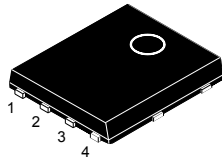
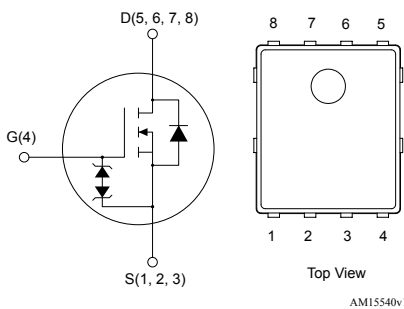


## N-channel 600 V, 0.390 $\Omega$ typ., 7 A MDmesh™ M2 EP Power MOSFET in a PowerFLAT™ 5x6 HV package


**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	$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	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

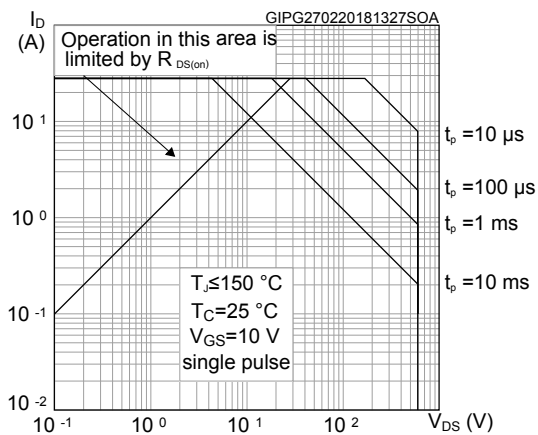


Figure 2. Thermal impedance

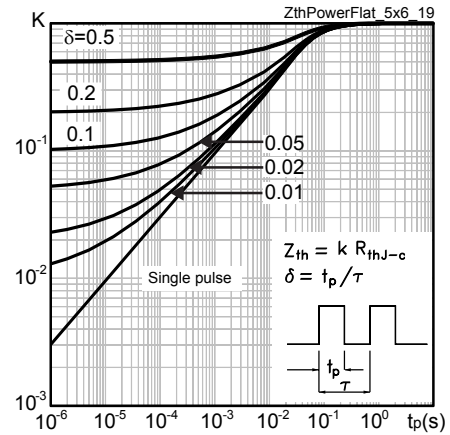


