

## N-channel 600 V, 0.175 $\Omega$ typ., 19.5 A, FDmesh™ II Power MOSFET (with fast diode) in PowerFLAT™ 8x8 HV package

Datasheet – production data

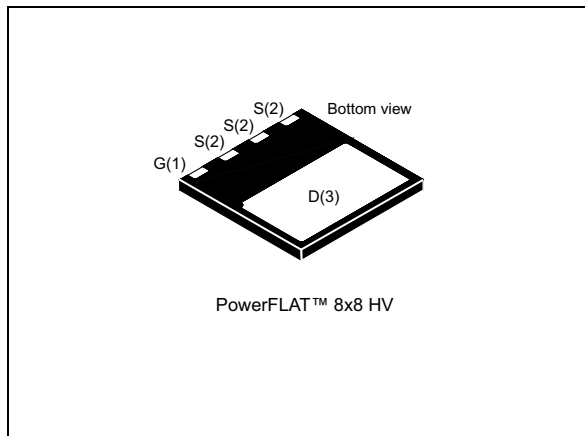
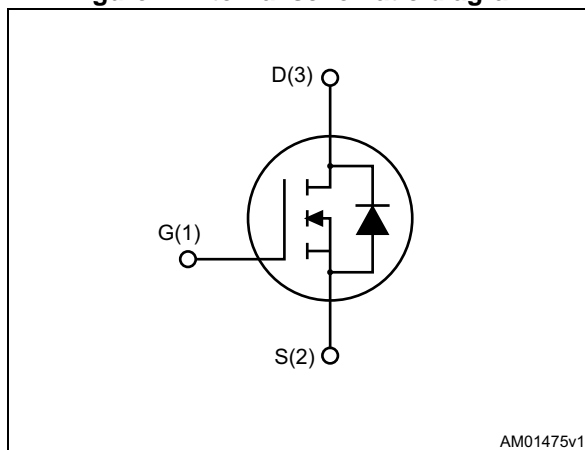


Figure 1. Internal schematic diagram



### Features

Order code	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max}$	$I_D$
STL23NM60ND	650 V	0.199 $\Omega$	19.5 A

- Fast-recovery body diode
- Low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- High dv/dt ruggedness

### Applications

- Switching applications

### Description

This FDmesh™ II Power MOSFET with fast-recovery body diode is produced using MDmesh™ II technology. Utilizing a new strip-lay-out vertical structure, this device features low on-resistance and superior switching performance. It is ideal for bridge topologies and ZVS phase-shift converters.

Table 1. Device summary

Order code	Marking	Package	Packaging
STL23NM60ND	23NM60ND	PowerFLAT™ 8x8 HV	Tape and reel

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	19.5	A
$I_D^{(1)}$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	11.7	A
$I_{DM}^{(1),(2)}$	Drain current (pulsed)	78	A
$I_D^{(3)}$	Drain current (continuous) at $T_{amb} = 25\text{ }^\circ\text{C}$	2.75	A
$I_D^{(3)}$	Drain current (continuous) at $T_{amb} = 100\text{ }^\circ\text{C}$	1.75	A
$I_{DM}^{(2),(3)}$	Drain current (pulsed)	11	A
$P_{TOT}^{(1)}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	150	W
$P_{TOT}^{(3)}$	Total dissipation at $T_{amb} = 25\text{ }^\circ\text{C}$	3	W
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)	9	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	700	mJ
$dv/dt^{(4)}$	Peak diode recovery voltage slope	40	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature	150	$^\circ\text{C}$

1. The value is rated according to  $R_{thj-case}$
2. Pulse width limited by safe operating area.
3. When mounted on FR-4 board of inch<sup>2</sup>, 2oz Cu.
4.  $I_{SD} \leq 19.5\text{ A}$ ,  $di/dt \leq 600\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ ,  $V_{DS(peak)} < V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.83	$^\circ\text{C}/\text{W}$
$R_{thj-amb}^{(1)}$	Thermal resistance junction-ambient max	45	$^\circ\text{C}/\text{W}$

1. When mounted on FR-4 board of inch<sup>2</sup>, 2oz Cu.

## 2 Electrical characteristics

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

**Table 4. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0, I_D = 1\text{ mA}$	600			V
$dv/dt^{(1)}$	Drain-source voltage slope	$V_{DD} = 480\text{ V}, I_D = 19.5\text{ A}, V_{GS} = 10\text{ V}$	30			V/ns
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0, V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0, V_{DS} = 600\text{ V}, T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0, V_{GS} = \pm 20\text{ V}$			$\pm 100$	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	$V_{GS} = 10\text{ V}, I_D = 10\text{ A}$		0.175	0.199	$\Omega$

