

N-channel 600 V, 0.130  $\Omega$  typ., 22 A MDmesh™ DM2 Power MOSFETs in D<sup>2</sup>PAK, TO-220 and TO-247 packages

Datasheet – preliminary data

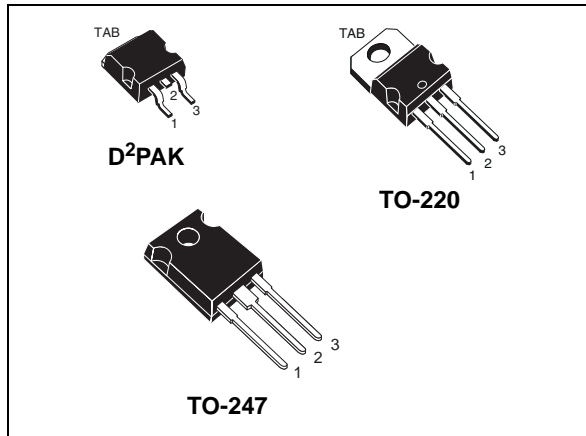
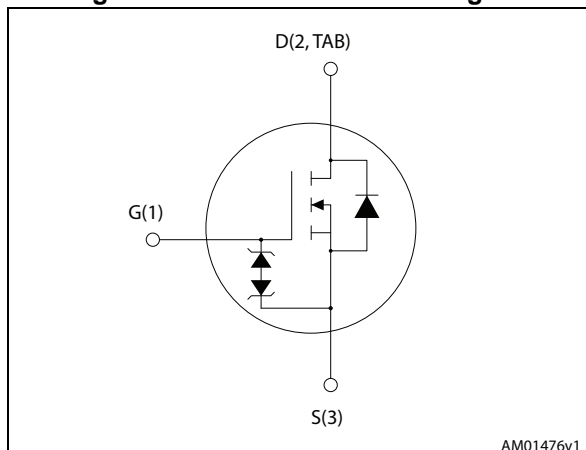


Figure 1. Internal schematic diagram



## Features

Order code	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max}$	$I_D$
STB28N60DM2	650 V	0.160 $\Omega$	22 A
STP28N60DM2			
STW28N60DM2			

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

## Applications

- Switching applications

## Description

These high voltage N-channel Power MOSFETs are part of the MDmesh DM2 fast recovery diode series. They offer very low recovery charge and time ( $Q_{rr}$ ,  $t_{rr}$ ) combined with low  $R_{DS(on)}$ , rendering them suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

Table 1. Device summary

Order code	Marking	Package	Packaging
STB28N60DM2	28N60DM2	D <sup>2</sup> PAK	Tape and reel
STP28N60DM2		TO-220	Tube
STW28N60DM2		TO-247	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	22	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	14	A
$I_{DM}^{(1)}$	Drain current (pulsed)	88	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	190	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature		

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 22\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ;  $V_{DD}=400\text{ V}$ .
3.  $V_{DS} \leq 480\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK	TO-220	TO-247	
$R_{thj-case}$	Thermal resistance junction-case max	0.66			$^\circ\text{C}/\text{W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max <sup>(1)</sup>	30			$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max		62.5	50	$^\circ\text{C}/\text{W}$

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

**Table 4. Avalanche characteristics**

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

## 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 ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 11\text{ A}$		0.130	0.160	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	TBD	-	pF
$C_{oss}$	Output capacitance		-	TBD	-	pF
$C_{rss}$	Reverse transfer capacitance		-	TBD	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0$ to $480\text{ V}$ , $V_{GS} = 0$	-	TBD	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0$	-	TBD	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 22\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 3</a> )	-	39	-	nC
$Q_{gs}$	Gate-source charge		-	TBD	-	nC
$Q_{gd}$	Gate-drain charge		-	TBD	-	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%  $V_{DSS}$

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 11\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 2</a> and <a href="#">7</a> )	-	TBD	-	ns
$t_r$	Rise time		-	TBD	-	ns
$t_{d(off)}$	Turn-off delay time		-	TBD	-	ns
$t_f$	Fall time		-	TBD	-	ns

