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# STB7ANM60N, STD7ANM60N

Automotive-grade N-channel 600 V, 5 A, 0.84  $\Omega$  typ., MDmesh™ II  
Power MOSFETs in D<sup>2</sup>PAK and DPAK packages

Datasheet - production data

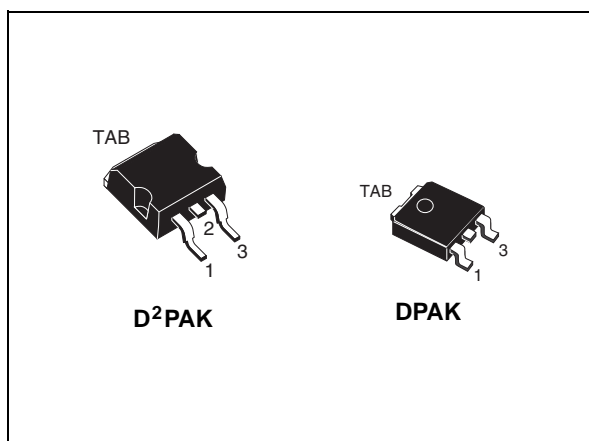
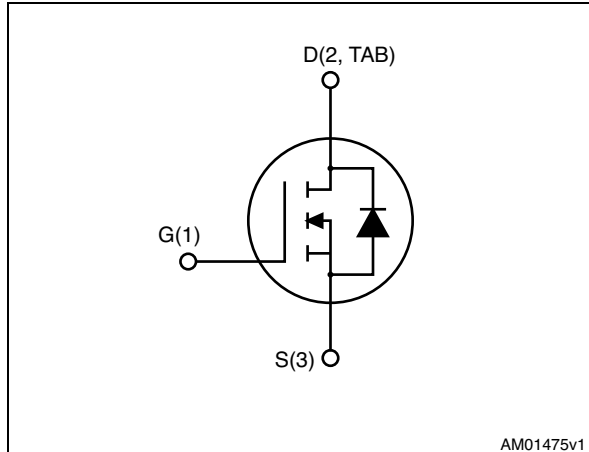


Figure 1. Internal schematic diagram



## Features

Order codes	V <sub>DS</sub> @ T <sub>jmax</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STB7ANM60N	650 V	0.9 $\Omega$	5 A
STD7ANM60N			

- Designed for automotive applications and AEC-Q101 qualified
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STB7ANM60N	7ANM60N	D <sup>2</sup> PAK	Tape and reel
STD7ANM60N		DPAK	

## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>4</b>
2.1	Electrical characteristics (curves) .....	6
<b>3</b>	<b>Test circuits</b> .....	<b>9</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>10</b>
<b>5</b>	<b>Packaging mechanical data</b> .....	<b>16</b>
<b>6</b>	<b>Revision history</b> .....	<b>19</b>

STB7ANM60N, STD7ANM60N

Electrical ratings

# 1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	5	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	3	A
$I_{DM}^{(1)}$	Drain current (pulsed)	20	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	45	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ ,  $V_{DS(Peak)} < V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK	DPAK	
$R_{thj-case}$	Thermal resistance junction-case max	2.78		$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb max	35	50	$^\circ\text{C}/\text{W}$

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

Table 4. Thermal data

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)	2	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	119	mJ

Electrical characteristics

STB7ANM60N, STD7ANM60N

## 2 Electrical characteristics

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

Table 5. On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	600			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	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	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 2.5\text{ A}$		0.84	0.9	$\Omega$

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	363	-	pF
$C_{oss}$	Output capacitance		-	24.6	-	pF
$C_{riss}$	Reverse transfer capacitance		-	1.1	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Output equivalent capacitance	$V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0$	-	130	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	5.4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 5\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> )	-	14	-	nC
$Q_{gs}$	Gate-source charge		-	2.7	-	nC
$Q_{gd}$	Gate-drain charge		-	7.7	-	nC

1.  $C_{oss\text{ eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DS}$ .

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 2.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17</a> )	-	7	-	ns
$t_r$	Rise time		-	10	-	ns
$t_{d(off)}$	Turn-off-delay time		-	26	-	ns
$t_f$	Fall time		-	12	-	ns

**STB7ANM60N, STD7ANM60N**
**Electrical characteristics**
**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		20	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 5\text{ A}$ , $V_{GS} = 0$	-		1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see <a href="#">Figure 20</a> )	-	213		ns
$Q_{rr}$	Reverse recovery charge		-	1.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	14		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 20</a> )	-	265		ns
$Q_{rr}$	Reverse recovery charge		-	1.8		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	14		A

