



# STD3NK90Z, STP3NK90Z, STP3NK90ZFP

N-channel 900 V, 4.1  $\Omega$  typ., 3 A Zener-protected SuperMESH™ Power MOSFET in DPAK, TO-220 and TO-220FP packages

Datasheet – production data

## Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>TOT</sub>
STD3NK90ZT4	900 V	4.8 $\Omega$	3 A	90 W
STP3NK90Z				25 W
STP3NK90ZFP				

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very good manufacturing repeatability
- Very low intrinsic capacitances

## Applications

- Switching applications

## Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications.

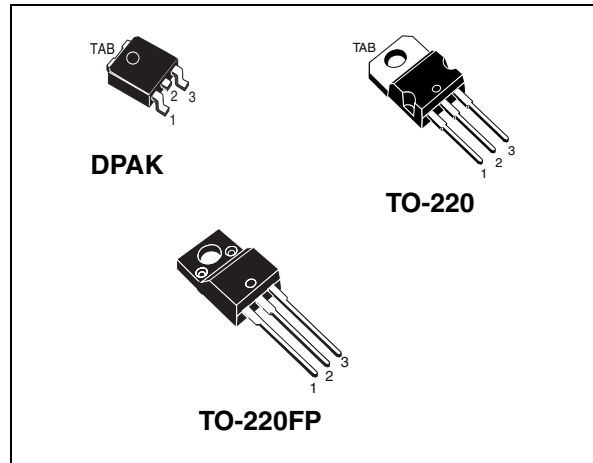


Figure 1. Internal schematic diagram

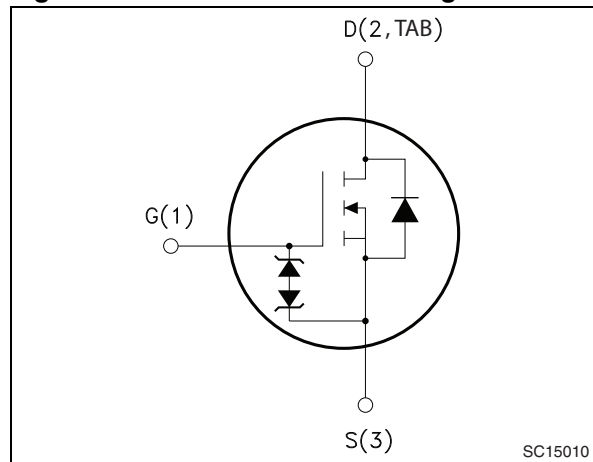


Table 1. Device summary

Order codes	Marking	Package	Packaging
STD3NK90ZT4	D3NK90Z	DPAK	Tape and reel
STP3NK90Z	P3NK90Z	TO-220	Tube
STP3NK90ZFP	P3NK90ZFP	TO-220FP	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		DPAK, TO-220	TO-220FP	
$V_{DS}$	Drain-source voltage	900		V
$V_{GS}$	Gate-source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25^\circ\text{C}$	3	3 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100^\circ\text{C}$	1.89	1.89 <sup>(1)</sup>	A
$I_{DM}$ <sup>(2)</sup>	Drain current (pulsed)	12	12 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	90	25	W
	Derating factor	0.72	0.2	W/°C
$E_{SD}$	Gate-source human body model (R=1,5 k $\Omega$ , C=100 pF)	4		kV
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	4.5		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all threeleads to external heat sink (t=1s; $T_C=25^\circ\text{C}$ )		2500	V
$T_j$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 150		°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 3\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	DPAK	TO-220	TO-220FP	Unit
$R_{thj-case}$	Thermal resistance junction-case max	1.38		5	°C/W
$R_{thj-amb}$	Thermal resistance junction-amb max		62.5		°C/W
$R_{thj-pcb}$ <sup>(1)</sup>	Thermal resistance junction-pcb max	50			°C

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

**Table 4. Avalanche characteristics**

Symbol	Parameter	Max value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{jmax}$ )	3	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50\text{V}$ )	180	mJ

## 2 Electrical characteristics

(T<sub>case</sub> =25°C unless otherwise specified)

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	900			V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = 900 V V <sub>DS</sub> = 900 V, T <sub>j</sub> = 125 °C			1 50	μA μA
I <sub>GSS</sub>	Gate body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ±20 V, V <sub>DS</sub> = 0			±10	μA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 50 μA	3	3.75	4.5	V
R <sub>DS(on)</sub>	Static drain-source on-resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 1.5 A		4.1	4.8	Ω

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> (1)	Forward transconductance	V <sub>DS</sub> = 15 V, I <sub>D</sub> = 1.5 A	-	2.7	-	S
C <sub>iss</sub> C <sub>oss</sub> C <sub>rss</sub>	Input capacitance Output capacitance Reverse transfer capacitance	V <sub>DS</sub> = 25 V, f = 1 MHz, V <sub>GS</sub> = 0	-	590 63 13	-	pF pF pF
C <sub>oss eq</sub> (2)	Equivalent output capacitance	V <sub>GS</sub> = 0, V <sub>DS</sub> = 0 V to 400 V	-	34	-	pF
Q <sub>g</sub> Q <sub>gs</sub> Q <sub>gd</sub>	Total gate charge Gate-source charge Gate-drain charge	V <sub>DD</sub> = 720 V, I <sub>D</sub> = 3 A V <sub>GS</sub> = 10 V see (Figure 18)	-	22.7 4.2 12	-	nC nC nC

