

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

Datasheet - production data

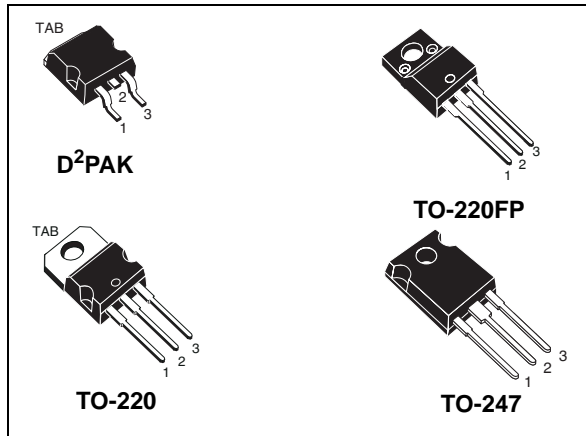
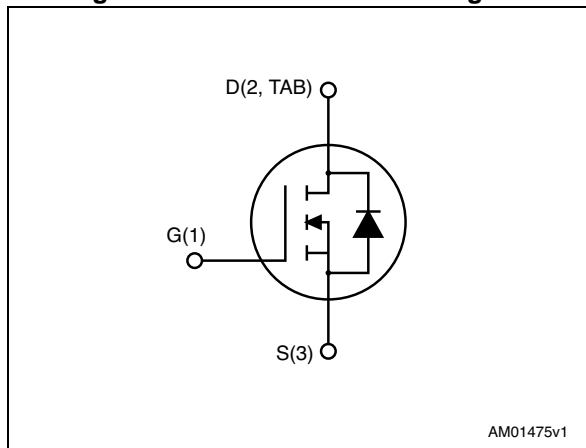


Figure 1. Internal schematic diagram



## Features

Order code	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max}$	$I_D$
STB38N65M5	710 V	< 0.095 $\Omega$	30 A
STF38N65M5			
STP38N65M5			
STW38N65M5			

- Worldwide best  $R_{DS(on)}$  \* area
- Higher  $V_{DS}$  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 code	Marking	Package	Packaging
STB38N65M5	38N65M5	D <sup>2</sup> PAK	Tape and reel
STF38N65M5		TO-220FP	Tube
STP38N65M5		TO-220	
STW38N65M5		TO-247	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK TO-220 TO-247	TO-220FP	
V <sub>GS</sub>	Gate-source voltage	± 25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	30	30 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	19	19 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	120	120 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	190	35	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/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C)	2500		V
T <sub>stg</sub>	Storage temperature	- 55 to 150		°C
T <sub>j</sub>	Max. operating junction temperature	150		°C

- Limited by maximum junction temperature.
- I<sub>SD</sub> ≤ 30 A, di/dt ≤ 400 A/μs; V<sub>Peak</sub> < V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 400 V
- V<sub>DS</sub> ≤ 480 V

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		D <sup>2</sup> PAK	TO-220FP	TO-220	TO-247	
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.66	3.6	0.66		°C/W
R <sub>thj-pcb</sub>	Thermal resistance junction-pcb max <sup>(1)</sup>	30				°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max		62.5		50	°C/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 $t_j = 25^\circ\text{C}$ , $I_d = I_{AR}$ ; $V_{dd} = 50\text{V}$ )	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 ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	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
$C_{iss}$ $C_{oss}$ $C_{riss}$	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	3000 74 5.8	-	pF pF 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	-	$\Omega$
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 520\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 20</a> )	-	71 18 30	-	nC nC 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	$V_{DD} = 400 \text{ V}$ , $I_D = 20 \text{ A}$ ,		66		ns
$t_r (v)$	Voltage rise time	$R_G = 4.7 \ \Omega$ , $V_{GS} = 10 \text{ V}$	-	9	-	ns
$t_f (i)$	Current fall time	(see <a href="#">Figure 21</a> and		9		ns
$t_{c(off)}$	Crossing time	<a href="#">Figure 24</a> )		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	$I_{SD} = 30 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$		382		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100 \text{ V}$ (see <a href="#">Figure 24</a> )	-	6.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			35		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 30 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$		522		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$	-	10.3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 24</a> )		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

