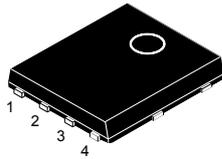
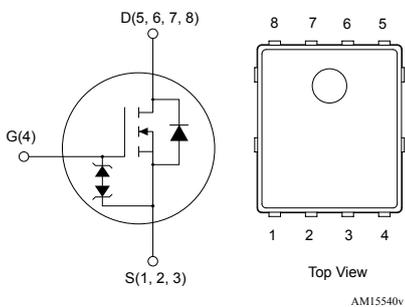


## N-channel 600 V, 0.390 $\Omega$ typ., 7 A MDmesh™ M2 EP Power MOSFET in a PowerFLAT™ 5x6 HV package


**PowerFLAT™ 5x6 HV**


### Features

Order code	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max.}$	$I_D$	$P_{TOT}$
STL15N60M2-EP	650 V	0.418 $\Omega$	7 A	55 W

- Extremely low gate charge
- Excellent output capacitance ( $C_{OSS}$ ) profile
- Very low turn-off switching losses
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications
- Tailored for very high frequency converters ( $f > 150$  kHz)

### Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 enhanced performance (EP) technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance, optimized switching characteristics with very low turn-off switching losses, rendering it suitable for the most demanding very high frequency converters.

#### Product status

STL15N60M2-EP

#### Product summary

<b>Order code</b>	STL15N60M2-EP
<b>Marking</b>	15N60M2E
<b>Package</b>	PowerFLAT™ 5x6 HV
<b>Packing</b>	Tape and Reel

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_{case} = 25\text{ }^\circ\text{C}$	7	A
	Drain current (continuous) at $T_{case} = 100\text{ }^\circ\text{C}$	4.6	
$I_{DM}^{(1)}$	Drain current (pulsed)	28	A
$P_{TOT}$	Total dissipation at $T_{case} = 25\text{ }^\circ\text{C}$	55	W
$I_{AR}^{(2)}$	Avalanche current, repetitive or not repetitive	1.5	A
$E_{AS}^{(3)}$	Single pulse avalanche energy	110	mJ
$dv/dt^{(4)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(5)}$	MOSFET $dv/dt$ ruggedness	50	
$T_{stg}$	Storage temperature range	-55 to 150	$^\circ\text{C}$
$T_j$	Operating junction temperature range		

1. Pulse width is limited by safe operating area.
2. Pulse width limited by  $T_{jmax}$ .
3. starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .
4.  $I_{SD} \leq 7\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
5.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	2.27	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	59	

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

## 2 Electrical characteristics

( $T_{case} = 25\text{ °C}$  unless otherwise specified)

**Table 3. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}, V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, V_{DS} = 600\text{ V}, T_{case} = 125\text{ °C}^{(1)}$			100	
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}, V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	3.25	4	4.75	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}, I_D = 4.5\text{ A}$		0.390	0.418	$\Omega$

1. Defined by design, not subject to production test.

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0\text{ V}$	-	590	-	$\mu\text{F}$
$C_{oss}$	Output capacitance		-	30	-	
$C_{riss}$	Reverse transfer capacitance		-	1.1	-	
$C_{oss\ eq.}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}, V_{GS} = 0\text{ V}$	-	148	-	$\mu\text{F}$
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}, I_D = 0\text{ A}$	-	7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}, I_D = 11\text{ A}, V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 15. Test circuit for gate charge behavior)	-	17	-	nC
$Q_{gs}$	Gate-source charge		-	3.1	-	
$Q_{gd}$	Gate-drain charge		-	7.3	-	

1.  $C_{oss\ eq.}$  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 5. Switching energy**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{OFF}$	Turn-off energy (from 90% $V_{GS}$ to 0% $I_D$ )	$V_{DD} = 400\text{ V}, I_D = 1.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$	-	4.7	-	$\mu\text{J}$
		$V_{DD} = 400\text{ V}, I_D = 3.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$	-	5.2	-	

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	11	-	ns
$t_r$	Rise time		-	10	-	
$t_{d(off)}$	Turn-off delay time		-	40	-	
$t_f$	Fall time		-	15	-	

