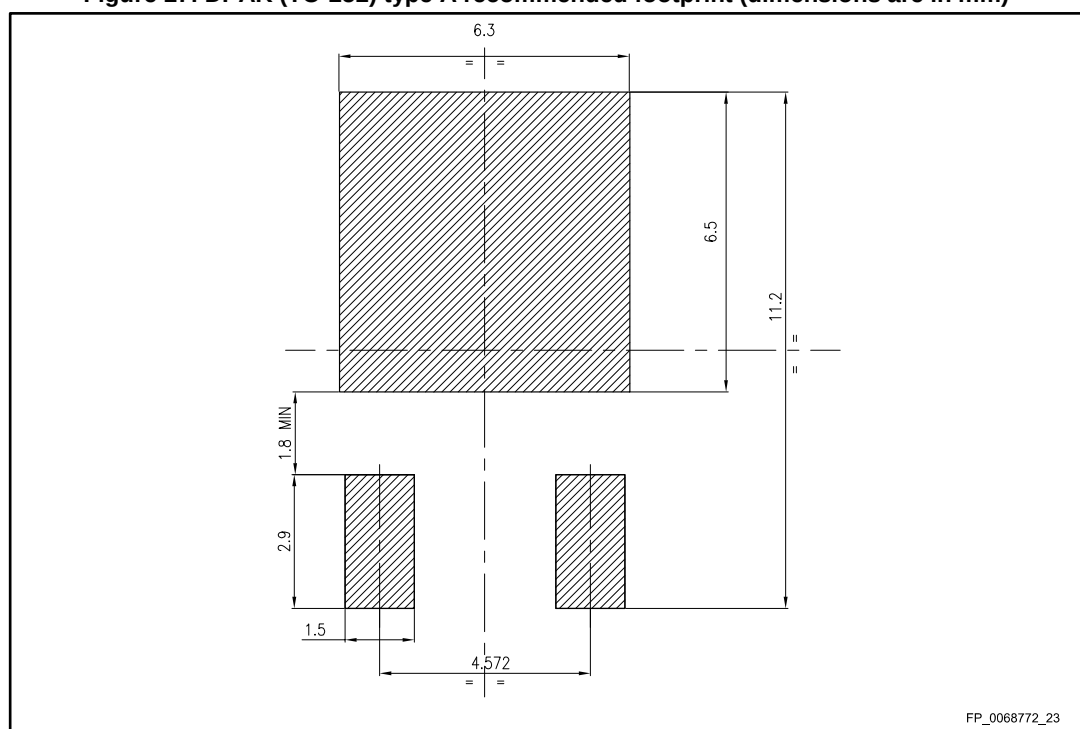


Table 11: DPAK (TO-252) type A mechanical data

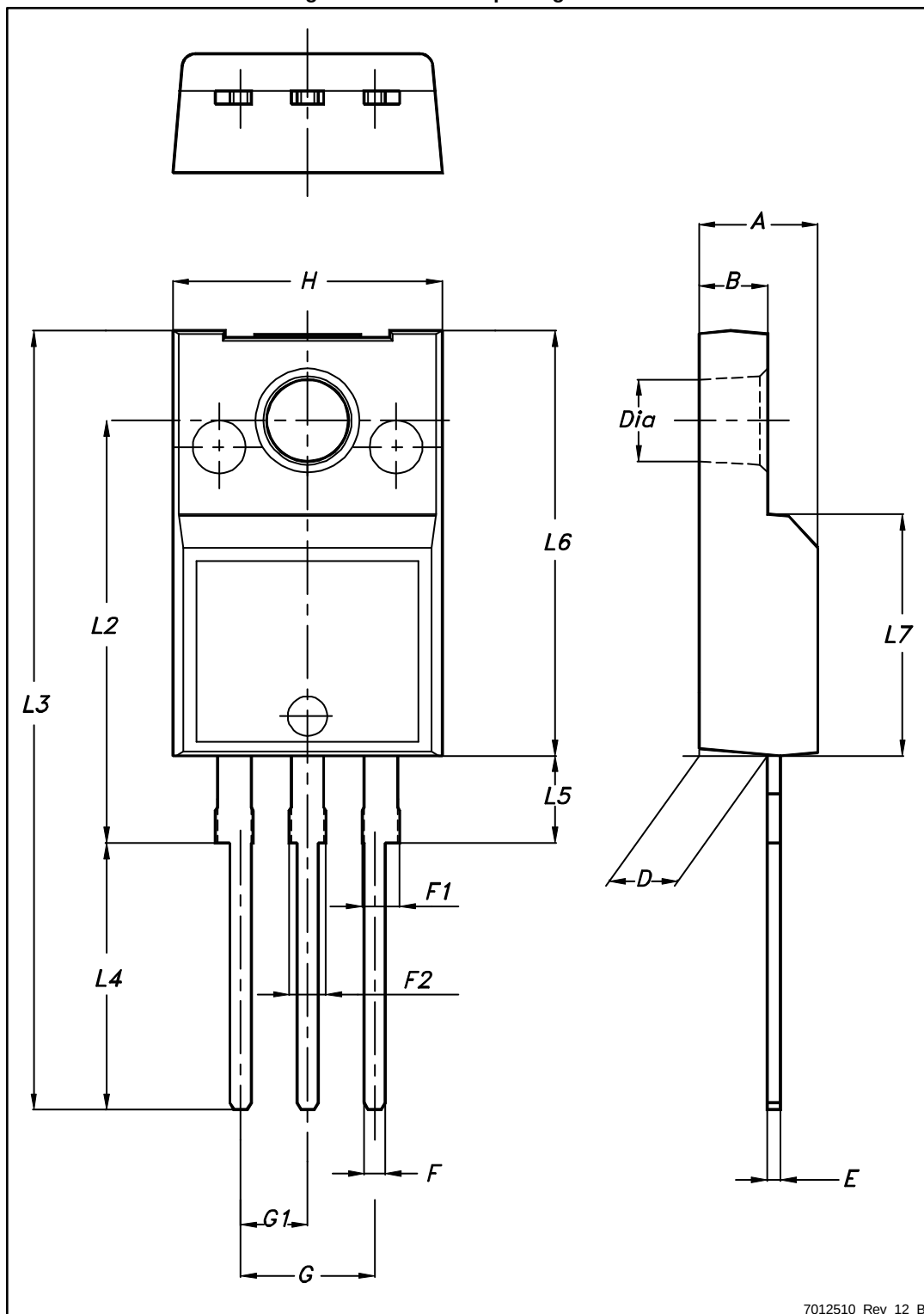
Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
e	2.16	2.28	2.40
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 27: DPAK (TO-252) type A recommended footprint (dimensions are in mm)



