STGB10NC60KDT4, STGD10NC60KDT4, STGF10NC60KD, STGP10NC60KD

10 A, 600 V short-circuit rugged IGBT

Datasheet - production data

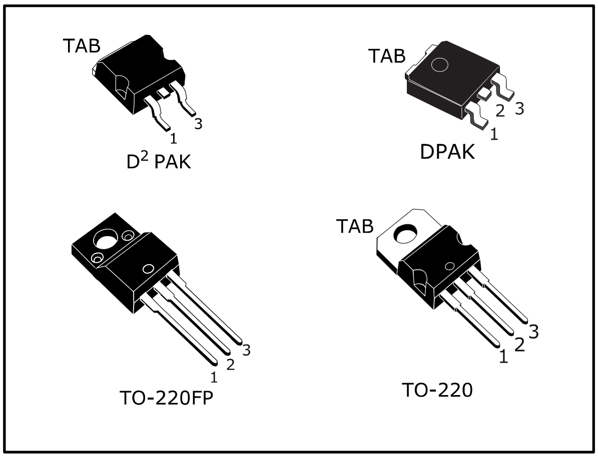
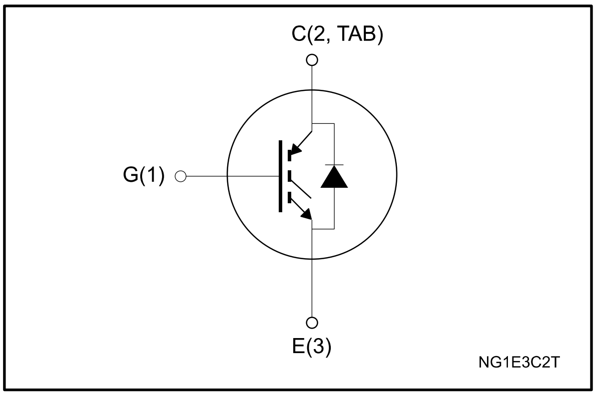


Figure 1: Internal schematic diagram



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 μs

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.

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	

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value			Unit
		D²PAK, 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 Tc=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, D²PAK	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 °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 mA, V_{GE} = 0 V	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} =15 V, I_C = 5 A		2.2	2.5	V
		V_{GE} = 15 V, I_C = 5 A, T_j= 125 °C		1.8		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 µA	4.5		6.5	V
I_{CES}	Collector cut-off current	V_{CE} = 600 V, V_{GE} = 0 V			150	µA
		V_{CE}=600 V, V_{GE} = 0 V, T_j = 125 °C (1)			1	mA
I_{GES}	Gate-emitter leakage current	V_{GE} = ±20 V			±100	nA
g_{fs}(2)	Forward transconductance	V_{CE} = 15 V, I_C= 5 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 V, f = 1 MHz, V_{GE} = 0 V	-	380	-	pF
C_{oes}	Output capacitance		-	46	-	
C_{res}	Reverse transfer capacitance		-	8.5	-	
Q_g	Total gate charge	V_{CE} = 390 V, I_C = 5 A, V_{GE} = 0 to 15 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 V, I_C = 5 A, R_G = 10 Ω , V_{GE} = 15 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/µs
$t_{d(on)}$	Turn-on delay time	V_{CC} = 390 V, I_C = 5 A, R_G = 10 Ω , V_{GE} = 15 V, T_j=125°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/µs
$t_{r(Voff)}$	Off voltage rise time	V_{CC} = 390 V, I_C = 5 A, R_G = 10 Ω, V_{GE} = 15 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 V, I_C = 5 A, R_G = 10 Ω, V_{GE} = 15 V, T_j=125 °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 V, I_C = 5 A, R_G = 10 Ω , V_{GE} = 15 V (see *Figure 18: " Test circuit for inductive load switching"*)	-	55	-	µJ
E_{off}(2)	Turn-off switching energy		-	85	-	µJ
E_{ts}	Total switching energy		-	140	-	µJ
E_{on}(1)	Turn-on switching energy	V_{CC} = 390 V, I_C = 5 A, R_G = 10 Ω , V_{GE} = 15 V, T_j=125°C (see *Figure 18: " Test circuit for inductive load switching"*)	-	87	-	µJ
E_{off}(2)	Turn-off switching energy		-	162	-	µJ
E_{ts}	Total switching energy		-	249	-	µJ

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 A	-	2	-	V
		I_F=5 A, T_j=125 °C	-	1.6	-	V
t_{rr}	Reverse recovery time	I_F=5 A, V_R=40 V, di/dt=100 A/µs (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 A, V_R=40 V, T_j=125 °C, di/dt=100 A/µs (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)

