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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



## N-channel 600 V, 0.065 $\Omega$ typ., 40 A MDmesh™ DM2 Power MOSFET in a TO-247 package

Datasheet - production data

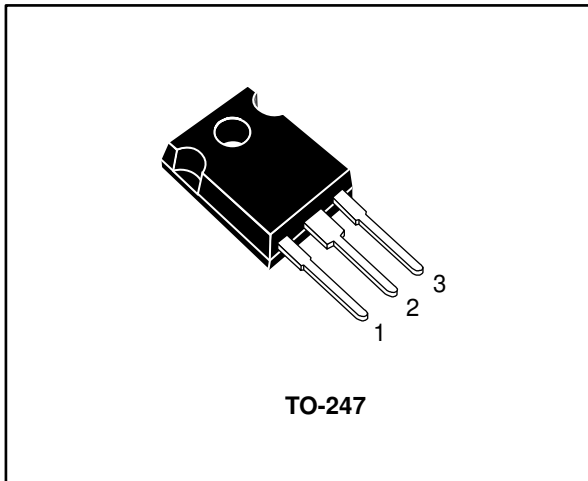
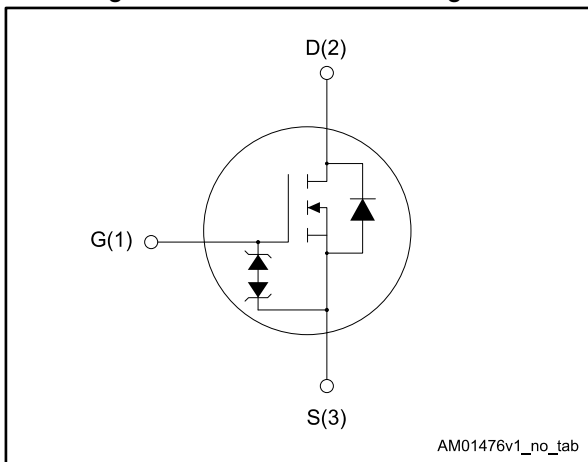


Figure 1: Internal schematic diagram



### Features

| Order code  | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|-------------|-----------------|--------------------------|----------------|
| STW48N60DM2 | 600 V           | 0.079 $\Omega$           | 40 A           |

- 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.

Table 1: Device summary

| Order code  | Marking  | Package | Packing |
|-------------|----------|---------|---------|
| STW48N60DM2 | 48N60DM2 | 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                                      | ±25        | V    |
| $I_D$          | Drain current (continuous) at $T_{case} = 25\text{ °C}$  | 40         | A    |
|                | Drain current (continuous) at $T_{case} = 100\text{ °C}$ | 25         |      |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                   | 160        | A    |
| $P_{TOT}$      | Total dissipation at $T_{case} = 25\text{ °C}$           | 300        | W    |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                        | 50         | V/ns |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                |            |      |
| $T_{stg}$      | Storage temperature                                      | -55 to 150 | °C   |
| $T_j$          | Operating junction temperature                           |            |      |

**Notes:**

(1) Pulse width is limited by safe operating area.

(2)  $I_{SD} \leq 40\text{ A}$ ,  $di/dt=900\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .

(3)  $V_{DS} \leq 480\text{ V}$ .

**Table 3: Thermal data**

| Symbol         | Parameter                           | Value | Unit |
|----------------|-------------------------------------|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 0.42  | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 50    |      |

**Table 4: Avalanche characteristics**

| Symbol   | Parameter  | Value | Unit |
|----------|--|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (Pulse width limited by $T_{jmax}$ )                     | 7     | A    |
| $E_{AR}$ | Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 950   | mJ   |

## 2 Electrical characteristics

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

**Table 5: Static**

| Symbol        | Parameter                         | Test conditions  | Min. | Typ.  | Max.    | Unit          |
|---------------|-----------------------------------|--|------|-------|---------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$  | 600  |       |         | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$  |      |       | 1       | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ ,<br>$T_{\text{case}} = 125\text{ °C}$ |      |       | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 20\text{ A}$   |      | 0.065 | 0.079   | $\Omega$      |