**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		7	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		28	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 7\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	280		ns
$Q_{rr}$	Reverse recovery charge		-	2.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	19.5		A
$t_{rr}$	Reverse recovery time		-	400		ns
$Q_{rr}$	Reverse recovery charge		-	3.8		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	19		A

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

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

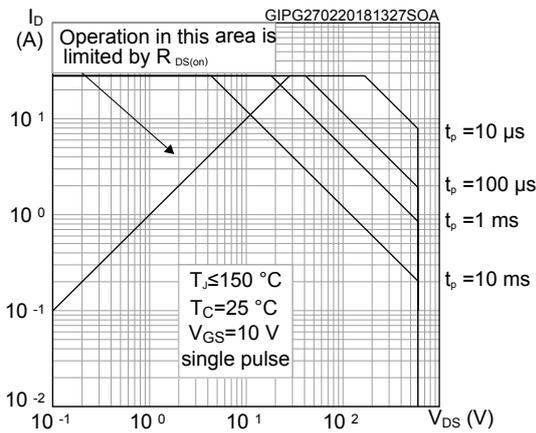


Figure 2. Thermal impedance

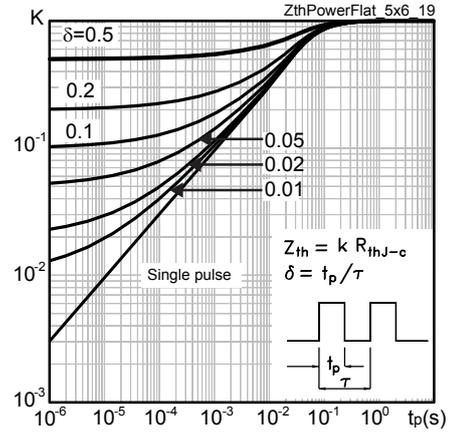


Figure 3. Output characteristics

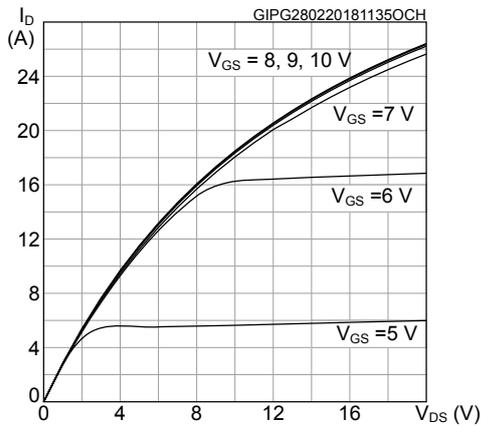


Figure 4. Transfer characteristics

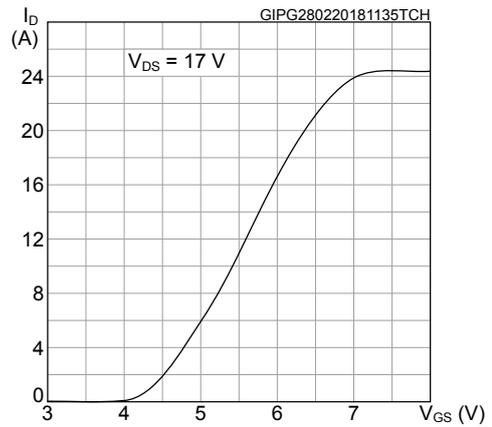


Figure 5. Gate charge vs gate-source voltage

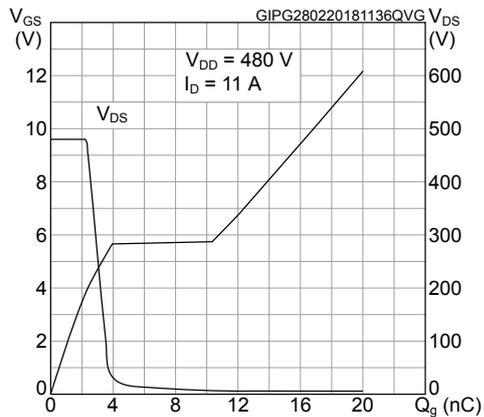


Figure 6. Static drain-source on-resistance

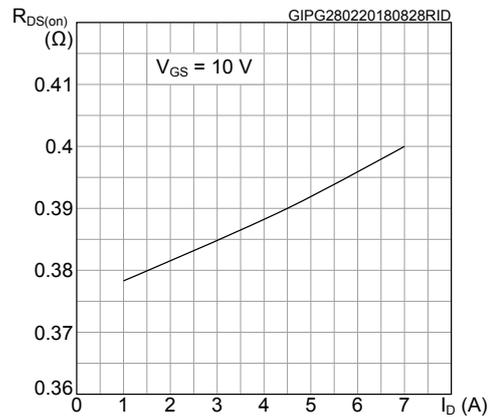


Figure 7. Capacitance variations

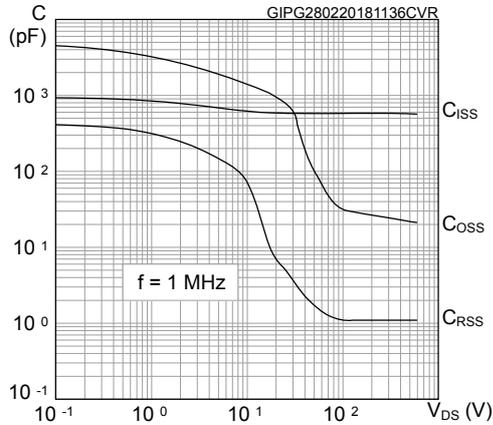


Figure 8. Output capacitance stored energy

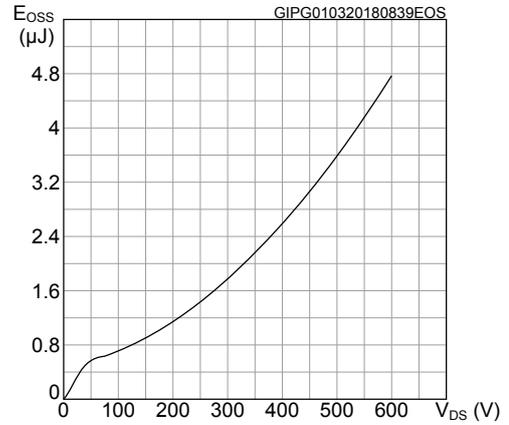


