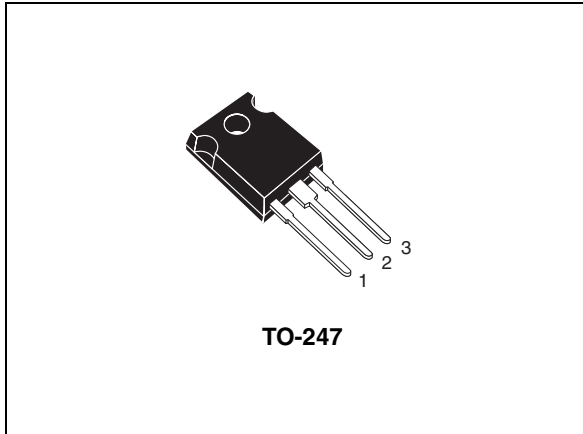
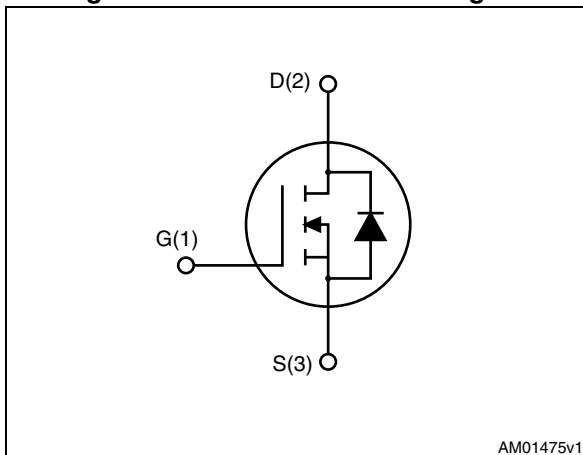


## Automotive-grade N-channel 600 V, 0.075 $\Omega$ typ., 35 A FDmesh™ II Power MOSFET (with fast diode) in a TO-247 package

Datasheet - production data



**Figure 1. Internal schematic diagram**



### Features

Order code	$V_{DS} @ T_{JMAX}$	$R_{DS(on) max}$	$I_D$
STW47NM60ND	650 V	0.088 $\Omega$	35 A

- Designed for automotive applications and AEC-Q101 qualified
- The worldwide best  $R_{DS(on)}$ \* area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities.

### Applications

- Switching applications

### Description

This device is an N-channel Power MOSFET developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

**Table 1. Device summary**

Order code	Marking	Packages	Packaging
STW47NM60ND	47NM60ND	TO-247	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	35	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	22	A
$I_{DM}^{(1)}$	Drain current (pulsed)	140	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	255	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	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.  $I_{SD} \leq 35\text{ A}$ ,  $di/dt \leq 600\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.49	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	$^\circ\text{C}/\text{W}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{j\text{ Max}}$ )	14	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J=25\text{ }^\circ\text{C}$ , $I_D=I_{AS}$ , $V_{DD}=50\text{ V}$ )	1000	mJ

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  unless otherwise specified).

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	600			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600\text{ V}$			10	$\mu\text{A}$
		$V_{DS} = 600\text{ V}$ , $T_J = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 17.5\text{ A}$		0.075	0.088	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}$ , $I_D = 17.5\text{ A}$	-	17	-	S
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	4200	-	pF
$C_{oss}$	Output capacitance		-	180	-	pF
$C_{rss}$	Reverse transfer capacitance		-	5	-	pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$ , $V_{DS} = 0\text{ to }480\text{ V}$	-	530	-	pF
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 35\text{ A}$ , $V_{GS} = 10\text{ V}$ , <i>(see Figure 15)</i>	-	120	-	nC
$Q_{gs}$	Gate-source charge		-	24	-	nC
$Q_{gd}$	Gate-drain charge		-	52	-	nC
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ , gate DC Bias = 0, test signal level = 20 mV, $I_D = 0$	-	1.7	-	$\Omega$

