N-channel 600 V, 0.35 Ω typ., 11 A MDmesh™ M2 Power MOSFETs in D²PAK and DPAK packages

D²PAK   DPAK

D(2, TAB)

G(1)

S(3)

NG1D2TS3Z

STPOWER
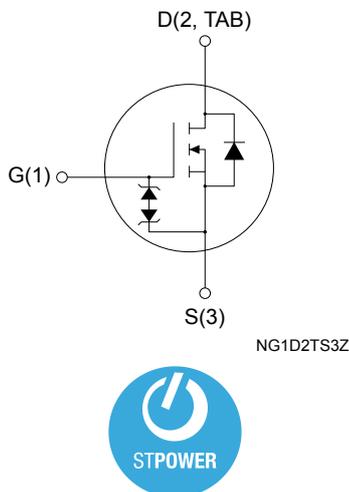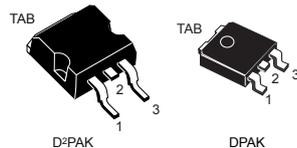
Features

Order code	$V_{DS}@T_{JMAX.}$	$R_{DS(on)}$ max.	I_D	Package
STB13N60M2	650 V	0.38 Ω	11 A	D²PAK
STD13N60M2				DPAK

- Extremely low gate charge
- Excellent output capacitance (C_{OSS}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using the MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, these devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high-efficiency converters.

Product status link
STB13N60M2
STD13N60M2

Product summary	
Order code	STB13N60M2
Marking	13N60M2
Package	D²PAK
Packing	Tape and reel
Order code	STD13N60M2
Marking	13N60M2
Package	DPAK
Packing	Tape and reel

DS9632 - Rev 5 - February 2019
For further information contact your local STMicroelectronics sales office.

www.st.com

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at T_C = 25 °C	11	A
I_D	Drain current (continuous) at T_C = 100 °C	7	A
I_{DM} [1]	Drain current (pulsed)	44	A
P_{TOT}	Total power dissipation at T_C = 25 °C	110	W
dv/dt[2]	Peak diode recovery voltage slope	15	V/ns
dv/dt[3]	MOSFET dv/dt ruggedness	50	
T_{stg}	Storage temperature range	- 55 to 150	°C
T_j	Operating junction temperature range		

1. *Pulse width limited by safe operating area.*
2. *$I_{SD} \leq 11$ A, di/dt ≤ 400 A/µs; $V_{DS\ peak} < V_{(BR)DSS}$, V_{DD} = 400 V*
3. *$V_{DS} \leq 480$ V.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		D²PAK	DPAK	
$R_{thj-case}$	Thermal resistance junction-case	1.14		°C/W
$R_{thj-pcb}$ [1]	Thermal resistance junction-pcb	30	50	

1. *When mounted on FR-4 board of 1 inch², 2 oz Cu.*

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetetive or not repetetive (pulse width limited by $T_{jmax.}$)	2.8	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}; V_{DD} = 50 V)	125	mJ

2 Electrical characteristics

$T_C = 25$ °C unless otherwise specified

Table 4. On/off-states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0$ V, $I_D = 1$ mA	600			V
I_{DSS}	Zero-gate voltage drain current	$V_{GS} = 0$ V, $V_{DS} = 600$ V			1	µA
		$V_{GS} = 0$ V, $V_{DS} = 600$ V, $T_C = 125$ °C [1]			100	µA
I_{GSS}	Gate-body leakage current	$V_{DS} = 0$ V, $V_{GS} = ±25$ V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250$ µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10$ V, $I_D = 5.5$ A		0.35	0.38	Ω

1. *Defined by design, not subject to production test.*

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance		-	580	-	pF
C_{oss}	Output capacitance	$V_{DS} = 100$ V, f = 1 MHz, $V_{GS} = 0$ V	-	32	-	pF
C_{rss}	Reverse transfer capacitance		-	1.1	-	pF
$C_{oss\ eq.}$ [1]	Equivalent output capacitance	$V_{DS} = 0$ to 480 V, $V_{GS} = 0$ V	-	120	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, $I_D = 0$ A	-	6.6	-	Ω
Q_g	Total gate charge	$V_{DD} = 480$ V, $I_D = 11$ A, $V_{GS} = 0$ to 10 V (see Figure 16. Test circuit for gate charge behavior)	-	17	-	nC
Q_{gs}	Gate-source charge		-	2.5	-	nC
Q_{gd}	Gate-drain charge		-	9	-	nC

1. *$C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}.*

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300$ V, $I_D = 5.5$ A, $R_G = 4.7$ Ω, $V_{GS} = 10$ V (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	11	-	ns
t_r	Rise time		-	10	-	ns
$t_{d(off)}$	Turn-off-delay time		-	41	-	ns
t_f	Fall time		-	9.5	-	ns

Table 7. **Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		11	A
I_{SDM} [1]	Source-drain current (pulsed)		-		44	A
V_{SD} [2]	Forward on voltage	V_{GS} = 0 V, I_{SD} = 11 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 11 A, di/dt = 100 A/µs, V_{DD} = 60 V (see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	297		ns
Q_{rr}	Reverse recovery charge		-	2.8		µC
I_{RRM}	Reverse recovery current		-	18.5		A
t_{rr}	Reverse recovery time	I_{SD} = 11 A, di/dt = 100 A/µs, V_{DD} = 60 V, T_j = 150 °C (see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	394		ns
Q_{rr}	Reverse recovery charge		-	3.8		µC
I_{RRM}	Reverse recovery current		-	19		A