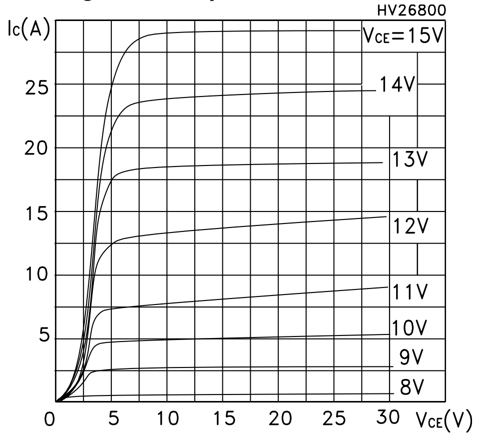


Figure 2: Output characteristics

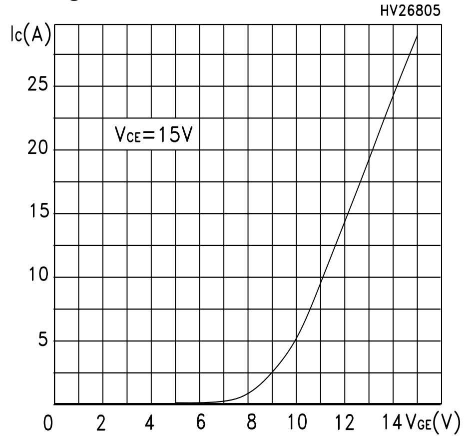


Figure 3: Transfer characteristics

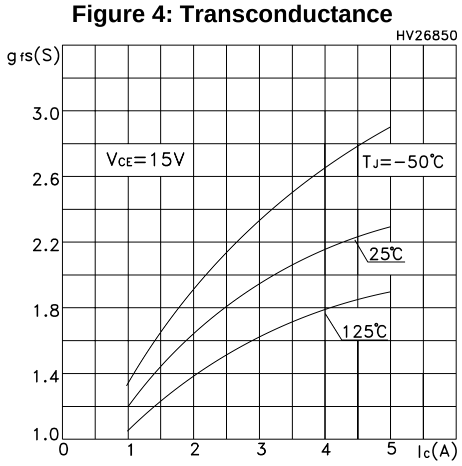


Figure 4: Transconductance

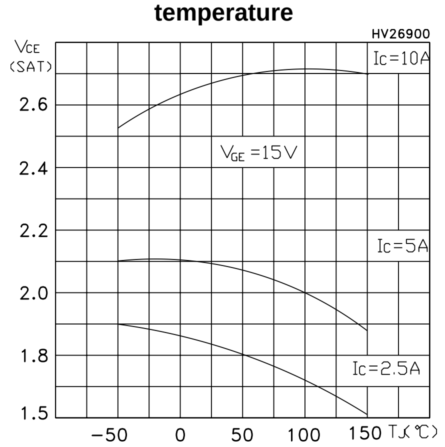


Figure 5: Collector-emitter on voltage vs temperature

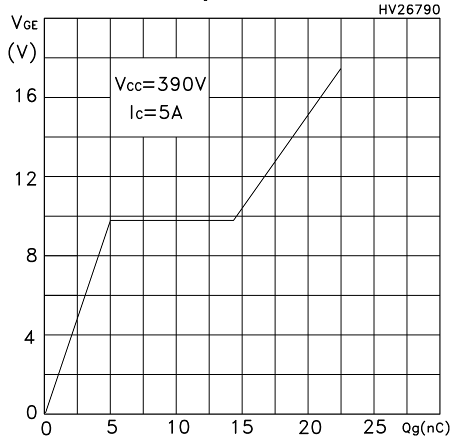


Figure 6: Collector-emitter on voltage vs temperature

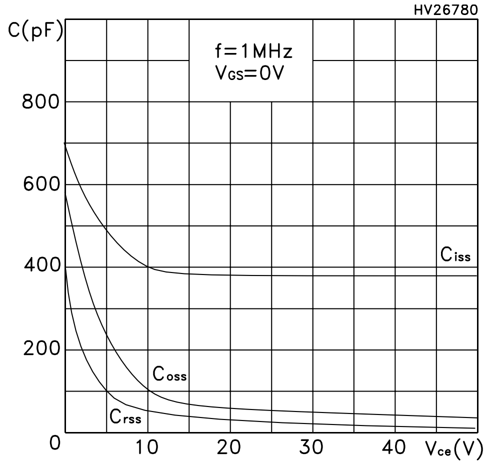


Figure 7: Capacitance variations

Figure 8: Normalized gate threshold voltage vs temperature

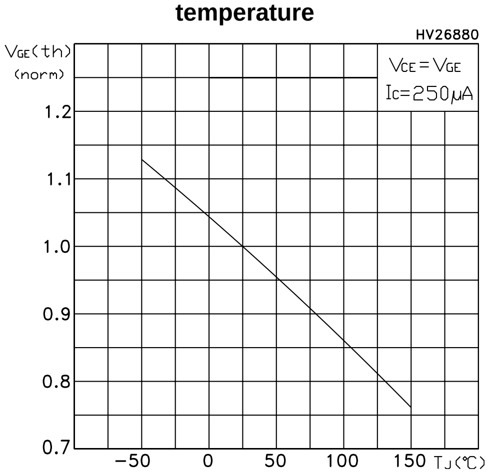


Figure 9: Collector-emitter on voltage vs collector current

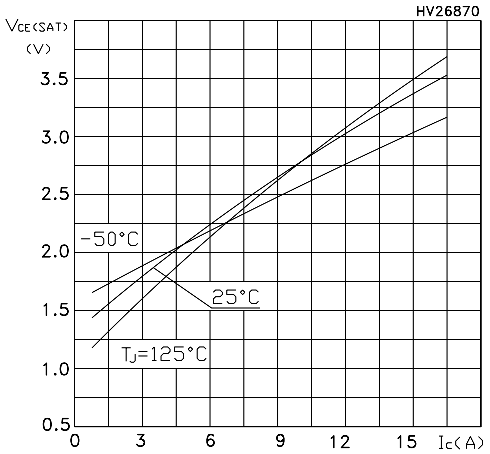


Figure 10: Normalized breakdown voltage vs temperature

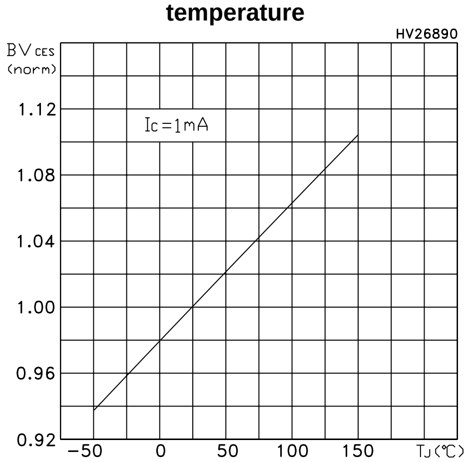


Figure 11: Switching energy vs temperature

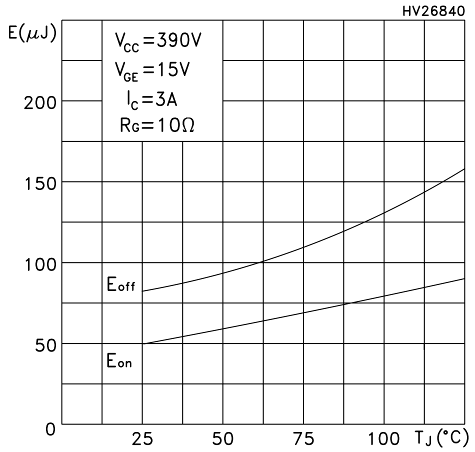


Figure 12: Switching energy vs gate resistance

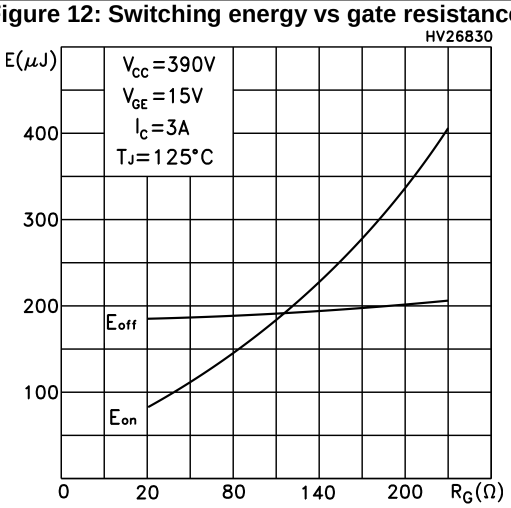


Figure 13: Switching energy vs collector current

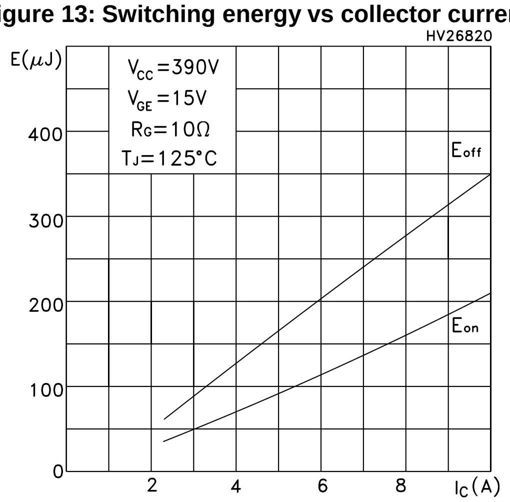


Figure 14: Thermal impedance for D²PAK, DPAK and TO-220

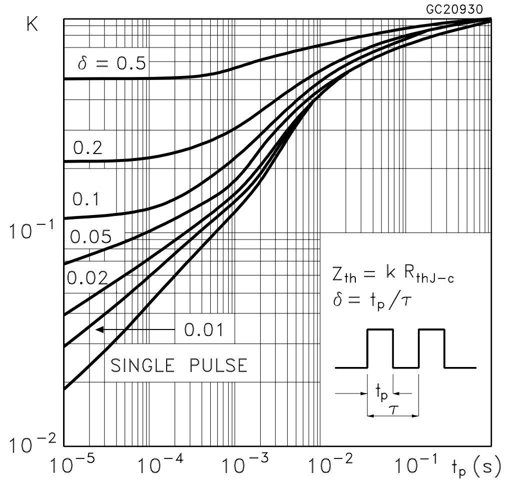


Figure 15: Turn-off SOA

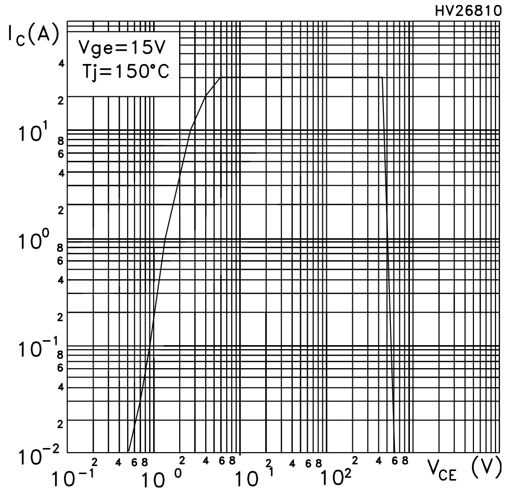


Figure 16: Emitter-collector diode characteristics

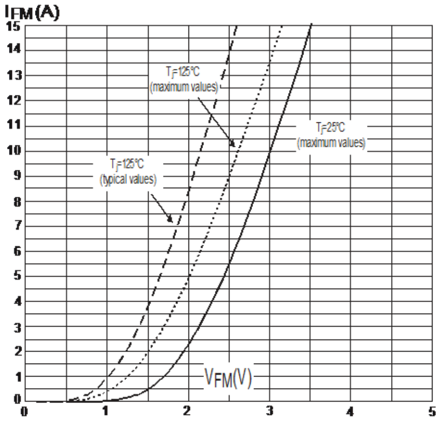
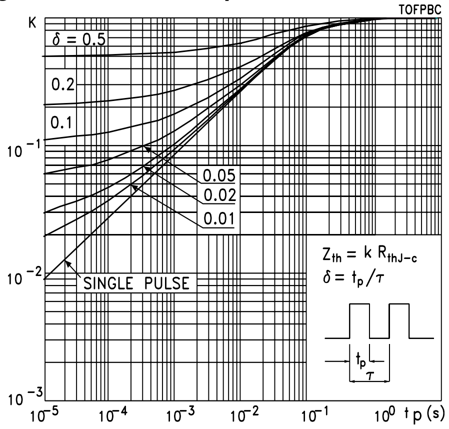


