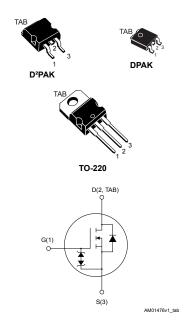


Datasheet

# N-channel 600 V, 0.55 $\Omega$ typ., 7.5 A MDmesh M2 Power MOSFET in a D<sup>2</sup>PAK, DPAK and TO-220 packages



#### **Features**

Order codes	V <sub>DS</sub> @ T <sub>J</sub> max.	R <sub>DS(on)</sub> max.	I <sub>D</sub>	Package
STB10N60M2	2			D²PAK
STD10N60M	2 650 V	650 V 0.60 Ω 7.5 A	0.60 Ω 7.5 A	DPAK
STP10N60M2	2			TO-220

- Extremely low gate charge
- Excellent output capacitance (Coss) profile
- 100% avalanche tested
- · Zener-protected

#### **Applications**

· Switching applications

#### **Description**

lectronics sales office

These devices are N-channel Power MOSFETs developed using the MDmesh M2 technology. Thanks to their strip layout and improved vertical structure, these devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high-efficiency converters.



Product status links		
STB10N60M2		
STD10N60M2		
STP10N60M2		



# 1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	±25	V
1-	Drain current (continuous) at T <sub>C</sub> = 25 °C	7.5	
Ι <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	4.9	Α
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	30	А
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	85	W
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	15	V/ns
dv/dt <sup>(3)</sup>	MOSFET dv/dt ruggedness	50	V/IIS
T <sub>stg</sub>	Storage temperature range	-55 to 150	°C
T <sub>J</sub>	Operating junction temperature range	-55 (0 150	°C

- 1. Pulse limited by safe operating area.
- 2.  $I_{SD} \le 7.5 \text{ A}$ ,  $di/dt \le 400 \text{ A/}\mu\text{s}$ ,  $V_{DS}$  peak  $< V_{(BR)DSS}$ ,  $V_{DD} = 400 \text{ V}$ .
- 3.  $V_{DS} \le 480 \text{ V}$ .

Table 2. Thermal data

Carmbal	Baramatar	Value			Unit
Symbol	Parameter	D <sup>2</sup> PAK	DPAK	TO-220	Unit
R <sub>thJC</sub>	Thermal resistance, junction-to-case		1.47		°C/W
R <sub>thJB</sub> <sup>(1)</sup>	Thermal resistance, junction-to-board	30 50			°C/W
R <sub>thJA</sub>	Thermal resistance, junction-to-ambient			62.5	°C/W

<sup>1.</sup> When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I <sub>AR</sub> <sup>(1)</sup>	Avalanche current, repetitive or not repetitive	1.5	Α
E <sub>AS</sub> <sup>(2)</sup>	Single pulse avalanche energy	110	mJ

- 1. Pulse width limited by  $T_J$  max.
- 2. Starting  $T_J = 25$  °C,  $I_D = I_{AR}$ ,  $V_{DD} = 50$  V.

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#### 2 Electrical characteristics

( $T_C$  = 25 °C unless otherwise specified)

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA	600			V
lass	Zoro goto voltogo droin ourrent	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 600 V			1	
I <sub>DSS</sub>	Zero gate voltage drain current	$V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_{C}$ = 125 °C <sup>(1)</sup>			100	μA
I <sub>GSS</sub>	Gate-body leakage current	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±25 V			±10	μA
V <sub>GS(th)</sub>	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_{D} = 250 \mu A$	2	3	4	V
R <sub>DS(on)</sub>	Static drain-source on-resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 3 A		0.55	0.60	Ω

<sup>1.</sup> Defined by design, not subject to production test.

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C <sub>iss</sub>	Input capacitance		-	400	-	pF
C <sub>oss</sub>	Output capacitance	$V_{DS} = 100 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0 \text{ V}$	-	22	-	pF
C <sub>rss</sub>	Reverse transfer capacitance		-	0.84	-	pF
Coss eq. (1)	Equivalent output capacitance	V <sub>DS</sub> = 0 to 480 V, V <sub>GS</sub> = 0 V	-	83	-	pF
R <sub>G</sub>	Intrinsic gate resistance	f = 1 MHz, I <sub>D</sub> = 0 A	-	6.4	-	Ω
Qg	Total gate charge	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 7.5 A, V <sub>GS</sub> = 0 to 10 V		13.5	-	nC
Q <sub>gs</sub>	Gate-source charge	(see Figure 16. Test circuit for gate charge behavior)		2.1	-	nC
Q <sub>gd</sub>	Gate-drain charge			7.2	-	nC

