

N-channel 950 V, 0.120  $\Omega$  typ., 38 A, MDmesh™ DK5  
Power MOSFETs in TO-247 and TO-247 long leads packages

Datasheet - production data

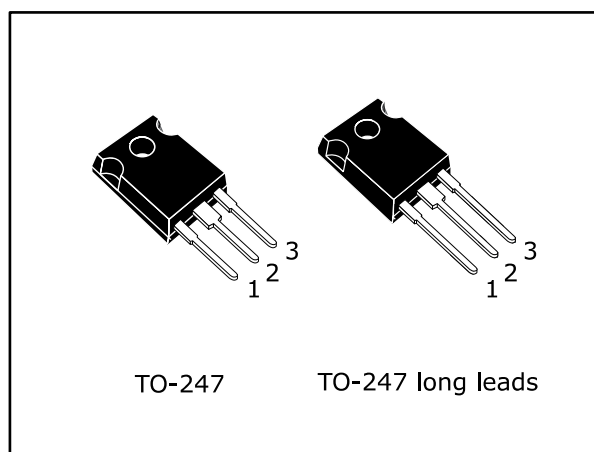
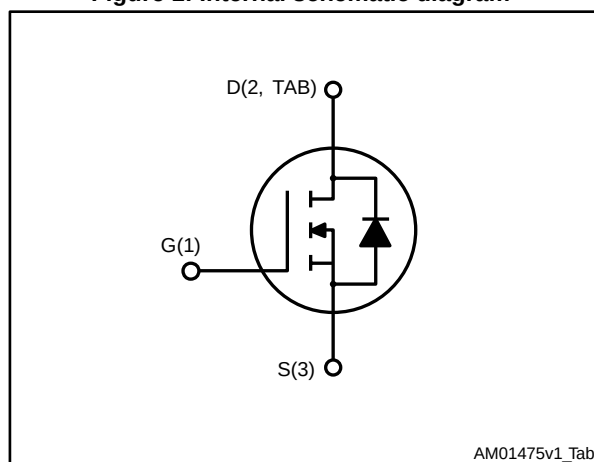


Figure 1: Internal schematic diagram



## Features

| Order code   | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|--------------|-----------------|--------------------------|----------------|
| STW40N95DK5  | 950 V           | 0.130 $\Omega$           | 38 A           |
| STWA40N95DK5 |                 |                          |                |

- 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 |
|--------------|----------|-------------------|---------|
| STW40N95DK5  | 40N95DK5 | TO-247            | Tube    |
| STWA40N95DK5 |          | TO-247 long leads |         |

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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                                 | 30         | V    |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ °C}$  | 38         | V    |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ °C}$ | 24         | A    |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                              | 152        | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$           | 450        | 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 | °C   |
| $T_j$          | Operating junction temperature range                |            |      |

**Notes:**

(1) Pulse width limited by safe operating area

(2)  $I_{SD} \leq 19\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 475\text{ V}$ (3)  $V_{DS} \leq 760\text{ V}$ 

Table 3: Avalanche characteristics

| Symbol         | Parameter                           | Value | Unit |
|----------------|-------------------------------------|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 0.28  | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 50    | °C/W |

