



# STB120N4F6 STD120N4F6

N-channel 40 V, 3.5 mΩ, 80 A, DPAK, D<sup>2</sup>PAK  
STripFET™ VI DeepGATE™ Power MOSFET

## Features

Order codes	V <sub>DSS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STB120N4F6	40 V	4 mΩ	80 A <sup>(1)</sup>
STD120N4F6	40 V	4 mΩ	80 A <sup>(1)</sup>

1. Current limited by package

- Standard threshold drive
- 100% avalanche tested

## Application

- Switching applications
- Automotive

## Description

These devices are 40 V N-channel STripFET™ VI Power MOSFET based on the ST's proprietary STripFET™ technology, with a new gate structure. The resulting Power MOSFET exhibits the lowest R<sub>DS(on)</sub> in all packages.

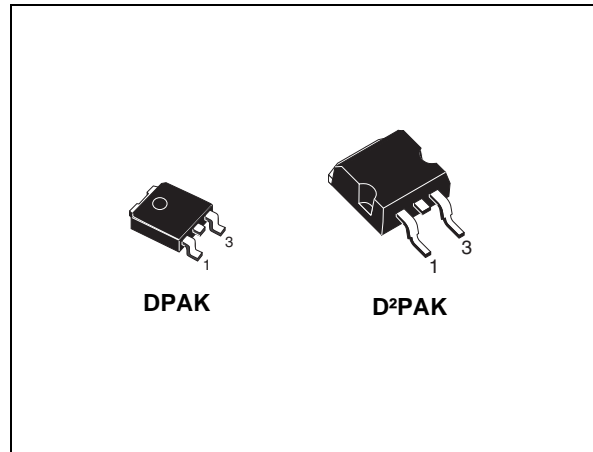


Figure 1. Internal schematic diagram

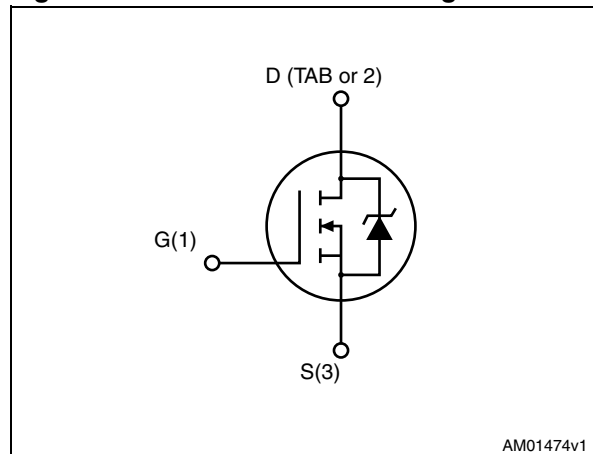


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB120N4F6	120N4F6	D <sup>2</sup> PAK	Tape and reel
STD120N4F6		DPAK	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	40	V
$V_{GS}$	Gate-source voltage	$\pm 20$	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	80	A
$I_D^{(1)}$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	80	A
$I_{DM}^{(2)}$	Drain current (pulsed)	320	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	110	W
$T_{stg}$	Storage temperature	-55 to 175	$^\circ\text{C}$
$T_j$	Operating junction temperature		

1. Current limited by package
2. Pulse width limited by safe operating area

**Table 3. Thermal resistance**

Symbol	Parameter	Value		Unit
		DPAK	D <sup>2</sup> PAK	
$R_{thj-case}$	Thermal resistance junction-case max	1.36		$^\circ\text{C}/\text{W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max <sup>(1)</sup>	50	35	$^\circ\text{C}/\text{W}$

1. When mounted on 1 inch<sup>2</sup> 2 oz. Cu board.

**Table 4. Thermal resistance**

Symbol	Parameter	Value	Unit
$I_{AR}^{(1)}$	Avalanche current, repetitive or not-repetitive	40	A
$E_{AS}^{(2)}$	Single pulse avalanche energy	394	mJ

1. Pulse width limited by  $T_j$  max
2. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = 40\text{ A}$ ,  $V_{DD} = 25\text{ V}$

## 2 Electrical characteristics

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

**Table 5. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown Voltage	$I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0$	40			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 20\text{ V}$ $V_{DS} = 20\text{ V}$ , $T_c = 125\text{ °C}$			1 10	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2		4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 40\text{ A}$		3.5	4.0	m $\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$		3850		pF
$C_{oss}$	Output capacitance		-	650	-	pF
$C_{rss}$	Reverse transfer capacitance			350		pF
$Q_g$	Total gate charge	$V_{DD} = 20\text{ V}$ , $I_D = 80\text{ A}$		65		nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10\text{ V}$	-	20	-	nC
$Q_{gd}$	Gate-drain charge	(see Figure 14)		16		nC
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	1.5	-	$\Omega$