**Table 6: Dynamic**

| Symbol                     | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------|---|------|------|------|---------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$   | -    | 3250 | -    | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance            |   | -    | 142  | -    |               |
| $C_{rss}$                  | Reverse transfer capacitance  |   | -    | 4.5  | -    |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$   | -    | 258  | -    | $\mu\text{F}$ |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$   | -    | 4    | -    | $\Omega$      |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 40\text{ A}$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14: "Test circuit for gate charge behavior"</a> ) | -    | 70   | -    | nC            |
| $Q_{gs}$                   | Gate-source charge            |   | -    | 18   | -    |               |
| $Q_{gd}$                   | Gate-drain charge             |   | -    | 28   | -    |               |

**Notes:**

<sup>(1)</sup>  $C_{oss\text{ eq.}}$  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 7: Switching times**

| Symbol       | Parameter           | Test conditions   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 20\text{ A}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 13: "Test circuit for resistive load switching times"</a> and ) | -    | 27   | -    | ns   |
| $t_r$        | Rise time           |   | -    | 27   | -    |      |
| $t_{d(off)}$ | Turn-off delay time |   | -    | 131  | -    |      |
| $t_f$        | Fall time           |   | -    | 9.8  | -    |      |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}^{(1)}$  | Source-drain current          |  | -    |      | 40   | A             |
| $I_{SDM}^{(2)}$ | Source-drain current (pulsed) |  | -    |      | 160  | A             |
| $V_{SD}^{(3)}$  | Forward on voltage            | $V_{GS} = 0 \text{ V}$ , $I_{SD} = 40 \text{ A}$   | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 40 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 60 \text{ V}$<br>(see <a href="#">Figure 15: "Test circuit for inductive load switching and diode recovery times"</a> )                                      | -    | 140  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 0.7  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 10   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 40 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 60 \text{ V}$ ,<br>$T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 15: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 256  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 2.5  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 20   |      | A             |

**Notes:**

- (1) Limited by maximum junction temperature  
(2) Pulse width is limited by safe operating area.  
(3) Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

Table 9: Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                                      | Min.     | Typ. | Max. | Unit |
|---------------|-------------------------------|--|----------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 250 \mu\text{A}$ , $I_D = 0 \text{ A}$ | $\pm 30$ | -    | -    | V    |

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.2 Electrical characteristics (curves)

