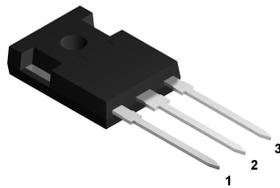
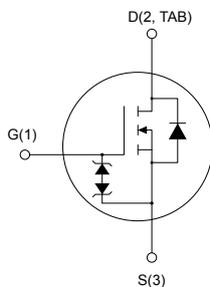


## Automotive-grade N-channel 650 V, 42 mΩ typ., 60 A MDmesh DM2 Power MOSFET in a TO-247 long leads package



TO-247 long leads



AM01476v1\_tab



### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$
STWA65N65DM2AG	650 V	50 mΩ	60 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 ( $Q_{rr}$ ) and time ( $t_{rr}$ ) combined with low  $R_{DS(on)}$ , rendering it suitable for the most demanding high-efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

#### Product status link

[STWA65N65DM2AG](#)

#### Product summary

<b>Order code</b>	STWA65N65DM2AG
<b>Marking</b>	65N65DM2
<b>Package</b>	TO-247 long leads
<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 $T_C = 25\text{ °C}$	60	A
	Drain current (continuous) at $T_C = 100\text{ °C}$	38	
$I_{DM}^{(1)}$	Drain current (pulsed)	240	A
$P_{TOT}$	Total power dissipation at $T_C = 25\text{ °C}$	446	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	100	V/ns
$dv/dt^{(2)}$	Peak diode recovery current slope	1000	A/ $\mu$ s
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	100	V/ns
$T_{stg}$	Storage temperature range	-55 to 150	$^{\circ}\text{C}$
$T_J$	Operating junction temperature range		$^{\circ}\text{C}$

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 60\text{ A}$ ,  $V_{DS}$  (peak)  $< V_{(BR)DSS}$ ,  $di/dt = 800\text{ A}/\mu\text{s}$ ,  $V_{DD} = 520\text{ V}$ .
3.  $V_{DD} = 520\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance, junction-to-case	0.28	$^{\circ}\text{C}/\text{W}$
$R_{thJA}$	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 not repetitive (pulse width limited by $T_J$ max.)	8	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	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	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	650			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$			10	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$ <sup>(1)</sup>			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	$V_{GS} = 10\text{ V}$ , $I_D = 30\text{ A}$		42	50	m $\Omega$

1. Specified by design, not tested in production.

**Table 5. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ kHz}$ , $V_{GS} = 0\text{ V}$	-	5500	-	pF
$C_{oss}$	Output capacitance		-	210	-	pF
$C_{rss}$	Reverse transfer capacitance		-	3	-	pF
$C_{oss\ eq}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0\text{ V}$	-	456	-	pF
$R_g$	Intrinsic gate resistance	$f = 250\text{ kHz}$ , $I_D = 0\text{ A}$	-	3.3	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 60\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	120	-	nC
$Q_{gs}$	Gate-source charge		-	27	-	nC
$Q_{gd}$	Gate-drain charge		-	58	-	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 stated value.

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325\text{ V}$ , $I_D = 30\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	33	-	ns
$t_r$	Rise time		-	13.5	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	114	-	ns
$t_f$	Fall time		-	11.5	-	ns

**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		60	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		240	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 60\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 60\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	154		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	0.94		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	12.2		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 60\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	288		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	3.65		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	25.4		A