Table 4: Thermal data

| Symbol   | Parameter                                                                                                        | Value | Unit |
|----------|------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Max current during repetitive or single pulse avalanche                                                          | 13    | A    |
| $E_{AS}$ | Single pulse avalanche energy<br>(starting $T_J = 25\text{ °C}$ , $I_D = 13\text{ A}$ , $V_{DD} = 50\text{ V}$ ) | 730   | 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                                         |      |       | 1     | 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                                        |      |       | ±10   | 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> = 19 A                                          |      | 0.120 | 0.130 | 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                                                                          | -    | 3480 | -    | pF   |
| C <sub>oss</sub>                  | Output capacitance                    |                                                                                                                                    | -    | 235  | -    | pF   |
| C <sub>rss</sub>                  | Reverse transfer capacitance          |                                                                                                                                    | -    | 2.3  | -    | pF   |
| C <sub>o(tr)</sub> <sup>(1)</sup> | Equivalent capacitance time related   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 0 to 760 V                                                                                | -    | 371  | -    | pF   |
| C <sub>o(er)</sub> <sup>(2)</sup> | Equivalent capacitance energy related |                                                                                                                                    | -    | 134  | -    | pF   |
| R <sub>g</sub>                    | Intrinsic gate resistance             | f = 1 MHz, I <sub>D</sub> = 0 A                                                                                                    | -    | 2    | -    | Ω    |
| Q <sub>g</sub>                    | Total gate charge                     | V <sub>DD</sub> = 760 V, I <sub>D</sub> = 38 A, V <sub>GS</sub> = 10 V<br>(see Figure 15: "Test circuit for gate charge behavior") | -    | 100  | -    | nC   |
| Q <sub>gs</sub>                   | Gate source charge                    |                                                                                                                                    | -    | 19.5 | -    | nC   |
| Q <sub>gd</sub>                   | Gate drain charge                     |                                                                                                                                    | -    | 67.6 | -    | nC   |

**Notes:**

<sup>(1)</sup>Time related 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>

<sup>(2)</sup>Energy related is defined as a 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  | $V_{DS} = 475 \text{ V}$ , $I_D = 19 \text{ A}$ ,<br>$R_G = 4.7 \text{ } \Omega$ , $V_{GS} = 10 \text{ V}$<br>(see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> ) | -    | 30   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                   | -    | 15   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                   | -    | 82   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                   | -    | 11   | -    | ns   |

Table 8: 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            | $I_{SD} = 38 \text{ A}$ , $V_{GS} = 0 \text{ V}$                                                                                                                                                                                           | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 19 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60 \text{ V}$<br>(see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )                                       | -    | 170  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                            | -    | 1.4  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                            | -    | 15   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 19 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ } ^\circ\text{C}$<br>(see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 340  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                            | -    | 5    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                            | -    | 30   |      | 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: Forward bias safe operating area

