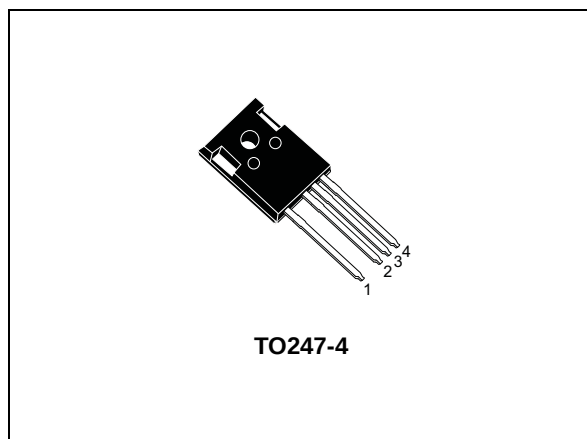
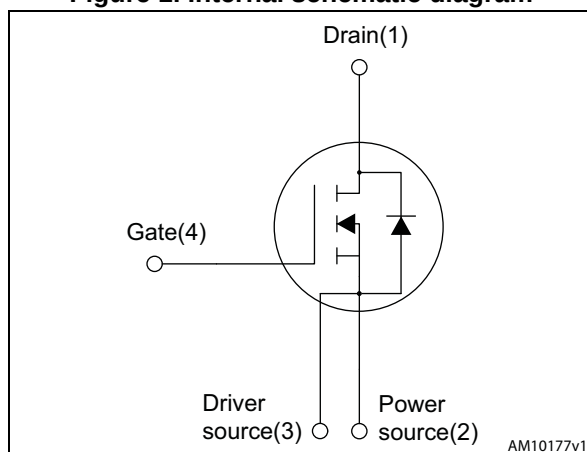


## N-channel 650 V, 0.037 $\Omega$ typ., 58 A, MDmesh™ V Power MOSFET in a TO247-4 package

Datasheet - production data



**Figure 1. Internal schematic diagram**



### Features

| Order code   | $V_{DS} @ T_{Jmax}$ | $R_{DS(on) max}$ | $I_D$ |
|--------------|---------------------|------------------|-------|
| STW69N65M5-4 | 710 V               | 0.045 $\Omega$   | 58 A  |

- Higher  $V_{DS}$  rating
- Higher dv/dt capability
- Excellent switching performance thanks to the extra driving source pin
- Easy to drive
- 100% avalanche tested

### Applications

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

### Description

This device is an N-channel MDmesh™ V Power MOSFET 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 code   | Marking | Package | Packaging |
|--------------|---------|---------|-----------|
| STW69N65M5-4 | 69N65M5 | TO247-4 | Tube      |

Contents

1      **Electrical ratings** ..... **3**

2      **Electrical characteristics** ..... **4**

        2.1      Electrical characteristics (curves) ..... 6

3      **Test circuits** ..... **9**

4      **Package mechanical data** ..... **10**

5      **Revision history** ..... **13**



# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol         | Parameter                                                                                                              | Value       | Unit               |
|----------------|------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|
| $V_{GS}$       | Gate- source voltage                                                                                                   | $\pm 25$    | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$                                                       | 58          | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$                                                      | 36.5        | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                                                                                 | 232         | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                | 330         | W                  |
| $I_{AR}$       | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{JMAX}$ )                           | 12          | A                  |
| $E_{AS}$       | Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 1410        | mJ                 |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                                                                                      | 15          | V/ns               |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                                                                              | 50          | V/ns               |
| $T_{stg}$      | Storage temperature                                                                                                    | - 55 to 150 | $^{\circ}\text{C}$ |
| $T_j$          | Max. operating junction temperature                                                                                    | 150         | $^{\circ}\text{C}$ |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 58\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ , peak  $V_{DS} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$

3.  $V_{DS} \leq 520\text{ V}$

Table 3. Thermal data

| Symbol         | Parameter                               | Value | Unit                        |
|----------------|-----------------------------------------|-------|-----------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max    | 0.38  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 50    | $^{\circ}\text{C}/\text{W}$ |

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified)

**Table 4. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                            | Min. | Typ.  | Max.      | Unit                           |
|---------------|--------------------------------------------------|----------------------------------------------------------------------------|------|-------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                         | 650  |       |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 650\text{ V}$<br>$V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$ |      |       | 1<br>100  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                                                 |      |       | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                         | 3    | 4     | 5         | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 29\text{ A}$                               |      | 0.037 | 0.045     | $\Omega$                       |