1. Pulse width is 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

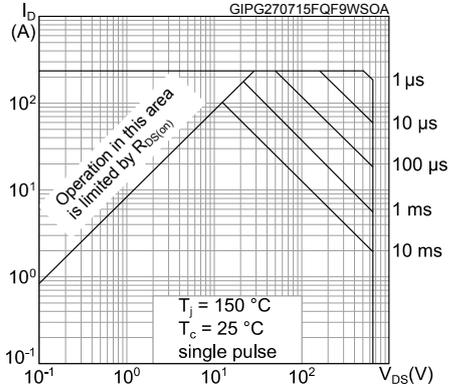


Figure 2. Normalized transient thermal impedance

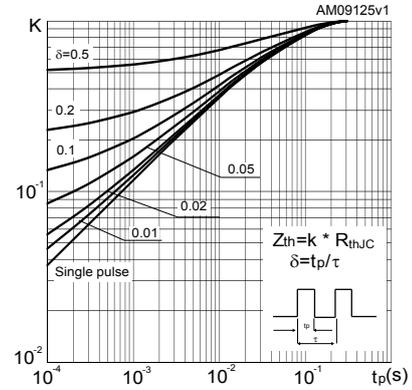


Figure 3. Typical output characteristics

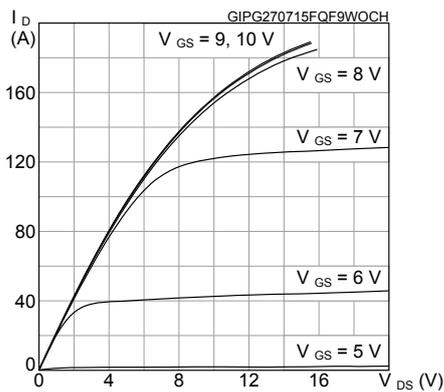


Figure 4. Typical transfer characteristics

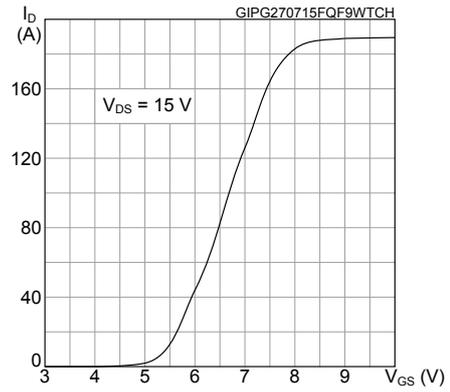


Figure 5. Typical gate charge characteristics

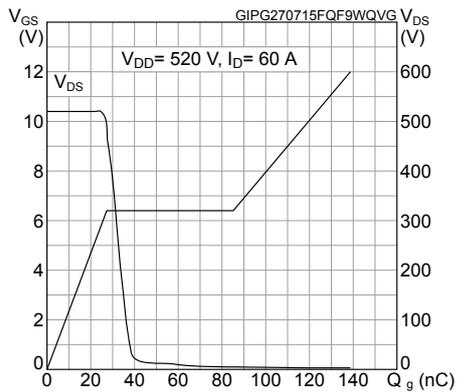
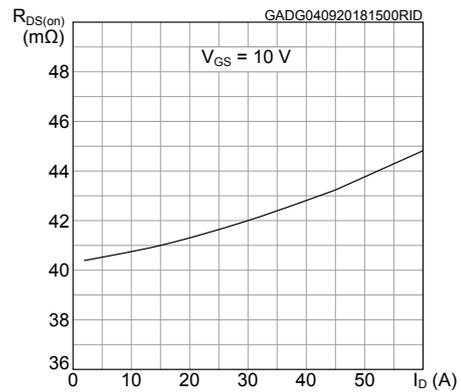
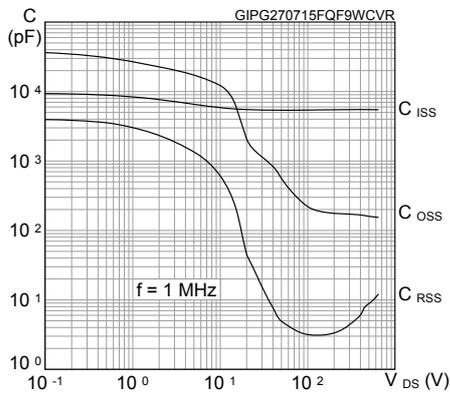


