

N-channel 600 V, 0.28  $\Omega$  typ., 11 A MDmesh™ II  
Power MOSFETs in D<sup>2</sup>PAK and DPAK packages

Datasheet — production data

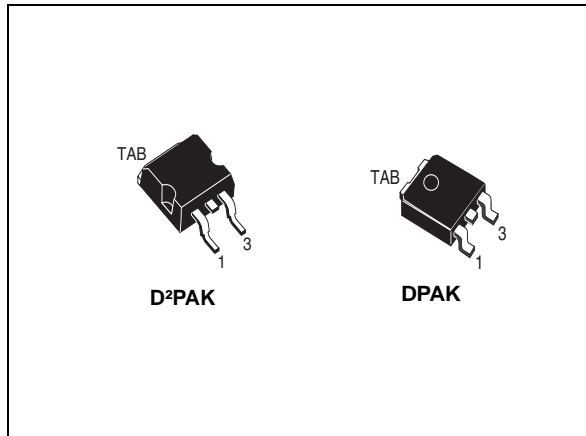
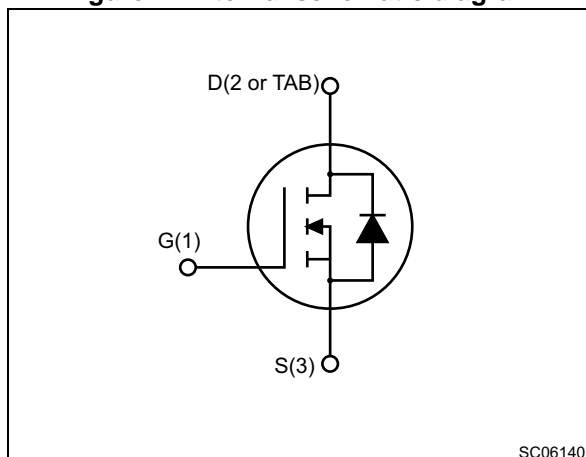


Figure 1. Internal schematic diagram



## Features

Order code	V <sub>DS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB13NM60N	650 V	0.36 $\Omega$	11 A
STD13NM60N			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order code	Marking	Packages	Packaging
STB13NM60N	13NM60N	D <sup>2</sup> PAK	Tape and reel
STD13NM60N		DPAK	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	11	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	6.93	A
$I_{DM}^{(1)}$	Drain current (pulsed)	44	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	90	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK	DPAK	
$R_{thj\text{-case}}$	Thermal resistance junction-case max	1.39		$^\circ\text{C}/\text{W}$
$R_{thj\text{-pcb}}$	Thermal resistance junction-pcb max	30	50	$^\circ\text{C}/\text{W}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)	3.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25\text{ }^\circ\text{C}$ , $I_D=I_{AS}$ , $V_{DD}=50\text{ V}$ )	200	mJ

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  unless otherwise specified)

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0, I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0, V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0, V_{DS} = 600\text{ V}, T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0, V_{GS} = \pm 25\text{ V}$			$\pm 0.1$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}$		0.28	0.36	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0, V_{DS} = 50\text{ V}, f = 1\text{ MHz}$	-	790	-	pF
$C_{oss}$	Output capacitance		-	60	-	pF
$C_{rss}$	Reverse transfer capacitance		-	3.6	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$	-	135	-	pF
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}, I_D = 11\text{ A}, V_{GS} = 10\text{ V},$ <i>(see Figure 16)</i>	-	27	-	nC
$Q_{gs}$	Gate-source charge		-	4	-	nC
$Q_{gd}$	Gate-drain charge		-	14	-	nC
$R_G$	Gate input resistance	$f = 1\text{ MHz}$ open drain	-	4.7	-	$\Omega$

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

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}, I_D = 5.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ <i>(see Figure 15)</i>	-	3	-	ns
$t_r$	Rise time		-	8	-	ns
$t_{d(off)}$	Turn-off delay time		-	30	-	ns
$t_f$	Fall time		-	10	-	ns

Table 8. 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	$I_{SD} = 11 \text{ A}, V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	-	230		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100 \text{ V}$ (see Figure 17)	-	2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	18		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 11 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	-	290		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ (see Figure 17)	-	2.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	17		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D<sup>2</sup>PAK

