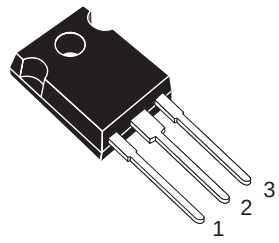
# STW88N65M5
# STWA88N65M5

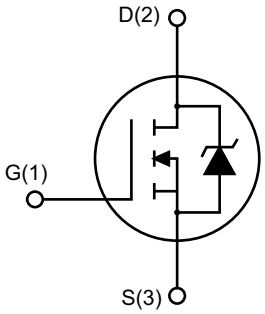
## N-channel 650 V, 0.024 Ω typ., 84 A, MDmesh™ V Power MOSFET in TO-247 and TO-247 long leads packages

**Datasheet - production data**




**TO-247**
**TO-247 long leads**

**Figure 1. Internal schematic diagram**




## Features

| Order codes | $V_{DSS}$ @$T_{jmax.}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STW88N65M5 | 710 V | < 0.029 Ω | 84 A |
| STWA88N65M5 | | | |

- Worldwide best $R_{DS(on)}$ in TO-247
- Higher $V_{DSS}$ rating
- Higher dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% avalanche tested

## Applications

- High efficiency switching applications:
  - Servers
  - PV inverters
  - Telecom infrastructure
  - Multi kW battery chargers

## Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

**Table 1. Device summary**

| Order codes | Marking | Packages | Packaging |
|---|---|---|---|
| STW88N65M5 | 88N65M5 | TO-247 | Tube |
| STWA88N65M5 | | TO-247 long leads | |

# Contents

# 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 $T_C$ = 25 °C | 84 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 50.5 | A |
| $I_{DM}$ (1) | Drain current (pulsed) | 336 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 450 | W |
| $I_{AR}$ | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{JMAX}$) | 15 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 2000 | mJ |
| dv/dt (2) | Peak diode recovery voltage slope | 15 | V/ns |
| $T_{stg}$ | Storage temperature | - 55 to 150 | °C |
| $T_j$ | Max. operating junction temperature | 150 | °C |

1. Pulse width limited by safe operating area
2. $I_{SD} \leq$ 84 A, di/dt = 400 A/µs, peak $V_{DS} < V_{(BR)DSS}$, $V_{DD}$ = 400 V

**Table 3. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 0.28 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient max | 50 | °C/W |
| $T_l$ | Maximum lead temperature for soldering purpose | 300 | °C |

# 2 Electrical characteristics

($T_C$ = 25 °C unless otherwise specified)

**Table 4. 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 | 650 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = 650 V<br>$V_{DS}$ = 650 V, $T_C$=125 °C | | | 1<br>100 | µA<br>µA |
| $I_{GSS}$ | Gate-body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ± 25 V | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$ = 10 V, $I_D$ = 42 A | | 0.024 | 0.029 | Ω |

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ = 100 V, f = 1 MHz,<br>$V_{GS}$ = 0 | - | 8825<br>223<br>11 | - | pF<br>pF<br>pF |
| $C_{o(tr)}$(1) | Equivalent capacitance time related | $V_{GS}$ = 0, $V_{DS}$ = 0 to 520 V | - | 778 | - | pF |
| $C_{o(er)}$(2) | Equivalent capacitance energy related | $V_{GS}$ = 0, $V_{DS}$ = 0 to 520 V | - | 202 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz open drain | - | 1.79 | - | Ω |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$ = 520 V, $I_D$ = 42 A,<br>$V_{GS}$ = 10 V<br>(see *Figure 16*) | - | 204<br>51<br>84 | - | nC<br>nC<br>nC |

1. $C_{o(tr)}$ is a constant capacitance value that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.
2. $C_{o(er)}$ is a constant capacitance value that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

**Table 6. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(V)}$ | Voltage delay time | $V_{DD}$ = 400 V, $I_D$ = 56 A, | - | 141 | - | ns |
| $t_{r(V)}$ | Voltage rise time | $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V | | 16 | | ns |
| $t_{f(i)}$ | Current fall time | (see *Figure 17*) | | 29 | | ns |
| $t_{c(off)}$ | Crossing time | (see *Figure 20*) | | 56 | | ns |

