

N-channel 650 V, 0.073  $\Omega$  typ., 30 A MDmesh™ V Power MOSFETs in D<sup>2</sup>PAK, TO-220 and TO-247 packages

Datasheet - production data

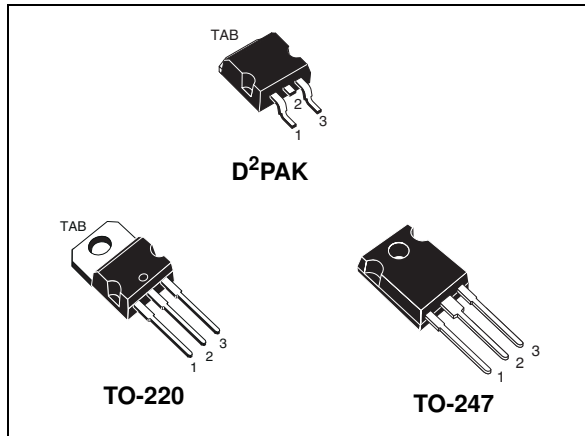
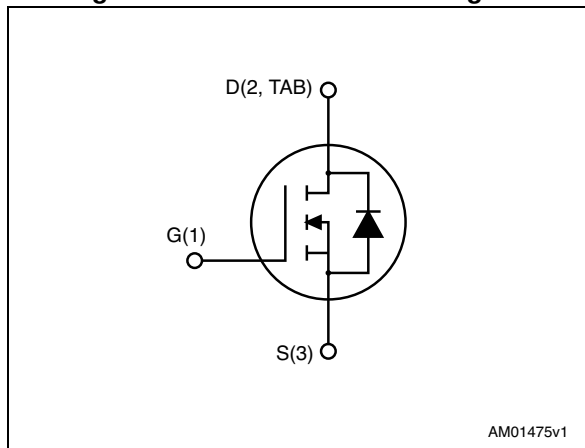


Figure 1. Internal schematic diagram



## Features

Order codes	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max}$	$I_D$
STB38N65M5	710 V	0.095 $\Omega$	30 A
STP38N65M5			
STW38N65M5			

- Higher  $V_{DSS}$  rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

## Applications

- Switching applications

## Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB38N65M5	38N65M5	D <sup>2</sup> PAK	Tape and reel
STP38N65M5		TO-220	Tube
STW38N65M5		TO-247	

# 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>
4.1	D2PAK, STB38N65M5 .....	11
4.2	TO-220, STP38N65M5 .....	14
4.3	TO-247, STW38N65M5 .....	16
<b>5</b>	<b>Packaging mechanical data</b> .....	<b>18</b>
<b>6</b>	<b>Revision history</b> .....	<b>20</b>

# 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 $T_C = 25\text{ }^\circ\text{C}$	30	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	19	A
$I_{DM}^{(1)}$	Drain current (pulsed)	120	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	190	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	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	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 30\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{Peak} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
3.  $V_{DS} \leq 520\text{ V}$

**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 1inch<sup>2</sup> FR-4 board, 2 oz Cu.

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	8	A
$E_{AS}$	Single pulse avalanche energy (starting $t_j = 25\text{ }^\circ\text{C}$ , $I_d = I_{AR}$ ; $V_{dd} = 50\text{ V}$ )	660	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	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	650			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 15\text{ A}$		0.073	0.095	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	3000	-	pF
$C_{oss}$	Output capacitance		-	74	-	pF
$C_{riss}$	Reverse transfer capacitance		-	5.8	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$	-	244	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	70	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	2.4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	71	-	nC
$Q_{gs}$	Gate-source charge		-	18	-	nC
$Q_{gd}$	Gate-drain charge		-	30	-	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%  $V_{DSS}$
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 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(v)}$	Voltage delay time	$V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 19</a> and <a href="#">Figure 22</a> )	-	66	-	ns
$t_{r(v)}$	Voltage rise time		-	9	-	ns
$t_{f(i)}$	Current fall time		-	9	-	ns
$t_{c(off)}$	Crossing time		-	13	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		30	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		120	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 30\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see <a href="#">Figure 22</a> )	-	382		ns
$Q_{rr}$	Reverse recovery charge		-	6.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	35		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 22</a> )	-	522		ns
$Q_{rr}$	Reverse recovery charge		-	10.3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	40		A