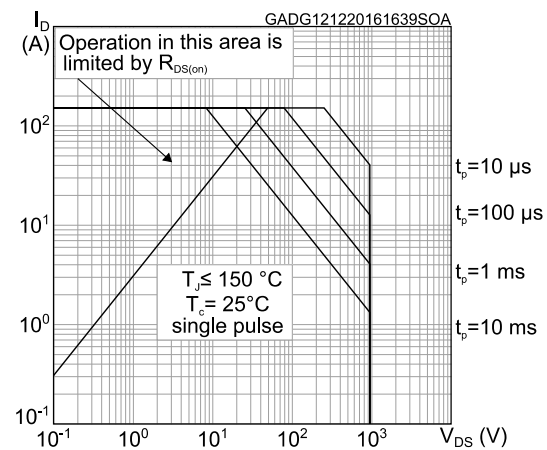


Figure 3: Thermal impedance

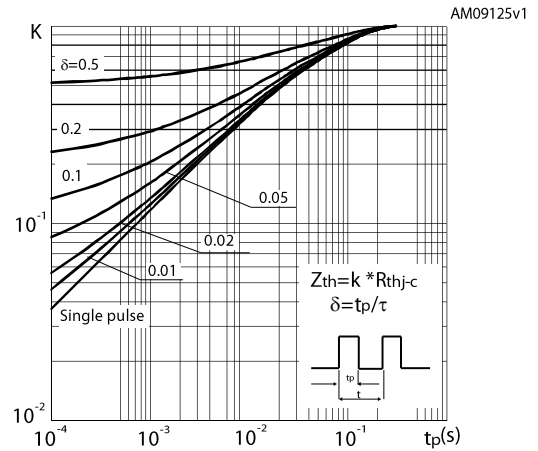


Figure 4: Output characteristics

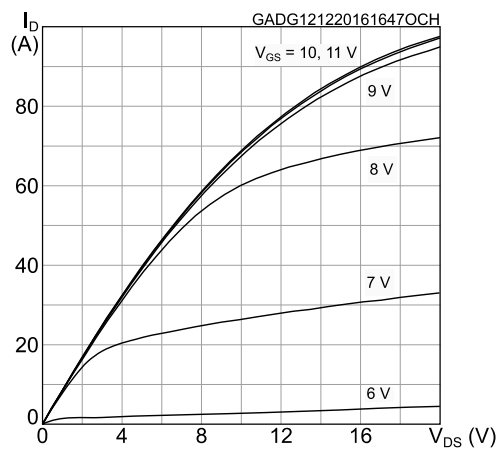


Figure 5: Transfer characteristics

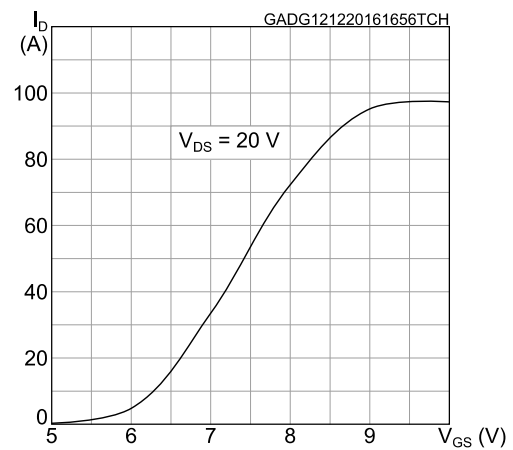


Figure 6: Gate charge vs gate-source voltage

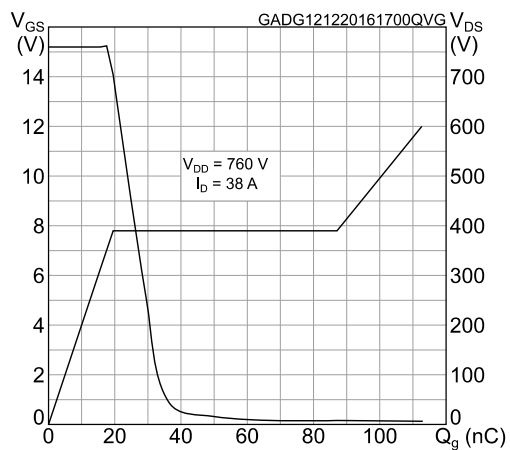


Figure 7: Static drain-source on-resistance

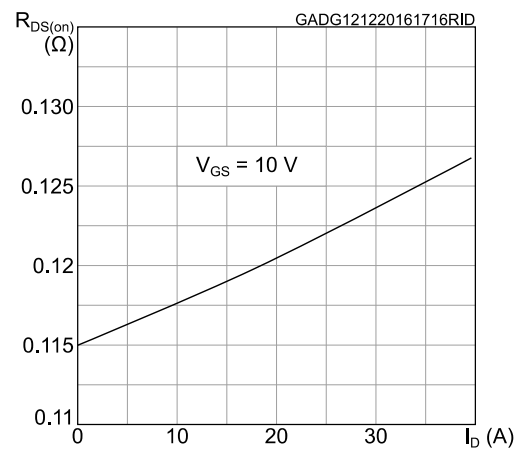


Figure 8: Capacitance variations

