

STD4N80K5, STF4N80K5, STP4N80K5, STU4N80K5

N-channel 800 V, 2.1 Ω typ., 3 A MDmesh™ K5 Power MOSFETs in DPAK, TO-220FP, TO-220 and IPAK packages

Datasheet - production data

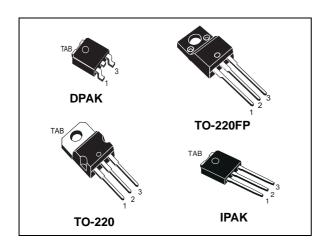
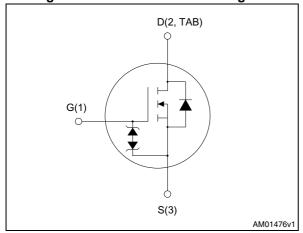


Figure 1. Internal schematic diagram



Features

Order code	V _{DS}	R _{DS(on)} max.	I _D	P _{TOT}
STD4N80K5				60 W
STF4N80K5	0001/	0.5.0	3 A	20 W
STP4N80K5	800 V	2.5 Ω		CO 14/
STU4N80K5				60 W

- Industry's lowest R_{DS(on)} x area
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- · Zener-protected

Applications

· Switching applications

Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1. Device summary

Order code	Marking	Packages	Packaging
STD4N80K5		DPAK	Tape and reel
STF4N80K5	4N80K5	TO-220FP	
STP4N80K5	4NOUN3	TO-220	Tube
STU4N80K5		IPAK	

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1 Electrical ratings

Table 2. Absolute maximum ratings

		Value			
Symbol	Parameter	DPAK, IPAK	TO-220FP	TO-220	Unit
V _{DS}	Drain-source voltage		800		V
V _{GS}	Gate- source voltage		±30		V
I _D	Drain current (continuous) at T _C = 25 °C	3	3 (1)	3	Α
I _D	Drain current (continuous) at T _C = 100 °C	1.7	1.7 ⁽¹⁾	1.7	Α
I _{DM} ⁽²⁾	Drain current (pulsed)	12	12 ⁽¹⁾	12	Α
P _{TOT}	Total dissipation at T _C = 25 °C	60	20	60	W
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max)	1			А
E _{AS}	Single pulse avalanche energy (starting $T_J = 25$ °C, $I_D = I_{AR}$, $V_{DD} = 50$ V)	74.5		mJ	
dv/dt ⁽³⁾	Peak diode recovery voltage slope		4.5		V/ns
dv/dt ⁽⁴⁾	MOSFET dv/dt ruggedness		50		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T _C = 25 °C)	2500		V	
TJ	Operating junction temperature	-55 to 150		°C	
T _{stg}	Storage temperature			°C	

^{1.} Limited by maximum junction temperature

Table 3. Thermal data

Symbol	ymbol Parameter		TO-220FP	TO-220	Unit
R _{thj-case}	Thermal resistance junction-case max	2.08	6.25	2.08	°C/W
R _{thj-amb} Thermal resistance junction-ambient max			62.5		°C/W
R _{thj-pcb} ⁽¹⁾	R _{thj-pcb} ⁽¹⁾ Thermal resistance junction-pcb max				°C/W

^{1.} When mounted on 1inch² FR-4 board, 2 oz Cu



^{2.} Pulse width limited by safe operating area

^{3.} $I_{SD} < 3 \text{ A, di/dt } < 100 \text{ A/}\mu\text{s, } V_{DS(peak)} \le V_{(BR)DSS}$

^{4.} $V_{DS} \le 640 \text{ V}$

2 Electrical characteristics

(Tcase =25 °C unless otherwise specified)