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

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

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 17.5\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 14)	-	30	-	ns
$t_r$	Rise time		-	40	-	ns
$t_{d(off)}$	Turn-off delay time		-	120	-	ns
$t_f$	Fall time		-	50	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current		-		35	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				140	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 35\text{ A}$ , $V_{GS} = 0$	-		1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 35\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see Figure 16)	-	190		ns
$Q_{rr}$	Reverse recovery charge				1.6	$\mu\text{C}$
$I_{RRM}$	Reverse recovery current				17	A
$t_{rr}$	Reverse recovery time	$I_{SD} = 35\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16)	-	280		ns
$Q_{rr}$	Reverse recovery charge				3.0	$\mu\text{C}$
$I_{RRM}$	Reverse recovery current				22	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 2. Safe operating area

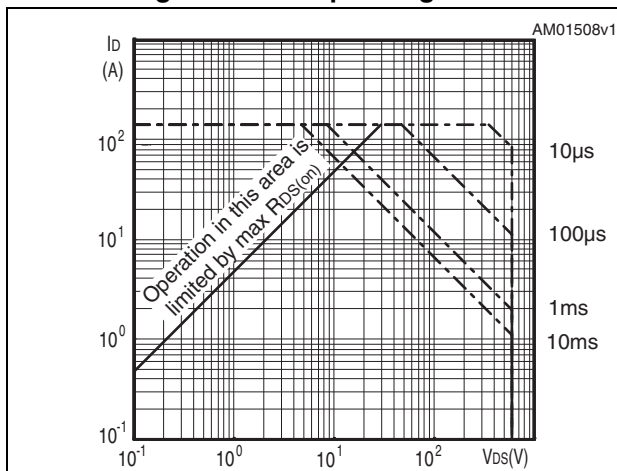


Figure 3. Thermal impedance

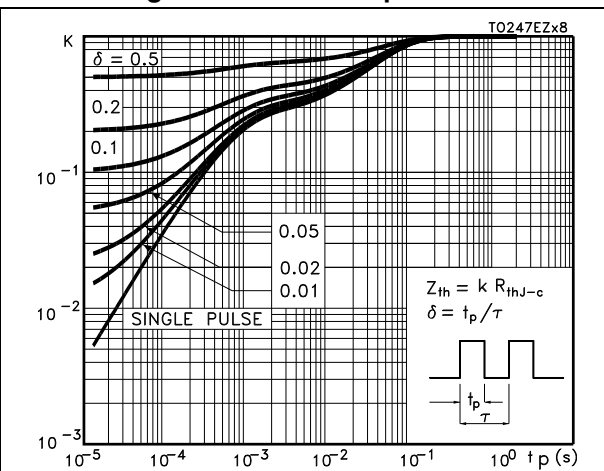


Figure 4. Output characteristics

