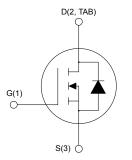


# N-channel 600 V, 38 mΩ typ., 55 A MDmesh DM9 Power MOSFET in a TO-247 long leads package

# TO-247 long leads



AM01475v1\_noZer



Product status link	
STWA60N043DM9	

Product summary			
Order code STWA60N043DM9			
Marking 60N043DM9			
Package TO-247 long leads			
Packing	Tube		

#### **Features**

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	
STWA60N043DM9 600 V		43 mΩ	55 A	

- Fast-recovery body diode
- Worldwide best R<sub>DS(on)</sub> 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.



# 1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	±30	V
	Drain current (continuous) at T <sub>C</sub> = 25 °C	55	
Ι <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	35	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	175	Α
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	312	W
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	120	V/ns
di/dt <sup>(2)</sup>	Peak diode recovery current slope	1300	A/µs
dv/dt <sup>(3)</sup>	MOSFET dv/dt ruggedness	120	V/ns
T <sub>stg</sub>	Storage temperature range	55.4-450	°C
TJ	Operating junction temperature range	-55 to 150	°C

<sup>1.</sup> Pulse width limited by safe operating area.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R <sub>thJC</sub>	Thermal resistance, junction-to-case	0.4	°C/W
R <sub>thJA</sub>	Thermal resistance, junction-to-ambient	50	°C/W

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>J</sub> max.)	6	Α
E <sub>AS</sub>	Single pulse avalanche energy (starting $T_J = 25$ °C, $I_D = I_{AR}$ , $V_{DD} = 100$ V)	839	mJ

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<sup>2.</sup>  $I_{SD} \le 28 \; A, \; V_{DS} \; (peak) < V_{(BR)DSS}, \; V_{DD} = 400 \; V.$ 

<sup>3.</sup>  $V_{DS} \le 400 \text{ V}$ .



## 2 Electrical characteristics

 $T_C$  = 25 °C unless otherwise specified.

Table 4. On/off-states

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	$V_{GS} = 0 \text{ V}, I_D = 1 \text{ mA}$	600			V
I	Zana nata waltana dunin awunut	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 600 V			5	
I <sub>DSS</sub>	Zero gate voltage drain current	$V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_{C}$ = 125 °C <sup>(1)</sup>			200	μA
I <sub>GSS</sub>	Gate-body leakage current	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±25 V			±100	nA
V <sub>GS(th)</sub>	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_{D} = 250 \mu A$	3.5	4.0	4.5	V
R <sub>DS(on)</sub>	Static drain-source on- resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 28 A		38	43	mΩ

<sup>1.</sup> Specified by design, not tested in production.

Table 5. Dynamic characteristics

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

<sup>1.</sup>  $C_{\text{oss eq}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{DS}$  increases from 0 to stated value.

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> = 300 V, I <sub>D</sub> = 28 A,	-	28	-	ns
t <sub>r</sub>	Rise time	$R_G = 4.7 \Omega, V_{GS} = 10 V$	-	27	-	ns
t <sub>d(off)</sub>	Turn-off delay time	(see Figure 13. Test circuit for resistive load switching times and	-	77	-	ns
t <sub>f</sub>	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 <sub>SD</sub>	Source-drain current		-		55	Α
I <sub>SDM</sub> <sup>(1)</sup>	Source-drain current (pulsed)		-		175	Α
V <sub>SD</sub> <sup>(2)</sup>	Forward on voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 56 A	-		1.6	V
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 56 A, di/dt = 100 A/µs, V <sub>DD</sub> = 60 V	-	165		ns
Q <sub>rr</sub>	Reverse recovery charge	(see Figure 15. Test circuit for inductive	-	1.06		μC
I <sub>RRM</sub>	Reverse recovery current	load switching and diode recovery times)		11		Α
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 56 A, di/dt = 100 A/μs,	-	215		ns
Q <sub>rr</sub>	Reverse recovery charge	V <sub>DD</sub> = 60 V, T <sub>J</sub> = 150 °C	-	2.2		μC
I <sub>RRM</sub>	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)		18		Α

<sup>1.</sup> Pulse width is limited by safe operating area.

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<sup>2.</sup> Pulsed: pulse duration =  $300 \mu s$ , duty cycle 1.5%.





#### 2.1 Electrical characteristics (curves)

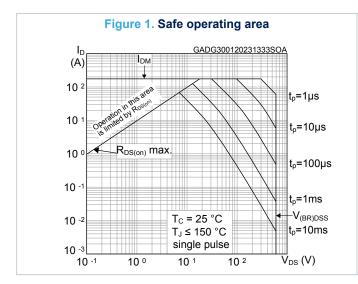
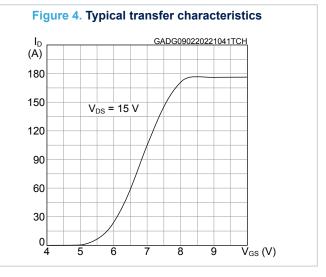
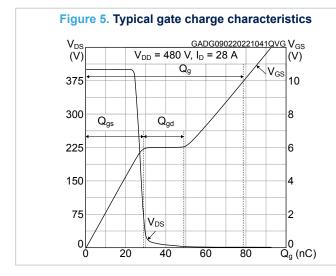
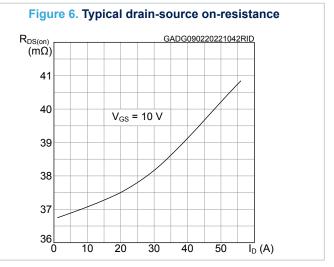