**Table 7. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 20\text{ V}$ , $I_D = 40\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ <i>(see Figure 15)</i>	-	20	-	ns
$t_r$	Rise time		-	70	-	ns
$t_{d(off)}$	Turn-off delay time	$V_{DD} = 20\text{ V}$ , $I_D = 40\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ <i>(see Figure 15)</i>	-	40	-	ns
$t_f$	Fall time		-	20	-	ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		80	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		320	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 40\text{ A}$ , $V_{GS} = 0$	-		1.1	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 80\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 30\text{ V}$ <i>(see Figure 17)</i>	-	40		ns
$Q_{rr}$	Reverse recovery charge		-	56		nC
$I_{RRM}$	Reverse recovery current		-	2.8		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

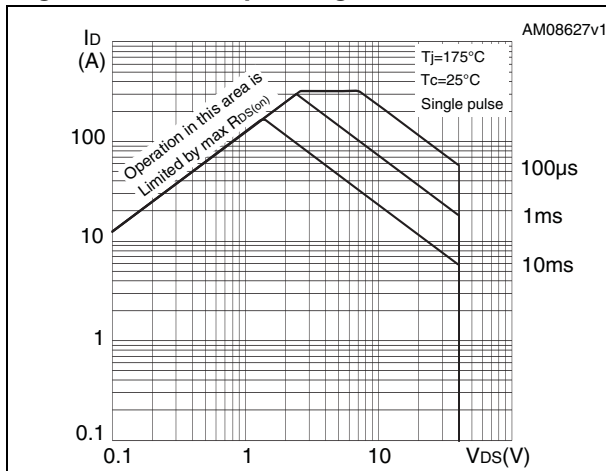


Figure 3. Thermal impedance

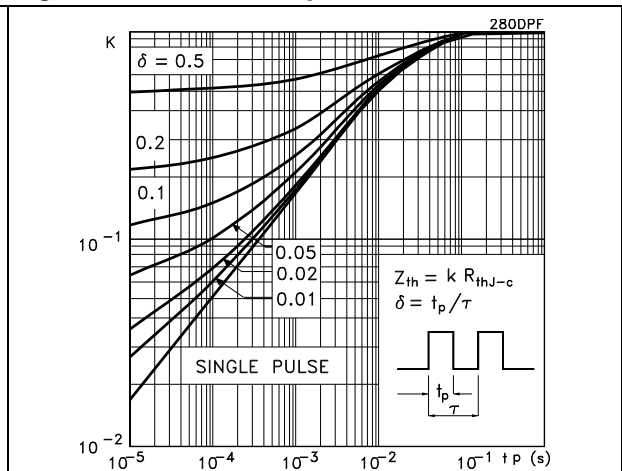


Figure 4. Output characteristics

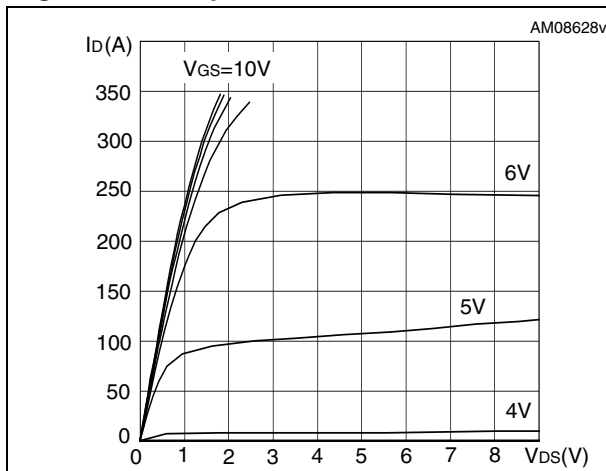


Figure 5. Transfer characteristics

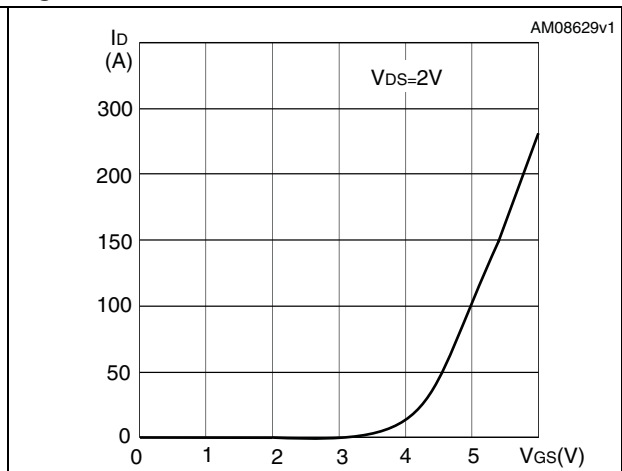


Figure 6. Normalized  $B_{V_{DS}}$  vs temperature

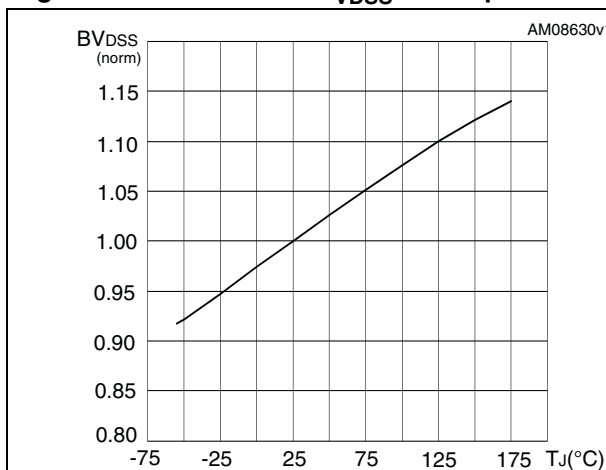
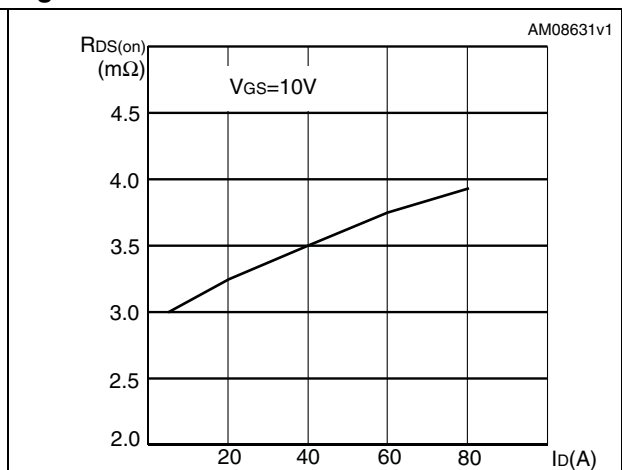
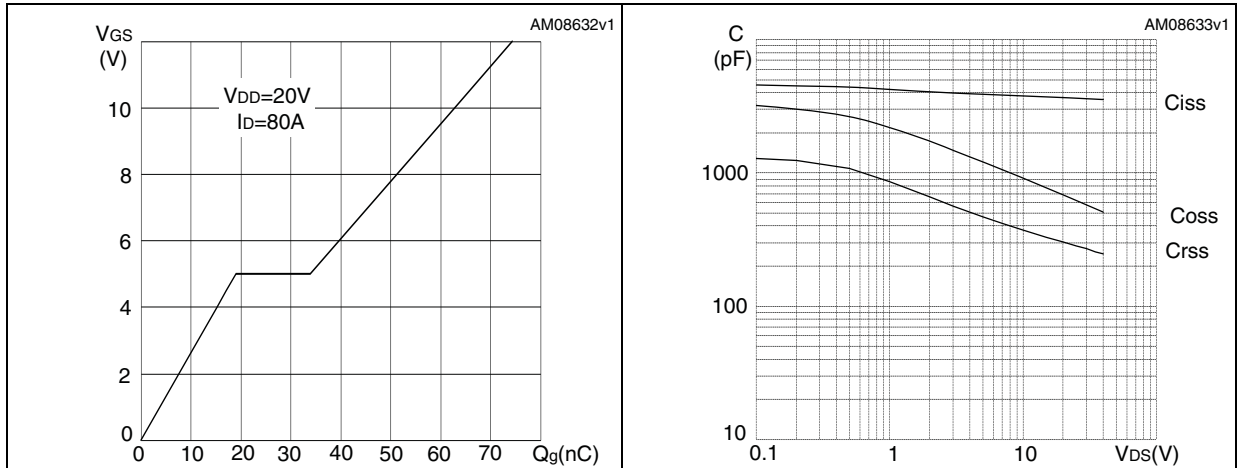


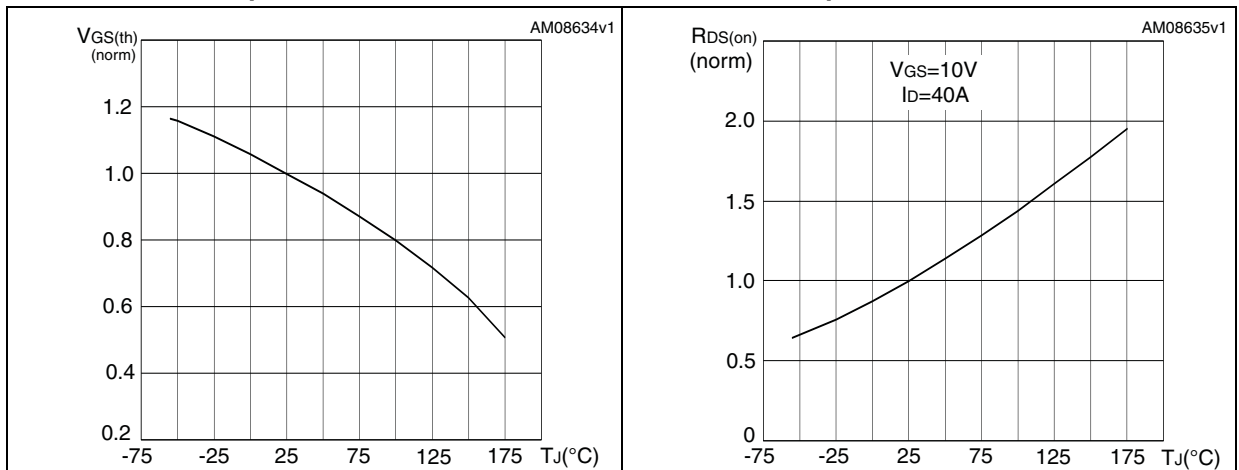
Figure 7. Static drain-source on resistance



