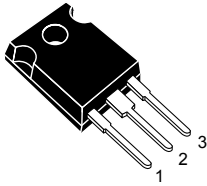
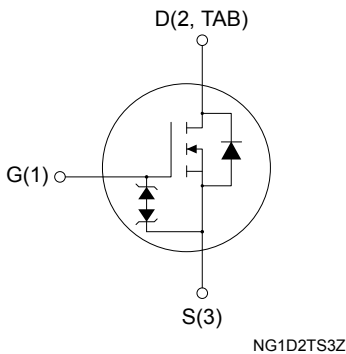


## Automotive-grade N-channel 650 V, 70 mΩ typ., 38 A Power MOSFET MDmesh DM2 in a TO-247 package




TO-247



### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STW50N65DM2AG	650 V	87 mΩ	38 A

- AEC-Q101 qualified 
- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

### Applications

- Switching applications

### Description

This high-voltage N-channel Power MOSFET is part of the MDmesh DM2 fast-recovery diode series. It offers very low recovery charge (Q<sub>rr</sub>) and time (t<sub>rr</sub>) combined with low R<sub>DS(on)</sub>, rendering it suitable for the most demanding high-efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

#### Product status link

[STW50N65DM2AG](#)

#### Product summary<sup>(1)</sup>

Order code	STW50N65DM2AG
Marking	50N65DM2
Package	TO-247
Packing	Tube

1. The HTRB test was performed at 80% V<sub>(BR)DSS</sub> in compliance with AEC-Q101 rev. C. All the other tests were performed according to rev. D.

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
V <sub>GS</sub>	Gate-source voltage (static)	±25	V
	Gate-source voltage (dynamic AC (f > 1 Hz))	±30	
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	38	A
	Drain current (continuous) at T <sub>C</sub> = 100 °C	24	
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	152	A
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	300	W
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	100	V/ns
di/dt <sup>(2)</sup>	Peak diode recovery current slope	1000	A/μs
dv/dt <sup>(3)</sup>	MOSFET dv/dt ruggedness	100	V/ns
T <sub>stg</sub>	Storage temperature	-55 to 150	°C
T <sub>J</sub>	Operating junction temperature		

1. Pulse width is limited by safe operating area.
2.  $I_{SD} \leq 38 \text{ A}$ ,  $V_{DS \text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .
3.  $V_{DS} \leq 520 \text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case	0.42	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	50	°C/W

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not repetitive	7.5	A
E <sub>AS</sub> <sup>(1)</sup>	Single pulse avalanche energy	850	mJ

1. Starting T<sub>J</sub> = 25 °C, I<sub>D</sub> = I<sub>AR</sub>, V<sub>DD</sub> = 50 V.

## 2 Electrical characteristics

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

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	650			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$			10	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			100	
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$			$\pm 5$	$\mu\text{A}$
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 19\text{ A}$		70	87	$\text{m}\Omega$

1. Defined by design, not subject to production test.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	3200	-	$\text{pF}$
$C_{oss}$	Output capacitance		-	130	-	$\text{pF}$
$C_{rss}$	Reverse transfer capacitance		-	3	-	$\text{pF}$
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0\text{ V}$	-	256	-	$\text{pF}$
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 38\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	69	-	$\text{nC}$
$Q_{gs}$	Gate-source charge		-	18	-	$\text{nC}$
$Q_{gd}$	Gate-drain charge		-	34	-	$\text{nC}$

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

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325\text{ V}$ , $I_D = 19\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	22.5	-	ns
$t_r$	Rise time		-	21	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	89	-	ns
$t_f$	Fall time		-	10.5	-	ns

**Table 7. Source-drain diode**

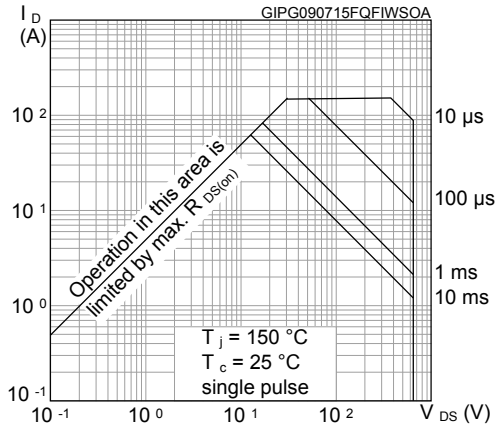
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		38	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		152	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 38\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 38\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	150		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$	-	0.96		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	12.8		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 38\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	245		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	2.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	22		A