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

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D<sup>2</sup>PAK and TO-220

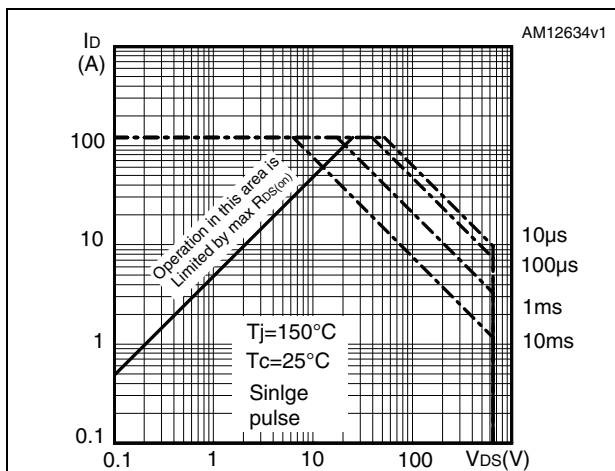


Figure 3. Thermal impedance for D<sup>2</sup>PAK and TO-220

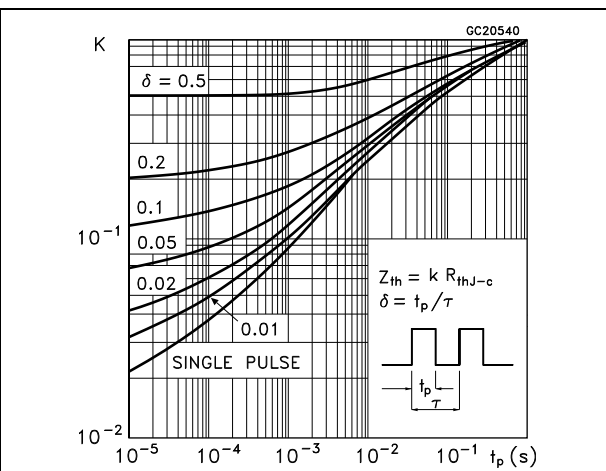


Figure 4. Safe operating area for TO-247

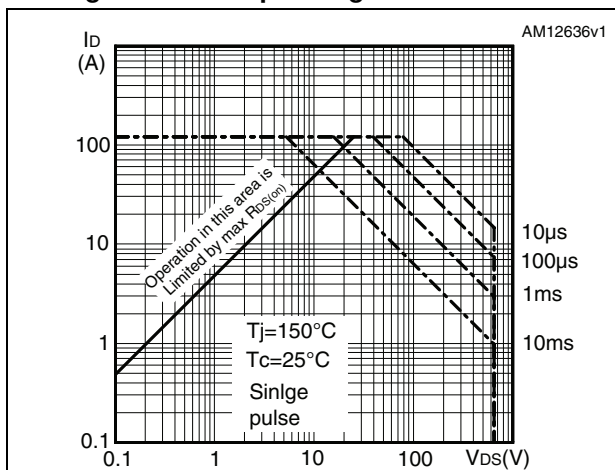


Figure 5. Thermal impedance for TO-247

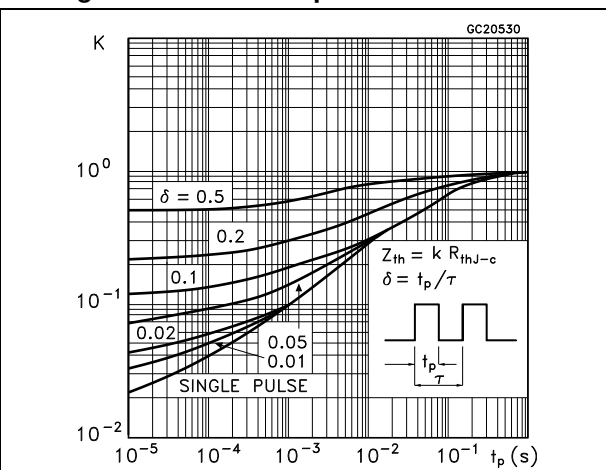


Figure 6. Output characteristics

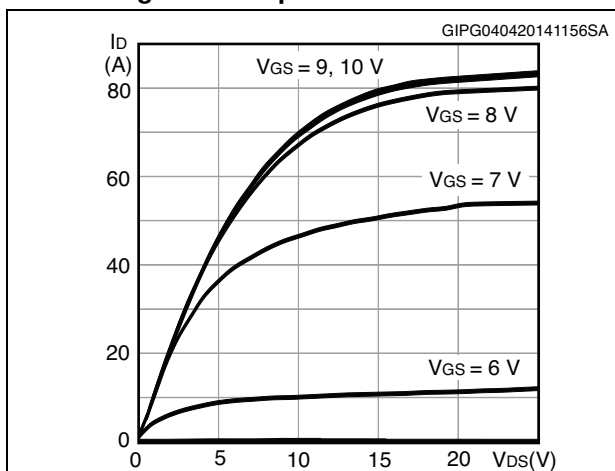


