

N-channel 600 V, 0.06  $\Omega$  typ., 42 A MDmesh™ M2

Power MOSFET in a TO-247 package

Datasheet - production data

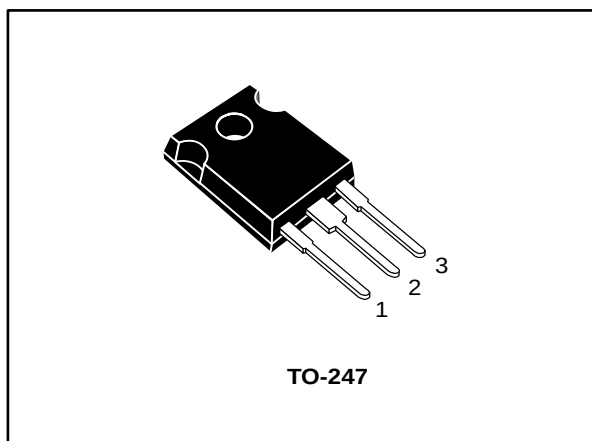
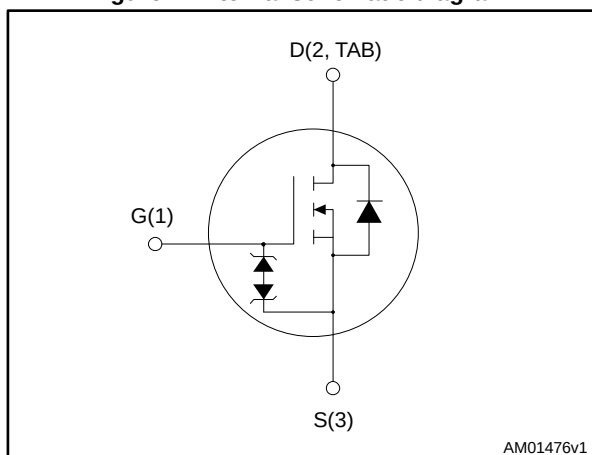


Figure 1: Internal schematic diagram



## Features

| Order code | $V_{DS}$ @ $T_{Jmax}$ . | $R_{DS(on)}$ max. | $I_D$ |
|------------|-------------------------|-------------------|-------|
| STW48N60M2 | 650 V                   | 0.07 $\Omega$     | 42 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.

Table 1: Device summary

| Order code | Marking | Package | Packing |
|------------|---------|---------|---------|
| STW48N60M2 | 48N60M2 | TO-247  | Tube    |

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## 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 $T_C = 25\text{ }^{\circ}\text{C}$  | 42          | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 26          | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                            | 168         | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 300         | 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 range                              |             |                    |

**Notes:**

<sup>(1)</sup>Pulse width limited by safe operating area.

<sup>(2)</sup> $I_{SD} \leq 42\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS(\text{peak})} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$

<sup>(3)</sup> $V_{DS} \leq 480\text{ V}$

Table 3: Thermal data

| Symbol         | Parameter                                | Value | Unit                        |
|----------------|------------------------------------------|-------|-----------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max.    | 0.42  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max. | 50    | $^{\circ}\text{C}/\text{W}$ |

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                              | Value | Unit |
|----------|------------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax.}$ )                                  | 7     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ ; $V_{DD} = 50\text{ V}$ ) | 1     | J    |

## 2 Electrical characteristics

(T<sub>C</sub> = 25 °C unless otherwise specified)

Table 5: On /off-states

| Symbol               | Parameter                         | Test conditions                                                                      | Min. | Typ. | Max. | Unit |
|----------------------|-----------------------------------|--------------------------------------------------------------------------------------|------|------|------|------|
| V <sub>(BR)DSS</sub> | Drain-source breakdown voltage    | V <sub>GS</sub> = 0, I <sub>D</sub> = 1 mA                                           | 600  |      |      | V    |
| I <sub>DSS</sub>     | Zero-gate voltage drain current   | V <sub>GS</sub> = 0, V <sub>DS</sub> = 600 V                                         |      |      | 1    | μA   |
|                      |                                   | V <sub>GS</sub> = 0, V <sub>DS</sub> = 600 V, T <sub>C</sub> = 125 °C <sup>(1)</sup> |      |      | 100  | μA   |
| I <sub>GSS</sub>     | Gate-body leakage current         | V <sub>DS</sub> = 0, V <sub>GS</sub> = ± 25 V                                        |      |      | ±10  | μA   |
| V <sub>GS(th)</sub>  | Gate threshold voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                          | 2    | 3    | 4    | V    |
| R <sub>DS(on)</sub>  | Static drain-source on-resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 21 A                                        |      | 0.06 | 0.07 | Ω    |