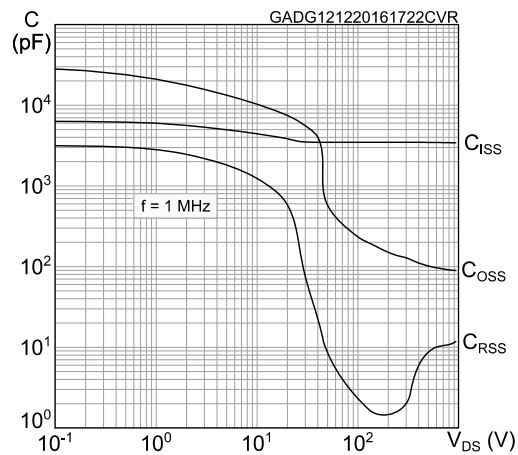


Figure 9: Normalized gate threshold voltage vs temperature

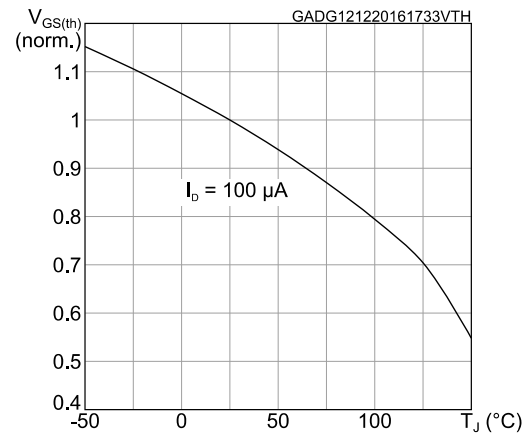


Figure 10: Normalized on-resistance vs temperature

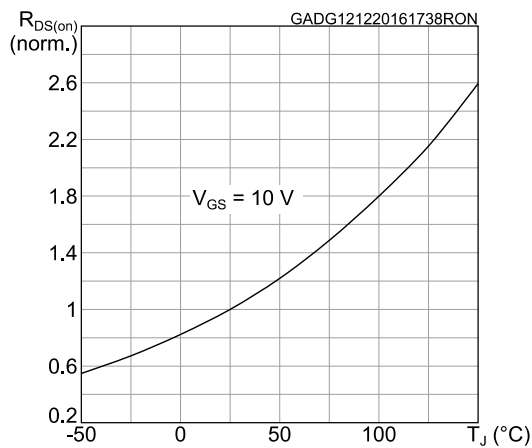
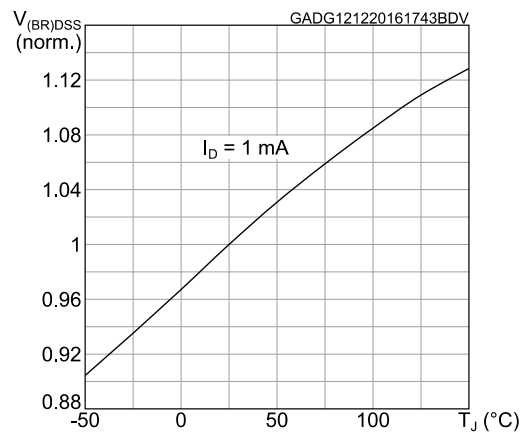
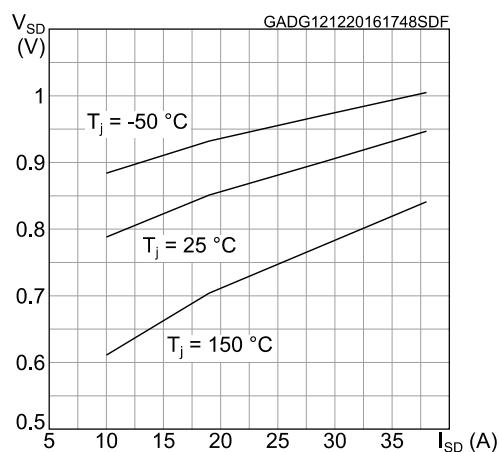
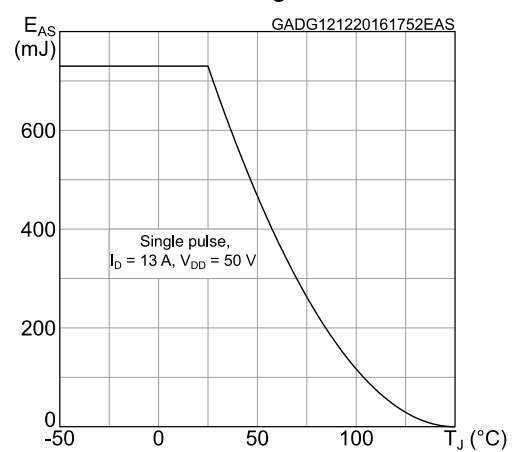
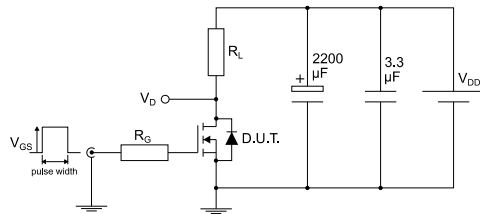
Figure 11: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 12: Source-drain diode forward characteristics