Figure 3. Output characteristics

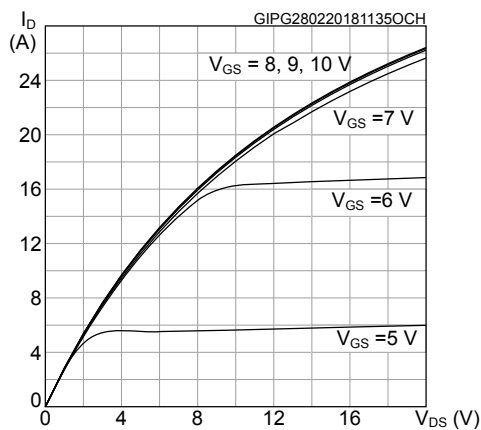


Figure 4. Transfer characteristics

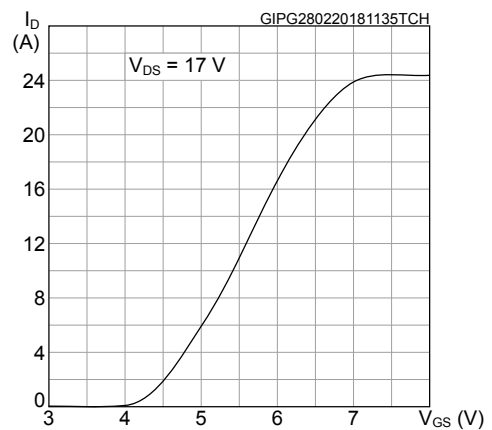


Figure 5. Gate charge vs gate-source voltage

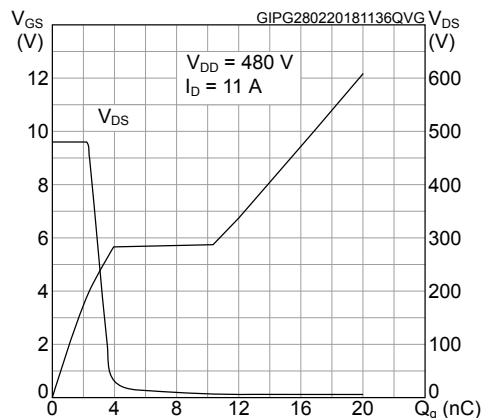


Figure 6. Static drain-source on-resistance

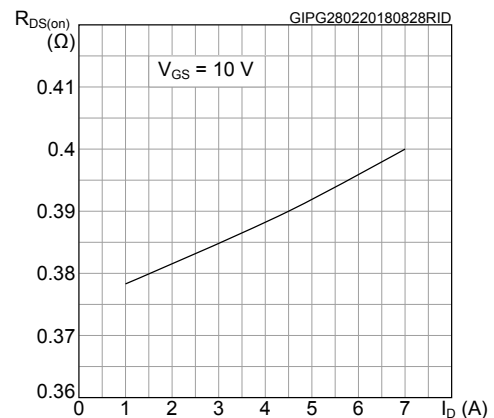


Figure 7. Capacitance variations

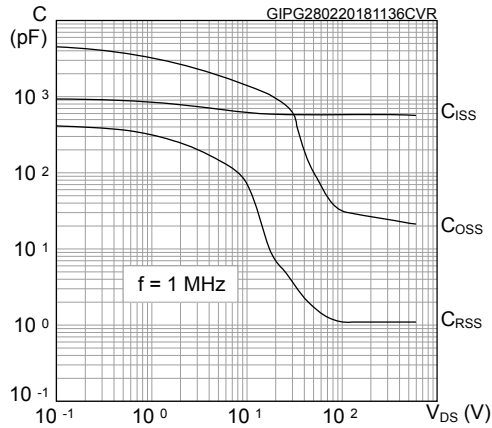


Figure 8. Output capacitance stored energy

