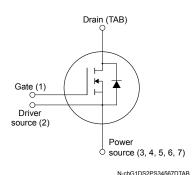
Datasheet

Automotive-grade N-channel 650 V, 38 mΩ typ., 51 A MDmesh DM9 Power MOSFET in an HU3PAK package



HU3PAK





Product statu	s link
STHU65N050D	M9AG

Product summary			
Order code	STHU65N050DM9AG		
Marking	65A050DM9		
Package HU3PAK			
Packing	Tape and reel		

Features

Order code	V _{DS}	R _{DS(on)} max.	I _D
STHU65N050DM9AG	650 V	50 mΩ	51 A



- AEC-Q101 qualified
- Fast-recovery body diode
- Very low FOM (R_{DS(on)}·Q_q)
- · Low gate charge, input capacitance and resistance
- 100% avalanche tested
- · Extremely high dv/dt ruggednes
- · Excellent switching performance thanks to the extra driving source pin

Applications

- DC/DC converter for EV/HEV
- On board charger (OBC)

Description

This N-channel Power MOSFET is based on the most innovative super-junction MDmesh DM9 technology, suitable for medium/high voltage MOSFETs featuring very low $R_{\rm DS(on)}$ per area coupled with a fast-recovery diode. The silicon-based DM9 technology benefits from a multi-drain manufacturing process which allows an enhanced device structure. The fast-recovery diode featuring very low recovery charge (Q_{rr}) , time (t_{rr}) and $R_{\rm DS(on)}$ makes this fast-switching super-junction Power MOSFET tailored for the most demanding high-efficiency bridge topologies and ZVS phase-shift converters.



1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V _{GS}	Gate-source voltage	±30	V
I _D ⁽¹⁾	Drain current (continuous) at T _C = 25 °C	51	А
ID(.)	Drain current (continuous) at T _C = 100 °C	32	A
I _{DM} ⁽²⁾	Drain current (pulsed)	220	Α
P _{TOT}	Total power dissipation at T _C = 25 °C	245	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	120	
di/dt ⁽³⁾	Peak diode recovery current slope	1000	A/µs
dv/dt ⁽⁴⁾	MOSFET dv/dt ruggedness	120	V/ns
T _{stg}	Storage temperature range	-55 to 150	°C
TJ	Operating junction temperature range	-55 to 150	°C

- 1. Referred to TO-247 long leads package.
- 2. Pulse width limited by safe operating area.
- 3. $I_{SD} \le 25.5 \, A$, V_{DS} (peak) $< V_{(BR)DSS}$, $V_{DD} = 400 \, V$.
- 4. V_{DS} (peak) < $V_{(BR)}$ DSS, V_{DD} = 400 V.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R _{thJC}	Thermal resistance, junction-to-case	0.51	°C/W
R _{thJA} ⁽¹⁾	Thermal resistance, junction-to-ambient	30	°C/W

^{1.} When mounted on a standard 1 inch² area of FR-4 PCB with 2-oz copper.

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T _J max.)	6	Α
E _{AS}	Single pulse avalanche energy (starting $T_J = 25$ °C, $I_D = I_{AR}$, $V_{DD} = 50$ V)	760	mJ

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2 Electrical characteristics

 T_{C} = 25 °C unless otherwise specified.

Table 4. On/off-states

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V _{(BR)DSS}	Drain-source breakdown voltage	V _{GS} = 0 V, I _D = 1 mA	650			V
I _{DSS}	Zero gate voltage drain current	V _{GS} = 0 V, V _{DS} = 650 V			5	μΑ
I _{GSS}	Gate-body leakage current	V _{DS} = 0 V, V _{GS} = ±25 V			±100	nA
V _{GS(th)}	Gate threshold voltage	V _{DS} = V _{GS} , I _D = 250 μA	3.5	4.0	4.5	V
R _{DS(on)}	Static drain-source on-resistance	V _{GS} = 10 V, I _D = 25.5 A		38	50	mΩ

Table 5. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C _{iss}	Input capacitance	V _{DS} = 400 V, f = 250 kHz, V _{GS} = 0 V		4680	-	pF
C _{oss}	Output capacitance			76	-	pF
Coss eq. (1)	Equivalent output capacitance	V _{DS} = 0 to 400 V, V _{GS} = 0 V	-	1070	-	pF
Rg	Intrinsic gate resistance	f = 250 kHz, open drain	-	1	-	Ω
Qg	Total gate charge	V _{DD} = 400 V, I _D = 25.5 A, V _{GS} = 0 to 10 V	-	100	-	nC
Q _{gs}	Gate-source charge	(see Figure 14. Test circuit for gate	-	26	-	nC
Q _{gd}	Gate-drain charge	charge behavior)		36	-	nC

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 stated value.

