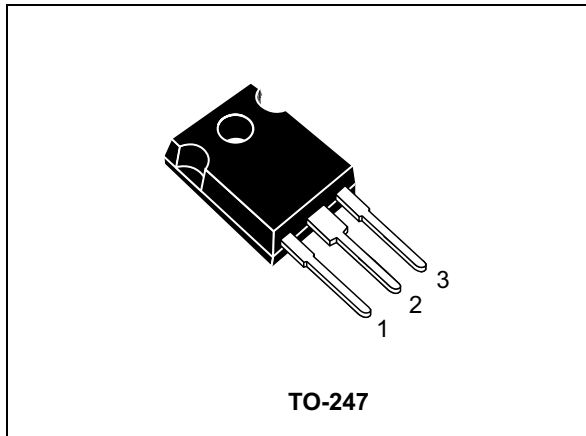


## N-channel 650 V, 0.049 $\Omega$ typ., 49 A MDmesh™ M2 Power MOSFET in a TO-247 package

Datasheet - production data



### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STW56N65M2	650 V	0.062 $\Omega$	49 A

- Extremely low gate charge
- Excellent output capacitance (C<sub>oss</sub>) profile
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### 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.

Figure 1. Internal schematic diagram

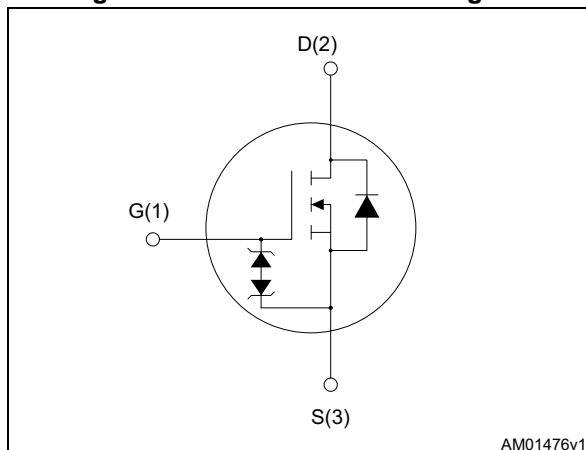


Table 1. Device summary

Order code	Marking	Package	Packaging
STW56N65M2	56N65M2	TO-247	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate- source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	49	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	31	A
$I_{DM}^{(1)}$	Drain current (pulsed)	196	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	358	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 49\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ , peak  $V_{DS} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
3.  $V_{DS} \leq 520\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	$^\circ\text{C}/\text{W}$
$R_{thj-case}$	Thermal resistance junction-case max	0.35	$^\circ\text{C}/\text{W}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Max current during repetitive or single pulse avalanche (pulse width limited by $T_{JMAX}$ )	3.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	1300	mJ

## 2 Electrical characteristics

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

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	650			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 10$	nA
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 24.5\text{ A}$		0.049	0.062	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	3900	-	pF
$C_{oss}$	Output capacitance		-	160	-	pF
$C_{riss}$	Reverse transfer capacitance		-	2.8	-	pF
$C_{o(er)}^{(1)}$	Equivalent Output Capacitance	$V_{GS} = 0$ , $V_{DS} = 0\text{ to }520\text{ V}$	-	838	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	4.6	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 49\text{ A}$ , $V_{GS} = 10\text{ V}$ , (see <a href="#">Figure 15</a> )	-	93	-	nC
$Q_{gs}$	Gate-source charge		-	16	-	nC
$Q_{gd}$	Gate-drain charge		-	40	-	nC