Table 4. On /off states

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V _{(BR)DSS}	Drain-source breakdown voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	800			V
1	Zero gate voltage drain current (V _{GS} = 0)	V _{DS} = 800 V			1	μΑ
DSS		V _{DS} = 800 V, T _C =125 °C			50	μΑ
I _{GSS}	Gate-body leakage current (V _{DS} = 0)	V _{GS} = ± 20 V			±10	μA
V _{GS(th)}	Gate threshold voltage	$V_{DS} = V_{GS}, I_{D} = 100 \mu A$	3	4	5	V
R _{DS(on)}	Static drain-source on- resistance	$V_{GS} = 10 \text{ V}, I_D = 1.5 \text{ A}$		2.1	2.5	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C _{iss}	Input capacitance		-	175	-	pF
C _{oss}	Output capacitance	V _{DS} = 100 V, f = 1 MHz,	-	18	-	pF
C _{rss}	Reverse transfer capacitance	$V_{GS} = 0$	-	0.5	-	pF
C _{o(tr)} ⁽¹⁾	Equivalent capacitance time related	V _{DS} = 0 to 640 V, V _{GS} = 0	-	26	-	pF
C _{o(er)} ⁽²⁾	Equivalent capacitance energy related	V _{DS} = 0 to 640 V, V _{GS} = 0	-	11	-	pF
Rg	Gate input resistance	f=1 MHz, I _D = 0	-	15	-	Ω
Qg	Total gate charge	V _{DD} = 640 V, I _D = 3 A,	-	10.5	-	nC
Q _{gs}	Gate-source charge	V _{GS} = 10 V	-	2	-	nC
Q _{gd}	Gate-drain charge	(see Figure 19)	-	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}

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^{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.	Тур.	Max.	Unit
t _{d(on)}	Turn-on delay time		-	16.5	-	ns
t _r	Rise time	$V_{DD} = 400 \text{ V}, I_D = 1.5 \text{ A},$ $R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$	-	15	-	ns
t _{d(off)}	Turn-off-delay time	(see Figure 18)	-	36	-	ns
t _f	Fall time		-	21	-	ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
I _{SD}	Source-drain current		-		3	Α
I _{SDM} ⁽¹⁾	Source-drain current (pulsed)				12	Α
V _{SD} (2)	Forward on voltage	$I_{SD} = 3 A, V_{GS} = 0$	-		1.5	V
t _{rr}	Reverse recovery time	I _{SD} = 3 A, di/dt = 100 A/μs	-	242		ns
Q _{rr}	Reverse recovery charge	V _{DD} = 60 V	-	1.42		μC
I _{RRM}	Reverse recovery current	(see Figure 20)	-	12		Α
t _{rr}	Reverse recovery time	I _{SD} = 3 A, di/dt = 100 A/μs	-	373		ns
Q _{rr}	Reverse recovery charge	V _{DD} = 60 V T _J = 150 °C	-	1.98		μC
I _{RRM}	Reverse recovery current	(see Figure 20)	-	10.5		Α

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

Table 8. Gate-source Zener diode

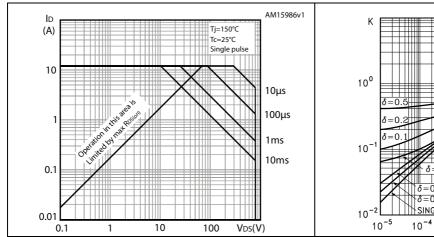
Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V _{(BR)GSO}	Gate-source breakdown voltage	I_{GS} = ± 1 mA, I_{D} =0	30		-	٧

The built-in back-to-back Zener diodes have been specifically designed to enhance the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK and IPAK

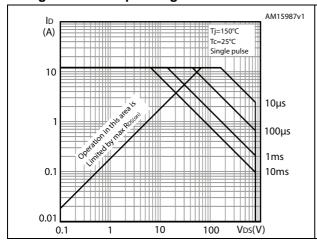
Figure 3. Thermal impedance for DPAK and IPAK



K 6c34560 $\delta = 0.5$ $\delta = 0.2$ $\delta = 0.05$ $\delta = 0.02$ $\delta = 0.05$ $\delta = 0.02$ $\delta = 0.01$ $\delta = 0.02$ $\delta =$

Figure 4. Safe operating area for TO-220FP

Figure 5. Thermal impedance for TO-220FP



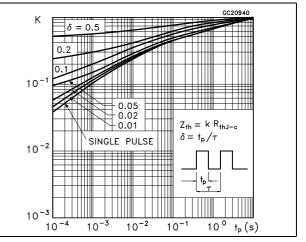
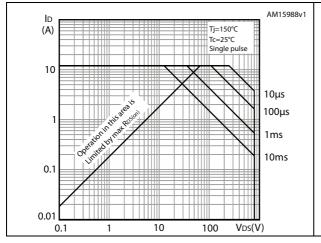
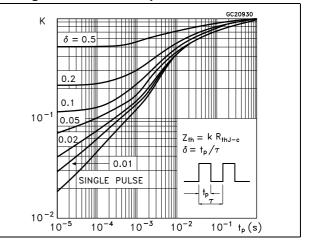