Figure 17: Thermal impedance for TO-220FP



3 Test circuits

Figure 18: Test circuit for inductive load switching

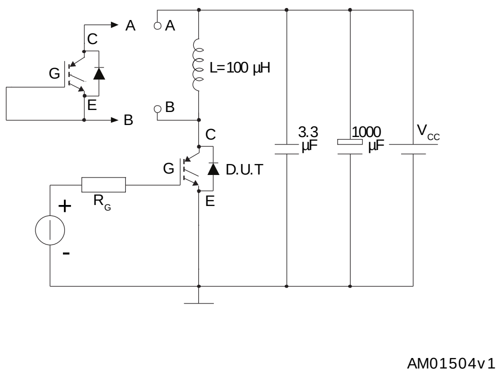


Figure 19: Gate charge test circuit

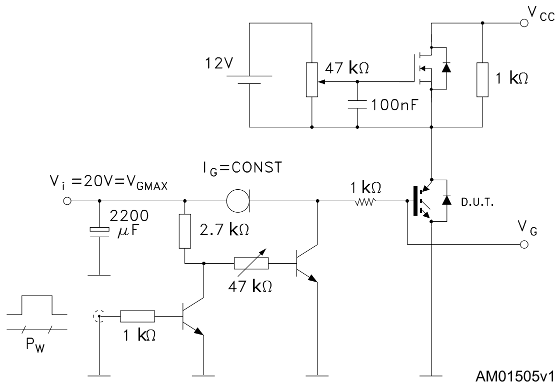


Figure 20: Switching waveform

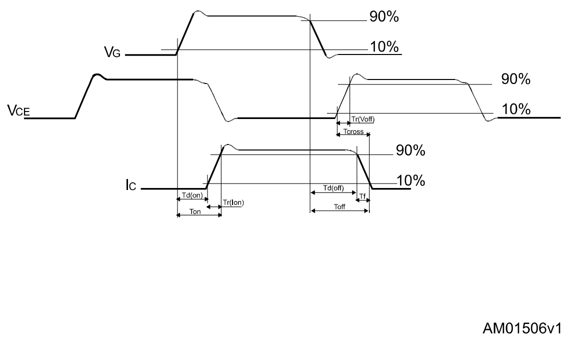
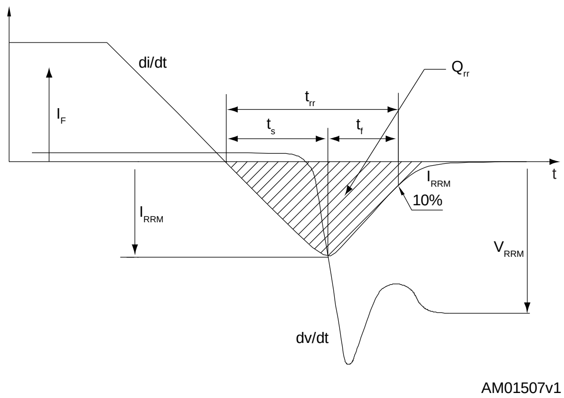


Figure 21: Diode reverse recovery waveform



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***.
ECOPACK® is an ST trademark.

4.1 D²PAK (TO-263) type A package information

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

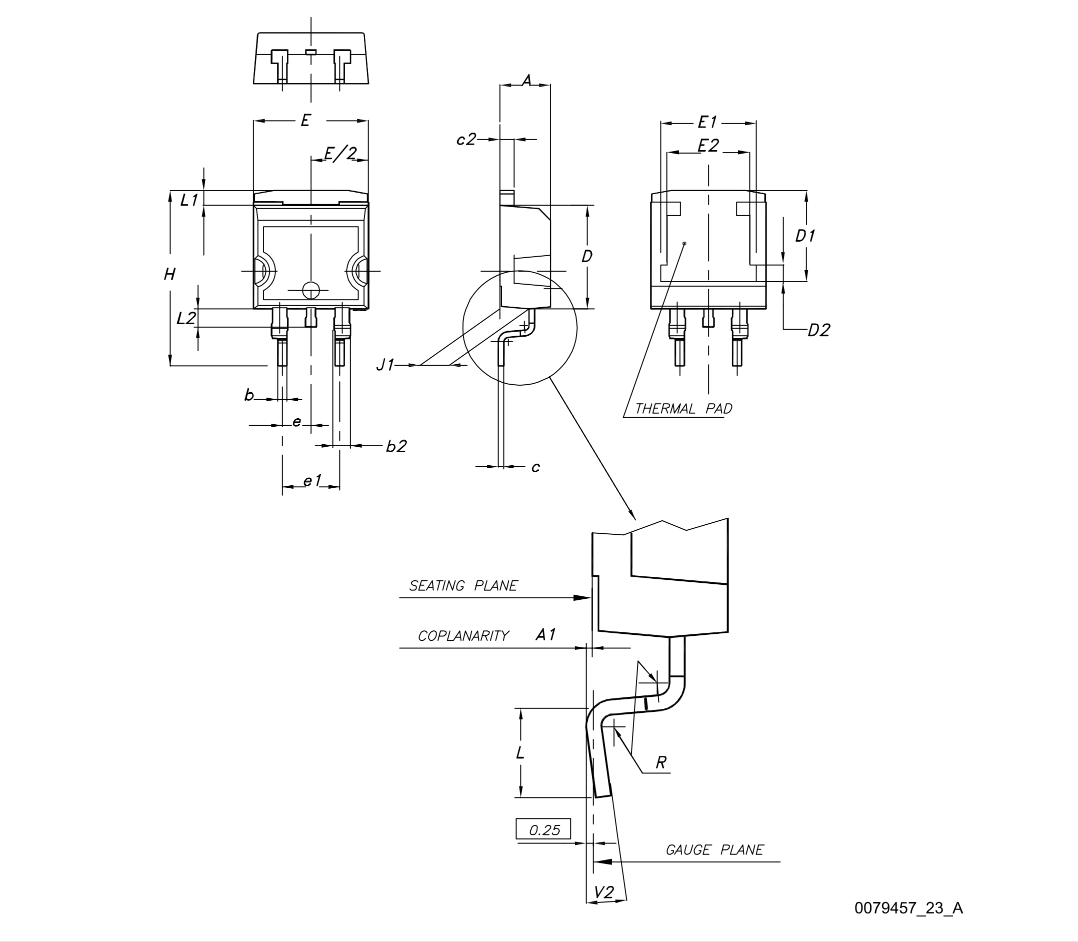
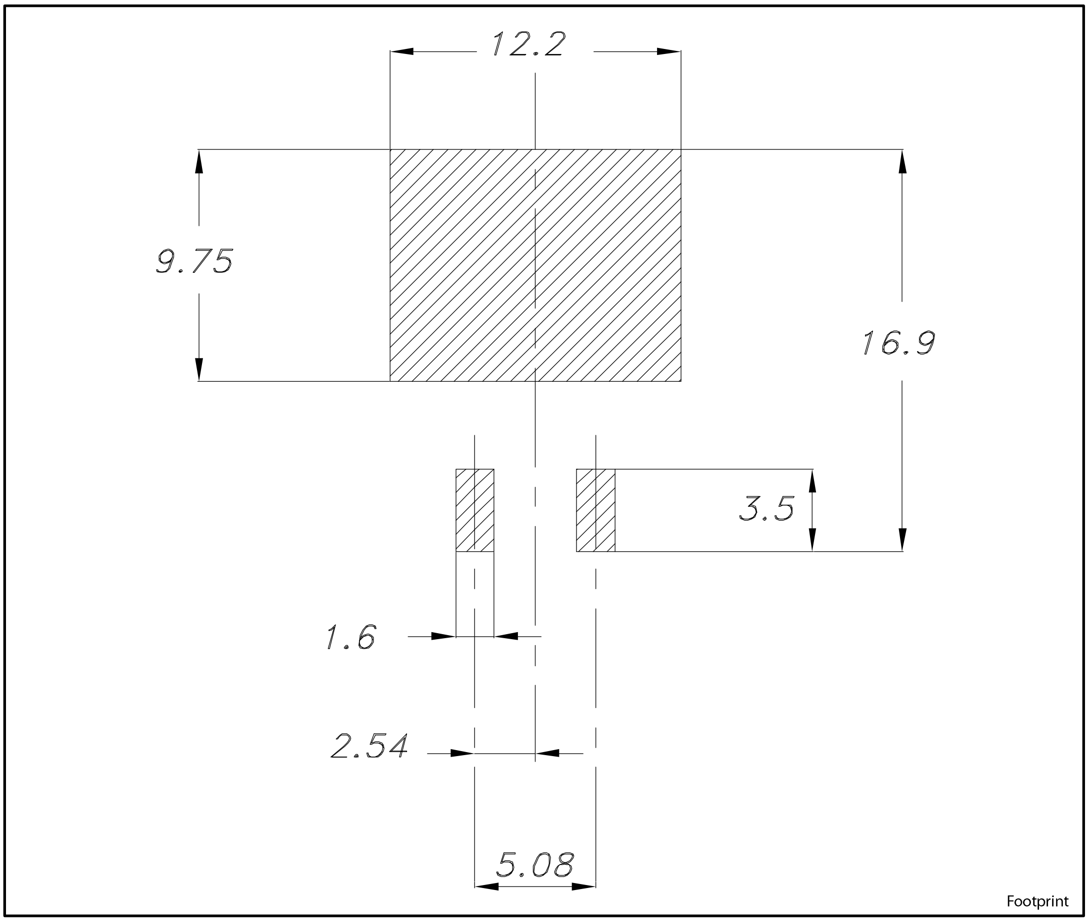


