

## N-channel 600 V, 85 mΩ typ., 30 A MDmesh™ M6 Power MOSFETs in TO-220 and TO-247 packages

Datasheet - production data

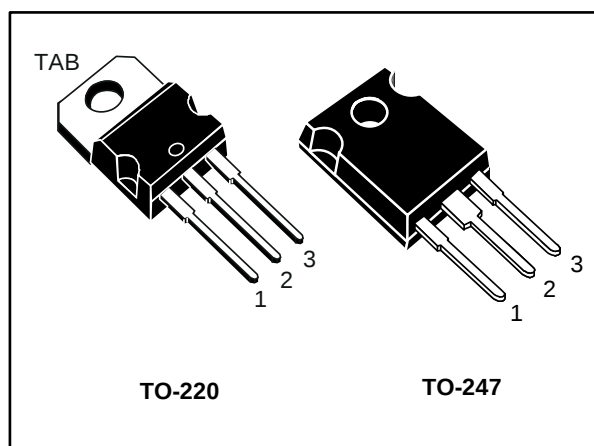
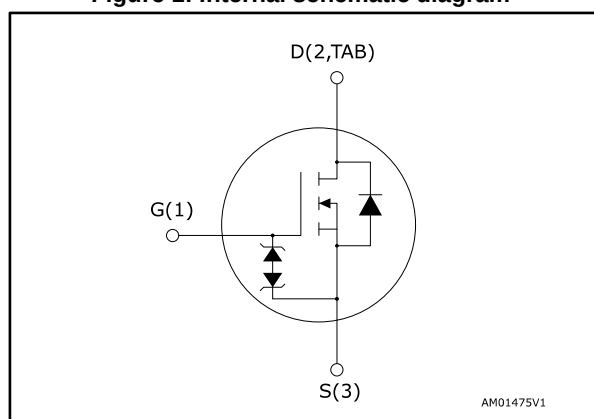


Figure 1: Internal schematic diagram



### Features

| Order code | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|------------|-----------------|--------------------------|----------------|
| STP36N60M6 | 600 V           | 99 mΩ                    | 30 A           |
| STW36N60M6 |                 |                          |                |

- Reduced switching losses
- Lower R<sub>DS(on)</sub> x area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

The new MDmesh™ M6 technology incorporates the most recent advancements to the well-known and consolidated MDmesh family of SJ MOSFETs. STMicroelectronics builds on the previous generation of MDmesh devices through its new M6 technology, which combines excellent R<sub>DS(on)</sub> \* area improvement with one of the most effective switching behaviors available, as well as a user-friendly experience for maximum end-application efficiency.

Table 1: Device summary

| Order code | Marking | Package | Packaging |
|------------|---------|---------|-----------|
| STP36N60M6 | 36N60M6 | TO-220  | Tube      |
| STW36N60M6 |         | TO-247  |           |

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# 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 $T_C = 25\text{ }^{\circ}\text{C}$  | 30         | A                  |
| $I_D$         | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 19         | A                  |
| $I_D^{(1)}$   | Drain current (pulsed)                                            | 102        | A                  |
| $P_{TOT}$     | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 208        | W                  |
| $dv/dt^{(2)}$ | Peak diode recovery voltage slope                                 | 15         | V/ns               |
| $dv/dt^{(3)}$ | MOSFET $dv/dt$ ruggedness                                         | 50         | V/ns               |
| $T_{stg}$     | Storage temperature range                                         | -55 to 150 | $^{\circ}\text{C}$ |
| $T_j$         | Operating junction temperature range                              |            |                    |

**Notes:**

(1) Pulse width limited by safe operating area.

(2)  $I_{SD} \leq 30\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS(\text{peak})} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .

