

## N-channel 800 V, 0.95 $\Omega$ typ., 6 A Zener-protected SuperMESH™ 5 Power MOSFETs in DPAK, TO-220 and IPAK packages

Datasheet - production data

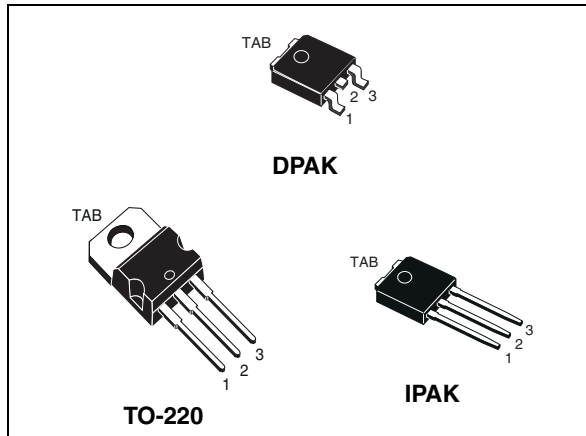
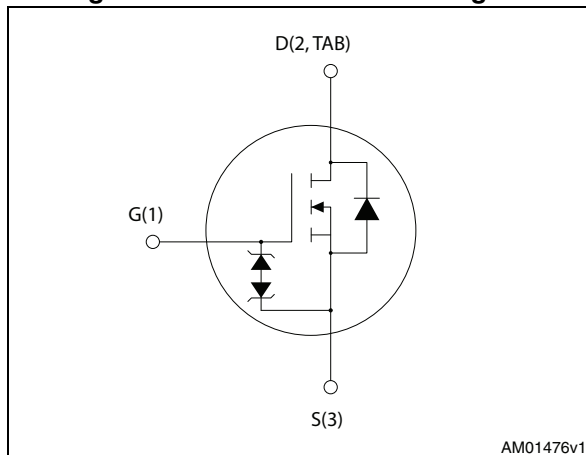


Figure 1. Internal schematic diagram



### Features

Order codes	$V_{DS}$	$R_{DS(on)max}$	$I_D$	$P_{TOT}$
STD7N80K5	800 V	1.2 $\Omega$	6 A	110 W
STP7N80K5				
STU7N80K5				

- Worldwide best FOM (figure of merit)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These N-channel Zener-protected Power MOSFETs are designed using ST's revolutionary avalanche-rugged very high voltage SuperMESH™ 5 technology, based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance, and ultra-low gate charge for applications which require superior power density and high efficiency.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STD7N80K5	7N80K5	DPAK	Tape and reel
STP7N80K5		TO-220	Tube
STU7N80K5		IPAK	

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
V <sub>GS</sub>	Gate- source voltage	± 30	V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	6	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	3.8	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	24	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	110	W
I <sub>AR</sub>	Max current during repetitive or single pulse avalanche (pulse width limited by T <sub>jmax</sub> )	2	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> =I <sub>AS</sub> , V <sub>DD</sub> = 50 V)	88	mJ
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	4.5	V/ns
T <sub>J</sub>	Operating junction temperature	-55 to 150	°C
T <sub>stg</sub>	Storage temperature		°C

1. Pulse width limited by safe operating area.
2. I<sub>SD</sub> ≤ 6 A, di/dt ≤ 100 A/μs, V<sub>DS(peak)</sub> ≤ V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		DPAK	TO-220	IPAK	
R <sub>thj-case</sub>	Thermal resistance junction-case max	1.14			°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-amb max		62.5	100	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb max	50			°C/W

1. When mounted on 1 inch<sup>2</sup> FR-4, 2 Oz copper board.

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage ( $V_{GS} = 0$ )	$I_D = 1\text{ mA}$	800			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 800\text{ V}$ $V_{DS} = 800\text{ V}, T_c = 125\text{ °C}$			1 50	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}, I_D = 3\text{ A}$		0.95	1.2	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	360	-	pF
$C_{oss}$	Output capacitance		-	30	-	pF
$C_{rss}$	Reverse transfer capacitance		-	1	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0, V_{DS} = 0\text{ to }640\text{ V}$	-	47	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	20	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}, I_D = 0$	-	6	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 640\text{ V}, I_D = 6\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 17)	-	13.4	-	nC
$Q_{gs}$	Gate-source charge		-	3.7	-	nC
$Q_{gd}$	Gate-drain charge		-	7.5	-	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%  $V_{DSS}$

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400\text{ V}$ , $I_D = 3\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 19</a> )	-	11.3	-	ns
$t_r$	Rise time			8.3		ns
$t_{d(off)}$	Turn-off delay time				23.7	ns
$t_f$	Fall time				20.2	ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		6	A
$I_{SDM}$	Source-drain current (pulsed)		-		24	A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 6\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 6\text{ A}$ , $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , (see <a href="#">Figure 18</a> )	-	315		ns
$Q_{rr}$	Reverse recovery charge		-	2.8		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	17.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 6\text{ A}$ , $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 18</a> )	-	480		ns
$Q_{rr}$	Reverse recovery charge		-	3.8		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	16		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
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$ , $I_D = 0$	30	-	-	V

The built-in back-to-back Zener diodes have been specifically designed to enhance not only the device's ESD capability, but also to make them capable of safely absorbing any voltage transients that may occasionally be applied from gate to source. In this respect, the Zener voltage is appropriate to achieve efficient and cost-effective protection of device integrity. The integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK and IPAK

