

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

Datasheet - production data

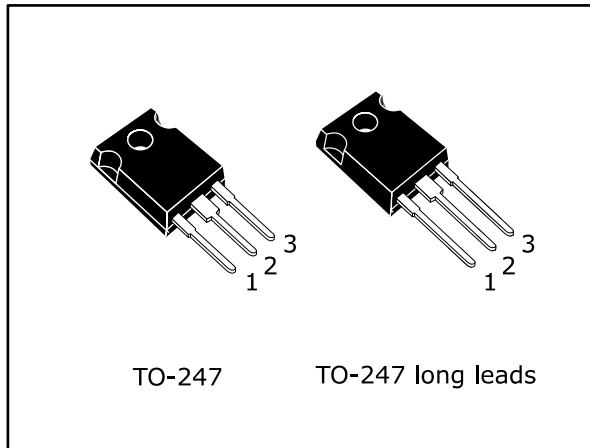
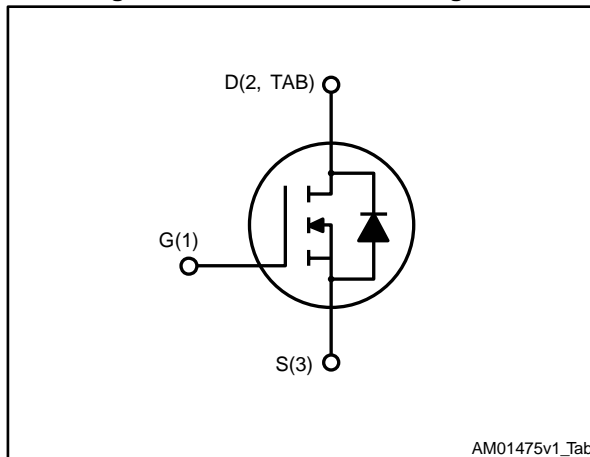


Figure 1: Internal schematic diagram



Features

| Order code | V _{DS} | R _{DS(on)} max. | I _D |
|--------------|-----------------|--------------------------|----------------|
| STW40N95DK5 | 950 V | 0.130 Ω | 38 A |
| STWA40N95DK5 | | | |

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

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 (starting $T_J = 25\text{ °C}$, $I_D = 13\text{ A}$, $V_{DD} = 50\text{ V}$) | 730 | 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 | | | 1 | 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 | | | ±10 | 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 = 19 A | | 0.120 | 0.130 | 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 | - | 3480 | - | pF |
| C _{oss} | Output capacitance | | - | 235 | - | pF |
| C _{rss} | Reverse transfer capacitance | | - | 2.3 | - | pF |
| C _{o(tr)} ⁽¹⁾ | Equivalent capacitance time related | V _{GS} = 0 V, V _{DS} = 0 to 760 V | - | 371 | - | pF |
| C _{o(er)} ⁽²⁾ | Equivalent capacitance energy related | | - | 134 | - | pF |
| R _g | Intrinsic gate resistance | f = 1 MHz, I _D = 0 A | - | 2 | - | Ω |
| Q _g | Total gate charge | V _{DD} = 760 V, I _D = 38 A, V _{GS} = 10 V (see Figure 15: "Test circuit for gate charge behavior") | - | 100 | - | nC |
| Q _{gs} | Gate source charge | | - | 19.5 | - | nC |
| Q _{gd} | Gate drain charge | | - | 67.6 | - | nC |

Notes:

⁽¹⁾Time related 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}

⁽²⁾Energy related is defined as a constant equivalent capacitance giving the same stored energy 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 | $V_{DS} = 475\text{ V}$, $I_D = 19\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 14 : "Test circuit for resistive load switching times") | - | 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 | $I_{SD} = 19\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 16 : "Test circuit for inductive load switching and diode recovery times") | - | 170 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.4 | | μC |
| I_{RRM} | Reverse recovery current | | - | 15 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 19\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16 : "Test circuit for inductive load switching and diode recovery times") | - | 340 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 5 | | μC |
| I_{RRM} | Reverse recovery current | | - | 30 | | 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)