(3)  $V_{DS} \leq 480\text{ V}$

Table 3: Thermal data

| Symbol         | Parameter                           | Value  |        | Unit                        |
|----------------|-------------------------------------|--------|--------|-----------------------------|
|                |                                     | TO-220 | TO-247 |                             |
| $R_{thj-case}$ | Thermal resistance junction-case    | 0.6    |        | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 62.5   | 50     | $^{\circ}\text{C}/\text{W}$ |

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                              | Value | Unit |
|----------|------------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )                                   | 5     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 750   | mJ   |

## 2 Electrical characteristics

$T_C = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

**Table 5: On/off states**

| Symbol        | Parameter                         | Test conditions                                                                                         | Min. | Typ. | Max.    | Unit          |
|---------------|-----------------------------------|---------------------------------------------------------------------------------------------------------|------|------|---------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                                             | 600  |      |         | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$                                                         |      |      | 1       | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ ,<br>$T_C = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 100     | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$                                                      |      |      | $\pm 5$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                      | 3.25 | 4    | 4.75    | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 15\text{ A}$                                                            |      | 85   | 99      | m $\Omega$    |

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

**Table 6: Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                                                    | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0\text{ V}$                                                                                            | -    | 1960 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                                                    | -    | 93   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                                                    | -    | 6    | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                        | -    | 332  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$                                                                                                                            | -    | 1.6  | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 30\text{ A}$ ,<br>$V_{GS} = 0\text{ to }10\text{ V}$<br>(see <a href="#">Figure 17: "Test circuit for gate charge behavior"</a> ) | -    | 44.3 | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                                                    | -    | 10.1 | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                                                    | -    | 25   | -    | nC       |

**Notes:**

<sup>(1)</sup> $C_{oss\text{ eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

Table 7: Switching times

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                                                                    | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 15\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 18: "Test circuit for inductive load switching and diode recovery times"</a> and <a href="#">Figure 21: "Switching time waveform"</a> ) | -    | 15.2 | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                                    | -    | 5.3  | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                                                                                                                                                    | -    | 50.2 | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                                    | -    | 7.3  | -    | ns   |

Table 8: Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                                       | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                                       | -    |      | 30   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                                       | -    |      | 102  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 30\text{ A}$                                                                                                                                                                                        | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$<br>(see <a href="#">Figure 18: "Test circuit for inductive load switching and diode recovery times"</a> )                                     | -    | 340  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                       | -    | 5.3  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                       | -    | 31   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 18: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 430  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                       | -    | 7.7  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                       | -    | 36   |      | A             |

**Notes:**<sup>(1)</sup>Pulse width is limited by safe operating area.<sup>(2)</sup>Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2: Safe operating area for TO-220