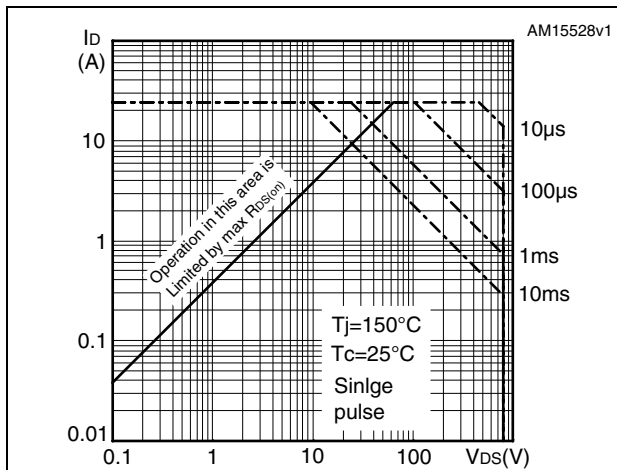


Figure 3. Thermal impedance for DPAK and IPAK

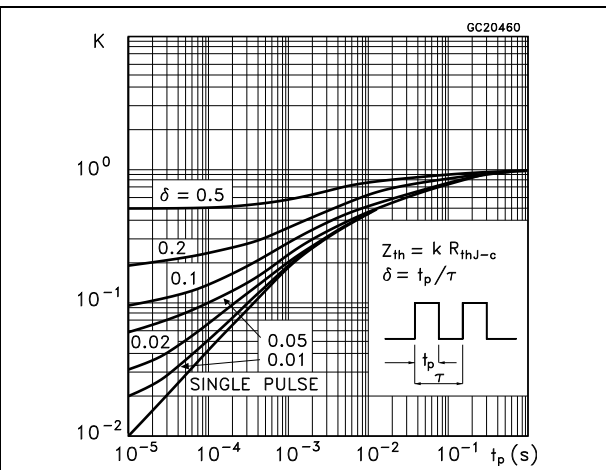


Figure 4. Safe operating area for TO-220

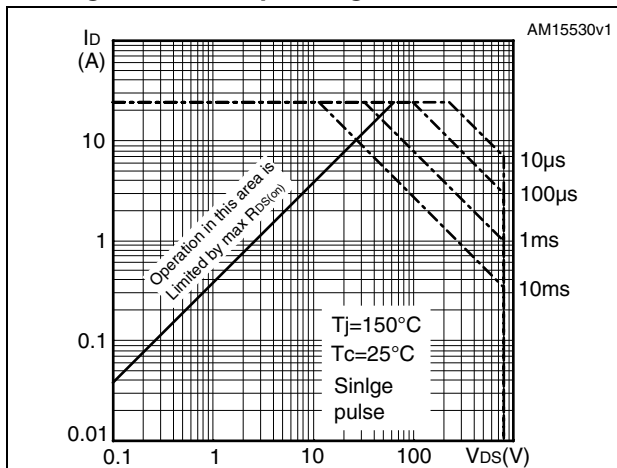


Figure 5. Thermal impedance for TO-220

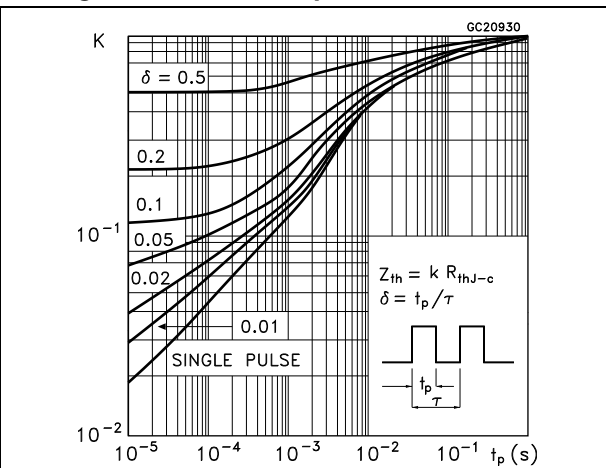


Figure 6. Output characteristics

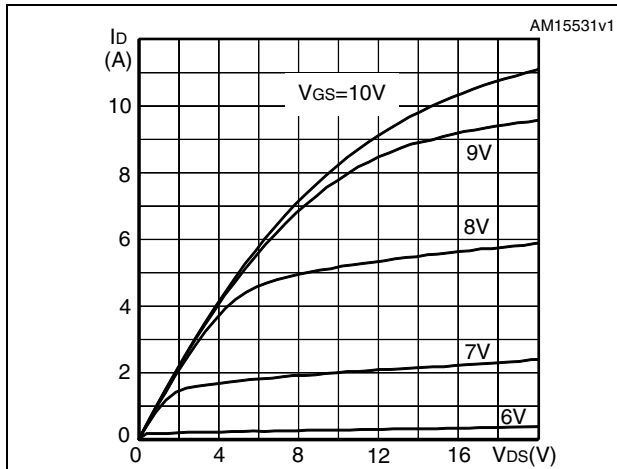


Figure 7. Transfer characteristics

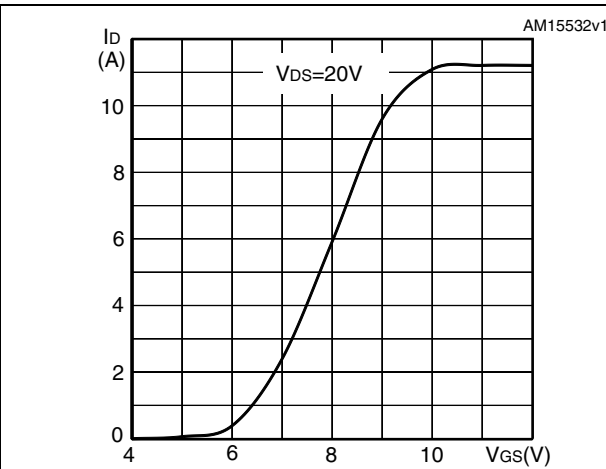


Figure 8. Gate charge vs gate-source voltage

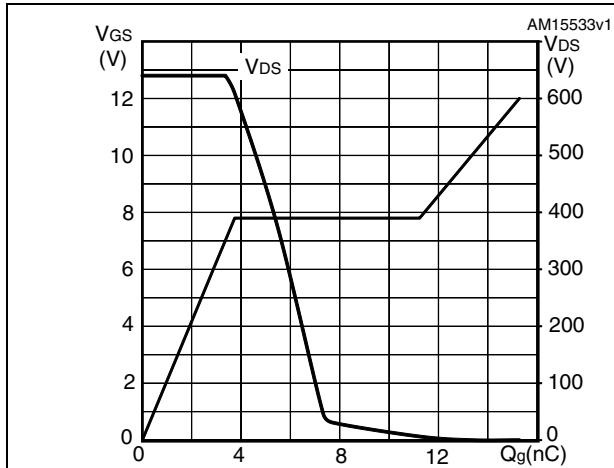


Figure 9. Static drain-source on-resistance