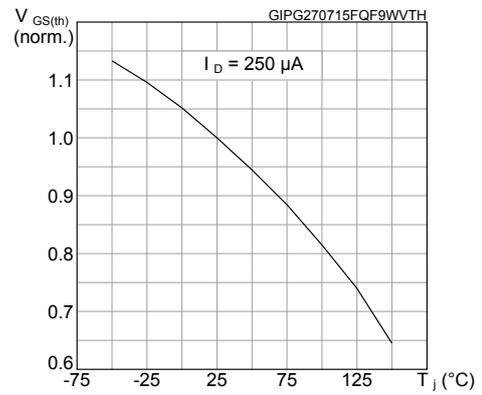
Figure 6. Typical drain-source on-resistance



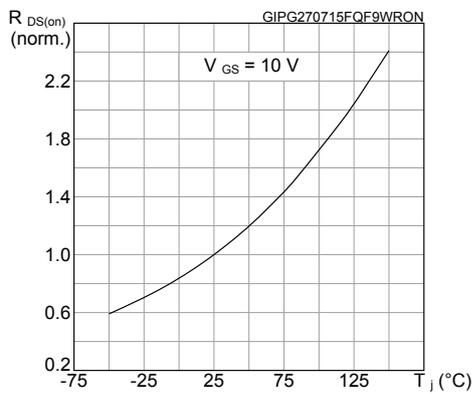
**Figure 7. Typical capacitance characteristics**



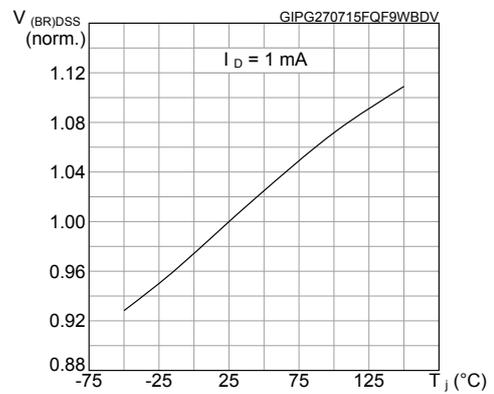
**Figure 8. Normalized gate threshold vs temperature**



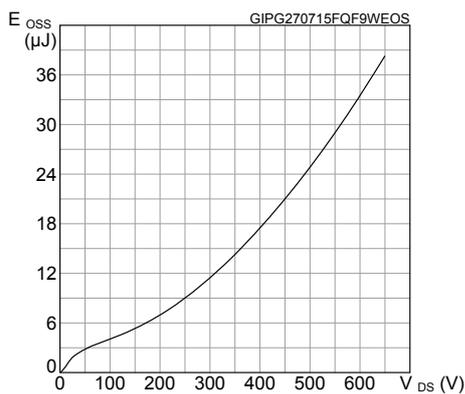
**Figure 9. Normalized on-resistance vs temperature**



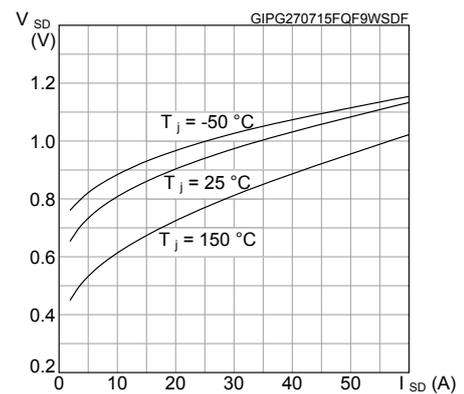
**Figure 10. Normalized breakdown voltage vs temperature**



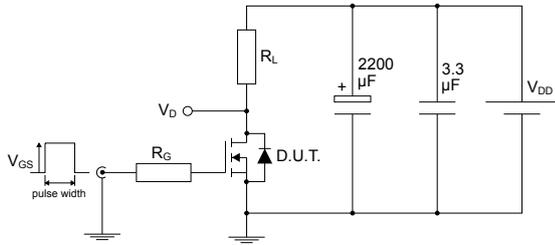
**Figure 11. Typical output capacitance stored energy**