1. Characteristic value at turn off on inductive load

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	2100	-	pF
$C_{oss}$	Output capacitance		-	80	-	pF
$C_{riss}$	Reverse transfer capacitance		-	10	-	pF
$C_{oss\text{ eq}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$	-	310	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}, \text{ gate DC Bias} = 0, \text{ test signal level} = 20\text{ mV}$	-	4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}, I_D = 19.5\text{ A}, V_{GS} = 10\text{ V}, \text{ (see Figure 14)}$	-	69	-	nC
$Q_{gs}$	Gate-source charge		-	13	-	nC
$Q_{gd}$	Gate-drain charge		-	35	-	nC

1.  $C_{oss\text{ eq}}$  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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 10\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 13</a> )	-	21	-	ns
$t_r$	Voltage rise time		-	19	-	ns
$t_{d(off)}$	Turn-off delay time		-	92	-	ns
$t_f$	Current fall time		-	42	-	ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		19.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		78	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 19.5\text{ A}$ , $V_{GS} = 0$	-		1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 19.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see <a href="#">Figure 15</a> )	-	190		ns
$Q_{rr}$	Reverse recovery charge		-	1.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	13		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 19.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 15</a> )	-	270		ns
$Q_{rr}$	Reverse recovery charge		-	2.0		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	15		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