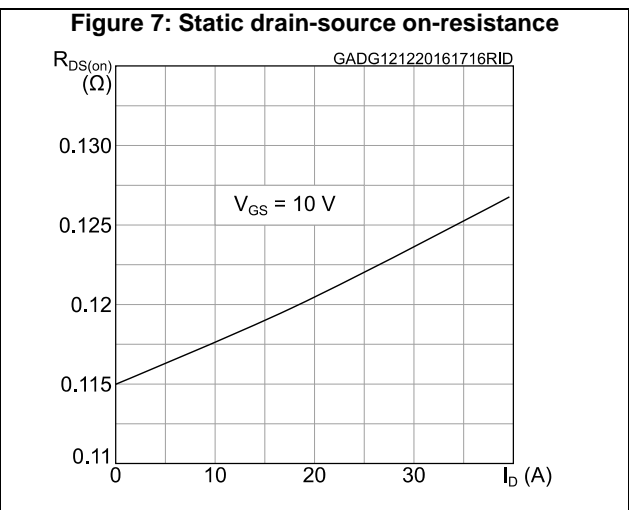
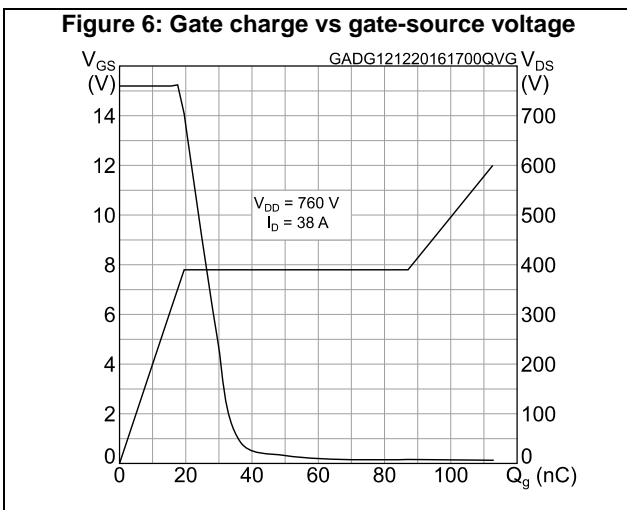
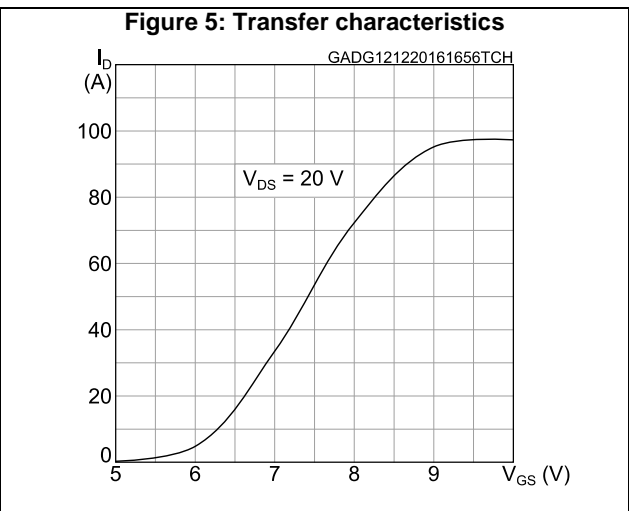
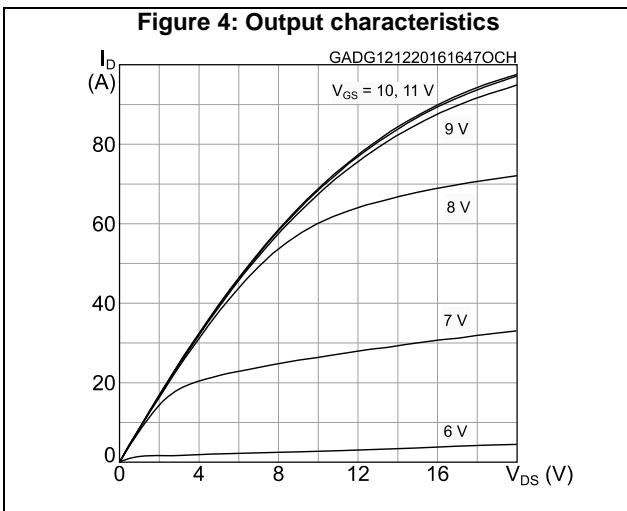
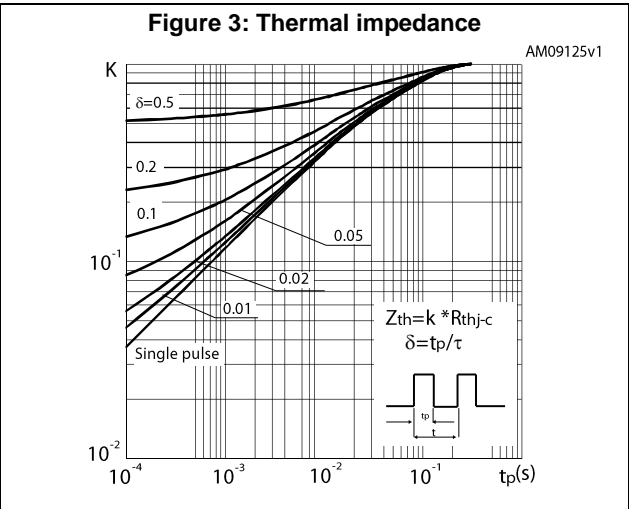
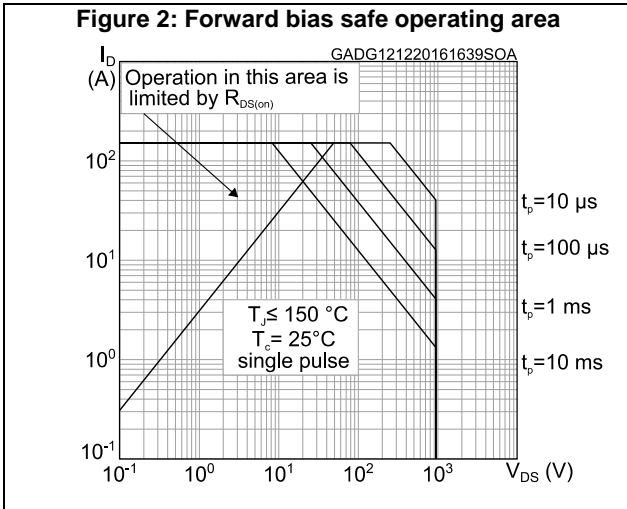


