

## N-channel 650 V, 0.067 $\Omega$ typ., 35 A MDmesh™ V Power MOSFET in D<sup>2</sup>PAK, TO-220FP and TO-220 packages

Datasheet – production data

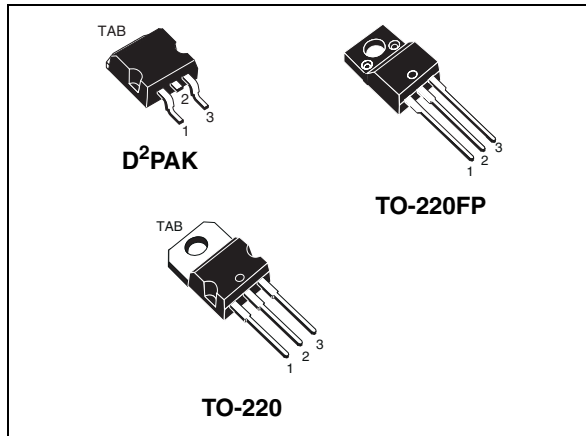
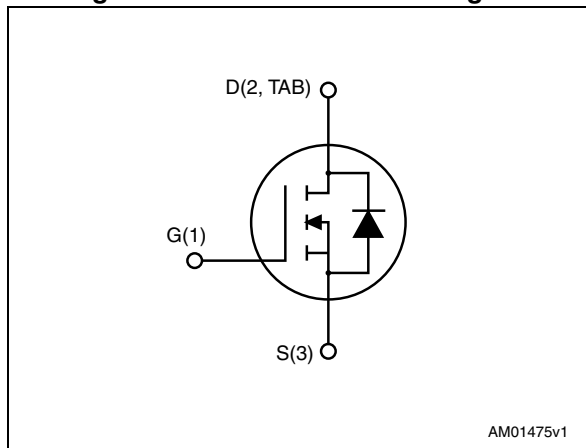


Figure 1. Internal schematic diagram



### Features

Order codes	V <sub>DSS</sub> @ T <sub>Jmax</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB45N65M5	710 V	0.078 $\Omega$	35 A
STF45N65M5			
STP45N65M5			

- Worldwide best R<sub>DS(on)</sub> \* area
- Higher V<sub>DSS</sub> 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
STB45N65M5	45N65M5	D <sup>2</sup> PAK	Tape and reel
STF45N65M5		TO-220FP	Tube
STP45N65M5		TO-220	

# 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-220FP	
V <sub>GS</sub>	Gate-source voltage	± 25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	35	35 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	22	22 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	140	140 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	210	40	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.
- $I_{SD} \leq 35 \text{ A}$ ,  $di/dt \leq 400 \text{ A}/\mu\text{s}$ ,  $V_{DS(\text{Peak})} < V_{(BR)DSS}$ ,  $V_{DD} = 400 \text{ V}$
- $V_{DS} \leq 480 \text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK	TO-220FP	TO-220	
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.60	3.13	0.60	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb max	30			°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max		62.5		°C/W

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

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>jmax</sub> )	9	A
E <sub>AS</sub>	Single pulse avalanche energy (starting t <sub>j</sub> =25°C, I <sub>d</sub> = I <sub>AR</sub> ; V <sub>dd</sub> =50)	810	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	$V_{GS} = 10\text{ V}$ , $I_D = 17.5\text{ A}$		0.067	0.078	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	3470	-	pF
$C_{oss}$	Output capacitance			82		
$C_{rss}$	Reverse transfer capacitance			7		
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$	-	280	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related			79		
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	2	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 17.5\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	82	-	nC
$Q_{gs}$	Gate-source charge			18.5		
$Q_{gd}$	Gate-drain charge			35		

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	$V_{DD} = 400$ V, $I_D = 23$ A,		79.5		ns
$t_r$ (v)	Voltage rise time	$R_G = 4.7$ $\Omega$ , $V_{GS} = 10$ V		11		ns
$t_f$ (i)	Current fall time	(see <a href="#">Figure 19</a> and	-	9.3	-	ns
$t_c$ (off)	Crossing time	<a href="#">Figure 22</a> )		16		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current				35	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		140	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 35$ A, $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 35$ A, $di/dt = 100$ A/ $\mu$ s		392		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100$ V (see <a href="#">Figure 19</a> )	-	7.4		$\mu$ C
$I_{RRM}$	Reverse recovery current			38		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 35$ A, $di/dt = 100$ A/ $\mu$ s		468		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100$ V, $T_j = 150$ °C	-	9.7		$\mu$ C
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 19</a> )		42		A