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t _{d(on)}	Turn-on delay time	V _{DD} = 400 V, I _D = 25.5 A,	-	29	-	ns
t _r	Rise time	$R_G = 4.7 \Omega$, $V_{GS} = 10 V$	-	7	-	ns
t _{d(off)}	Turn-off delay time	(see Figure 13. Switching times test circuit for resistive load and	-	80	-	ns
t _f	Fall time	Figure 18. Switching time waveform)	-	5	-	ns

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Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
I _{SD} ⁽¹⁾	Source-drain current		-		51	Α
I _{SDM} ⁽²⁾	Source-drain current (pulsed)		-		220	Α
V _{SD} ⁽³⁾	Forward on voltage	V _{GS} = 0 V, I _{SD} = 51 A	-	1.1	1.6	V
t _{rr}	Reverse recovery time	I _{SD} = 51 A, di/dt = 100 A/μs,	-	170		ns
Q _{rr}	Reverse recovery charge	V _{DD} = 150 V	-	1.2		μC
I _{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	12		Α
t _{rr}	Reverse recovery time	I _{SD} = 51 A, di/dt = 100 A/μs,	-	225		ns
Q _{rr}	Reverse recovery charge	V _{DD} = 150 V, T _J = 150 °C	-	2.2		μC
I _{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	18		Α

- 1. Referred to TO-247 long leads package.
- 2. Pulse width is limited by safe operating area.
- 3. Pulsed: pulse duration = 300 μs, duty cycle 1.5%.

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10 -3

10-1

100

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area GPDP220120251049SOA I_{DM} (A) 10² t_p=1µs 10 t_p=10μs 10 t_p=100µs 10 $T_C = 25$ °C $t_{\rm p}$ =1ms 10 -2 T_J ≤ 150 °C -V_{(BR)DSS} V_{GS}=10 V

single pulse

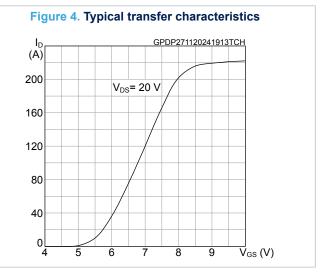
10²

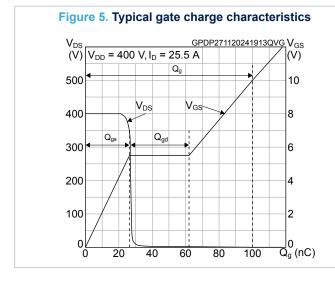
10¹

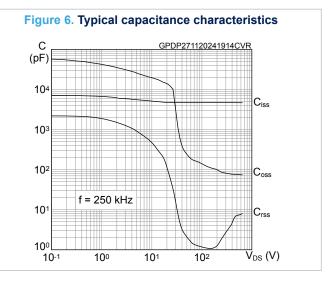
t_o=10ms

 $\vec{V}_{DS}(V)$

Figure 2. Maximum transient thermal impedance Z_{thJC} (°C/W) GPDP220120251049ZTH duty=0.5 0.4 10 -0.1 0.3 0.05 10 -2 t_{thJC} = 0.51 °C/W $duty = t_{on} / T$ Single pulse 10 -3 10 -6 10 -5 10 -4 10 -3 10 -2 10 -1 $t_p(s)$







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Figure 7. Typical drain-source on-resistance

