



## P-channel 500 V, 3 $\Omega$ typ., 2.8 A Zener-protected SuperMESH™ Power MOSFET in a DPAK package

Datasheet — production data

### Features

Order code	V <sub>DSS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>	P <sub>TOT</sub>
STD3PK50Z	500 V	< 4 $\Omega$	2.8 A	70 W

- Gate charge minimized
- Extremely high dv/dt capability
- 100% avalanche tested
- Very low intrinsic capacitance
- Improved ESD capability

### Applications

- Switching applications

### Description

This device is a P-channel Zener-protected Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

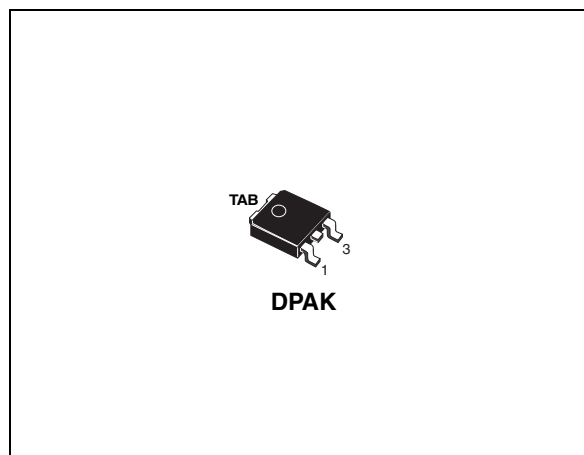


Figure 1. Internal schematic diagram

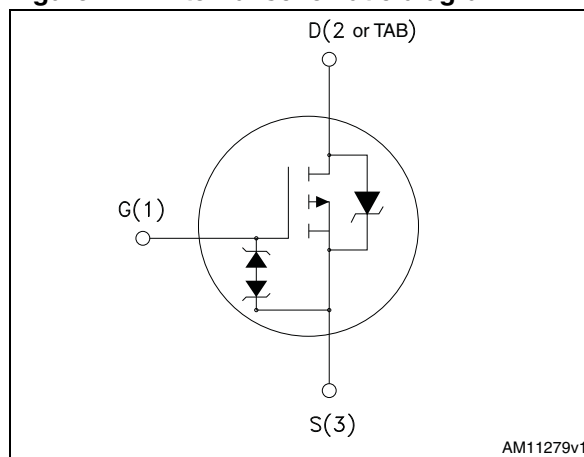


Table 1. Device summary

Order code	Marking	Package	Packaging
STD3PK50Z	3PK50Z	DPAK	Tape and reel

**Note:** For the P-channel Power MOSFETs actual polarity of voltages and current has to be reversed.

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain source voltage	500	V
$V_{GS}$	Gate- source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$	2.8	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	1.8	A
$I_{DM}^{(1)}$	Drain current (pulsed)	11	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	85	W
$I_{AR}$	Max current during repetitive or single pulse avalanche (pulse width limited by $T_{jmax}$ )	2.8	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
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	V/ns
ESD	Gate-source human body model ( $R = 1,5\text{ k}$ , $C = 100\text{ pF}$ )	3	kV
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	- 55 to 150	$^{\circ}\text{C}$

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 2.8\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{Peak} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	1.47	$^{\circ}\text{C}/\text{W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max	50	$^{\circ}\text{C}/\text{W}$

**Note:** For the P-channel Power MOSFETs actual polarity of voltages and current has to be reversed.

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	500			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 500\text{ V}$ , $V_{DS} = 500\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 1.4\text{ A}$		3	4	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	530	-	pF
$C_{oss}$	Output capacitance			50		pF
$C_{rss}$	Reverse transfer capacitance			25		pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0$ , $V_{DS} = 0\text{ to }400\text{ V}$	-	32	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related			23		pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	4.7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}$ , $I_D = 2.8\text{ A}$	-	29	-	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10\text{ V}$		4.3		nC
$Q_{gd}$	Gate-drain charge	(see <a href="#">Figure 14</a> )		15		nC

1. Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$
2. energy related is defined as a constant equivalent capacitance giving the same stored energy as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