1. Pulse width limited by safe operating area

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

Electrical characteristics

STB7ANM60N, STD7ANM60N

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D<sup>2</sup>PAK

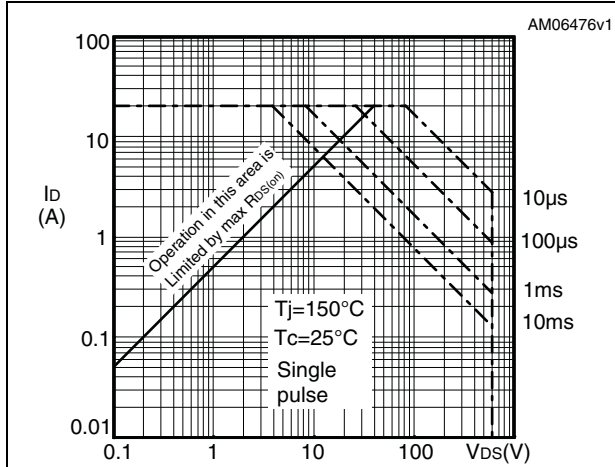


Figure 3. Thermal impedance for D<sup>2</sup>PAK

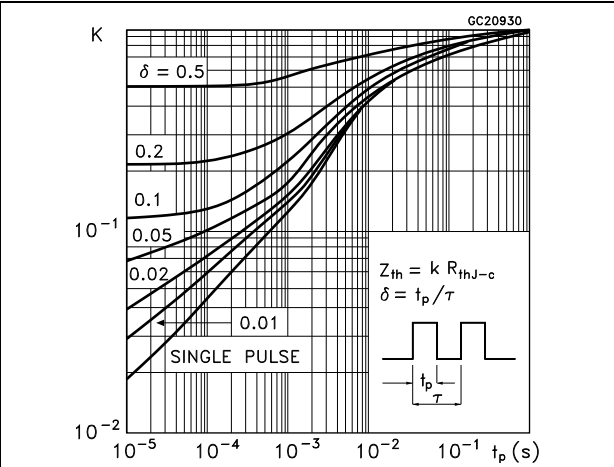


Figure 4. Safe operating area for DPAK

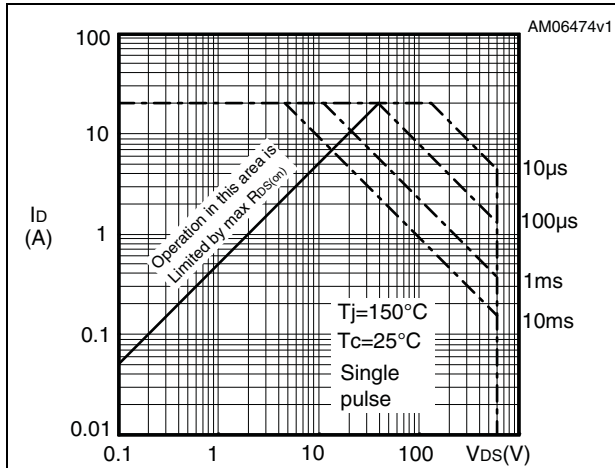


Figure 5. Thermal impedance for DPAK

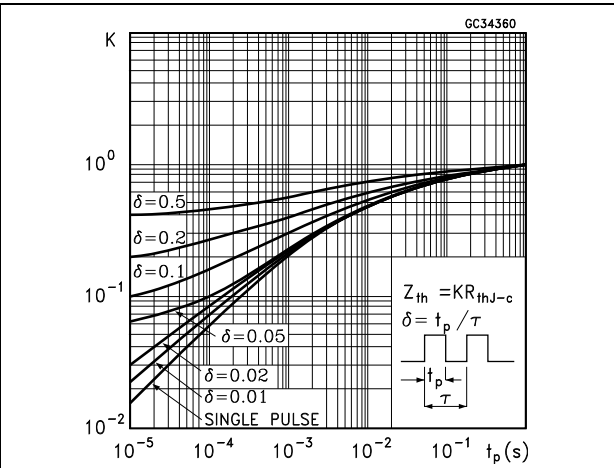


Figure 6. Output characteristics

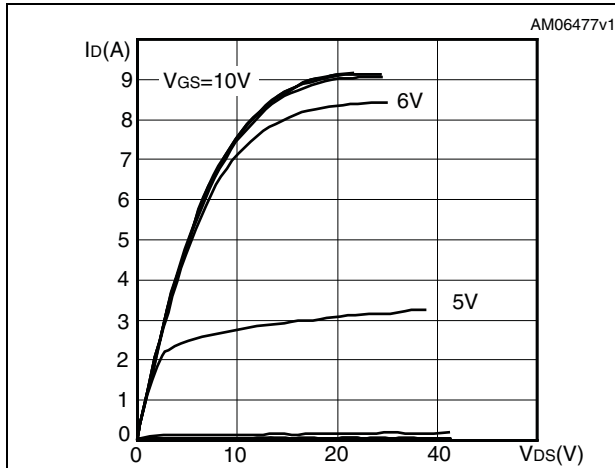
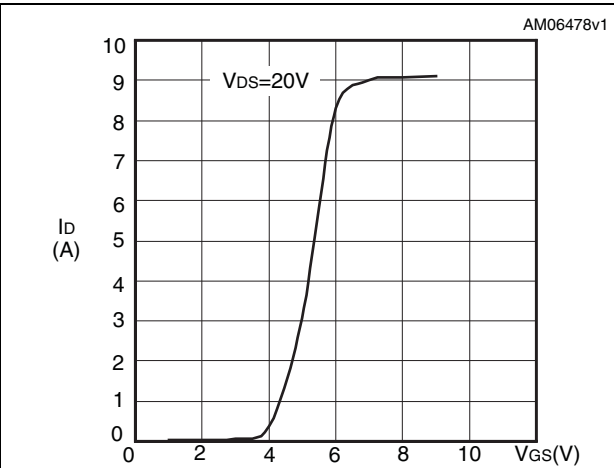