Figure 13: Maximum avalanche energy vs starting  $T_J$ 

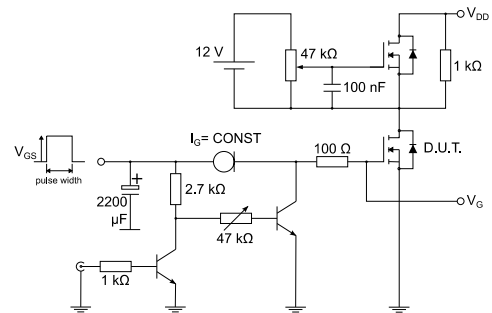
### 3 Test circuits

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



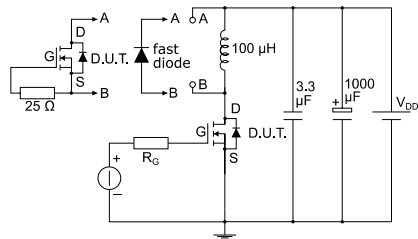
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**Figure 15: Test circuit for gate charge behavior**



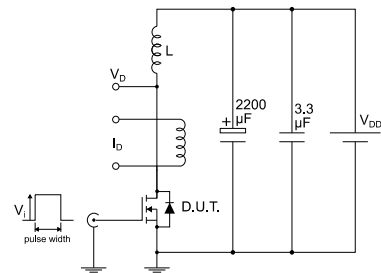
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



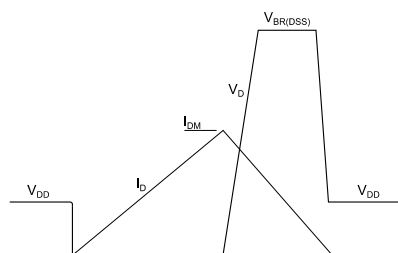
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**Figure 17: Unclamped inductive load test circuit**



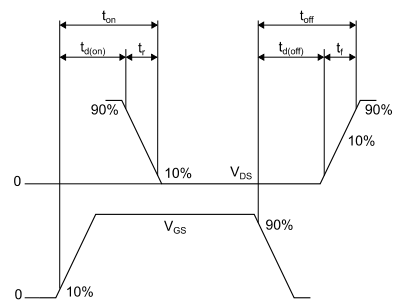
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**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



