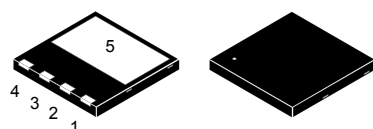
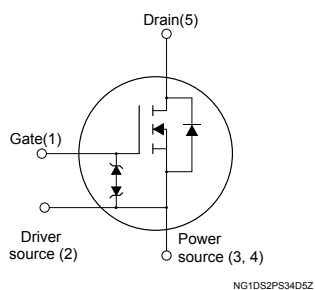


N-channel 600 V, 0.115 Ω typ., 22 A MDmesh M2 Power MOSFET in a PowerFLAT 8x8 HV package



PowerFLAT 8x8 HV



Features

Order code	$V_{DS} @ T_{Jmax}$	$R_{DS(on)max}$	I_D
STL33N60M2	650 V	0.135 Ω	22 A

- Extremely low gate charge
- Excellent output capacitance (C_{OSS}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications
- LLC converters, resonant converters

Description

This device is an N-channel Power MOSFET developed using MDmesh M2 technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance and optimized switching characteristics, rendering it suitable for the most demanding high efficiency converters.



Product status link

[STL33N60M2](#)

Product summary

Order code	STL33N60M2
Marking	33N60M2
Package	PowerFLAT™ 8x8 HV
Packing	Tape & reel

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	22	A
$I_D^{(1)}$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	13.8	A
$I_{DM}^{(2)}$	Drain current (pulsed)	88	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	150	W
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	5	A
E_{AS}	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	450	mJ
$dv/dt^{(3)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(4)}$	MOSFET dv/dt ruggedness	50	V/ns
T_{stg}	Storage temperature range	- 55 to 150	$^\circ\text{C}$
T_j	Operating junction temperature range	150	$^\circ\text{C}$

1. The value is limited by package.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 22\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DS(\text{peak})} < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$.
4. $V_{DS} \leq 480\text{ V}$.

Table 2. Thermal data

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

1. When mounted on FR-4 board of 1 inch², 2oz Cu.

2 Electrical characteristics

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

Table 3. On /off states

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	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾			100	μA
I_{GSS}	Gate-body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on- resistance	$V_{GS} = 10\text{ V}$, $I_D = 11\text{ A}$		0.115	0.135	Ω

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

Table 4. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	1781	-	pF
C_{oss}	Output capacitance		-	85	-	pF
C_{rss}	Reverse transfer capacitance		-	2.5	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$, $V_{GS} = 0\text{ V}$	-	135	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	5.2	-	Ω
Q_g	Total gate charge	$V_{DD} = 480\text{ V}$, $I_D = 26\text{ A}$	-	45.5	-	nC
Q_{gs}	Gate-source charge	$V_{GS} = 0\text{ to }10\text{ V}$	-	9.9	-	nC
Q_{gd}	Gate-drain charge	(see Figure 15. Gate charge test circuit)	-	18.5	-	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 5. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 13\text{ A}$	-	16	-	ns
t_r	Rise time	$R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	9.6	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 14. Switching times test circuit for resistive load and Figure 19. Switching time waveform)	-	109	-	ns
t_f	Fall time		-	9	-	ns

Table 6. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		22	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		88	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 22\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 26\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	375		ns
Q_{rr}	Reverse recovery charge		-	5.6		μC
I_{RRM}	Reverse recovery current		-	30		A
t_{rr}	Reverse recovery time	$I_{SD} = 26\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	478		ns
Q_{rr}	Reverse recovery charge		-	7.7		μC
I_{RRM}	Reverse recovery current		-	32.5		A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics (curves)