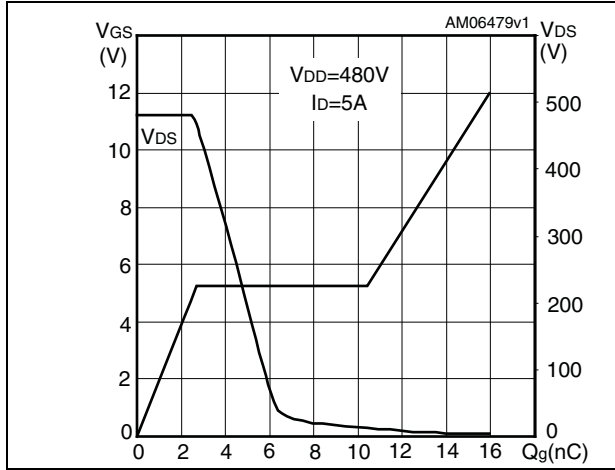
Figure 7. Transfer characteristics



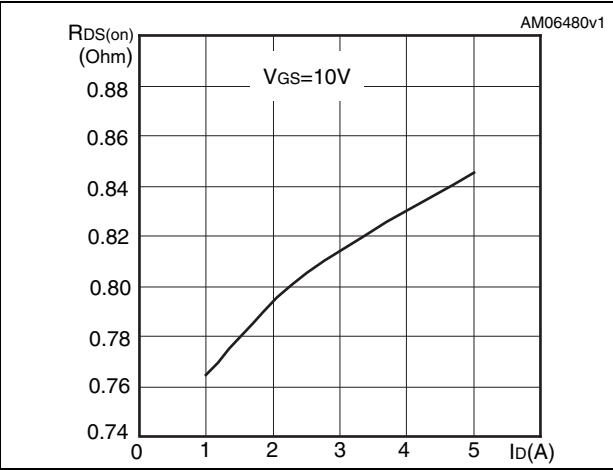
**STB7ANM60N, STD7ANM60N**

**Electrical characteristics**

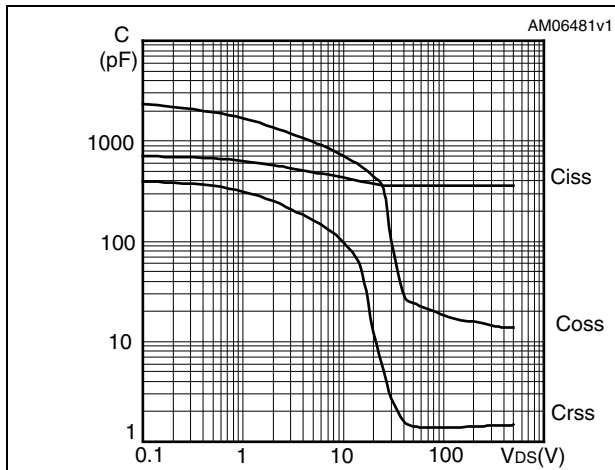
**Figure 8. Gate charge vs gate-source voltage**



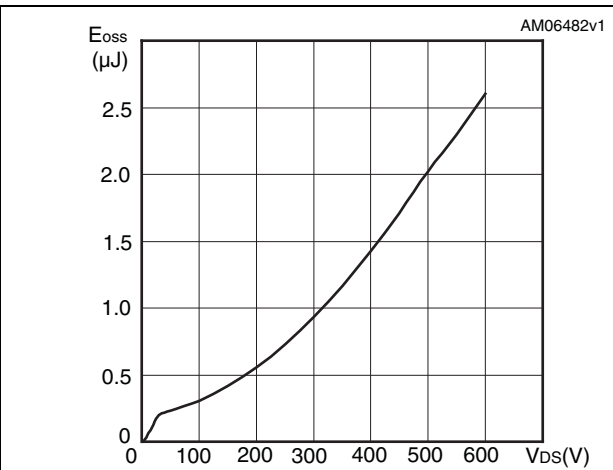
**Figure 9. Static drain-source on resistance**



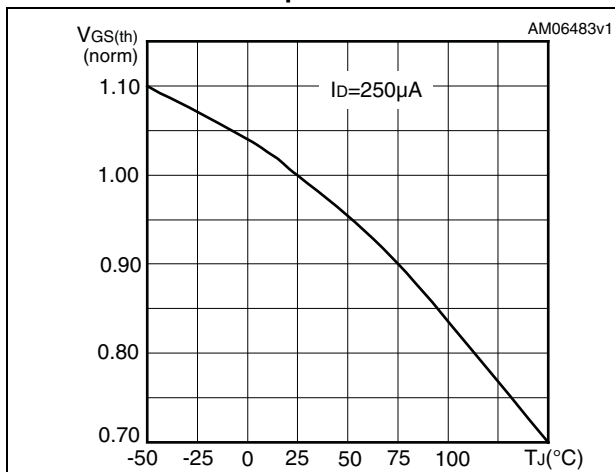
**Figure 10. Capacitance variations**



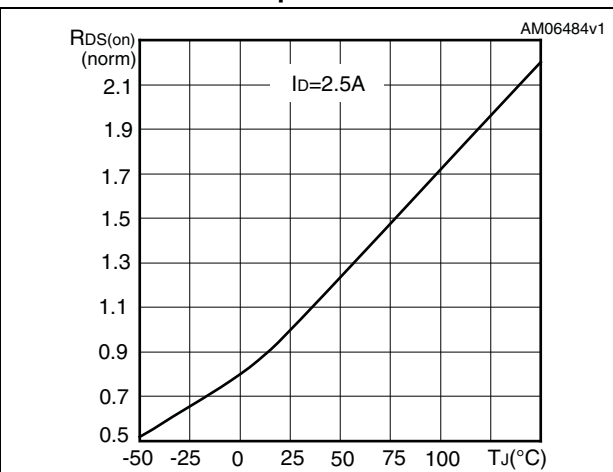
**Figure 11. Output capacitance stored energy**