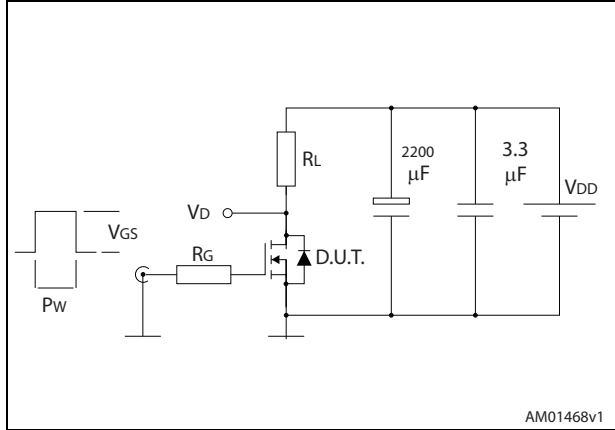
Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}^{(1)}$	Source-drain current		-		22	A
$I_{SDM}^{(2)}$	Source-drain current (pulsed)		-		88	A
$V_{SD}^{(3)}$	Forward on voltage	$I_{SD} = 22 \text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 22 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 4</a> )	-	140		ns
$Q_{rr}$	Reverse recovery charge		-	TBD		nC
$I_{RRM}$	Reverse recovery current		-	TBD		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 22 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 4</a> )	-	TBD		ns
$Q_{rr}$	Reverse recovery charge		-	TBD		nC
$I_{RRM}$	Reverse recovery current		-	TBD		A

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

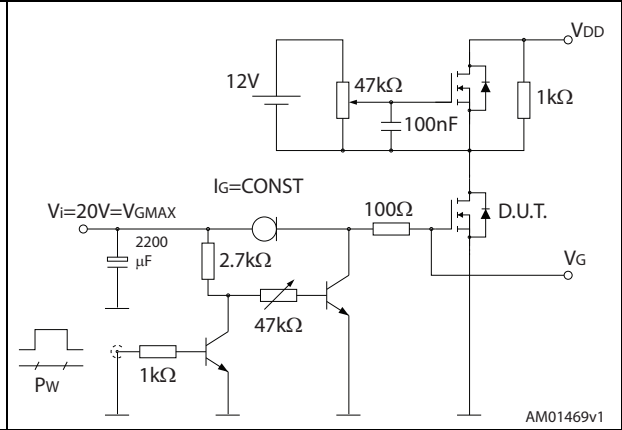
### 3 Test circuits

Figure 2. Switching times test circuit for resistive load



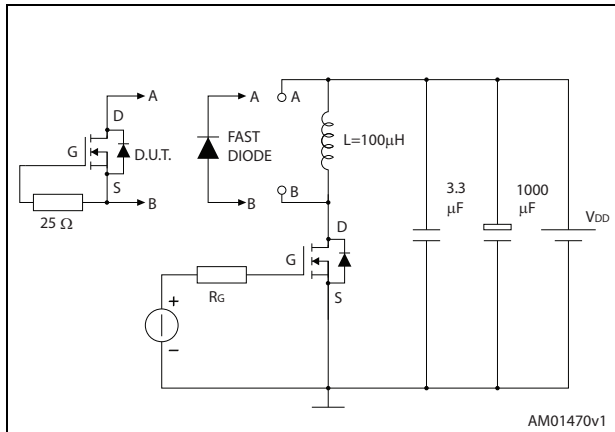
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Figure 3. Gate charge test circuit