**Table 5. Dynamic**

| Symbol            | Parameter                             | Test conditions                                                                                               | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$                                                | -    | 6420 | -    | pF       |
| $C_{oss}$         | Output capacitance                    |                                                                                                               | -    | 170  | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |                                                                                                               | -    | 11   | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }520\text{ V}$                                                            | -    | 536  | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }520\text{ V}$                                                            | -    | 146  | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}$ open drain                                                                                 | -    | 1.3  | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 520\text{ V}$ , $I_D = 29\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 16</a> ) | -    | 143  | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |                                                                                                               | -    | 38   | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     |                                                                                                               | -    | 64   | -    | 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 | $V_{DD} = 400\text{ V}$ , $I_D = 38\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 17</a> )<br>(see <a href="#">Figure 20</a> ) | -    | 102  | -    | ns   |
| $t_{r(V)}$   | Voltage rise time  |                                                                                                                                                                         | -    | 10   | -    | ns   |
| $t_{f(i)}$   | Current fall time  |                                                                                                                                                                         | -    | 11.5 | -    | ns   |
| $t_{c(off)}$ | Crossing time      |                                                                                                                                                                         | -    | 14.5 | -    | ns   |

Table 7. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                   | -    |      | 58   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                   | -    |      | 232  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 58\text{ A}$ , $V_{GS} = 0$                                                                                                                             | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 58\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ (see <a href="#">Figure 17</a> )                                        | -    | 480  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                   | -    | 11   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                   | -    | 46   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 58\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 17</a> ) | -    | 592  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                   | -    | 16   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                   | -    | 53   |      | A             |

