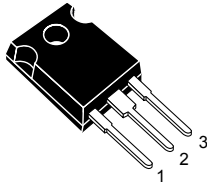
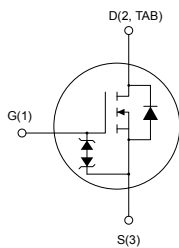


## N-channel 600 V, 45 mΩ typ., 52 A MDmesh M2 Power MOSFET in a TO-247 package


**TO-247**


AM01476v1\_lab



### Features

Order code	$V_{DS}$ at $T_J$ max.	$R_{DS(on)}$ max.	$I_D$
STW56N60M2	650 V	55 mΩ	52 A

- Extremely low gate charge
- Excellent output capacitance ( $C_{OSS}$ ) 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.

#### Product status link

[STW56N60M2](#)

#### Product summary

<b>Order code</b>	STW56N60M2
<b>Marking</b>	56N60M2
<b>Package</b>	TO-247
<b>Packing</b>	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	52	A
	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	33	
$I_{DM}^{(1)}$	Drain current (pulsed)	208	A
$P_{TOT}$	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	350	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 range	-55 to 150	$^\circ\text{C}$
$T_J$	Operating junction temperature	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 52\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ ,  $V_{DS} (\text{peak}) < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
3.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance, junction-to-case	0.36	$^\circ\text{C}/\text{W}$
$R_{thJA}$	Thermal resistance, junction-to-ambient	50	$^\circ\text{C}/\text{W}$

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or non-repetitive (pulse width limited by $T_J$ max.)	7.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	1100	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			100	
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 26\text{ A}$		45	55	m $\Omega$

1. Specified by design, not tested in production.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	3750	-	pF
$C_{oss}$	Output capacitance		-	175	-	pF
$C_{rss}$	Reverse transfer capacitance		-	6.6	-	pF
$C_{o(er)}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }480\text{ V}$	-	740	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , open drain	-	4.7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 52\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	91	-	nC
$Q_{gs}$	Gate-source charge		-	13.5	-	nC
$Q_{gd}$	Gate-drain charge		-	41	-	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 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 26\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	18	-	ns
$t_r$	Rise time		-	26.5	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	119	-	ns
$t_f$	Fall time		-	14	-	ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		52	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		208	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 52 \text{ A}, V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 52 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	-	496		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}$	-	10		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	41		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 52 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	-	632		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}, T_J = 150 \text{ }^\circ\text{C}$	-	14		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	45		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 1. Safe operating area