Figure 9. Normalized gate threshold voltage vs temperature

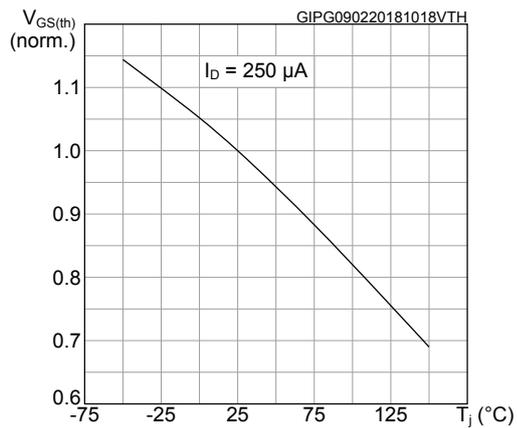


Figure 10. Normalized on-resistance vs temperature

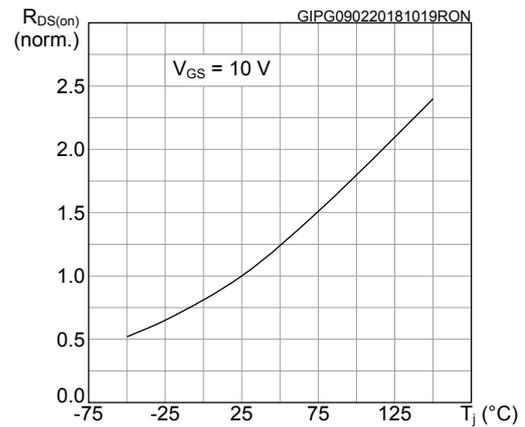


Figure 11. Normalized  $V_{(BR)DSS}$  vs temperature

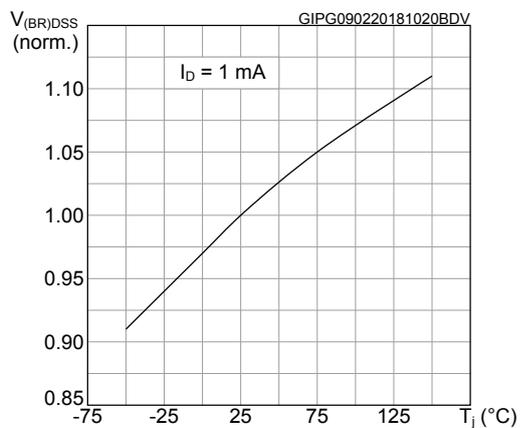


Figure 12. Turn-off switching energy vs drain current

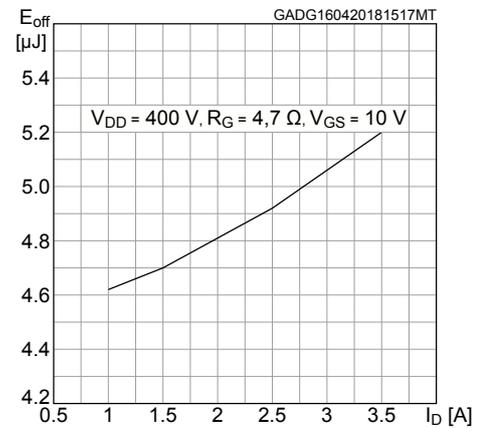
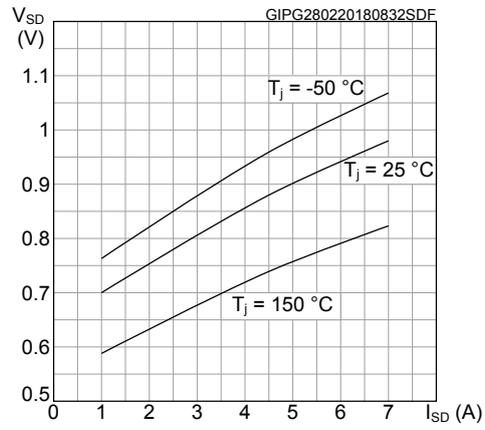
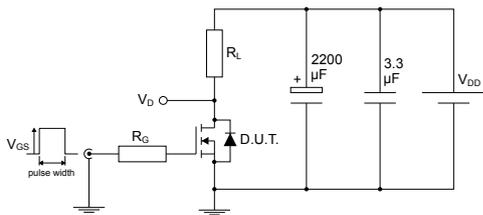


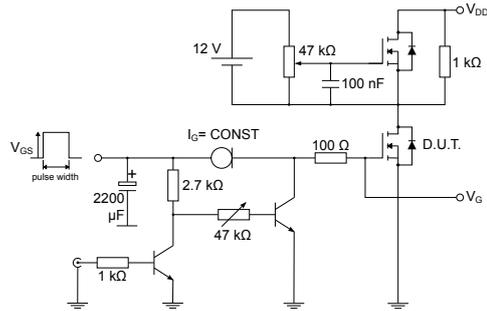
Figure 13. Source-drain diode forward characteristics