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

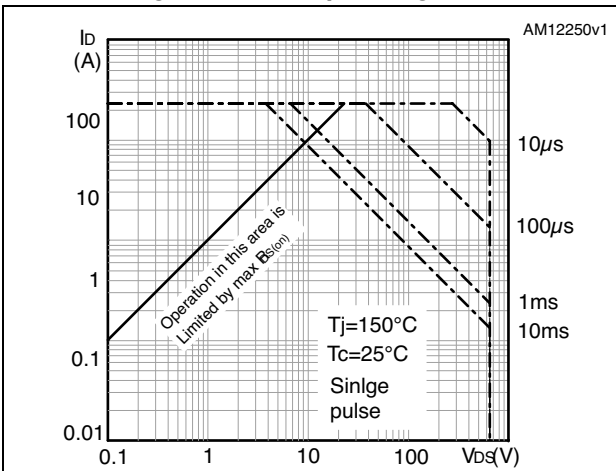


Figure 3. Thermal impedance

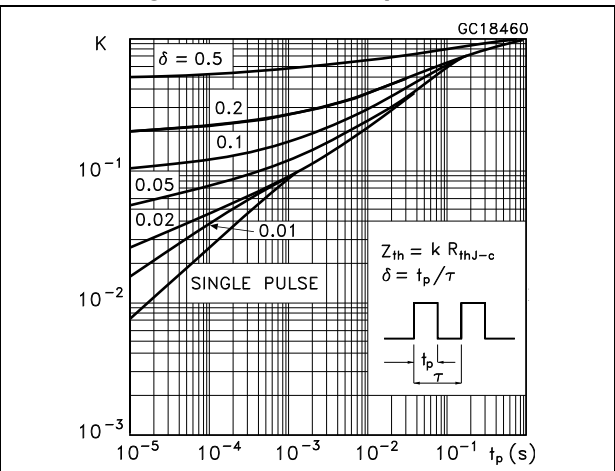


Figure 4. Output characteristics

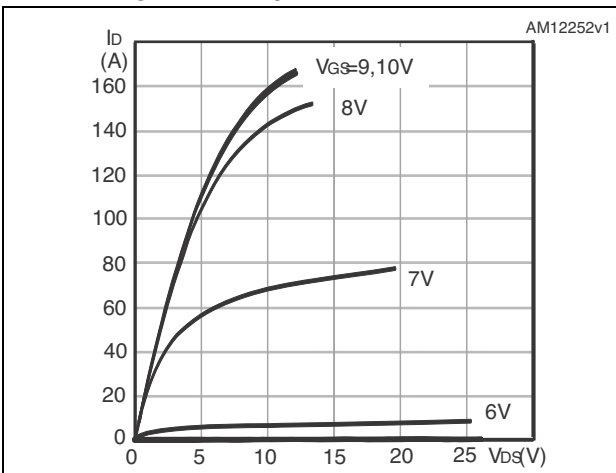


Figure 5. Transfer characteristics

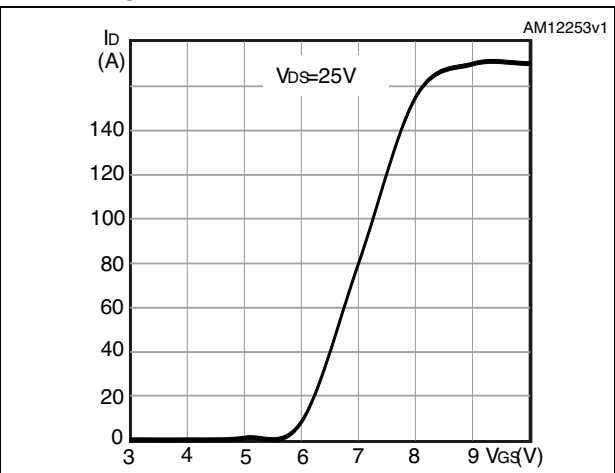


Figure 6. Gate charge vs gate-source voltage

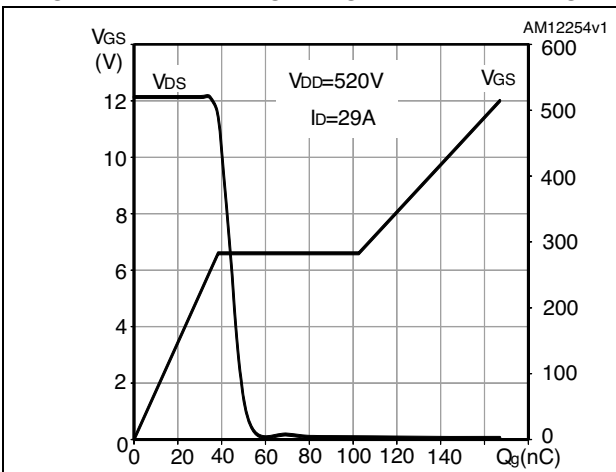