4.4 TO-220FP package information

Figure 28: TO-220FP package outline



7012510_Rev_12_B

Table 12: 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

4.5 TO-220 type A package information

Figure 29: TO-220 type A package outline

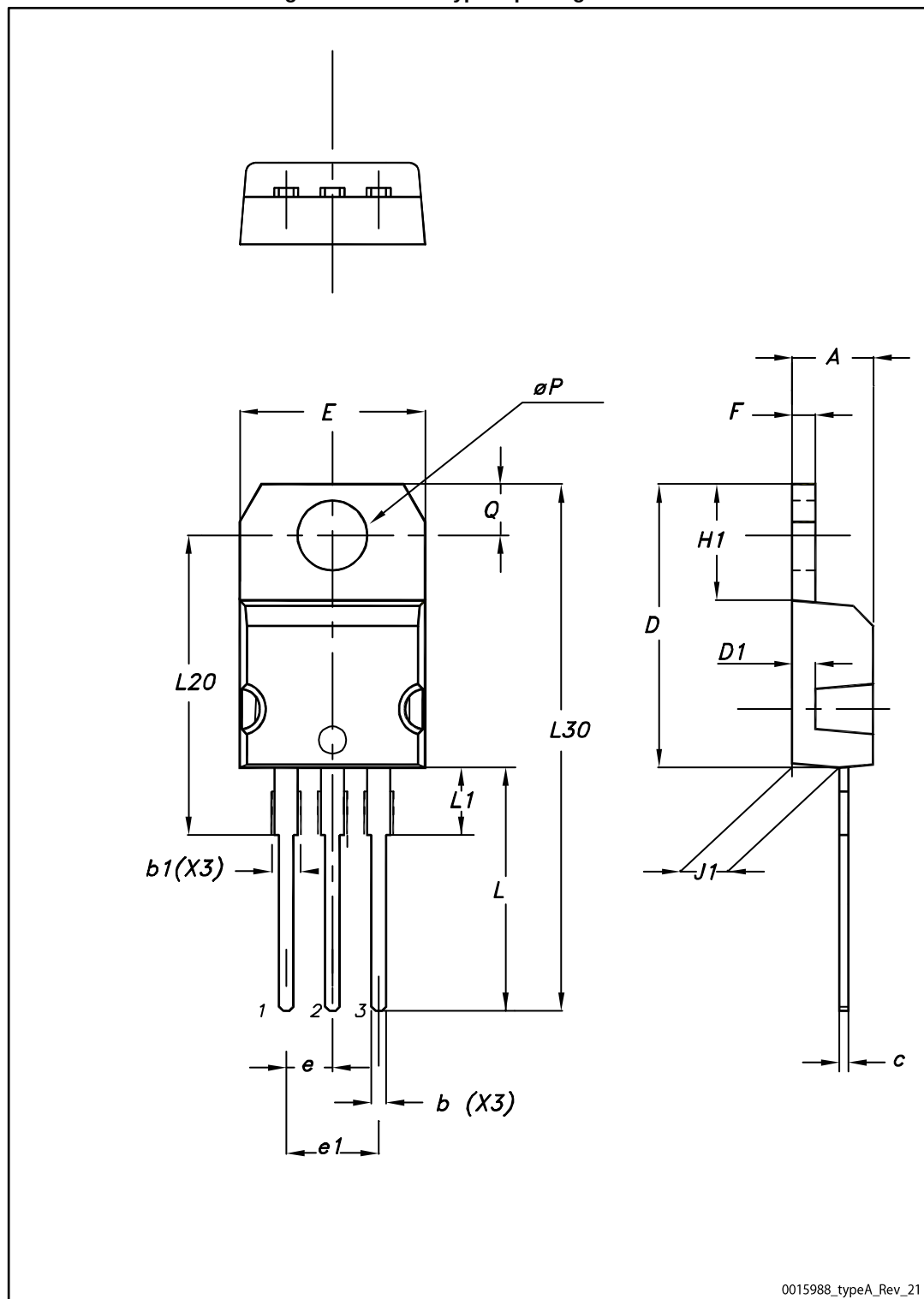


Table 13: TO-220 type A package mechanical data

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

