

N-channel 950 V, 0.275  $\Omega$  typ., 18 A, MDmesh™ DK5  
Power MOSFETs in TO-247 and TO-247 long leads packages

Datasheet - production data

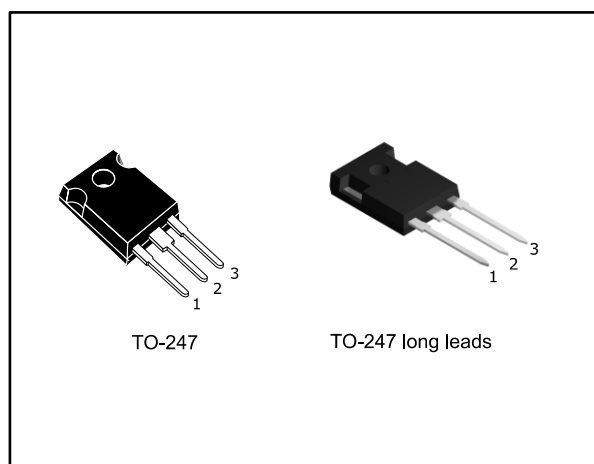
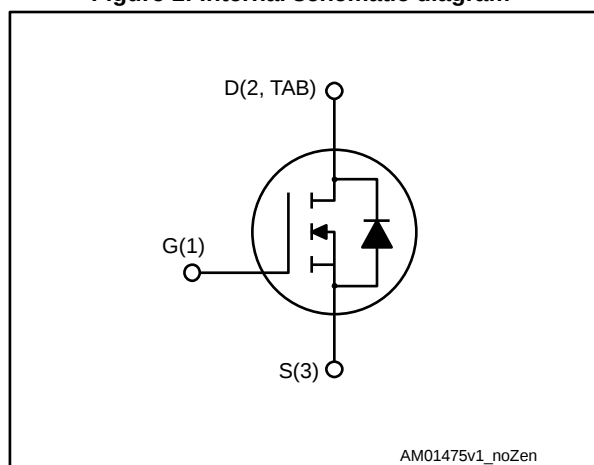


Figure 1: Internal schematic diagram



## Features

| Order code   | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|--------------|-----------------|--------------------------|----------------|
| STW20N95DK5  | 950 V           | 0.330 $\Omega$           | 18 A           |
| STWA20N95DK5 |                 |                          |                |

- Fast-recovery body diode
- Best R<sub>DS(on)</sub> x area
- Low gate charge, input capacitance and resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness

## Applications

- Switching applications

## Description

These very high voltage N-channel Power MOSFETs are part of the MDmesh™ DK5 fast recovery diode series. The MDmesh™ DK5 combines very low recovery charge (Q<sub>rr</sub>) and recovery time (t<sub>rr</sub>) with an excellent improvement in R<sub>DS(on)</sub> \* area and one of the most effective switching behaviors, ideal for half bridge and full bridge converters.

Table 1: Device summary

| Order code   | Marking  | Package           | Packing |
|--------------|----------|-------------------|---------|
| STW20N95DK5  | 20N95DK5 | TO-247            | Tube    |
| STWA20N95DK5 |          | TO-247 long leads |         |

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                                         | Value      | Unit               |
|----------------|-------------------------------------------------------------------|------------|--------------------|
| $V_{GS}$       | Gate-source voltage                                               | $\pm 30$   | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 18         | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 11         | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                            | 72         | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 250        | W                  |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                                 | 50         | 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:**

(1) Pulse width limited by safe operating area

(2)  $I_{SD} \leq 8.5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 475\text{ V}$ (3)  $V_{DS} \leq 760\text{ V}$ 

Table 3: Avalanche characteristics

| Symbol         | Parameter                           | Value | Unit                        |
|----------------|-------------------------------------|-------|-----------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 0.5   | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 50    | $^{\circ}\text{C}/\text{W}$ |

Table 4: Thermal data

| Symbol   | Parameter                                                                                                                 | Value | Unit |
|----------|---------------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Maximum current during repetitive or single pulse avalanche                                                               | 6     | A    |
| $E_{AS}$ | Single pulse avalanche energy<br>(starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 520   | mJ   |