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

Table 6: Dynamic

| Symbol                              | Parameter                     | Test conditions                                                                                                                                        | Min. | Typ. | Max. | Unit |
|-------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| C <sub>iss</sub>                    | Input capacitance             | V <sub>GS</sub> = 0, V <sub>DS</sub> = 100 V, f = 1 MHz                                                                                                | -    | 3060 | -    | pF   |
| C <sub>oss</sub>                    | Output capacitance            |                                                                                                                                                        | -    | 143  | -    | pF   |
| C <sub>rss</sub>                    | Reverse transfer capacitance  |                                                                                                                                                        | -    | 4.3  | -    | pF   |
| C <sub>oss eq.</sub> <sup>(1)</sup> | Equivalent output capacitance | V <sub>GS</sub> = 0, V <sub>DS</sub> = 0 to 480 V                                                                                                      | -    | 630  | -    | pF   |
| R <sub>G</sub>                      | Intrinsic gate resistance     | f = 1 MHz, I <sub>D</sub> = 0                                                                                                                          | -    | 4.6  | -    | Ω    |
| Q <sub>g</sub>                      | Total gate charge             | V <sub>DD</sub> = 480 V, I <sub>D</sub> = 42 A,<br>V <sub>GS</sub> = 10 V<br>(see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> ) | -    | 70   | -    | nC   |
| Q <sub>gs</sub>                     | Gate-source charge            |                                                                                                                                                        | -    | 10.5 | -    | nC   |
| Q <sub>gd</sub>                     | Gate-drain charge             |                                                                                                                                                        | -    | 31   | -    | nC   |

**Notes:**

<sup>(1)</sup>C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>.

Table 7: Switching times

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                                                    | Min. | Typ. | Max. | Unit |
|--------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 21\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> and<br><a href="#">Figure 19: "Switching time waveform"</a> ) | -    | 18.5 | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                    | -    | 17   | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                                                                                                                                    | -    | 13   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                    | -    | 119  | -    | ns   |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                        | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                        | -    |      | 42   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                        | -    |      | 168  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0$ , $I_{SD} = 21\text{ A}$                                                                                                                                                                  | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 42\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 17: "Unclamped inductive load test circuit"</a> )                                        | -    | 487  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                        | -    | 9.1  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                        | -    | 37.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 42\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 17: "Unclamped inductive load test circuit"</a> ) | -    | 605  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                        | -    | 12.5 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                        | -    | 41.5 |      | A             |