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

2. C<sub>oss eq</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80%

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
t <sub>d(on)</sub> t <sub>r</sub>	Turn-on delay time Rise time	V <sub>DD</sub> = 450 V, I <sub>D</sub> = 1.5 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V see (Figure 17)	-	18 7	-	ns ns
t <sub>d(off)</sub> t <sub>f</sub>	Turn-off delay time Fall time	V <sub>DD</sub> = 720 V, I <sub>D</sub> = 1.5 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V see (Figure 17)	-	45 18	-	ns ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		3	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		12	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 3 \text{ A}, V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 3 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s},$ $V_{DD} = 40 \text{ V}, T_j = 150^\circ\text{C}$ <i>(Figure 22)</i>	-	510		ns
$Q_{rr}$	Reverse recovery charge			2.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			8.7		A

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

**Table 9. 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 TO-220

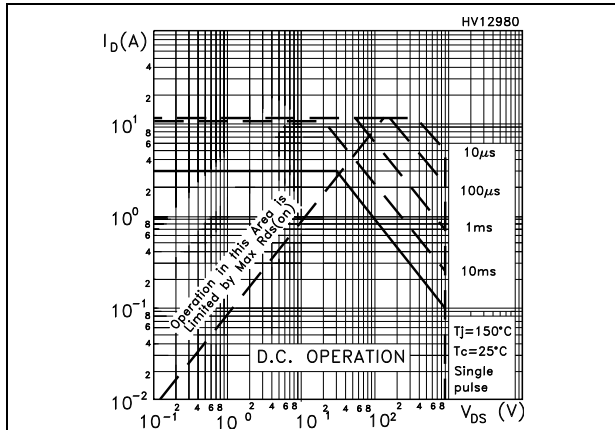


Figure 3. Thermal impedance for DPAK and TO-220

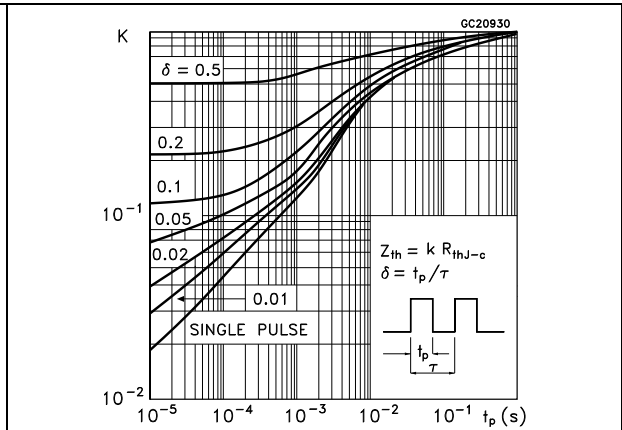


Figure 4. Safe operating area for TO-220FP

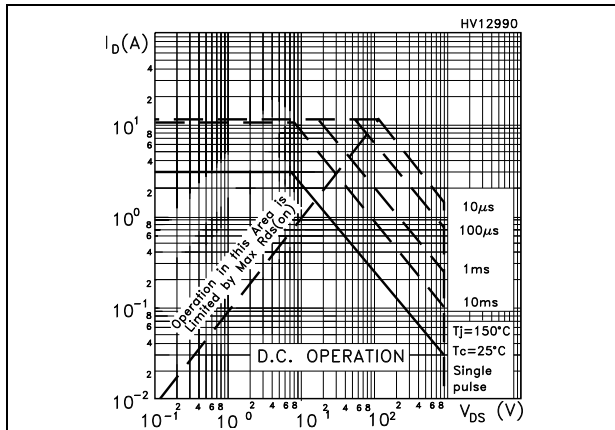


Figure 5. Thermal impedance for TO-220FP

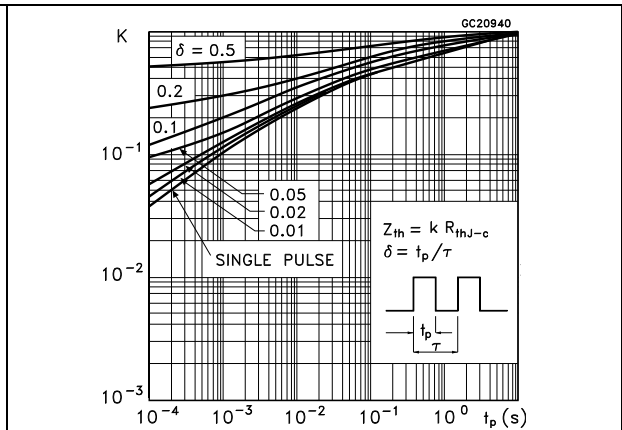


Figure 6. Output characteristics

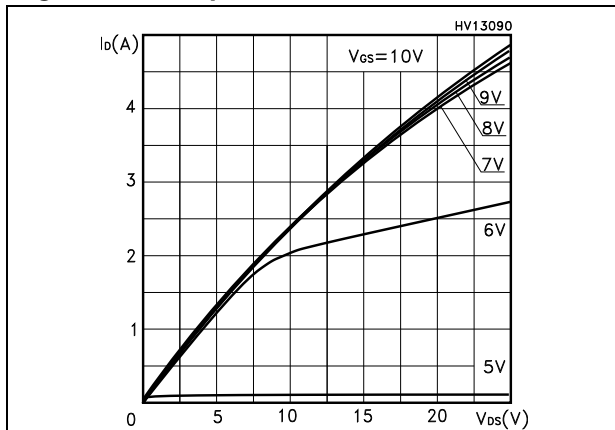


Figure 7. Transfer characteristics

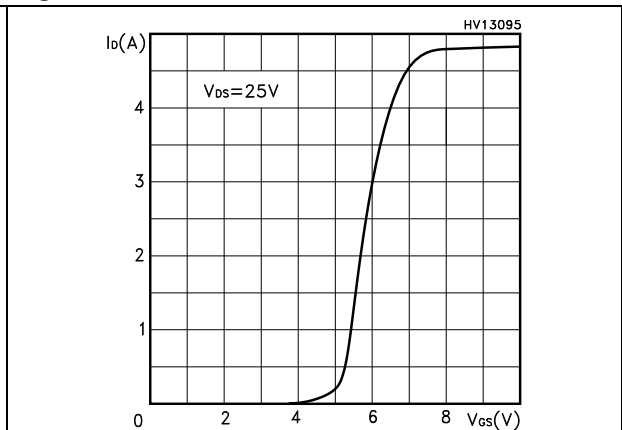


Figure 8. Transconductance