Table 9: D²PAK (TO-263) type A package mechanical data

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 information

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

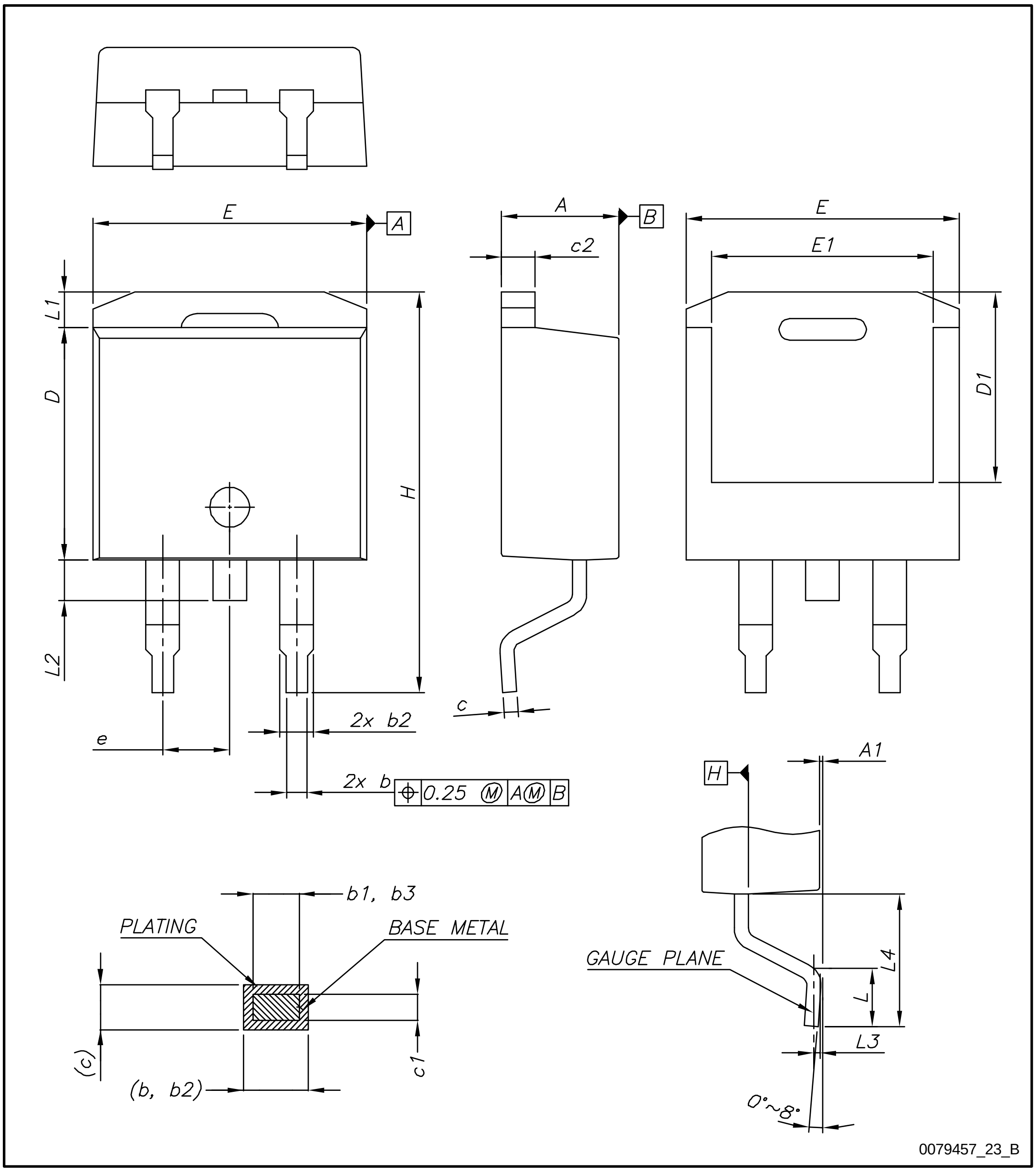
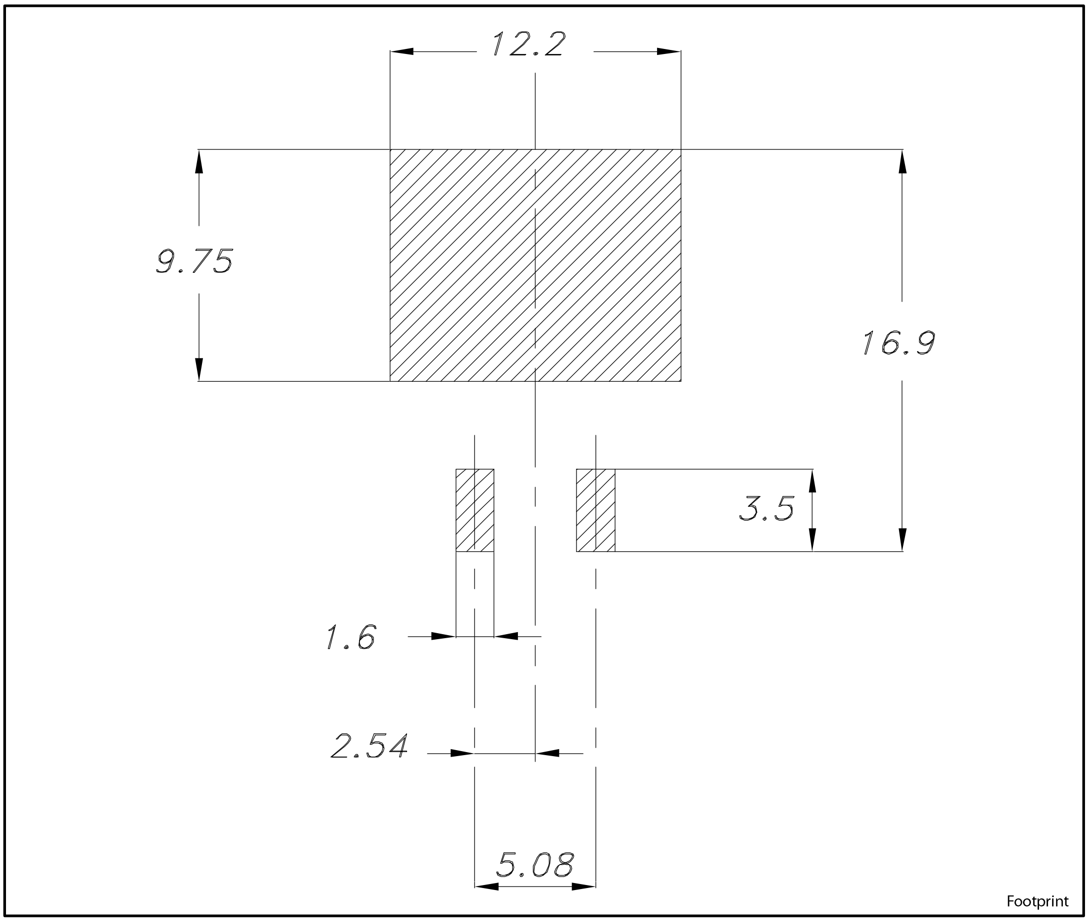