**Note:** For the P-channel Power MOSFETs actual polarity of voltages and current has to be reversed.

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250\text{ V}$ , $I_D = 1.4\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 13</a> )	-	16	-	ns
$t_r$	Rise time			15		ns
$t_{d(off)}$	Turn-off delay time			46		ns
$t_f$	Fall time			26		ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		2.8	mA
$I_{SDM}$	Source-drain current (pulsed)				11.2	A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 2.8\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.8\text{ A}$ , $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , (see <a href="#">Figure 15</a> )	-	220		ns
$Q_{rr}$	Reverse recovery charge			1600		nC
$I_{RRM}$	Reverse recovery current			14		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.8\text{ A}$ , $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 15</a> )	-	280		ns
$Q_{rr}$	Reverse recovery charge			2100		nC
$I_{RRM}$	Reverse recovery current			15		A

1. Pulsed: pulse duration = 300 $\mu\text{s}$ , duty cycle 1.5%

**Table 8. Gate-source Zener diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-source breakdown voltage	$I_{gs} \pm 1\text{ mA}$ , (open drain)	30	-		V

The built-in back- to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

**Note:** For the P-channel Power MOSFETs actual polarity of voltages and current has to be reversed.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

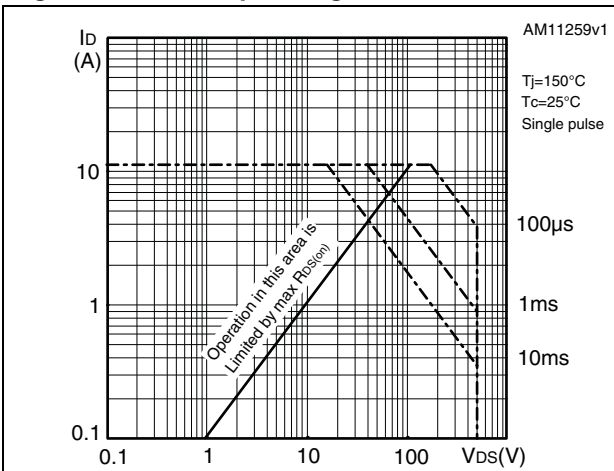


Figure 3. Thermal impedance

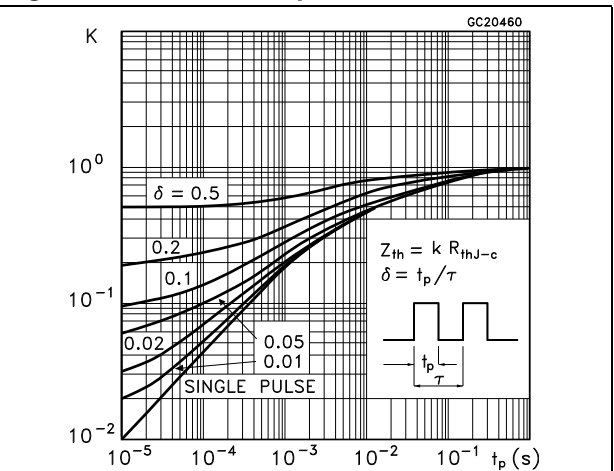