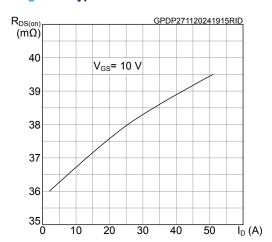


Figure 8. Normalized on-resistance vs temperature

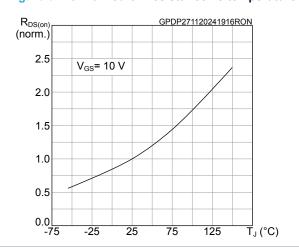


Figure 9. Normalized gate threshold vs temperature

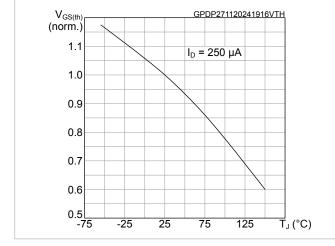


Figure 10. Normalized breakdown voltage vs temperature

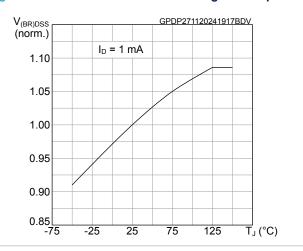


Figure 11. Typical reverse diode forward characteristics

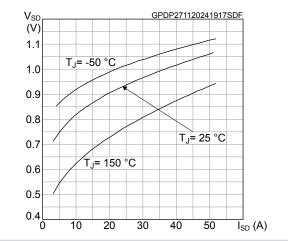
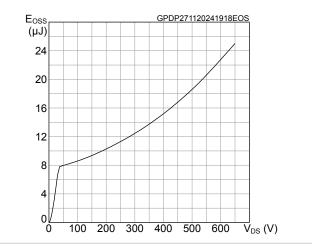


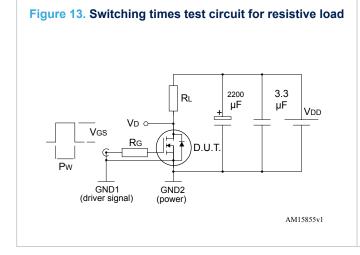
Figure 12. Typical output capacitance stored energy



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3 Test circuits



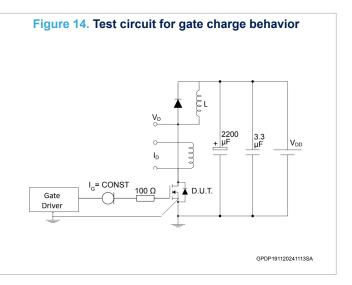
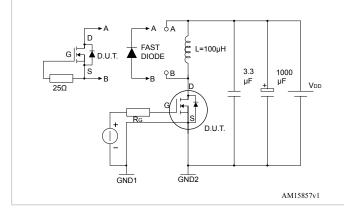


Figure 15. Test circuit for inductive load switching and diode recovery times



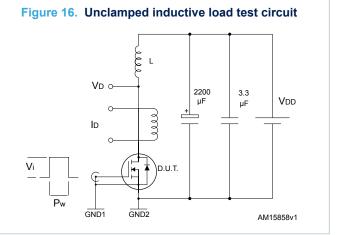


Figure 17. Unclamped inductive waveform

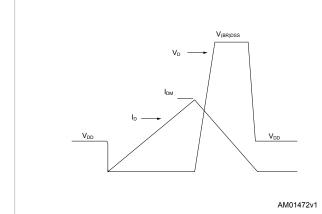
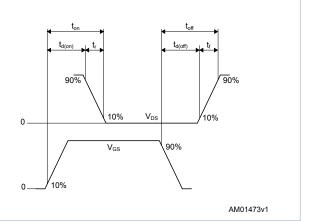


Figure 18. Switching time waveform



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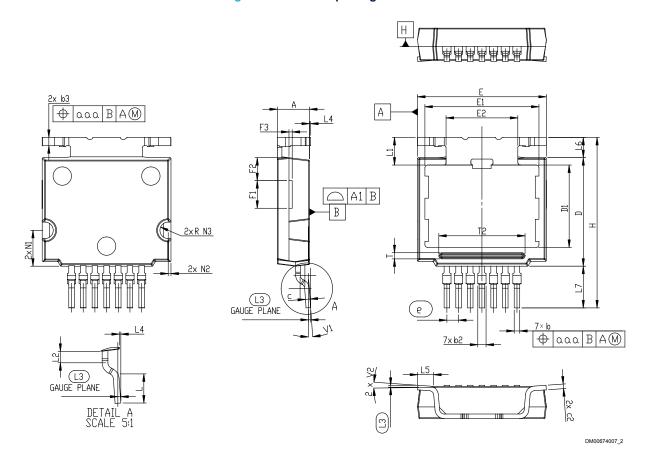