Table 10: D²PAK (TO-263) type B mechanical data

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

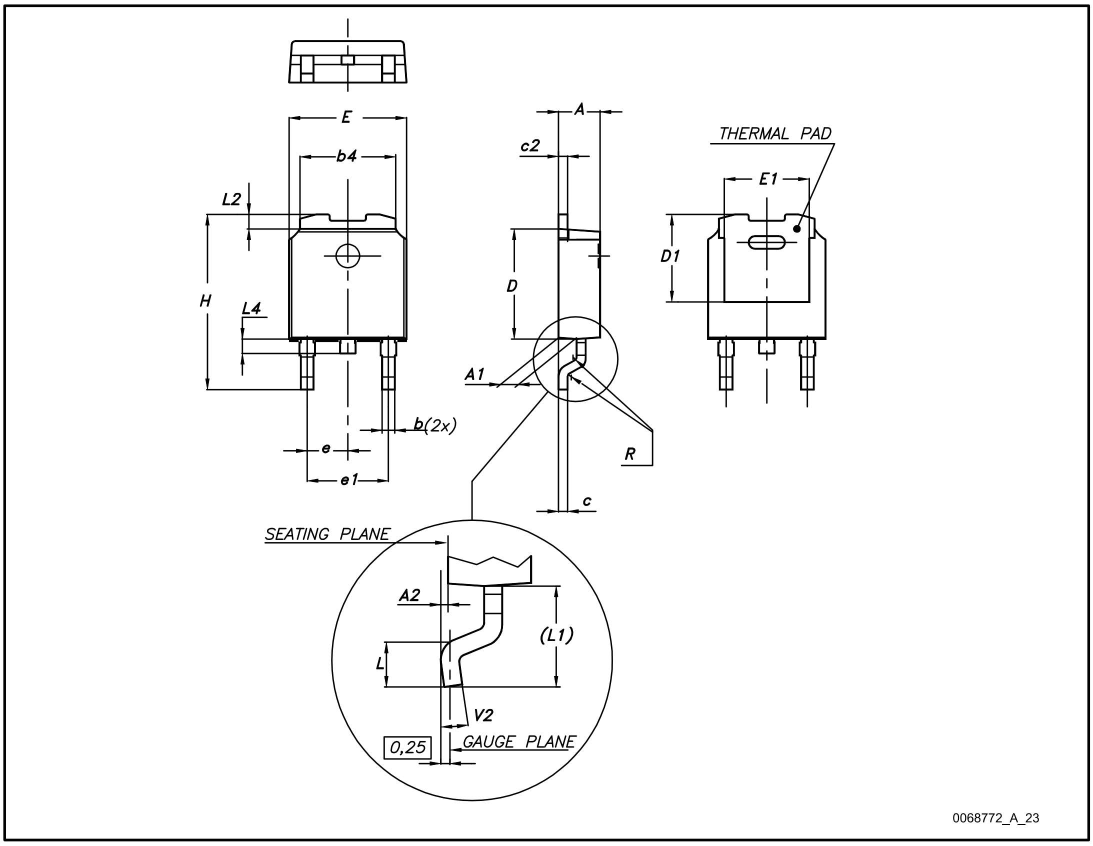
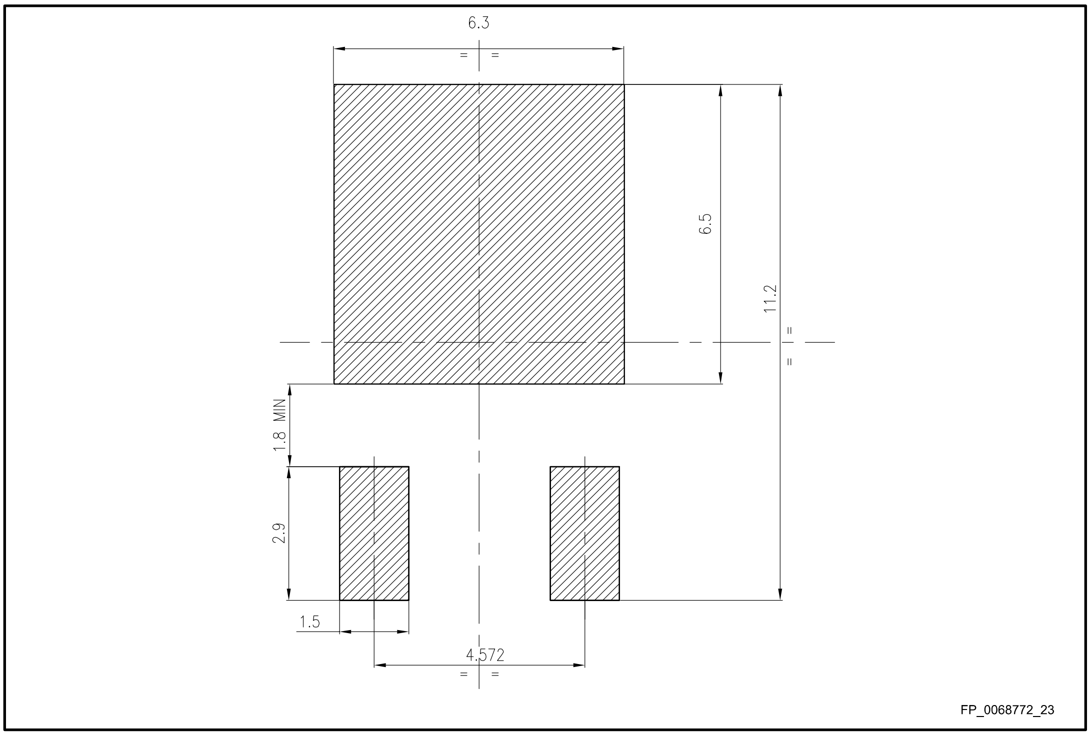