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

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> = 300 V, I <sub>D</sub> = 3.75 A,	-	8.8	-	ns
t <sub>r</sub>	Rise time	$R_G = 4.7 \Omega, V_{GS} = 10 V$	-	8	-	ns
t <sub>d(off)</sub>	Turn-off delay time	(see Figure 15. Test circuit for	-	32.5	-	ns
t <sub>f</sub>	Fall time	resistive load switching times and Figure 20. Switching time waveform)		13.2	-	ns

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Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
I <sub>SD</sub>	Source-drain current		-		7.5	Α
I <sub>SDM</sub> <sup>(1)</sup>	Source-drain current (pulsed)		-		30	Α
V <sub>SD</sub> <sup>(2)</sup>	Forward on voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 7.5 A	-		1.6	V
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 7.5 A, di/dt = 100 A/μs,	-	270		ns
Q <sub>rr</sub>	Reverse recovery charge	V <sub>DD</sub> = 60 V	-	2		μC
I <sub>RRM</sub>	Reverse recovery current	(see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	14.4		Α
t <sub>rr</sub>	Reverse recovery time	$I_{SD} = 7.5 \text{ A, di/dt} = 100 \text{ A/}\mu\text{s,}$	-	376		ns
Q <sub>rr</sub>	Reverse recovery charge	V <sub>DD</sub> = 60 V, T <sub>J</sub> = 150 °C	-	2.8		μC
I <sub>RRM</sub>	Reverse recovery current	(see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	15		Α

<sup>1.</sup> Pulse width is limited by safe operating area.

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<sup>2.</sup> Pulse test: pulse duration =  $300 \mu s$ , duty cycle 1.5%.



10 -1

10 -2

10 -1

#### 2.1 Electrical characteristics (curves)

R<sub>DS(on)</sub> max.

t<sub>p</sub> =1ms t<sub>p</sub> =10ms

 $V_{(BR)DSS}$ 

 $\overline{V}_{DS}\left(V\right)$ 

Figure 2. Maximum transient thermal impedance for D²PAK and TO-220

ZthJC
(°C/W)

0.4 0.3 0.2

duty=0.5

10 0

Renc=1.47 °C/W
duly=ton/T

Single pulse

Figure 3. Safe operating area for DPAK

T<sub>J</sub> = 150 °C T<sub>C</sub> = 25 °C

Single pulse

10 ¹

10 <sup>2</sup>

10 º

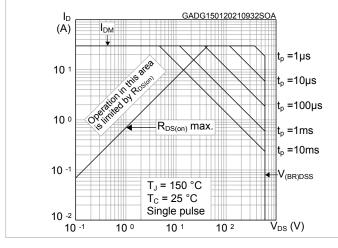


Figure 4. Maximum transient thermal impedance for DPAK

10 -3

10 -2

10 -1

t<sub>p</sub> (s)

10 -6

10 -5

10 -4

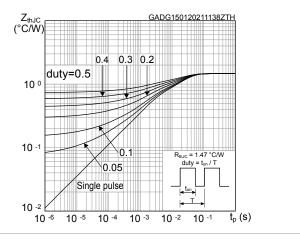


Figure 5. Output characteristics

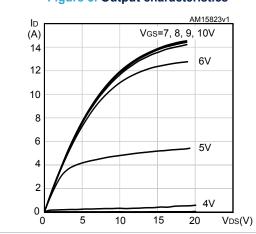
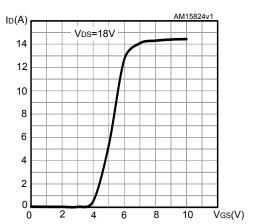


Figure 6. Transfer characteristics



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Figure 7. Gate charge vs gate-source voltage