Figure 4. Output characteristics

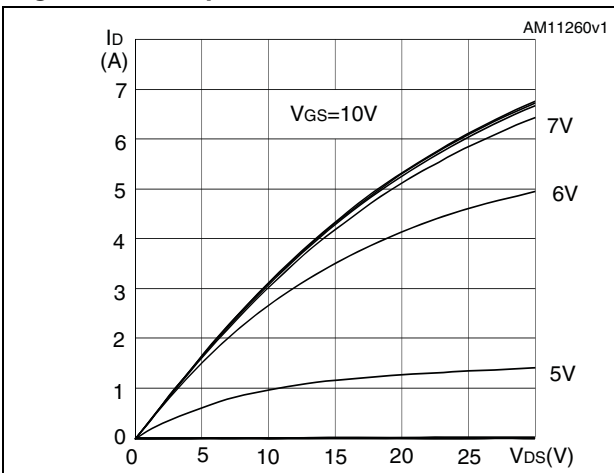


Figure 5. Transfer characteristics

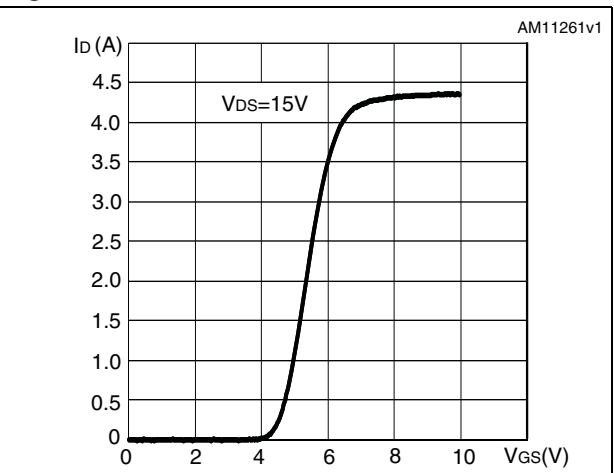


Figure 6. Normalized  $B_{VDSS}$  vs temperature

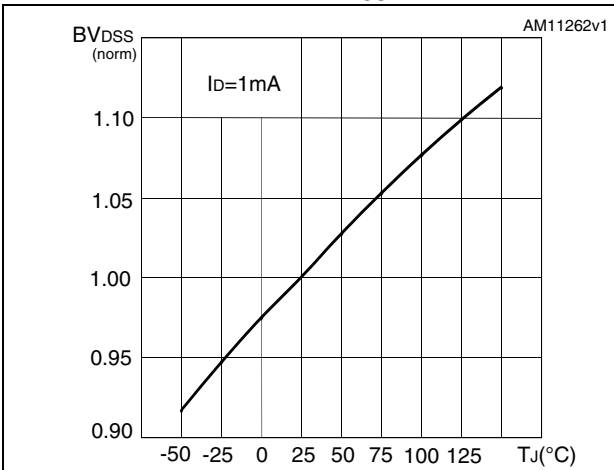


Figure 7. Static drain-source on-resistance

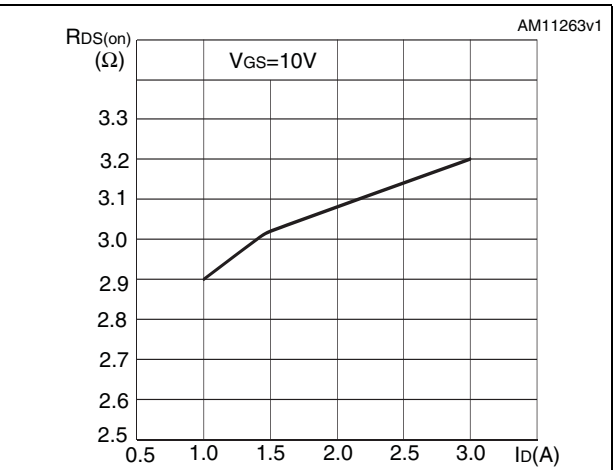


Figure 8. Gate charge vs gate-source voltage

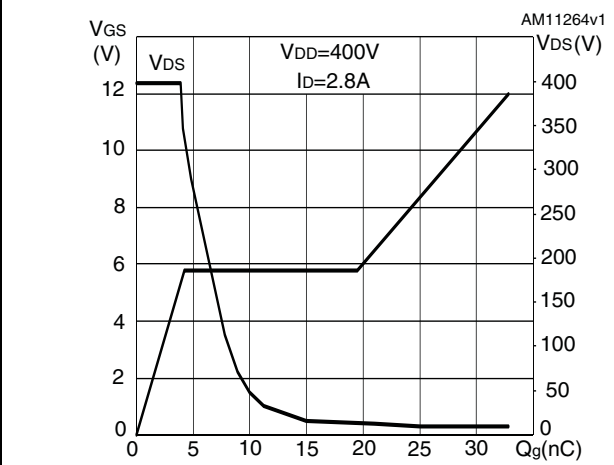


Figure 9. Capacitance variations

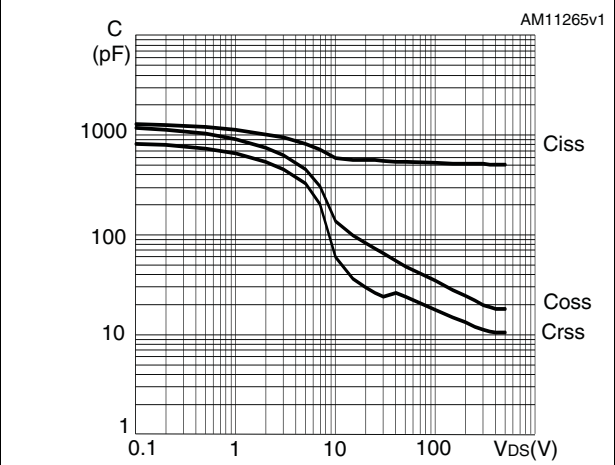


Figure 10. Normalized gate threshold voltage vs temperature

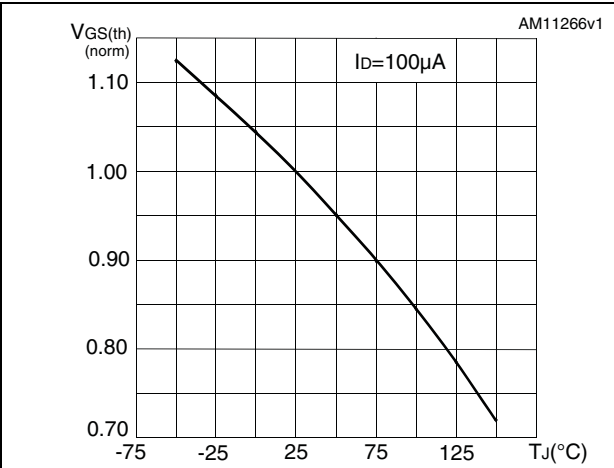


Figure 11. Normalized on-resistance vs temperature

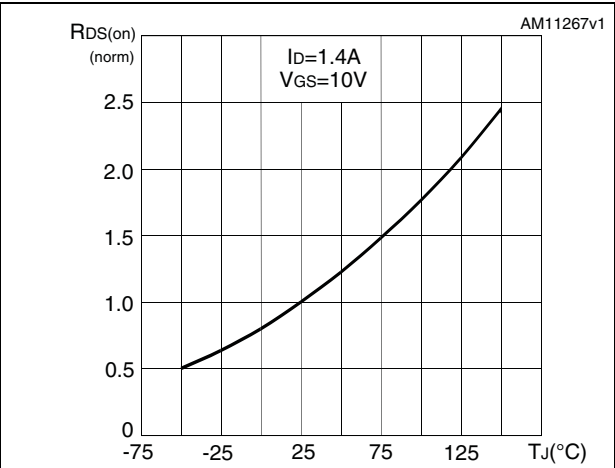
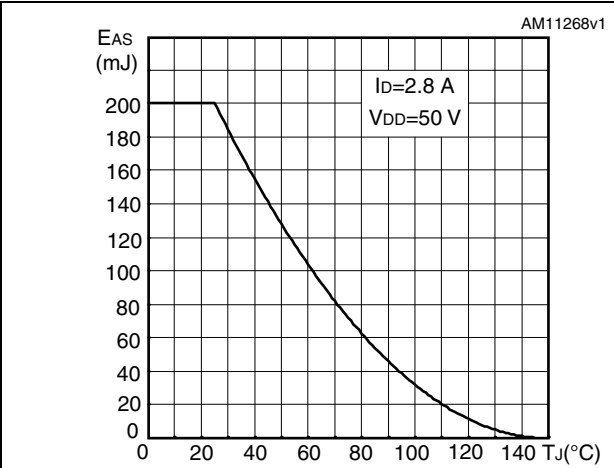
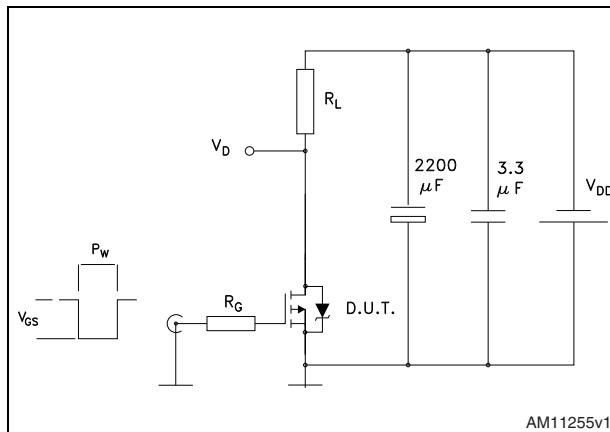