Figure 2. Maximum transient thermal impedance GADG300120231246ZTH Z<sub>thJC</sub> (°C/W) duty=0.5 10 -1 0.1 0.3 0.05 0.2 10 -2 Single pulse 10 -6 10 -5 10 -4 10 -2 10 -1  $t_p(s)$ 

Figure 3. Typical output characteristics I<sub>D</sub> (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

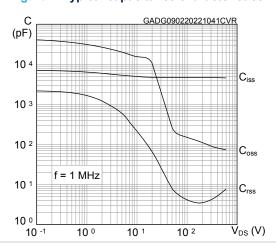


Figure 8. Typical output capacitance stored energy

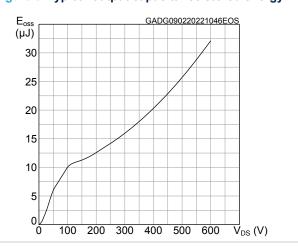


Figure 9. Normalized gate threshold vs temperature

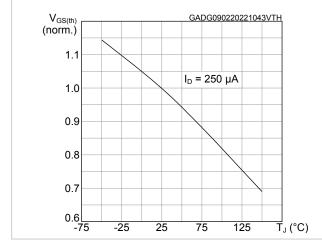


Figure 10. Normalized on-resistance vs temperature

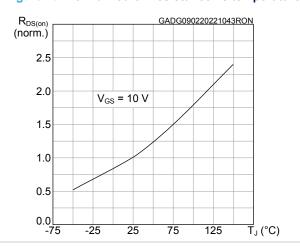


Figure 11. Normalized breakdown voltage vs temperature

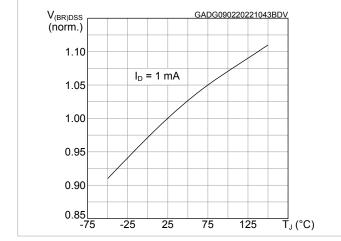
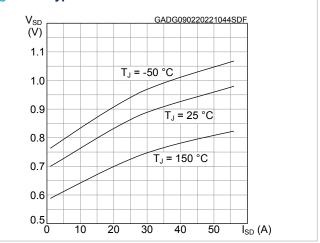


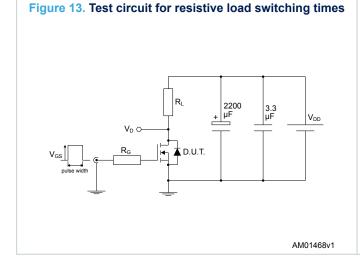
Figure 12. Typical reverse diode forward characteristics



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## 3 Test circuits



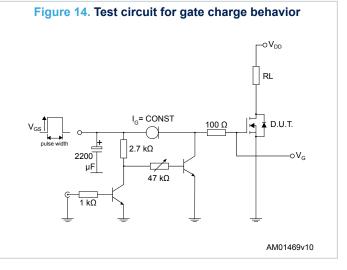
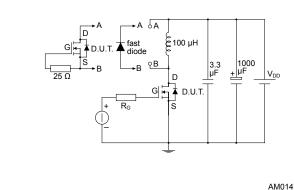


Figure 15. Test circuit for inductive load switching and diode recovery times



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Figure 16. Unclamped inductive load test circuit

AM01471v1

Figure 17. Unclamped inductive waveform

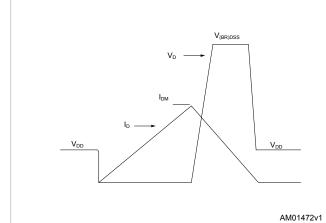
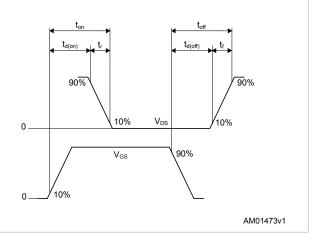


Figure 18. Switching time waveform



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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-247 long leads package information

HEAT-SINK PLANE

A2

A1

b2

b2

Figure 19. TO-247 long leads package outline

BACK VIEW 8463846\_5

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(3x) b



Table 8. TO-247 long leads package mechanical data

Dim.		mm	
Dilli.	Min.	Тур.	Max.
А	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
С	0.59		0.66
D	D 20.90 21.00		21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
е	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
M	0.35		0.95
Р	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

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# **Revision history**

Table 9. Document revision history

Date	Revision	Changes
23-Feb-2023	1	First release.
28-Apr-2023	2	Updated Table 6. Switching times.
29-Aug-2023	3	Updated title and Features on cover page.  Updated Table 1. Absolute maximum ratings.  Updated Table 6. Switching times.  Updated Table 7. Source-drain diode.  Updated Section 3 Test circuits.
21-Mar-2024	4	Updated Table 3. Avalanche characteristics.

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