1.  $C_{oss}$  eq. is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

Table 7. Switching times

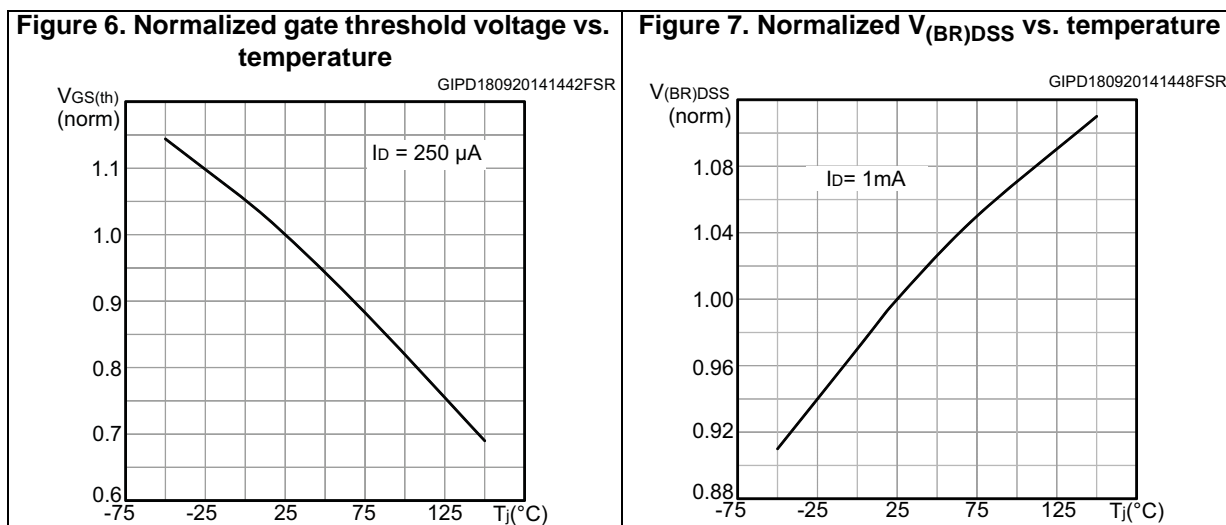
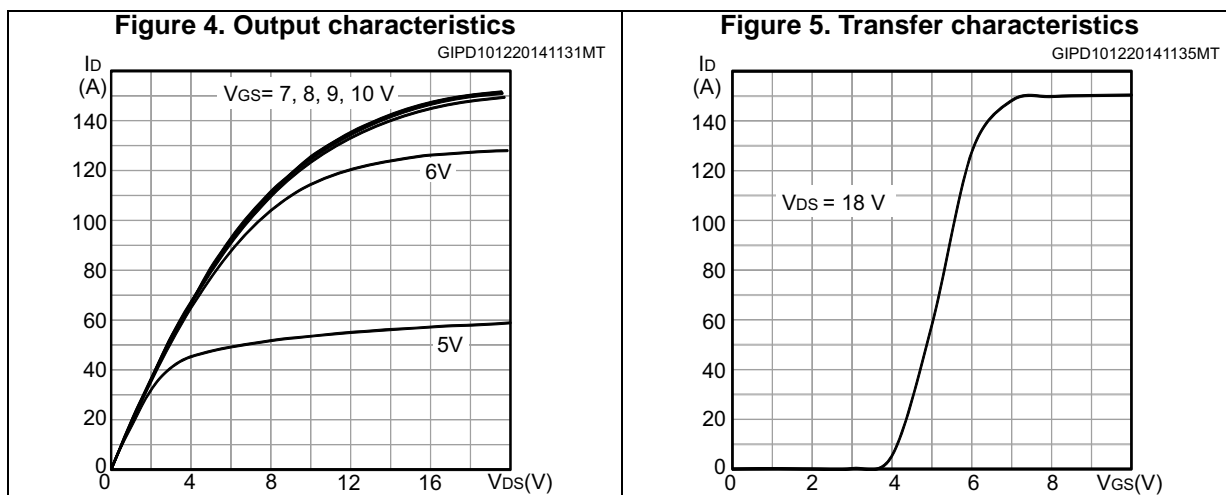
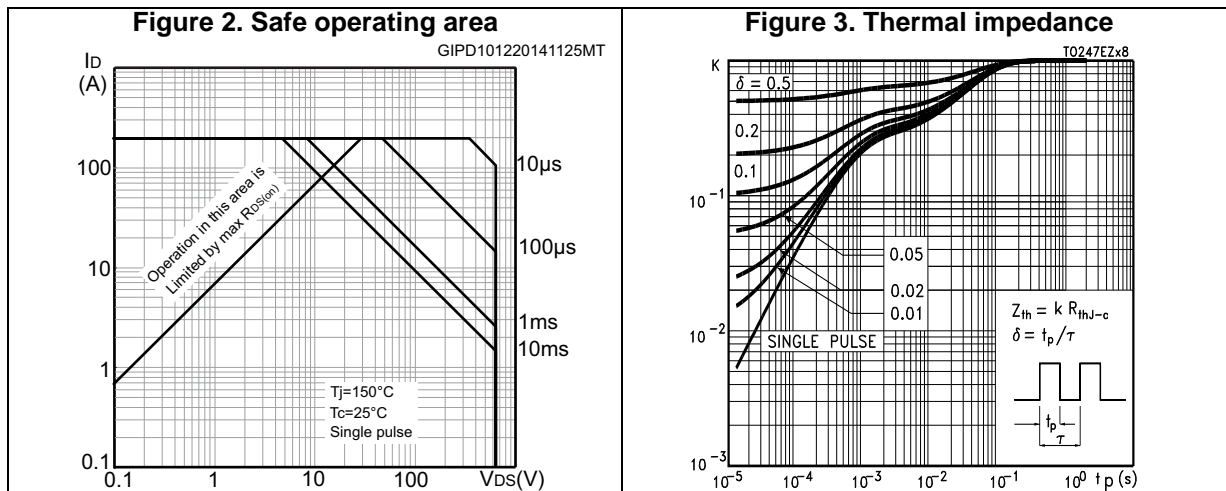
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325 \text{ V}$ , $I_D = 24.5 \text{ A}$ , $R_G = 4.7 \text{ } \Omega$ , $V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 16</a> and <a href="#">Figure 19</a> )	-	19	-	ns
$t_r$	Rise time		-	27.5	-	ns
$t_{d(off)}$	Turn-off delay time		-	146	-	ns
$t_f$	Fall time		-	13	-	ns