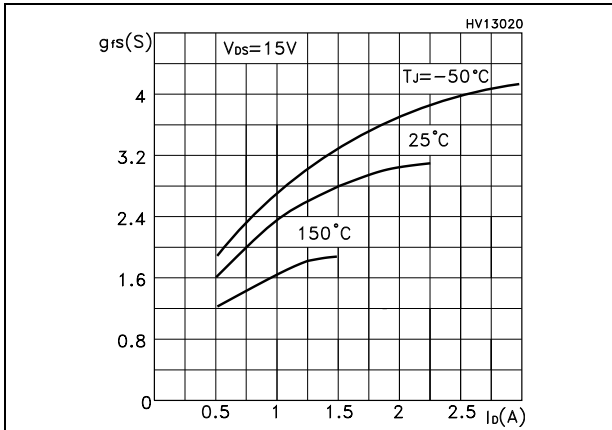


Figure 9. Static drain-source on-resistance

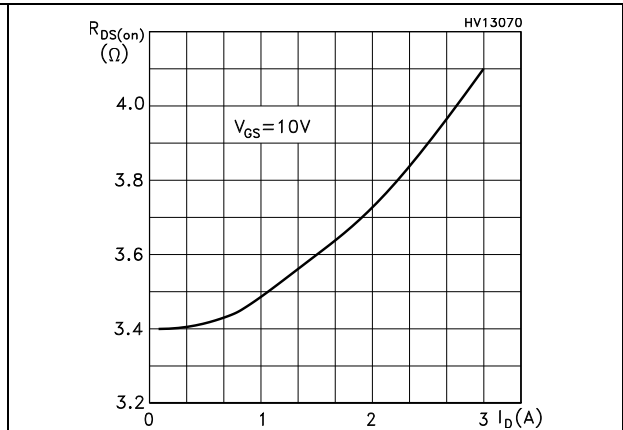


Figure 10. Gate charge vs gate-source voltage

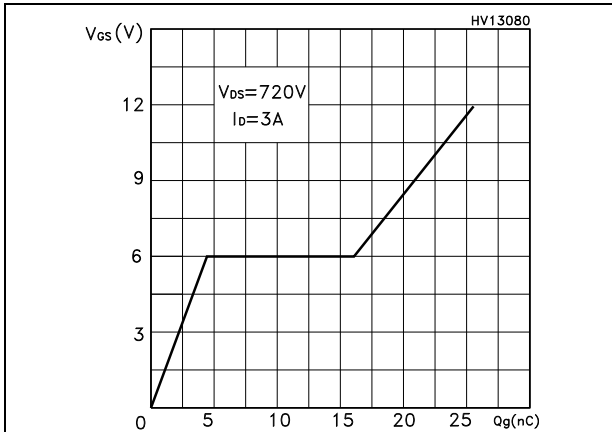


Figure 11. Capacitance variations

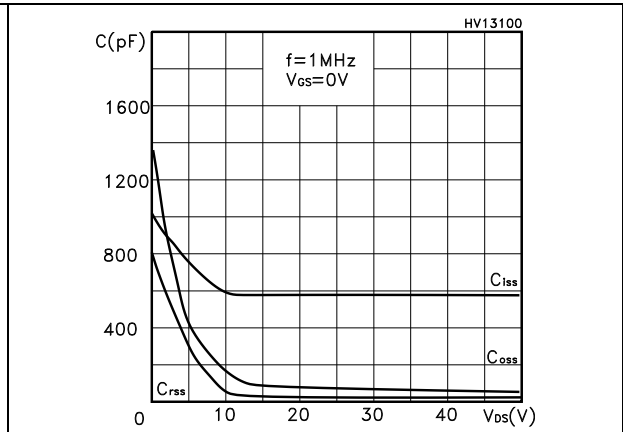


Figure 12. Normalized gate threshold voltage vs temperature

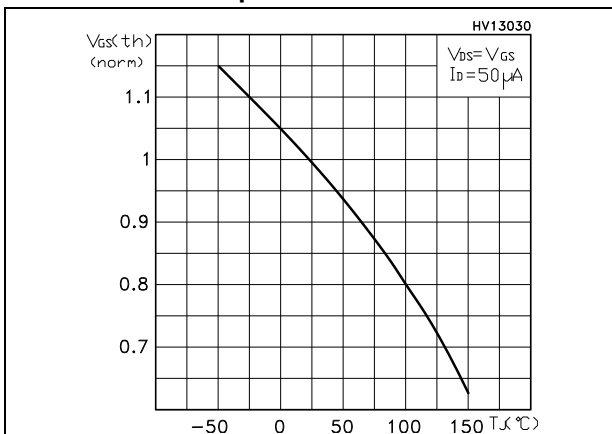


Figure 13. Normalized on-resistance vs temperature

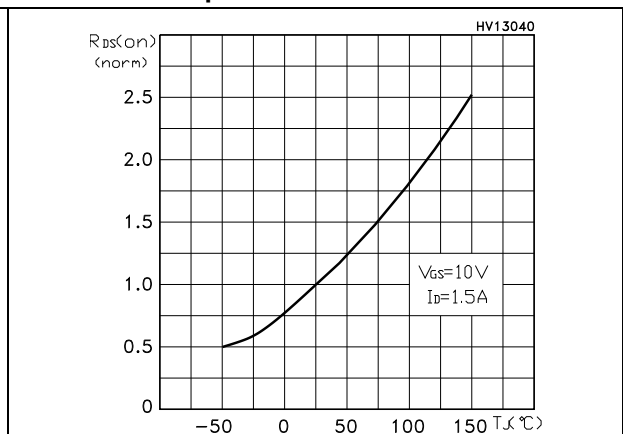


Figure 14. Source-drain diode forward characteristics

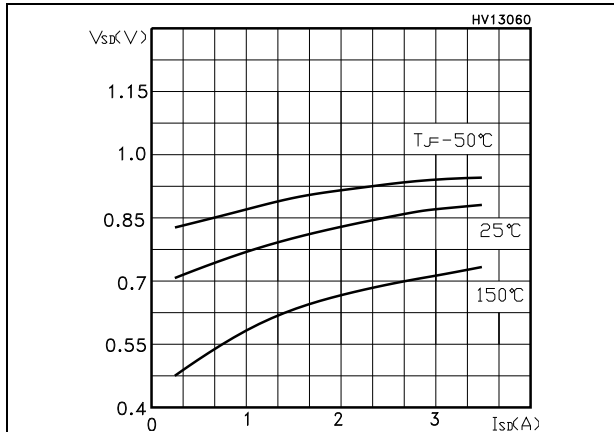


Figure 15. Maximum avalanche energy vs temperature

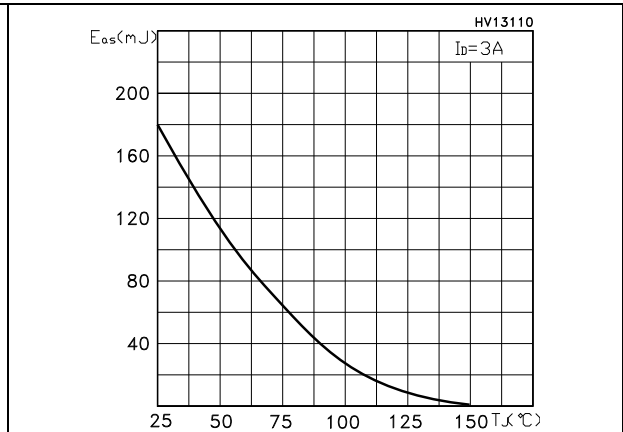
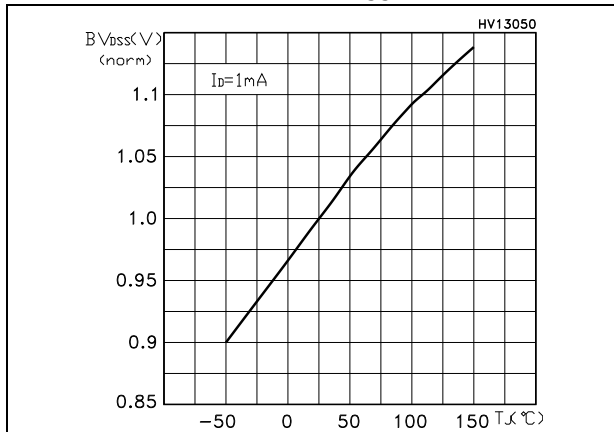


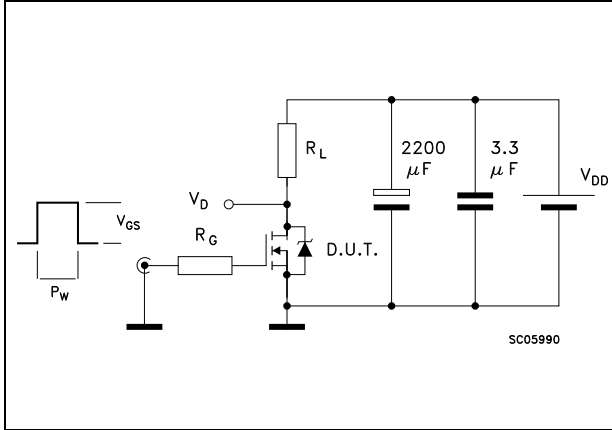
Figure 16. Normalized  $B_{V_{DSS}}$  vs temperature