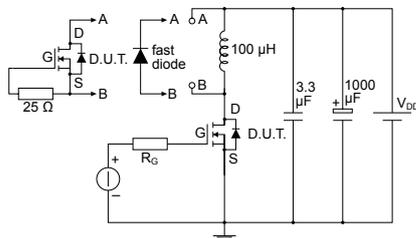
### 3 Test circuits

**Figure 14. Test circuit for resistive load switching times**


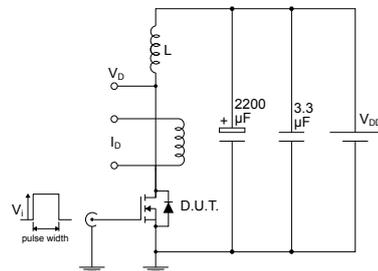
AM01468v1

**Figure 15. Test circuit for gate charge behavior**


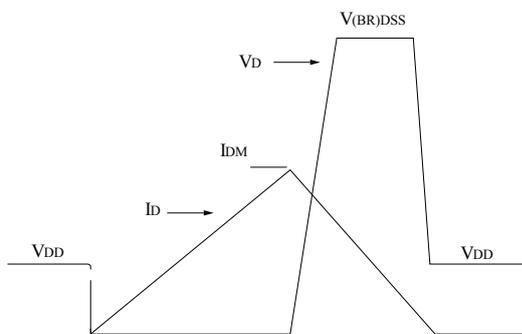
AM01469v1

**Figure 16. Test circuit for inductive load switching and diode recovery times**


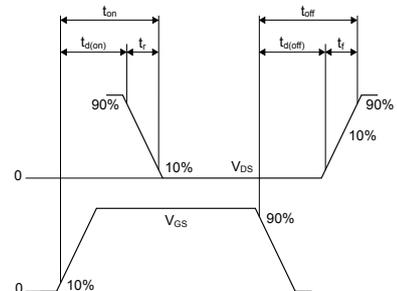
AM01470v1

**Figure 17. Unclamped inductive load test circuit**


AM01471v1

**Figure 18. Unclamped inductive waveform**


AM01472v1

**Figure 19. Switching time waveform**


AM01473v1