## 2 Electrical characteristics

(T<sub>CASE</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    | I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0 V                                           | 950  |       |       | V    |
| I <sub>DSS</sub>     | Zero gate voltage drain current   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 950 V                                         |      |       | 10    | μA   |
|                      |                                   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 950 V, T <sub>C</sub> = 125 °C <sup>(1)</sup> |      |       | 100   | μA   |
| I <sub>GSS</sub>     | Gate source leakage current       | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V                                        |      |       | ±2    | μA   |
| V <sub>GS(th)</sub>  | Gate threshold voltage            | V <sub>DD</sub> = V <sub>GS</sub> , I <sub>D</sub> = 100 μA                            | 3    | 4     | 5     | V    |
| R <sub>DS(on)</sub>  | Static drain-source on-resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 9 A                                           |      | 0.275 | 0.330 | 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>DS</sub> = 100 V, f = 1 MHz, V <sub>GS</sub> = 0 V                                                                               | -    | 1600 | -    | pF   |
| C <sub>oss</sub>                  | Output capacitance                    |                                                                                                                                         | -    | 76   | -    | pF   |
| C <sub>rss</sub>                  | Reverse transfer capacitance          |                                                                                                                                         | -    | 5    | -    | pF   |
| C <sub>o(tr)</sub> <sup>(1)</sup> | Time- related equivalent capacitance  | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 0 to 760 V                                                                                     | -    | 169  | -    | pF   |
| C <sub>o(er)</sub> <sup>(2)</sup> | Energy-related equivalent capacitance |                                                                                                                                         | -    | 60   | -    | pF   |
| R <sub>g</sub>                    | Intrinsic gate resistance             | f = 1 MHz, I <sub>D</sub> = 0 A                                                                                                         | -    | 4    | -    | Ω    |
| Q <sub>g</sub>                    | Total gate charge                     | V <sub>DD</sub> = 760 V, I <sub>D</sub> = 18 A, V <sub>GS</sub> = 0 to 10 V<br>(see Figure 16: "Test circuit for gate charge behavior") | -    | 50.7 | -    | nC   |
| Q <sub>gs</sub>                   | Gate source charge                    |                                                                                                                                         | -    | 7.8  | -    | nC   |
| Q <sub>gd</sub>                   | Gate drain charge                     |                                                                                                                                         | -    | 34.2 | -    | nC   |

**Notes:**

<sup>(1)</sup>C<sub>o(tr)</sub> is defined as the 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>.

<sup>(2)</sup>C<sub>o(er)</sub> is defined as the constant equivalent capacitance giving the same stored energy 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  | $V_{DS} = 475 \text{ V}$ , $I_D = 9 \text{ A}$ , $R_G = 4.7 \Omega$ ,<br>$V_{GS} = 10 \text{ V}$<br>(see <a href="#">Figure 15: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 20: "Switching time waveform"</a> ) | -    | 23   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                  | -    | 23   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                                                  | -    | 74   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                  | -    | 25.4 | -    | ns   |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                                          | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                                          | -    |      | 18   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                                          | -    |      | 72   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 18 \text{ A}$ , $V_{GS} = 0 \text{ V}$                                                                                                                                                                                         | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 9 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60 \text{ V}$<br>(see <a href="#">Figure 17: "Test circuit for inductive load switching and diode recovery times"</a> )                                      | -    | 150  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                          | -    | 1    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                          | -    | 13.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 9 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$<br>(see <a href="#">Figure 17: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 264  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                          | -    | 2.9  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                          | -    | 22   |      | 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

