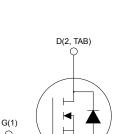


N-channel 600 V, 38 m Ω typ., 55 A MDmesh DM9 Power MOSFET in a TO-220 package

Features





S(3)

AM01475v1_noZen

- Order code
 V_{DS}
 R_{DS(on)} max.
 I_D

 STP60N043DM9
 600 V
 43 mΩ
 55 A
- Fast-recovery body diode
- Worldwide best R_{DS(on)} per area among silicon-based fast recovery devices
- · Low gate charge, input capacitance and resistance
- 100% avalanche tested
- · Extremely high dv/dt ruggedness

Applications

- Power supplies and converters
- LLC resonant converter

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 $R_{DS(\text{on})}$ 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 $R_{DS(\text{on})}$ makes this fast-switching super-junction Power MOSFET tailored for the most demanding high-efficiency bridge topologies and ZVS phase-shift converters.



Product status link
STP60N043DM9

Product summary			
Order code STP60N043DM9			
Marking	60N043DM9		
Package	TO-220		
Packing	Tube		



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	55	Α
ID.	Drain current (continuous) at T _C = 100 °C	35	
I _{DM} ⁽²⁾	Drain current (pulsed)	175	Α
P _{TOT}	Total power dissipation at T _C = 25 °C	245	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	120	V/ns
di/dt ⁽³⁾	Peak diode recovery current slope	1300	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. $I_{SD} \le 28 \, A$, V_{DS} (peak) $< V_{(BR)DSS}$, $V_{DD} = 400 \, V$.
- $4. \quad V_{DS} \leq 400 \ V.$

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R _{thJC}	Thermal resistance, junction-to-case	0.51	°C/W
R _{thJA}	Thermal resistance, junction-to-ambient	62.5	°C/W

Table 3. Avalanche characteristics

Syml	ol Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{J} max.)	6	А
EAS	Single pulse avalanche energy (starting $T_J = 25$ °C, $I_D = I_{AR}$, $V_{DD} = 100$ V)	839	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	600			V
I	Zero gate voltage drain current	V _{GS} = 0 V, V _{DS} = 600 V			5	
I _{DSS}		V_{GS} = 0 V, V_{DS} = 600 V, T_{C} = 125 °C ⁽¹⁾			200	μΑ
I _{GSS}	Gate-body leakage current	V _{DS} = 0 V, V _{GS} = ±25 V			±100	nA
V _{GS(th)}	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_{D} = 250 \mu A$	3.5	4.0	4.5	V
R _{DS(on)}	Static drain-source on- resistance	V _{GS} = 10 V, I _D = 28 A		38	43	mΩ

^{1.} Specified by design, not tested in production.

Table 5. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C _{iss}	Input capacitance	V _{DS} = 400 V, f = 1 MHz, V _{GS} = 0 V		4675	-	pF
C _{oss}	Output capacitance			82	-	pF
Coss eq. (1)	Equivalent output capacitance	V _{DS} = 0 to 400 V, V _{GS} = 0 V		729	-	pF
R _G	Intrinsic gate resistance	f = 1 MHz, open drain		0.78	-	Ω
Qg	Total gate charge	V _{DD} = 400 V, I _D = 28 A, V _{GS} = 0 to 10 V	-	78.6	-	nC
Q _{gs}	Gate-source charge	(see Figure 14. Test circuit for gate charge behavior)	-	29	-	nC
Q _{gd}	Gate-drain charge		-	20	-	nC