Table 11: DPAK (TO-252) type A mechanical data

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

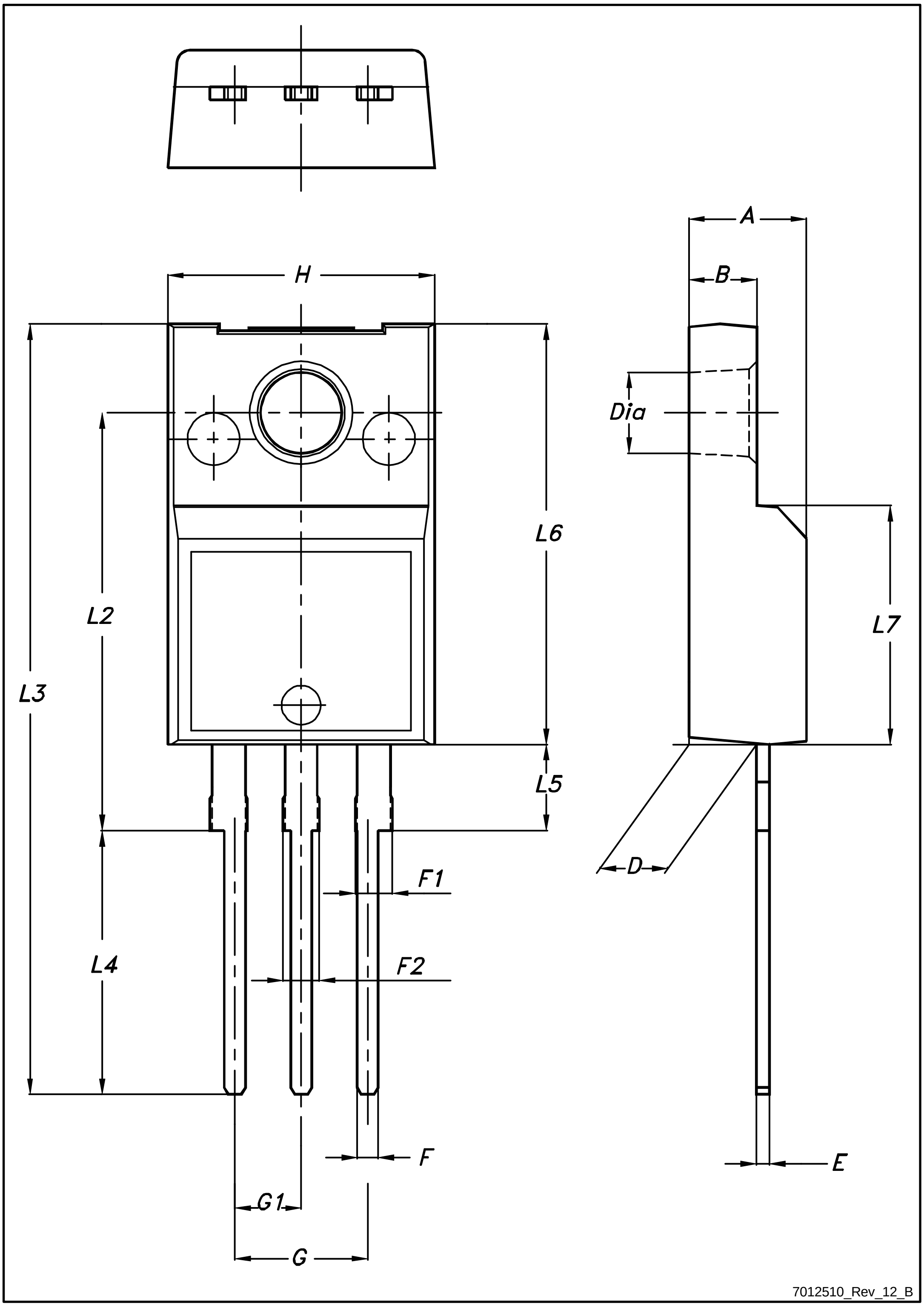


Table 12: TO-220FP package mechanical data

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

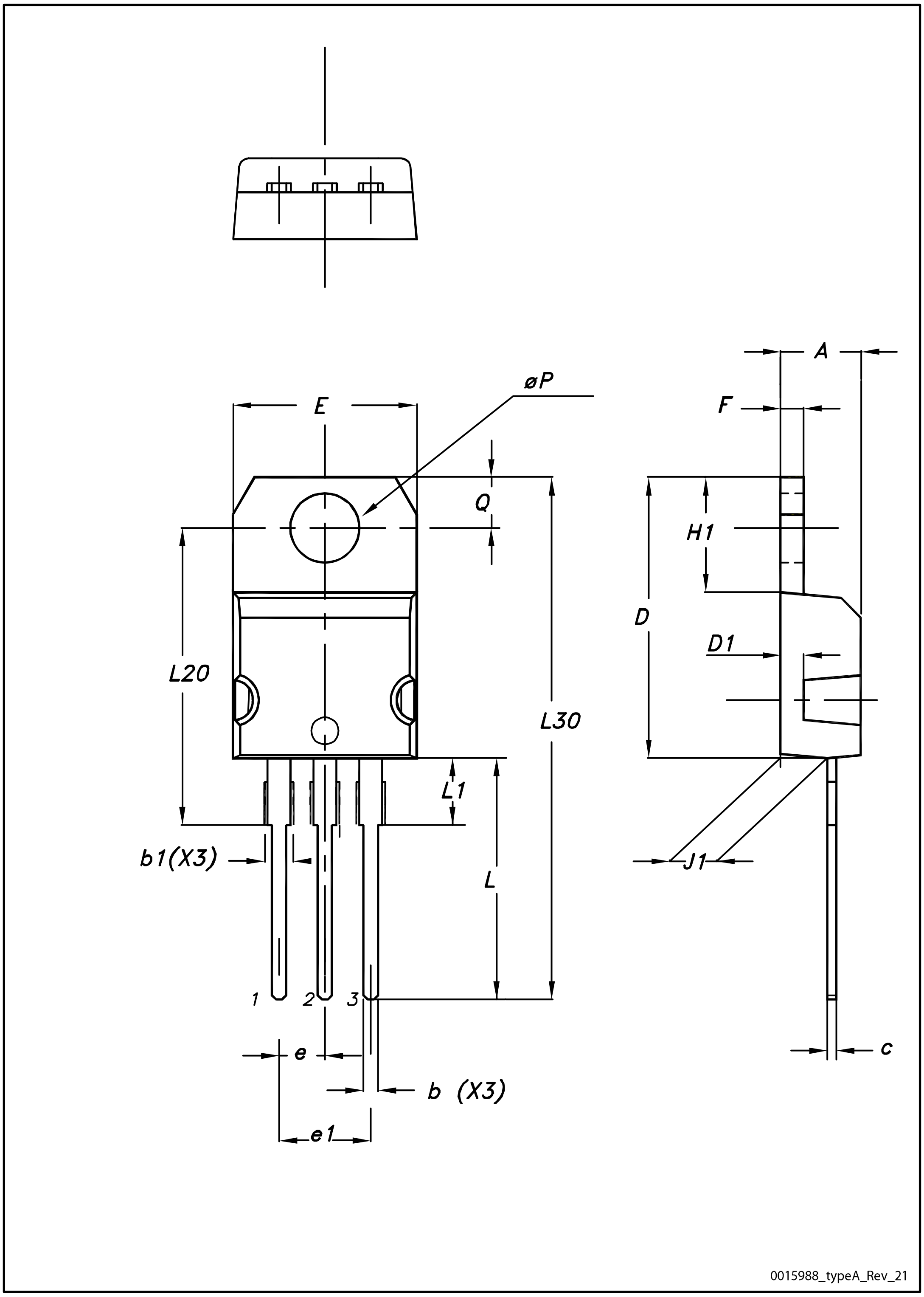


Table 13: TO-220 type A package mechanical data

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

