

N-channel 600 V, 0.150  $\Omega$  typ., 20 A MDmesh™ M2 EP  
Power MOSFETs in TO-220 and TO-247 packages

Datasheet - production data

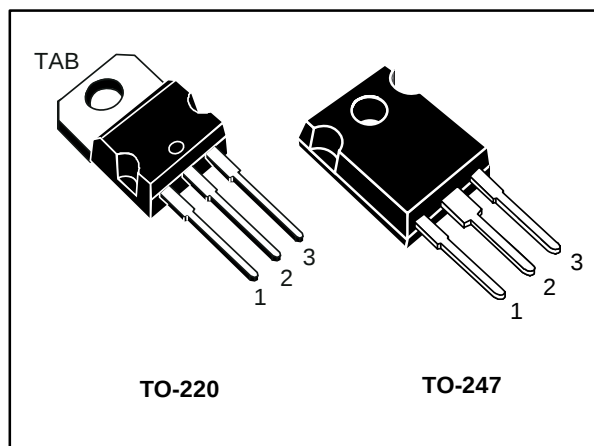
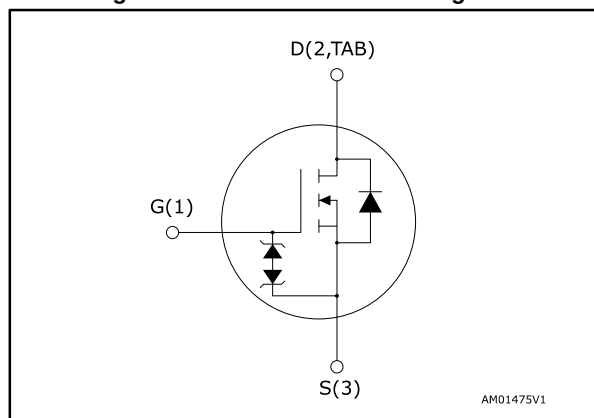


Figure 1: Internal schematic diagram



## Features

| Order code    | V <sub>DS</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> |
|---------------|-----------------|-------------------------|----------------|
| STP27N60M2-EP | 600 V           | 0.163 $\Omega$          | 20 A           |
| STW27N60M2-EP | 600 V           | 0.163 $\Omega$          | 20 A           |

- Extremely low gate charge
- Excellent output capacitance (C<sub>oss</sub>) profile
- Very low turn-off switching losses
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications
- Tailored for very high frequency converters (f > 150 kHz)

## Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 EP enhanced performance technology. Thanks to their strip layout and an improved vertical structure, these devices exhibit low on-resistance, optimized switching characteristics with very low turn-off switching losses, rendering them suitable for the most demanding very high frequency converters.

Table 1: Device summary

| Order code    | Marking   | Package | Packaging |
|---------------|-----------|---------|-----------|
| STP27N60M2-EP | 27N60M2EP | TO-220  | Tube      |
| STW27N60M2-EP |           | TO-247  |           |

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## Contents

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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 $T_C = 25\text{ }^{\circ}\text{C}$  | 20          | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 13          | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                            | 80          | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 170         | 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                                               | - 55 to 150 | $^{\circ}\text{C}$ |
| $T_j$          | Operating junction temperature                                    |             |                    |

**Notes:**

<sup>(1)</sup>Pulse width limited by safe operating area.

<sup>(2)</sup> $I_{SD} \leq 20\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS(\text{peak})} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .

<sup>(3)</sup> $V_{DS} \leq 480\text{ V}$

Table 3: Thermal data

| Symbol                | Parameter                               | Value  |        | Unit                        |
|-----------------------|-----------------------------------------|--------|--------|-----------------------------|
|                       |                                         | TO-220 | TO-247 |                             |
| $R_{thj\text{-case}}$ | Thermal resistance junction-case max    | 0.74   |        | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj\text{-amb}}$  | Thermal resistance junction-ambient max | 62.5   | 50     | $^{\circ}\text{C}/\text{W}$ |

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                              | Value | Unit |
|----------|------------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetetive or not repetetive (pulse width limited by $T_{j\text{max}}$ )                            | 3.6   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 260   | 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>$T_C = 125\text{ }^{\circ}\text{C}$ |      |       | 100      | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$                                       |      |       | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                       | 2    | 3     | 4        | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 10\text{ A}$                                             |      | 0.150 | 0.163    | $\Omega$      |