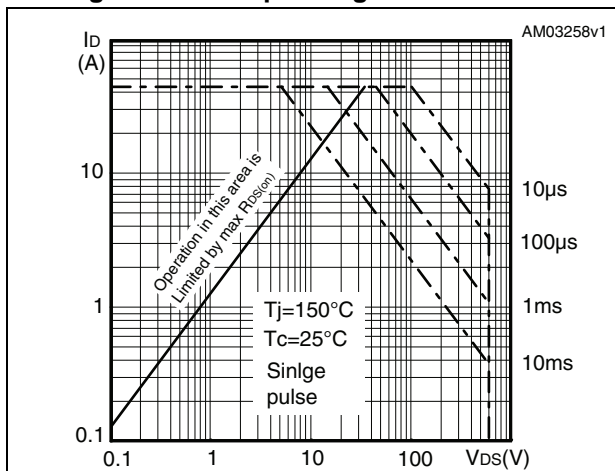


Figure 3. Thermal impedance for D<sup>2</sup>PAK

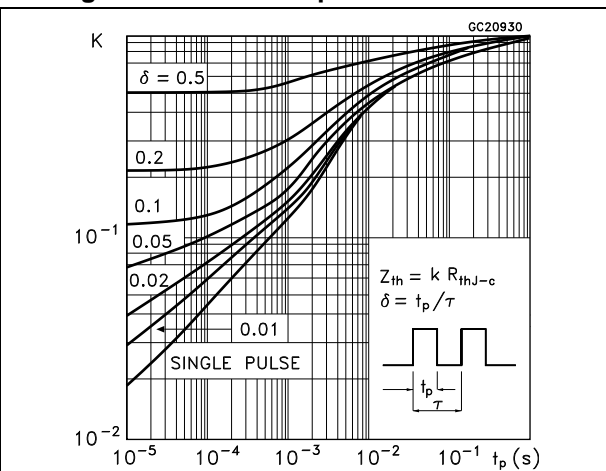


Figure 4. Safe operating area for DPAK

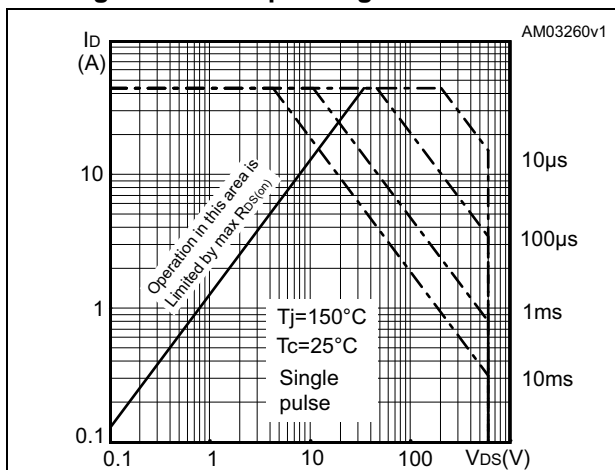


Figure 5. Thermal impedance for DPAK

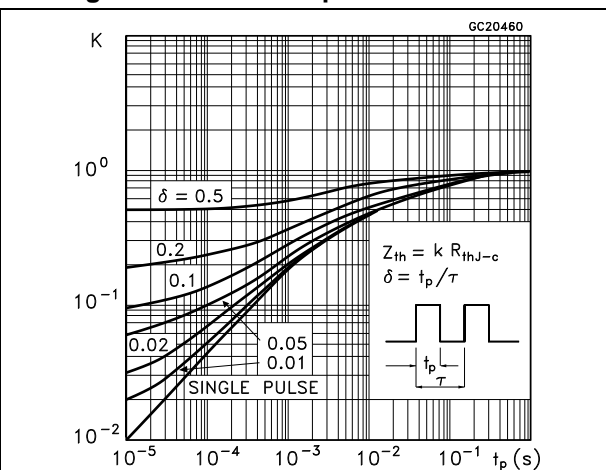


Figure 6. Output characteristics

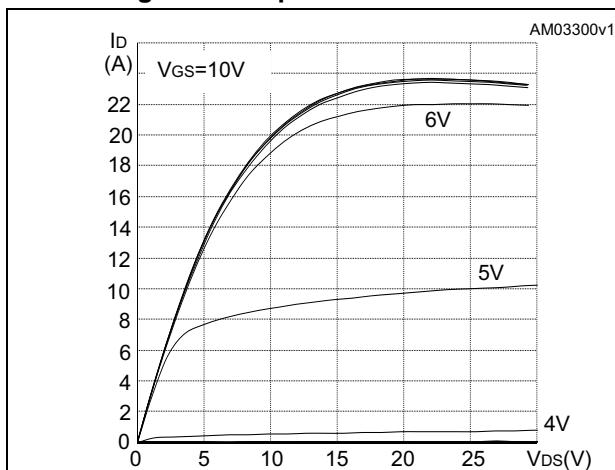


Figure 7. Transfer characteristics

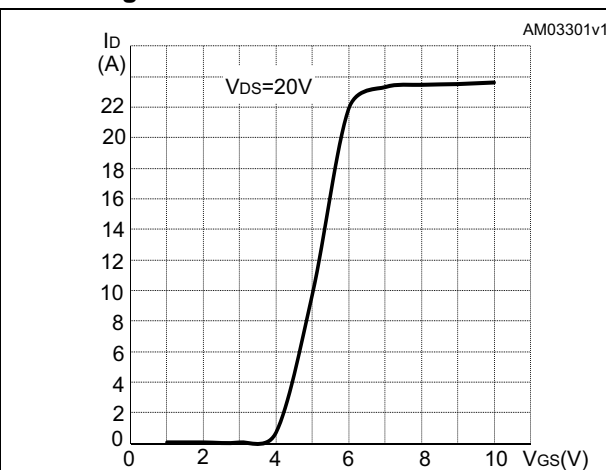


Figure 8. Normalized  $V_{(BR)DSS}$  vs temperature

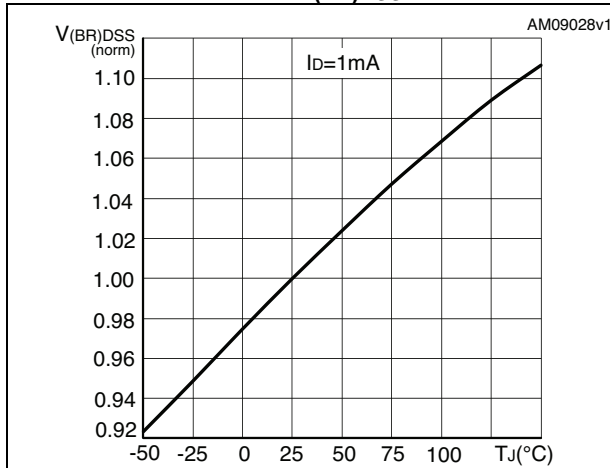


Figure 9. Static drain-source on-resistance

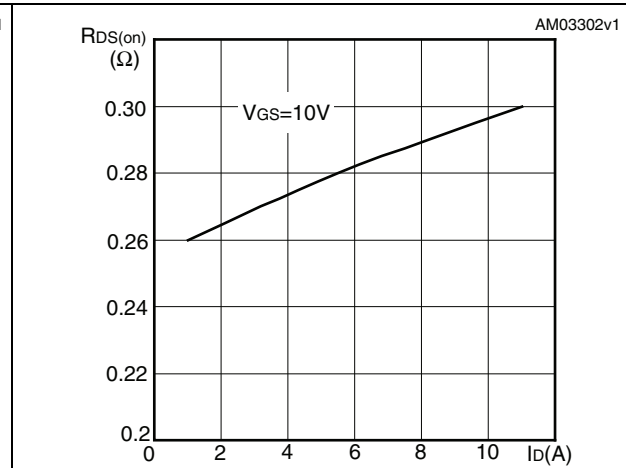


Figure 10. Gate charge vs gate-source voltage