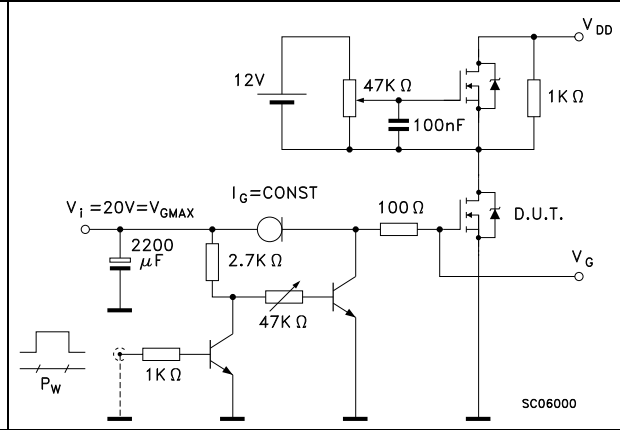


### 3 Test circuits

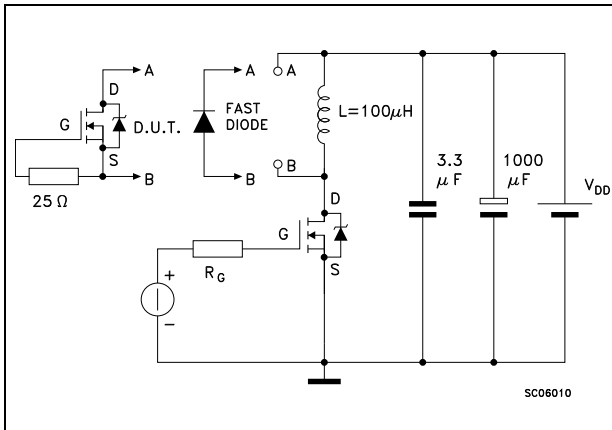
**Figure 17. Switching times test circuit for resistive load**



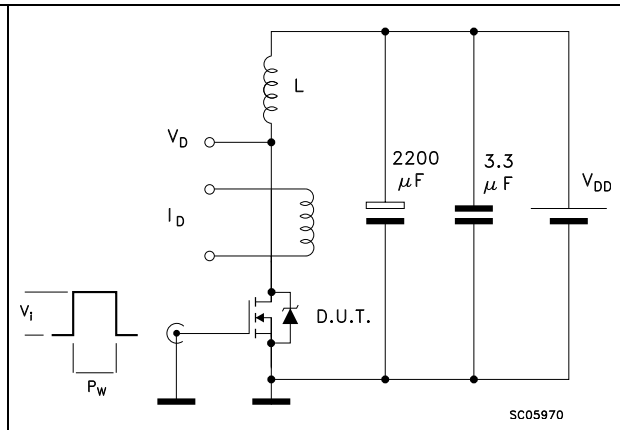
**Figure 18. Gate charge test circuit**



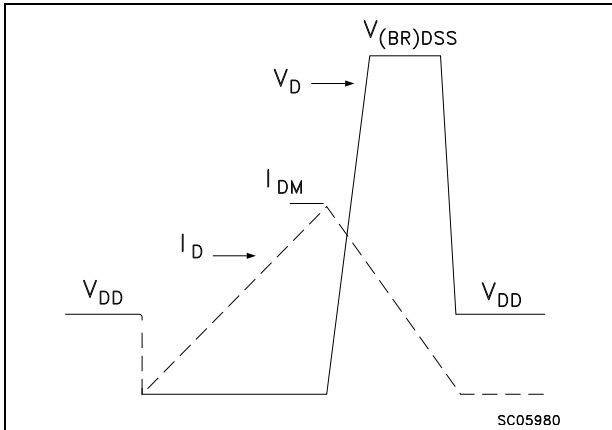
**Figure 19. Test circuit for inductive load switching and diode recovery times**



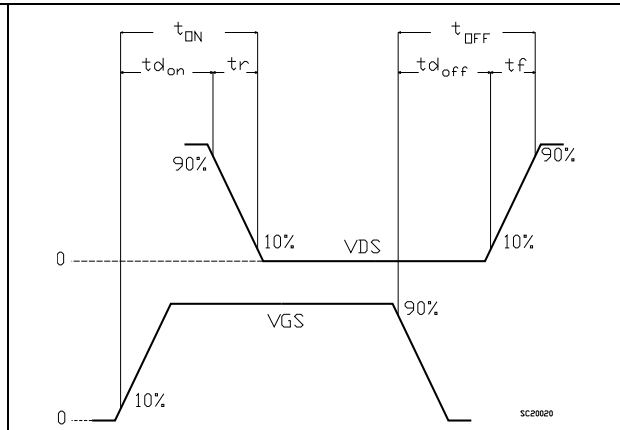
**Figure 20. Unclamped Inductive load test circuit**



**Figure 21. Unclamped inductive waveform**



**Figure 22. Switching time waveform**



## 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 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		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 23. DPAK (TO-252) drawing