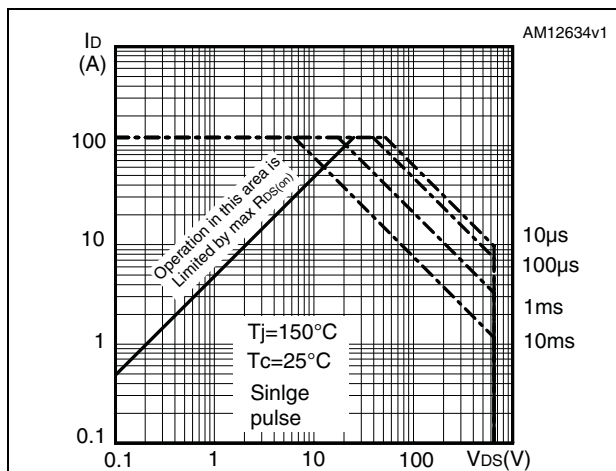


Figure 3. Thermal impedance for D<sup>2</sup>PAK and TO-220

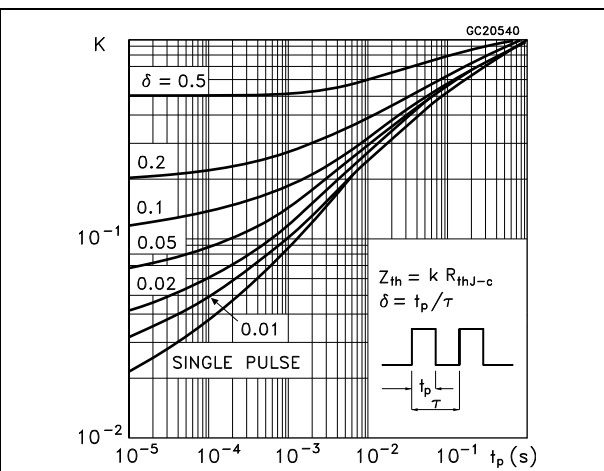


Figure 4. Safe operating area for TO-220FP

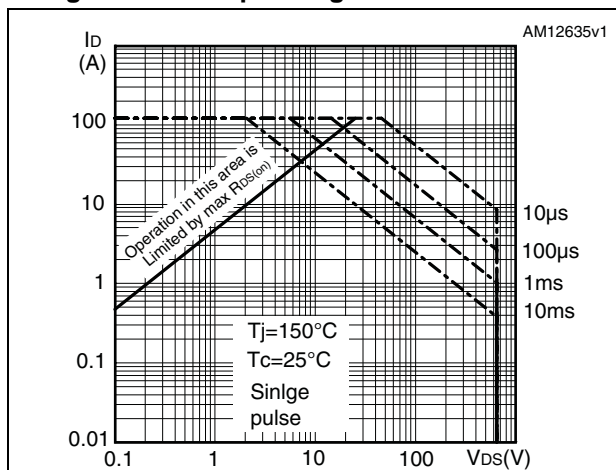


Figure 5. Thermal impedance for TO-220FP

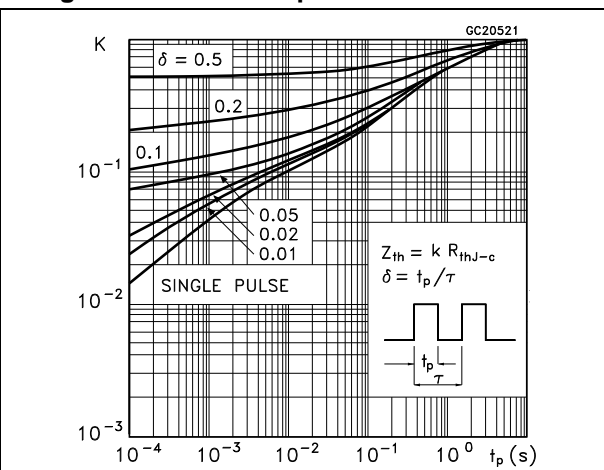


Figure 6. Safe operating area for TO-247

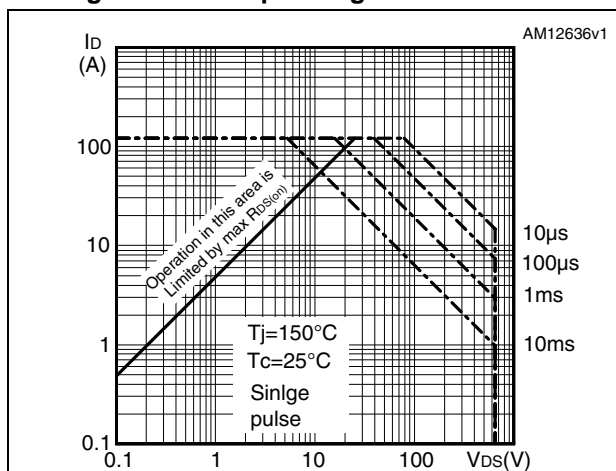


Figure 7. Thermal impedance for TO-247

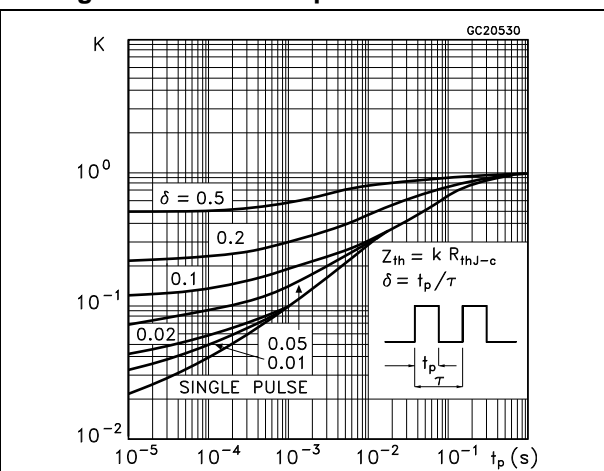


Figure 8. Output characteristics

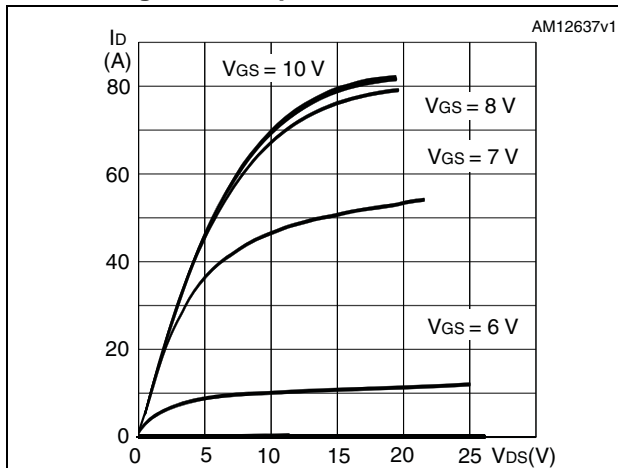


Figure 9. Transfer characteristics

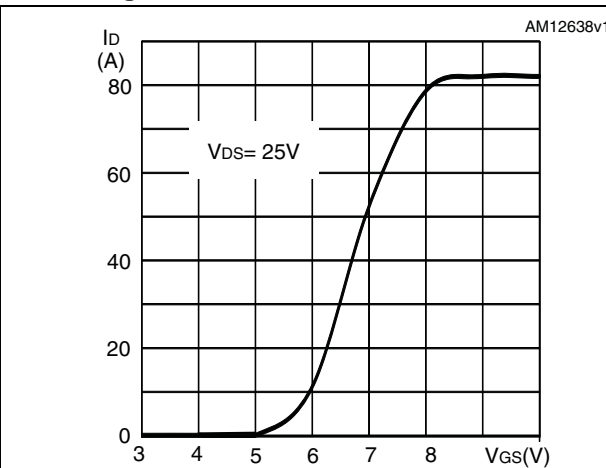


Figure 10. Gate charge vs gate-source voltage

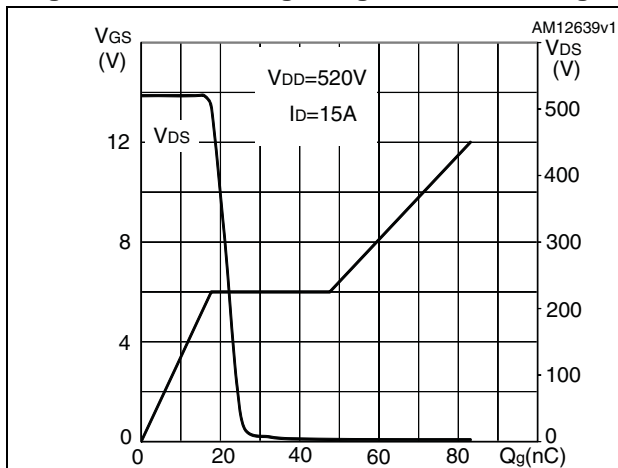