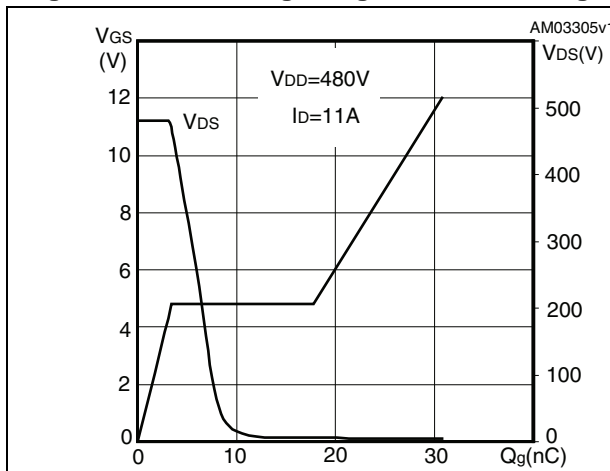


Figure 11. Capacitance variations

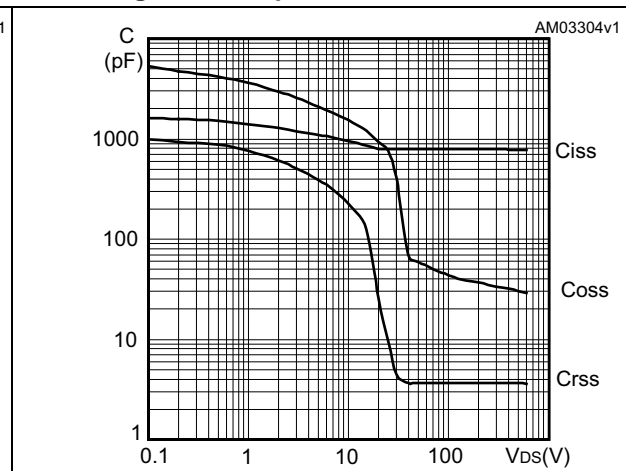


Figure 12. Normalized gate threshold voltage vs temperature

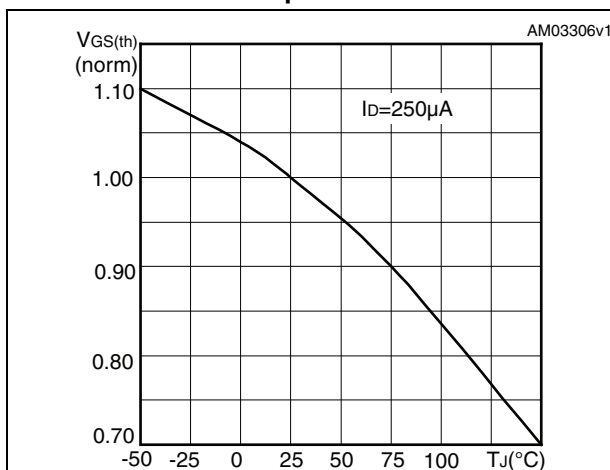


Figure 13. Normalized on-resistance vs temperature

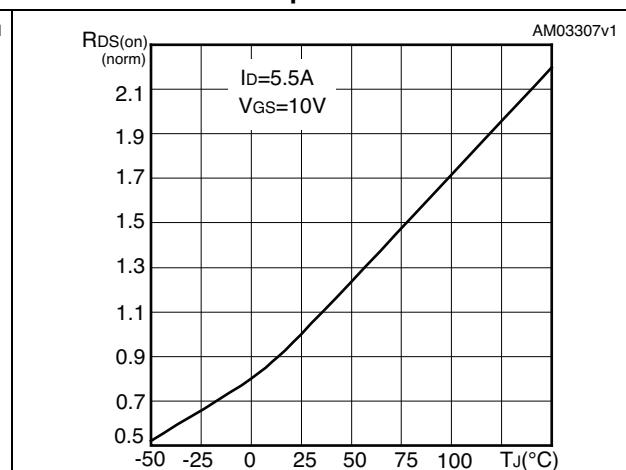
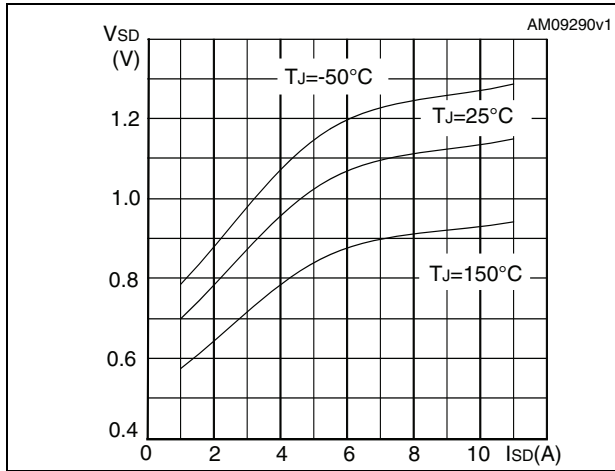


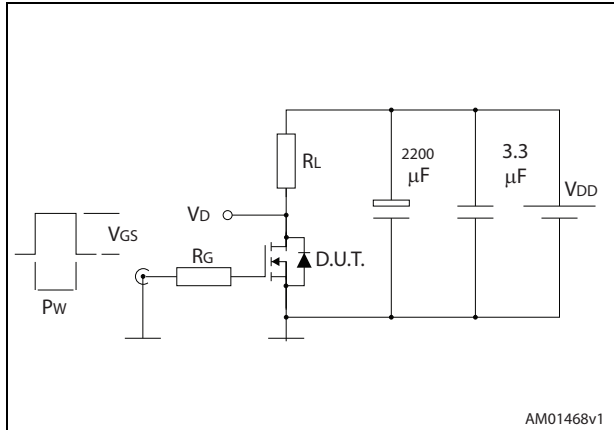
Figure 14. Source-drain diode forward characteristics





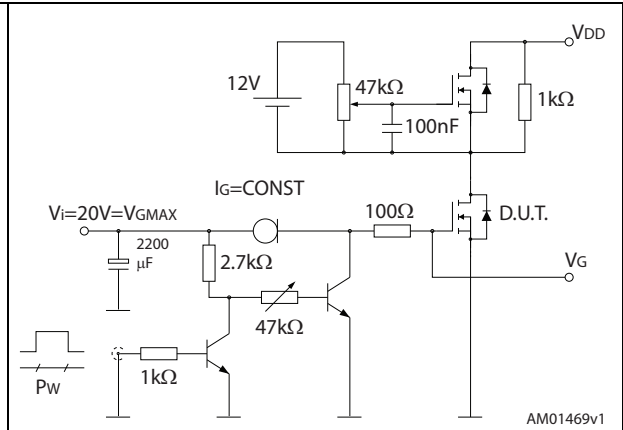
### 3 Test circuits

**Figure 15. Switching times test circuit for resistive load**



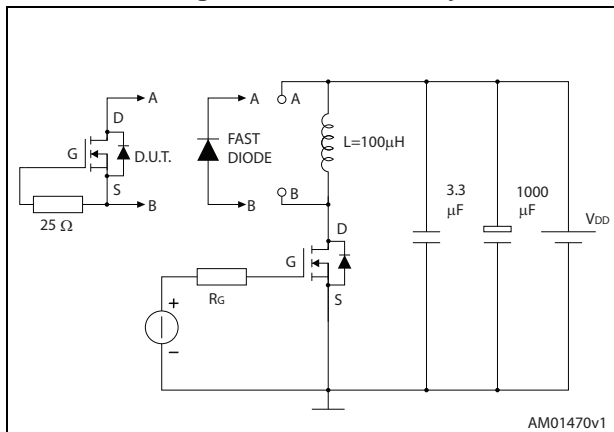
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**Figure 16. Gate charge test circuit**