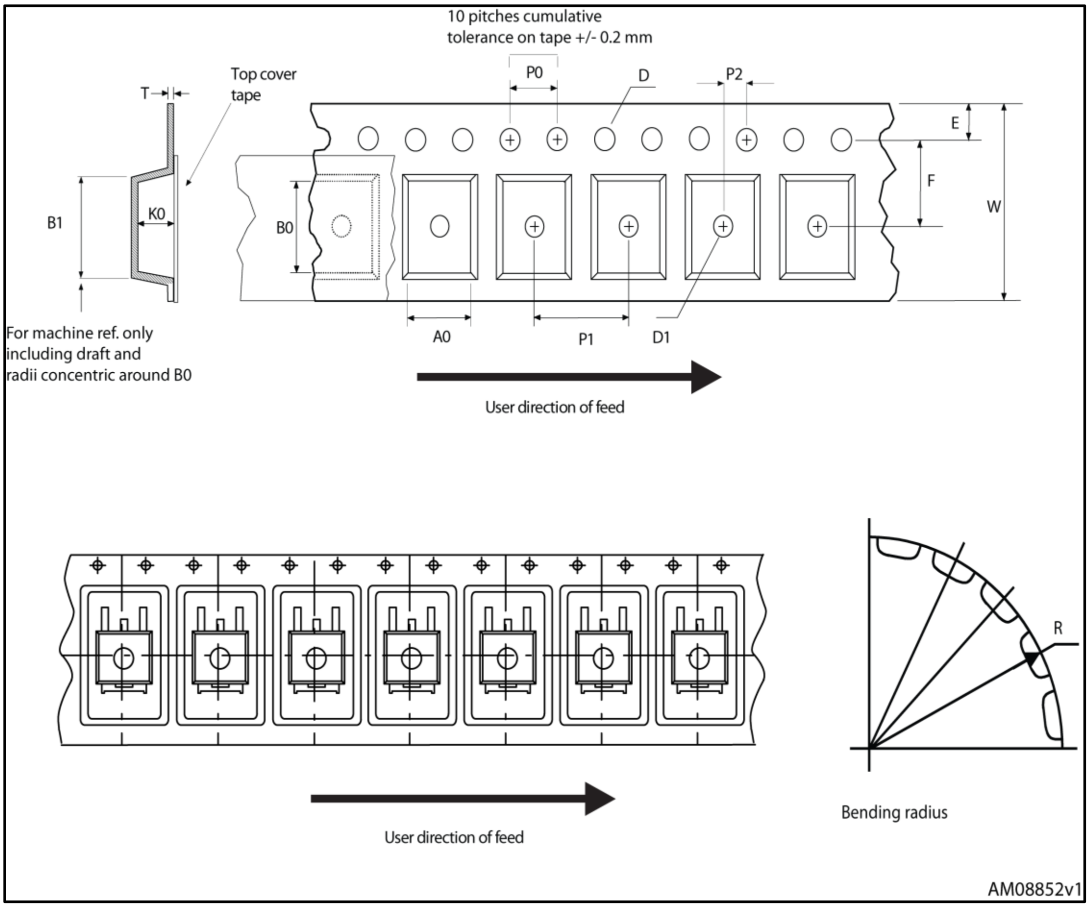


Figure 31: D2PAK type A reel outline

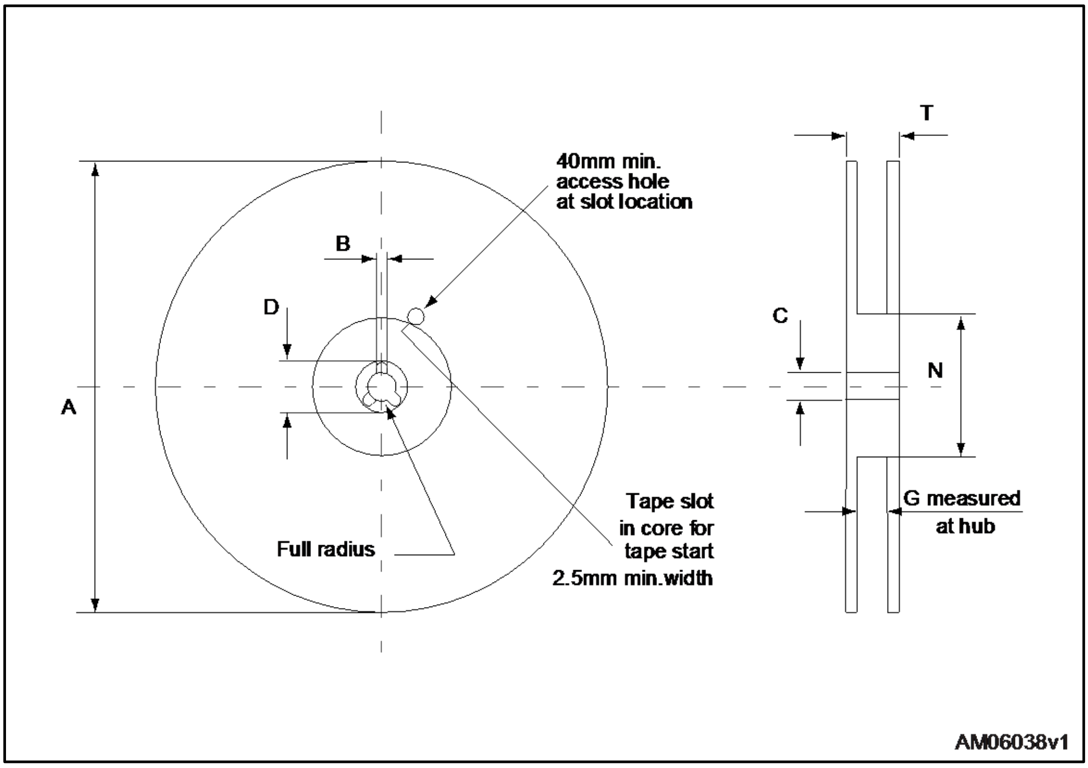


Table 14: D²PAK type A tape and reel mechanical data

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

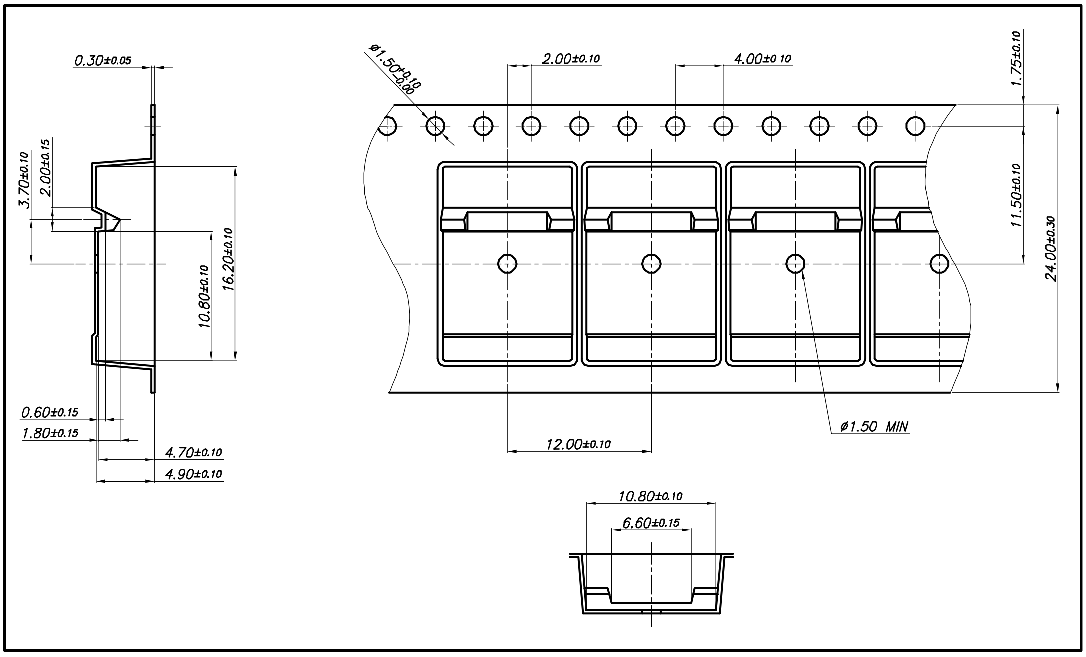


Figure 33: D2PAK type B reel outline

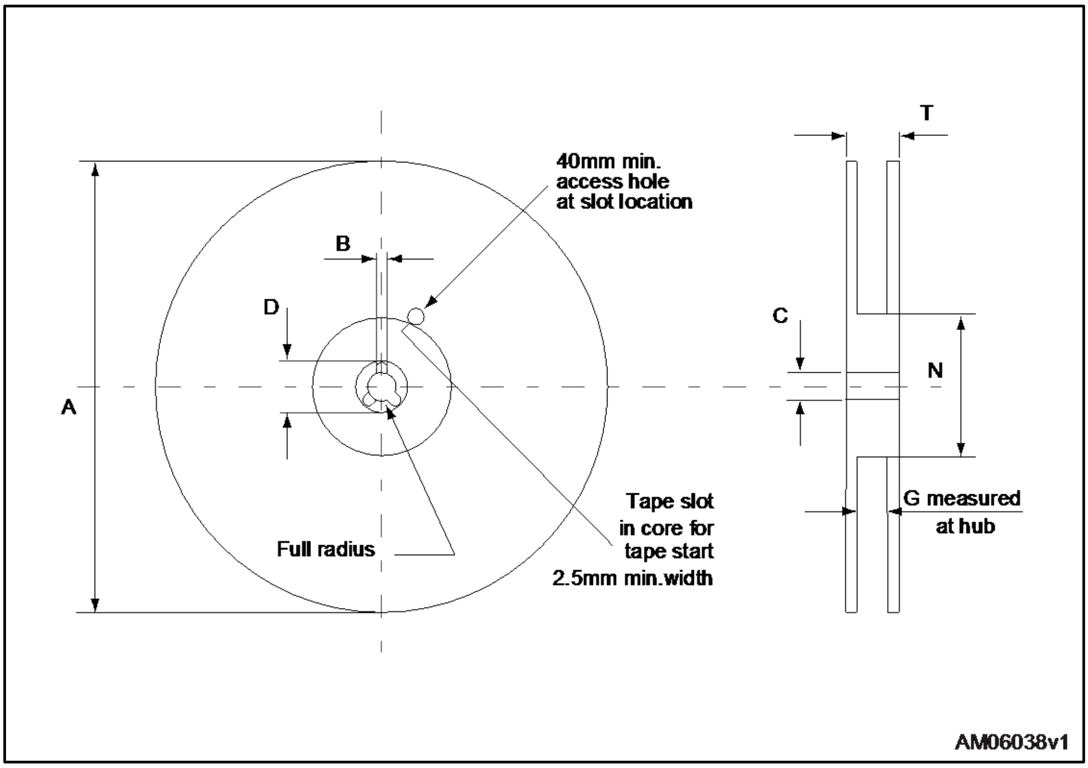