Figure 12. Maximum avalanche energy vs starting Tj

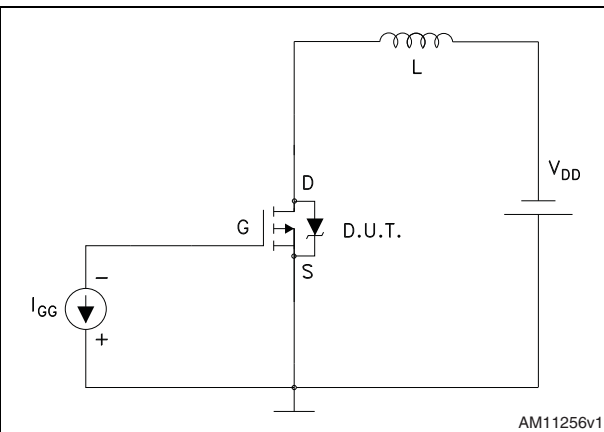


### 3 Test circuits

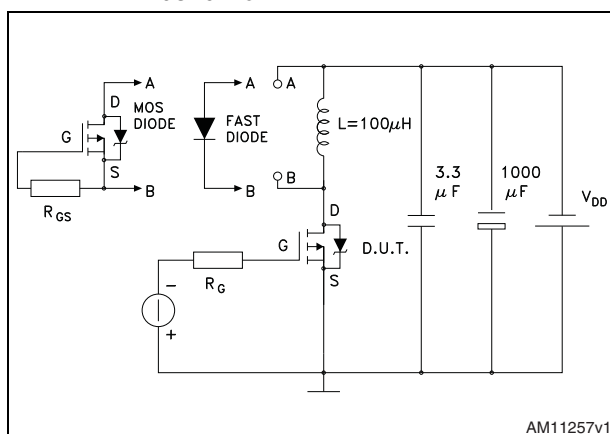
**Figure 13. Switching times test circuit for resistive load**



**Figure 14. Gate charge test circuit**



**Figure 15. Test circuit for diode recovery behavior**





## 4      **Package mechanical data**

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

Table 9. 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 16. DPAK (TO-252) drawing