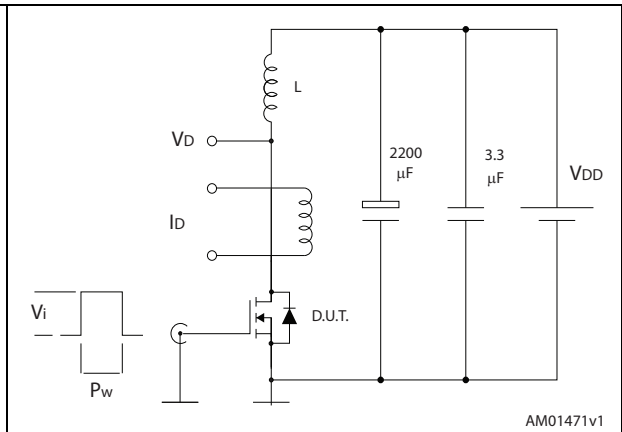
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Figure 4. Test circuit for inductive load switching and diode recovery times



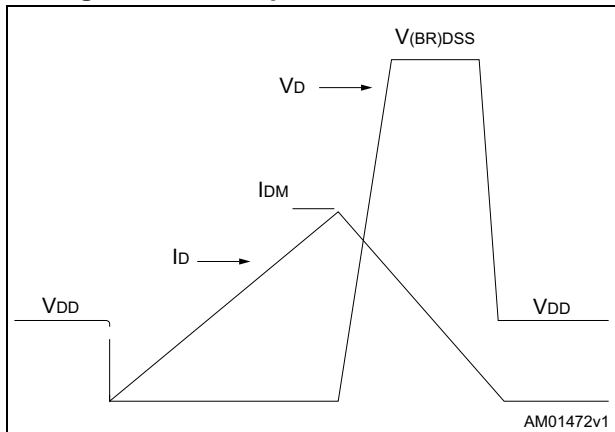
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Figure 5. Unclamped inductive load test circuit



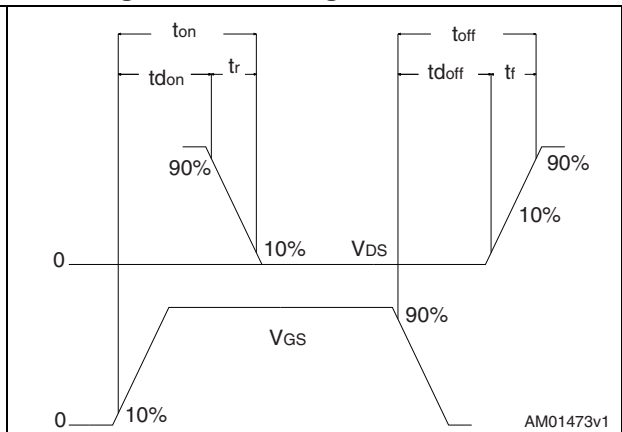
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Figure 6. Unclamped inductive waveform



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Figure 7. 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.