Figure 7. Static drain-source on-resistance

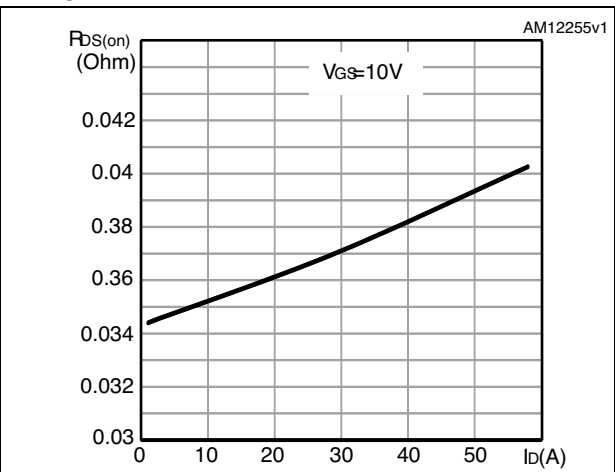


Figure 8. Capacitance variations

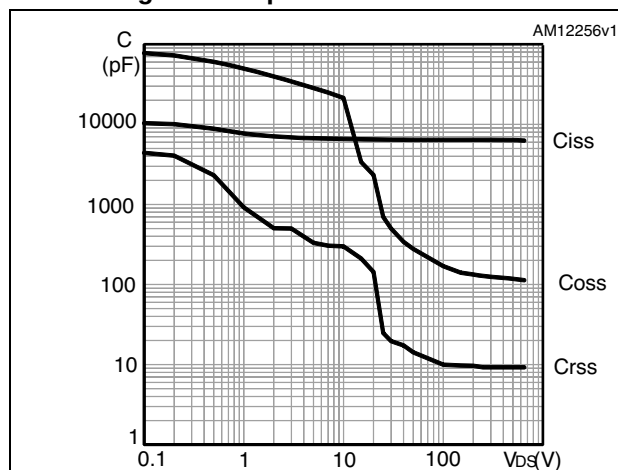


Figure 9. Output capacitance stored energy

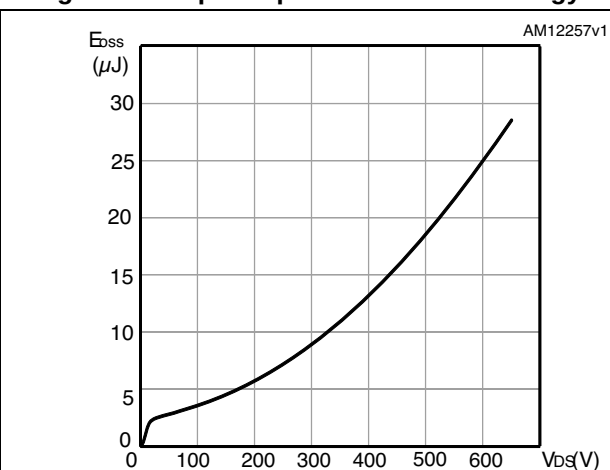


Figure 10. Normalized gate threshold voltage vs temperature

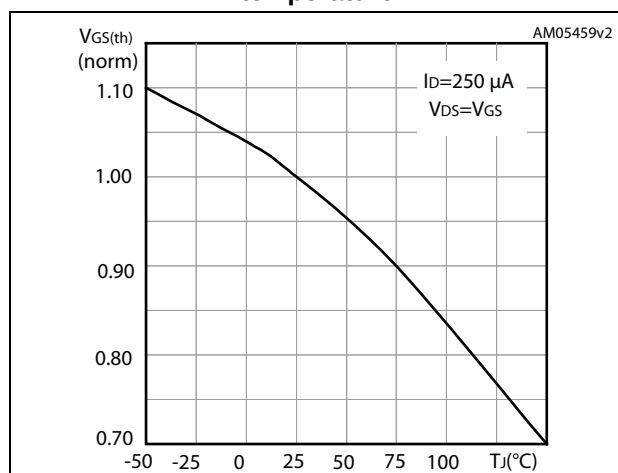


Figure 11. Normalized on-resistance vs temperature