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>$V_{GS} = 0\text{ V}$                                                                             | -    | 1320 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                                     | -    | 70   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                                     | -    | 1    | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                         | -    | 146  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$                                                                                                             | -    | 4    | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17: "Test circuit for gate charge behavior"</a> ) | -    | 33   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                                     | -    | 5.2  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                                     | -    | 16   | -    | 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  | $V_{DD} = 300\text{ V}$ , $I_D = 10\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 21: "Switching time waveform"</a> ) | -    | 13.4 | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                    | -    | 8.1  | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                                                                                                                                    | -    | 55.6 | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                    | -    | 6.3  | -    | ns   |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                            | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                            | -    |      | 20   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                            | -    |      | 80   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 20\text{ A}$                                                                                                                                             | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 21: "Switching time waveform"</a> )                                        | -    | 271  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                            | -    | 3.44 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                            | -    | 25.4 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 21: "Switching time waveform"</a> ) | -    | 352  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                            | -    | 4.82 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                            | -    | 27.4 |      | 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

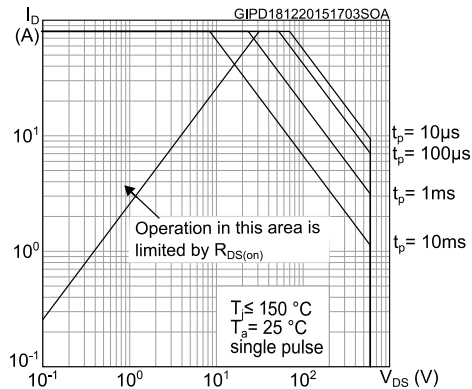


Figure 3: Thermal impedance for TO-220

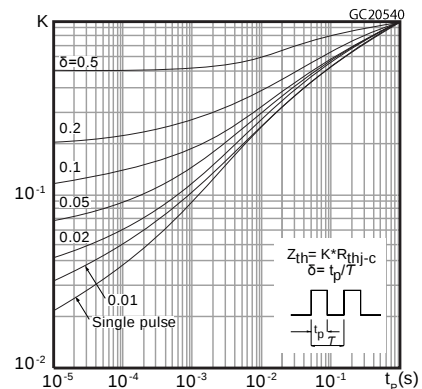


Figure 4: Safe operating area for TO-247

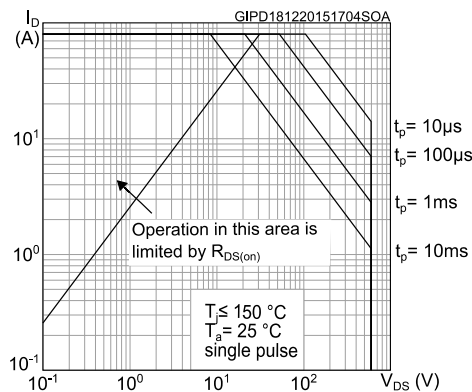


Figure 5: Thermal impedance for TO-247

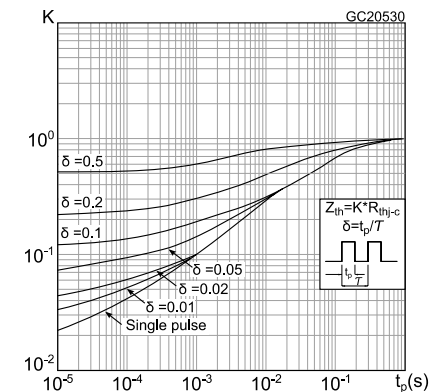


Figure 6: Output characteristics

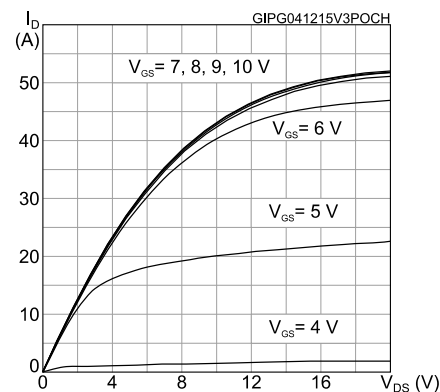


Figure 7: Transfer characteristics

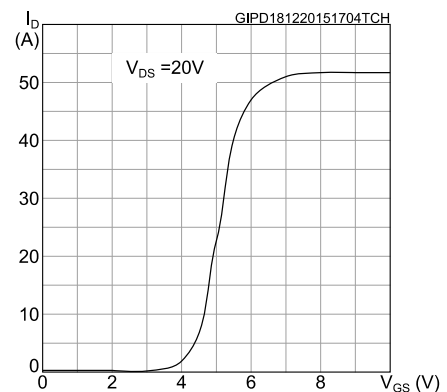


Figure 8: Gate charge vs gate-source voltage

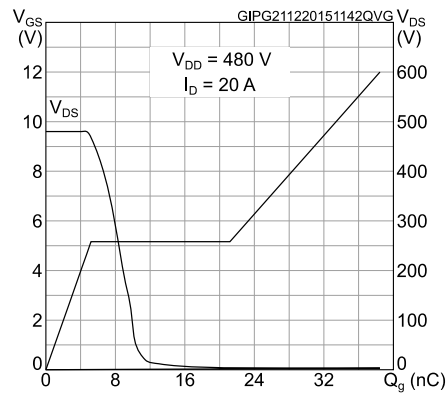


Figure 9: Static drain-source on-resistance

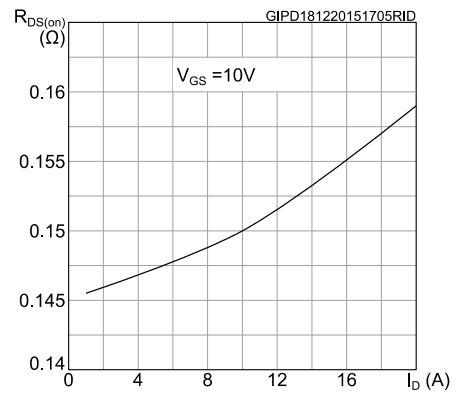


Figure 10: Capacitance variations

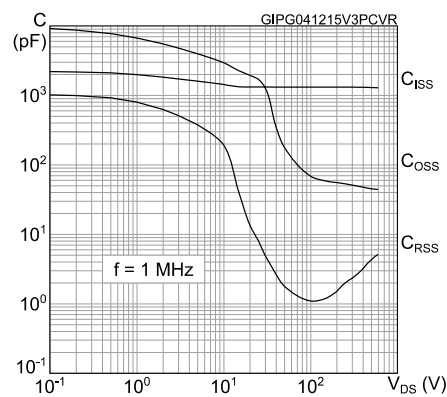


Figure 11: Output capacitance stored energy

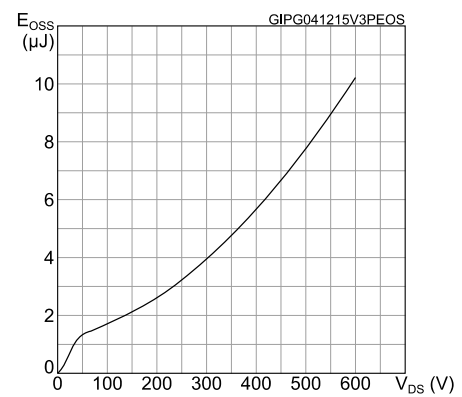
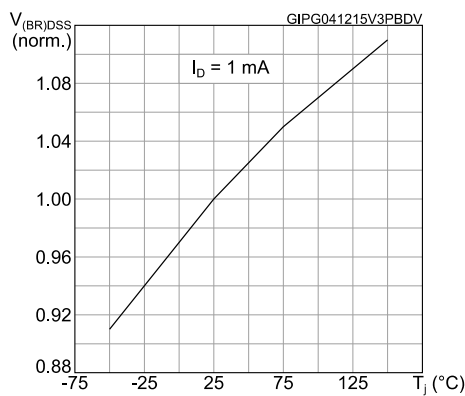
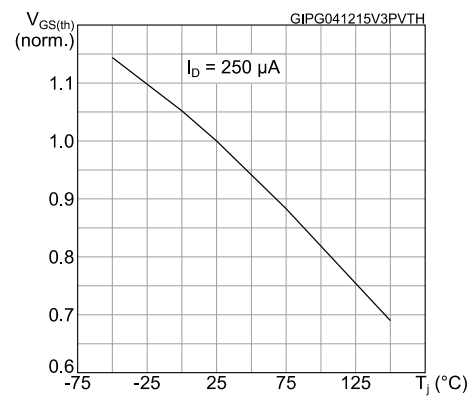
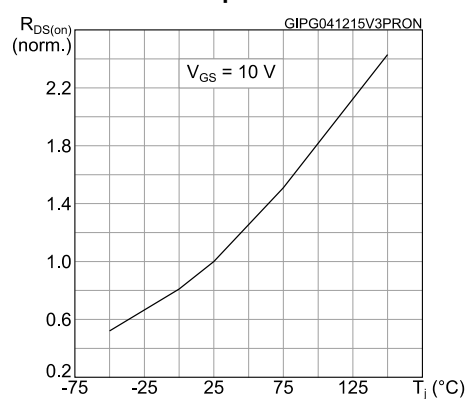
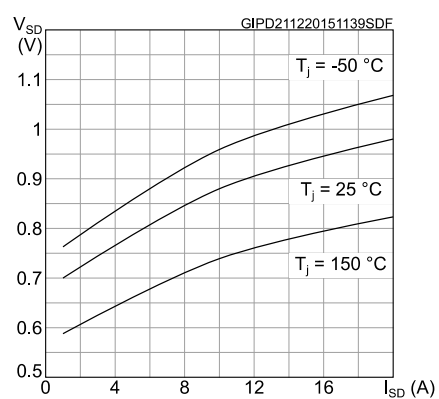
Figure 12: Normalized  $V_{(BR)DSS}$  vs temperature

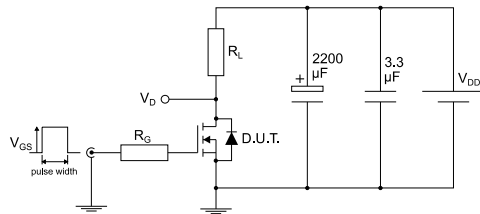
Figure 13: Normalized gate threshold voltage vs temperature



