

# STW88N65M5 STWA88N65M5

# N-channel 650 V, 0.024 Ω typ., 84 A, MDmesh™ V Power MOSFET in TO-247 and TO-247 long leads packages

Datasheet - production data

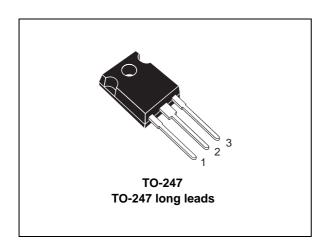
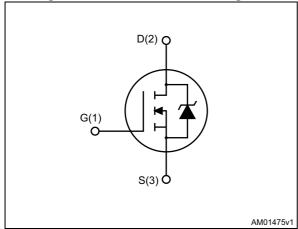


Figure 1. Internal schematic diagram



#### **Features**

Order codes	V <sub>DSS</sub> @T <sub>jmax.</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STW88N65M5	710 V	< 0.029 Ω	84 A
STWA88N65M5	710 0	V 0.025 32	0471

- Worldwide best R<sub>DS(on)</sub> in TO-247
- Higher V<sub>DSS</sub> rating
- Higher dv/dt capability
- Excellent switching performance
- · Easy to drive
- 100% avalanche tested

#### **Applications**

- High efficiency switching applications:
  - Servers
  - PV inverters
  - Telecom infrastructure
  - Multi kW battery chargers

## **Description**

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low onresistance, which is unmatched among siliconbased Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

**Table 1. Device summary** 

Order codes	Marking	Packages	Packaging
STW88N65M5	88N65M5	TO-247	Tube
STWA88N65M5	CONOCIVIO	TO-247 long leads	Tube

# **Contents**

1	Electrical ratings	3
2	Electrical characteristics	4
	2.1 Electrical characteristics (curves)	6
3	Test circuits	9
4	Package mechanical data	0
5	Revision history	4

# 1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate- source voltage	±25	V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	84	Α
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	50.5	Α
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	336	Α
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	450	W
I <sub>AR</sub>	Max current during repetitive or single pulse avalanche (pulse width limited by T <sub>JMAX</sub> )	15	А
E <sub>AS</sub>	Single pulse avalanche energy (starting $T_j = 25$ °C, $I_D = I_{AR}$ , $V_{DD} = 50$ V)	2000	mJ
dv/dt (2)	Peak diode recovery voltage slope	15	V/ns
T <sub>stg</sub>	Storage temperature	- 55 to 150	°C
Tj	Max. operating junction temperature	150	°C

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

Table 3. Thermal data

Symbol	Parameter	Value	Unit	
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.28	°C/W	
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	50	°C/W	
T <sub>I</sub>	Maximum lead temperature for soldering purpose 300			

<sup>2.</sup>  $I_{SD} \leq 84 \text{ A, di/dt} = 400 \text{ A/µs, peak } V_{DS} < V_{(BR)DSS}, V_{DD} = 400 \text{ V}$ 

## 2 Electrical characteristics

(T<sub>C</sub> = 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	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	650			٧
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = 650 V V <sub>DS</sub> = 650 V, T <sub>C</sub> =125 °C			1 100	μA μA
I <sub>GSS</sub>	Gate-body leakage current (V <sub>DS</sub> = 0)	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	4	5	٧
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 42 A		0.024	0.029	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C <sub>iss</sub> C <sub>oss</sub> C <sub>rss</sub>	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 100 \text{ V, f} = 1 \text{ MHz,}$ $V_{GS} = 0$	-	8825 223 11	-	pF pF pF
C <sub>o(tr)</sub> <sup>(1)</sup>	Equivalent capacitance time related	$V_{GS} = 0$ , $V_{DS} = 0$ to 520 V	-	778	-	pF
C <sub>o(er)</sub> <sup>(2)</sup>	Equivalent capacitance energy related	$V_{GS} = 0$ , $V_{DS} = 0$ to 520 V	-	202	-	pF
R <sub>G</sub>	Intrinsic gate resistance	f = 1 MHz open drain	-	1.79	-	Ω
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 520 V, I <sub>D</sub> = 42 A,		204		nC
$Q_{gs}$	Gate-source charge	V <sub>GS</sub> = 10 V	-	51	-	nC
$Q_{gd}$	Gate-drain charge	(see Figure 16)		84		nC