1. Pulse width limited by safe operating area.

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

## 2.1 Electrical characteristics (curves)

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

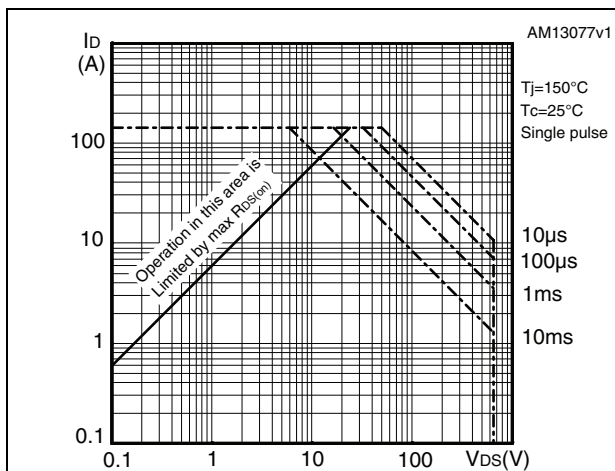


Figure 3. Thermal impedance for D<sup>2</sup>PAK and TO-220

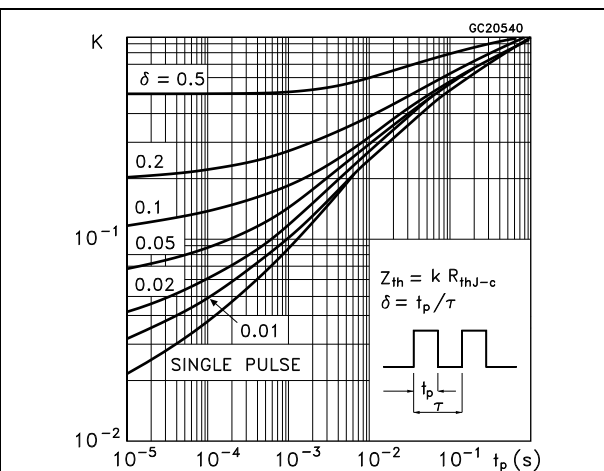


Figure 4. Safe operating area TO220FP

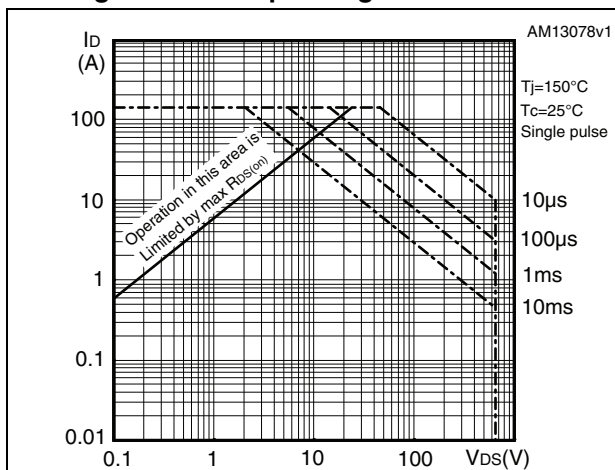


Figure 5. Thermal impedance for TO-220FP