1. *Pulse width is limited by safe operating area.*

2. *Pulsed: pulse duration = 300 µs, duty cycle 1.5%.*

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for D^{2}PAK
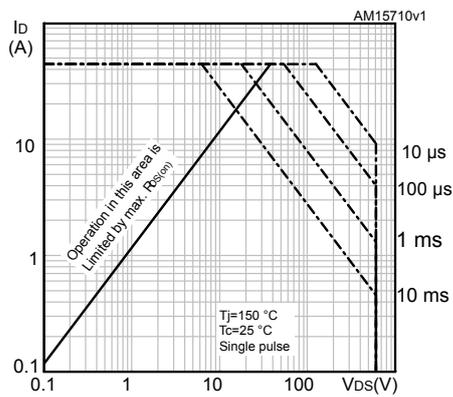
Figure 2. Thermal impedance for D^{2}PAK

$$Z_{th} = k \, R_{thJ-c}$$
$$\delta = t_p / \tau$$
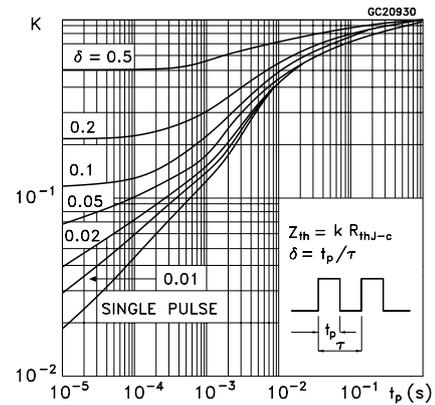
Figure 3. Safe operating area for DPAK
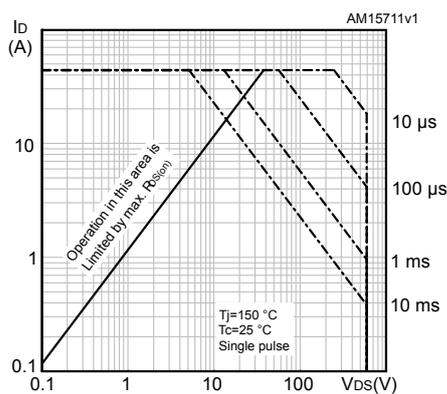
Figure 4. Thermal impedance for DPAK

$$Z_{th} = K \cdot R_{thj-c}$$
$$\delta = t_p / T$$
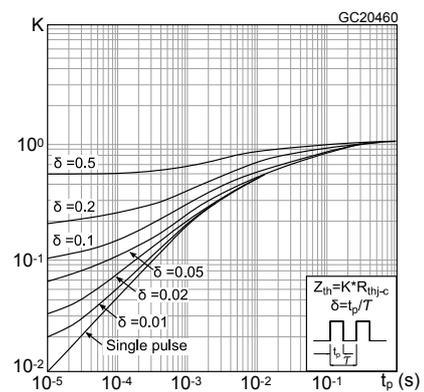
**Figure 5. Output characteristics**
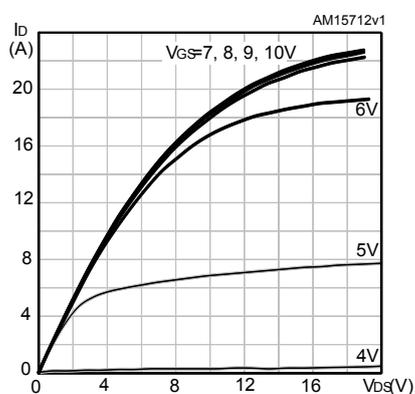