**Figure 12. Normalized gate threshold voltage vs temperature**



**Figure 13. Normalized on-resistance vs temperature**

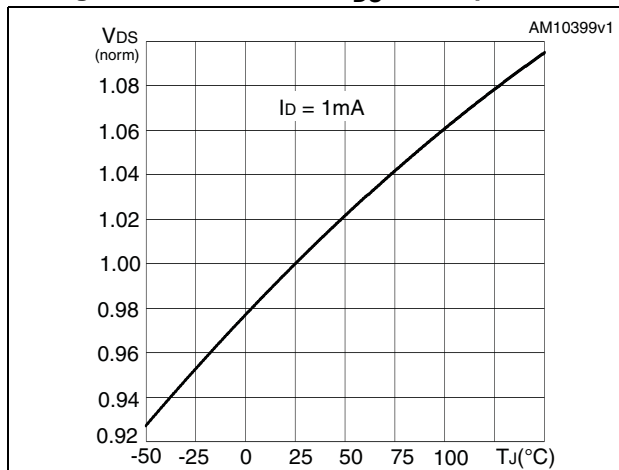




**Electrical characteristics**

**STB7ANM60N, STD7ANM60N**

**Figure 14. Normalized  $V_{DS}$  vs temperature**

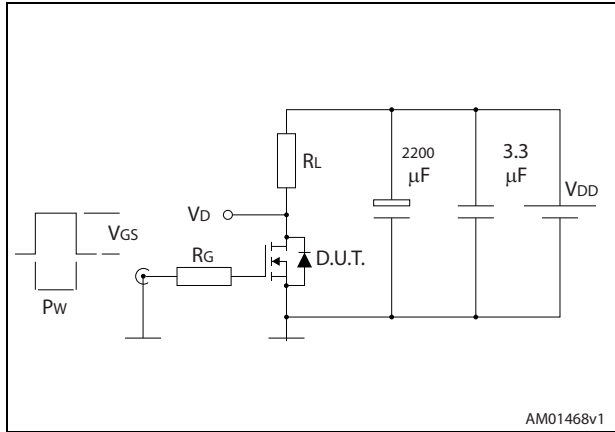


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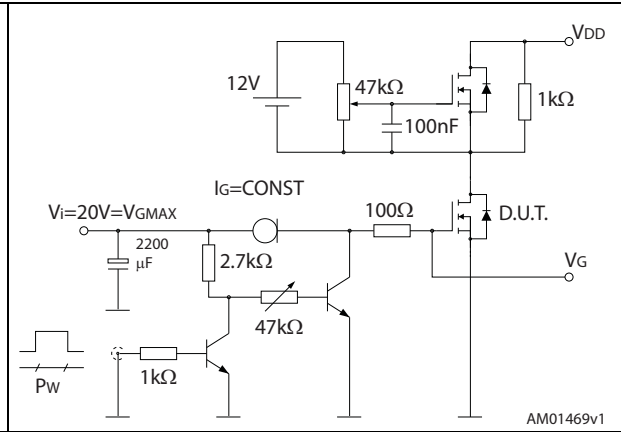
**Test circuits**

**3 Test circuits**

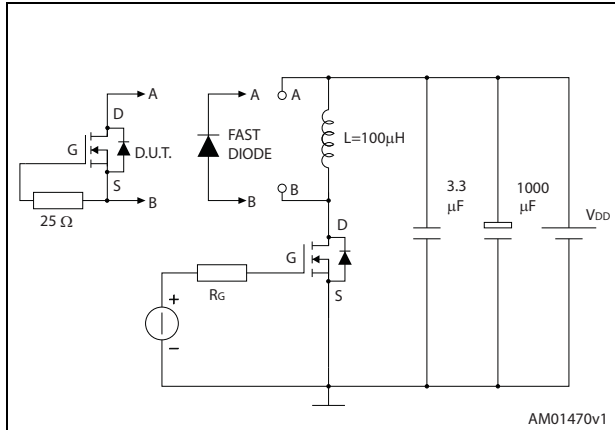
**Figure 15. Switching times test circuit for resistive load**