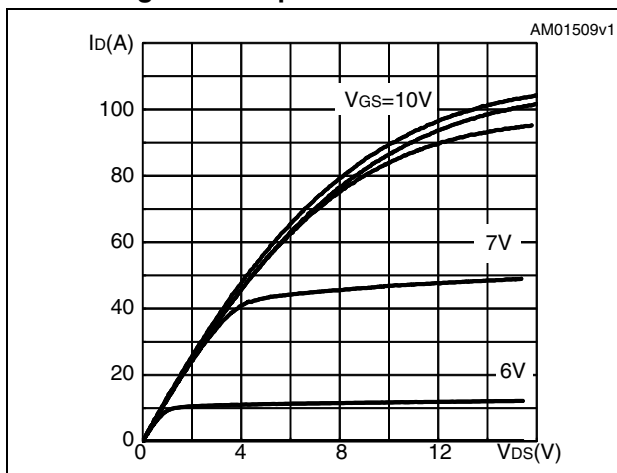


Figure 5. Transfer characteristics

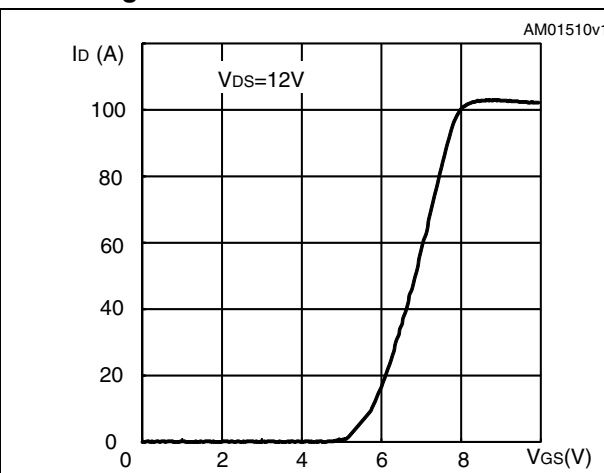


Figure 6. Transconductance

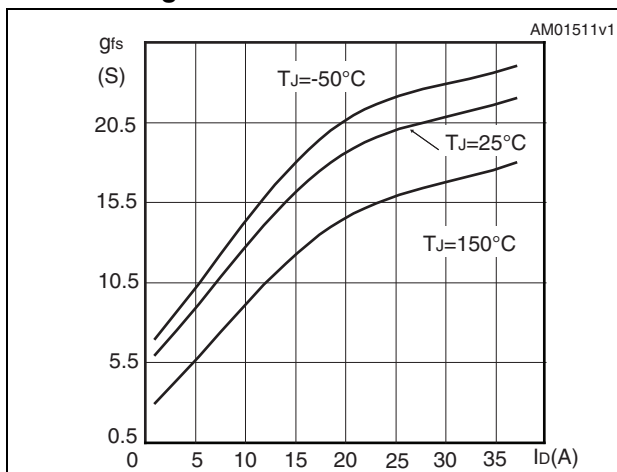


Figure 7. Static drain-source on-resistance

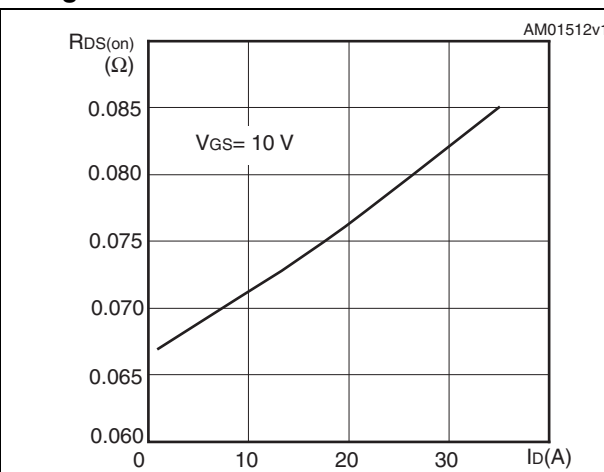


Figure 8. Gate charge vs gate-source voltage

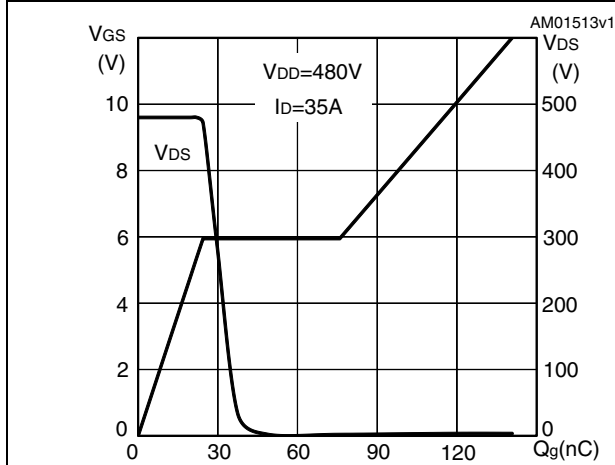


Figure 9. Capacitance variations

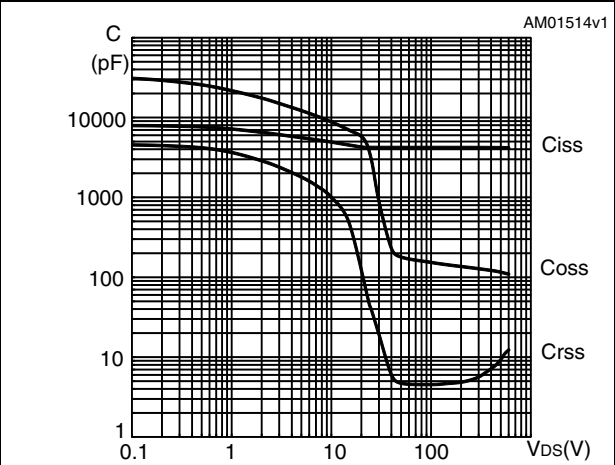


Figure 10. Normalized gate threshold voltage vs temperature

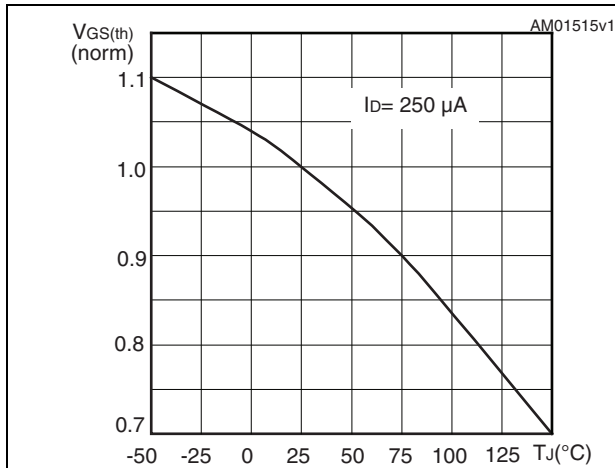


Figure 11. Normalized on resistance vs temperature