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 84 | A |
| $I_{SDM}$ (1) | Source-drain current (pulsed) | | | | 336 | A |
| $V_{SD}$ (2) | Forward on voltage | $I_{SD}$ = 84 A, $V_{GS}$ = 0 | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 84 A, | - | 544 | | ns |
| $Q_{rr}$ | Reverse recovery charge | di/dt = 100 A/µs | | 14 | | µC |
| $I_{RRM}$ | Reverse recovery current | $V_{DD}$ = 100 V (see *Figure 17*) | | 50 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 84 A, | - | 660 | | ns |
| $Q_{rr}$ | Reverse recovery charge | di/dt = 100 A/µs | | 20 | | µC |
| $I_{RRM}$ | Reverse recovery current | $V_{DD}$ = 100 V, $T_j$ = 150 °C (see *Figure 17*) | | 60 | | A |

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**

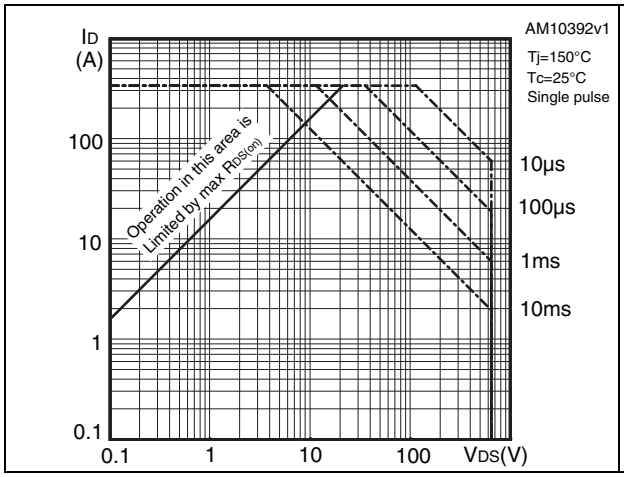



**Figure 3. Thermal impedance**

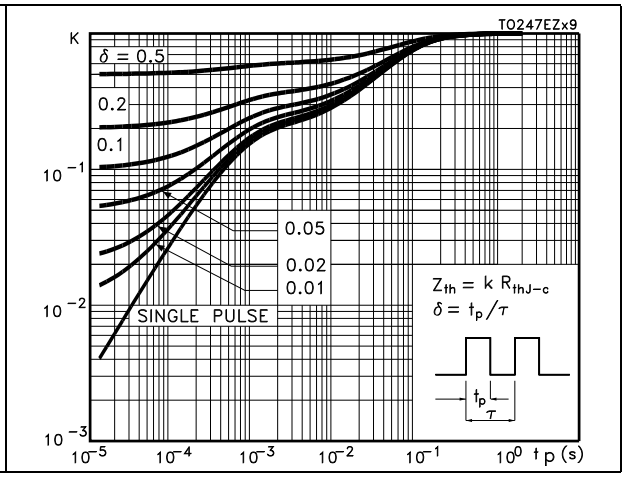



**Figure 4. Output characteristics**

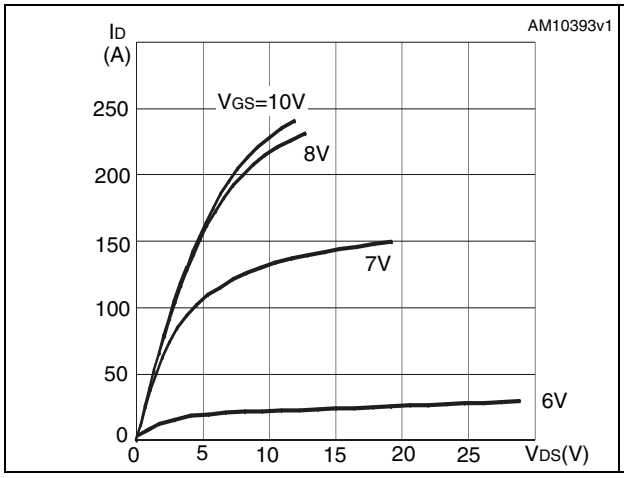