Figure 11. Static drain-source on-resistance

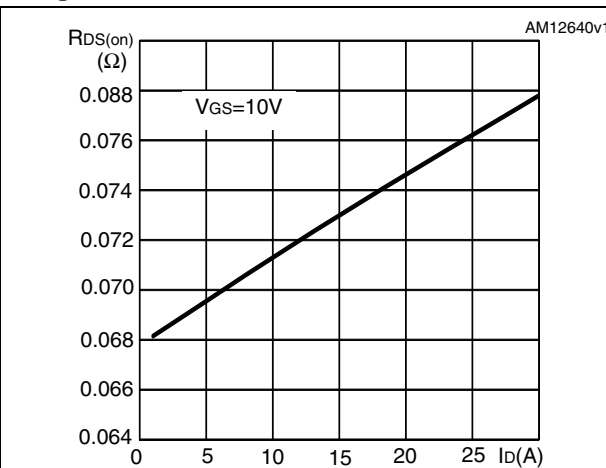


Figure 12. Capacitance variations

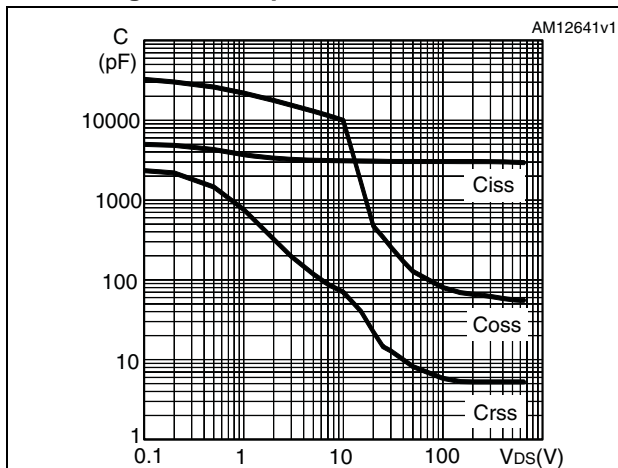


Figure 13. Output capacitance stored energy

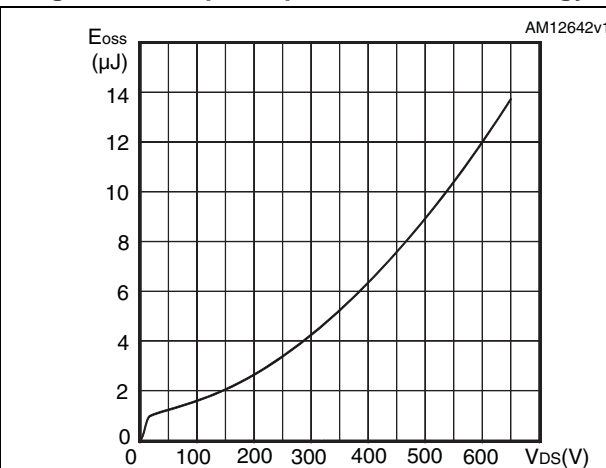




Figure 14. Normalized gate threshold voltage vs temperature

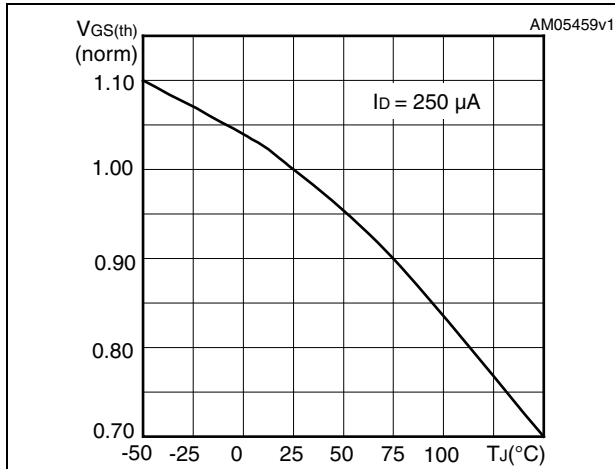


Figure 15. Normalized on-resistance vs temperature

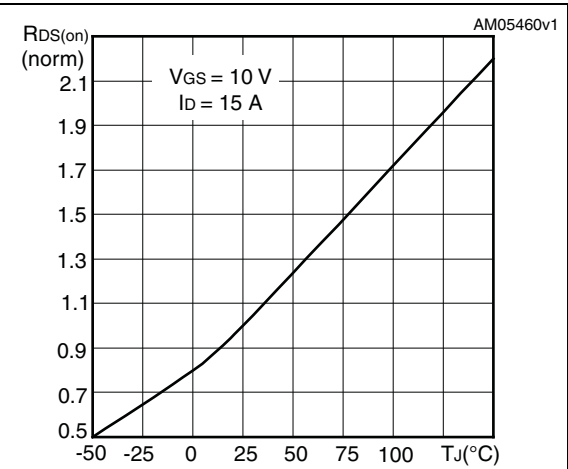


Figure 16. Source-drain diode forward characteristics

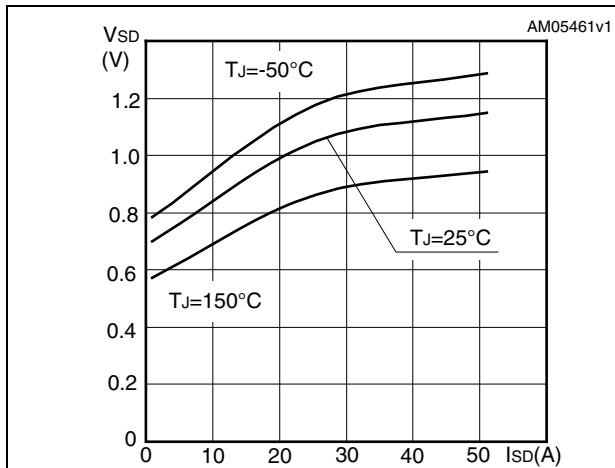


Figure 17. Normalized V<sub>DS</sub> vs temperature

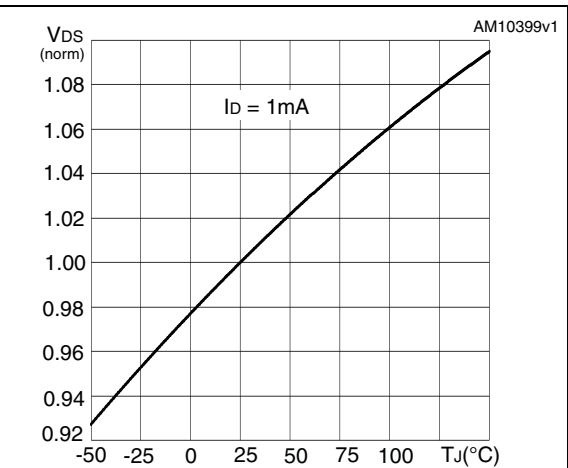
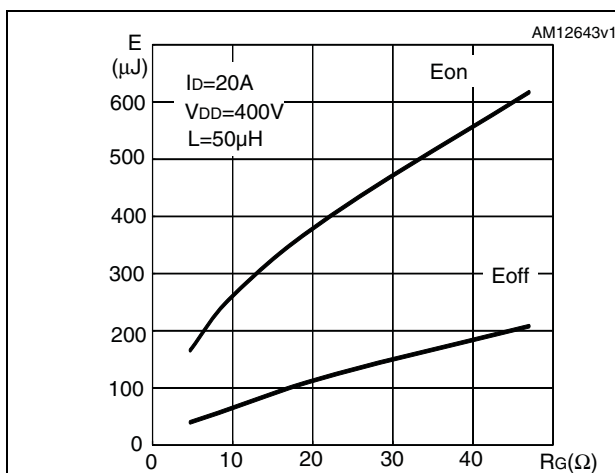


Figure 18. Switching losses vs gate resistance (1)