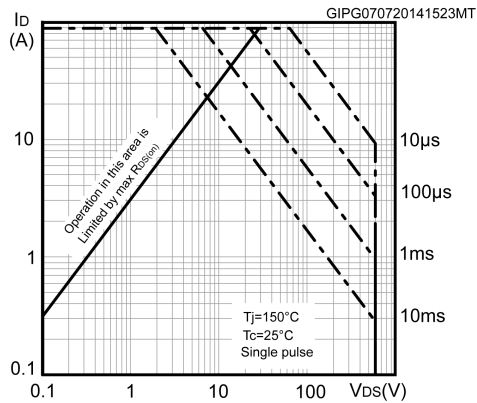
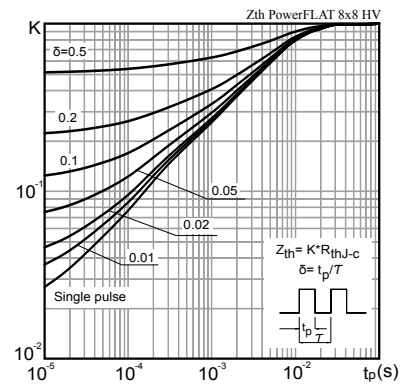
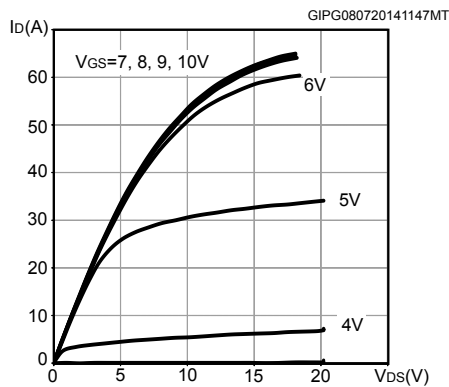
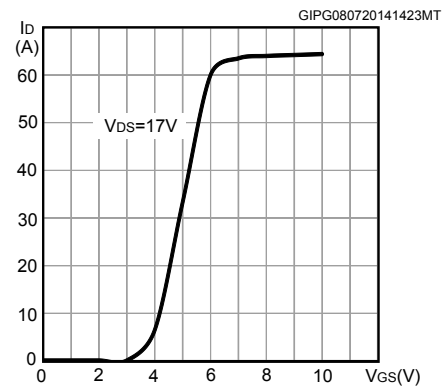
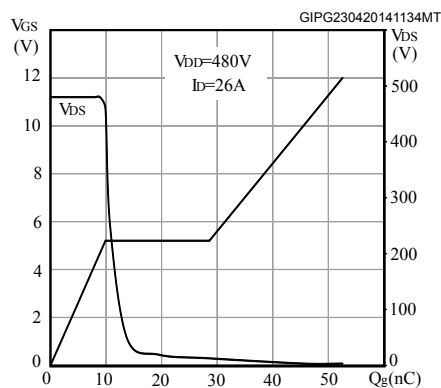
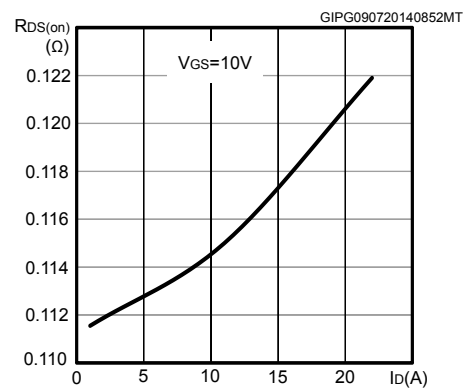
Figure 1. Safe operating area