**Figure 14: Normalized on-resistance vs temperature****Figure 15: Source-drain diode forward characteristics**

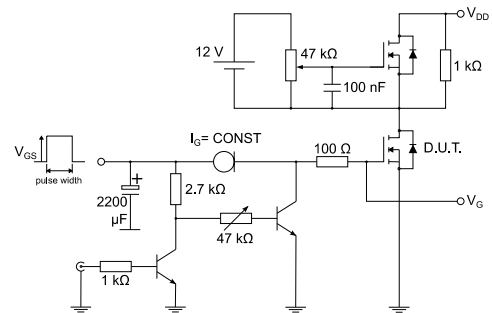
### 3 Test circuits

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



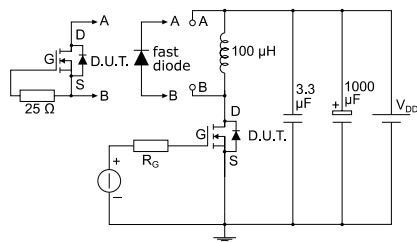
AM01468v1

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



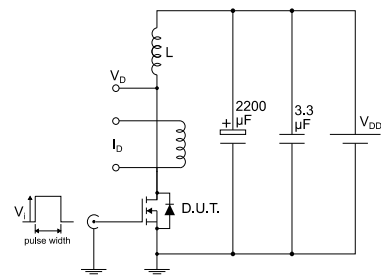
AM01469v1

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



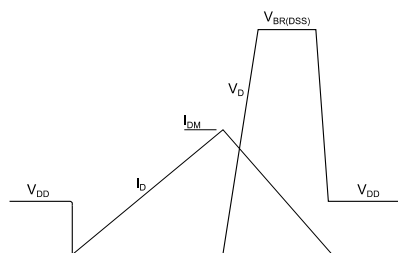
AM01470v1

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



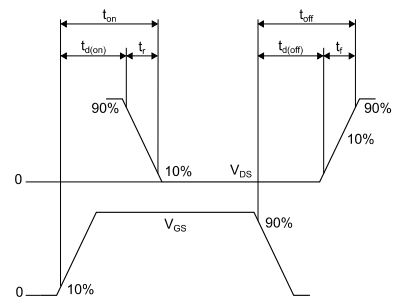
AM01471v1

**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

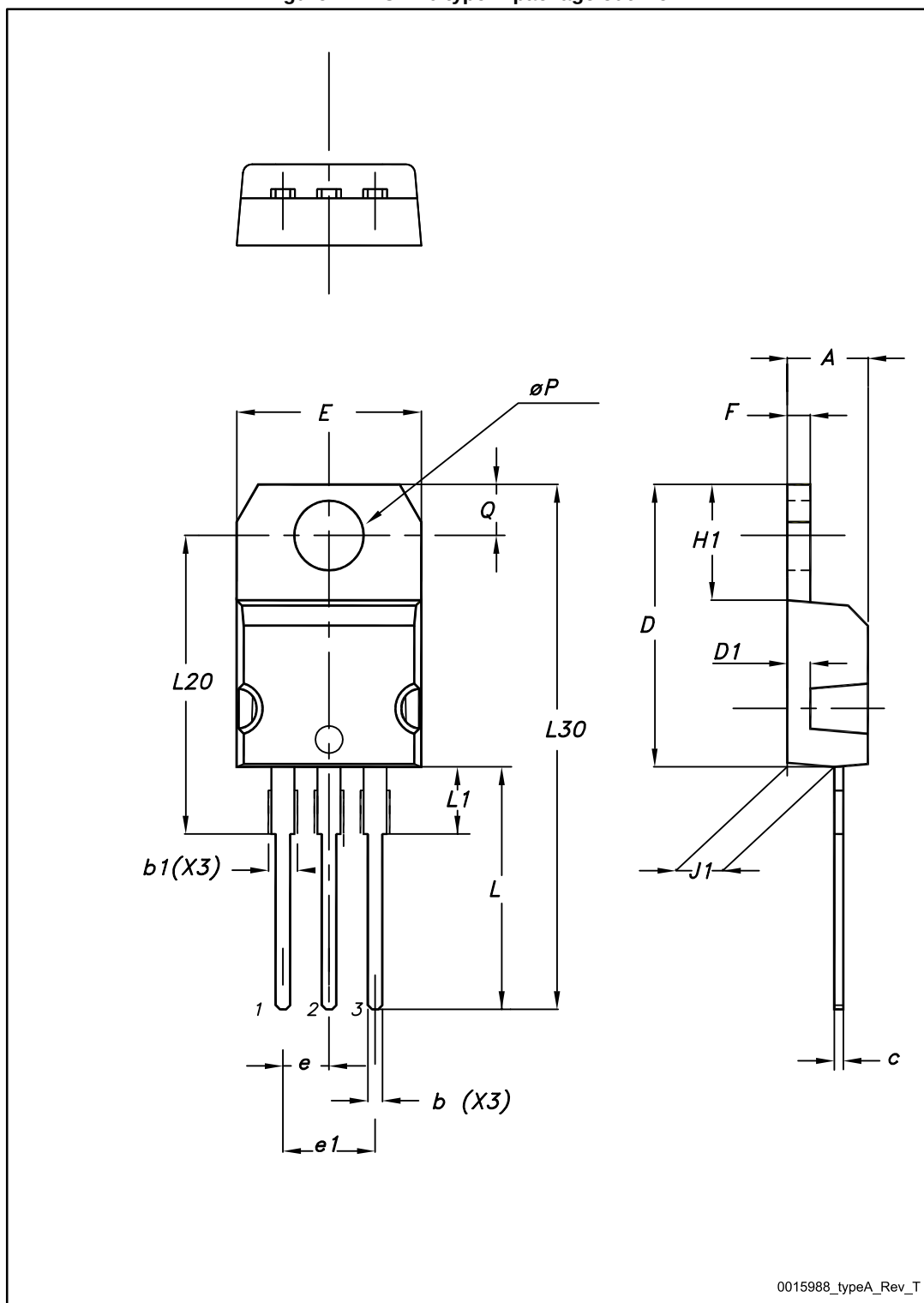


Table 9: TO-220 type A mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 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    |       | 14    |
| 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