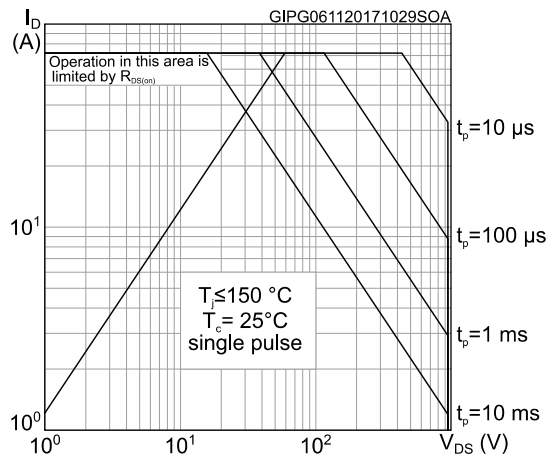


Figure 3: Thermal impedance

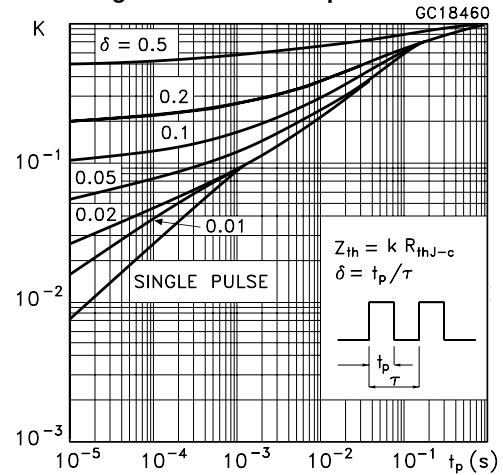


Figure 4: Output characteristics

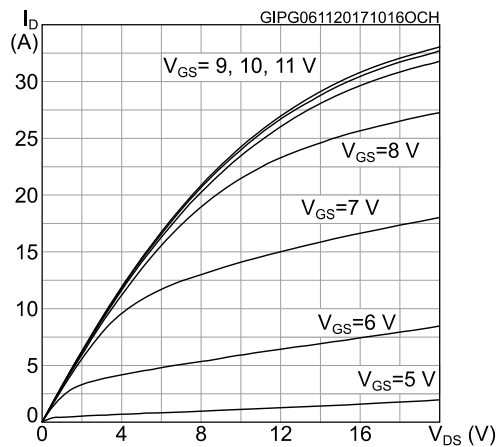


Figure 5: Transfer characteristics

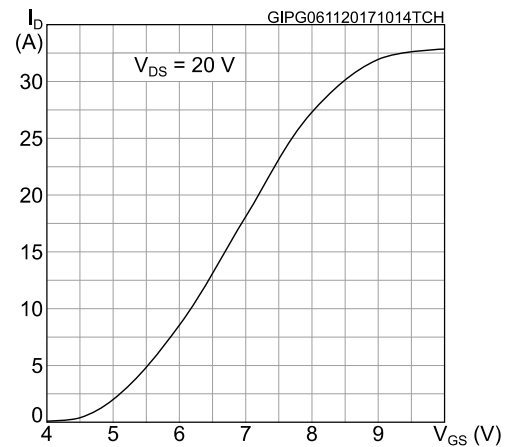


Figure 6: Gate charge vs gate-source voltage

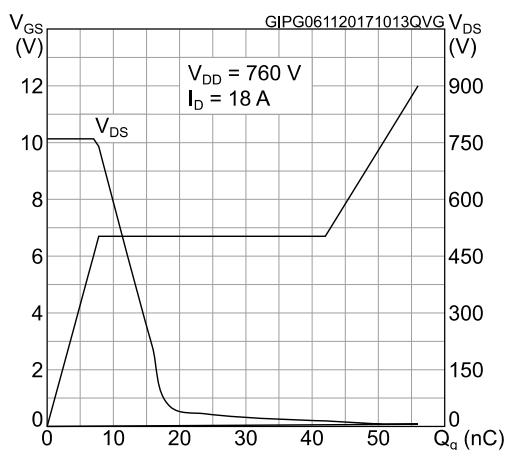


Figure 7: Static drain-source on-resistance

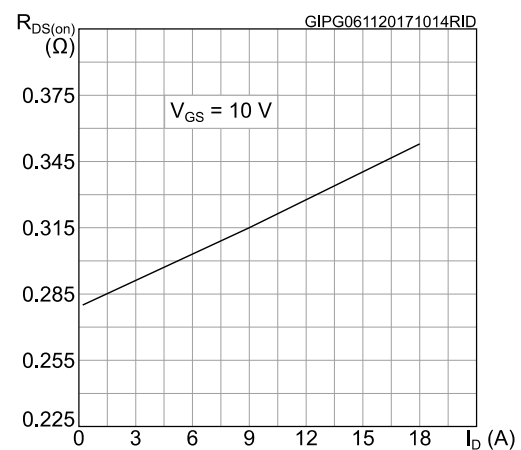


Figure 8: Capacitance variations