Figure 7. Transfer characteristics

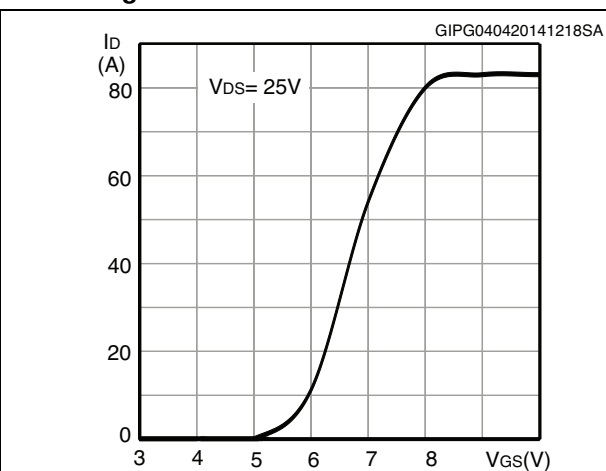


Figure 8. Gate charge vs gate-source voltage

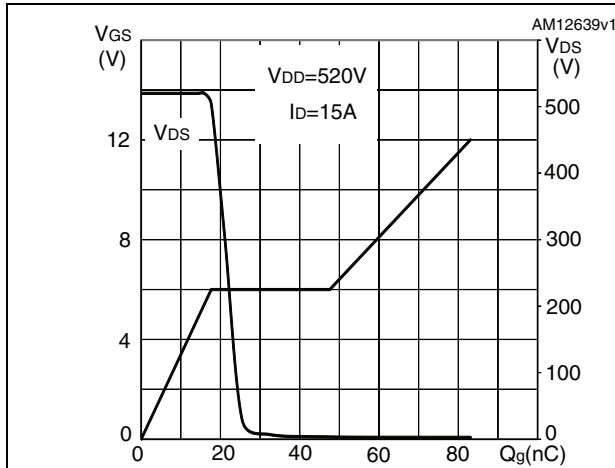


Figure 9. Static drain-source on-resistance

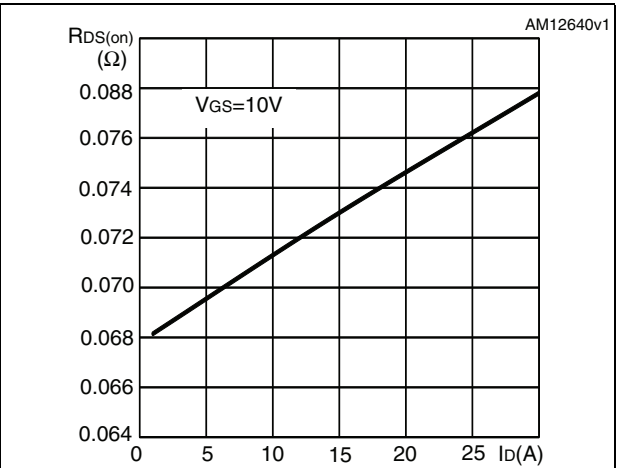


Figure 10. Capacitance variations

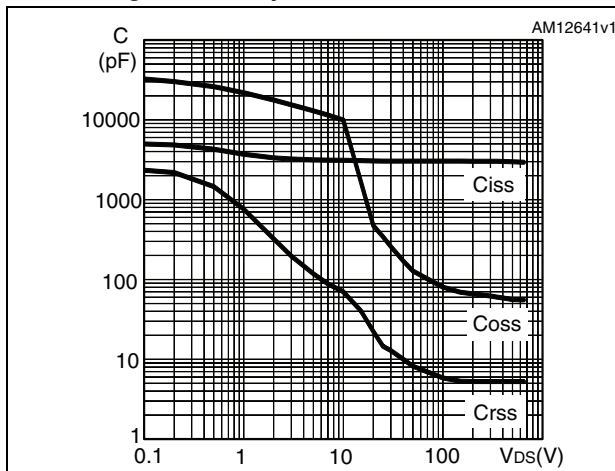


Figure 11. Output capacitance stored energy

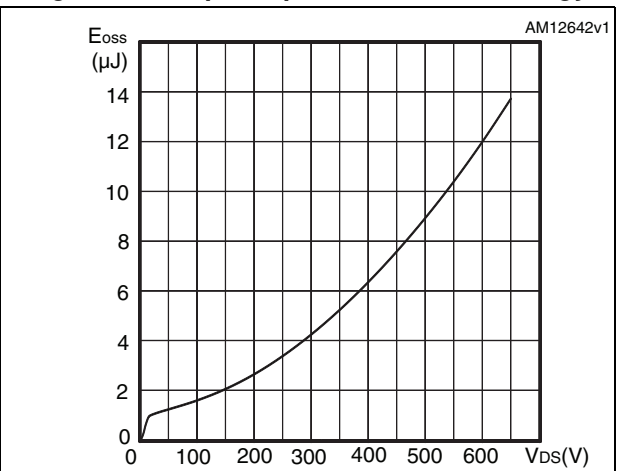


Figure 12. Normalized gate threshold voltage vs temperature