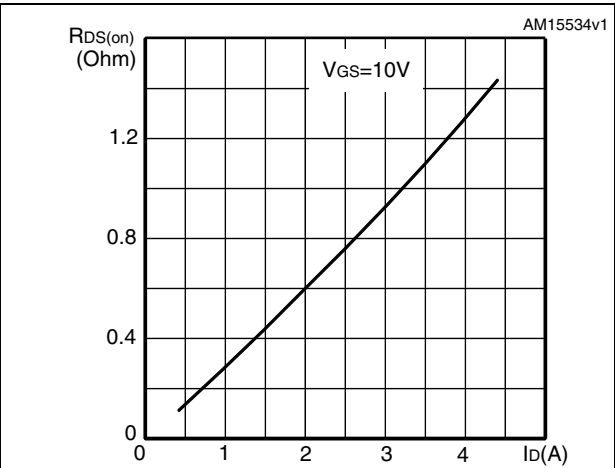


Figure 10. Capacitance variations

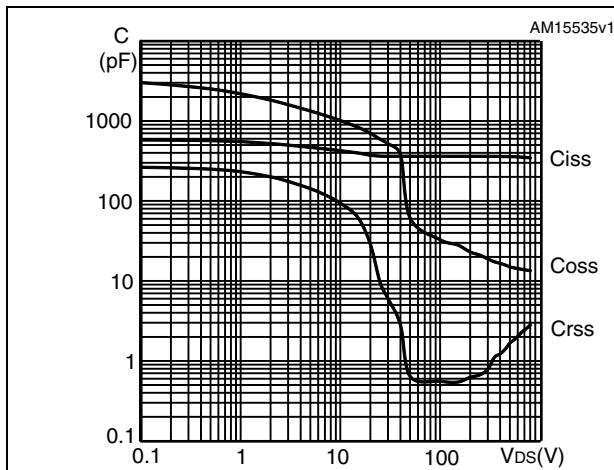


Figure 11. Source-drain diode forward characteristics

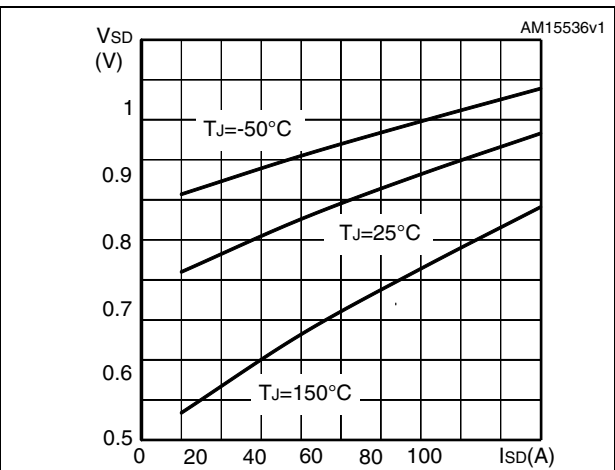


Figure 12. Normalized gate threshold voltage vs temperature

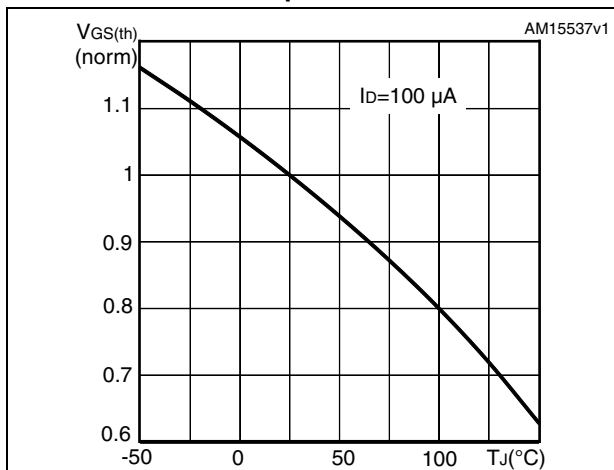


Figure 13. Normalized on-resistance vs temperature

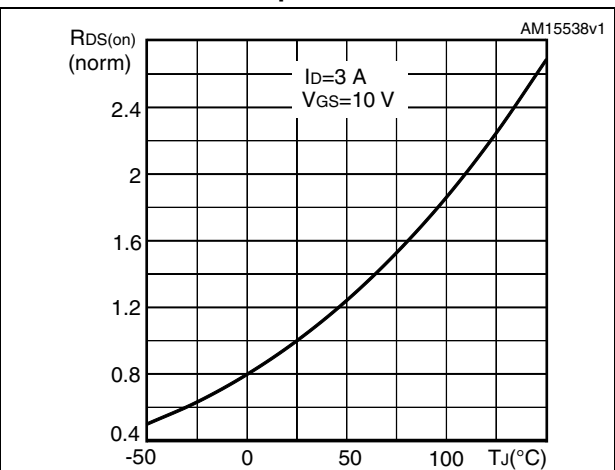


Figure 14. Normalized  $V_{(BR)DSS}$  vs temperature

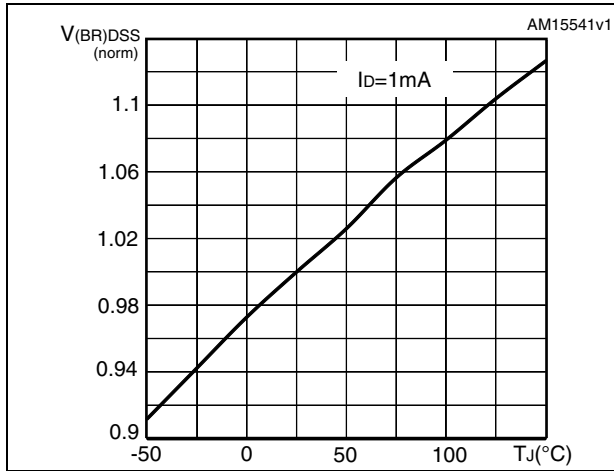
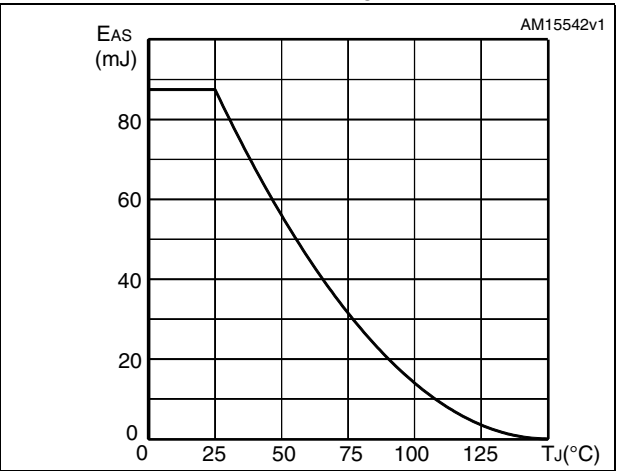