1. E<sub>on</sub> including reverse recovery of a SiC diode.

### 3 Test circuits

Figure 19. Switching times test circuit for resistive load

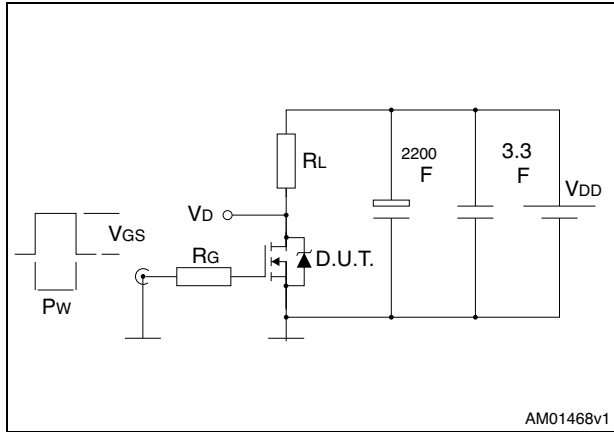


Figure 20. Gate charge test circuit

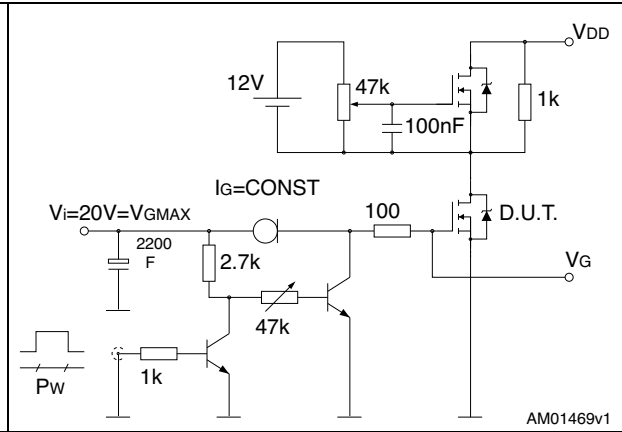


Figure 21. Test circuit for inductive load switching and diode recovery times

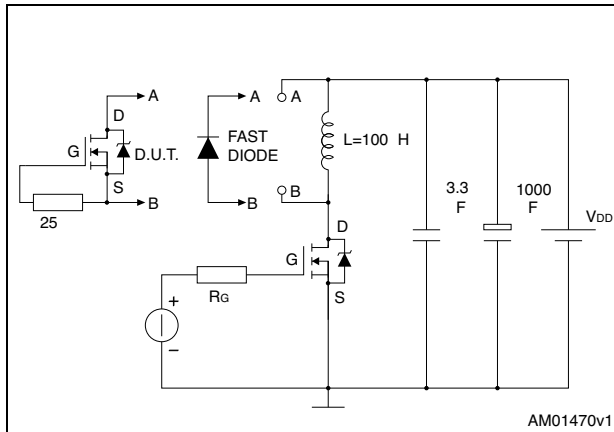


Figure 22. Unclamped inductive load test circuit