Figure 8: Capacitance variations

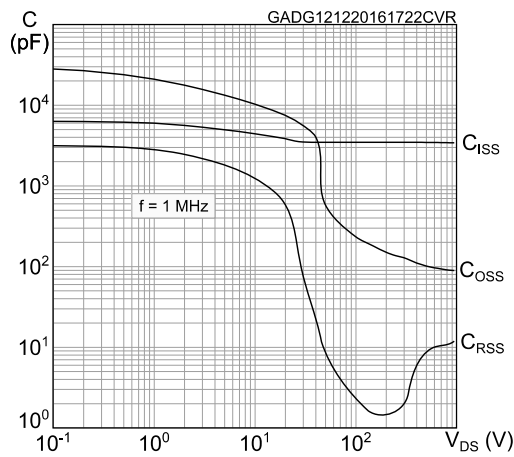


Figure 9: Normalized gate threshold voltage vs temperature

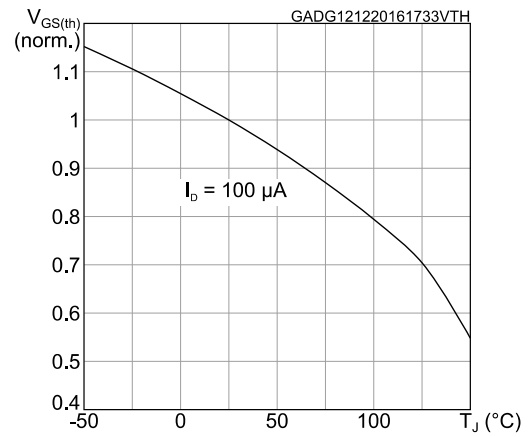


Figure 10: Normalized on-resistance vs temperature

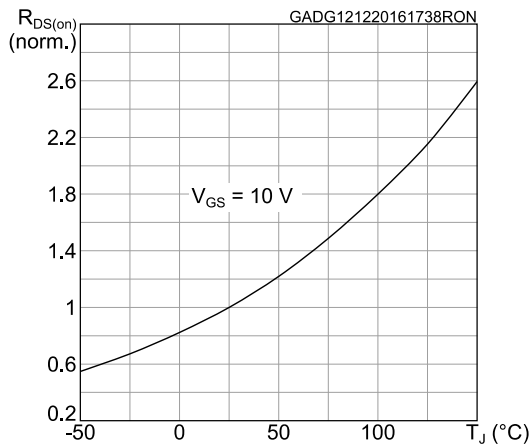


Figure 11: Normalized V(BR)DSS vs temperature

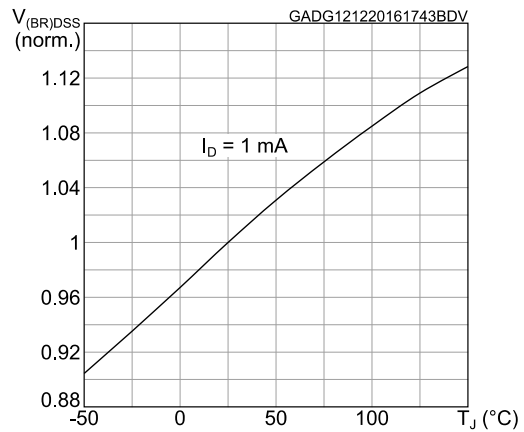


Figure 12: Source-drain diode forward characteristics

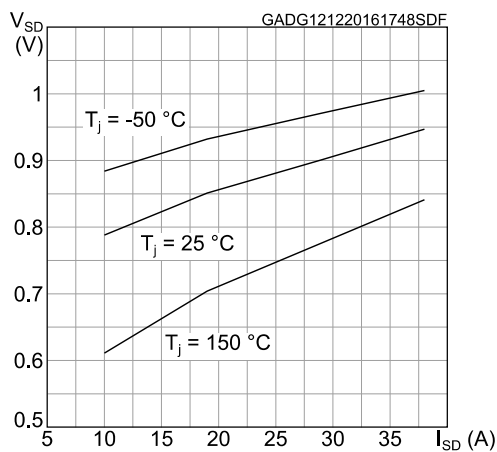
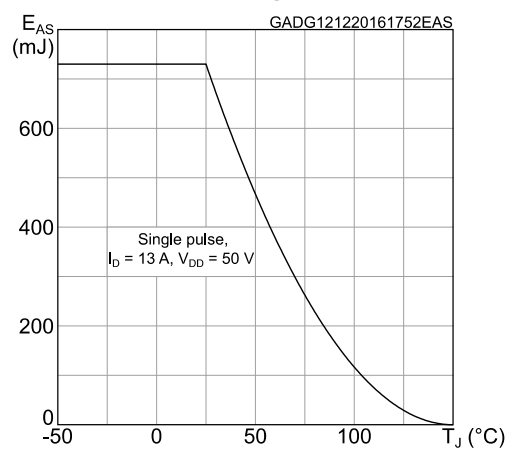


Figure 13: Maximum avalanche energy vs starting T_J



3 Test circuits

Figure 14: Test circuit for resistive load switching times