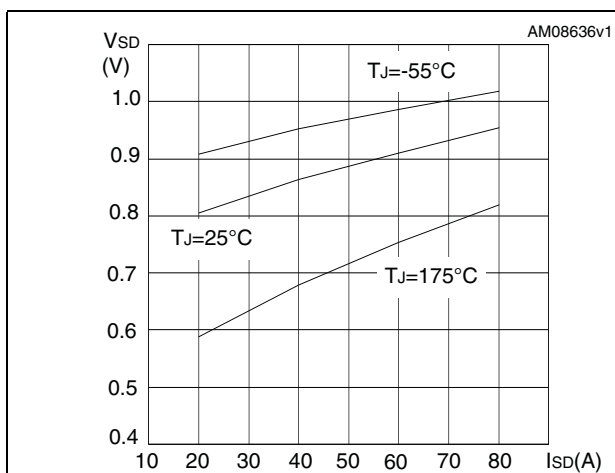
**Figure 8. Gate charge vs gate-source voltage** **Figure 9. Capacitance variations**



**Figure 10. Normalized gate threshold voltage vs temperature** **Figure 11. Normalized on resistance vs temperature**

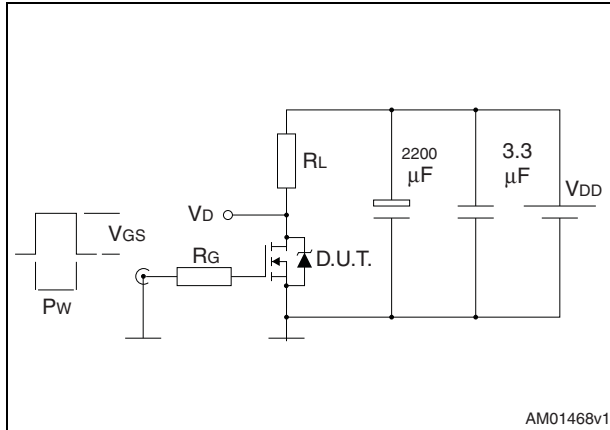


**Figure 12. Source-drain diode forward characteristics**

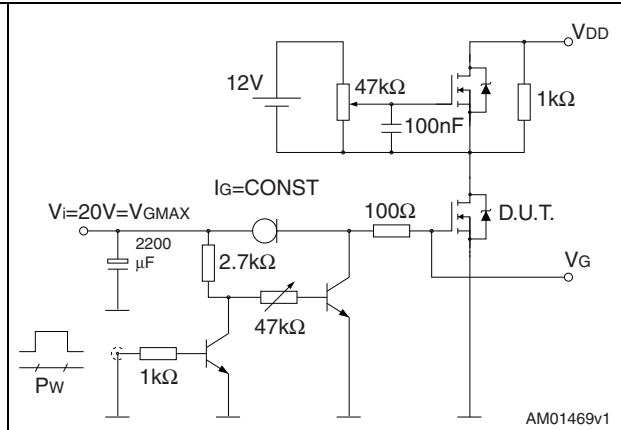


### 3 Test circuits

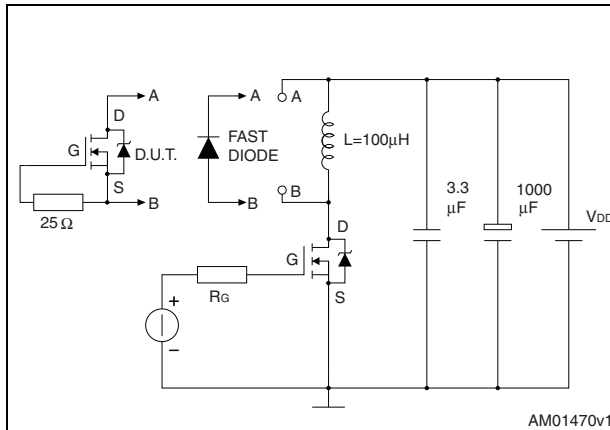
**Figure 13. Switching times test circuit for resistive load**