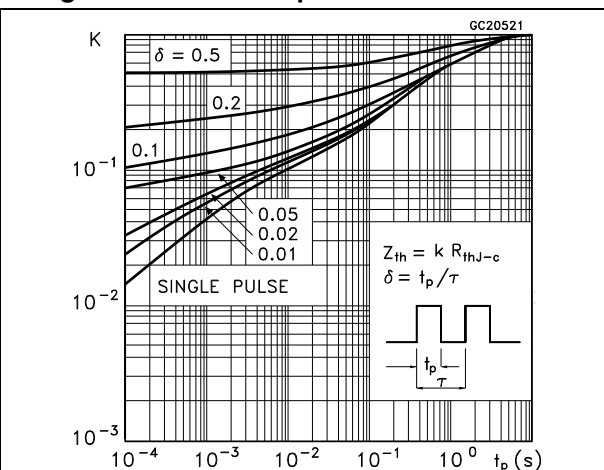


Figure 6. Output characteristics

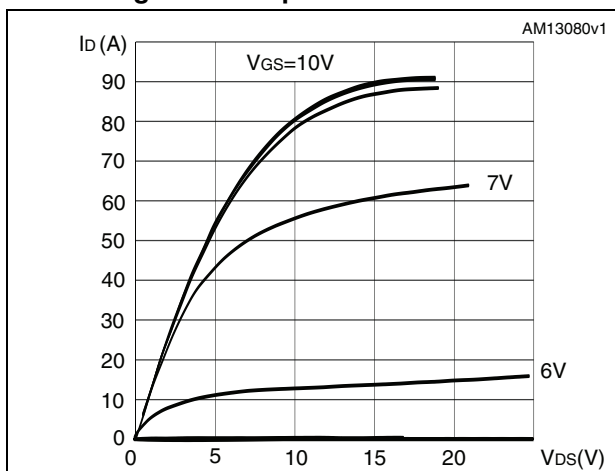


Figure 7. Transfer characteristics

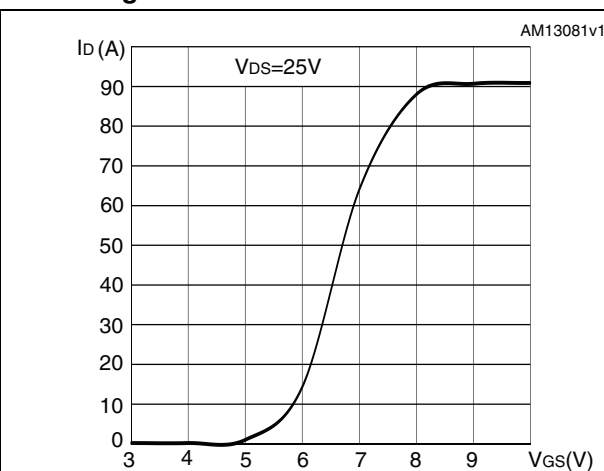


Figure 8. Gate charge vs gate-source voltage

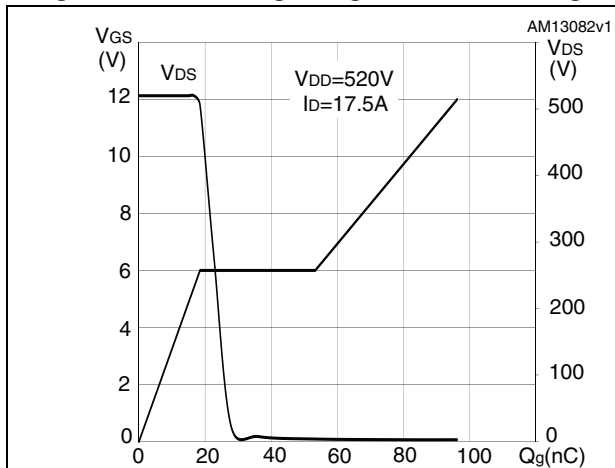


Figure 9. Static drain-source on-resistance

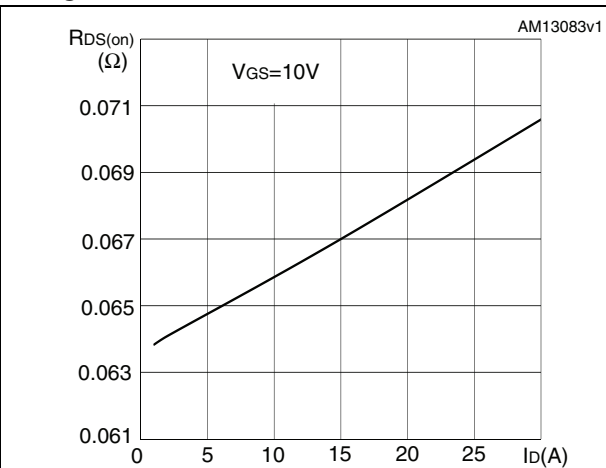


Figure 10. Capacitance variations

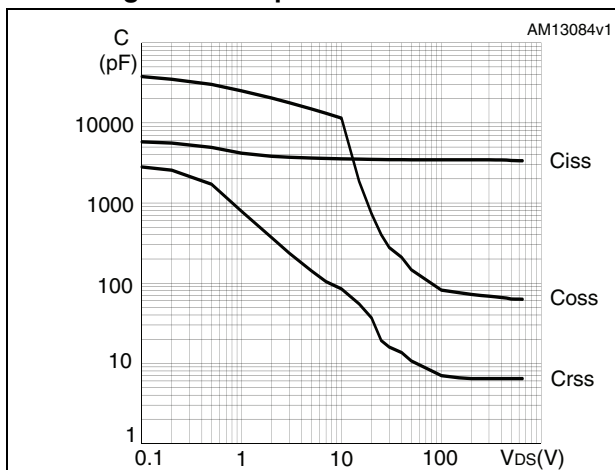


Figure 11. Output capacitance stored energy