Table 8. Source drain diode

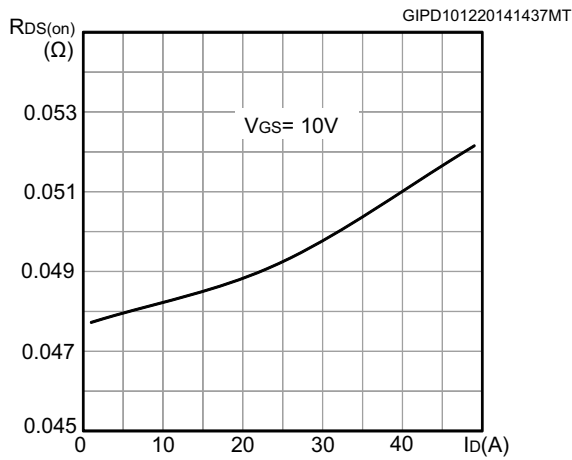
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		49	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		196	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 49 \text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 49 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 16</a> )	-	554		ns
$Q_{rr}$	Reverse recovery charge		-	13.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	49.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 49 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 19</a> )	-	688		ns
$Q_{rr}$	Reverse recovery charge		-	18		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	52		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

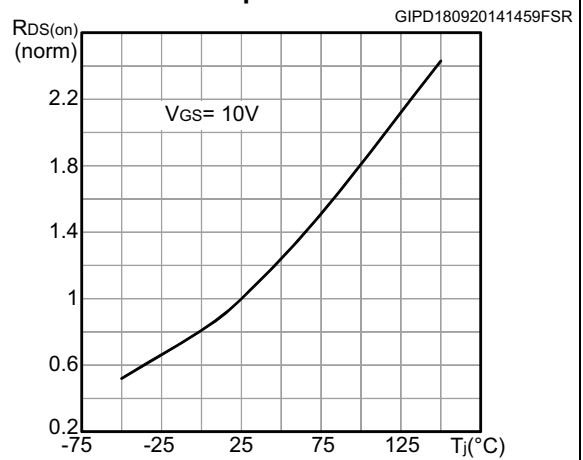
## 2.1 Electrical characteristics (curves)



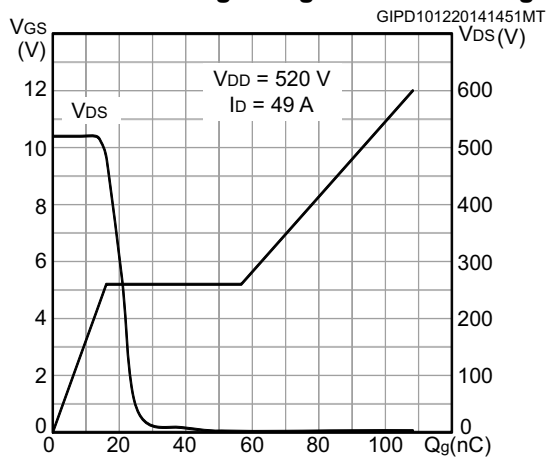
**Figure 8. Static drain-source on-resistance**



