# STW20N95DK5, STWA20N95DK5

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

Datasheet - production data

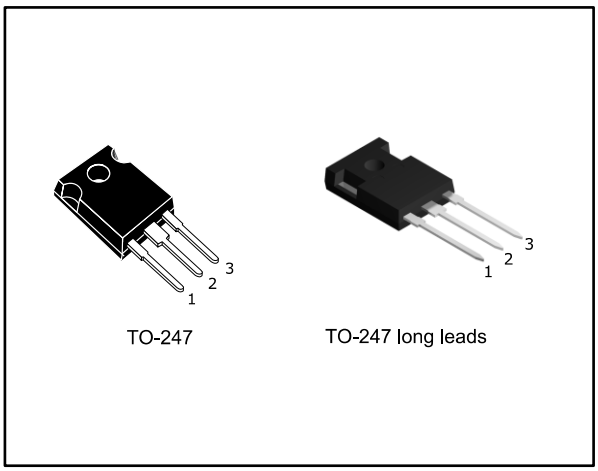
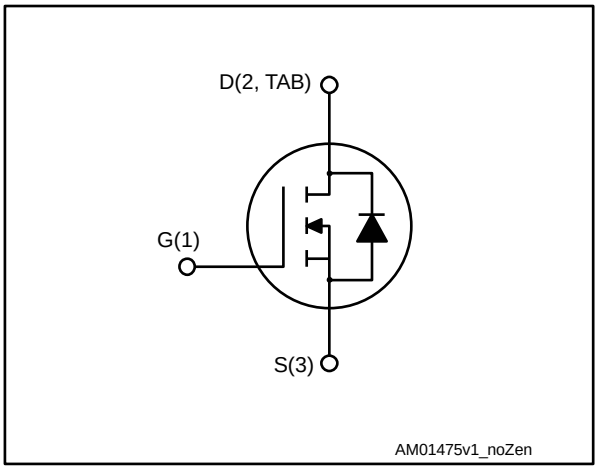



**Figure 1: Internal schematic diagram**




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STW20N95DK5 | 950 V | 0.330 Ω | 18 A |
| STWA20N95DK5 | | | |

- Fast-recovery body diode
- Best $R_{DS(on)}$ 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 ($Q_{rr}$) and recovery time ($t_{rr}$) with an excellent improvement in $R_{DS(on)}$ * 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 | |

# Contents

# 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 °C | 18 | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 11 | A |
| $I_{DM}$(1) | Drain current (pulsed) | 72 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °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 | °C |
| $T_j$ | Operating junction temperature range | | |

**Notes:**

(1)Pulse width limited by safe operating area

(2)$I_{SD}$ ≤ 8.5 A, di/dt ≤ 400 A/µs, $V_{DS}$ peak ≤ $V_{(BR)DSS}$, $V_{DD}$ = 475 V

(3)$V_{DS}$ ≤ 760 V

**Table 3: Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 0.5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient | 50 | °C/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 (starting $T_J$ = 25 °C, $I_D$ = $I_{AR}$ ,$V_{DD}$ = 50 V) | 520 | mJ |

# 2 Electrical characteristics

($T_{CASE}$ = 25 °C unless otherwise specified)

**Table 5: On/off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ = 1 mA, $V_{GS}$= 0 V | 950 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 950 V | | | 10 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 950 V, $T_C$= 125 °C (1) | | | 100 | µA |
| $I_{GSS}$ | Gate source leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ± 20 V | | | ±2 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DD}$ = $V_{GS}$, $I_D$ = 100 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 9 A | | 0.275 | 0.330 | Ω |