Figure 15. Maximum avalanche energy vs starting  $T_J$





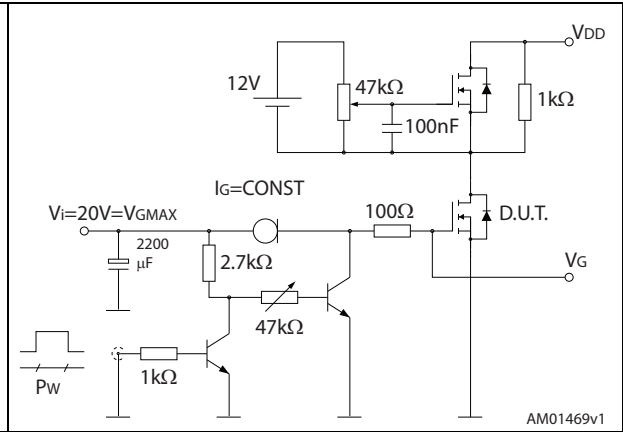
### 3 Test circuits

**Figure 16. Switching times test circuit for resistive load**



AM01468v1

**Figure 17. Gate charge test circuit**



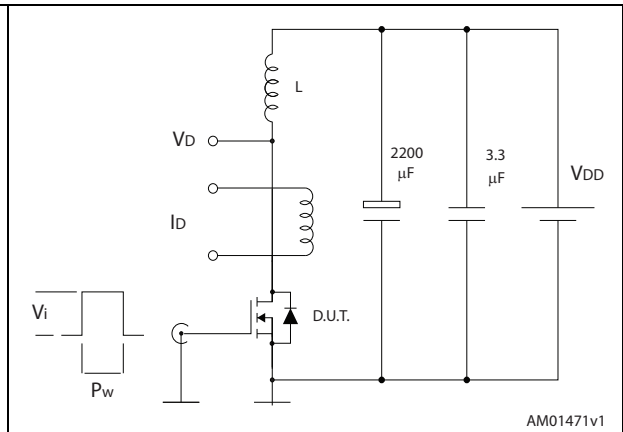
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**Figure 18. Test circuit for inductive load switching and diode recovery times**



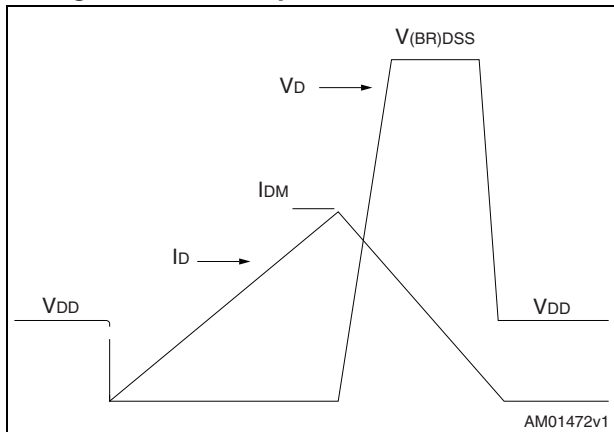
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**Figure 19. Unclamped inductive load test circuit**