1. Pulse width is limited by safe operating area.

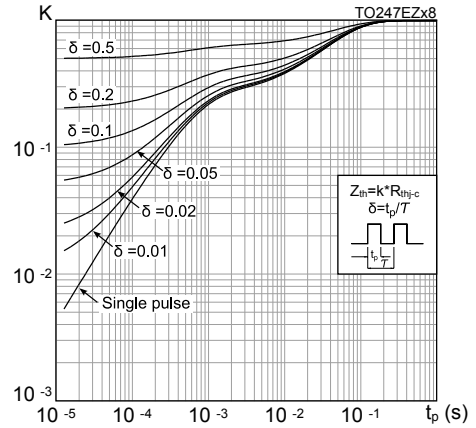
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

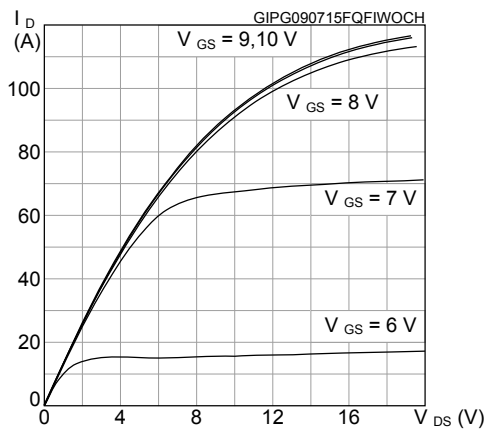
**Figure 1. Safe operating area**



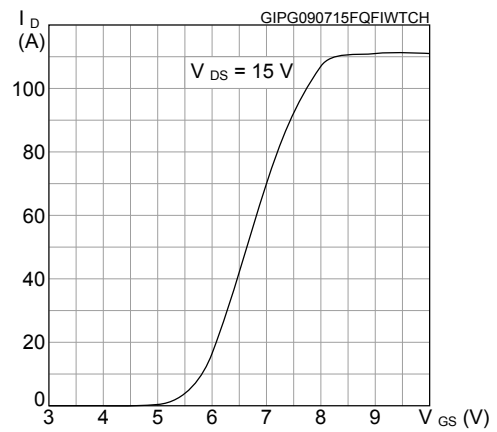
**Figure 2. Thermal impedance**



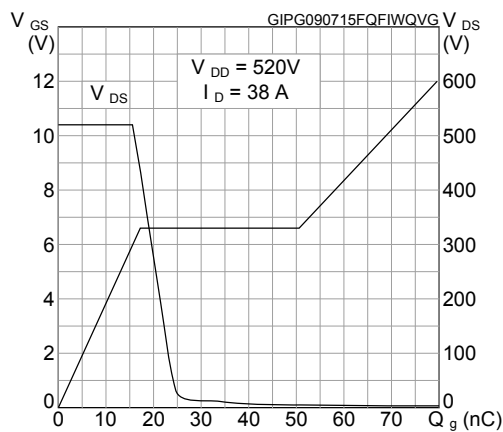
**Figure 3. Output characteristics**



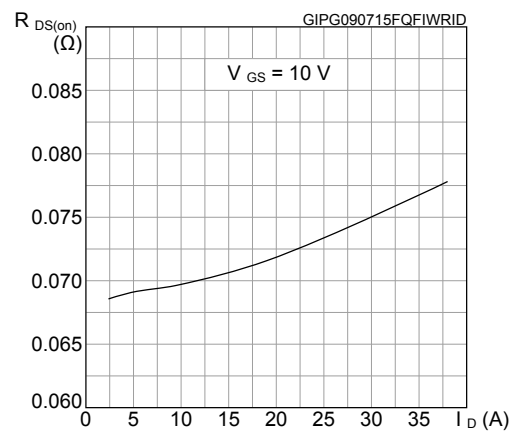
**Figure 4. Transfer characteristics**



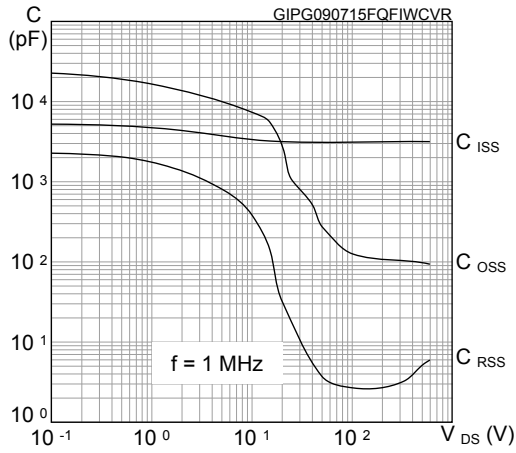