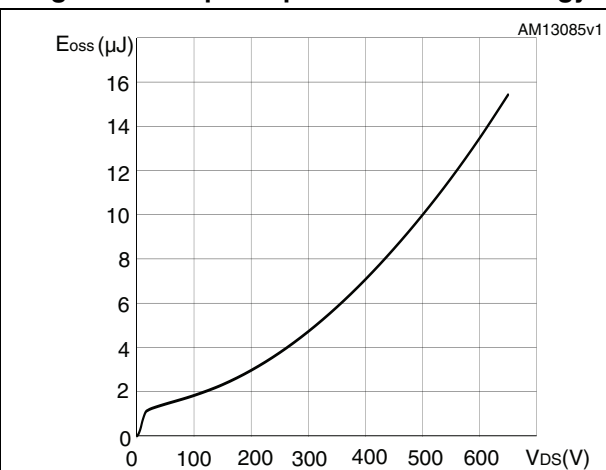


Figure 12. Normalized gate threshold voltage vs. temperature

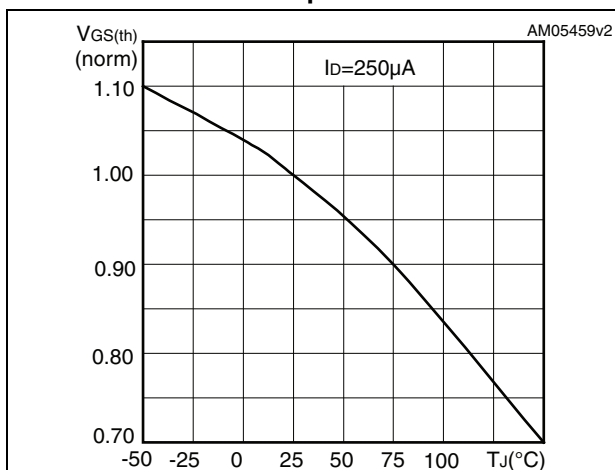


Figure 13. Normalized on resistance vs. temperature

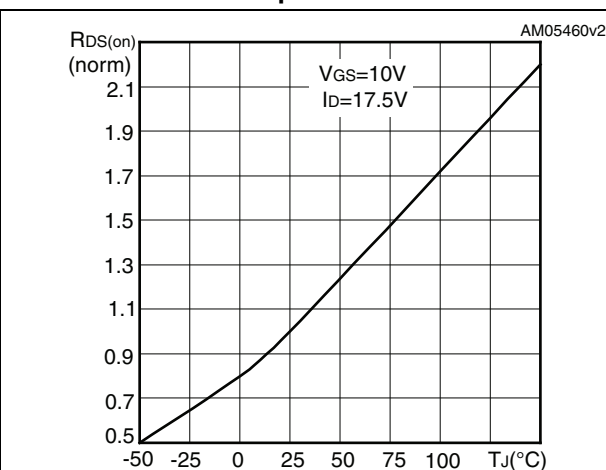


Figure 14. Drain-source diode forward characteristics

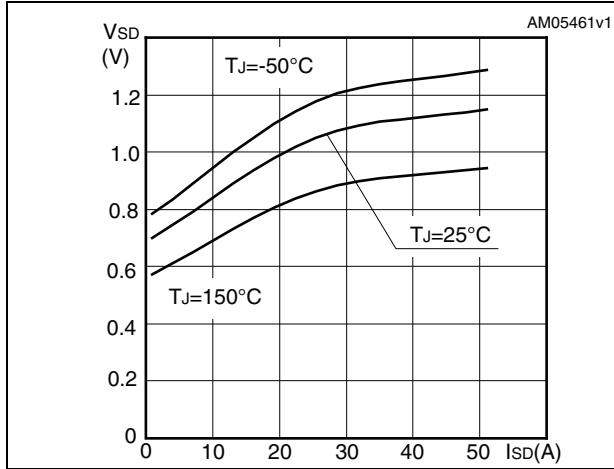


Figure 15. Normalized  $V_{DS}$  vs. temperature

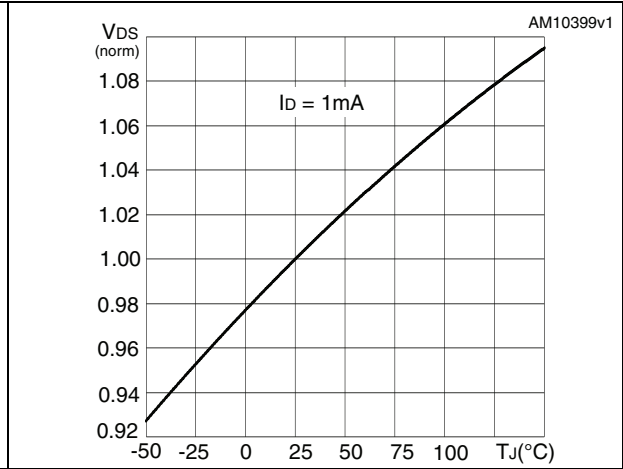
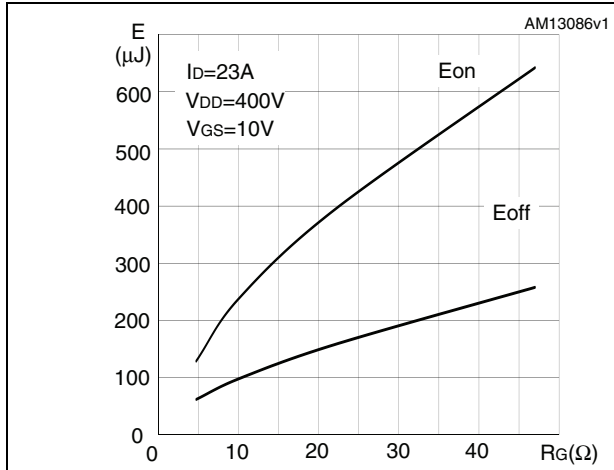