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

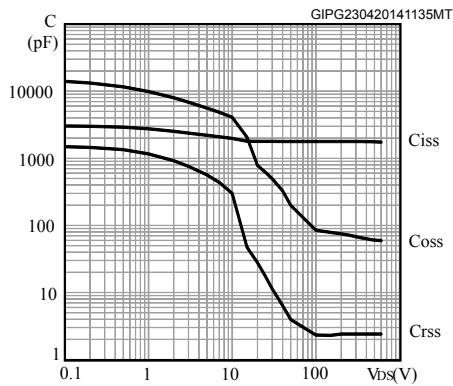


Figure 8. Normalized gate threshold voltage vs temperature

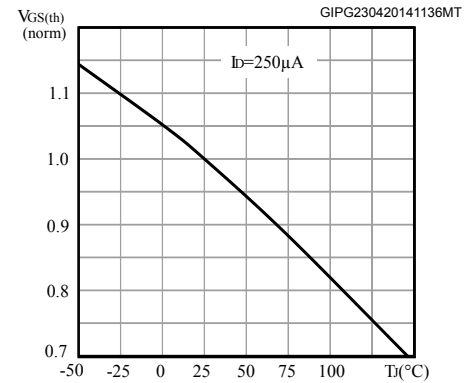


Figure 9. Normalized on-resistance vs temperature

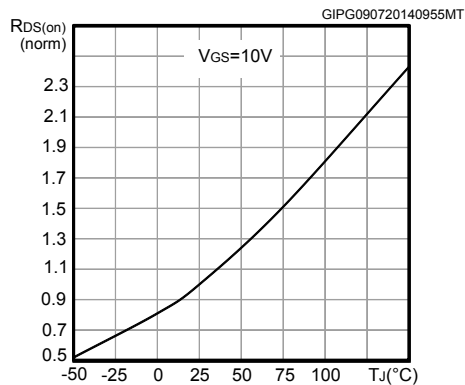


Figure 10. Normalized $V_{(BR)DSS}$ vs temperature

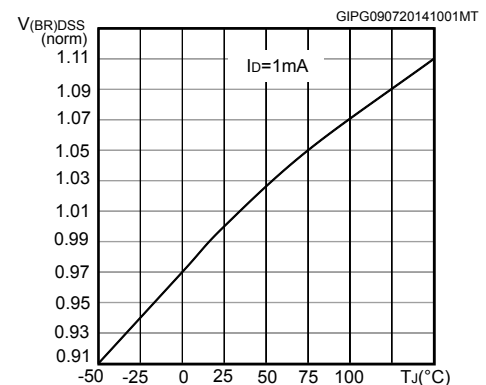


Figure 11. Source-drain diode forward characteristics

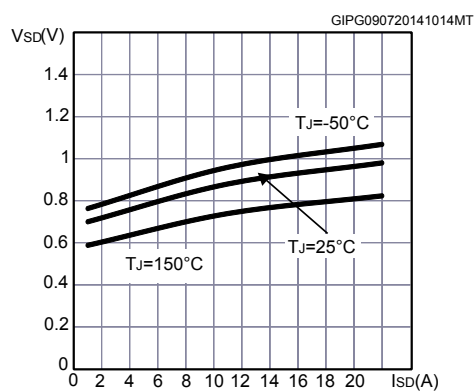


Figure 12. Output capacitance stored energy

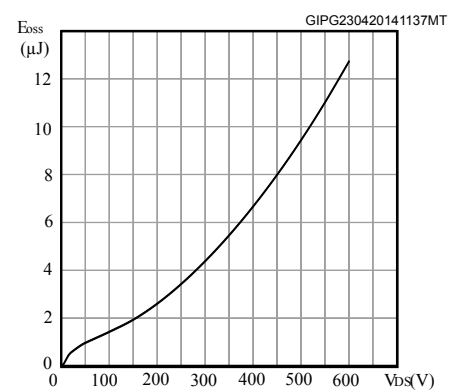
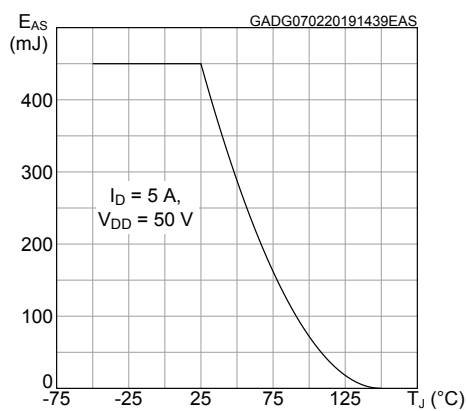
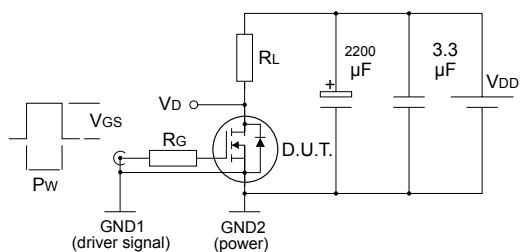