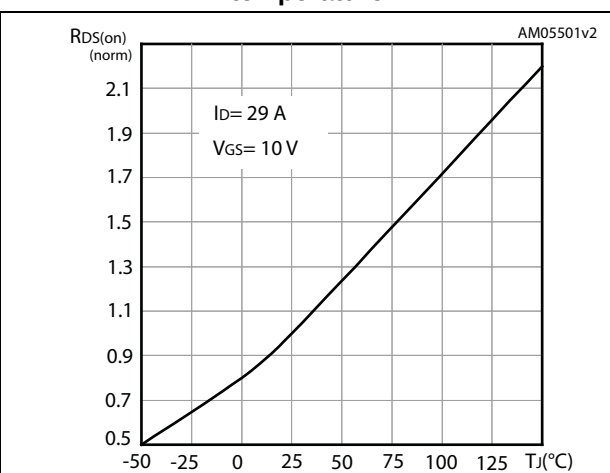


Figure 12. Source-drain diode forward characteristics

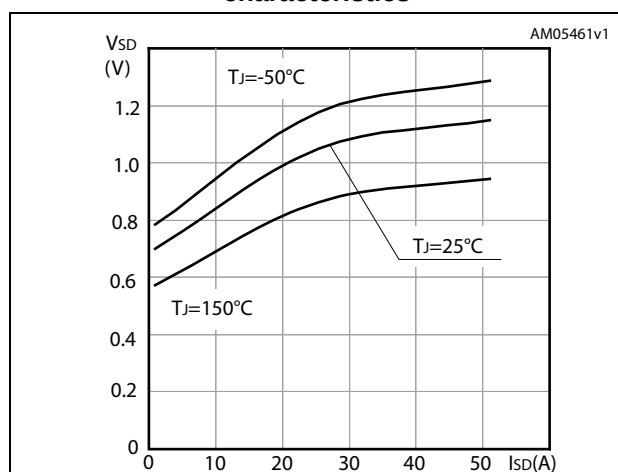
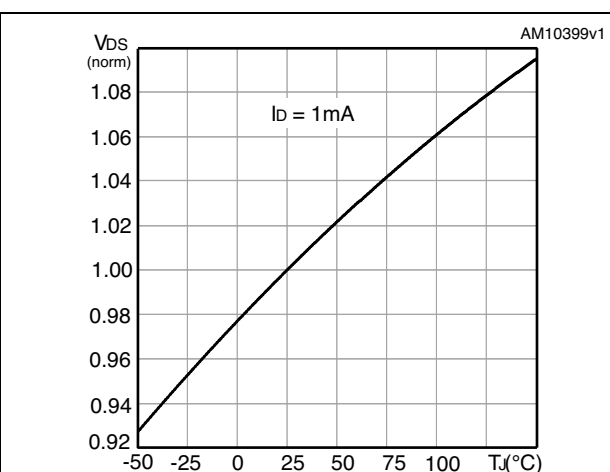
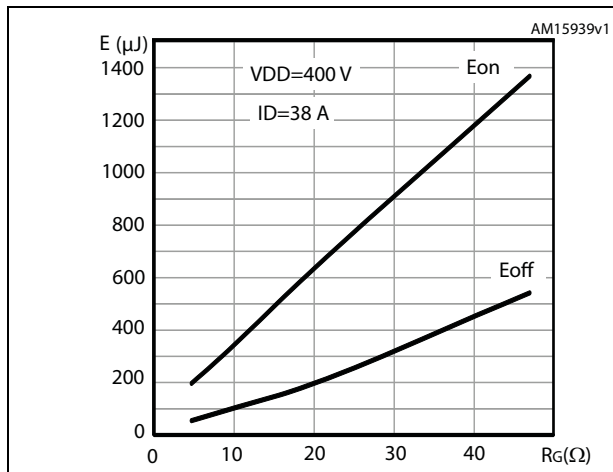
Figure 13. Normalized  $V_{DS}$  vs temperature

Figure 14. Switching losses vs gate resistance <sup>(1)</sup>



1.  $E_{on}$  including reverse recovery of a SiC diode.