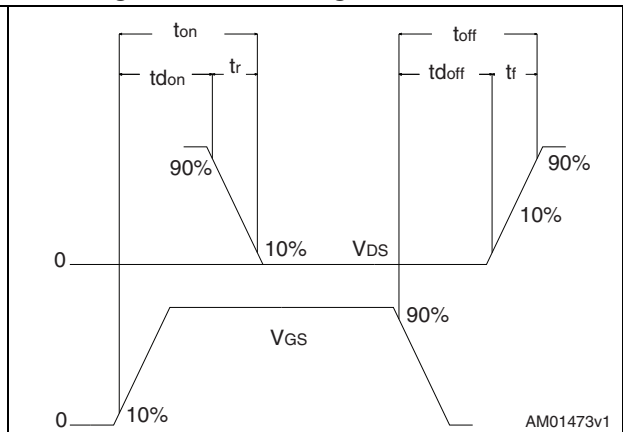
AM01471v1

**Figure 20. Unclamped inductive waveform**



AM01472v1

**Figure 21. Switching time waveform**



AM01473v1

## 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) 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		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 22. DPAK (TO-252) type A drawing

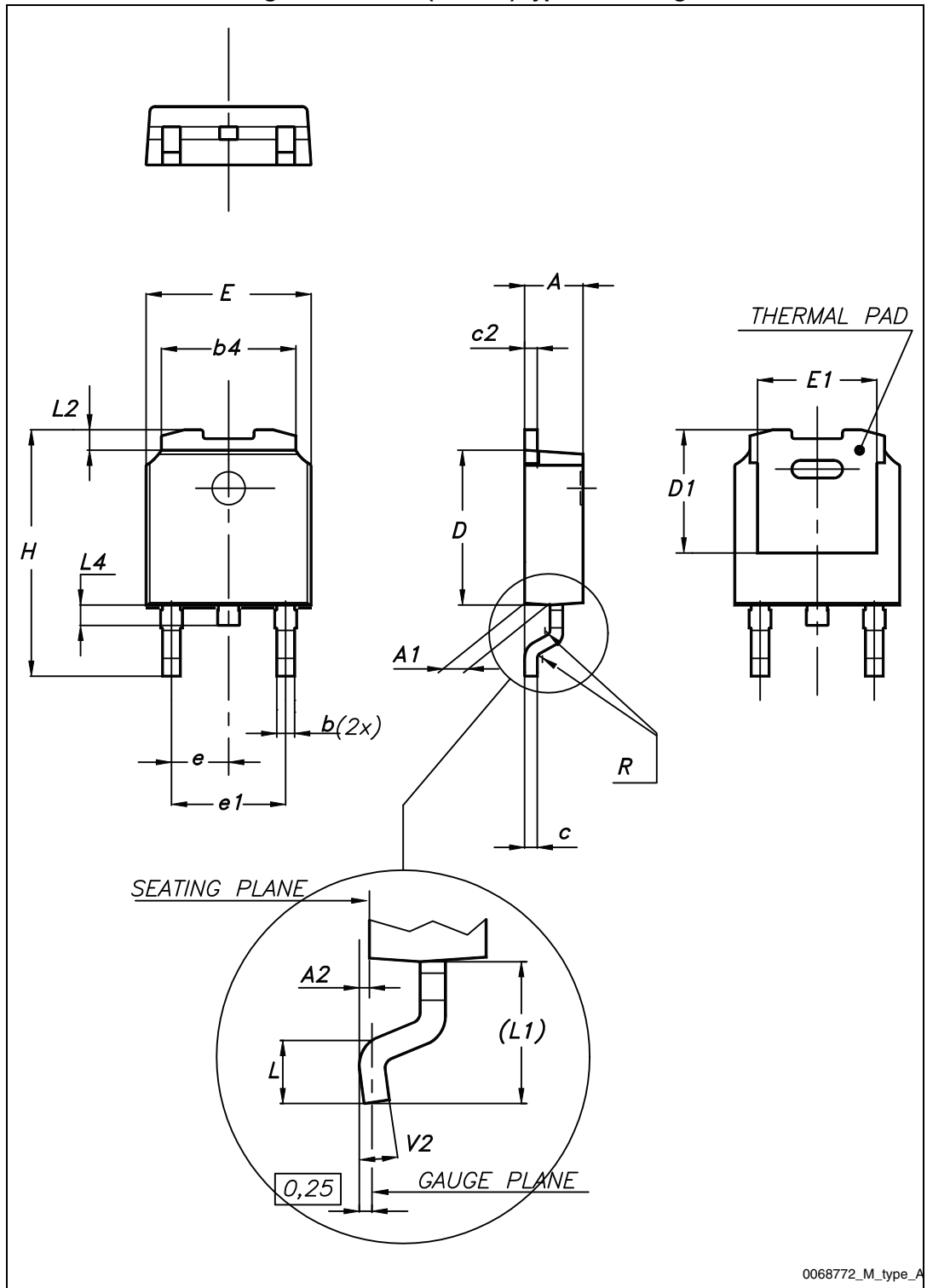
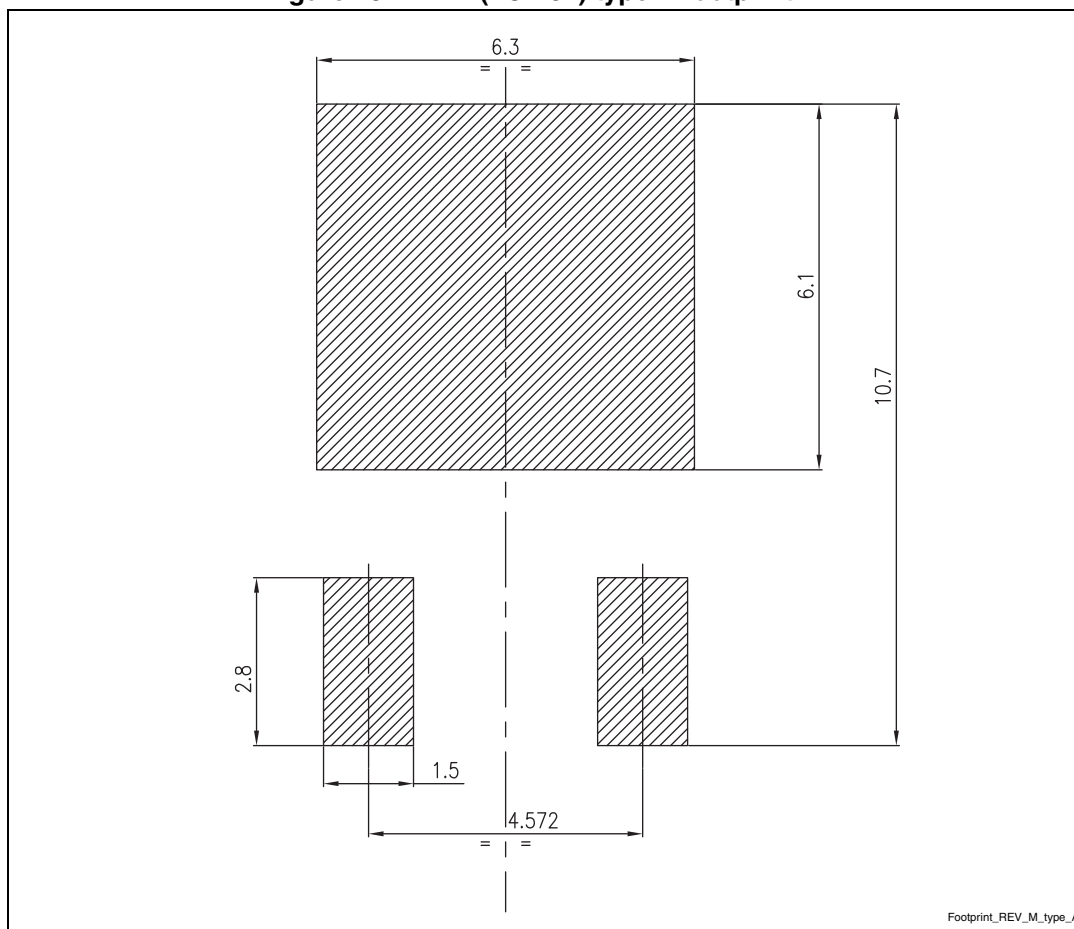