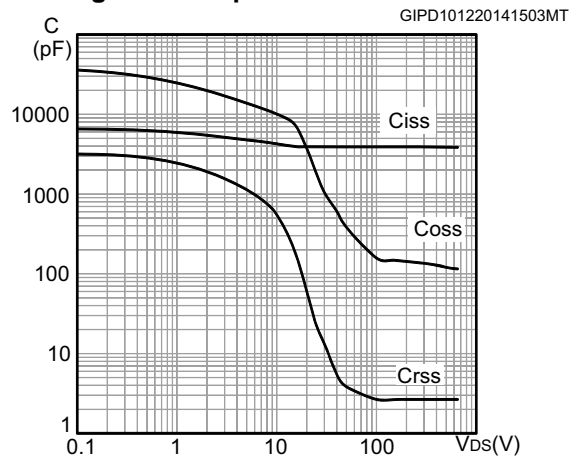
**Figure 9. Normalized on-resistance vs. temperature**



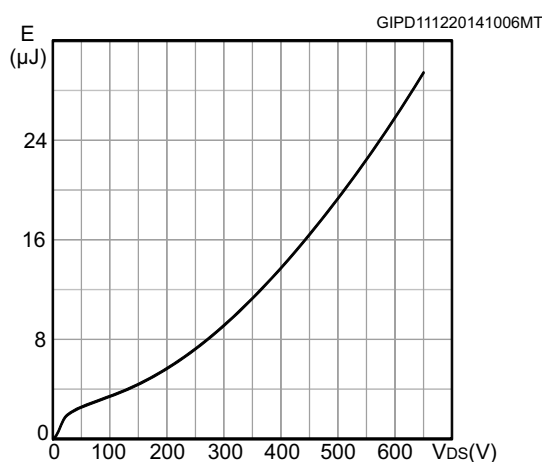
**Figure 10. Gate charge vs. gate-source voltage**