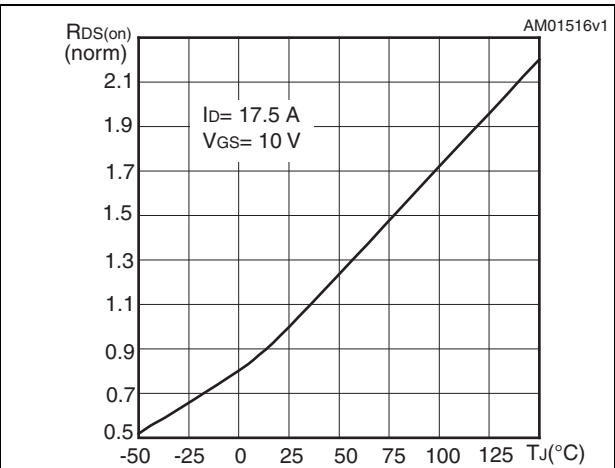


Figure 12. Source-drain diode forward characteristics

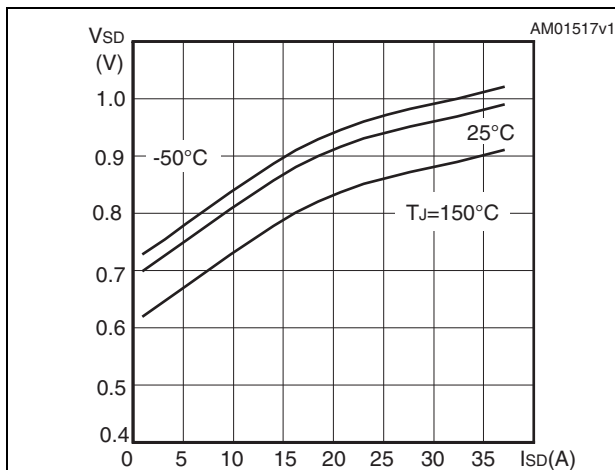
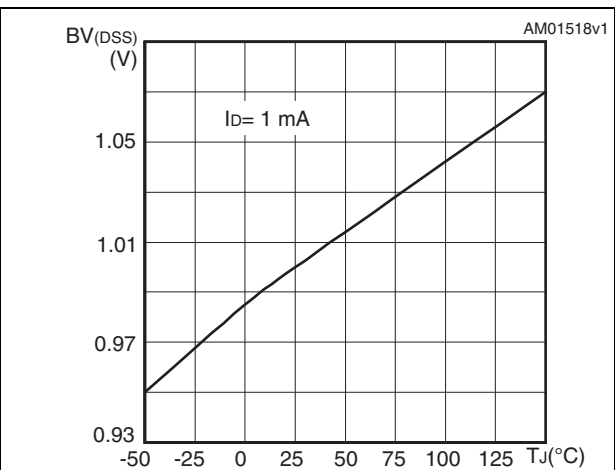


Figure 13. Normalized BV(DSS) vs temperature



### 3 Test circuits

**Figure 14. Switching times test circuit for resistive load**



**Figure 15. Gate charge test circuit**



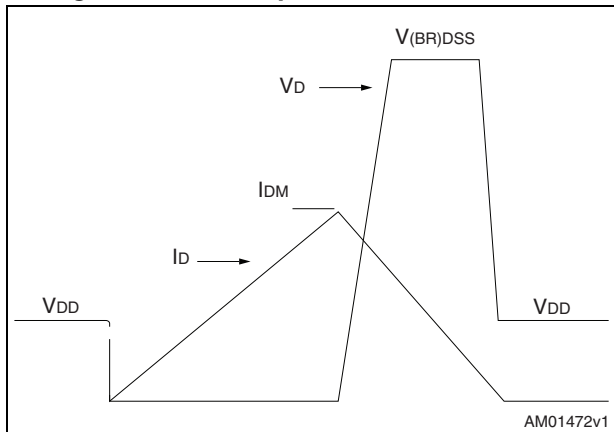
**Figure 16. Test circuit for inductive load switching and diode recovery times**



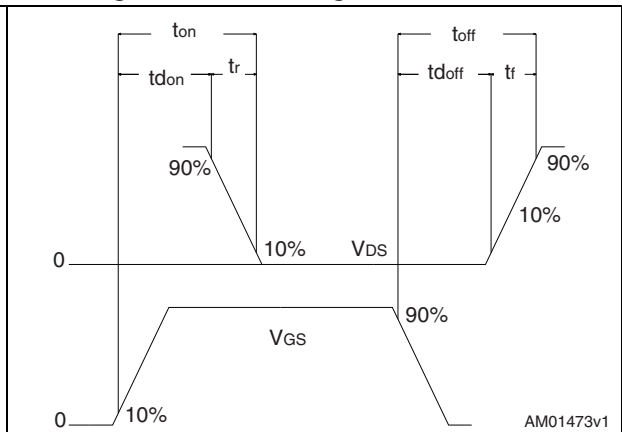
**Figure 17. Unclamped inductive load test circuit**