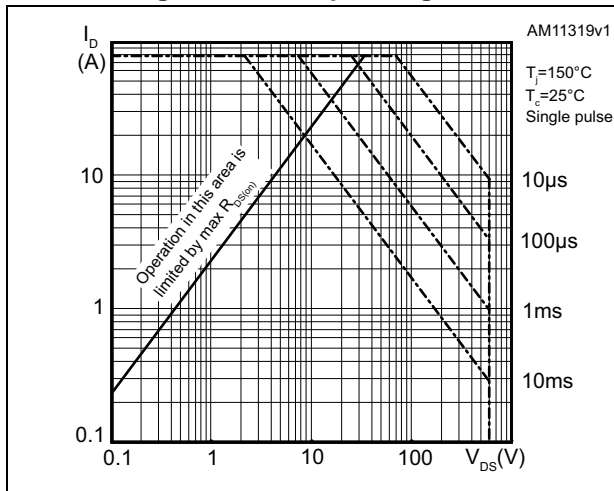


Figure 3. Thermal impedance

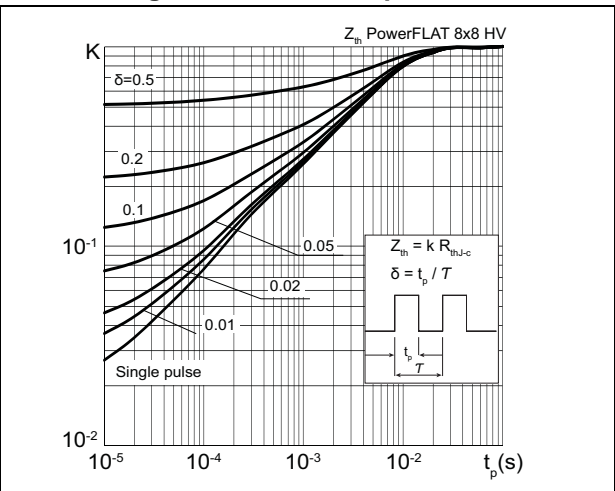


Figure 4. Output characteristics

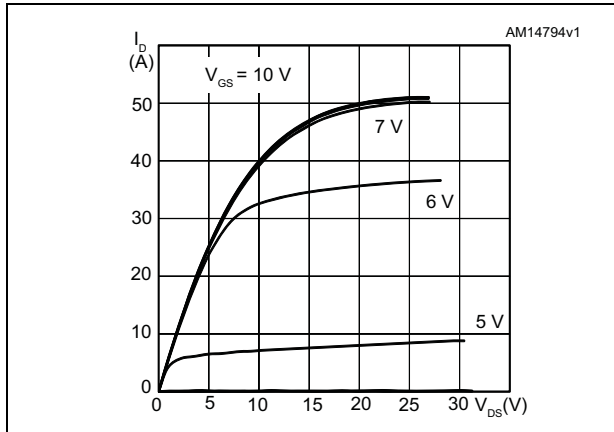


Figure 5. Transfer characteristics

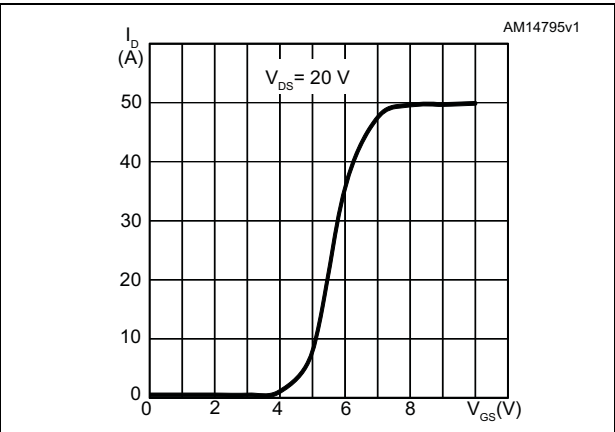


Figure 6. Normalized  $B_{(BR)DSS}$  vs temperature

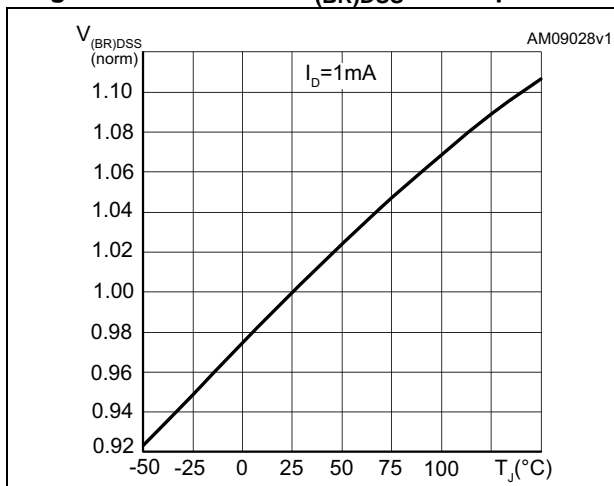


Figure 7. Static drain-source on-resistance