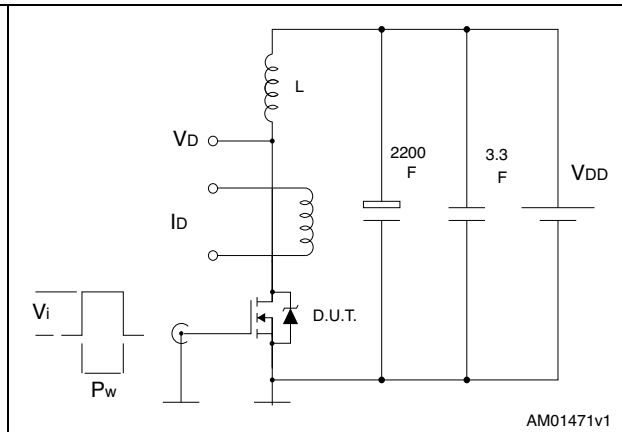


Figure 23. Unclamped inductive waveform

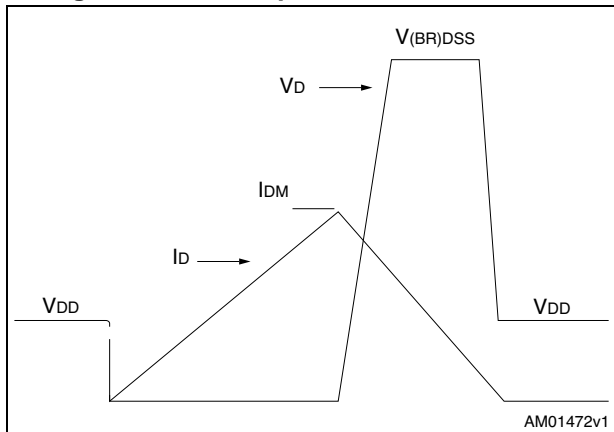
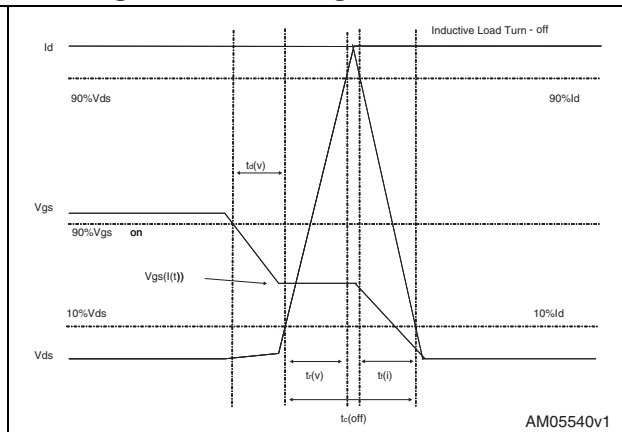


Figure 24. Switching time waveform



## 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 is an ST trademark.

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

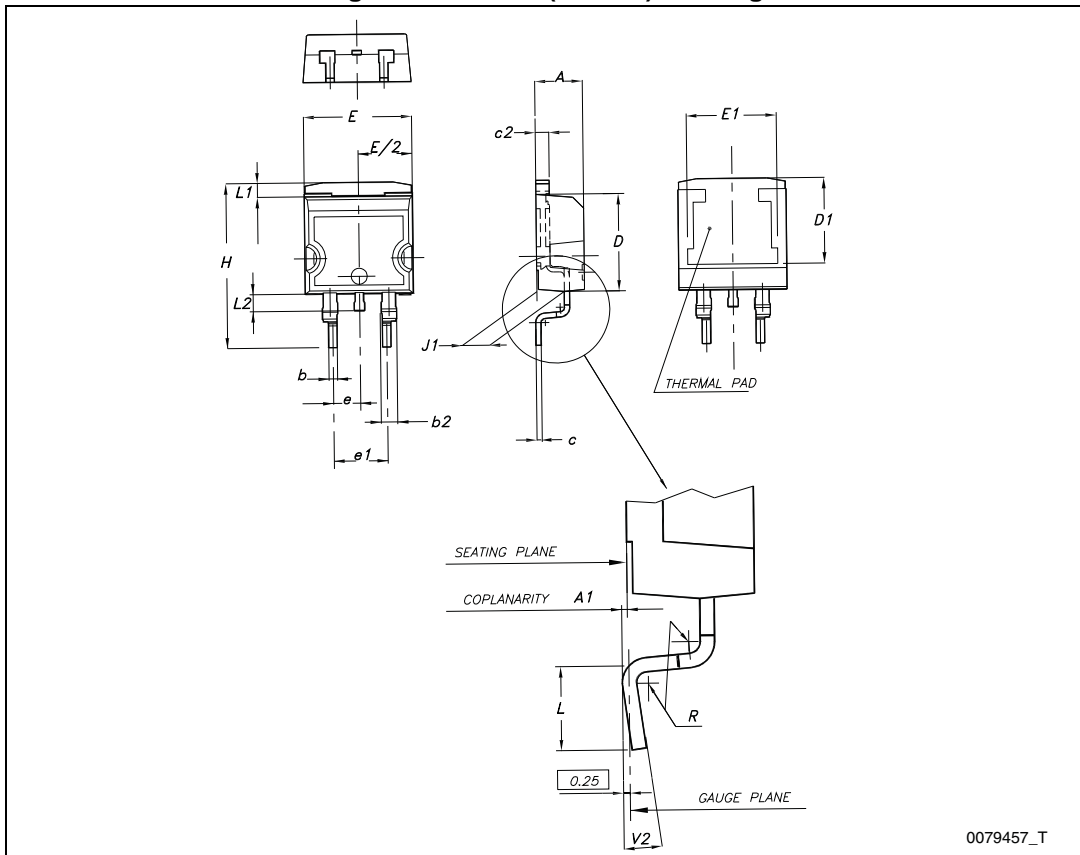
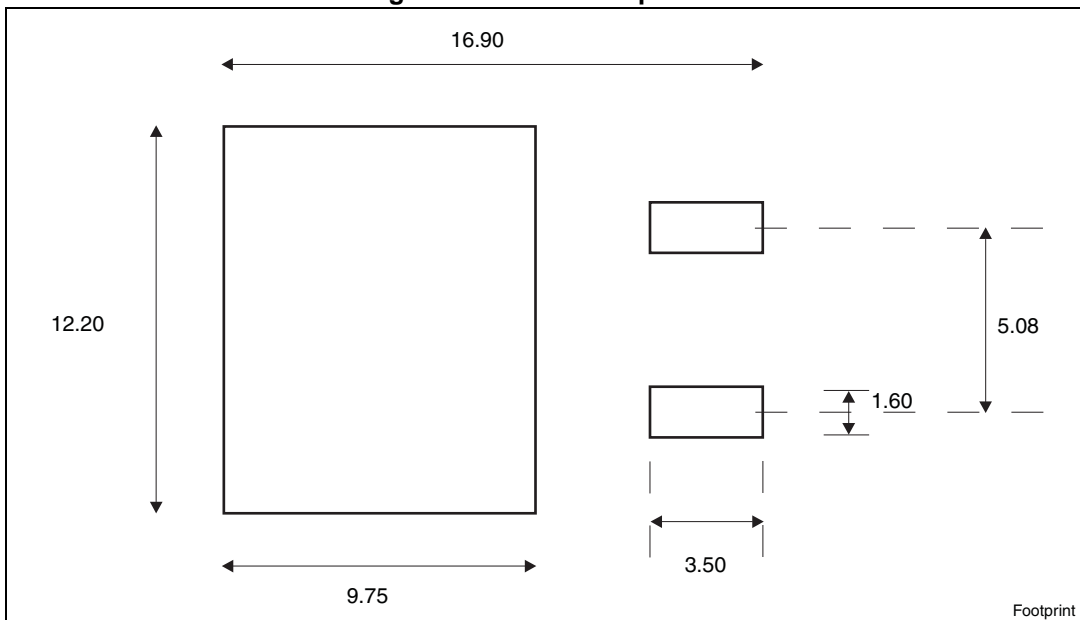