**Figure 5. Transfer characteristics**

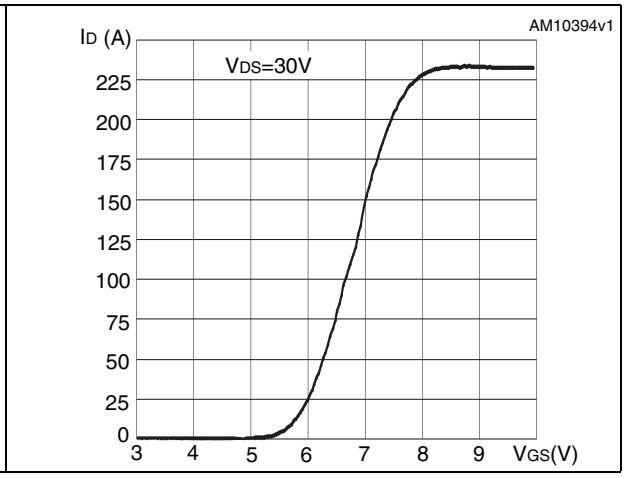



**Figure 6. Gate charge vs gate-source voltage**

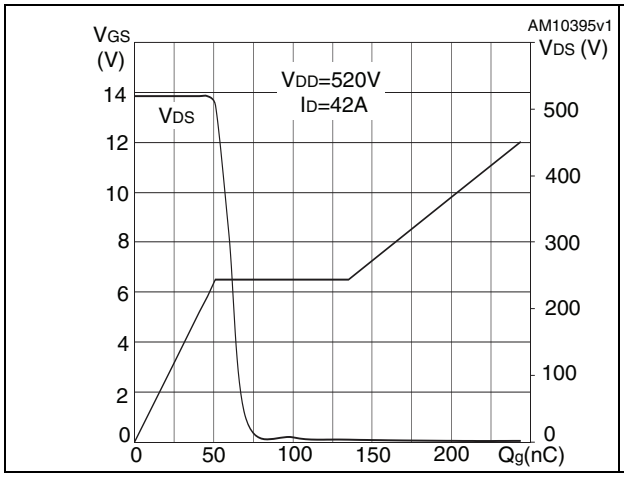



**Figure 7. Static drain-source on resistance**

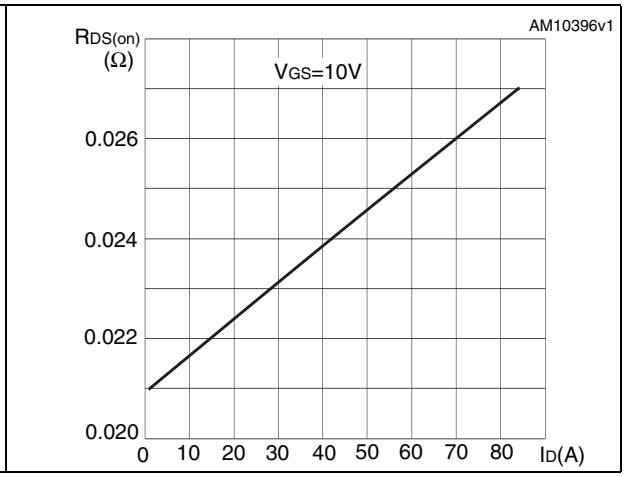


**Figure 8. Capacitance variations**

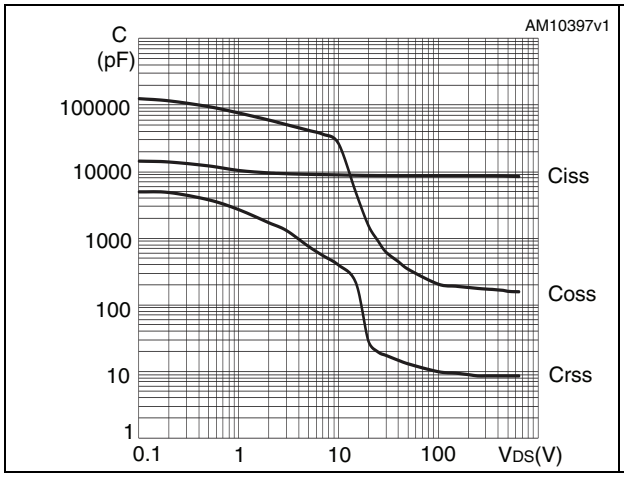



**Figure 9. Output capacitance stored energy**

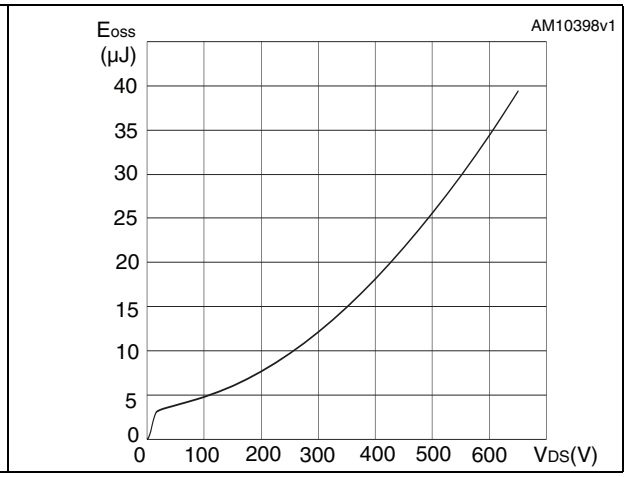