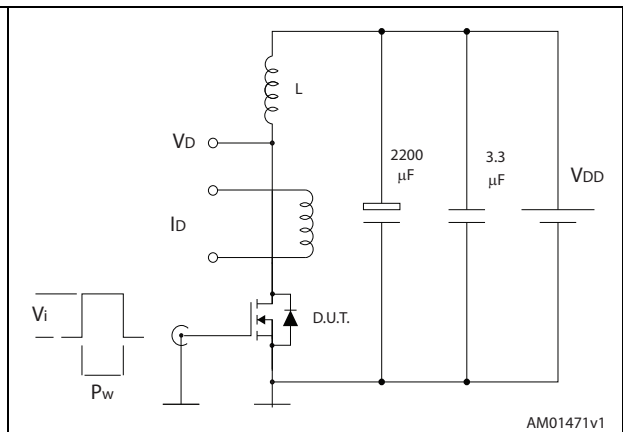
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**Figure 17. Test circuit for inductive load switching and diode recovery times**



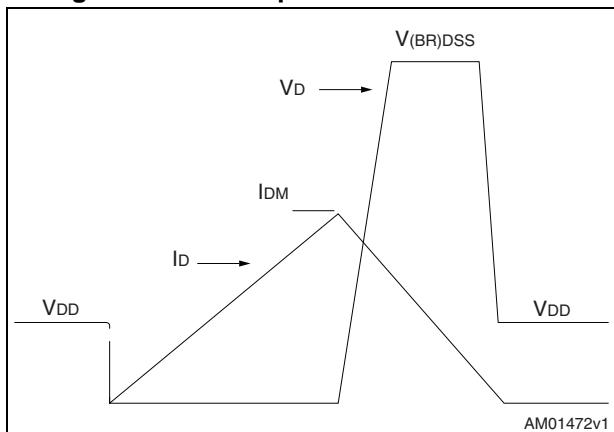
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**Figure 18. Unclamped inductive load test circuit**



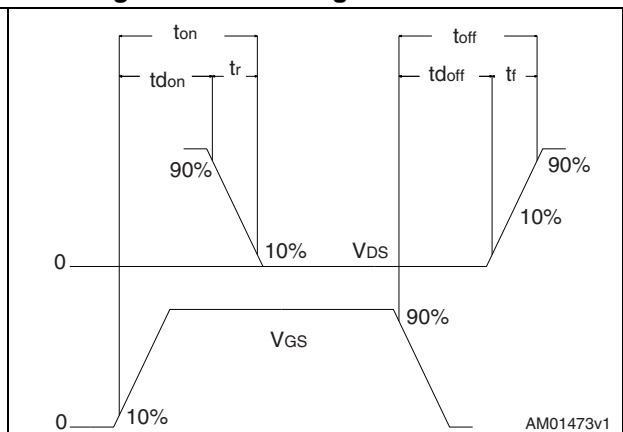
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**Figure 19. Unclamped inductive waveform**