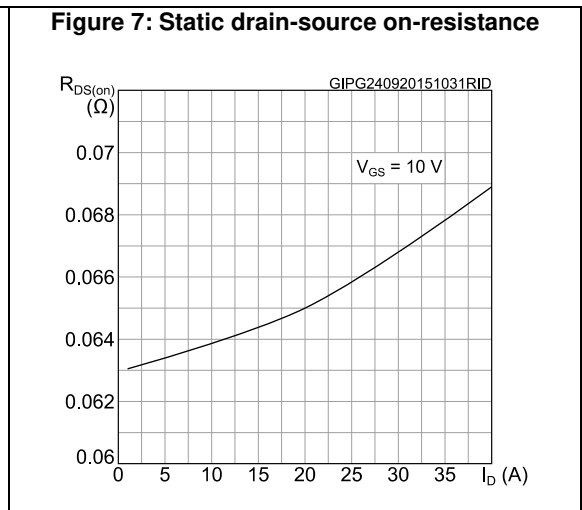
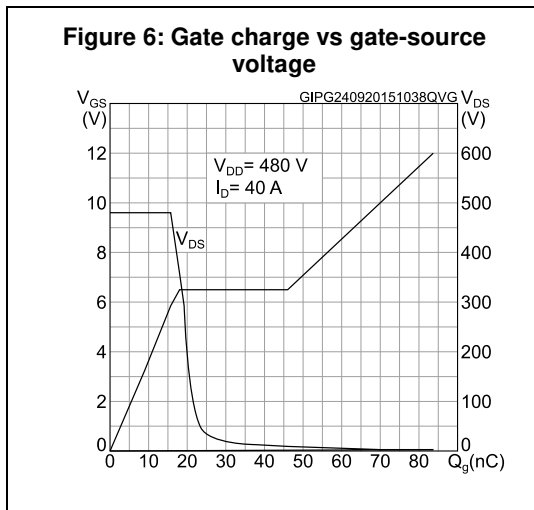
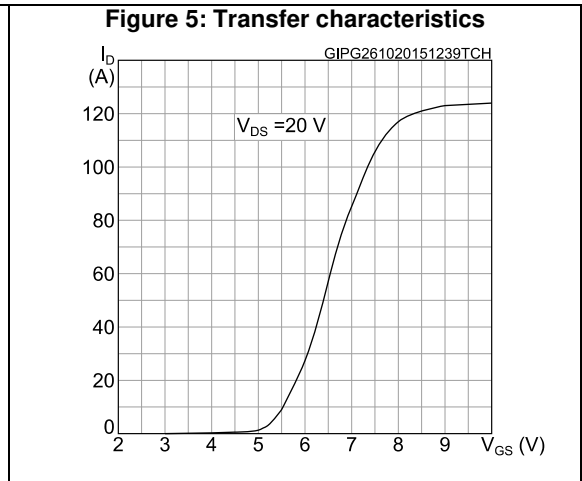
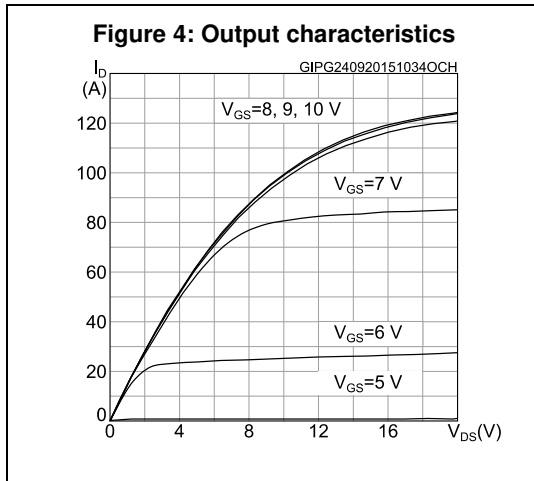
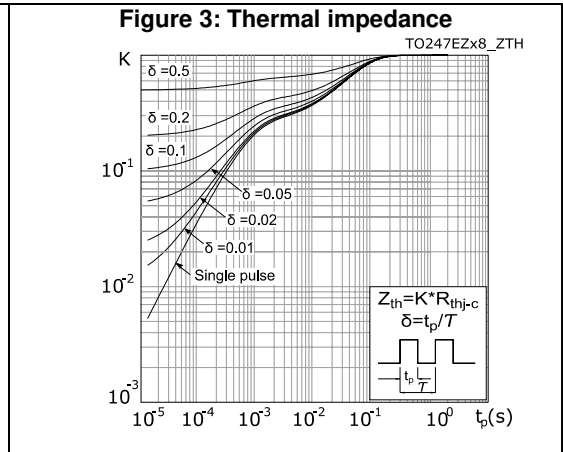
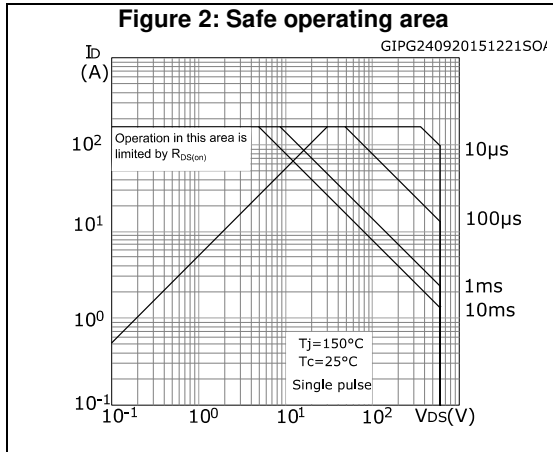