Figure 6. Transfer characteristics
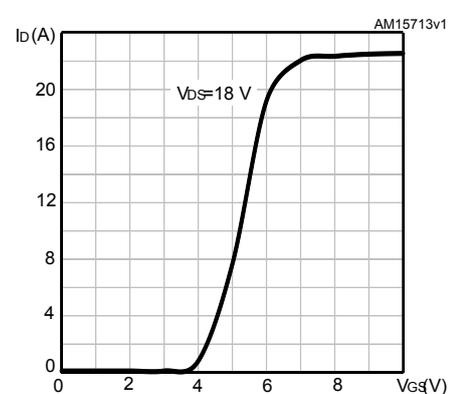
Figure 7. Normalized V(BR)DSS vs. temperature
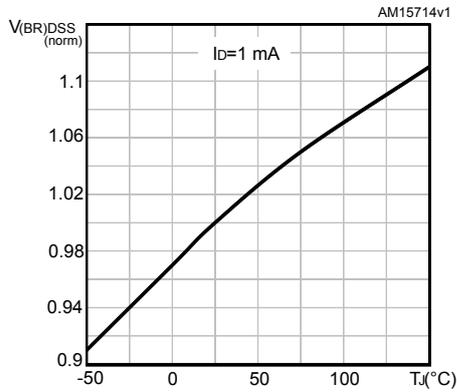
Figure 8. Static drain-source on-resistance
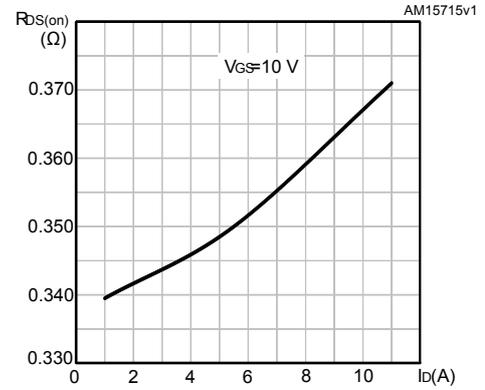
Figure 9. Gate charge vs. gate-source voltage
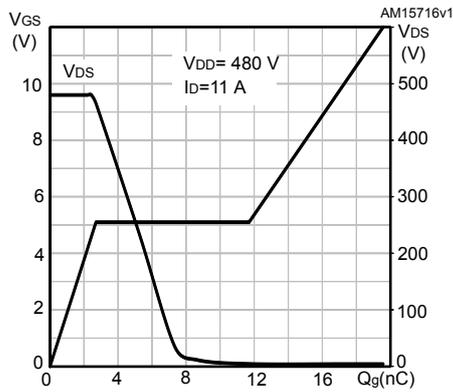
Figure 10. Capacitance variations
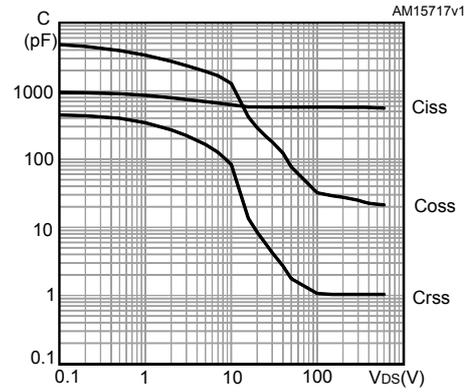
Figure 11. Normalized gate threshold voltage vs. temperature
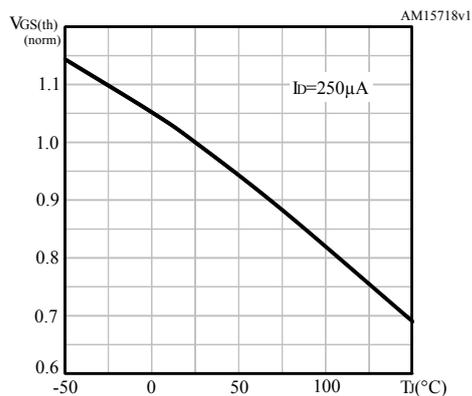
Figure 12. Normalized on-resistance vs. temperature
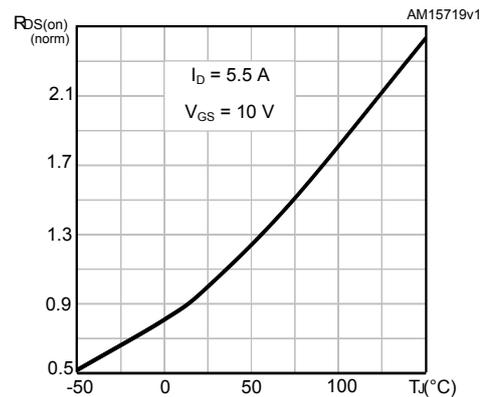
Figure 13. Source-drain diode forward characteristics
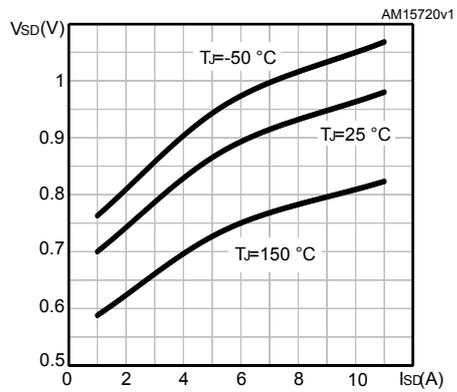
**Figure 14. Output capacitance stored energy**
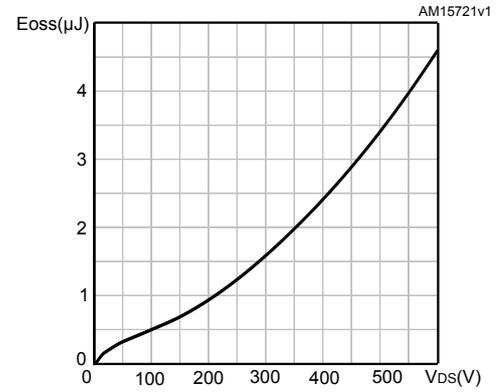
3   Test circuits