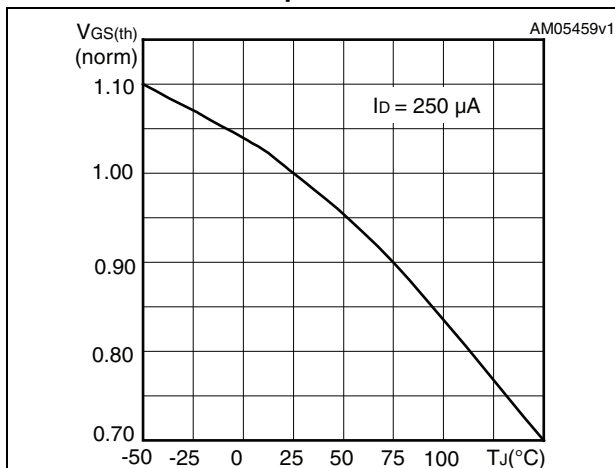


Figure 13. Normalized on-resistance vs temperature

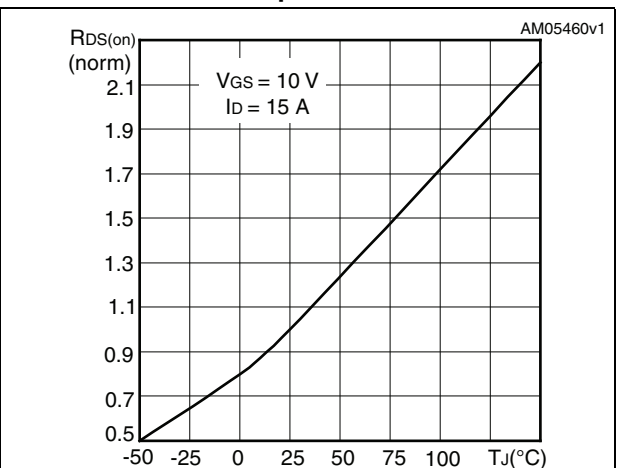


Figure 14. Source-drain diode forward characteristics

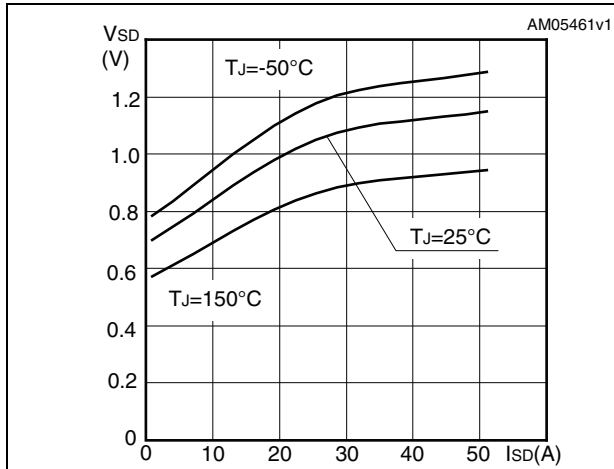


Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature

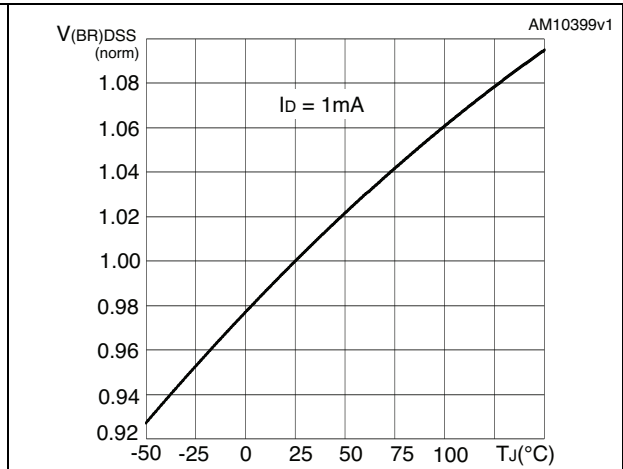
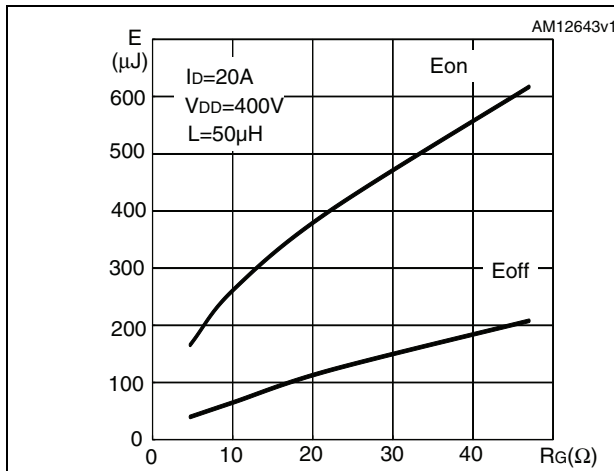


Figure 16. Switching losses vs gate resistance (1)

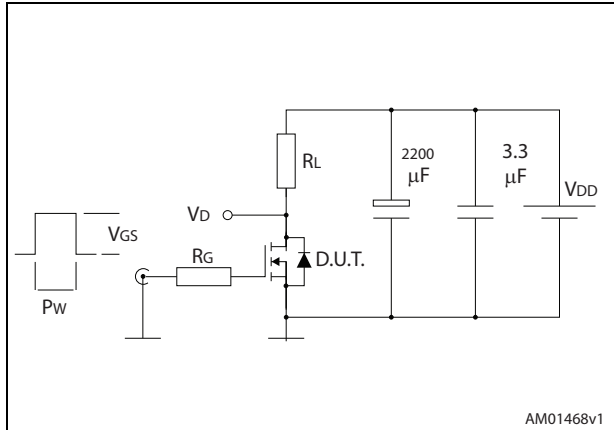


1.  $E_{on}$  including reverse recovery of a SiC diode.