**Notes:**

(1)Defined by design, not subject to production test

**Table 6: Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 100 V, f = 1 MHz, $V_{GS}$= 0 V | - | 1600 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 76 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 5 | - | pF |
| $C_{o(tr)}$(1) | Time- related equivalent capacitance | $V_{GS}$ = 0 V, $V_{DS}$= 0 to 760 V | - | 169 | - | pF |
| $C_{o(er)}$(2) | Energy-related equivalent capacitance | | - | 60 | - | pF |
| $R_g$ | Intrinsic gate resistance | f =1 MHz, $I_D$= 0 A | - | 4 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 760 V, $I_D$ = 18 A, $V_{GS}$ = 0 to 10 V (see *Figure 16: "Test circuit for gate charge behavior"*) | - | 50.7 | - | nC |
| $Q_{gs}$ | Gate source charge | | - | 7.8 | - | nC |
| $Q_{gd}$ | Gate drain charge | | - | 34.2 | - | nC |

**Notes:**

(1)$C_{o(tr)}$ is defined as the constant equivalent capacitance giving the same charging time as Coss when $V_{DS}$ increases from 0 to 80% $V_{DSS}$.

(2)$C_{o(er)}$ is defined as the constant equivalent capacitance giving the same stored energy as Coss 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 | $V_{DS}$ = 475 V, $I_D$= 9 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 15: "Test circuit for resistive load switching times"* and *Figure 20: "Switching time waveform"*) | - | 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 A, $V_{GS}$ = 0 V | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 9 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see *Figure 17: "Test circuit for inductive load switching and diode recovery times"*) | - | 150 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 1 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 13.5 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 9 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V, $T_j$ = 150 °C (see *Figure 17: "Test circuit for inductive load switching and diode recovery times"*) | - | 264 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 2.9 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 22 | | A |

**Notes:**

(1)Pulse width limited by safe operating area

(2)Pulsed: pulse duration = 300 µs, duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