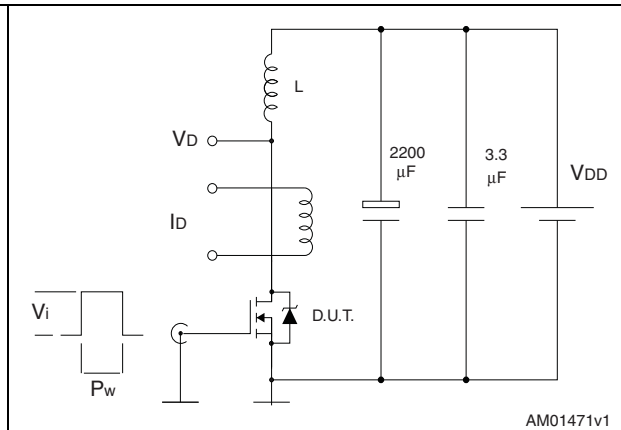
**Figure 14. Gate charge test circuit**



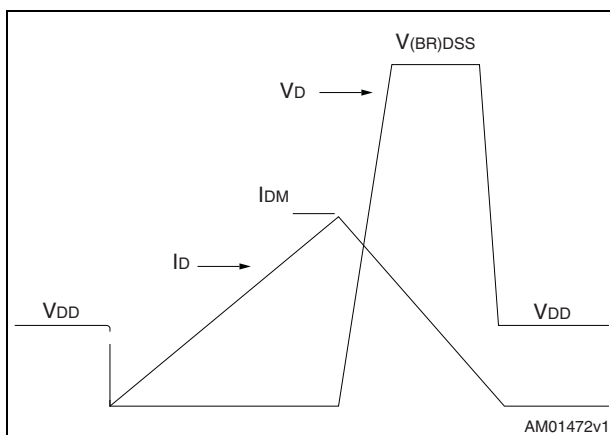
**Figure 15. Test circuit for inductive load switching and diode recovery times**



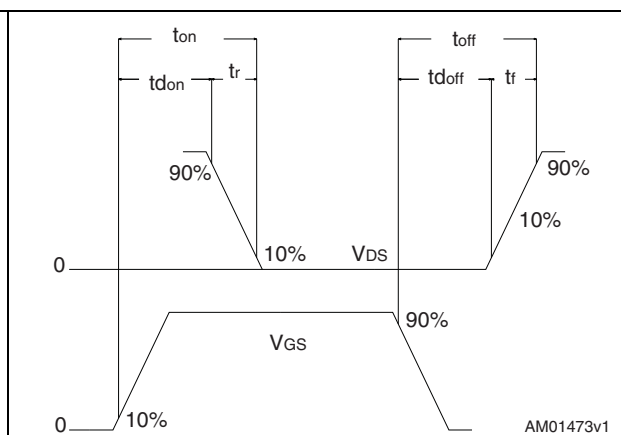
**Figure 16. Unclamped Inductive load test circuit**



**Figure 17. Unclamped inductive waveform**



**Figure 18. Switching time waveform**





## 4 Package mechanical data

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 products status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Table 9. D<sup>2</sup>PAK (TO-263) 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		
E	10		10.40
E1	8.50		
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 19. D<sup>2</sup>PAK footprint<sup>(a)</sup>