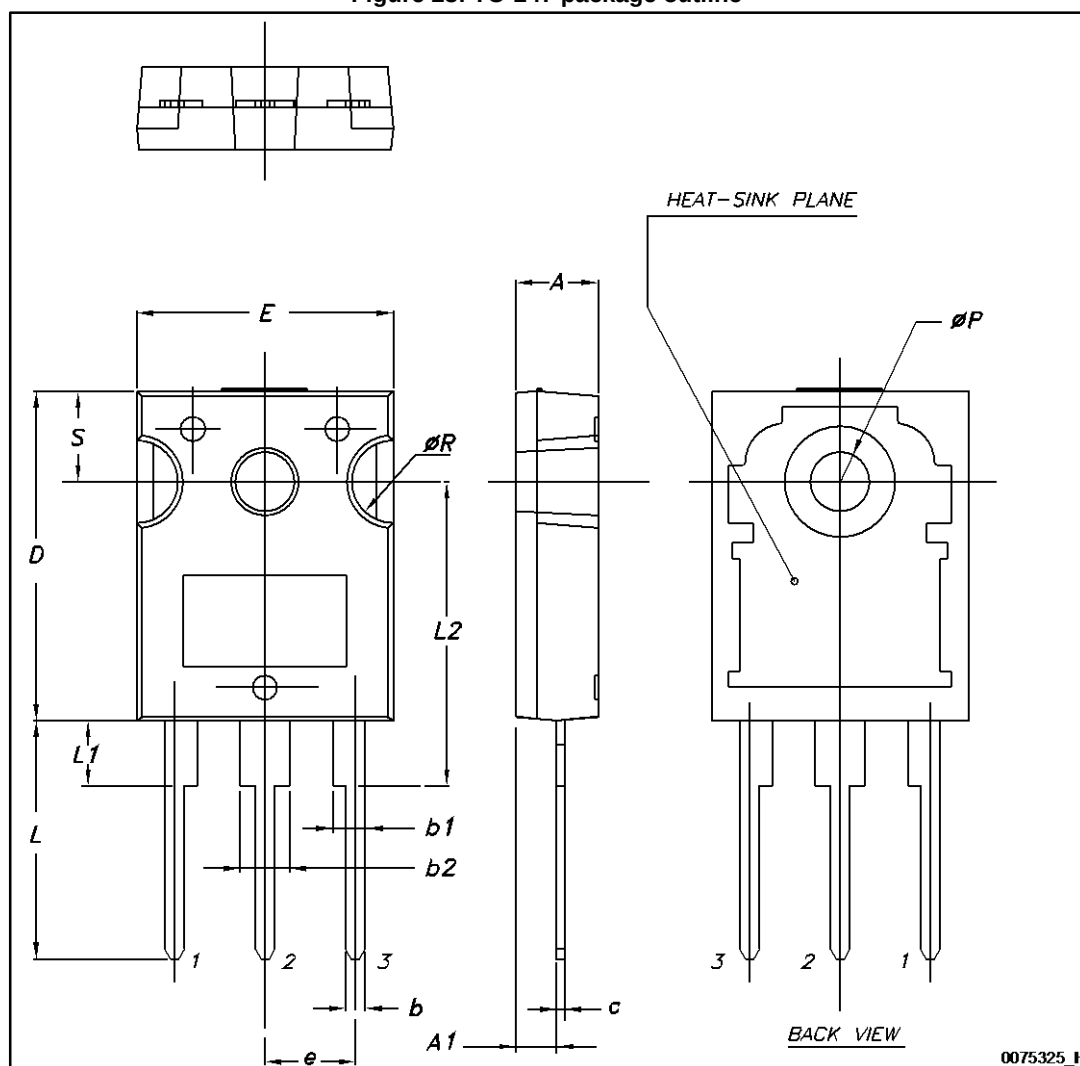


Table 10: TO-247 package mechanical data

| 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        |
|-------------|----------|----------------|
| 15-Dec-2015 | 1        | First release. |

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