Figure 26. D<sup>2</sup>PAK footprint<sup>(a)</sup>

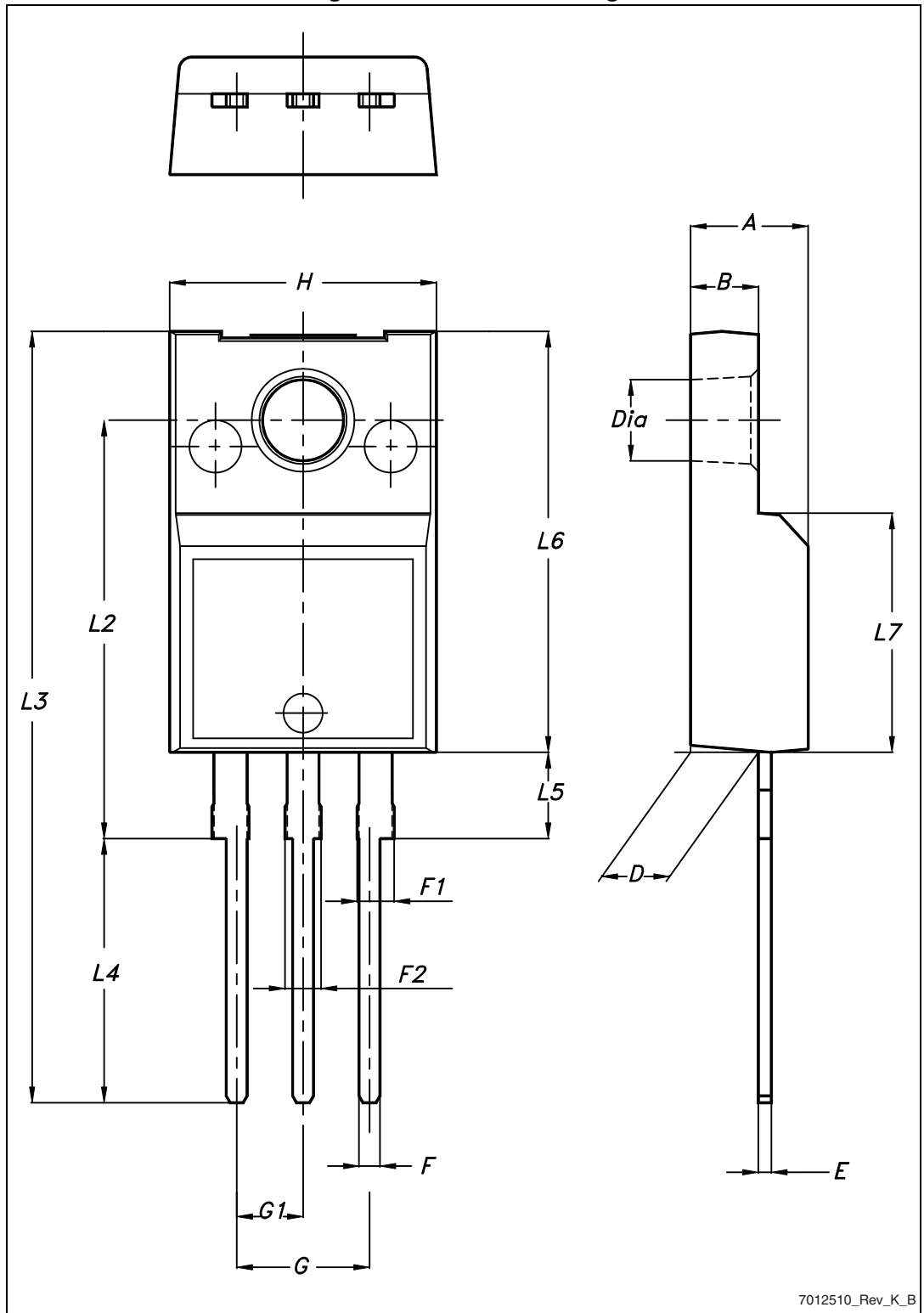


a. All dimension are in millimeters

Table 10. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	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
H	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