^{1.} $C_{\text{oss eq}}$ 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} = 300 V, I _D = 28 A,	-	28	-	ns
t _r	Rise time	$R_G = 4.7 \Omega, V_{GS} = 10 V$	-	27	-	ns
t _{d(off)}	Turn-off delay time	(see Figure 13. Test circuit for resistive	-	77	-	ns
t _f	Fall time	load switching times and 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		-		55	Α
I _{SDM} ⁽²⁾	Source-drain current (pulsed)		-		175	Α
V _{SD} ⁽³⁾	Forward on voltage	V _{GS} = 0 V, I _{SD} = 56 A	-		1.6	V
t _{rr}	Reverse recovery time	I _{SD} = 56 A, di/dt = 100 A/μs, V _{DD} = 60 V	-	165		ns
Q _{rr}	Reverse recovery charge	(see Figure 15. Test circuit for inductive load switching and diode recovery times)		1.06		μC
I _{RRM}	Reverse recovery current			11		Α
t _{rr}	Reverse recovery time	$I_{SD} = 56 \text{ A}, \text{ di/dt} = 100 \text{ A/}\mu\text{s},$	-	215		ns
Q _{rr}	Reverse recovery charge	V _{DD} = 60 V, T _J = 150 °C (see Figure 15. Test circuit for inductive	_	2.2		μC
I_{RRM}	Reverse recovery current	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 = $300 \mu s$, duty cycle 1.5%.

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2.1 Electrical characteristics (curves)

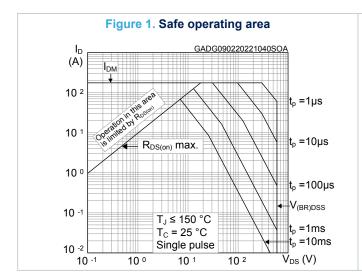
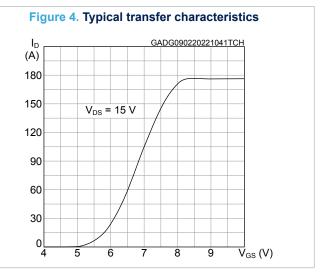
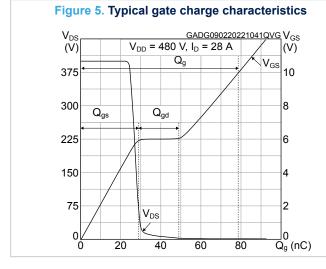
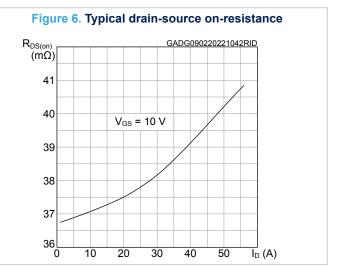


Figure 2. Maximum transient thermal impedance GADG090220221040ZTH Z_{thJC} (°C/W) 0.4 0.3 0.2 duty=0.5 10 -1 0.05 10 -2 R_{thJC} = 0.51 °C/W $duty = t_{on} / T$ Single pulse 10 -3 $\overline{\mathsf{t}_{\mathsf{p}}}$ (s) 10 -5 10 -4 10 -3 10 -2 10 -1 10 -6

Figure 3. Typical output characteristics Ι_D (A) GADG090220221040OCH 180 $V_{GS} = 9, 10 V$ 8 V 150 120 7 V 90 60 30 6 V 8 10 12 $\overline{V}_{DS}(V)$







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Figure 7. Typical capacitance characteristics

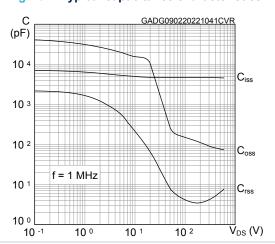


Figure 8. Typical output capacitance stored energy

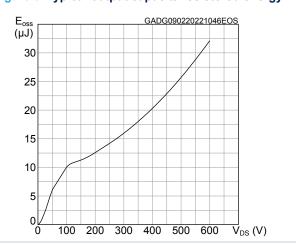


Figure 9. Normalized gate threshold vs temperature

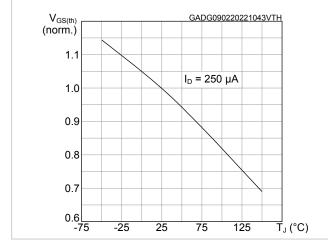


Figure 10. Normalized on-resistance vs temperature

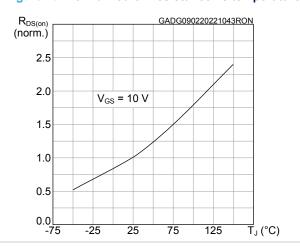


Figure 11. Normalized breakdown voltage vs temperature

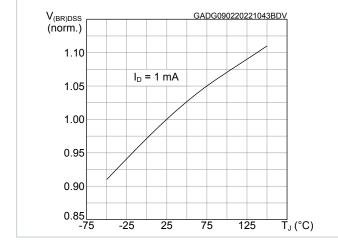
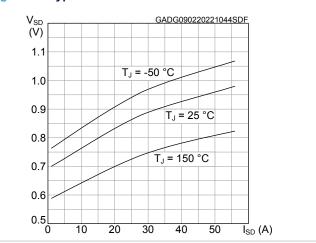