### 4.1 D2PAK, STB33N60DM2

Figure 8. D<sup>2</sup>PAK (TO-263) drawing

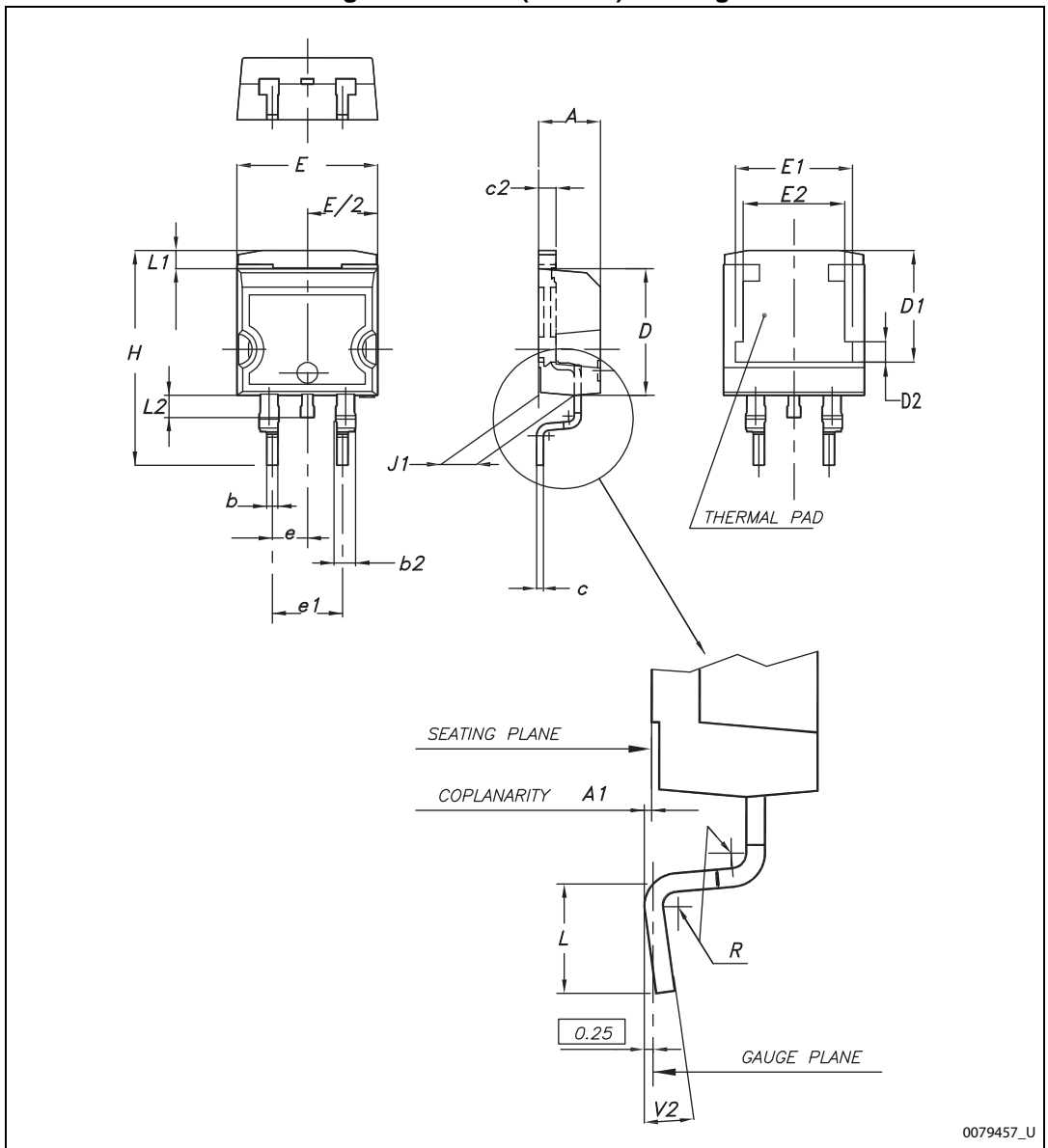
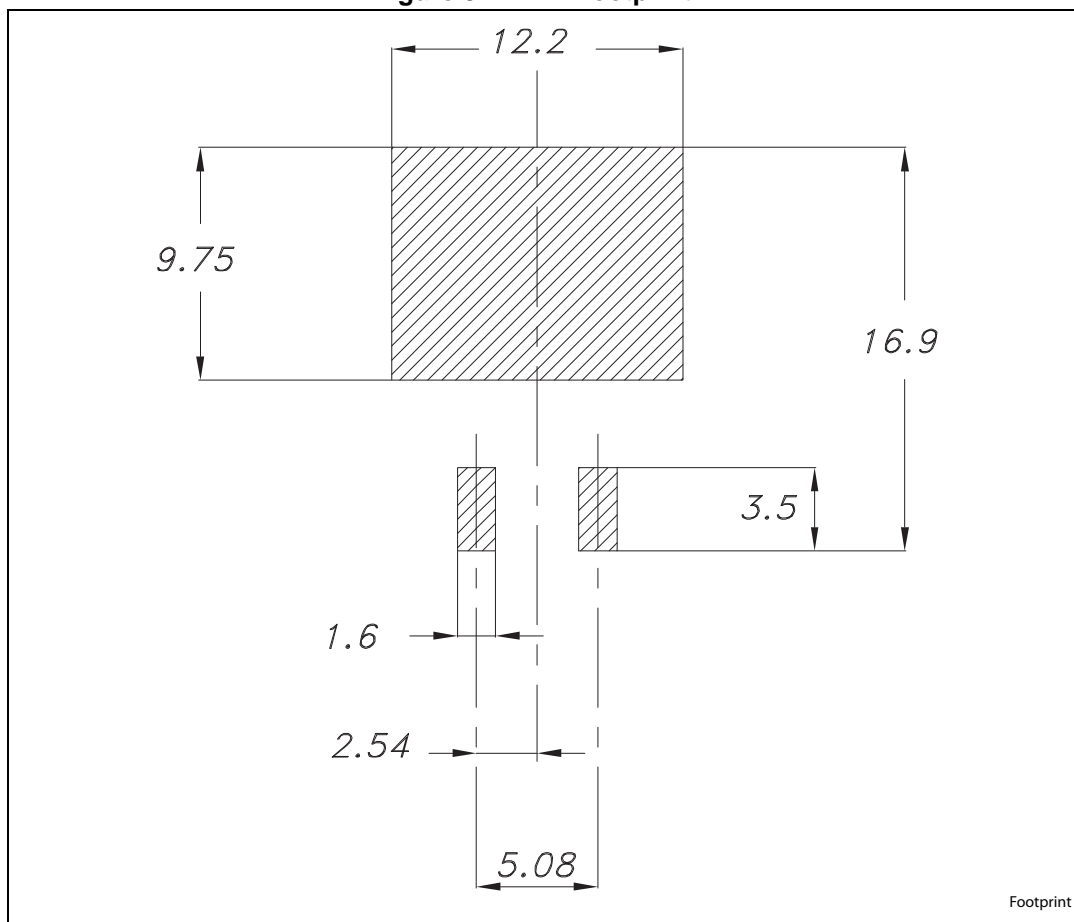