**Figure 2: Safe operating area**

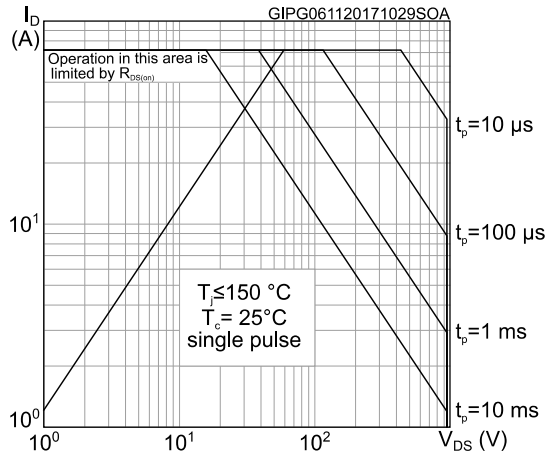



**Figure 3: Thermal impedance**

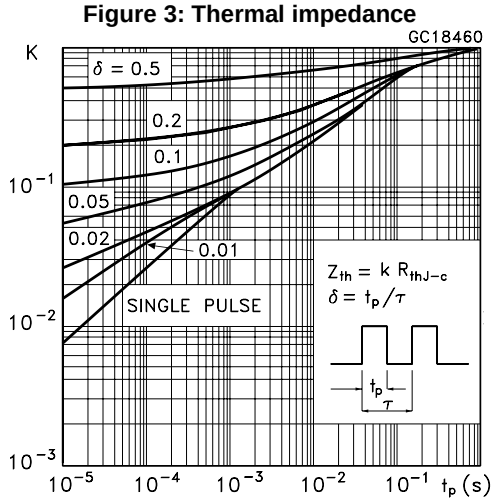



**Figure 4: Output characteristics**

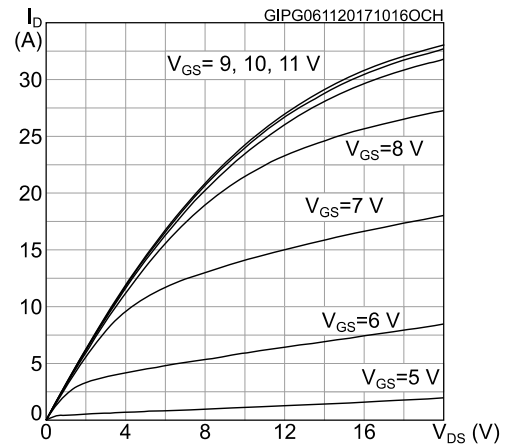



**Figure 5: Transfer characteristics**

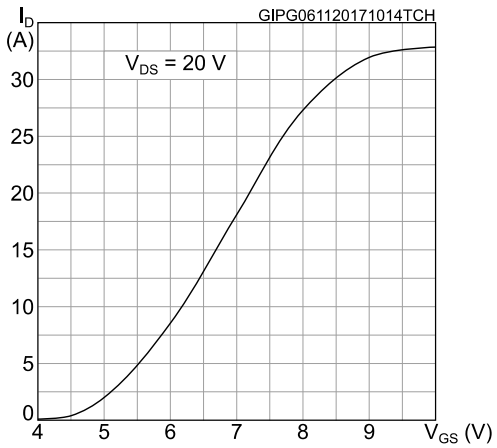



**Figure 6: Gate charge vs gate-source voltage**

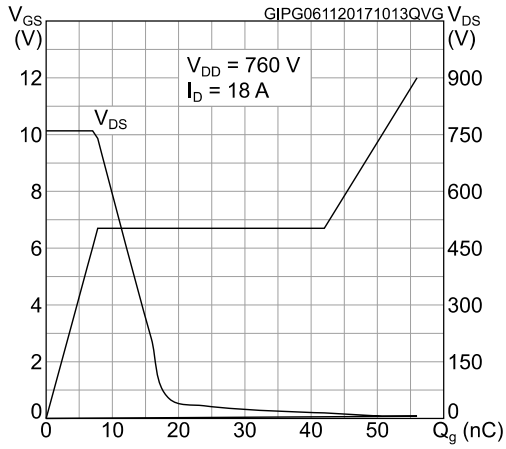



**Figure 7: Static drain-source on-resistance**

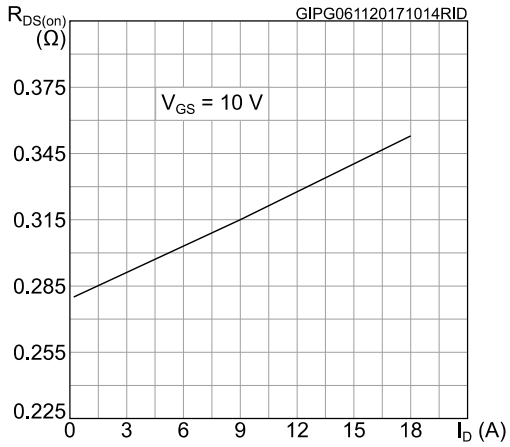


**Figure 8: Capacitance variations**

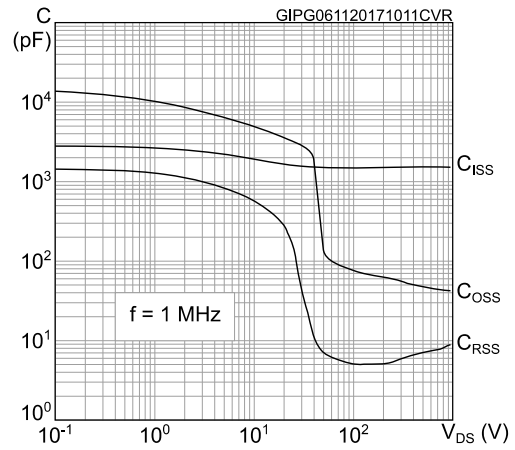