AM01472v1

**Figure 20. Switching time waveform**



AM01473v1

## 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 package information

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

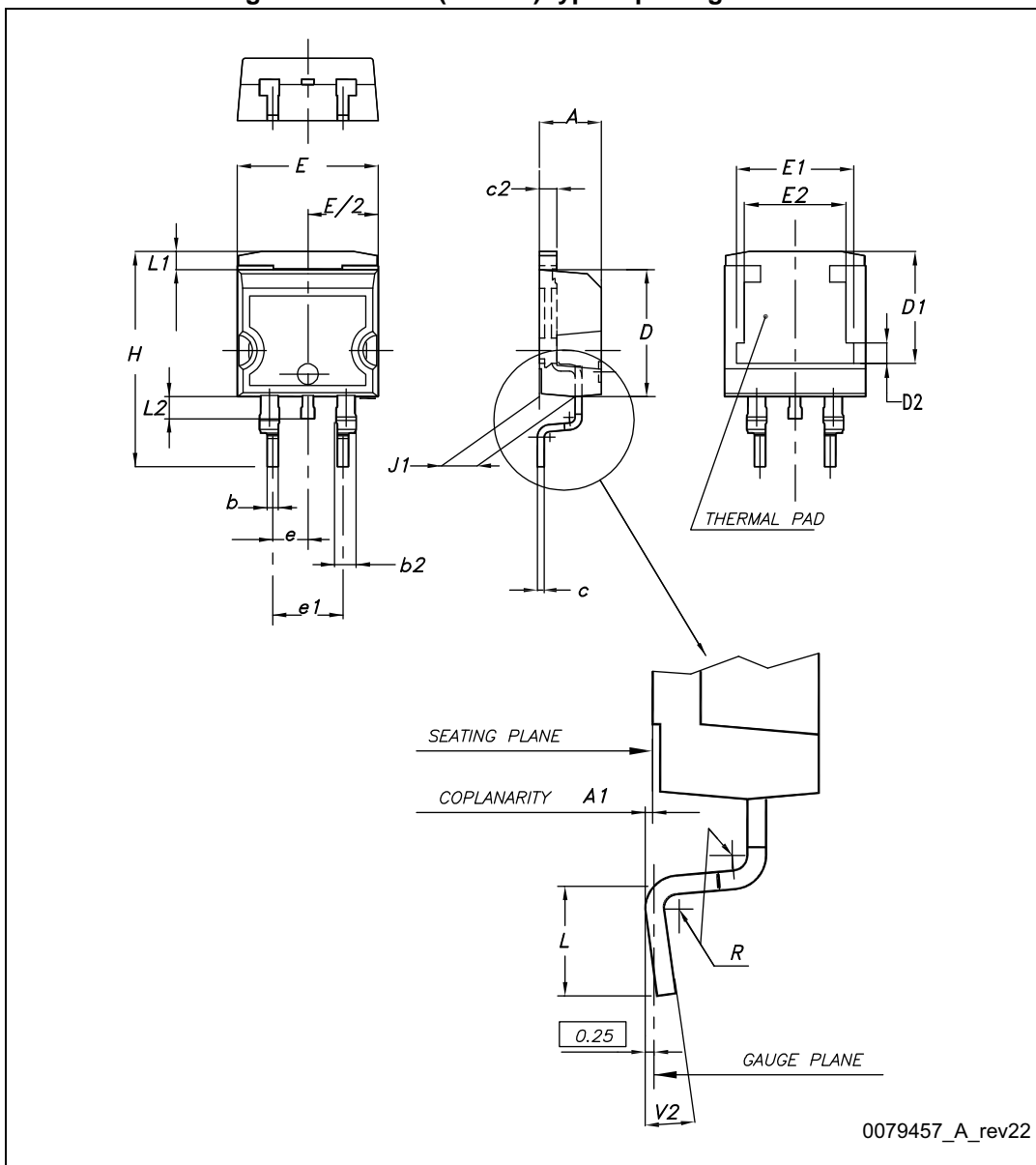


Table 9. D<sup>2</sup>PAK (TO-263) type A package mechanical data

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) type B package outline

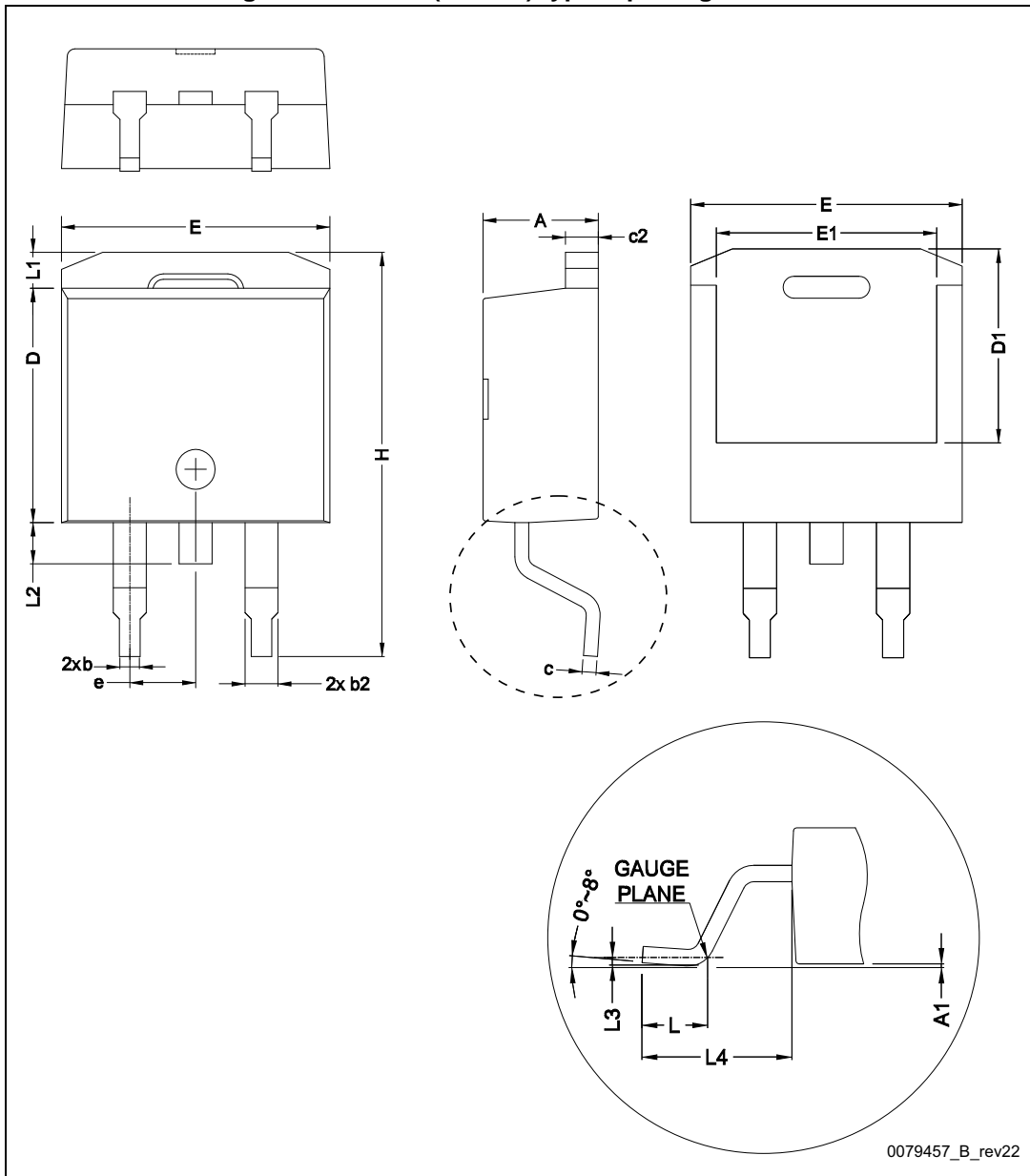
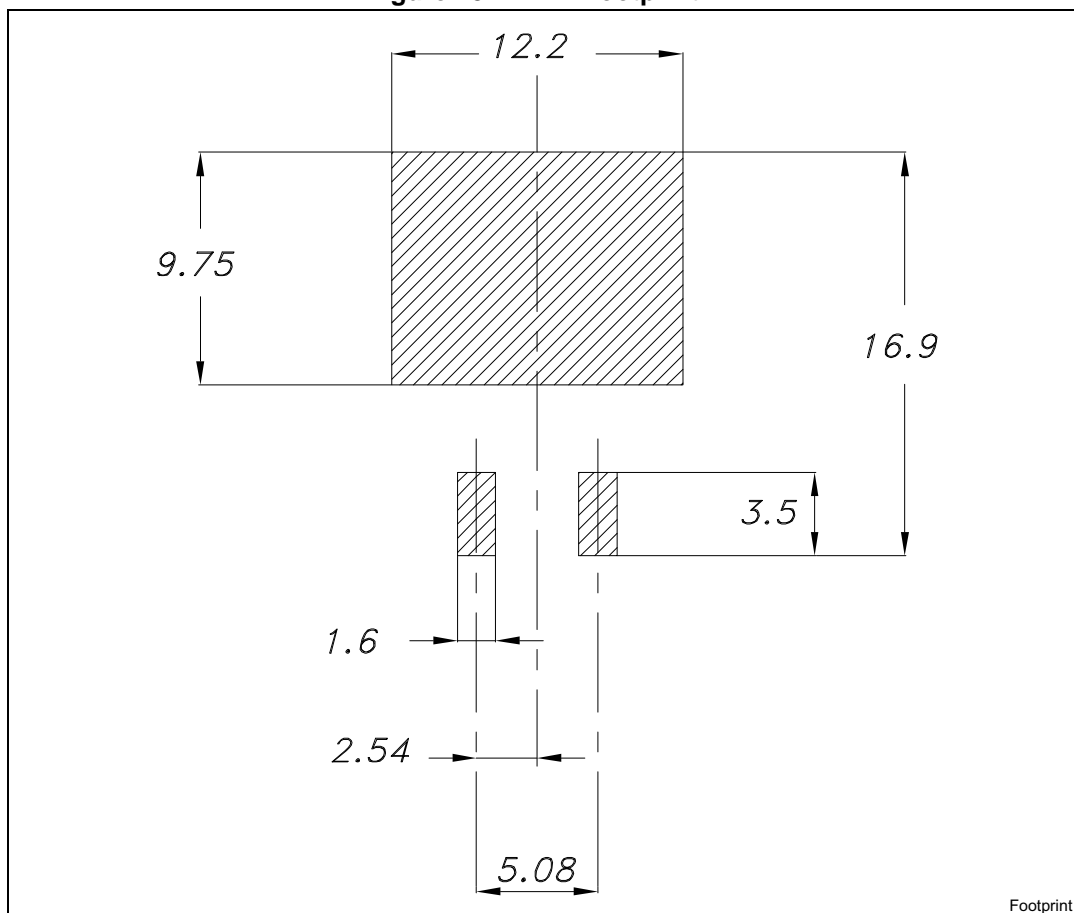