Figure 23. DPAK (TO-252) type A footprint (a)



a. All dimensions are in millimeters

Table 10. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		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		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

Figure 24. TO-220 type A drawing

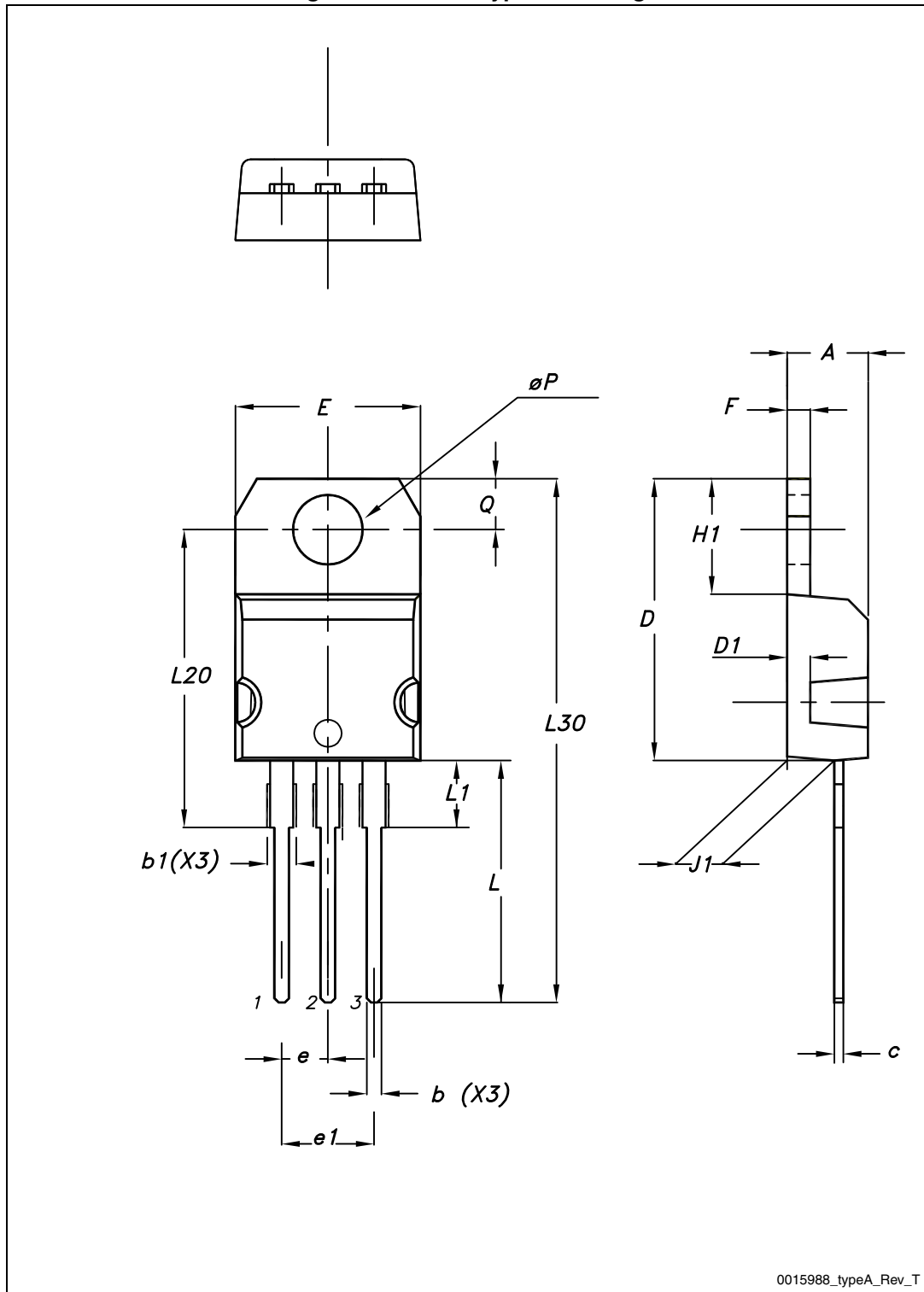
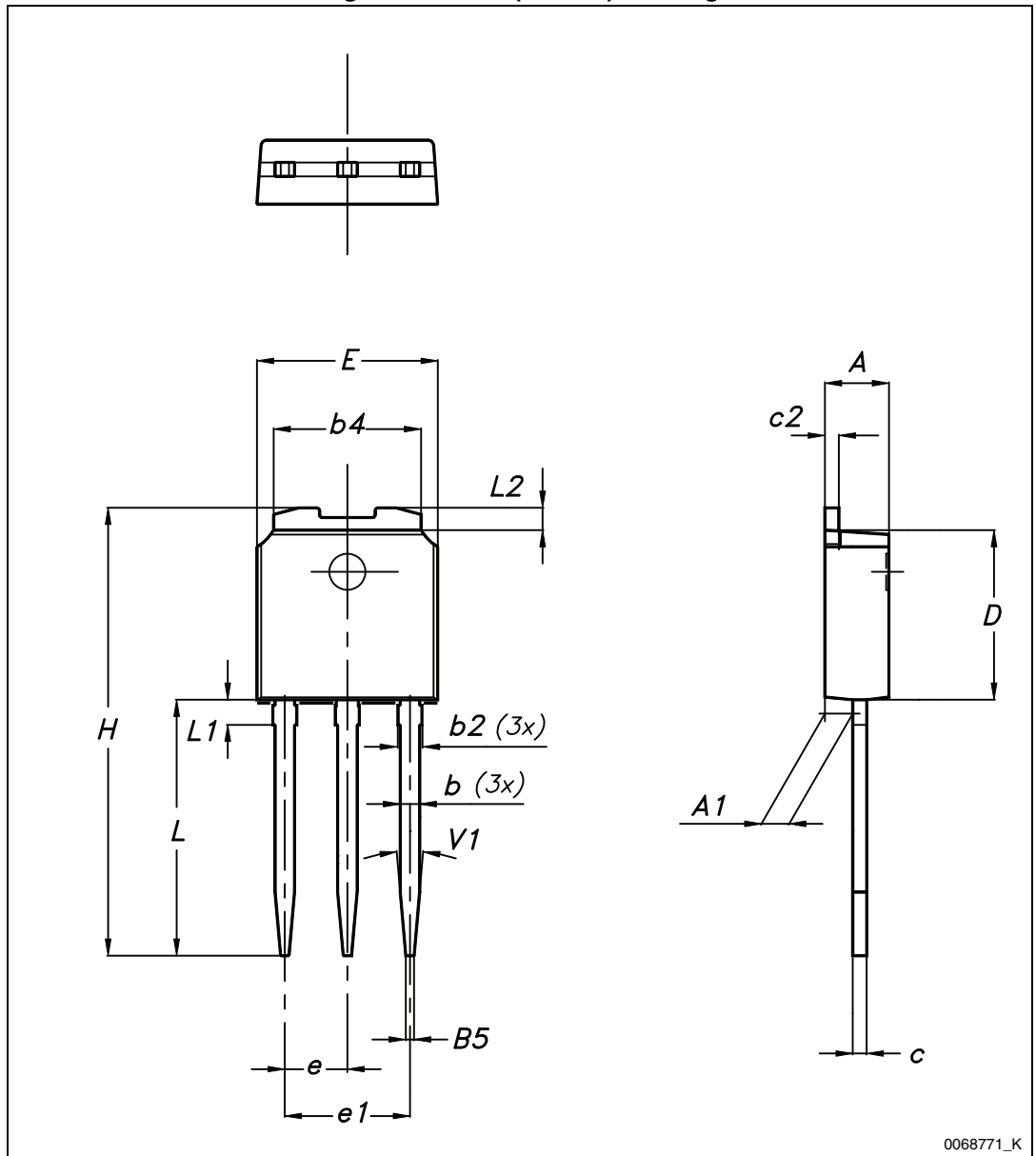


Table 11. IPAK (TO-251) mechanical data

DIM	mm.		
	min.	typ.	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.30	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10°	