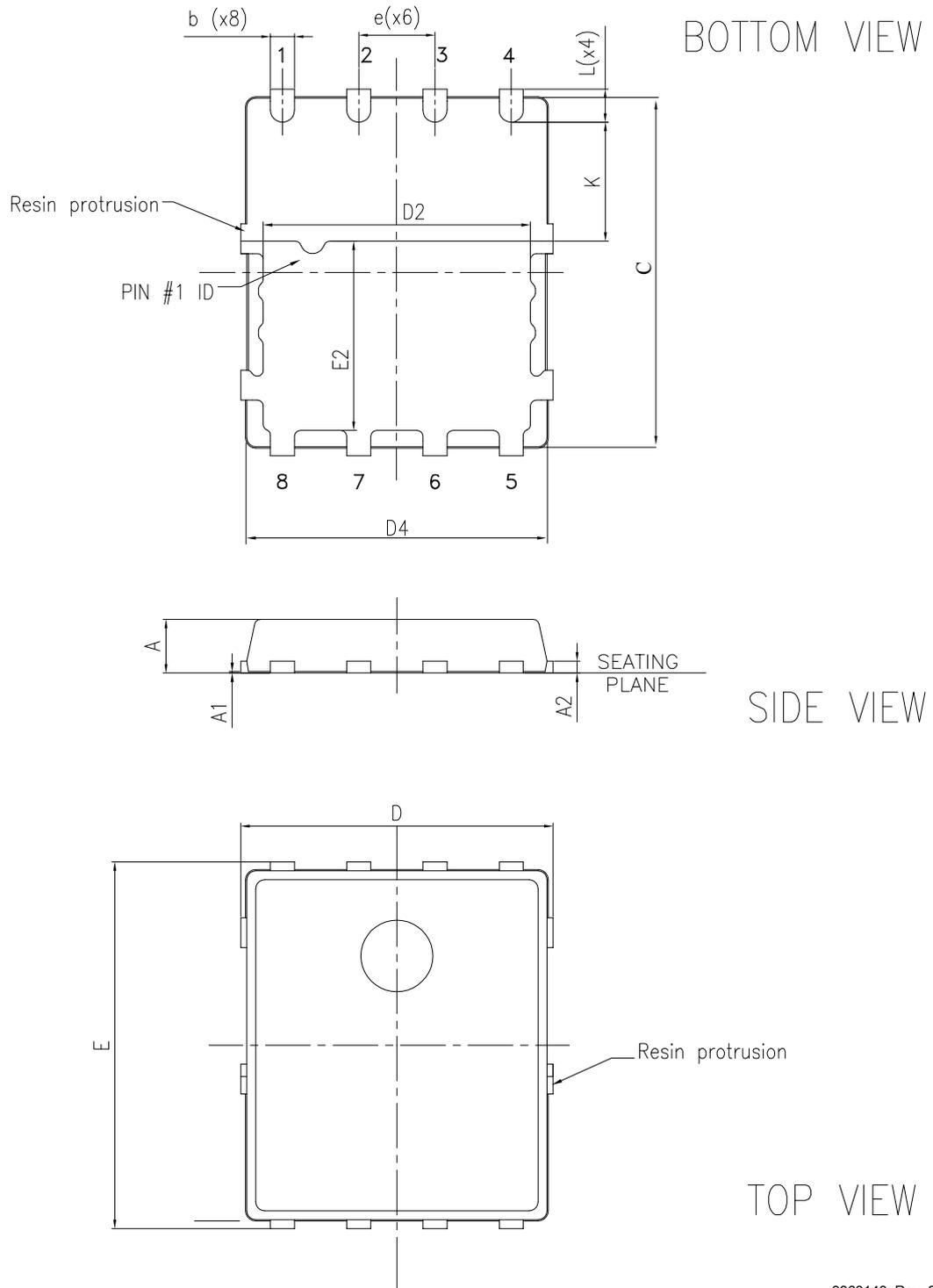
## 4 Package information

---

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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 PowerFLAT™ 5x6 HV package information

Figure 20. PowerFLAT™ 5x6 HV package outline

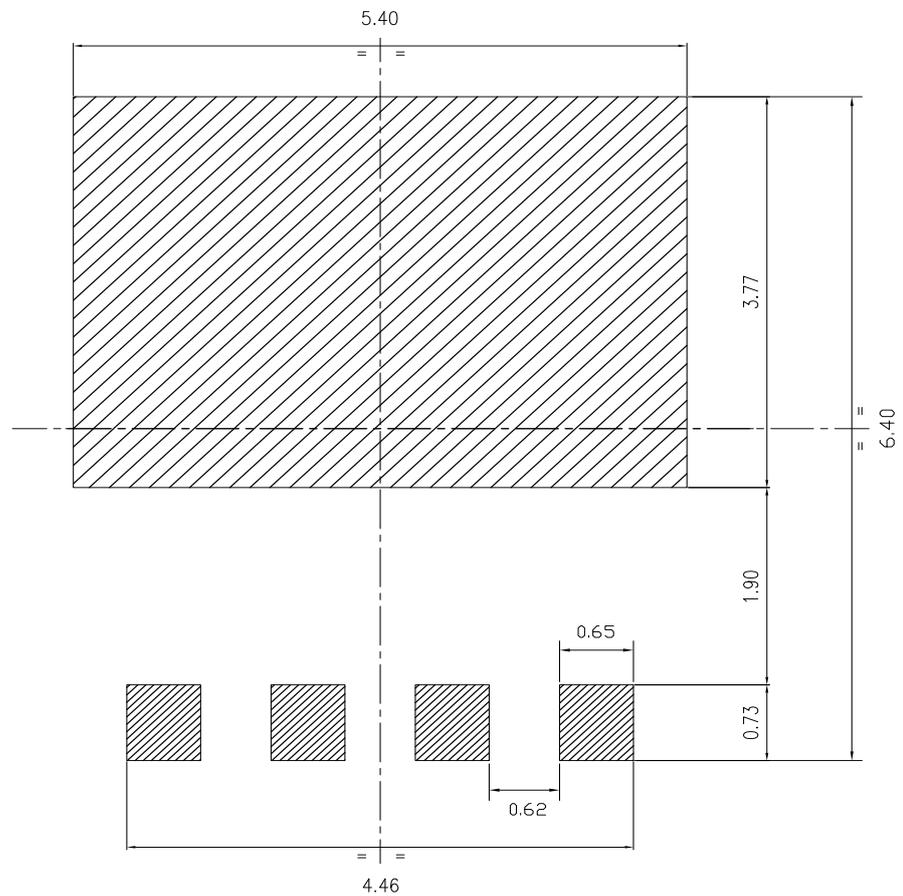


8368143\_Rev\_3

Table 8. PowerFLAT™ 5x6 HV mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80		1.00
A1	0.02		0.05
A2		0.25	
b	0.30		0.50
C	5.8	6	6.1
D	5.10	5.20	5.30
E	6.05	6.15	6.25
E2	3.10	3.20	3.30
D2	4.30	4.40	4.50
D4	4.8	5	5.1
e		1.27	
L	0.50	0.55	0.60
K	1.90	2.00	2.10