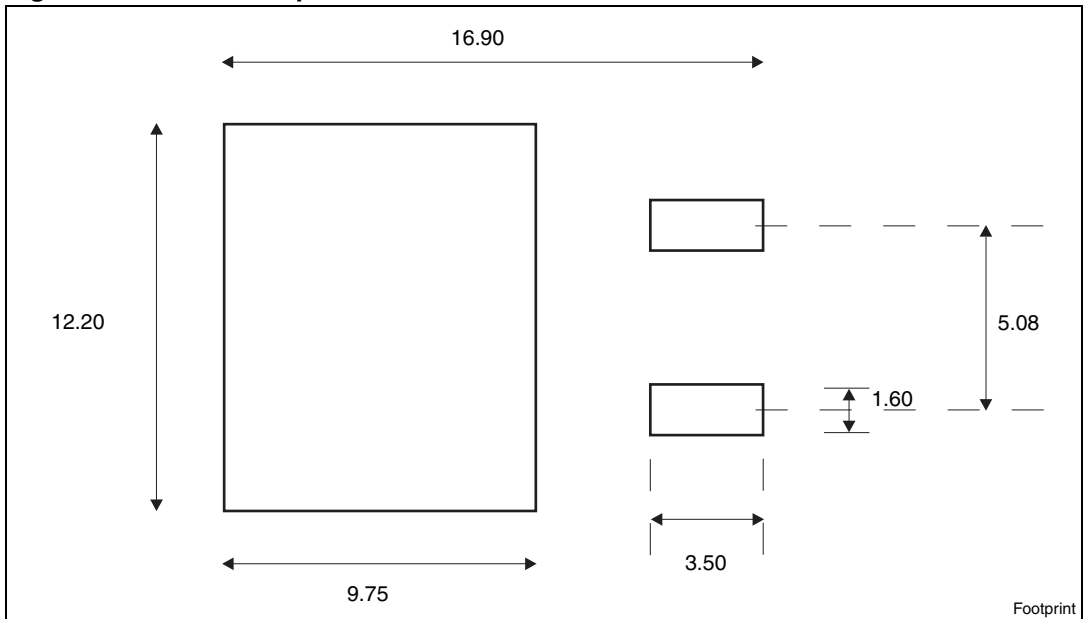
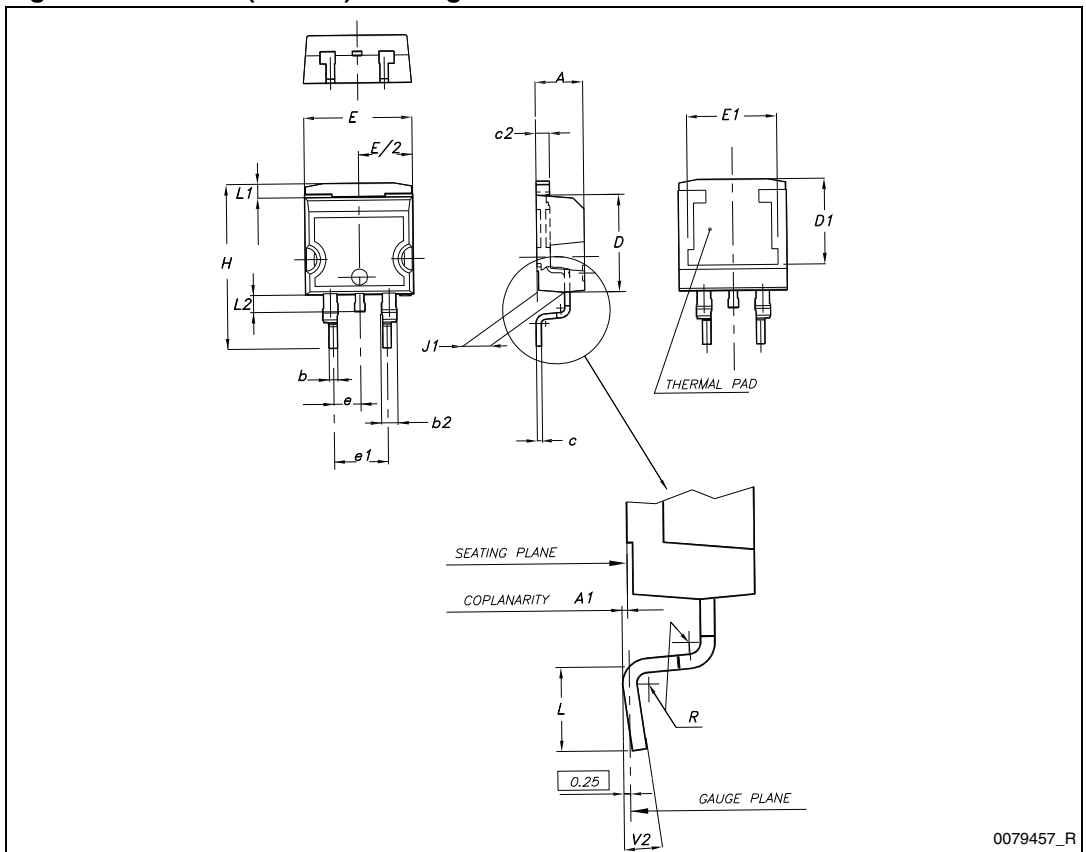