Table 9. D<sup>2</sup>PAK (TO-263) mechanical data

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	7.75	8.00
D2	1.10	1.30	1.50
E	10		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
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°

Figure 9. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

4.2 TO-220, STP33N60DM2

Figure 10. TO-220 type A drawing

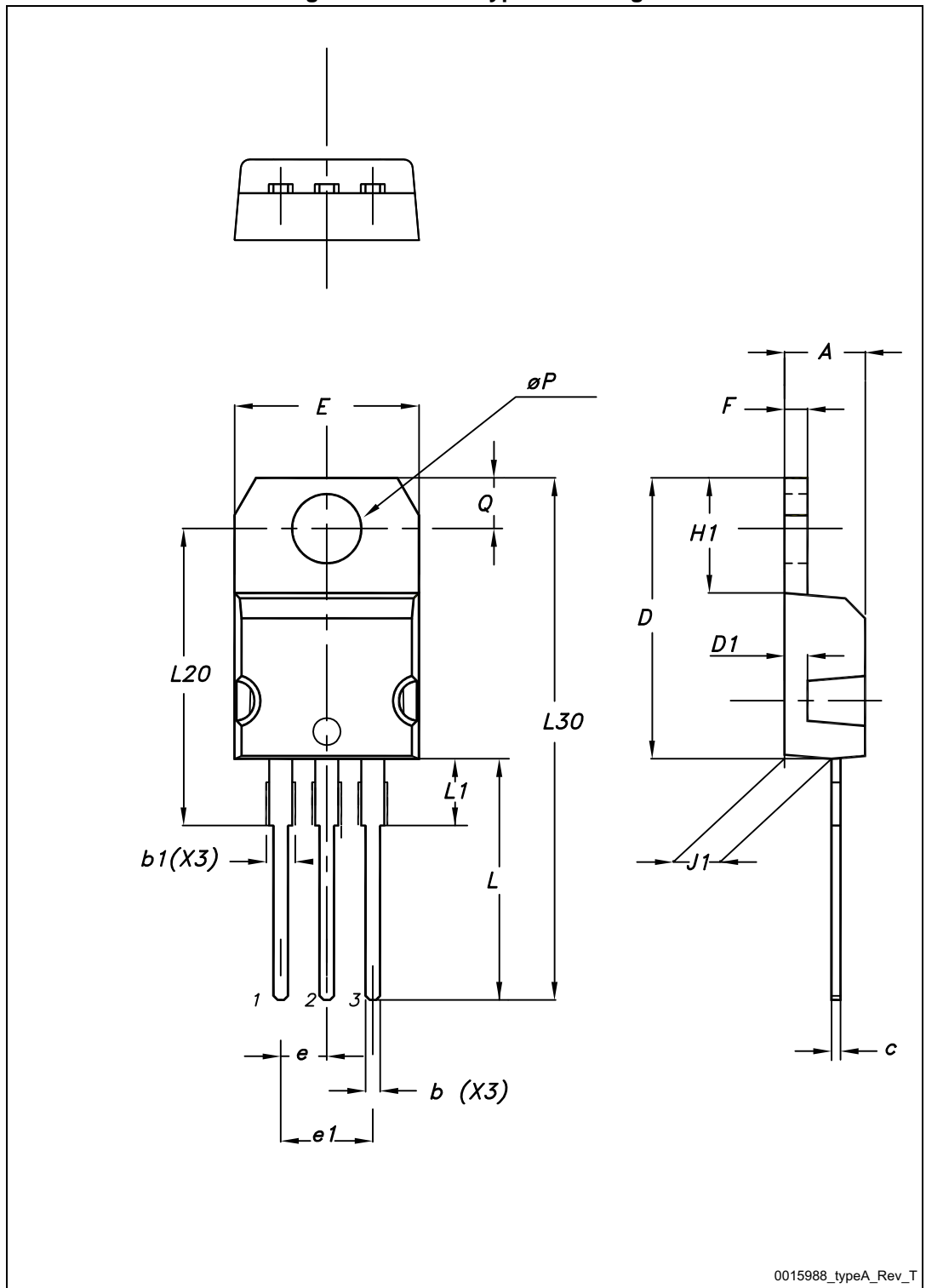


Table 10. TO-220 type A mechanical data

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

### 4.3 TO-247, STW33N60DM2

Figure 11. TO-247 drawing

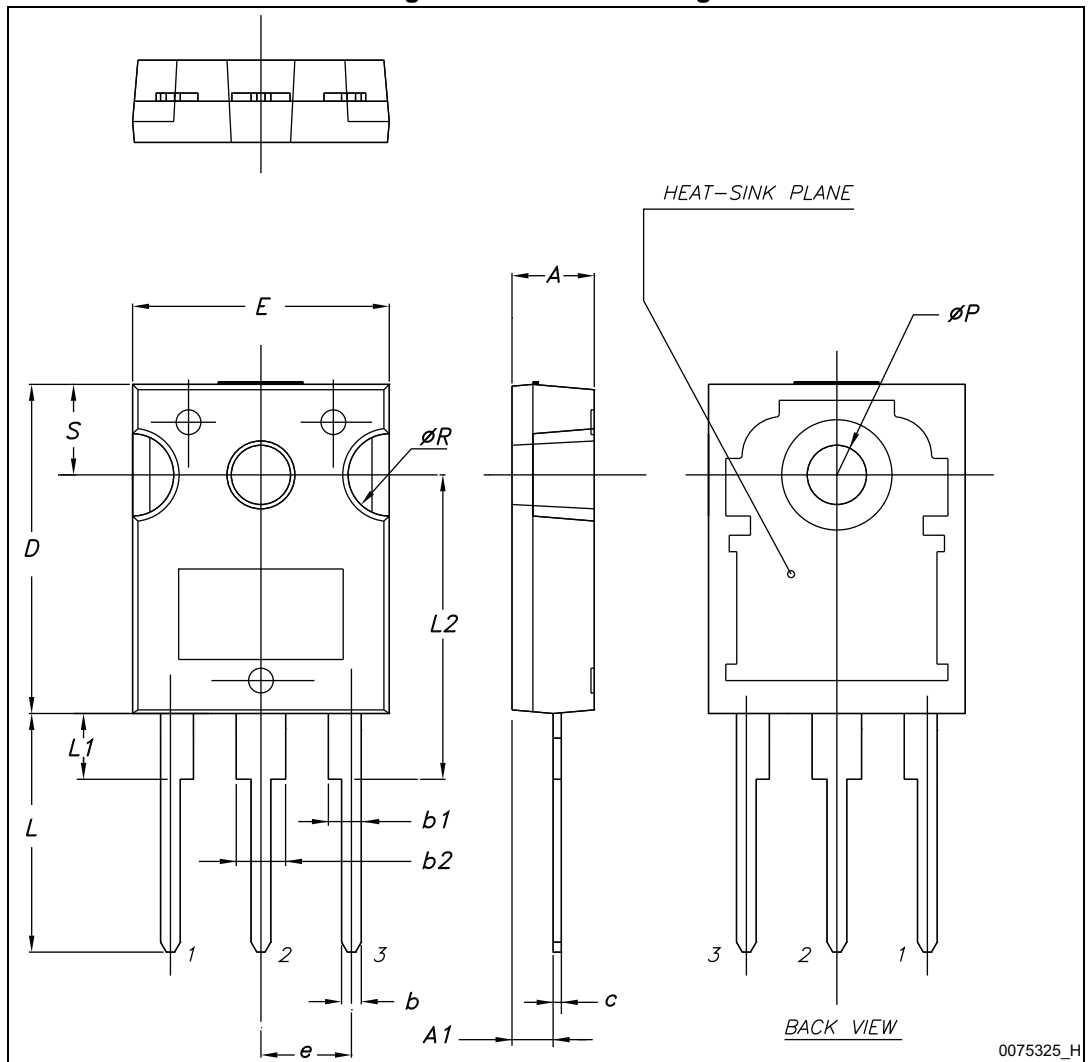


Table 11. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

# 5 Packaging mechanical data

Figure 12. Tape for D<sup>2</sup>PAK (TO-263)