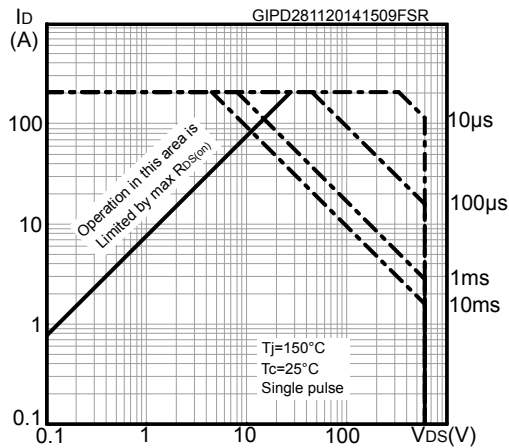


Figure 2. Thermal impedance

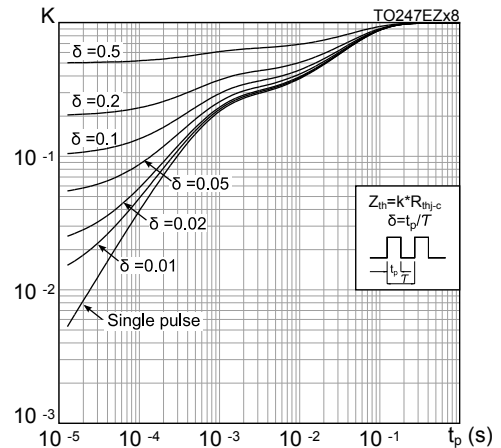


Figure 3. Output characteristics

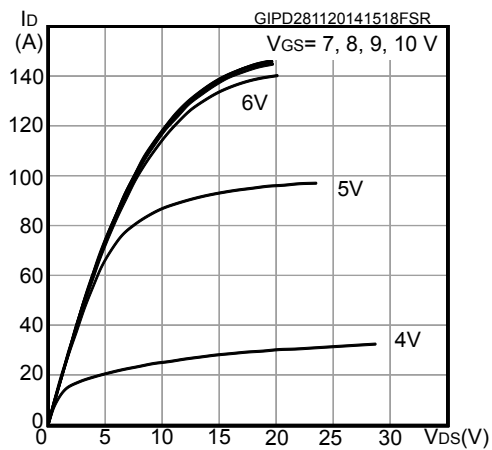


Figure 4. Transfer characteristics

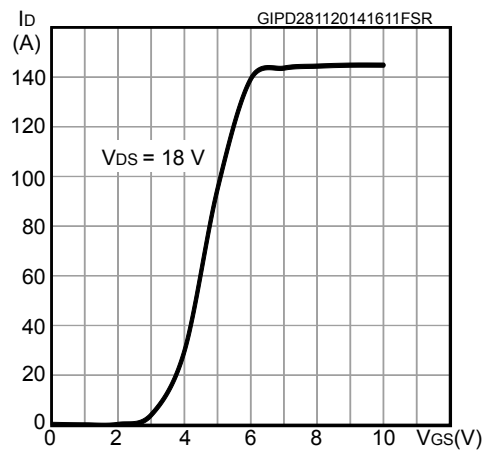


Figure 5. Gate charge vs gate-source voltage

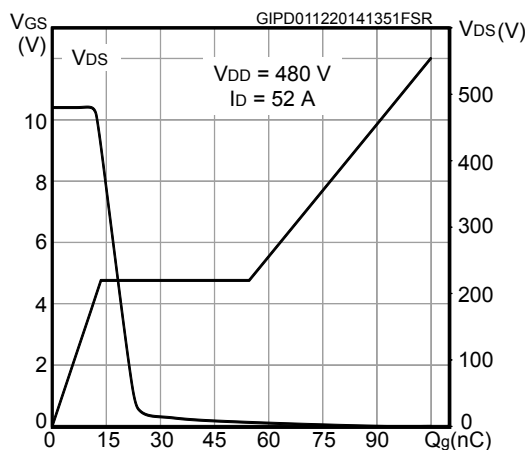
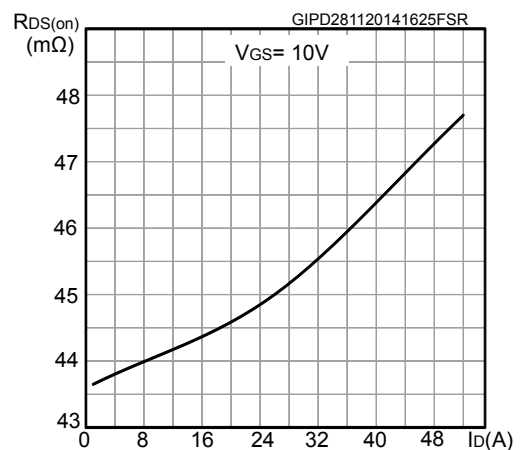
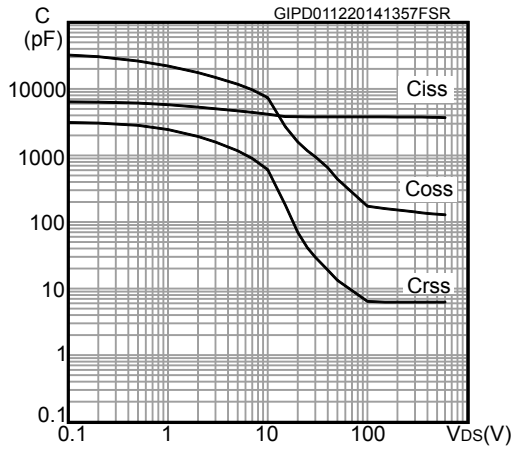