Figure 16. Switching losses vs. gate resistance (1)



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





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

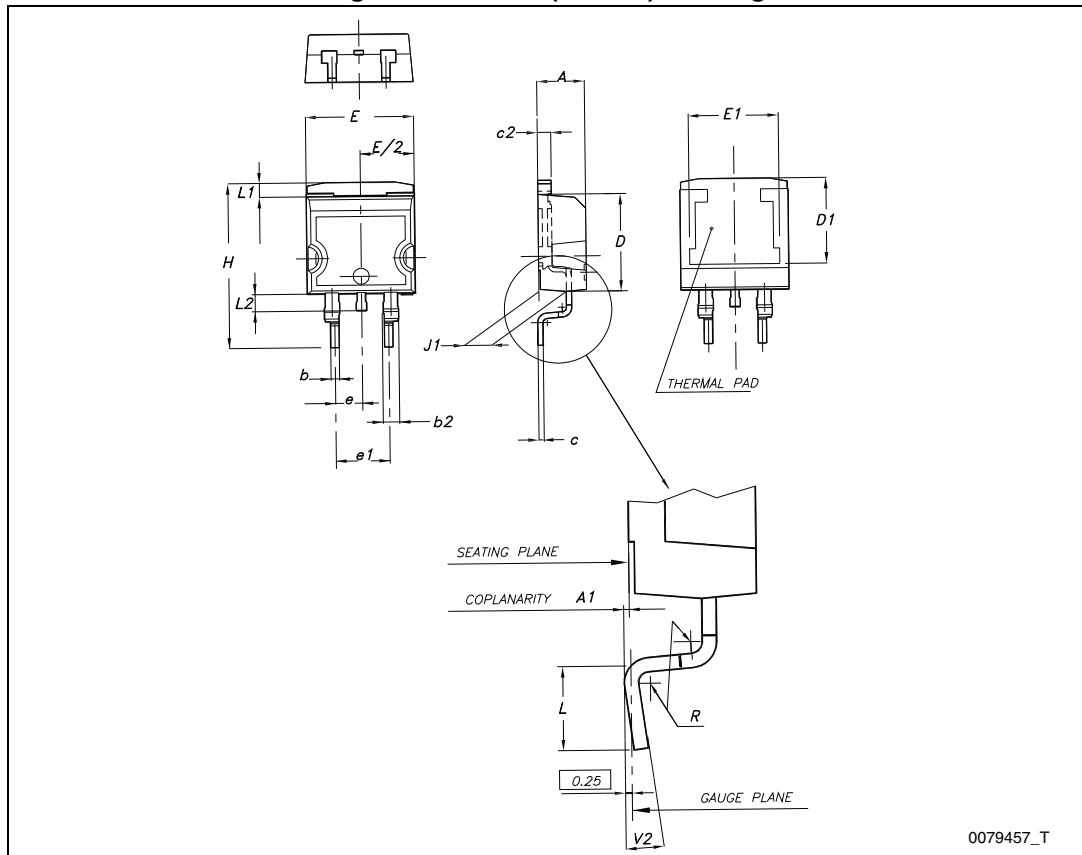
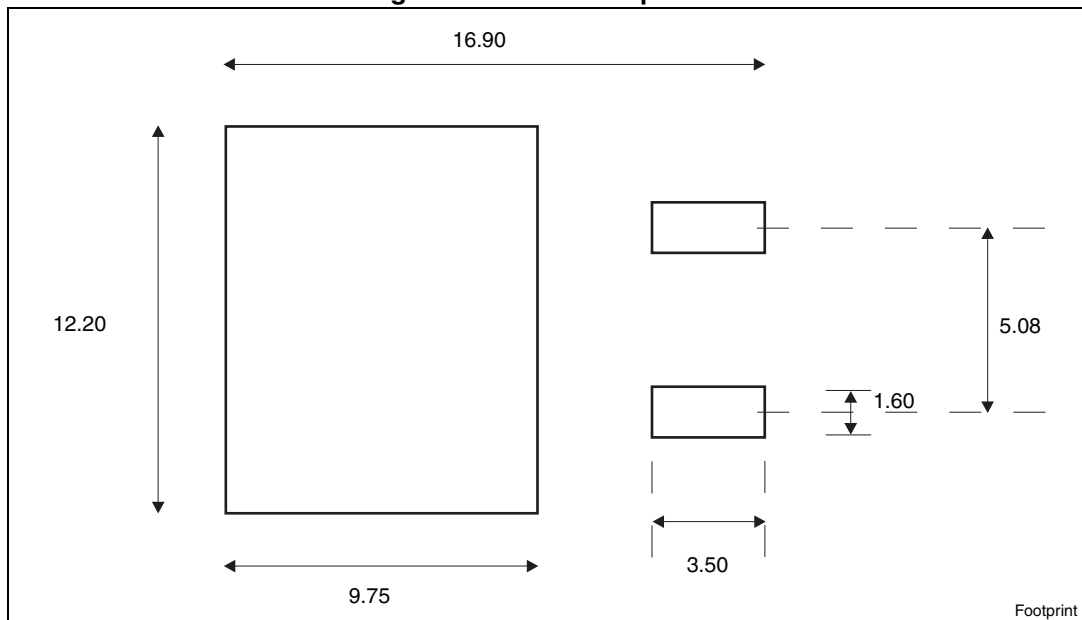