### 3 Test circuits

Figure 15. Switching times test circuit for resistive load

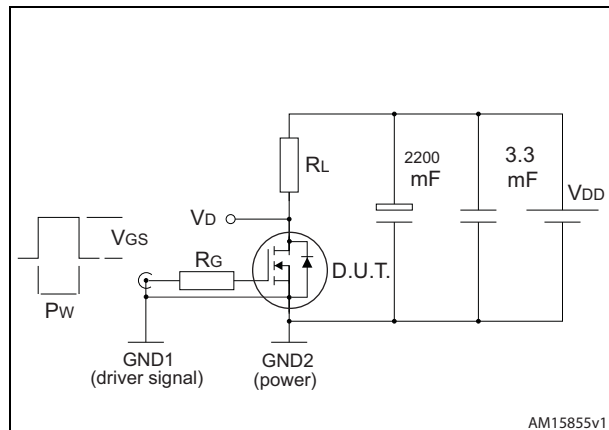


Figure 16. Gate charge test circuit

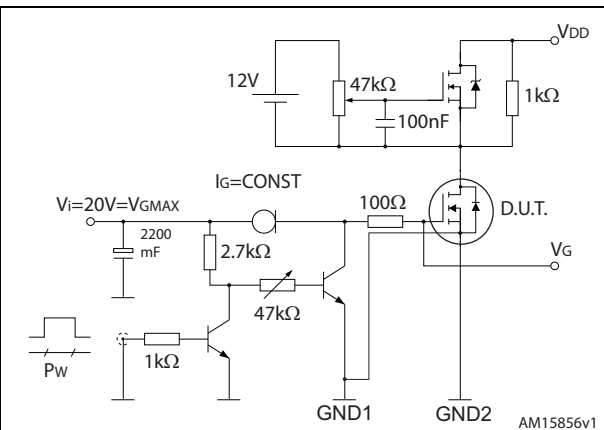


Figure 17. Test circuit for inductive load switching and diode recovery times

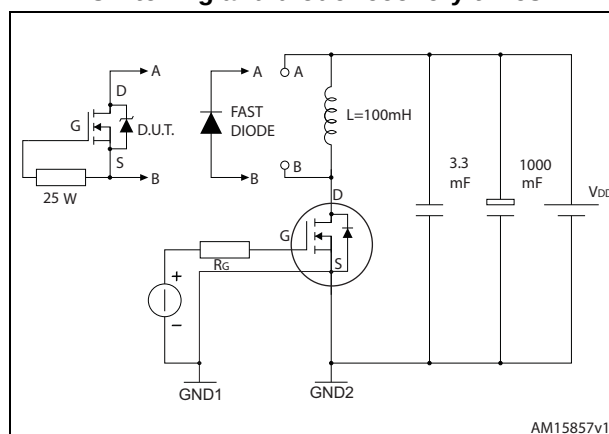


Figure 18. Unclamped inductive load test circuit

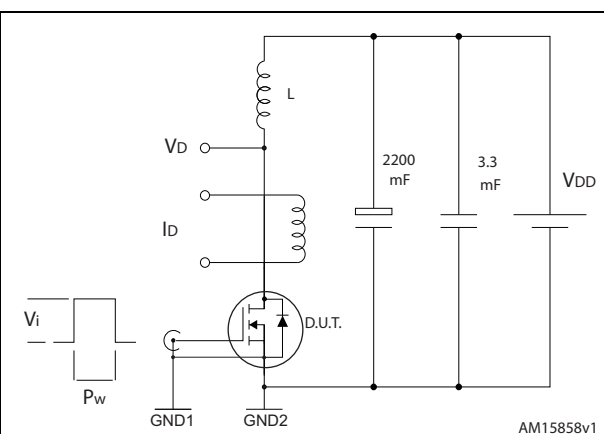


Figure 19. Unclamped inductive waveform

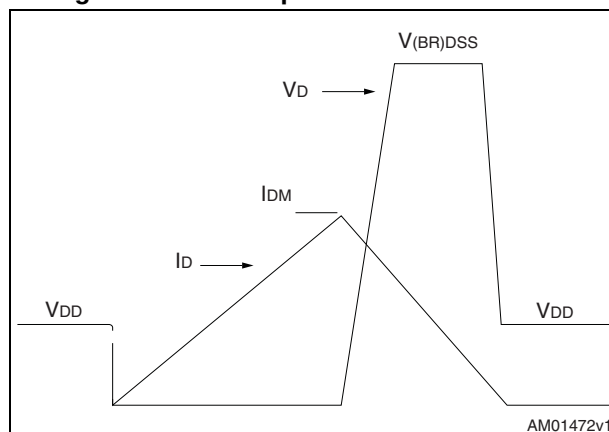
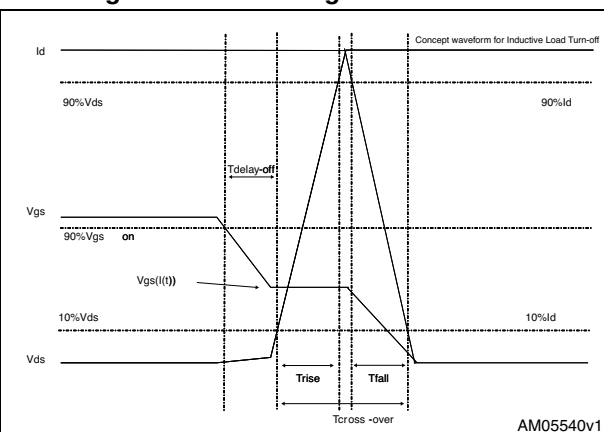