Figure 8: Capacitance variations

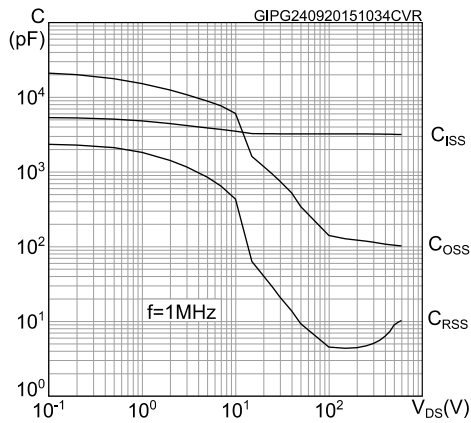


Figure 9: Normalized gate threshold voltage vs temperature

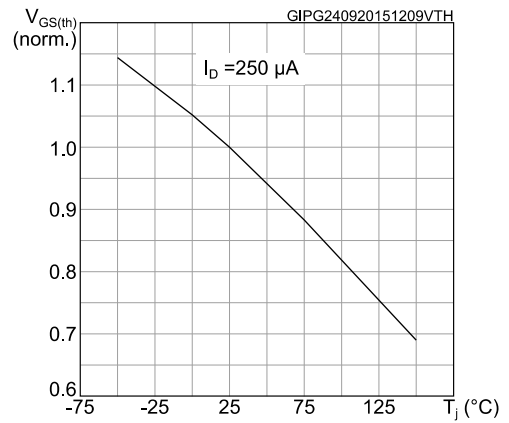


Figure 10: Normalized on-resistance vs temperature

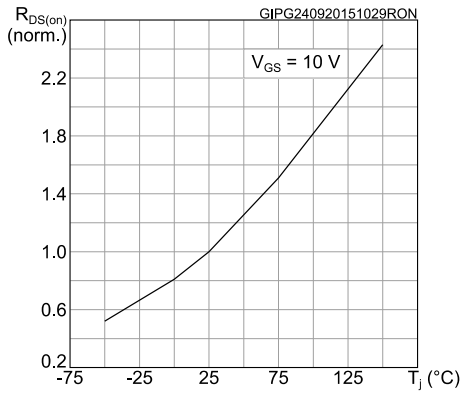


Figure 11: Normalized V(BR)DSS vs temperature

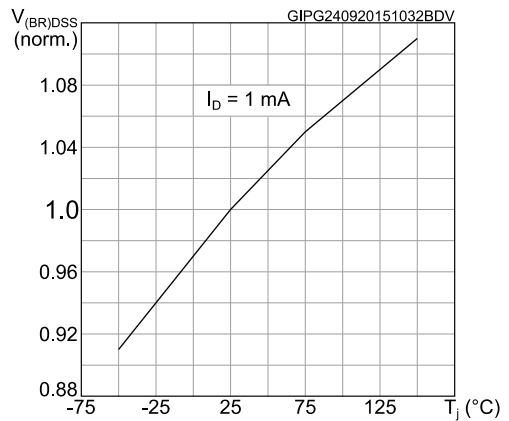
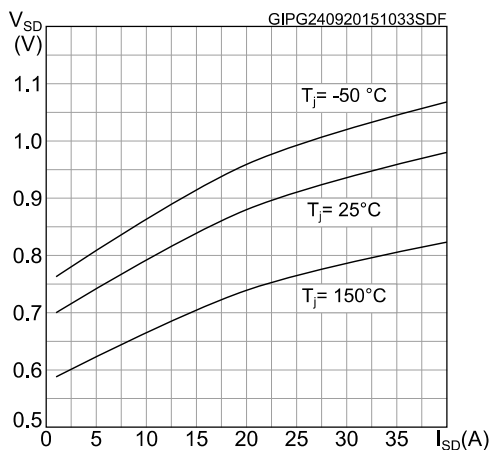
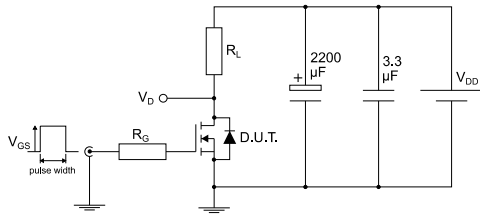