4 Package information

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 HU3PAK package information

Figure 19. HU3PAK package outline



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Table 8. HU3PAK package mechanical data

	Dimensions			
Ref.		mm		
	Min.	Тур.	Max.	
А	3.40	3.50	3.60	
A1		0.05		
b	0.50	0.60	0.70	
b2	0.50	0.70	1.00	
b3	0.80	0.90	1.00	
С	0.40	0.50	0.60	
c2	0.40	0.50	0.60	
D	11.70	11.80	11.90	
D1	8.80	8.955	9.10	
Е	13.90	14.00	14.10	
E1	12.30	12.40	12.50	
E2	7.75	7.80	7.85	
е		1.27		
Н	18.00	18.58	19.00	
aaa		0.10		
L	2.40	2.52	2.60	
L1		3.05		
L2	0.90	1.00	1.10	
L3		0.26		
L4	0.075	0.125	0.175	
L5	1.83	1.93	2.03	
L6	2.14	2.24	2.34	
L7	4.44	4.54	4.64	
F1	2.90	3.00	3.10	
F2	2.40	2.50	2.60	
F3	0.25	0.35	0.45	
N1	3.80	3.90	4.00	
N2	0.25	0.30	0.45	
N3	0.80	0.90	1.00	
Т	0.50	0.67	0.70	
T2	9.18	9.38	9.43	
V1		0 °	8°	
V2		0 °	8°	

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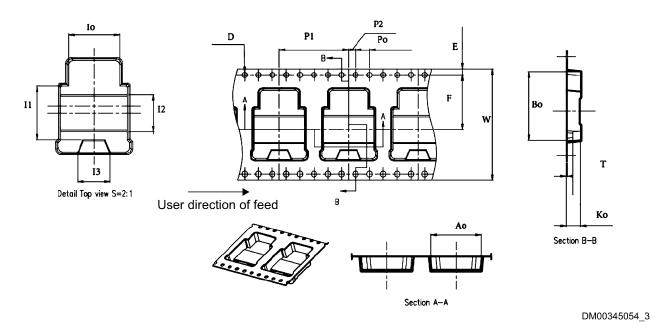


14.70 2.45 00% 6×1.27 7×0.90

Figure 20. HU3PAK recommended footprint (dimensions in mm)

4.2 HU3PAK packing information

Figure 21. HU3PAK carrier tape outline



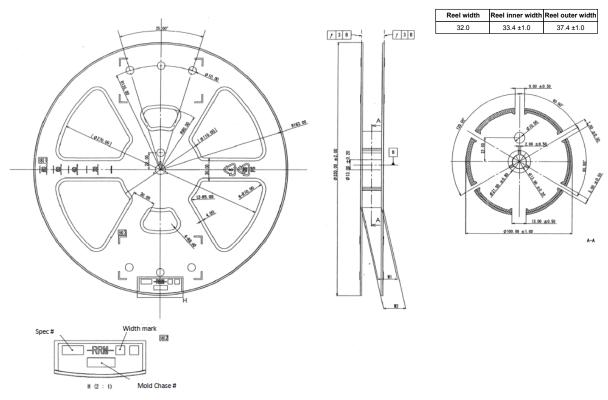
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Table 9. HU3PAK tape mechanical data

Dimension	Value
Dilliension	mm
AO	14.40 ±0.10
В0	19.70
D	1.50 ±0.10
E	1.75 ±0.10
F	15.65 ±0.10
10	11.00
I1	11.60 ±0.10
I2	8.00
13	7.00
K0	4.20
P0	4.00 ±0.10
P1	20.00 ±0.10
P2	2.00 ±0.10
Т	0.40 ±0.50
W	32.00 ±0.30

Figure 22. HU3PAK reel outline (dimensions are in mm)



DM00345054_3_reel

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Revision history

Table 10. Document revision history

Date	Revision	Changes
18-Jun-2024	1	First release.
23-Jan-2025	2	Updated Features. Updated Table 1. Absolute maximum ratings and added Table 3. Avalanche characteristics. Updated Section 2: Electrical characteristics. Updated Section 2.1: Electrical characteristics (curves).
10-Feb-2025	3	Updated Section Applications.

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