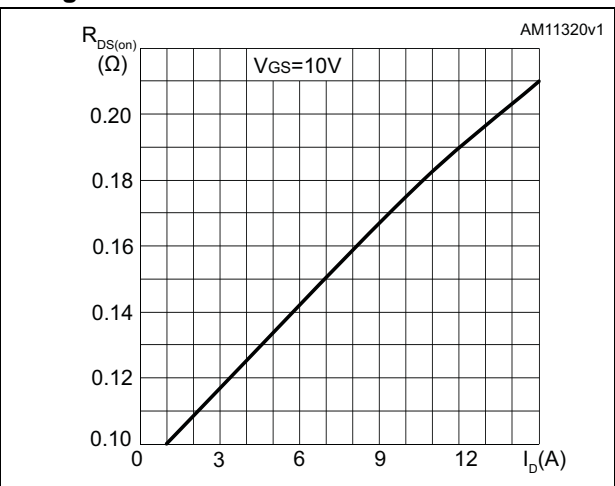


Figure 8. Gate charge vs gate-source voltage

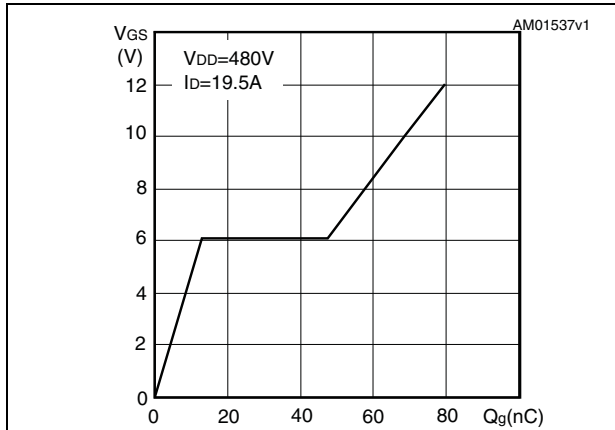


Figure 9. Capacitance variations

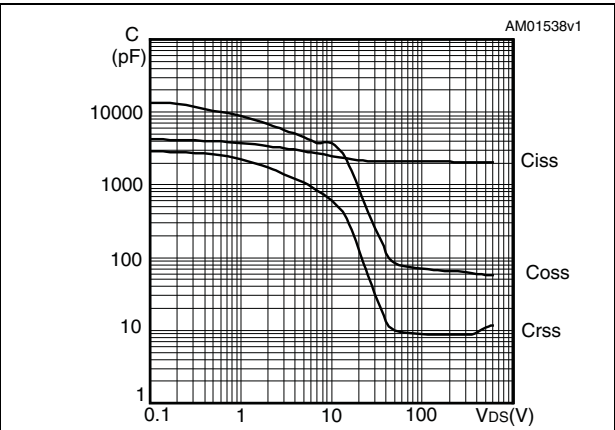


Figure 10. Normalized gate threshold voltage vs temperature

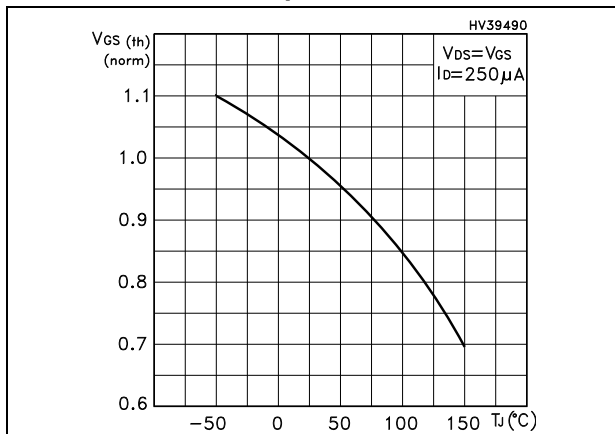


Figure 11. Normalized on-resistance vs temperature

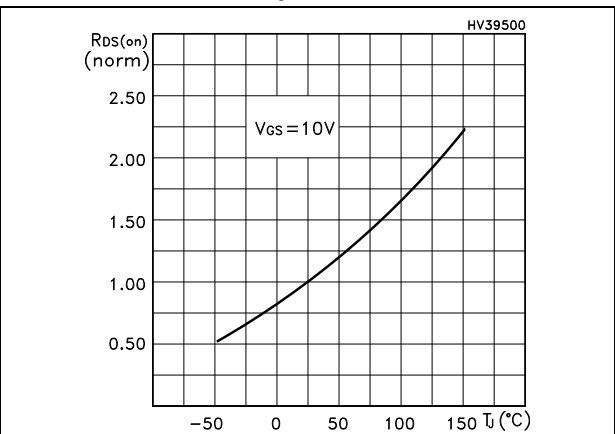
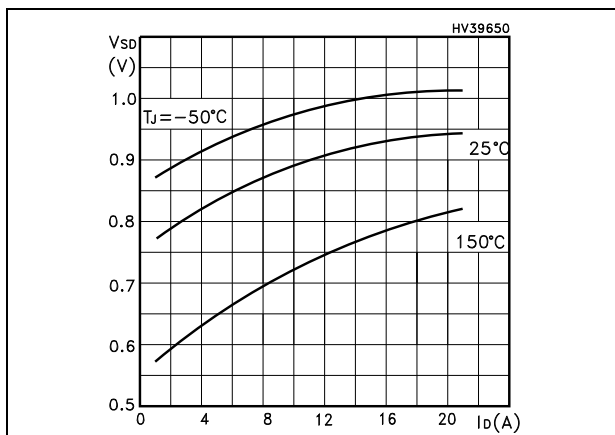