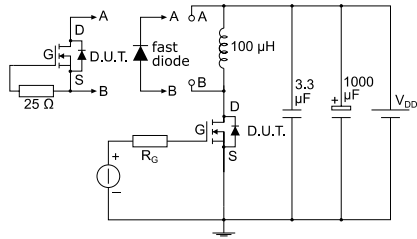
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Figure 15: Test circuit for gate charge behavior



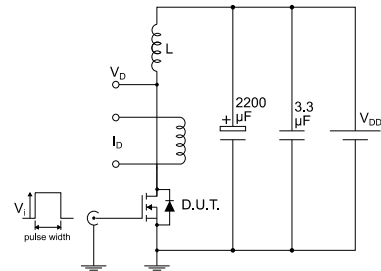
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Figure 16: Test circuit for inductive load switching and diode recovery times



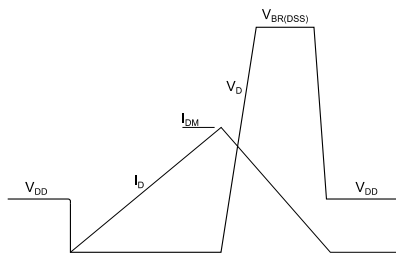
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Figure 17: Unclamped inductive load test circuit



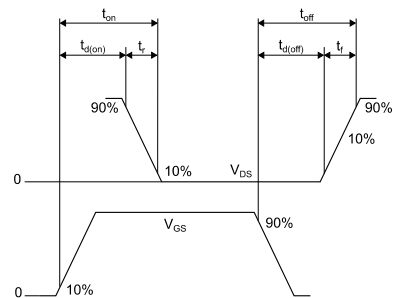
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Figure 18: Unclamped inductive waveform