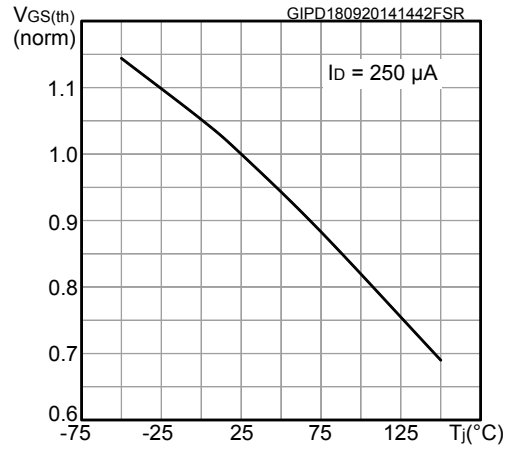
Figure 6. Static drain-source on-resistance



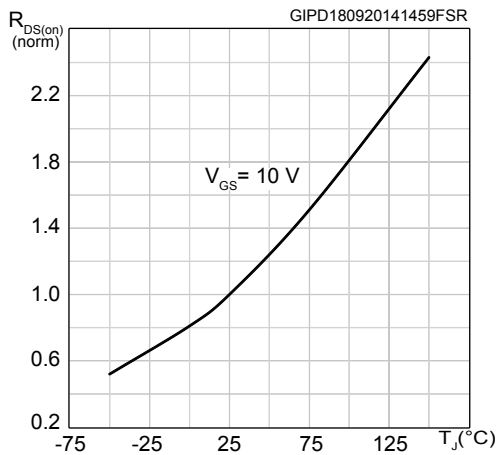
**Figure 7. Capacitance variations**



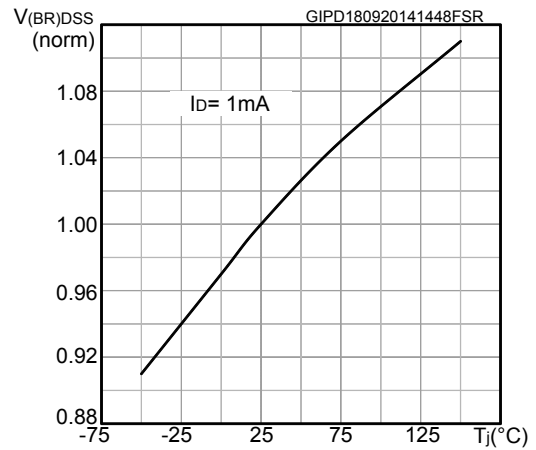
**Figure 8. Normalized gate threshold voltage vs temperature**



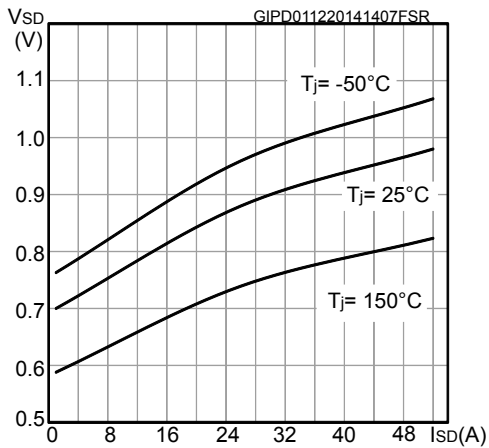
**Figure 9. Normalized on-resistance**



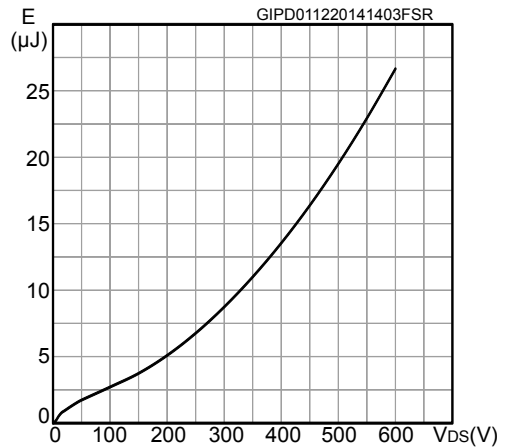
**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**