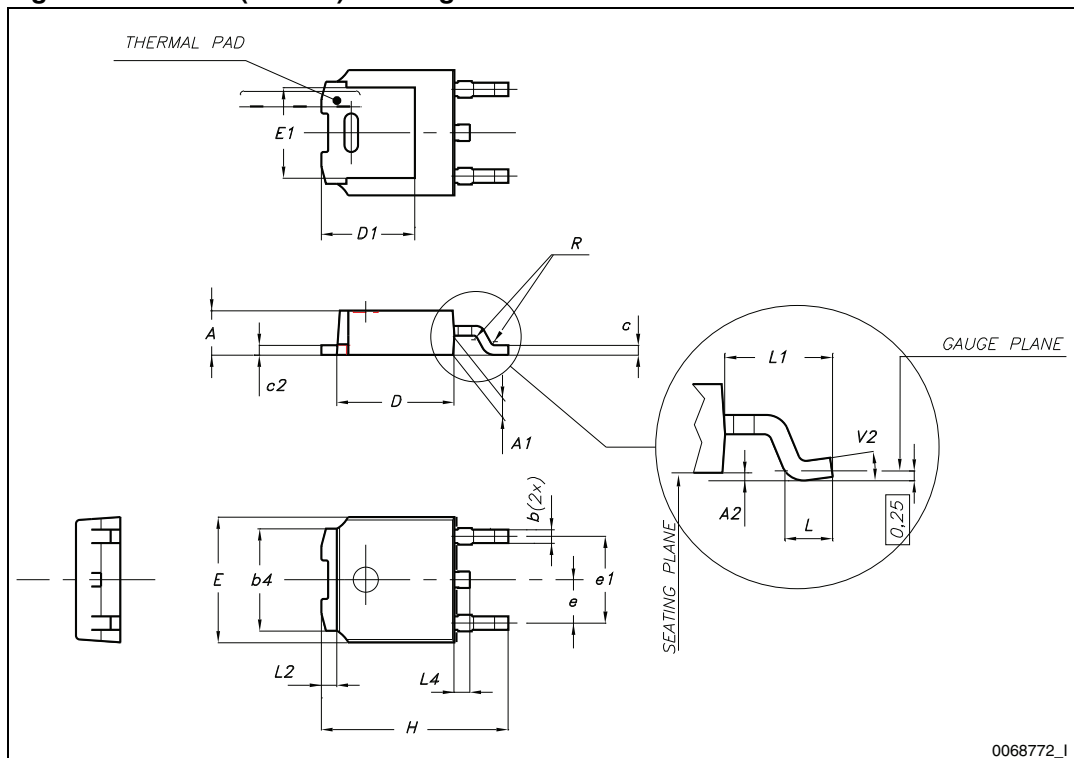
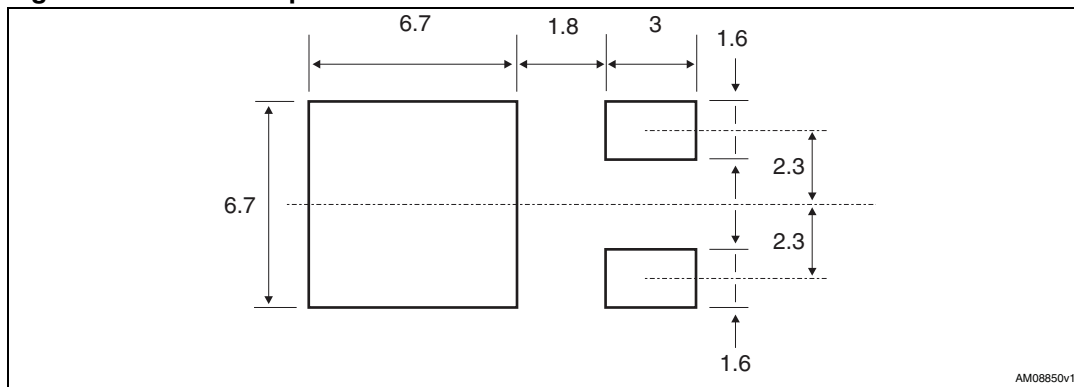


Figure 24. DPAK footprint (a)



a. All dimensions are in millimeters

Table 11. 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 25. TO-220 type A drawing