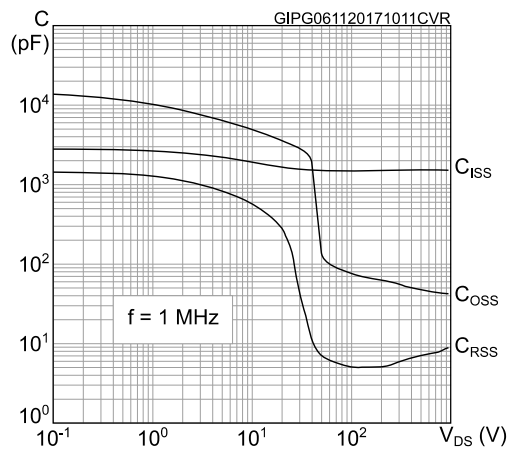


Figure 9: Output capacitance stored energy

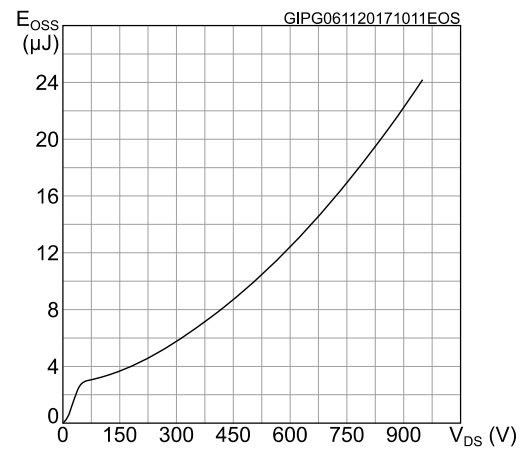


Figure 10: Normalized gate threshold voltage vs temperature

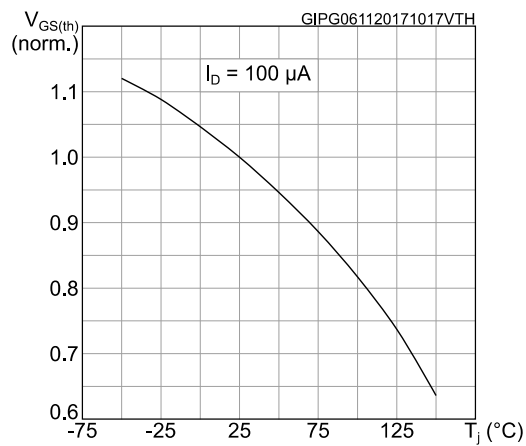


Figure 11: Normalized on-resistance vs temperature

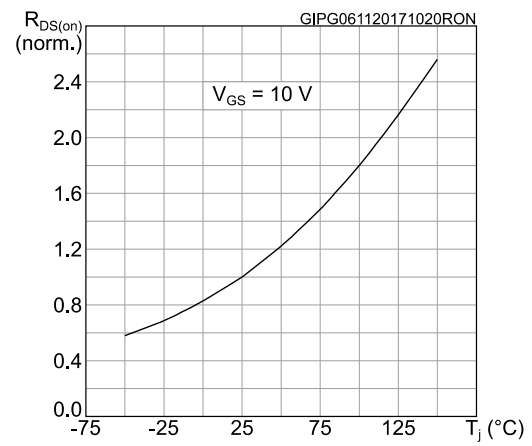
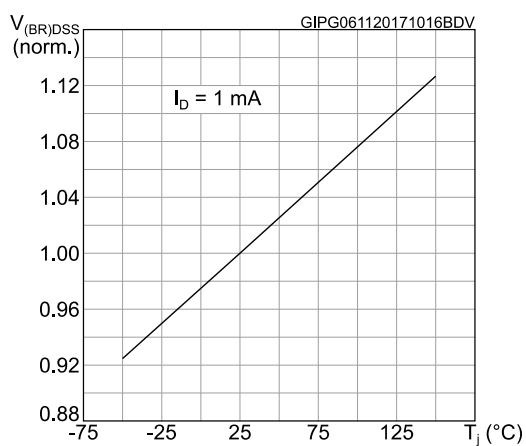
Figure 12: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 13: Source-drain diode forward characteristics