Figure 20. Switching time waveform



## 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](http://www.st.com). ECOPACK® is an ST trademark.

Figure 21. TO247-4 drawing

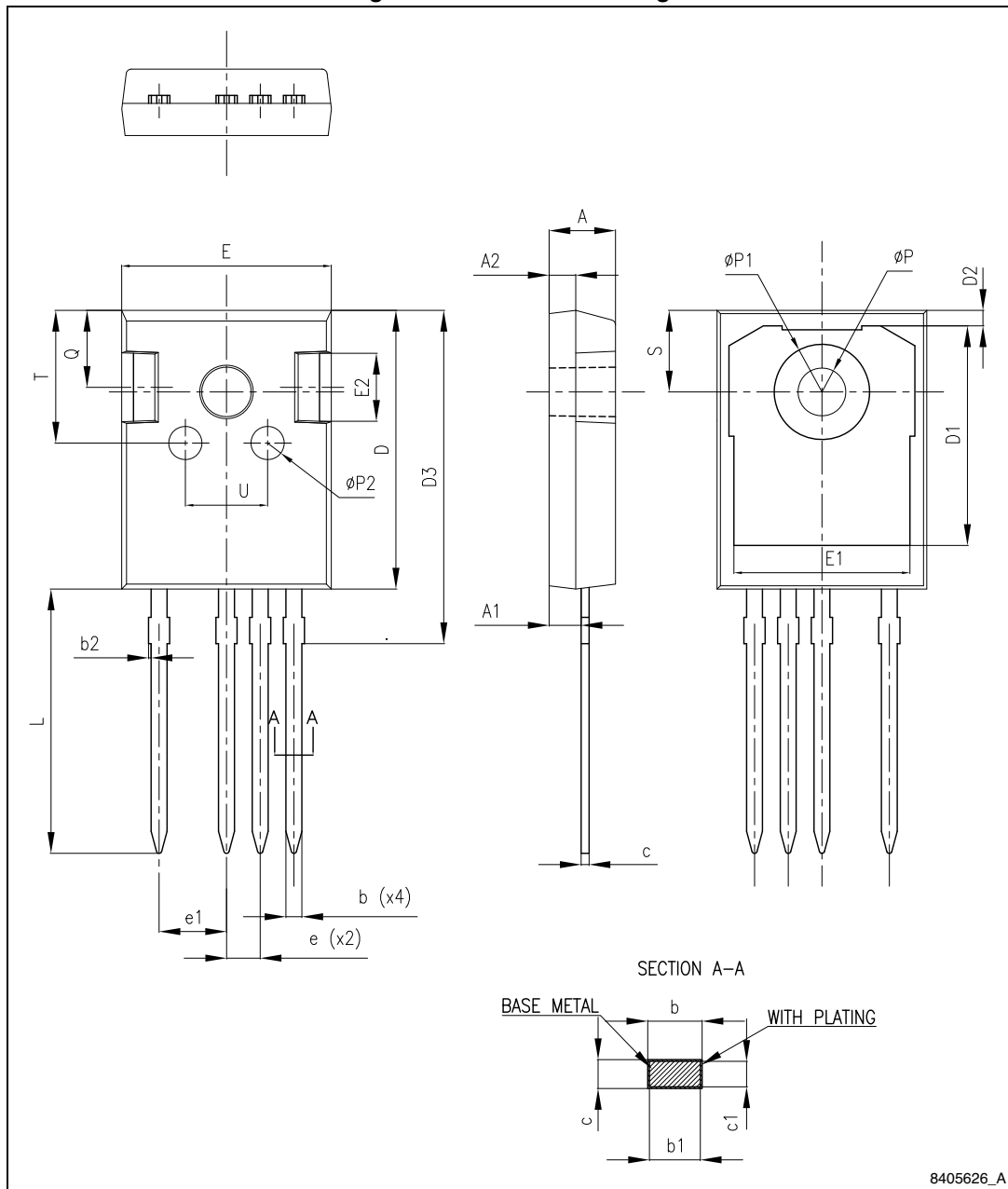


Table 8. TO247-4 mechanical data

| 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  |       | 1.29  |
| b1   | 1.15  | 1.20  | 1.25  |
| b2   | 0     |       | 0.20  |
| c    | 0.59  |       | 0.66  |
| c1   | 0.58  | 0.60  | 0.62  |
| D    | 20.90 | 21.00 | 21.10 |
| D1   | 16.25 | 16.55 | 16.85 |
| D2   | 1.05  | 1.20  | 1.35  |
| D3   | 24.97 | 25.12 | 25.27 |
| E    | 15.70 | 15.80 | 15.90 |
| E1   | 13.10 | 13.30 | 13.50 |
| E2   | 4.90  | 5.00  | 5.10  |
| E3   | 2.40  | 2.50  | 2.60  |
| e    | 2.44  | 2.54  | 2.64  |
| e1   | 4.98  | 5.08  | 5.18  |
| L    | 19.80 | 19.92 | 20.10 |
| P    | 3.50  | 3.60  | 3.70  |
| P1   |       |       | 7.40  |
| P2   | 2.40  | 2.50  | 2.60  |
| Q    | 5.60  |       | 6.00  |
| S    |       | 6.15  |       |
| T    | 9.80  |       | 10.20 |
| U    | 6.00  |       | 6.40  |

## 5 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes                                                       |
|-------------|----------|---------------------------------------------------------------|
| 28-Jun-2013 | 1        | Initial release.                                              |
| 17-Jan-2014 | 2        | Document status promoted from preliminary to production data. |

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