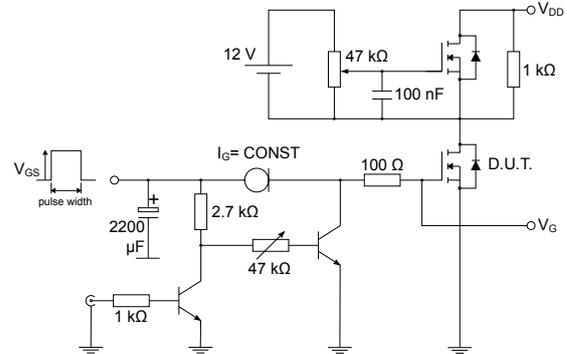
**Figure 12. Typical reverse diode forward characteristics**



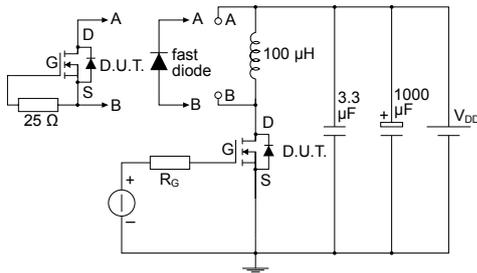
### 3 Test circuits

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


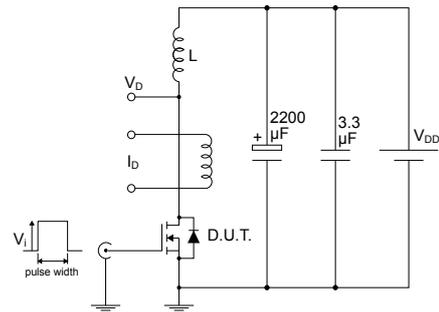
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**Figure 14. Test circuit for gate charge behavior**


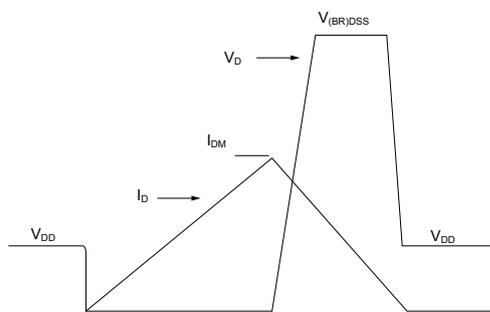
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


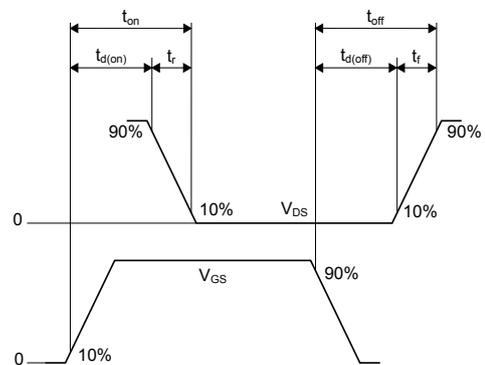
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**Figure 16. Unclamped inductive load test circuit**


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**Figure 17. Unclamped inductive waveform**


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**Figure 18. Switching time waveform**