**Figure 15. Test circuit for resistive load switching times**
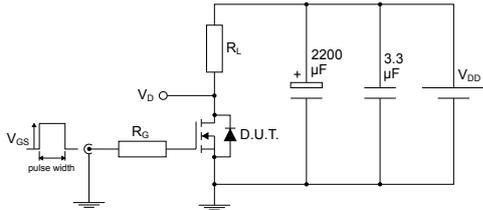
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Figure 16. Test circuit for gate charge behavior
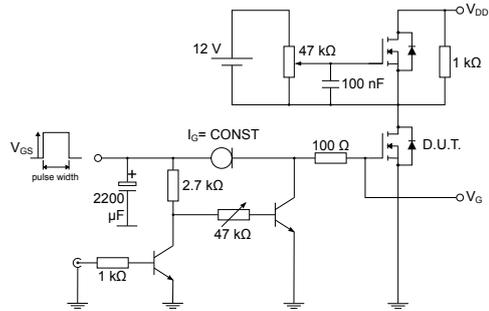
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Figure 17. Test circuit for inductive load switching and diode recovery times
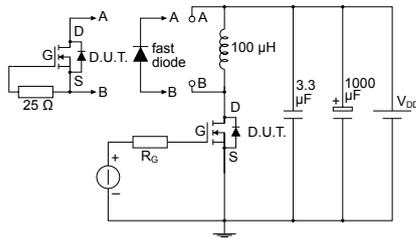
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Figure 18. Unclamped inductive load test circuit
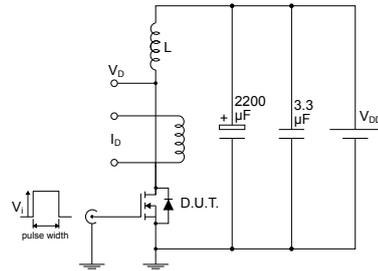
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Figure 19. Unclamped inductive waveform
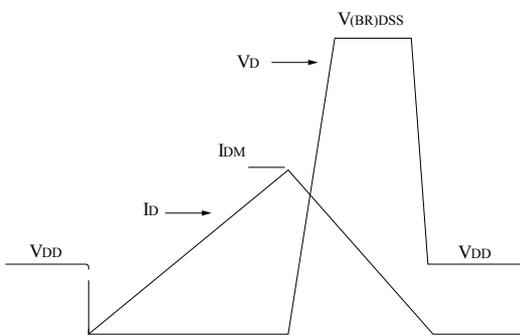
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Figure 20. Switching time waveform
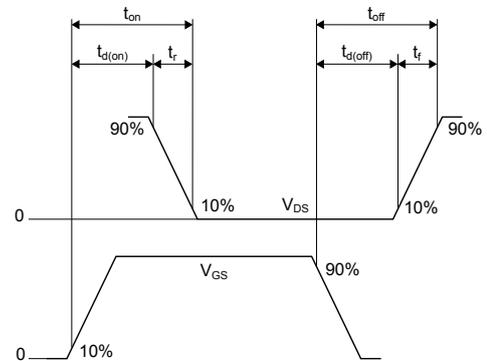
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4 Package information

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 21. D²PAK (TO-263) type A package outline
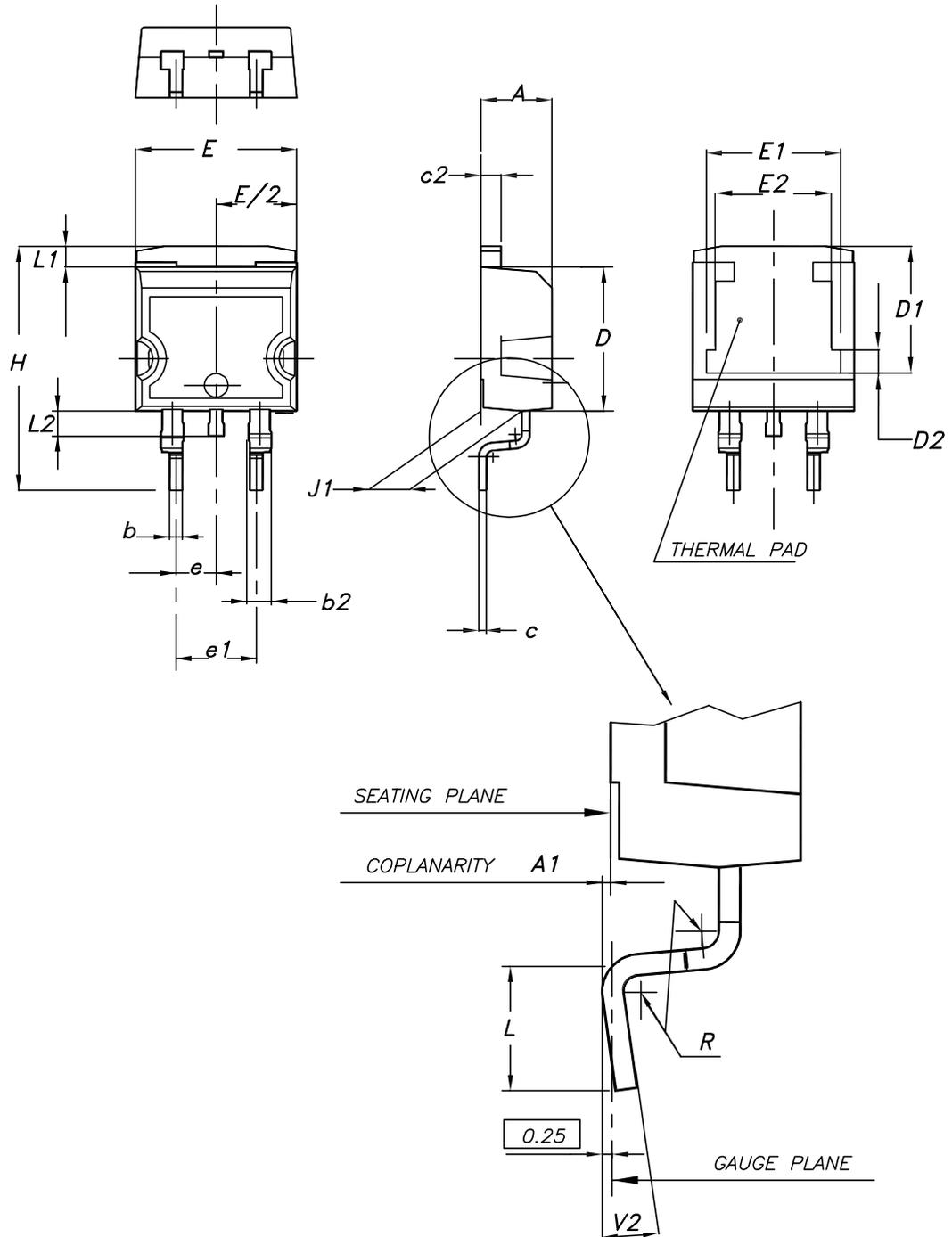
0079457_25