<sup>1.</sup>  $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>2.</sup>  $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t <sub>d(V)</sub>	Voltage delay time	$V_{DD} = 400 \text{ V}, I_D = 56 \text{ A},$		141		ns
t <sub>r(V)</sub>	Voltage rise time	$R_G = 4.7 \Omega, V_{GS} = 10 V$		16		ns
$t_{f(i)}$	Current fall time	(see Figure 17)	_	29	_	ns
t <sub>c(off)</sub>	Crossing time	(see Figure 20)		56		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
I <sub>SD</sub>	Source-drain current Source-drain current (pulsed)		-		84 336	A A
V <sub>SD</sub> (2)	Forward on voltage	I <sub>SD</sub> = 84 A, V <sub>GS</sub> = 0	-		1.5	V
t <sub>rr</sub> Q <sub>rr</sub> I <sub>RRM</sub>	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 84 \text{ A},$ di/dt = 100 A/ $\mu$ s $V_{DD} = 100 \text{ V}$ (see <i>Figure 17</i> )	-	544 14 50		ns μC A
t <sub>rr</sub> Q <sub>rr</sub> I <sub>RRM</sub>	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 84 \text{ A},$ $di/dt = 100 \text{ A/}\mu\text{s}$ $V_{DD} = 100 \text{ V}, T_j = 150 \text{ °C}$ (see <i>Figure 17</i> )	-	660 20 60		ns μC A

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

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

#### **Electrical characteristics (curves)** 2.1

Figure 2. Safe operating area

Figure 3. Thermal impedance

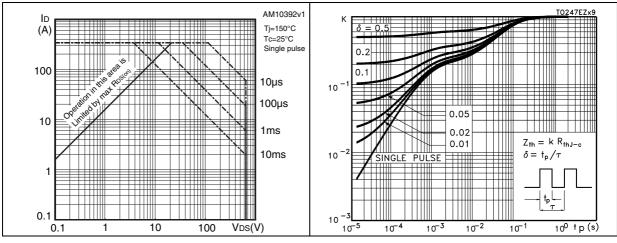


Figure 4. Output characteristics

Figure 5. Transfer characteristics

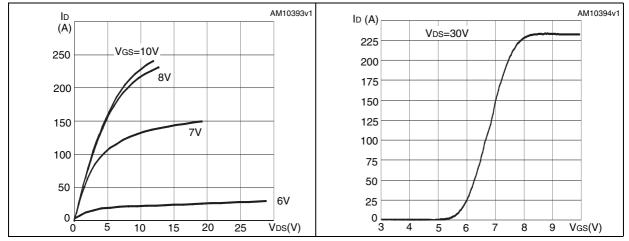
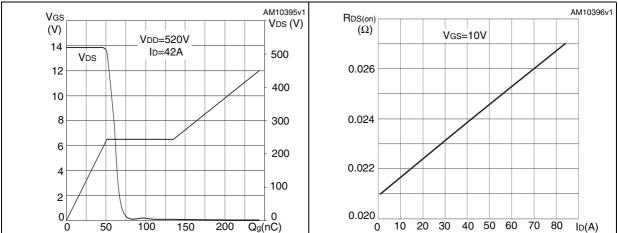


Figure 6. Gate charge vs gate-source voltage

Figure 7. Static drain-source on resistance



DocID022522 Rev 4 6/15

Figure 8. Capacitance variations

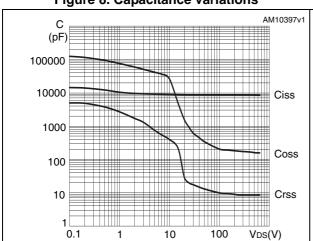


Figure 9. Output capacitance stored energy

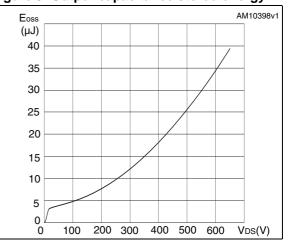
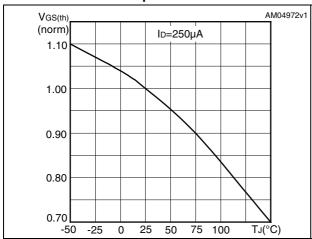