Figure 12. Typical reverse diode forward characteristics



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3 Test circuits

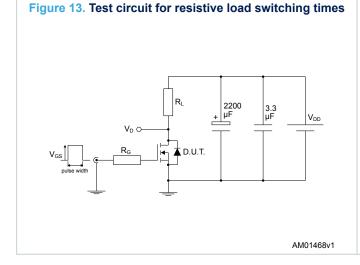
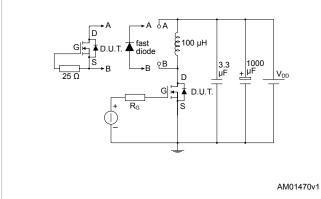


Figure 15. Test circuit for inductive load switching and diode recovery times



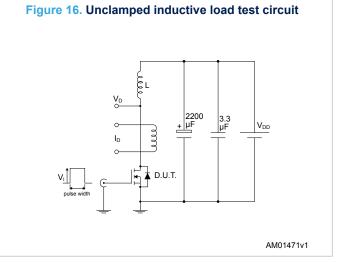


Figure 17. Unclamped inductive waveform

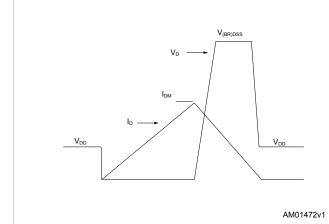
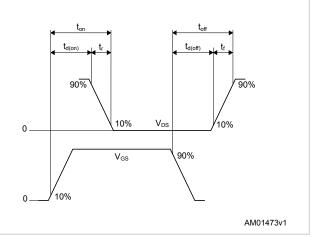


Figure 18. Switching time waveform



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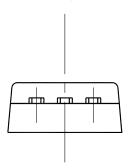


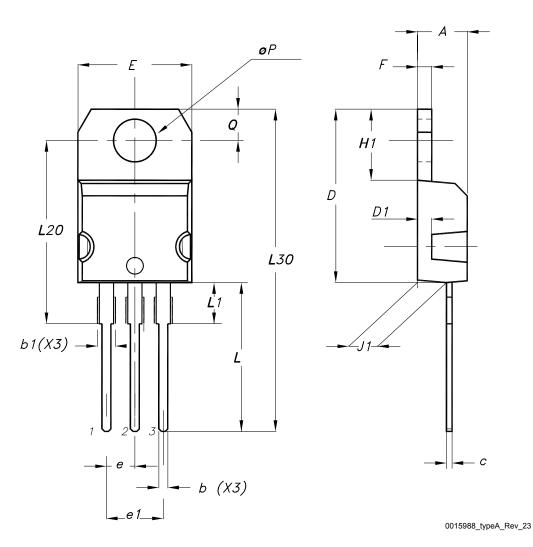
4 Package information

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 TO-220 type A package information

Figure 19. TO-220 type A package outline





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Table 8. TO-220 type A package mechanical data

Dim.		mm	
Dilli.	Min.	Тур.	Max.
А	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
С	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		10.40
е	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øΡ	3.75		3.85
Q	2.65		2.95
Slug flatness		0.03	0.10

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Revision history

Table 9. Document revision history

Date	Revision	Changes
16-Feb-2022	1	First release.
06-Sep-2022	2	Updated Features on cover page.
16-Mar-2023	3	Updated Table 7. Source-drain diode.
31-Aug-2023	4	Updated title and Features on cover page. Updated Table 1. Absolute maximum ratings. Updated Table 6. Switching times. Updated Section 3 Test circuits. Minor text changes.
21-Mar-2024	5	Updated Table 3. Avalanche characteristics.

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