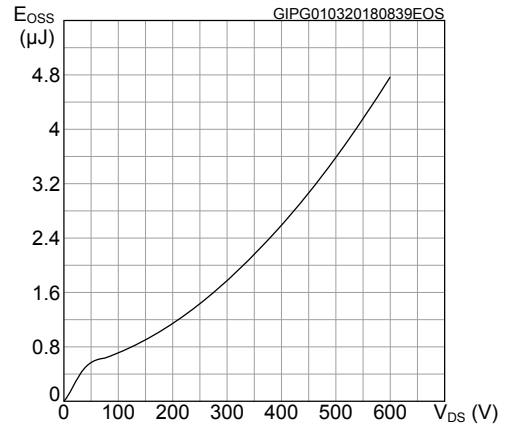


Figure 9. Normalized gate threshold voltage vs temperature

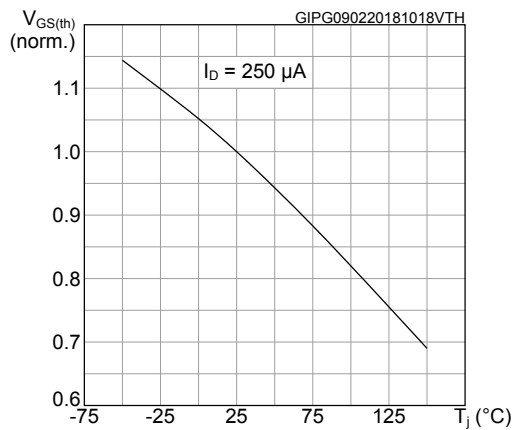


Figure 10. Normalized on-resistance vs temperature

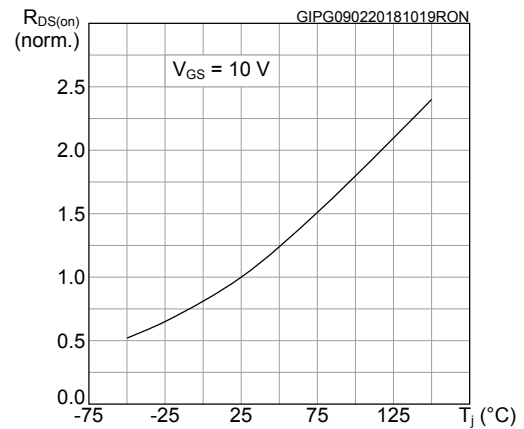


Figure 11. Normalized  $V_{(BR)DSS}$  vs temperature

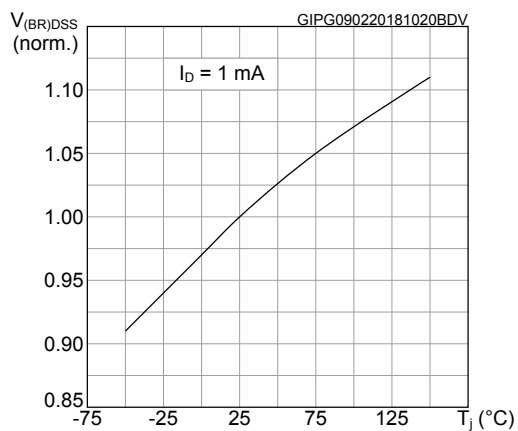


Figure 12. Turn-off switching energy vs drain current

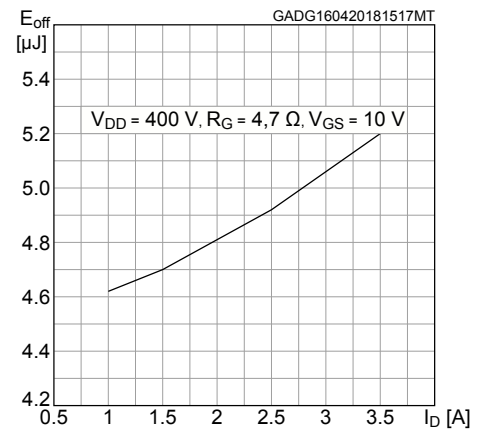
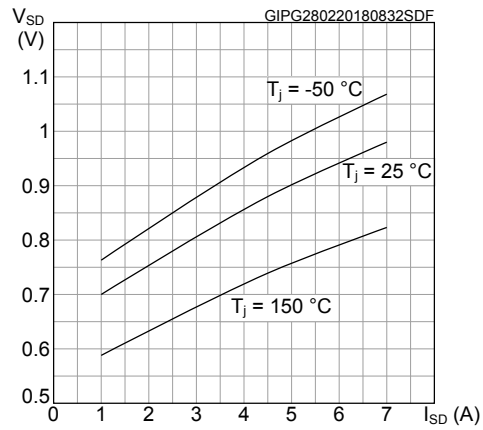