Figure 6. Safe operating area for TO-220

Figure 7. Thermal impedance for TO-220

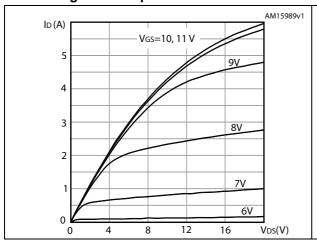




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Figure 8. Output characteristics

Figure 9. Transfer characteristics



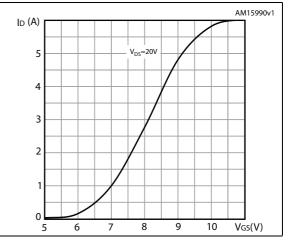
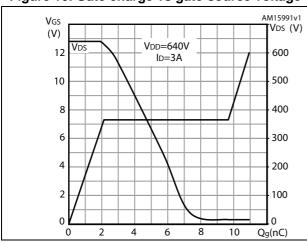


Figure 10. Gate charge vs gate-source voltage

Figure 11. Static drain-source on-resistance



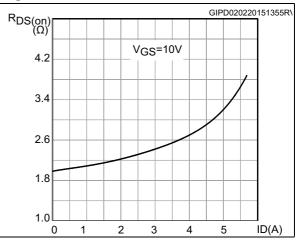
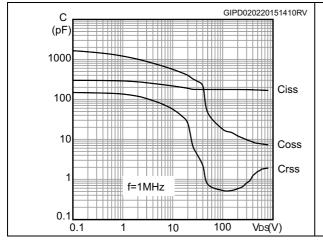


Figure 12. Capacitance variations

Figure 13. Normalized gate threshold voltage vs temperature



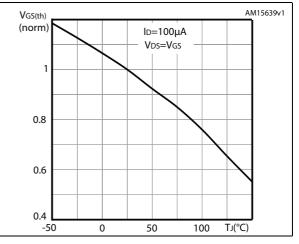


Figure 14. Normalized on-resistance vs temperature

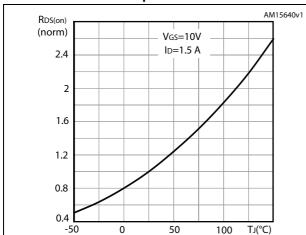


Figure 15. Source-drain diode forward characteristics

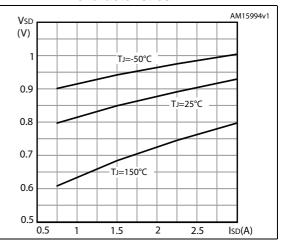
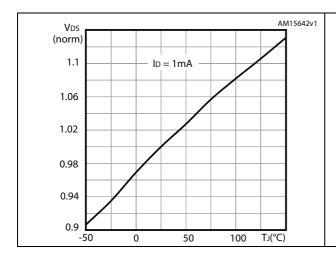
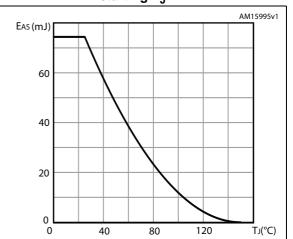


Figure 16. Normalized V_{DS} vs temperature

Figure 17. Maximum avalanche energy vs. starting T_J





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3 Test circuits

Figure 18. Switching times test circuit for resistive load

Figure 19. Gate charge test circuit

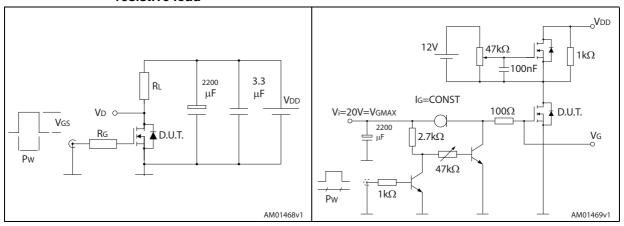


Figure 20. Test circuit for inductive load switching and diode recovery times

Figure 21. Unclamped inductive load test circuit

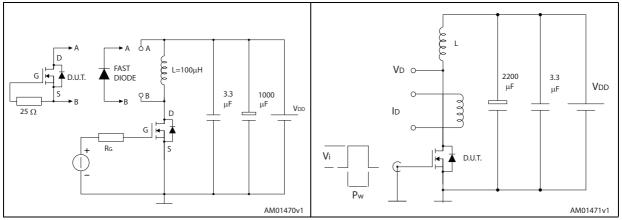
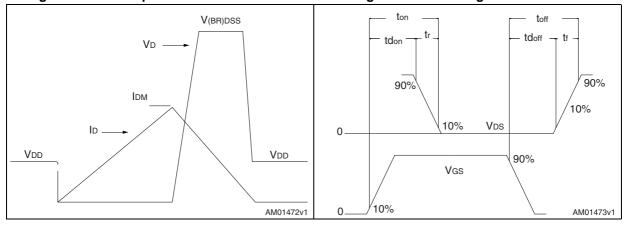


Figure 22. Unclamped inductive waveform

Figure 23. Switching time waveform





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. ECOPACK[®] is an ST trademark.