Figure 24. D<sup>2</sup>PAK footprint<sup>(a)</sup>

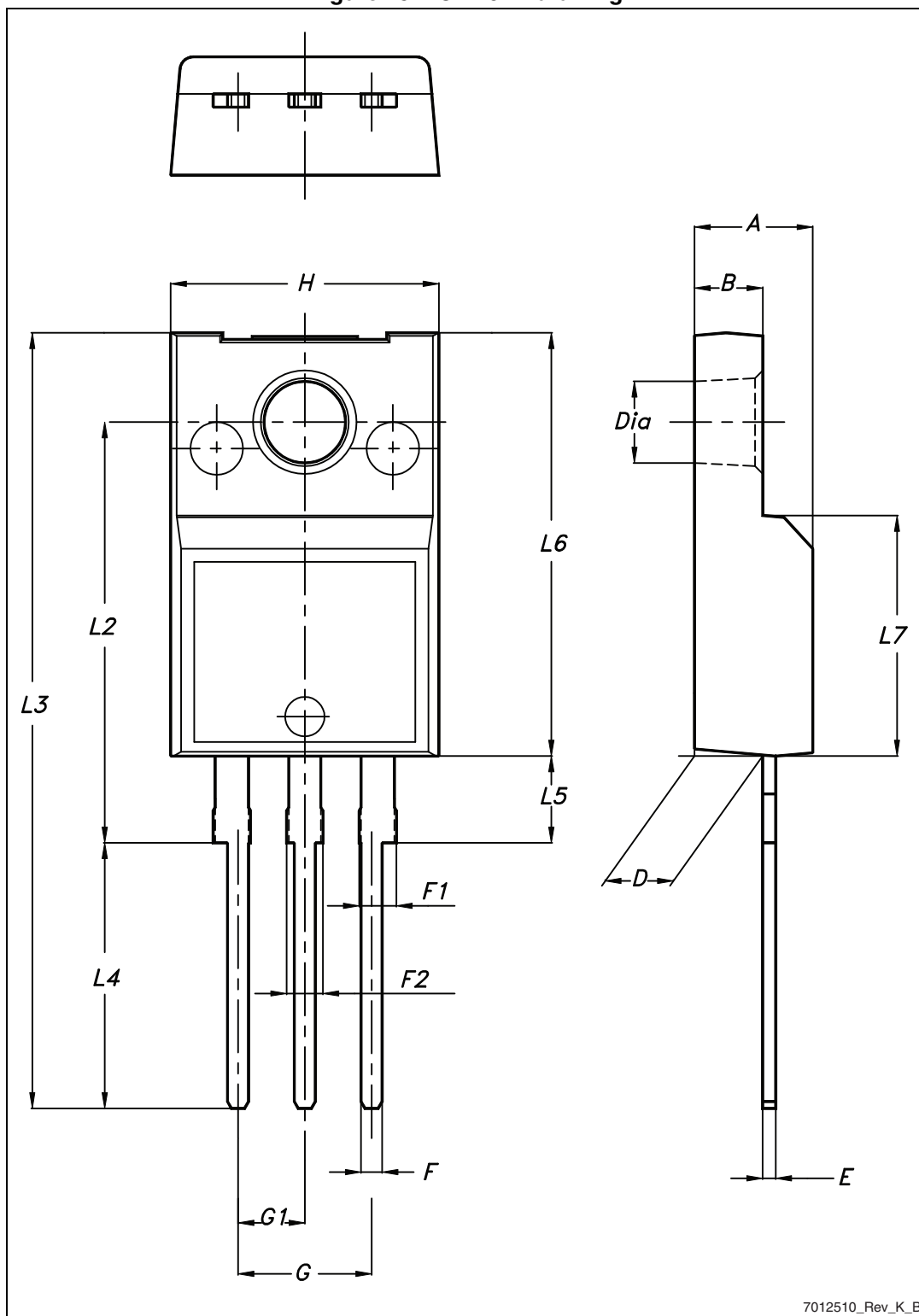


a. All dimensions are in millimeters

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 25. TO-220FP drawing

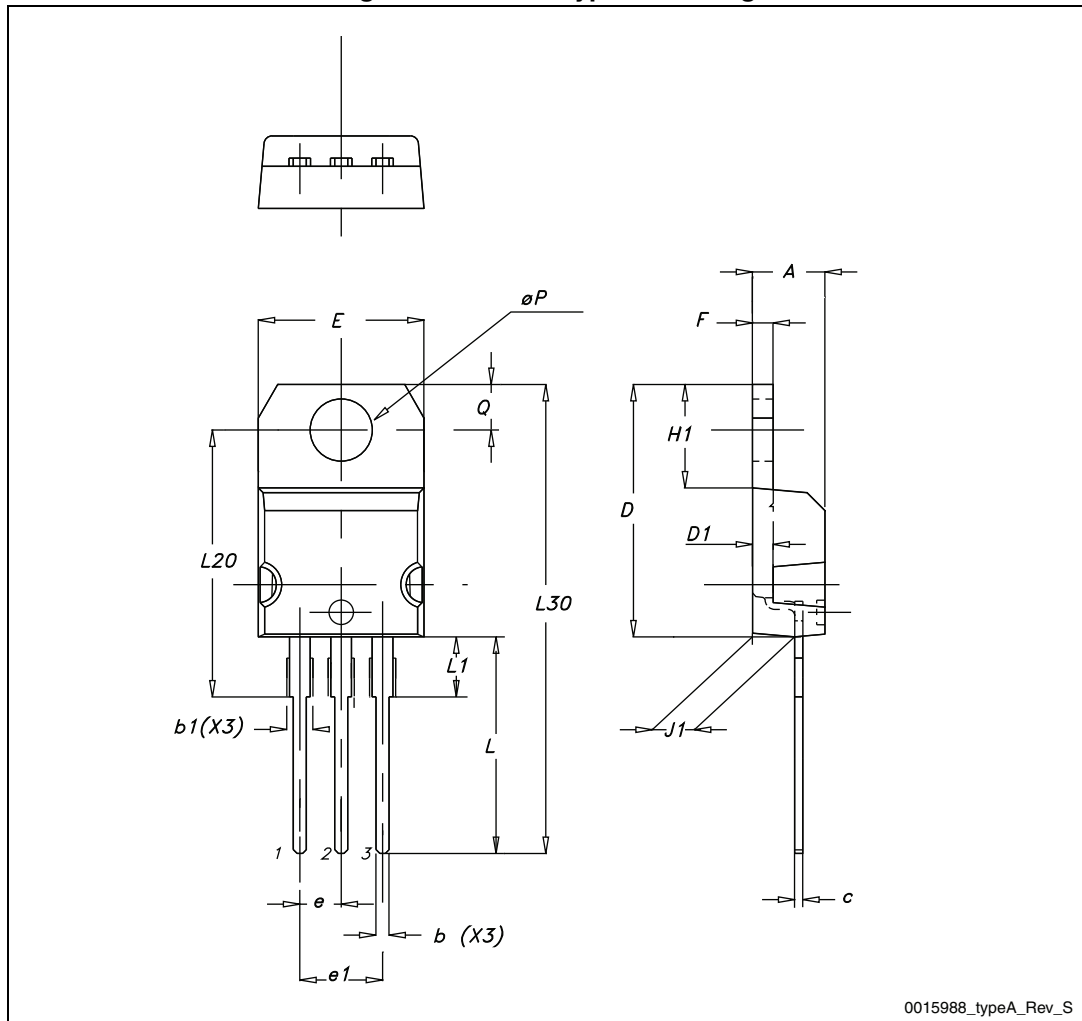


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Table 11. TO-220 type A mechanical data

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 26. TO-220 type A drawing



0015988\_typeA\_Rev\_S



## 5 Packaging mechanical data

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			

Figure 27. Tape for D<sup>2</sup>PAK (TO-263)