**Figure 9: Output capacitance stored energy**

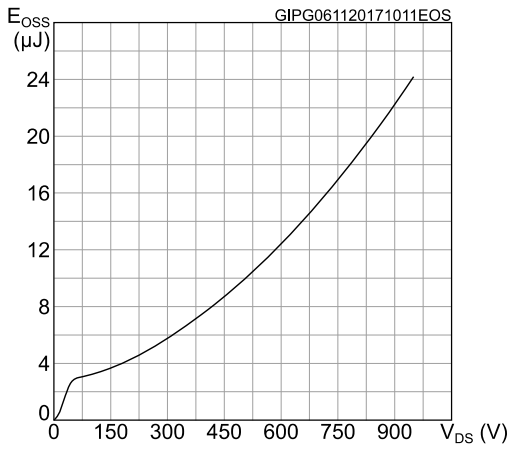



**Figure 10: Normalized gate threshold voltage vs temperature**

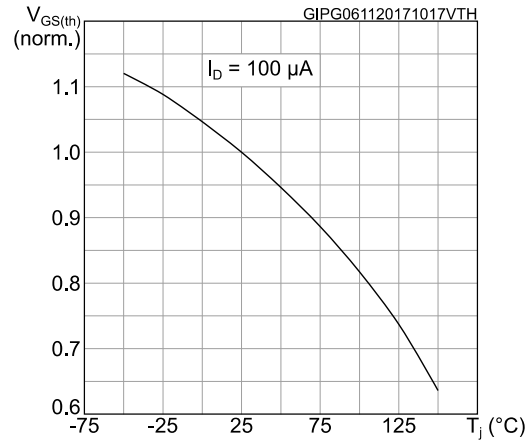



**Figure 11: Normalized on-resistance vs temperature**

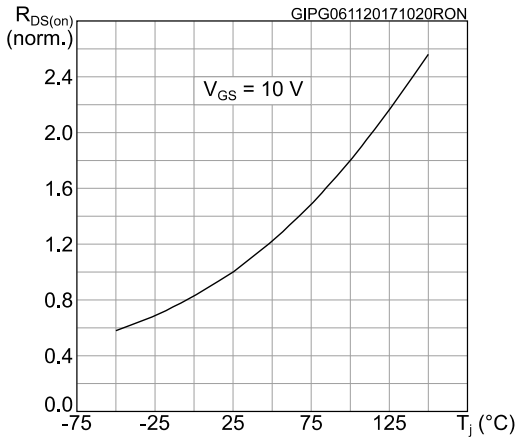



**Figure 12: Normalized $V_{(BR)DSS}$ vs temperature**

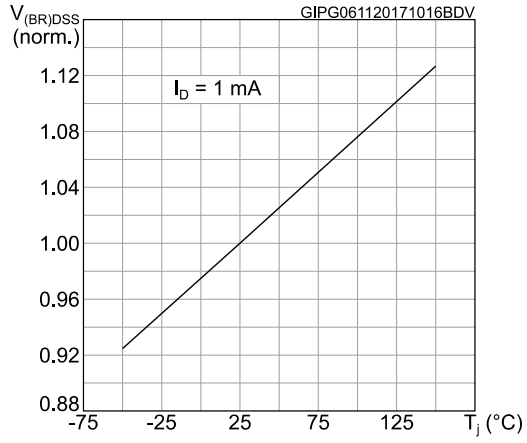



**Figure 13: Source-drain diode forward characteristics**

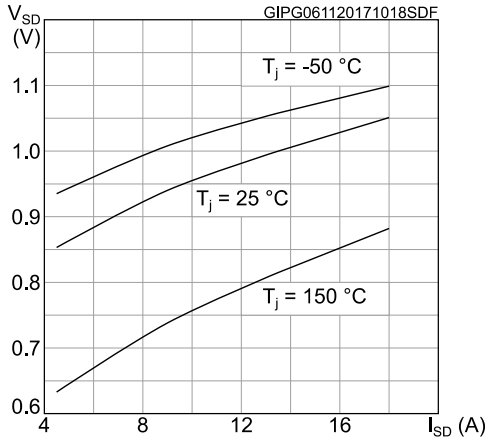
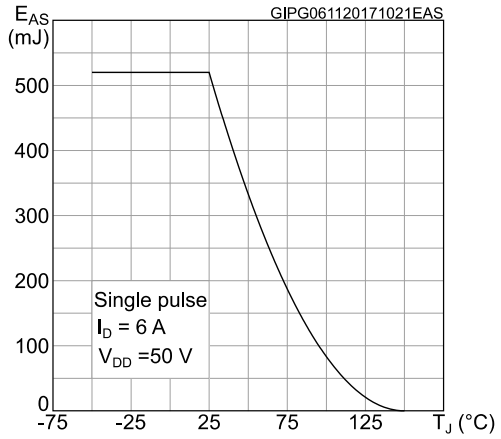