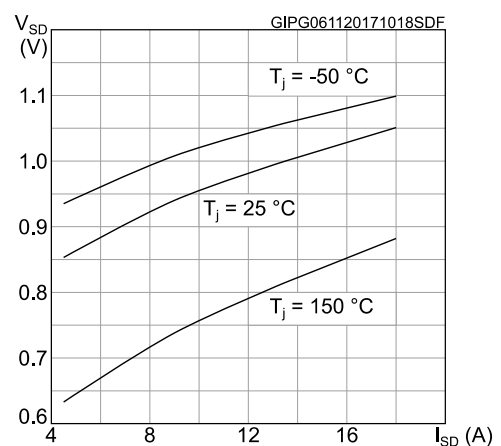
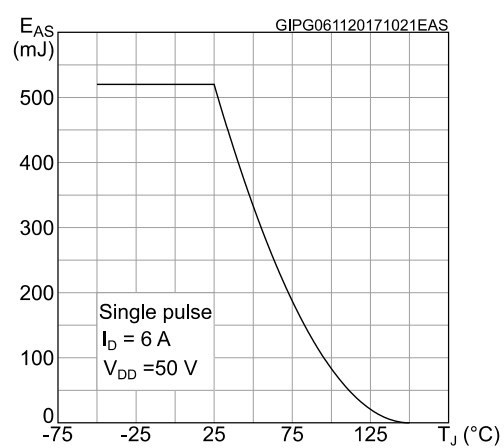


Figure 14: Maximum avalanche energy vs starting  $T_J$ 

### 3 Test circuits

**Figure 15: Test circuit for resistive load switching times**



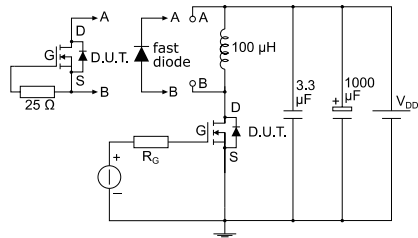
AM01468v1

**Figure 16: Test circuit for gate charge behavior**



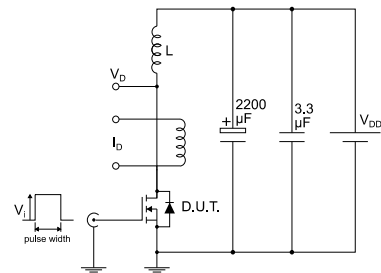
AM01469v1

**Figure 17: Test circuit for inductive load switching and diode recovery times**



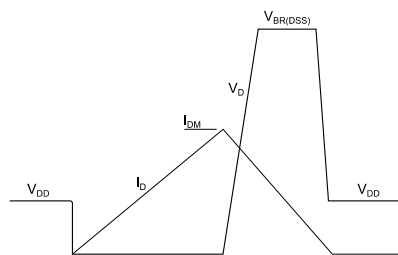
AM01470v1

**Figure 18: Unclamped inductive load test circuit**



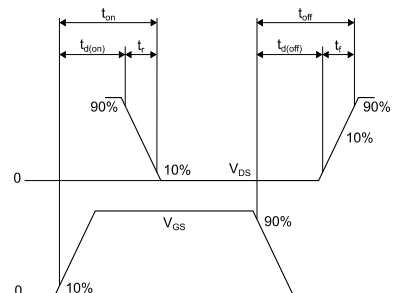
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**Figure 19: Unclamped inductive waveform**