Figure 12. Source-drain diode forward characteristics



### 3 Test circuits

Figure 13. Switching times test circuit for resistive load

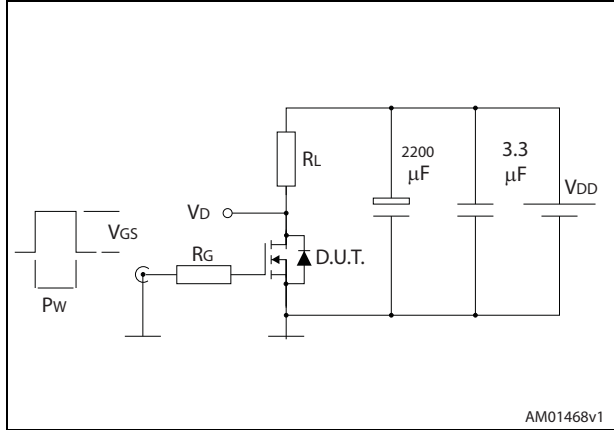


Figure 14. Gate charge test circuit

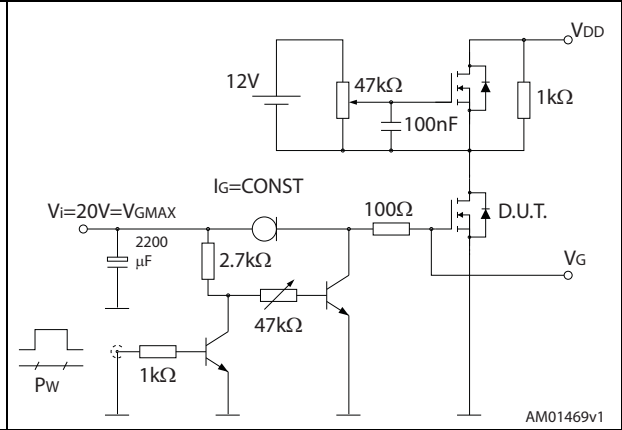


Figure 15. Test circuit for inductive load switching and diode recovery times

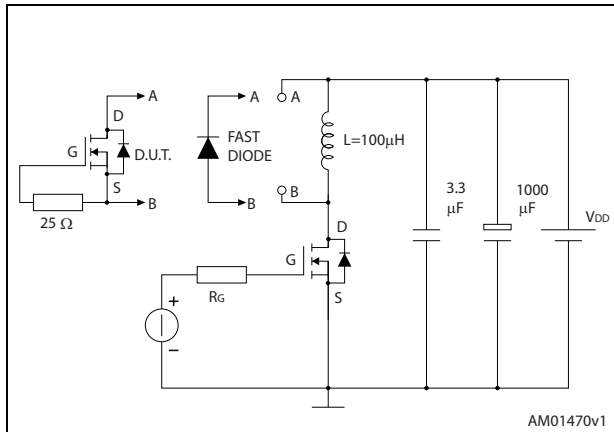


Figure 16. Unclamped inductive load test circuit

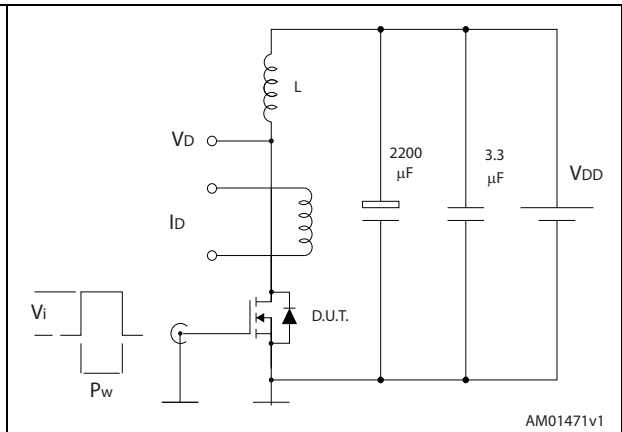


Figure 17. Unclamped inductive waveform

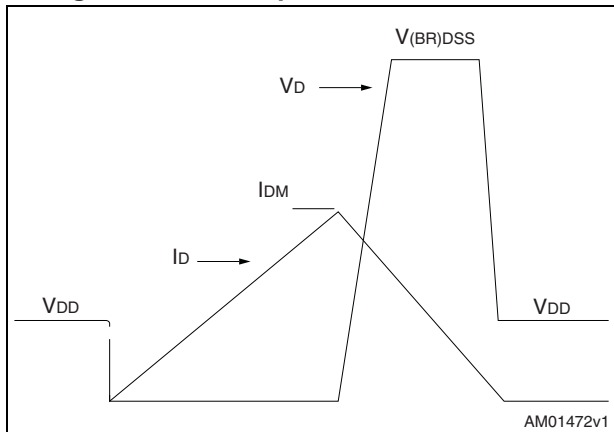
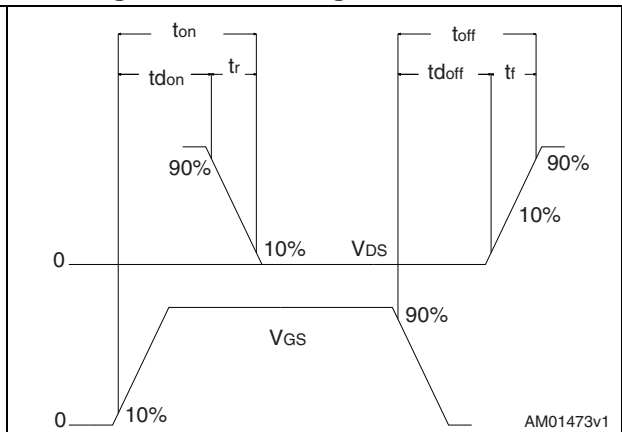