4.6 D²PAK (TO-263) type A packing information

Figure 30: D2PAK type A tape outline

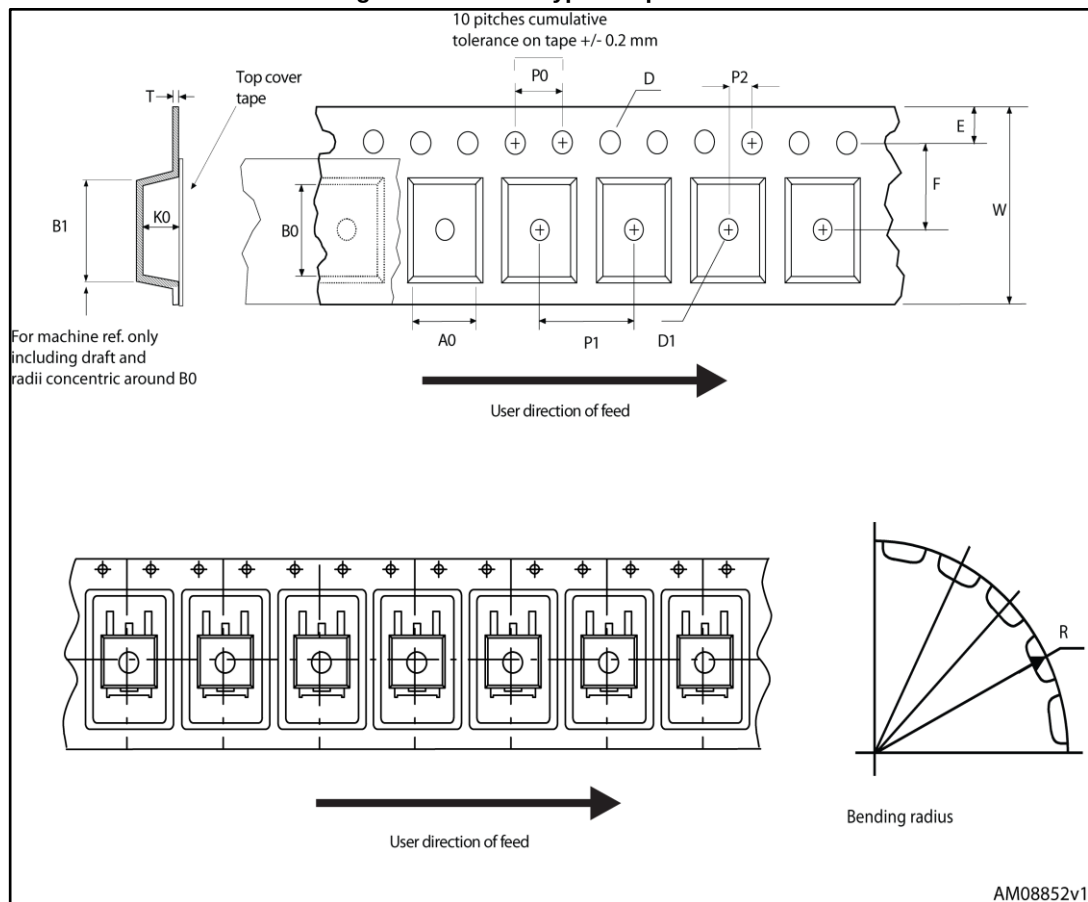


Figure 31: D2PAK type A reel outline

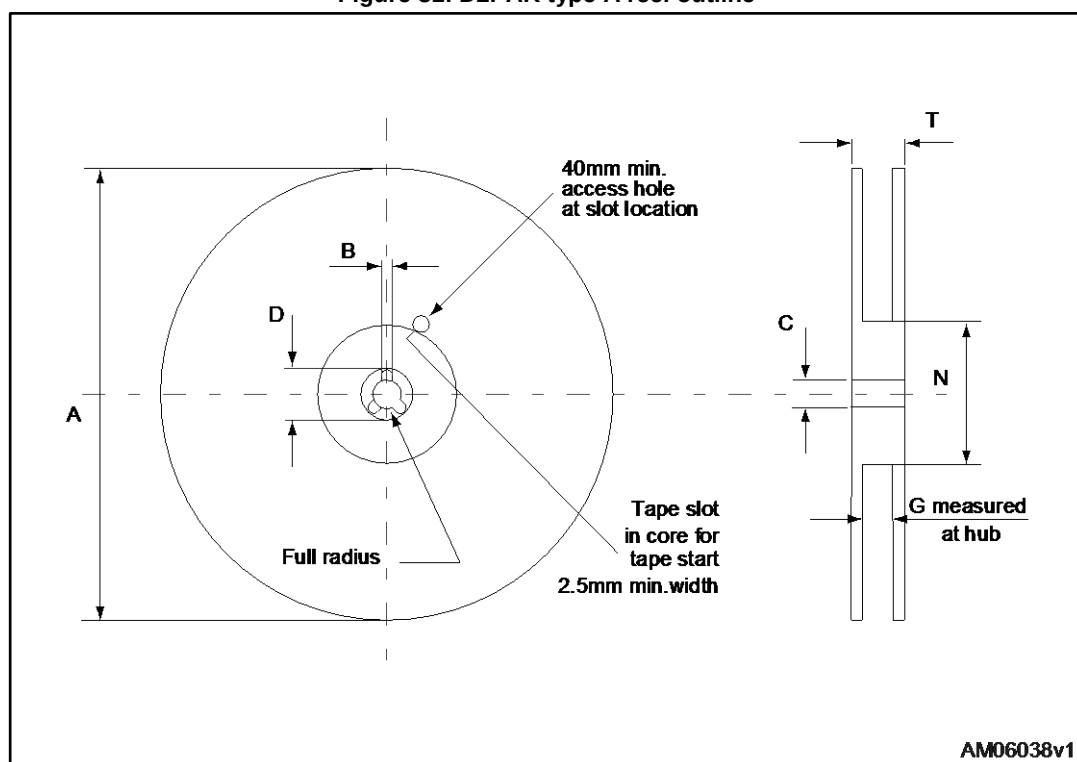


Table 14: D²PAK type A tape and reel mechanical data

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			

4.7 D²PAK (TO-263) type B packing information