Figure 13. Source-drain diode forward characteristics



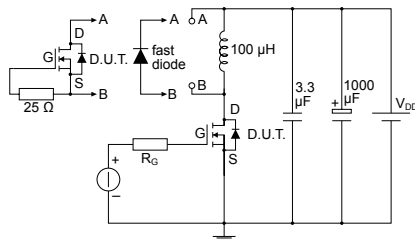
### 3 Test circuits

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

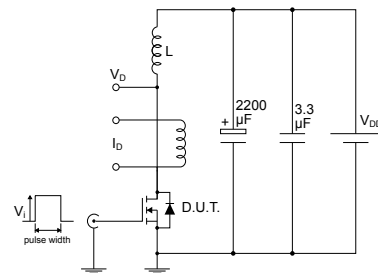

AM01468v1

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


AM01469v1

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


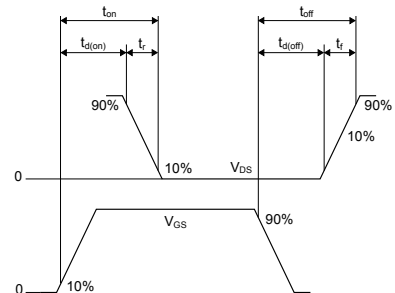
AM01470v1

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


AM01471v1

**Figure 18. Unclamped inductive waveform**


AM01472v1

**Figure 19. Switching time waveform**


AM01473v1



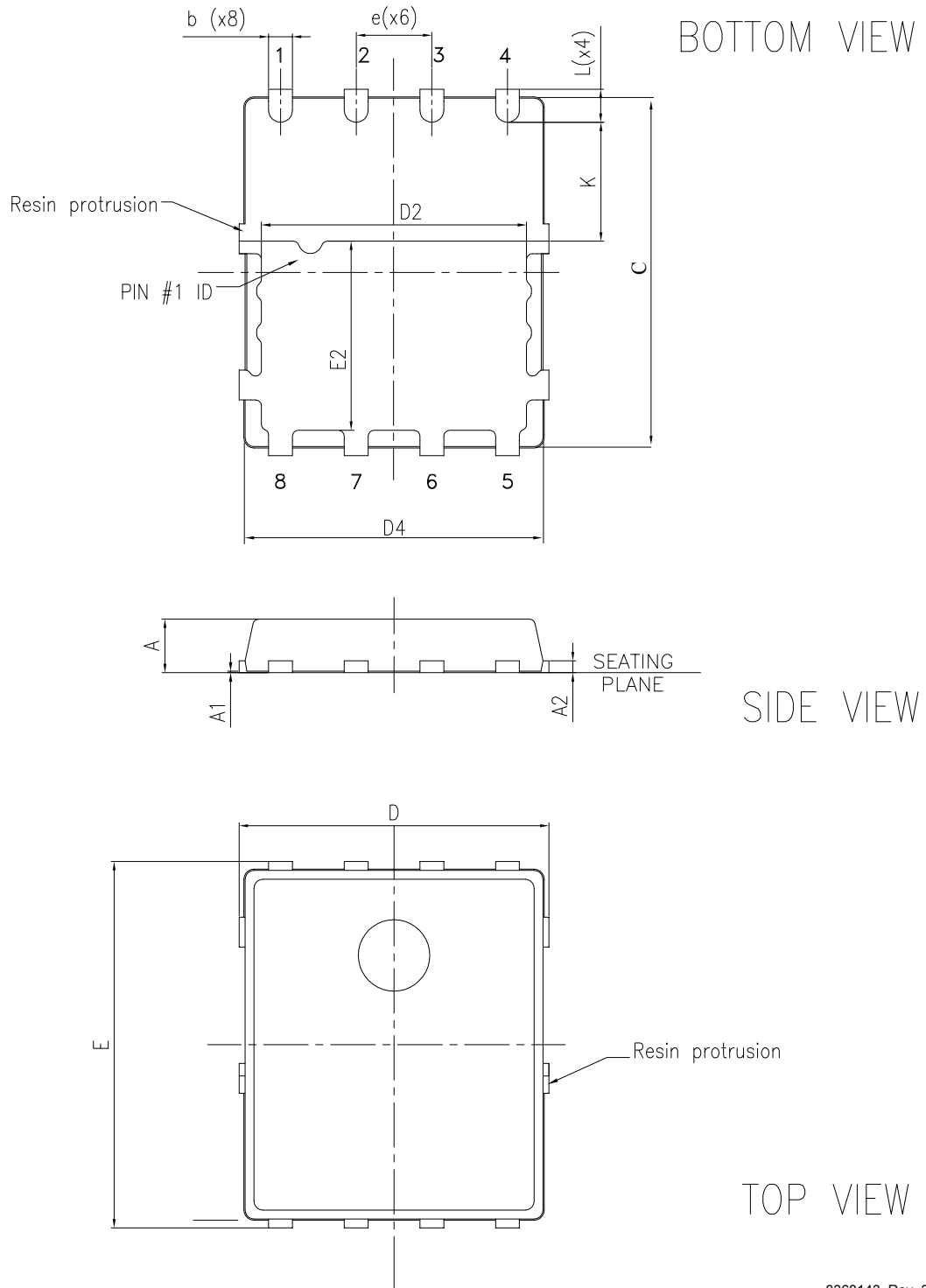
## **4** Package information

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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