Figure 20. D<sup>2</sup>PAK (TO-263) drawing

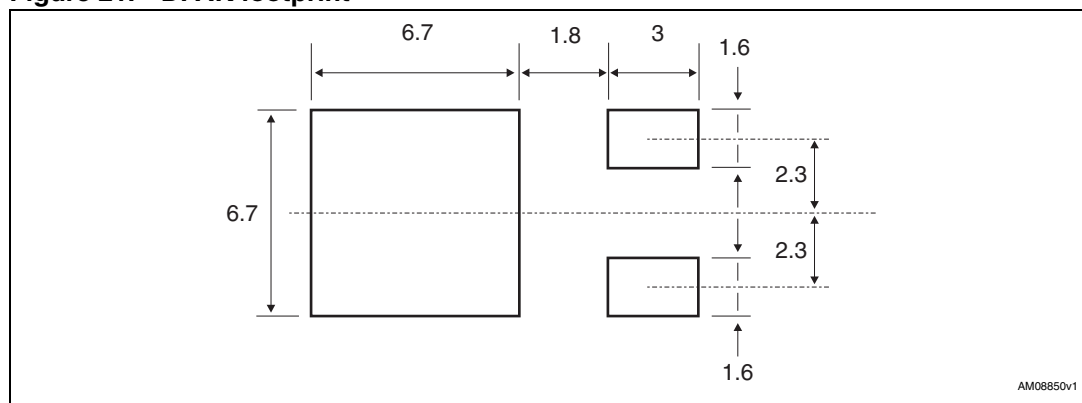


a. All dimension are in millimeters

Table 10. DPAK (TO-252) mechanical data

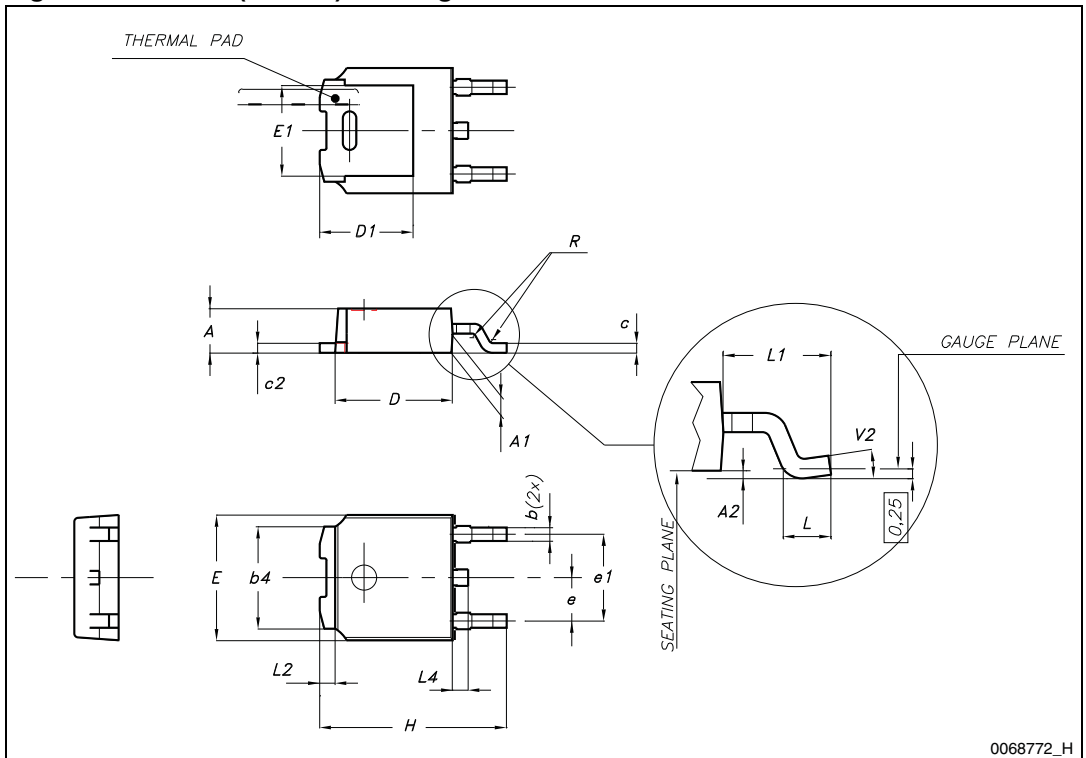
Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		1.50
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 21. DPAK footprint<sup>(b)</sup>