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4.1 DPAK(TO-252), package information

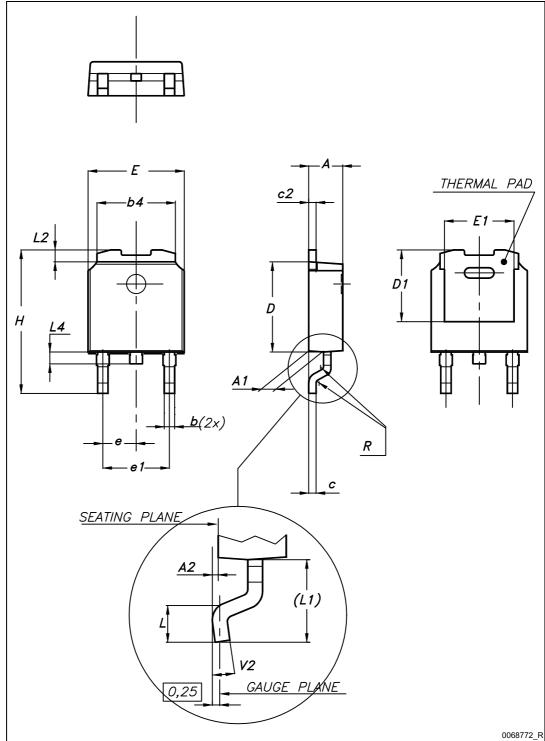


Figure 24. DPAK (TO-252) type A outline

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Figure 25. DPAK (TO-252) mechanical data

Dim		mm	
Dim.	Min.	Тур.	Max.
А	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
С	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
Е	6.40		6.60
E1		4.70	
е		2.28	
e1	4.40		4.60
Н	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°

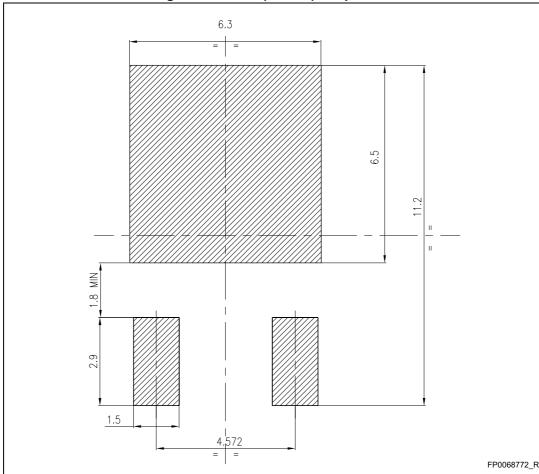


Figure 26. DPAK (TO-252) footprint (a)

a. All dimensions are in millimeters

4.2 TO-220FP, package information

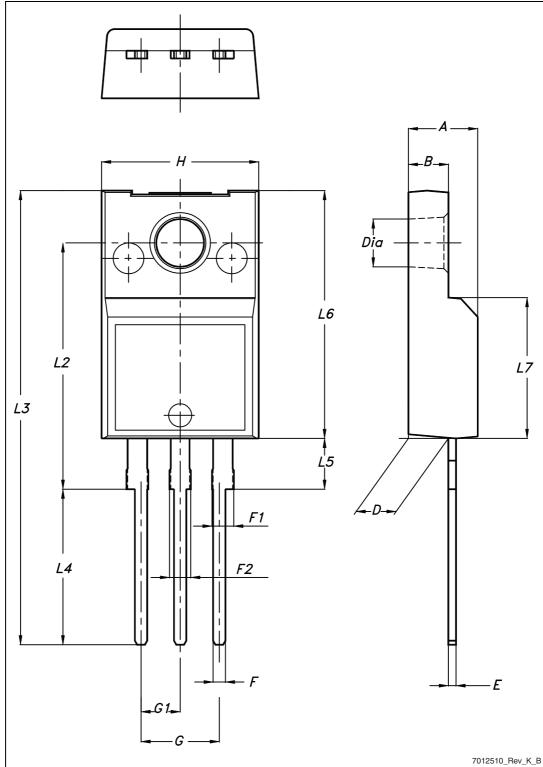


Figure 27. TO-220FP outline

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Table 9. TO-220FP mechanical data

		mm	
Dim.	Min.	Тур.	Max.
А	4.4		4.6
В	2.5		2.7
D	2.5		2.75
Е	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
Н	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