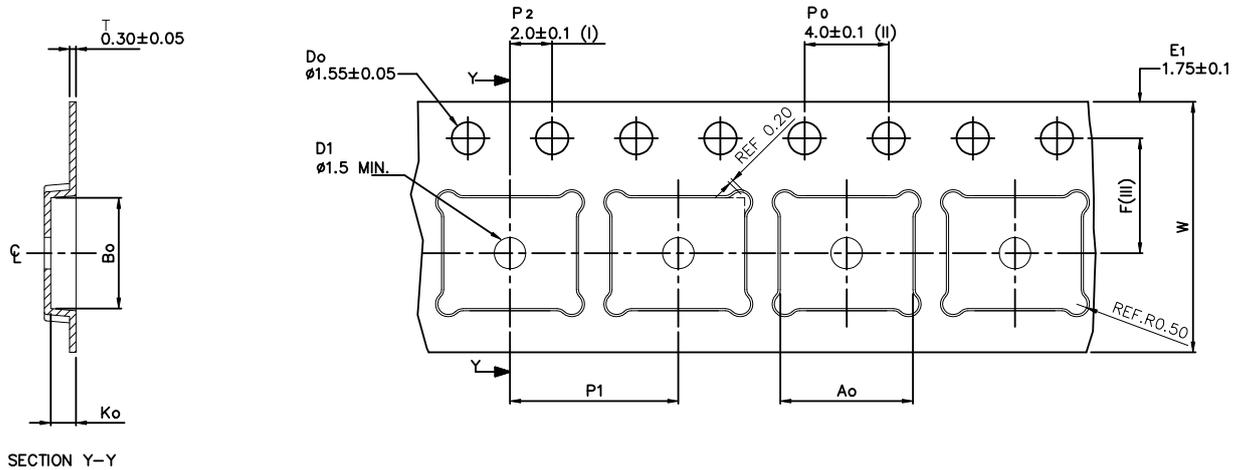
Figure 21. PowerFLAT™ 5x6 HV recommended footprint (dimensions are in mm)



8368143\_Rev\_3\_footprint

## 4.2 PowerFLAT™ 5x6 packing information

Figure 22. PowerFLAT™ 5x6 tape (dimensions are in mm)



A <sub>0</sub>	6.30 +/− 0.1
B <sub>0</sub>	5.30 +/− 0.1
K <sub>0</sub>	1.20 +/− 0.1
F	5.50 +/− 0.1
P <sub>1</sub>	8.00 +/− 0.1
W	12.00 +/− 0.3

(I) Measured from centreline of sprocket hole to centreline of pocket.

(II) Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$ .