**Notes:**

(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

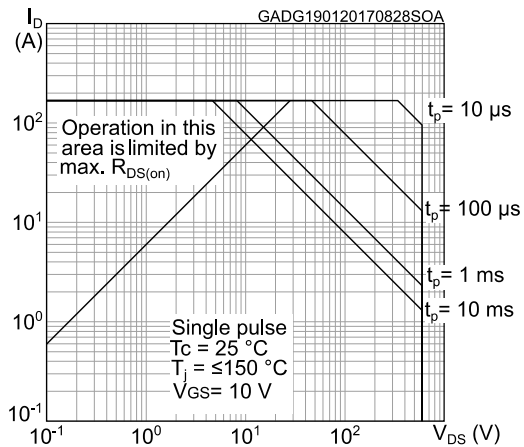


Figure 3: Thermal impedance

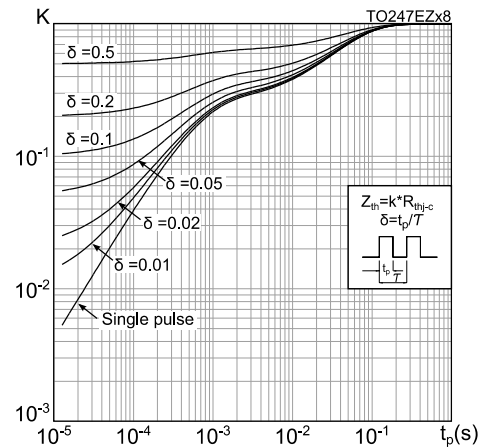


Figure 4: Output characteristics

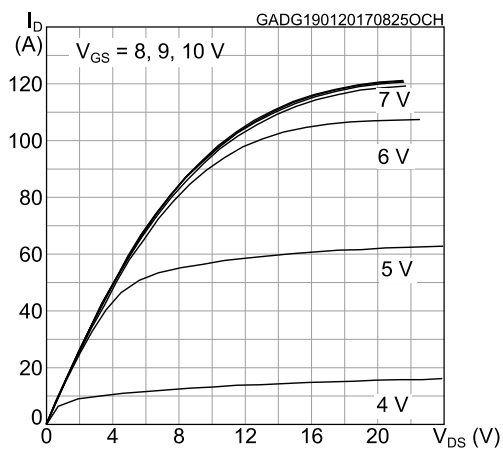


Figure 5: Transfer characteristics

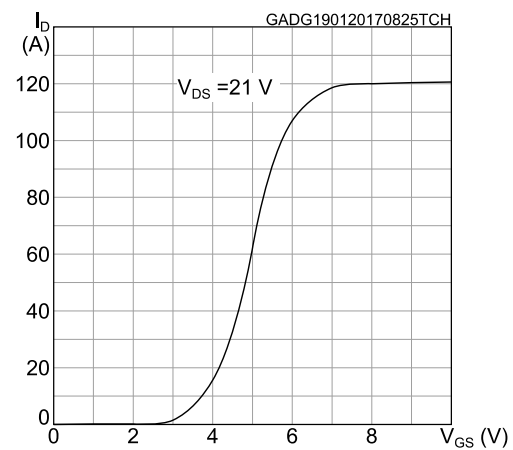


Figure 6: Gate charge vs gate-source voltage

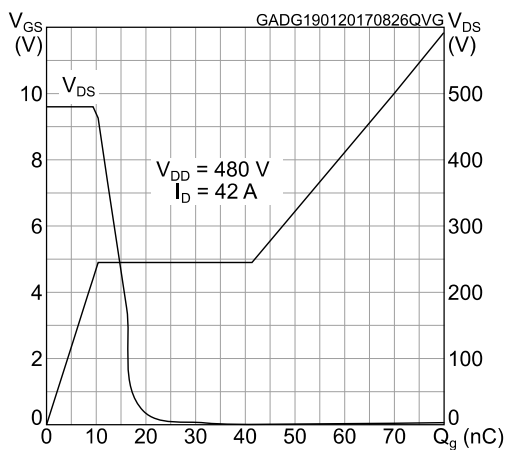


Figure 7: Static drain-source on-resistance

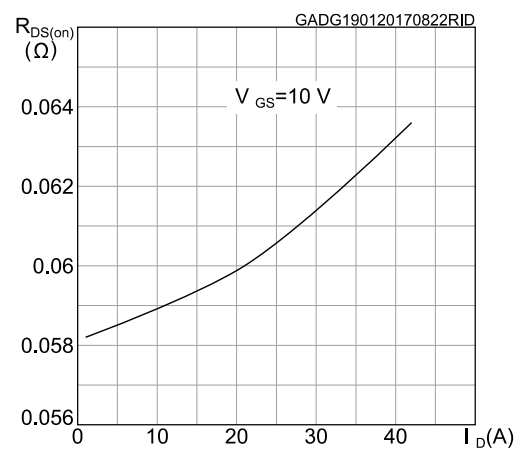


Figure 8: Capacitance variations