TO-220, package information 4.3

øΡ H1 D1 L20 L30 <u>L</u>1 b1(X3) b (X3) _e1__

Figure 28. TO-220 type A outline

0015988_typeA_Rev_T

Table 10. TO-220 type A mechanical data

Dim.	mm			
	Min.	Тур.	Max.	
А	4.40		4.60	
b	0.61		0.88	
b1	1.14		1.70	
С	0.48		0.70	
D	15.25		15.75	
D1		1.27		
E	10		10.40	
е	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	

4.4 IPAK(TO-251), package information

Figure 29. IPAK (TO-251) type A outline

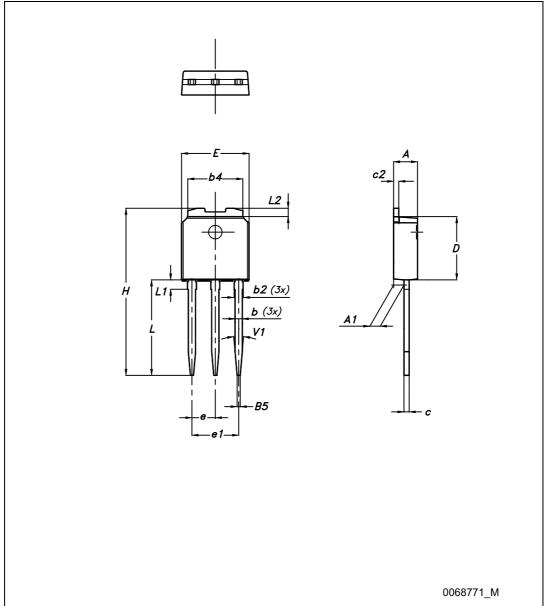


Table 11. IPAK (TO-251) type A mechanical data

DIM	mm.			
DIW	min.	typ.	max.	
Α	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		
С	0.45		0.60	
c2	0.48		0.60	
D	6.00		6.20	
E	6.40		6.60	
е		2.28		
e1	4.40		4.60	
Н		16.10		
L	9.00		9.40	
L1	0.80		1.20	
L2		0.80	1.00	
V1		10°		

5 Packaging mechanical data

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

	Таре	217 (10 202)		Reel		
Dim.	n	nm	Dim.	mm		
	Min.	Max.	Dilli.	Min.	Max.	
Α0	6.8	7	А		330	
В0	10.4	10.6	В	1.5		
B1		12.1	С	12.8	13.2	
D	1.5	1.6	D	20.2		
D1	1.5		G	16.4	18.4	
Е	1.65	1.85	N	50		
F	7.4	7.6	Т		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					
Т	0.25	0.35				
W	15.7	16.3				

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Top cover tolerance on tape +/- 0.2 mm

Top cover tolerance on tape +/- 0.2 mm

For machine ref. only including draft and radii concentric around B0

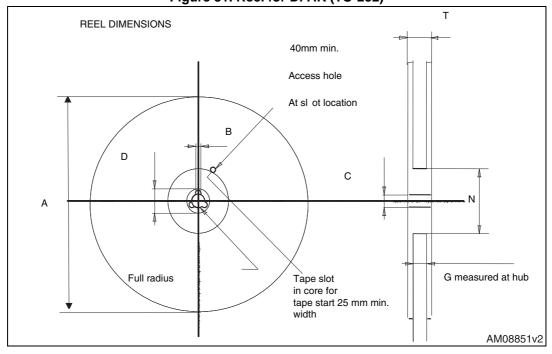
User direction of feed

Liser direction of feed

AM08852v1

Figure 30. Tape for DPAK (TO-252)





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6 Revision history

Table 13. Document revision history

Date	Revision	Changes
09-Aug-2013	1	First release
13-Dec-2013	2	Added: IPAK packageAdded: <i>Table 11</i> and <i>Figure 29</i>Minor text changes
04-Feb-2015	3	 Updated title and description in cover page. Updated Table 2.: Absolute maximum ratings, Table 5.: Dynamic and Table 7.: Source drain diode. Updated 4: Package information and 5: Packaging mechanical data. Minor text changes.



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