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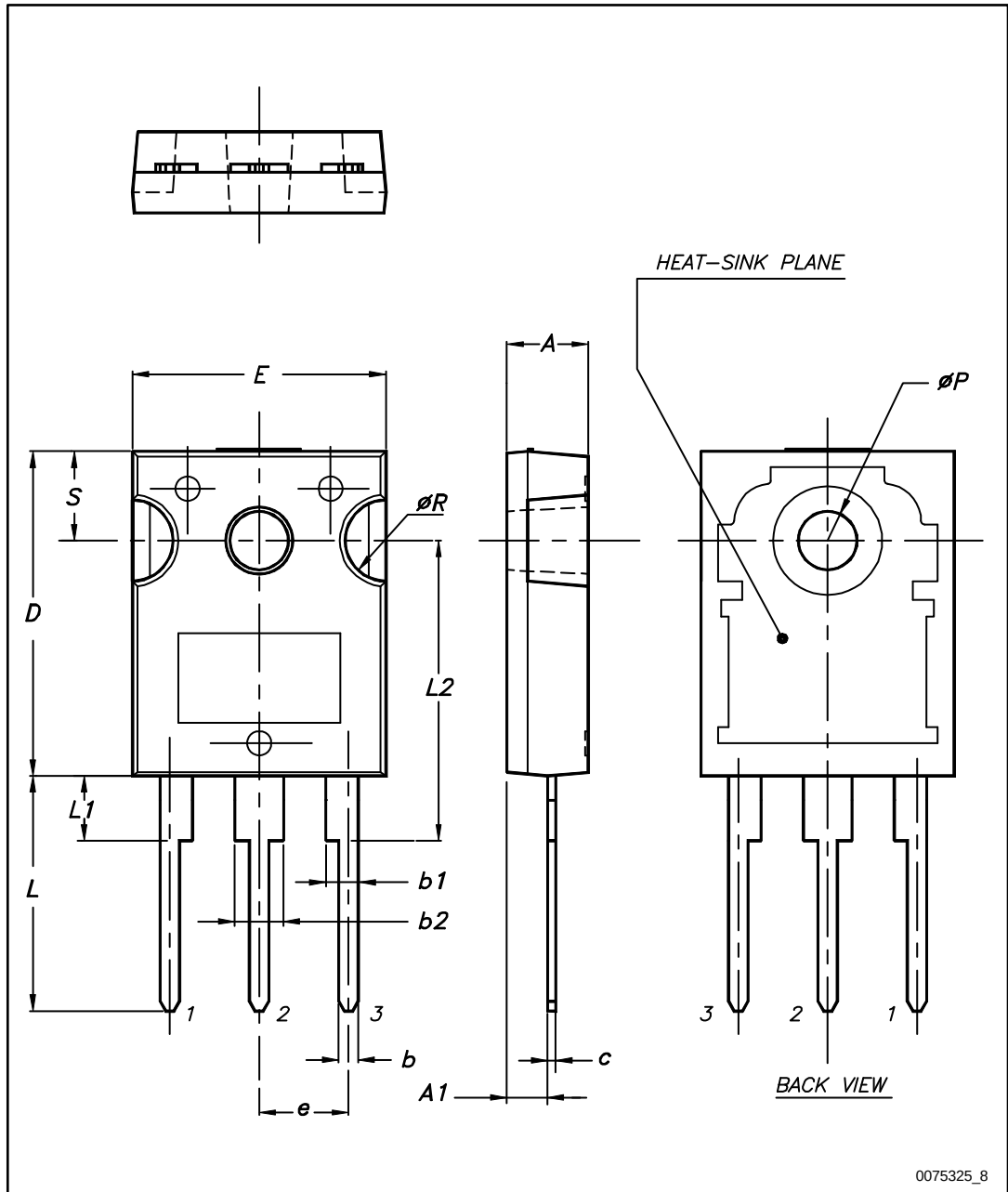