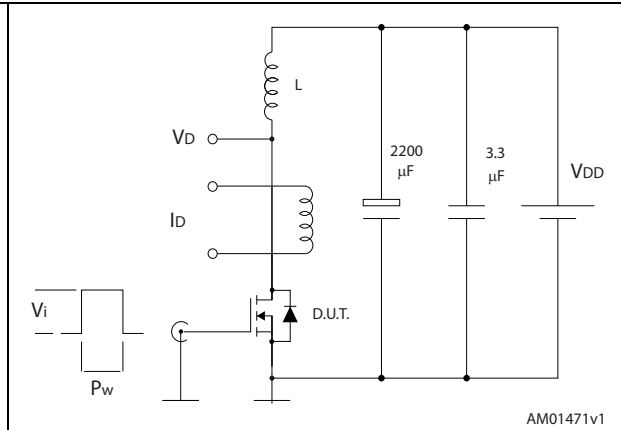
**Figure 16. Gate charge test circuit**



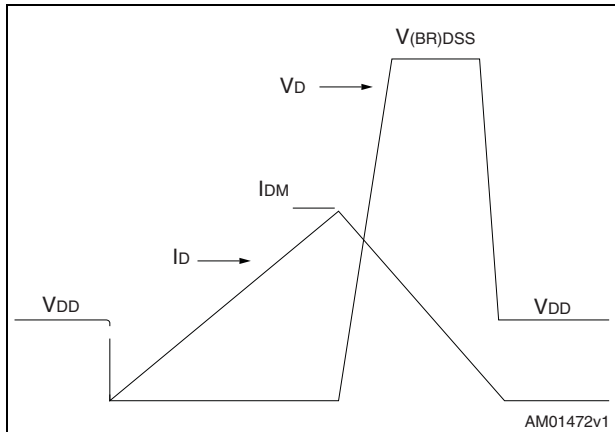
**Figure 17. Test circuit for inductive load switching and diode recovery times**



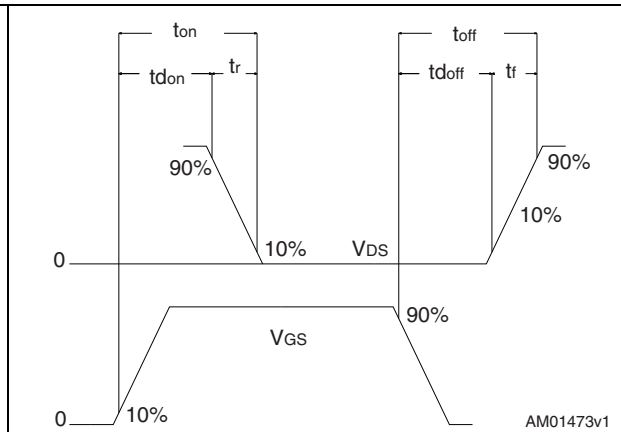
**Figure 18. Unclamped inductive load test circuit**



**Figure 19. Unclamped inductive waveform**



**Figure 20. 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.

**STB7ANM60N, STD7ANM60N**

**Package mechanical data**

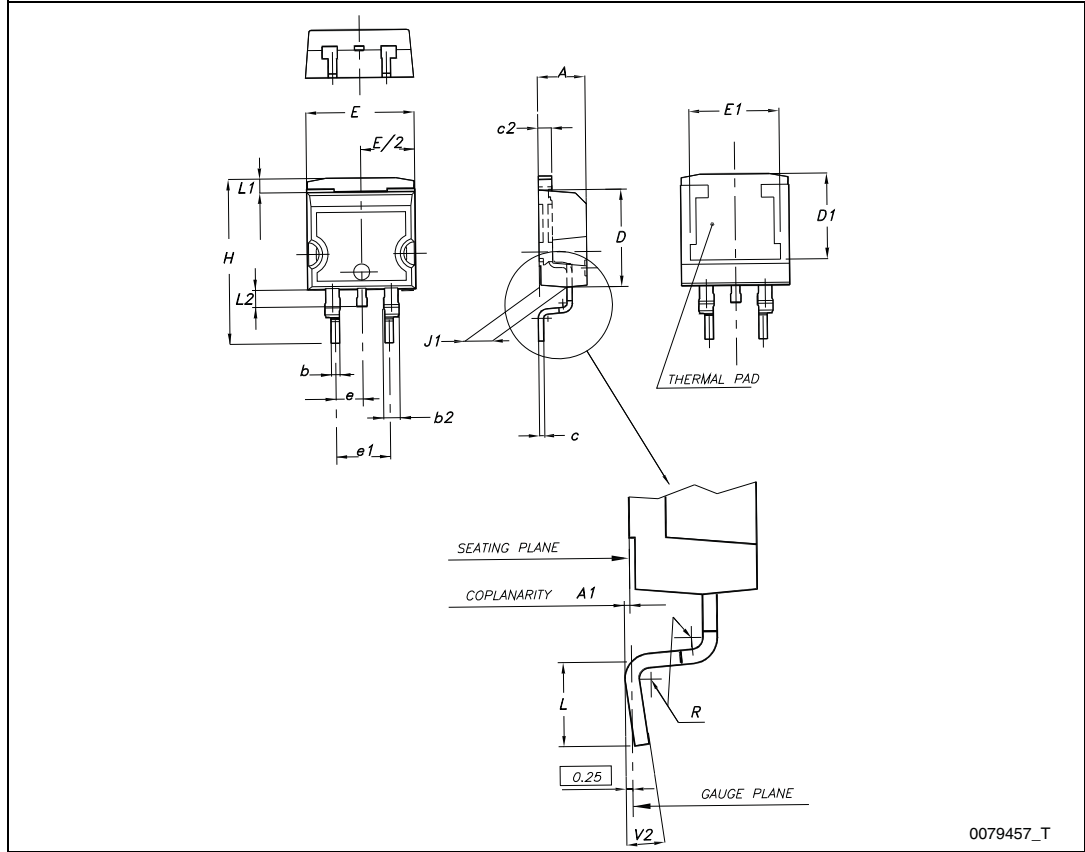
**Table 9. D<sup>2</sup>PAK (TO-263) mechanical data**