Figure 32: D2PAK type B tape outline

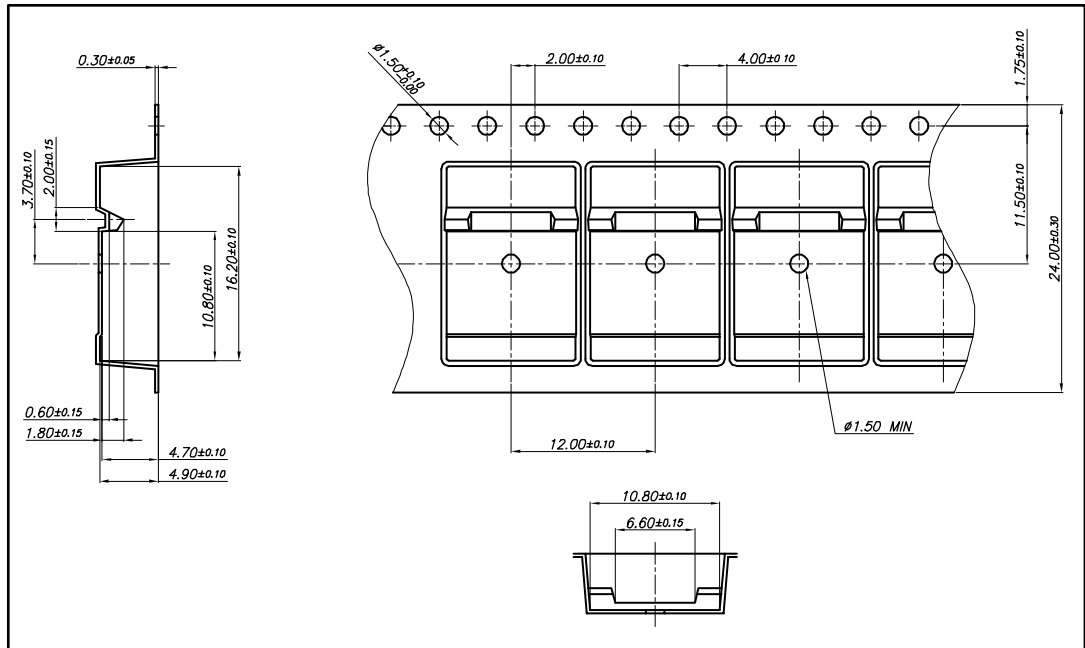


Figure 33: D2PAK type B reel outline

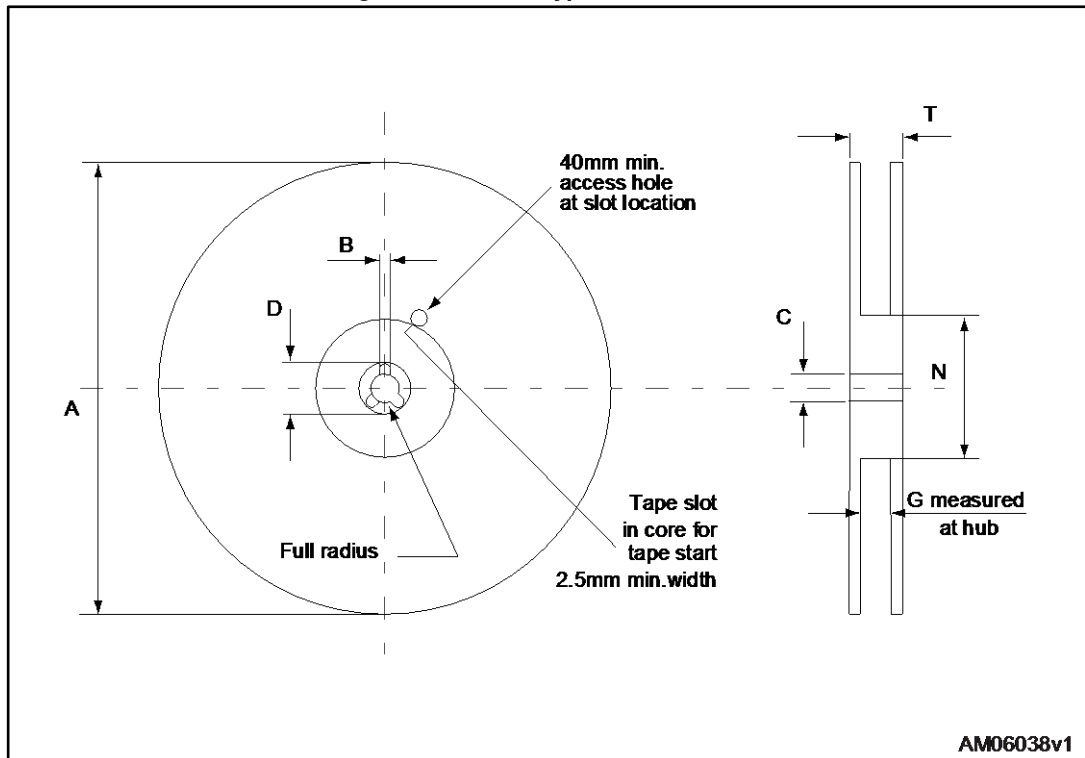


Table 15: D²PAK type B reel mechanical data

Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

4.8 DPAK (TO-252) type A tape packing information

Figure 34: DPAK (TO-252) tape outline

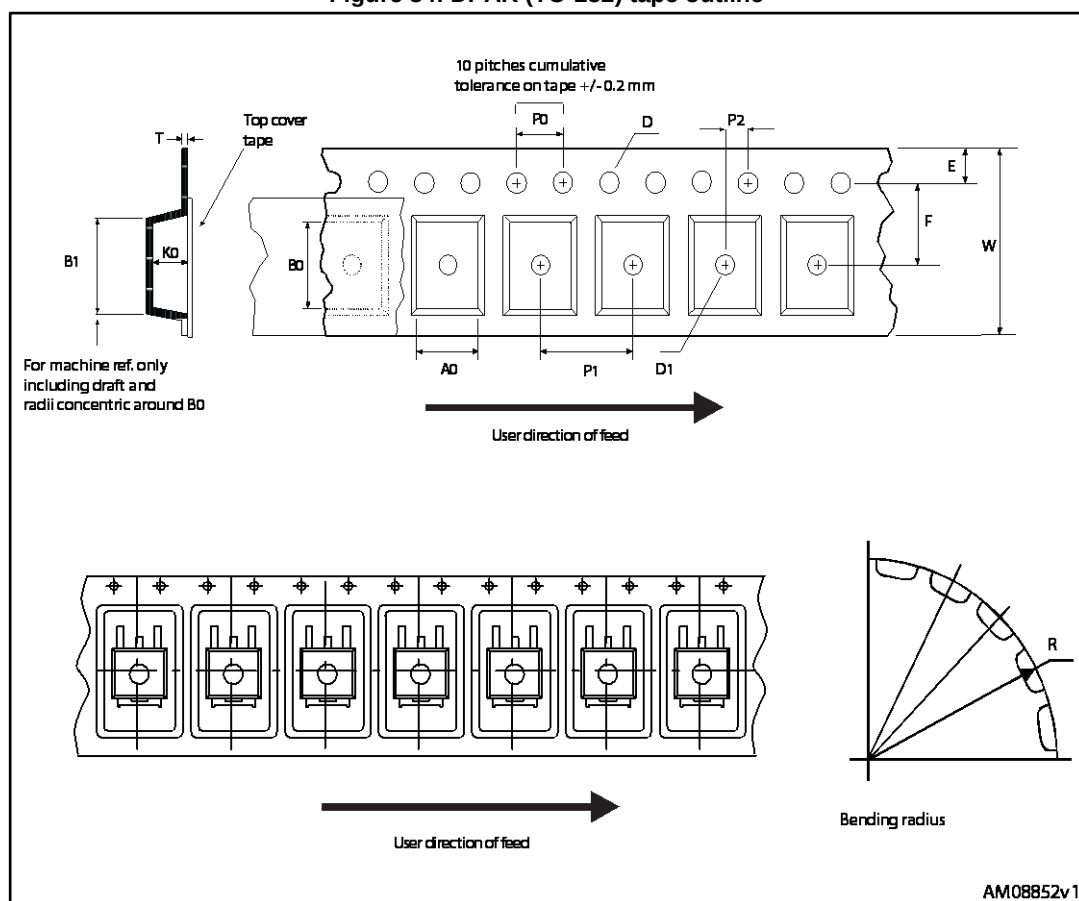