Figure 13. Maximum avalanche energy vs temperature



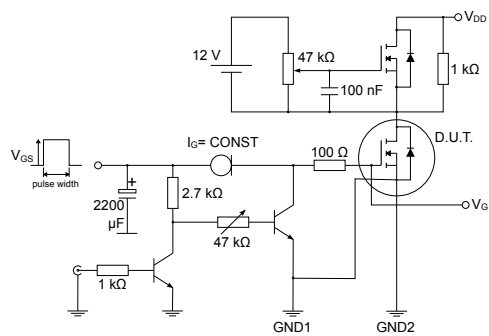
3 Test circuits

Figure 14. Switching times test circuit for resistive load



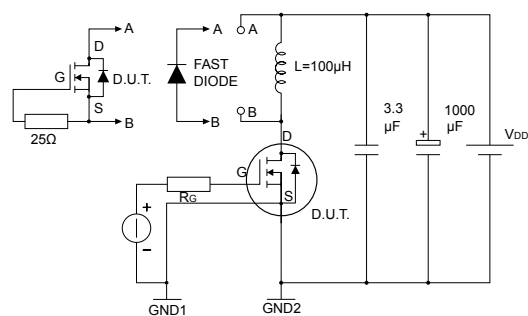
AM15855v1

Figure 15. Gate charge test circuit



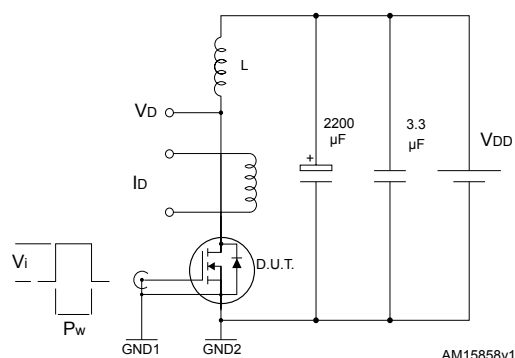
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Figure 16. Test circuit for inductive load switching and diode recovery times



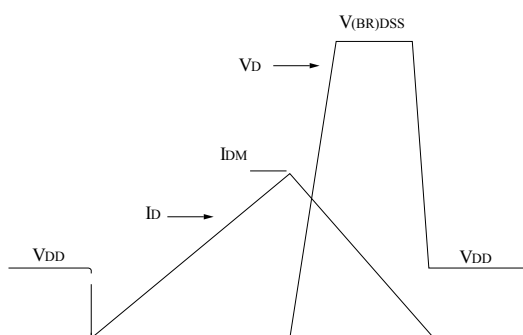
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Figure 17. Unclamped inductive load test circuit



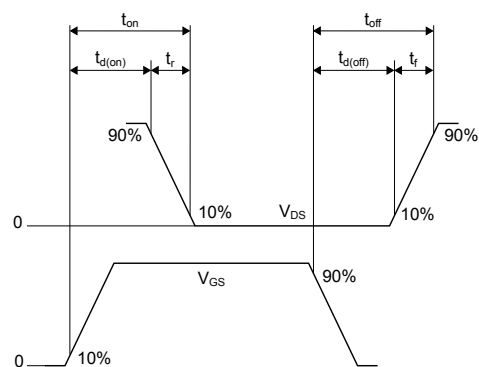
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Figure 18. Unclamped inductive waveform



AM01472v1

Figure 19. Switching time waveform



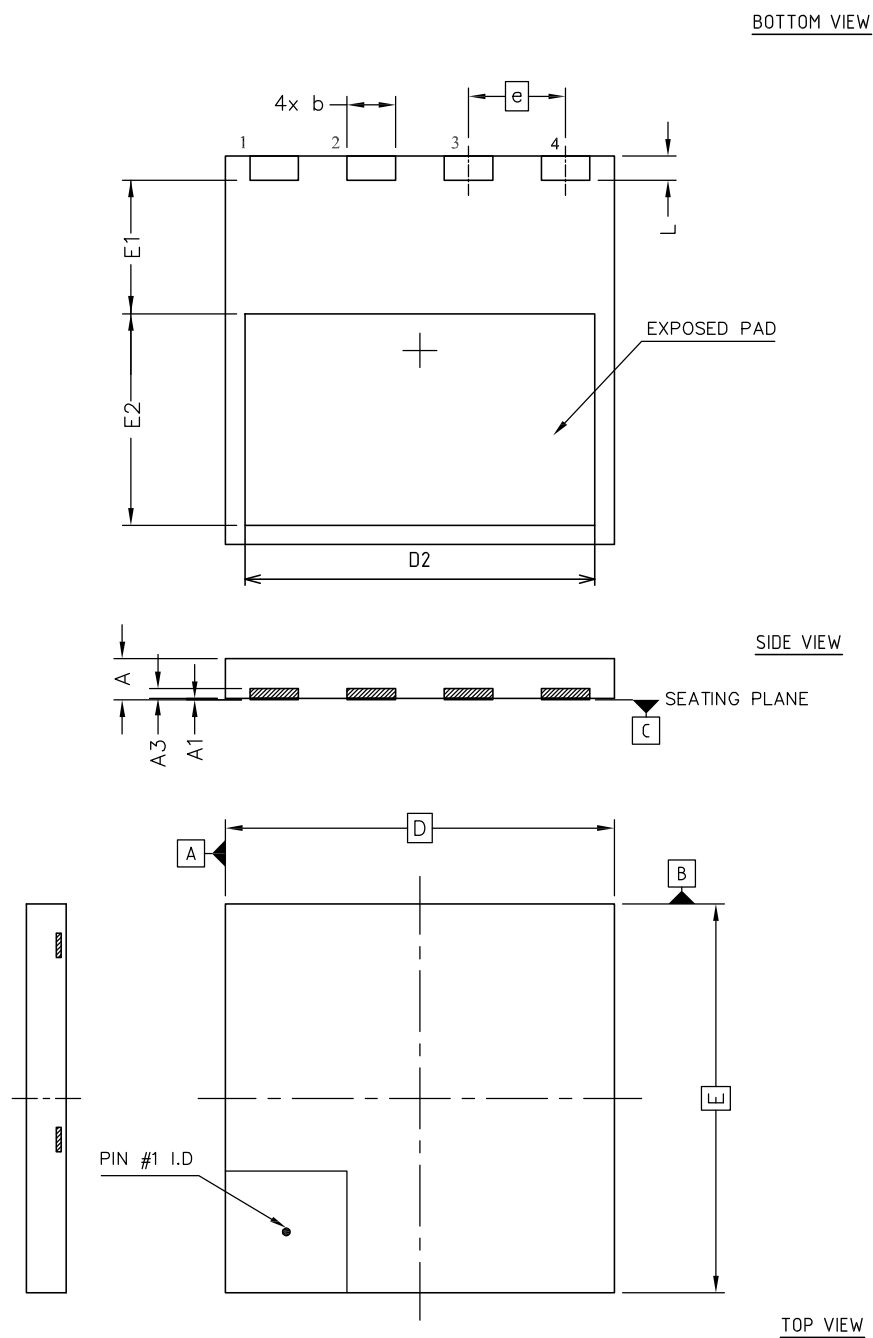
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4 Package information