Figure 18. Switching time waveform





## 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<sup>®</sup> is an ST trademark.

Figure 19. PowerFLAT™ 8x8 HV drawing mechanical data

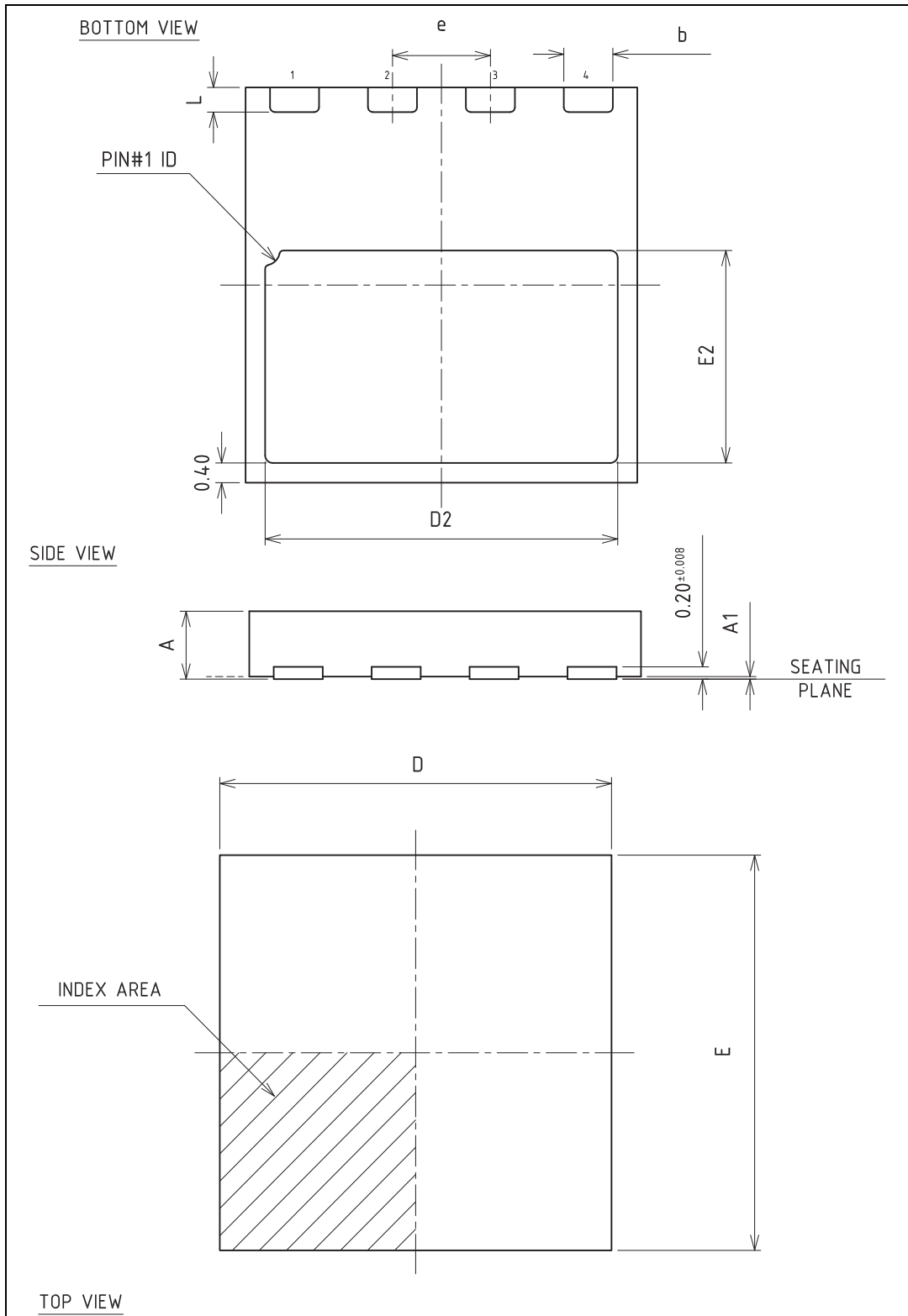
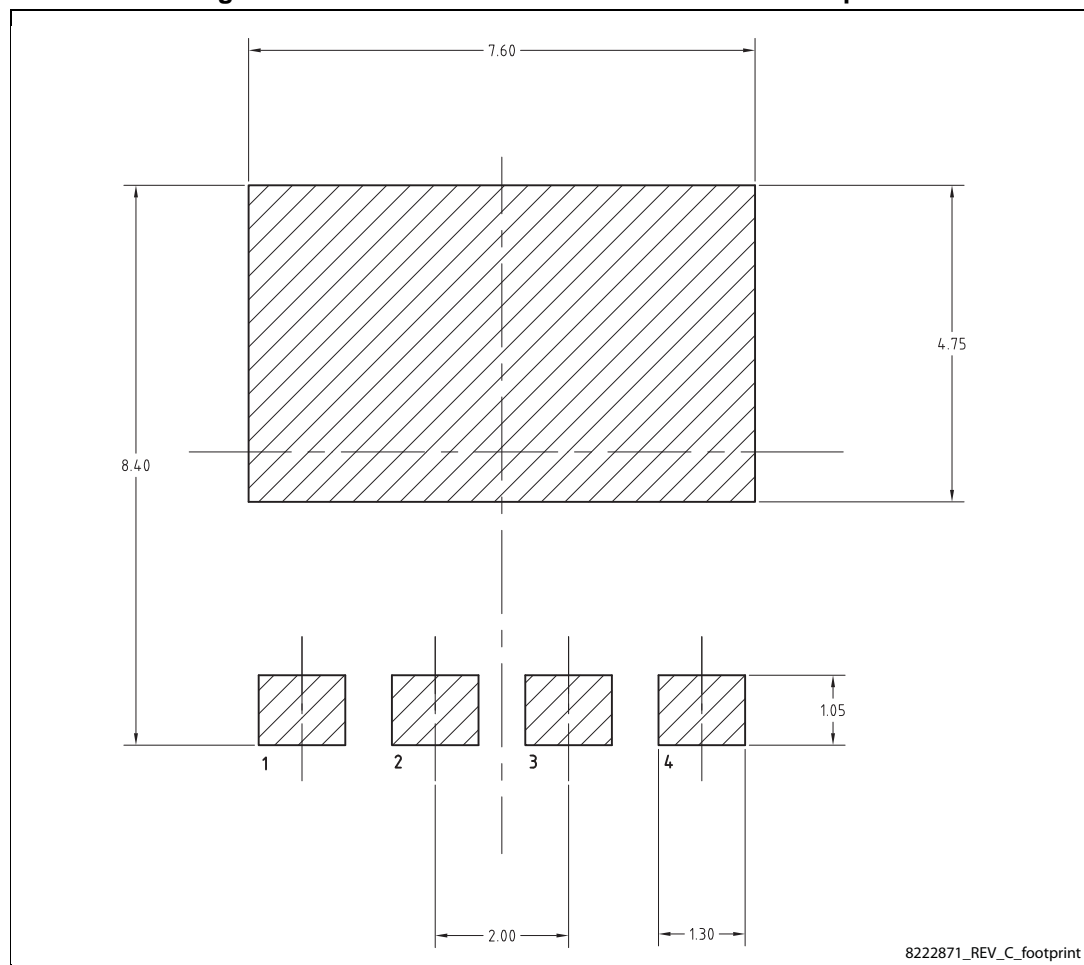