(III) Measured from centreline of sprocket hole to centreline of pocket

Base and bulk quantity 3000 pcs  
All dimensions are in millimeters

8234350\_Tape\_rev\_C

Figure 23. PowerFLAT™ 5x6 package orientation in carrier tape

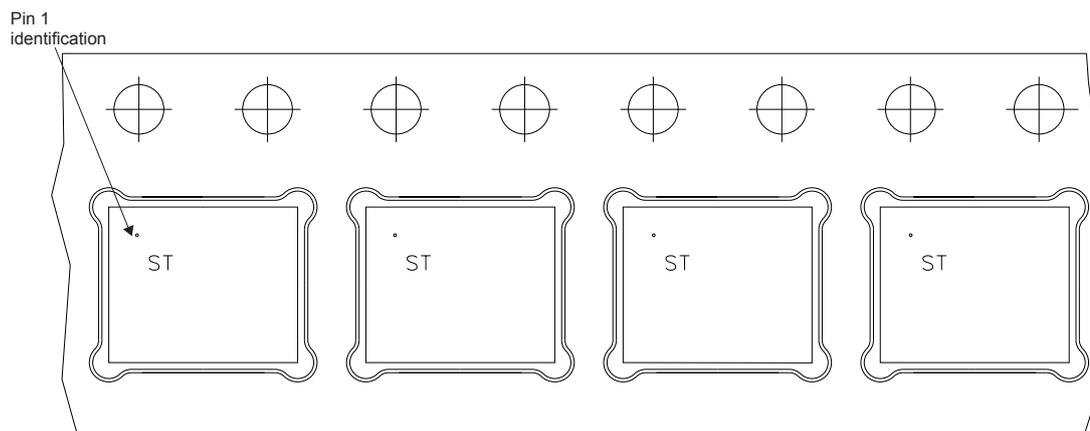
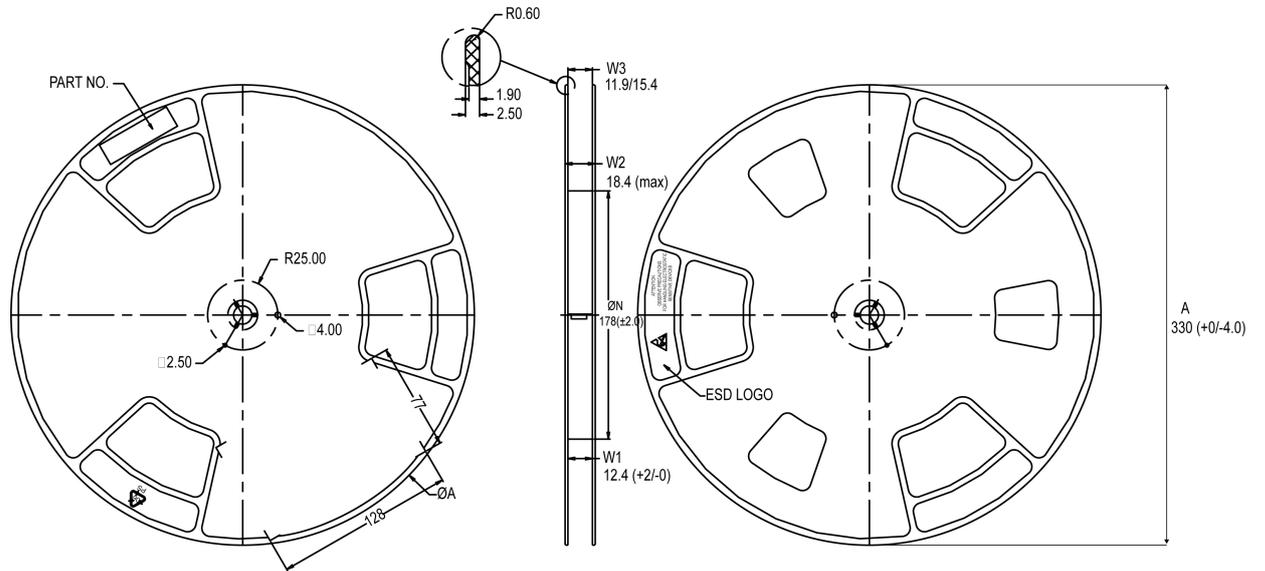


Figure 24. PowerFLAT™ 5x6 reel



All dimensions are in millimeters

8234350\_Reel\_rev\_C

## Revision history

**Table 9. Document revision history**

Date	Revision	Changes
15-Jun-2015	1	First release.
06-Mar-2018	2	Removed maturity status indication from cover page. The document status is production data. Modified <i>Table 3. Static</i> . Modified the entire <i>Section 2.1 Electrical characteristics (curves)</i> . Minor text changes.
15-May-2018	3	Added note in <i>Table 4. Dynamic</i> . Updated <i>Table 5. Switching energy</i> and <i>Figure 12. Turn-off switching energy vs drain current</i> . Minor text changes.

## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>2</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>3</b>
<b>2.1</b>	Electrical characteristics (curves) .....	5
<b>3</b>	<b>Test circuits</b> .....	<b>8</b>
<b>4</b>	<b>Package information</b> .....	<b>9</b>
<b>4.1</b>	PowerFLAT™ 5x6 HV package information .....	9
<b>4.2</b>	PowerFLAT™ 5x6 packing information .....	11
	<b>Revision history</b> .....	<b>14</b>

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2018 STMicroelectronics – All rights reserved



## Стандарт Электрон Связь

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

### Наши контакты:

**Телефон:** +7 812 627 14 35

**Электронная почта:** [sales@st-electron.ru](mailto:sales@st-electron.ru)

**Адрес:** 198099, Санкт-Петербург,  
Промышленная ул, дом № 19, литера Н,  
помещение 100-Н Офис 331