**Figure 10. Normalized gate threshold voltage vs temperature**

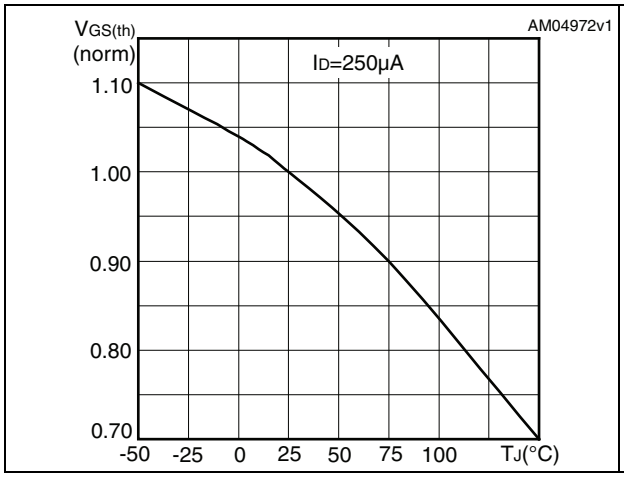



**Figure 11. Normalized on resistance vs temperature**

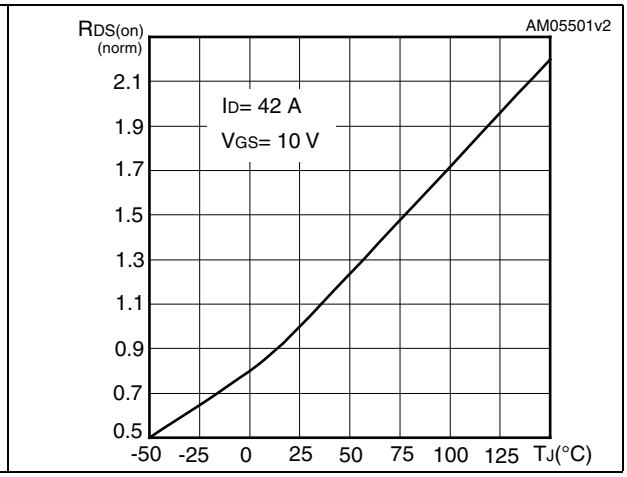



**Figure 12. Source-drain diode forward characteristics**

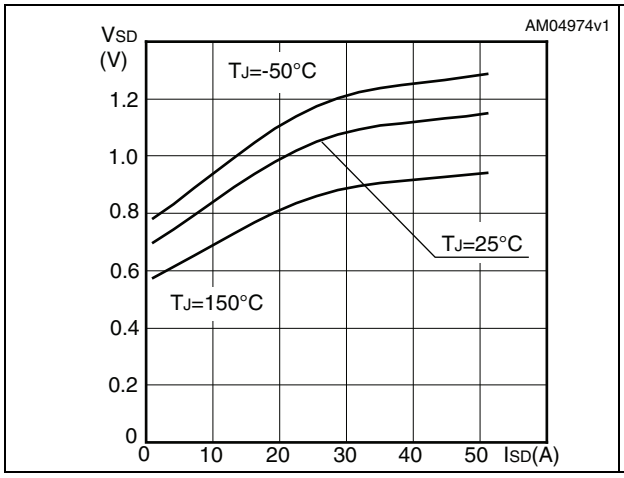



**Figure 13. Normalized $V_{DS}$ vs temperature**

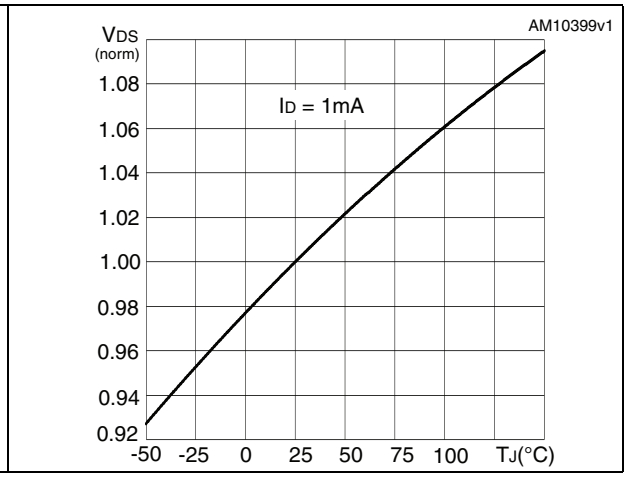
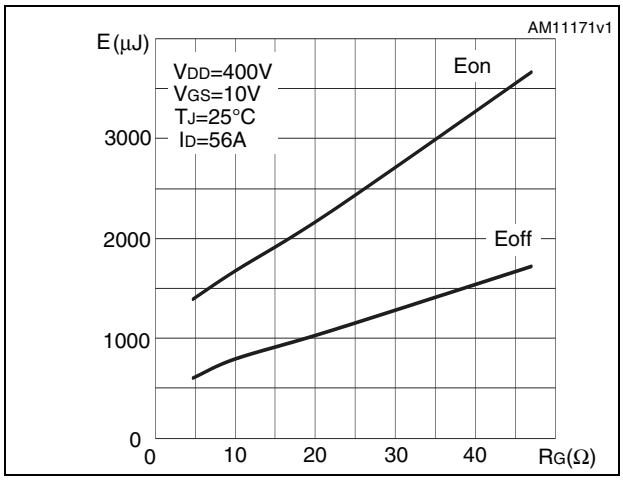