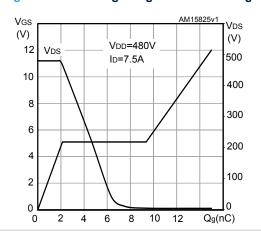


Figure 8. Static drain-source on-resistance

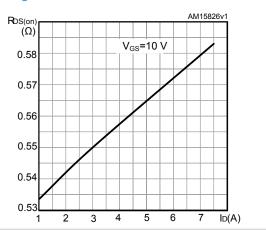


Figure 9. Capacitance variations

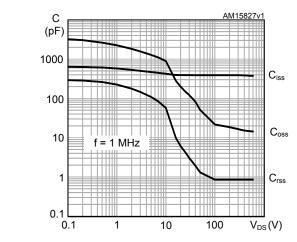


Figure 10. Normalized gate threshold voltage vs temperature

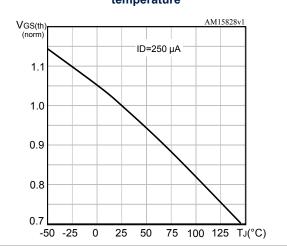


Figure 11. Normalized on-resistance vs temperature

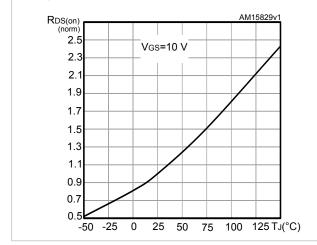
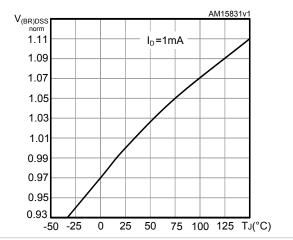


Figure 12. Normalized V<sub>(BR)DSS</sub> vs temperature



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0.0

2 3

VSD(V)

1.4

1.2

1.0

0.8

0.6

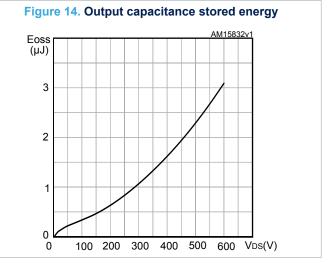
TJ=150°C

0.4

0.2

5 6

IsD(A)



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#### 3 Test circuits

Figure 15. Test circuit for resistive load switching times

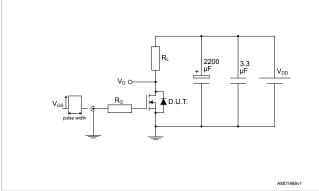


Figure 16. Test circuit for gate charge behavior

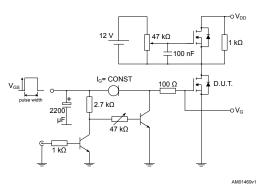


Figure 17. Test circuit for inductive load switching and diode recovery times

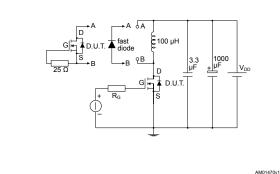


Figure 18. Unclamped inductive load test circuit

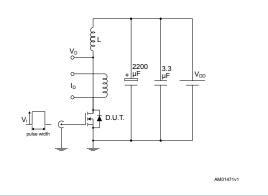


Figure 19. Unclamped inductive waveform

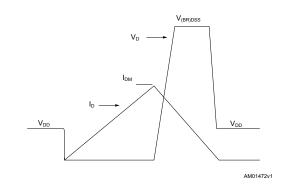
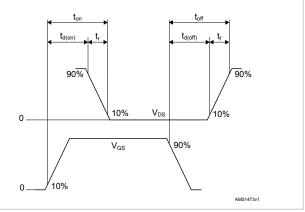


Figure 20. Switching time waveform



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# 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.

#### 4.1 D<sup>2</sup>PAK (TO-263) type A package information

E1 c2--D2 THERMAL PAD SEATING PLANE COPLANARITY A1 0.25 GAUGE PLANE

Figure 21. D<sup>2</sup>PAK (TO-263) type A package outline

0079457\_26



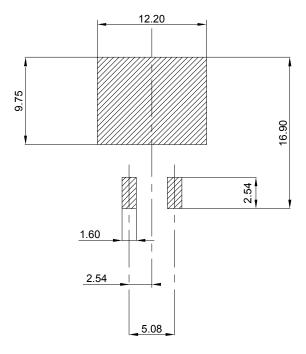
Table 8. D<sup>2</sup>PAK (TO-263) type A package mechanical data

Div		mm	
Dim.	Min.	Тур.	Max.
А	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
С	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.30	8.50	8.70
E2	6.85	7.05	7.25
е		2.54	
e1	4.88		5.28
Н	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

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Figure 22. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint\_26

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#### 4.2 DPAK (TO-252) type A package information

Ε THERMAL PAD c2 *b4* - E1 -*L2* D1 D <u>L4</u> <u>b(2x)</u> R С SEATING PLANE <u>A</u>2 (L1)*V2* 0,25