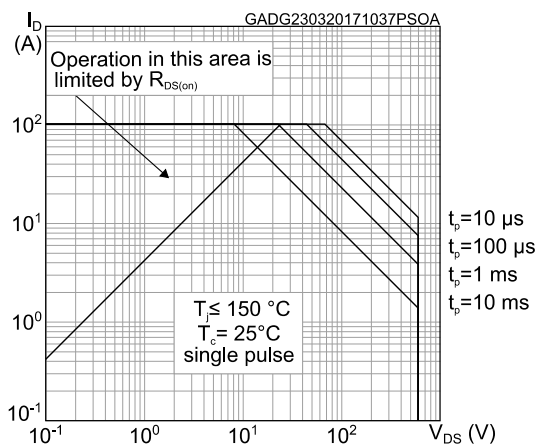


Figure 3: Thermal impedance for TO-220

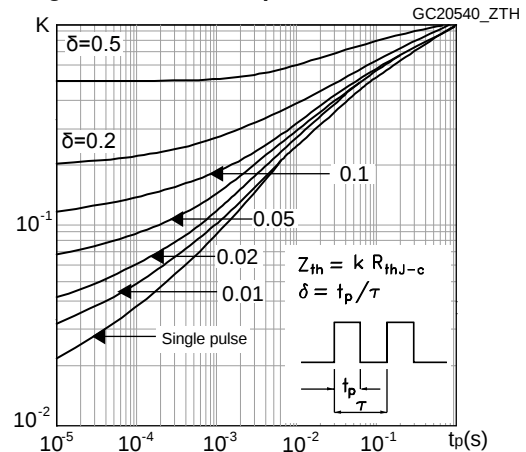


Figure 4: Safe operating area for TO-247

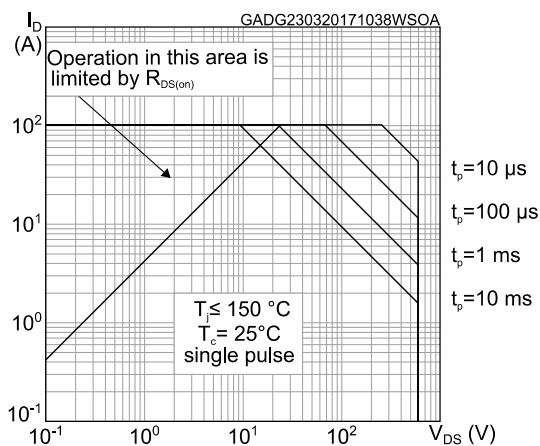


Figure 5: Thermal impedance for TO-247

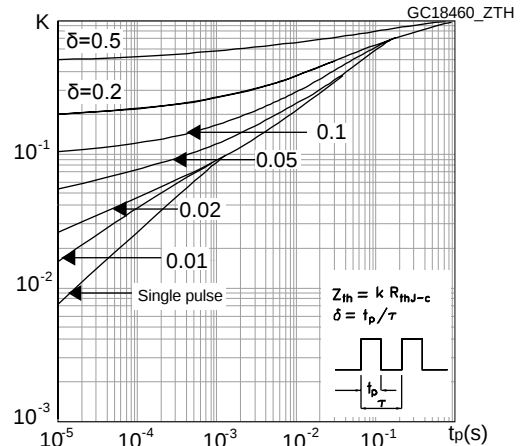


Figure 6: Output characteristics

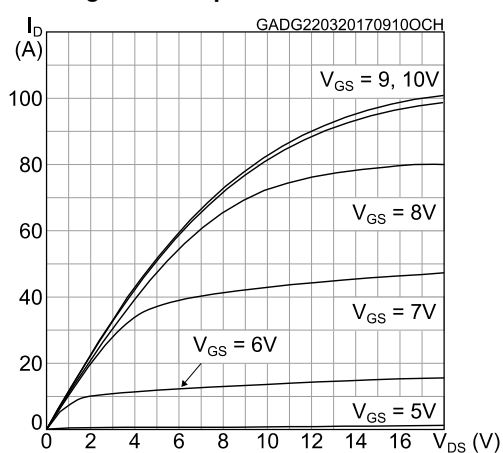


Figure 7: Transfer characteristics

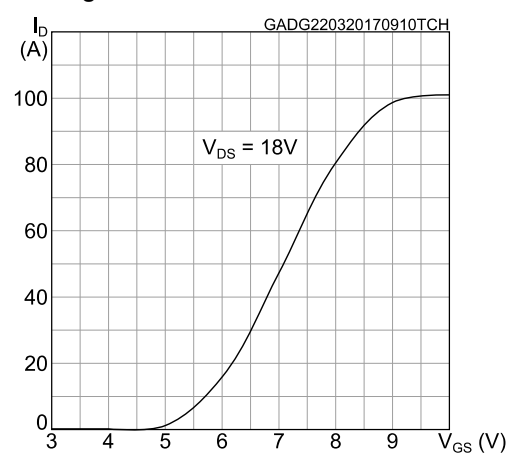


Figure 8: Gate charge vs gate-source voltage

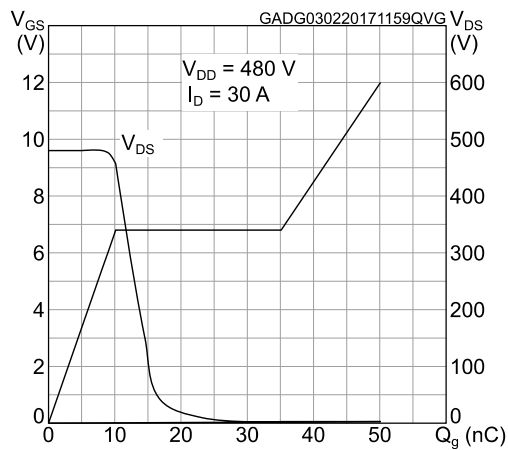