AM01472v1

**Figure 20: Switching time waveform**



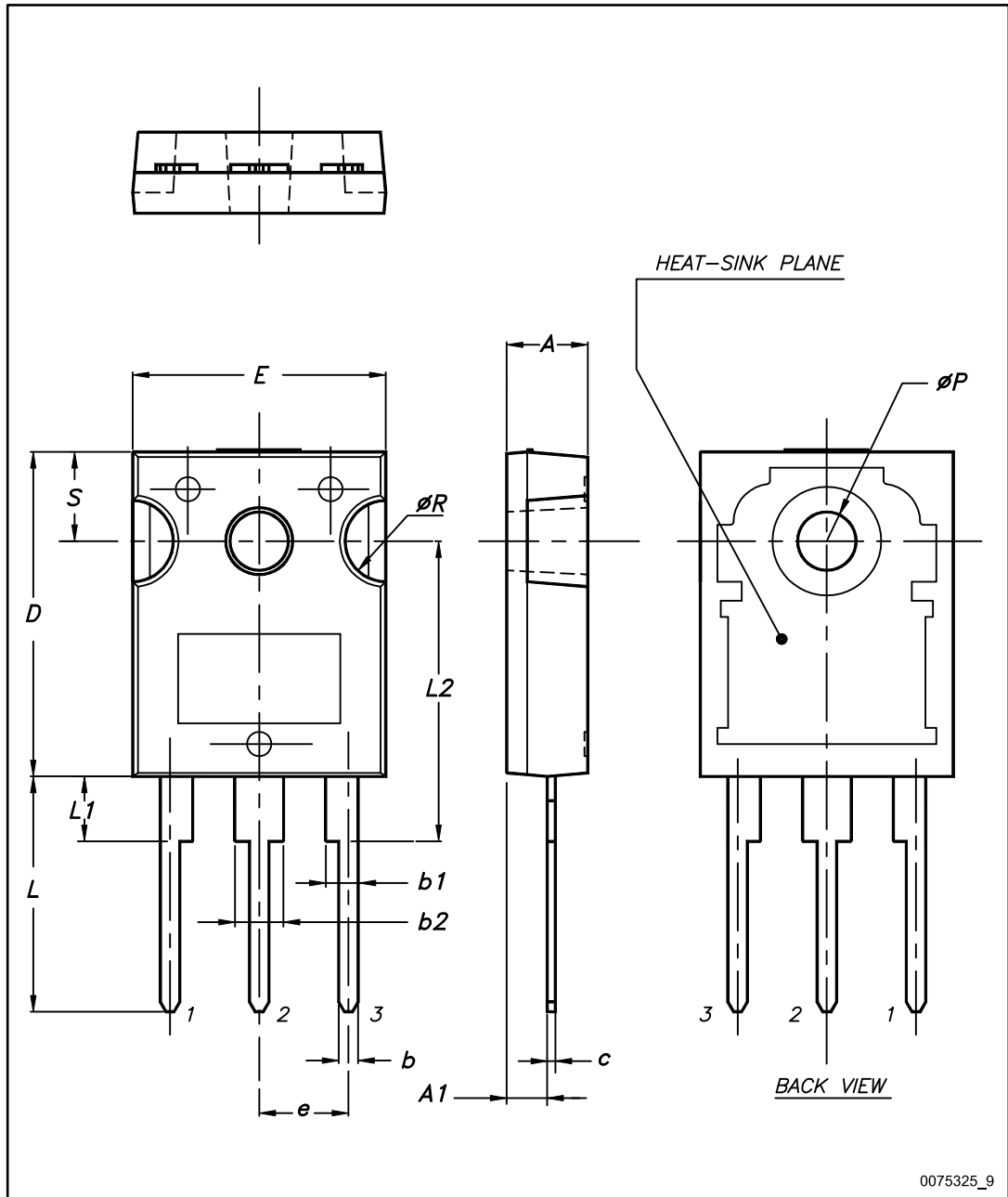
AM01473v1

## 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 21: TO-247 package outline



0075325\_9

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  |

## 4.2 TO-247 long leads package information

Figure 22: TO-247 long leads package outline

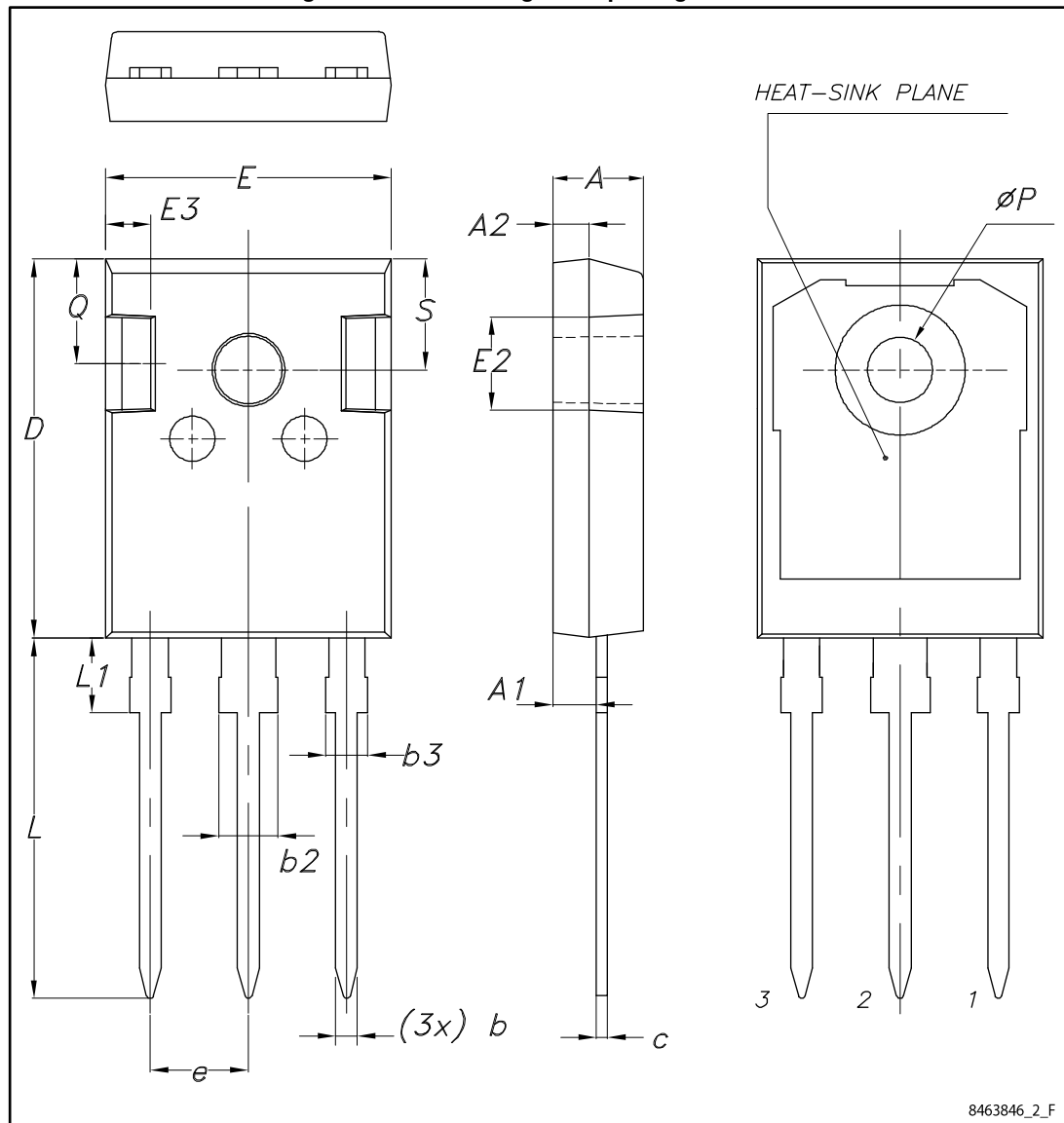


Table 10: TO-247 long leads package mechanical data

| 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  |
| P    | 3.50  | 3.60  | 3.70  |
| Q    | 5.60  |       | 6.00  |
| S    | 6.05  | 6.15  | 6.25  |

## 5 Revision history

**Table 11: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10-May-2017 | 1        | Initial release                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 06-Nov-2017 | 2        | Datasheet promoted from preliminary data to production data.<br>Modified title and features table on cover page<br>Modified <a href="#">Table 2: "Absolute maximum ratings"</a> , <a href="#">Table 4: "Thermal data"</a> , <a href="#">Table 5: "On/off states"</a> , <a href="#">Table 6: "Dynamic"</a> , <a href="#">Table 7: "Switching times"</a> and <a href="#">Table 8: "Source-drain diode"</a> .<br>Added <a href="#">Section 2.1: "Electrical characteristics (curves)"</a> .<br>Minor text changes. |

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