Table 8. 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	8.30	8.50	8.70
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 22. D²PAK (TO-263) recommended footprint (dimensions are in mm)
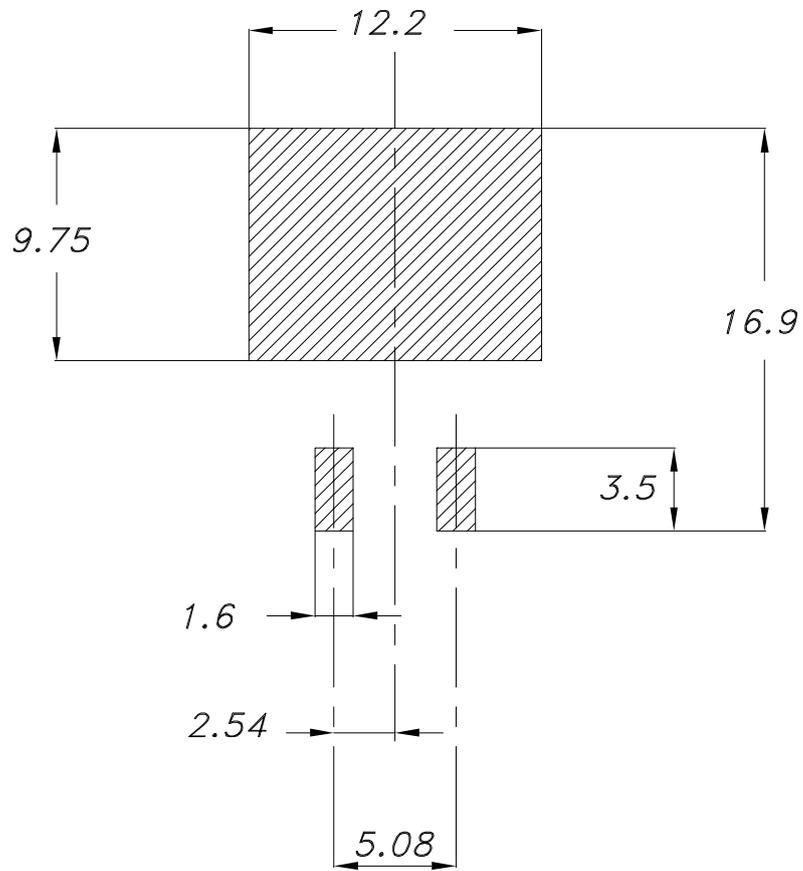
Footprint