Figure 9: Static drain-source on-resistance

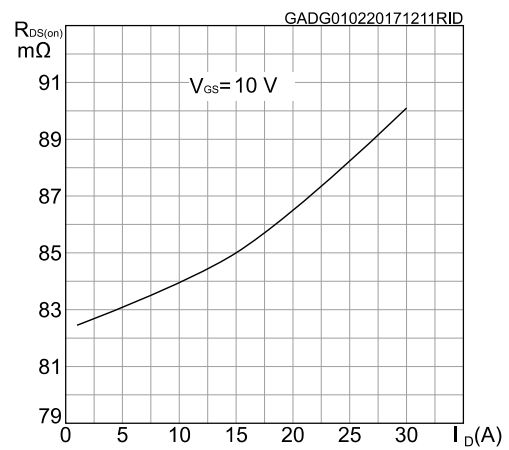


Figure 10: Capacitance variations

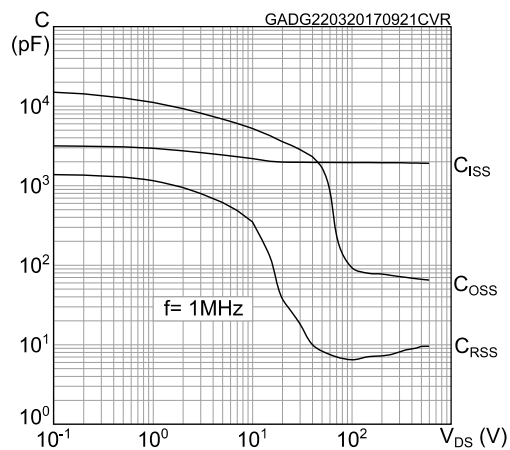


Figure 11: Normalized gate threshold voltage vs temperature

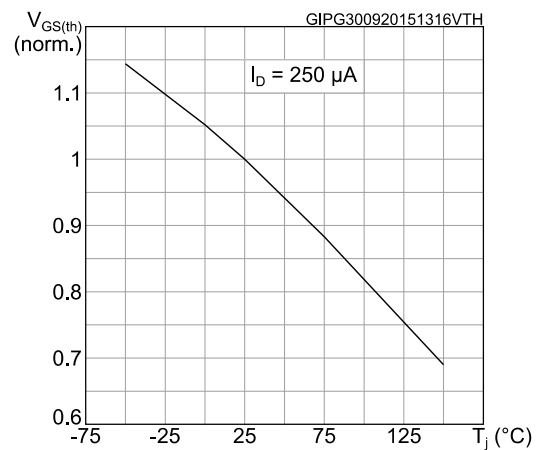


Figure 12: Normalized on-resistance vs temperature

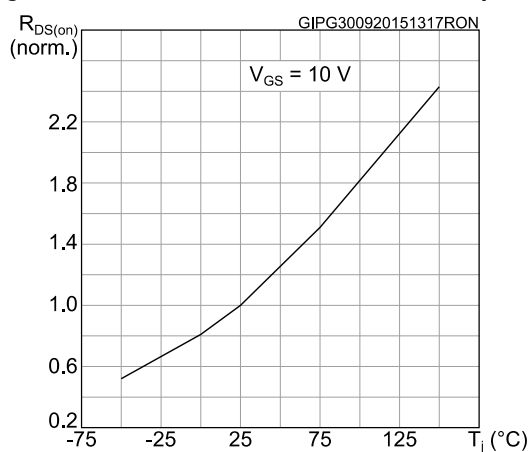
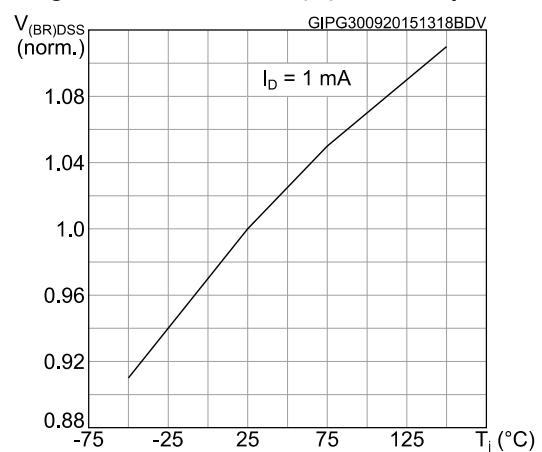
Figure 13: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 14: Output capacitance stored energy