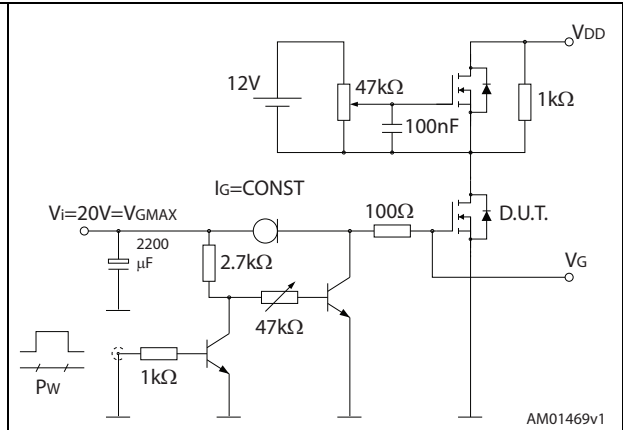
### 3 Test circuits

Figure 17. Switching times test circuit for resistive load



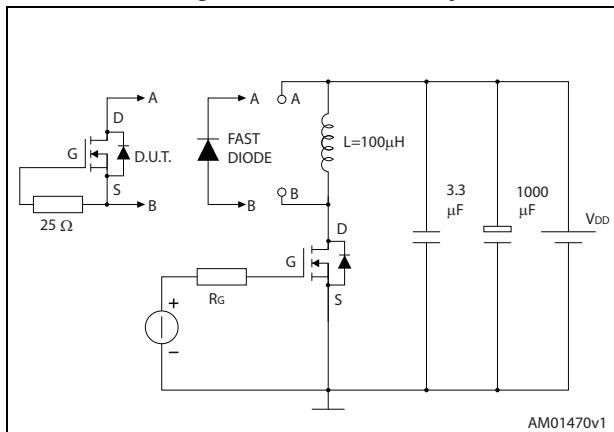
AM01468v1

Figure 18. Gate charge test circuit



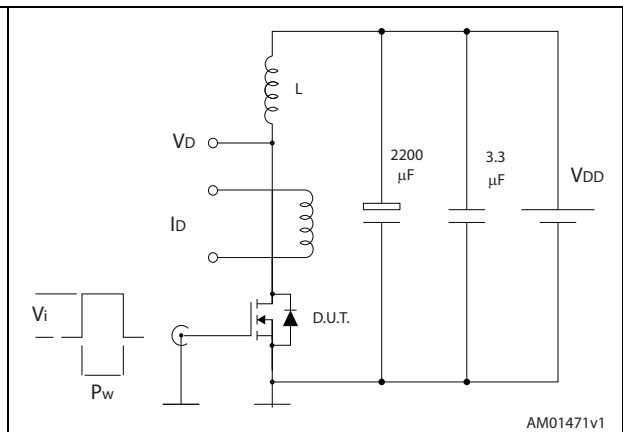
AM01469v1

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



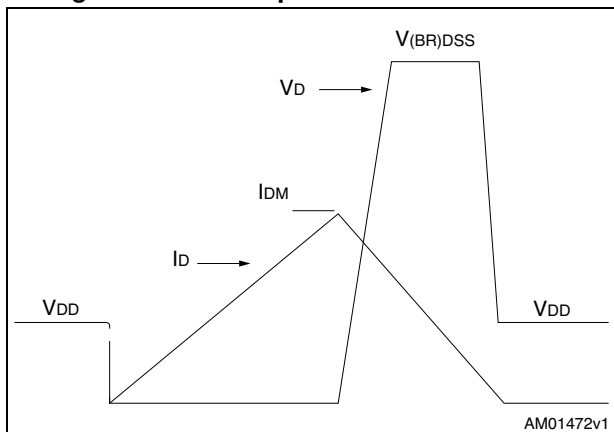
AM01470v1

Figure 20. Unclamped inductive load test circuit



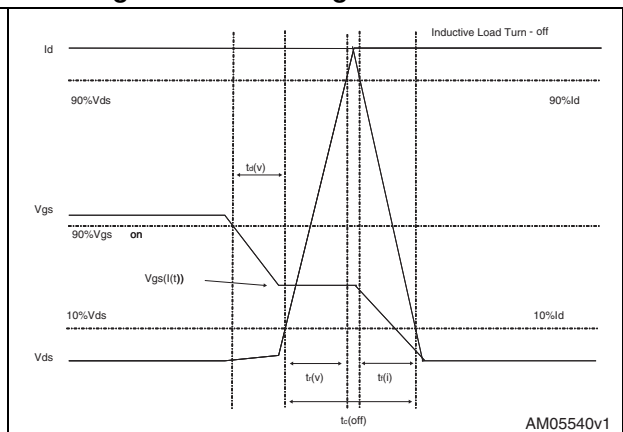
AM01471v1

Figure 21. Unclamped inductive waveform



AM01472v1