Figure 10. Normalized gate threshold voltage vs temperature

10

100

Figure 11. Normalized on resistance vs temperature



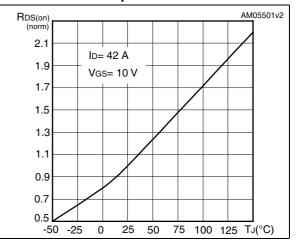
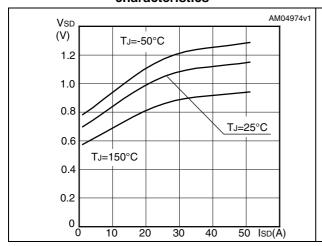


Figure 12. Source-drain diode forward characteristics

Figure 13. Normalized  $V_{DS}$  vs temperature



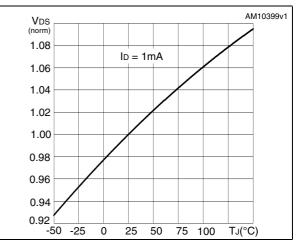
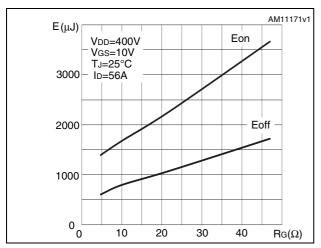


Figure 14. Switching losses vs gate resistance (1)



1. Eon including reverse recovery of a SiC diode

## 3 Test circuits

Figure 15. Switching times test circuit for resistive load

Figure 16. Gate charge test circuit

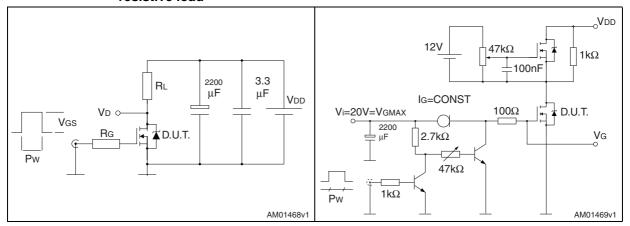


Figure 17. Test circuit for inductive load switching and diode recovery times

Figure 18. Unclamped inductive load test circuit

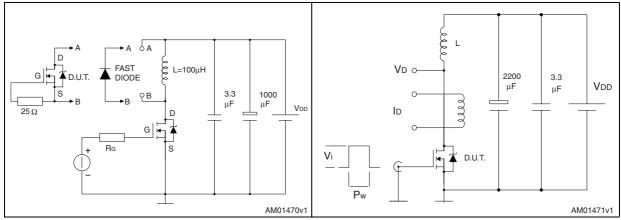
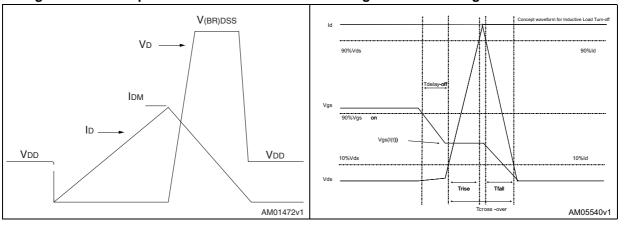


Figure 19. Unclamped inductive waveform

Figure 20. 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. ECOPACK is an ST trademark.

Table 8. TO-247 mechanical data

Dim		mm.	
Dim.	Min.	Тур.	Max.
А	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
С	0.40		0.80
D	19.85		20.15
E	15.45		15.75
е	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

HEAT-SINK PLANE

BACK VIEW 0075325\_G

Figure 21. TO-247 drawing

Table 9. TO-247 long leads mechanical data

D:		mm	
Dim. –	Min.	Тур.	Max.
А	4.90		5.15
D	1.85		2.10
E	0.55		0.67
F	1.07		1.32
F1	1.90		2.38
F2	2.87		3.38
G		10.90 BSC	•
Н	15.77		16.02
L	20.82		21.07
L1	4.16		4.47
L2	5.49		5.74
L3	20.05		20.30
L4	3.68		3.93
L5	6.04		6.29
М	2.25		2.55
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66

HEAT-SINK PLANE -D F2 BACK VIEW 7395426\_G

Figure 22. TO-247 long leads drawing

# 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
23-Nov-2011	1	First release.
09-Dec-2011	2	Document status promoted from preliminary data to datasheet.
12-Jun-2012	3	Updated title on the coverpage.
30-Nov-2012	4	Added new part number: STWA88N65M5 Updated: Section 4: Package mechanical data

#### Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

ST PRODUCTS ARE NOT AUTHORIZED FOR USE IN WEAPONS. NOR ARE ST PRODUCTS DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