**Figure 14: Maximum avalanche energy vs starting $T_J$**



# 3 Test circuits

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

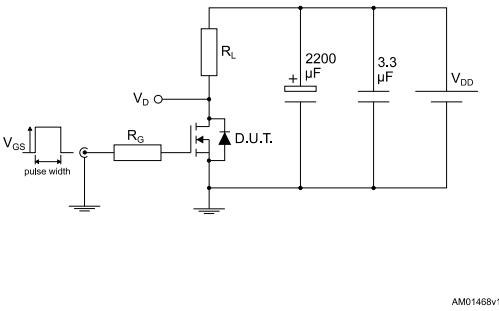



**Figure 16: Test circuit for gate charge behavior**

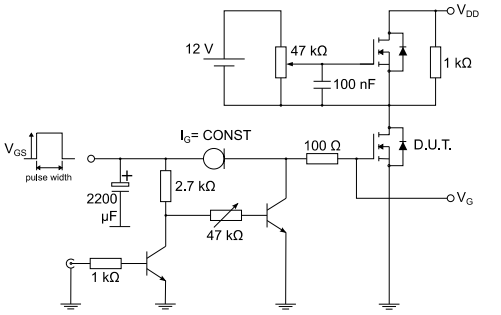



**Figure 17: Test circuit for inductive load switching and diode recovery times**

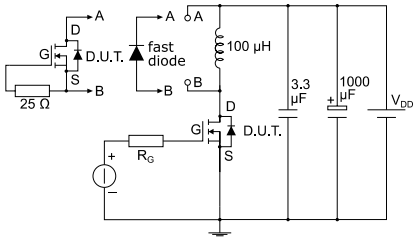



**Figure 18: Unclamped inductive load test circuit**

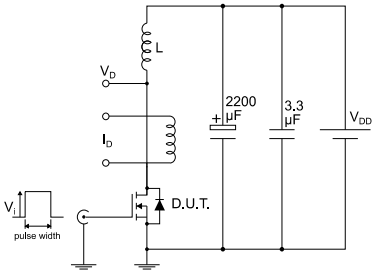



**Figure 19: Unclamped inductive waveform**

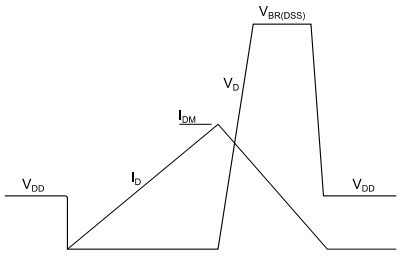
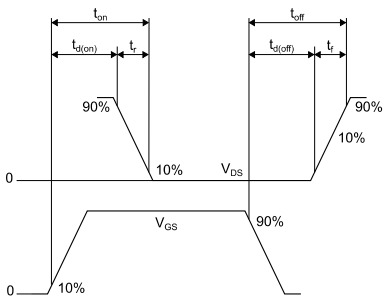