Figure 23. DPAK (TO-252) type A package outline

0068772\_A\_30



Table 9. DPAK (TO-252) type A mechanical data

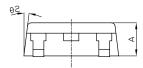
Dim.		mm	
Dim.	Min.	Тур.	Max.
Α	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
С	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
е	2.159	2.286	2.413
e1	4.445	4.572	4.699
Н	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

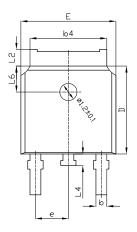
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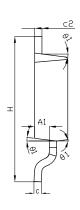


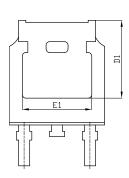
## 4.3 DPAK (TO-252) type C package information

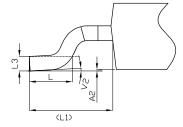
Figure 24. DPAK (TO-252) type C package outline











0068772\_C\_30

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

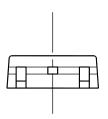
Dim		mm	
Dim.	Min.	Тур.	Max.
А	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
С	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.25		
E	6.50	6.60	6.70
E1	4.70		
е	2.186	2.286	2.386
Н	9.80	10.10	10.40
L	1.40	1.50	1.70
L1		2.90 REF	
L2	0.90		1.25
L3		0.51 BSC	
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

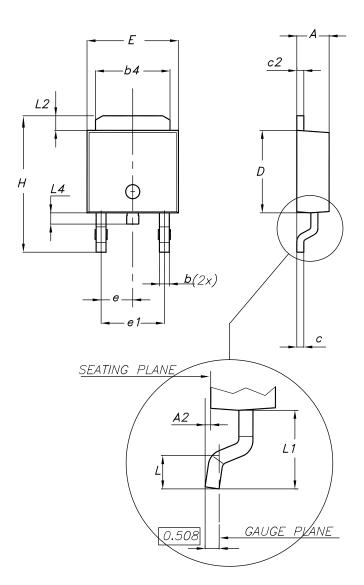
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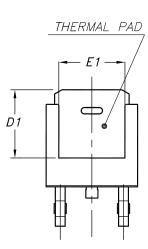


#### 4.4 DPAK (TO-252) type E package information

Figure 25. DPAK (TO-252) type E package outline







0068772\_typeE\_rev.30



Table 11. DPAK (TO-252) type E mechanical data

Dim.	mm			
	Min.	Тур.	Max.	
А	2.18		2.39	
A2			0.13	
b	0.65		0.884	
b4	4.95		5.46	
С	0.46		0.61	
c2	0.46		0.60	
D	5.97		6.22	
D1	5.21			
Е	6.35		6.73	
E1	4.32			
е		2.286		
e1		4.572		
Н	9.94		10.34	
L	1.50		1.78	
L1		2.74		
L2	0.89		1.27	
L4			1.02	

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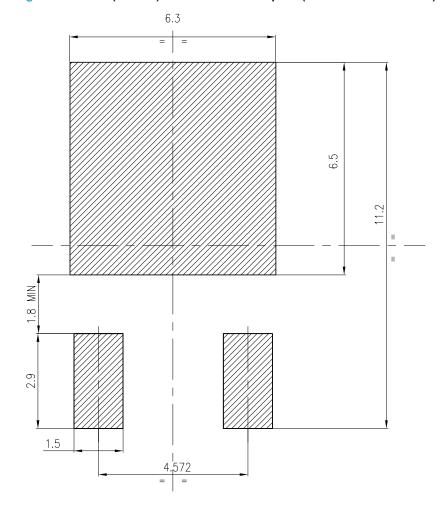


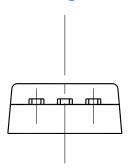
Figure 26. DPAK (TO-252) recommended footprint (dimensions are in mm)

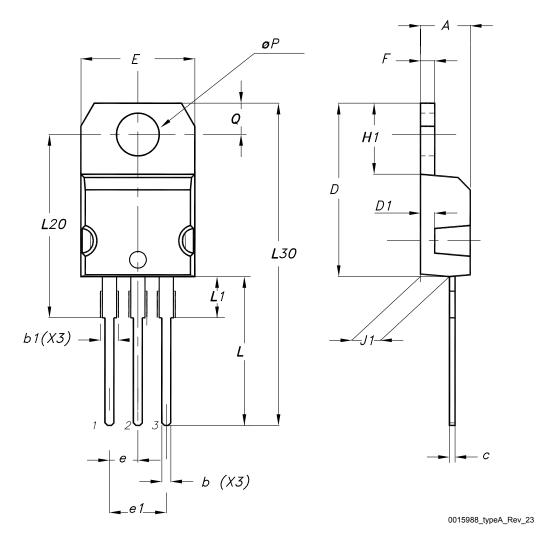
FP\_0068772\_30



#### 4.5 TO-220 type A package information

Figure 27. TO-220 type A package outline





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Table 12. TO-220 type A package mechanical data