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. ECOPACK is an ST trademark.

4.1 PowerFLAT 8x8 HV package information

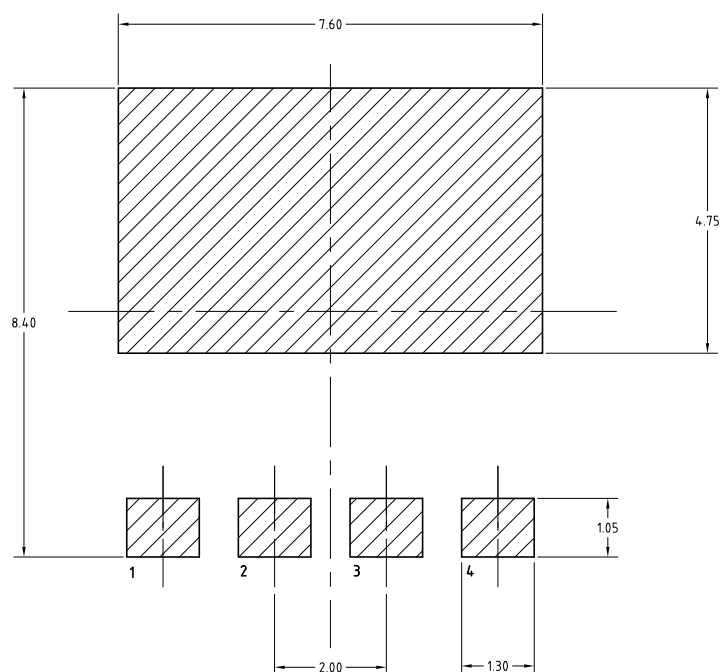
Figure 20. PowerFLAT 8x8 HV package outline



8222871_Rev_4

Table 7. PowerFLAT 8x8 HV mechanical data

Ref.	Dimensions (in mm)		
	Min.	Typ.	Max.
A	0.75	0.85	0.95
A1	0.00		0.05
A3	0.10	0.20	0.30
b	0.90	1.00	1.10
D	7.90	8.00	8.10
E	7.90	8.00	8.10
D2	7.10	7.20	7.30
E1	2.65	2.75	2.85
E2	4.25	4.35	4.45
e	2.00 BSC		
L	0.40	0.50	0.60