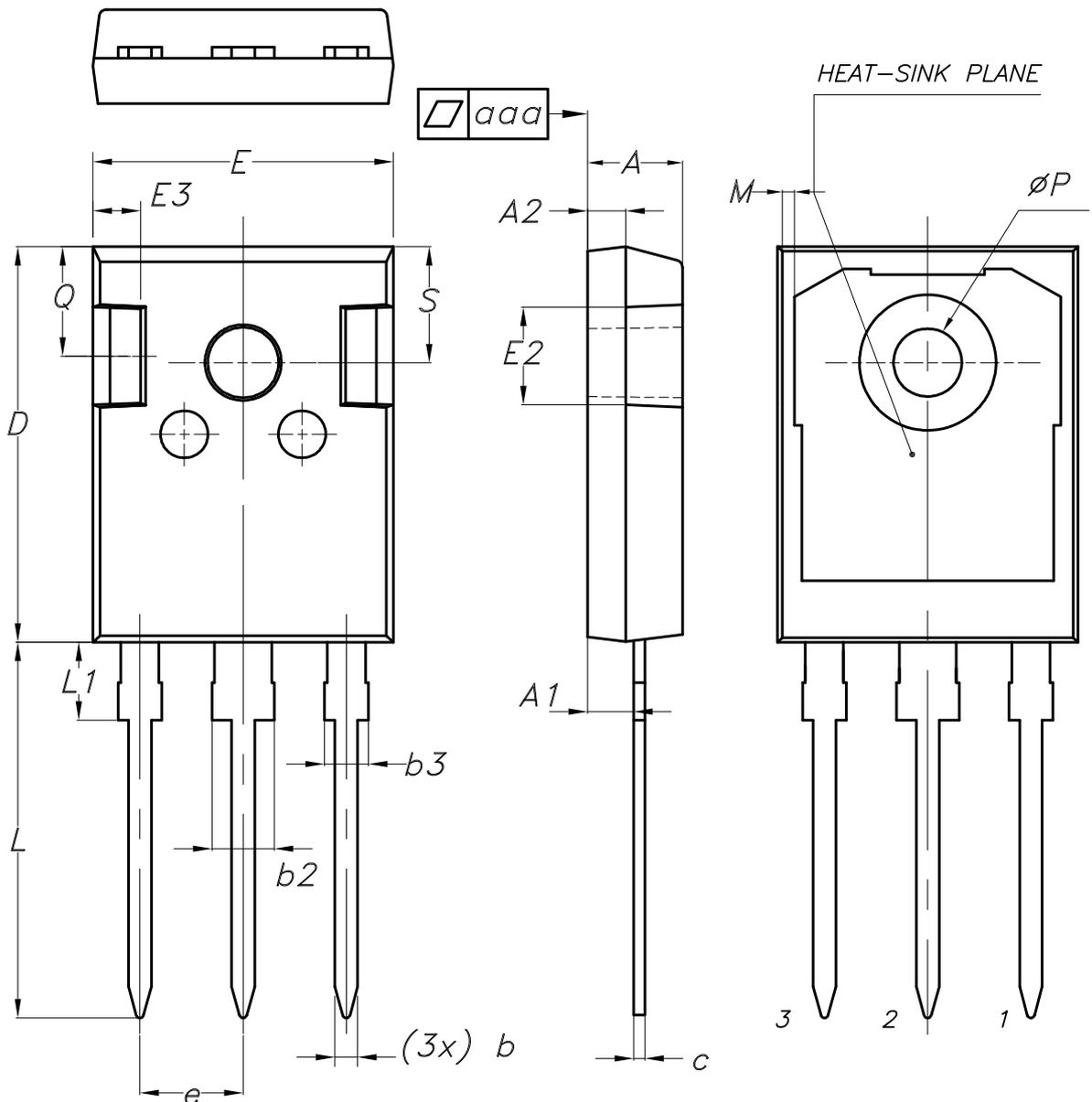
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## 4 Package information

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 long leads package information

Figure 19. TO-247 long leads package outline



BACK VIEW

8463846\_6

**Table 8. TO-247 long leads package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
M	0.35		0.95
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

## Revision history

**Table 9. Document revision history**

Date	Revision	Changes
04-Sep-2018	1	Initial release.
03-Oct-2018	2	Modified <i>Table 1. Absolute maximum ratings</i> , <i>Table 3. Avalanche characteristics</i> and <i>Table 7. Source-drain diode</i> . Updated <i>Figure 1. Safe operating area</i> . Minor text changes.
25-May-2020	3	Updated <i>Table 1. Absolute maximum ratings</i> .
11-Mar-2025	4	Updated <a href="#">Section 4.1: TO-247 long leads package information</a> . Minor text changes.

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