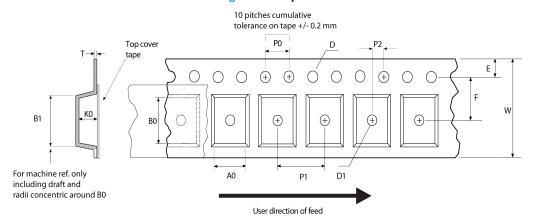
Div	mm			
Dim.	Min.	Тур.	Max.	
А	4.40		4.60	
b	0.61		0.88	
b1	1.14		1.55	
С	0.48		0.70	
D	15.25		15.75	
D1		1.27		
E	10.00		10.40	
е	2.40		2.70	
e1	4.95		5.15	
F	1.23		1.32	
H1	6.20		6.60	
J1	2.40		2.72	
L	13.00		14.00	
L1	3.50		3.93	
L20		16.40		
L30		28.90		
øΡ	3.75		3.85	
Q	2.65		2.95	
Slug flatness		0.03	0.10	

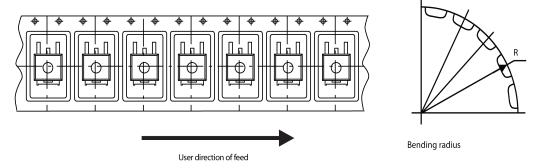
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#### 4.6 D<sup>2</sup>PAK and DPAK packing information

Figure 28. Tape outline



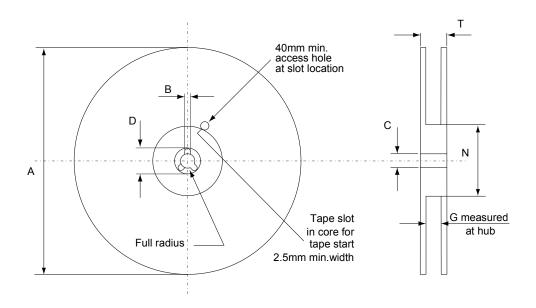


AM08852v1

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Figure 29. Reel outline



AM06038v1

Table 13. D2PAK tape and reel mechanical data

Таре		Reel			
Dim.	mm		Dim.	mm	
	Min.	Max.	DIM.	Min.	Max.
A0	10.5	10.7	А		330
В0	15.7	15.9	В	1.5	
D	1.5	1.6	С	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	Т		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
Т	0.25	0.35			
W	23.7	24.3			

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Table 14. DPAK tape and reel mechanical data

Таре				Reel		
Dim.	mm		Dive		mm	
Dim.	Min.	Max.	Dim.	Min.	Max.	
A0	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	
E	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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## 5 Order codes

Table 15. Device summary

Order code	Marking	Package	Packing
STB10N60M2	10N60M2	D²PAK	Tana and real
STD10N60M2		DPAK	Tape and reel
STP10N60M2		TO-220	Tube

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# **Revision history**

Table 16. Document revision history

Date	Version	Changes
29-May-2013	1	First release.
		– Added: D²PAK package
	2	– Modified: title and R <sub>DS(on)</sub> values in cover page
		- Modified: R <sub>DS(on)</sub> values in <i>Table 5</i>
06-Dec-2013		– Modified: R <sub>G</sub> value in <i>Table</i> 6
00-Dec-2013	2	– Modified: Figure 9 and I <sub>D</sub> value in Figure 12
		- Added: Table 9, 13, Figure 22 and 23
		- Updated: Table 10, 11, Figure 24, 25 and 26
		Minor text changes.
	3	Updated the title and the description in cover page.
		Updated Table 4: "Avalanche characteristics".
08-Mar-2017		Updated Section 4.2: "DPAK (TO-252) type A package information".
00 Wai 2017		Added Section 4.4: "DPAK (TO-252) type E package information", and Section 4.7: "IPAK (TO-251) type C package information".
		Minor text changes.
19-Jan-2021	4	The part number STU10N60M2 have been removed and the document has been updated accordingly.
		Updated Figure 1. Safe operating area for D²PAK and TO-220, Figure 2. Maximum transient thermal impedance for D²PAK and TO-220, Figure 3. Safe operating area for DPAK and Figure 4. Maximum transient thermal impedance for DPAK.
		Minor text changes.

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