Figure 27. TO-220FP drawing



7012510\_Rev\_K\_B

Table 11. 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

Figure 28. TO-220 type A drawing

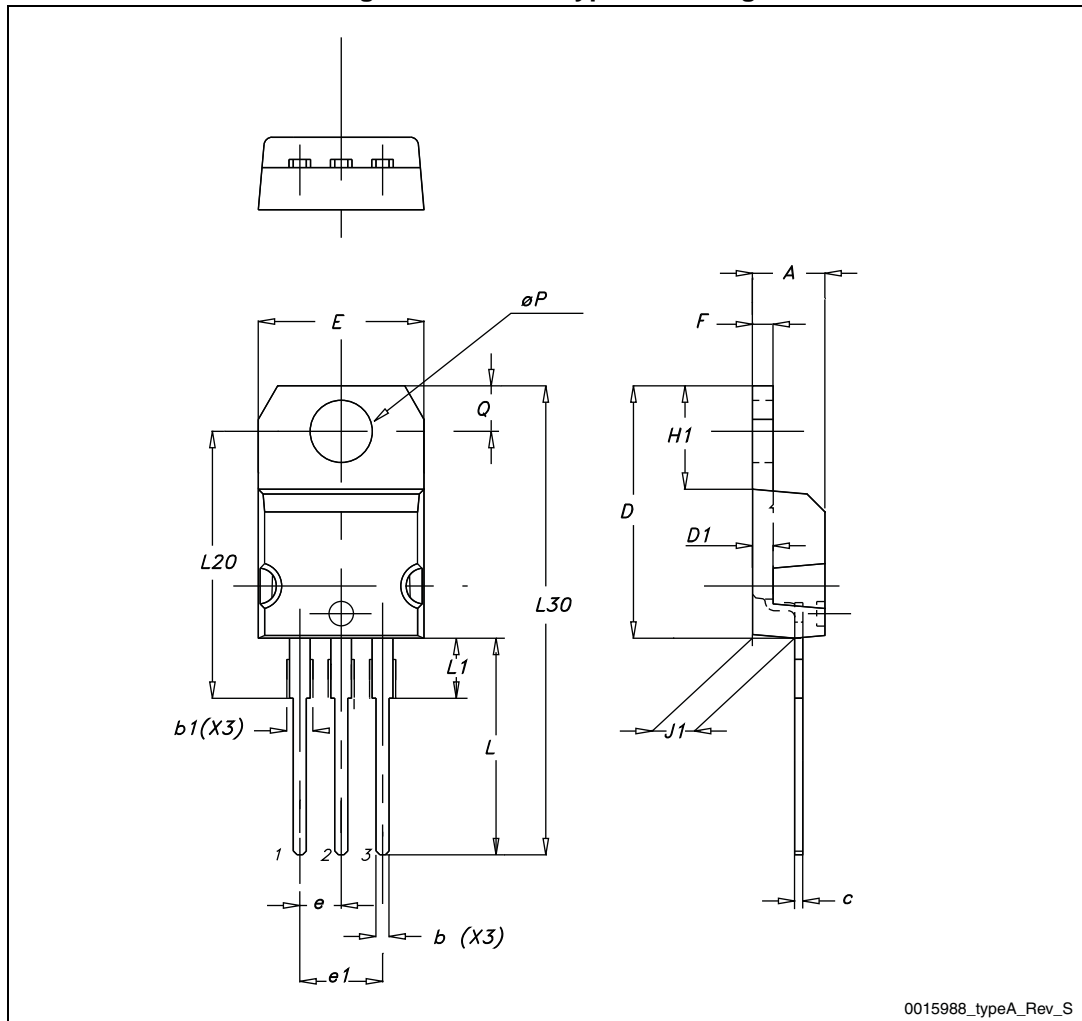
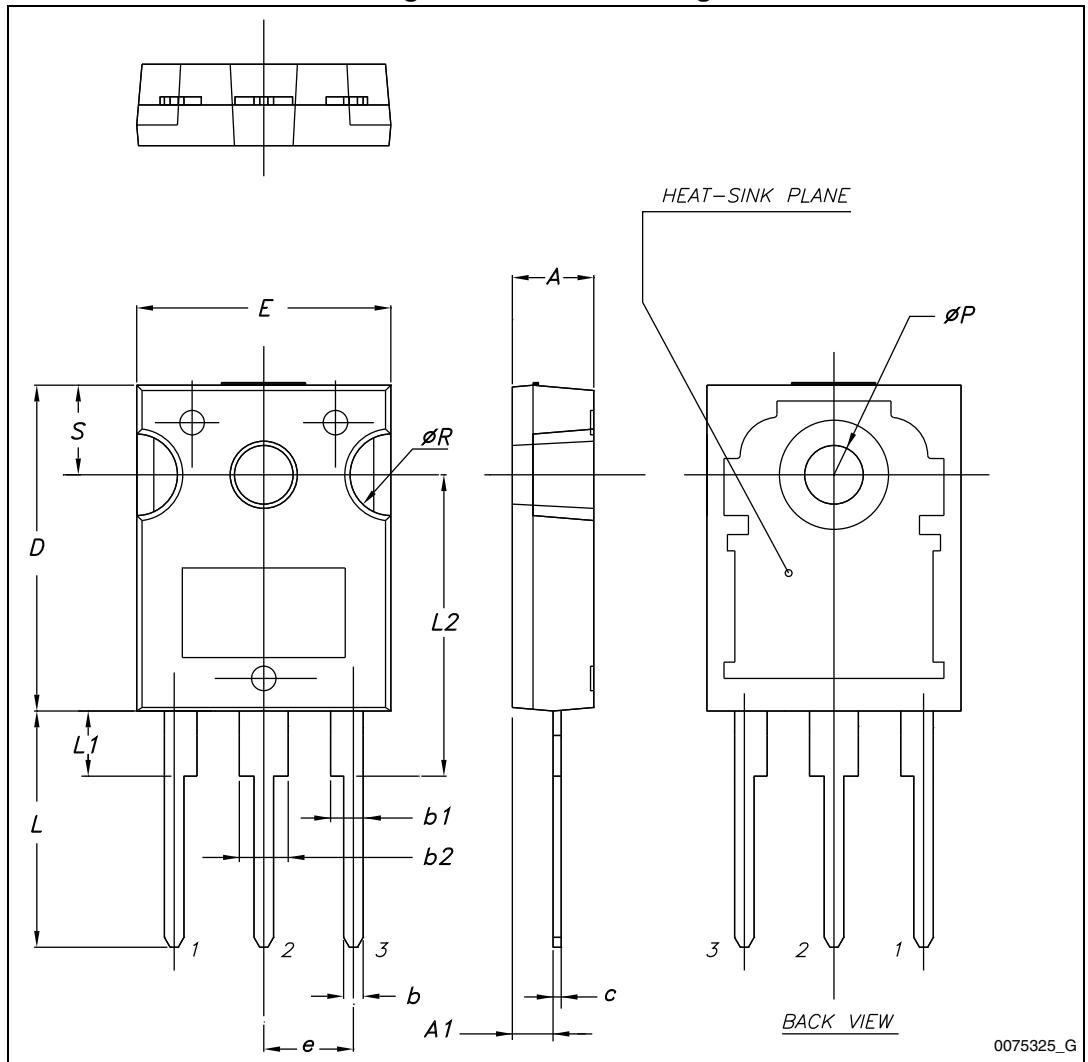