Table 10. D<sup>2</sup>PAK (TO-263) type B package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.60
A1	0		0.25
b	0.70		0.93
b2	1.14		1.70
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.36
D	8.6		9.35
D1	6.9		
E	10		10.55
E1	8.1		
e		2.54	
H	15		15.85
L	1.9		2.79
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 23. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

### 4.2 DPAK package information

Figure 24. DPAK (TO-252) type A2 package outline

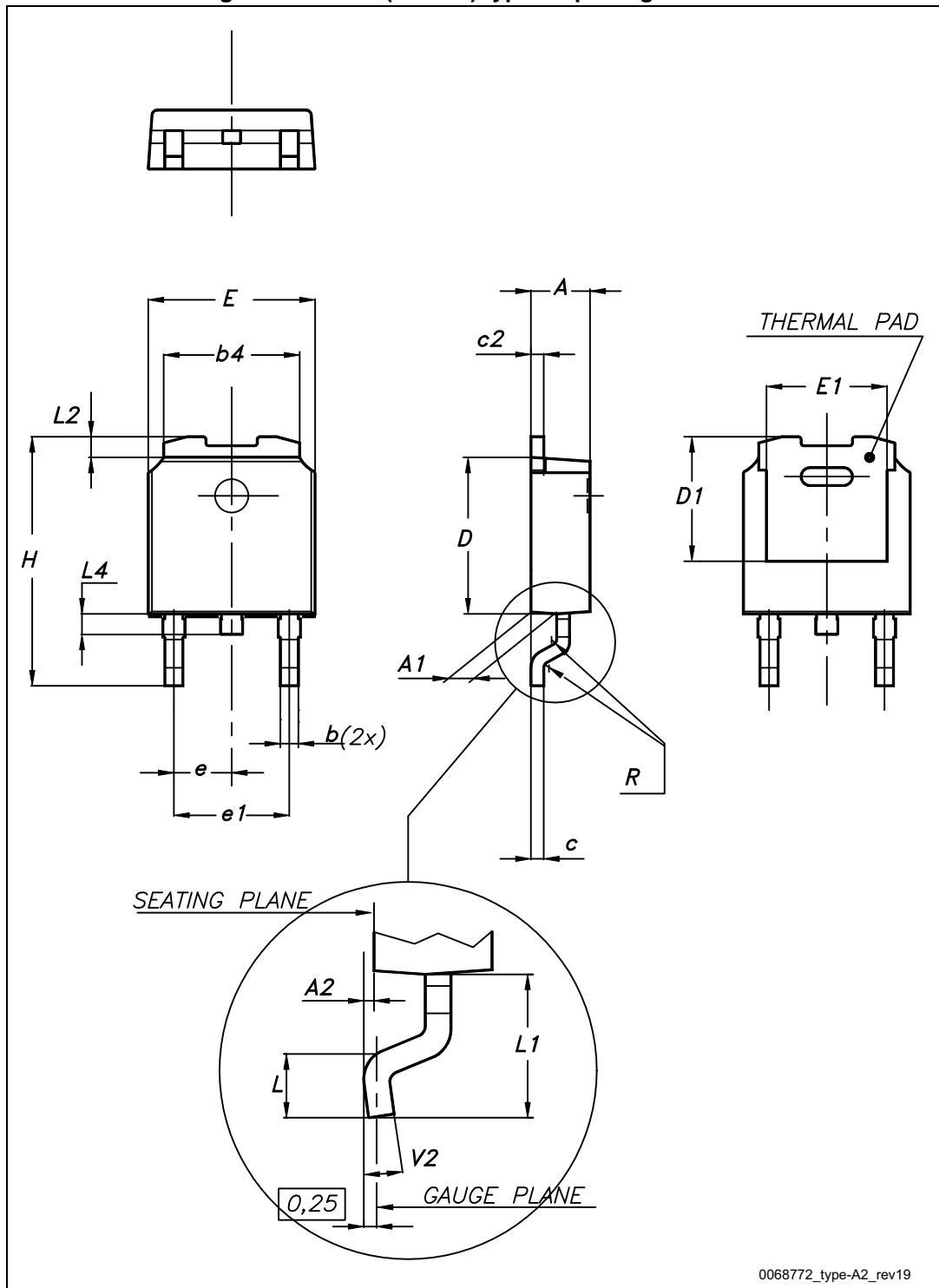


Table 11. DPAK (TO-252) type A2 package mechanical data

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	2.16	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 25. DPAK (TO-252) type C2 outline