**Figure 14. Switching losses vs gate resistance (1)**




1. Eon including reverse recovery of a SiC diode

# 3 Test circuits

**Figure 15. Switching times test circuit for resistive load**

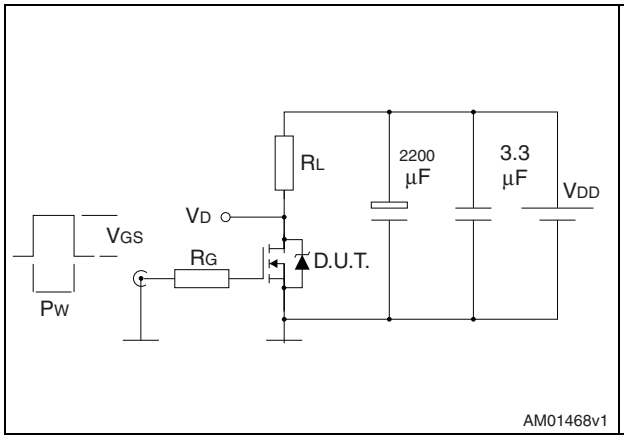



**Figure 16. Gate charge test circuit**

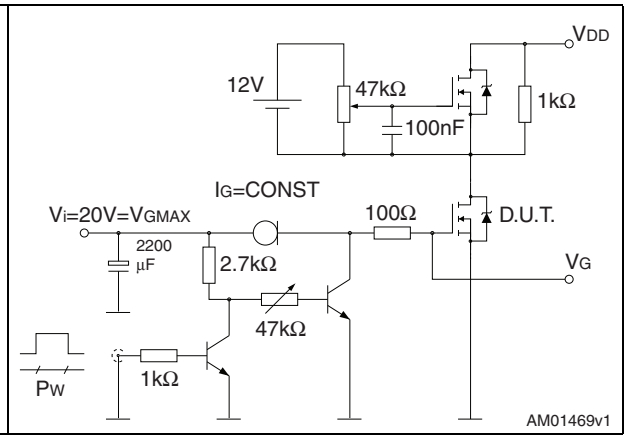



**Figure 17. Test circuit for inductive load switching and diode recovery times**

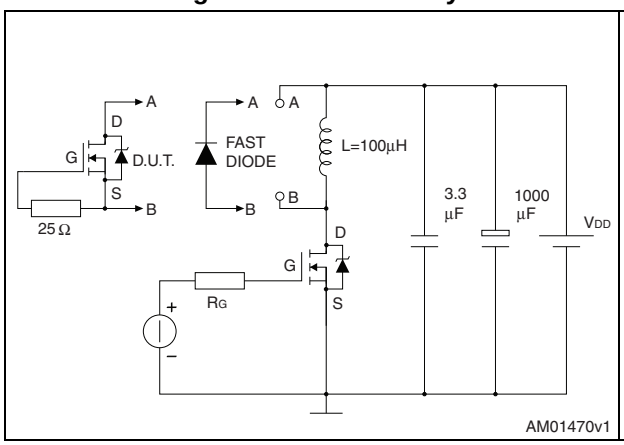



**Figure 18. Unclamped inductive load test circuit**

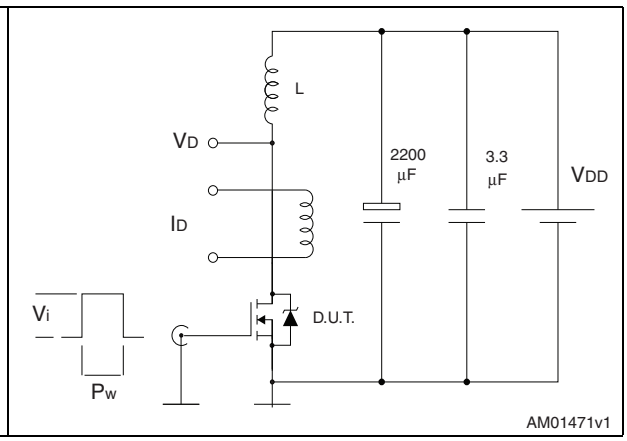



**Figure 19. Unclamped inductive waveform**

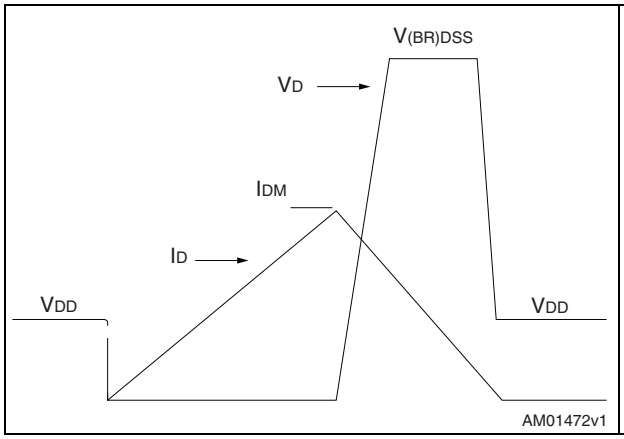
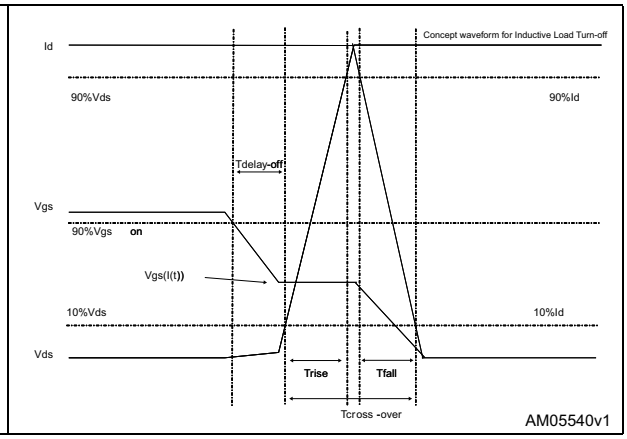



**Figure 20. Switching time waveform**



# 4 Package mechanical data

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.