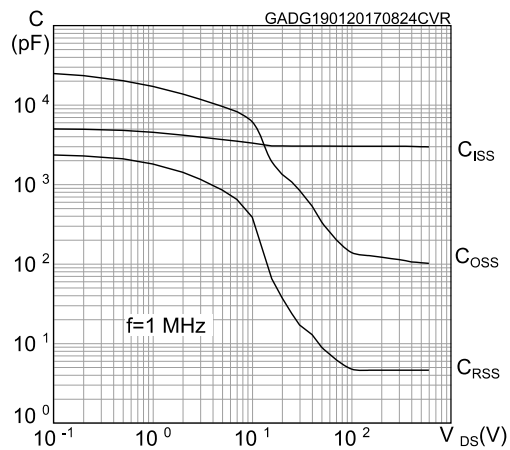


Figure 9: Output capacitance stored energy

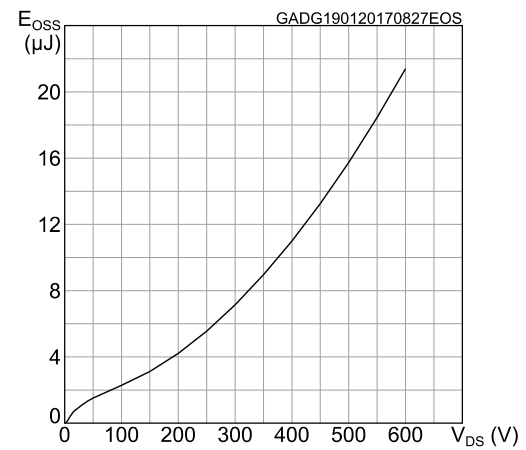


Figure 10: Normalized gate threshold voltage vs temperature

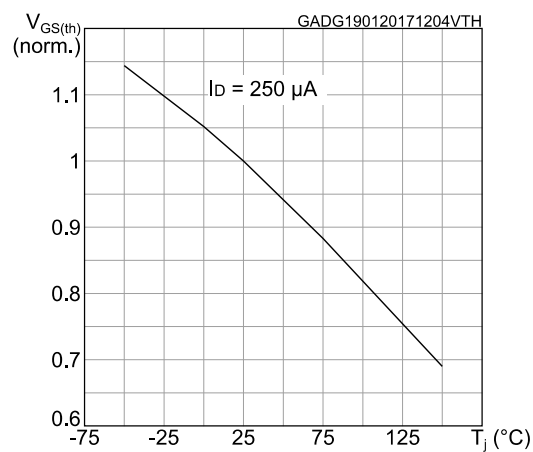


Figure 11: Normalized on-resistance vs temperature

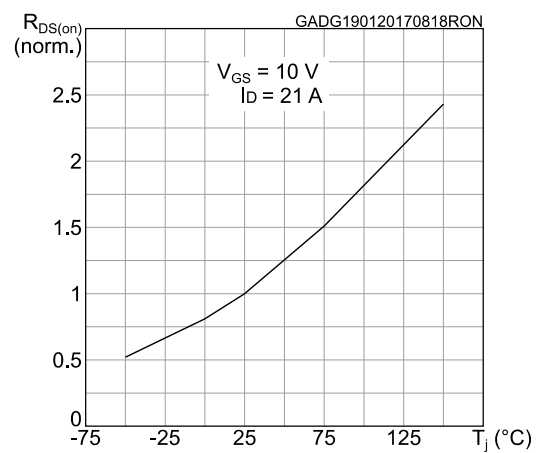
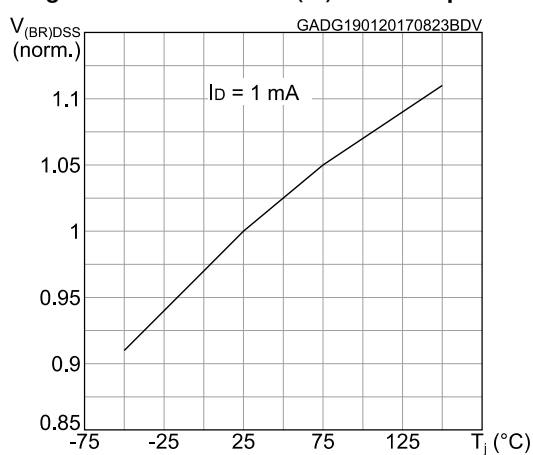
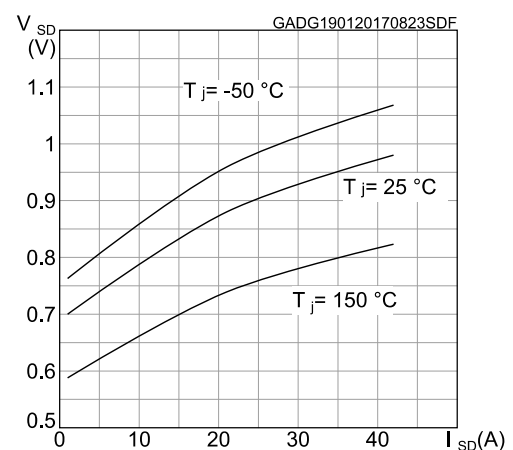
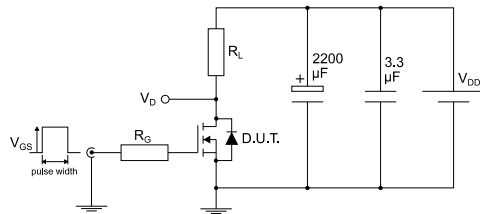
Figure 12: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 13: Source-drain diode forward characteristics