4.2 DPAK (TO-252) type A2 package information

Figure 23. **DPAK (TO-252) type A2 package outline**
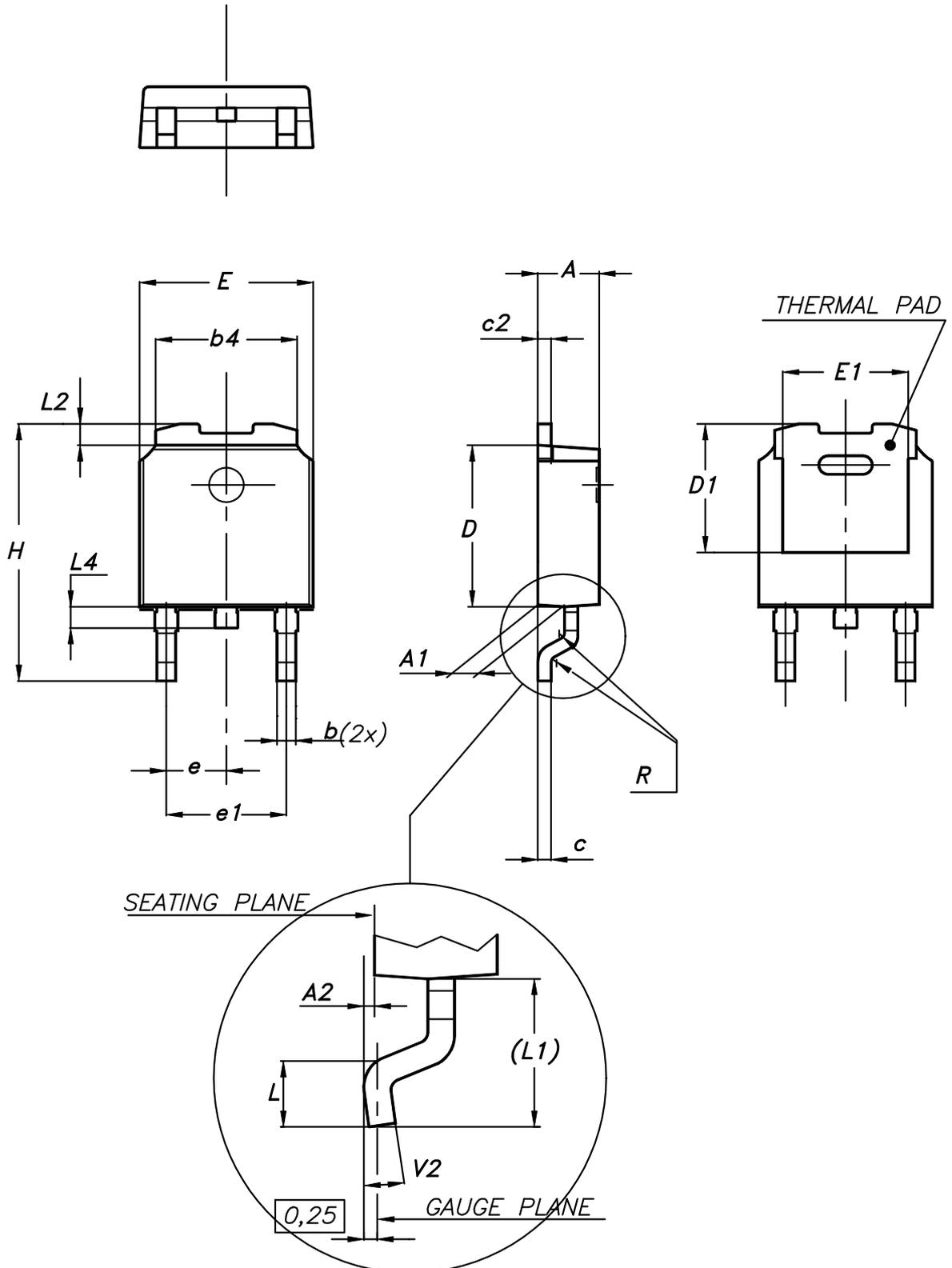
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**Table 9. DPAK (TO-252) type A2 mechanical data**

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	5.10	5.20	5.30
e	2.159	2.286	2.413
e1	4.445	4.572	4.699
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°

4.3 DPAK (TO-252) type C2 package information

Figure 24. DPAK (TO-252) type C2 package outline

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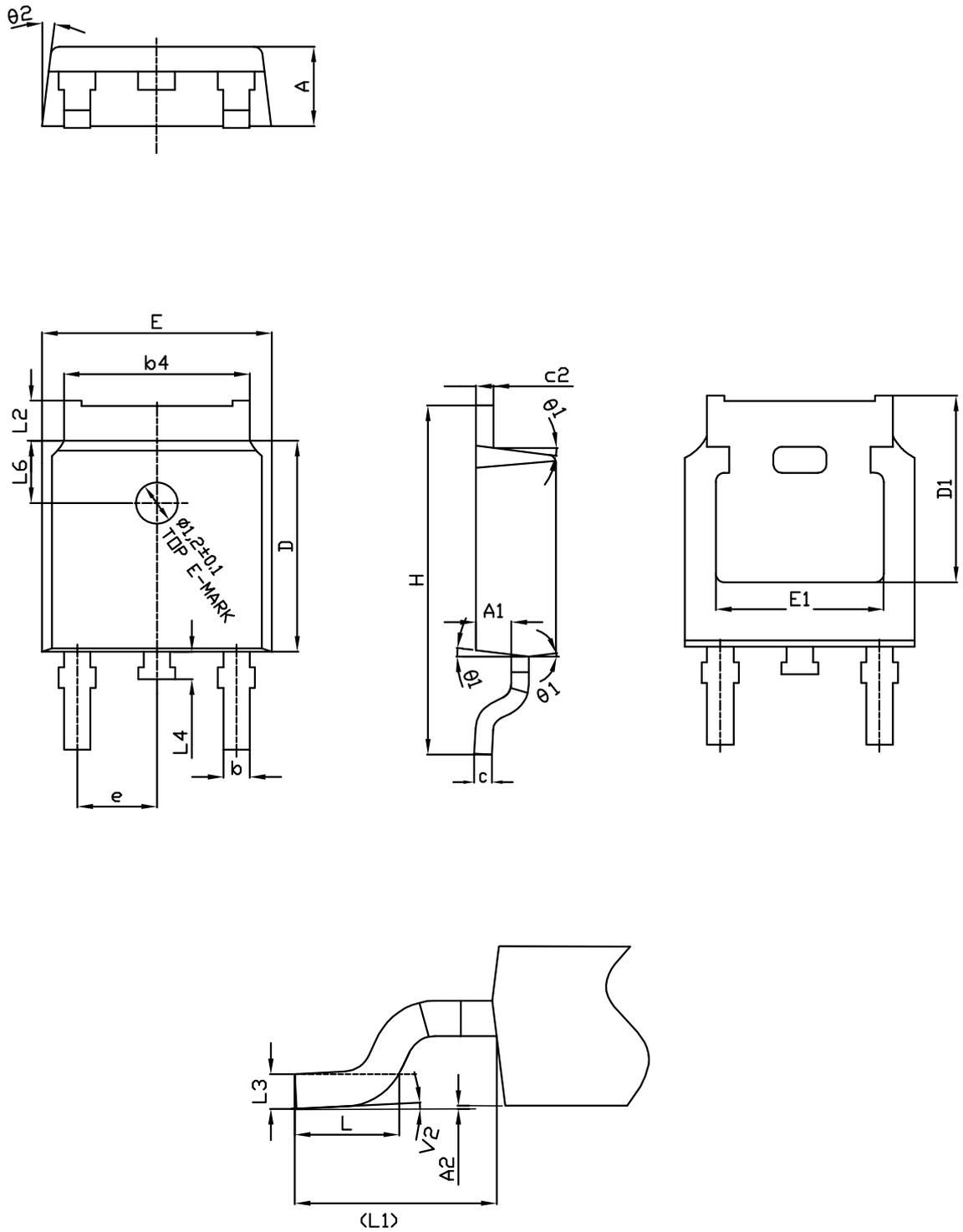
Table 10. DPAK (TO-252) type C2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.10		5.60
E	6.50	6.60	6.70
E1	5.20		5.50
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.90		1.25
L3	0.51 BSC		
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