Figure 12: Source- drain diode forward characteristics



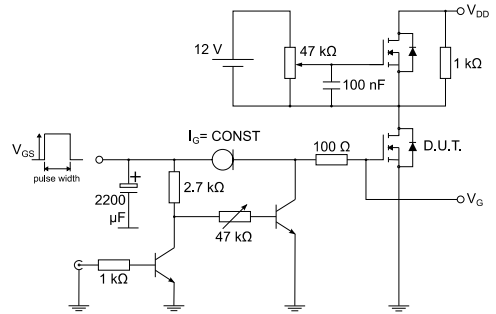
### 3 Test circuits

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



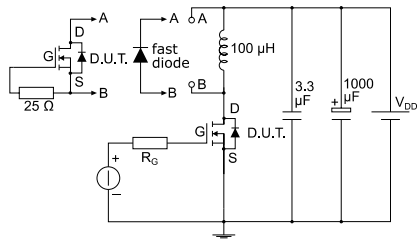
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**Figure 14: Test circuit for gate charge behavior**



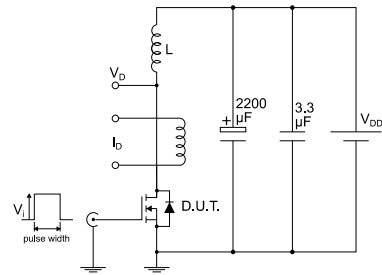
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**Figure 15: Test circuit for inductive load switching and diode recovery times**



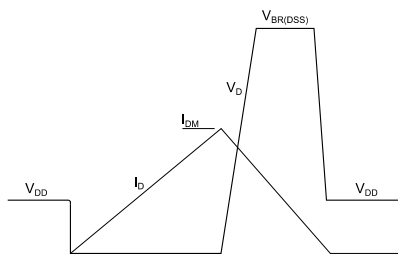
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**Figure 16: Unclamped inductive load test circuit**



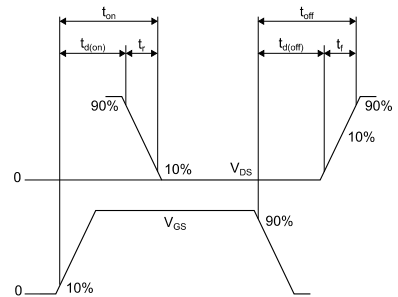
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**Figure 17: Unclamped inductive waveform**