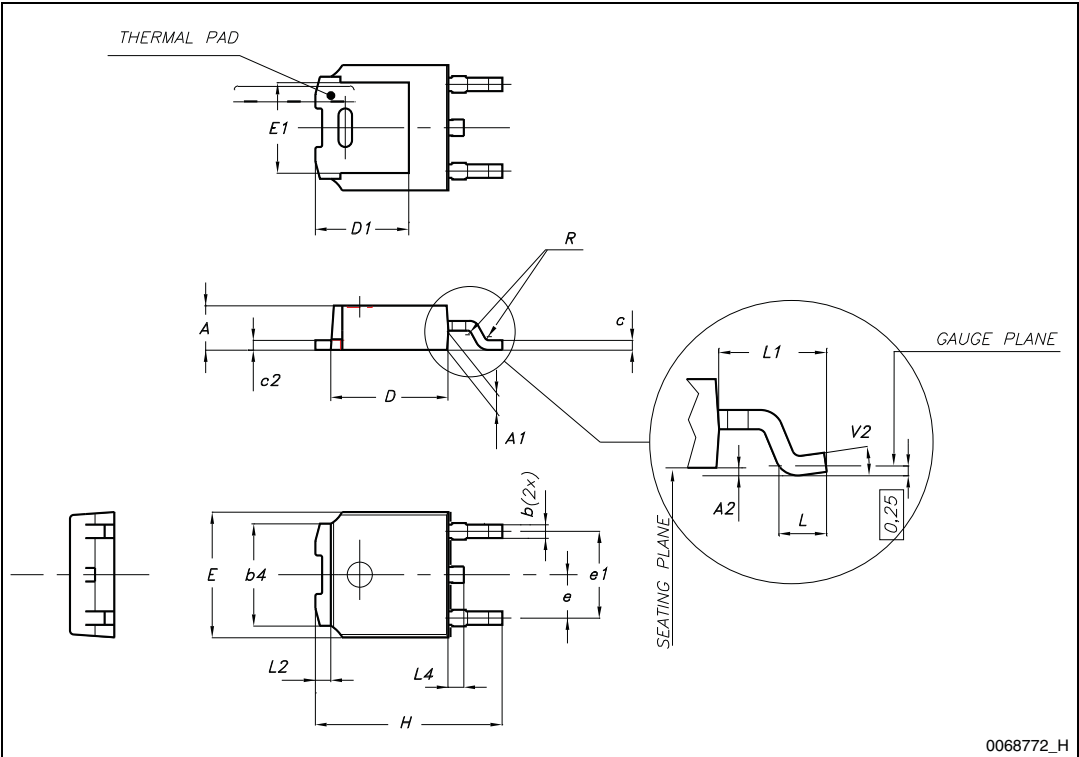
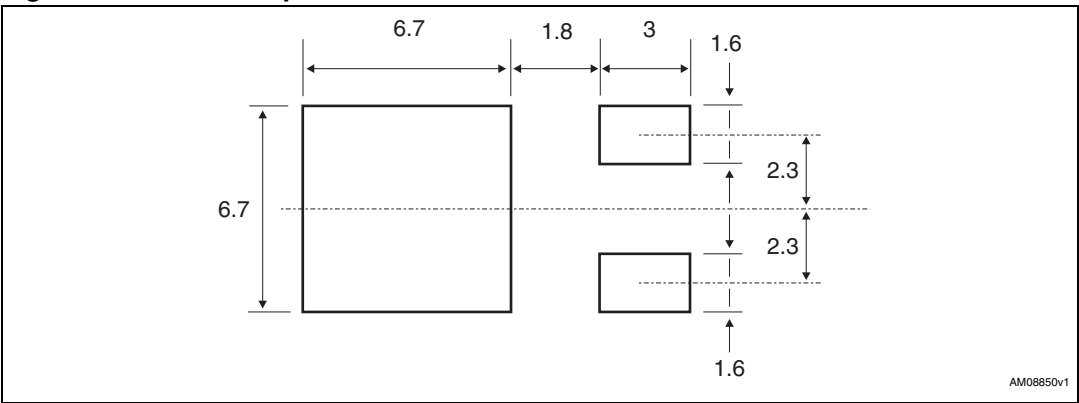


Figure 17. DPAK footprint<sup>(a)</sup>



a. All dimensions are in millimeters

## 5 Packaging mechanical data

Table 10. 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 18. Tape for DPAK (TO-252)