**Figure 5. Gate charge vs gate-source voltage**



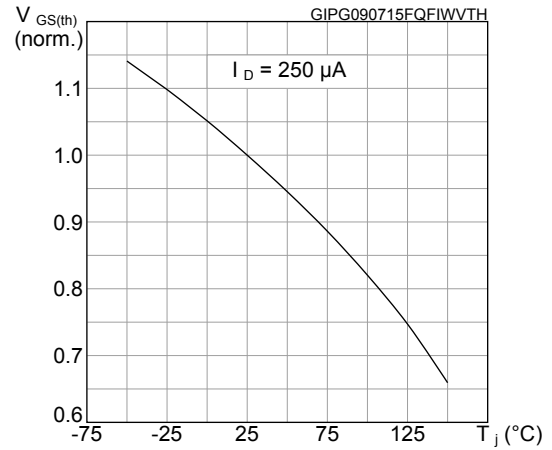
**Figure 6. Static drain-source on-resistance**



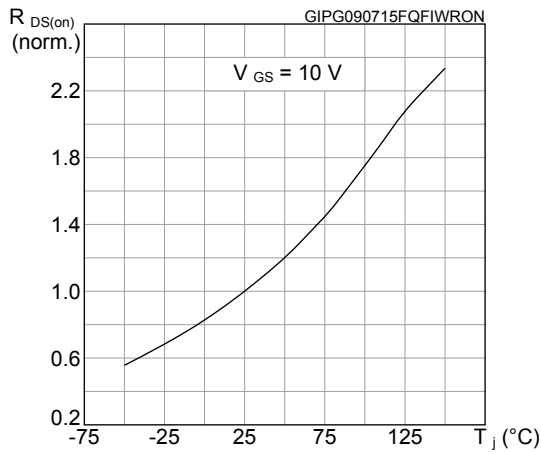
**Figure 7. Capacitance variations**



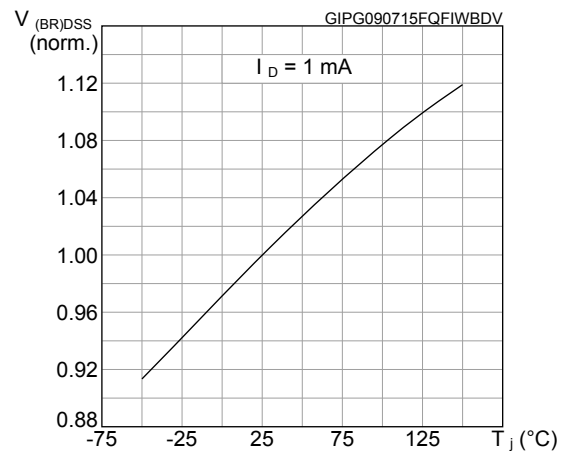
**Figure 8. Normalized gate threshold voltage vs temperature**



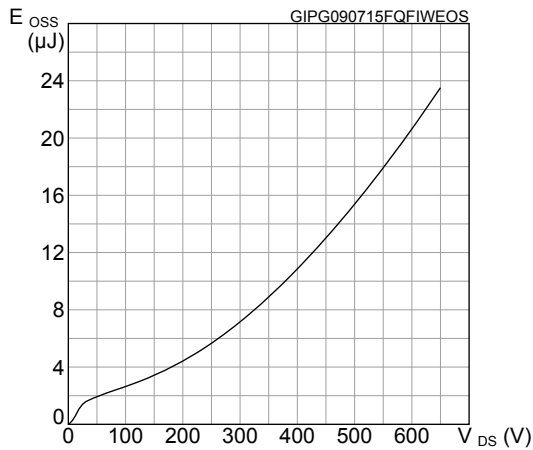
**Figure 9. Normalized on-resistance vs temperature**