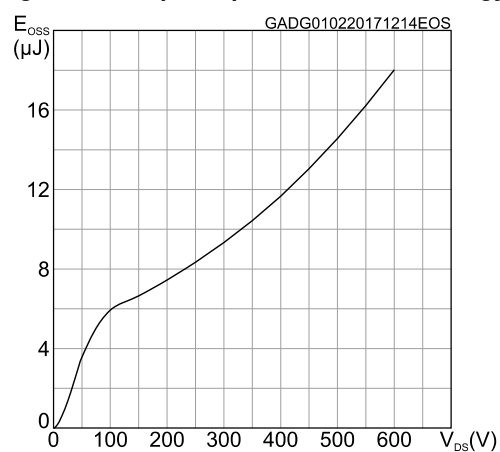
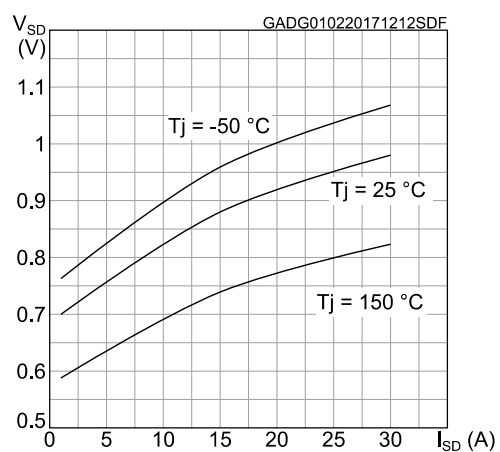
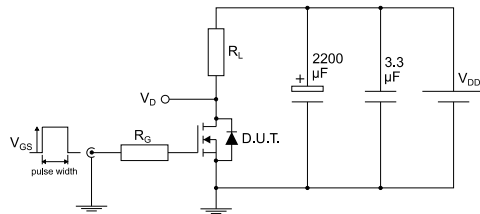