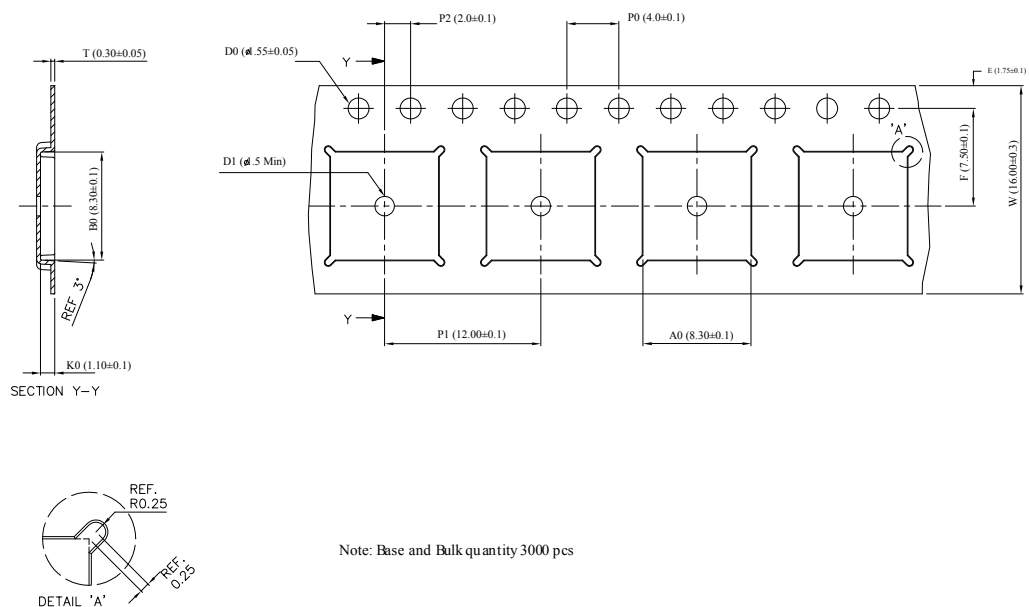
Figure 21. PowerFLAT 8x8 HV footprint


8222871_REV_4_footprint

Note: All dimensions are in millimeters.

4.2 PowerFLAT 8x8 HV packing information

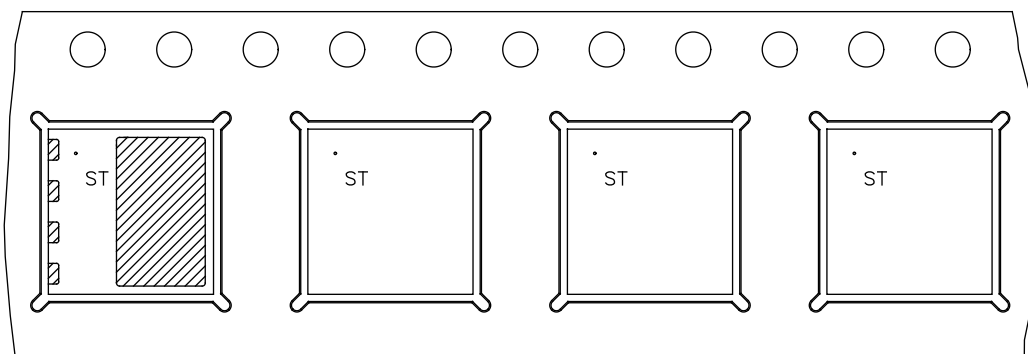
Figure 22. PowerFLAT 8x8 HV tape



8229819_Tape_revA

Note: All dimensions are in millimeters.

Figure 23. PowerFLAT 8x8 HV package orientation in carrier tape



Revision history

Table 8. Document revision history

Date	Revision	Changes
26-Jun-2013	1	First release.
23-Jul-2014	2	Updated the title, the features and the description in cover page. Document status promoted from preliminary data to production data. Updated Figure 1: "Internal schematic diagram", Section 1: "Electrical ratings", Section 2: "Electrical characteristics". Added Section 2.1: "Electrical characteristics (curves)" Updated Section 3: "Test circuits", Section 4.1: "PowerFLAT™ 8x8 HV package mechanical data"..
20-Nov-2015	3	Updated: cover image and <i>Figure 1: "Internal schematic diagram"</i> Table 2: "Absolute maximum ratings", Table 3: "Thermal data" and <i>Table 6: "Switching times"</i> Updated: <i>Figure 3: "Thermal impedance"</i> Updated: <i>Section 5: "Test circuits"</i> Updated: Section 6.1: "PowerFLAT™ 8x8 HV package mechanical data" Minor text changes
11-Jun-2019	4	Update Section 1 Electrical ratings . Added Figure 13. Maximum avalanche energy vs temperature . Minor text changes.

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