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°

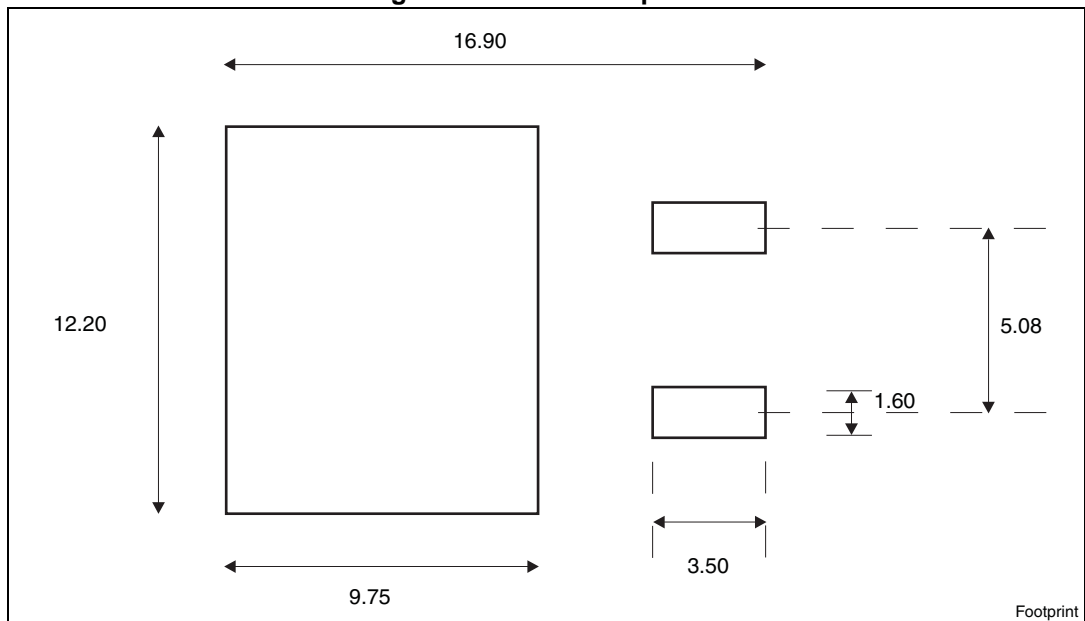
**Package mechanical data**

**STB7ANM60N, STD7ANM60N**

**Figure 21. D<sup>2</sup>PAK (TO-263) drawing**



**Figure 22. D<sup>2</sup>PAK footprint<sup>(a)</sup>**



a. All dimensions are in millimeters

**STB7ANM60N, STD7ANM60N**

**Package mechanical data**

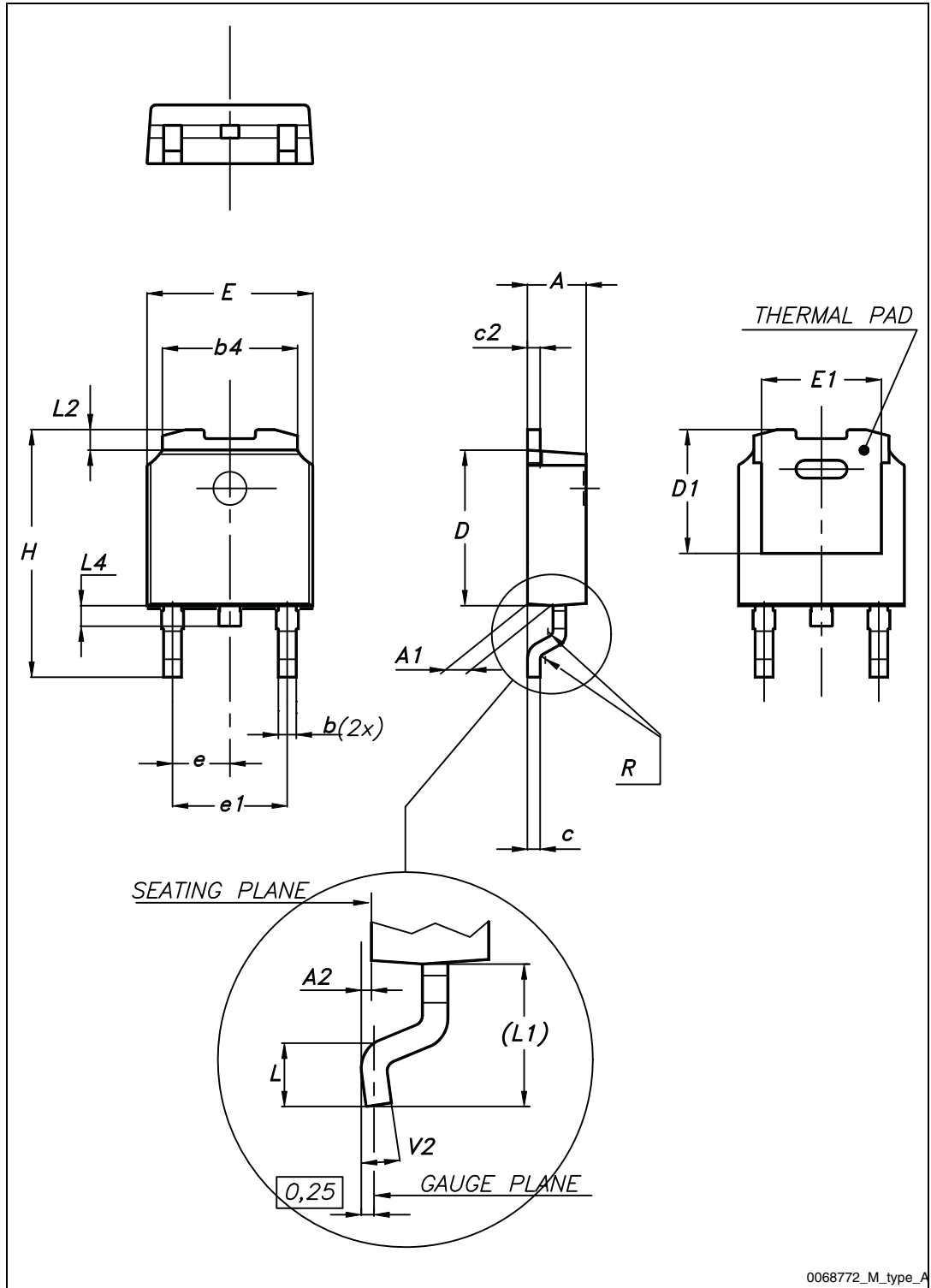
**Table 10. DPAK (TO-252) type A mechanical data**