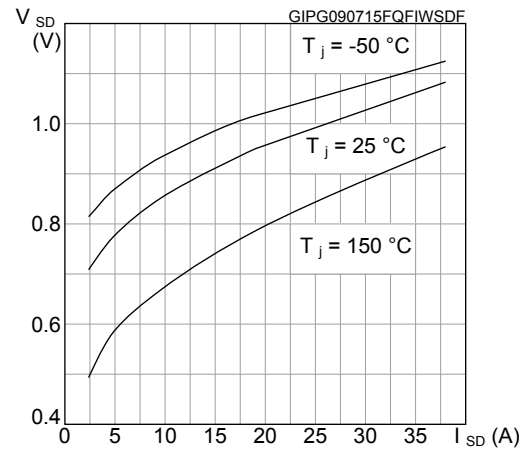
**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**



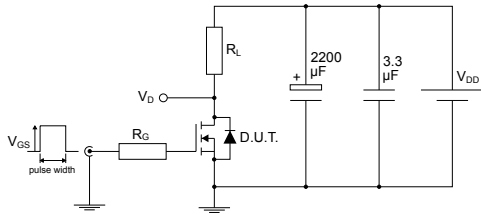
**Figure 11. Output capacitance stored energy**



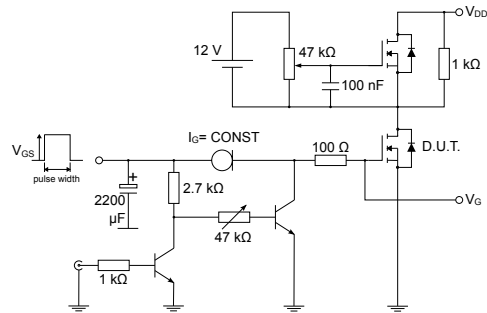
**Figure 12. Source-drain diode forward characteristics**



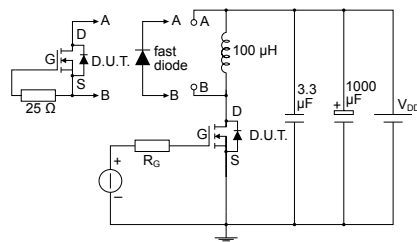
### 3 Test circuits

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


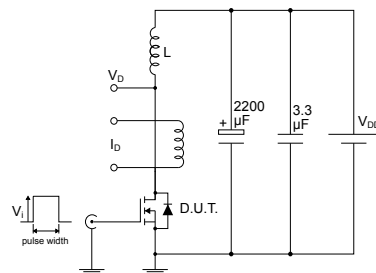
AM01468v1

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


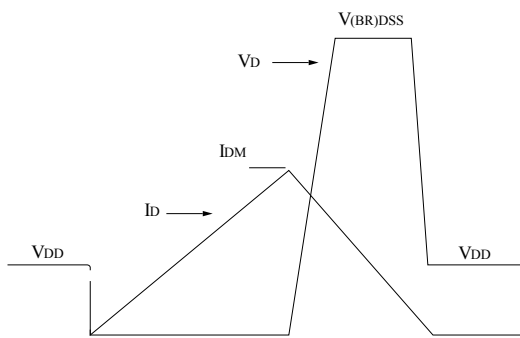
AM01469v1

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


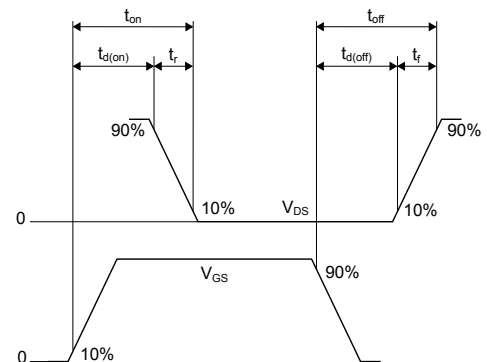
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**Figure 16. Unclamped inductive load test circuit**