Figure 25. IPAK (TO-251) drawing



## 5 Packaging mechanical data

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 26. Tape

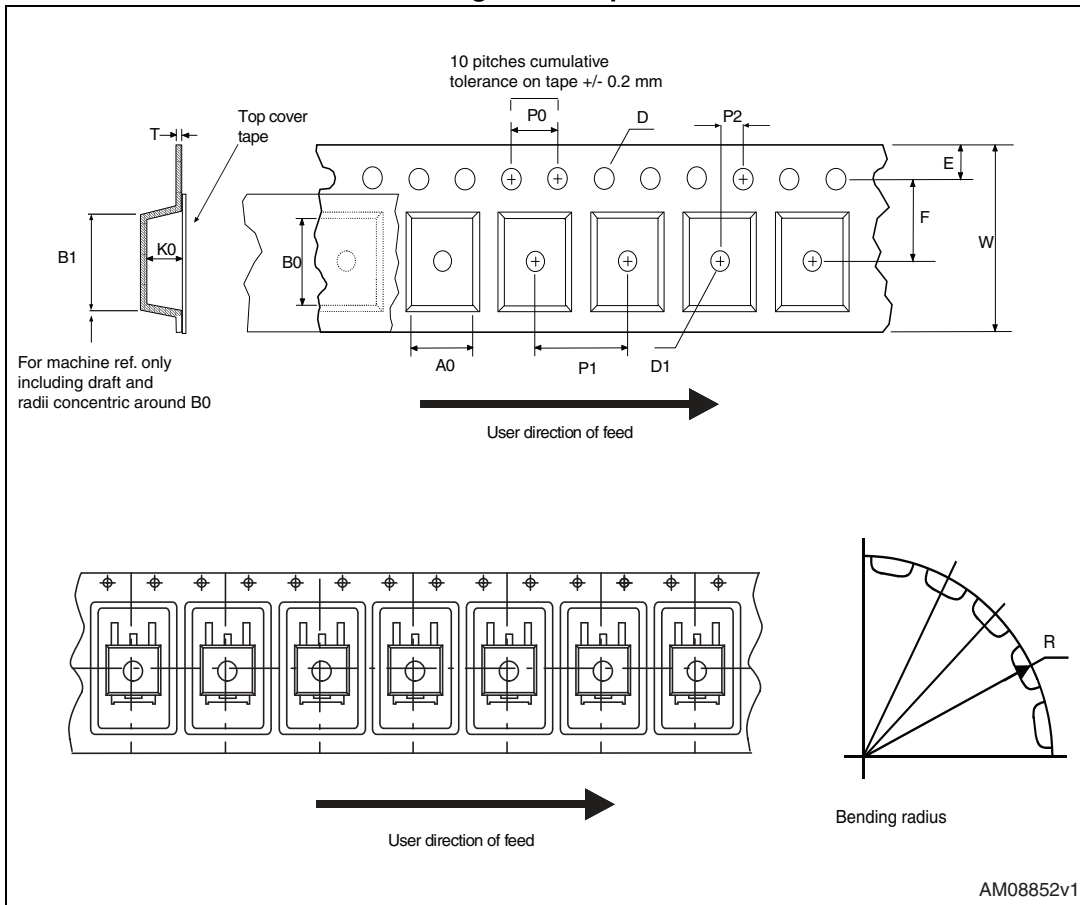
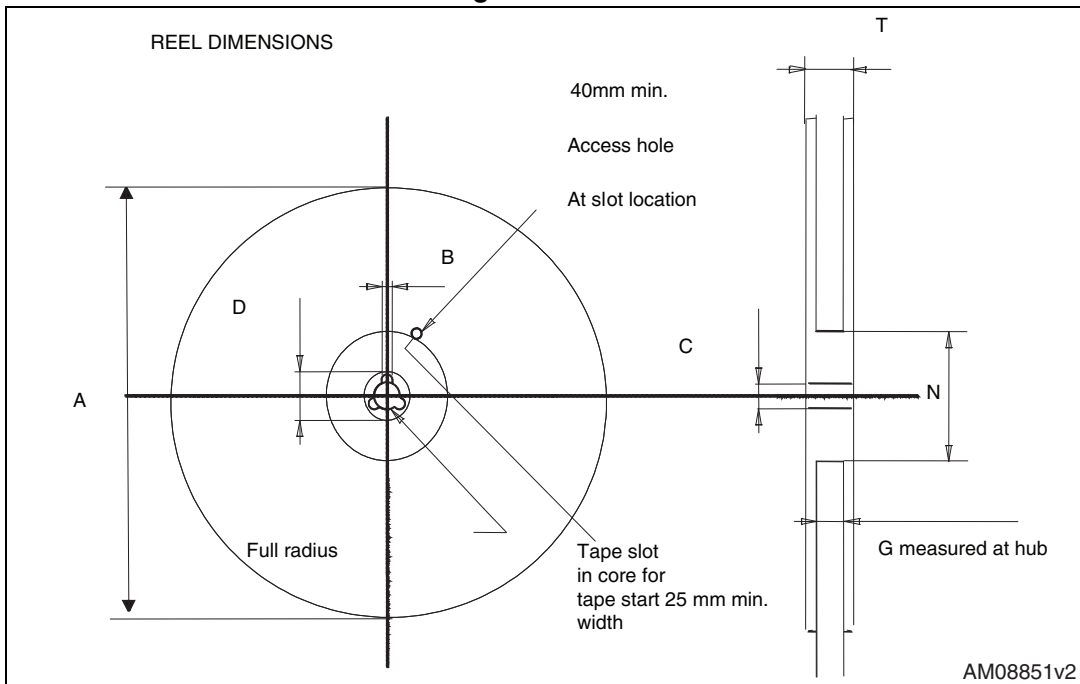


Figure 27. Reel



## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
17-Jul-2012	1	First release.
17-Oct-2012	2	– Minor text changes in cover page – Modified: title and $I_D$ value in cover page
19-Dec-2012	3	– Minor text changes – Added: IPAK package – Updated: <a href="#">Section 4: Package mechanical data</a> for IPAK
18-Mar-2013	4	– Modified: $I_{AR}$ value on <a href="#">Table 2</a> – Updated: <a href="#">Section 4: Package mechanical data</a> only for DPAK package
09-Oct-2013	5	– The part number STF7N80K5 has been moved to a separate datasheet – Minor text changes

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