Figure 35: DPAK (TO-252) reel outline

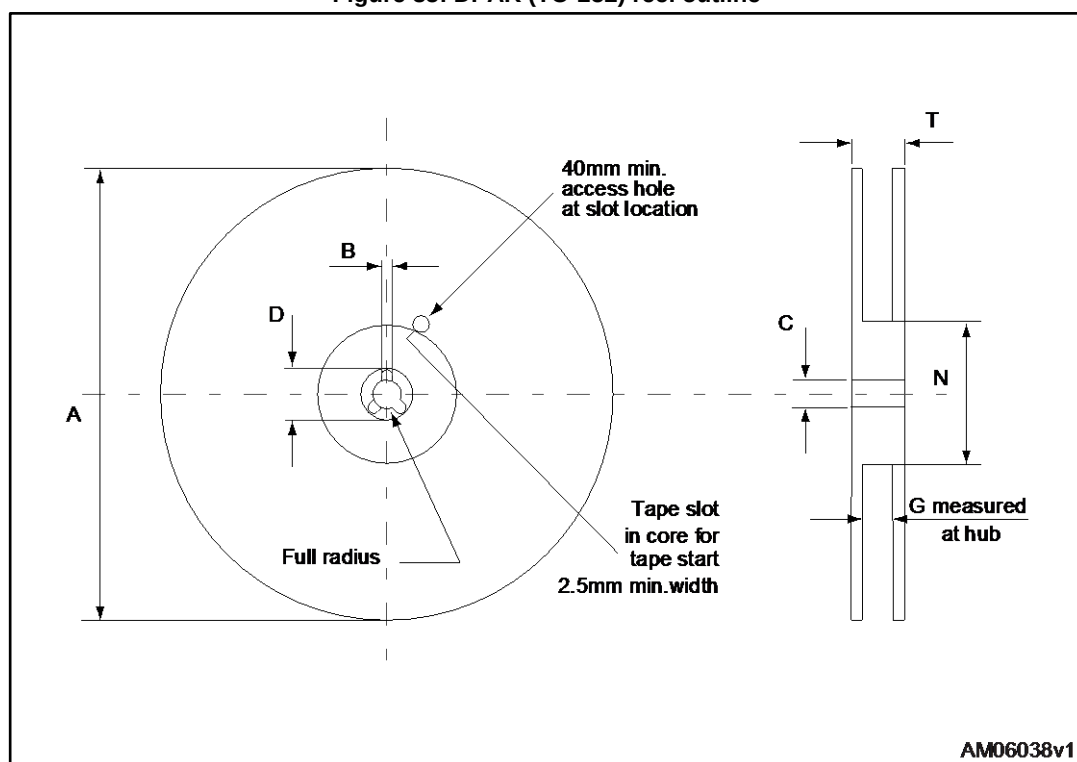


Table 16: DPAK (TO-252) tape and reel mechanical data

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			

5 Revision history

Table 17: Document revision history

Date	Revision	Changes
14-Jun-2005	1	First release.
19-Jul-2005	2	Complete version.
27-Jan-2006	3	Inserted ecopack indication.
01-Mar-2006	4	The document has been reformatted.
08-Feb-2007	5	Modified value on <i>Table 6.: Switching on/off (inductive load)</i> .
24-Nov-2009	6	Inserted DPAK package option.
06-Jun-2017	7	Modified part numbers on cover page. Updated Section 4: "Package information" . Minor text changes.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2017 STMicroelectronics – All rights reserved