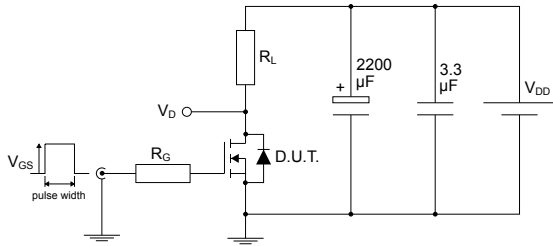
**Figure 11. Source-drain diode forward characteristics**



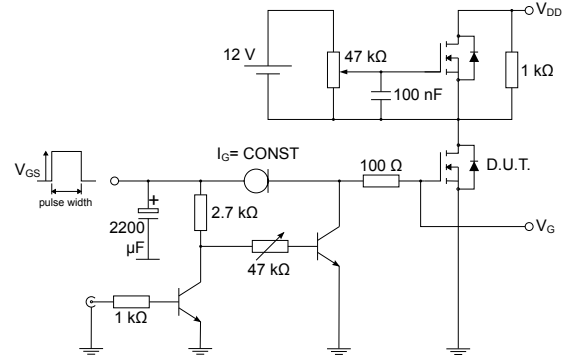
**Figure 12. Output capacitance stored energy**



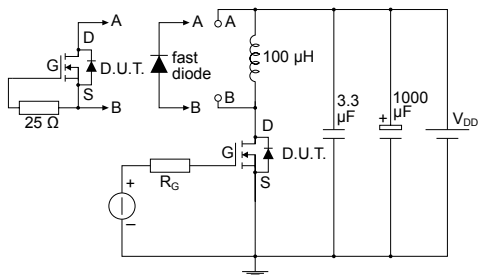
### 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**


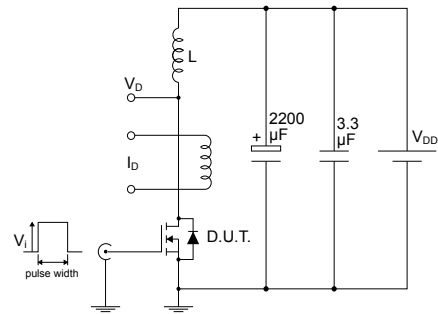
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**Figure 14. Test circuit for gate charge behavior**


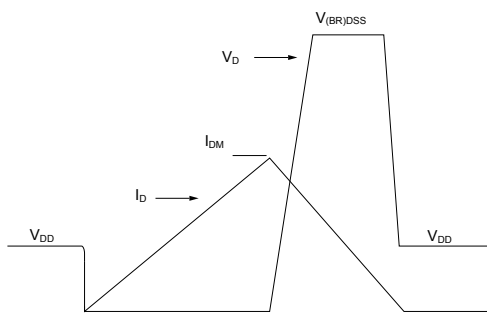
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


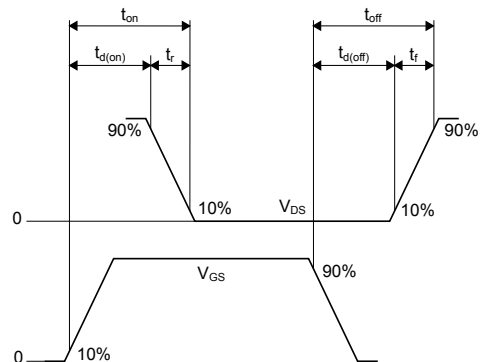
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**Figure 16. Unclamped inductive load test circuit**


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**Figure 17. Unclamped inductive waveform**


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**Figure 18. Switching time waveform**