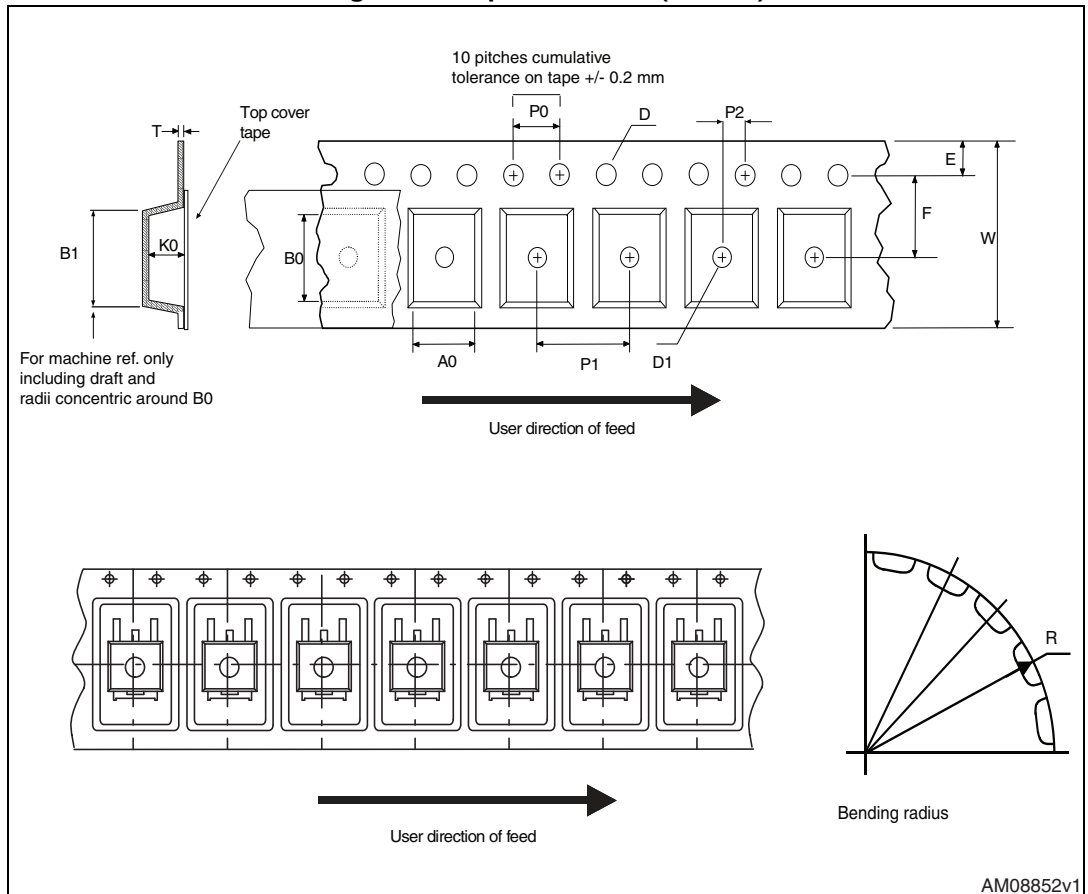


Figure 13. Reel for D<sup>2</sup>PAK (TO-263)

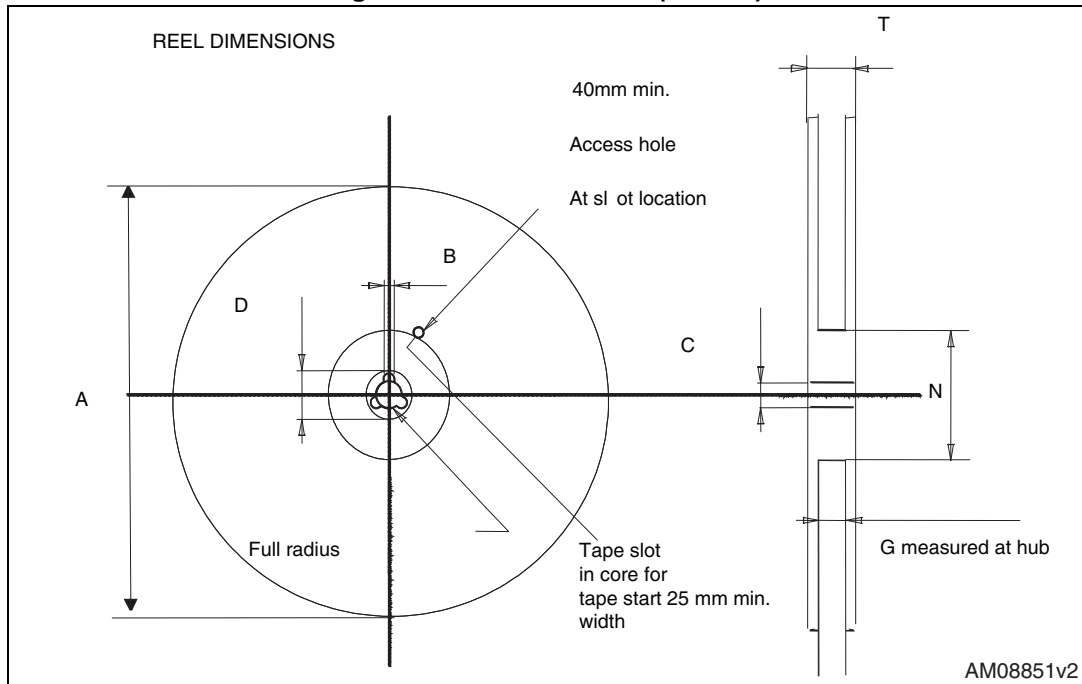


Table 12. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

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			



## 6 Revision history

Table 13. Document revision history

Date	Revision	Changes
21-Oct-2014	1	First release.

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