Table 8. PowerFLAT™ 8x8 HV mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80	0.90	1.00
A1	0.00	0.02	0.05
b	0.95	1.00	1.05
D		8.00	
E		8.00	
D2	7.05	7.20	7.30
E2	4.15	4.30	4.40
e		2.00	
L	0.40	0.50	0.60

Figure 20. PowerFLAT™ 8x8 HV recommended footprint



# 5 Packaging mechanical data

Figure 21. PowerFLAT™ 8x8 HV tape

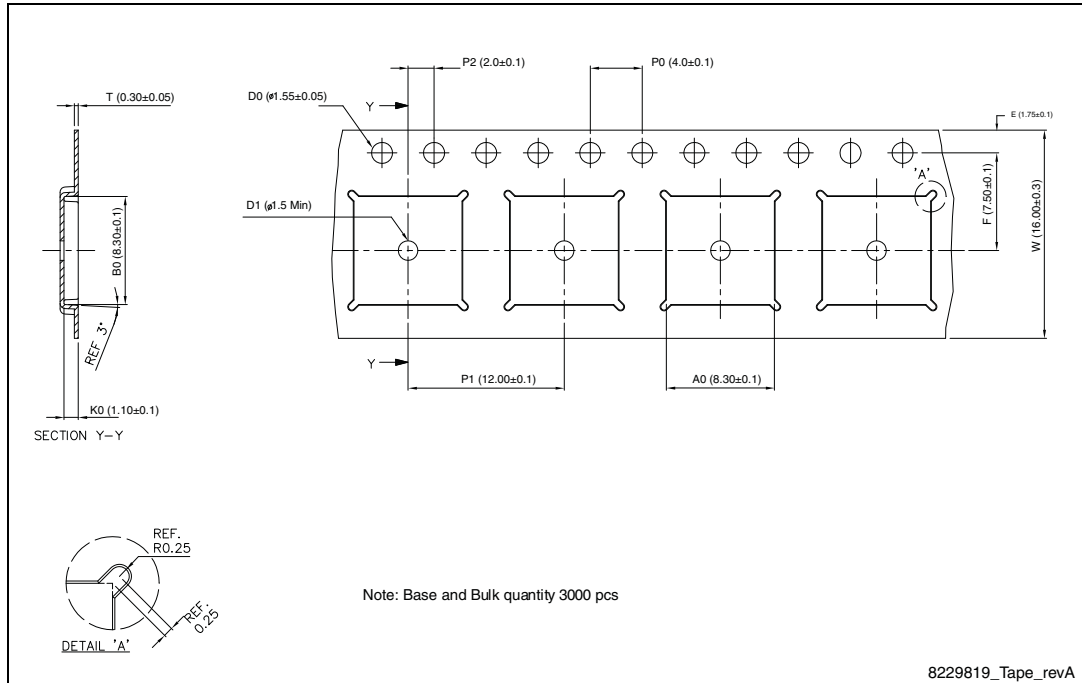


Figure 22. PowerFLAT™ 8x8 HV package orientation in carrier tape.