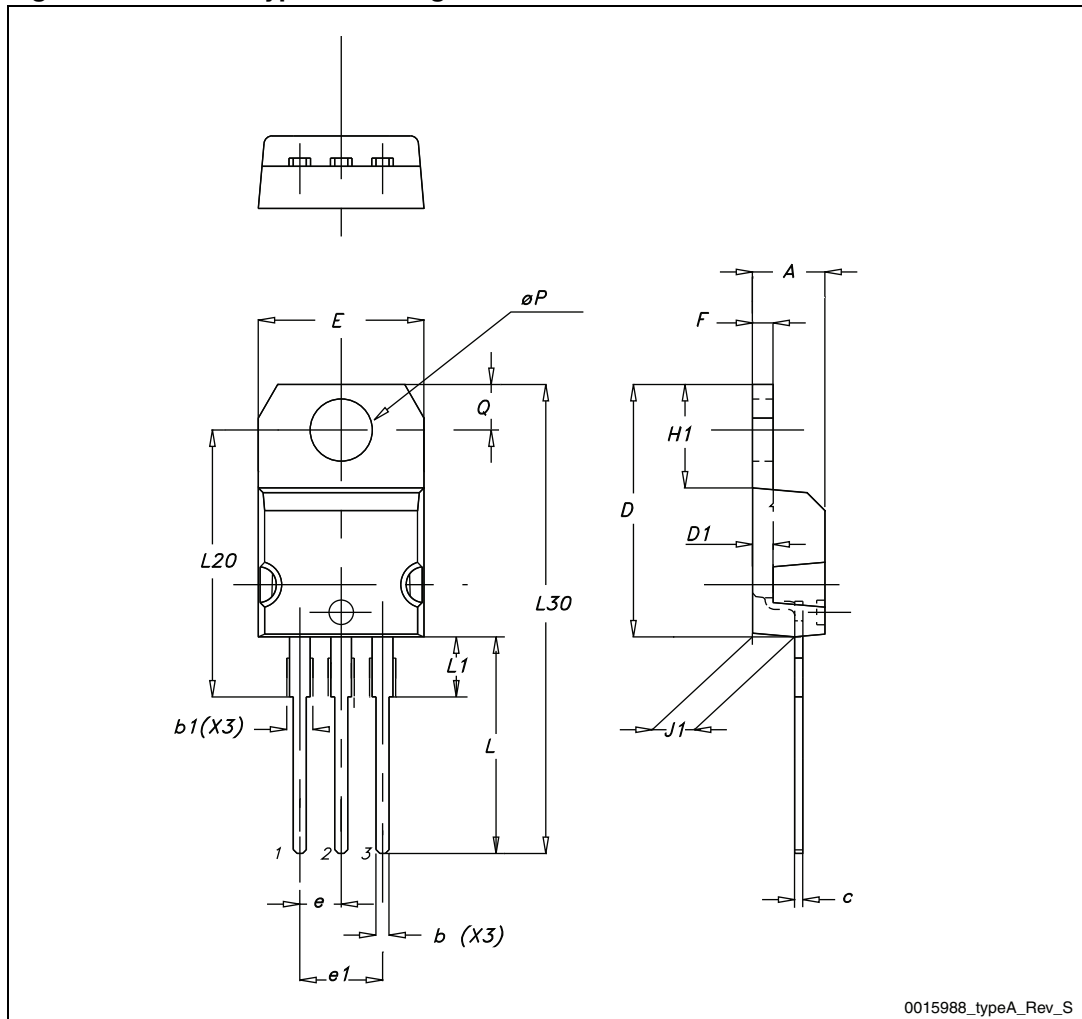
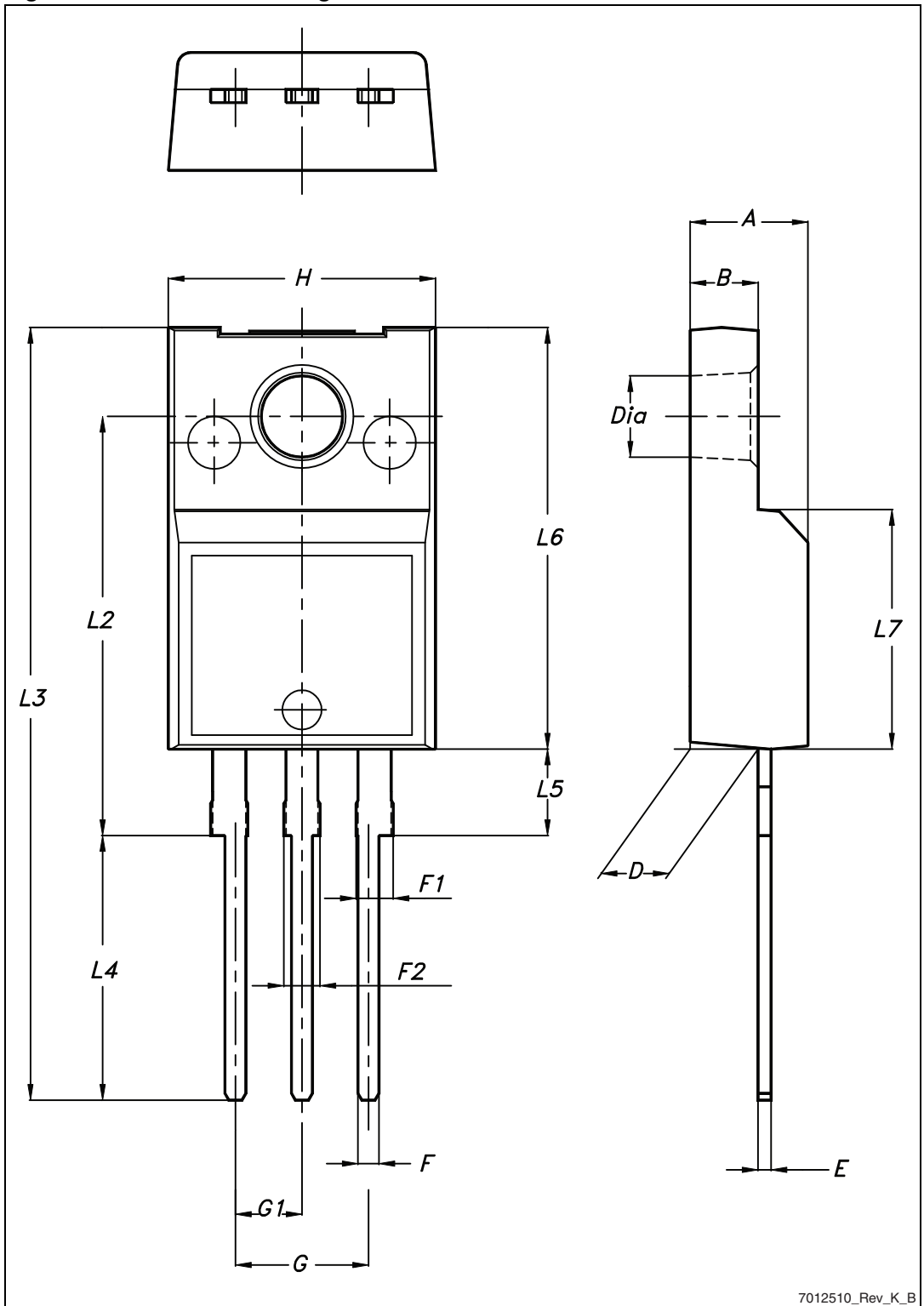


Table 12. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 26. TO-220FP drawing



7012510\_Rev\_K\_B



## 5 Packaging mechanical data

Table 13. 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 27. Tape for DPAK (TO-252)