Figure 15: Source-drain diode forward characteristics



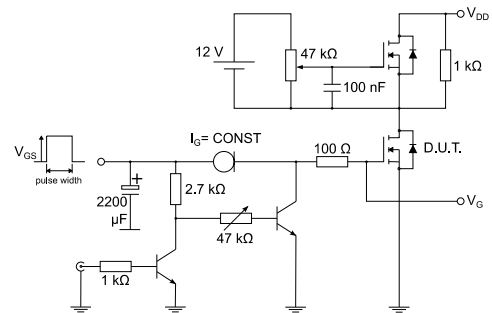
### 3 Test circuits

**Figure 16: Test circuit for resistive load switching times**



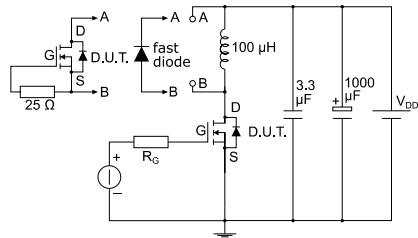
AM01468v1

**Figure 17: Test circuit for gate charge behavior**



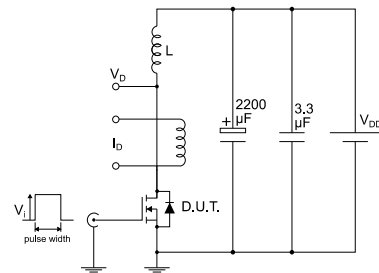
AM01469v1

**Figure 18: Test circuit for inductive load switching and diode recovery times**



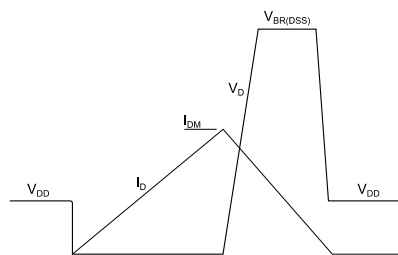
AM01470v1

**Figure 19: Unclamped inductive load test circuit**



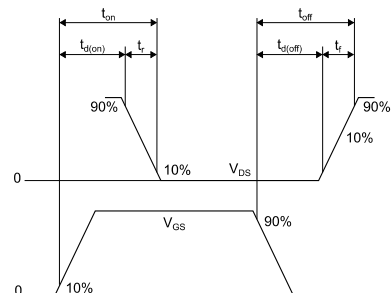
AM01471v1

**Figure 20: Unclamped inductive waveform**



AM01472v1

**Figure 21: Switching time waveform**



AM01473v1

## 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-220 type A package information

Figure 22: TO-220 type A package outline

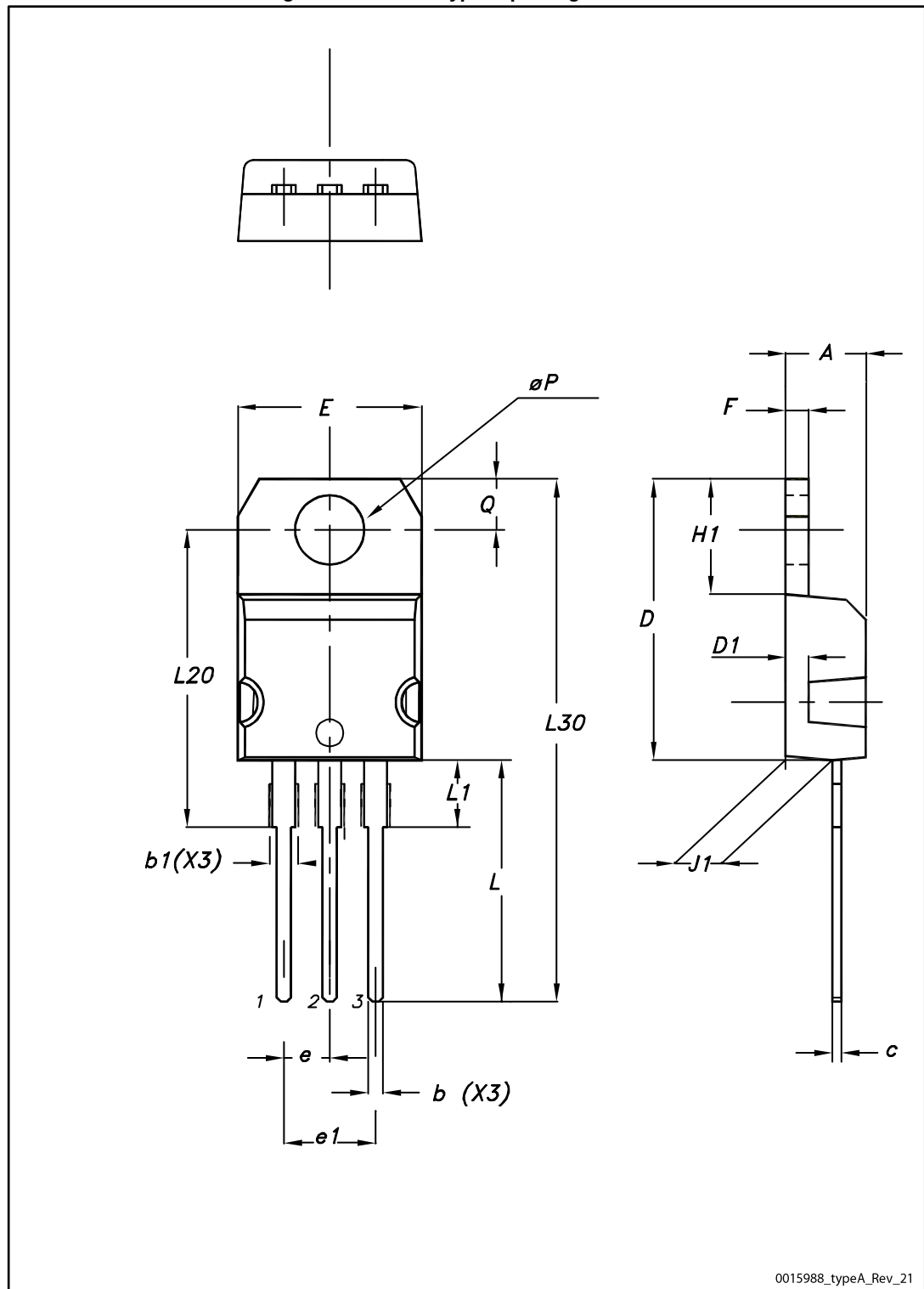


Table 9: TO-220 type A mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.55  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10.00 |       | 10.40 |
| e    | 2.40  |       | 2.70  |
| e1   | 4.95  |       | 5.15  |
| F    | 1.23  |       | 1.32  |
| H1   | 6.20  |       | 6.60  |
| J1   | 2.40  |       | 2.72  |
| L    | 13.00 |       | 14.00 |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| øP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