**Figure 20: Switching time waveform**



# 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***. ECOPACK® is an ST trademark.

## 4.1 TO-247 package information

**Figure 21: TO-247 package outline**

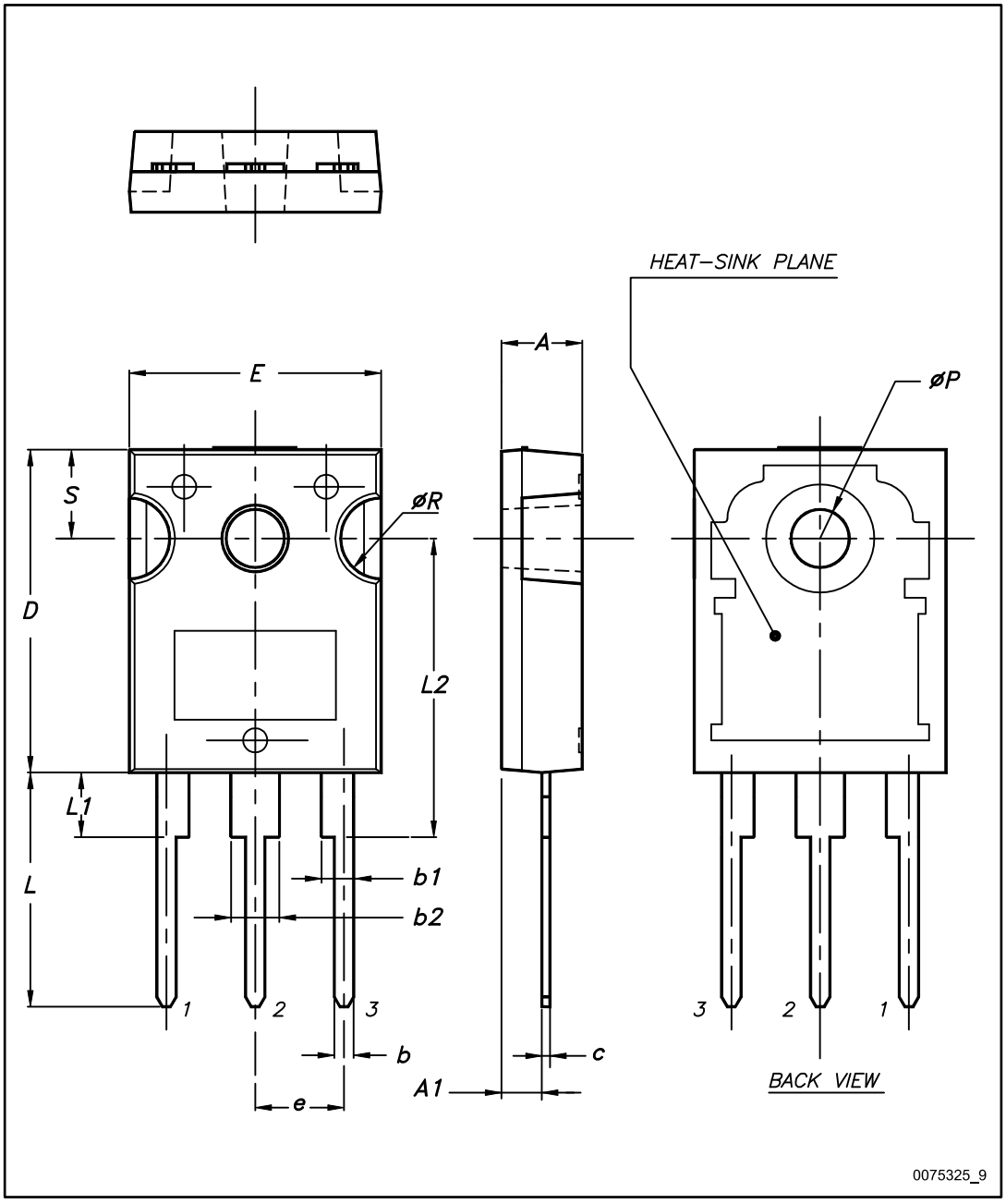


Table 9: TO-247 package mechanical data

| 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**

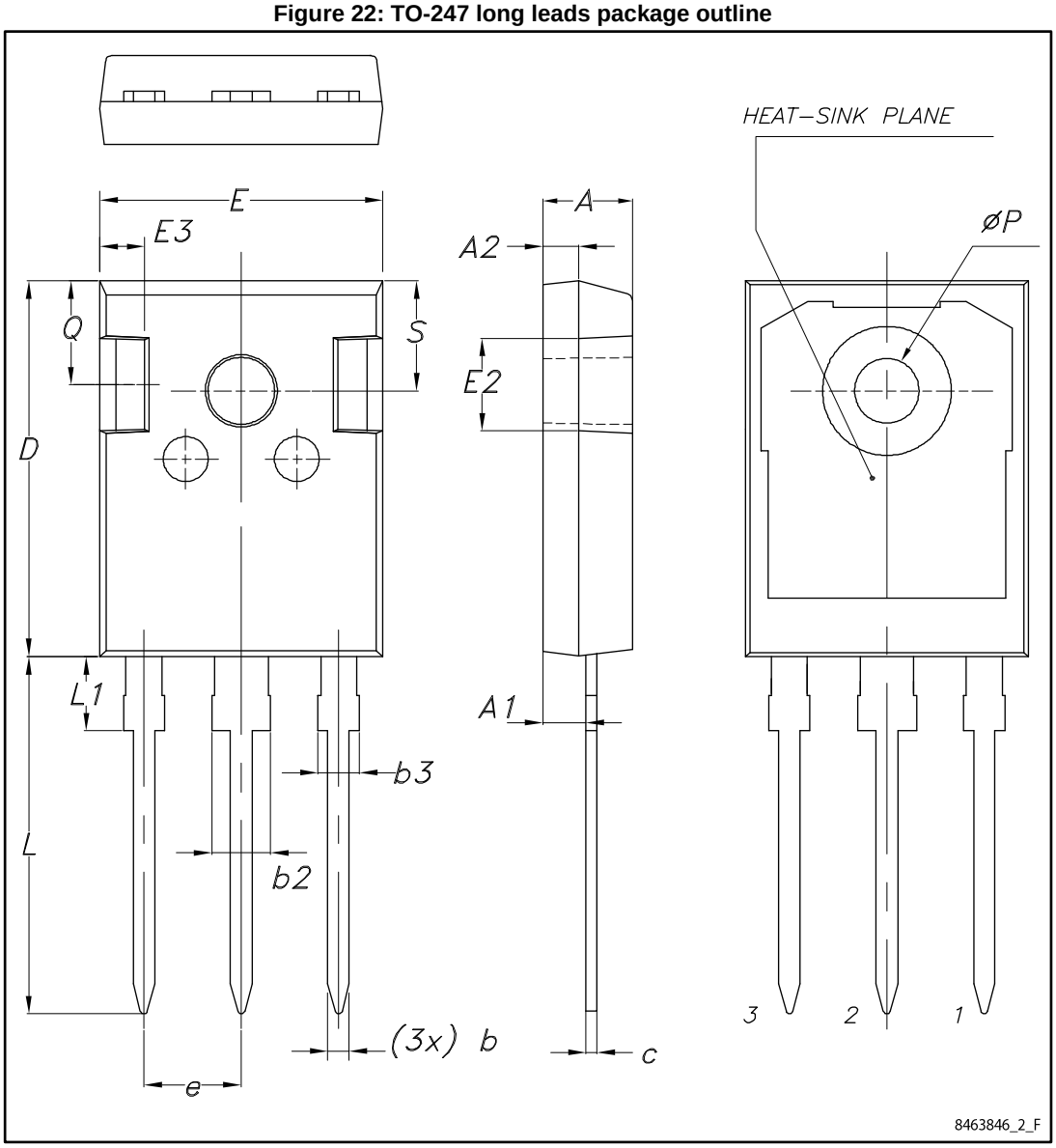


Table 10: TO-247 long leads package mechanical data

| 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 *Table 2: "Absolute maximum ratings"*, *Table 4: "Thermal data"*, *Table 5: "On/off states"*, *Table 6: "Dynamic"*, *Table 7: "Switching times"* and *Table 8: "Source-drain diode"*.<br>Added *Section 2.1: "Electrical characteristics (curves)".*<br>Minor text changes. |

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