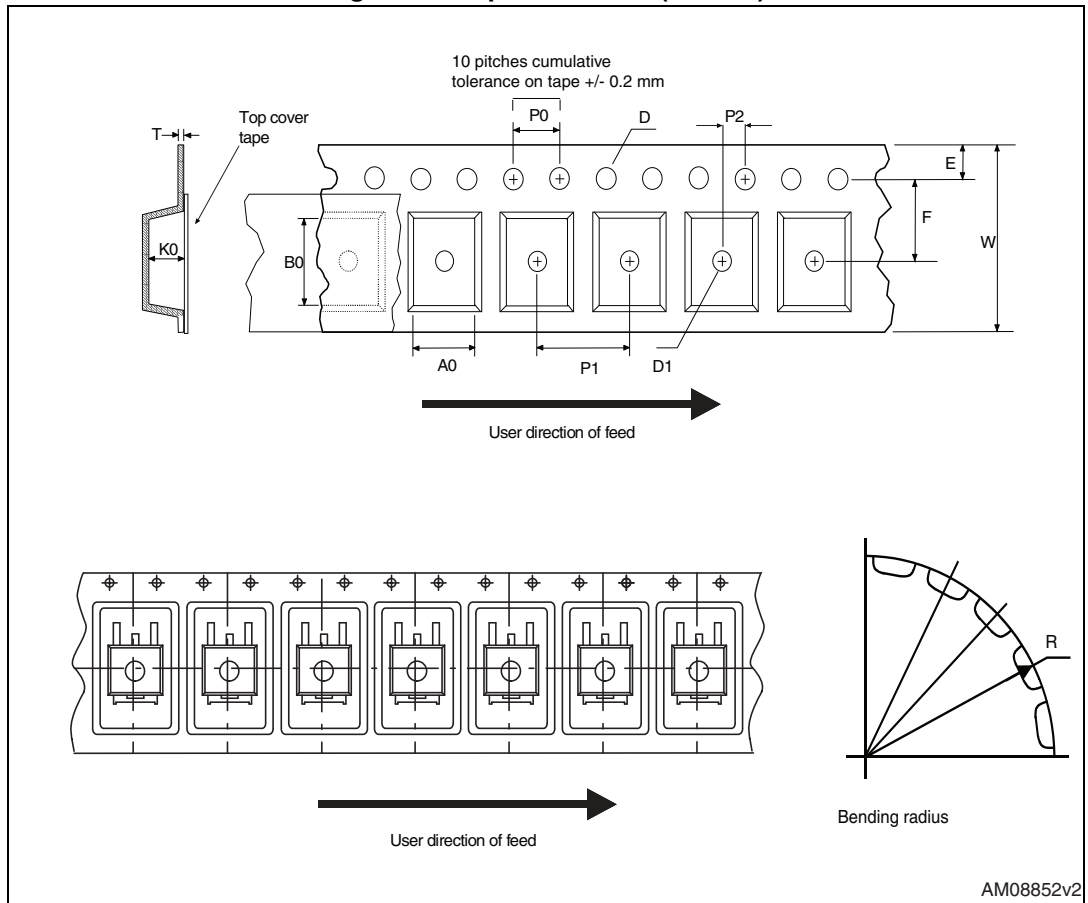
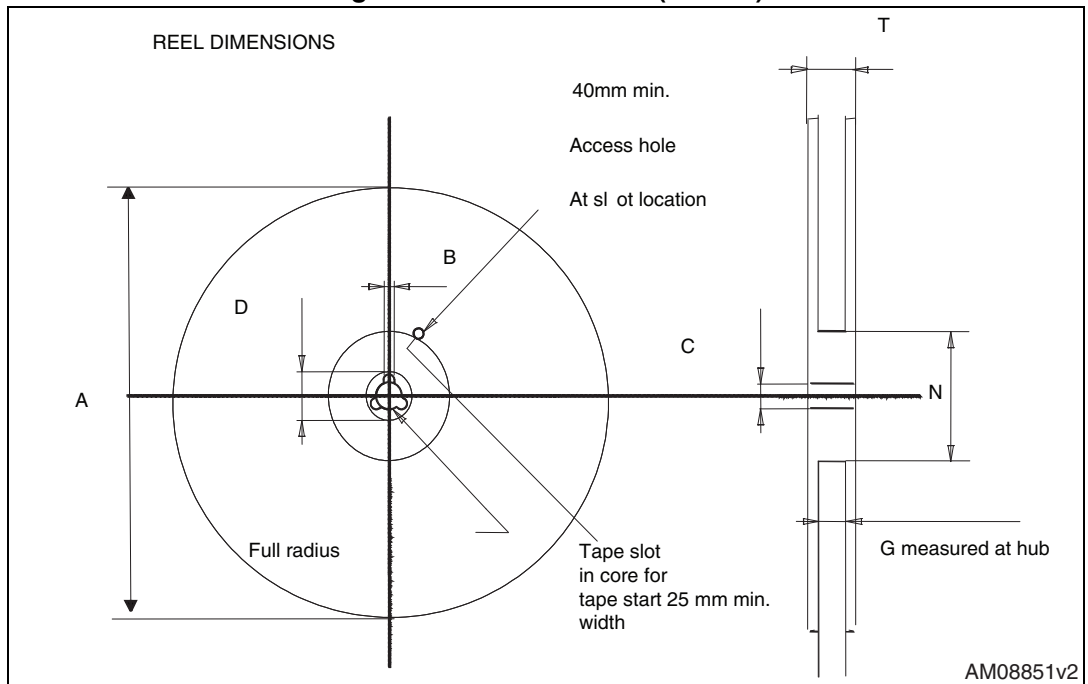


Figure 28. Reel for D<sup>2</sup>PAK (TO-263)



## 6 Revision history

Table 13. Document revision history

Date	Revision	Changes
22-Feb-2012	1	First release.
28-Aug-2012	2	Document status promoted from preliminary data to production data. Inserted <a href="#">Section 2.1: Electrical characteristics (curves)</a> .
05-Dec-2012	3	The part number STW45N65M5 has been moved to a separate datasheet.
05-Mar-2013	4	– Added dv/dt value on <a href="#">Table 2: Absolute maximum ratings</a> – Minor text changes

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**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.