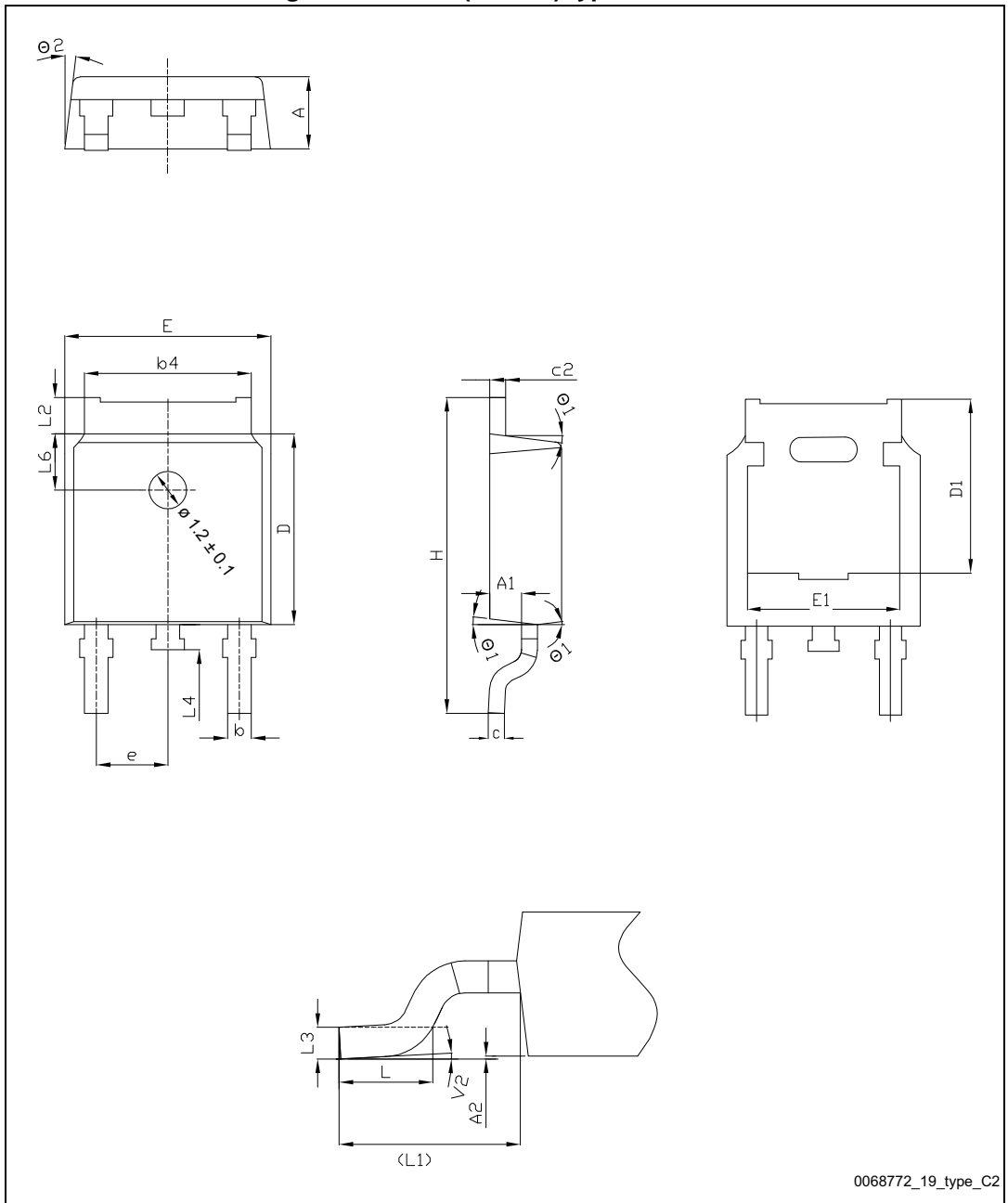
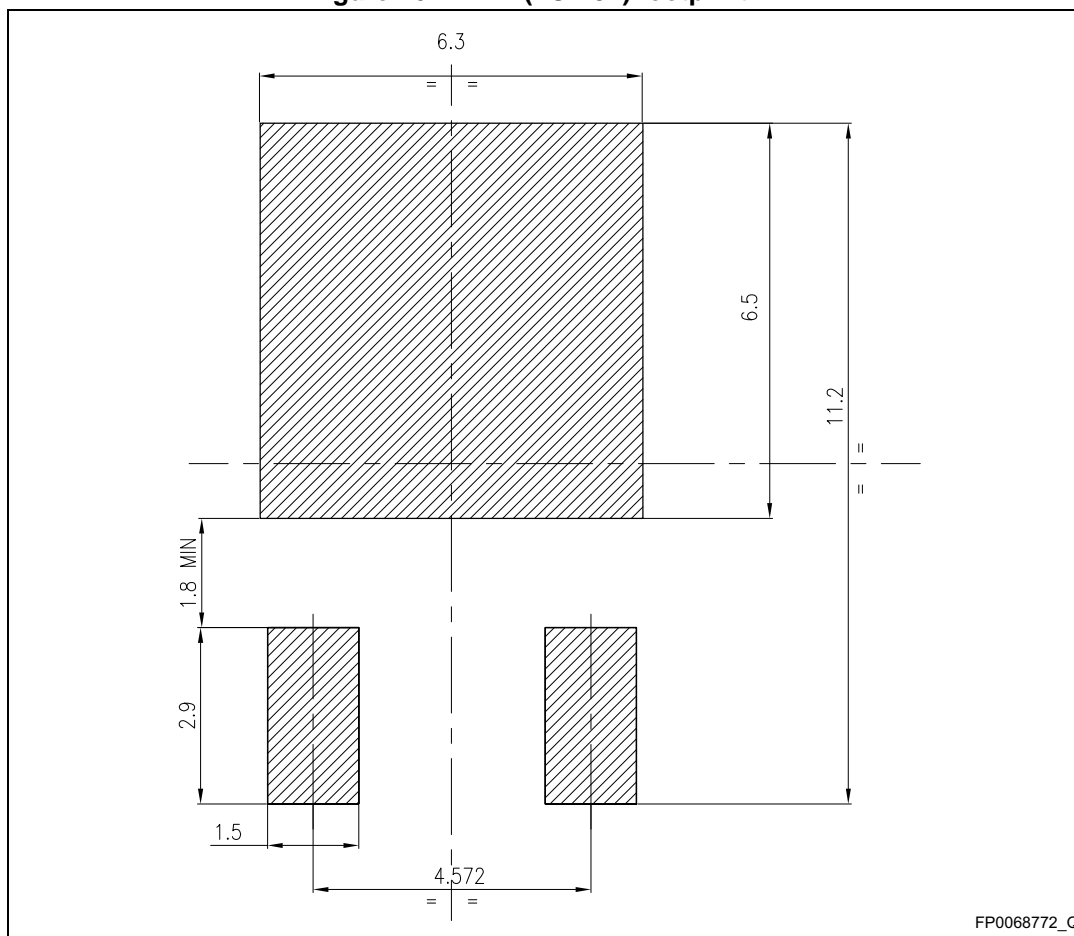