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°

Package mechanical data

STB7ANM60N, STD7ANM60N

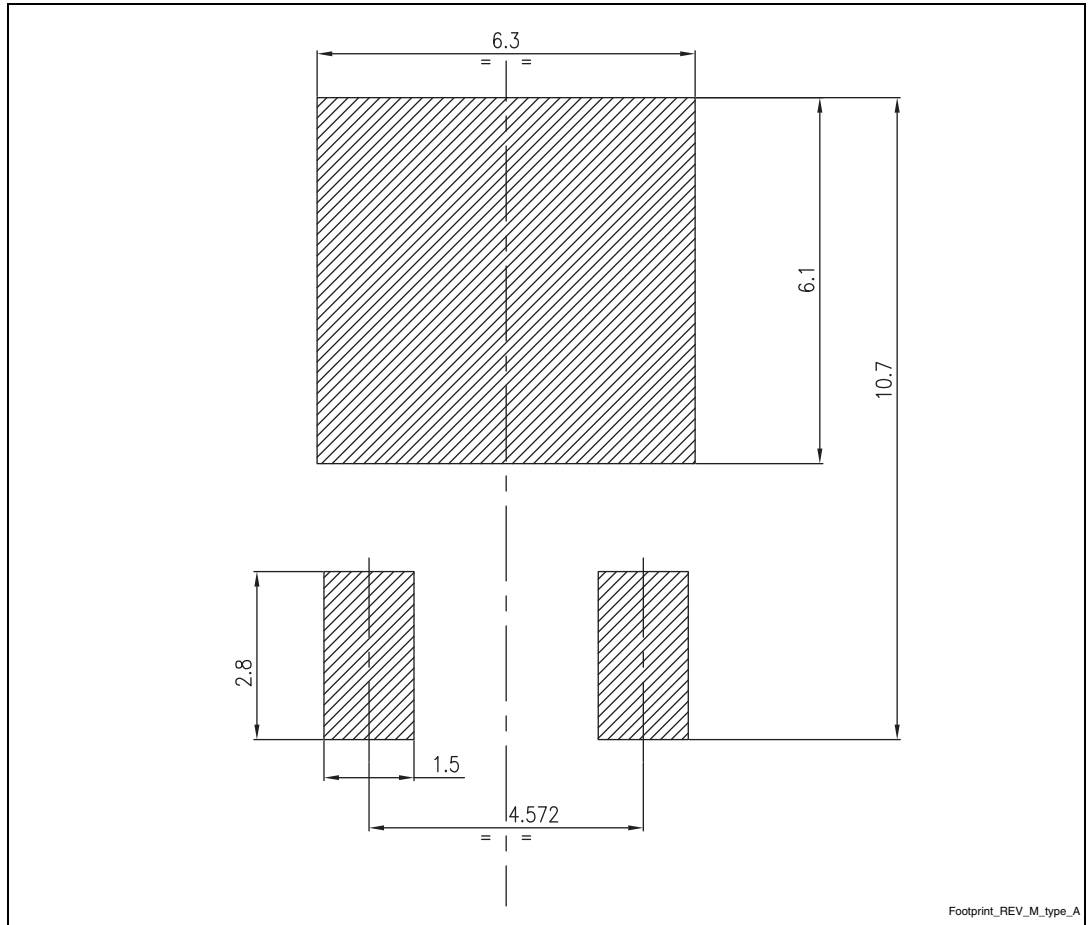
Figure 23. DPAK (TO-252) type A drawing



**STB7ANM60N, STD7ANM60N**

**Package mechanical data**

**Figure 24. DPAK (TO-252) type A footprint (b)**



b. All dimensions are in millimeters



## 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

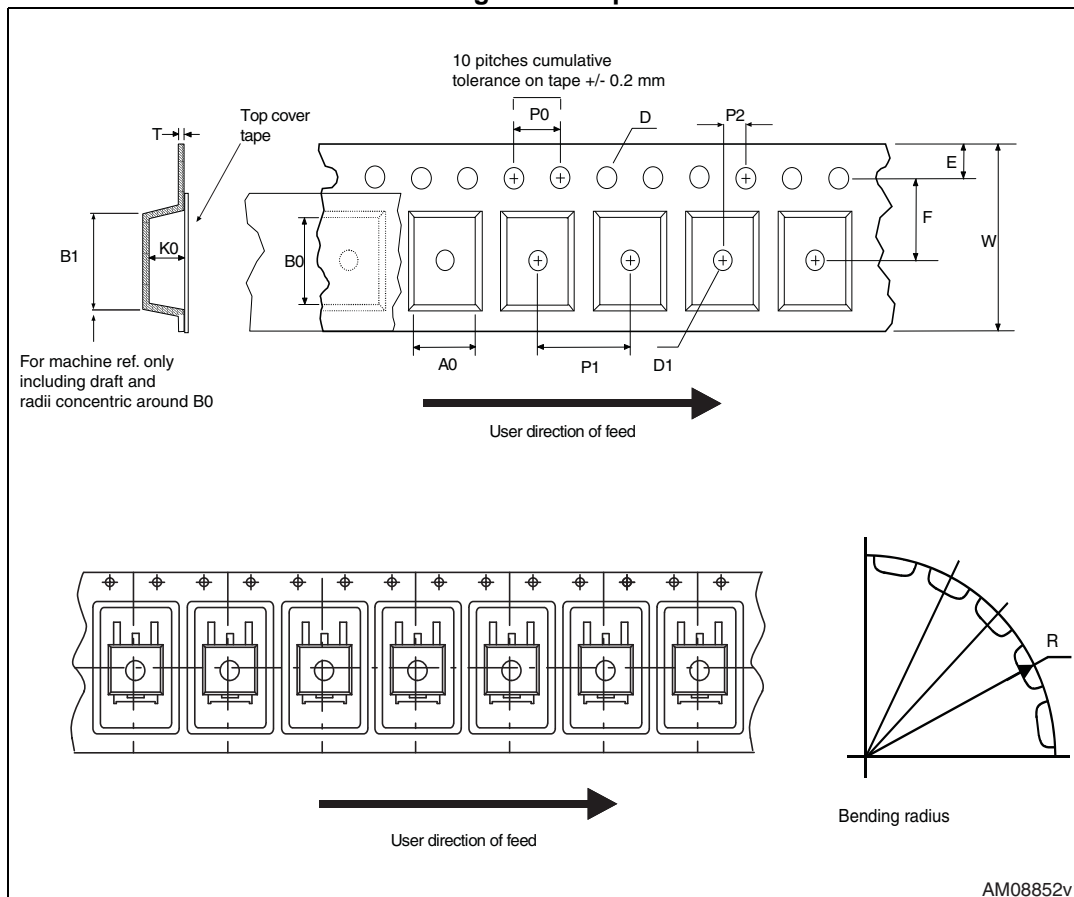
**STB7ANM60N, STD7ANM60N**

**Packaging mechanical data**

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

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