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

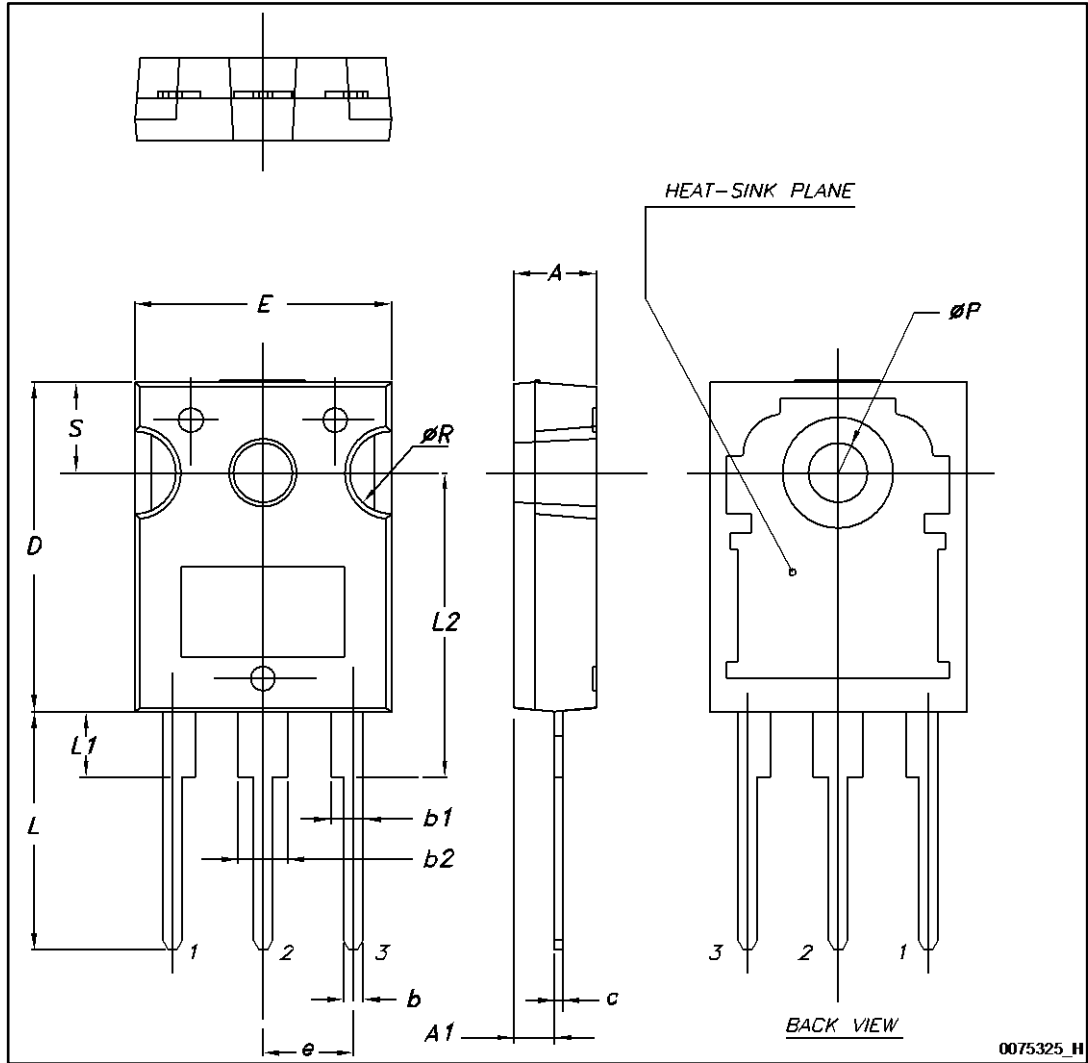


Table 10: TO-247 package mechanical data

| 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 11: Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 21-Oct-2014 | 1        | First release.   |
| 29-Oct-2015 | 2        | Document status promoted from preliminary to production data.<br>Modified: title<br>Modified: $V_{DS}$ in cover page<br>Modified: Peak diode recovery voltage slope parameter value and <i>note 2</i><br>Modified: $R_{thj-case}$ value in <i>Table 3: "Thermal data"</i><br>Modified: the entire values in <i>Table 4: "Avalanche characteristics"</i><br>Modified: $I_{DSS}$ , $I_{GSS}$ max values and $R_{DS(on)}$ typical value in <i>Table 5: "Static"</i><br>Modified: the entire values in <i>Table 6: "Dynamic"</i> , <i>Table 7: "Switching times"</i><br>and <i>Table 8: "Source-drain diode"</i><br>Added: <i>Table 9: "Gate-source Zener diode"</i><br>Added: <i>Section 2.1: "Electrical characteristics (curves)"</i><br>Minor text changes |

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