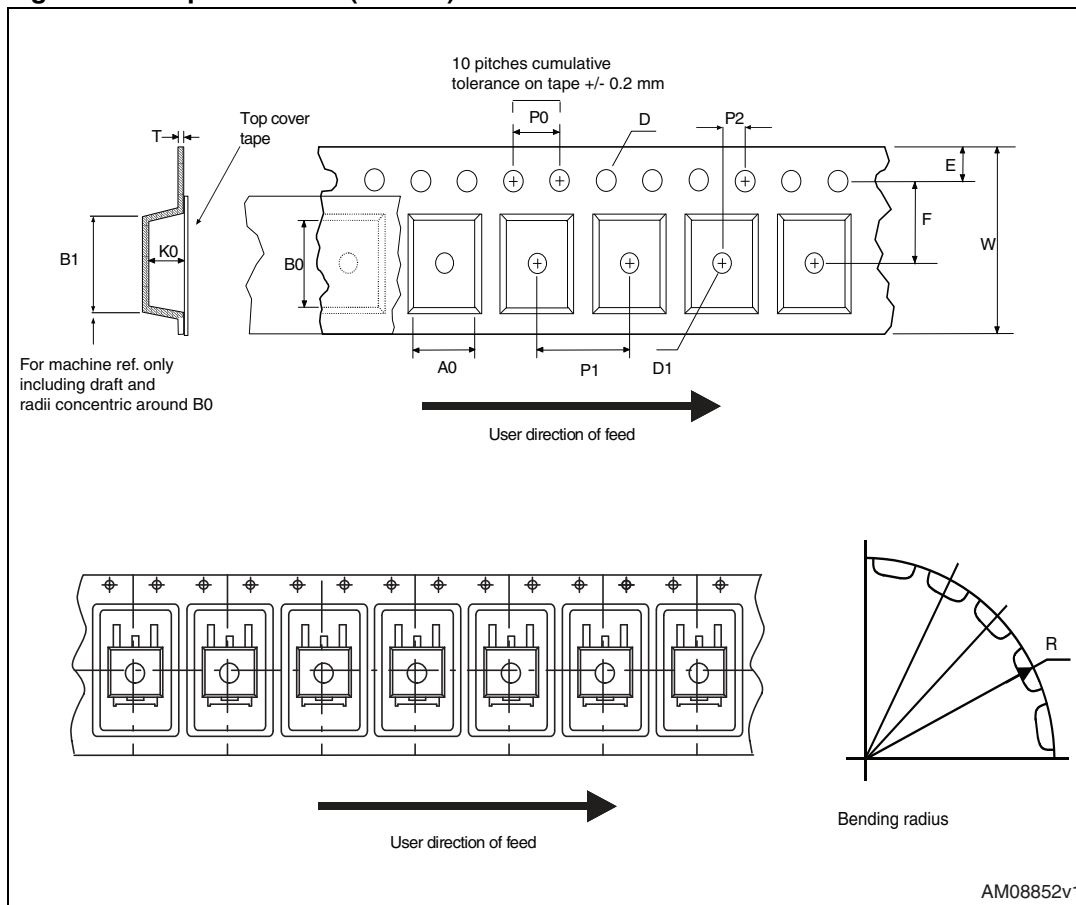
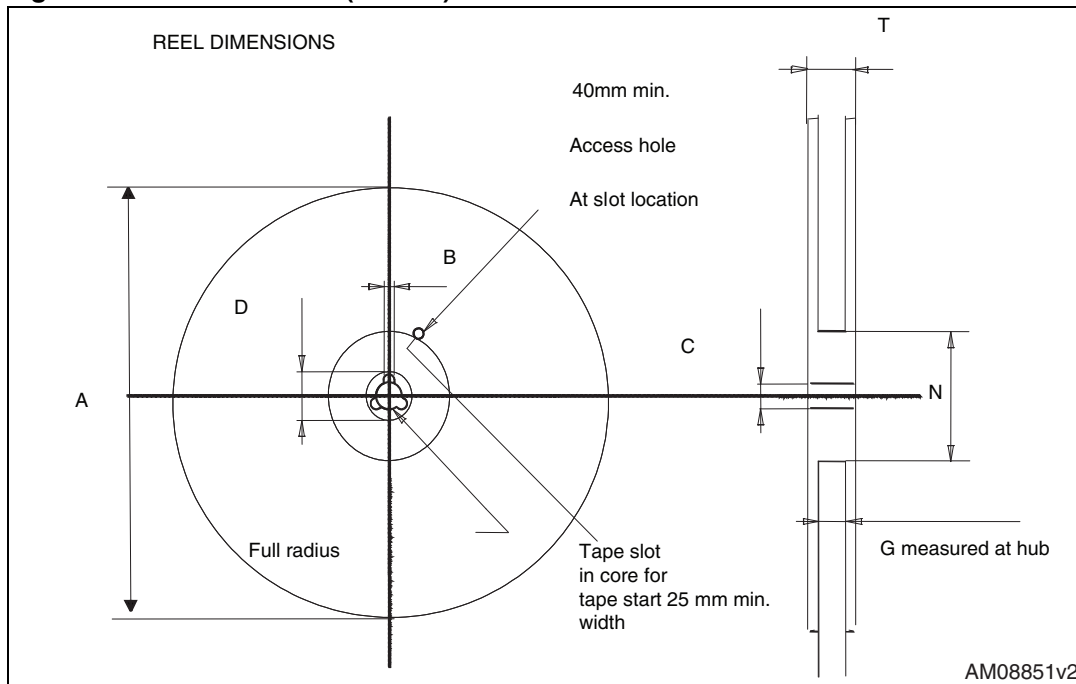


Figure 28. Reel for DPAK (TO-252)



## 6 Revision history

Table 14. Document revision history

Date	Revision	Changes
24-Oct-2006	1	First release.
29-Jan-2013	2	<ul style="list-style-type: none"><li>– The part number STD3NK90Z-1 has been moved to a separate datasheet</li><li>– Minor text changes</li><li>– Updated: <a href="#">Section 4: Package mechanical data</a></li></ul>

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