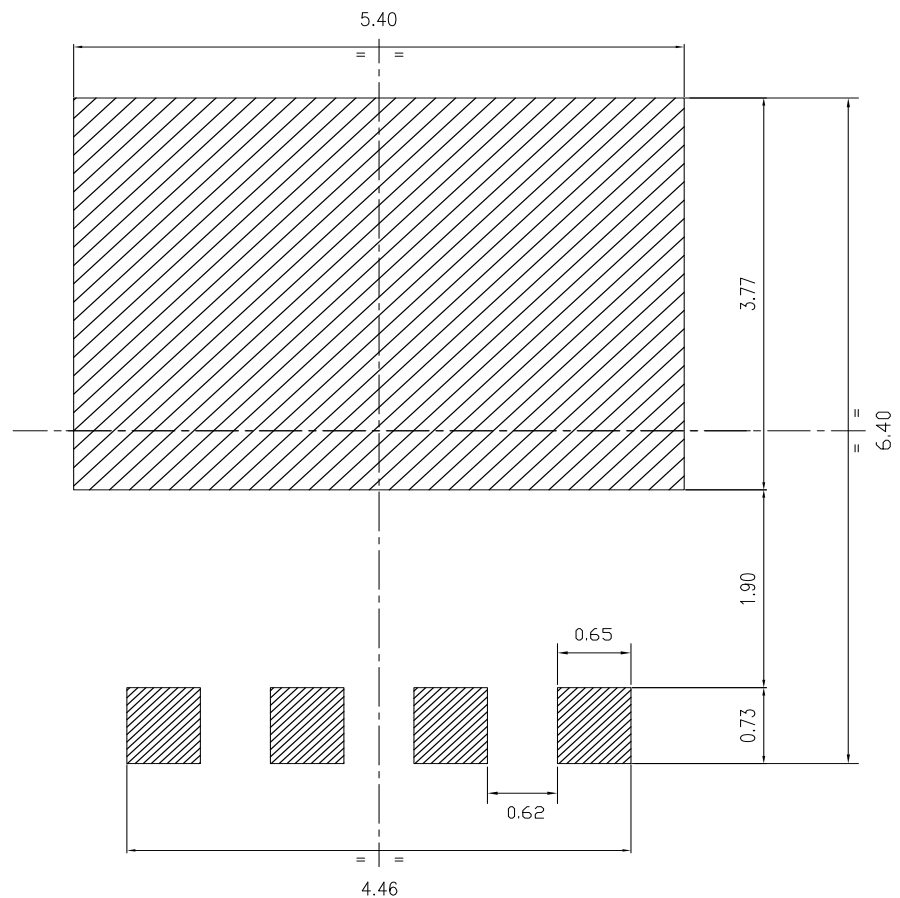


8368143\_Rev\_3

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

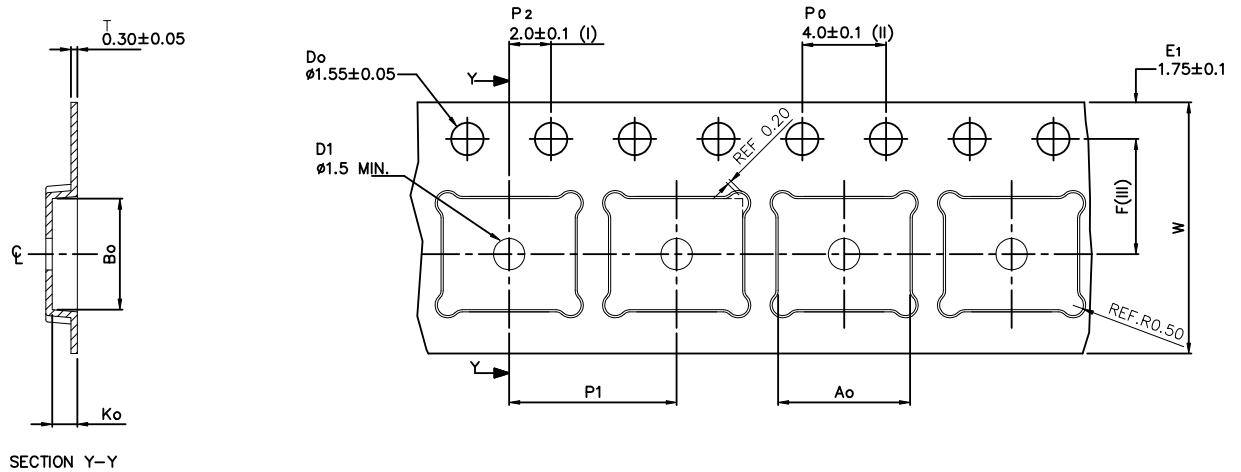
Figure 21. PowerFLAT™ 5x6 HV recommended footprint (dimensions are in mm)