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Figure 19: Switching time waveform



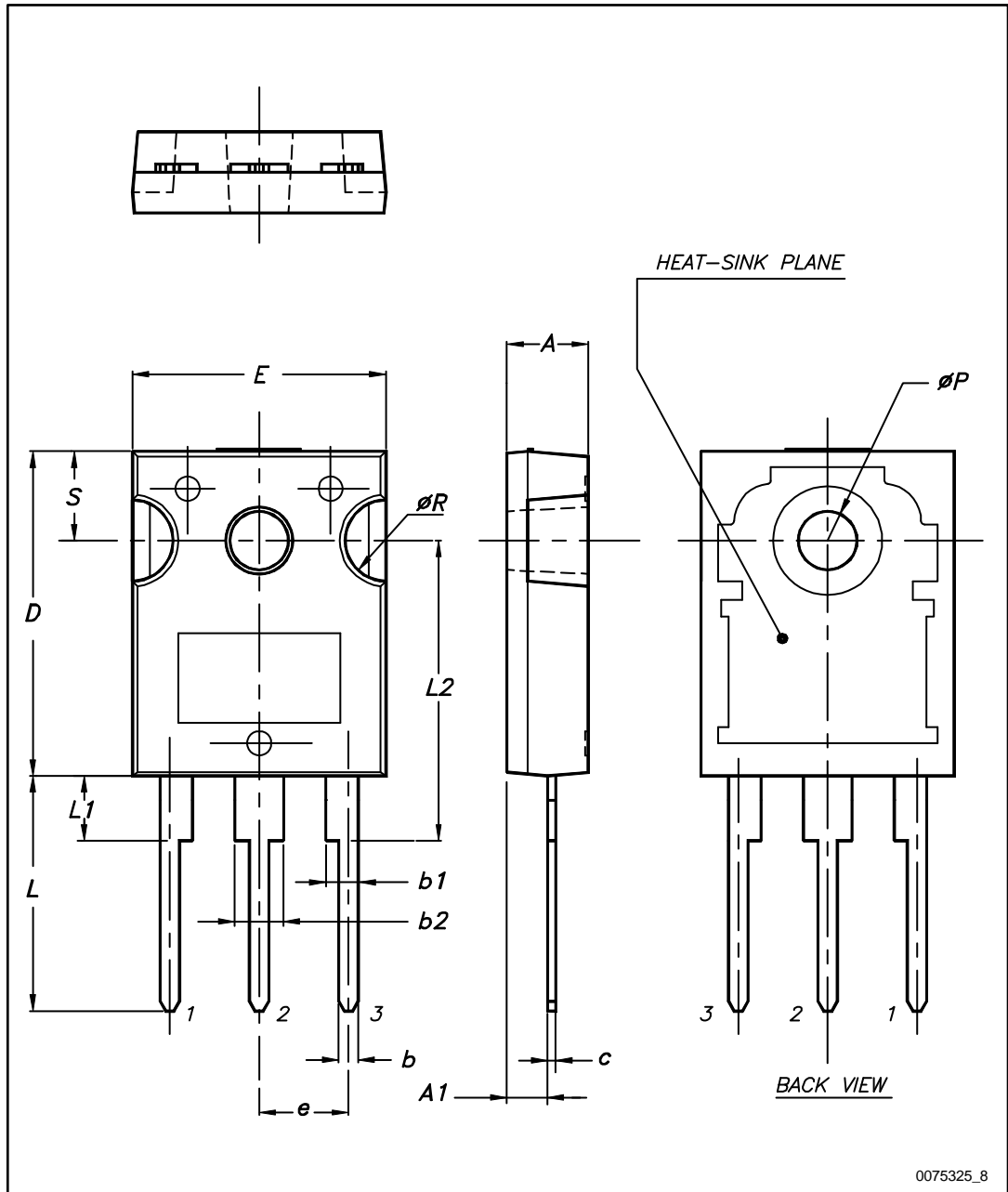
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4 Package information

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. ECOPACK® is an ST trademark.