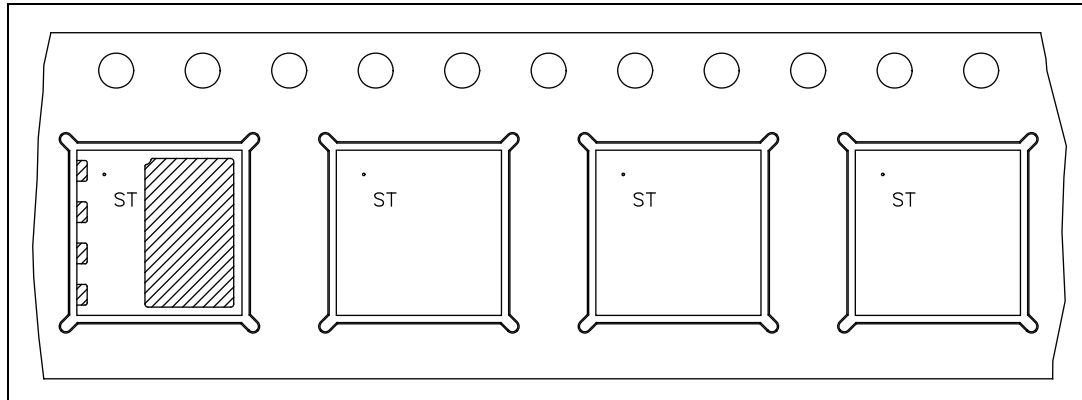
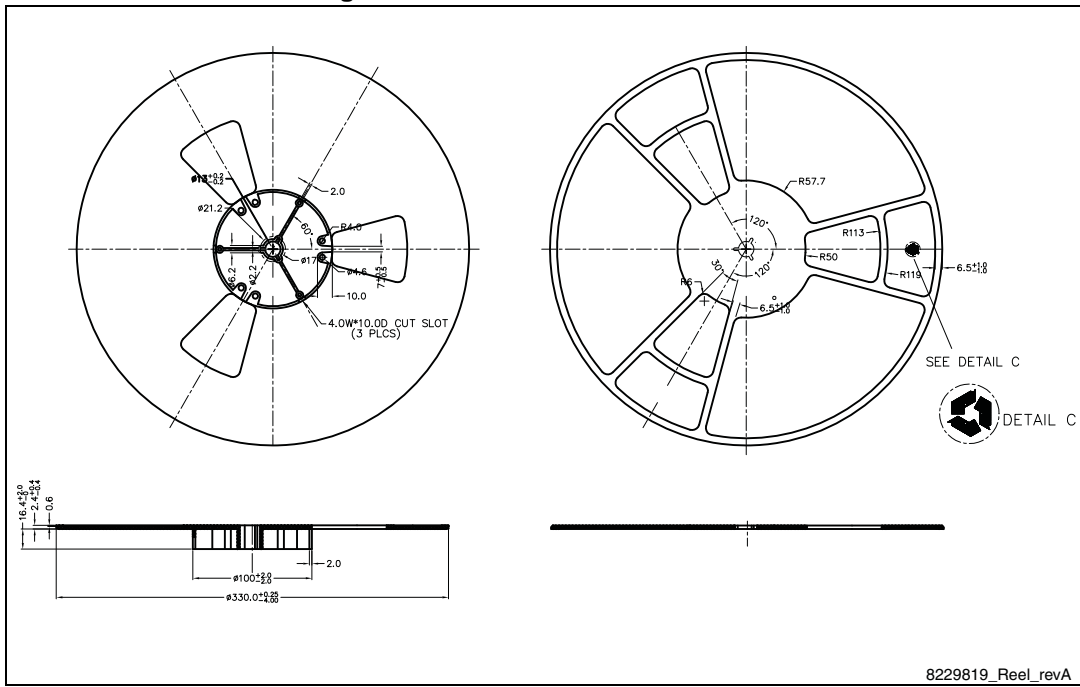


Figure 23. PowerFLAT™ 8x8 HV reel



8229819\_Reel\_revA

## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
28-Apr-2010	1	First release.
01-Mar-2013	2	<ul style="list-style-type: none"> <li>– <a href="#">Section 4: Package mechanical data</a> has been modified.</li> <li>– <a href="#">Section 2.1: Electrical characteristics (curves)</a> has been inserted.</li> <li>– Minor text changes.</li> </ul>
17-Dec-2014	3	<p>Minor text and formatting changes throughout document.</p> <p>On Cover page, updated Features and Description.</p> <p>In <a href="#">Table 2: Absolute maximum ratings</a>, changed Values for both <math>P_{TOT}</math> rows.</p> <p>In <a href="#">Table 7: Source drain diode</a>, changed Units for both <math>Q_{rr}</math> rows.</p> <p>In <a href="#">Figure 3: Thermal impedance</a>, added inset with plot and formulas.</p> <p>In <a href="#">Section 3: Test circuits</a>, updated figures.</p> <p>In <a href="#">Section 4: Package mechanical data</a>, updated figures and tables.</p>

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