b. All dimension are in millimeters

Figure 22. DPAK (TO-252) drawing



## 5 Packaging mechanical data

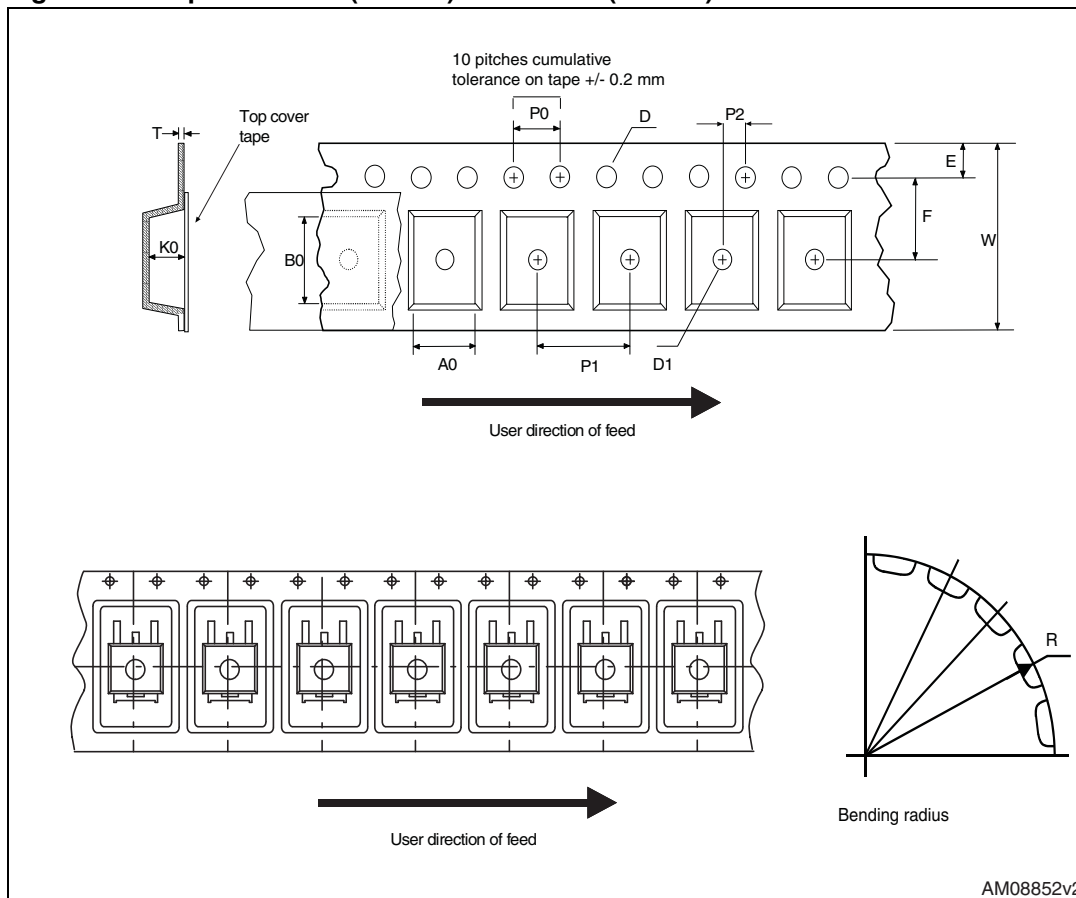
Table 11. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

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

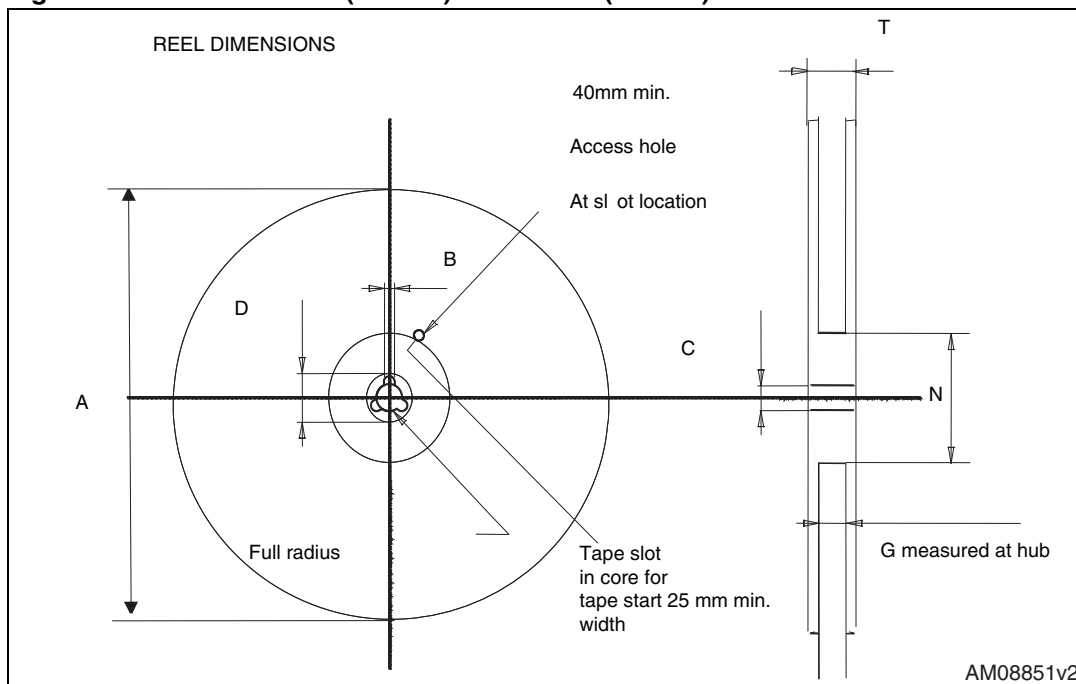
Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Figure 23. Tape for DPAK (TO-252) and D<sup>2</sup>PAK (TO-263)



AM08852v2

Figure 24. Reel for DPAK (TO-252) and D<sup>2</sup>PAK (TO-263)



AM08851v2



## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
09-Feb-2010	1	First release
29-Oct-2010	2	Document status promoted from preliminary data to datasheet.
11-Nov-2010	3	Corrected $R_{DS(on)}$ value in <a href="#">Table 5: Static</a> .
13-May-2011	4	Removed package and mechanical data: TO-220
17-May-2011	5	<a href="#">Description</a> in cover page has been updated.

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