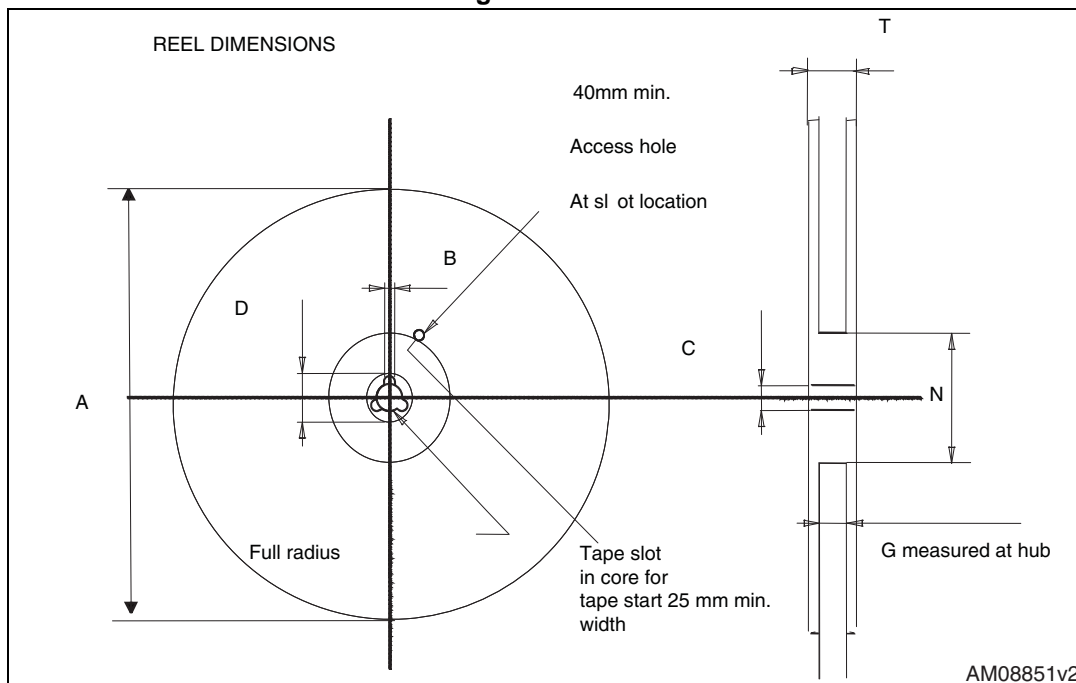
**Figure 25. Tape**



**Packaging mechanical data**

**STB7ANM60N, STD7ANM60N**

**Figure 26. Reel**



## 6 Revision history

Table 13. Document revision history

Date	Revision	Changes
21-Jun-2012	1	First issue.
12-Dec-2013	2	<ul style="list-style-type: none"><li>– Modified: title, <i>Features</i> and <i>Table 1</i> in cover page</li><li>– Modified: <i>Figure 15</i>, <i>16</i>, <i>17</i> and <i>18</i></li><li>– Updated: <i>Table 10</i> and <i>Figure 23</i>, <i>24</i></li><li>– Minor text changes</li></ul>

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