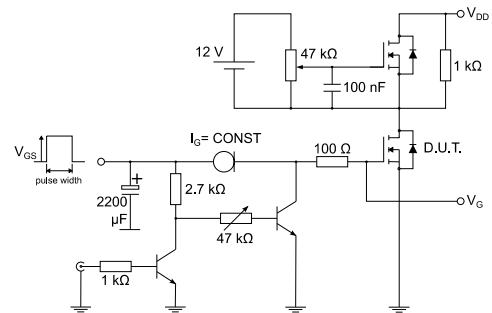
### 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**



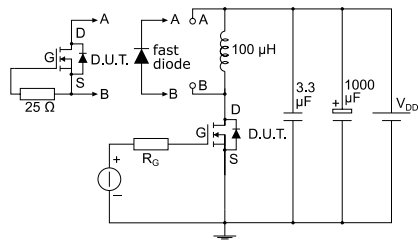
AM01468v1

**Figure 15: Test circuit for gate charge behavior**



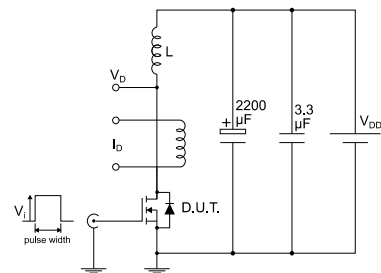
AM01469v1

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



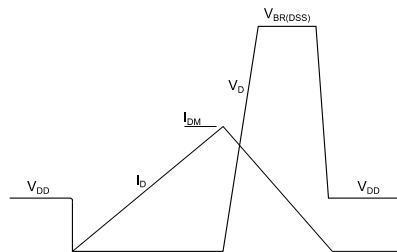
AM01470v1

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



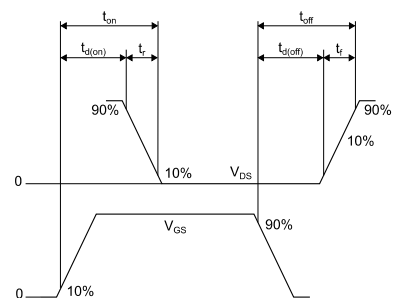
AM01471v1

**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



AM01473v1

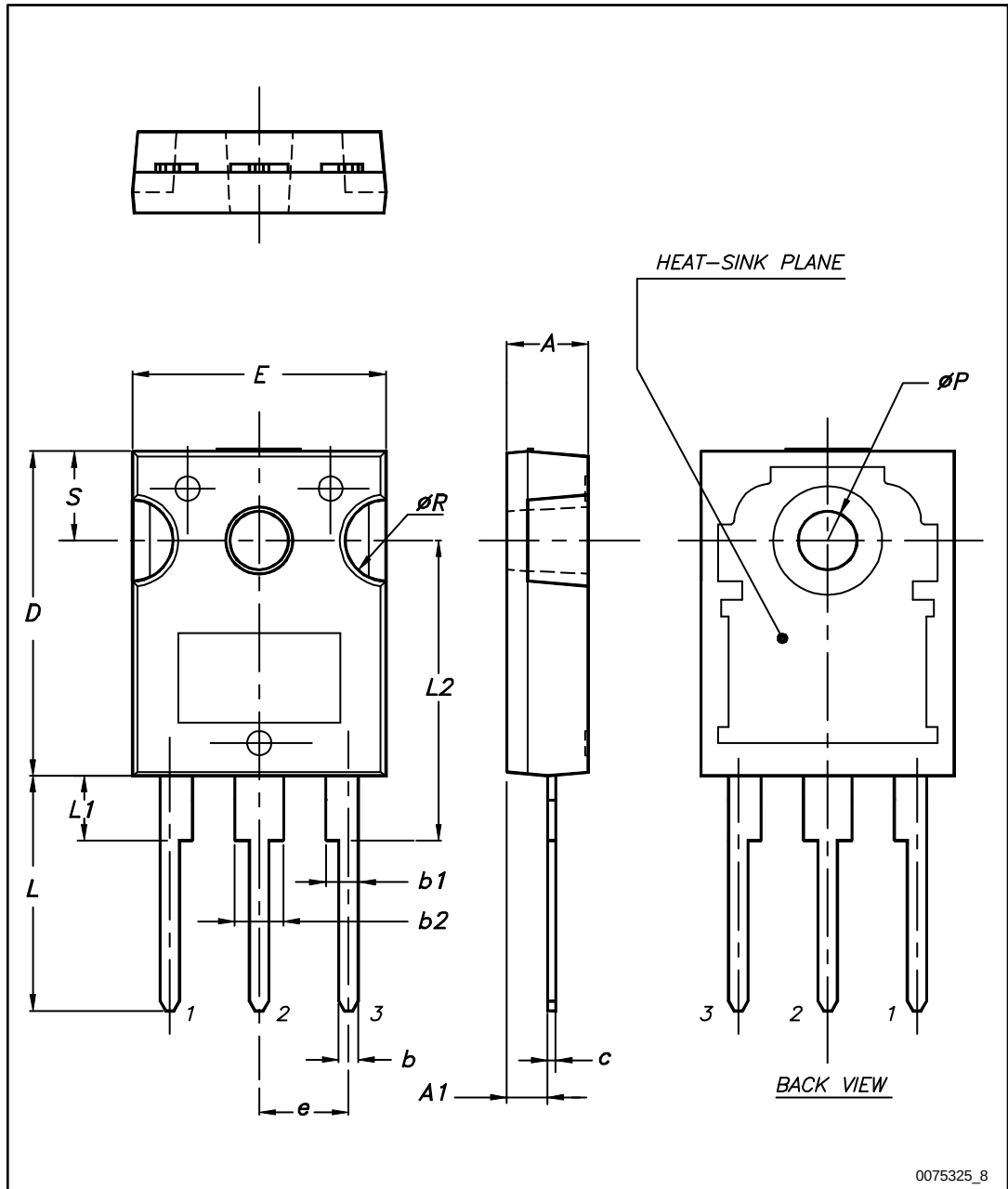


## 4 Package information

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 20: TO-247 package outline



0075325\_8

Table 9: 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  |

## 5 Revision history

**Table 10: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                         |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 09-Jun-2014 | 1        | First release.                                                                                                                                                                                                                                                                                  |
| 01-Sep-2014 | 2        | Document status promoted from preliminary to production data.<br>Added Section 2.1: "Electrical characteristics curves".<br>Minor text changes.                                                                                                                                                 |
| 19-Jan-2017 | 3        | Updated <a href="#">Table 2: "Absolute maximum ratings"</a> , <a href="#">Table 4: "Avalanche characteristics"</a> , <a href="#">Table 5: "On /off-states"</a> and <a href="#">Table 7: "Switching times"</a> .<br>Updated <a href="#">Section 2.1: "Electrical characteristics (curves)"</a> . |

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