Table 12. DPAK (TO-252) type C2 package mechanical data

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	5.25	-	-
E	6.50	6.60	6.70
E1	5.20	-	-
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 26. DPAK (TO-252) footprint (b)



b. All dimensions are in millimeters

# 5 Packing information

Figure 27. Tape

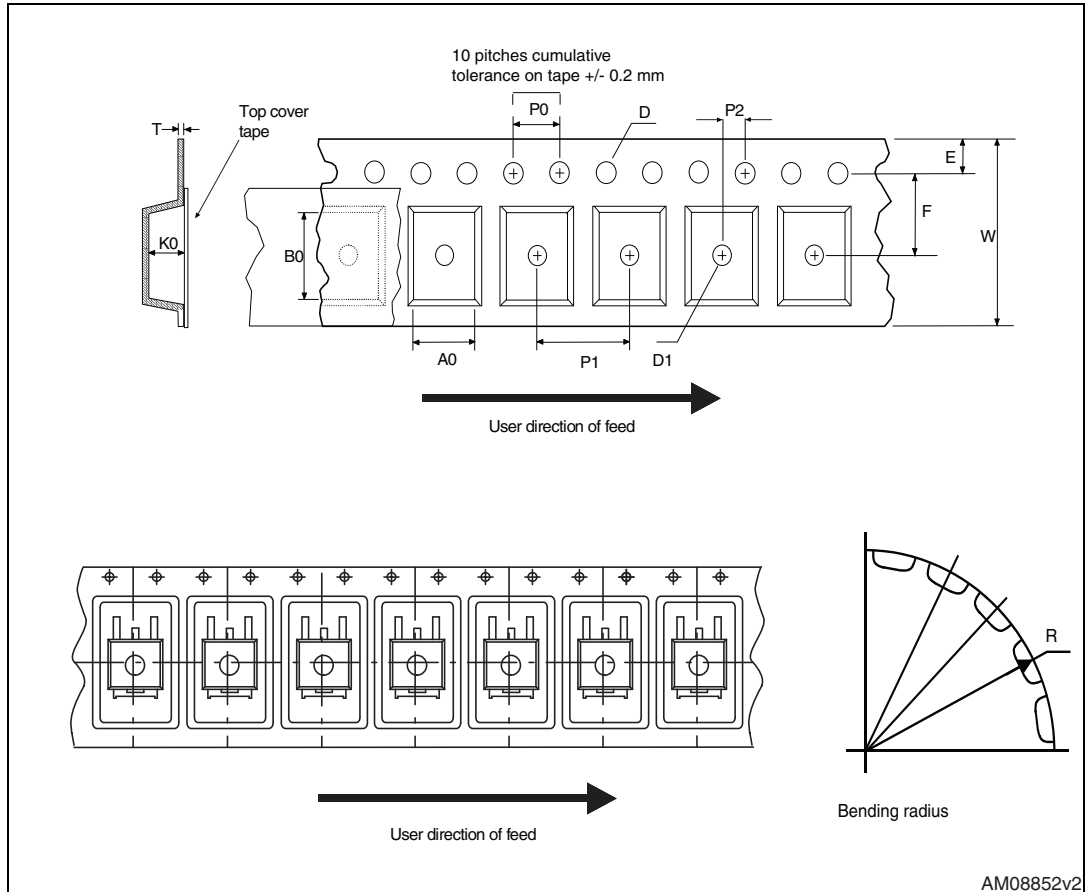
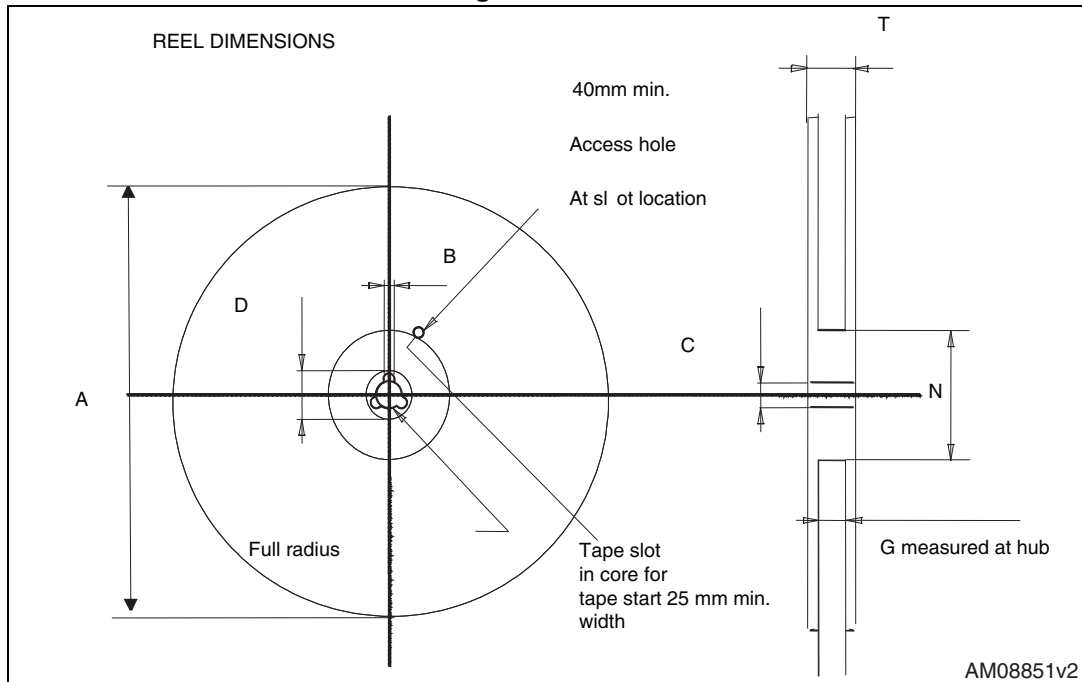


Figure 28. Reel



AM08851v2

Table 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			

Table 14. 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			

## 6 Revision history

Table 15. Document revision history

Date	Revision	Changes
18-Dec-2012	1	First release
10-Jul-2014	2	– Updated: <a href="#">Section 3: Test circuits</a> – Updated: <a href="#">Section 4: Package information</a> – Minor text changes
19-Jun-2015	3	– Updated <a href="#">4: Package information</a> – Minor text changes

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