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

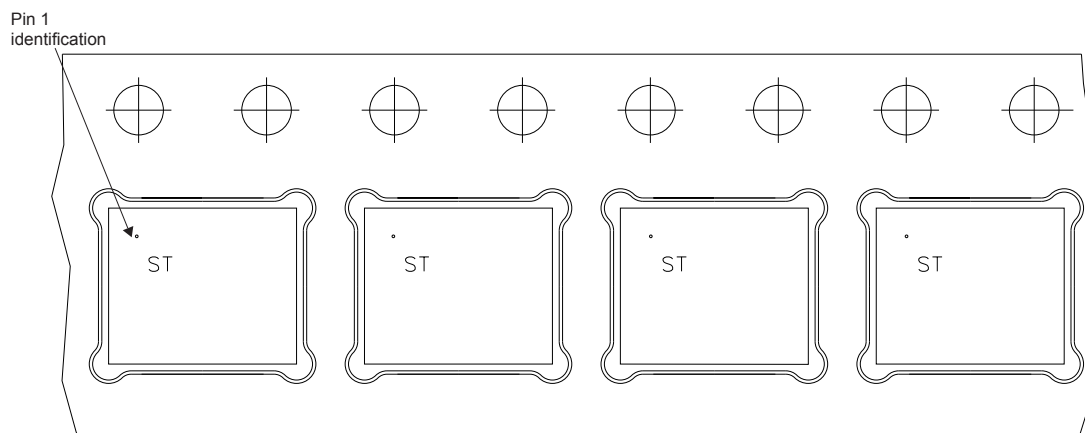
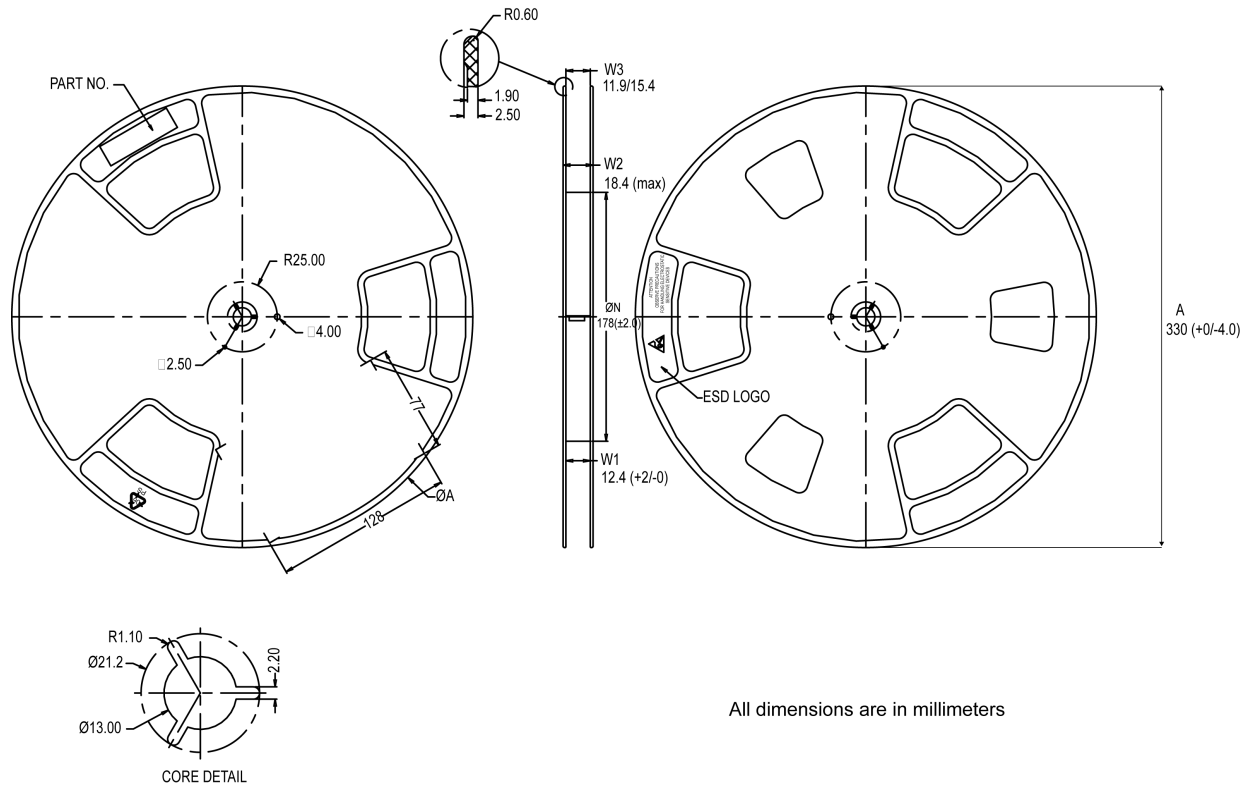


Figure 24. PowerFLAT™ 5x6 reel



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.

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**Телефон:** +7 812 627 14 35

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Промышленная ул, дом № 19, литера Н,  
помещение 100-Н Офис 331