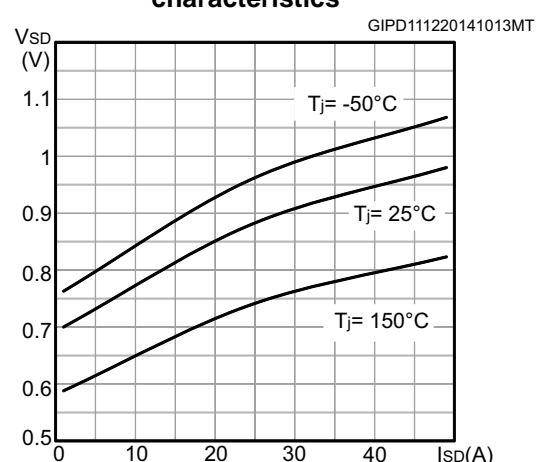
**Figure 11. Capacitance variations**



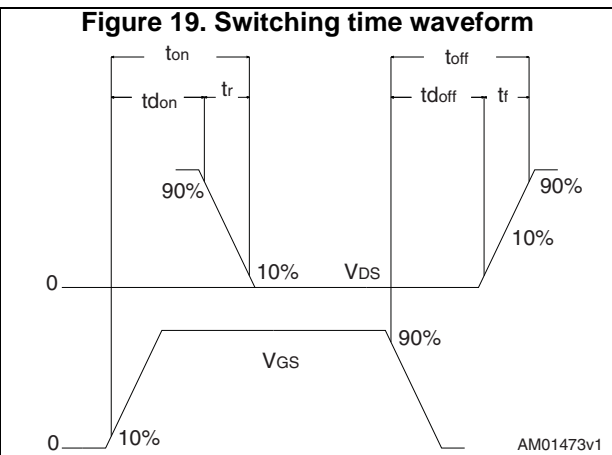
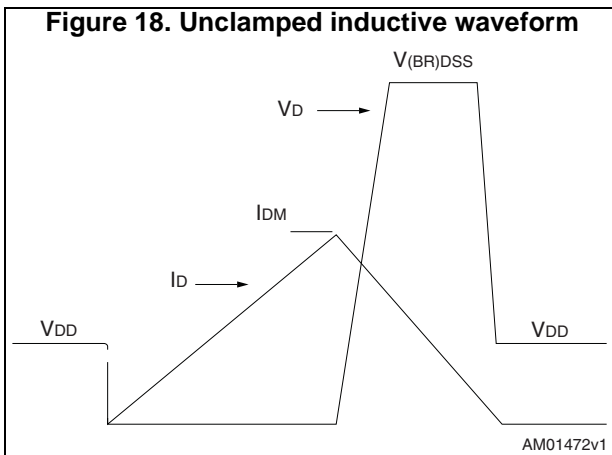
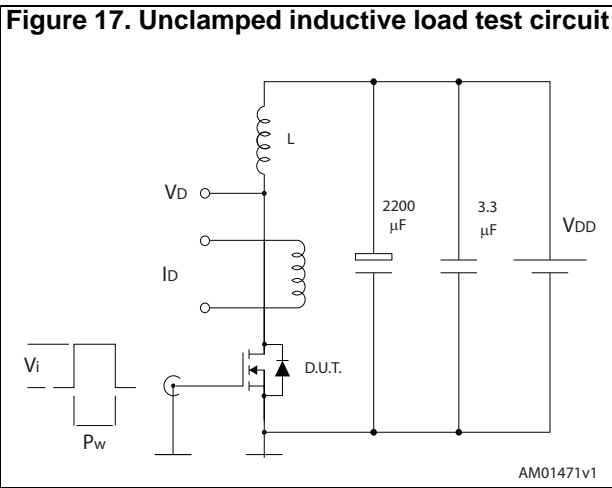
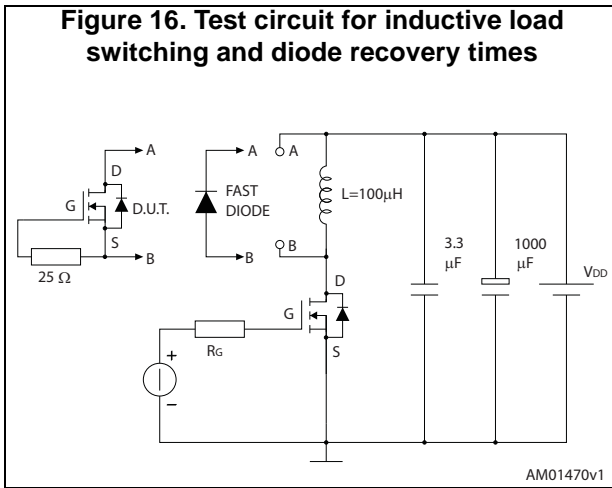
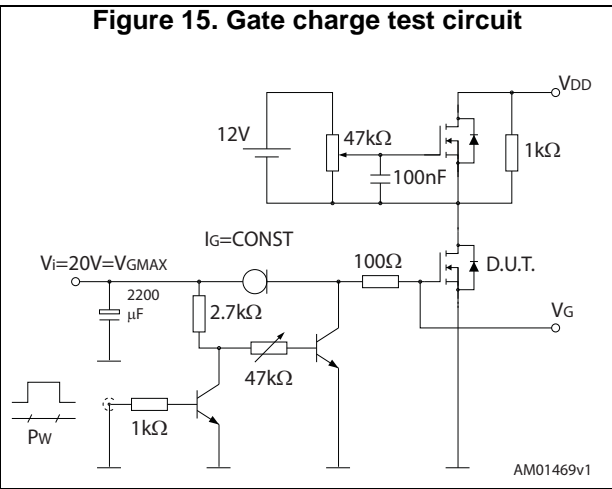
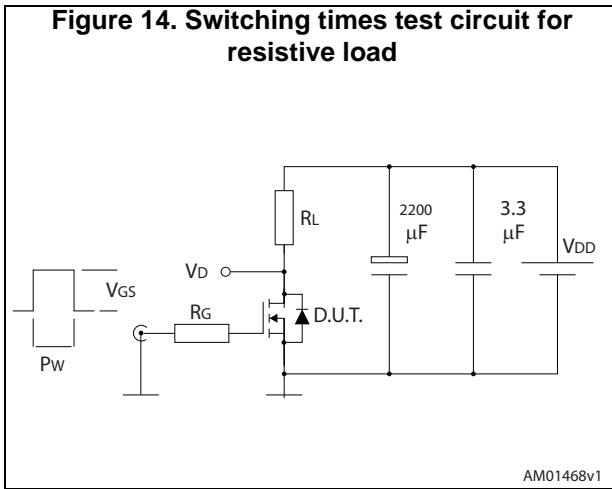
**Figure 12. Output capacitance stored energy**