**Figure 18. Unclamped inductive waveform**



**Figure 19. Switching time waveform**





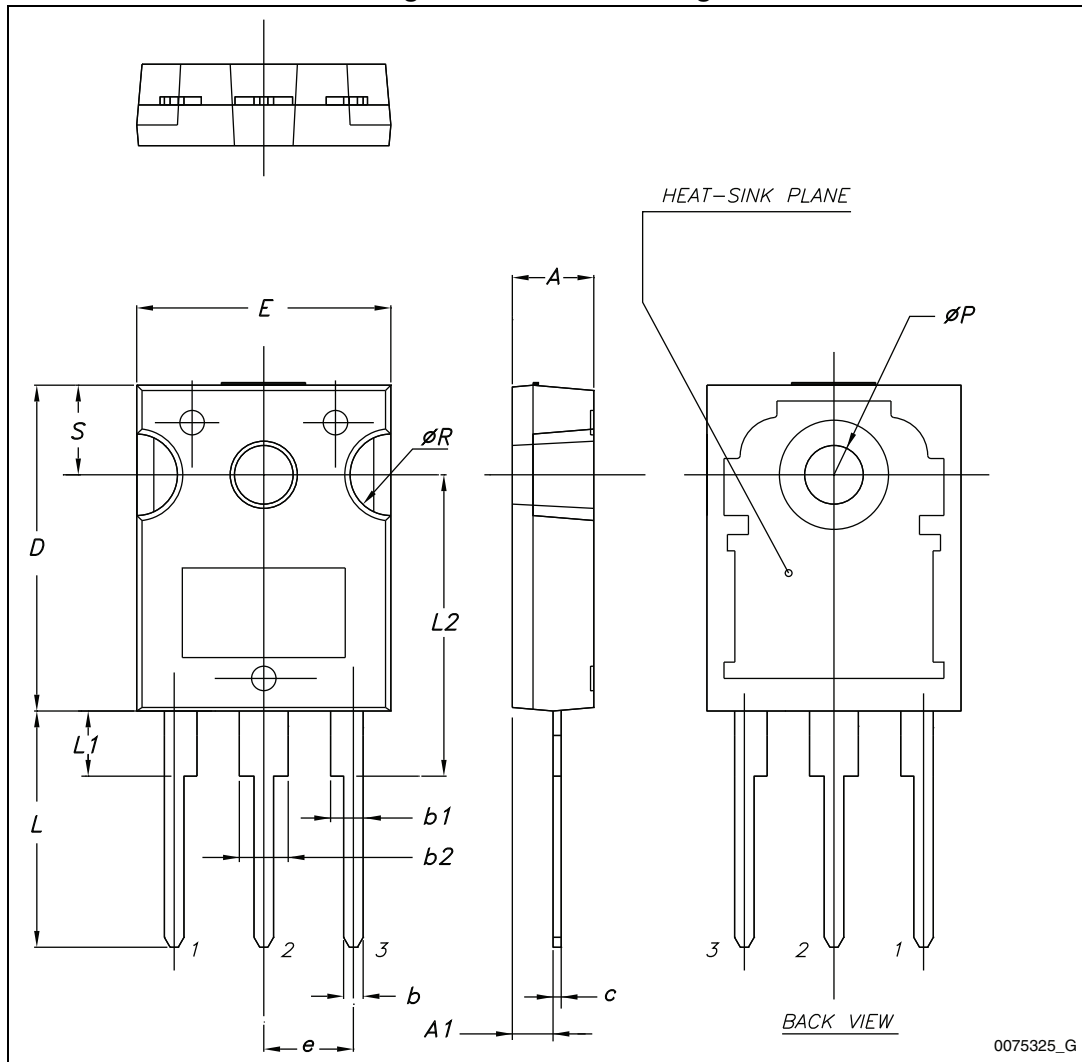
## 4 Package mechanical data

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

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

Figure 20. TO-247 drawing



## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
26-Nov-2010	1	First release.
11-Feb-2011	2	Updated coverpage, <a href="#">Table 5</a> and <a href="#">Section 4</a> .
30-Nov-2012	3	Updated: – Capacitances and gate charge values on <a href="#">Table 6</a> – <a href="#">Figure 4</a> , <a href="#">Figure 5</a> , <a href="#">Figure 7</a> , <a href="#">Figure 8</a> , <a href="#">Figure 9</a> , <a href="#">Figure 10</a> , <a href="#">Figure 11</a> and <a href="#">Figure 13</a> – <a href="#">Section 4: Package mechanical data</a> Minor text changes on the cover page to improve readability.
22-Oct-2013	4	– Updated title and features in cover page – Minor text changes

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