Figure 25. DPAK (TO-252) recommended footprint (dimensions are in mm)
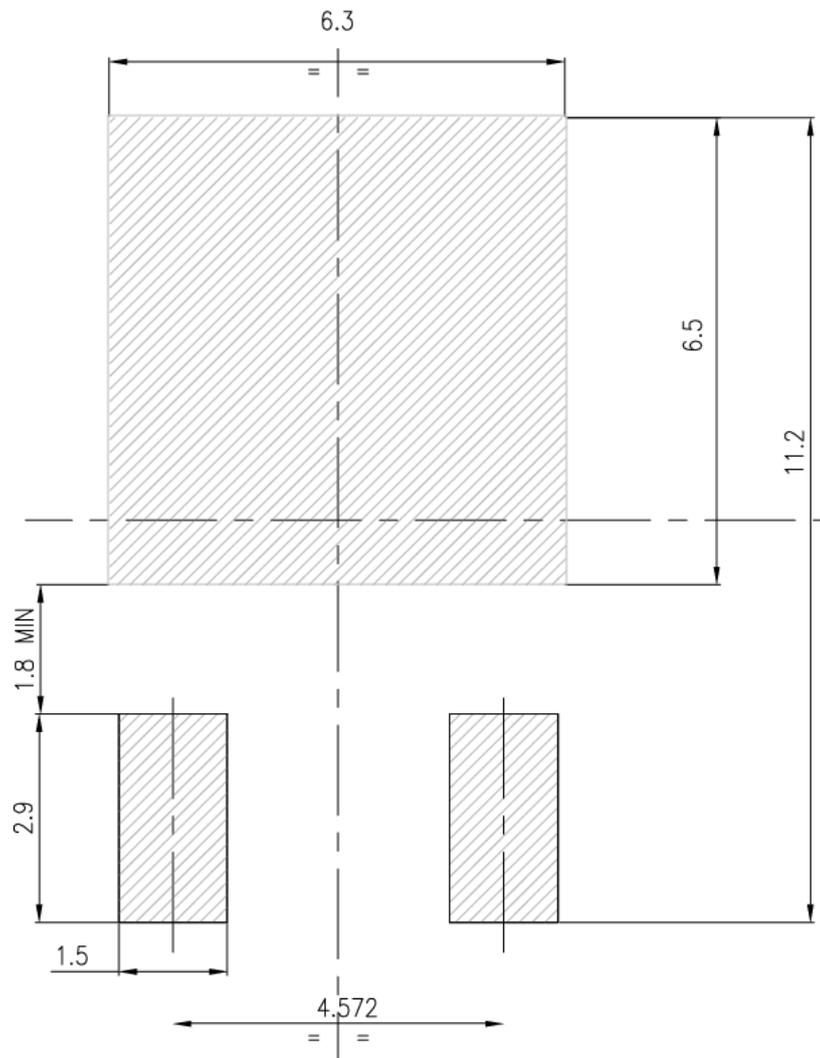
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4.4 D²PAK and DPAK packing information