**Figure 13. Source-drain diode forward characteristics**



### 3 Test circuits





## 4 Package mechanical data

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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 TO-247, STW56N65M2

Figure 20. TO-247 drawing

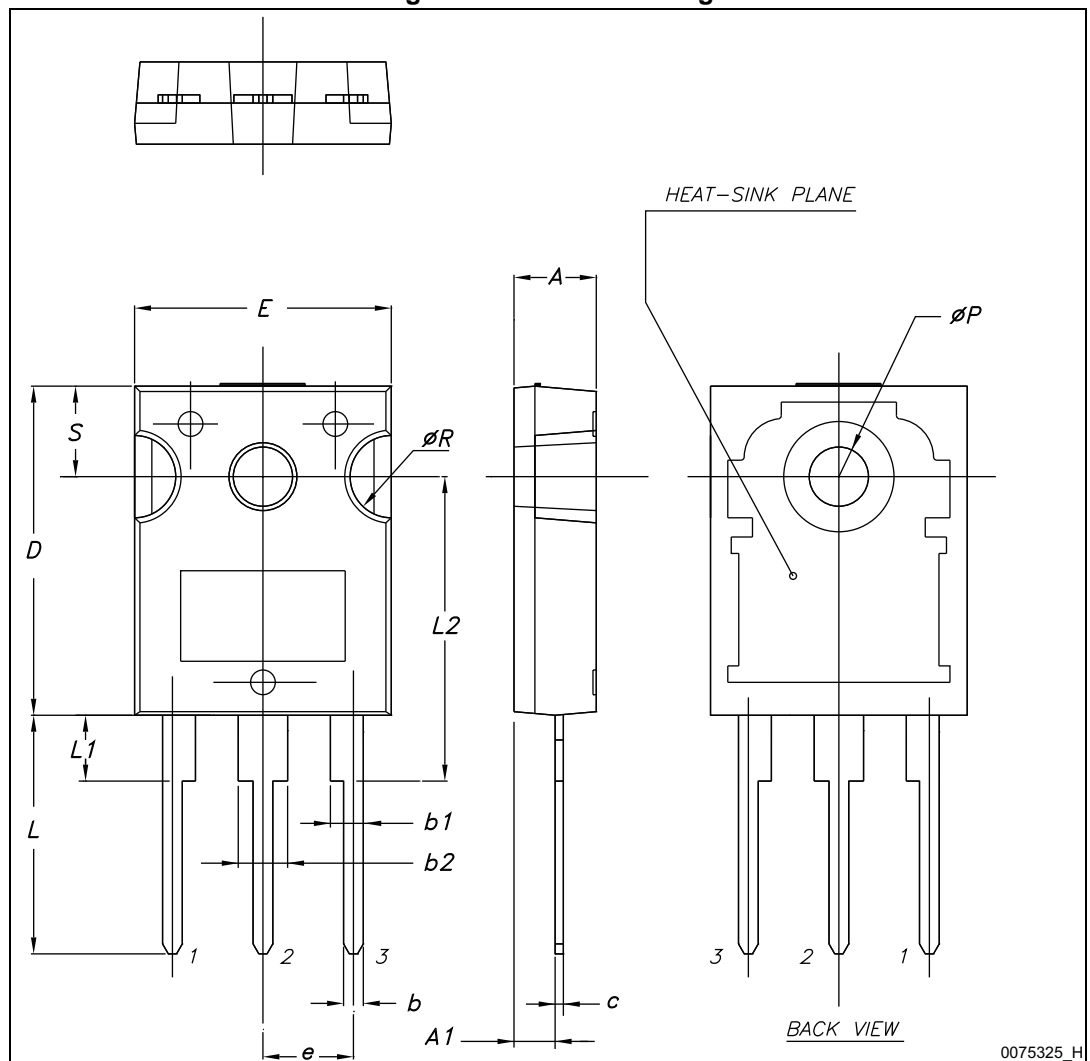


Table 9. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	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

## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
10-Dec-2014	1	Initial release.

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