Table 12. TO-247 mechanical data

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

Figure 29. TO-247 drawing

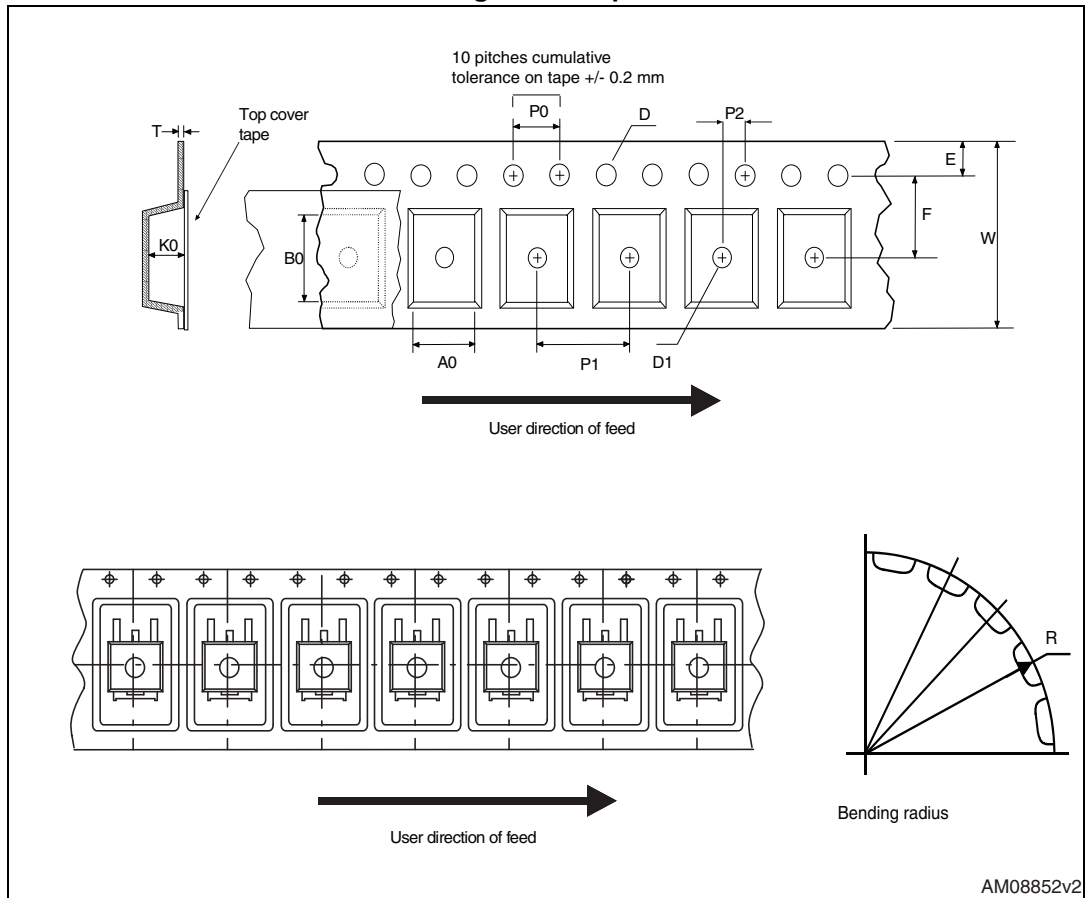


## 5 Packaging mechanical data

Table 13. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

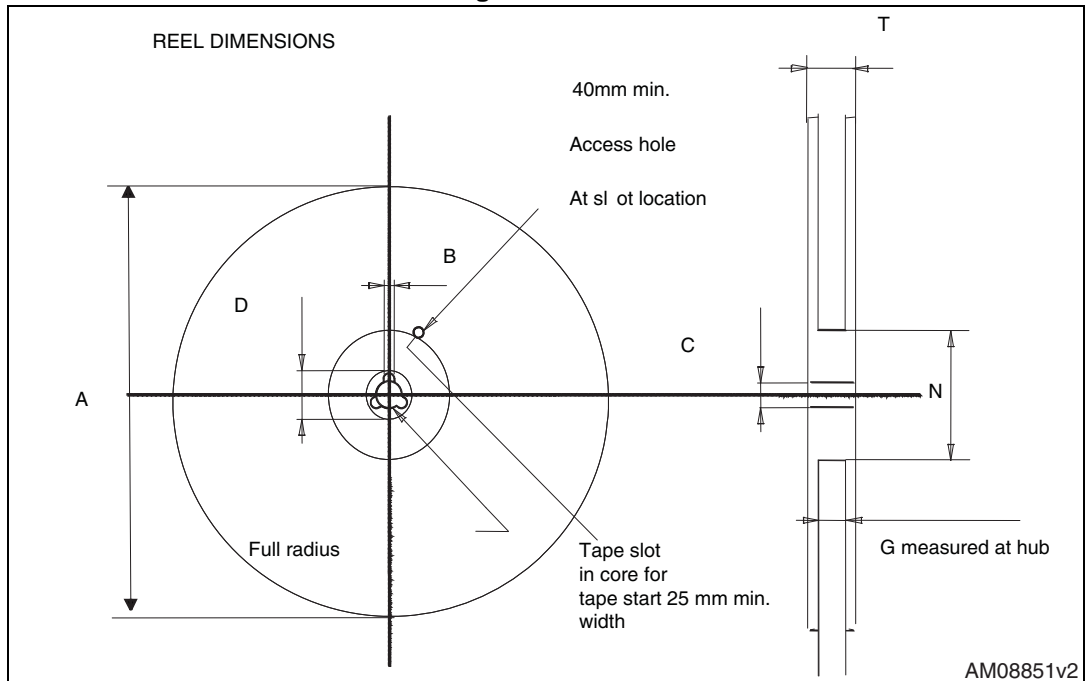
Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1		Base qty	1000
P2	1.9	2.1		Bulk qty	1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 30. Tape



AM08852v2

Figure 31. Reel



AM08851v2

## 6 Revision history

Table 14. 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> .

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