Figure 26. Tape outline
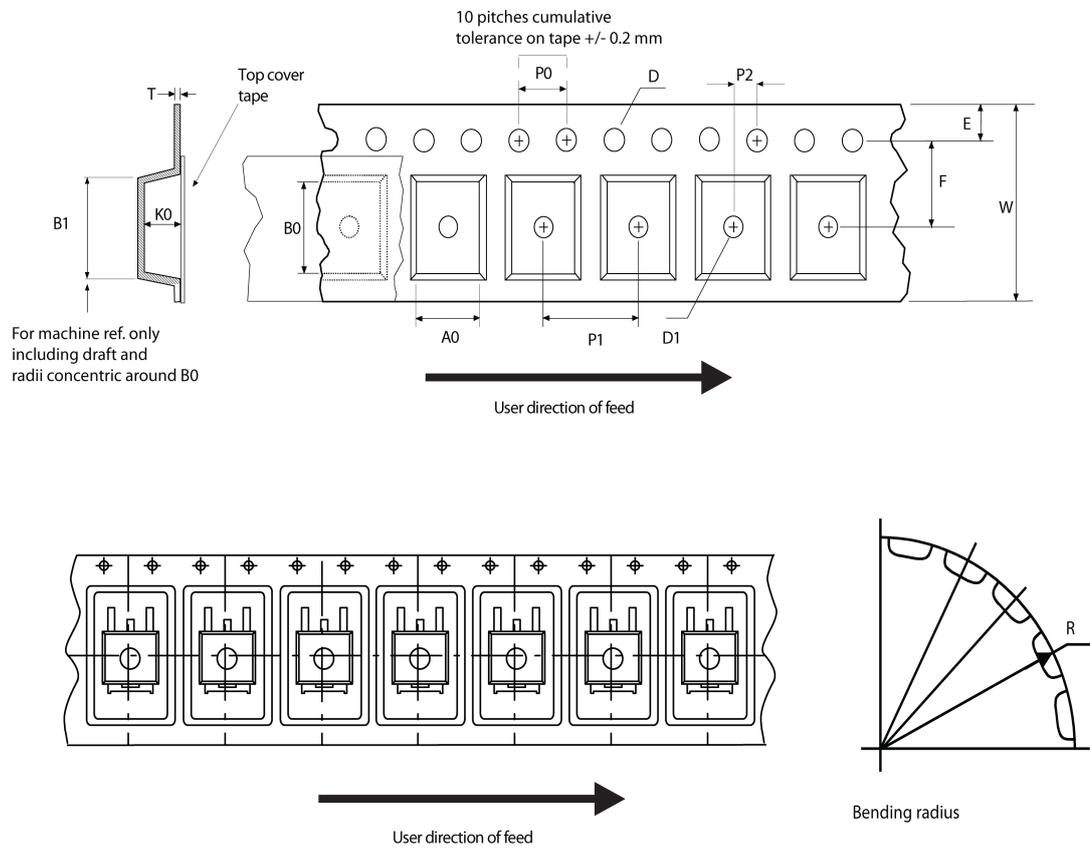
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Figure 27. Reel outline
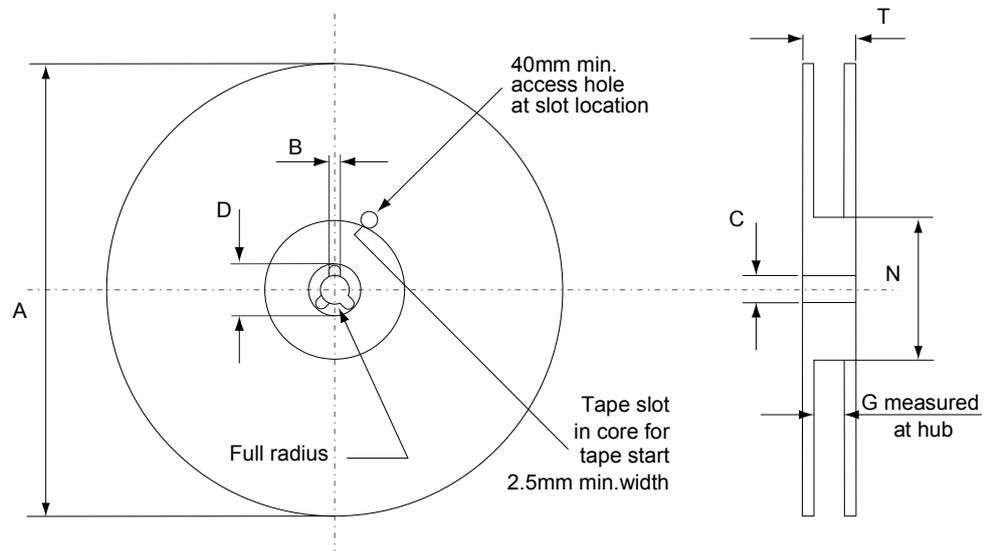
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Table 11. D²PAK tape and reel mechanical data

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			

Table 12. DPAK 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			

Revision history

Table 13. Document revision history

Date	Revision	Changes
22-Apr-2013	1	First release.
28-Jun-2013	2	– Document status promoted from preliminary data to production data - Minor text changes
03-Mar-2014	3	– Updated: *Table 10* and *Table 25* - Minor text changes
12-Sep-2016	4	Updated the title, features and the description. Updated D²PAK (TO-263) type A package information, *Section 4.2 DPAK (TO-252) type A2 package information*, *Section 4.3 DPAK (TO-252) type C2 package information* and *Section 4.4 D²PAK and DPAK packing information.*
12-Feb-2019	5	Updated Section 4 Package information. Minor text changes.

Contents

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