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


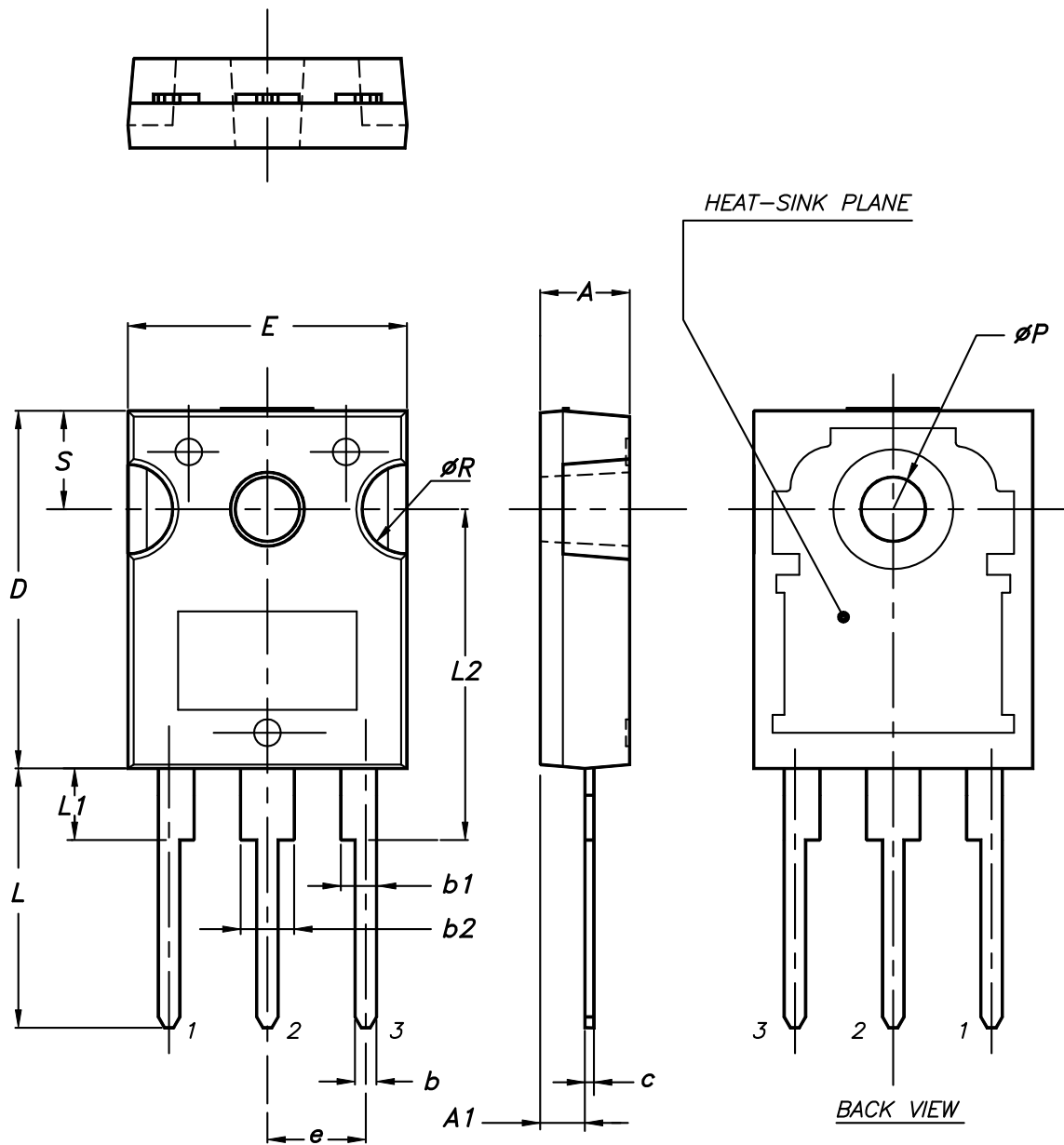
AM01473v1

## 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\_9



**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

## Revision history

**Table 9. Document revision history**

Date	Revision	Changes
09-Jul-2015	1	Initial release.
20-Dec-2017	2	Modified <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 4: "Avalanche characteristics"</i> and <i>Table 8: "Source-drain diode"</i> . Modified <i>Figure 2: "Safe operating area"</i> . Minor text changes.
31-Aug-2020	3	Updated <i>Table 1. Absolute maximum ratings</i> . Minor text changes.

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