## 4 Package information

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  |

## 4.2 TO-247 long leads package information

Figure 21: TO-247 long lead package outline

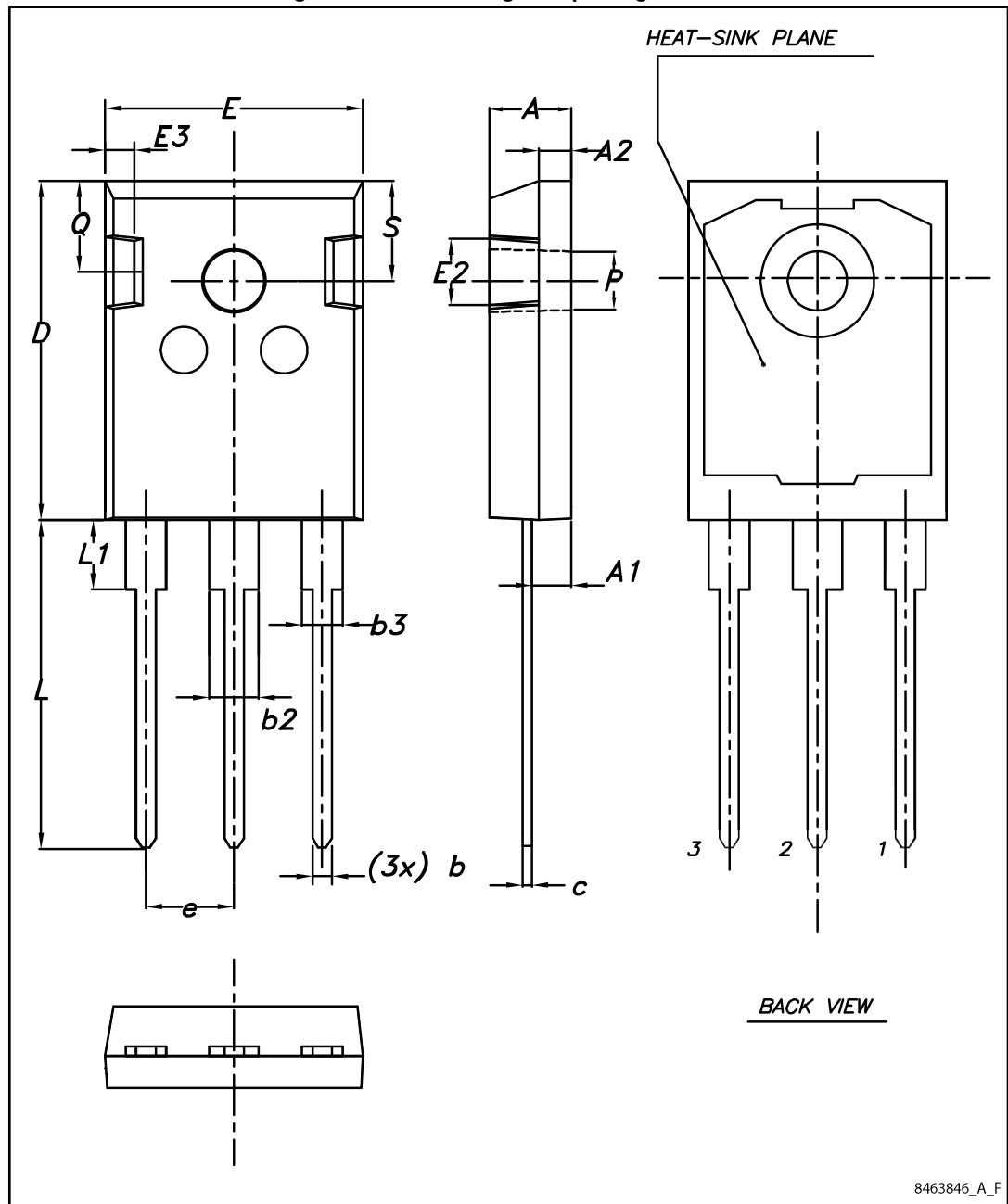


Table 10: TO-247 long lead package mechanical data

| 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                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19-Sep-2013 | 1        | First release.                                                                                                                                                                                                                                                                                                                                                                                     |
| 13-Nov-2015 | 2        | Updated title, features and description in cover page.<br>Updated Section 10 : "Electrical characteristics" and Section 12.1:"TO-247 package information"<br>Minor text changes.                                                                                                                                                                                                                   |
| 12-Apr-2016 | 3        | Updated title,silhouette and description in cover page.<br>Updated <i>Table 2: "Absolute maximum ratings"</i> .<br>Updated <i>Section 10: "Electrical characteristics"</i> .<br>Added <i>Figure 21: "TO-247 long lead package outline"</i> .<br>Minor text changes                                                                                                                                 |
| 15-Dec-2016 | 4        | Datasheet status promoted from preliminary to production data.<br>Updated document title on cover page.<br>Updated <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 4: "Thermal data"</i> , <i>Table 5: "On/off states"</i> , <i>Table 6: "Dynamic"</i> and <i>Table 8: "Source-drain diode"</i> .<br>Added <i>Section 2.1: "Electrical characteristics (curves)"</i> .<br>Minor text changes |

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