## 4.2 TO-247 package information

Figure 23: TO-247 package outline

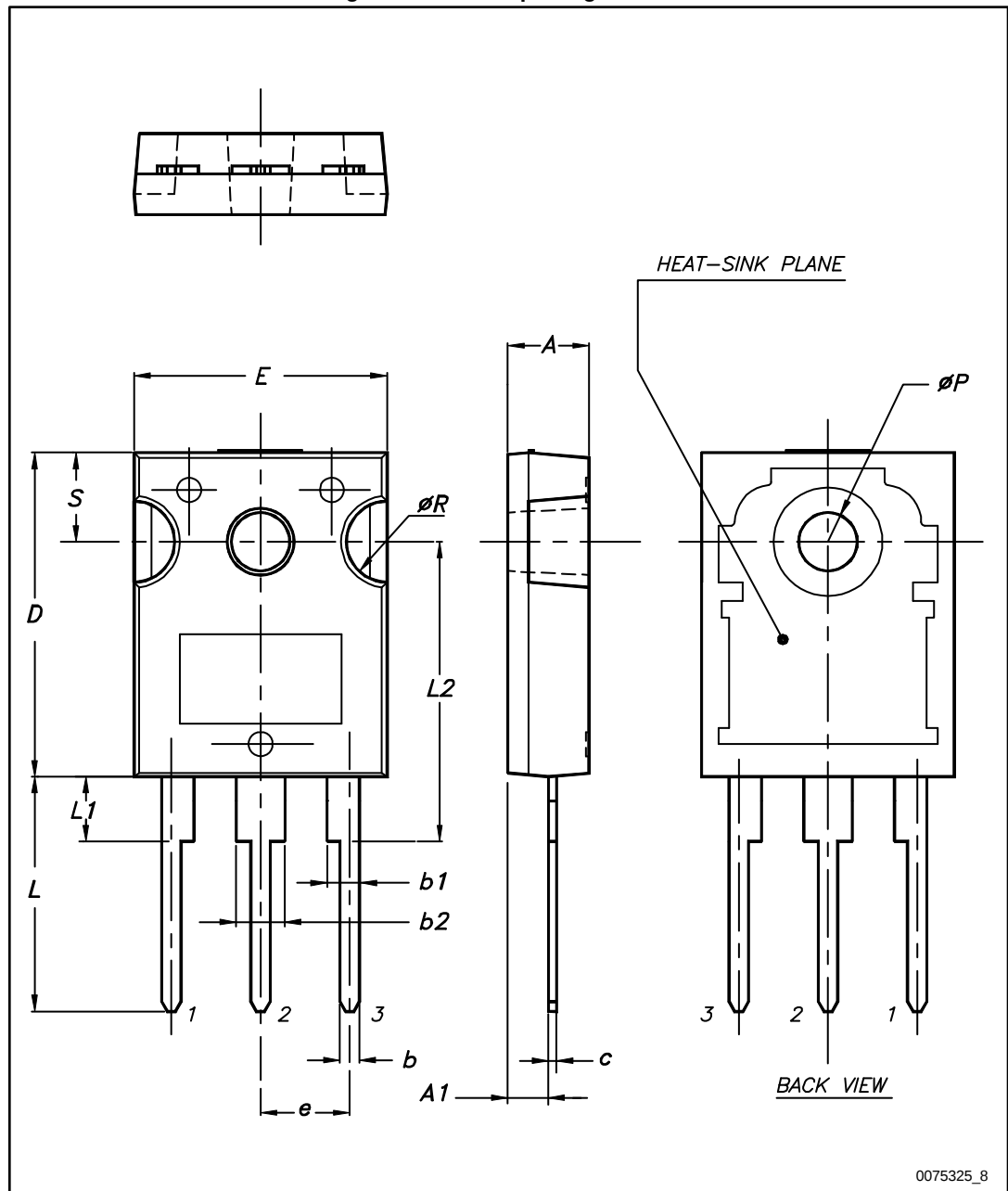


Table 10: TO-247 package mechanical data

| 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  |

## 5 Revision history

**Table 11: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                     |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 06-Oct-2015 | 1        | First release                                                                                                                                                                               |
| 14-Oct-2015 | 2        | Updated: $V_{DD}$ value in <i>Table 8: "Source drain diode"</i><br>Minor text changes                                                                                                       |
| 27-Mar-2017 | 3        | Updated <i>Table 2: "Absolute maximum ratings"</i> .<br>Updated <i>Section 2: "Electrical characteristics"</i> .<br>Updated <i>Section 4: "Package information"</i> .<br>Minor text changes |

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