4.1 TO-247 package information

Figure 20: TO-247 package outline



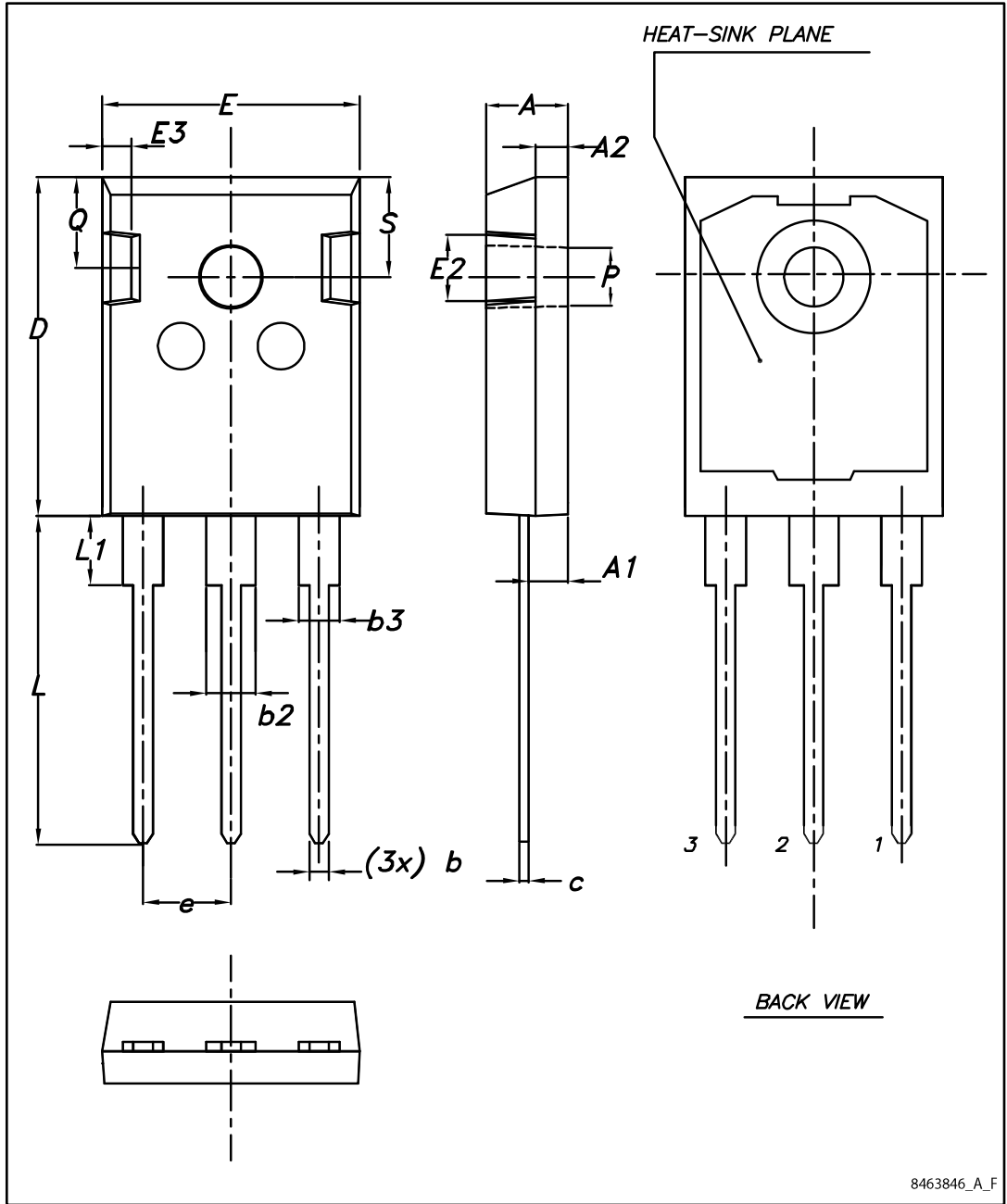
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Table 9: TO-247 package mechanical data

| 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



8463846_A_F

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. Updated Section 10 : "Electrical characteristics" and Section 12.1:"TO-247 package information" Minor text changes. |
| 12-Apr-2016 | 3 | Updated title,silhouette and description in cover page. Updated <i>Table 2: "Absolute maximum ratings"</i> . Updated <i>Section 10: "Electrical characteristics"</i> . Added <i>Figure 21: "TO-247 long lead package outline"</i> . Minor text changes |
| 15-Dec-2016 | 4 | Datasheet status promoted from preliminary to production data. Updated document title on cover page. 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> . Added <i>Section 2.1: "Electrical characteristics (curves)"</i> . Minor text changes |

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