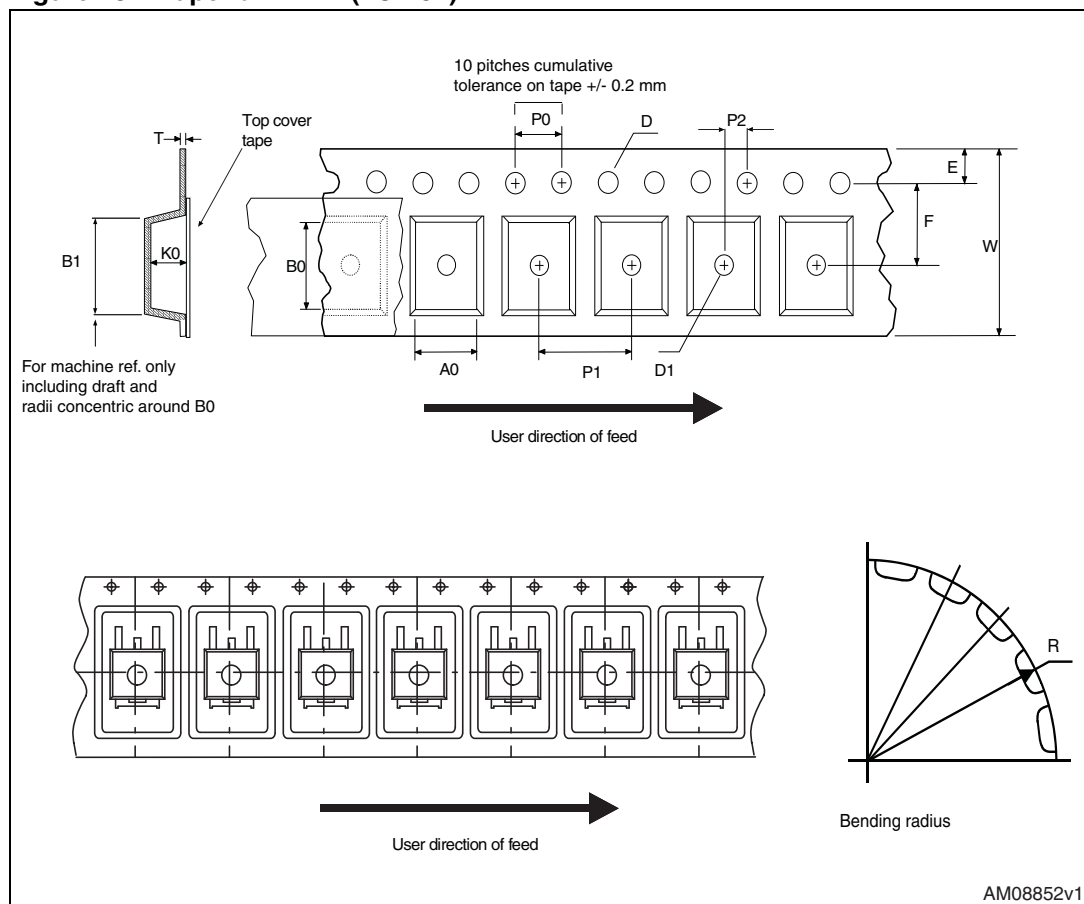
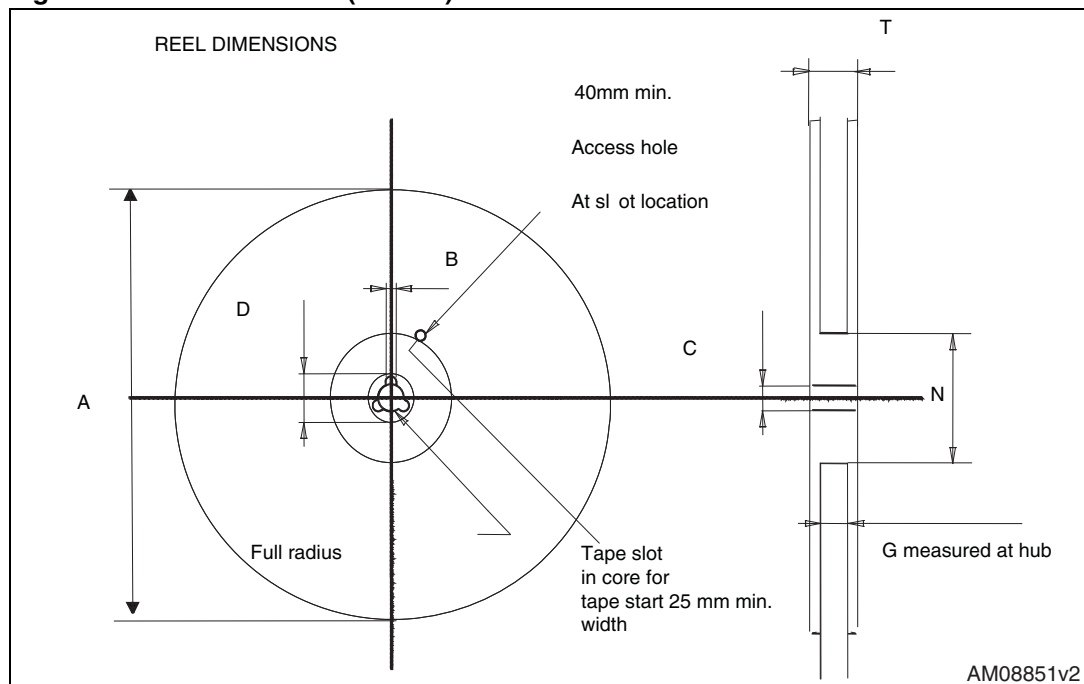


Figure 19. Reel for DPAK (TO-252)



## 6 Revision history

**Table 11. Document revision history**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
26-Nov-2010	1	First release.
31-Aug-2012	2	Document status promoted from preliminary data to production data. Minor text changes on the cover page.

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