Table 15: D²PAK type B reel mechanical data

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

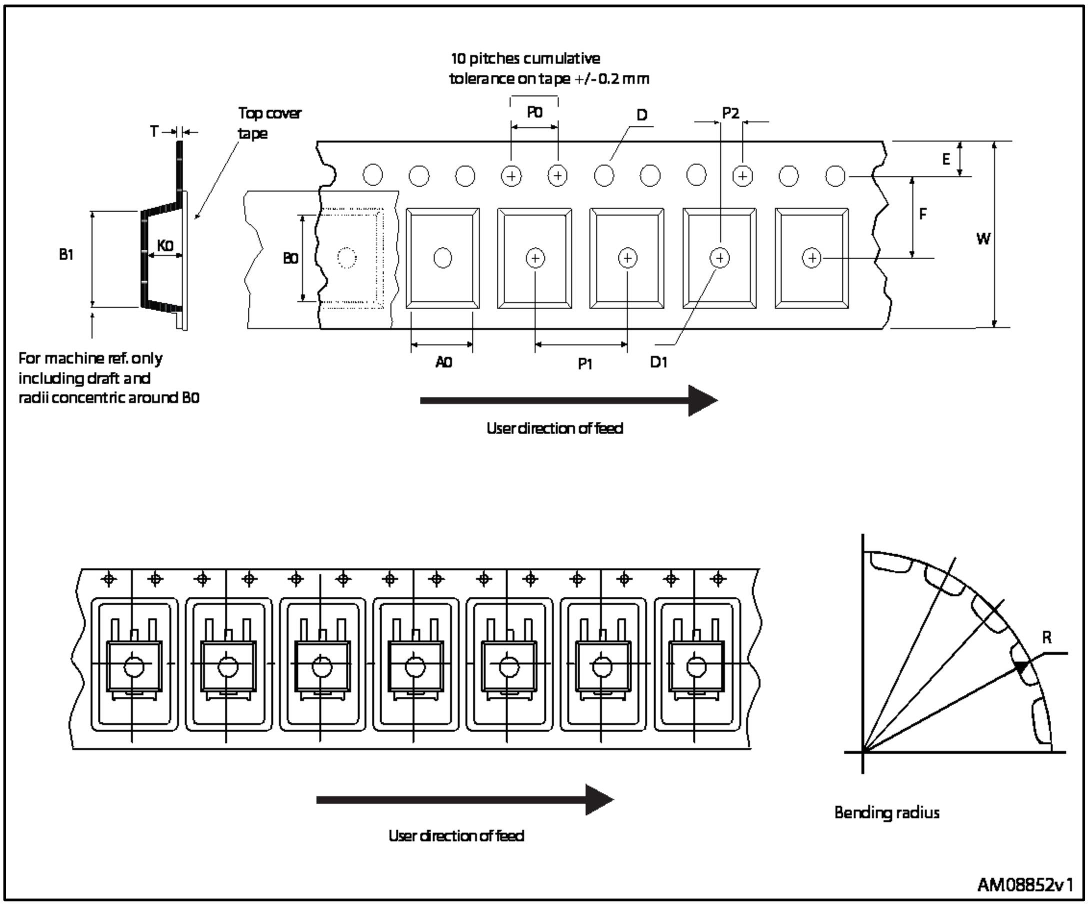


Figure 35: DPAK (TO-252) reel outline

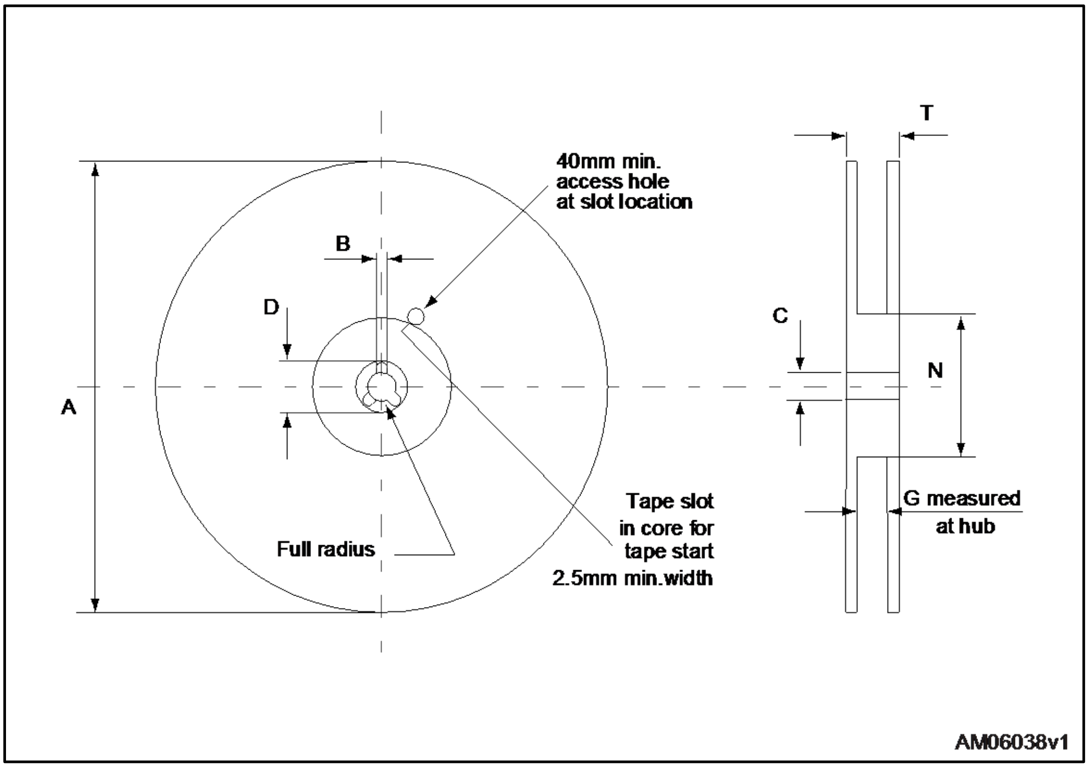


Table 16: DPAK (TO-252) tape and reel mechanical data

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

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