**Table 8. TO-247 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 | |
| ∅P | 3.55 | | 3.65 |
| ∅R | 4.50 | | 5.50 |
| S | 5.30 | 5.50 | 5.70 |

**Figure 21. TO-247 drawing**

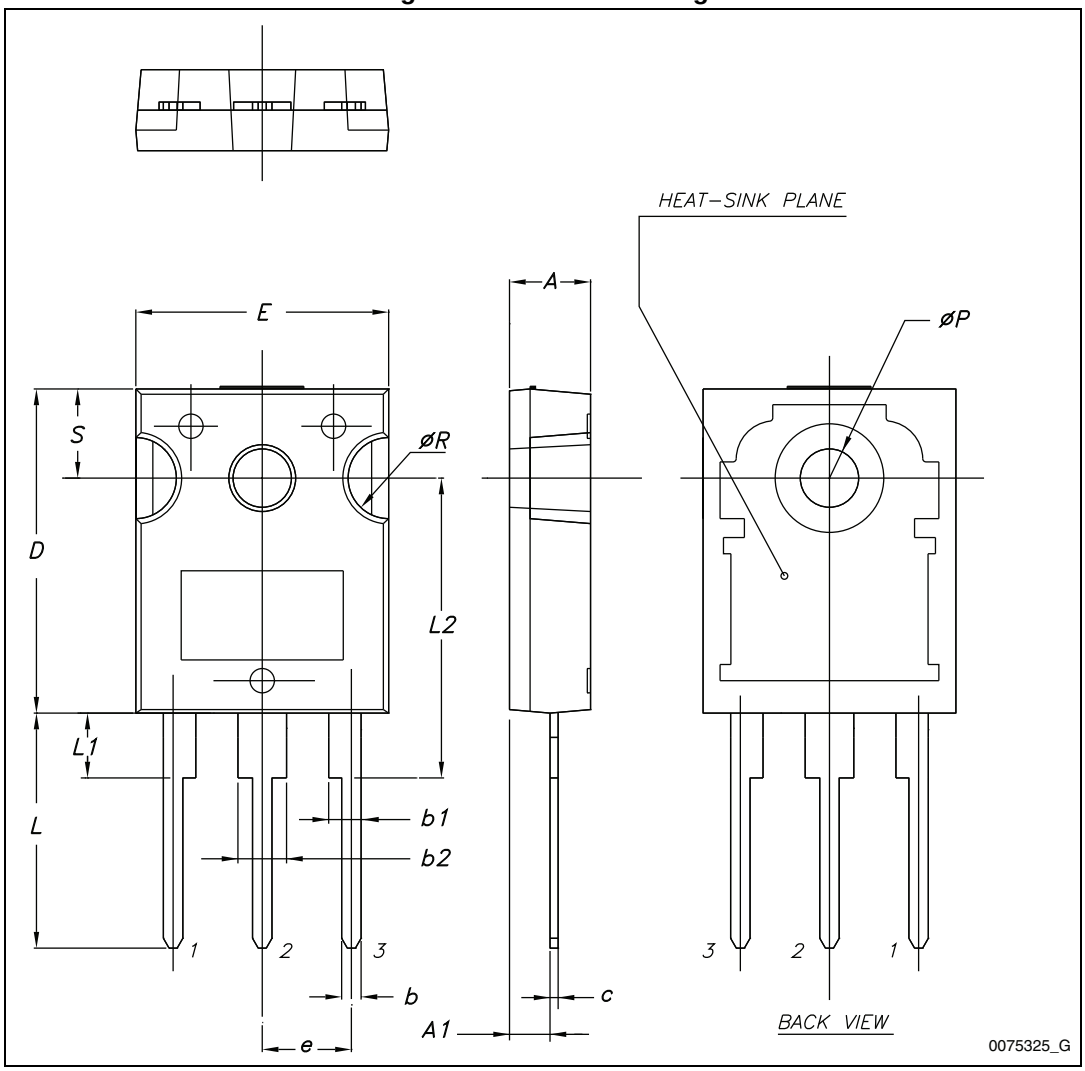
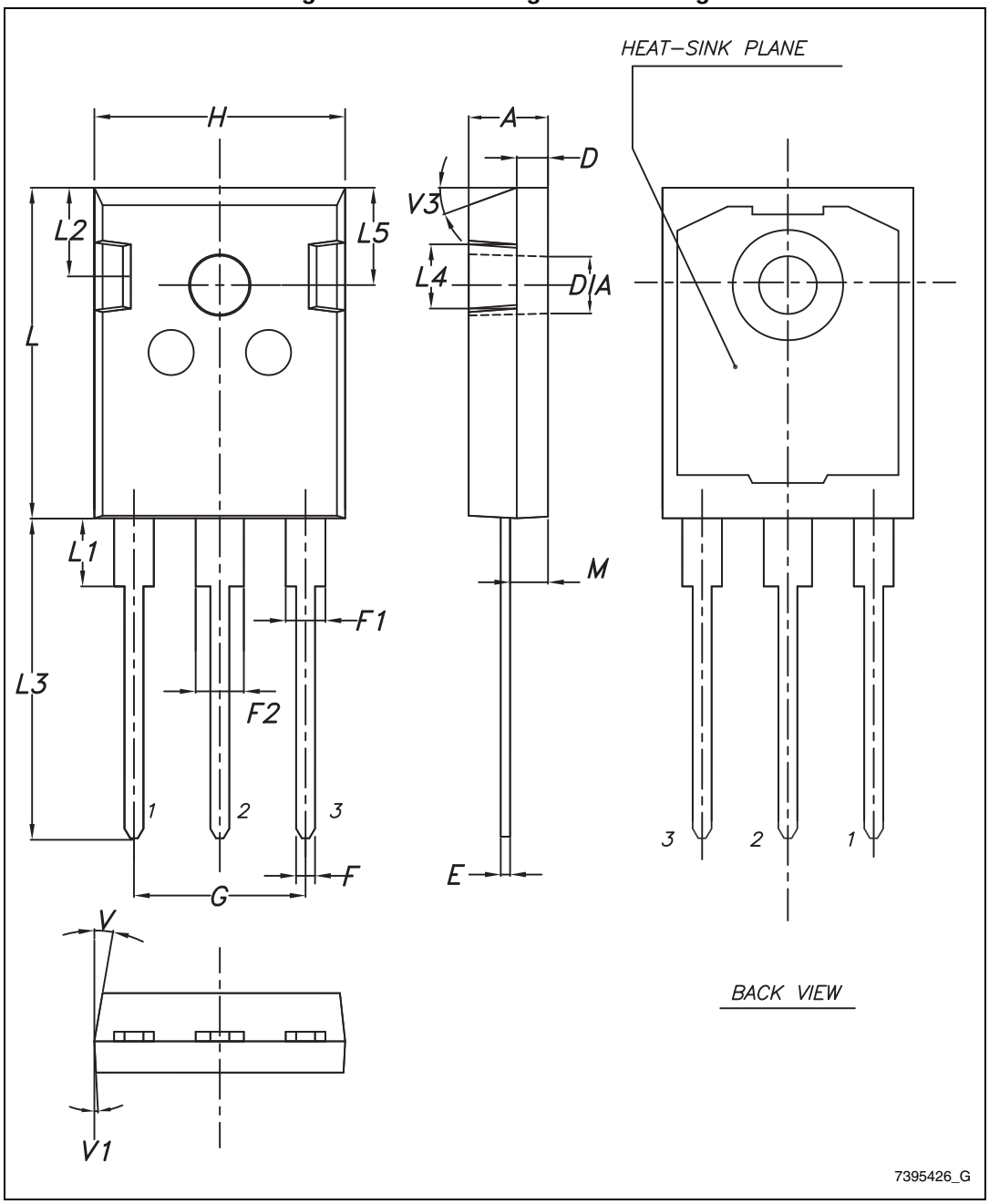


**Table 9. TO-247 long leads mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.90 | | 5.15 |
| D | 1.85 | | 2.10 |
| E | 0.55 | | 0.67 |
| F | 1.07 | | 1.32 |
| F1 | 1.90 | | 2.38 |
| F2 | 2.87 | | 3.38 |
| G | 10.90 BSC | | |
| H | 15.77 | | 16.02 |
| L | 20.82 | | 21.07 |
| L1 | 4.16 | | 4.47 |
| L2 | 5.49 | | 5.74 |
| L3 | 20.05 | | 20.30 |
| L4 | 3.68 | | 3.93 |
| L5 | 6.04 | | 6.29 |
| M | 2.25 | | 2.55 |
| V | | 10° | |
| V1 | | 3° | |
| V3 | | 20° | |
| Dia. | 3.55 | | 3.66 |

**Figure 22. TO-247 long leads drawing**



# 5 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 23-Nov-2011 | 1 | First release. |
| 09-Dec-2011 | 2 | Document status promoted from preliminary data to datasheet. |
| 12-Jun-2012 | 3 | Updated title on the coverpage. |
| 30-Nov-2012 | 4 | Added new part number: STWA88N65M5<br>Updated: *Section 4: Package mechanical data* |

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