Figure 22. Switching time waveform



AM05540v1

## 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 D<sup>2</sup>PAK, STB38N65M5

Figure 23. D<sup>2</sup>PAK (TO-263) drawing

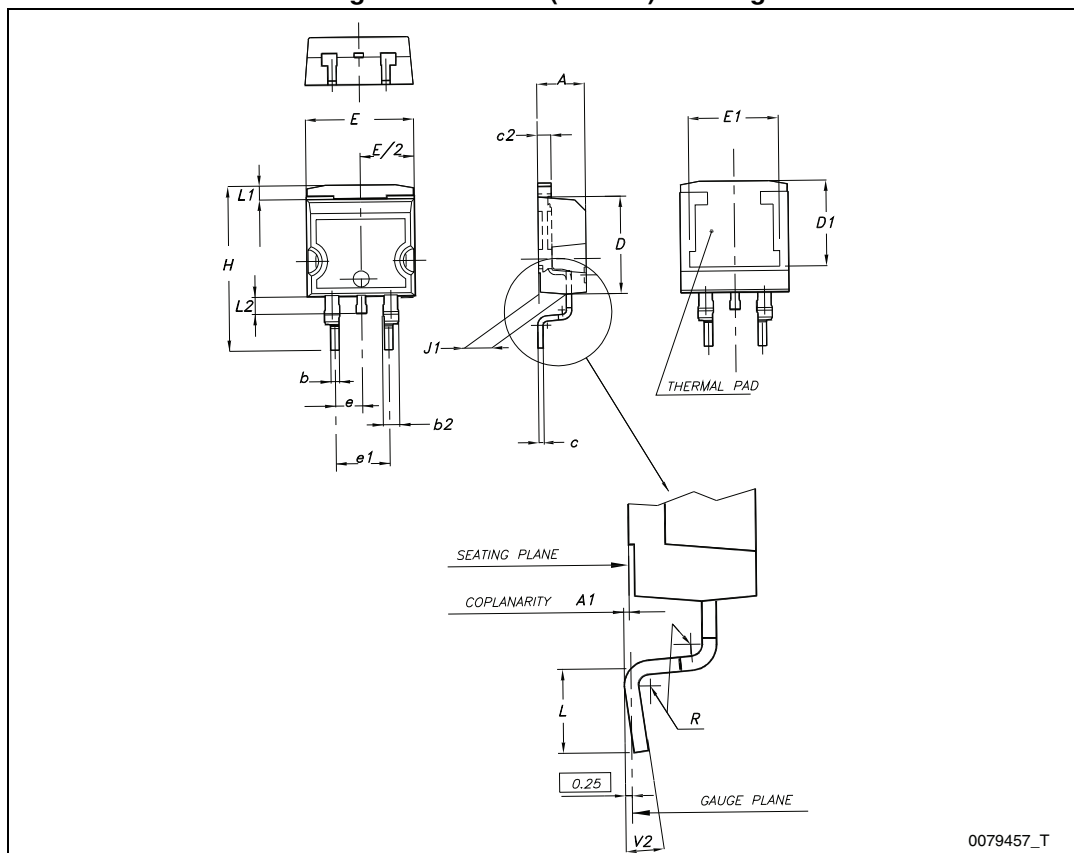
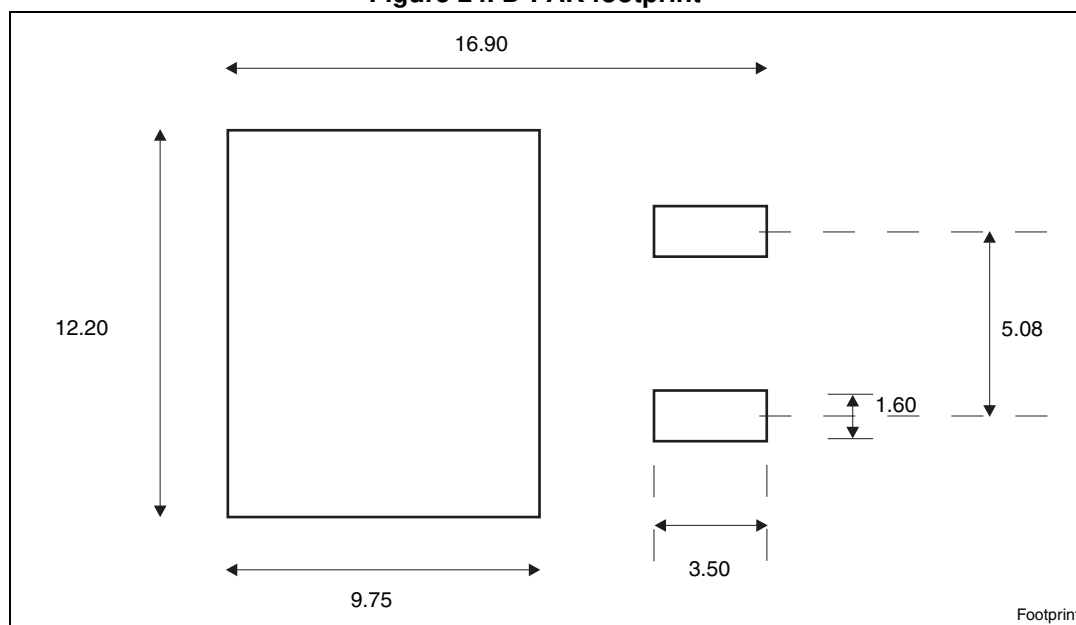


Table 9. D<sup>2</sup>PAK (TO-263) mechanical data

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		
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°

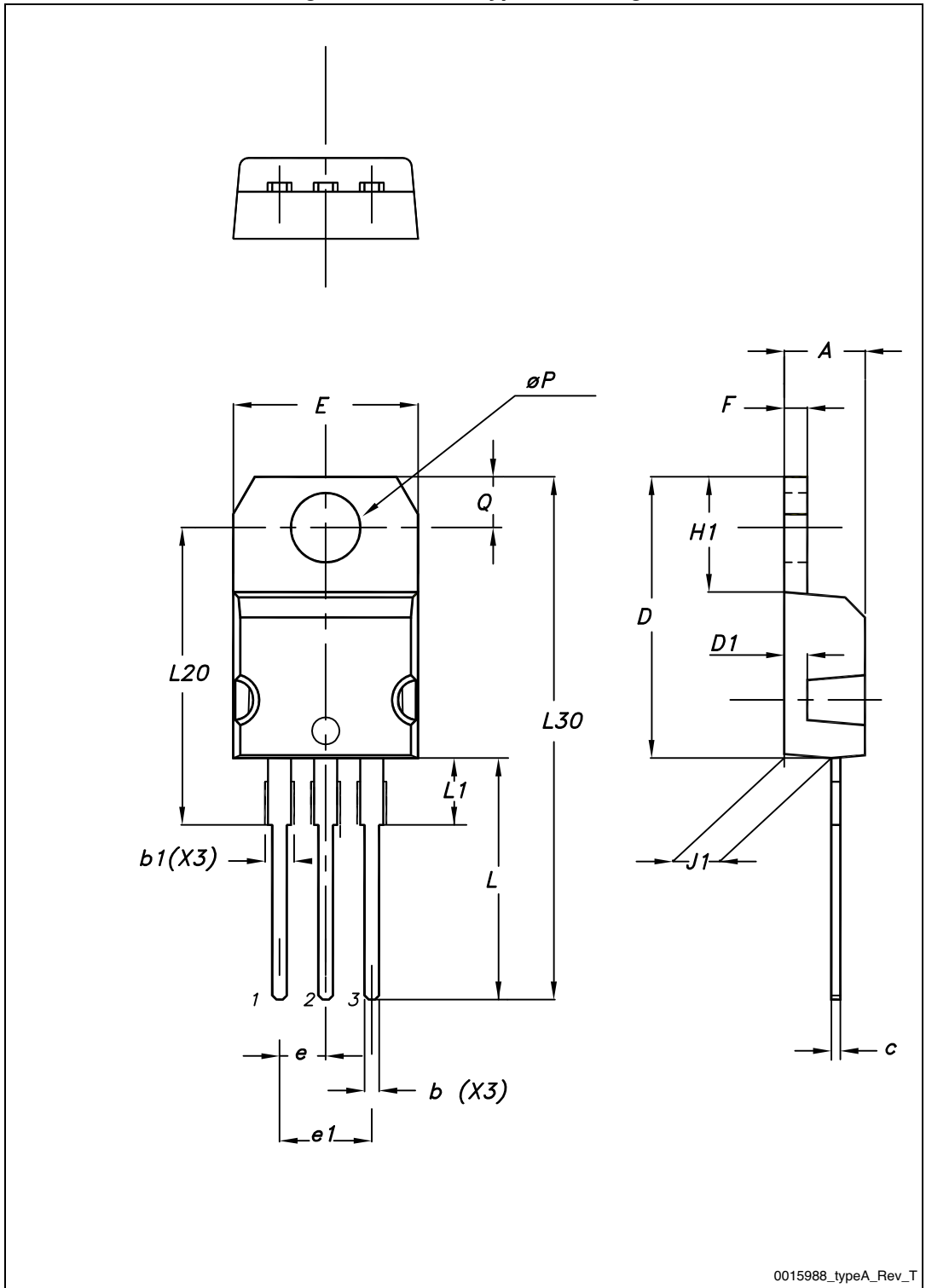
Figure 24. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