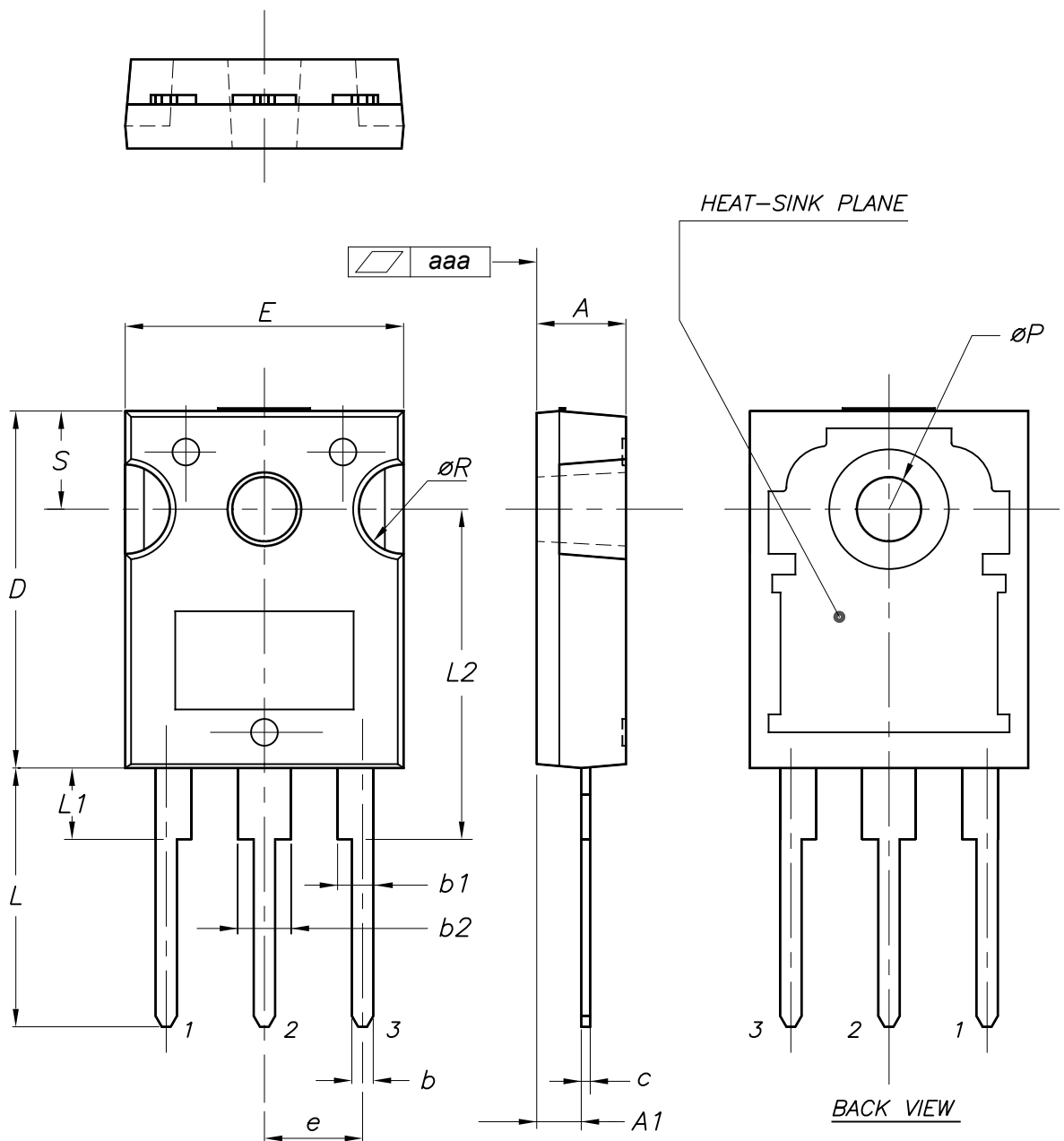
AM01473v1

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

### 4.1 TO-247 package information

Figure 19. TO-247 package outline



0075325\_10



**Table 8. TO-247 package 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
aaa		0.04	0.10

## Revision history

**Table 9. Document revision history**

Date	Revision	Changes
01-Dec-2014	1	Initial release.
10-Dec-2014	2	Updated <i>Section 3: Test circuits</i> .
25-Aug-2022	3	Updated <i>Internal schematic diagram</i> on cover page. Updated <i>Section 4 Package information</i> . Minor text changes.

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