### 4.2 TO-220, STP38N65M5

Figure 25. TO-220 type A drawing



0015988\_typeA\_Rev\_T

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, STW38N65M5

Figure 26. TO-247 drawing

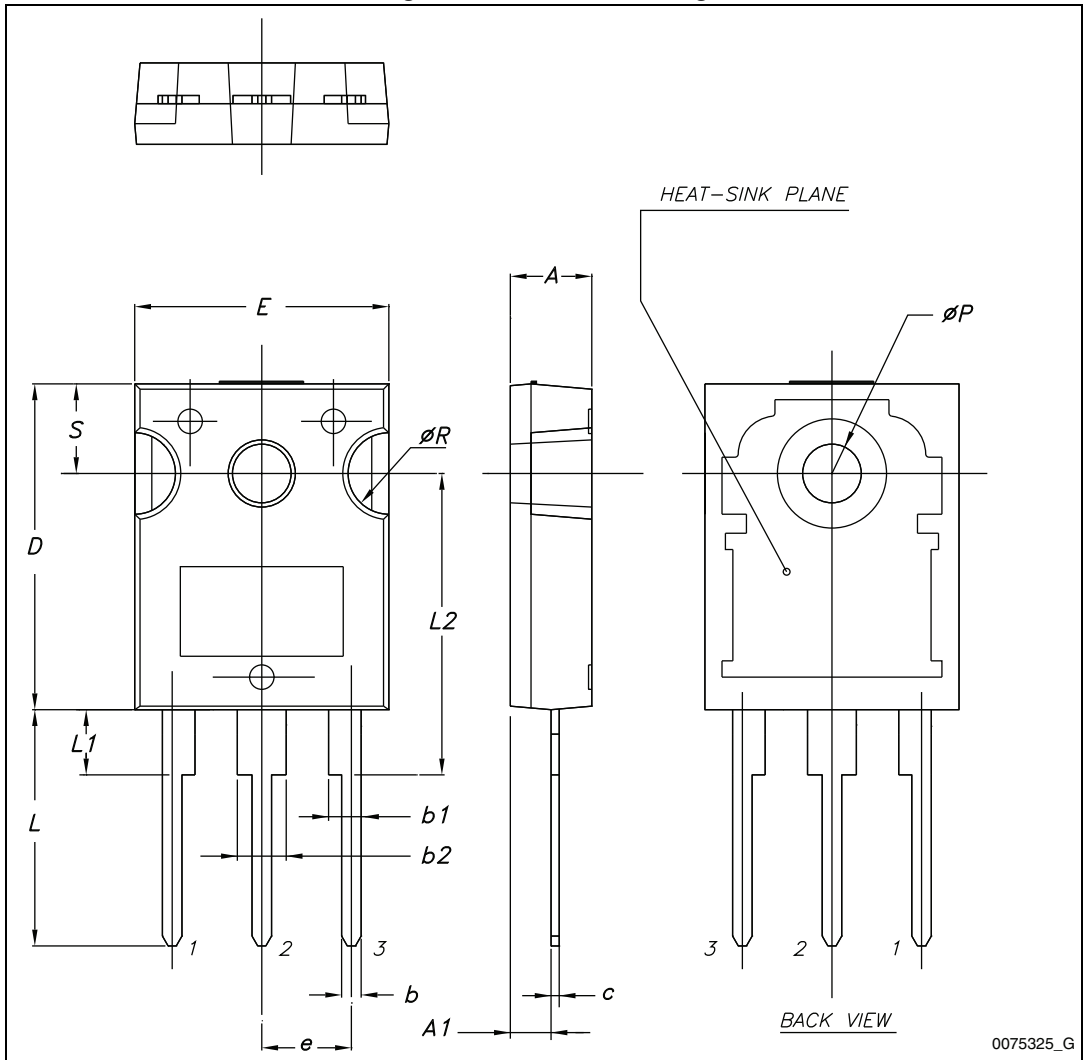




Table 11. TO-247 mechanical data

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 27. Tape

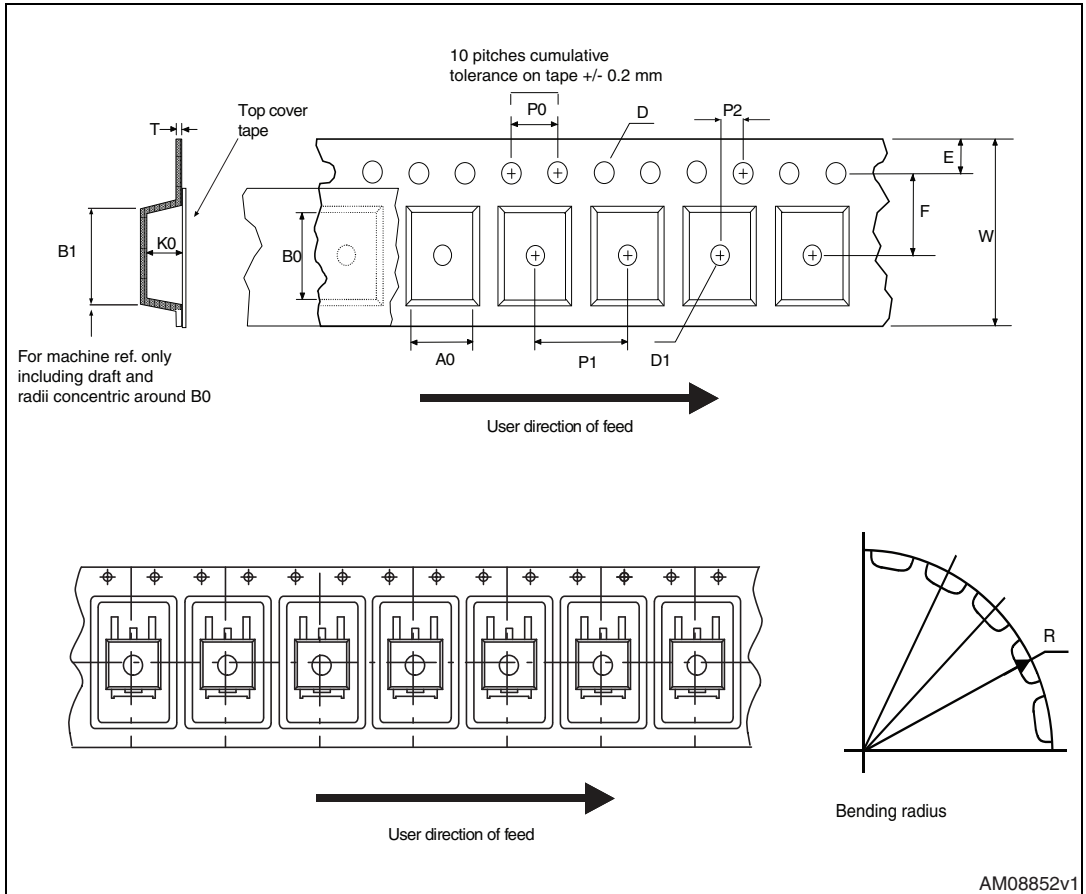


Figure 28. Reel

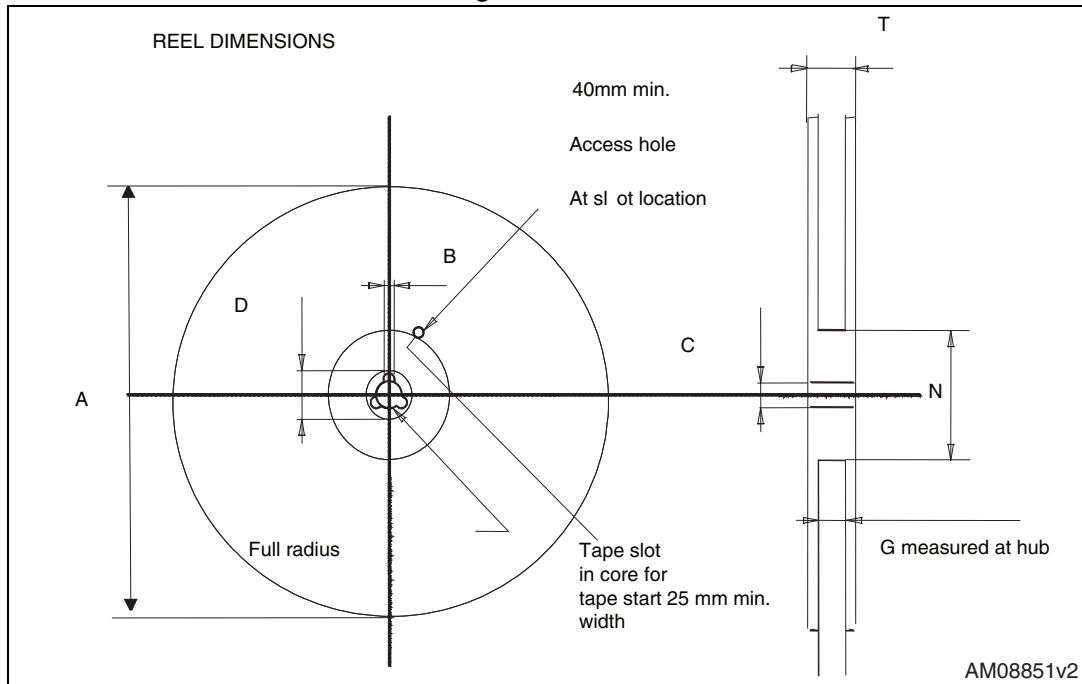


Table 12. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

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
22-Feb-2012	1	First release.
21-Jun-2012	2	Document status changed from preliminary data to production data. Added <a href="#">Section 2.1: Electrical characteristics (curves)</a> .
05-Mar-2013	3	Added dv/dt value on <a href="#">Table 2: Absolute maximum ratings</a> .
09-Apr-2014	4	<ul style="list-style-type: none"><li>– The part number STF38N65M5 has been moved to a separate datasheet</li><li>– Minor text changes</li></ul>

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